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(See full list in Appendix 4)

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An aerial photograph of a coastal region, possibly a bay or estuary, with a grid of dashed white lines overlaid. A large, solid red rectangular box is centered horizontally across the middle of the image. Inside this box, the word "ACKNOWLEDGEMENTS" is written in white, bold, uppercase letters. In the bottom right corner of the image, there is a small white box containing a scale bar with the text "500 m" and "2000 ft".

ACKNOWLEDGEMENTS

500 m
2000 ft

ACKNOWLEDGEMENTS

To all the institutions that co-created MapBiomas Alerta and to all the analysts who worked tirelessly to evaluate tens of thousands of deforestation alerts – especially those who coordinated the work on the biomes: Eduardo Vélez, Natalia Crusco, Nerivaldo Afonso, Eduardo Rosa, Joaquim Pereira, Roberta Rocha, Larissa Amorim, and Lana Teixeira. All member institutions and analysts on the teams are listed in Appendix 4 and in <http://alerta.mapbiomas.org/team>.

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To Instituto Arapyaú and the recently created IAMap (MapBiomas Support Institute), for the crucial institutional, administrative, legal and financial support in organizing the MapBiomas network.

An aerial photograph of a coastal region, possibly a bay or estuary, with a white grid overlay. The land is outlined in white, and the water is a darker grey. A large, dark red rectangular box is centered over the image, containing the word "ABBREVIATIONS" in white, bold, sans-serif capital letters.

ABBREVIATIONS

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ABBREVIATIONS

ACPs	Public Civil Actions
ADEMA	State Administration of the Environment of Sergipe
APA	Environmental Protection Area
API	Application Programming Interface
APNE	Northeast Plant Association
APP	Permanent preservation area
ASV	Vegetation Suppression Authorization
BPAmb-FV	Green Force Environmental Police Battalion
BPMPA	Military Police Battalion for Environmental Protection
CAR	Rural Environmental Registry
CIFF	Children’s Investment Fund Foundation
CIMAM	Integrated Environmental Monitoring Center
CLUA	Climate and Land Use Alliance
CNAL	National Council for the Legal Amazon
CNUC	National Registry of Conservation Units
CPRH	State Agency for the Environment
CRQ	Remnant Quilombo Communities
DETER	Real Time Deforestation Detection System
ESEC	Ecological Station
FECD	State Force to Combat Deforestation
FEMARH	State Foundation for the Environment and Water Resources of Roraima
FEPAM	State Foundation for Environmental Protection
FES	State Forest
Flona	National Forest
FLOREX	Extractive Forest
Funai	National Foundation for Indigenous Peoples
GEE	Google Earth Engine
GLAD	Global Land Analysis and Discovery of the University of Maryland
GWC	Global Wildlife Conservation

ha*	Hectares
IAT	Water and Land Institute of Paraná
IBAMA	Brazilian Institute for the Environment and Renewable Natural Resources
IBGE	Brazilian Institute of Geography and Statistics
IBRAM	Institute for the Environment and Water Resources of the Federal District
IC	Institute of Criminalistics of the Paraná Scientific Police
ICMBio	Chico Mendes Institute for Biodiversity Conservation
ICS	Climate and Society Institute
ICV	Life Center Institute
ID	Unique Identifier of an Alert
IDAF	Institute of Agricultural and Forestry Defense of Espírito Santo
IDEFLOR-Bio	Institute for Forestry Development and Biodiversity of the State of Pará
IDEMA	Institute for Sustainable Development and Environment of Rio Grande do Norte
IEF	State Forest Institute
IMA	Environmental Institute of Alagoas
IMA	Environmental Institute of Santa Catarina
IMAC	Environmental Institute of Acre
IMASUL	Environmental Institute of Mato Grosso do Sul
IMAZON	Institute of People and Environment of the Amazon
INCRA	National Institute for Colonization and Agrarian Reform
INEA	State Environmental Institute of Rio de Janeiro
INEMA	Institute for the Environment and Water Resources
INPE	National Institute for Space Research
IPAAM	Amazon Environmental Protection Institute
IPAM	Amazon Environmental Research Institute
ISA	Socio-environmental Institute
JAXA	Japan Aerospace Exploration Agency
JICA	Japan International Cooperation Agency

ABREVIATURAS

JJ-FAST	Forest Early Warning System in the Tropics
LAI	Access to Information Law
LAPIG /UFG	Image Processing and Geoprocessing Laboratory at the Federal University of Goiás
LDI	Illegal Deforestation List
MMA	Ministry of Environment and Climate Change
MODIS	Moderate-Resolution Imaging Spectroradiometer
MP	Public Prosecution Service
MPF	Federal Public Prosecution Service
MPMT	Public Prosecution Service of the State of Mato Grosso
MPPR	Public Prosecution Service of Paraná
NATURATINS	Nature Institute of Tocantins
NICFI	Norway's International Climate and Forests Initiative
OEMAs	State Environmental Agencies
PA	Settlement Project
PAF	Forest Settlement Project
PARNA	National Park
PDS	Sustainable Development Project
PES	State Park
PF	Federal Police
PMFS	Sustainable Forest Management Plan
PMMAmb	Environmental Military Police
PRODES	Amazon Deforestation Monitoring Program
PRODES Cerrado	Cerrado Deforestation Monitoring Program
QGIS	Quantum GIS software
RAD	Annual Deforestation Report
RDS	Sustainable Development Reserve
RESEX	Extractive reserve
RL	legal reserve
SAD	Imazon Deforestation Alert System
SAD-Caatinga	Caatinga Biome Deforestation Alert System

SAD Pantanal	Pantanal Biome Deforestation Alert System
SAD-Mata Atlântica	Deforestation Alert System for the Atlantic Forest biome
SCCON	Santiago & Cintra Consultancy
SEDAM	State Secretariat for Environmental Development of Rondônia
SEMA	State Department of the Environment
SEMACE	Superintendência Estadual do Meio Ambiente of the state of Ceará
SEMAD	State Secretariat for the Environment and Sustainable Development
SEMAPI	State Secretariat for the Environment and Indigenous Policies of Acre
SEMAR	State Secretariat for the Environment and Water Resources of Piauí
SFB	Brazilian Forest Service
SIAD	Integrated Deforestation Alert System for the Legal Amazon
SICAR	National Rural Environmental Registry System
SIGEF	Land Management System
SEMIL	State Secretariat for the Environment, Infrastructure and Logistics of São Paulo
SIMLAM	Integrated Environmental Monitoring and Licensing System
SINAFLOR	National System for Controlling the Origin of Forest Products
SIPAM/SAR	Integrated Deforestation Alert System with orbital radar
SIRAD-X	Deforestation Radar Indication System in the Xingu Basin
SIVAM	Amazon Surveillance System
SLAPR	Environmental licensing system for rural properties
SPU	Federal Assets Secretariat
SUDEMA	Paraíba Environmental Administration Superintendence
TCU	Federal Audit Court
TI	Indigenous Land
TNC	The Nature Conservancy
UC	Conservation Unit
UEFS	State University of Feira de Santana
UF	State (Federation Unit)
UFRGS	Federal University of Rio Grande do Sul
WRI	World Resources Institute

An aerial photograph of a coastal region, possibly a bay or estuary, with a white outline of a landmass. A red rectangular overlay is centered on the image, containing the title "EXECUTIVE SUMMARY" in white, bold, sans-serif capital letters. The background is a grayscale aerial view showing water, land, and some structures.

EXECUTIVE SUMMARY

500 m
2000 ft

EXECUTIVE SUMMARY

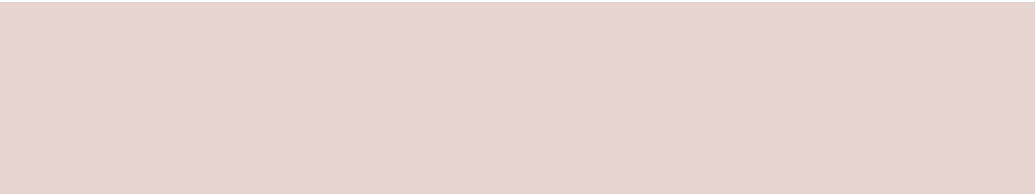
This report analyzes the **deforestation/conversion alerts detected in Brazil in 2022 that were validated and refined using high resolution satellite images by MapBiomass Alerta.**

As part of the multi-institutional MapBiomass initiative (<https://mapbiomas.org/>) involving universities, NGOs and technology companies, the MapBiomass Alerta project aims to contribute to the end of deforestation in Brazil by providing a **system for validating, refining and generating deforestation alert reports automatically across the country** (<http://alerta.mapbiomas.org/>).

In this fourth edition of the Annual Report, the alerts generated by several detection systems were validated and refined using daily satellite images with high spatial resolution (3.7 m). They were: DETER (INPE's Real Time Deforestation Detection System, in the Amazon and Cerrado biomes), SAD (Imazon's Deforestation Alert System for the Amazon), SAD Caatinga (Caatinga Deforestation Alert System, developed by UEFS and Geodatin), GLAD (Global Land Analysis and Discovery of the University of Maryland), SIRAD-X (System for indicating deforestation by radar in the Xingu Basin, in the Amazon and in the Cerrado, developed by ISA), SAD Mata Atlântica (Deforestation Alert Detection System in the Atlantic Forest developed by SOS Mata Atlântica and ArcPlan), SAD Pantanal (Deforestation Alert Detection System in the Pantanal developed by SOS Pantanal and ArcPlan) and SAD Pampa (Pampa Deforestation Alert Detection System, developed by GeoKarten and UFRGS).

For each validated and refined alert, a report is generated with images of before and after deforestation/conversion. Possible intersections with areas of the Rural Environmental Registry (CAR), Land Management System (SIGEF), National System for Controlling the Origin of Forest Products (SINAFLOR), National Registry of Conservation Units (CNUC), Indigenous Lands (FUNAI), and other geographical boundaries (e.g., biomes, states, municipalities, watersheds). In addition, land cover and land use history of the area from the annual maps of MapBiomas Brazil are integrated (Collection 7.1).

In 2022, 76,193 alerts were identified, validated and refined throughout the national territory, totaling 20,572 km² (2,057,251 ha) of deforestation/conversion, a 22.3% increase in the deforested area compared to 2021.



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Of the total deforested in 2022, 58% occurred in the Amazon biome, representing an area of 1,192,635 ha deforested and 62.1% of the total deforestation events across Brazil. The Cerrado biome appears next with 659,670 thousand ha deforested (32.1% of the area and 8.3% of the alerts). The Caatinga had 6.8% of the deforested area, totaling 140,637 ha and 18.4% of the alerts. The Pantanal had 31,211 ha deforested (1.5% of the area), followed by the Atlantic Forest with 30,012 ha deforested (1.5% of the area) and the Pampa with 3,087 ha (0.2%) (Table 1).

The Amazon and Cerrado together accounted for 90.1% of the country's deforested area. When added to the Caatinga, the three biomes accounted for 96.9% of the losses. Up until 2019, only the Cerrado and Amazon had me-

Table 1 Alerts (area and units) by biome and in Brazil in 2019 to 2022

Number of Validated Alerts per year (2019-2022)

BIOME	2019	2020	2021	2022	Total	Share 2022	Variation 2021-2022	Variation 2021-2022
Amazon	46.995	61.222	48.174	47.317	203.708	62,1%	-857	-1,8%
Caatinga	531	5.644	10.621	13.989	30.785	18,4%	3.368	31,7%
Cerrado	7.354	28.759	7.136	6.296	49.545	8,3%	-840	-11,8%
Atlantic Forest	1.387	3.082	5.144	7.905	17.518	10,4%	2.761	53,7%
Pampa	67	105	160	420	752	0,6%	260	162,5%
Pantanal	201	208	292	266	967	0,3%	-26	-8,9%
Total	56.535	99.020	71.527	76.193	303.275	100,0%	4.666	6,5%

Validated Alerts Area by year (2019-2022)

BIOME	2019	2020	2021	2022	Total	Share 2022	Variation 2021-2022	Variation 2021-2022
Amazon	774.135	883.998	1.002.202	1.192.635	3.852.970	58,0%	190.433	19,0%
Caatinga	13.922	67.141	115.069	140.637	336.769	6,8%	25.567	22,2%
Cerrado	408.361	642.494	502.798	659.670	2.213.322	32,1%	156.871	31,2%
Atlantic Forest	10.510	24.239	30.184	30.012	94.944	1,5%	-172	-0,6%
Pampa	646	1.271	2.426	3.087	7.430	0,2%	661	27,2%
Pantanal	13.996	25.962	29.895	31.211	65.949	1,5%	1.315	4,4%
Total	1.221.570	1.645.104	1.682.575	2.057.251	6.606.499	100,0%	374.676	22,3%

thodological approaches for generating alerts adapted to the respective regions. In 2020, SAD Caatinga was developed, as a system adapted to detect deforestation in strongly seasonal dry forests. As a result, the number of alerts detected and validated in the biome increased almost five fold in 2020, during the pilot phase, and almost doubled in 2021 as it was consolidated, with a 22.2% increase in 2022. Testing of the beta phase of SAD Mata Atlântica and SAD Pantanal began in 2021, and doubled the area of deforestation detected that year with GLAD alerts alone. These two new alert detection systems entered the operational phase in 2022.

In the Pampa in 2022, in addition to the data from the Global Land Analysis and Discovery (GLAD), SAD Pampa was used for the first time and in a complementary manner though still adapted for detecting deforestation in forest formations. Compared to 2021, the Pampa biome had a 27% increase in the deforested area. In the other biomes the methods and detection systems remained the same in 2021 and 2022. There-

fore, the increase in the deforested area is closely related to the occurrence of more deforestation events in 2022.

The average size of deforestation events and clearings of more than 100 ha in 2022 also increased, by 14.8% and 19.3% respectively compared to 2021. The largest deforestation detected in 2022 in Brazil (alert code 564317), with 12,272 ha, occurred in the Cerrado biome in the state of Bahia, in the municipality of Formosa do Rio Preto.

Agriculture and cattle ranching accounted for almost 96% of deforestation in Brazil in 2022, consolidating their role as the main driver for the suppression of native vegetation, along with other drivers such as garimpo (placer or artisanal mining), mining, natural causes, urban expansion and others.

In relation to the type of native vegetation, by crossing the deforested area with the MapBiomass land cover and land use map (Collection 7.1), in 2022 there was a predominance of deforestation in the forest formation (64.9%) and in the sa-

vannah formation (31.3%), with the remainder in grassland formation (3.6%).

The state that presented the largest deforested area detected in 2022 was Pará for the fourth consecutive year – loss of 456,702 ha, which represents 22.2% of the total deforested in the country. Amazonas remained in second place, with 274,184 ha deforested, representing 13.3% of the total and with an increase of 37% in the deforested area. Mato Grosso appeared in third, with a loss of 239,144 ha (11.6%), and this year, the state of Bahia, with a 48% growth in the deforested area and 225,151 ha deforested (10.9%) surpassed Maranhão, with 168,446 ha (8.2%). Together, these 5 states accounted for two thirds (66.2%) of deforestation in Brazil in 2022. In 2022, there was growth in the deforested area in 20 states, with two remaining stable (MA and GO) and a drop in five (MS, PB, RN, PR, DF).

Of the 5,570 Brazilian municipalities, 3,471 (62%) had at least one deforestation alert validated in 2022. Of these municipalities that had alerts in 2022,

50 municipalities accounted for half (50.4%) of the total deforested area in Brazil. The municipality of Lábrea, in Amazonas, with 62,419 ha deforested, surpassed the deforested area of the municipality of Altamira in Pará, the deforestation leader in the three previous reports.

Of the total deforested area in the country in 2022, 3.2% are in Conservation Units (UCs) (disregarding APAs), 1.4% in Indigenous Lands (TIs), 0.05% in Remnant Quilombo Communities (CRQ) and 15.2% in rural settlements. In the last four years (from 2019 to 2022), deforestation increased in almost all land categories, with the exception of Indigenous Lands (TIs), which saw a decrease for the period.

In 2022, the average area deforested per day was 5,636.3 hectares – or 234.8 hectares per hour (Table 10). In the Amazon alone, 3,267.5 hectares were deforested per day, or 136.1 hectares per hour, 2.3 hectares per minute, which is equivalent to about 21

trees per second. The Cerrado is in second place with 1,807.3 hectares per day, equivalent to 75.3 ha per hour.

Of the total deforested area in Brazil in 2022, 83% (1,729,099 ha) occurred in properties declared in the CAR. However, this deforestation was verified in only 1.1% of the properties registered in the CAR. When considering the last 4 years, there were 212,884 rural properties that had deforestation alerts detected, which represents 3.1% of the total properties in the CAR.

More than half (**52%**, 39,661 alerts) of all alerts detected **have an overlap of at**

About 98% of the deforestation alerts (89% of the total deforested area) do not have their authorization for the suppression of vegetation registered in SINAFLOR/IBAMA or in the state systems consulted.

least 0.3 ha with areas registered as a Legal Reserve (RL). This represents 34% (699,189 ha) of the total deforested area in the country. All biomes had an increase in the deforested area in the Legal Reserve in 2022 compared to 2021, except for the Cerrado. The number of alerts that overlap with Permanent Preservation Areas (APP) declared in the CAR reached 9% (6,867 alerts) of the total (in terms of area 1.1%, 23,839 ha). **In all biomes, there was an increase in the area deforested in APPs in 2022 when compared to 2021.**

When crossing data for authorized deforestation, not overlapping with Legal Reserve, APP, springs or protected areas (strict protection UCs and TIs), it is observed that only 228 of the 76,193 alerts, that is 0.3% of the total (0.7% in area), did not show any indication of irregularity. **These data point to more than 99% of all deforested land in Brazil in 2022 had at least one indication of irregularity,** considering the available official data.

About 98% of the deforestation alerts (89% of the total deforested area) do not have their authorization for the su-

ppression of vegetation registered in SINAFLOR/IBAMA or in the state systems consulted. Authorization is mandatory for legal activity in Brazil.

The analysis of law enforcement actions carried out by environmental control bodies to curb illegal deforestation indicates that the embargoes and assessments conducted by IBAMA and ICMBio up to May 2023 reached 2.4% of the deforestation alerts and 10.2% of the deforested area identified from 2019 to 2022. When considering the 59 municipalities defined as priorities by the Ministry of the Environment for combating deforestation in the Amazon, this index is a little better: it represents 4.1% of the total alerts and 17.7% of the deforested area.

Based on available data, when adding the actions carried out by federal and state agencies, the number of deforestation alerts detected from 2019 to 2022 with authorizations or enforcement actions rose to 29,370, which represents 9.7% of the total and 35.4% of the deforested area (2.34 million hectares) from 2019 to 2022.

In the period from 2019 to 2022, the states with the highest proportion of deforestation responded to with some type of action (whether authorization, sanctions or embargoes) by environmental agencies and public prosecution services were Espírito Santo (73.7% of alerts in the state), Rio Grande do Sul (55.6%), São Paulo (40.3%), Mato Grosso (37.3%). The states with the lowest performance were Pernambuco (0.8%), Maranhão (1.6%) and Ceará (1.9%).

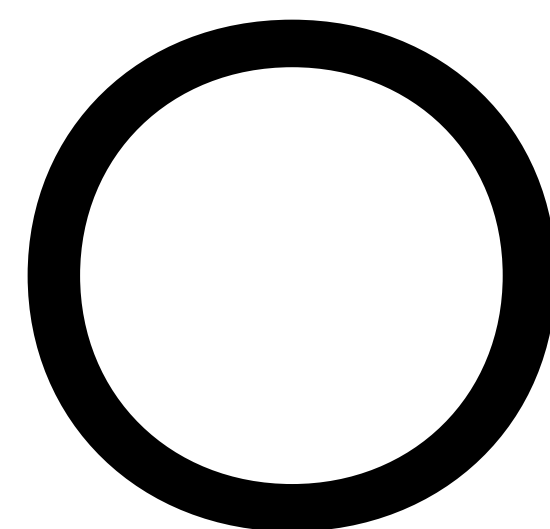
For 2022, more than 100,000 reports were produced with analyses of deforestation alerts and their overlap with different territorial cutouts, in addition to authorizations. All alerts and reports are publicly available and free of charge on the MapBiomias Alerta's platform - <http://alerta.mapbiomas.org>.

This is a contribution from the MapBiomias Project to support public and private institutions in their activities for reducing deforestation and promoting the conservation and sustainable use of the Brazilian territory.

An aerial photograph of a coastal area, possibly a bay or estuary, with a grid of dashed white lines overlaid. A large, solid red rectangle is centered over the image, containing the text '1. INTRODUCTION' in white, bold, sans-serif capital letters. The background shows land with some buildings and vegetation, and water areas. A scale bar is located in the bottom right corner.

1. INTRODUCTION

500 m
2000 ft

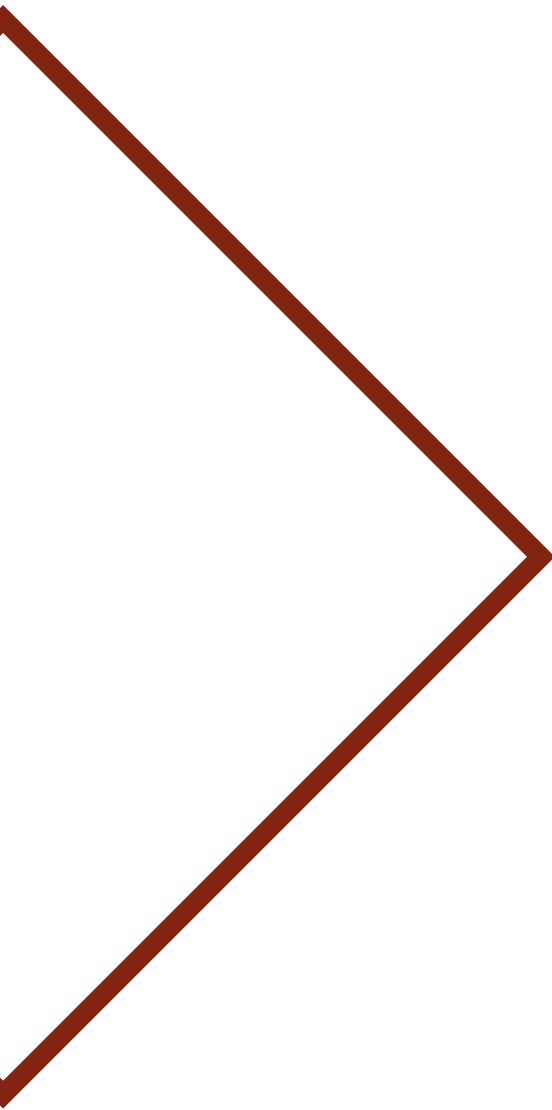


ver the last four years, MapBiomas Alerta has been publishing the Annual Report on Deforestation in Brazil, providing society with transparency and certainty regarding deforestation throughout the Brazilian territory using the best available technology. From 2019 to 2021, and now again for 2022, reports indicate that around 99% of deforestation in Brazil has indications of illegality. To combat illegal deforestation, it is necessary to attack impunity — the risk of being penalized and held accountable for the illegal suppression of native vegetation needs to be real and duly perceived by environmental offenders.

This requires action on three fronts:

- (i) ensure that all deforestation is detected and reported.
- (ii) ensure that all reported deforestation of an illegal nature receives is acted upon in order to hold accountable and punish offenders (e.g., fines, embargoes); and
- (iii) ensure that the violator does not benefit from the illegally deforested area and does receive some type of penalty (e.g., suspension from the CAR, cancellation of land title regularization, exclusion from production chains).

Brazil has a long tradition of monitoring deforestation. In the late 1980s, the Amazon Deforestation Monitoring Program (PRODES) was created at INPE and shortly afterwards, the Atlas of Forest Remains of the Atlantic Forest was created in a partnership between INPE and the SOS Mata Atlântica Foundation. In 2004, INPE launched the Deforestation Detection System in almost Real Time (DETER), a tool that provides monthly information on deforestation in the Amazon. Recently, DETER was



expanded to the Cerrado biome. Since 2006, it has also operated the IMAZON Deforestation Alert System (SAD), covering the Amazon biome. In addition, new SADs were created to fill gaps in monitoring deforestation alerts in other biomes, such as the Caatinga (Geodatin), Pantanal (SOS Pantanal and ArcPlan), Mata Atlântica (SOS Mata Atlântica and ArcPlan) and Pampa (GeoKarten and UFRGS). Currently, there are at least 11 national and international systems that monitor deforestation in Brazil covering different biomes and with varying frequencies and spatial resolutions.

Monitoring is the centerpiece for taking actions to control deforestation and to restrict it only to areas that have been specifically authorized through the proper environmental licensing process.

Although monitoring has existed for a long time, actions taken to prevent, control or penalize illegal deforestation in

all Brazilian biomes are still limited. IBAMA itself estimated that less than 1% of the deforested areas in the Amazon, between 2005 and 2018, were reprimanded for fines, public civil actions or embargoes, according to a 2018 survey.

The MapBiomas Alerta initiative emerged at the end of 2018 with the aim of adding value to existing deforestation monitoring systems in Brazil. The objective, using satellite images with high spatial resolution, is to verify, validate, refine and analyze each deforestation alert and determine its degree of legal regularity.

This report is the fourth in a series that aims to consolidate and analyze information on all deforestation in all Brazilian biomes detected by the multiple alert systems available from 2019 to 2022, focusing on the last year and that have been validated and published by the MapBiomas Alerta project.

An aerial photograph of a coastal region, possibly a bay or estuary, with a grid of dashed white lines overlaid. A large, solid red rectangle is centered over the water area. In the bottom center, there is a small white box containing a scale bar with the text '500 m' and '2000 ft'.

2. PURPOSE AND SCOPE

500 m
2000 ft

RAD2022, the fourth **Annual** Report on Deforestation in Brazil, covers all Brazilian biomes and has three objectives:

- 1.** Present an **overview of the deforestation** detected and confirmed for all Brazilian biomes since 2019, focusing on data from the year 2022, based on alerts validated and refined from high resolution images provided by the MapBiomas Alerta project.
- 2.** Present an assessment of the degree of regularity of deforestation and an estimate of the total deforestation with **indication of illegality**.
- 3.** Present an **overview of the actions carried out** by government environmental agencies and the private sector to control and combat illegal deforestation.

It should be noted that the deforestation data processed and analyzed in this report are limited to places where there were deforestation detection alerts by the monitoring systems (e.g., DETER/INPE, SAD/Imazon, GLAD/UMD, SAD Caatinga, SAD Mata Atlântica, SAD Pantanal, SAD Pampa and SIRAD-X/ISA). Therefore, the numbers presented, although significant, still to some degree underestimate the real deforestation, since there may be deforested areas that were not detected by these systems.

An aerial photograph of a coastal area, possibly a bay or estuary, with a white grid overlay. A large, dark red rectangular box is centered over the image, containing the text '3. CONCEPTS' in white, bold, sans-serif capital letters. The map shows various land parcels outlined in white, some of which are shaded in light gray. The water area is a darker gray, and the land is a lighter gray. The grid consists of both horizontal and vertical dashed lines.

3 . C O N C E P T S

500 m
2000 ft

Deforestation is the complete or almost complete suppression/conversion of existing native vegetation in a given area.

The suppression or felling of isolated trees or when the rest of the native vegetation remains intact do not constitute deforestation. For this reason, selective cutting of native vegetation, forest management, forest fires resulting in vegetation thinning, or processes resulting in degradation of native vegetation are not registered as deforestation alerts.

The definition of deforestation encompasses a series of particularities that are clarified below, in order to accurately qualify the data and analyses in this report.

Deforestation or suppression of native vegetation

Deforestation is commonly associated with complete suppression of forest vegetation. In this report, the term deforestation refers to the broader understanding, which includes any and all suppression of native vegetation, which also covers the suppression of non-forest vegetation such as fields and savannas. Therefore, in this report we are dealing with suppression/conversion of native vegetation.

Primary or Secondary Deforestation

Primary deforestation refers to the deforestation of forest or primary native vegetation, and secondary deforestation to the suppression of secondary vegetation (an area that was deforested previously and where the vegetation is regenerating).

This report mainly addresses primary deforestation, given that the alert systems used focus on areas of primary vegetation. However, areas of secondary deforestation, when verified, are also included in the MapBiomas Alerta data.

Gross and Net Deforestation

Gross deforestation considers only the loss of native vegetation cover, whereas net deforestation or net loss refers to deforestation minus the area where vegetation has regenerated. In this report, we deal only with gross deforestation.

This report mainly addresses primary deforestation, given that the alert systems used focus on areas of primary vegetation.

Deforestation alert and Deforested area

The deforestation alert refers to an event or evidence of deforestation in a given location. The deforested area is the area effectively affected by the suppression of native vegetation. MapBiomas Alerta identifies and refines deforested areas, using as a starting point deforestation alerts from monitoring systems available levels such as DETER, SAD and GLAD.

Date of Detection and of Occurrence of deforestation

The detection date refers to the moment when deforestation was detected and/or verified. The date of occurrence refers to the period in which deforestation took place (always a date before detection). This report covers areas with deforestation detected in the year 2022.

Deforestation rate and Observed area of deforestation

The observed area is the spatial extent quantified directly by comparing satellite images from different dates (before and after deforestation). The official PRODES deforestation rate uses information from the observed area to estimate the deforestation that has taken place across the entire territory, including areas that could not be observed. MapBiomas Alerta works only with the concept of observed area.

Deforestation speed

Refers to ratio between the total deforested area and the number of days elapsed between the beginning and the end of deforestation, usually expressed in hectares or km² per day. In MapBiomas Alerta, the speed is underestimated, because the calculation is done in an approximate manner, based on the dates of the satellite images available for documenting the moment before and after the deforestation episode.

Deforestation and Degradation

Deforestation deals with the complete suppression of native vegetation, while degradation deals with the partial removal of areas of native vegetation. This report deals only with the cases of deforestation.

An aerial photograph of a coastal region, possibly a bay or estuary, with a white grid overlay. The land is outlined in white, and the water is a darker grey. A large, dark red rectangular box is centered over the image, containing the text '4. METHODS' in white, bold, sans-serif capital letters. In the bottom right corner, there is a small white box with a black border containing the text '500 m' and '2000 ft' in black, indicating a scale.

4. METHODS

500 m
2000 ft

MapBiomass Alerta compiles alerts from several satellite-based deforestation detection systems in Brazil. It validates and refines these alerts with high-resolution images (Planet Scope 3m spatial resolution). The system automatically generates detailed reports and publishes all the data on a single, open access platform.

The detailed description of the deforestation detection systems considered in the process and the step-by-step of the validation and refinement method can be found in Appendices 1 and 2.

In this chapter, we present a simplified explanation of the MapBiomass Alerta process, as well as limitations with the method and differences in relation to official annual deforestation data.

4.1. Description of the Steps

The MapBiomass Alerta process involves the stages of compilation, validation, refinement, spatial overlapping with public data, auditing and publication of alerts and deforestation reports (Figure 4.1).

PROCESS

MapBiomass Alerta

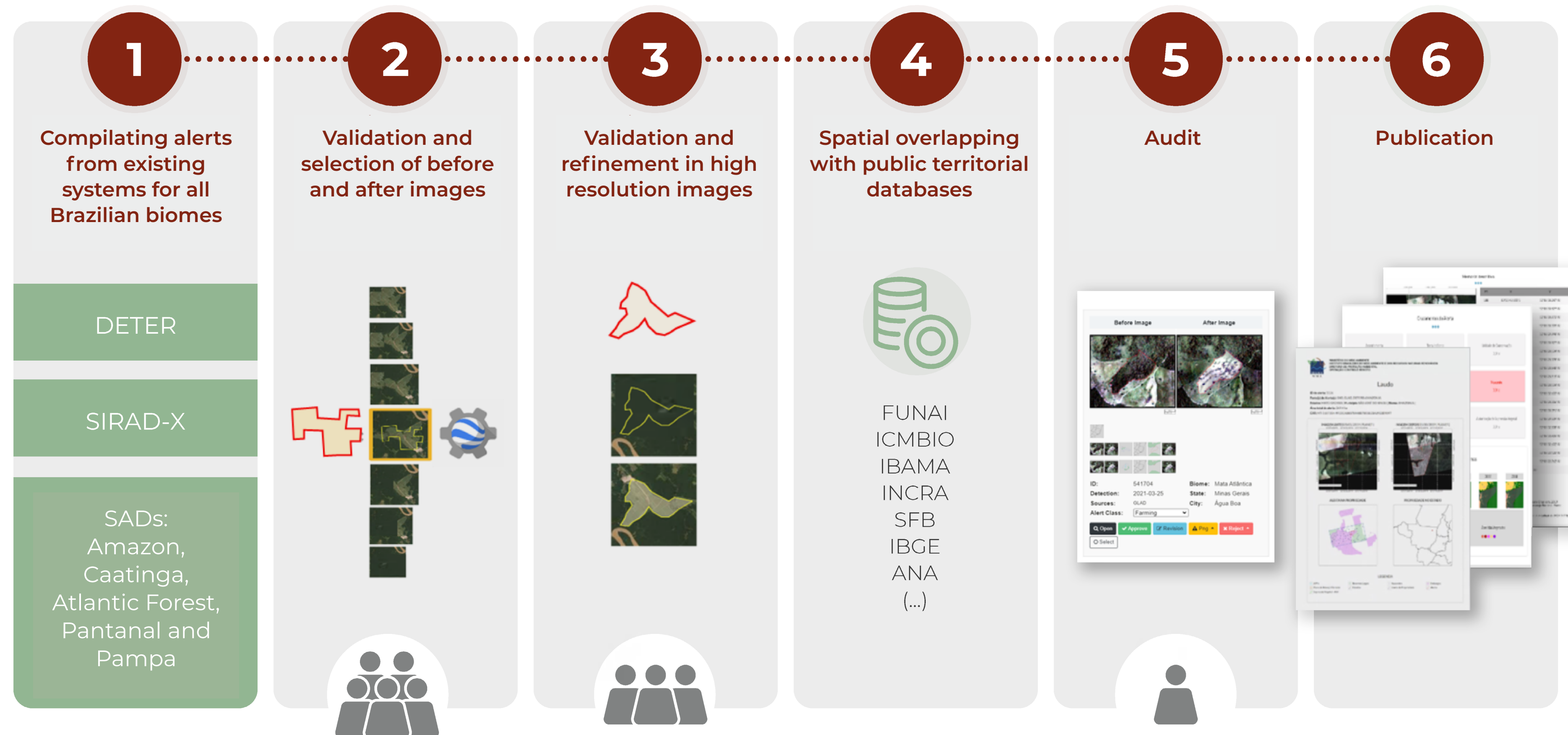


Figure 4.1 | Methodological process of MapBiomass Alerta for compilation, validation, refinement, data crossing, auditing and publication of deforestation alerts in Brazil.

Stage 1: Compiling alerts from existing systems for all Brazilian biomes.

MapBiomas Alerta queries, organizes and consolidates information produced by various official and independent systems that monitor deforestation in Brazil and generate deforestation alerts based on images of 10 m, 30 m or even 60 m of spatial resolution. For the year 2022, MapBiomas Alerta consults the alerts provided by the following information sources and existing systems on a monthly basis:

- ◆ Deter/INPE - for the Amazon and Cerrado (only deforestation alerts are analyzed. Degradation, fire or logging alerts are not analyzed).
- ◆ SAD/Imazon - for the Amazon.
- ◆ GLAD/University of Maryland - for the Pampas.
- ◆ SAD Caatinga/Geodatin - for the Caatinga.
- ◆ SIRAD-X/Instituto Socioambiental

(ISA) - for the Xingu Basin region in the Amazon and Cerrado.

- ◆ SAD Mata Atlântica/SOS Mata Atlântica and ArcPlan - for the Atlantic Forest.
- ◆ SAD Pantanal/SOS Pantanal and ArcPlan - for the Pantanal.
- ◆ SAD Pampa/GeoKarten and UFRGS - for Pampa.
- ◆ SAD Cerrado/Amazon Environmental Research Institute (IPAM) - for the Cerrado (in the inclusion phase).

The systems used since the beginning of the operation can be consulted in Appendix 1.

SIRAD-X complements SAD and DETER data with radar monitoring in the Xingu Basin. SAD Caatinga was developed by Geodatin in partnership with the State University of Feira de Santana (UEFS) to detect deforestation with a focus on dry forests in the Caatinga biome, which may include some are-

as in the Cerrado and Atlantic Forest. SAD Mata Atlântica and SAD Pantanal were developed with a focus on forest and savannah formations in the respective biomes, by SOS Mata Atlântica and SOS Pantanal in partnership with ArcPlan. SAD Pampa was developed by GeoKarten in partnership with the Federal University of Rio Grande do Sul and is in operation to detect deforestation in forest environments and in tests for rural environments. SAD Cerrado was developed by IPAM in partnership with the Image Processing and Geoprocessing Laboratory of the Federal University of Goiás (LAPIG-UFG) and MapBiomas, focusing on forest, savannah and grassland formations of the Cerrado biome (<https://sadcerrado.ipam.org.br/>).

In addition to the sources of monthly alerts, annual alerts are being included to avoid omissions (PRODES/INPE for the Amazon and Cerrado and Atlas dos Remanescentes Florestais/SOS Mata Atlântica and INPE for the Atlantic Forest).

Stage 2: Validation and selection of before and after images

Validation takes place in two steps. The first is performed in an automated process that eliminates all alerts that overlap with agricultural and ranching areas from the annual land use and land cover maps in MapBiomas Brasil¹ or that have already been detected in previous surveys, because it designates the vegetation cover as non-native. The second step is done visually by trained analysts and organized into teams by biomes, with the support of monthly high-resolution Planet mosaics (images with 4 m resolution). At that moment, alerts corresponding to cases of false positives are discarded, and the corresponding reason for rejection is recorded (silviculture, agriculture, seasonality, etc.). When the alert is considered valid, an image is selected and purchased with project funds, that makes it possible to visualize the native vegetation before deforestation and an image that makes it possible to verify the area that was deforested. The pur-

1 | To learn more, visit: <https://mapbiomas.org>

chase of images considers a minimum area of 500 by 500 m and a surrounding area that helps to contextualize the deforested area.

Stage 3: Validation and refinement in high resolution images

A technician with experience in interpreting satellite images of the biomes performs a new validation of the deforestation identified in the high-resolution images. If confirmed, a refinement process is carried out in order to more precisely delimit the area where the native vegetation was suppressed. The refined polygon is generated automatically using a supervised classification algorithm (Random Forest), which is processed on the Google Earth Engine platform through Workspace, an application of the MapBiomias Project. The only manual action in this step is to collect training samples that represent the deforested and non-deforested area in the high resolution images for use by the classifier. The refined polygon goes through a simplification process that removes excess vertices. Based on the before and after images, the interpreter also identifies the deforestation drivers that may have caused the deforestation event (mining, garimpo, urban expansion, agriculture and ranching, natural causes or others).

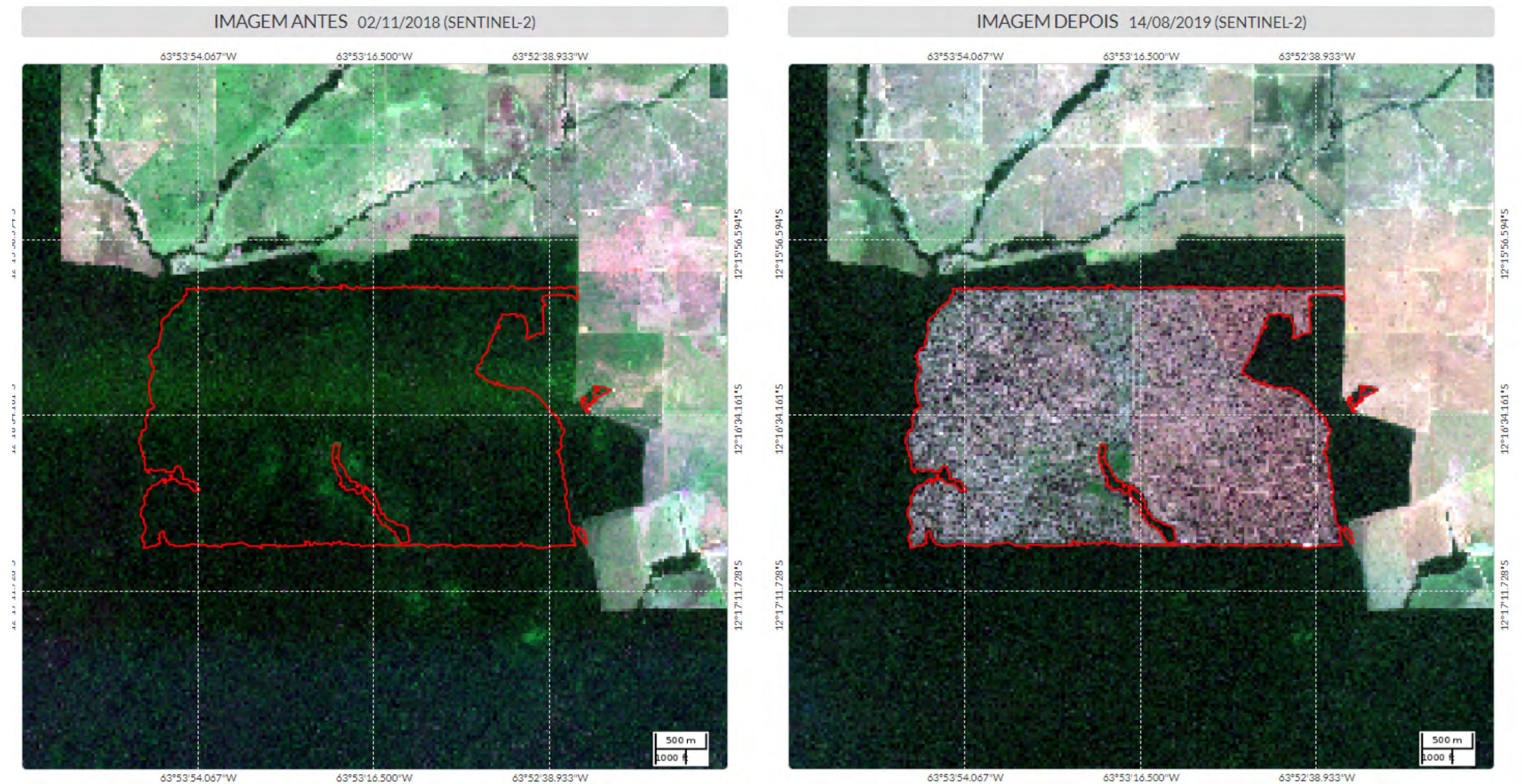


Figure 4.2 | Example of Planet images before and after deforestation and the refined polygon of the Cód.93831 of 2019.

Stage 4: Spatial overlapping with public territorial databases

The refined polygons are spatially overlapped with spatial land and inspection information, including boundaries of Indigenous Lands (TIs), Conservation Units (UCs), quilombola territories, rural settlements, areas registered in the Rural Environmental Registry (CAR) – including declared Permanent Preservation Areas (APPs) and Legal Reserves (RL), as well as areas embargoed by the environmental agency, authorizations for suppression and forest management plans by Sinaflor and IBAMA. The alerts are also linked to geographical boundaries such as municipalities, states, biomes and watersheds. Cross-references with special territories are also considered, such as the Legal Amazon, areas where the Atlantic Forest Law is applicable, MATOPIBA, AMACRO, Biosphere Reserves and others. These intersections qualify the alerts and enable generation of technical reports based on information that is relevant to the user institutions. The tables that detail all the databases

used, as well as the crossing rules are in Appendix 2.

Stage 5: Audit

Each refined polygon undergoes an audit process performed by the technical supervisor of each biome. At this stage, the possible need to redo any adjustments before the final publication of the confirmed deforestation is evaluated.

Stage 6: Publication

All confirmed deforestation polygons are published on the MapBiomas Alert platform with weekly updates. Reports are made available for each confirmed deforestation and for each crossing of an alert with a property registered in the CAR, SIGEF and SNCI (with an area greater than 0.1 ha). The reports contain the following information:

- ◆ deforestation alert code;
- ◆ original source of the alert (detection system);

- ◆ Biome, State and Municipality;
- ◆ deforested area;
- ◆ deforested area that crosses with the property;
- ◆ property code;
- ◆ image and date before deforestation;
- ◆ image and date after deforestation;
- ◆ deforestation overlapping with: APP, Legal Reserve, water sources, Indigenous Lands, Conservation Units, Sustainable Forest Management Plan, embargoed areas, authorization to suppress vegetation, and others;
- ◆ simplified description of the coordinates of the deforestation polygon;
- ◆ historical coverage and land use by MapBiomas in the assessed area.

Note:

In the event of an error at any stage of this processing in the deforestation polygon published by MapBiomas Alerta that is formally reported by environmental agencies or platform users, the technical team performs a new detailed analysis. If it is confirmed that it is not a case of deforestation of native vegetation the alert is removed from the map and platform statistics. The polygon is kept in the database only for individual consultation through its identifier code, in which the reason for its cancellation is recorded. We emphasize that there is no analysis of the legality or regularity of deforestation on the platform. Any event with confirmed loss of native vegetation is considered an alert.

All confirmed deforestation polygons are published on the MapBiomas Alert platform with weekly updates.

4.2. Limitations of the Method

Like any method, MapBiomas Alerta has certain limitations that must be considered when applying its data:

A | A. Processing time – the import of alerts from their sources (detection systems) occurs monthly, with the exception of DETER alerts, which occur every 15 days. Because part of the processing of alerts is done individually visually by trained analysts, the validation and processing time depends on the biome and the time of year. It can range from 30 to 90 days, from the date of detection by the source system up to publication on the platform in MapBiomas Alerta. The proposal with MapBiomas Alerta is to increase certainty about confirmed deforestation data and provide ready reports for remote inspection. Quick inspection operations in the field aimed at catching offenders in the act can be planned directly with pre-existing detection systems.

B | Omissions – deforestations are validated and refined based on the existence of an alert previously captured by a third-party deforestation detection system. The possible omissions of these systems in detecting deforestation also affect the alerts evaluated by MapBiomas Alerta.

At the beginning of the project, most of the Brazilian biomes did not have a monthly monitoring system, and the main source of alerts used was GLAD. GLAD is a global system that uses Landsat satellite imagery to automatically flag areas where forest cover has been disturbed. The system covers the entire tropical region. However, alerts detect changes more reliably in areas with at least 60% forest cover, making them most useful in dense tropical forests. Therefore, it had omissions because it was not adjusted to the specific characteristics of each Brazilian biome.

To avoid omissions, MapBiomas supported the development of Deforestation Alert Systems (SAD) adapted for each Brazilian biome by several universities,

research institutions and civil society organizations:

- ◆ SAD Caatinga, which started operating in 2020, developed by the MapBiomas team in the Caatinga (UEFS and Geodatin).;
- ◆ SAD Mata Atlântica, developed by SOS Mata Atlântica and ArcPlan, was implemented in 2021 for four river basins (Tietê, Jequitinhonha, Iguaçu and Miranda/Aquidauana), where 2,126 alerts were identified in addition to the GLAD alerts and has been operating for the entire biome since January/2022;
- ◆ SAD Pantanal, developed by SOS Pantanal and ArcPlan to monitor deforestation alerts in forest and savannah formations, implemented at the end of 2021 (where 103 alerts were identified), operating monthly from January 2022.;
- ◆ SAD Pampa, developed by GeoKarten and UFRGS, which in 2022 operated as a complement to GLAD;
- ◆ SAD Cerrado, developed by IPAM in 2022. The means of integrating with MapBiomas Alerta is still under develop-

ment and only part of the alerts was incorporated into the 2022 data.

Complementarily, the annual deforestation identified by PRODES Amazonia and Cerrado were used to identify omissions in the monthly monitoring systems of these biomes. With the same objective of reducing omissions, the annual deforestation identified by the Atlas of Forest Remnants in SOS Mata Atlântica/INPE was also included, rejecting events that overlap with already validated alerts.

It is also worth noting that deforestation monitoring systems have minimal detection areas and may therefore omit some deforestation. For example, alerts smaller than 6.25 hectares are not detected in the Amazon (DETER Amazônia) and those smaller than 1 hectare are not detected in the Cerrado (DETER Cerrado).

C | Deforestation speed Underestimated – when validating and refining an alert, a pair of good quality Planet satellite images from before and after

deforestation is searched. The “before” image is the most recent one available for up to 12 months before detection, and the “after” image is the one closest to the end of deforestation. The presence of clouds can increase the period between before and after images by days, weeks and even months. This does not change the claim that deforestation occurred in the period between the two images, but it does affect calculation of the average speed at which deforestation actually occurred.

D | Automatic Polygon Delimitation – the polygons that delimit the refined alerts are established by an automatic classification process of the area of change between the two images, meaning the place where the native vegetation was suppressed. When delimiting the deforestation polygon, areas with signs of previous alteration or with small groupings of trees that were maintained in the midst of deforestation are removed. In 2020, a procedure was developed to minimize the small islands inside the polygons in the refinement step, as well as the excess

of vertices, which correspond to the points that form polygons. To decrease the number of vertices, a simplification mechanism was established.

E | Limitation for Non-Woody Native Vegetation – the detection of suppression of non-forest vegetation such as grassland vegetation has limitations in the systems that generate alerts, whose methods are focused on identifying where there was suppression of forest vegetation. However, when there is also suppression of non-forest vegetation in the alert area or in an adjacent area, the use of high-resolution images allows that to be registered during the alert refinement phase. As a result, most of the deforestation in non-woody vegetation that has been detected since 2019 has occurred occasionally, whenever observed around woody vegetation alerts, so that the current system still underestimates the suppression of native non-forest vegetation.

4.3. Differences in relation to the Official Annual Data

The comparison of deforestation data from MapBiomas Alerta with official

deforestation data (PRODES) must be done with caution, as they present some important differences (Table 4.1):

Table 4.1 Differences between data from official deforestation systems and MapBiomas Alert in 2022

Item	PRODES Amazon	PRODES Caatinga, Cerrado, Atlantic Forest, Pantanal and Pampa	ATLAS Atlantic Forest	MapBiomas Alert
Minimum Mapped Area	6.25 ha	1 ha	3 ha	0.3 ha
Area Calculation	discloses rate that estimates deforestation in unobserved areas as well	data represents the sum of the observed areas	data represents the sum of the observed areas	data represents the sum of the observed areas
Period Analyzed	August 2019 to July 2022	August 2019 to July 2022	October 2018 to September 2022	deforestation detected between January and December 2019, 2020, 2021 and 2022.
Image Capture Window	July to September 2019, 2020, 2021 and 2022	June to September 2020, 2021 and 2022	July to November 2019, 2020, 2021 and 2022	July 2018 to December 2022
Territorial Scope	Legal Amazon	boundaries of biomes at scale 1:250,000 (for the Cerrado, subtracting the overlapping area with the Legal Amazon)	Area of application of the Atlantic Forest Law (biome + northeast enclaves)	IBGE biome boundaries on a scale of 1:250,000
Vegetation Type Mapped	primary or existing forest vegetation in 1988 (excludes Cerrado areas and non-forest areas in 1988)	forest and savannah vegetation existing in 2000	primary forest vegetation or existing in 1985	primary vegetation and may include secondary vegetation

An aerial photograph of a coastal region, possibly a bay or estuary, with a white outline of a landmass. A red rectangular overlay is centered on the image, containing the text "5. RESULTS" in white, bold, sans-serif capital letters. The background is a grayscale aerial view showing water, land, and some structures. A scale bar in the bottom right corner indicates 500 m and 2000 ft.

5 . R E S U L T S

500 m
2000 ft

5.1. Number of original and consolidated alerts

The monitoring systems considered in MapBiomass Alerta detected 242,674 deforestation alerts in 2022 (Table 2). Almost two thirds (62.3%) of the alerts were detected in the Amazon. In the other biomes, 18.5% of the number of original system alerts were in the Atlantic Forest, 7.9% in the Caatinga, 4.8% in the Cerrado, 4.2% in the Pantanal and 1.6% in the Pampa.

Table 2 Number of original deforestation alerts by system and by biome in Brazil in 2022*

	AMAZON	CAATINGA	CERRADO	ATLANTIC FOREST	PAMPA	PANTANAL	TOTAL
Deter Cerrado	2,741	11	5,010	-	-	-	7,762
DETER Amazon	38,678	-	53	-	-	7	38,738
SAD Amazônia	97,620	-	1,365	-	-	17	99,002
SAD Caatinga	-	18,964	3,853	584	-	-	23,401
SAD Atlantic Forest	-	77	725	43,947	184	-	44,933
SAD Cerrado **	-	-	356	-	-	-	356
SAD Pampa	-	-	-	9	1,034	-	1,043
SAD Pantanal	14	-	96	-	-	9.981	10,091
SIRAD-X	12,119	-	167	-	-	-	12,286
GLAD***	-	-	2	1840	2675	93	4610
SOS-INPE	-	1	1	450	-	-	452
TOTAL	151,172	19,053	11,628	44,830	3,893	10,098	242,674

* In this table, the numbers indicate the intersection of the alerts with the biome limits defined by the IBGE on a scale of 1:250,000 published in 2019. That explains why there are DETER-CERRADO alerts in the Amazon and Caatinga, given that this new version of the IBGE Biome Map IBGE changed the limits of the 1:5,000,000 scale map published in 2004.

** SAD Cerrado data refer to a test and will be fully implemented in 2023.

*** For GLAD, only alerts that affect the Atlantic Forest and Pampa biomes were considered.

After consolidating the alerts, where overlaps with previously detected areas are eliminated and between the systems, the effective number of alerts that were used later on for the validation and refinement process was 231,770 (Table 3).

There was a 29.6% increase in the number of alerts evaluated between 2021 and 2022. However, there was a decrease in the number of alerts in the Cerrado and Pantanal biomes, where there were several false positives of the alerts evaluated by GLAD. Some methodological factors contributed to this result:

- ◆ In 2022, the SAD Mata Atlântica alerts were incorporated for the entire biome already on a production basis (pre-

viously, in 2021, this system had been integrated in the pilot phase in 4 river basins).

- ◆ From 2022 on, GLAD is not used anymore as a source of alerts for the Caatinga and Pantanal biomes and remained only for the Atlantic Forest and Pampa.
- ◆ In Pampa, alerts from SAD Pampa were also incorporated.
- ◆ In the Pantanal, with the departure of GLAD, with its many false positives due to confusion with burned areas and flooded areas, SAD Pantanal came in. It had been developed specifically for the biome, and which was in the testing phase in 2021.

Table 3

Number of deforestation alerts consolidated by biome in Brazil in 2019, 2020, 2021 and 2022

BIOME	2019	2020	2021	2022	Variação 2021-2022
AMAZON	84,850	116,106	89,992	140,280	56%
CAATINGA	1,446	10,216	17,617	19,053	8%
CERRADO	12,006	13,480	18,934	11,619	-39%
ATLANTIC FOREST	12,938	12,388	22,911	46,830	104%
PAMPA	611	667	843	3,893	362%
PANTANAL	1,946	41,573	28,590	10,095	-65%
TOTAL	113,797	194,430	178,887	231,770	29,6%

COMPARISON WITH PRODES ANNUAL DEFORESTATION DATA

For the years 2020 and 2021, the use of PRODES was tested in the Amazon and Cerrado as a complementary source of alerts, despite the fact that the system works with annual deforestation assessments. The objective was to evaluate the degree of omission of real-time alerts generated at monthly intervals. This is because, in theory, PRODES should consolidate the deforestation data detected throughout the year by the DETER system.

In the Amazon when considering PRODES data from August 2019 to July 2020 we identified a total of 14,607 polygons that had not appeared in the DETER deforestation alerts for 2019 or 2020. After the validation and refinement analysis, 2,219 alerts were identified (amounting to 32,743 hectares), which is equivalent to an approximately 3.7% increase in the deforested area in the biome. For the period of August 2020 to July 2021

there was a total of 36,359 polygons that had not appeared in DETER's deforestation alerts. After the validation and refinement analysis, 3,297 alerts were identified (amounting to 37,519 hectares), which is equivalent to an increase of approximately 3.6% in the deforested area in the biome.

In the Cerrado, when considering PRODES Cerrado data, from August 2019 to July 2020 we identified a total of 35,000 polygons that had not appeared in the DETER deforestation alerts for 2019 or 2020. Of these, 21,194 alerts were validated, totaling 207,000 hectares, which represented a 56% increase in the deforested area in the biome in 2020. This was mainly an increase in alerts that had smaller deforested areas.

In 2023, PRODES data for the period 2021-2022 are being evaluated. Therefore, the data in this report do not include PRODES as a source for 2022.

- ◆ In the Cerrado, GLAD alerts were no longer used because of the numerous false positives, and the focus was placed on DETER Cerrado.
- ◆ In the Amazon, the same systems remained as a source of alerts, with an increase in deforestation.

5.2. Validation and Refinement of Alerts

The alerts produced by the deforestation detection systems were consolidated and validated considering the over-

lapping of different systems (e.g., SAD and DETER in the Amazon) and also the aggregation of the alerts with overlapping of their spatial contours. Next, alerts that could not be validated due to lack of images were discarded and false positives were excluded (e.g., tree harvesting in reforested areas). More details are available in Appendix 3.

The process resulted in the validation and refinement of **76,193 alerts** in 2022, which totaled **2,057,251 hectares deforested** and distributed across the six Brazilian biomes (Figure 2). This represented an increase of 22.3% in the defo-

rested area and 6.5% in the total number of alerts compared to 2021 (Table 4). In 2022, there is a greater concentration of alerts in the arc of deforestation in the Amazon, as well as in the Matopiba region in the Cerrado (Figure 3). In addition, there was an increase in alerts in the Caatinga and Pantanal biomes, as well as in the states of Santa Catarina and Rio Grande do Sul (Figure 3) in southern Brazil.

Of the total alerts analyzed, 39% were validated, refined and published; 21% of the alerts were duplicated (when during in the validation process, the delimitation of another nearby had alert already included that deforestation); and 40% were false positives, meaning that they did not correspond to real deforestation. Among the main reasons for false positives are confusion with burned areas (especially in the Pantanal), forestry (Pampa and Atlantic Forest) and the effect of seasonality on native vegetation (Caatinga and Pantanal) (Table 5).

Table 5 Reasons for validating or not validating alerts in biomes in 2022

STATUS	AMAZON	CAATINGA	CERRADO	ATLANTIC FOREST	PAMPA	PANTANAL	BRAZIL
Validated, Refined and Published	52%	60%	37%	23%	19%	1%	39%
Not Validated	48%	40%	63%	77%	81%	99%	61%
Duplicated	35%	7%	14%	7%	7%	3%	21%
False positive	13%	33%	49%	71%	73%	96%	40%
Not observed	0%	0%	0%	0%	0%	0%	0%
Others	0%	0%	0%	0%	0%	0%	0%
TOTAL	100%	100%	100%	100%	100%	100%	100%

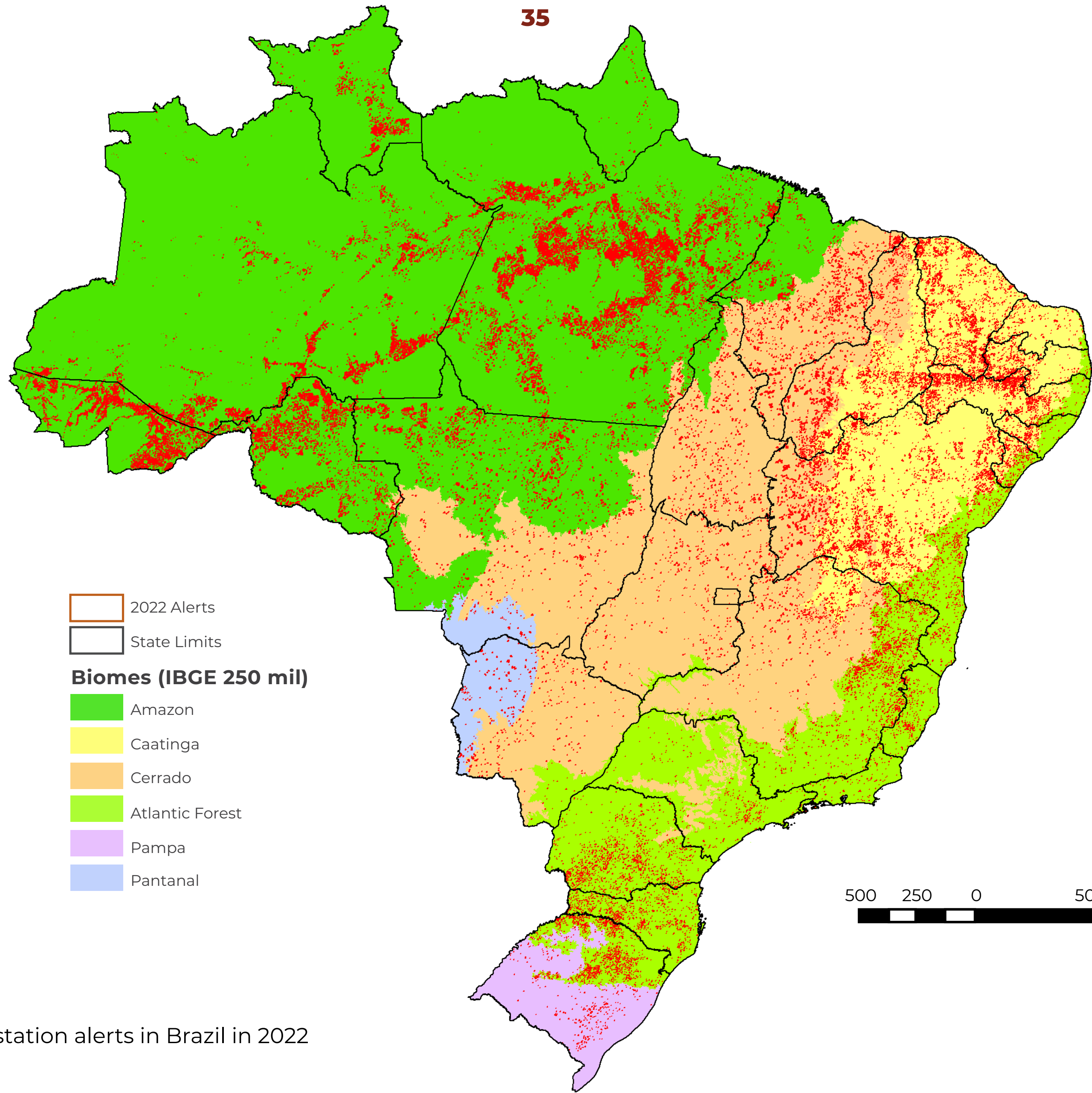
Table 4 Deforestation alerts validated by MapBiomas Alert in Brazil in 2019, 2020, 2021 and 2022

Validação de Alertas	2019	2020	2021	2022	Variation between 2021-2022
Number of Alerts	56,635	99,020	71,525	76,193	6,5%
Total area deforested(ha)	1,221,570	1,645,104	1,682,575	2,057,251	22,3%

Obs. There may be differences in total alerts and deforested area for years reported in previous RADs. This occurs because there are remnants of alerts where images were not available and could only be validated after closing the report, or due to the addition of new alert sources. Another factor is the inclusion of alerts in deforested areas identified by PRODES in the Amazon and Cerrado, which are carried out in the following years. In 2022, the PRODES Cerrado 2020 validation processes were completed.

RESULTS

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- 2022 Alerts
- State Limits
- Biomes (IBGE 250 mil)**
- Amazon
- Caatinga
- Cerrado
- Atlantic Forest
- Pampa
- Pantanal

Figure 2 | Map of deforestation alerts in Brazil in 2022

RESULTS

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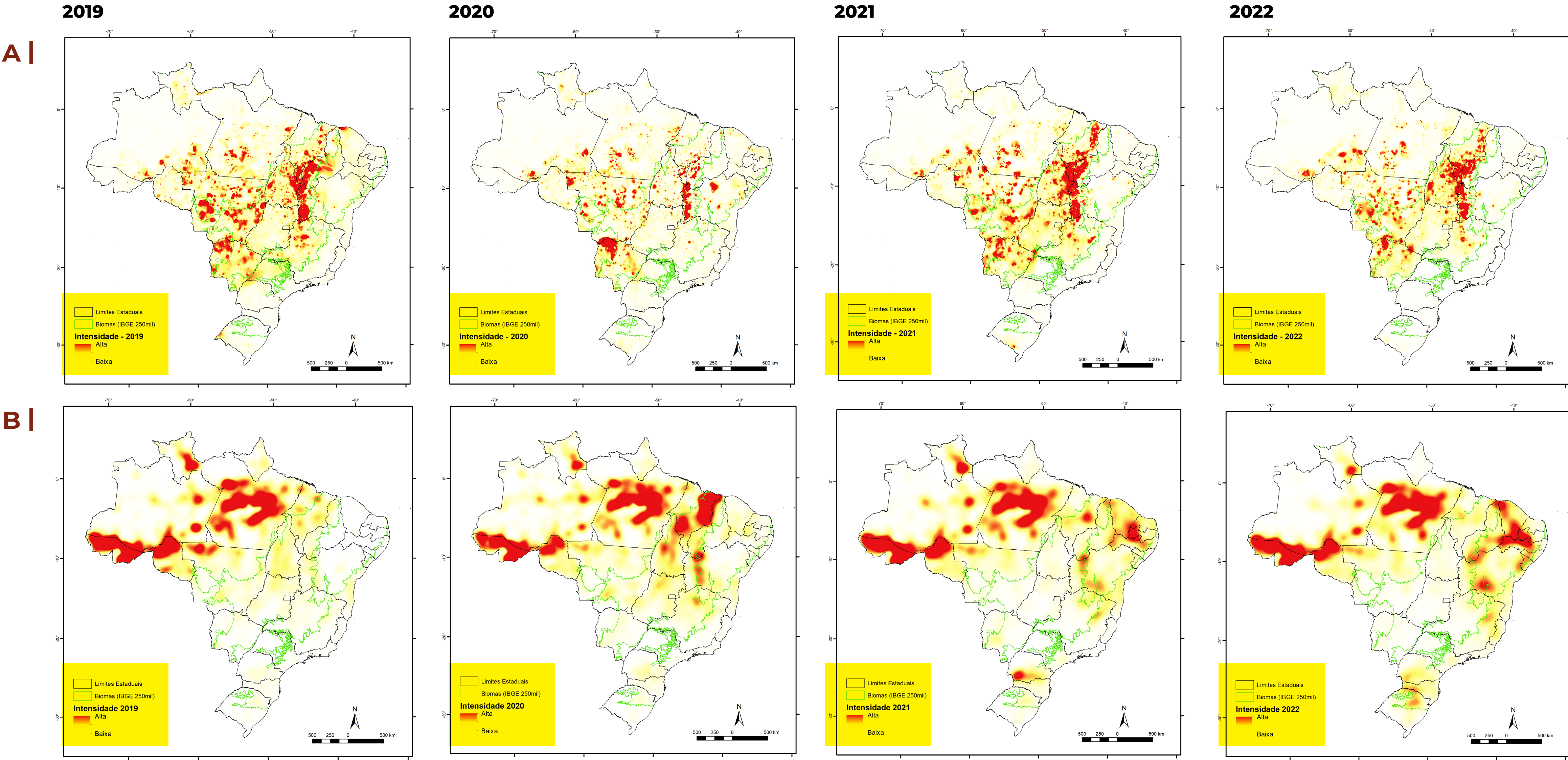


Figure 3 | Density of deforested area in Brazil in 2019, 2020, 2021 and 2022. A) Heat map by area; B) Heat map by event

5.3. Overview of Validated and Refined Alerts

5.3.1. Deforestation by Biome

There was an increase in the deforested area in five of the six Brazilian biomes between 2021 and 2022, with the exception of the Atlantic Forest. In terms of area, the largest increases occurred in the Amazon (increase of 190,433 ha) and in the Cerrado (increase of 156,871 ha). In proportional terms, the biggest increases occurred in the Cerrado (31.2%) and Pampa (27.2%) (Table 6 and Figure 4).

In the Pampa, in addition to GLAD, SAD Pampa was used for the first time and part of the increase in deforestation may be related to the inclusion of the new system. In the other biomes, the increase is only related to the occurrence of more deforestation events since the method remained stable from one year to the next.

The Amazon and the Cerrado together account for 70.4% of the alerts and 90.1% of the deforested area in 2022. Although the Cerrado has a share of only 8.3% in the total number of alerts, the total deforested area represents almost one third of the total due to the size of the alerts (32.1%) (Table 6).

In 2022, the Amazon was the biome with the largest deforested area, representing 58% of the total (1,192,635 ha). The Cerrado is in second place, with 32.1% of the area (659,670 ha), followed by the Caatinga in third place, with 7% of the area (140,637 ha). Even with most of its forest area deforested, with less than 29% of its forest cover remaining, 30,012 ha were deforested in the Atlantic Forest, which represents 1.5% of the total deforested area in the country. Despite accounting for the smallest alert area (0.2% of the total), the Pampa had an 27.2% increase in its deforested area from 2021 to 2022 (Table 6 and Figure 4). In the Pantanal, there was a decrease in the number of validated alerts (-8.9%), but a 4.4% increase in the area deforested between 2021 and 2022.

Table 6 Deforested area and number of alerts validated by biome and in Brazil from 2019 to 2022

Number of Validated Alerts per year (2019-2022)

BIOME	2019	2020	2021	2022	Total	Share 2022	Variation 2021-2022	Variation 2021-2022
Amazon	46,995	61,222	48,174	47,317	203,708	62.1%	-857	-1.8%
Caatinga	531	5,644	10,621	13,989	30,785	18.4%	3,368	31.7%
Cerrado	7,354	28,759	7,136	6,296	49,545	8.3%	-840	-11.8%
Atlantic Forest	1,387	3,082	5,144	7,905	17,518	10.4%	2,761	53.7%
Pampa	67	105	160	420	752	0.6%	260	162.5%
Pantanal	201	208	292	266	967	0.3%	-26	-8.9%
Grand Total	56,535	99,020	71,527	76,193	303,275	100.0%	4,666	6.5%

Area of Validated Alerts per year (2019-2022)

BIOME	2019	2020	2021	2022	Total	Share 2022	Variation 2021-2022	Variation 2021-2022
Amazon	774,135	883,998	1,002,202	1,192,635	3,852,970	58.0%	190,433	19.0%
Caatinga	13,922	67,141	115,069	140,637	336,769	6.8%	25,567	22.2%
Cerrado	408,361	642,494	502,798	659,670	2,213,322	32.1%	156,871	31.2%
Atlantic Forest	10,510	24,239	30,184	30,012	94,944	1.5%	-172	-0.6%
Pampa	646	1,271	2,426	3,087	7,430	0.2%	661	27.2%
Pantanal	13,996	25,962	29,895	31,211	65,949	1.5%	1,315	4.4%
Grand Total	1,221,570	1,645,104	1,682,575	2,057,251	6,606,499	100.0%	374,676	22.3%

* There may be differences in total alerts and deforested area for years reported in previous RADs. In the case of the Cerrado, the main factor for the increase in alerts in 2020 is the inclusion of alerts in deforested areas identified by PRODES Cerrado, which was done in 2022.

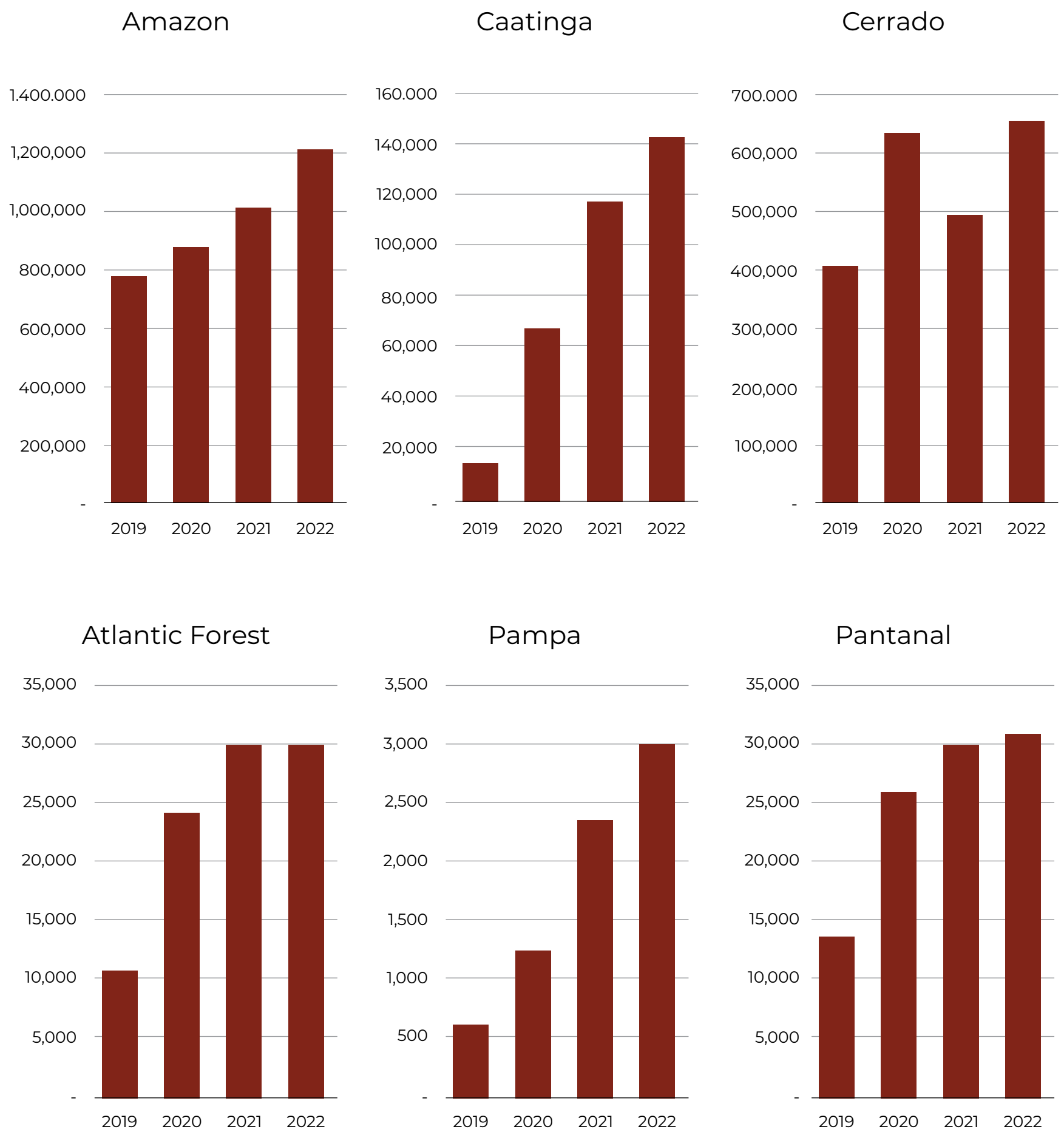


Figure 4 | Deforested area per biome (ha) per year from 2019 to 2022

MATOPIBA AND AMACRO

Two regions marked by the targeted expansion of agricultural and ranching activities have become regions of important deforestation pressure: Amacro and Matopiba. The Amacro region is where the border of the three Amazonian states (Amazonas, Acre and Rondônia) is located and is considered the new frontier of deforestation in the Amazon. Matopiba is the region where the states of Maranhão, Tocantins, Piauí and Bahia meet where the expansion of agriculture has been intensifying over the last two decades, mainly in the Cerrado biome.

In 2022 Matopiba concentrated 26.3% of the deforested area in Brazil. There were 4,975 alerts and 541,803 ha deforested – a 37% increase in the area deforested compared to 2021. The Matopiba region was where most of the deforestation in the Cerrado was concentrated, around 82.1% of the native vegetation suppression area for that biome. Matopiba is also where the 10 municipalities that deforested the most in the Cerrado in 2022 are located (item 5.3.5, Table 14).

In the Amacro region there were 7,055 alerts and 231,955 ha deforested in 2022 – 11.3% of the deforested area in Brazil and approximately 19.4% of the forest loss in the Amazon. There was a 12.3% increase in deforestation in this region in 2022 compared to 2021.

Deforestation detected in the AMACRO region

	NUMBER OF ALERTS	DEFORESTED AREA (HA)
2019	4,574	277,719
2020	21,010	484,647
2021	5,438	395,393
2022	4,975	541,803
Total	35,997	1,699,562

Deforestation detected in the MATOPIBA region

	NUMBER OF ALERTS	DEFORESTED AREA (HA)
2019	7,009	155,268
2020	8,036	165,284
2021	7,001	206,526
2022	7,055	231,955
Total	29,101	759,034

5.3.2. Alerts Size

The average size of deforestation in 2022 was 27 ha, a 14.8% increase o compared to the average of 23.5 ha verified in 2021. Breaking down deforestation by each biome, there was an increase in the average area of deforestation in the Cerrado (48. 7%), the Amazon (21.2%), and the Pantanal (14.6%) (Table 7).

The Pantanal has the largest average area deforested per alert (117.3 ha), followed by the Cerrado (104.8 ha). The Atlantic Forest and the Pampa have the smallest average areas due to deforestation (3.8 and 7.4 ha, respectively), which can be explained by the greater fragmentation of the landscape and their land title structure that involves smaller rural properties in these biomes when compared to the others.

Table 7 Average and maximum size (ha) of alerts by biome and in Brazil from 2019 to 2022

Average size of deforestation by biome and by year (2019 to 2022)

BIOME	2019	2020	2021	2022	Average from 2019 to 2022	Variation 2021-2022	Variation 2021-2022
AMAZON	16.5	14.4	20.8	25.2	18.9	4	21.2%
CAATINGA	26.2	11.9	10.8	10.1	10.9	-1	-7.2%
CERRADO	55.5	22.3	70.5	104.8	44.7	34	48.7%
ATLANTIC FOREST	7.6	7.9	5.9	3.8	5.4	- 2	-35.3%
PAMPA	9.6	12.1	15.2	7.4	9.9	-8	-51.5%
PANTANAL	69.6	124.8	102.4	117.3	104.5	15	14.6%
BRAZIL	21.6	16.6	23.5	27.0	21.8	3	14.8%

Maximum size (ha) of validated alerts of deforestation by biome and by year (2019 to 2022)

BIOME	2019	2020	2021	2022	Total	Maximum for the period from 2019 to 2022	Variation 2021-2022	Variation 2021-2022
AMAZON	4,478.1	6,476.5	2,966.1	3,580.4	153,093	6,476.5	614	20.7%
CAATINGA	1,050.9	1,049.3	1,268.3	1,096.8	15,442	1,268.3	- 171	-13.5%
CERRADO	2,384.6	7,506.9	4,977.6	12,272.0	21,867	12,272.0	7,294	146.5%
ATLANTIC FOREST	125.5	274.1	456.0	294.9	9,632	456.0	- 161	-35.3%
PAMPA	117.2	127.6	466.5	80.5	333	466.5	- 386	-82.8%
PANTANAL	1,249.3	4,132.1	968.5	2,804.9	695	4,132.1	1,836	189.6%
BRAZIL	4,478.1	7,506.9	4,977.6	12,272.0	201,062	12,272.0	7,294	146.5%

5.3.2.1. Largest deforestation by biome

The largest deforestation detected in 2022 in Brazil (alert code 564317), with 12,272 ha, occurred in the **Cerrado** biome in the state of Bahia, in the municipality of Formosa do Rio Preto (Table 8 and Figure 5). The report from the MapBiomas Alerta platform indicates that deforestation occurred within the Environmental Protection Area of Rio Preto (state). According to the State environmental agency INEMA-BA, the area where deforestation occurred is duly registered in CEFIR (state CAR). In INEMA's analysis, the suppression is related to an area of 24,732.80 hectares authorized through INEMA Ordinance No. 9.077/2015, which had the Extension of the Validity Period authorized - PPV, through INEMA Ordinance No. 18.440/2019 up to 05/22/2023.

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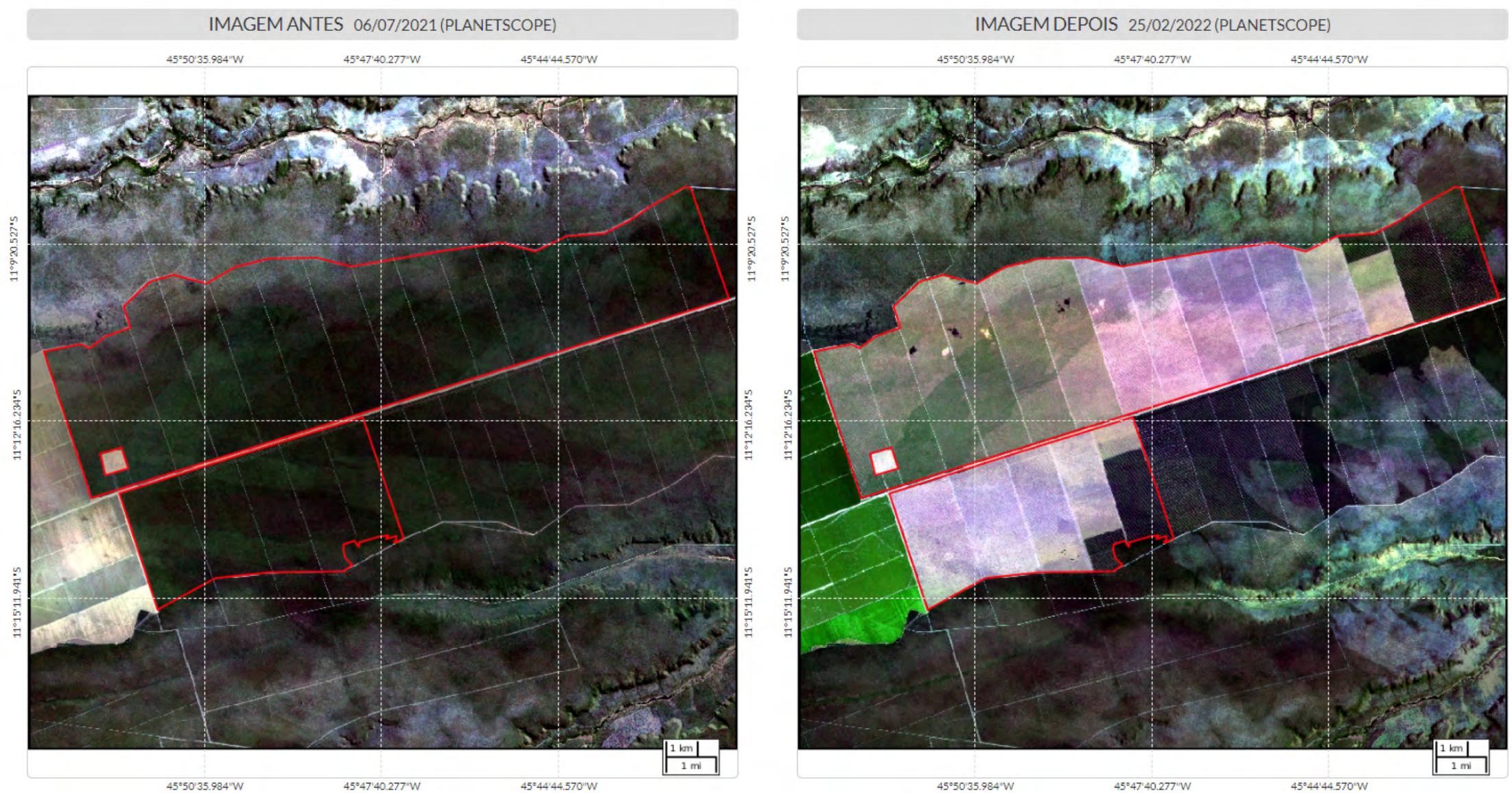


Image from 27.05.2022 also shows the expansion of deforestation after the publication of alert 564317.

Figure 5 | Largest deforestation in Brazil in 2022(alert code 564317), with 12,272 ha, occurred in the Cerrado biome in the state of Bahia in the municipality of Formosa do Rio Preto.

The largest deforestation detected in the **Caatinga** biome in 2022 (alert code 809597) has an area of 1,096 ha and occurred in the municipality of Barra, also in the state of Bahia. According to the State environmental agency INEMA-BA, the area is duly registered with CEFIR (state CAR). INEMA identified the existence of Authorization for the Suppression of Native Vegetation No. 010/2022 issued by the Municipality of Barra.

The largest deforestation detected in the **Amazon** biome in 2022 (alert code 562784) has an area of 3,580 ha and occurred in the municipality of Colniza, in the state of Mato Grosso. According to the State environmental agency Sema-MT, the event is a clear-cut that took place between 01/04/2022 and 09/16/2022 and no authorization for deforestation is recorded. Sema-MT also informed that the area was inspected in loco by teams from the Military Police Battalion for Environmental Protection (BPMPA).

The largest deforestation detected in the **Atlantic Forest** biome in 2022 (alert code 612986) has an area of 294 ha and occurred in the municipalities of Araçuaí and Itinga, in Minas Gerais. According to the State environmental agency Semad-MG, there was no authorization for the deforestation in question and that there are two Infraction Notices in the corresponding area (no.292971/2022 and no. 303825/2022), issued according to the Continuous Monitoring System of the State Institute of Forests (IEF).

The largest deforestation detected in the **Pampa** biome in 2022 (alert code 702512) has an area of 80 ha and occurred in the municipality of Canguçu, in Rio Grande do Sul. According to Fepam-RS, the deforestation occurred on a property with licensed forestry activity, but that would not encompass the entirety of the alert. The State environmental agency Fepam-RS informed that it would verify any inconsistencies between deforestation and licensing.

The largest deforestation detected in the **Pantanal** biome in 2022 (alert code 796153) has an area of 2,804 ha and occurred in the municipality of Corumbá, in Mato Grosso do Sul. The State environmental agency Imasul-MS was contacted about possible authorizations and/or enforcement actions corresponding to the area but did not respond in time for the conclusion of this report.

Details on each of the major deforestation events by biome and their respective responses by the responsible state agencies are in the **Appendix 9** of this report.

Table 8

Largest deforestation by biome and in Brazil in 2022*

BIOME	Area (ha)	Alert Code	Municipality	State
AMAZON	3,580.44	562784	Colniza	MT
CAATINGA	1,096.84	809597	Barra	BA
CERRADO	12,271.95	564317	Formosa do Rio Preto	BA
ATLANTIC FOREST	294.9	612986	Araçuaí	MG
PAMPA	80.47	702512	Canguçu	RS
PANTANAL	2,804.91	796153	Corumbá	MS
BRAZIL	12,272.0	564317	Formosa do Rio Preto	BA

*See Appendix 9 for more details on each of the alerts in this table and the position of the responsible state agencies.

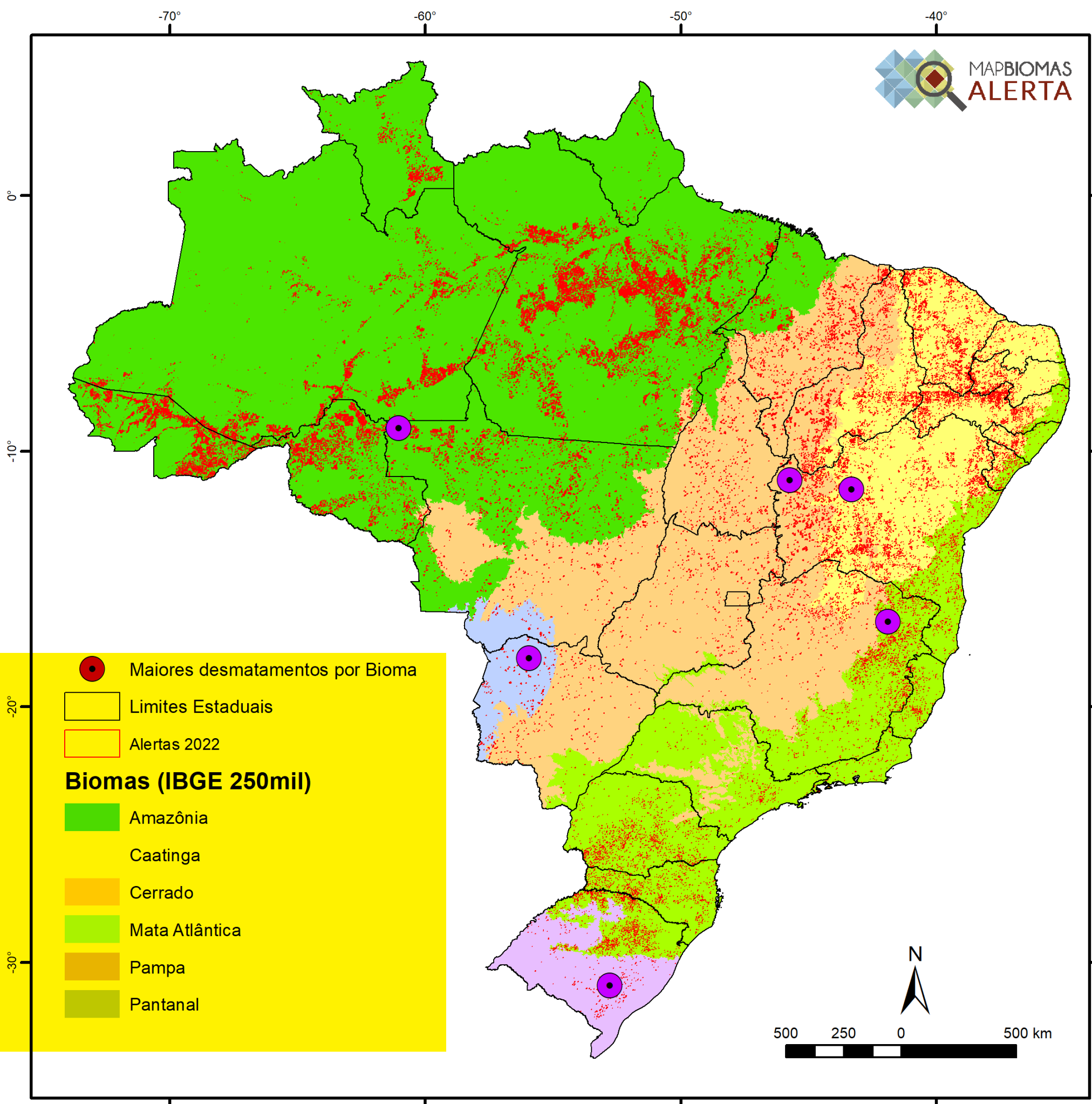


Figure 6 | Location of the largest deforestation detected in Brazil in 2022 in each of the biomes.

5.3.2.2. Alerts by size class

The areas deforested of less than 25 ha represent 81,9% of total alerts, but only 15% of the deforested area. On the other hand, the deforestation of more than 100 ha represent 4.8% of alerts, but accounts for 60.6% of the total deforested in the country. There was a 19.3% increase in the number of these alerts for more than 100 ha from 2021 to 2022(Figure7 and Table 9).

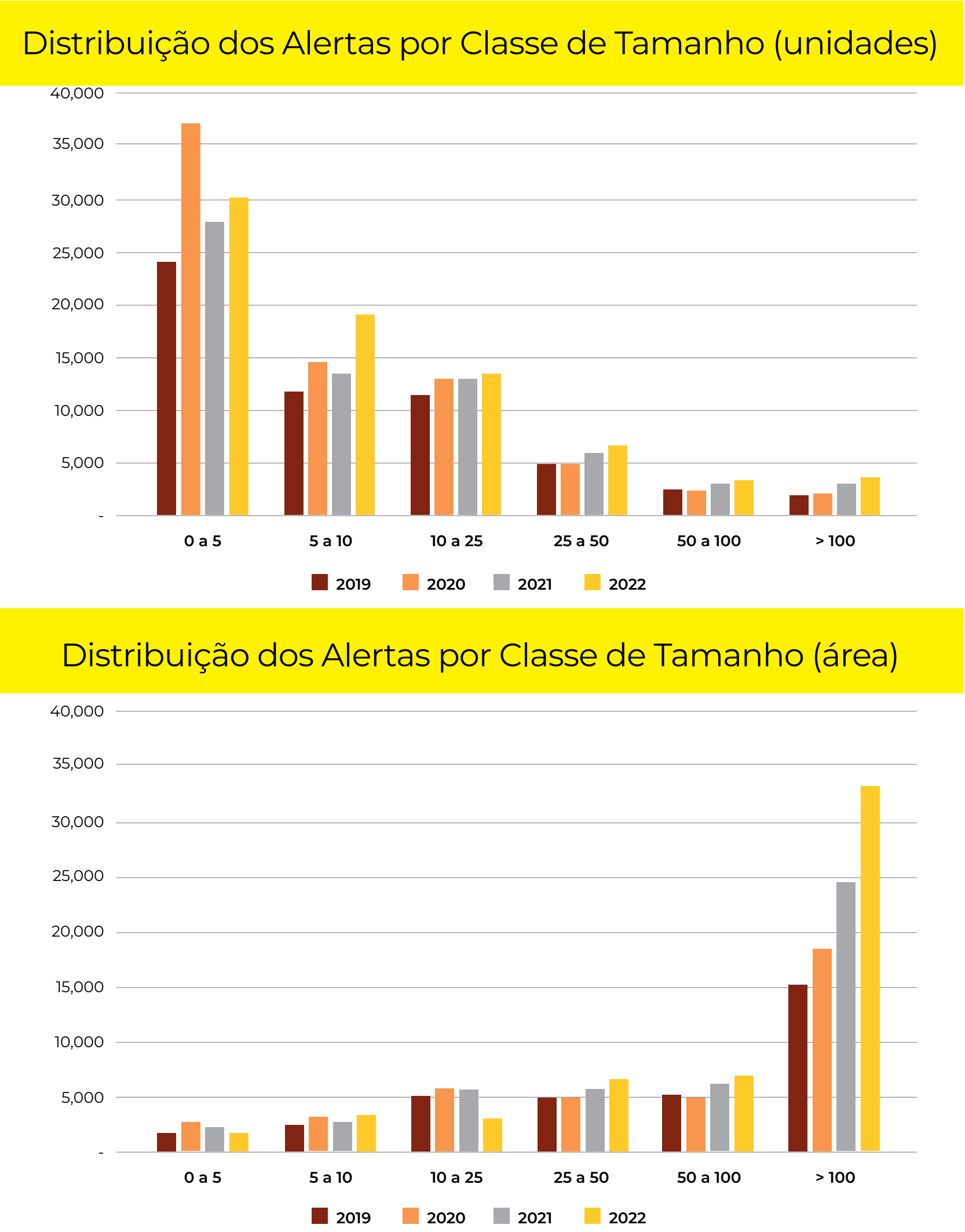


Figure 7 | Distribution of the proportion of the number of alerts and deforested area by size class (ha) in Brazil from 2019 to 2022.

Table 9 Distribution of the amount of deforestation and deforested area by size class (ha) in Brazil from 2019 to 2022.

Size Class	Units				Area (ha)			
	2019	2020	2021	2022	2019	2020	2021	2022
0 a 5	24,047	36,899	27,807	29,951	60,093	90,464	77,633	58,538
5 a 10	11,850	14,785	13,572	18,957	84,847	105,198	96,721	122,972
10 a 25	11,427	12,954	12,955	13,522	180,098	202,299	204,559	109,015
25 a 50	4,921	4,976	5,815	6,649	171,121	172,771	203,873	227,471
50 a 100	2,644	2,457	3,151	3,485	183,550	170,887	218,273	242,519
> 100	2,118	2,206	3,040	3,627	537,319	646,859	858,891	1,169,312

Size Class	Units				Area (ha)			
	2019	2020	2021	2022	2019	2020	2021	2022
0 a 5	42.2%	49.7%	41.9%	39.3%	4.9%	6.5%	4.7%	3.0%
5 a 10	20.8%	19.9%	20.5%	24.9%	6.9%	7.6%	5.8%	6.4%
10 a 25	20.0%	17.4%	19.5%	17.6%	14.8%	14.6%	12.3%	5.6%
25 a 50	8.6%	6.7%	8.8%	8.7%	14.1%	12.4%	12.3%	11.8%
50 a 100	4.6%	3.3%	4.8%	4.6%	15.1%	12.3%	13.2%	12.6%
> 100	3.7%	3.0%	4.6%	48%	44.2%	46.6%	51.7%	60.6%

5.3.3. Deforestation Speed

In 2022, the average area deforested per day was 5,636.3 hectares – or 234.8 hectares per hour (Table 10). In the Amazon alone, 3,267.5 hectares were deforested per day, or 136.1 hectares per hour. That works out to 2.3 hectares per minute, which is equivalent to about 21 trees per second. The Cerrado is in second place with 1,807.3 hectares per day, equivalent to 75.3 ha per hour.

There was a 24.3% increase in the average area deforested per day in the country compared to 2021 (which had been 4,536 ha per day or 189 ha/h). The increment occurred in all biomes, except in the Atlantic Forest, where it remained stable.

The average speed per alert also increased in 2022 (it was 0.18 in 2021 and is now 0.20 ha/alert/day). An average of 239 new deforestation events were detected and validated per day in 2022 (in 2021 there were 191).

The speed of deforestation for an alert is calculated by dividing the area deforested by the number of days elapsed between the image before and after deforestation. This speed is always underestimated since it is not always possible to obtain a good image of the exact day of the deforestation began or ended, especially in periods and places with high cloud cover. However, it is a good indication of the speed with which events occur.

The highest average rate of deforestation again occurred in the Pantanal, with 1.14 ha/day per deforestation event, followed by the Cerrado, with 0.71 ha/day (Table 10).

The maximum average deforestation speed for a single deforestation event was achieved in alert code 617708 (239 ha/day). A total of 1,913 ha was deforested between 06/11/2022 and 06/19/2022 in the municipality of Alto Parnaíba, in the state of Maranhão, in the Cerrado biome (Figure 8). In the Amazon, the highest average maximum speed observed was 36.3 ha/day for alert code

Table 10 Deforestation speed indicators by biome and in Brazil in 2022

BIOME	Average speed per Alert (ha/alert/day)	Maximum speed (ha/alert/day)	Average deforestation events per day	Deforested area per day (ha)	Deforested area per hour (ha)
AMAZON	0.20	36.3	129.6	3.267.5	136.1
CAATINGA	0.05	8.6	38.3	385.3	16.1
CERRADO	0.71	239.1	17.2	1.807.3	75.3
ATLANTIC FOREST	0.05	2.9	21.7	82.2	3.4
PAMPA	0.06	1.0	1.2	8.5	0.4
PANTANAL	1.14	25.5	0.7	85.5	3.6
BRAZIL	0.20	239.1	208.7	5.636.3	234.8

600321 located in the municipality of Novo Aripuanã, in the state of Amazonas. In the Pantanal, the alert with the highest average maximum speed observed was 25.5 ha/day, in the municipality of Corumbá, in the state of Mato Grosso do Sul (Table 11).

There was a 24.3% increase in the average area deforested per day in the country compared to 2021.

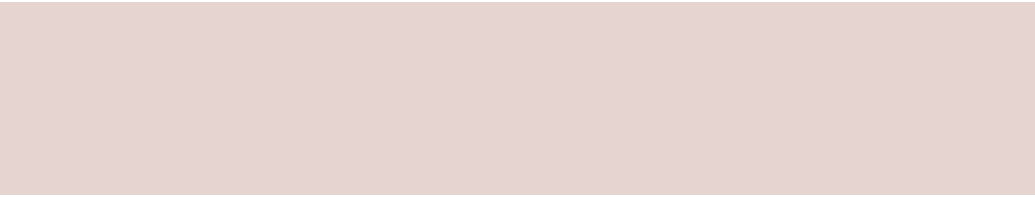




Figure 8 | Alert with the highest maximum average speed (Cód.617708) in Brazil in 2022 of 239 ha/day in the municipality of Alto Parnaíba, in the state of Maranhão, Cerrado biome, with 1,913 ha deforested between 06/11/2022 and 06/19/2022.



Table 11 Alerts with the highest average maximum speed (ha/day) by biome in 2022

BIOME	Alert code	Average Speed (ha/day)	Municipality	State
AMAZON	600321	36.30	Novo Aripuanã	AM
CAATINGA	614011	8.60	Boninal Mucuge	BA
CERRADO	617708	239.11	Alto Parnaíba	MA
ATLANTIC FOREST	589629	2.90	Aracuai	MG
PAMPA	702512	0.99	Canguçu	RS
PANTANAL	796153	25.50	Corumbá	MS

In the Amazon, the highest average maximum speed observed was 36.3 ha/day for alert located in the municipality of Novo Aripuanã.

5.3.4. Deforestation by State

All states and the Federal District had deforestation alerts detected in 2022 (Figure 9). The State of Pará leads the deforestation ranking for the fourth consecutive year with 22.2% of the deforested area in Brazil, followed by Amazonas, with 13.3%. For the second year in a row, Amazonas has overtaken Mato Grosso for second place. The deforested area in Amazonas grew by 37% compared to 2021 (Table 12).

In third place was the state of Mato Grosso, with 11.6% of the deforested area, followed by Bahia, with 10.9%. Together these 4 states (PA, AM, MT and BA) accounted for 58.1% of the deforestation detected in Brazil in 2022. In fifth place is the state of Maranhão, which in 2021 was in fourth place, but in 2022 Bahia surpassed the deforested area of this state (Table 12).

Table 12 Area and number of deforestation alerts by Brazilian state in 2019, 2020, 2021 and 2022

Data in Area (hectares):							
States	2019	2020	2021	2022	Ranking 2022	Share 2022	Variation 2021 - 2022
Pará	300,310	385,964	413,961	456,702	1	22.20%	10%
Amazonas	126,245	133,747	200,467	274,184	2	13.33%	37%
Mato Grosso	202,255	200,533	191,628	239,144	3	11.62%	25%
Bahia	66,543	116,708	151,687	225,151	4	10.94%	48%
Maranhão	81,227	232,587	172,270	168,446	5	8.19%	-2%
Piauí	42,458	77,035	68,891	148,477	6	7.22%	116%
Rondônia	122,725	119,796	132,209	139,531	7	6.78%	6%
Acre	57,238	58,155	66,242	92,189	8	4.48%	39%
Tocantins	104,406	110,652	63,501	82,966	9	4.03%	31%
Minas Gerais	26,434	46,564	47,336	50,454	10	2.45%	7%
Mato Grosso do Sul	26,496	52,044	55,959	49,162	11	2.39%	-12%
Goiás	33,682	54,495	31,410	30,915	12	1.50%	-2%
Roraima	24,206	23,153	22,322	23,535	13	1.14%	5%
Ceará	849	8,860	20,474	23,206	14	1.13%	13%
Pernambuco	132	3,766	14,442	21,886	15	1.06%	52%
Paraíba	11	2,751	6,834	6,421	16	0.31%	-6%
Rio Grande do Sul	1,145	2,159	3,748	5,197	17	0.25%	39%
Paraná	2,171	5,770	7,031	4,069	18	0.20%	-42%
Sergipe	258	846	1,495	3,658	19	0.18%	145%
Rio Grande do Norte	71	3,927	6,597	3,500	20	0.17%	-47%
Alagoas	60	952	919	3,149	21	0.15%	243%



RESULTS

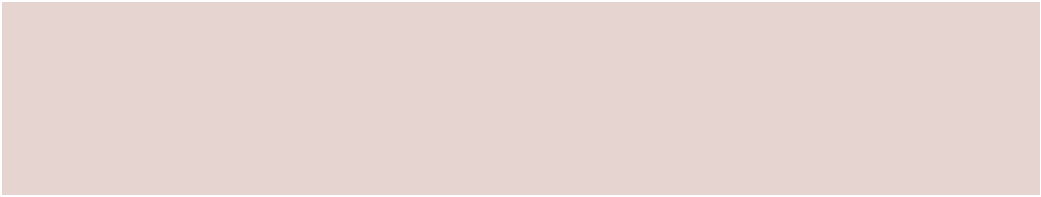
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States	2019	2020	2021	2022	Ranking 2022	Share 2022	Variation 2021 - 2022
Santa Catarina	487	1,763	1,471	2,321	22	0.11%	58%
Amapá	1,461	1,629	768	1,090	23	0.05%	42%
São Paulo	371	534	463	769	24	0.04%	66%
Espírito Santo	108	240	162	543	25	0.03%	236%
Rio de Janeiro	125	321	161	495	26	0.02%	208%
Distrito Federal	95	153	125	90	27	0.00%	-28%
Total	1.221.570	1.645.104	1.682.575	2.057.251		100%	

Data in number of deforestation events:

States	2019	2020	2021	2022	Ranking 2022	Share 2022	Variation 2021 - 2022
Pará	18,443	25,498	19,021	19,832	1	26.03%	4%
Acre	9,228	11,508	10,108	9,981	2	13.10%	-1%
Amazonas	6,987	10,237	7,963	7,463	3	9.79%	-6%
Bahia	1,224	4,741	4,801	5,986	4	7.86%	25%
Rondônia	5,217	5,464	4,841	4,553	5	5.98%	-6%
Mato Grosso	4,677	6,229	3,851	3,834	6	5.03%	0%
Ceará	29	788	2,595	3,472	7	4.56%	34%
Piauí	594	3,119	2,097	3,088	8	4.05%	47%
Minas Gerais	856	3,523	2,268	2,876	9	3.77%	27%
Pernambuco	15	344	1,569	2,543	10	3.34%	62%
Maranhão	2,486	13,237	2,796	2,236	11	2.93%	-20%
Rio Grande do Sul	222	363	586	1,955	12	2.57%	234%

Together these 4 states (PA, AM, MT and BA) accounted for 58.1% of the deforestation detected in Brazil in 2022.



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The mark of 1,000 deforestation events detected in 2022 was surpassed in 14 states. In 2021, this occurred in 13 states, and in 2020, in 12 states (Table 12 and Figure 9).

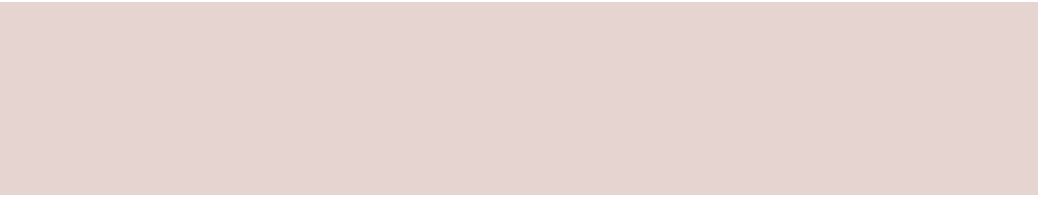
There was growth in the deforested area in 20 states, while it remained stable in two (MA and GO) and fell in only five (MS, PB, RN, PR, DF) (Table 12 and Figure 10). The most significant drops occurred in Rio Grande do Norte and Paraná (47% and 42% respectively).

Among the states where deforestation has grown the most in proportional terms are Piauí, Alagoas, Sergipe, Espírito Santo and Rio de Janeiro, with a more than 80% increase in the area detected. Sergipe falls into this group for the second consecutive year. This reflects both the growth in deforestation and improvement in the detection systems.

Eleven states surpassed the average of 100 hectares deforested per day throughout 2022, with Pará being the only one that surpassed the average of 1,000 hectares per day.

States	2019	2020	2021	2022	Ranking 2022	Share 2022	Variation 2021 - 2022
Paraná	261	783	1,901	1,491	13	1.96%	-22%
Roraima	2,121	2,525	2,114	1,360	14	1.78%	-36%
Santa Catarina	130	354	382	959	15	1.26%	151%
Paraíba	3	369	982	894	16	1.17%	-9%
Tocantins	1,916	4,814	833	726	17	0.95%	-13%
Goiás	1,097	3,075	559	505	18	0.66%	-10%
Mato Grosso do Sul	402	801	747	465	19	0.61%	-38%
Sergipe	15	63	127	420	20	0.55%	231%
São Paulo	54	90	180	366	21	0.48%	103%
Espírito Santo	19	41	33	325	22	0.43%	885%
Alagoas	6	71	61	306	23	0.40%	402%
Rio Grande do Norte	4	258	793	273	24	0.36%	-66%
Rio de Janeiro	21	42	25	143	25	0.19%	472%
Amapá	504	656	292	138	26	0.18%	-53%
Distrito Federal	4	27	2	3	27	0.00%	50%
Total	56,535	99,020	71,527	76,193		100%	

Eleven states surpassed the average of 100 hectares deforested per day throughout 2022.



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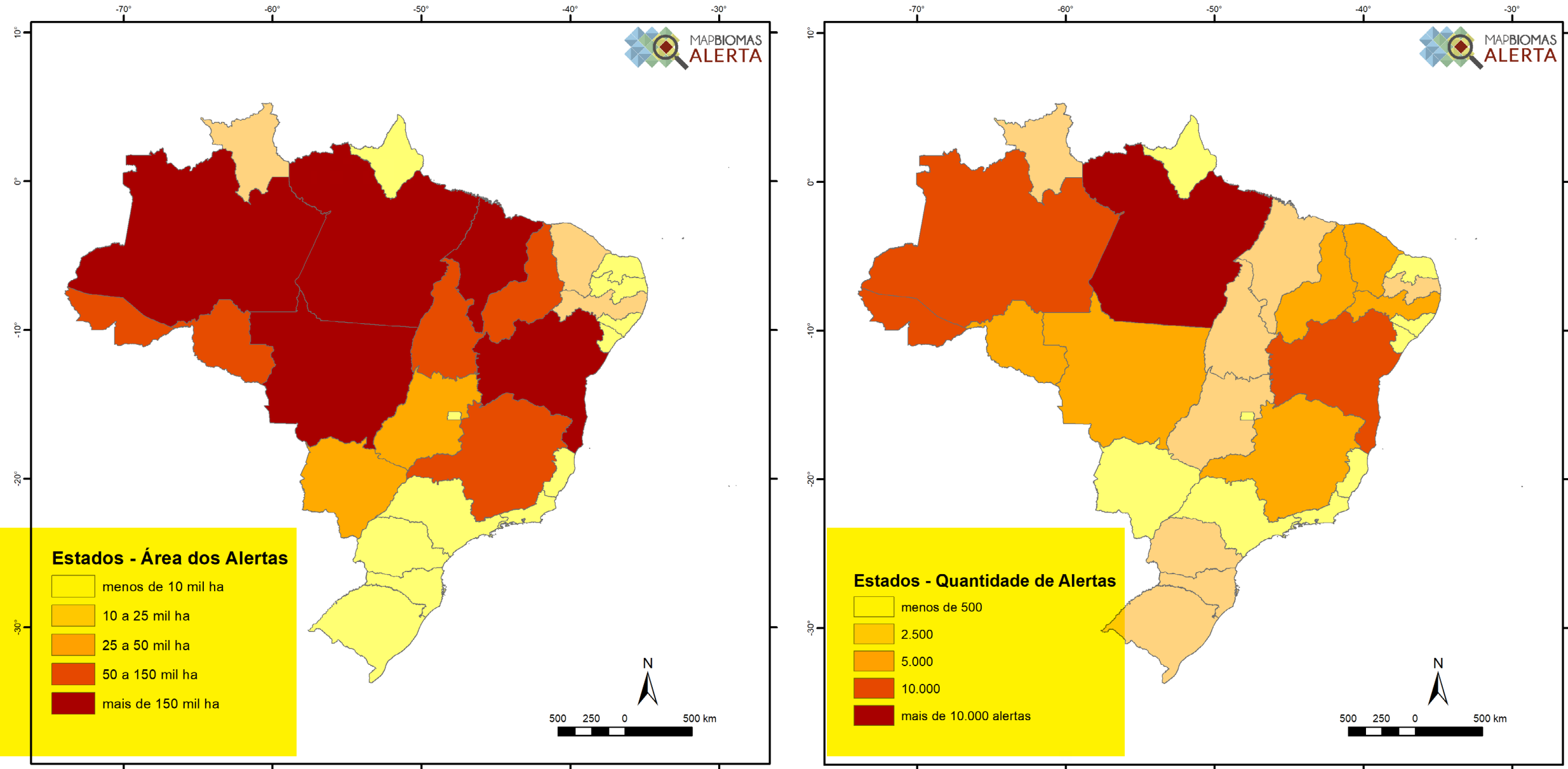


Figure 9 | Intensity of deforested area in Brazilian states in 2022

Among the states where deforestation has grown the most in proportional terms are Piauí, Alagoas, Sergipe, Espírito Santo and Rio de Janeiro, with a more than 80% increase in the area detected.

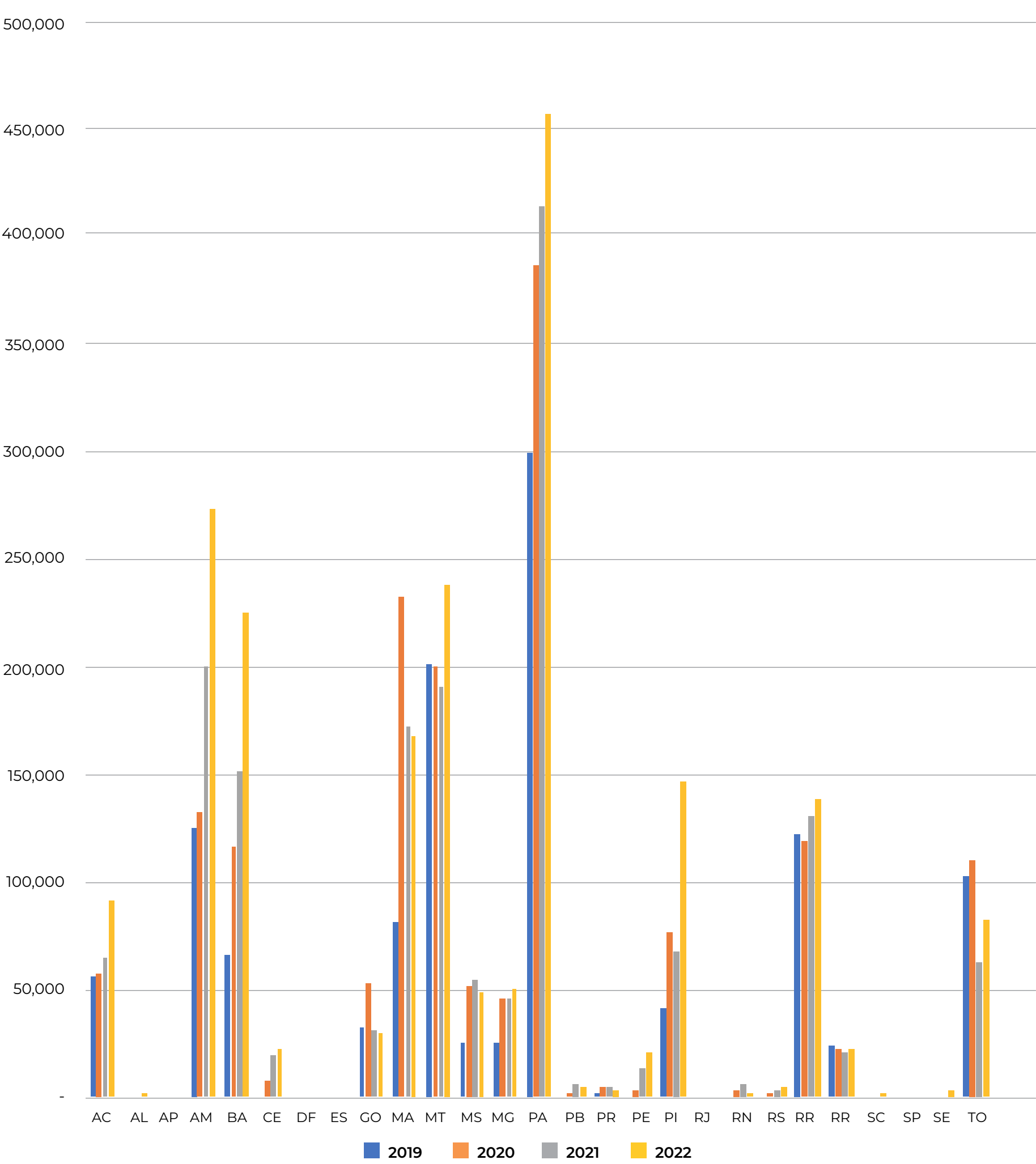
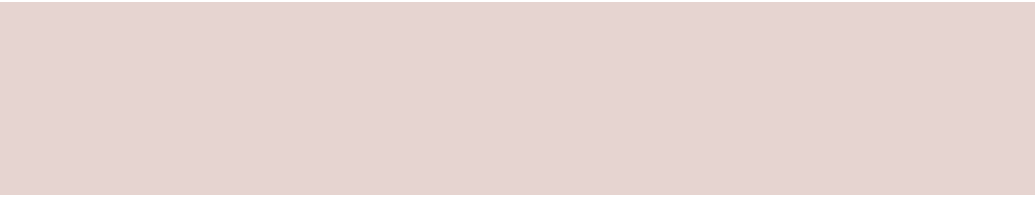


Figure 10 | Deforested area (hectares) per year in each Brazilian state from 2019 to 2022

5.3.5. Deforestation by Municipality

Of the 5,570 Brazilian municipalities, 3,471 (62%) had at least one deforestation event detected and validated in 2022 (Table 13). In the last four years combined, 74.4% of Brazilian municipalities had at least one deforestation event detected and validated. The rest (25.6%) had no deforestation detected over the last four years.

Table 13 Number of Brazilian municipalities with deforestation detected from 2019 to 2022

Period	Number of municipalities with deforestation detected	Proportion of municipalities with deforestation detected
2019	1,733	31.1%
2020	2,790	50.1%
2021	2,887	51.8%
2022	3,471	62.3%
2019-2022	4,144	74.4%

Among the 3,471 municipalities that had alerts in 2022, 50 alone accounted for 52% of the total deforested area in Brazil, with 17 of these municipalities in the state of Pará, eight in Amazonas and six in Bahia (Table 14 and Figure 11).

At the top of the ranking, the ten municipalities that deforested the most in 2022 together accounted for 21.8% of the total deforestation detected in the country in 2022.

Table 14 List of the 50 municipalities that deforested the most from 2019 to 2022 in Brazil, area deforested by municipality, variation from 2021 to 2022 and average area deforested per day by municipality.

Ranking	State	Municipality	2019	2020	2021	2022	Variation 2019-2022	Average Deforestation per day (ha/day)
1	AM	Lábrea	32,545.7	37,750.1	50,245.1	62,419.5	24%	171
2	PA	Altamira	54,250.7	60,675.6	67,856.1	61,446.2	-9%	168
3	AM	Apuí	21,865.2	22,227.7	38,337.4	61,036.4	59%	167
4	RO	Porto Velho	35,267.0	44,378.4	49,886.6	48,140.8	-3%	132
5	PA	São Félix do Xingu	40,193.2	47,005.4	52,808.8	46,892.3	-11%	128
6	BA	São Desidério	2,463.1	12,508.3	17,203.5	36,594.8	113%	100
7	MT	Colniza	18,542.9	19,877.5	23,054.4	35,708.1	55%	98
8	BA	Formosa do Rio Preto	20,636.1	14,603.1	15,086.7	33,421.3	122%	92
9	PA	Itaituba	19,222.4	21,691.5	28,070.2	33,108.1	18%	91
10	PA	Portel	11,692.1	19,247.5	22,404.8	29,723.5	33%	81
11	AM	Novo Aripuanã	18,168.4	10,841.0	16,479.3	29,534.6	79%	81
12	MA	Balsas	8,010.6	22,744.1	16,298.0	28,157.0	73%	77
13	PA	Pacajá	13,623.3	24,510.4	16,971.3	25,112.8	48%	69
14	PA	Novo Progresso	21,528.1	25,573.1	37,494.8	23,796.2	-37%	65
15	PI	Uruçuí	9,875.9	8,902.0	9,586.6	23,791.8	148%	65
16	AM	Manicoré	6,441.6	7,521.4	13,366.6	21,695.4	62%	59
17	AM	Boca do Acre	13,104.3	13,074.2	15,456.5	21,396.7	38%	59
18	BA	Jaborandi	7,799.0	7,626.5	13,390.1	20,927.5	56%	57
19	PA	Uruará	11,665.6	11,034.1	13,952.9	20,419.5	46%	56
20	PI	Sebastião Leal	124.4	8,056.1	5,594.1	20,088.9	259%	55
21	AM	Canutama	5,654.5	5,543.9	11,481.8	19,612.6	71%	54
22	RO	Candeias do Jamari	10,108.7	9,902.5	18,363.9	19,509.2	6%	53
23	BA	Correntina	3,714.1	3,870.3	8,683.2	19,087.0	120%	52
24	AC	Feijó	8,824.9	8,776.2	12,295.4	17,194.1	40%	47



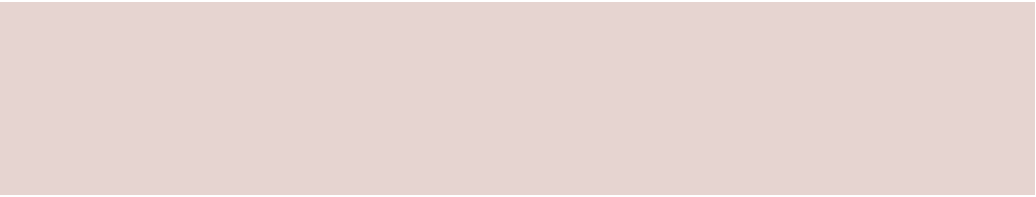
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The municipality of Lábrea, in Amazonas, with 62,419 ha de-forested, surpassed the deforested area of the municipality of Altamira in Pará, which had been the leader in deforested areas in the last three reports.

Among the 50 municipalities that deforested the most in 2022 (municipalities that proportionally more than doubled their deforested area compared to 2021), four are in the state of Piauí (Sana Filomena, Sebastião Leal, Baixa Grande do Ri-beiro and Uruçuí) and four in Bahia (Barreiras, Formosa do Rio Preto, Correntina and São Desidério). Santa Filomena, in the state of Piauí, had the highest proportional increase, with a 528% growth in the deforested area in the municipality com-pared to 2021.

Among the 50 municipalities that deforested the most in 2022 (municipalities that proportionally more than doubled their deforested area compared to 2021), four are in the state of Piauí.



Ranking	State	Municipality	2019	2020	2021	2022	Variation 2019-2022	Average Deforestation per day (ha/day)
25	PI	Santa Filomena	1,475.6	1,551.8	2,680.2	16,822.1	528%	46
26	AM	Humaitá	8,174.2	9,688.7	18,217.1	16,371.4	-10%	45
27	MS	Corumbá	4,283.0	13,985.1	10,832.3	15,749.0	45%	43
28	RO	Nova Mamoré	12,665.1	9,009.1	10,487.6	14,435.5	38%	40
29	PA	Anapu	7,728.1	11,042.1	11,173.7	13,667.3	22%	37
30	BA	Barreiras	5,390.6	5,001.3	5,310.6	13,623.5	157%	37
31	PA	Placas	8,617.8	11,858.2	10,124.4	13,449.9	33%	37
32	AC	Rio Branco	5,543.7	6,277.2	6,817.4	12,821.6	88%	35
33	PA	Novo Repartimento	8,836.2	15,438.4	12,865.0	12,638.9	-2%	35
34	PA	Medicilândia	4,714.8	9,206.6	9,695.5	12,576.2	30%	34
35	MT	Nova Bandeirantes	10,317.2	6,770.4	14,656.1	12,344.8	-16%	34
36	PA	Senador José Porfírio	9,306.5	14,325.4	10,971.4	11,943.1	9%	33
37	PI	Baixa Grande do Ribeiro	8,150.4	8,954.7	4,197.5	11,774.4	181%	32
38	PI	Currais	2,440.1	11,072.8	6,123.3	11,535.4	88%	32
39	AC	Sena Madureira	8,470.6	7,509.3	8,508.4	10,829.7	27%	30
40	PA	Mojuí dos Campos	2,204.9	3,490.7	5,577.4	10,758.6	93%	29
41	MT	Aripuanã	15,099.5	13,019.1	13,977.3	10,596.4	-24%	29
42	AC	Tarauacá	5,565.8	4,907.8	7,292.7	10,321.9	42%	28
43	AM	Juara	5,828.1	5,725.4	5,523.7	10,305.5	87%	28
44	PA	Maju	1,801.3	3,430.8	5,885.9	10,048.8	71%	28
45	RO	Cujubim	8,444.6	9,459.0	9,483.0	9,637.7	2%	26
46	PA	Trairão	8,320.7	8,101.6	11,267.9	9,381.0	-17%	26
47	BA	Riachão das Neves	1,694.5	4,454.5	4,859.8	9,105.2	87%	25
48	PA	Jacareacanga	9,366.7	7,287.8	7,974.5	8,869.3	11%	24
49	RR	Rorainópolis	5,871.1	6,393.8	5,958.9	8,826.7	48%	24
50	PA	Rurópolis	9,133.6	11,964.2	12,333.6	8,822.3	-28%	24
TOTAL			574,766.5	687,866.5	807,163.2	1,066,070.2	32%	2921

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As for the 50 municipalities that deforested the most, these are concentrated in the region where deforestation is advancing in the Amazon (in the south-central part of the states of Pará and Amazonas, the north of Mato Grosso on the border with Amazonas, in the state of Acre) and also in western portion in Bahia and in the Matopiba region (Figure 12).

Among the 50 municipalities that deforested the most in 2022, ten of them showed a decrease in deforestation compared to 2021.

The average area of daily deforestation of the 50 municipalities that deforested the most ranged from 24 ha/day (Rurópolis - PA) to 171 ha/day (Lábrea - AM).

Among the 50 municipalities that deforested the most in 2022, ten of them showed a decrease in deforestation compared to 2021.

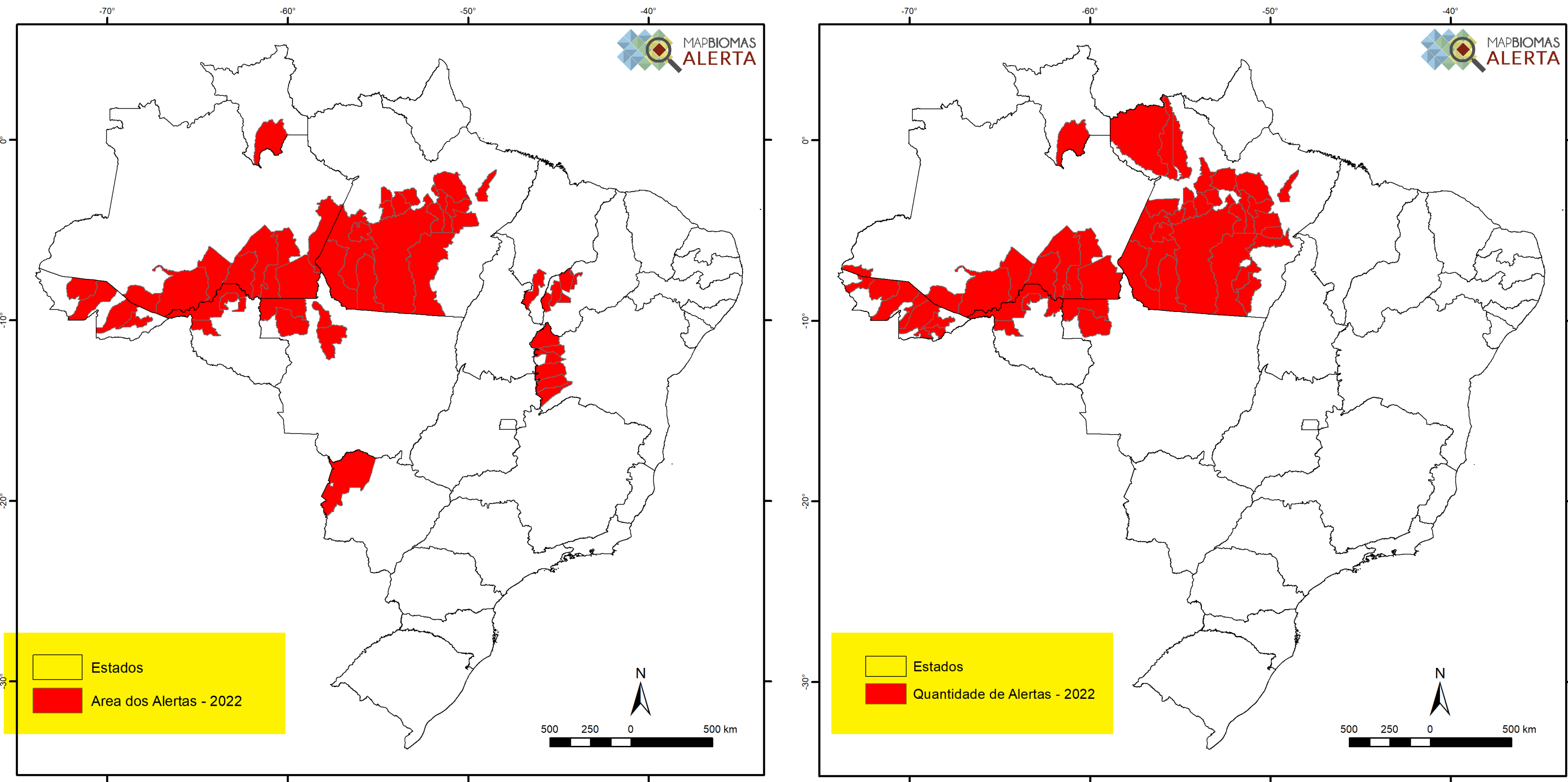


Figure 11 | 50 Brazilian municipalities with the largest area and amount of deforestation in 2022

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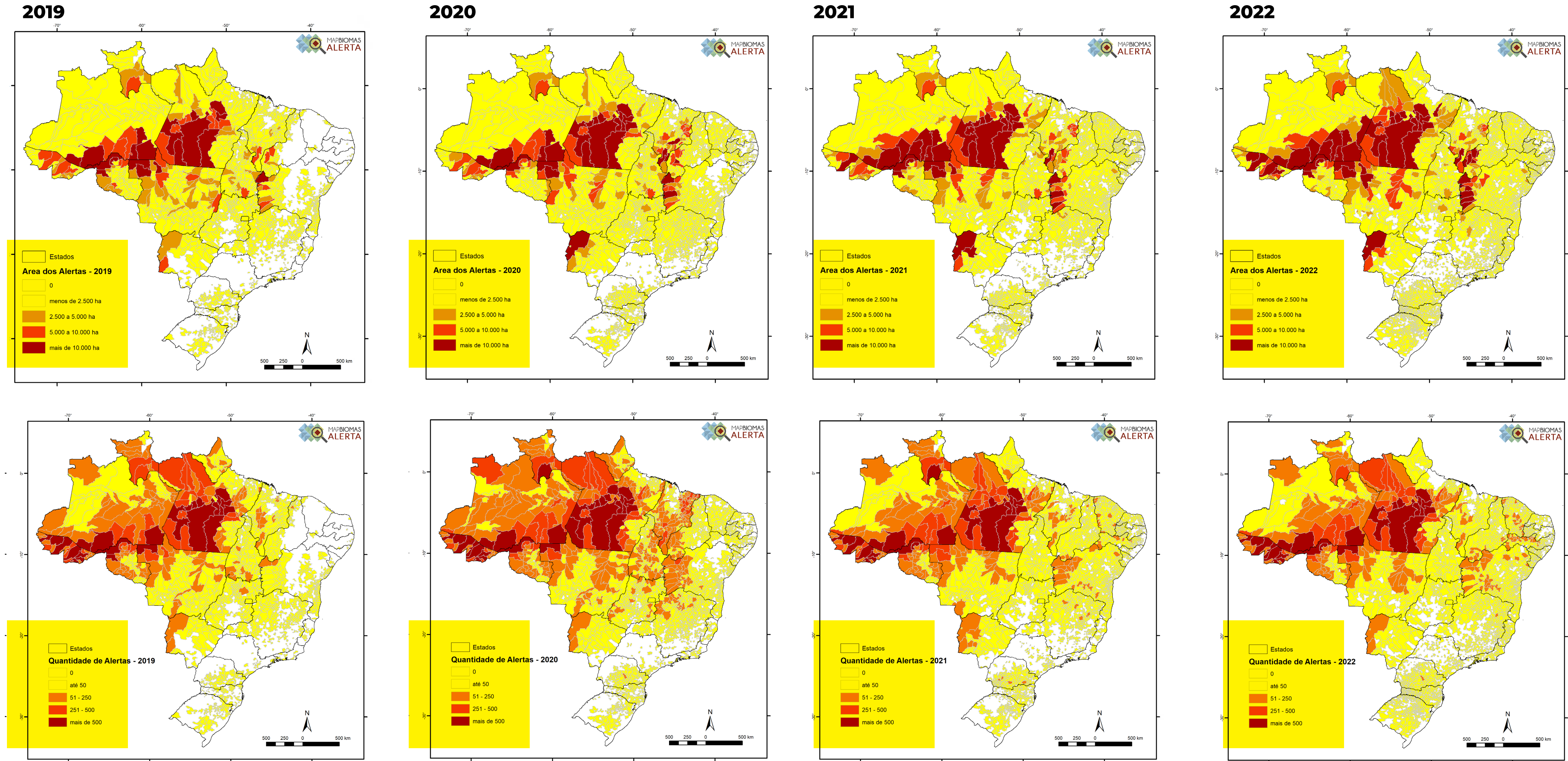


Figure 12 | Deforestation intensity in municipalities in Brazil in 2019, 2020, 2021 and 2022

5.3.6. Distribution of deforestation throughout the year

Distributing the deforested area in each alert by the days that passed between the before and after deforestation satellite image, it is possible to estimate how much was deforested each day in Brazil in 2022 (Figure 13 A).

We estimate that the day with the largest area deforested in 2022 was July 25, with 6,945 ha deforested, which is equivalent to 804 m² per second or 4.8 hectares per minute. In a single day, an area equivalent to 8,400 soccer fields was deforested.

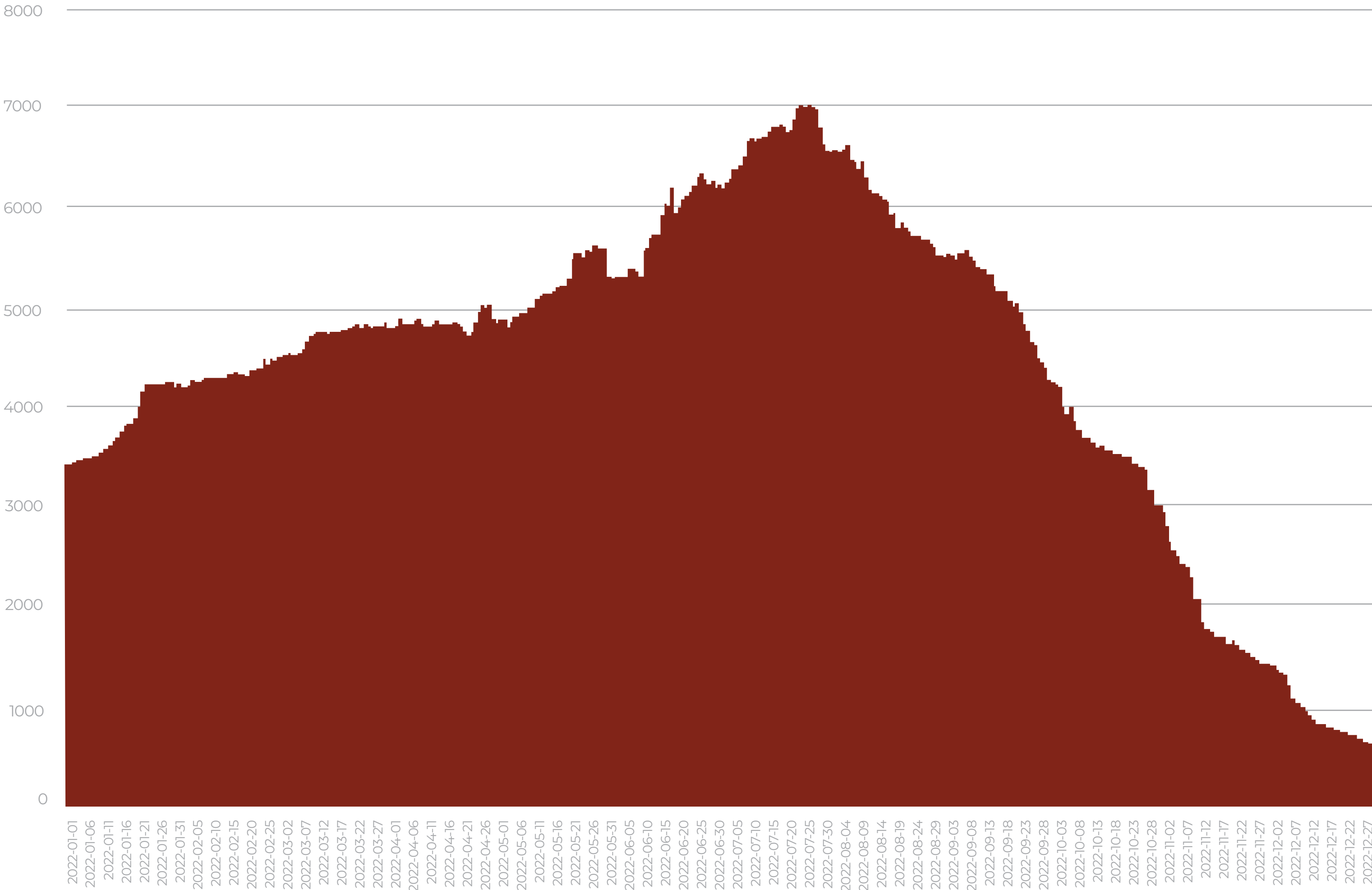
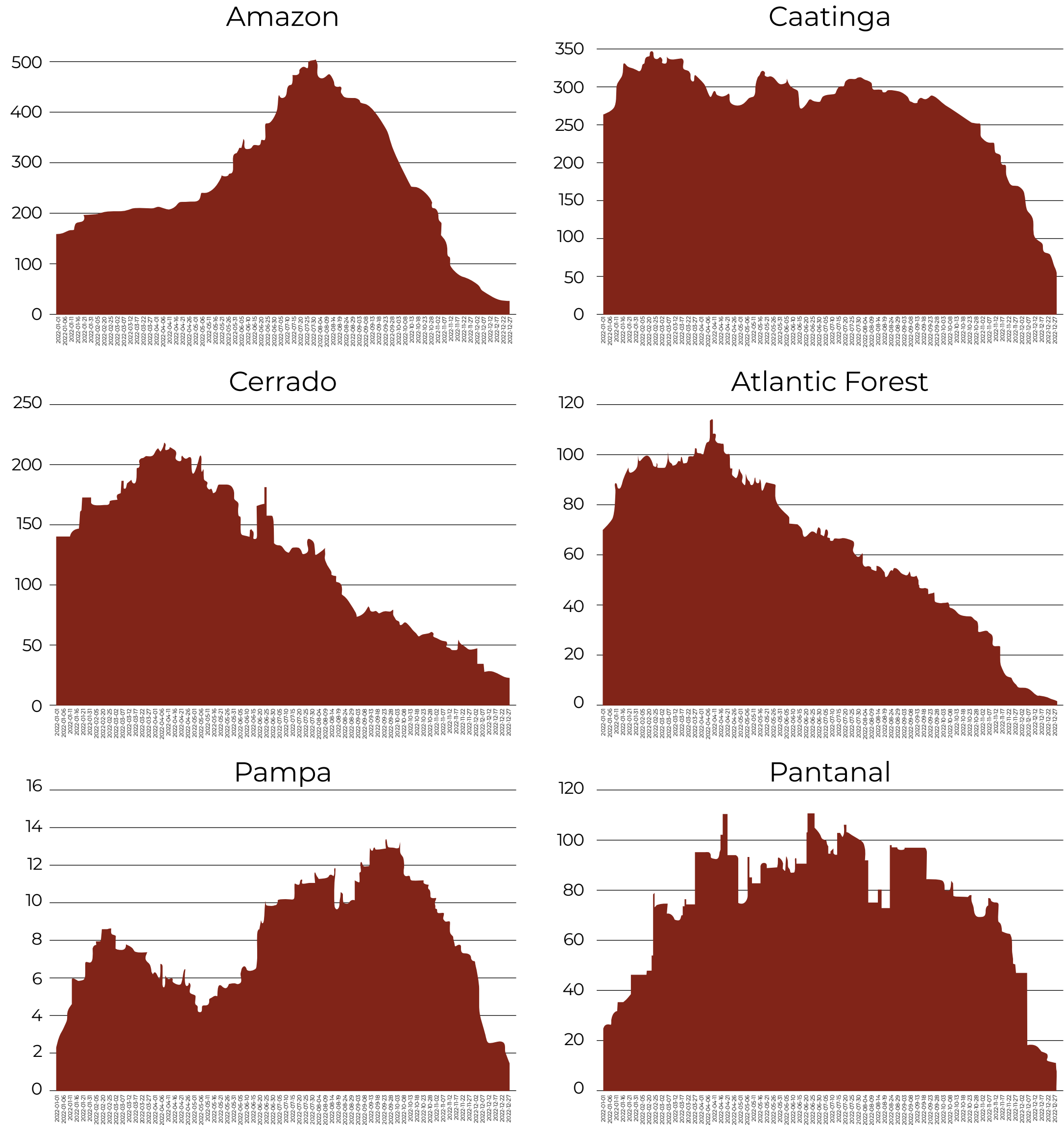


Figure 13 A | Estimate of the area deforested per day in Brazil in 2022 (ha)

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The dynamics of deforestation in the biomes present differences in behavior. In the Cerrado, the peak of deforestation occurred in early April. In the Amazon, it was at the end of July. In the Atlantic Forest, the pattern was different from the year 2021 (with its peak in August) and occurred at the end of March 2022. In the Pantanal, it was in the first half of June. In the Pampa, it was in the second half of September, and in the Caatinga in the first half of February (Figure 13 B).



Biome	Day with the most deforestation	Deforested Area (ha)
AMAZON	28/07/2022	5,092
CAATINGA	10/02/2022	348
CERRADO	04/04/2022	2,176
ATLANTIC FOREST	31/03/2022	112
PAMPA	24/09/2022	13.6
PANTANAL	14/06/2022	113
TOTAL	25/07/2022	6,945

Figure 13 B | Estimated area deforested per day per biome in 2022 (ha)

5.3.7. Type of Native Vegetation Deforested

Deforestation/conversion can happen in different formations of native vegetation. By crossing the deforested area with the coverage and land use map from MapBiomas (Collection 7.1), it is observed that in 2022 there was a predominance of deforestation in the forest formation (64.9%) and in the savanna formation (31.3%), with the remainder predominantly on rural formations (3.6%) (Figure 14).

In the Amazon, Atlantic Forest and Pampa biomes, deforestation predominates in forest formations, while in the Cerrado, Caatinga and Pantanal, it predominates in other non-forest formations. It is worth mentioning, however, that the means for detecting deforestation in non-forest native vegetation are still deficient and, therefore, deforestation in these classes is underestimated.

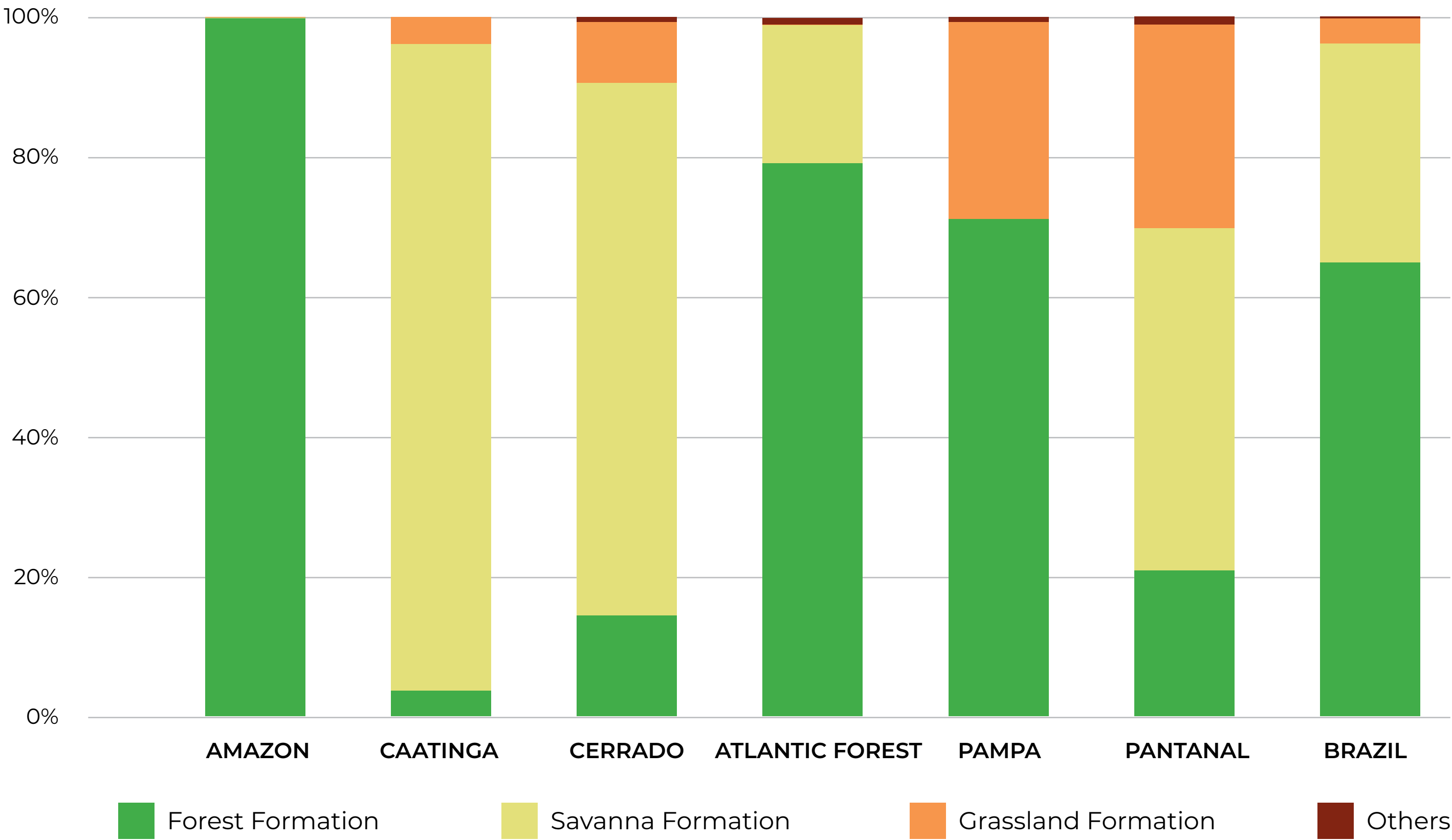


Figure 14 | Proportion of deforested area by type of native vegetation in biomes and in Brazil in 2022

Tipologia	AMAZÔNIA	CAATINGA	CERRADO	MATA ATLÂNTICA	PAMPA	PANTANAL	BRASIL
Forest Formation	99.8%	3.6%	14.4%	79.1%	71.1%	20.8%	64.9%
Savanna Formation	0.1%	92.5%	76.2%	19.7%	0.0%	49.0%	31.3%
Grassland Formation	0.1%	3.9%	8.7%	0.1%	28.2%	29.1%	3.6%
OTHERS	0.0%	0.0%	0.7%	1.0%	0.7%	1.2%	0.3%

5.3.8. Deforestation Drivers

In the validation process, an analysis is also carried out regarding the deforestation drivers, such as agriculture and ranching, garimpo, mining, urban expansion and others (Figure 15). The "other" category also includes cases in which it was not possible to identify a specific driver or in cases of deforestation for wind and solar power plants, dams, infrastructure and aquaculture.

Deforestation due to pressure from agriculture and ranching accounted for almost 96% of all deforestation validated by MapBiomas Alerta in 2022 in Brazil (Table 15). One difference occurred in some areas of Pará, where there were concentrations of alerts in which garimpo was the main driver. In areas close to capitals and large urban centers, such as in the region of São Paulo, the pressure came from urban expansion (Figure 15).

The deforestation driver class “Natural Disaster Causes” includes deforestation caused by landslides or floods (in 2021 they were considered in the “Others” class), such as, landslides located in the Serra do Mar region, between São Paulo and Rio of January.

The concentration of alerts in the "Other" category in the Caatinga refers to the challenge of initially establishing the deforestation driver right after the event, e.g., agricultural and ranching pressure. In addition, some cases are related to the expansion of infrastructure such as solar, wind and power transmission lines (Figure 15). At least 69 alerts were recorded by MapBiomas analysts in areas of wind farms, totaling 1,087.8 ha, and 23 alerts in areas of photovoltaic plants, totaling 3,203.48 ha.

Table 15 Deforested area (ha) and proportion (%) by deforestation driver in 2019 to 2022 in Brazil

Deforestation drivers	2019	2020	2021	2022	Total
Agriculture and ranching	1,203,976	1,621,725	1,626,245	1,969,095	6,421,041
Garimpo	8,992	9,029	8,049	5,965	32,035
Mining	1,479	1,447	1,466	1,128	5,521
Natural cause *	-	-	-	652	691
Urban expansion	1,053	2,507	5,867	3,407	12,834
Others	7,123	10,395	40,948	77,003	134,376
Total	1,221,570	1,645,104	1,682,575	2,057,251	6,606,499

Deforestation drivers	2019	2020	2021	2022	Total
Agriculture and ranching	98.6%	98.6%	96.7%	95.7%	97.2%
Garimpo	0.7%	0.5%	0.5%	0.3%	0.5%
Mining	0.1%	0.1%	0.1%	0.1%	0.1%
Natural cause *	-	-	-	-	-
Urban expansion	0.1%	0.2%	0.3%	0.2%	0.2%
Others	0.6%	0.6%	2.4%	3.7%	2.0%
Total	100%	100%	100%	100%	100%

* Natural Cause began to be mapped in 2022

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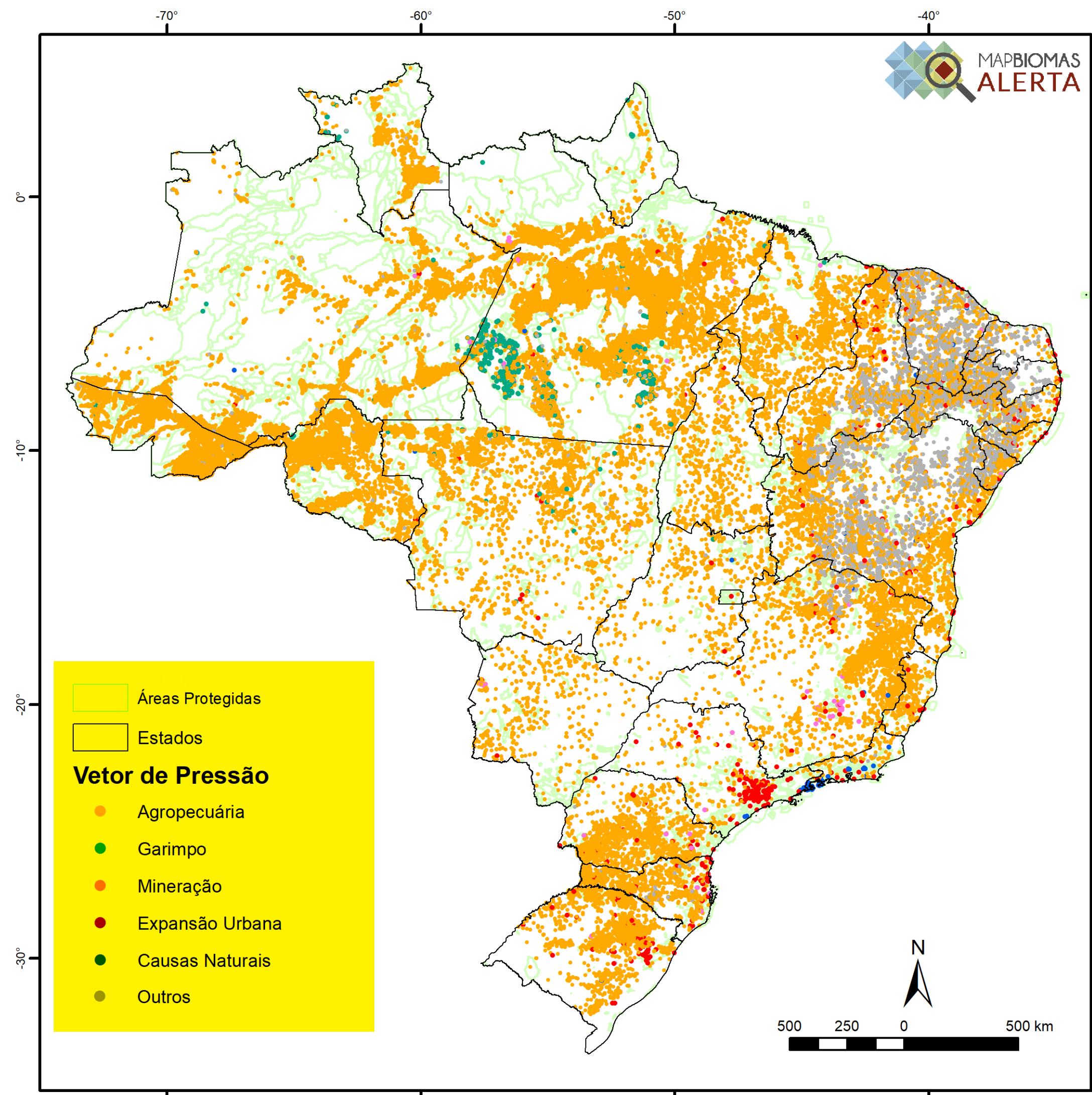


Figure 15 | Distribution of deforestation drivers in Brazil in 2022 and characteristics of deforestation alerts by different drivers

5.4. Land use planning and deforestation

In this section, we analyze the alerts according to the different types of territory in which they occur, such as Conservation Units, Indigenous Lands, Rural Settlements, Remnant Quilombo Communities, and properties registered in the Rural Environmental Registry (CAR), as well as other land types.

5.4.1. Deforestation in Conservation Units

In 2022, of the total of 2,647 federal and state terrestrial Conservation Units (UCs) - protected areas - registered in the National Registry of Conservation Units (CNUC), 289 UCs (11%) had at least one deforestation event of at least 1 hectare, a 14% increase when compared to the number observed in 2021 (253 UCs). Considering the period from 2019 to 2022, 399 PAs (15%) had at least 1 ha deforested in the period (Table 17 and Figure 15).

In total, 184,240 hectares of deforestation were detected within UCs in 2022, which represents a 9.4% increase of the total area detected in Brazil in 2021 (Table 17 and Figure 15).

Most of this deforestation occurred in Sustainable Use Conservation Units (89.6%). Deforestation in Full Protection Conservation Units represented 10.4% of the total observed in Conservation Units. However, it was in these units where the problem advanced the most. The deforested area in Full Protection UCs grew 55% compared to 2021, the second consecutive year of significant increase in the deforested area in Full Protection UCs (Table 17).

Most of this deforestation occurred in Sustainable Use Conservation Units (89.6%).

Table 16 Number of Conservation Units with deforestation detected from 2019 to 2022 in Brazil

	2019	2020	2021	2022	Total in the period from 2019 to 2022
Total UCs with detected deforestation	218	282	253	289	399
Number of Continental UCs in CNUC*	2569	2594	2639	2647	2647
% of UCs with deforestation	8%	11%	10%	11%	15%

*excluding marine UCs.

Table 17 Deforested Area (hectares) and proportion of deforested area by type of Conservation Unit in Brazil from 2019 to 2022

Conservation Unit Categories	2019	2020	2021	2022	Total for the Period
Comprehensive Protection	8,066	8,258	12,305	19,109	47,738
Ecological Station	3,091	1,584	3,714	7,157	15,546
Natural Monument	32	102	0	40	174
State Park	1,182	1,313	4,829	6,981	14,305
National Park	2,086	2,751	2,531	2,699	10,066
Wildlife Refuge	7	7	249	169	432
Biological Reserve	1,669	2,501	983	2,062	7,215
Sustainable Use	126,181	141,647	156,040	165,131	588,998
Environmental Protection area	82,773	96,084	104,609	117,513	400,979
Area of Relevant Ecological Interest	70	106	23	89	288
State Forest	1,872	3,868	1,304	6,454	13,497
National Forest	19,792	19,128	27,773	18,764	85,457
Sustainable Development Reserve	201	450	314	282	1,246
Extractive reserve	21,475	22,009	22,015	22,029	87,528
Private Natural Heritage Reserve		1	1	2	4
Total	134,247	149,904	168,344	184,240	636,736

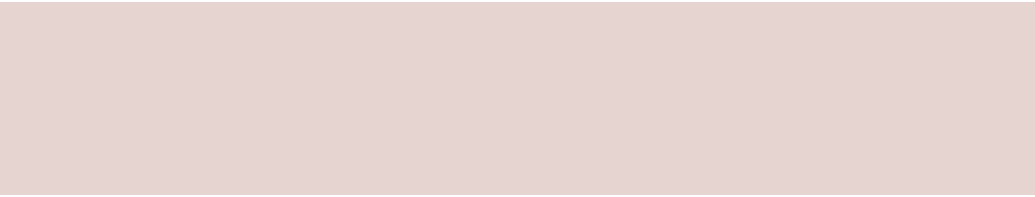
Table 17 Deforested Area (hectares) and proportion of deforested area by type of Conservation Unit in Brazil from 2019 to 2022

Conservation Unit Categories	2019	2020	2021	2022	Total for the Period
Comprehensive Protection	6.0%	5.5%	7.3%	10.4%	7.5%
Ecological Station	2.3%	1.1%	2.2%	3.9%	2.4%
Natural Monument	0.02%	0.07%	<0.01%	0.02%	0.03%
State Park	0.9%	0.9%	2.9%	3.8%	2.2%
National Park	1.6%	1.8%	1.5%	1.5%	1.6%
Wildlife Refuge	0.01%	<0.01%	0.15%	0.09%	0.07%
Biological Reserve	1.2%	1.7%	0.6%	1.1%	1.1%
Sustainable Use	94.0%	94.5%	92.7%	89.6%	92.5%
Environmental Protection area	61.7%	64.1%	62.1%	63.8%	63.0%
Area of Relevant Ecological Interest	0.05%	0.07%	0.01%	0.05%	0.05%
State Forest	1.4%	2.6%	0.8%	3.5%	2.1%
National Forest	14.7%	12.8%	16.5%	10.2%	13.4%
Sustainable Development Reserve	0.1%	0.3%	0.2%	0.2%	0.2%
Extractive reserve	16.0%	14.7%	13.1%	12.0%	13.7%
Private Natural Heritage Reserve	<0.01%	<0.01%	<0.01%	<0.01%	<0.01%
Total	100.0%	100.0%	100.0%	100.0%	100.0%

The Amazon concentrated the highest number of deforestation events in UCs in 2022 (125,422, 68%), which corresponds to 6% of the total deforested area in the country. As in previous years and reports, no deforestation was identified in UCs in the Pantanal. In the Pampa, in 2022, only 60 deforestation activities were detected in Sustainable Use UCs, specifically in Environmental Protection Areas (Table 18).

Altogether, around 9% of the deforested area in 2022 took place within a Conservation Unit in Brazil (Table 19). When excluding the Environmental Protection Area (APA) category, which allows rural production activities on private properties, the area deforested in UCs in 2022 drops to 3.2% of total deforestation in Brazil (Table 19).

The Amazon concentrated the highest number of deforestation events in UCs in 2022 (125,422, 68%).



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Table 18 Quantity and proportion of deforestation area with total or partial overlap by type of Conservation Unit in each biome in 2022

Conservation Unit Categories	Amazon	Caatinga	Cerrado	Atlantic Forest	Pampa	Pantanal	Total	Conservation Unit Categories	Amazon	Caatinga	Cerrado	Atlantic Forest	Pampa	Pantanal	Total
Comprehensive Protection	18,672	212	132	92	-	-	19,105	Comprehensive Protection	14.9%	3.7%	0.3%	8.9%	-	-	10.4%
Ecological Station	7,086	31	38	3	-	-	7,157	Ecological Station	5.6%	0.5%	0.1%	0.3%	-	-	3.9%
Natural Monument	-	40	-	0	-	-	40	Natural Monument	-	0.70%	-	0.03%	-	-	0.02%
State Park	6,890	9	73	9	-	-	6,980	State Park	5.5%	0.2%	0.1%	0.9%	-	-	3.8%
National Park	2,644	21	0	33	-	-	2,698	National Park	2.1%	0.4%	0.0%	3.2%	-	-	1.5%
Wildlife Refuge	-	111	22	36	-	-	168	Wildlife Refuge	-	1.93%	0.04%	3.53%	-	-	0.09%
Biological Reserve	2,052	-	-	10	-	-	2,062	Biological Reserve	1.6%	-	-	1.0%	-	-	1.1%
Sustainable Use	106,750	5,521	51,869	932	60		165,117	Sustainable Use	85.1%	96.3%	99.7%	91.1%	100.0%	-	89.6%
Environmental Protection area	59,960	5,521	51,050	923	60	-	117,505	Environmental Protection area	47.8%	96.3%	98.2%	90.2%	100.0%	-	63.8%
Area of Relevant Ecological Interest	88	-	-	0	-	-	89	Area of Relevant Ecological Interest	0.07%	-	-	0.05%	-	-	0.05%
State Forest	6,454	-	-	-	-	-	6,453	State Forest	5.1%	-	-	-	-	-	-
National Forest	17,958	-	806	-	-	-	18,761	National Forest	14.3%	-	1.5%	-	-	-	-
Sustainable Development Reserve	279	-	-	3	-	-	282	Sustainable Development Reserve	0.2%	-	-	0.2%	-	-	0.2%
Extractive reserve	22,012	-	13	4	-	-	22,025	Extractive reserve	17.5%	-	0.03%	0.4%	-	-	12.0%
Private Natural Heritage Reserve	-	-	-	2	-	-	2	Private Natural Heritage Reserve	-	-	-	0.2%	-	-	0.0%
Total	125,422	5,733	52,001	1,023	60		184,222	Total	100.0%	100.0%	100.0%	100.0%	100.0%	-	100.0%

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Table 19 Proportion of deforested area in Conservation Units in each biome and in Brazil in 2022 and without considering Environmental Protection Areas

Conservation Unit Categories	Amazon	Caatinga	Cerrado	Atlantic Forest	Pampa	Pantanal	Brazil
Comprehensive Protection	0.9%	0.01%	0.01%	<0.01%			0.93%
Ecological Station	0.3%	<0.01%	<0.01%	<0.01%			0.35%
Natural Monument		<0.01%	<0.01%	<0.01%			<0.01%
State Park	0.3%	<0.01%	<0.01%	<0.01%			0.34%
National Park	0.1%	<0.01%	<0.01%	<0.01%			0.13%
Wildlife Refuge		0.01%	<0.01%	<0.01%			0.01%
Biological Reserve	0.1%			<0.01%			0.10%
Sustainable Use	5.2%	0.27%	2.52%	0.05%	<0.01%	-	8.03%
Environmental Protection area	2.9%	0.27%	2.48%	0.04%	<0.01%		5.71%
Area of Relevant Ecological Interest	<0.01%			<0.01%			<0.01%
State Forest	0.3%						0.31%
National Forest	0.9%		0.04%				0.91%
Sustainable Development Reserve	<0.01%			<0.01%			0.01%
Extractive reserve	1.1%		0.00%	<0.01%			1.07%
Private Natural Heritage Reserve				<0.01%			<0.01%
Total	6.1%	0.28%	2.53%	0.05%	<0.01%	-	8.96%
Total without considering APA	3.2%	0.01%	0.05%	<0.01%	<0.01%		3.24%

Of the total of 289 PAs with deforestation in 2022, 25 had more than 1,000 hectares deforested, 11 of which were APAs. They are located in ten states: PA, RO, BA, TO, AC, CE, MA, PI, MG and GO (Figure 16).

In 2022, the PA with the largest area deforested for the second consecutive year was the APA of Triunfo do Xingu (PA) in the Amazon biome, with 45,543 ha deforested (Figure 17). In second place was the APA of Rio Preto (BA) in the Cerrado, with 33,348 ha. The UC with the highest number of deforestation events was RESEX Chico Mendes, in Acre, with 1,448 alerts (Table 20).

Table 20 List of the 50 Conservation Units with the largest deforested area in Brazil in 2022

Ranking	Name and Code of the Conservation Unit in SNUC	State	Number of Alerts in 2022	Area (ha) deforested in 2022
1	Triunfo do Xingu Environmental Protection Area (1039)	PA	597	45,543
2	Rio Preto Environmental Protection Area (1016)	BA	110	33,348
3	Tapajós Environmental Protection Area (268)	PA	352	10,621
4	Jamanxim National Forest (266)	PA	89	9,590
5	Chico Mendes Extractive Reserve (222)	AC	1,448	8,485
6	Ilha do Bananal/Cantão Environmental Protection Area (1501)	TO	65	6,970
7	Guajará-Mirim State Park	RO	178	6,834
8	Jaci-Paraná Extractive Reserve (776)	RO	123	5,177
9	Terra do Meio Ecological Station	PA	89	4,334
10	Altamira National Forest (83)	PA	53	3,371



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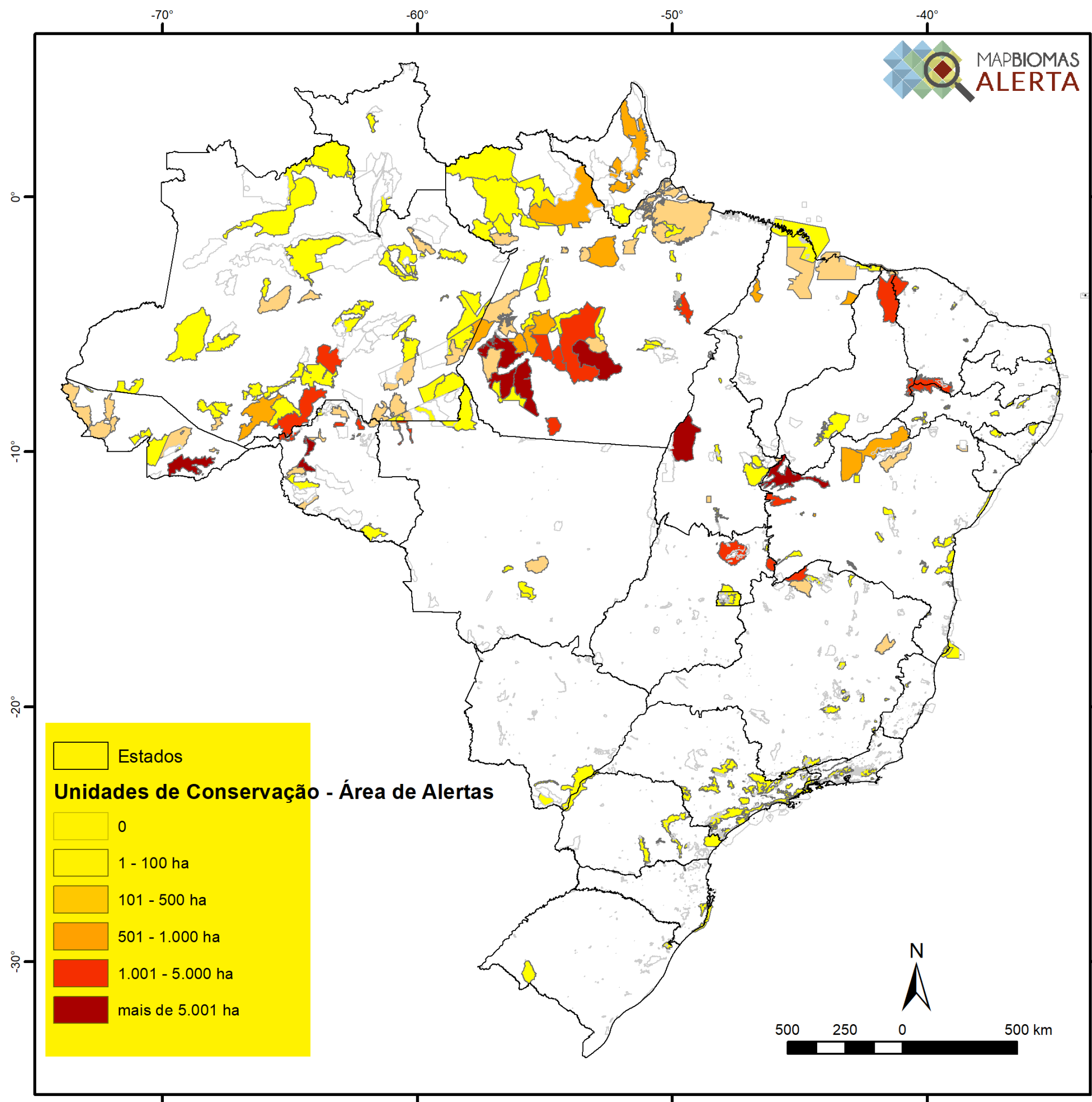


Figure 16 | Conservation Units with deforestation in Brazil in 2022

Ranking	Name and Code of the Conservation Unit in SNUC	State	Number of Alerts in 2022	Area (ha) deforested in 2022
11	Iriti State Forest (1036)	PA	16	2,859
12	Serra da Ibiapaba Environmental Protection Area (29)	CE e PI	412	2,768
13	Samuel Ecological Station	RO	77	2,508
14	Rio De Janeiro Basin Environmental Protection Area (305)	BA	16	2,169
15	Tucuruí Lake Environmental Protection Area (1029)	PA	168	2,105
16	Chapada do Araripe Environmental Protection Area (8)	CE, PE e PI	238	2,068
17	Rio Preto-Jacundá Extractive Reserve (777)	RO	42	1,901
18	Pouso Alto Environmental Protection Area (900)	GO	11	1,853
19	Tapauá State Forest (1731)	AM	20	1,769
20	Nascentes Serra do Cachimbo Biological Reserve	PA	26	1,382
21	Guariba-Roosevelt Extractive Reserve (463)	MT	51	1,366
22	Environmental Protection Area of Nascentes do Rio Vermelho (28)	GO	14	1,309
23	Urupadi National Forest (3408)	AM e PA	26	1,308
24	Cochá E Gibão Environmental Protection Area (894)	MG	16	1,162
25	Mapinguari National Park	AM e RO	39	1,104
26	Forever Green Extractive Reserve (260)	PA	197	958
27	Paru State Forest (1038)	PA	35	860
28	Cristópolis National Forest (90)	BA	4	806
29	Jamanxim National Park	PA	9	755
30	Dunas e Veredas do Baixo Médio São Francisco Environmental Protection Area (317)	BA	84	706



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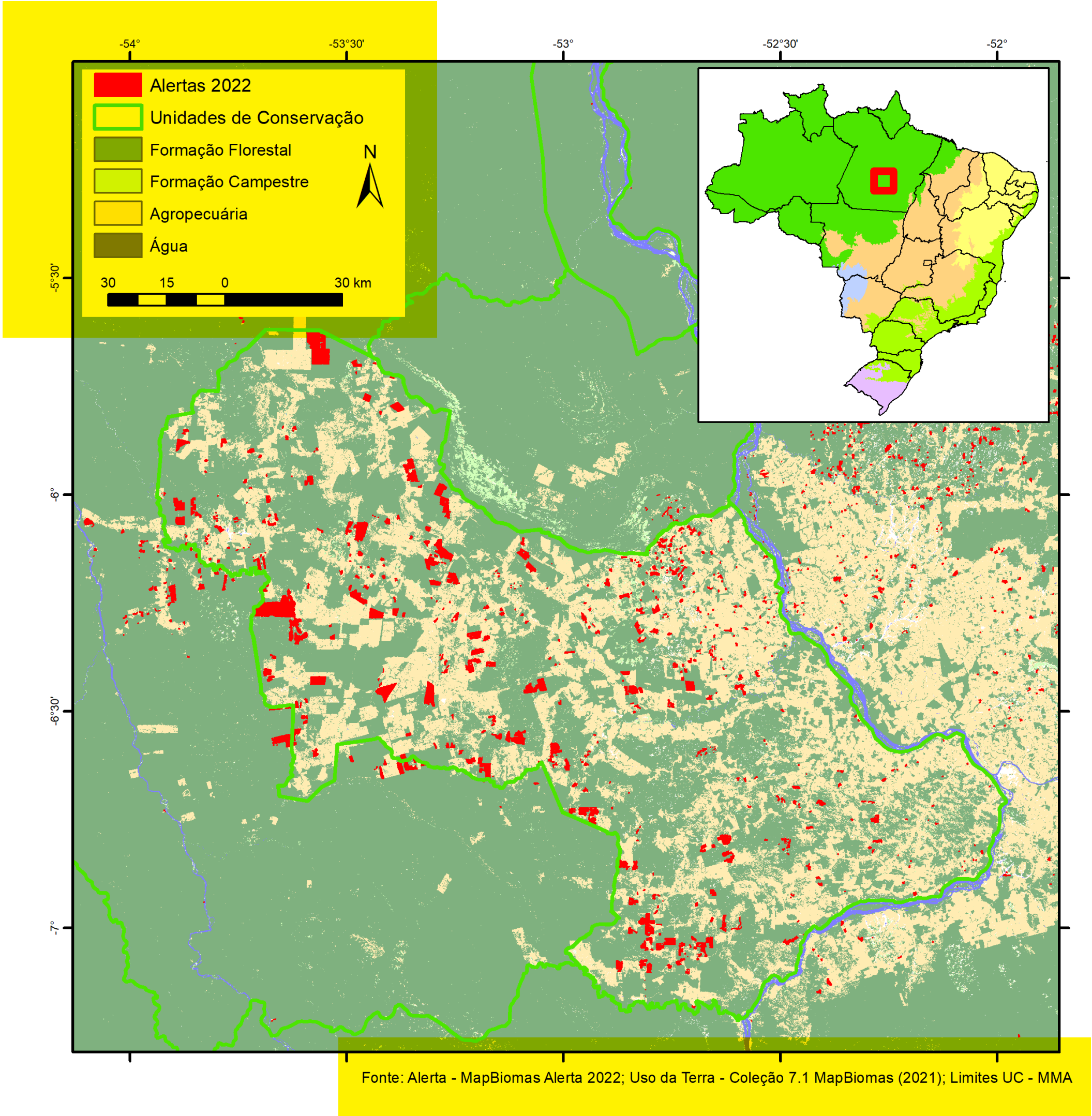


Figure 17 | Deforestation alerts at APA Triunfo do Xingu (PA), Conservation Unit with the largest area of deforestation detected in 2022

Ranking	Name and Code of the Conservation Unit in SNUC	State	Number of Alerts in 2022	Area (ha) deforested in 2022
31	Iquiri National Forest (1612)	AM	11	671
32	Gurupi Biological Reserve	MA	46	657
33	Riozinho Do Anfrísio Extractive Reserve (258)	PA	75	563
34	Amaná National Forest (271)	PA	50	558
35	Morros Garapenses Environmental Protection Area (1892)	AM e PA	9	557
36	Lago De Sobradinho Environmental Protection Area (1015)	BA	99	536
37	Angelim Extractive Reserve (743)	RO	26	528
38	Amapá State Forest (885)	AP	31	517
39	Alto Juruá Extractive Reserve (1517)	AC	166	489
40	Aripuanã National Forest (3409)	AM	6	485
41	Rio Cautário Extractive Reserve (775)	AC	9	474
42	Baixada Maranhense Environmental Protection Area (1887)	MA	37	432
43	Presidente Figueiredo Environmental Protection Area - Moroaga Cave (993)	AM	66	413
44	Bacia do Rio Pandeiros Environmental Protection Area (355)	MG	8	369
45	Cazumbá-Iracema Extractive Reserve (232)	AC	111	358
46	Serra Branca / Raso Da Catarina Environmental Protection Area (322)	BA	6	354
47	Environmental Protection Area of Cuiabá River Headwaters (453)	MA	4	343
48	Upaon-Açu / Miritiba / Alto Preguiças Environmental Protection Area (1888)	MA	25	341
49	Saracá-Taquera National Forest (109)	PA	21	329
50	Serra da Tabatinga Environmental Protection Area (12)	BA	1	323

5.4.2. Deforestation in Indigenous Lands

Of the total of 573 Indigenous Lands (TIs) in Brazil (considering their various phases of recognition and demarcation, including an interdiction order), 210 (37%) had at least one deforestation event in 2022 (Figure 18). The number of TIs where some deforestation was observed from 2019 to 2022 reached 354 (62%) (Table 21).

Table 21 Distribution of deforestation in Indigenous Lands in Brazil from 2019 to 2022

Deforestation in TIs compared to total TIs	2019	2020	2021	2022	Total in the period from 2019 to 2022
Number of TIs with detected deforestation	212	288	228	210	354
Number of TIs in Brazil	573				
% of TIs with detected deforestation	37%	50%	40%	37%	62%

Deforestation in TIs compared to Brazil's total	2019	2020	2021	2022	Total in the period from 2019 to 2022
Deforested area in TIs (ha)	40,217	38,959	32,598	29,344	141,117
Total deforested area in Brazil (ha)	1,221,570	1,645,104	1,682,575	2,057,251	6,606,499
% of deforested areas in TIs in Brazil	3.3%	2.4%	1.9%	1.4%	2.1%

Deforestations that occurred in TIs represented 4.5% of the total alerts and 1.4% of the total deforested area in Brazil in 2022. Most of the alerts and the deforested area in TIs are in the Amazon biome (26,598 ha, 91 %). Pampa had no overlapping alerts in TIs (Table 22).

Table 22 Deforestation alerts overlapping with Indigenous Lands by biome from 2019 to 2022

Deforestation Area (ha) in TIs by biome

Biome	2019	2020	2021	2022	Total
Amazon	36,998	34,619	28,841	26,598	127,056
Caatinga	12	10	116	114	252
Cerrado	2,850	3,671	3,438	2,450	12,409
Atlantic Forest	190	599	203	180	1,171
Pampa	-	-	-	-	-
Pantanal	168	60		2	230
Total	40,217	38,959	32,598	29,344	141,117

Number of deforestation events in TIs by biome

Biome	2019	2020	2021	2022	Total
Amazon	3,298	5,306	3,257	3,283	15,144
Caatinga	2	5	23	41	71
Cerrado	26	312	101	111	550
Atlantic Forest	14	38	46	42	140
Pampa	-	-	-	-	-
Pantanal	3	2		3	8
Total	3,343	5,663	3,427	3,480	15,913

Most of the alerts and the deforested area in TIs are in the Amazon biome.

3 | This number only excludes TIs that are in the "delimited" and "under study" categories in the FUNAI database. Includes finally approved, forwarded RI (Indigenous Reserve), declared and regularized.

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The largest area deforested in a TI in 2022 occurred in TI Apyterewa in the state of Pará, for the second consecutive year, with 10,525 ha deforested in 594 deforestation events (Figure 19 and Table 23). There was deforestation of more than 1,000 ha in six TIs.

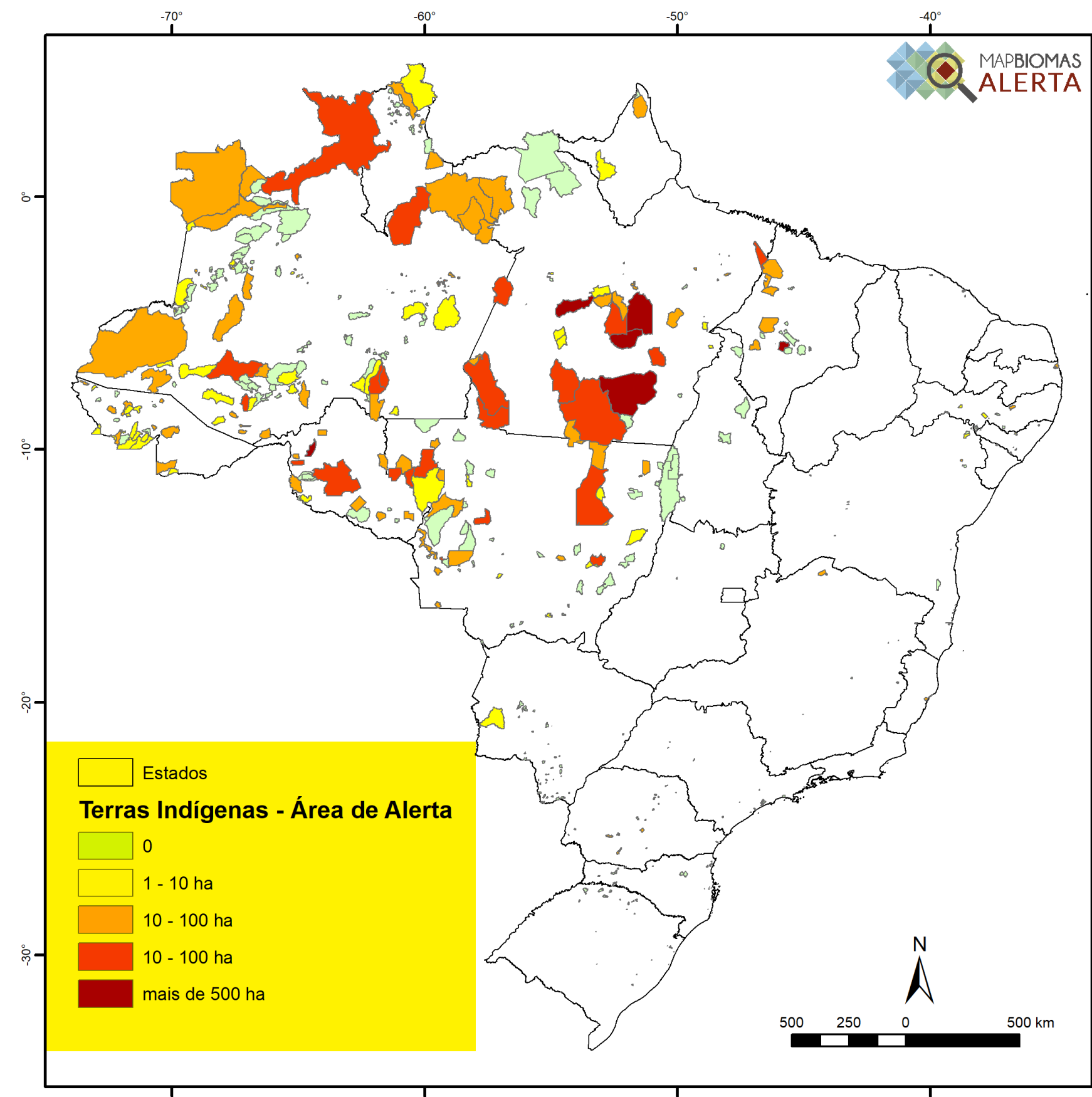


Figure 18 | Indigenous Lands with deforestation above 100 ha in Brazil in 2022

Table 23 List of the 50 Indigenous Lands with the largest deforested area in 2022 in Brazil

	Indigenous land name	State	Number of deforestation alerts in IT	Deforested area in the TI (ha)
1	Apyterewa (3002)	Pará	594	10,525
2	Cachoeira Seca (7601)	Pará	235	2,096
3	Karipuna (21601)	Rondônia	69	1,796
4	Kayapó (23001)	Pará	632	1,641
5	Trincheira Bacaja (46201)	Pará	192	1,188
6	Ituna/Itatá (restrição de uso) (72601)	Pará	72	1,150
7	Kanela Memortumré (20702)	Maranhão	5	998
8	Bacurizinho (4902)	Maranhão	9	470
9	Tenharim Marmelos (Gleba B) (62901)	Amazonas	14	444
10	Manoki (17302)	Mato Grosso	10	429
11	Sepoti (42301)	Amazonas	18	428
12	Porquinhos dos Canela-Apãnjekra (36602)	Maranhão	5	388
13	Igarapé Lage(16101)	Rondônia	35	347
14	Parque do Xingu (33801)	Mato Grosso and Roraima	175	610
15	Sete de Setembro (43001)	Mato Grosso	14	258
16	Alto Rio Guamá (1001)	Pará	45	256
17	Munduruku (29801)	Pará	48	253
18	Aripuanã (4201)	Mato Grosso	17	224
19	Uirapuru (47901)	Mato Grosso	1	220
20	Kayabi (22902)	Mato Grosso	3	211
21	Araweté Igarapé Ipixuna (3801)	Pará	35	190
22	Sissaíma (69001)	Amazonas	8	189
23	Andirá-Marau (2001)	Amazonas and Pará	97	185



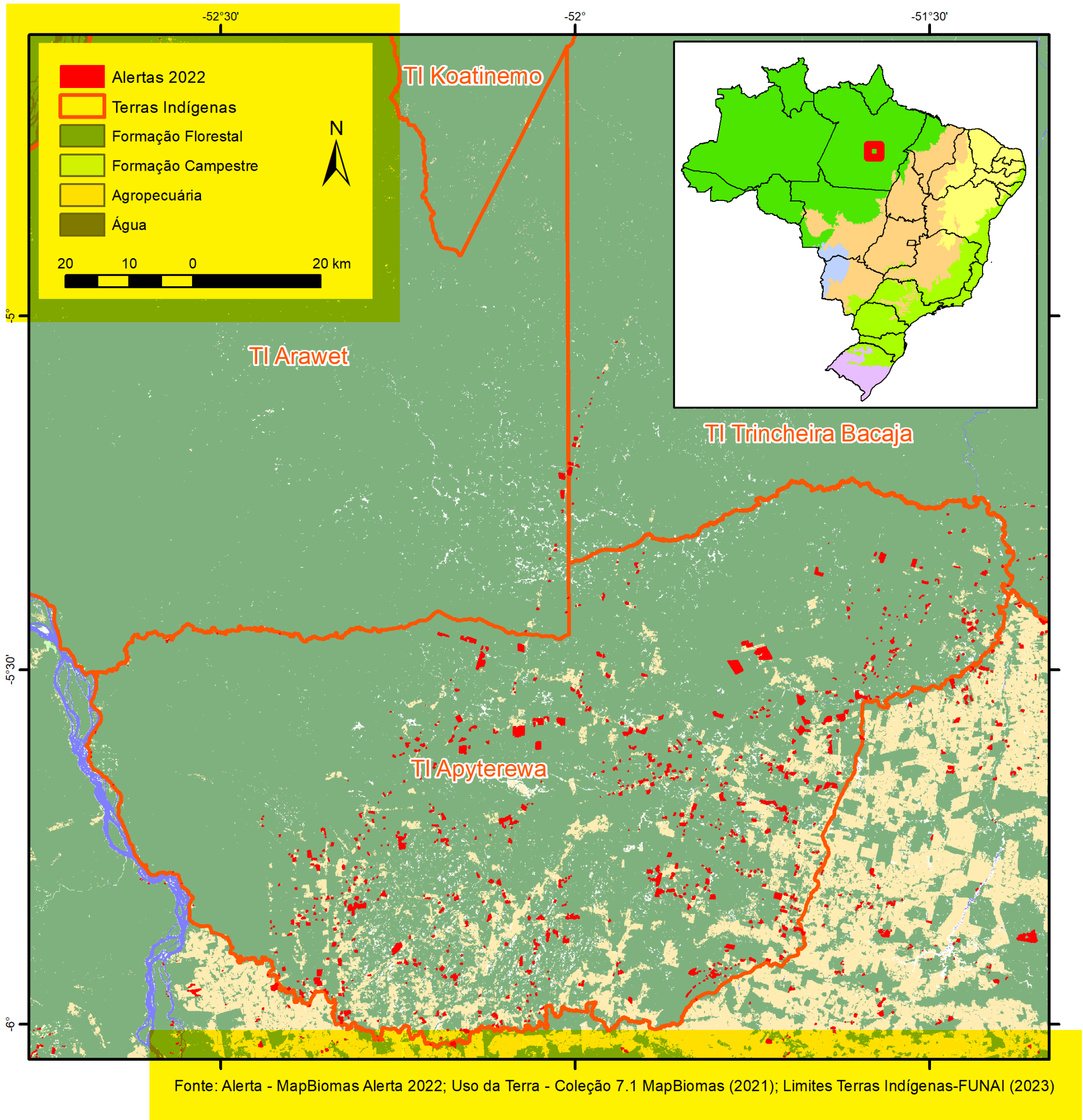


Figure 19 | Deforestation alerts in the Apyterewa TI (PA), Indigenous Land with the largest area of deforestation detected in 2022

	Indigenous land name	State	Number of deforestation alerts in IT	Deforested area in the TI (ha)
24	Uru-Eu-Wau-Wau (48201)	Rondônia	17	158
25	Parabubure (32701)	Mato Grosso	51	151
26	Peneri/Tacaquiri (34701)	Amazonas	7	151
27	Deni (10901)	Amazonas	17	129
28	Amanayé(1701)	Pará	2	125
29	Xikrin do Rio Catete (50501)	Pará	15	123
30	Roosevelt (40701)	Rondônia	24	232
31	Murutinga/Tracaja (30101)	Amazonas	10	101
32	Karitiana (21801)	Rondônia	2	100
33	Urubu Branco (48301)	Mato Grosso and Para	25	186
34	Menkragnoti (28701)	Mato Grosso	2	88
35	Alto Rio Purus (1201)	Acre	7	85
36	Tuwa Apekuokawera (63901)	Pará	3	82
37	Arariboia (3601)	Maranhão	15	80
38	Waimiri-Atroari (49501)	Amazonas	22	76
39	Vale do Javari (48701)	Amazonas	34	70
40	Boca do Acre (6401)	Amazonas	11	70
41	Zoró (51101)	Mato Grosso	5	62
42	Sarauá (58901)	Pará	13	62
43	Jauary (19301)	Amazonas	6	60
44	Uaçá (47601)	Amapá e Pará	42	115
45	Alto Rio Negro (1101)	Amazonas	26	54
46	Zuruahã (51201)	Amazonas	5	51
47	Enawenê-Nawê (11201)	Mato Grosso	10	51
48	Tenharim Marmelos (44801)	Amazonas and Rondônia	18	98
49	Ponciano (53201)	Amazonas	2	48
50	Rio das Cobras (39001)	Paraná	2	48

5.4.3. Deforestation in Rural Settlements

Of the 9,155 rural settlements registered in the INCRA database, including those within Sustainable Use Conservation Units (e.g., RDS and Resex), 1,562 (17%) had at least one deforestation alert in 2022 (Table 24 and Figure 20). Considering only those that had more than 10 ha deforested, 994 (10.8%) registered some deforestation event.

Table 24 Alerts with full or partial overlap with rural settlements in Brazil in 2022

Deforestation in Settlements compared to the total of Settlements	2019	2020	2021	2022	Total in the period from 2019 to 2022
Total Settlements with detected deforestation	1,327	2,099	1,534	1,562	2,851
Number of Settlements in Brazil	9,155				
% of Settlements with detected deforestation	14%	23%	17%	17%	31%

Deforestation in Settlement compared to Brazil's total	2019	2020	2021	2022	Total in the period from 2019 to 2022
Deforested area in Settlements (ha)*	197,920	248,145	256,483	312,462	1,015,010
Total deforested area in Brazil (ha)	1,221,570	1,645,104	1,682,575	2,057,251	6,606,499
% of deforested areas in Settlements in Brazil	16.2%	15.1%	15.2%	15.2%	15.4%

* not counting settlements in UCs (FLONA, Resex and RDS) and considering deforestation greater than 0.3 ha.

Deforestations that overlapped with areas of rural settlements represented 17% of the total area deforested in Brazil in 2022 (Table 24). The Amazon biome had the highest concentration of deforested area in rural settlements (295,402 ha, 95%) (Table 25).

Table 25 Distribution of deforestation in rural settlements in Brazil by biome from 2019 to 2022

Deforestation Area (ha) in Settlements by Biome

Biome	2019	2020	2021	2022	Total
Amazon	184,484	216,479	237,501	295,402	933,865
Caatinga	967	3,086	3,676	3,764	11,494
Cerrado	12,058	27,981	13,936	12,355	66,330
Atlantic Forest	277	434	1,189	659	2,558
Pampa	3	5	14	56	78
Pantanal	132	160	167	226	684
Total	197,920	248,145	256,483	312,462	1,015,010

Number of Deforestation Alerts in Settlements by Biome

Biome	2019	2020	2021	2022	Total
Amazon	15,222	18,746	15,114	15,279	64,361
Caatinga	68	512	644	665	1,889
Cerrado	727	3,604	795	537	5,663
Atlantic Forest	34	85	197	172	488
Pampa	1	2	4	11	18
Pantanal	11	13	18	32	74
Total	16,063	22,962	16,772	16,696	72,493

The Amazon biome had the highest concentration of deforested area in rural settlements (295,402 ha, 95%)

The greatest deforestation in rural settlements occurred in the states of Amazonas, Pará, Rondônia, Acre and Roraima (Table 26 and Figure 20). With 32,373 ha of native vegetation suppressed, the rural settlement PA Rio Juma, in the municipality of Apuí (AM), for the third consecutive year was the settlement that most deforested in Brazil (Figure 21). The runner-up was again deforestation in PDS Liberdade I, in Pará, with 14,450 ha (Table 26).

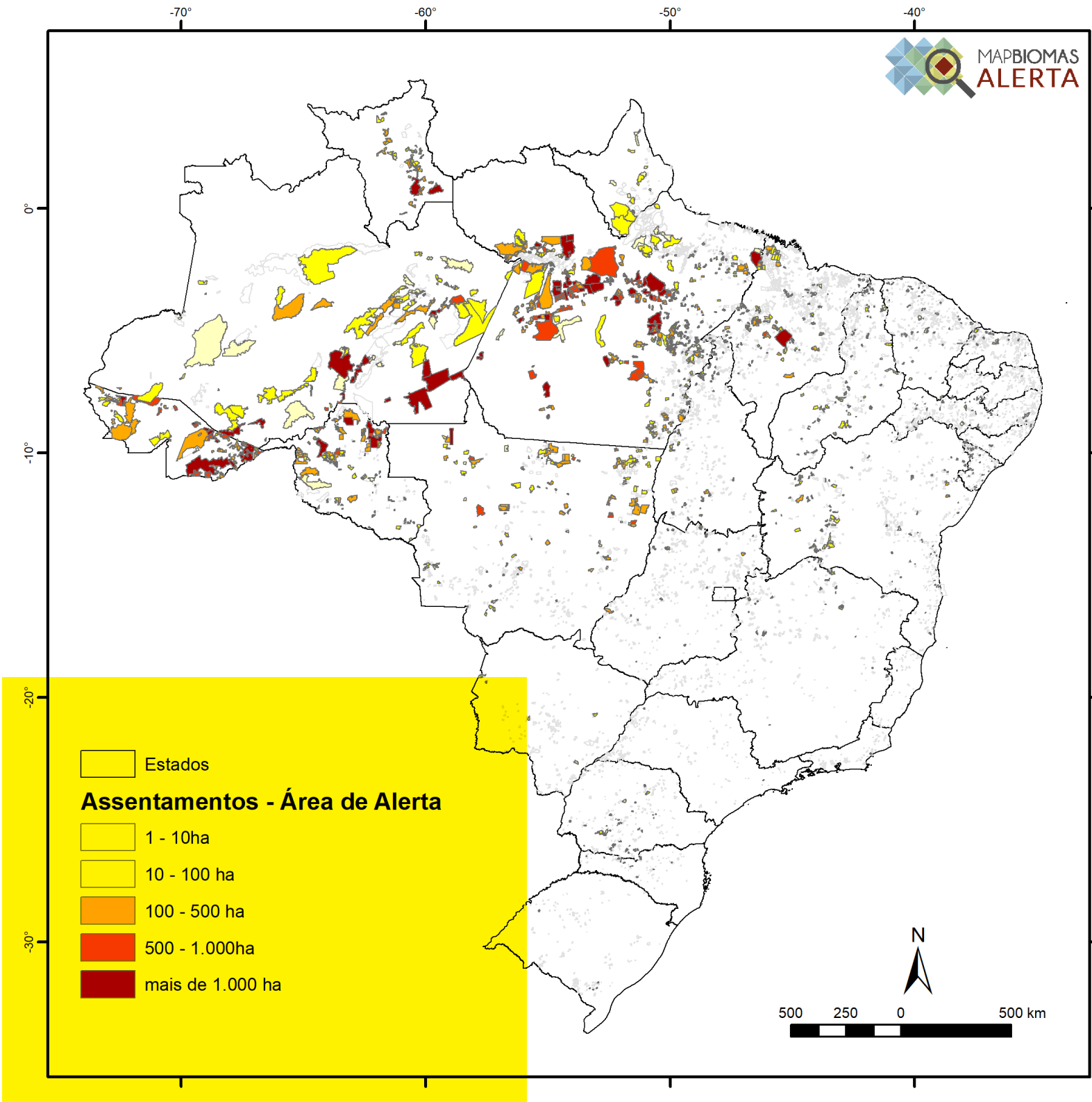


Figure 20 | Rural settlements with deforestation in 2022 in Brazil

Table 26 List of the 50 rural settlements with the largest deforested area in 2022 in Brazil

Ranking	Settlement	State	Number of Alerts in 2022	Deforested area in 2022
1	PA RIO JUMA	Amazonas	482	31,727
2	PDS LIBERDADE I	Pará	214	14,450
3	PA ACARI	Amazonas	107	9,517
4	PAF JEQUITIBÁ	Rondônia	187	7,720
5	PDS ADEMIR FREDERICCE	Pará	90	7,712
6	PAE ANTIMARY	Amazonas	243	6,735
7	PA TERRA PARA PAZ	Pará	131	5,091
8	PAE SÃO BENEDITO	Amazonas	50	4,236
9	PA MOJU I E II	Pará	247	4,235
10	PA RIO CURURUÍ	Pará	181	3,753
11	PAE SANTA MARIA AUXILIADORA	Amazonas	96	3,692
12	PDS TERRA NOSSA	Pará	98	3,545
13	PA CORTA CORDA	Pará	86	3,388
14	PA JUARI	Roraima	271	3,360
15	PDS RENASCER II	Pará	13	3,045
16	PA TUERE	Pará	179	2,889
17	PAC OURO BRANCO I	Pará	8	2,867
18	PDS REALIDADE	Amazonas	72	2,773
19	PA MONTE	Amazonas	81	2,690
20	PDS MÃE MENININHA	Pará	7	2,604
21	PAC BOM SOSSEGO	Pará	123	2,561
22	PAE ARIPUANÃ-GUARIBA	Amazonas	26	2,496
23	PA PARAÍSO	Pará	90	2,319
24	PA PILÃO POENTE II e III	Pará	220	2,091



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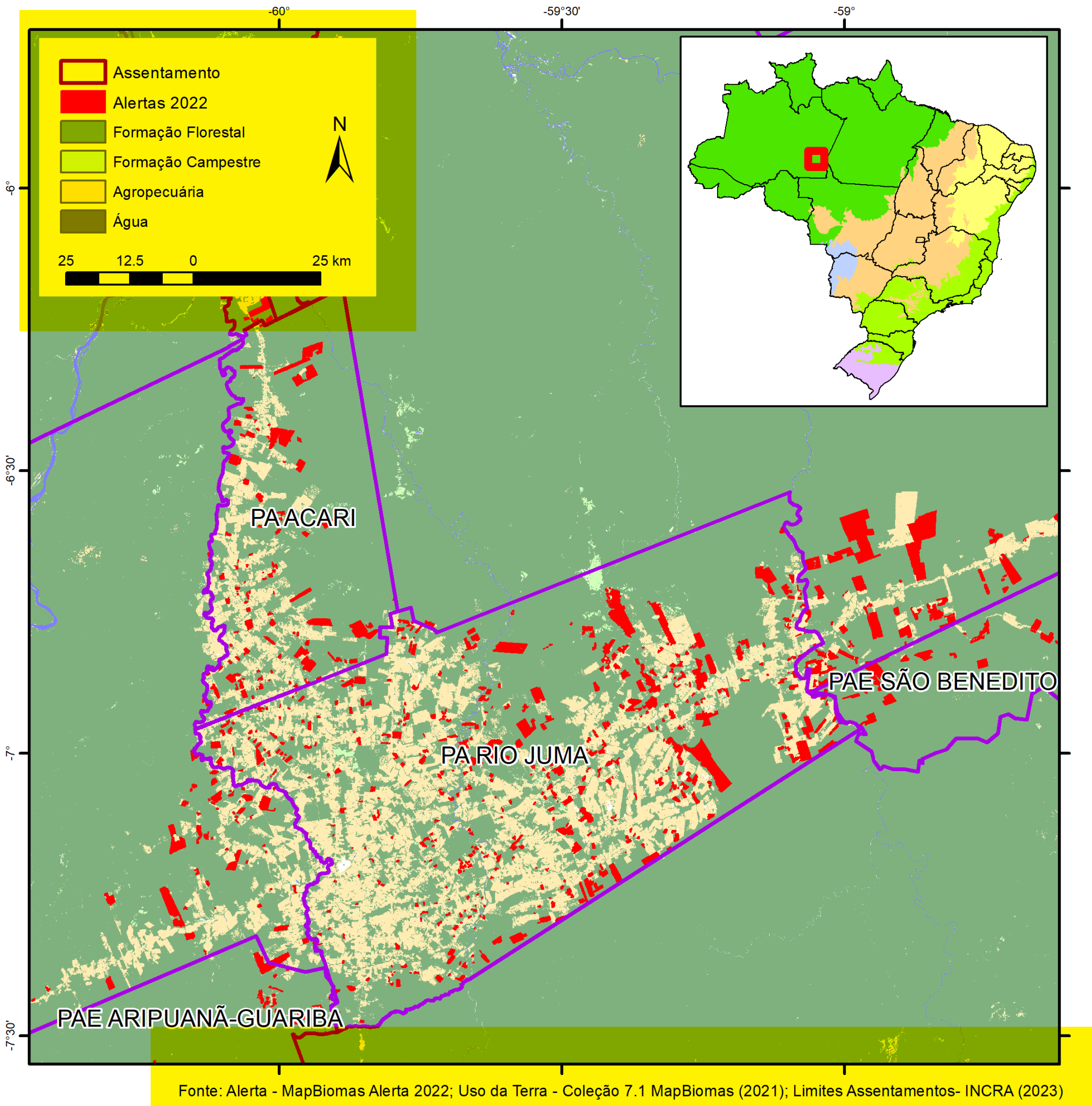


Figure 21 | Deforestation alerts in PA Rio Juma (AM), the rural settlement with the largest area of deforestation detected in 2022

Ranking	Settlement	State	Number of Alerts in 2022	Deforested area in 2022
25	PA SURUBIM	Pará	121	2,065
26	PDS ITATÁ	Pará	254	2,060
27	PA PARAÍSO DO NORTE	Pará	55	2,011
28	PA CIDAPAR 1ª PARTE	Pará	158	2,000
29	PA RIO GELADO	Pará	93	1,988
30	PAD PEDRO PEIXOTO	Acre	141	1,861
31	PA JACARÉ	Pará	49	1,553
32	PIC - BARRA DO CORDA	Maranhão	31	1,511
33	PA JATAPU	Roraima	114	1,473
34	PA BOM JARDIM	Pará	94	1,443
35	PAR ALELUIA	Acre	52	1,411
36	PAE BOTOS	Amazonas	20	1,385
37	PA ITAPUAMA	Pará	159	1,377
38	PDS SANTA CLARA	Pará	40	1,355
39	PAE REMANSO	Acre	108	1,347
40	PA YPIRANGA	Pará	60	1,343
41	PDS LARANJAL	Pará	32	1,320
42	PAE TROCANÃ	Amazonas	6	1,309
43	PAE RIOZINHO	Acre	126	1,230
44	PDS SERRA AZUL	Pará	131	1,228
45	PA MATUPI	Amazonas	47	1,185
46	PA ALTO PARÁ	Pará	30	1,183
47	PA POMBAL	Pará	81	1,158
48	PA NOVA COTRIGUAÇU	Mato Grosso	80	1,142
49	PA TUTUÍ NORTE	Pará	41	1,129
50	PDS CUPARI	Pará	20	1,103

5.4.4. Deforestation in Quilombo Communities

Of the total of 456 certified Quilombo Communities (CRQ), 62 (26.1%) had at least one deforestation alert detected and validated in 2022 with at least 0.3 hectares. Deforestations that overlap CRQs represented 0.05% of the total area deforested in Brazil in 2022 (Table 27).

The CRQ with the largest deforested area was Kalunga (GO) with 258 ha of native vegetation suppressed (Table 28, Figure 22). Part of it was inside the Pouso Alto Environmental Protection Area, in the area around the Chapada dos Veadeiros National Park.

Table 27 Alerts with total or partial overlap with Remnant Quilombo Communities in Brazil in 2022

Deforestation in CRQs compared to total CRQs	2019	2020	2021	2022	Total in the period from 2019 to 2022
Total CRQs with detected deforestation	38	62	52	62	119
Number of CRQs in Brazil	456*				
% of CRQs with deforestation detected in Brazil	8.3%	13.6%	11.4%	13.6%	26.1%

* IBGE indicates the existence of 5972 quilombola communities based on the 2022 census. The INCRA database - the only one available in geographic data (shape) contains 456 quilombos.

Deforestation in CRQ compared to total for Brazil	2019	2020	2021	2022	Total in the period from 2019 to 2022
Deforested area in CRQs (ha)	1,248	2,275	1,779	957	6,259
Total deforested area in Brazil (ha)	1,221,570	1,645,104	1,682,575	2,057,251	6,606,499
% of deforested areas in CRQs in Brazil	0.10%	0.14%	0.11%	0.05%	0.09%

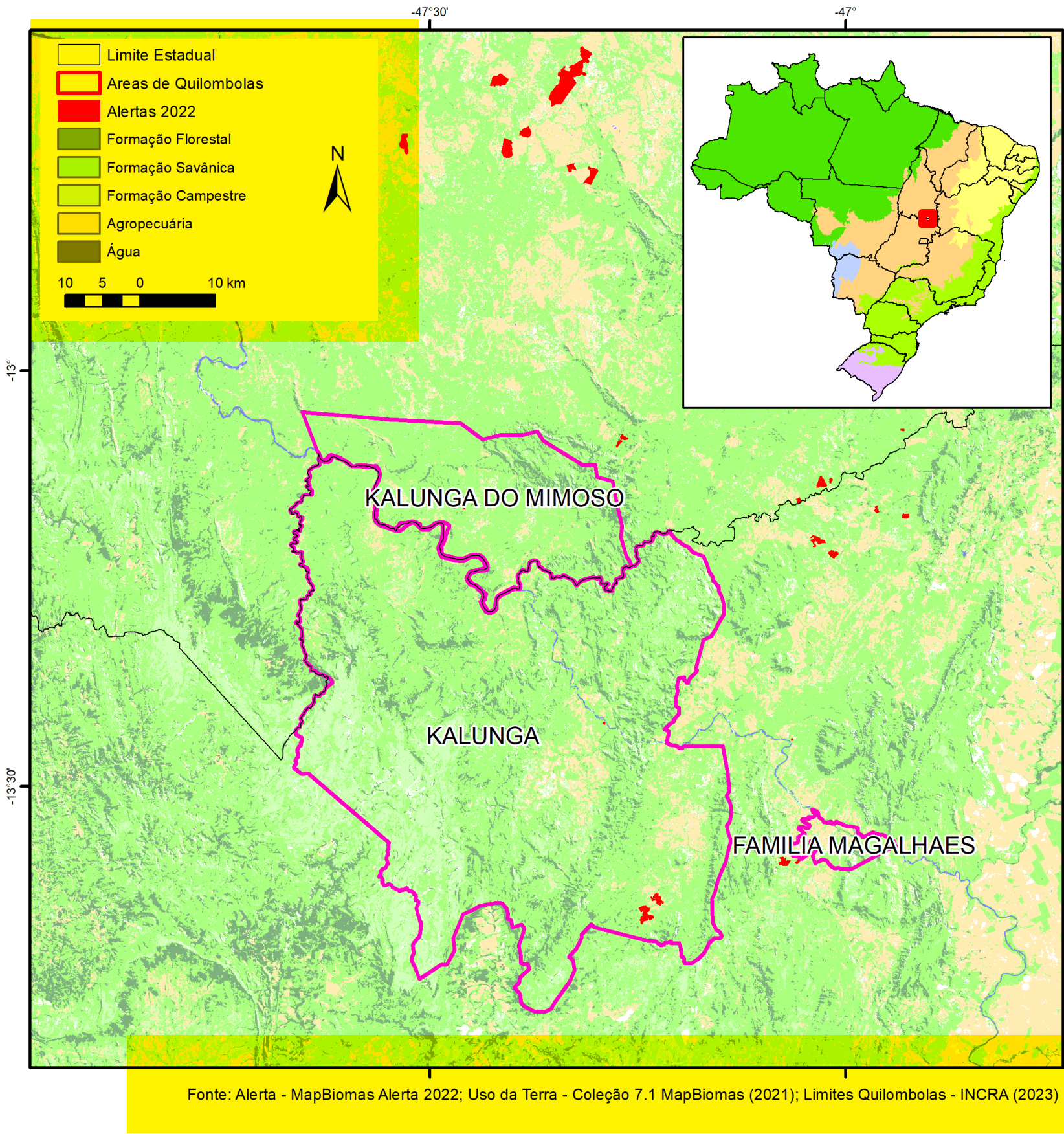


Figure 22 | Deforestation alerts in the Kalunga Remnant Quilombo Community (GO), where the highest deforestation was recorded for this land category in 2022.

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Table 28 List of the 50 Remnant Quilombo Communities with the largest deforested areas in 2022 in Brazil

Ranking	CRQ name	State	Number of alerts in 2022	Deforested area (ha) in 2022	Ranking	CRQ name	State	Number of alerts in 2022	Deforested area (ha) in 2022
1	KALUNGA	Goiás	3	257.8	26	FAMILIA MAGALHAES	Goiás	1	8.0
2	QUEIMADAS	Ceará	7	66.5	27	BAILIQUE BEIRA, BAILINQUE CENTRO, POCAO	Pará	2	7.3
3	GURUTUBA	Minas Gerais	5	49.8	28	LAGOA DAS PEDRAS E ENCANTADOS DO BOM JARDIM	Ceará	2	7.3
4	PARATECA E PAU DARCO	Bahia	4	45.3	29	ARQUIMEC	Pará	1	7.2
5	BARRA DO PARATECA	Bahia	2	40.1	30	SANTA ROSA I	Maranhão	1	7.1
6	AMAROS	Minas Gerais	1	34.4	31	PATIOBA	Sergipe	1	6.4
7	JIBÓIA	Bahia	1	31.9	32	MATOES MOREIRA	Maranhão	1	5.7
8	VELAME	Bahia	2	30.7	33	LUZIENSE	Sergipe	3	5.7
9	FORTE	Sergipe	1	30.5	34	TININGU	Pará	1	5.4
10	SANTANA e SÃO PATRÍCIO	Maranhão	1	25.3	35	GURUPA MIRIM, JOCOJO, FLEXINHA, CARRAZEDO	Pará	2	5.2
11	SERRA DA GUIA	Sergipe	1	23.9	36	SABONETE	Piauí	2	4.8
12	SETE LADEIRAS e TERRA DURA	Minas Gerais	1	21.4	37	ALTO ITACURUCA, BAIXO ITACURUCA, BOM REMEDIO	Pará	3	4.7
13	MURUMURU	Pará	1	18.6	38	MATA DO SAPÉ	Bahia	2	4.3
14	BREJO DE CRIoulos	Minas Gerais	4	18.5	39	MARIA ROSA	São Paulo	2	4.1
15	RIO ANDIRÁ (Parte 01)	Amazonas	7	18.2	40	SAMBAÍBA	Bahia	1	3.9
16	LAGO GRANDE	Maranhão	3	16.5	41	ALTAMIRA	Maranhão	1	3.2
17	QUILOMBOLA COMUNIDADE DE JESUS	Rondônia	1	15.8	42	VACA MORTA	Paraíba	1	3.0
18	IGARAPE PRETO, BAIXINHA, PANPELONIA, TEOFILO	Pará	4	15.8	43	SÃO JOÃO	Paraná	2	3.0
19	ALTO TROMBETAS II - ÁREA II	Pará	3	13.9	44	CARIONGO	Maranhão	1	2.9
20	LAGOAS	Piauí	9	12.4	45	PORTO DOS PILOES	São Paulo	1	2.2
21	ARIRAMBA	Pará	3	11.7	46	RIO ANDIRÁ (Parte 02)	Amazonas	2	2.2
22	TORRINHA	Bahia	2	11.5	47	TRES IRMAOS	Ceará	1	2.1
23	TIMBAUBA	Ceará	4	10.7	48	CUNANI	Amapá	1	2.0
24	CENTRO OURO, NOSSA SENHORA DAS GRACAS	Pará	3	8.7	49	JACUNDAY	Pará	1	1.9
25	PERUANA	Pará	4	8.1	50	KALUNGA DO MIMOSO	Tocantins	1	1.8

5.4.5. Deforestation in areas registered at the Rural Environmental Registry (CAR)

Of the total of 6,944,101 properties registered in the Rural Environmental Registry in Brazil up to March 2023, deforestation with total or partial overlap (with a minimum deforested area of 0.5 hectare) was detected in 74,997 properties (1.1%) in 2022 (Table 29).

From 2019 to 2022, 212,884 properties suffered from deforestation, which represents 3.1% of rural properties registered in the CAR. The highest concentration of properties in the CAR with deforestation is in the Amazon biome (118,711 properties, 56%), followed by the Cerrado (49,405 properties, 23%) and Caatinga (28,364 properties, 13%) (Table 29 and Figure 23).

Of the properties registered in the CAR with deforestation validated in 2022, 39,063 (52%) were repeat offenders, meaning that they had a deforestation recorded for more than one year. And 8% had a record in the last four years (Table 30).

Although 1.1% of the properties registered in the CAR had deforestation records in 2022 in Brazil, they accounted for 79% of the alerts in the country – 60,183 alerts identified in 2022 overlap fully or partially with areas with CAR.

4 | To generate reports on the MapBiomass Alert platform, a minimum overlapping area of 0.1 ha between the alert and the property registered in the CAR is considered. For the analysis of this report, a minimum area of 0.5 ha is used for this crossing.

Table 29 Rural properties with deforestation alerts by biome and in Brazil from 2019 to 2022, with a minimum deforested area of 0.5 ha.

Biome	Properties in CAR with alerts in 2019	Properties in CAR with alerts in 2020	Properties in CAR with alerts in 2021	Properties in CAR with alerts in 2022	Total Properties in CAR with alert from 2019 to 2022
AMAZON	41,874	50,376	42,298	44,215	118,711
CAATINGA	601	5,744	10,308	14,189	28,364
CERRADO	8,776	28,492	10,133	9,124	49,405
ATLANTIC FOREST	1,404	3,162	4,794	6,826	15,140
PAMPA	67	116	167	422	731
PANTANAL	175	192	269	260	682
BRAZIL	52,855	88,016	67,923	74,997	212,884
Total Non-SICAR Records*	6,944,101				
% CAR with confirmed deforestation in Brazil	0.8%	1.3%	1.0%	1.1%	3.1%

* March 2023

Table 30 Recurrence of deforestation in properties registered in the CAR with deforestation detected in Brazil in 2022 (minimum deforestation area of 0.5 ha)

Number of years of Recidivism from 2019 to 2022)	2 years	3 years	4 years	Total recidivism
Number of CAR Properties with deforestation in the period	21,415	11,386	6,261	39,063
Proportion of properties with deforestation in 2022	29%	15%	8%	52%

The deforestation area with total overlap with areas with CAR reached 1,729,099 hectares, which represents 83% of the deforested area in the country in 2022. However, when considering the area of alerts that also partially cross with CAR, this number rises to 1,887,247 hectares, or 90% of the deforested area in Brazil. The Pantanal and the Cerrado are the biomes that presented the highest proportion of the total area of alerts that totally or partially cross with CAR (99% and 98%, respectively) (Table 31).

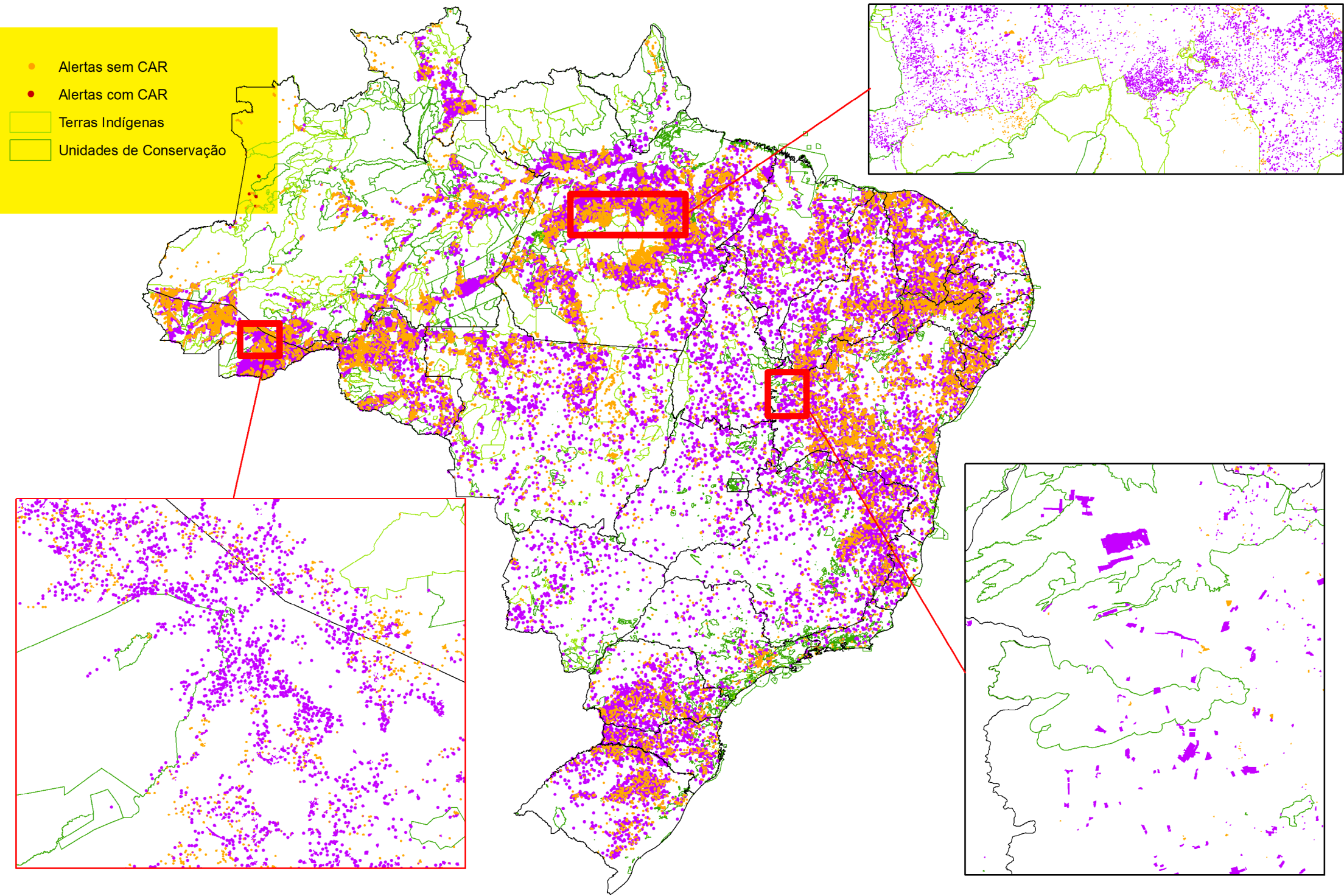


Figure 23 | Deforestation alerts with spatial overlap with properties on CAR in Brazil in 2022

Table 31 Alerts with total or partial overlap (minimum 0.5 ha) with areas registered in the Rural Environmental Registry (CAR) in 2022 by biome and in Brazil in 2022

Biome	Number of Alerts that cross with CAR	Deforested area that crosses with CAR	Total area of alerts that cross totally or partially with CAR	Proportion of Total Alerts that cross CAR areas	Proportion of the total deforestation area that crosses CAR areas	Proportion of the total area of alerts that cross completely or partially with CAR
Amazon	37,580	928,644	1,056,092	79%	78%	89%
Caatinga	10,886	113,836	124,307	78%	81%	88%
Cerrado	5,467	629,011	647,452	87%	95%	98%
Atlantic Forest	5,664	24,374	25,855	72%	81%	86%
Pampa	341	2,472	2,713	81%	80%	88%
Pantanal	245	30,763	30,830	92%	99%	99%
Total	60,183	1,729,099	1,887,247	79%	83%	90%

The deforestation area with total overlap with areas with CAR reached 1,729,099 hectares, which represents 83% of the deforested area in the country in 2022.

5.4.6. Deforestation by Land tenure

The analysis of this session was carried out by crossing data from deforestation alerts with the Land Map of the Atlas of Brazilian Agriculture and Ranching (2017), produced by Imaflora and LabGeo/ESALQ-USP, which consolidates all land types with criteria for eliminating overlaps.

Because this mapping eliminates overlaps and crossing values with territories such as protected areas or private areas it is different from the separate analysis of each of the territorial sections, as in the previous sections.

Of all the deforested area in 2022 in Brazil, 56.8% fell in private domain areas, and another 14.1% in settlements. Another 9.5% fell in unallocated public lands. Deforestation in protected areas was equivalent to 4.4% of the total, with 1.3% in Indigenous Lands and 3.1% in Conservation Units (Tables 32 and 33, Figure 24).

In all biomes most of the deforested areas are concentrated in private areas. In the Amazon, in addition to private areas (44.8%), deforestation is observed in protected areas (7.4%), public areas (17.1%), rural settlements (23.1%) and empty land (23.1%) (Table 33 and Figure 24).

Table 32 Deforested area (ha) in biomes by land category in 2022

Land Category	Amazon	Caatinga	Cerrado	Atlantic Forest	Pampa	Pantanal	Total
Private area	529,926	69,059	515,092	16,286	1,827	28,606	1,160,794
Private area	83,893		3,625				87,518
CAR	253,428	44,182	87,117	10,827	1,334	1,982	398,870
Private SIGEF	192,604	24,876	424,349	5,459	493	26,624	674,406
Protected Area	87,261	467	1,596	339		6	89,669
Indigenous land	25,260	283	1,467	244		6	27,260
Conservation Unit	62,002	184	129	95			62,409
Full Protection UC	17,596	184	116	86			17,982
Sustainable Use UC	44,406	0	13	8			44,427
Public Area	202,804	494	6,723			19	210,040
Public Area	14,879	492	1,285				16,656
Non-Dedicated Public Area	187,925	2	5,438			19	193,384
Settlements	272,820	3,215	10,997	641	54	220	287,949
Urban infrastructure	2,284	1,168	3,429	198	21	116	7,216
Community Territory	2,973	260	331	78			3,643
Land Vacuum and others	272,820	3,215	10,997	641	54	220	287,949
Total	1,182,790	139,573	657,422	29,503	2,992	31,000	2,043,280

* The total sum of the area is 1% smaller than the total area of the alerts in 2021 for reasons of scale when crossing the data. The Land Map has a 30 m pixel that was converted to 5 m and the deforestation data has a resolution of 3 m. The land map was produced by Imaflora for the Atlas of Brazilian Agriculture and Ranching and is based on the year 2017.

In the last four years (from 2019 to 2022), there has been an increase in deforestation in almost all land categories. Only Indigenous Lands (TIs) showed a decrease in the four years. Also noteworthy is the continuous increase in deforestation in the categories of public areas and vacant land, which includes private areas not yet registered in the CAR. (Tables 34 and 35).

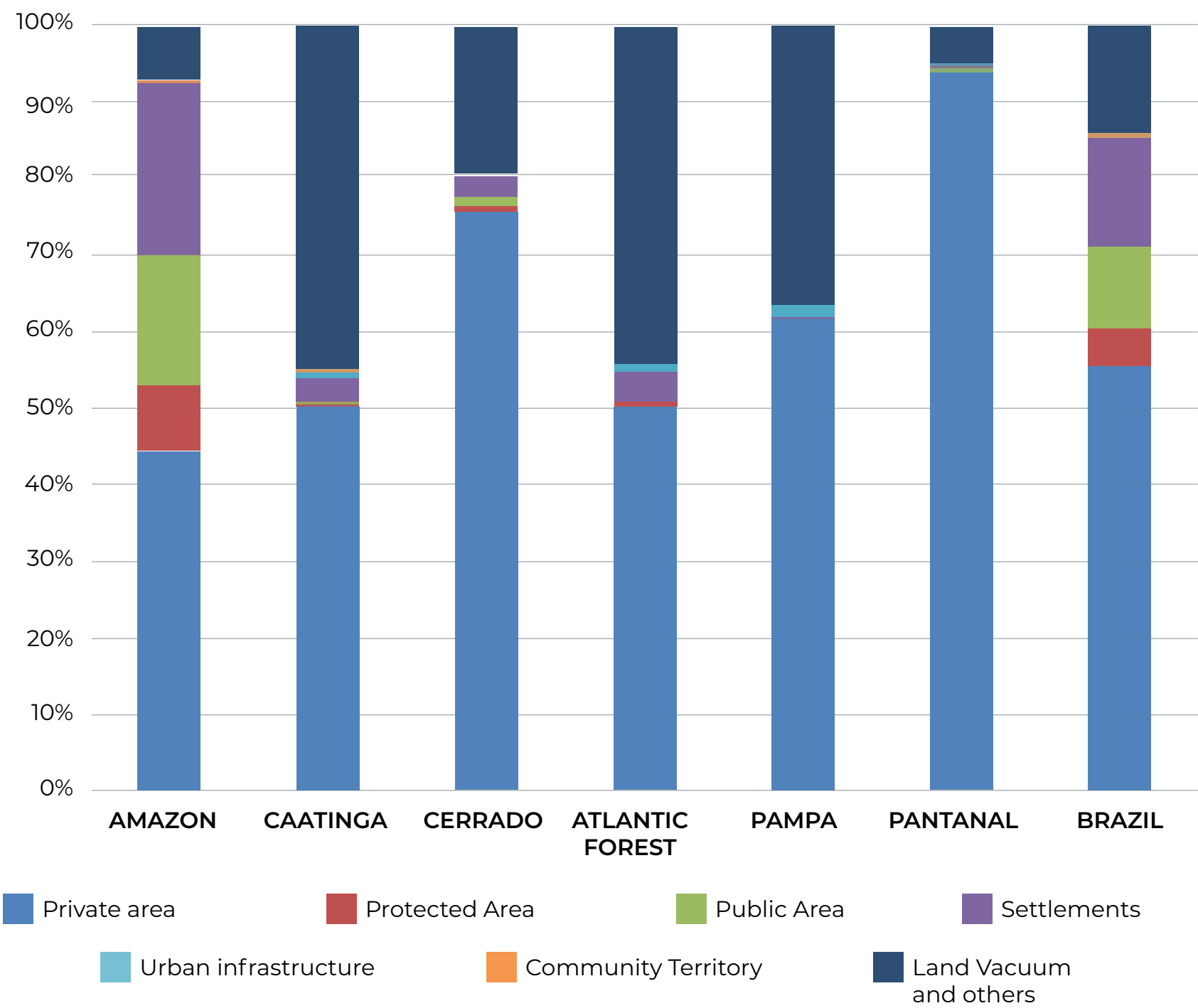


Figure 24 | Distribution of deforestation by land category and by biome in Brazil in 2022

Table 33 Proportion of the deforested area by land category in each biome in 2022.

Land Category	Amazon	Caatinga	Cerrado	Atlantic Forest	Pampa	Pantanal	Total
Private area	44.8%	49.5%	78.4%	55.2%	61.0%	92.3%	56.8%
Private area	7.1%		0.6%				4.3%
CAR	21.4%	31.7%	13.3%	36.7%	44.6%	6.4%	19.5%
Private SIGEF	16.3%	17.8%	64.5%	18.5%	16.5%	85.9%	33.0%
Protected Area	7.4%	0.3%	0.2%	1.1%		<0.1%	4.4%
Indigenous land	2.1%	0.2%	0.2%	0.8%		<0.1%	1.3%
Conservation Unit	5.2%	0.1%	<0.1%	0.3%			3.1%
Full Protection UC	1.5%	0.1%	<0.1%	0.3%			0.9%
Sustainable Use UC	3.8%		<0.1%	<0.1%			2.2%
Public Area	17.1%	0.4%	1.0%			0.1%	10.3%
Public Area	1.3%	0.4%	0.2%				0.8%
Non-Dedicated Public Area	15.9%	<0.1%	0.8%			0.1%	9.5%
Settlements	23.1%	2.3%	1.7%	2.2%	1.8%	0.7%	14.1%
Urban infrastructure	0.2%	0.8%	0.5%	0.7%	0.7%	0.4%	0.4%
Community Territory	0.3%	0.2%	0.1%	0.3%			0.2%
Land Vacuum and others	23.1%	2.3%	1.7%	2.2%	1.8%	0.7%	14.1%
Total	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

* The total sum of the area is 1% smaller than the total area of the alerts in 2021 for reasons of scale when crossing the data. The Land Map has a 30 m pixel that was converted to 5 m and the deforestation data has a resolution of 3 m. The land map was produced by Imaflora for the Atlas of Brazilian Agriculture and Ranching and is based on the year 2017.

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Table 34 Deforestation (hectares) by land category per year from 2019 to 2022 in Brazil

Land Category	2019	2020	2021	2022	Total
Private area	694,390	925,515	920,498	1,160,794	3,701,197
Private area	63,984	68,393	79,100	87,518	298,996
CAR	228,092	339,069	338,820	398,870	1,304,851
Private SIGEF	402,314	518,053	502,578	674,406	2,097,351
Protected Area	81,953	82,867	89,169	89,669	343,659
Indigenous land	34,829	32,282	29,304	27,260	123,674
Conservation Unit	47,125	50,585	59,865	62,409	219,984
Full Protection UC	6,961	7,161	11,501	17,982	43,606
Sustainable Use UC	40,163	43,423	48,364	44,427	176,378
Public Area	118,727	148,489	177,088	210,040	654,344
Public Area	14,299	19,217	21,317	16,656	71,490
Non-Dedicated Public Area	104,428	129,272	155,771	193,384	582,855
Settlements	183,064	228,980	238,508	287,949	938,500
Urban infrastructure	4,539	6,507	5,798	7,216	24,060
Community Territory	2,892	3,556	3,973	3,643	14,065
Land Vacuum and others	183,064	228,980	238,508	287,949	938,500
Total	1,209,210	1,628,047	1,669,363	2,043,280	6,549,900

* The total sum of the area is 1% smaller than the total area of the alerts in 2021 for reasons of scale when crossing the data. The Land Map has a f 30 m pixel that was converted to 5 m and the deforestation data has a resolution of 3 m. The land map was produced by Imaflora for the Atlas of Brazilian Agriculture and Ranching and is based on the year 2017.

Table 35 Proportion of deforestation area (%) by land category per year from 2019 to 2022 in Brazil

Categoria Fundiária	2019	2020	2021	2022	Total
Private area	57.4%	56.8%	55.1%	56.8%	56.5%
Private area	5.3%	4.2%	4.7%	4.3%	4.6%
CAR	18.9%	20.8%	20.3%	19.5%	19.9%
Private SIGEF	33.3%	31.8%	30.1%	33.0%	32.0%
Protected Area	6.8%	5.1%	5.3%	4.4%	5.2%
Indigenous land	2.9%	2.0%	1.8%	1.3%	1.9%
Conservation Unit	3.9%	3.1%	3.6%	3.1%	3.4%
Full Protection UC	0.6%	0.4%	0.7%	0.9%	0.7%
Sustainable Use UC	3.3%	2.7%	2.9%	2.2%	2.7%
Public Area	9.8%	9.1%	10.6%	10.3%	10.0%
Public Area	1.2%	1.2%	1.3%	0.8%	1.1%
Non-Dedicated Public Area	8.6%	7.9%	9.3%	9.5%	8.9%
Settlements	15.1%	14.1%	14.3%	14.1%	14.3%
Urban infrastructure	0.4%	0.4%	0.3%	0.4%	0.4%
Community Territory	0.2%	0.2%	0.2%	0.2%	0.2%
Land Vacuum and others	15.1%	14.1%	14.3%	14.1%	14.3%
Total	100.0%	100.0%	100.0%	100.0%	100.0%

* The total sum of the area is 1% smaller than the total area of the alerts in 2021 for reasons of scale when crossing the data. The Land Map has a 30 m pixel that was converted to 5 m and the deforestation data has a resolution of 3 m. The land map was produced by Imaflora for the Atlas of Brazilian Agriculture and Ranching and is based on the year 2017.

5.5. Regularity or legality analysis of deforestation

This section presents data on indication of irregularities related to deforestation events in Brazil in 2022. To this end, for each alert we assessed whether there were authorizations for suppression of vegetation and the overlap with areas protected by law (Conservation Units and Lands Indigenous Peoples), protected areas within rural properties (Legal Reserve and Permanent Preservation Area), areas under embargo and areas with Sustainable Forest Management Plan (PMFS).

5.5.1. Deforestation in Legal Reserves and Permanent Preservation

Legal Reserve Areas (RL) and Permanent Preservation Areas (APP) are not subject to deforestation, except under extremely specific and authorized conditions. Thus, the overlapping of deforestation with Legal Reserve and APP is a strong indication of irregularity (Figure 25).

There were 39,661 alerts overlapping by at least 0.3 hectare over the Legal Reserve in 2022. This means that half (52%) of the alerts overlap with RL. In terms of area, 699,189 hectares overlapped with RL, which represents 34% of the total area deforested in 2022 (Table 36).

All biomes had an increase in the deforested area in the Legal Reserve in 2022 when compared to the previous year (2021), with the exception of the Cerrado (Table 36).

In analyzing deforestation in Permanent Preservation Areas along the rivers, data self-declared by the landowner in SICAR were considered, and these are underestimated. Even so, in 2022, there was an overlap of 6,867 alerts (9% of the total) with at least 0.3 hectares in APP. In terms of area, the overlap was 23,839 hectares, or 1.1% of the total deforested in the country (Table 37).

In Brazil and in all biomes, there was an increase in the area deforested in APPs in 2022 compared to 2021 (Table 37).

Table 36 Alerts and deforested area (ha) overlapping with the legal reserve by biome and in Brazil by year from 2019 to 2022

Number of Alerts crossing Legal Reserve (>= 0.3 ha)

Biome	2019	2020	2021	2022	Total
Amazon	28,015	35,857	29,780	30,208	123,860
Caatinga	150	1,414	2,613	3,720	7,897
Cerrado	3,319	10,463	3,309	2,951	20,042
Atlantic Forest	449	1,096	1,750	2,519	5,814
Pampa	25	34	59	168	286
Pantanal	75	65	85	95	320
Total	32,033	48,929	37,596	39,661	158,219
% of total alerts	57%	49%	53%	52%	52%

Deforestation area that overlaps the Legal Reserve (>= 0,3 ha)

Biome	2019	2020	2021	2022	Total
Amazon	344,247	419,277	482,653	600,347	1,846,524
Caatinga	1,189	6,334	15,064	16,495	39,083
Cerrado	43,503	88,766	64,309	73,604	270,182
Atlantic Forest	1,858	3,827	5,155	5,492	16,333
Pampa	54	121	208	467	850
Pantanal	869	785	706	2,783	5,142
Total	391,719	519,110	568,095	699,189	2,178,114
% of total alerts	32%	32%	34%	34%	33%

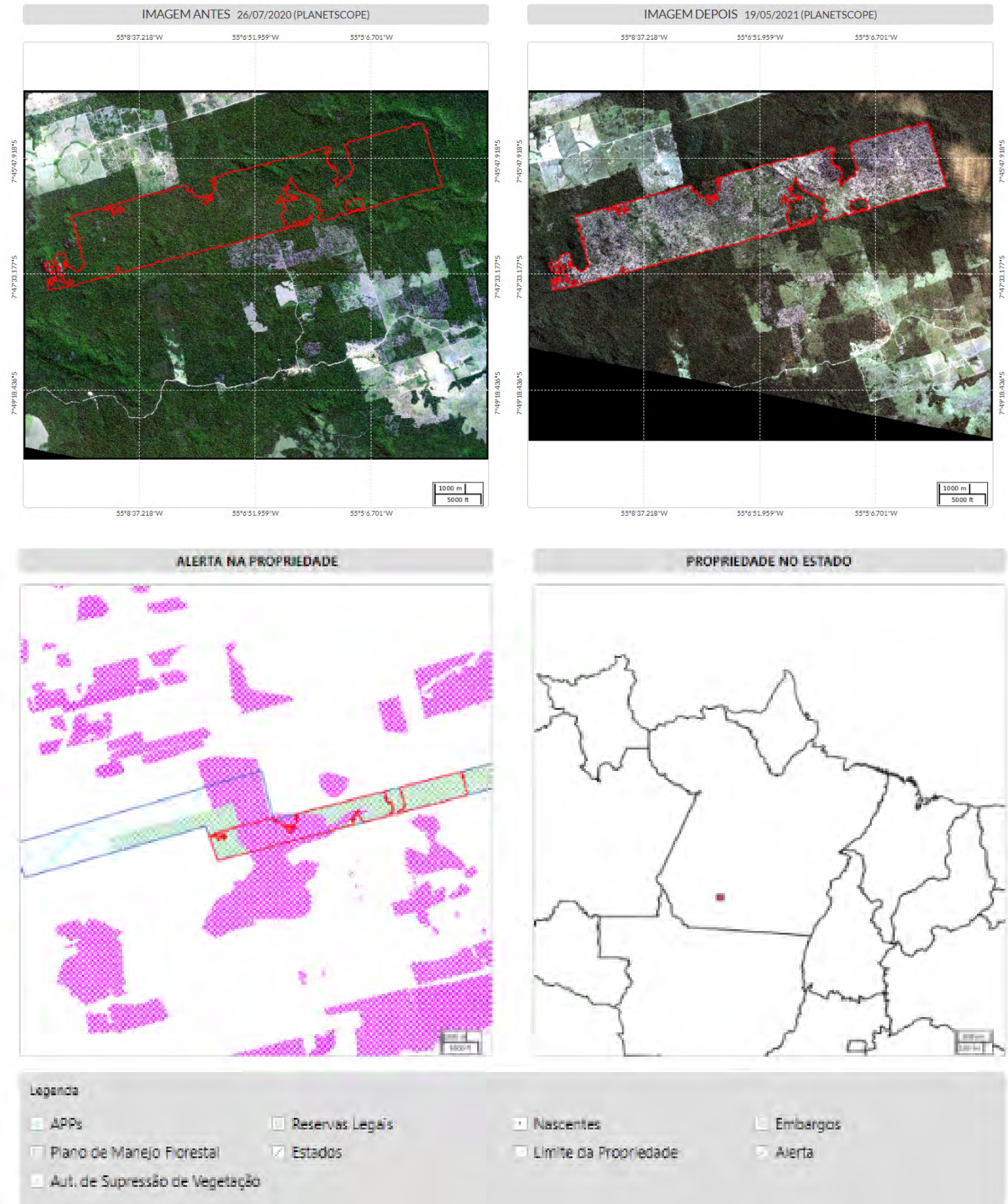


Figure 25 | Example of deforestation alert with overlap between Legal Reserve and Permanent Preservation Area in 2021

Table 37 Alerts and deforested area (ha) overlapping with **Permanent preservation area** by biome and in Brazil by year from 2019 to 2022

Number of Alerts crossing APP (>= 0.3 ha)					
Biome	2019	2020	2021	2022	Total
Amazon	4,399	5,363	4,870	4,940	19,572
Caatinga	25	196	387	522	1,130
Cerrado	1,130	2,721	806	807	5,464
Atlantic Forest	126	293	419	504	1,342
Pampa	13	24	40	62	139
Pantanal	29	23	45	32	129
Total	5,722	8,620	6,567	6,867	27,776
% of total alerts	10%	9%	9%	9%	9%
Deforestation area that overlaps the APP (>= 0.3 ha)					
Biome	2019	2020	2021	2022	Total
Amazon	10,184	11,625	13,752	16,867	52,428
Caatinga	51	447	680	830	2,008
Cerrado	3,416	6,358	3,453	5,008	18,235
Atlantic Forest	204	361	494	860	1,919
Pampa	56	42	83	108	289
Pantanal	82	114	205	166	567
Total	13,993	18,947	18,667	23,839	75,446
% da área total desmatada	1.1%	1.2%	1.1%	1.2%	1.1%

5.5.2. Deforestation in rural properties with embargoed areas

The embargoed areas cannot be used until they have been regularized in terms of environmental compliance. It thus makes no sense to issue deforestation authorization for properties with embargoed areas, until they have definitive environmental regularization. Consequently, there is a strong indication of irregularity when deforestation in properties with embargoed areas.

Deforestation analysis was carried out in properties with embargoed areas through spatial crossing the deforestation alert base with the IBAMA and ICMBio embargo databases, complemented with databases for the states of Ceará, Goiás, Mato Grosso and Pará. In 2022, 3,023 deforestation events were identified in properties that have an overlap with an embargoed area. This number represents a 31% reduction in relation to that observed in 2021. The area of alerts that overlap properties with embargoes dropped 55%, from 216,869 ha in 2021 to 96,015 ha in 2022, 4.6% of the total deforested area in the country (Table 38).

The Amazon has 92% of the alerts and 88% of the area deforested in 2022 containing overlap with rural properties that have an embargoed area. There was a decrease in the number of alerts and in the area deforested in properties with embargoed areas in all biomes.

Table 38 Alerts and deforested area with total or partial overlap with embargoed area by biome and in Brazil from 2019 to 2022

Number of alerts in embargoed areas detected between 2019 to 2022

Bioma	2019	2020	2021	2022	Total 2019-2022
Amazon	4,585	4,988	3,863	2,783	16,219
Caatinga	3	40	47	27	117
Cerrado	492	644	300	158	1,594
Atlantic Forest	74	116	171	44	405
Pampa	-	-	-	-	-
Pantanal	17	16	17	11	61
Brazil	5,171	5,804	4,398	3,023	18,396

Area (ha) embargoed in alerts from 2019 to 2022

Bioma	2019	2020	2021	2022	Total 2019-2022
Amazon	170,489	186,705	193,757	84,256	635,208
Caatinga	35	678	1,037	230	1,980
Cerrado	30,531	28,210	20,241	10,710	89,692
Atlantic Forest	725	1,190	1,418	511	3,844
Pampa	-	-	-	-	-
Pantanal	772	394	416	308	1,890
Brazil	202,553	217,178	216,869	96,015	732,614

5.5.3. Deforestation in areas with a Forest Management Plans

Areas with a Sustainable Forest Management Plan (PMFS) are licensed for the practice of selective forestry, with clear-cutting and land use conversion prohibited at least until the management cycle is completed (except in the Caatinga). For the Amazon, this cycle can be from 25 to 40 years.

In the Amazon, any deforestation in areas with a Forest Management Plan is a strong indication of illegality. The exception would be in areas with feeder roads and log storage yards, which generally are temporary openings that cover small areas.

In the Caatinga, forest management is characterized by clear-cutting in strips, which then need to go through a recovery cycle that lasts from 10 to 15 years. This is due to the characteristic of the biome's native vegetation, with tree species that regrow after cutting. Thus, the existence of clear-cutting (detected as deforestation) in PMFS areas in the

Caatinga may correspond to an authorized area.

In 2022, 163 deforestation events of 0.3 hectares or more (0.2% of the total alerts) were identified that overlapped with a Sustainable Forest Management Plan in Brazil. This represents an 8.6% increase compared to 2021 (with 150 alerts). The area overlapping with PMFS increased from 1,804 ha, in 2021, to 2,641 ha, in 2022 (Table 39). The Amazon accounts for 90% (147) of the alerts overlapping with PMFS. In the Caatinga, 15 alerts were identified in PMFS areas, totaling 123 ha. In the Cerrado, only one deforestation alert overlapping with a PMFS was identified, covering 3 hectares. In the other biomes none were identified (Table 39).

Table 39 Alerts and deforested area (ha) overlapping 0.3 ha or more with areas of Sustainable Forest Management Plans (PMFS) by biome and in Brazil from 2019 to 2022.

Number of Alerts that cross-reference with PMFS (>= 0.3 ha)					
Biome	2019	2020	2021	2022	Total 2019-2022
Amazon	88	134	117	147	486
Caatinga	2	8	33	15	58
Cerrado	-	4	-	1	5
Atlantic Forest	-	-	-	-	-
Pampa	-	-	-	-	-
Pantanal	-	-	-	-	-
Total	90	146	150	163	549
% of total alerts	0.2%	0.1%	0.2%	0.2%	0.2%
Deforestation area that overlaps the PMFS (>= 0.3 ha)					
Biome	2019	2020	2021	2022	Total 2019-2022
Amazon	265	556	1,344	2,514	4,679
Caatinga	45	117	460	123.84	745.54
Cerrado	-	154	-	3	157
Atlantic Forest	-	-	-	-	-
Pampa	-	-	-	-	-
Pantanal	-	-	-	-	-
Total	309	827	1.804	2.641	5.581
% of total alerts	<0.1%	0.1%	0.1%	0.1%	0.1%

5.5.4. Deforestation with Vegetation Suppression Authorizations

Deforestation is an intervention that has a high environmental impact and, in Brazil it must be preceded by an Authorization for Suppressing Vegetation (ASV) in order to be carried out. As a rule, this authorization is issued by state environmental agencies (OEMAs) and IBAMA, in cases where it involves federal public areas or projects involving two or more states. Complementarily, the municipal environmental agencies act by having authority delegated to them through an agreement and also in some specific cases, such as cutting trees in urban areas.

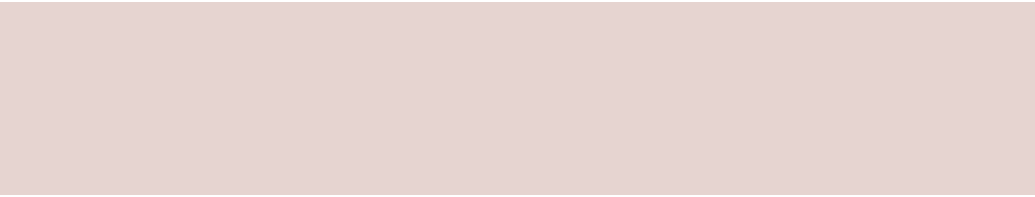
Since 2018, authorizations given by the states must be issued or registered in the National System for the Control of Origin of Forest Products (SINAFLOR), which is managed by IBAMA. Although all states are connected to SINAFLOR, there are different levels of integration, and it is notable that the databases are not always up to date, so that some authorizations may not be included in the national system. For this reason, the data were complemented by means of a direct consultation with the state databases that we already have access to (Pará, Mato Grosso, Goiás and Minas Gerais). Nonetheless, as a matter of principle, SINAFLOR is the system consulted for checking the existence of authorization in places where a deforestation alert has been detected.

Table 40 Alerts and deforested area (ha) in rural properties with Vegetation Suppression Authorization (ASV) by biome and in Brazil in 2019 and 2022**

Biome	Number of Alerts crossing property with ASV (>= 0.3 ha)				Deforestation area that overlaps the property with ASV (>= 0.3 ha)			
	2019	2020	2021	2022	2019	2020	2021	2022
Amazon	274	352	397	443	21,385	36,017	40,670	58,377
Caatinga	4	32	95	54	20	1,173	1,639	1,702
Cerrado	297	600	389	288	27,718	89,102	58,278	50,142
Atlantic Forest	3	12	29	25	7	82	279	148
Pampa	-	-	-	-	-	-	-	-
Pantanal	1	1	2	4	3	40	167	85
Total	651	1,114	1,004	899	49,141	126,425	101,044	110,460

* in the case of Minas Gerais there are some authorizations made to energy companies that operate in rural electricity connections, covering territories of thousands of hectares and inflate the number of authorizations.
** does not mean that the entire alert area is within the authorized area.

Authorizations given by the states must be issued or registered in the National System for the Control of Origin of Forest Products (SINAFLOR).



The following analysis focuses only on the existence of authorization on the rural property where the alert was detected – with an overlap of at least 0.3 hectares between the deforested area and the authorized area. We did not verify whether or not the authorization for deforestation is being complied with for all parameters (e.g., validity period, location).

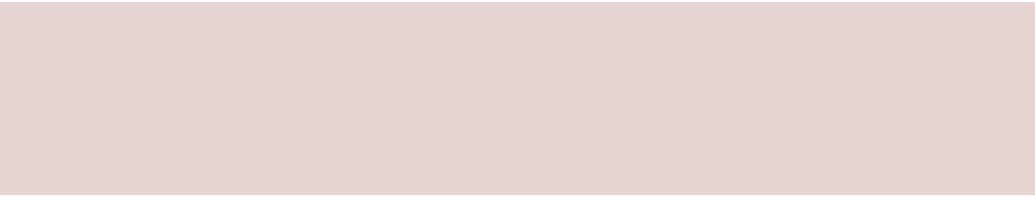
In 2022, 899 alerts were identified, totaling 110,460 ha deforested in rural properties with at least one ASV registered in SINAFLOR or in the state systems consulted. These represented 1.1% of the alerts and 5.4% of the deforested area in the country (Tables 40 and 41).

In 2022, the Amazon biome had the highest number of alerts (474) in properties with ASV and the largest deforested area (58,377 ha) in properties with ASV, about 5% of the deforested area in the biome. In second place is the Cerrado, with 306 alerts and 50,143 ha deforested, representing 7.6% of the deforested area in the biome (Tables 40 and 41).

Table 41 Proportion of alerts and deforested area with Vegetation Suppression Authorization (ASV) by biome in Brazil from 2019 to 2022

Biome	Number of Alerts crossing property with ASV (>= 0.3 ha)				Deforestation area that overlaps the property with ASV (>= 0.3 ha)			
	2019	2020	2021	2022	2019	2020	2021	2022
Amazon	0.6%	0.6%	0.8%	0.9%	2.8%	4.1%	4.1%	4.9%
Caatinga	0.8%	0.6%	0.9%	0.4%	0.1%	1.7%	1.4%	1.2%
Cerrado	4.0%	2.1%	5.5%	4.6%	6.8%	13.9%	11.6%	7.6%
Atlantic Forest	0.2%	0.4%	0.6%	0.3%	0.1%	0.3%	0.9%	0.5%
Pampa								
Pantanal	0.5%	0.5%	0.7%	0.4%	<0.1%	0.2%	0.6%	0.3%
Total	1.0%	1.0%	1.3%	1.1%	4.0%	7.7%	6.0%	5.4%

In 2022, 899 alerts were identified, totaling 110,460 ha deforested in rural properties with at least one ASV registered in SINAFLOR.



5.5.5. Degree of Regularity and/ or Legality

To estimate the degree of regularity or legality of deforestation, each alert is assessed considering:

- (i) if there is an authorization to suppress native vegetation on the property where the alert occurred.
- (ii) if there is overlap with areas protected by law (Conservation Units – except APAs – and Indigenous Lands).
- (iii) if there is overlap with protected areas within rural properties (Legal Reserve, Permanent Preservation Area and water sources).
- (iv) if there is overlap with areas of Sustainable Forest Management Plans in the Amazon and Caatinga; and
- (v) if there are embargoed areas on the property where the deforestation occurred.

If there is no authorization (i) or if there is overlap with any of the above territories (ii to v), it is considered that there is an indication of irregularity or illegality⁵.

228 alerts were identified (0.3% of the total) without evidence of irregularity or illegality, which indicates that almost all alerts had some indication of irregularity, according to the analysis of available databases. When observing the area of alerts that do not have signs of irregularity, the proportion is not very different: 13,959 ha (0.7% of the total deforested) had no signs of irregularities. That is, more than 99% of the deforested area in Brazil in 2022 had at least one indication of irregularity according to the criteria presented above. All Pampa and Pantanal alerts showed some evidence of irregularity in 2022 (Table 42).

Table 42 Deforestation alerts without evidence of irregularity or illegality by biome and in Brazil from 2019 to 2022*

Biome	Alerts without signs of irregularity				Total area of Alerts without evidence of irregularity (ha)			
	2019	2020	2021	2022	2019	2020	2021	2022
Amazon	68	87	100	92	2,420	4,456	5,179	7,069
Caatinga	4	23	89	44	85	1,061	1,951	1,038
Cerrado	106	210	125	74	7,518	12,967	14,333	5,691
Atlantic Forest	3	8	21	18	8	60	204	160
Pampa	-	-	-	-	-	-	-	-
Pantanal	1	1	1	-	37	40	99	-
Brazil	182	329	336	228	10,069	18,585	21,766	13,959

Biome	Alerts without signs of irregularity				Total area of Alerts with no indication of irregularity			
	2019	2020	2021	2022	2019	2020	2021	2022
Amazon	0.14%	0.14%	0.21%	0.19%	0.31%	0.50%	0.52%	0.59%
Caatinga	0.75%	0.41%	0.84%	0.31%	0.61%	1.58%	1.70%	0.74%
Cerrado	1.44%	0.73%	1.75%	1.18%	1.84%	2.02%	2.85%	0.86%
Atlantic Forest	0.22%	0.26%	0.41%	0.23%	0.07%	0.25%	0.68%	0.53%
Pampa								
Pantanal	0.50%	0.48%	0.34%	0.00%	0.27%	0.16%	0.33%	
Brazil	0.32%	0.33%	0.47%	0.30%	0.82%	1.13%	1.29%	0.68%

* evidence /indications are characterized by at least one of the following situations: (i) total or partial overlap (>0.3ha) with APP, RL, water sources or IT; (ii) total or partial overlap (>0.3ha)with UC except APA or Sustainable Use UCs with authorization to suppress vegetation (e.g., mining in Flona); (iii) overlap (>0.3ha) with PMFS areas except in Caatinga; (iv) absence of vegetation suppression authorization (ASV).

5 | Appendix 6 presents the numbers for all these analysis steps.

An aerial photograph of a coastal area, possibly in the Amazon, showing a river and surrounding land. A white grid is overlaid on the image. A dark red rectangular box is centered over the image, containing white text. In the bottom right corner, there is a small white box with a scale bar.

6 . L A W E N F O R C E M E N T A C T I O N S A G A I N S T D E F O R E S T A T I O N

500 m
2000 ft

6

LAW ENFORCEMENT ACTIONS AGAINST DEFORESTATION

In this chapter, we present an analysis of actions taken by public and private agents to combat, contain or discourage deforestation detected in Brazil.

The analysis focuses on the actions carried out in relation to the deforestation areas that have been validated, refined and reported by MapBiomas Alerta from 2019 to 2022. In characterizing the actions of state and federal environmental agencies, sanctions, embargoes and others are considered actions and identified as enforcement. A sanction is the procedure/administrative act destined to investigate the environmental infraction. As for an **embargo**, it is a penalty, applied by the appropriate environmental agency, to prevent a degrading activity from continuing in progress or that jeopardizes the regeneration of the area. Also included in the analysis were authorizations for suppression of vegetation and alternative land use issued by federal and state agencies.

In the case of Public Prosecution Services, the main actions are characterized by notifications of facts, public civil actions, criminal actions, inquiries and other procedures.

6.1. Characterization of key actors for action

Several public and private actors can and should act in relation to combating, containing and discouraging illegal deforestation. The main actors involved are described as follows.

6.1.1. Public Stakeholders

Brazilian Institute for the Environment and Renewable Natural Resources (IBAMA) – linked to the Ministry of the Environment (MMA), this agency exercises policing, monitoring and environmental control powers. IBAMA is the highest body for environmental inspection and deforestation control, focusing on areas under Federal domain, on priority areas for the federal government (the MMA and the National Council for the Legal Amazon) to control deforestation and. Additionally, it acts when state agencies fail in their enforcement duties.

Chico Mendes Institute for Biodiversity Conservation (ICMBio) – linked to the MMA, this agency administers the federal Conservation Units and exercises the enforcement and environmental police powers within these CUs.

National Council for the Legal Amazon (CNAL) – established for the purpose of coordinating government actions in the Legal Amazon, including the 2021-2022 Amazon Plan⁶. **Actions previously assigned to CNAL are now carried out within the scope of the Permanent Interministerial Commission for the Prevention and Control of Deforestation**, instituted by Decree No. 11.367, of January 1, 2023⁷, which restores the **Action Plan for the Prevention and Control of Deforestation** in the Legal Amazon – PPCDAm and provides for the Action Plans for the Prevention and Control of Deforestation in the Cerrado, the Atlantic Forest, the Caatinga, the Pampa and the Pantanal.

Brazilian Forest Service (SFB)– linked to the Ministry of Agriculture, Livesto-

ck and Food Supply (MAPA), the agency is responsible for promoting forestry and managing public forest areas and manages the National Registry of Public Forests and the Rural Environmental Registry System (SICAR). It thus has full and permanent access to data from each property, its APPs and RLs and in real time, with INPE data is able to identify and describe deforestation in registered areas.

National Foundation of Indigenous Peoples (FUNAI) – has the purpose of establishing guidelines and ensuring compliance with the indigenous policy, administering indigenous heritage – in the sense of its conservation, expansion and appreciation – and exercising police power in reserved areas and in case of actions that threaten indigenous people, such as occupations and deforestation in these territories.

National Institute for Colonization and Agrarian Reform (INCRA) – is responsible for carrying out the agrarian reform policy and implementing fede-

ral settlements. It is legally responsible for the areas in the settlements until their emancipation. It is also responsible for organizing and regulating national land tenure on federal lands. It is the body responsible for monitoring, controlling and inspecting the occupation of land and federal rural settlements in Brazil.

Other bodies also have, directly or indirectly, control attributions in relation to deforestation in the country, with emphasis on:

- ◆ **Federal Assets Secretariat (SPU)**, for the responsibility for managing the Union's public lands,
- ◆ **Federal Audit Court (TCU)**, for the responsibility of evaluating the efficiency and effectiveness of public expenditures and federal programs, including the PPCDAm or its successor.
- ◆ **Federal and State Public Prosecution Services (MP)**, are responsible for civil and criminal investigations into cri-

6 | <https://www.in.gov.br/en/web/dou/-/resolucao-n-3-de-9-de-abril-de-2021-314033004>

7 | <https://www.in.gov.br/en/web/dou/-/decreto-n-11.367-de-1-de-janeiro-de-2023-455351826>

mes and damages due to illegal deforestation and for implementing the Amazonia Protege and Mata Atlântica em Pé Program.

- ◆ **Federal Police (PF)**, for investigating federal environmental crimes.
- ◆ **State Environmental Agencies (OEMAs)**, responsible for managing the Environmental Registry and the Environmental Regularization Programs (PRA) in the States and for issuing (and consequent inspection) authorizations for deforestation.

B. Private Actors and Financial Institutions

Private sector and financial institutions play an important role in preventing the sale and financing of products from illegally deforested areas. In order to comply with standards and requirements for access to credit and markets, the productive sector has already adopted practices to combat illegal deforestation and actions to prevent deforestation within

its own businesses and monitor production chains. Financial institutions operate in compliance with the sector's norms and regulations, considering criteria of environmental responsibility in managing and mitigating risks. Also, they are responsible for decision-making regarding rural credit and portfolio analysis so as to avoid benefiting the commercial use of illegally deforested areas. For example, in March 2023 the Brazilian Development Bank BNDES announced the adoption of MapBiomas Alerta in the rural credit analysis procedures, which had an immediate impact on around BRL 24.8 million that would be allocated to rural properties with deforestation in 14 states⁸.

6.2. Actions of the Federal Government

Throughout 2022, we continued the work of conversations with the main federal agencies and state governments on knowledge of the alerts and reports generated by MapBiomas Alerta, on the measures taken in relation to reported

deforestation and the systematization and transparency of data from authorizations and enforcement actions.

We present below an analysis of the deforestation alerts that were investigated and embargoed by IBAMA and ICMBio superimposed on their areas. The description of the analysis method is in Appendix 5.

6.2.1. Assessments and embargoes by IBAMA and ICMBio

Upon crossing the information on embargoes and assessments by IBAMA between January 2018 and May 2023, it was found that **7.6% of the total area deforested** checked, refined and reported by MapBiomas Alerta from 2019 to 2022 crossed spatially with embargoes issued by IBAMA with description related to deforestation. The states in which these spatial crossings indicate a greater correspondence with IBAMA actions were Amazonas, with 22.8% of the area and 5.1% of the embargoed

alerts, and Pará, with 13.1% of the area and 1.9% of alerts (Table 43).

Considering the infraction notices from IBAMA related to deforestation, 3.7% of the deforested area and 0.5% of the alerts in Brazil during the period from 2019 to 2022 had overlapping assessments (Table 44).

This intersection pointed to ICMBio embargoes for flora violations in 1,179 deforestation alerts, which represents 1.3% of the total area of the alerts (83,287 hectares) (Table 45).

The embargoes and assessments by IBAMA and ICMBio together reached 2.4% of the alerts detected from 2019 to 2022, which represent 10.2% of the entire deforested area in the period (Table 46).

No embargoes or assessments were observed in the IBAMA and ICMBio databases related to the deforestation verified from 2019 to 2022 in two Brazilian states (São Paulo and Rio de Janeiro) and in the Federal District.

8 | More information on the use of MapBiomas Alert by the BNDES at: <https://agenciadenoticias.bndes.gov.br/detalhe/noticia/BNDES-çouia-emprestimos-a-propriedades-rurais-desmatadas-illegalmente/>

9 | For analyses of government actions, the area considered is the totality of the detected alert that was spatially crossed with an authorization or inspection action, which may not reflect the area effectively inspected.

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Table 43 Alerts and deforested area from 2019 to 2022 with **embargoes from IBAMA** drawn up by state and in Brazil from January 2018 to May 2023

State	Deforested area (ha)	Total area of the alert that crosses with IBAMA embargoes (ha)	% of the area deforested with action	Alerts (no.)	Alerts crossed with actions (no.)	% of the number of alerts with actions	State	Deforested area (ha)	Total area of the alert that crosses with IBAMA embargoes (ha)	% of the area deforested with action	Alerts (no.)	Alerts crossed with actions (no.)	% of the number of alerts with actions
ACRE	273,681	4,517	1.7%	40,825	181	0.4%	PARANÁ	19,041	1,875	9.8%	4,436	169	3.8%
ALAGOAS	5,079	144	2.8%	444	12	2.7%	PERNAMBUCO	40,225			4,471		
AMAPÁ	4,948	548	11.1%	1,590	25	1.6%	PIAUÍ	336,659	16	0.0%	8,896	1	0.0%
AMAZONAS	734,436	167,763	22.8%	32,650	1,668	5.1%	RIO DE JANEIRO	1,102	0	0	231	0	0
BAHIA	560,067	6,406	1.1%	16,752	103	0.6%	RIO GRANDE DO NORTE	14,096	3	0.0%	1,328	1	0.1%
CEARÁ	53,384	90	0.2%	6,884	6	0.1%	RIO GRANDE DO SUL	12,249	13	0.1%	3,126	5	0.2%
DISTRITO FEDERAL	463	0	0	36	0	0	RONDÔNIA	514,091	44,361	8.6%	20,074	492	2.5%
ESPIRITO SANTO	1,053	6	0.5%	418	2	0.5%	RORAIMA	93,205	6,911	7.4%	8,121	237	2.9%
GOIÁS	150,485	2,941	2.0%	5,235	53	1.0%	SANTA CATARINA	6,041	0	0	1,825	0	0
MARANHÃO	654,504	3,188	0.5%	20,755	29	0.1%	SÃO PAULO	2,138	0	0	690	0	0
MATO GROSSO	833,383	50,538	6.1%	18,590	513	2.8%	SERGIPE	6,257	228	3.6%	625	12	1.9%
MATO GROSSO DO SUL	183,623	831	0.5%	2,414	20	0.8%	TOCANTINS	361,501	5,399	1.5%	8,288	69	0.8%
MINAS GERAIS	170,753	1,081	0.6%	9,521	54	0.6%	Brazil	6,604,227	500,661	7.6%	303,264	5,249	1.7%
PARÁ	1,555,750	203,466	13.1%	82,791	1,566	1.9%							
PARAÍBA	16,015	334	2.1%	2,248	31	1.4%							

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Table 44 Alerts and deforested area detected from 2019 to 2022 with **infraction notices** from IBAMA by state from January 2018 to May 2023*

State	Deforested area (ha)	Total area of the alert that crosses with IBAMA infraction notices (ha)	% of the area deforested with action	Alerts (no.)	Alerts crossed with actions (no.)	% of the number of alerts with actions	State	Deforested area (ha)	Total area of the alert that crosses with IBAMA infraction notices (ha)	% of the area deforested with action	Alerts (no.)	Alerts crossed with actions (no.)	% of the number of alerts with actions
ACRE	273,681	5,289	1.9%	40,825	214	0.5%	PARANÁ	19,041	548	2.9%	4,436	53	1.2%
ALAGOAS	5,079	387	7.6%	444	17	3.8%	PERNAMBUCO	40,225	135	0.3%	4,471	8	0.2%
AMAPÁ	4,948			1,590			PIAUÍ	336,659	0	0	8,896	0	0
AMAZONAS	734,436	54,905	7.5%	32,650	237	0.7%	RIO DE JANEIRO	1,102	0	0	231	0	0
BAHIA	560,067	5,207	0.9%	16,752	65	0.4%	RIO GRANDE DO NORTE	14,096	3	<0.1%	1,328	1	0.1%
CEARÁ	53,384	858	1.6%	6,884	38	0.6%	RIO GRANDE DO SUL	12,249	9	0.1%	3,126	2	0.1%
DISTRITO FEDERAL	463	0	0	36	0	0	RONDÔNIA	514,091	19,893	3.9%	20,074	160	0.8%
ESPIRITO SANTO	1,053	4	0.4%	418	1	0.2%	RORAIMA	93,205	1,339	1.4%	8,121	53	0.7%
GOIÁS	150,485	1,269	0.8%	5,235	31	0.6%	SANTA CATARINA	6,041	58	1.0%	1,825	3	0.2%
MARANHÃO	654,504	1,104	0.2%	20,755	15	0.1%	SÃO PAULO	2,138	0	0	690	0	0
MATO GROSSO	833,383	20,983	2.5%	18,590	100	0.5%	SERGIPE	6,257	52	0.8%	625	5	0.8%
MATO GROSSO DO SUL	183,623	123	0.1%	2,414	4	0.2%	TOCANTINS	361,501	3,889	1.1%	8,288	24	0.3%
MINAS GERAIS	170,753	663	0.4%	9,521	27	0.3%	Brazil	6,604,227	242,025	3.7%	303,264	1,649	0.5%
PARÁ	1,555,750	124,832	8.0%	82,791	567	0.7%	*For the infraction notice data, which is just a point representation, a buffer of 60 meters radius was used for the spatial crossing with the alert.						
PARAÍBA	16,015	477	3.0%	2,248	24	1.1%							

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Table 45

Alerts and deforested area from 2019 to 2022 with embargo ICMBio by state and in Brazil between January 2018 and May 2023

State	Deforested area (ha)	Total area of the alert that crosses with ICMBio embargoes (ha)	% of the area deforested with action	Alerts (no.)	Alerts crossed with actions (no.)	% of the number of alerts with actions
ACRE	273,681	3,509	1.3%	40,825	397	1.0%
ALAGOAS	5,079	0	0	444	0	0
AMAPÁ	4,948	3	0.1%	1,590	2	0.1%
AMAZONAS	734,436	10,378	1.4%	32,650	55	0.2%
BAHIA	560,067	42	0.0%	16,752	6	0.0%
CEARÁ	53,384	0	0	6,884	0	0
DISTRITO FEDERAL	463	0	0	36	0	0
ESPIRITO SANTO	1,053	0	0	418	0	0
GOIÁS	150,485	597	0.4%	5,235	7	0.1%
MARANHÃO	654,504	27	<0.1%	20,755	1	<0.1%
MATO GROSSO	833,383	675	0.1%	18,590	6	<0.1%
MATO GROSSO DO SUL	183,623	2	<0.1%	2,414	1	<0.1%
MINAS GERAIS	170,753	57	0.0%	9,521	3	<0.1%
PARÁ	1,555,750	60,888	3.9%	82,791	508	0.6%
PARAÍBA	16,015	0	0	2,248	0	0

State	Deforested area (ha)	Total area of the alert that crosses with ICMBio embargoes (ha)	% of the area deforested with action	Alerts (no.)	Alerts crossed with actions (no.)	% of the number of alerts with actions
PARANÁ	19,041	10	0.1%	4,436	3	0.1%
PERNAMBUCO	40,225	0	0	4,471	0	0
PIAUÍ	336,659	369	0.1%	8,896	2	<0.1%
RIO DE JANEIRO	1,102	0	0	231	0	0
RIO GRANDE DO NORTE	14,096	12	0.1%	1,328	2	0.2%
RIO GRANDE DO SUL	12,249	0	0	3,126	0	0
RONDÔNIA	514,091	6,717	1.3%	20,074	186	0.9%
RORAIMA	93,205	0	0	8,121	0	0
SANTA CATARINA	6,041	0	0	1,825	0	0
SÃO PAULO	2,138	0	0	690	0	0
SERGIPE	6,257	0	0	625	0	0
TOCANTINS	361,501	0	0	8,288	0	0
Brasil	6,604,227	83,287	1.3%	303,264	1,179	0.4%

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Table 46

Alerts and deforested area from 2019 to 2022, by state and in Brazil, with overlap **infraction notices** and/or **embargoes** for deforestation by IBAMA and ICMBio drawn up between January 2018 and May 2023

State	Deforested area (ha)	Total area of the alert that crosses with embargoes and infraction notices from IBAMA and ICMBio (ha)	% of the area deforested with action	Alerts (no.)	Alerts crossed with actions (no.)	% of the number of alerts with actions
ACRE	273,681	11,654	4.3%	40,825	689	1.7%
ALAGOAS	5,079	465	9.2%	444	25	5.6%
AMAPÁ	4,948	551	11.1%	1,590	27	1.7%
AMAZONAS	734,436	197,886	26.9%	32,650	1,807	5.5%
BAHIA	560,067	10,627	1.9%	16,752	151	0.9%
CEARÁ	53,384	944	1.8%	6,884	43	0.6%
DISTRITO FEDERAL	463	0	0	36	0	0
ESPIRITO SANTO	1,053	10	0.9%	418	3	0.7%
GOIÁS	150,485	3,977	2.6%	5,235	74	1.4%
MARANHÃO	654,504	4,054	0.6%	20,755	42	0.2%
MATO GROSSO	833,383	64,877	7.8%	18,590	587	3.2%
MATO GROSSO DO SUL	183,623	910	0.5%	2,414	24	1.0%
MINAS GERAIS	170,753	1,291	0.8%	9,521	66	0.7%
PARÁ	1,555,750	293,562	18.9%	82,791	2,281	2.8%

State	Deforested area (ha)	Total area of the alert that crosses with embargoes and infraction notices from IBAMA and ICMBio (ha)	% of the area deforested with action	Alerts (no.)	Alerts crossed with actions (no.)	% of the number of alerts with actions
PARAÍBA	16,015	661	4.1%	2,248	45	2.0%
PARANÁ	19,041	2,135	11.2%	4,436	196	4.4%
PERNAMBUCO	40,225	135	0.3%	4,471	8	0.2%
PIAUÍ	336,659	16	<0.1%	8,896	1	<0.1%
RIO DE JANEIRO	1,102			231	0	0
RIO GRANDE DO NORTE	14,096	12	0.1%	1,328	2	0.2%
RIO GRANDE DO SUL	12,249	13	0.1%	3,126	5	0.2%
RONDÔNIA	514,091	63,269	12.3%	20,074	748	3.7%
RORAIMA	93,205	7,470	8.0%	8,121	255	3.1%
SANTA CATARINA	6,041	58	1.0%	1,825	3	0.2%
SÃO PAULO	2,138	0	0	690	0	0
SERGIPE	6,257	270	4.3%	625	15	2.4%
TOCANTINS	361,501	8,564	2.4%	8,288	84	1.0%
Brazil	6,604,227	673,411	10.2%	303,264	7,181	2.4%

6.2.2. Action in Priority Municipalities in the Amazon

A List of Priority Municipalities for Prevention, Monitoring and Control of Deforestation in the Amazon was instituted by Decree nº 6.321/2007. Art. 2 of this decree establishes that the Ministry of the Environment (MMA) is responsible for annually editing an ordinance with the list of municipalities located in the Amazon biome to be considered a priority for actions to prevent and control deforestation.

The criteria for inclusion in the list of priority municipalities consider the dynamics of recent deforestation and are established by ordinances of the Ministry of the Environment. Currently, the list has 59 municipalities (Appendix 6).

In the 59 priority municipalities of the MMA, 4,760 (4.1%) of the 115,723 alerts published by MapBiomas Alerta for these same municipalities from 2019 to 2022 were assessed or embargoed, which represented 17.7% of the deforested area (Table 48).

Table 48 Assessment and embargo by IBAMA and ICMBio on alerts and deforested area in the 59 Priority Municipalities for Prevention, Monitoring and Control of Deforestation in the Amazon (MMA) between January 2018 and May 2023.

State	Municipality	Deforested area (ha)	Total area of the alert that crosses with embargoes and infraction notices from IBAMA and ICMBio (ha)	% of the area deforested with action	Alerts (no.)	Alerts crossed with actions (no.)	% of the number of alerts with actions in the 52 priority municipalities
AC	FEIJÓ	47,072	1,858	3.9%	7,258	61	0.8%
AC	RIO BRANCO	31,437	456	1.5%	3,162	42	1.3%
AC	SENA MADUREIRA	35,300	1,182	3.3%	5,096	91	1.8%
AC	TARAUACÁ	28,069	23	0.1%	5,099	2	0.0%
AM	APUÍ	143,435	23,511	16.4%	2,659	192	7.2%
AM	BOCA DO ACRE	63,006	5,622	8.9%	3,884	115	3.0%
AM	CANUTAMA	42,283	9,639	22.8%	1,398	156	11.2%
AM	HUMAITÁ	52,435	8,012	15.3%	1,699	165	9.7%
AM	LÁBREA	182,900	100,553	55.0%	3,180	828	26.0%
AM	MANICORÉ	49,011	11,146	22.7%	1,166	105	9.0%
AM	NOVO ARIPUANÃ	75,003	12,031	16.0%	1,250	87	7.0%
MA	AMARANTE DO MARANHÃO	5,692	0	0	351	0	0
MA	GRAJAÚ	20,934	0	0	564	0	0
MT	APIACÁS	26,385	5,255	19.9%	537	43	8.0%
MT	ARIPUANÃ	52,677	8,901	16.9%	1,386	117	8.4%
MT	CLÁUDIA	11,334	78	0.7%	171	7	4.1%
MT	COLNIZA	97,151	20,651	21.3%	2,199	166	7.5%
MT	COTRIGUAÇU	15,301	309	2.0%	653	6	0.9%
MT	FELIZ NATAL	20,956	975	4.7%	252	8	3.2%
MT	GAÚCHA DO NORTE	6,218	21	0.3%	280	2	0.7%
MT	JUARA	27,374	1045	3.8%	443	18	4.1%
MT	JUÍNA	12,634	196	1.5%	535	2	0.4%
MT	MARCEL NDIA	24,784	2404	9.7%	309	5	1.6%
MT	NOVA BANDEIRANTES	44,080	2319	5.3%	870	34	3.9%
MT	NOVA MARINGÁ	17,770	1113	6.3%	135	10	7.4%
MT	PARANAÍTA	10,550	1384	13.1%	305	16	5.2%
MT	PEIXOTO DE AZEVEDO	19,831	0	0	675	0	0



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State	Municipality	Deforested area (ha)	Total area of the alert that crosses with embargoes and infraction notices from IBAMA and ICMBio (ha)	% of the area deforested with action	Alerts (no.)	Alerts crossed with actions (no.)	% of the number of alerts with actions in the 52 priority municipalities
MT	QUERÊNCIA	13,369	57	0.4%	313	3	1.0%
MT	UNIÃO DO SUL	24,227	685	2.8%	277	16	5.8%
PA	ALTAMIRA	244,191	89,250	36.5%	5,667	450	7.9%
PA	ANAPU	43,592	1,915	4.4%	3,565	28	0.8%
PA	CUMARU DO NORTE	7,720	0	0	978	0	0
PA	DOM ELISEU	12,021	0	0	202	0	0
PA	ITAITUBA	102,076	20,136	19.7%	4,638	101	2.2%
PA	ITUPIRANGA	11,409	0	0	1,174	0	0
PA	JACAREACANGA	33,490	844	2.5%	1,704	5	0.3%
PA	MARABÁ	15,538	0	0	1265	0	0
PA	MEDICIL NDIA	36,125	1,259	3.5%	1,607	12	0.7%
PA	MOJU	21,156	121	0.6%	1,342	3	0.2%
PA	NOVO PROGRESSO	107,732	41,968	39.0%	1,647	230	14.0%
PA	NOVO REPARTIMENTO	49,760	228	0.5%	3,356	6	0.2%
PA	PACAJÁ	80,194	5,176	6.5%	5,018	74	1.5%
PA	PLACAS	44,039	2,224	5.1%	2,410	26	1.1%
PA	PORTEL	83,043	16,275	19.6%	3,364	196	5.8%
PA	RURÓPOLIS	42,243	2,882	6.8%	2,140	36	1.7%
PA	SANTANA DO ARAGUAIA	6,369	0	0	256	0	0
PA	SÃO FÉLIX DO XINGU	186,843	32,471	17.4%	7,558	280	3.7%
PA	SENADOR JOSÉ PORFÍRIO	46,531	10,737	23.1%	3,650	227	6.2%
PA	TRAIRÃO	37,066	6,152	16.6%	1,316	83	6.3%
PA	ULIANÓPOLIS	5,958	0	0	110	0	0
PA	URUARÁ	57,054	6,151	10.8%	2,806	31	1.1%
RO	BURITIS	11,276	465	4.1%	464	9	1.9%
RO	CANDEIAS DO JAMARI	57,871	7,886	13.6%	1,873	98	5.2%
RO	CUJUBIM	37,014	6,047	16.3%	1,185	62	5.2%
RO	MACHADINHO D'OESTE	22,541	168	0.7%	1,152	9	0.8%
RO	NOVA MAMORÉ	46,577	2,564	5.5%	1,703	46	2.7%
RO	PORTO VELHO	177,624	28,074	15.8%	5,096	355	7.0%
RR	MUCAJAÍ	5,865	211	3.6%	479	19	4.0%
RR	RORAINÓPOLIS	27,044	2,744	10.1%	1,892	77	4.1%
Total		2,861,177	505,373	17.7%	115,723	4,760	4.1%

6.2.3. Task Force of the Federal Public Prosecutor’s Office

Amazônia Protege (AP) is a project led by the Federal Public Prosecution Service (MPF) that intends to combat illegal deforestation in the Brazilian Amazon Forest through the use of satellite images and crossing public data to initiate Public Civil Actions (ACP) against those responsible for the illegal deforestation detected. Since the beginning of the project in 2017 the actions have been divided into three phases, according to the year in which the processes began: 1st phase in 2017; 2nd phase in 2018 and 3rd phase in 2019. Currently, the 4th phase of the AP, which covers the period from 2020 to 2021 is in the planning phase. In this new phase the project uses MapBiomass Alert as a data source and filters alerts with sizes greater than 60 hectares for each state of the Amazon biome. The data are then used to carry out spatial crossings, generation of technical reports and subsequent establishment of ACPs.

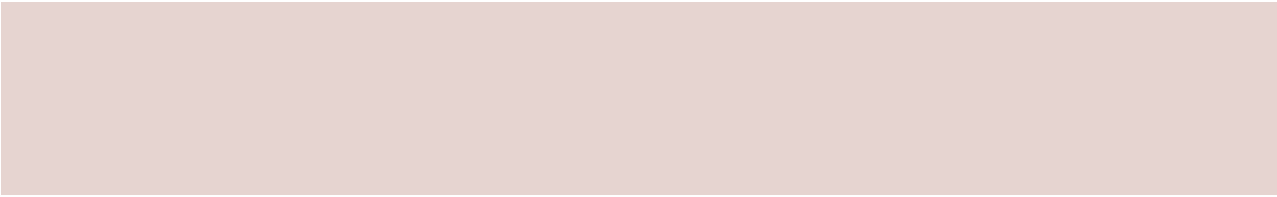
It is expected that the products resulting from this project will above all, inform the actions to be taken in conducting Public Civil Actions issued by the MPF, not only to the detriment of the defendants identified as directly responsible for the deforestation caused in the Amazon biome, but also deforested areas where it was not possible to identify those responsible. The result will be to inhibit the dynamics of deforestation in the Amazon, through the prevention or repair of environmental damage by illegal deforesters.

Table 49 summarizes the actions of the third phase of the project, the last one implemented. With this it was possible to analyze the crossing of alerts with the ACPs of Amazônia Protege of Phase 3, which covers deforestation polygons from August 2017 to December 2019. Amazônia Protege ACPs related to deforestation alerts of 18,626 hectares were identified.

Table 49 Deforestation alerts with Public Civil Actions in areas of the Amazônia Protege Project by state (3rd phase)

States	Overlapping area of the Amazônia Protege with deforestation alerts (ha)
ACRE	9
AMAPÁ	0
AMAZONAS	5,658
MARANHÃO	21
MATO GROSSO	3,354
PARÁ	6,141
RONDÔNIA	3,442
RORAIMA	0,3
TOCANTINS	0
Total	18,626

Currently, the 4th phase of the AP, which covers the period from 2020 to 2021 is in the planning phase. In this new phase the project uses MapBiomass Alert as a data source and filters alerts with sizes greater than 60 hectares.



6.3. Actions by the State Governments and the Federal District

In addition to the federal bodies, the state control agencies are also responsible for controlling and supervising deforestation. In this section we analyze the law enforcement performance by the states.

The structure and stage for implementing control systems and the systematization of sanctions and embargo data are different in each Federation Unit. This year, an attempt was made to understand these differences and collect possible information to characterize the action in the states and in the DF.

It is important to mention that the quantities of actions mentioned here refer to data that MapBiomas had access to up till when this report was published, and for which it was possible to perform spatial and crossing analysis. The results may thus not represent the totality of actions effectively carried out by the executing institutions in states across the country.

6.3.1. Overview on active transparency

MapBiomas has been working with State Environmental agencies in partnership with civil society organizations to propose solutions that can be put into operation to improve methods and processes with agility, effectiveness and transparency in actions to combat illegal deforestation.

To that end, active transparency on information regarding authorized deforestation and enforcement actions for illegal deforestation is essential. The situation of systematization and availability of these data by the states is heterogeneous and significantly impacts the potential for analysis, use and integration of these data. In this sense, the transparency of this data and the quality with which this information is made available to society are monitored, considering criteria such as updating frequency, format and georeferencing of data (Table 2).

The upgrade level varies between states. In eight states, Amazonas, Espírito Santo, Goiás, Mato Grosso, Minas Gerais, Pará, Rio Grande do Sul and São Paulo, it was possible to access up-to-date data on assessments or embargoes, online and complete.

In the states of Ceará, Piauí and Rondônia, at least part of the data is available online and georeferenced or with a pair of coordinates and has associated information.

In five states (BA, RR, SC, SE and TO) no available information was found.

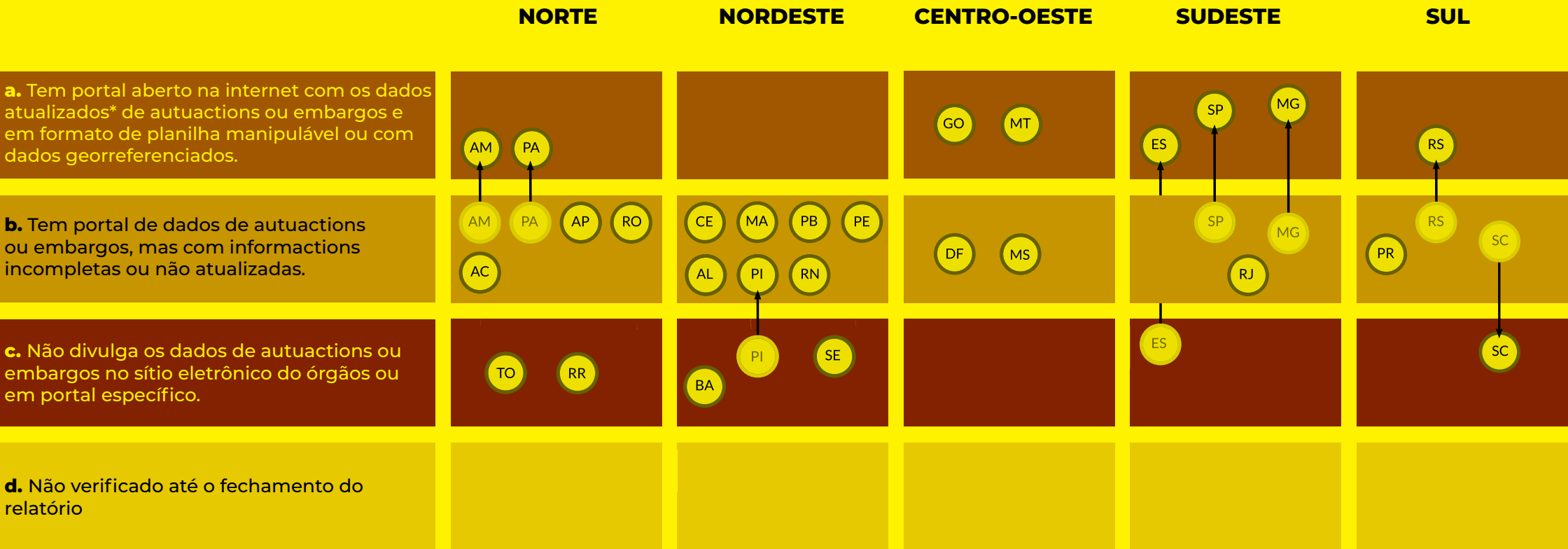
Appendix 7 apresents a complement on the classification of data availability and transparency by state informed in the overview for Table 2.

6.3.1.1 Quality and limitations of databases made available to society

As dealt with throughout this chapter, both authorizations for suppression of native vegetation or alternative land use, as well as enforcement actions (embargoes, infraction notices, etc.) need to be systematized, georeferenced and made available to public bodies, institutions financial institutions, private companies and civil society in order to be effective. This responsibility falls mainly on the state environmental agencies (OEMAs) due to their attributions. Public institutions need to be able to differentiate between authorized deforestation and what has already been assessed for planning operations. Financial institutions and private companies need access to this data for proper analysis of financing agricultural and ranching production and production chains. Nonetheless, active transparency in the availability of georeferenced data on authorizations and enforcement actions is not yet a reality for all OEMAs.

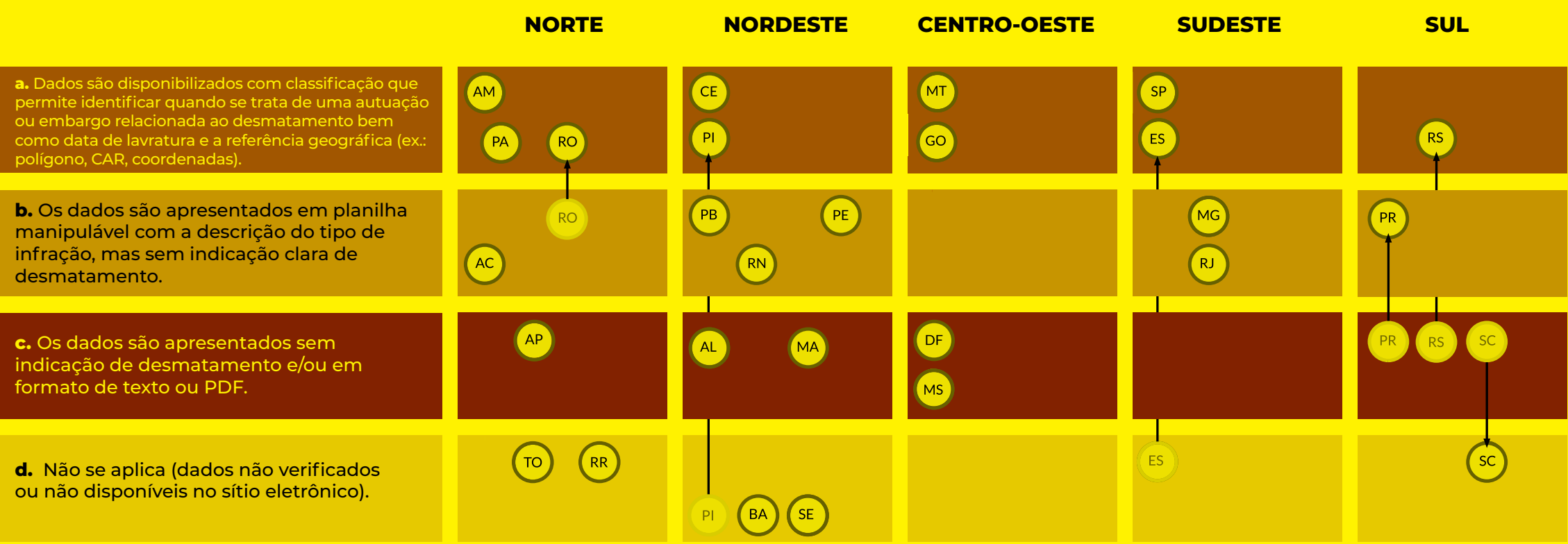
Table 2 Overview on the availability of data on assessments and embargoes by state and region in Brazil between 2022 and 2023

1. Quanto à **disponibilidade** dos dados sobre actions de combate ao desmatamento (autuactions e embargos):



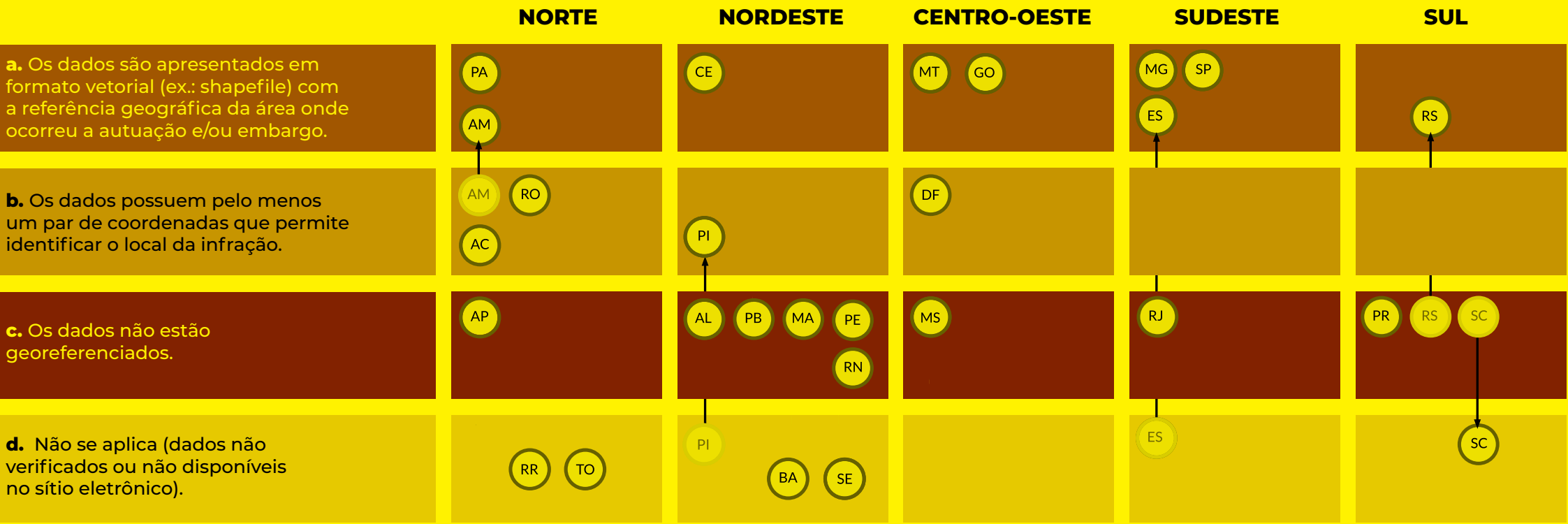
*Critério quanto à atualização: se o dado de infração ou embargo tem data de até três meses anteriores à consulta para este relatório. Base de referência: Lei 10.650/2003, que dispõe sobre o acesso público aos dados e informações ambientais existentes nos órgãos e entidades integrantes do SISNAMA. (...) Art.4. Parágrafo único. As relações contendo os dados referidos neste artigo deverão estar disponíveis para o público trinta dias após a publicação dos atos a que se referem.

2. Quanto ao **formato** dos dados disponibilizados



*Critério quanto à atualização: se o dado de infração ou embargo tem data de até três meses anteriores à consulta para este relatório. Base de referência: Lei 10.650/2003, que dispõe sobre o acesso público aos dados e informações ambientais existentes nos órgãos e entidades integrantes do SISNAMA. (...) Art.4. Parágrafo único. As relações contendo os dados referidos neste artigo deverão estar disponíveis para o público trinta dias após a publicação dos atos a que se referem.

3. Quanto ao **georreferenciamento** do dado:



*Critério quanto à atualização: se o dado de infração ou embargo tem data de até três meses anteriores à consulta para este relatório. Base de referência: Lei 10.650/2003, que dispõe sobre o acesso público aos dados e informações ambientais existentes nos órgãos e entidades integrantes do SISNAMA. (...) Art.4. Parágrafo único. As relações contendo os dados referidos neste artigo deverão estar disponíveis para o público trinta dias após a publicação dos atos a que se referem.

In addition, the level of quality of the data made available in some cases limits the use and reuse of this information – for example: information that is incomplete, outdated i or without a history that includes previous years; absence of data such as dates, reason for the assessments and embargoes, and data without geographic reference. In addition to these, other limitations found in the databases when carrying out the survey for the preparation of this report were: the lack of a data dictionary and other information relevant to users, such as the most recent data update date; lack of concentration of data into a single page or portal; and technical challenges of connection security in accessing the state agency websites.

The availability of data on environmental violations and the respective penalties imposed by environmental agencies, as well as authorizations granted for suppression of vegetation is provided for in Law No. 10,650/2003. In order to improve active transparency and access to this information, it is recommended that the OEMAs strengthen the mana-

gement and maintenance of these databases, ensuring their completeness, updating and availability in an open format. This will allow society to use and reuse this public information.

6.3.2. Highlights on actions taken

State Public Prosecution Services

In order to collect information and georeferenced data on the work of the Public Prosecution Service in the states and in the DF in relation to the alerts available on the MapBiomas Alerta platform, as well as for the OEMAs, a data request questionnaire was sent to the State Public Prosecution Services (MPEs). Twenty-six State MPs answered the questionnaire, of which 9 effectively attached action data on deforestation alerts published on the MapBiomas Alerta platform (Table 50). Of this set, the Public Prosecution Services of Rio Grande do Sul and Espírito Santo are the ones that had the highest number of alerts with actions, reaching 52.8% and 39% of the alerts of the states, respectively.

Table 50 Number of alerts and total deforested area from 2019 to 2022 that cross-reference with actions reported by State Public Prosecution Services that sent data via questionnaire on action in deforestation.

Public Prosecution Services	Total area two alerts in the state	Area of alerts with action	% of the area deforested with action	Total number of alerts in the state	Number of alerts with action	% of the number of alerts with actions
MPAC	273,681	6,830.42	2.5%	40,825	177	0.4%
MPES	1,053	549.80	52.2%	418	163	39.0%
MPMS	183,623	32,889.18	17.9%	2,414	324	13.4%
MPPI	336,659	9,960.73	3.0%	8,896	371	4.2%
MPRN	14,096	216.99	1.5%	1,328	15	1.1%
MPRO	514,091	12,964.23	2.5%	20,074	192	1.0%
MPRS	12,249	6,589.08	53.8%	3,126	1,650	52.8%
MPSC	6,041	187.25	3.1%	1,825	70	3.8%
MPTO	361,501	77,792.75	21.5%	8,288	641	7.7%
Total	1,702,995	147,980.43	8.69%	87,194	3,603	4.13%

It is important to point out that, in addition to the performance data received via questionnaire response, other state MP units provided georeferenced data by email or via access links, as is the case of the MPPR, for example, which is among the 17 MSEs participating in Operation Mata Atlântica em Pé – see details in the next section.

Operation Mata Atlântica em Pé (Standing Atlantic Forest)

Operation “Mata Atlântica em Pé” is a nationwide initiative, launched in 2016, which seeks to identify illegally deforested areas in the biome, halt the illicit acts, hold offenders accountable in the administrative, civil and criminal spheres and

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contribute to the recovery of degraded areas. In 2018 the task force began to operate in the 17 states (Figure 26) that are part of the Atlantic Forest occurrence area. Results have been expanded annually.

The Public Prosecution Service of Paraná is responsible for coordinating the Operation, which takes place together with the Public Prosecution Services of the other states. In the operation, the performance of the MPs and appropriate environmental agencies involve the following phases:

- 1) survey of deforested areas support from Fundação SOS Mata Atlântica and MapBiomas Alerta,
- 2) identification of the owners, any environmental licenses obtained, the history of use and conservation of the area and crossing with specific databases on the subject,
- 3) inspection and assessment, and
- 4) assigning liability for environmental damage.

The balance of the results of the Operation in 2022 reported the monitoring of 1,279 alerts in the 17 states, allowing the identification of more than 12 thousand hectares of illegal deforestation, an increase of 47% in relation to the edition of the previous year (Table 51).



Alagoas
Bahia
Ceará
Espírito Santo
Goiás
Mato Grosso do Sul
Minas Gerais
Paraíba
Paraná
Pernambuco
Piauí
Rio de Janeiro
Rio Grande do Norte
Rio Grande do Sul
Santa Catarina
São Paulo
Sergipe

Figure 26 | States of Operation Mata Atlântica em Pé.

Table 51 Results of Operation Mata Atlântica em Pé from 2019 to 2022.

Indicator	2019	2020	2019/2020 increment	2021	2020/2021 increment	2022	2021/2022 increment
States	16	134	-	17	-	17	
Verified polygons	559	8	-	649	-	1,279	
Extent of illegal suppression(ha)	5,473	4	15.22%	8,189	30%	12,009	47%
Total amount of fines applied (BRL)	R\$ 25,137,359.00	R\$ 32,554,818.29	29.51%	R\$ 55.531.184,19	70%	R\$ 48,651,613.65*	

*Partial value so far due to non-completion of calculations. Because of that it was not possible to report the increase in financial terms.

State Environmental Agencies

This section presents the results of the crossings between the deforestation alerts published by MapBiomas Alerta from 2019 to 2022, the authorizations for the suppression of vegetation or the enforcement actions of the state environmental agencies (OEMAs) on unauthorized deforestation.

Information on actions carried out by the OEMAs was obtained in three ways: i) data sent directly by the OEMAs to MapBiomas via the questionnaire response form and/or via e-mail; ii) data accessed from the websites of OEMAs and federal agencies; and iii) information made available by the OEMASs in the RAD 2021. The request for information via questionnaire was carried out in the same way as in previous years to collect georeferenced data on authorizations, assessments and embargoes for the years 2018 to 2022 from all states and the DF. All states except Mato Grosso do Sul responded to the questionnaire and 19 sent action data. Action data from the ten states that are currently on the Enforcement Monitor (plataforma.alerta.mapbiomas.org/monitor-da-fiscalizacao) were also used in the preparation of this report. Details of the data collection methodology may be found in **Appendix 5**.

Analyzing the data from deforestation **permits** made available by the states and those contained in Sinaflor, 4,034 (1.3%) alerts included authorizations, which represents 10.9% of the total deforested area. Bahia was the state with the

Table 52 Alerts and deforested area from 2019 to 2022 overlapping with **suppression authorizations** made available by state agencies and listed on Sinaflor, by state.

State	Deforested area (ha)	Total area of the alert that crosses with authorizations (ha)	% of the area deforested with authorization	Alerts (no.)	Crossed alerts with authorization (no.)	% of the number of alerts with authorizations
ACRE	273,680.67	4,299.97	1.6%	40,825	152	0.4%
ALAGOAS	5,079.16	60.426	1.2%	444	5	1.1%
AMAPÁ	4,947.86	308.169	6.2%	1,590	9	0.6%
AMAZONAS	734,436.07	597.785	0.1%	32,650	33	0.1%
BAHIA	560,066.61	258,289.47	46.1%	16,752	788	4.7%
CEARÁ	53,383.72	3,250.26	6.1%	6,884	70	1.0%
DISTRITO FEDERAL	462.807	99.446	21.5%	36	4	11.1%
ESPÍRITO SANTO	1,052.88	380.986	36.2%	418	146	34.9%
GOIÁS	150,485.00	1,179.15	0.8%	5,235	21	0.4%
MARANHÃO	654,503.73	106,633.64	16.3%	20,755	294	1.4%
MATO GROSSO	833,383.04	174,695.93	21.0%	18,590	813	4.4%
MATO GROSSO DO SUL	183,623.49	15.878	0.0%	2,414	3	0.1%
MINAS GERAIS	170,752.62	13,640.28	8.0%	9,521	148	1.6%
PARÁ	1,555,749.67	7,647.86	0.5%	82,791	186	0.2%
PARAÍBA	16,015.34	1,489.21	9.3%	2,248	31	1.4%
PARANÁ	19,040.64	214.923	1.1%	4,436	57	1.3%
PERNAMBUCO	40,224.57	1,810.13	4.5%	4,471	24	0.5%
PIAUÍ	336,658.88	32,748.12	9.7%	8,896	64	0.7%
RIO DE JANEIRO	1,102.23	11.45	1.0%	231	2	0.9%
RIO GRANDE DO NORTE	14,095.67	1,487.73	10.6%	1,328	40	3.0%
RIO GRANDE DO SUL	12,249.30	56.45	0.5%	3,126	10	0.3%
RONDÔNIA	514,091.36	3,428.12	0.7%	20,074	29	0.1%
RORAIMA	93,205.01	11,475.27	12.3%	8,121	305	3.8%
SANTA CATARINA	6,041.41	22.71	0.4%	1,825	5	0.3%
SÃO PAULO	2,137.51	236.15	11.0%	690	60	8.7%
SERGIPE	6,257.04	5.52	0.1%	625	1	0.2%
TOCANTINS	361,501.07	97,940.72	27.1%	8,288	734	8.9%
Total	6,604,227.36	722,025.75	10.9%	303,264	4,034	1.3%

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largest deforested area where authorizations were granted, 46% of the total area, although this represents only 4.7% of the number of alerts in the state.

Other states such as Espírito Santo, Tocantins, Distrito Federal and Mato Grosso also had a higher incidence of **permits** in their deforestation percentages compared to the others, ranging from 21 to 36% of the total area of alerts published in these states (Table 52).

In relation to **enforcement actions** by the state environmental agencies, we were unable to obtain the data base for only six states (AL, AP, MA, MS, SE and SC) . In the case of Rio Grande do Norte, authorization data were sent, but not databases identified as enforcement. In general, 5.4% of the alerts crossed with geographic inspection data (infraction notices, embargoes, among others), which represents 17.1% of the total deforested area.

Among the states with the largest area of alerts with incidence of enforcement actions are Mato Grosso (401 thousand hectares), Pará (349 thousand hectares) and Amazonas (140 thousand hectares). When analyzing the proportion of deforested areas that cross enforcement actions with the total area of alerts in the State, the states at the top of the ranking were Espírito Santo (68.3%), Mato Grosso (48.2%), Minas Gerais (38.5%) and São Paulo (33.6%) (Table 53).

Table 53 Alerts and deforested area from 2019 to 2022 overlapping with **enforcement actions** made available by state agencies, by state.

State	Deforested area (ha)	Total area of the alert that crosses with state enforcement actions (ha)	% of the area deforested with action	Alerts (no.)	Alerts crossed with actions (no.)	% of the number of alerts with actions
AC	273,680.7	5,221.9	1.9%	40,825	249	0.6%
AL	5,079.2			444		
AP	4,947.9			1,590		
AM	734,436.1	139,687.7	19.0%	32,650	978	3.0%
BA	560,066.6	20,100.6	3.6%	16,752	192	1.1%
CE	53,383.7	276.5	0.5%	6,884	22	0.3%
DF	462.8	8.3	1.8%	36	2	5.6%
ES	1,052.9	719.3	68.3%	418	192	45.9%
GO	150,485.0	45,562.3	30.3%	5,235	536	10.2%
MA	654,503.7			20,755		
MT	833,383.0	401,552.8	48.2%	18,590	5,843	31.4%
MS	183,623.5			2,414		
MG	170,752.6	65,765.5	38.5%	9,521	2,010	21.1%
PA	1,555,749.7	349,062.2	22.4%	82,791	4,415	5.3%
PB	16,015.3	105.7	0.7%	2,248	10	0.4%
PR	19,040.6	5,245.1	27.5%	4,436	860	19.4%
PE	40,224.6	31.9	0.1%	4,471	7	0.2%
PI	336,658.9	69,606.4	20.7%	8,896	59	0.7%
RJ	1,102.2	207.3	18.8%	231	27	11.7%
RN	14,095.7			1,328		
RS	12,249.3	3,201.4	26.1%	3,126	488	15.6%
RO	514,091.4	14,934.8	2.9%	20,074	226	1.1%
RR	93,205.0			8,121		
SC	6,041.4			1,825		
SP	2,137.5	718.8	33.6%	690	223	32.3%
SE	6,257.0			625		
TO	361,501.1	7,016.1	1.9%	8,288	45	0.5%
Total	6,604,227.4	1,129,024.6	17.1%	303,264	16,384	5.4%

6.4 Consolidated data for Brazil on actions and authorizations for deforestation

Considering data from federal and state agencies made available, 9.7% of deforestation alerts overlapped with authorizations or enforcement actions. The area covered by these alerts totals 2,340,382 hectares, which corresponds to 35.4% of the total area deforested between January 2019 and December 2022 (Table 54).

No período de 2019 a 2022, os dados analisados indicam In the period from 2019 to 2022, the analyzed data indicate a greater relative performance of environmental agencies and public prosecution services in the state of Espírito Santo, with 73.7% of alerts in the state with actions, followed by Rio Grande do Sul (55.6%), São Paulo (40.3%) and Mato Grosso (37.3%). The states where there was less correspondence between the area of alerts and the areas of enforcement actions, in relation to the total number of alerts in the State, were Pernambuco (0.8%), Maranhão (1.6%) and Ceará (1.9 %).

For each year of deforestation alerts validated and published by MapBiomas, the accumulated data of enforcement actions by federal and/or state agencies carried out up to May 2023 were crossed. This is because an alert registered in one year can only be inspected in the following year.

Table 54 Deforestation alerts validated by MapBiomas in the states and in Brazil from 2019 to 2022 that cross-reference with authorizations and enforcement actions by federal and state agencies

State	Deforested area (ha)	Total area of the alert that crosses authorization or action (ha)	% of the area deforested with action	Alerts (no.)	Alerts crossed with actions (no.)	% of the number of alerts with actions	Access to data from state agencies
ACRE	273,680.7	25,265.0	9.2%	40,825.0	1,234	3.0%	Yes
ALAGOAS	5,079.2	525.3	10.3%	444.0	30	6.8%	No
AMAPÁ	4,947.9	859.2	17.4%	1,590.0	36	2.3%	No
AMAZONAS	734,436.1	291,272.6	39.7%	32,650.0	2,682	8.2%	Yes
BAHIA	560,066.6	272,470.6	48.6%	16,752.0	1,110	6.6%	Yes
CEARÁ	53,383.7	4,442.1	8.3%	6,884.0	133	1.9%	Yes
DISTRITO FEDERAL	462.8	107.7	23.3%	36.0	6	16.7%	Yes
ESPIRITO SANTO	1,052.9	873.7	83.0%	418.0	308	73.7%	Yes
GOIÁS	150,485.0	49,181.9	32.7%	5,235.0	618	11.8%	Yes
MARANHÃO	654,503.7	110,709.0	16.9%	20,755.0	338	1.6%	Yes
MATO GROSSO	833,383.0	571,189.7	68.5%	18,590.0	6,936	37.3%	Yes
MATO GROSSO DO SUL	183,623.5	33,716.7	18.4%	2,414.0	346	14.3%	Yes
MINAS GERAIS	170,752.6	72,666.3	42.6%	9,521.0	2,146	22.5%	Yes
PARÁ	1,555,749.7	503,264.5	32.3%	82,791.0	6,321	7.6%	Yes
PARAÍBA	16,015.3	2,189.2	13.7%	2,248.0	84	3.7%	Yes
PARANÁ	19,040.7	7,366.0	38.7%	4,436.0	1,086	24.5%	Yes
PERNAMBUCO	40,224.6	1,972.1	4.9%	4,471.0	38	0.8%	Yes
PIAUÍ	336,658.9	105,270.3	31.3%	8,896.0	489	5.5%	Yes
RIO DE JANEIRO	1,102.2	218.8	19.8%	231.0	29	12.6%	Yes (2021 RAD data)
RIO GRANDE DO NORTE	14,095.7	1,717.0	12.2%	1,328.0	57	4.3%	Yes
RIO GRANDE DO SUL	12,249.3	7,560.2	61.7%	3,126.0	1,738	55.6%	Yes
RONDÔNIA	514,091.4	90,237.7	17.6%	20,074.0	1,276	6.4%	Yes
RORAIMA	93,205.0	18,599.2	20.0%	8,121.0	554	6.8%	Yes
SANTA CATARINA	6,041.4	267.5	4.4%	1,825.0	78	4.3%	No
SÃO PAULO	2,137.5	942.0	44.1%	690.0	278	40.3%	Yes
SERGIPE	6,257.0	276.0	4.4%	625.0	16	2.6%	No
TOCANTINS	361,501.1	167,221.9	46.3%	8,288.0	1,403	16.9%	Yes
Brazil	6,604,227.4	2,340,382.1	46.3%	303,264.0	29,370	9.7%	

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Considering the alerts validated in 2022, 8.8% of them had actions up to the analyzed period within the universe of databases to which MapBiomas had access. As for the 2021 alerts, 11.2% of the alerts crossed with actions. In 2020 it was 8.5% and in 2019 it was 11% of alerts with actions. When analyzing the area of alerts validated in 2022, 36% of deforestation was carried out by the appropriate agencies. In 2019, 2020 and 2021 they were 32%, 33.8% and 38.8% respectively (Table 55).

In 2022, the states with more than half of the area deforested but with federal or state actions were Mato Grosso (74.3%), Espírito Santo (67%) and Tocantins (56.9%). The states with less than 2% of the area deforested but with such actions were Santa Catarina (0.9%), Ceará and Sergipe (both with 1.9%) (Table 55).

Table 55 Alerts with authorization or inspection action by federal and/or state agencies carried out up to May 2023 on alerts detected from 2019 to 2022 in the states and in Brazil

less than or equal to 10% between 10 and 40% between 40 and 70% above 70%								
UF	% of the area deforested per year that already have federal or state actions up to May 2023				% of alerts per year that already have federal or state actions by May 2023			
	2019	2020	2021	2022	2019	2020	2021	2022
AC	13.0%	7.7%	8.4%	8.5%	4.6%	2.9%	2.4%	2.4%
AL	44.7%	25.4%	15.4%	3.7%	66.7%	15.5%	8.2%	3.3%
AP	23.2%	6.7%	7.1%	32.8%	2.0%	1.4%	1.4%	9.4%
AM	42.5%	32.9%	40.6%	41.0%	10.5%	5.3%	8.9%	9.3%
BA	46.4%	37.9%	56.9%	49.3%	10.9%	4.7%	7.9%	6.3%
CE	2.9%	16.9%	12.1%	1.9%	13.8%	4.7%	2.4%	0.9%
DF	27.6%	16.0%	23.4%	31.0%	25.0%	11.1%	50.0%	33.3%
ES	100.0%	100.0%	100.0%	67.0%	100.0%	100.0%	100.0%	66.2%
GO	42.8%	27.8%	43.5%	19.4%	18.9%	8.0%	20.8%	9.5%
MA	13.3%	26.8%	14.1%	7.9%	2.2%	1.3%	2.6%	1.7%
MT	53.9%	67.4%	77.9%	74.3%	32.2%	33.7%	45.7%	40.9%
MS	4.2%	5.7%	9.3%	49.8%	4.2%	5.0%	9.8%	46.6%
MG	32.0%	30.2%	58.0%	45.0%	26.3%	16.8%	37.1%	17.0%
PA	31.0%	32.8%	36.4%	29.2%	8.5%	8.1%	8.2%	5.7%
PB	30.9%	7.5%	14.0%	15.9%	33.3%	3.8%	5.2%	2.0%
PR	45.1%	45.2%	41.0%	22.1%	43.3%	43.9%	25.0%	10.3%
PE	1.9%	2.5%	2.2%	7.1%	6.7%	2.3%	0.8%	0.7%
PI	16.7%	26.0%	31.7%	38.0%	15.7%	7.8%	4.9%	1.6%
RJ	12.8%	39.5%	39.9%	2.4%	19.0%	40.5%	24.0%	1.4%
RN	92.8%	14.5%	7.4%	17.0%	75.0%	3.9%	3.7%	5.5%
RS	84.8%	78.8%	85.5%	32.3%	94.6%	94.2%	80.7%	36.5%
RO	19.7%	21.3%	18.5%	11.6%	8.8%	6.6%	6.3%	3.3%
RR	16.8%	24.0%	18.6%	20.5%	6.8%	5.7%	6.5%	9.4%
SC	0.0%	3.7%	12.3%	0.9%	0.0%	1.1%	15.4%	1.6%
SP	50.6%	46.6%	65.3%	26.4%	42.6%	42.2%	67.2%	26.2%
SE	29.7%	8.5%	4.0%	1.9%	33.3%	7.9%	3.1%	0.5%
TO	22.9%	43.6%	75.6%	56.9%	11.9%	10.4%	49.3%	36.6%
Brazil	32.0%	33.8%	38.8%	36.0%	11.0%	8.5%	11.2%	8.8%

An aerial photograph of a coastal region, possibly a bay or estuary, with a grid overlay. A large red rectangular box is centered over the image, containing the text '7. FINAL REMARKS' in white, bold, sans-serif capital letters. The background shows landmasses with irregular shorelines and some internal boundaries, surrounded by water. A scale bar is located in the bottom right corner.

7. FINAL REMARKS

500 m
2000 ft

This is the fourth edition of the Annual Deforestation Report, and the MapBiomas Project has been deepening the understanding of the dynamics of deforestation in Brazil and in different territorial and land areas, in addition to its relations with signs of irregularity or illegality, as well as with actions by supervisory bodies to combat illegal deforestation in the country.

We sought to demonstrate where, when, how much and how deforestation evolved in all Brazilian biomes from 2019 to 2022, adding new detection systems and improving territorial cross-checking to better characterize deforestation.

In this reporting period, deforestation increased in all biomes but there were different dynamics in the states. In general, more than 98% of deforestation alerts in Brazil presented at least one indication or evidence of irregularities.

In preparing the Report, we also encountered challenges in accessing and using data on authorizations and actions to combat deforestation at the federal and state level, with some points on active transparency, systematization and georeferencing of data that we recommend improvements. Consolidated data for the whole country indicate that the percentage of deforestation alerts that had authorizations or enforcement actions does not reach 10%, which corresponds to 35.4% of the deforested area in the period from 2019 to 2022.

All data, such as alerts, statistics and reports, are available for free on the MapBiomas Alert platform - <http://alerta.mapbiomas.org>.

This is a contribution from the MapBiomas Project to support public and private institutions, as well as society in general, in the process of reducing deforestation and promoting conservation and sustainable use throughout Brazil.

An aerial photograph of a coastal region, possibly a bay or estuary, with a white grid overlay. The land is outlined in white, and the water is a darker grey. A large, solid dark red rectangle is centered over the image, containing the word 'APPENDICES' in white, bold, sans-serif capital letters.

APPENDICES

500 m
2000 ft

Appendix 1. Description of deforestation monitoring systems in Brazil used by MapBiomas Alerta

The following table presents the deforestation detection systems used since the beginning of MapBiomas Alerta project.

System	Institution	Scope	Characteristics	Reference	Period used
DETER Amazon	INPE	Legal Amazon forest areas	Uses images from the Amazônia 1-WFI (64m), CBERS4-WFI (64m), AwiFS (56m) and CBERS4A-WFI (55m) satellites to map weekly forest clear-cutting, forest degradation in preparation for deforestation and forest fire scars , which may also include areas with logging activities.	http://www.obt.inpe.br/OBT/assuntos/programas/amazonia/deter/deter	from 2019 to 2022
DETER Cerrado	INPE	Cerrado, except areas covered by DETER Amazônia	Uses CBERS-4 (64m) and Resourcesat2 (56m) images with visual interpretation for weekly mapping of deforested areas in the biome.	http://cerrado.obt.inpe.br	from 2019 to 2022
SAD Amazônia	Imazon	Legal Amazon Forest Areas	Uses images from Landsat and Sentinel satellites (with spatial resolution from 10 to 30 m) to detect deforestation in primary forests in the Amazon.	https://imazon.org.br/categorias/sad-alerta/	from 2019 to 2022
GLAD	University of Maryland	Forest areas in tropical regions	Globally tracks the loss and gain of tropical forests on a weekly basis with Landsat imagery since 2015.	https://glad.umd.edu	• 2019 for Caatinga, Atlantic Forest, Pantanal and Pampa • 2020 and 2021 for the Atlantic Forest, Pantanal and Pampa • 2022 for Pampa
CERRADO-X	ONE	Xingu River Basin	Based on radar images from the Sentinel satellite, it produces monthly deforestation data since the beginning of 2018.	https://xingumais.org.br/siradx	from 2020 to 2022
ATLAS OF THE ATLANTIC FOREST	SOS Mata Atlântica and INPE	Atlantic Forest Law Area	Annually monitors with visual interpretation of Landsat images (30m) the deforestation of the Atlantic Forest since 1985.	https://www.sosma.org.br/iniciativa/atlas-da-mata-atlantica/	from 2020 to 2022



There are still other initiatives located in states and municipalities that also monitor deforestation and have been used occasionally. Among these systems are:

- IEF/MG - 12 alerts were used in 2020 and 7 alerts in 2019
- INEMA/BA - 38 alerts were used in 2020

System	Institution	Scope	Characteristics	Reference	Period used
SIPAMSAR	SIPAM/ Ministry of Defense	Priority areas in the Amazon	Based on radar images, it delivers weekly data in the rainy months between October and April of each year to IBAMA in priority areas. Data is not public.	https://panorama.sipam.gov.br/panorama/pages/index.php	2019
SAD Caatinga	GEODATIN / UEFS	Caatinga	Generates monthly alerts, based on Sentinel 2A images with a spatial resolution of 10 m and machine learning methods.	n.a.	from 2020 to 2022
SAD Atlantic Forest	SOS Mata Atlântica and ArcPlan	4 watersheds (Tietê, Jequitinhonha, Iguaçu and Miranda/Aquidauana) in 2021 and the entire biome from 2022	Generates monthly alerts based on Sentinel 2 images with 10 m of spatial resolution that are a source for validation in MapBiomas Alerta.	https://www.sosma.org.br/iniciativas/alertas/	from 2021 to 2022
SAD Pantanal	SOS Pantanal and ArcPlan	Pantanal	Generates monthly alerts based on Sentinel 2 images with 10m of spatial resolution that are a source for validation in MapBiomas Alerta.	n.a.	from 2021 to 2022
SAD Pampa	Geokarten and UFRGS	Pampa	Generates monthly alerts based on Sentinel-2 imagery with 10 m spatial resolution	n.a.	2022
SAD Cerrado	IPAM and LAPIG-UFG	Cerrado	Generates monthly alerts based on Sentinel-2 images with 10 m of spatial resolution, with machine learning and artificial intelligence techniques.	https://sadcerrado.ipam.org.br/	2022

Appendix 2. Table of complementary data

Databases and rules used for spatial overlap analysis

Layer	Source	Crossover Rule
- country	IBGE, 2021	Assigns the territory with the largest crossing area
- biomes (refined_biomes)	IBGE, 2019 1:250.000	Assigns the territory with the largest crossing area
- states	IBGE, 2021	Assigns the territory with the largest crossing area
- municipalities	IBGE, 2021	Assigns the territory with the largest crossing area
- PNRH Basins (National Water Resources Plan)	ANA, 2006	Assigns the territory with the largest crossing area
- AMACRO	Municipalities of IBGE 1:250,000	Assigns to territory if it contains more than 1ha
- Limit of Application of the Atlantic Forest Law	SOS Mata Atlântica (refined by IBGE 1:5,000,000 based on RADAM 1:1,000,000)	Assigns to territory if it contains more than 1ha
- Limit of the Legal Amazon	TerraBrasilis, 2016	Assigns to territory if it contains more than 1ha
- Semi-arid limit	EMBRAPA, 2015	Assigns to territory if it contains more than 1ha
- Limit of MATOPIBA	ANA, 2017	Assigns to territory if it contains more than 1ha
- Geoparques	UNESCO	Assigns to territory if it contains more than 1ha
- Biosphere Reserves	MMA	Assigns to territory if it contains more than 1ha
- Conservation units	MMA/I3Geo	Assigns to territory if it contains more than 1ha
- Indigenous Lands	FUNAI, 03/3023	Assigns to territory if it contains more than 1ha
- Quilombos	INCRA 03/3023	Assigns to territory if it contains more than 1ha
- SINAFLOR authorizations (ASV, EFP, PMFS, UAS, UPA)	IBAMA 03/3023	Calculates amount and area (ha) overlapped
- SINAFLOR embargo	IBAMA 03/3023	Calculates quantity and overlapping area
- SICAR real estate limit	SFB 03/3023	Calculates amount and area (ha) overlapped
- SICAR Legal Reserve	SFB 03/3023	Calculates amount and area (ha) overlapped
- SICAR APP	SFB 03/3023	Calculates amount and area (ha) overlapped
- SICAR water sources	SFB 03/3023	Calculate quantity
- SIGEF	INCRA 03/3023	Calculates amount and area (ha) overlapped
- SNCI	INCRA 03/3023	Calculates amount and area (ha) overlapped
- Rural Settlements	INCRA 03/3023	Assigns to territory if it contains more than 1ha

Appendix 3. Reasons for Discarding Alerts During Pre-validation

- ◆ **Duplicate:** several polygons very close together can be grouped together as a single larger alert (the other polygons in the overlapping area are discarded as duplicates), polygons that overlap already published alerts are also considered duplicates.
- ◆ **Reforestation:** the alert is due to the cutting of silviculture (for example, pine or eucalyptus).
- ◆ **Seasonality:** the alert is a false positive generated in native vegetation that had seasonal variation (dry or wet).
- ◆ **Agriculture:** the alert is a false positive generated in an agricultural area (usually after harvest).
- ◆ **Relay Shadow:** the alert is a false positive generated by variation in the relief shadow.
- ◆ **Burned:** the alert is a false positive generated by a wildfire.
- ◆ **Cloud noise:** the alert is a false positive probably generated with atmospheric contamination in the original images (clouds or shadows).
- ◆ **Degradation:** the alert was generated by a forest degradation process.
- ◆ **Already changed:** the alert was generated in an area that was already altered before the detection date.

Appendix 4. Who's Who in MapBiomias Alerta

MapBiomias Alerta is conducted by the following institutions:

Coordination in biomes:

- ◆ **Amazon** – Institute of People and Environment of the Amazon (IMAZON) in partnership with LAPIG/UFG
- ◆ Caatinga – State University of Feira de Santana (UEFS) in partnership with Geodatin
- ◆ Cerrado – Amazon Environmental Research Institute (IPAM) with support from LAPIG and University of Brasília (UnB)
- ◆ Atlantic Forest – Fundação SOS Mata Atlântica and ArcPlan
- ◆ Pampa – Federal University of Rio Grande do Sul (UFRGS) and GeoKarten
- ◆ Pantanal – Instituto SOS Pantanal and ArcPlan

Technology and Systems Partners:

- ◆ Google
- ◆ EcoStage
- ◆ Solved
- ◆ LAPIG/UFG

Technical Coordination: Marcos Rosa

Scientific Coordination: Julia Shimbo

Overall coordination: Tasso Azevedo

Financing:

- ◆ Children's Investment Fund Foundation (CIFF)
- ◆ Climate and Land Use Alliance (CLUA)
- ◆ Global Wildlife Conservation (GWC)
- ◆ Good Energies Foundation
- ◆ Gordon & Betty Moore Foundation
- ◆ International Climate and Forests Initiative Norway (NICFI)
- ◆ Instituto Arapyaú
- ◆ Instituto Clima e Sociedade (ICS)
- ◆ Instituto Humanize
- ◆ Oak Foundation
- ◆ Quadracture Climate Foundation (QCF)
- ◆ Skoll Foundation
- ◆ Sequoia Climate Foundation
- ◆ Walmart Foundation (in USA)

Institutional Partners:

- ◆ MapBiomias Support Institute (IAMap)
- ◆ Arapyaú Institute
- ◆ The Nature Conservancy (TNC)
- ◆ Avina Foundation

Technical Partners:

- ◆ Life Center Institute (ICV)
- ◆ Democracy and Sustainability Institute (IDS)
- ◆ Socio-environmental Institute (ISA)
- ◆ Institute of Forestry and Agricultural Management and Certification (Imaflora)
- ◆ Brazil I.O.

Login <http://alerta.mapbiomas.org/team> to see all the people who make MapBiomias Alerta happen.

APPENDICES

Team of analysts working on validating and refining deforestation alerts:

Name	Biome	Institution
Mariana Dias Ramos	Atlantic Forest and Pantanal	ArcPlan
Eduardo Reis Rosa	Atlantic Forest and Pantanal	ArcPlan
Fernando Frizeira Paternost	Atlantic Forest	ArcPlan
Jacqueline Freitas	Atlantic Forest	ArcPlan
Natalia Crusco	Atlantic Forest	ArcPlan
Marcos Reis Rosa	Atlantic Forest	ArcPlan
Camila dos Santos Pereira	Atlantic Forest	ArcPlan
Carlos Eduardo do N. F. Silva	Atlantic Forest	ArcPlan
Caroline dos Santos Pereira	Atlantic Forest	ArcPlan
Giovana Fuzaro	Atlantic Forest	ArcPlan
Nathalia Tareto	Atlantic Forest	ArcPlan
Aline Beatriz da Silva	Atlantic Forest	ArcPlan
Amanda Rosa Falcão	Amazon	Lapig
Ana Flávia Soares Carneiro	Amazon	Lapig
Edésio Severino Vieira Júnior	Amazon	Lapig
Eduarda Gabriella Raiam Oliveira	Amazon	Lapig
Elis Regina Rocha Silva	Amazon	Lapig
Felipe Sousa de Jesus	Amazon	Lapig
Gabriela Rodrigues Gonçalves	Amazon	Lapig
Gleiciania Luiz de Oliveira	Amazon	Lapig
Guilherme de Paula	Amazon	Lapig
Igor Boson Schetine	Amazon	Lapig
Igor Rodrigues dos Santos	Amazon	Lapig
Igor Sousa Luiz	Amazon	Lapig

Name	Biome	Institution
Lana Teixeira	Amazon and Cerrado	Lapig
Lorena Souza Miranda	Amazon	Lapig
Luan de Sousa Rodrigues	Amazon	Lapig
Luana Cristina de Oliveira	Amazon	Lapig
Lythielle Silva Almeida	Amazon	Lapig
Mário Henrique Monteiro Dornelas	Amazon	Lapig
Matheus Azevedo da Silva	Amazon	Lapig
Michele Pereira Mendanha	Amazon	Lapig
Poliana Vieira	Amazon	Lapig
Sara Fernandes Martins dos Santos	Amazon	Lapig
Stefanny Leão Martins	Amazon	Lapig
Thamires de Jesus Silva	Amazon	Lapig
Larissa Amorim	Amazon	Imazon
Bianca Santos	Amazon	Imazon
Raissa Ferreira	Amazon	Imazon
Júlia Ribeiro	Amazon	Imazon
Ana Carolinne Cesário Reis	Cerrado	Lapig
Carolina Ribeiro Coelho	Cerrado	Lapig
Elaine Barbosa da Silva	Cerrado	Lapig
Isabela Nogueira de Macedo	Amazon and Cerrado	Lapig
Kaio Henrique Gama	Cerrado	Lapig
Karla Cristina Reis	Cerrado	Lapig
Victor Soares	Cerrado	Lapig
Wellington Alves Oliveira	Cerrado	Lapig

Name	Biome	Institution
Roberta Rocha	Cerrado	IPAM
Joaquim Raposo	Cerrado	IPAM
Paula Lopes	Cerrado	IPAM
Yanara Ferreira	Cerrado	IPAM
Marcella de Oliveira	Cerrado	IPAM
Paola Aires	Cerrado	IPAM
Bárbara Guedes	Cerrado	IPAM
Débora Sally	Cerrado	IPAM
Júlia Shimbo	Cerrado	IPAM
Ane Alencar	Cerrado	IPAM
Débora Sally	Cerrado	IPAM/UnB
Maria Regina	Cerrado	IPAM/UnB
William Bach	Cerrado	IPAM/UnB
Ycles Campos	Cerrado	IPAM/UnB
Nerivaldo Afonso Santos	Caatinga	Geodatin
Rafael Oliveira Franca Rocha	Caatinga	Geodatin
Ericka Medeiros da Silva	Caatinga	UEFS
Ellen Monteiro Ribeiro Santos	Caatinga	Geodatin
Bruno Manoel Lôbo Soares	Caatinga	UEFS
Eduardo Vélez Martin	Pampa	GeoKarten
Juliano Schirmbeck	Pampa	GeoKarten
Gilvan Andrade	Pampa	GeoKarten
Allan de Oliveira	Pampa	UFRGS
Vanessa Iorati	Pampa	UFRGS

Appendix 5. Method of Analysis of Law Enforcement Actions to Combat Deforestation

Survey of Actions by Federal Public Agencies via LAI

The complete methodology for consulting federal agencies was published in a previous report.¹¹

Survey of Actions in State and Federal Public Agencies

The analysis performed adopted and crossed the databases of deforestation alerts, deforestation authorizations, areas embargoed and assessed by environmental agencies and areas with civil actions filed by Public Prosecution Services.

The deforestation alert databases were obtained from the MapBiomas Alert portal on May 16, 2023. The data refer to validated and refined deforestation areas using high-resolution images.

At the federal level, the bases of embargoed areas and infraction notices issued by the Brazilian Institute of the Environment and Renewable Natural Resources (IBAMA), on May 21, 2023, and the Chico Mendes Institute for Biodiversity Conservation (ICMBio), were adopted, on May 31, 2023, and the Sinaflor database of vegetation suppression and alternative land use authorizations accessed in its Shared Environmental Information System (Siscom) on May 21, 2023.

At the state level, two forms of data acquisition were considered. We considered databases obtained both by sending them directly to MapBiomas, through collaboration between the OEMAs and the network (AC, AM, BA, CE, DF, ES, GO, MG, MT, PA, PB, PE, PI, PR, RN, RR, RS, SP, TO), as well as direct access to the public data portals of environmental agencies, when available. The data were also added to the databases used for the reports from previous years in order to consolidate cumulative information.

Information on actions carried out by the OEMAs was obtained in three ways: i) data sent directly by the OEMAs to MapBiomas via the questionnaire response form and/or via e-mail; ii) data accessed from the websites of OEMAs and federal agencies; and iii) information made available by the SEAs in the RAD 2021. The request for information via questionnaire was carried out in the same way as in previous years, to collect georeferenced data on authorizations, assessments and embargoes for the years 2018 to 2022 from all states and the DF. All states except Mato Grosso do Sul responded to the questionnaire, and 19 sent action data. Action data from the ten states that are currently on the Enforcement Monitor ([plataforma.alerta.mapbiomas.org/monitor-da-fiscalização](http://plataforma.alerta.mapbiomas.org/monitor-da-fiscaliza%C3%A7%C3%A3o)) were also used in the preparation of this report.

¹¹ | Analysis of federal government actions in relation to deforestation alerts - São Paulo, Brazil - Instituto Democracia e Sustentabilidade and MapBiomas, 2021 - 27 pages. Available at: <http://alerta.mapbiomas.org/relatorio>

APPENDICES

Overview of OEMA’ responses to georeferenced data on authorizations, assessments and embargoes for the years 2018 – 2022

State	Answered Questionnaire	Sent data on actions	Sent data on actions via Questionnaire	Sent data on actions via Email	Is in Inspection Monitor (05/2022)	State	Answered Questionnaire	Sent data on actions	Sent data on actions via Questionnaire	Sent data on actions via Email	Is in Inspection Monitor (05/2022)
AC	X	X	-	X	X	PB	X	X	X	-	-
AL	X	-	-	-	-	PE	X	X	X	-	-
AM	X	X	X	-	X	PI	X	X	X	-	-
AP	X	-	-	-	-	PR	X	X	X	X	-
BA	X	X	-	X	-	RJ	X	-	-	-	-
CE	X	X	X	-	X	RN	X	X	X	-	-
DF	X	X	X	-	-	RO	X	-	-	-	X
ES	X	X	-	X	X	RR	X	X	X	-	-
GO	X	X	X	-	X	RS	X	X	-	X	-
MA	X	-	-	-	-	SC	X	-	-	-	-
MG	X	X	-	X	X	SE	X	-	-	-	-
MS	did not respond	-	-	-	-	SP	X	X	-	X	X
MT	X	X	X	-	X	TO	X	X	X	-	-
PA	X	X	X	-	X	Total	26	19	13	7	10

The State Public Prosecution Services of Acre (MPAC), Espírito Santo (MPES), Mato Grosso do Sul (MPMS), Tocantins (MPTO), Rio Grande do Sul (MPRS), Rondônia (MPRO), Rio Grande do Norte (MPRN), Piauí (MPPI) and Santa Catarina (MPSC), also sent data on enforcement actions in May 2023.

Data analysis

The databases were standardized in the system of coordinates with equivalent conical projection from Albers and Sirgas 2000 datum. ArcGIS 10.8 software was adopted for processing and spatial analysis of the data.

After standardizing the coordinate systems, the database geometries were checked and repaired. This step has the function of ridding the base of topological inconsistencies, empty geometries and other errors that compromise the processing of the next steps.

Subsequently, the Identity tool was used to cross the alerts with the deforestation authorizations valid for the analysis period. This tool calculates the geometric intersection between the databases, so that the alert polygons that affected authorized areas loaded the information related to authorizations into its database. With this, in the database of defo-

restation alerts it was possible to identify which were legal (authorized) and illegal (unauthorized).

For databases in point format, as in the case of infraction notices from Ibama and from some states, a buffer of 60 meters was generated and adopted for crossing with deforestation alerts. The area assigned to the infraction notice was that of the deforestation alert that crossed with the notice. The assessments and embargoes with an issue date from 01/01/2018 on were selected.

In order to analyze the actions of the Amazônia Protege Project, polygons without identification of the Public Civil Action number and those referring to phases 1 and 2 of this project were excluded from the database, since they refer to deforestation prior to 2019. Data were exported and analyzed using Excel software.

For the states where the data were in Excel, the geographic coordinates indicated in the database or the deforestation alert code identified by the agency responsible for transferring the data were used for spatialization. The area assigned to the actions that crossed deforestation alerts was the total area of the alerts.

Appendix 6. List of priority municipalities for actions to prevent, monitor and control deforestation

	State	Name	Entry year	Return Year	Entry ordinance	Ordinance return
1	AC	FEIJÓ	2021		Ordinance no. 9/2021	
2	AC	SENA MADUREIRA	2021		Ordinance no. 9/2021	
3	AM	LÁBREA	2008		Ordinance no. 28/2008	
4	AM	BOCA DO ACRE	2011		Ordinance no. 175/2011	
5	AM	APUÍ	2017		Ordinance no. 361/2017	
6	AM	MANICORÉ	2017		Ordinance no. 361/2017	
7	AM	NOVO ARIPUANÃ	2017		Ordinance no. 361/2017	
8	AM	HUMAITÁ	2021		Ordinance no. 9/2021	
9	MA	"AMARANTE DO MARANHÃO"	2009		Ordinance no. 102/2009	
10	MA	GRAJAÚ	2011		Ordinance no. 175/2011	
11	MT	PARANAÍTA	2008		Ordinance no. 28/2008	
12	MT	NOVA MARINGÁ	2008		Ordinance no. 28/2008	
13	MT	NOVA BANDEIRANTES	2008		Ordinance no. 28/2008	
14	MT	JUÍNA	2008		Ordinance no. 28/2008	
15	MT	GAÚCHA DO NORTE	2008		Ordinance no. 28/2008	
16	MT	COTRIGUAÇU	2008		Ordinance no. 28/2008	
17	MT	COLNIZA	2008		Ordinance no. 28/2008	
18	MT	ARIPUANÃ	2008		Ordinance no. 28/2008	
19	MT	MARCELÂNDIA	2008	2018	Ordinance no. 28/2008	Ordinance no. 428/2018
20	MT	QUERÊNCIA	2008	2020	Ordinance no. 28/2008	Ordinance no. 162/2020
21	MT	JUARA	2009		Ordinance no. 102/2009	
22	MT	FELIZ NATAL	2009	2020	Ordinance no. 102/2009	Ordinance no. 162/2020
23	MT	CLÁUDIA	2011	2020	Ordinance no. 175/2011	Ordinance no. 162/2020
24	MT	UNIÃO DO SUL	2021		Ordinance no. 475/2021	
25	MT	PEIXOTO DE AZEVEDO	2008	2021	Ordinance no. 28/2008	Ordinance no. 9/2021
26	PA	SÃO FÉLIX DO XINGU	2008		Ordinance no. 28/2008	
27	PA	NOVO REPARTIMENTO	2008		Ordinance no. 28/2008	
28	PA	NOVO PROGRESSO	2008		Ordinance no. 28/2008	
29	PA	CUMARU DO NORTE	2008		Ordinance no. 28/2008	

	State	Name	Entry year	Return Year	Entry ordinance	Ordinance return
30	PA	ALTAMIRA	2008		Ordinance no. 28/2008	
31	PA	PACAJÁ	2009		Ordinance no. 102/2009	
32	PA	MARABÁ	2009		Ordinance no. 102/2009	
33	PA	ITUPIRANGA	2009	2022	Ordinance no. 102/2009	Ordinance no. 251/2022
34	PA	MOJU	2011		Ordinance no. 175/2011	
35	PA	"SENADOR JOSÉ PORFÍRIO"	2012		Ordinance no. 323/2012	
36	PA	ANAPU	2012		Ordinance no. 323/2012	
37	PA	PORTEL	2017		Ordinance no. 361/2017	
38	PA	ITAITUBA	2017		Ordinance no. 361/2017	
39	PA	PLACAS	2018		Ordinance no. 428/2018	
40	PA	URUARÁ	2018		Ordinance no. 428/2018	
41	PA	JACAREACANGA	2021		Ordinance no. 9/2021	
42	PA	MEDICILÂNDIA	2021		Ordinance no. 9/2021	
43	PA	RURÓPOLIS	2021		Ordinance no. 9/2021	
44	PA	TRAIRÃO	2021		Ordinance no. 9/2021	
45	PA	"SANTANA DO ARAGUAIA"	2008	2021	Ordinance no. 28/2008	Ordinance no. 475/2021
46	PA	ULIANÓPOLIS	2008	2021	Ordinance no. 28/2008	Ordinance no. 475/2021
47	RO	PORTO VELHO	2008		Ordinance no. 28/2008	
48	RO	NOVA MAMORÉ	2008		Ordinance no. 28/2008	
49	RO	MACHADINHO D'OESTE	2008		Ordinance no. 28/2008	
50	RO	BURITIS	2017		Ordinance no. 361/2017	
51	RO	CANDEIAS DO JAMARI	2017		Ordinance no. 361/2017	
52	RO	CUJUBIM	2017		Ordinance no. 361/2017	
53	RR	MUCAJAÍ	2009		Ordinance no. 102/2009	
54	RR	RORAINÓPOLIS	2021		Ordinance no. 9/2021	
55	AC	RIO BRANCO	2022		Ordinance no. 251/2022	
56	AC	TARAUACÁ	2022		Ordinance no. 251/2022	
57	AM	CANUTAMA	2022		Ordinance no. 251/2022	
58	MT	APIACÁS	2022		Ordinance no. 251/2022	
59	PA	DOM ELISEU	2008	2022	Ordinance no. 28/2008	Ordinance no. 251/2022

Appendix 7. Supplement on classification of availability and active transparency of data by federation unit

State	Agency	Status of the online availability of data in an open portal during the preparation of this report	State	Agency	Status of the online availability of data in an open portal during the preparation of this report
AC	IMAC	Classification: (b), (b), (b) IMAC provides information on notices of infraction for the years 2019 to 2022 (outdated). The spreadsheets (xls) contain case number, name of interested party, name of person responsible, alert ID (for some), address, municipality, damage, report/notification number, sanction applied, amount, geographic coordinates (for some), volume (for some), area (for some), burning, term of deposit, TC. The spreadsheets present the sanction applied based on the article of legislation, which is not indicated (probably the environmental crimes law).	DF	IBRAM	Classification: (b), (c), (b) IBRAM provides information on notices of infraction and embargoes as a PDF list containing basic information, including pairs of coordinates (only for the embargo worksheet) and a column that identifies whether there is a CAR or not. The embargo list does not contain the date of preparation, only the identification July 2022 in the file name. The data are presented without a clear indication of deforestation, but for infraction notices, the legal provision that has been infringed is provided. The embargo data has at least one pair of coordinates that allow identification of the location of the infraction. The notices of infraction lack geographic information. The availability of information through the Geoservice page and downloads from ONDA , show and error.
AL	IMA	Classification: (b), (c), (c) IMA provides notices of final allegations, the last one being in May 2023. PDF file, containing name of the interested party, CNPJ/CPF, number of the opening process, number of notice of infraction. The information is presented without indication of deforestation. The IMAGEO portal does not allow downloading of information such as embargoes.	ES	IDAF	Classification: (a), (a), (a) IDAF provides information regarding environmental and forest inspections with complete and updated data. The available information is in spreadsheet format (with coordinates) and shapefile. It is possible to identify the type of inspection and whether it is related to deforestation.
AM	IPAAM	Classification: (a), (a), (a) The transparency section on the IPAAM website provides worksheets of notices of infraction and embargoes, identified by year and month, up to December 2022. In the notice of infraction worksheet, it is possible to identify the type of infraction from the column description of the infraction (whether by deforestation or not). It is also possible in the embargo work sheet, from the description column. The infraction and embargo worksheets show the geographic coordinates. In addition, the IPAAM Geoportal provides information on embargoes issued by the body, in addition to other embargoes and notices of infraction by federal bodies.	GO	SEMAD	Classification: (a), (a), (a) SEMAD-GO provides data (from the SIGA-GO system) of infraction notices and embargoes in complete and updated vector format (shapefile). The databases provided specific information on deforestation in the attribute table.
AP	SEMA	Classification: (b), (c), (c) SEMA-AP provides environmental reports in PDF, containing notices of infraction from 2018 to 2020 (outdated). The files do not have the date of the assessment (only the reference to the year in the file name), or a clear description of deforestation. Information on the location of the infraction is presented as an address, without coordinates. No georeferenced data were found.	MA	SEMA	Classification: (b), (c), (c) SEMA-MA makes data on notices of infraction available by listing them on the screen. Violations are dated up to April 2022 (out of date). It is not possible to download the database. The information available as a list on screen, presents in detail the signature date and a text that explains the reason for the notice of infraction (where the information can be extracted if it is due to deforestation). Geographical coordinates are only included in some of the records. No georeferenced data were found.
BA	INEMA	Classification: (c), (d), (d) No databases on assessments and embargoes were found on the agency's website. on the GeoBahia portal. it is possible to access information about forestry projects and processes, but it is necessary to insert the identification number. of the process, activity and size.	Classification: (a), (b), (a).		
CE	SEMACE	Classification: (b), (a), (a) SEMACE provides for downloading maps in PDF, spreadsheets and KML/shapefile files, of notices of infraction (2012-2022), terms of embargo (2012-2022) and areas under recovery. In the term for the embargo there is no description of the reason (to identify whether it was deforestation), but in the notice of infraction there is a related description. In the notice of infraction, the date of drawing up is presented, but in the term it is not possible to identify it.	MG	SEMAD	SEMAD-MG provides information on inspected activities through IDE-SISEMA. The available data were updated up to 1 May 2023. The data are available in point and with indication of deforestation (as damage to the flora). However, there is no indication of which action (notification, notice, embargo) was generated by the body, only the indication that the area was inspected. On the transparency portal at the link Controle de Autos de Infração e Processos it is possible to consult the details of each case individually, as long as one has the number of the infraction notice, the verification digit of the infraction of the defendant, year of the infraction of the person charged.

State	Agency	Status of the online availability of data in an open portal during the preparation of this report
MS	IMASUL	Classification: (b), (c), (c) IMASUL provides a search tool for infringement notice processes. As a result, a listing containing basic and procedural information is presented. One may click on the process to access more details. The last update was in 2020 and the data does not provide address or location coordinates. Information available as a list on screen, contains the registration number, date of submission, subject (notice of infraction) and name/corporate name of the interested party. By clicking on the process number, it is possible to view the information table containing, besides the information already mentioned, the registration number, date of opening, municipality, State, CNPJ/CPF/RG, description of the enterprise/entrepreneur and name of the IMASUL employees involved. There is no mention of the type of damage or specifying deforestation. No georeferenced data were found.
MT	SEMA	Classification: (a), (a), (a) SEMA-MT provides information on notices of infraction and embargoes in an open portal with updated data and in georeferenced format. Information is available in shapefile and spreadsheets containing a subtype category that makes it possible to identify whether it was deforestation, inspection and denunciation, among other classifications. In addition, it has the date of issue of the notice, or execution of the embargo. Both are georeferenced information, in shapefile format, with embargoes in polygons and notices in points.
PA	SEMAS	Classification: (a), (a), (a). The main page for SEMAS gives access to different systems. Information on assessment processes may be contained in an internal system (Fiscalização e no SIMLAM), , with no public access or database download option. SEMAS-PA makes embargo data available through the "Illegal Deforestation List - LDI" on two different portals (LDI monitoring and on the CAR Analysis Portal), both in spreadsheet and shapefile. Information on notices of infraction is available at the Transparency Portal , containing the record number, date written up, CPF/CNPJ, name or corporate name, municipality, location (geographical coordinates), reason/area/volume. The bases of notices of infraction include data up to May 2023.
PB	SUDEMA	Classification (b), (b), (c) SUDEMA has a search tool for infraction notices. However, the most recent information is from January 2022 and the option to click on the process number to obtain details is not working and always gives error in the system. Additionally, it has a page dedicated to the annual reports of infraction notices (years 2022 and 2023). However, it does not display geographic coordinates. No georeferenced data were found either.

State	Agency	Status of the online availability of data in an open portal during the preparation of this report
PE	CPRH	Classification (b), (b), (c) The CPRH has a search system that identifies the infraction notice with basic information, and the detailed information in each notice can also be accessed. However, it is not available in the form of a spreadsheet or shapefile. It is possible to consult the notices of infraction specifying the CPF/CNPJ, number of the notice or a free query. In the free consultation, the processes are listed by process number, infraction notice, corporate name/name, CPF/CNPJ, defense/appeal and type. In each process, it is possible to obtain more data informing the amount of the fine, address, municipality, date written up, levying of fines, appeals, and whether the notice was paid. In the detail section of the information, the address and reason are given for each case, but without the geographic reference.
PI	SEMAR	Classification: (b), (a), (b) SEMAR provides information on the 2022 tax assessment notices and embargoes, in spreadsheet format, containing i) tax assessment notices: case number, report number, name or corporate name, CPF or CNPJ, date of assessment, municipality, type of violation, legal framework, taxable event and situation; ii) embargoes: case number, report number, name or corporate name, CPF or CNPJ, date of assessment, municipality, legal framework, type of infraction, description of the embargo/seizure, embargo status and geographic coordinates. No georeferenced data were found.
PR	IAT	Classification (b), (b), (c) The IAT provides information on infraction notices drawn up, judged or with terms of embargo. The infraction notices tables in PDF, contain notice number, date, name of the offender, group of occurrence, motive, area, volume, municipality, infraction address (anonymous) and value of assessment. The reason column provides information about the causative activity. Embargo terms tables in PDF, contain the infraction number, date, name of the violator, group of occurrence, reason, unit, area, volume, municipality, address (anonymous), situation, conversion, amounts. No georeferenced data or geographic coordinates were found.
RJ	INEA	Classification: (b), (b), (c) Information from notices of infraction is available on a dashboard and can be accessed through graphs and tables. In the table, the number of the notice, number of the process, the penalty, date of issue, legal article, identification (CNPJ/CPF), municipality, fine amount and sector are available. There is no georeferenced information. The latest update is contained in a notice of infraction dated February 2022. Therefore, it is not up to date. No georeferenced data were found.
RN	IDEMA	Classification: (b), (b), (c) IDEMA provides a search tool on the website, presenting a general listing of the records, with the possibility of accessing a PDF file for each record, containing detailed information (differentiating for deforestation), but without geographic reference. The list on screen contains case number, date, municipality, person in charge, CNPJ and description of the infraction. Idema's SEIA portal does not provide data on notices of infraction or embargoes. Therefore, no georeferenced data were found.

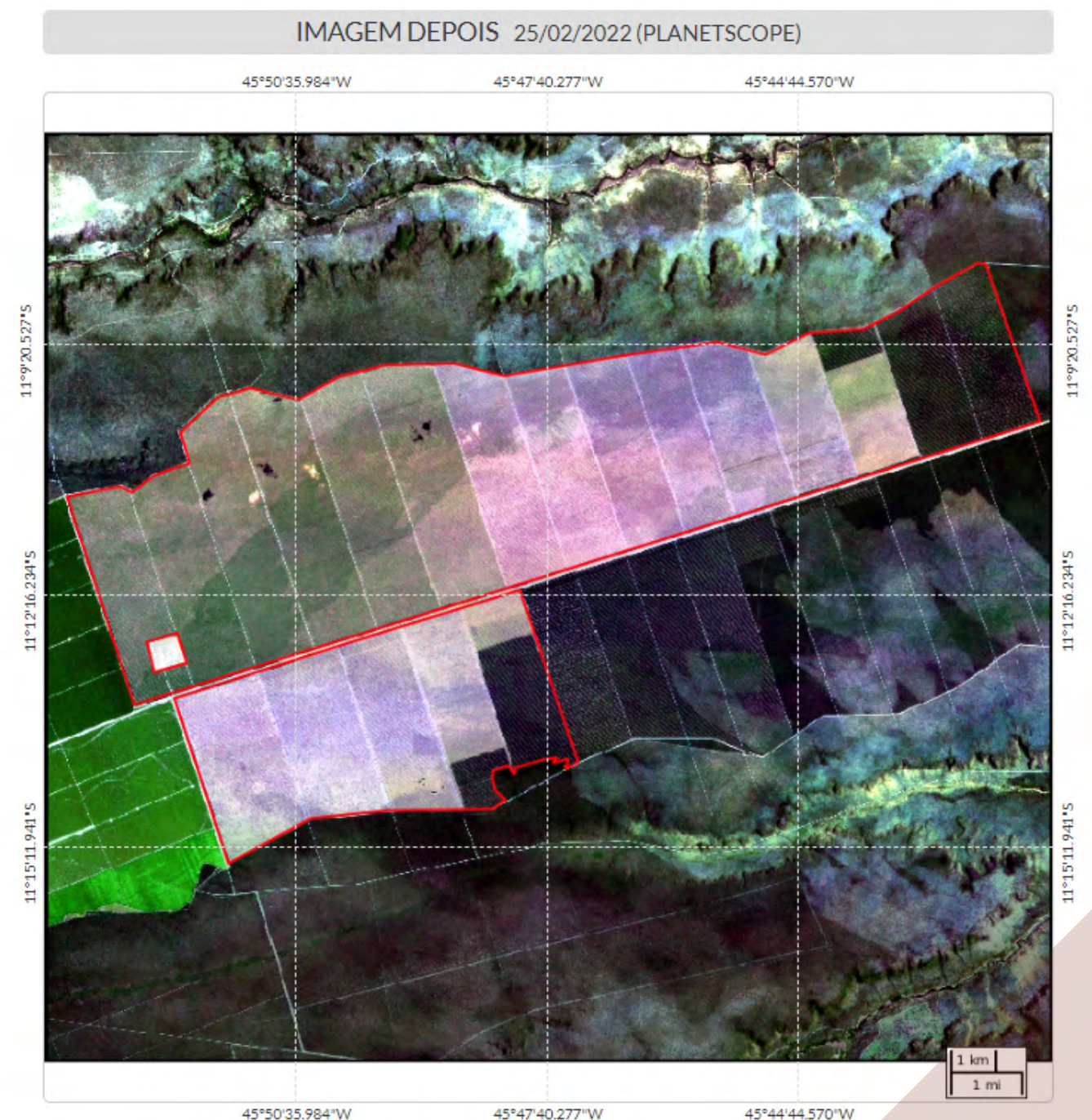
State	Agency	Status of the online availability of data in an open portal during the preparation of this report
RO	SEDAM	Classification: (b), (a), (b) SEDAM has a Transparency Portal for environmental information of interest. This Portal contains the report on the embargoed areas for 2013 and 2022. A spreadsheet is also available containing the report for the notices of infraction from 2005 to 2022. Therefore, outdated data. The notice of infraction worksheet contains date of entry, date of the notice, type of document, n. of the document, no. of the process, name, CGC/CPF, municipality, amount and destination (blank). The embargo worksheet presents n. term of embargo, area, n. of the process, no. of the notice of infraction, name or corporate name, location of the property (with coordinates), State, municipality, mailing address, judgment, violation, date of inclusion in the list. In the embargo worksheet, there is an indication of the article and legislation used for the action and presents geographic coordinates. The GeoPortal page from SEDAM provides data from notices of infraction and areas assessed, however, no way was found to download the data.
RR	FEMARH	Classification: (c), (d), (d) The FEMARH website indicates that the inspection section, linked to the Environmental Monitoring and Control Board, is being updated. The body has a page on the Geographic Information and Environmental Management System of Roraima (SIGGARR), however, the database of embargoes made available refers to the embargoes issued by Ibama. Therefore, data from notices of infraction and embargoes drawn up by FEMARH were not found.
RS	FEPAM	Classification: (a), (a), (a) FEPAM presents a data transparency portal, providing information in shapefile (based on points) of infraction notices (2017 - 2023) and embargoes (2017 - 2023). The reason for the notice of infraction or embargo is shown in the table of attributes, making it possible to identify when the notice is due to deforestation. In addition, FEPAM presents notices of notification with a list of administrative proceedings for notices of infraction drawn up between the years 2013 and 2022. The information contained in the list is Entrepreneur's corporate name, CPF/CNPJ and administrative process number.
SC	HAVE	Classification: (c), (d), (d) The IMA only publishes a search tool for infraction notices; however, it is necessary to have the number of the notice or the name of the person assessed.
SE	ADEMA	Classification: (c), (d), (d) ADEMA does not provide information on infraction notices or embargoes.
SP	SIMA	Classification: (a), (a), (a) Through the SIGAM/SEMIL website, the state body provides data on notices of infraction and also on areas with intervention in the flora (embargoes). It is possible to access information regarding the areas with intervention in the flora in shapefile, with data from 2017 to 2023. The infraction notices are available in shapefile between 2021 to 2023.
TO	NATURATINS	Classification: (c), (d), (d). Naturatins does not provide inspection data on its website.

Appendix 8. Reasons for not validating alerts

STATUS	AMAZON	CAATINGA	CERRADO	ATLANTIC FOREST	PAMPA	PANTANAL	BRAZIL
Duplicidade	87,803	1,116	3,098	1,862	85	753	94,717
Falso Positivo	4,664	3,848	2,252	37,041	3,374	9,081	60,260
Antropizado anteriormente	2,458	2,159	714	18,470	141	1,548	25,490
Queimada	150	139	231	1,602		293	2,415
Degradação	1,059	161	9	4	1		1,234
Agropecuária	104	850	438	2,044	101	275	3,812
Mineração	11	3					14
Área natural sem mudança	16	7	21				44
Reflorestamento	9	41	54	9,468	2,679	1	12,252
Sazonalidade	857	471	785	5,408	451	6,964	14,936
Sombra de relevo		17		45	1		63
Não Observado	402	11	11	3	2		429
Outros	70	43	6	33	11		163
TOTAL Não validado	92,939	5,018	5,367	38,939	3,480	9,834	155,577

Appendix 9. Situation of the largest deforestation detected in 2022 in each biome**Largest deforestation in Brazil in 2022 (Cerrado)**

The largest deforestation detected in 2022 in Brazil (alert code [564317](#)), with 12,271 ha, occurred in the Cerrado biome in the state of Bahia, municipality of Formosa Do Rio Preto. The report from the MapBiomas Alerta platform indicates that deforestation occurred within the Environmental Protection Area of Rio Preto (State). According to the INEMA-BA Inspection Board, the area where deforestation took place is duly registered with CEFIR (state CAR) in rural property code BA-2911105-D4E8.58AC.04AA.4190.A8D7.8AC0.34E7.3344. In INEMA's analysis, the suppression is related to an area of 24,732.80 hectares authorized through INEMA Ordinance No. 9.077/2015, which had the Extension of the Validity Period authorized - PPV, through INEMA Ordinance No. 18.440/ 2019 up to 05/22/2023.

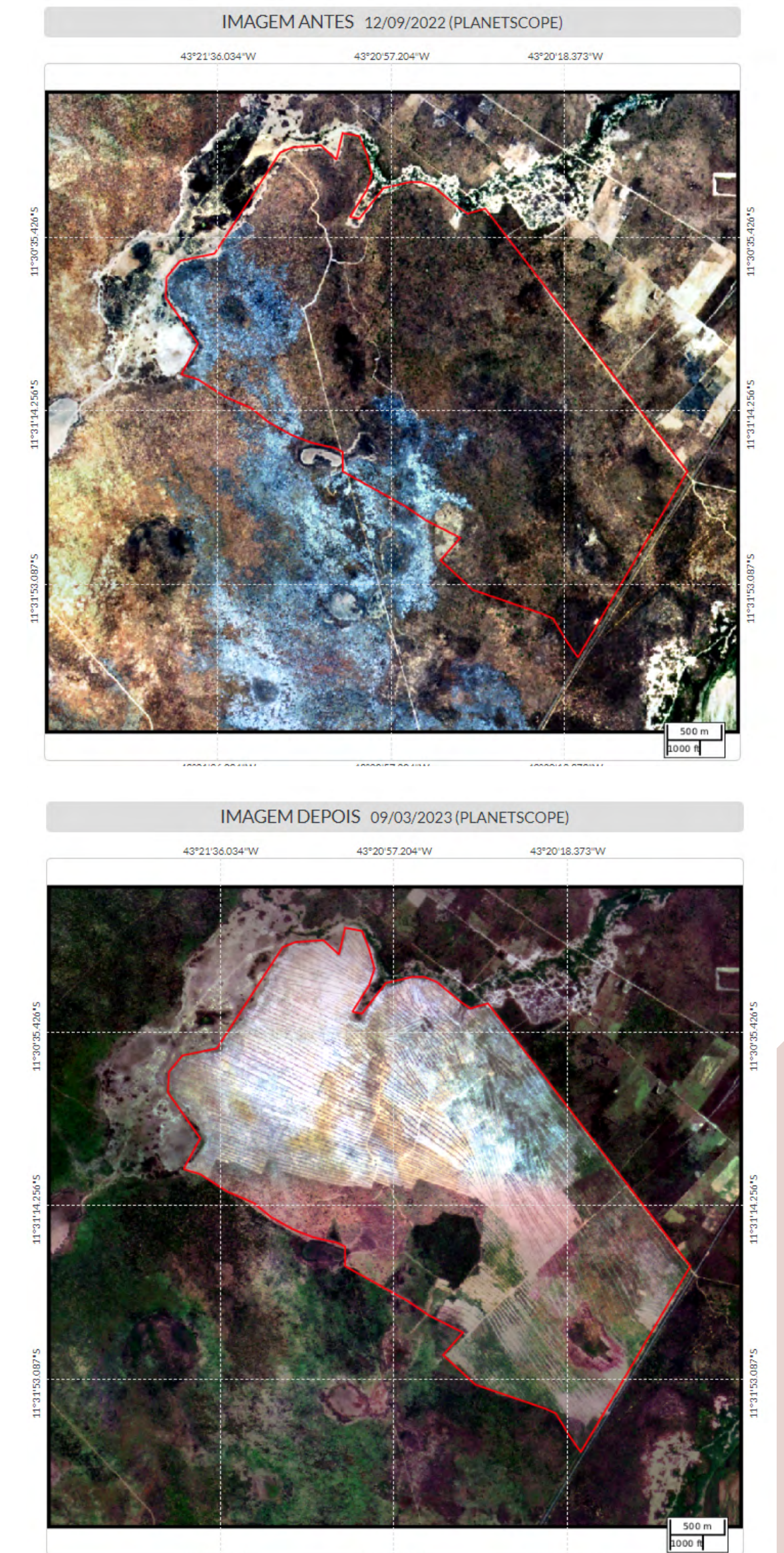


Largest deforestation in the Caatinga biome in 2022

The largest deforestation detected in the **Caatinga** biome in 2022 (alert code [809597](#)) has an area of 1,096 ha and occurred in the municipality of Barra, in the state of Bahia. According to the Inema-BA Inspection Board, the area is duly registered with CEFIR (state CAR) in rural property code BA-2902708-3AC4.D29A.F6DD.49E7.8ED8.1A43.79EE.6940. The INEMA analysis does not have an Authorizing Act issued by the agency authorizing the suppression of native vegetation on the property related to the alert. However, it was possible to identify the existence of Authorization for the Suppression of Native Vegetation No. 010/2022 issued by the Municipality of Barra, authorizing the suppression of 2,000 hectares of the rural property. INEMA also stated that, as it does not have access to the authorized polygon, it was not possible to accurately confirm the relationship between the authorized area and that registered in the alert. Finally, the agency points out that the property is included in the application map of the Atlantic Forest Law.

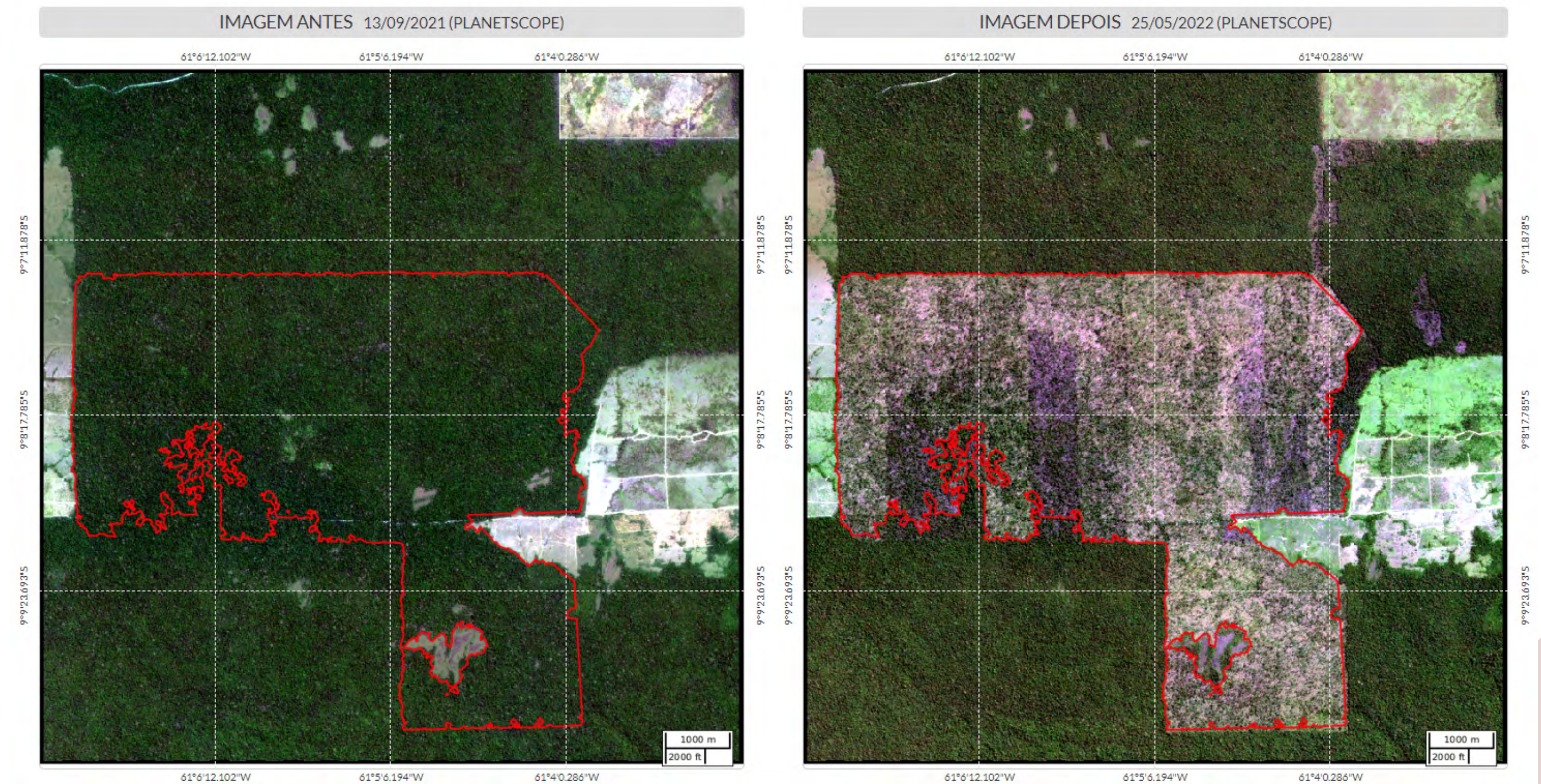
INEMA-BA also declared that the Authorizing Acts for the Suppression of Vegetation - ASV, issued by the INSTITUTE, such as this one that was issued under Ordinance No. norms established by the State of Bahia. ASV acts are authorized interventions to enable the alternative use of land in the implementation or expansion of activity or an enterprise and can occur in an enterprise located in an urban or rural area and is duly supported in Art. 123 of State Law No. 10.431/06 and

Art. 32, paragraph 1 of State Decree No. 15180/14. Registration in CEFIR is the initial step in applying for the Authorization for the Suppression of Native Vegetation – ASV. This registry contains the data of the owner, possessor or person directly responsible for the rural property, data on the documents confirming ownership and/or possession, in addition to information georeferenced of the perimeter of the property, the location of remnants of native vegetation, Permanent Preservation Areas - APP, Restricted Use areas and Legal Reserves - RL, consolidated areas, degraded areas and productive areas. For an ASV to be granted, the location of the RL is essential and mandatory, except for situations exempted from this determination, as described in Art. 12 of the Forestry Code No. 12.651/12 § 6 to § 8. Additionally, this Authorization for the Suppression of Vegetation needs to be linked to a licensable activity or to an activity that is exempt from licensing., That link must comply with the requirements of Federal Code No. 12.651 /12 in its Art. 26, paragraph 4.



Largest deforestation in the Amazon biome in 2022

The largest deforestation detected in the **Amazon** biome in 2022 (alert code [562784](#)) has an area of 3,580 ha and occurred in the municipality of Colniza, in the state of Mato Grosso. According to Sema-MT, the event is a clear-cut that took place between 01/04/2022 and 09/16/2022 and there is no authorization for deforestation or other authorizations for the area in question. Part of the deforestation affects a property registered in the CAR, and most of the lies in areas without CAR or SIGEF. Sema-MT also reported that the area was inspected in loco by teams from the Military Police Battalion for Environmental Protection (BPMPE) in the months of April, May and June/2022 and the drafting of the infraction notices and the polygons corresponding to the terms of embargoes were inserted in the Sema-MT database.

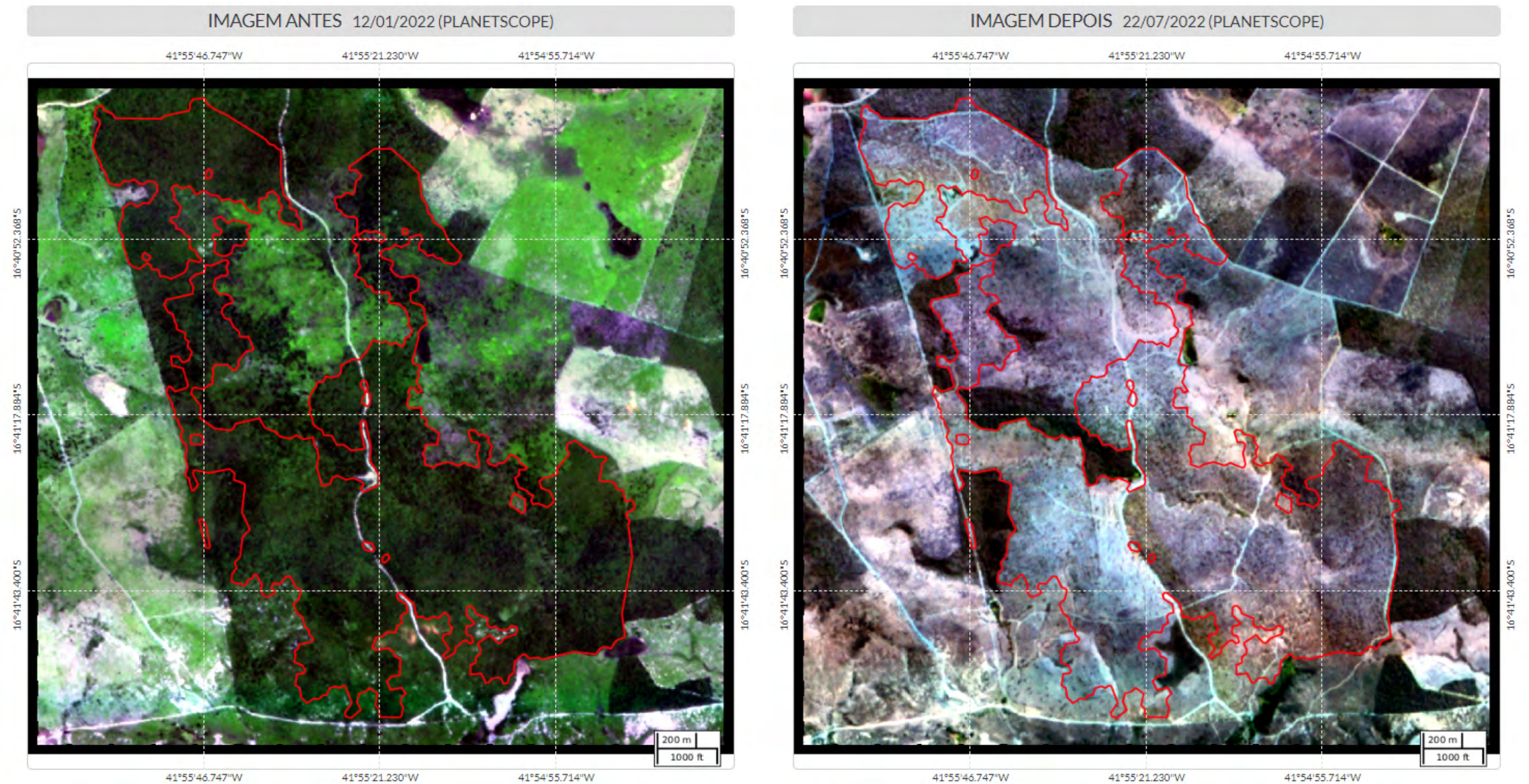


Largest deforestation in the Atlantic Forest biome in 2022

The largest deforestation detected in the **Atlantic Forest** biome in 2022 (alert code [612986](#)) has an area of 294 ha and occurred in the municipalities of Araçuaí and Itinga, in Minas Gerais. According to the Semad-MG Environmental Inspection Strategy Board, there was no authorization for the deforestation in question.

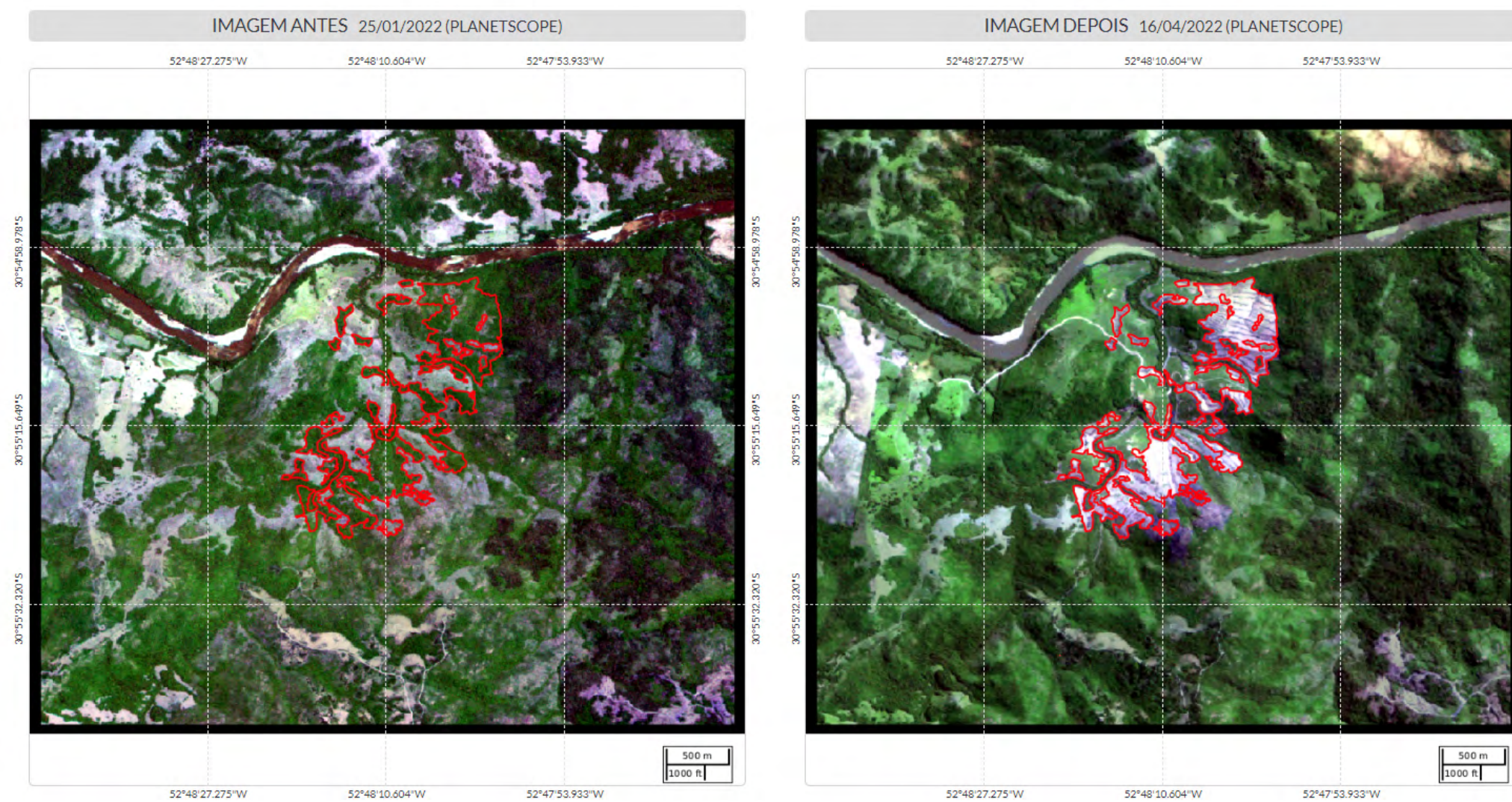
Semad-MG also informed the existence of two Infraction Notices in the corresponding area (n° 292971/2022 and n° 303825/2022), these being due to compliance with the Continuous Monitoring System of the State Institute of Forests (IEF) - ID alerts #120330222 for the first and alert IDs #136680720 and #136690722 for the second notice. Native firewood wastes were seized at the site, and were kept under the custody of the accused as *bona fide* depositaries.

The assessments refer to the suppression of native vegetation of the Atlantic Deciduous Seasonal Forest typology that was in the initial and medium secondary stages of natural regeneration. The burning performed in an area of 164 hectares, most of it in the deforested area, was also subject to a fine. Activities were suspended at the sites where the violations took place until they were regularized with the appropriate environmental agency.



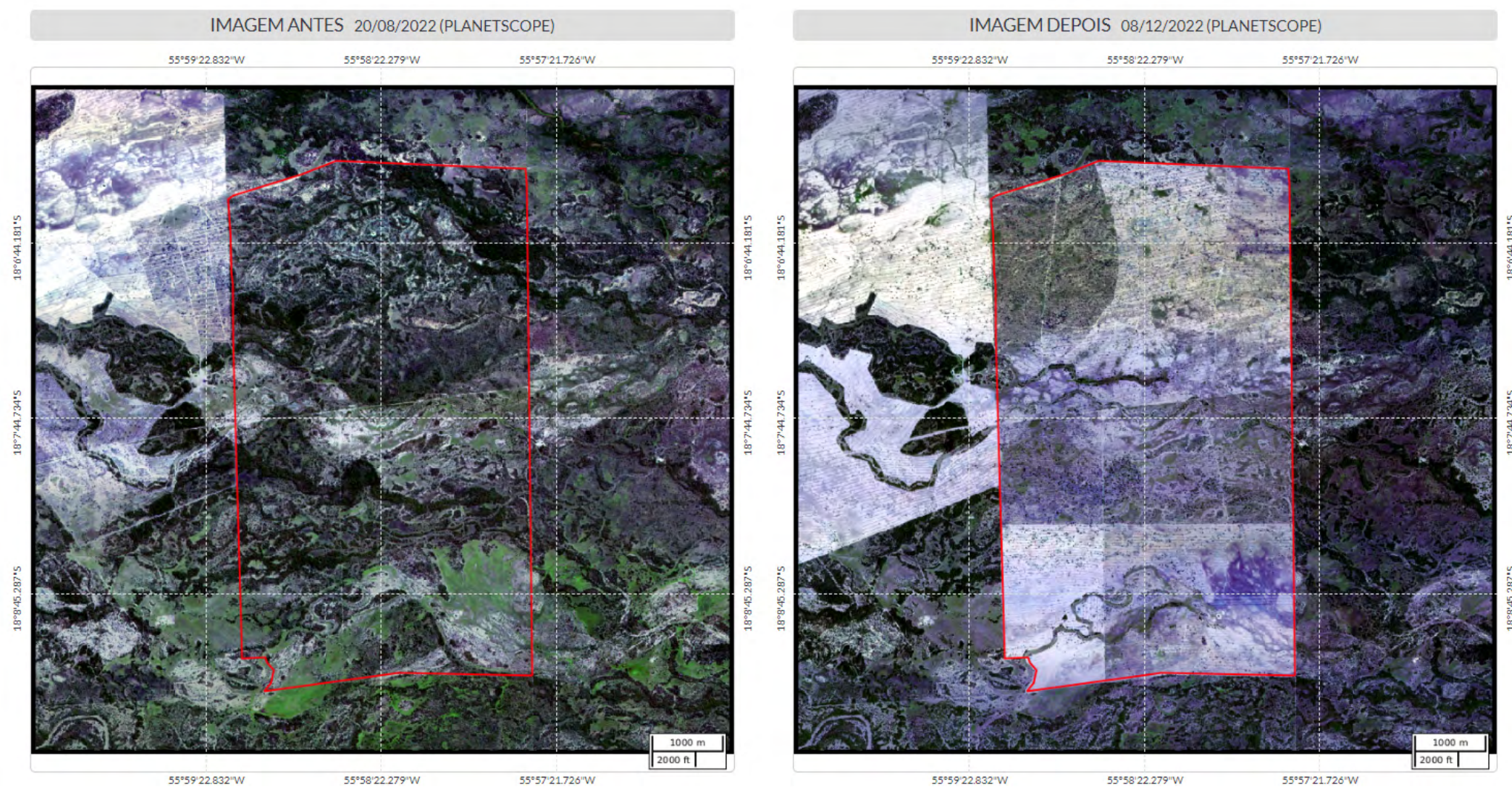
Largest deforestation in the Pampa biome in 2022

The largest deforestation detected in the Pampa biome in 2022 (alert code [702512](#)) has an area of 80 ha and occurred in the municipality of Canguçu, in Rio Grande do Sul. According to Fepam-RS, the deforestation occurred on a property with licensed forestry activity, but one that does not encompass the entirety of the alert. As of the writing of this report, the site had not yet been inspected, but Fepam-RS stated that they were organizing the inspection.



Largest deforestation in the Pantanal biome in 2022

The largest deforestation detected in the Pantanal biome in 2022 (alert code [796153](#)) has an area of 2,804 ha and occurred in the municipality of Corumbá, in Mato Grosso do Sul. The Imasul-MS Licensing Board was contacted about possible authorizations and/or enforcement actions corresponding to the area but did not respond in time for the conclusion of this report.



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