



MAPBIOMAS

# Technical Note

## Potential impacts of due diligence criteria on the protection of threatened South American non-forest natural ecosystems

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# Abstract

- A new regulation currently under discussion in the European Union restricts the import of several agricultural commodities produced in deforested areas.
- The definition of "deforestation" in the proposed European regulation is based on the FAO definition of forest. **This leaves aside relevant areas of natural ecosystems and biomes in South America, where extensive areas are being converted to farming, such as in the Cerrado and Pampa biomes.**
- In this technical note, we use MapBiomias' land cover and land use data in the Amazon, Atlantic Forest, Chaco, Cerrado, Caatinga, Pampa and Pantanal biomes to assess the percentage of natural ecosystems that would not be protected by EU regulation in South America, if the FAO's definition of forest is the only one considered.
- Considering a total of 990 Mha of natural remnants of the seven biomes, covering all of Brazil, the Amazon, Atlantic Forest, Chaco and Pampa biomes, the FAO Forest definition criterion would only include 719.4 Mha, 72.6% of the natural ecosystems in these biomes.
- **270.9 Mha natural ecosystems are not included in the FAO definition. This implies that 27.4% of the natural ecosystems in these biomes would not be protected, corresponding to five times the size of France. Those would be left unprotected by the European regulation and thus not guaranteeing that commodities are free of conversion on those ecosystems.**
- The proportion of unprotected natural ecosystems is unevenly distributed. **The FAO definition covers a large proportion of only three of the seven mapped biomes: the Amazon (84%), Chaco (75%) and Atlantic Forest (71%). In Caatinga, Pampa, Pantanal and Cerrado only a small portion is covered by the definition (10% of the remaining Caatinga, 11% of the Pampa, 24% of the Pantanal, and 26% of the Cerrado). All of them are now under intense pressure by large-scale agriculture expansion.**

# Summary

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# 1. Introduction

## 1.1 European Union legislation and the FAO definition of forest

This technical note assesses the scope of a regulation proposed by the European Commission that restricts the import of commodities produced in recently deforested areas, using the FAO definition of forest as reference for due diligence to be carried out by importers.

The aim of this analysis is to **evaluate whether the FAO definition of forest covers all or most of the large-scale natural ecosystem conversion to commodities production in the South America**, based on the land cover and land use data of the MapBiomass initiatives.

According to FAO, "Forest" is defined as: *"land with a tree canopy cover of more than 10 percent and area of more than 0.5 ha. The trees should be able to reach a minimum height of 5 m at maturity in situ"*.





# 1. Introduction

## 1.2 MapBiomass land cover and land use data

MapBiomass is a collaborative network of NGOs, universities and technology companies dedicated to mapping land cover and land use changes throughout South America and Indonesia.

All MapBiomass processing is done on Google Earth Engine platform, using artificial intelligence and cloud computing to perform a pixel-by-pixel classification of land cover and land use over a time series.

MapBiomass started in Brazil in 2015 and now it is currently mapping 25 classes of land cover and land use of all Brazilian biomes from 1985 to the present. The initiative has expanded to other regions, such as the Amazon, Chaco, Atlantic Forest and Pampa biomes, and most recently Indonesia.

All MapBiomass data and maps of land cover and land use are freely available and transparent in platforms (<https://mapbiomas.org/>).

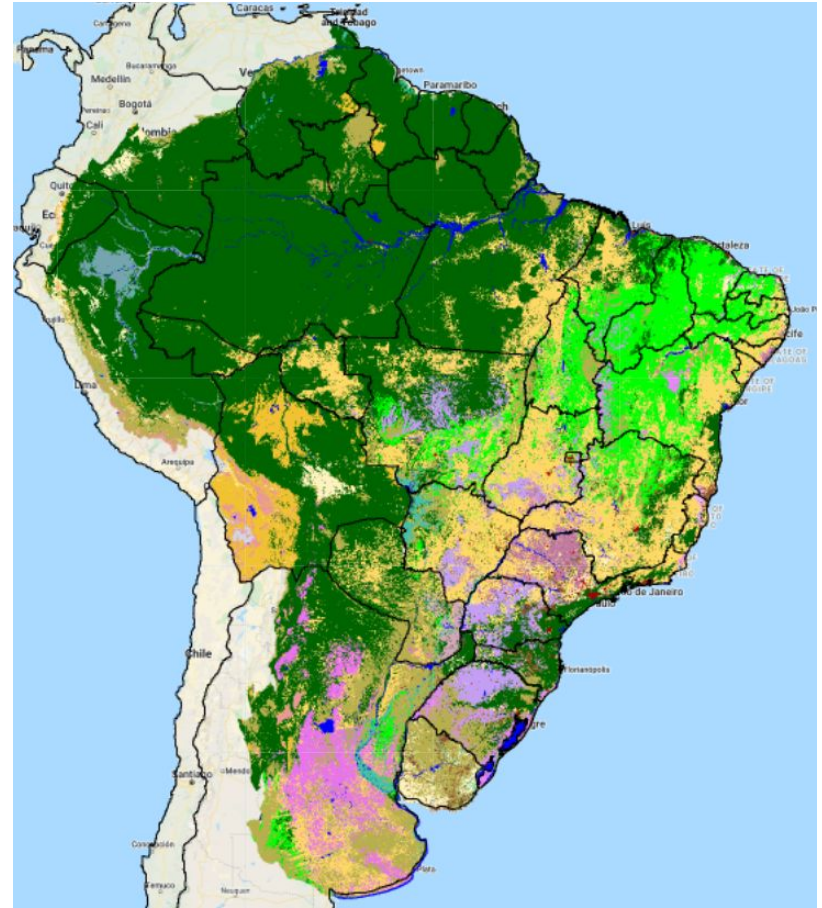


# 2. Method

## 2.1 Scope

The analyses included areas already mapped by the MapBiomas network in South America for land cover and land use which includes:

- **Amazon Biome** - covering parts of Brazil, Bolivia, Colombia, Ecuador, Guyana, French Guiana, Peru, Suriname and Venezuela;
- **Atlantic Forest Biome** - covering parts of Brazil, Argentina and Paraguay;
- **Chaco Biome** - covering parts of Paraguay, Argentina and Bolivia;
- **Pampa Biome** - covering parts of Brazil, Argentina and Uruguay;
- Other Biomes in Brazil: **Caatinga, Cerrado, and Pantanal.**



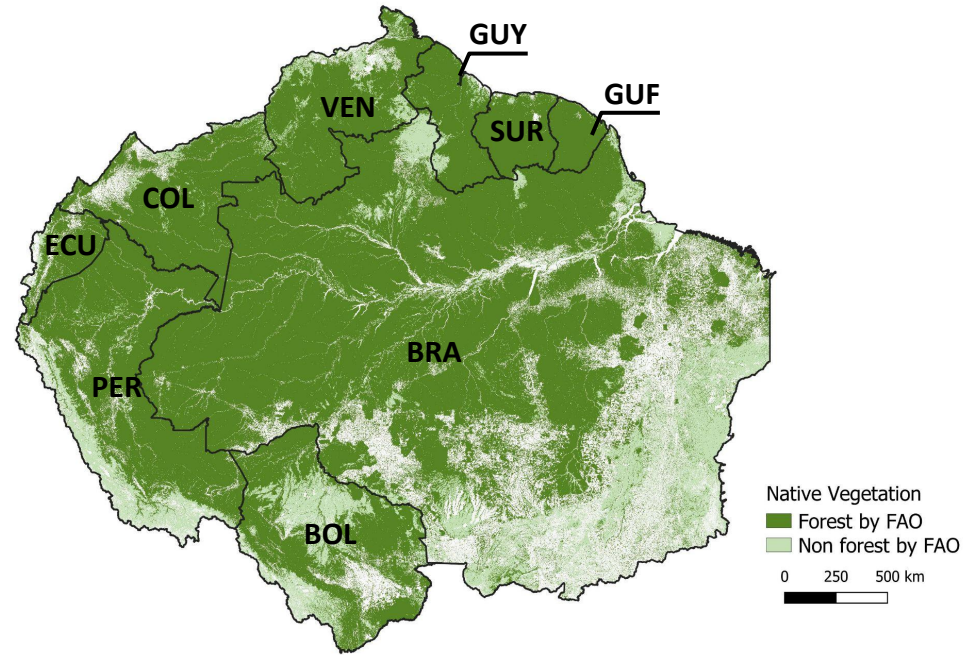
# 2. Method

## 2.1 Scope

### Amazon

The Amazon is the largest remaining tropical rainforest in the world, housing a large part of Earth's biodiversity. Despite being covered predominantly by tropical forest, several other vegetation types are present, such as savannas and grasslands (Devecchi et al. 2020). The biome is threatened by the growing incidence of fires and deforestation in the region (Silva Jr. et al. 2021), which are enhanced by the weakening of environmental agencies (Coelho-Junior et al. 2022).

**83% of the Amazon are covered with native vegetation, whereas the non-forest natural ecosystems represent 13% of the biome.**



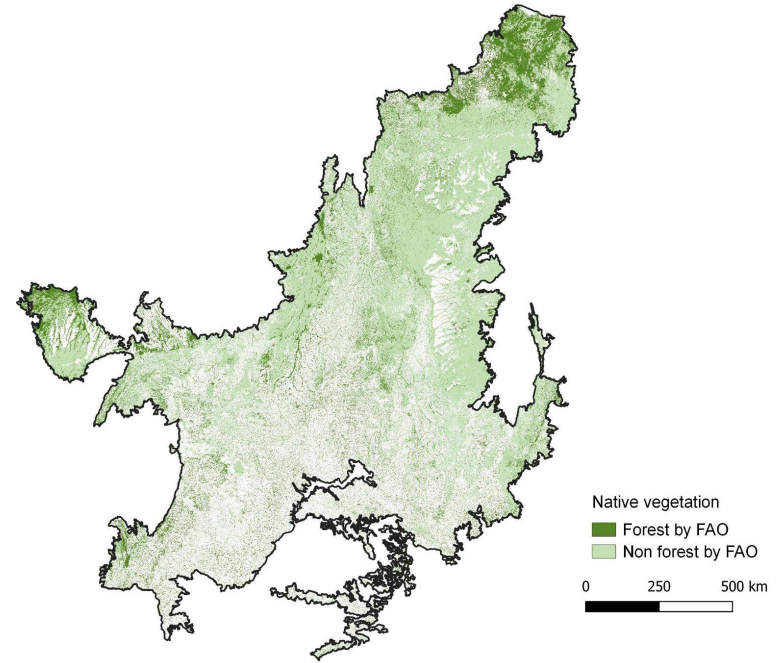
# 2. Method

## 2.1 Scope

### Cerrado

The Cerrado is one of the world's biodiversity hotspots (Myers et al. 2000), and also one of the hottest agriculture expansion frontiers (Spera et al. 2016). The biome has already lost almost half of its original extension (mainly to cattle and soy) (Alencar et al. 2020). It has a highly specialized unique vegetation with gradients of forest, savannas and grasslands (Ribeiro & Walter, 2008), but only 6.5% of its territory are legally protected areas (Françoso et al. 2015).

**55% of the Cerrado biome are native vegetation, whereas the non-forest natural ecosystems represent 41% of the biome.**





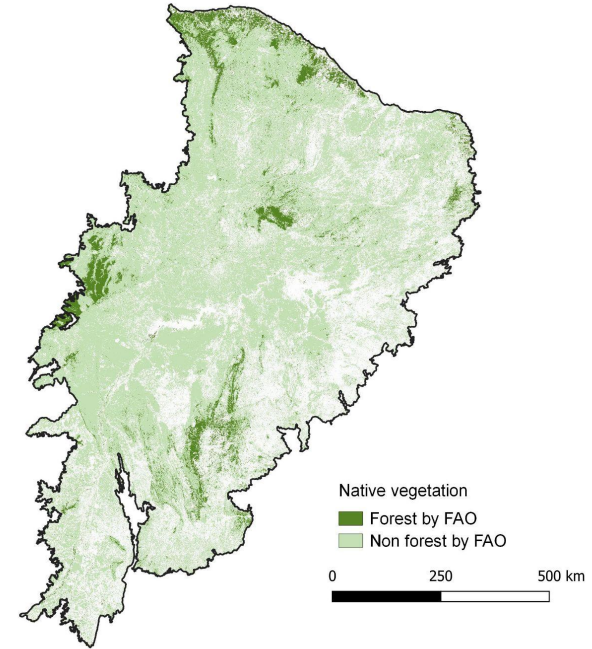
# 2. Method

## 2.1 Scope

### Caatinga

The Caatinga biome occurs exclusively in Brazil. It is a vast semi-arid region dominated by deciduous and xerophytic woodlands (Da Costa et al. 2007). Around 35% of its extension has been converted to farming, of which 15% suffers desertification (Leal et al. 2005). The main drivers of conversion are cattle ranching, smallholder livestock production, non-timber forestry, and large-scale irrigated agriculture.

**64% of the Caatinga biome are covered with native vegetation, whereas the non-forest natural ecosystems represent 58% of the biome.**



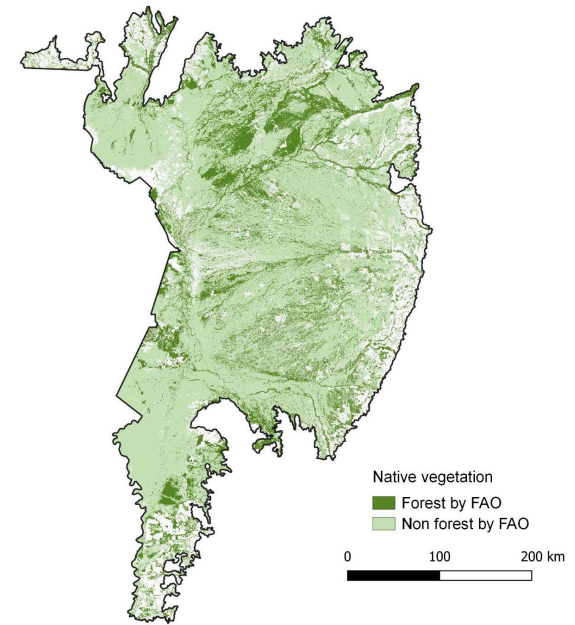
# 2. Method

## 2.1 Scope

### Pantanal

The Pantanal is the world's largest tropical wetland. Its overall vegetation cover is still preserved (Souza Jr. et al. 2020), but under high conversion pressure due to cattle ranching (Seidl et al. 2001). The worst impacts are on the water system, where Cerrado deforestation upstream stilts the riverbeds and reduces the water flows (Bergier, 2013).

**80% of the Pantanal biome are native vegetation, whereas the non-forest natural ecosystems represent 61% of the biome.**

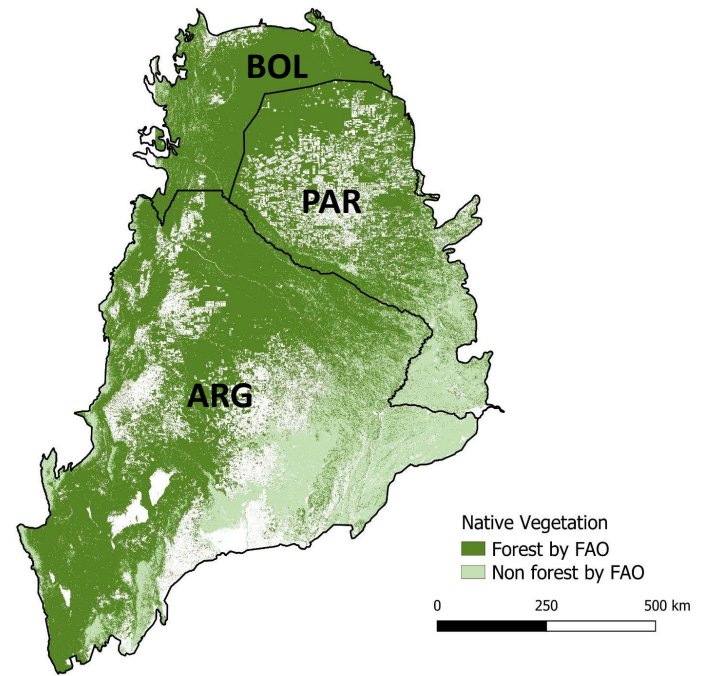


# 2. Method

## 2.1 Scope

### Chaco

The Chaco is the largest forest in South America after the Amazon rainforest ([www.nature.org](http://www.nature.org)). It is a semi-arid lowland covered by mixed dry forests, grasslands and wetlands (Fernández et al. 2020). **With 81% of its native vegetation still preserved**, it has nonetheless one of the world's highest conversion rates, due to large scale cattle and soy expansion (Fehlenberg et al. 2017). **The non-forest natural ecosystems represent 20% of the Chaco biome.**





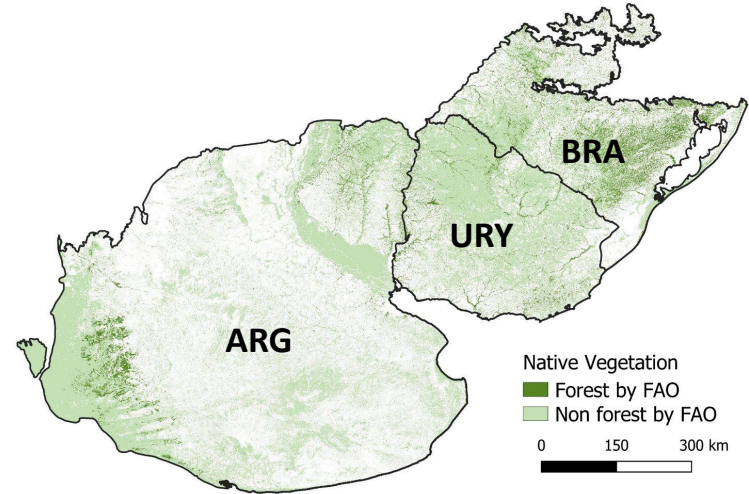
# 2. Method

## 2.1 Scope

### Pampa

The Pampa is a vast region dominated by natural grasslands (Andrade et al. 2018). Nearly half of it has already been converted to large-scale crop production and cattle ranching. At the same time, protected areas are less than 0.5% of the biome (Overbeck et al. 2007). Most of the conversion occurs on the natural grasslands, with almost 17% increase of farming cover since the year 2000.

**43% of the Pampa biome are under native vegetation, where the non-forest natural ecosystems represent 38% of the biome.**





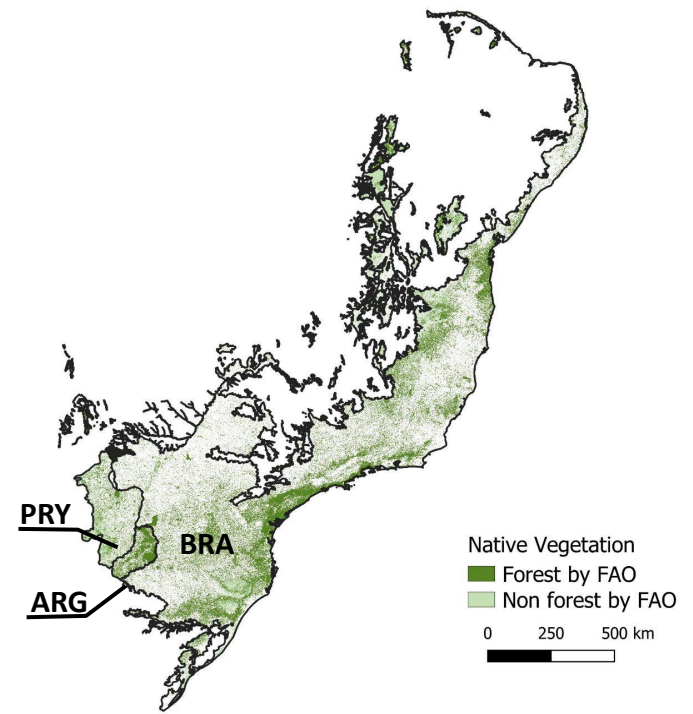
# 2. Method

## 2.1 Scope

### Atlantic Forest

The Atlantic Forest occupies 8% of South America. Native vegetation now covers 37% of the biome's extent, with a high rate of secondary vegetation and many fragmented areas (Rosa et al. 2021). In Brazil, the Atlantic Forest covers about 15% the territory and is home to 72% of the population, concentrating 70% of the national GDP. It provides many essential services, such as water supply, climate regulation, agriculture, fisheries, energy production and tourism ([www.sosma.org.br](http://www.sosma.org.br)).

**37% of the Atlantic Forest biome are native vegetation, whereas the non-forest natural ecosystems represent 11% of the biome.**



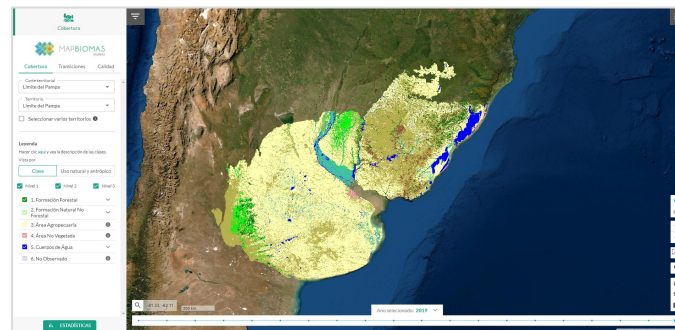
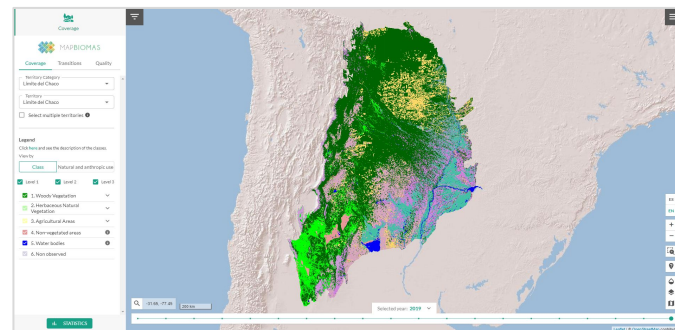
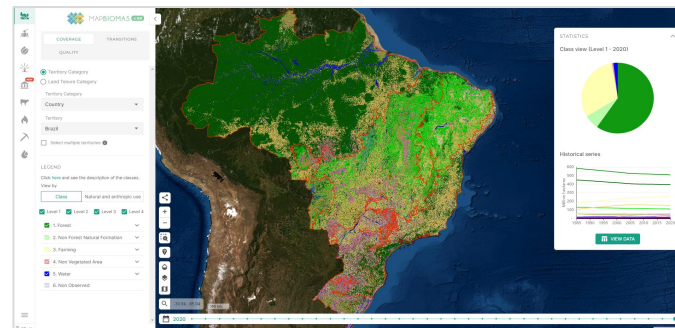
# 2. Methods

## 2.2 MapBiomass land cover and land use data

The proportion of the natural ecosystems detected by MapBiomass that would fit the FAO definition of forest was calculated, as well as the non-forest natural ecosystems that do not meet the FAO definition.

MapBiomass data for the Amazon, Atlantic Forest, Chaco, Pampa and for the Brazilian biomes Caatinga, Cerrado and Pantanal from 2000 to 2019 were used in this analysis.

INITIATIVE	COLLECTION Nº	PERIOD	Nº CLASSES
BRAZIL - <a href="https://mapbiomas.org/">https://mapbiomas.org/</a> (Cerrado, Caatinga and Pantanal)	6	1985-2020	25
CHACO - <a href="https://chaco.mapbiomas.org/">https://chaco.mapbiomas.org/</a>	2	2000-2019	15
PAMPA - <a href="https://pampa.mapbiomas.org/">https://pampa.mapbiomas.org/</a>	1	2000-2019	8
AMAZON - <a href="https://amazonia.mapbiomas.org/">https://amazonia.mapbiomas.org/</a>	3	1985-2020	15
ATLANTIC FOREST <a href="https://bosqueatlantico.mapbiomas.org/">https://bosqueatlantico.mapbiomas.org/</a>	1	2000-2019	13



# 2. Methods

## 2.3. Legend correspondence between MapBiomias and FAO

The MapBiomias classes of native vegetation cover corresponding to FAO definition of forest in the seven mapped biomes (Amazon, Chaco, Atlantic Forest, Cerrado, Pantanal, Pampa and Caatinga) were clustered into two categories:

1. Correspondence to the FAO definition of Forest: Forest, Flooded Forest, Mangroves and Natural Woodlands;

2. Non-forest natural ecosystems not corresponding to the FAO definition of Forest: Savannas, Open Woodlands, Grasslands, Wetlands and Other Non-Forest Natural Formation.

This correspondence between MapBiomias classes and FAO definition of forest was based on the MapBiomias ATBDs and FAO (2012).

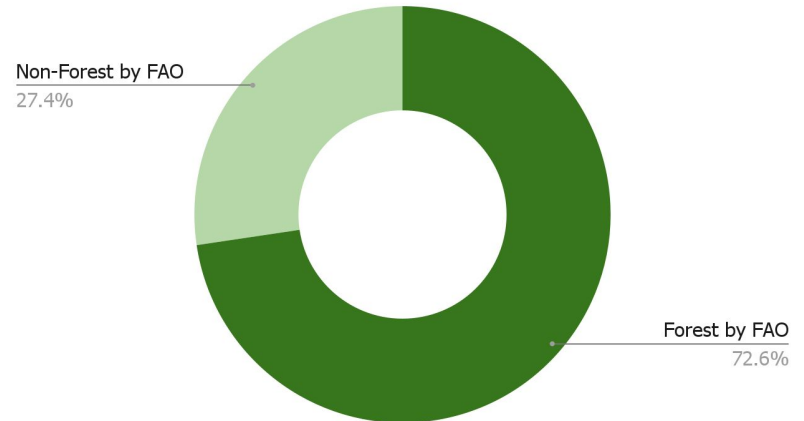
BRAZIL Collection 6	AMAZON Collection 3	ATLANTIC FOREST Collection 1	CHACO Collection 2	PAMPA Collection 1	FAO
1. Forest (1)	1. Forest (1)	1.1 Natural Forest (2)	1.1. Woody Natural Vegetation (2)	1. Natural Forest (2)	Forest
1.1. Forest Formation (3)	1.1. Forest Formation (3)	1.1.1 Forest Formation (3)	1.1.1. Closed Natural Woodlands (3)	1.1.1. Forest Formation (3)	Forest by FAO
			1.1.2. Open Natural Woodlands (4)		Forest by FAO
1.3. Mangrove (5)	1.3. Mangrove (5)				Forest by FAO
1.4. Wooded Restinga (49)					Forest by FAO
	1.4. Flooded Forest (6)		1.1.4. Flooded Natural Woodlands (6)		Forest by FAO
1.2. Savanna Formation (4)	1.2. Savanna Formation (4)	1.1.2 Savanna Formation (4)	1.1.3. Sparse Natural Woodlands (45)	1.1.2. Savanna Formation (4)	Non-Forest by FAO
<b>2. Non Forest Natural Formation (10)</b>	<b>2. Non Forest Natural Formation (10)</b>	<b>2. Non Forest Natural Formation (10)</b>	<b>2. Herbaceous Natural Vegetation (10)</b>	<b>2. Non Forest Natural Formation (10)</b>	<b>Non-Forest by FAO</b>
2.1. Flooded Grassland and Swamped Area (11)	2.1. Flooded Grassland and Swamped Area (11)	2.1. Flooded Grassland and Swamped Area (11)	2.1. Grassland (12)	2.1. Wetland (11)	
2.2. Grassland (12)	2.2. Grassland (12)	2.2. Grassland (12)	2.1. Grassland (12)	2.2. Grassland (12)	
2.3. Salt Flat (32)			2.1.1. Open Grassland (42)		Non-Forest by FAO
2.4. Rocky Outcrop (29)	2.3. Rocky Outcrop (29)	2.4. Rocky Outcrop (29)	2.1.2. Closed Grassland (43)		
2.6. Other non Forest Formations (13)	2.4. Other non Forest Formations (13)	2.5. Other non Forest Formations (13)	2.1.3. Sparse Grassland (44)		
			2.1.4. Flooded Grassland (11)		

# 3. RESULTS

## 3.1 Main Findings

- From a total of **990 Mha** of native vegetation remnants from the seven biomes, covering all Amazon, Atlantic Forest, Chaco, Pampa, Caatinga, Cerrado and Pantanal biomes, **the FAO forest definition criterion would only include 719.4 Mha, 72.6% of the natural ecosystems in these biomes.**
- 270.9 Mha of non-forest natural ecosystems are not included in the FAO definition. 27.4% of these natural ecosystems would not be protected by the EU regulation, corresponding to 5 times the size of France.**

Biomes	Forest by FAO (ha)	Non-Forest by FAO (ha)	Non-Forest by FAO (%)	Total
Amazon	593,715,426	109,296,330	15.6%	703,011,755
Cerrado	28,271,277	80,733,503	74.1%	109,004,780
Chaco	73,428,428	24,025,433	24.7%	97,453,861
Caatinga	5,321,260	50,014,725	90.4%	55,335,985
Pampa	4,917,207	38,566,667	88.7%	43,483,874
Atlantic Forest	36,928,649	15,310,601	29.3%	52,239,250
Pantanal	2,920,368	9,150,443	75.8%	12,070,811
<b>Total*</b>	<b>719,472,285</b>	<b>270,874,640</b>	<b>27.4%</b>	<b>990,346,925</b>

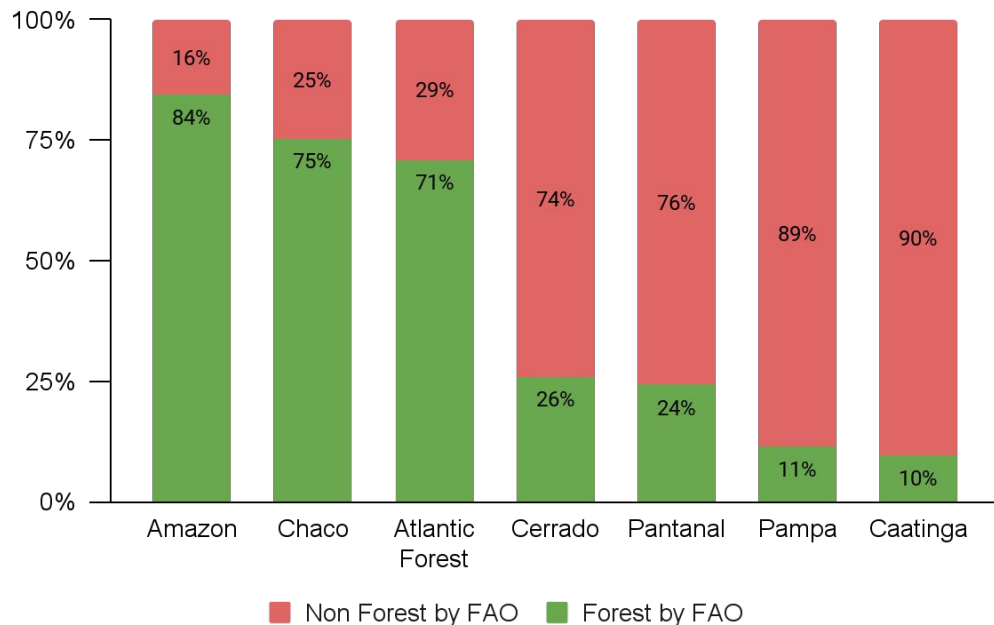


\* For this total amount, Cerrado, Caatinga and Pantanal were considered only in the Brazilian territory. Intersections between different MapBiomias' initiatives were handled by keeping data from the most recent collections.

# 3. RESULTS

## 3.1 Main findings

Native vegetation cover according to FAO definition



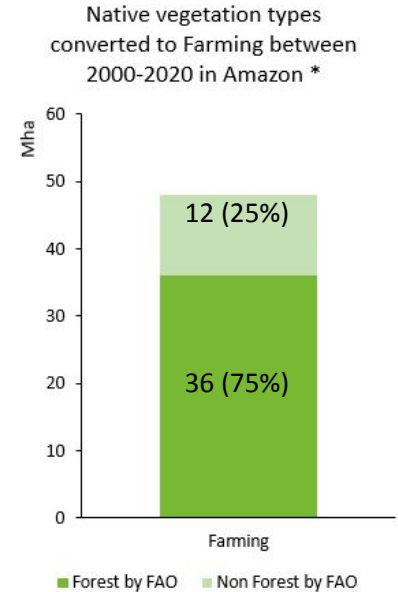
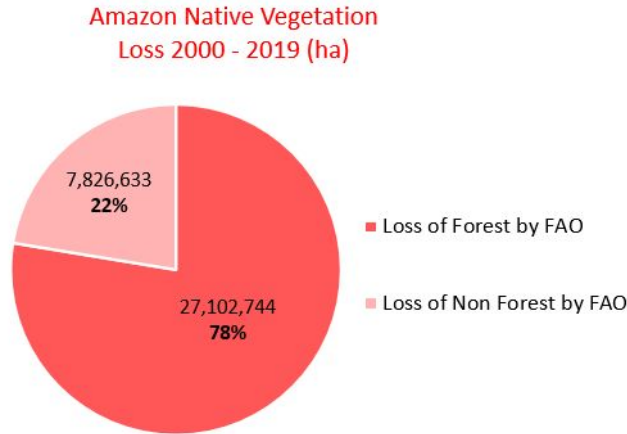
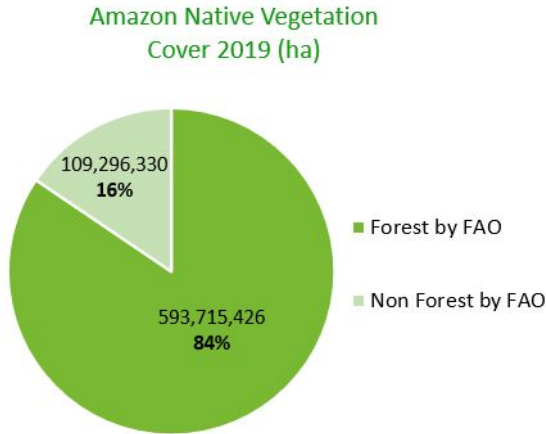
- The FAO forest definition covers mostly three of the seven mapped biomes: the **Amazon (84%)**, the **Chaco (75%)** and the **Atlantic Forest (71%)**.
- The **Caatinga, Pampa, Pantanal and Cerrado showed the largest gaps** (only 10% forest in Caatinga, 11% in Pampa, 24% in Pantanal, 26% in the Cerrado).

# 3. RESULTS

## 3.2 Amazon

(BRA, BOL, COL, ECU, GUY, GUF, PER, SUR, VEN)

- 16% of the Amazon native vegetation would not be protected by the FAO definition, an area twice the size of Spain.
- 22% of native vegetation loss between 2000 and 2019 were in non-forest natural ecosystems.
- 12 Mha of non-forest vegetation were converted to farming lands in the last 20 years, representing 25% of native vegetation loss to farming.

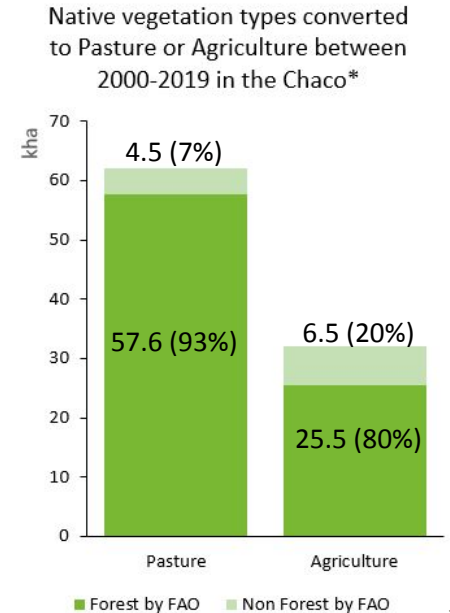
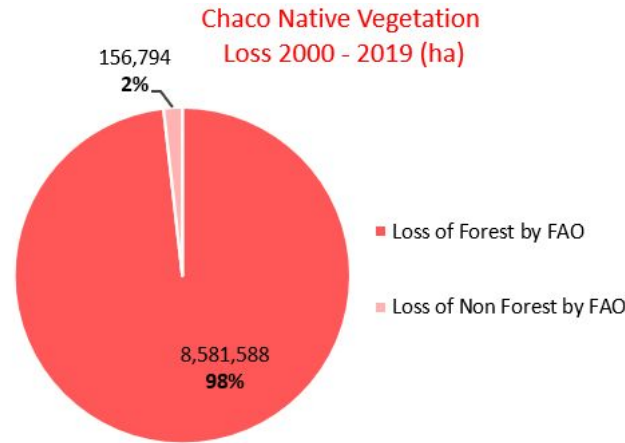
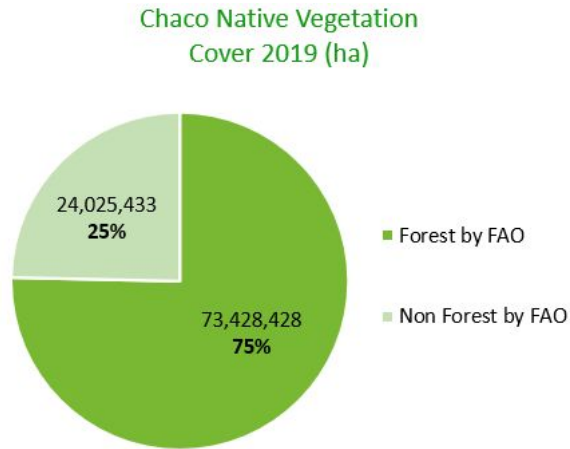


\* It is not necessarily a direct conversion, other land uses and land covers could be present between the 2000 and 2020.

# 3. RESULTS

- 25% of the Chaco native vegetation would not be protected by the FAO definition, an area nearly the size of United Kingdom.
- 2% of native vegetation loss between 2000 and 2019 were in non-forest natural ecosystems.
- 4.5k ha of non-forest vegetation was converted to pasture, and 6.5k ha to agriculture, where 7% and 20% of native vegetation conversion to pasture and agriculture, respectively, were in non-forest natural ecosystems.

## 3.3 Chaco (ARG, BOL, PAR)



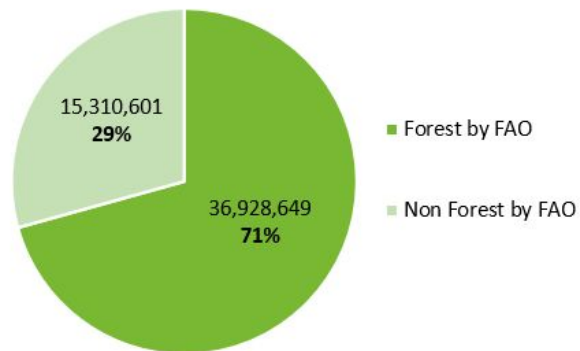
\* It is not necessarily a direct conversion, other land uses and land covers could be present between the 2000 and 2019.

# 3. RESULTS

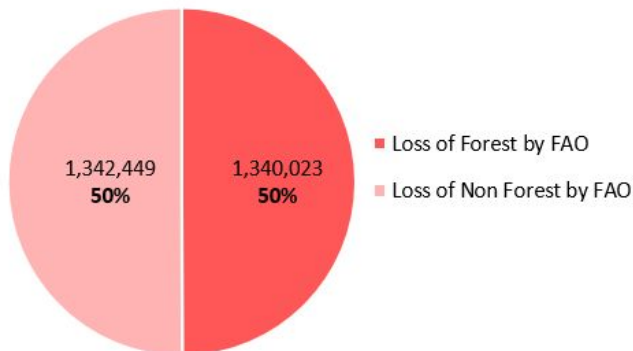
## 3.4 Atlantic Forest (BRA, ARG, PAR)

- 29% of the Atlantic Forest native vegetation would not be protected by the FAO definition, an area larger than Greece.
- 50% of native vegetation loss between 2000 and 2019 were in non-forest natural ecosystems.
- 12.1k ha of non-forest vegetation was converted to pasture, and 7.8k ha to agriculture, where 60% and 48% of native vegetation conversion to pasture and agriculture, respectively, were in non-forest natural ecosystems.

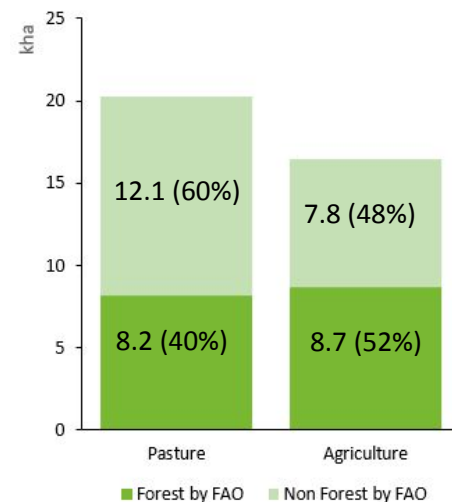
Atlantic Forest Native Vegetation Cover 2019 (ha)



Atlantic Forest Native Vegetation Loss 2000 - 2019 (ha)



Native vegetation types converted to Pasture or Agriculture between 2000-2019 in the Atlantic Forest\*



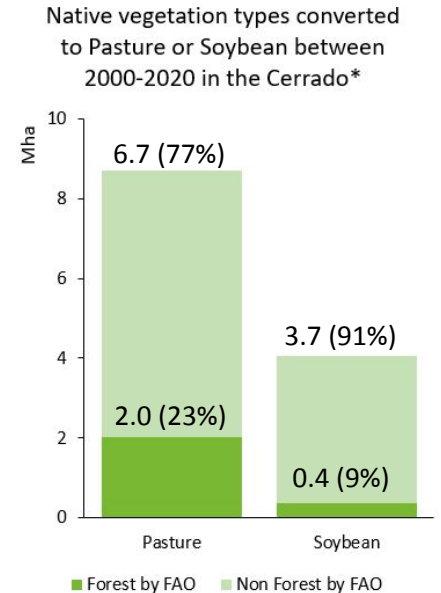
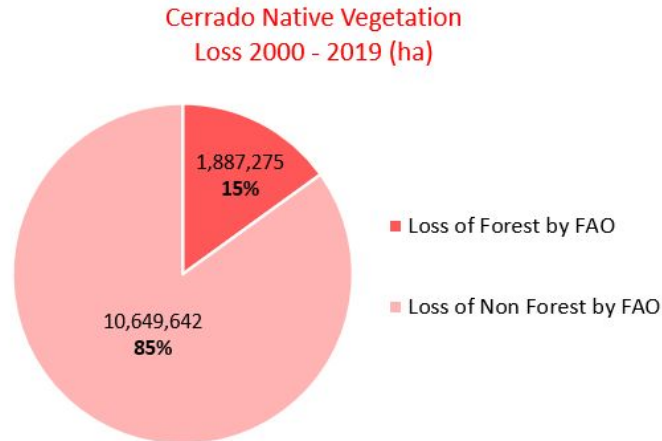
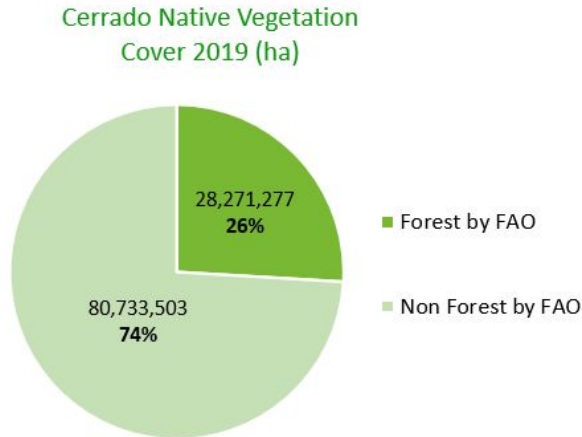
\* It is not necessarily a direct conversion, other land uses and land covers could be present between the 2000 and 2019.



# 3. RESULTS

- 74% of the Cerrado native vegetation would not be protected by the FAO definition, an area nearly the size of Ukraine and Belarus combined.
- 85% of native vegetation loss between 2000 and 2019 were in non-forest natural ecosystems.
- 6.7 Mha of non-forest vegetation was converted to pasture, and 3.7 Mha to soybean, representing, respectively.
- 77% of native vegetation conversion to pasture were in non-forest natural ecosystems, in the case of soybean the proportion is even higher - 91%.

## 3.5 Cerrado (BRA)



\* It is not necessarily a direct conversion, other land uses and land covers could be present between the 2000 and 2020.

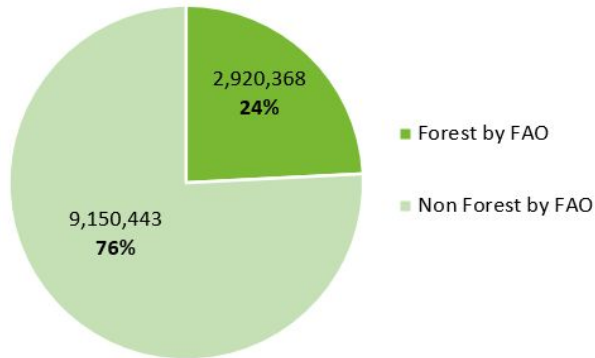
# 3. RESULTS

- 76% of the Pantanal native vegetation would not be protected by the FAO definition, an area roughly the size of Portugal.

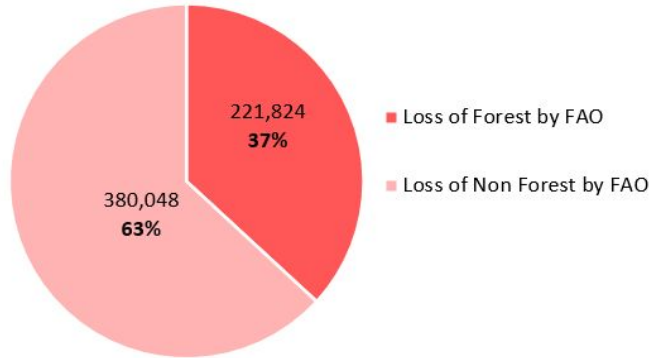
## 3.6 Pantanal (BRA)

- 63% of native vegetation loss between 2000 and 2019 were in non-forest natural ecosystems.
- 777k ha of non-forest vegetation was converted to farming lands in the last two decades; more than two times the forest lost.
- 73% of native vegetation conversion to farming lands were in non-forest natural ecosystems.

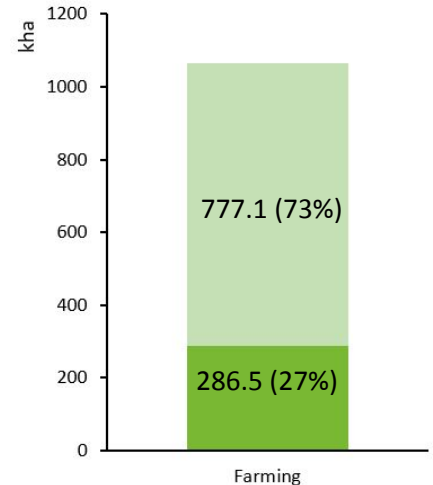
Pantanal Native Vegetation Cover 2019 (ha)



Pantanal Native Vegetation Loss 2000 - 2019 (ha)



Native vegetation types converted to Farming between 2000-2020 in Pantanal\*

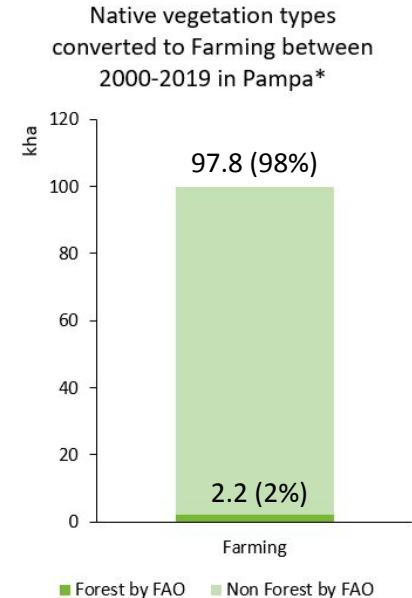
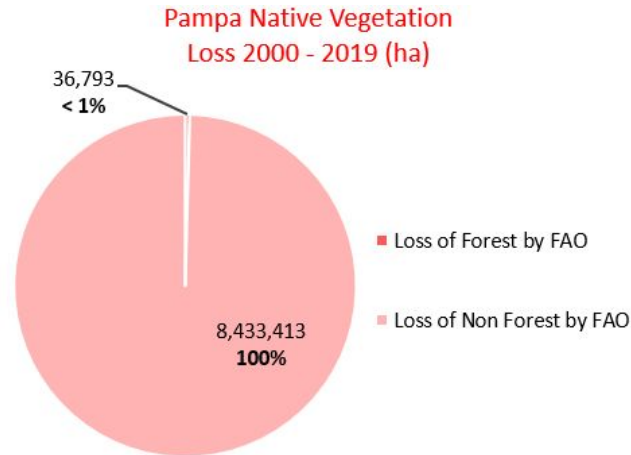
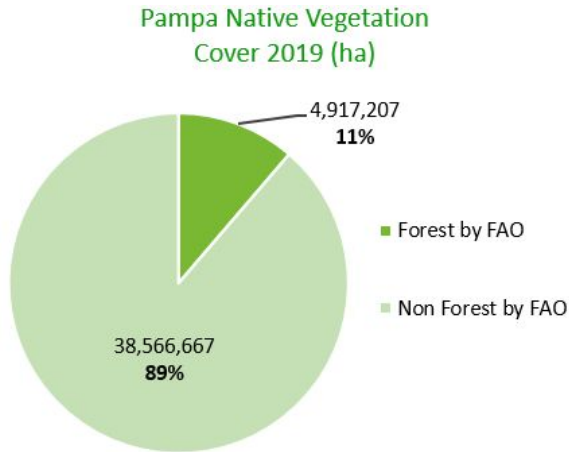


\* It is not necessarily a direct conversion, other land uses and land covers could be present between the 2000 and 2020.

# 3. RESULTS

- 89% of the Pampa native vegetation would not be protected by the FAO definition, an area larger than Norway.
- Almost 100% of native vegetation loss between 2000 and 2019 happened in non-forest natural ecosystems.
- 97.8k ha of non-forest vegetation was converted to farming lands between 2000-2019, representing 98% of native vegetation conversion to farming lands.

## 3.7 Pampa (BRA, ARG, URY)

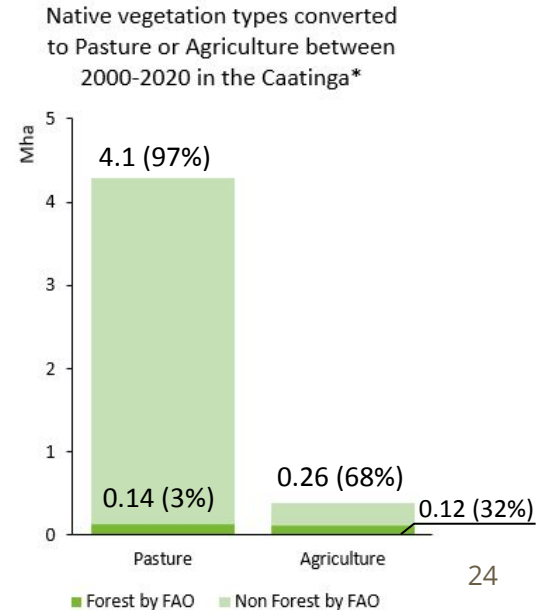
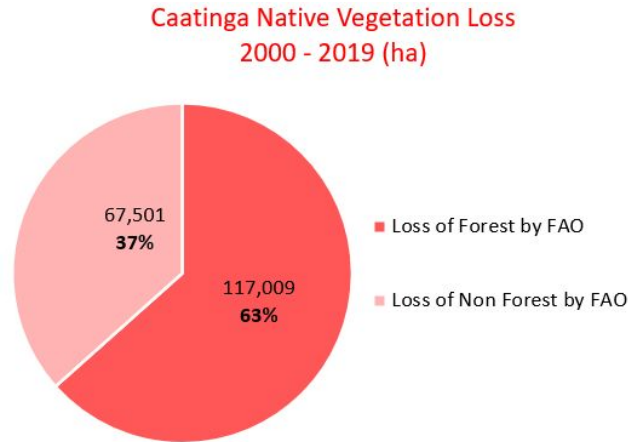
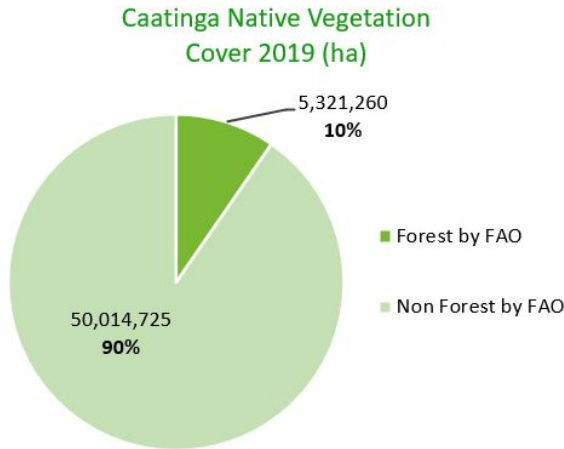


\* It is not necessarily a direct conversion, other land uses and land covers could be present between the 2000 and 2019.

# 3. RESULTS

- 90% of the Caatinga native vegetation would not be protected by the FAO definition, an area nearly the size Spain.
- 37% of native vegetation loss between 2000 and 2019 happened in non-forest natural ecosystems.
- 4.1 Mha of non-forest vegetation was converted to pasture, and 0.26 Mha to agriculture; more than 16 times the forest lost.
- 97% and 68% of native vegetation conversion to pasture and agriculture, respectively, were in non-forest natural ecosystems.

## 3.8 Caatinga (BRA)



\* It is not necessarily a direct conversion, other land uses and land covers could be present between the 2000 and 2020.

# 4. Concluding remarks

## 4.1 The natural ecosystems threatened in South American biomes

- The adoption of FAO definition of forest as a criteria for **EU regulation of deforestation free commodities will leave unprotected 27.9% of the natural ecosystems' remnants in seven biomes of South America** (in Amazon, Cerrado, Chaco, Atlantic Forest, Chaco, Pampa and Pantanal) which represents **270.9 million hectares**, corresponding to 5 times the size of France. Those would not be covered by the European regulation and thus there would be no assurance that commodities produced in those areas would be free of conversion.
- **Most of the natural ecosystems' remnants in Caatinga, Pampa, Pantanal and Cerrado biomes are categorized as non-forest natural ecosystem as per FAO and thus will not be covered by European regulation.**
- **The Cerrado savannas and grasslands are being converted mostly by pasture and soybean expansion. The Pantanal non-forest natural ecosystems are also critically threatened by pasture expansion.**
- **The Pampa and Caatinga biomes are proportionally the ones with more non-forest natural ecosystems.** In the Pampa biome, grasslands are threatened by farming, while in Caatinga, non-forest natural ecosystems are converted into planted pastures.
- **The biomes show different levels of conservation.** The Amazon, Chaco and Pantanal still have significant remnants of native vegetation, while the Atlantic Forest, Cerrado, Caatinga and Pampa are already highly impacted. But **all of them under process of deforestation and conversion of natural ecosystems to farming.**

# 4. Concluding remarks

## 4.2 Land cover mapping to decision making

- The natural ecosystems dynamics and its conversion to other land uses can be monitored and mapped over the time series using remote sensing, machine learning and local institution collaboration network.
- The MapBiomass network is now mapping all the South American biomes, as well as Indonesia. The MapBiomass approach would allow to efficiently and rapidly generate similar monitoring information where needed, including forest and non-forest natural ecosystems.
- All MapBiomass data and maps of land use and land cover are freely available and transparent in platforms and this knowledge could be taken into account for building legislation, public policy and decision making to evaluate the impacts on these biomes for their long-term protection.

# Contact us

Write to us on [contato@mapbiomas.org](mailto:contato@mapbiomas.org) , access our social networks or participate in the MapBiomias Forum, where the user community interacts with the MapBiomias teams on the different technical and scientific aspects of the project.

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