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## SUMMARY

In July 2012, the Sistema de Alerta de Desmatamento (SAD - Deforestation Alert System) detected 139.5 square kilometers of deforestation in the Amazon. This represented an increase of 50% compared to July 2011 when the deforestation totaled 93.5 square kilometers. It was possible to monitor 80% of the territory, a value similar to July 2011 (82%).

The accumulated deforestation from August 2011 to July 2012 totaled 1047 square kilometers. There was a reduction of 36% over the previous period (August 2010 to July 2011) when the deforestation totaled 1,628 square kilometers.

In July 2012, the vast majority (83%) of the deforestation occurred in Pará, and in particular in the area of influence of the BR 163 (Western Pará). After appears the Mato Grosso with 10%. The remainder (7%) occurred in Rondônia (4%) and Amazonas (3%).

The degraded forests in the Amazon

totaled 27.5 square kilometers in July 2012.

Compared to July 2011, when the forest degradation totaled 116 square kilometers, there was a decrease of 76%. The majority (55.5%) of this degradation occurred in Mato Grosso.

Forest degradation accumulated in the period (August 2011 to July 2012) reached 2,002 square kilometers. In comparison with the previous period (August 2010 to July 2011) when the deforestation summed 6,389 square kilometers, there was a reduction of 69%.

In July 2012, the deforestation detected by SAD endangered 10 million tons of CO<sub>2</sub> equivalent.

In the accumulated of the period (August 2011 to July 2012) the CO<sub>2</sub> equivalent emissions endangered with deforestation totaled 83.5 million tons, representing a reduction of 14% over the previous period (August 2010 to July 2011).

## Deforestation Statistics

According to the SAD, deforestation (total suppression of forest to other alternative uses of the soil) reached 139.5 km squares in July 2012 (Figure 1

and Figure 2). This represented an increase of 50% compared to July 2011 when the deforestation reached 93.5 square kilometers

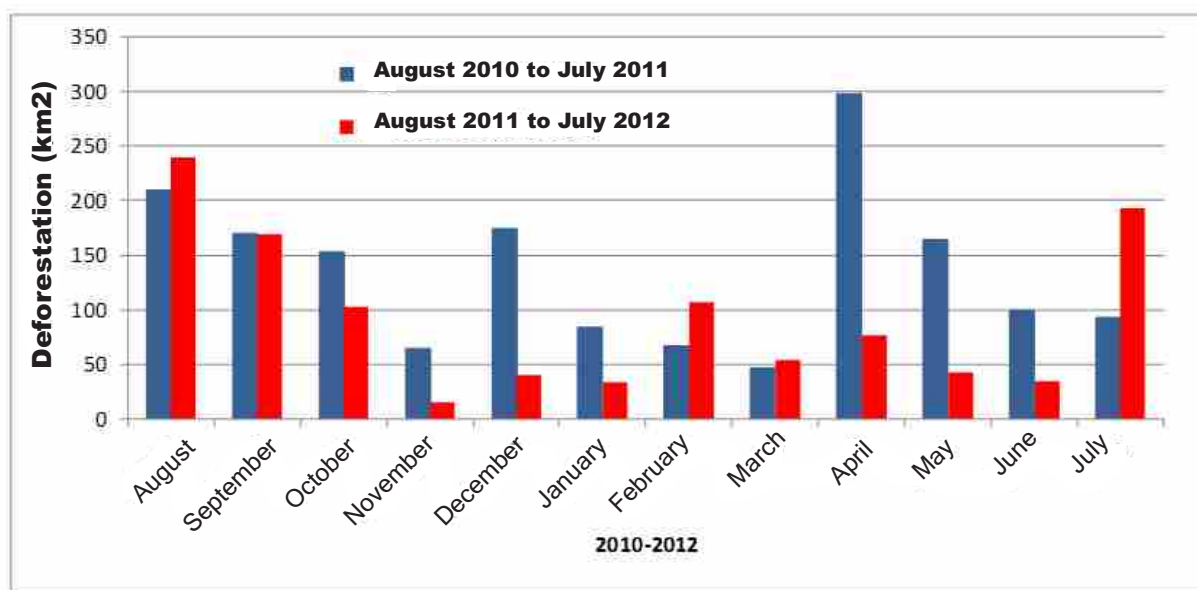


Figure 1. Deforestation from August 2010 to July 2012 in the Amazon (Source: Imazon/SAD).

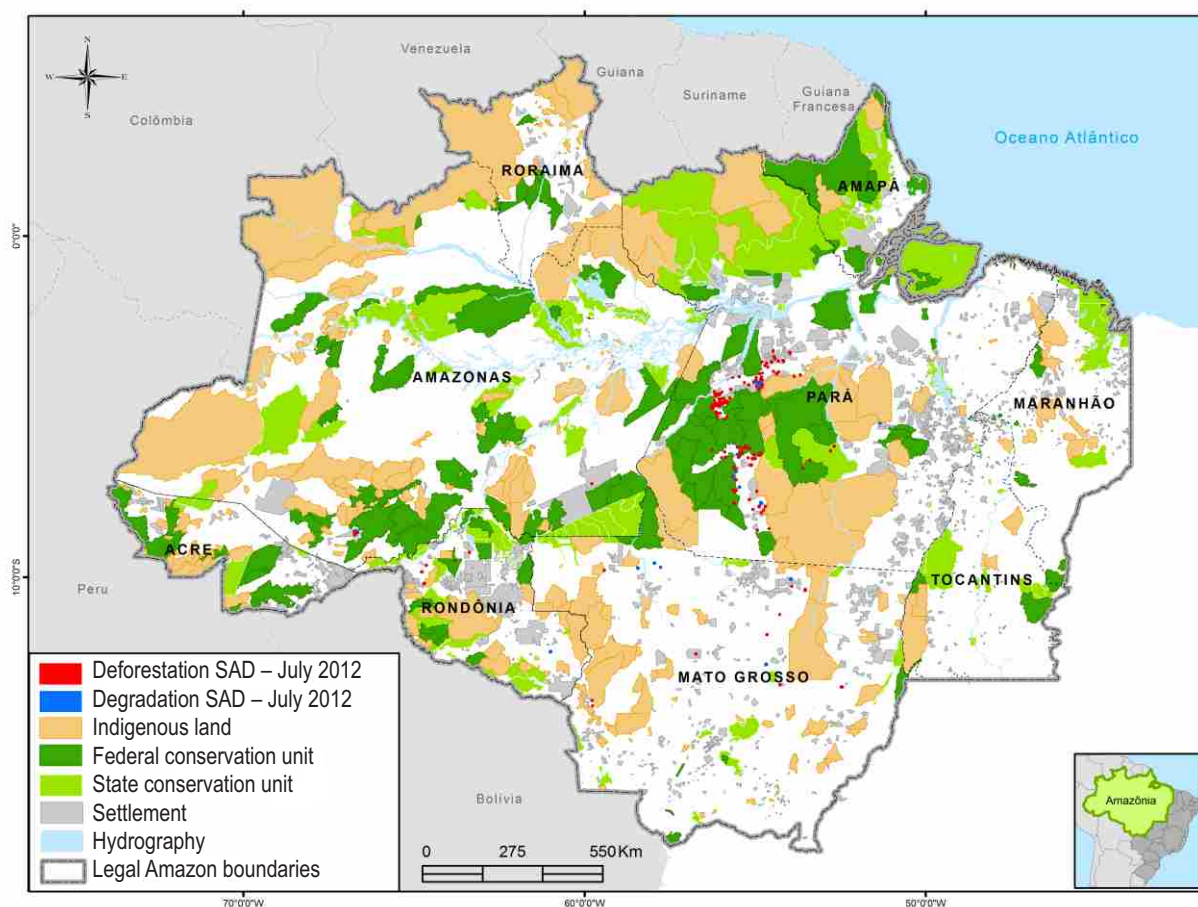
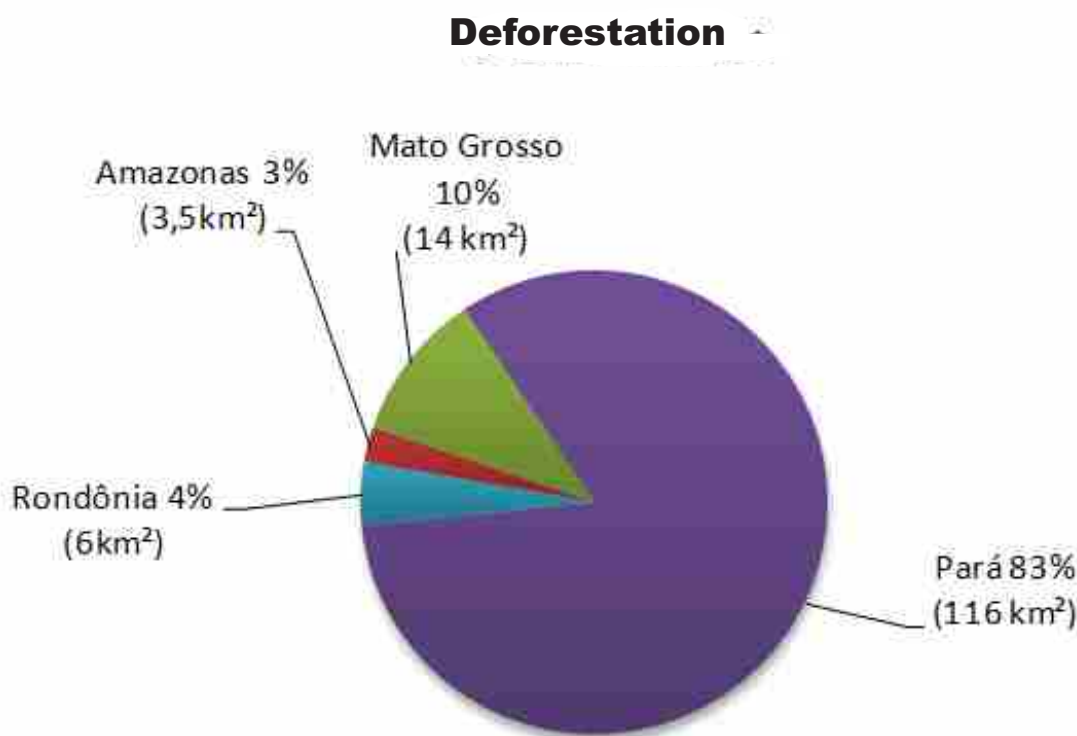


Figure 2. Deforestation and Forest Degradation in July 2012 in the Amazon (Source: Imazon/SAD).

The accumulated deforestation from August 2011 to July 2012<sup>1</sup>, corresponding to the twelve months of the official calendar of measuring of the deforestation reached 1,046.8 square kilometers. There was reduction of 36% of the deforestation in

comparison with the previous period (August 2010 to July 2011) when reached 1,628 square kilometers. In July 2012, the majority (83%) of the deforestation occurred in Pará, followed by Mato Grosso (10%), Rondônia (4%) and Amazonas (3%).



**Figure 3.** Percentage of deforestation in the Legal Amazon in July 2012 (Source: Imazon/SAD).

Considering the accumulated deforestation in the twelve months of the current calendar of deforestation (August 2011 to July 2012), Pará leads the ranking with 41% of total deforestation. After appears Mato Grosso with 29%, Rondônia with 17% and Amazonas with 8%. These four states accounted for 95% of deforestation occurred in Legal Amazon in that period.

There was a 36% reduction in deforestation occurred in August 2011 to July 2012 compared with the previous period (August 2010 to July 2011) (Table 1). In relative terms, a reduction of 65% in Acre, 55% in Amazonas, 49% in Mato Grosso% and

49% in Rondônia. On the other hand, there was an increase of 194% in Roraima, and 61% in Tocantins. But in Pará there was no change between the two periods.

In absolute terms, Pará leads the ranking of accumulated deforestation with 425 square kilometers, followed by Mato Grosso (308 square kilometers), Rondônia (173 square kilometers), Amazonas (84 square kilometers), Roraima (23 square kilometers), Acre (20 square kilometers) and Tocantins (14 square kilometers).

<sup>1</sup> The official calendar of deforestation measuring begins in August and ends in July.

**Table 1.** Evolution of deforestation among states in the Brazilian Legal Amazon from August 2010 to July 2011 and August 2011 to July 2012 (source: Imazon/SAD).

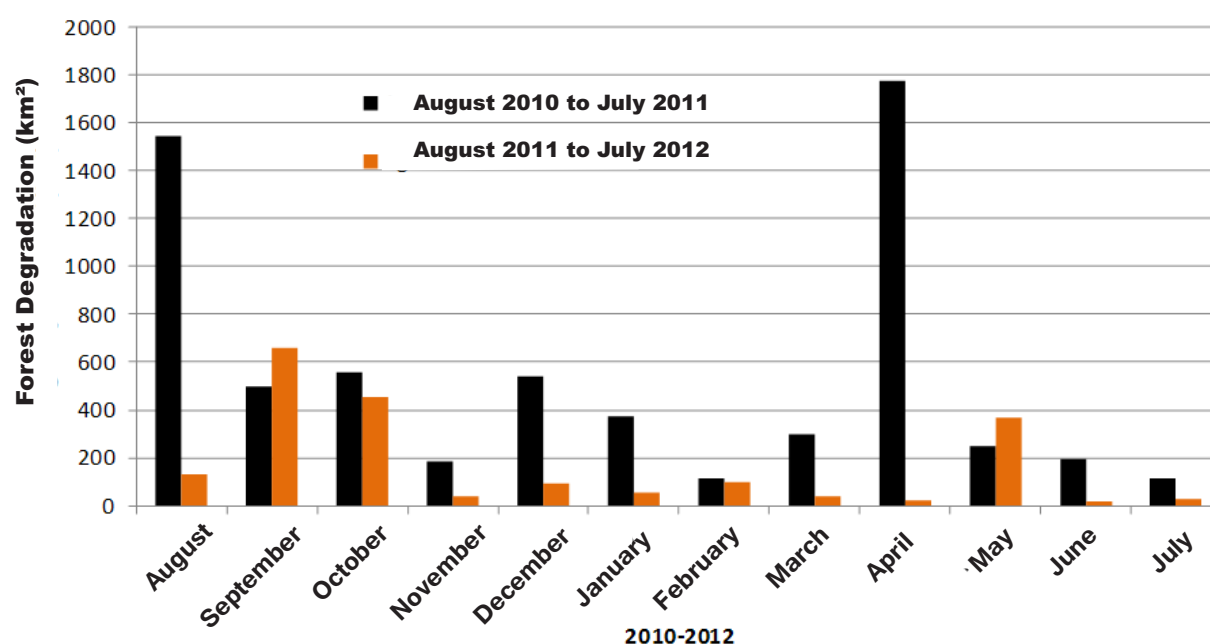
State	August 2010 to June 2011	August 2011 to June 2012	Variation (%)
Pará	423	425	0
Mato Grosso	603	308	-49
Rondônia	338	173	-49
Amazonas	187	84	-55
Roraima	8	23	+194
Acre	57	20	-65
Tocantins	9	14	+53
Amapá	2	-	-
<b>Total</b>	<b>1.628</b>	<b>1.047</b>	<b>-36</b>

\* Data from Maranhão were not analyzed.

## Forest Degradation

In July 2012, the SAD recorded 27.5 kilometer square of degraded forests (forests intensively exploited by logging and/or burned) (Figures 2 and 4). Compared to the same period of last year (July 2011) there was a

decrease of 76%, when the forest degradation reached 116 square kilometers. The majority (55%) of this degradation occurred in Mato Grosso.



**Figure 4.** Deforestation and Forest Degradation from August 2010 to July 2012 in the Legal Amazon (Source: Imazon/SAD).

Forest degradation accumulated in the period of August 2011 to July 2012 reached 2,002 square kilometers. This represents a reduction of 69% in forest degradation accumulated during this period (August 2011 to July 2012) over the same period (August 2010 to July 2011), when the forest degradation totaled 6,389 square kilometers (Table 2). The largest reductions were in Acre (-98%), Rondônia (-90%), Amazonas (-85%), Pará (-77%) and Mato Grosso (-58%).

In absolute terms, the Mato Grosso leads the ranking of forest degradation accumulated with 1,602 km<sup>2</sup> (80%), distantly followed by Pará with 248 square kilometers (12%). The remainder (8%) occurred in Rondônia (105 square kilometers), Amazonas (30 square kilometers), Roraima (15 square kilometers) and Acre (3 square kilometers).

**Table 2.** Evolution of forest degradation among states in the Brazilian Legal Amazon from August 2010 to July 2011 and August 2011 to July 2012 (Source: Imazon/SAD).

State	August 2010 to June 2011	August 2011 to June 2012	Variation (%)
Mato Grosso	3847	1.602	-58
Pará	1077	248	-77
Rondônia	1076	105	-90
Amazonas	193	30	-85
Roraima	2	15	+865
Acre	163	3	-98
Tocantins	31	-	-
Amapá	-	-	-
<b>Total</b>	<b>6.389</b>	<b>2.002</b>	<b>-69</b>

\* Data from Maranhão were not analyzed.

<sup>2</sup> The official calendar of deforestation measuring begins in August and ends in July.

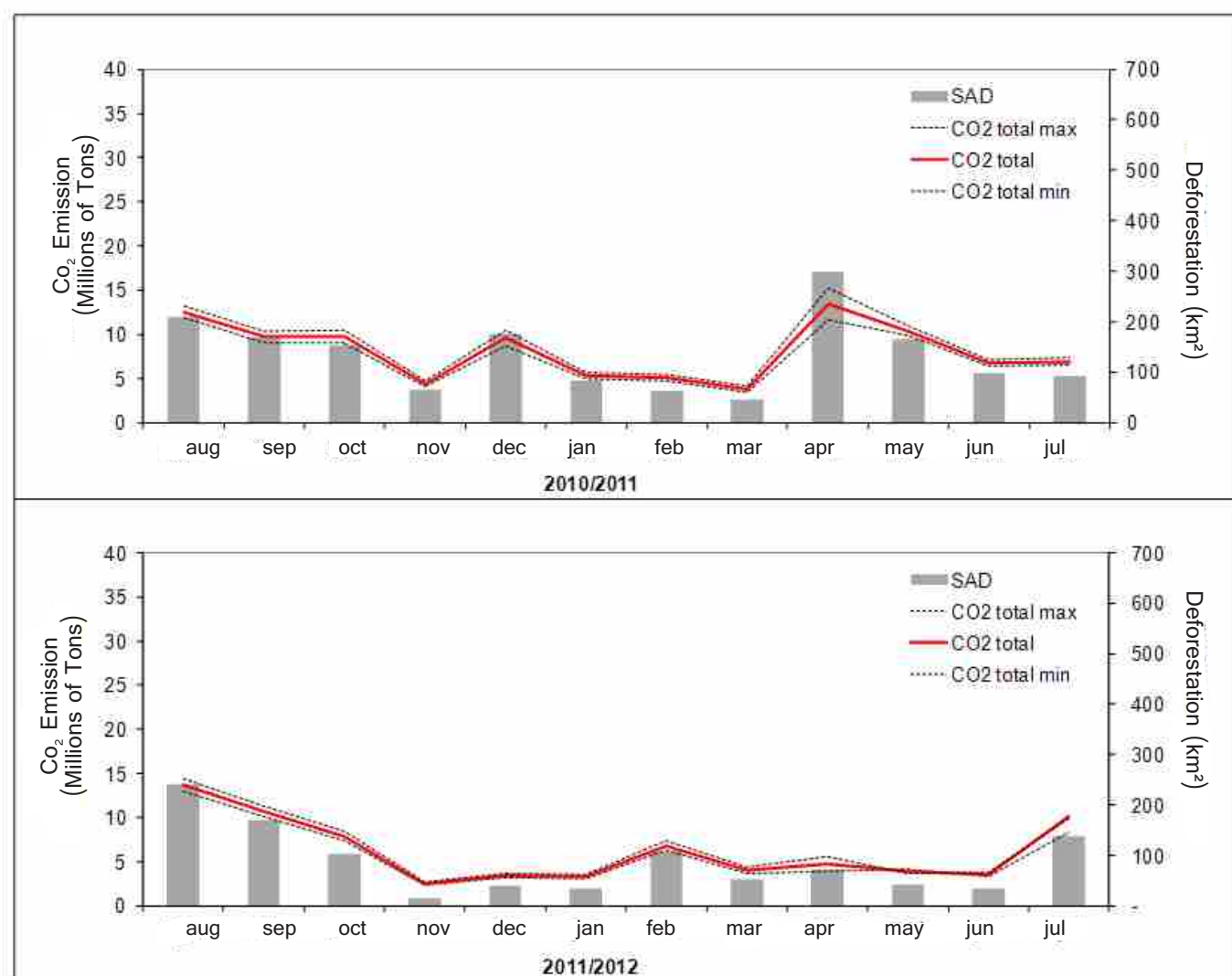


### Carbon Affected by the Deforestation

In July 2012 the 139.5 square kilometers of deforestation detected by SAD in Legal Amazon endangered 2.7 million tons of carbon (with a margin of error of 313 thousand tons of carbon). This amount of endangered of carbon emissions may result in emissions of 10 million tons equivalent CO<sub>2</sub> (Figure 6).

The forest carbon endangered by deforestation

from August 2011 to July 2012 was 22.7 million tonnes (with a margin of error of 417,700 tonnes), representing approximately 83.5 million tons of equivalent CO<sub>2</sub> (Figure 6). Compared to the same period last year (August 2010 to July 2011) there was a 14% reduction in the amount of carbon endangered by deforestation.



**Figure 6.** Deforestation and emissions of equivalent Carbon Dioxide (CO<sub>2</sub>) total from August 2010 to July 2012 in Legal Amazon (Source: Imazon).

## Deforestation Geography

In July 2012, the majority (53%) of the deforestation occurred in private areas or under various stages of ownership. The rest of deforestation was

recorded in Conservation Units (30%), Indigenous Land (0.5%) and Land Reform Settlements (16%) (Table 3).

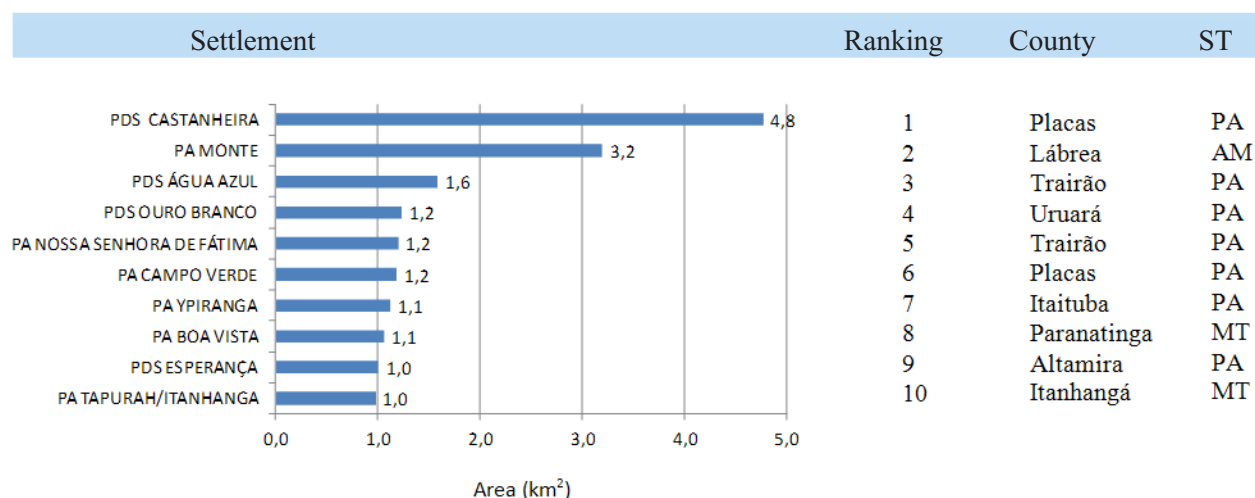
**Tabela 3.** Desmatamento por categoria fundiária em julho de 2012 na Amazônia Legal (Fonte: Imazon/ SAD).

Category	July 2012	
	km <sup>2</sup>	%
Agrarian Reform Settlement	22,5	16
Conservation Units	41,5	30
Indigenous Lands	0,5	1
Private, Owned and in Abeyance <sup>3</sup>	74,5	53,5
<b>Total (km<sup>2</sup>)</b>	<b>139,5</b>	<b>100</b>

## Agrarian Reform Settlements

The SAD recorded 22.5 square kilometers of deforestation in Land Reform Settlements in July 2012 (Figure 7). The 10 settlements most affected by deforestation were: PDS Castanheira (Placas; Pará), PA Monte (Lábrea, Amazonas), PDS Água Azul (Trairão, Pará), PDS Ouro Branco (Uruará, Pará), PA

Nossa Senhora de Fátima (Trairão, Pará), PA Campo Verde (Placas, Pará), PA Ypiranga (Itaituba, Pará), PA Boa Vista (Paranatinga, Mato Grosso), PDS Esperança (Altamira, Pará) and PA Tapurah/Itanhanga (Itanhanga, Mato Grosso).



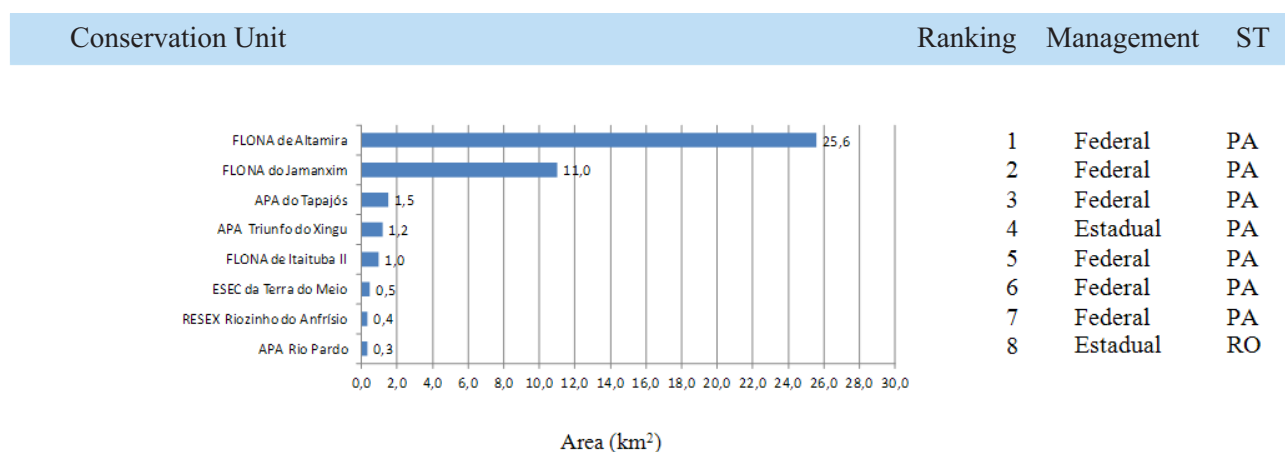
**Figure 7.** Land Reform Settlements deforested in July 2012 in the Legal Amazon (Source: Imazon/SAD).

<sup>3</sup> Includes private areas (with ownership title or not) and not protected public forests

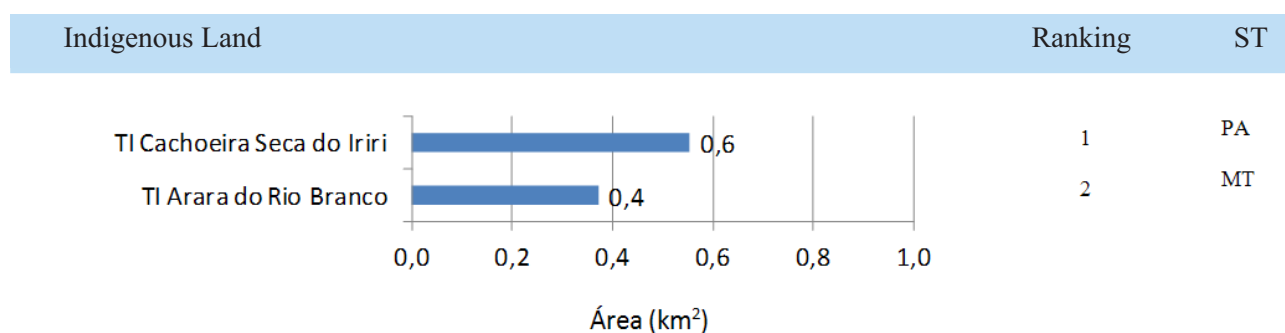
### Protected Areas

The SAD detected 41.5 square kilometers of deforestation in Conservation Areas Units (Figure 8). The most deforested Conservation Units were Flona de Altamira (Pará), Flona do Jamanxim (Pará), APA Tapajós (Pará) and APA Trinunfo Xingu (Pará). In

the case of Indigenous Lands in July 2012 was detected 1 square kilometer of deforestation in Terras Cachoeira Seca do Iriri (Pará) and Arara do Rio Branco (Pará) (Figure 9).



**Figure 8.** Conservation Unit deforested in the Legal Amazon in July 2012 (Source: Imazon/SAD).



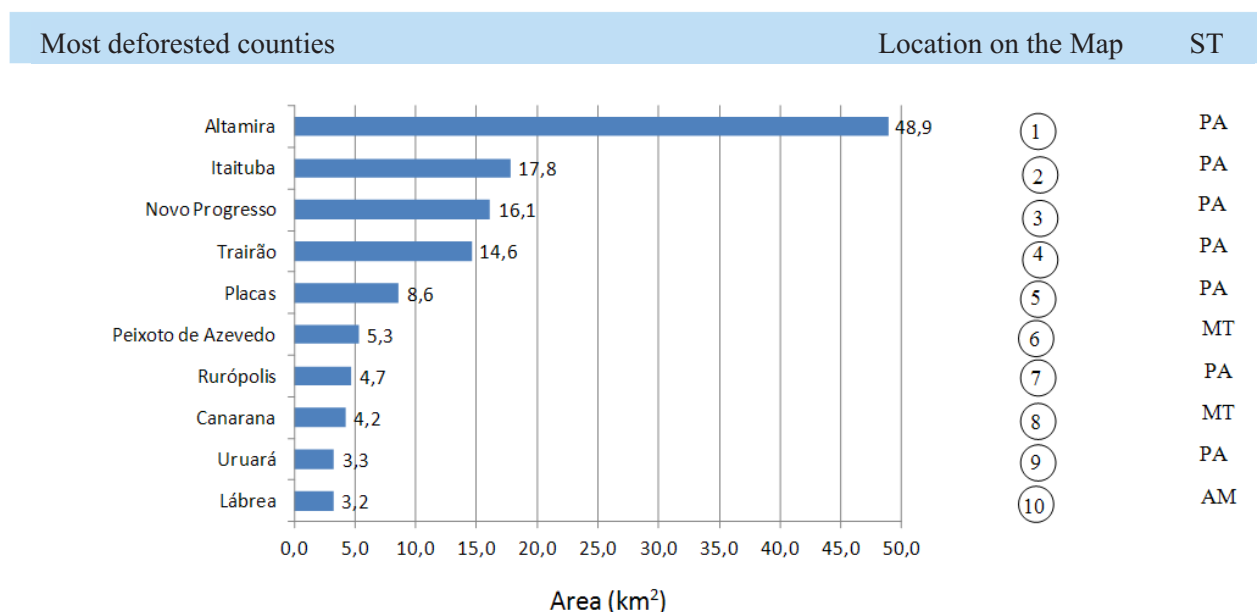
**Figure 9.** Indigenous Land deforested in the Legal Amazon in July 2012 (Source: Imazon/SAD).



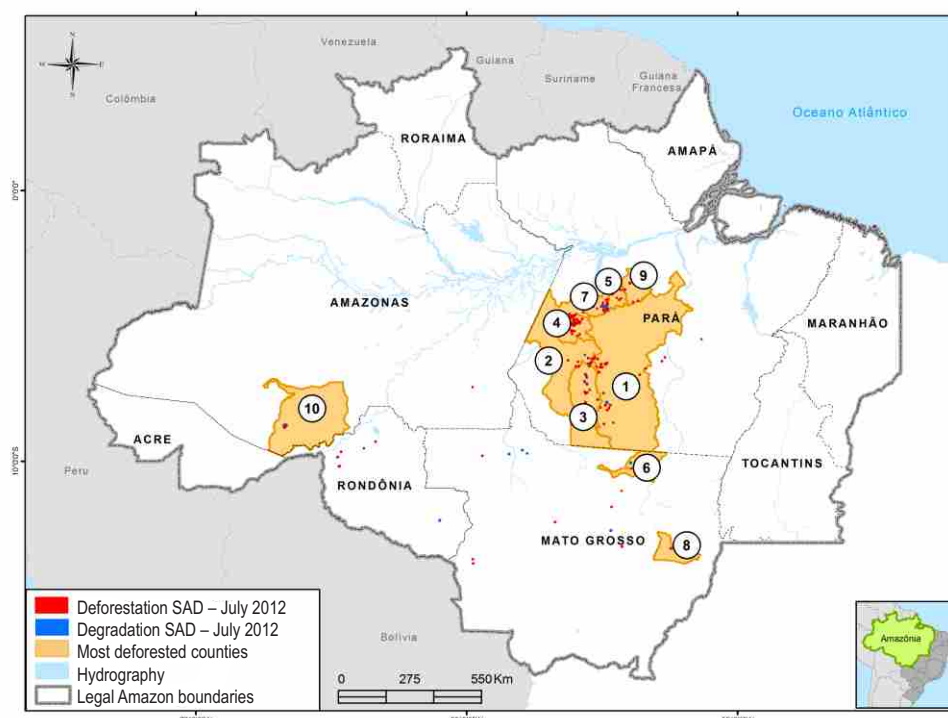
## Critical Municipalities

In July 2012, the most deforested municipalities were Altamira (PA), Itaituba (PA) and Novo Progresso

(PA) (Figures 10 and 11).



**Figure 10.** Municipalities most deforested in the Legal Amazon in July 2012 (Source: Imazon/SAD).



**Figure 11.** Municipalities with the largest deforested areas in July 2012 (Source: Imazon/SAD).

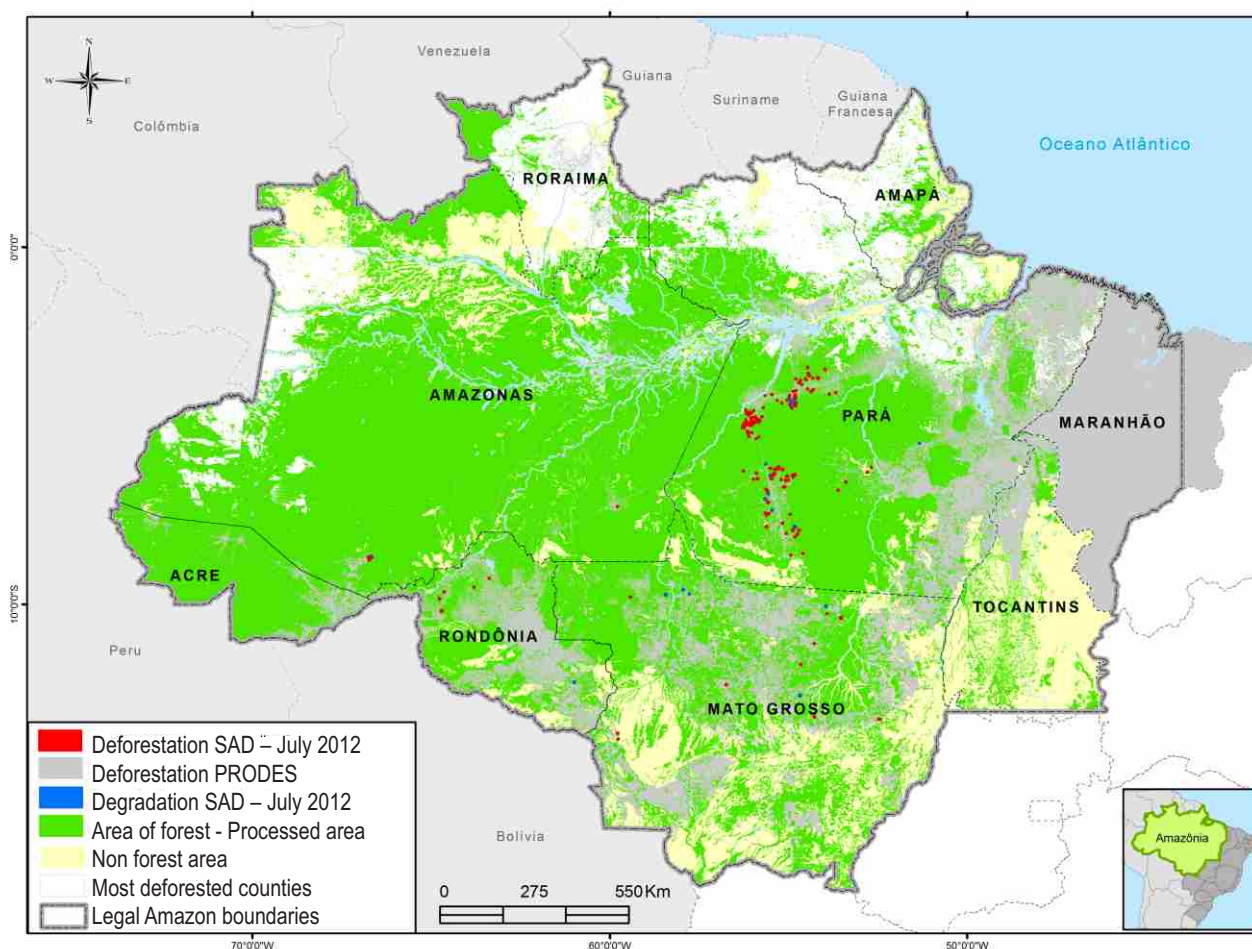
<sup>4</sup> The 3.1 km<sup>2</sup> detected as deforestation in Paragominas were authorized by the Secretary of State for the Environment (SEMA) of Para for the expansion of mining area of the company Norsk Hydro ASA.

## Coverage by clouds and Shade

Em julho de 2012, foi possível monitorar com o SAD 80% da área florestal na Amazônia Legal. Os outros 20% do território florestal estavam cobertos por nuvens o que dificultou a detecção do desmatamento e da degradação florestal. Os Estados

com maior cobertura de nuvem foram Roraima (91%), Amapá (77%), Pará (28%) e Amazonas (11%). Em virtude disso, os dados de desmatamento e degradação florestal em julho de 2012 podem estar subestimados (Figura 12).

\* The part of Maranhão that integrates the Legal Amazon was not analyzed.



**Figure 12.** Area with cloud and shadow in July 2012 in the Legal Amazon.

### Google SAD-EE

Since June 2012 the detection of deforestation and forest degradation alerts has been performed on the platform Google Earth Engine (EE), with the new version SAD EE. This system

was developed in collaboration with Google and uses the same process already used by SAD, with reflectance images of MODIS to generate alerts from deforestation and forest degradation

## Table I: SAD 3.0

Since August 2009, the SAD had some news. First, we create a graphical interface for integrating all image processing programs used in the SAD. Second, we begin to compute deforestation in areas that were covered by clouds in previous months in a new class. Finally, deforestation and degradation are detected with pairs of NFDI images in an algorithm of changes' detection. The primary method remains the same as SAD 2 as described below.

The SAD generates a temporal mosaic of daily MODIS images of products and MOD09GQ and MOD09GA for filtering clouds. In the following, we used a technique of bands fusion of different spectral resolution, this is, with different pixel sizes. In this case, we made the change of scale from 5 bands with pixel of 500 meters to 250 meters from MODIS. This allowed to enhance the model of spectral mixing pixel, providing the ability to estimate the abundance of Vegetation, Soils and Non-active Photosynthetic Vegetation (NPV from English - Non-Photosynthetic components (vegetation, soil and Shadow) to calculate the NDFI, with equation below:

$$NDFI = \frac{(VGs - (NPV + Soil))}{(VGs + NPV + Soil)}$$

Where VGs is the Vegetation component normalized for shade given by:  
 $VGs = \text{Vegetation} / (1 - \text{Shadow})$

The NDFI varies from -1 (pixel with 100% of bare soil) to 1 (pixel with > 90% with forest vegetation). Thus, we now have a continuous image that shows the transition from deforested areas, passing through degraded forests until reach the forest with no signs of disturbance. The detection of deforestation and degradation was made this month with the difference of NDFI images of consecutive months. Thus, a reduction of NDFI values between -200 and -50 indicates possibly deforested areas and between -49 and -20 with signs of degradation.

The SAD 3.0 Beta is compatible with previous versions (SAD 1.0 and 2.0), because the threshold of deforestation detection was calibrated to generate the same type of response obtained by the previous method.

The SAD is already operational in the State of Mato Grosso since August 2006 and in the Legal Amazon since April 2008. In this report, we present the monthly data generated by SAD from August 2006 to July 2012.

### Table II: Carbon affected by Deforestation

Since January 2010 we reported the estimates of carbon endangered (e.g., subject to the forest carbon emissions due to burning and decomposition of forest biomass residues) from deforestation detected by SAD in the Amazon.

The carbon estimates are generated based on the combination of deforestation maps of the SAD with simulations of the spatial distribution of biomass for Amazonia. We develop a model of the estimates of carbon emissions, based on stochastic simulation (Morton et al, in prep.), and called Carbon Emission Simulator (CES). We generated 1000 simulations of the spatial distribution of biomass in the Amazon using a geostatistic model (Sales et al., 2007), and transformed these biomass simulations in C stocks using conversion factors for biomass for C of the literature, according to the formula below:

$$C_t = \sum C(S)_t$$

$$C_t(S) = S_D \times \left[ BVAS - BPF \right] \times (1 - fc) \times (t == 0) + \left( BAS_0 \times pd \times e^{(-pd \times t)} \right)$$

$$BPF = ff * AGLB$$

$$BAS_0 = bf * AGLB$$

where:

t: time (month)

Ct: Carbon emitted in the month t.

C<sub>t</sub>(S): Carbon emitted of a deforested polygon in time t.

SD: Deforest area.

BVAS: Biomass above the soil of the deforested region SD.

BPF: Biomass of forest products removed from the forest before the deforestation.

fc: charcoal fraction (3 to 6%).

BAS<sub>0</sub>: Biomass below the soil before the deforestation.

pd: monthly decomposition parameter of the biomass below the soil after the deforestation (0.0075).

$pd \times e^{(-pd \times t)}$ : monthly decomposition rate of the biomass below the soil after the deforestation.

For the application of the CES model using data from SAD, we consider only the carbon endangered by deforestation, e.g. the fraction of forest biomass composed of carbon (50%) subject to instantaneous emissions due to burning of forests by logging and/or further decomposition of remaining forest biomass. In addition, we adapted the model to estimate the CES for the forest carbon endangered by deforestation in a monthly scale. Finally, the simulations allowed to estimate the uncertainty of carbon endangered, represented by the standard deviation (+/- 2 times) of the simulations of carbon affected in each month.

For the conversion of carbon to CO equivalent value of the applied 3.68:2

#### References:

- D.C. Morton<sup>1</sup>, M.H. Sales<sup>2</sup>, C.M. Souza, Jr.<sup>2</sup>, B. Griscom<sup>3</sup>. Baseline Carbon Emissions from Deforestation and Forest Degradation: AREDD case study in Mato Grosso, Brazil. In preparation.
- Sales, M.H. et al., 2007. Improving spatial distribution estimation of forest biomass with geostatistics: A case study for Rondônia, Brazil. *Ecological Modeling*, 205(1-2), 221-230.



## **Responsible Team:**

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## **Data Source:**

The deforestation statistics are generated using data from the SAD (Imazon);

INPE data - Deforestation (PRODES)

<http://www.obt.inpe.br/prodes/>

## **Thanks:**

Google Earth Engine Team

<http://earthengine.google.org/>

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Secretary of State for the Environment Mato Grosso (SEMA)

Federal Public Attorney's office of the Pará

State Public Attorney's office of the Pará

State Public Attorney's office of the Roraima

State Public Attorney's office of the Amapá

State Public Attorney's office of the Mato Grosso

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