

Heron Martins; Antônio Fonseca; Carlos Souza Jr.; Márcio Sales & Adalberto Veríssimo (Imazon)

ABSTRACT

In August 2012, SAD has detected 232 square km of deforestation in the Legal Amazon [first month of the deforestation new year]. This represented a 3% decrease compared to August 2011, when deforestation summed up 239 square km. Out of this total, 50% took place in Pará, followed by Mato Grosso (19%), Amazonas (16%), and Rondônia (15%).

Degraded forests in Legal Amazon summed 60 square km in August 2012. Compared to August 2011, a reduction of 54%

was observed in that for that period forest degradation was mainly observed in Pará (54%) and Mato Grosso (35%).

In June 2012, the deforestation detected by SAD pledged 1.2 million tons of equivalent CO₂, what represents a 66% increase compared to August 2011.

In August 2012, cloud covering was significantly reduced what allowed to monitor up to 84% of the Legal Amazon.

Deforestation Statistics

According to Imazon's Deforestation Alert System [SAD], deforestation (forest total suppression with soil exposure) has reached 232 square km in Legal Amazon in August 2012 [first month of the official calendar of 2012-2013 deforesting]¹ (Figure 1 and

Figure 2). This represented a decrease of 3% of deforestation in August 2012, compared to deforestation detected in August 2011, when deforestation reached 239 square km. August is the first month of the official calendar of deforestation.

¹ The official calendar of deforestation measurements starts in Augusts and ends in July

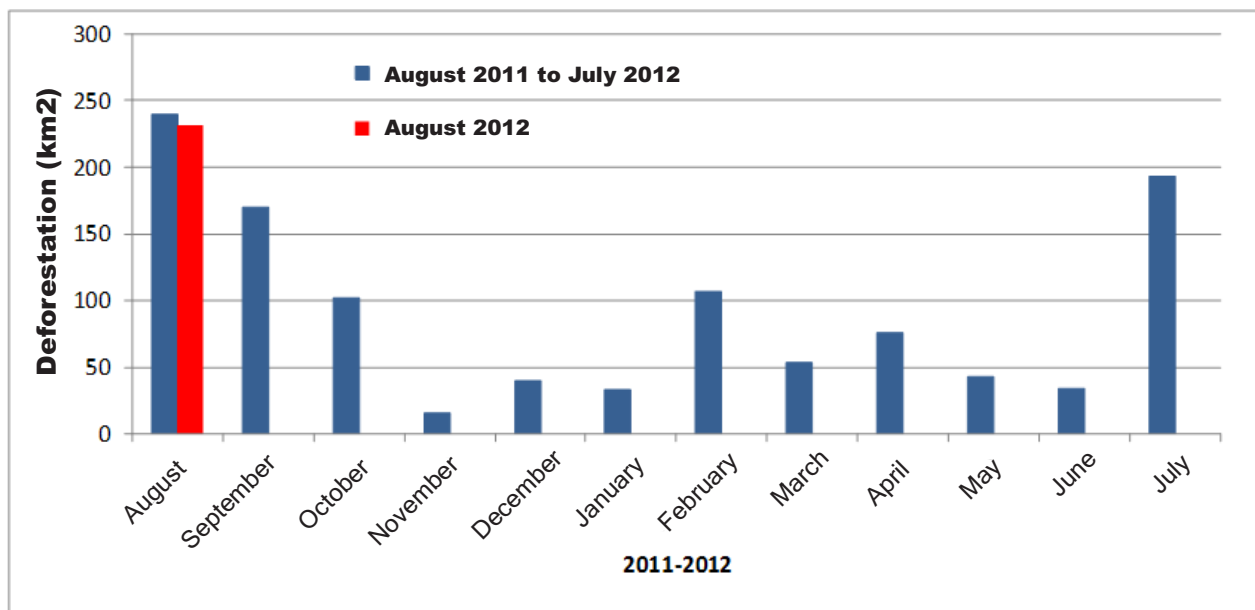


Figure 1: Deforestation from August 2011 to August 2012 in Legal Amazon (Source: Imazon/SAD)

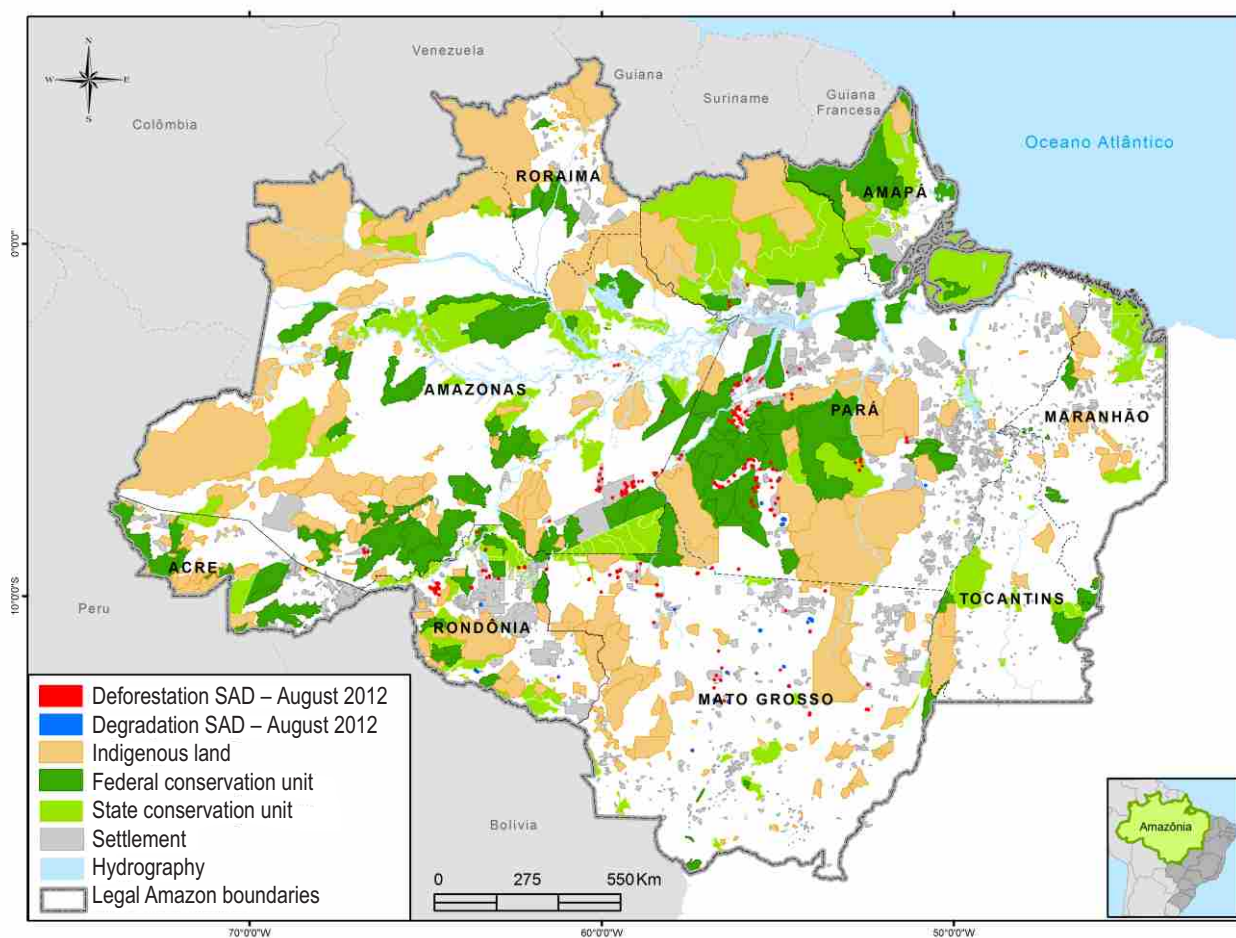


Figure 2: Deforestation and Forest Degradation in August 2012 in Legal Amazon (Source: Imazon/SAD).

In August 2012 the State of Pará led the deforestation reaching a 50% level, followed by Mato Grosso (19%), Amazonas (16%) and Rondônia (15%) (Figure 3). Compared to August 2011, deforestation in August 2012 showed an expressive increase in

Amazonas (+ 66%), and Mato Grosso (+ 21%). On the other hand, in Roraima (-100%), Acre (-89%), Rondônia (-26%), and Pará (-2%) (Table 1) deforestation was reduced.

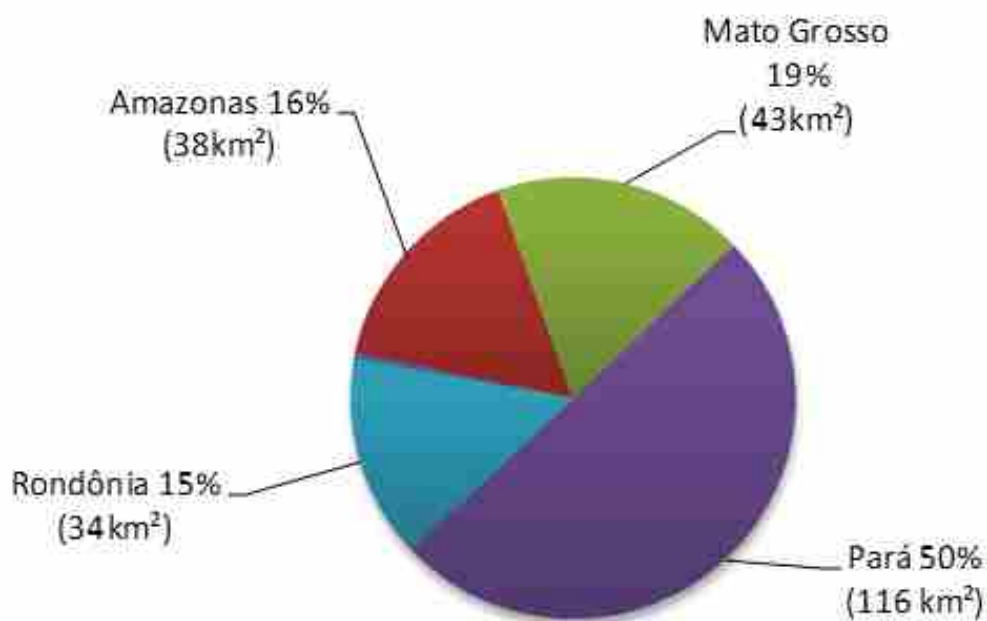


Figure 3: Percentage of deforestation in the states of Legal Amazon, in August 2012 (Source: Imazon/SAD)

Table 1: Deforestation evolution across the states of Legal Amazon in August 2011 and August 2012 [Source: Imazon/SAD]

State	August 2011	August 2012	Variation (%)
Pará	119	116	-2
Mato Grosso	35	43	+21
Rondônia	46	34	-26
Amazonas	23	38	+66
Roraima	6	0	-100
Acre	10	1	-89
Tocantins	1	0	-100
Amapá	-	-	-
Total	239	232	-3

* Data from the State of Maranhão has not been analyzed.

Forest Degradation

In August 2012 SAD recorded 60 square km of degrade forests [forests that are extremely exploited by wood activities and/or burnings] (Figures 2 and 4). Out

of that total, most (54%) took place in the state of Pará, followed by Mato Grosso (35%), Rondônia (8%), and Amazonas (3%).

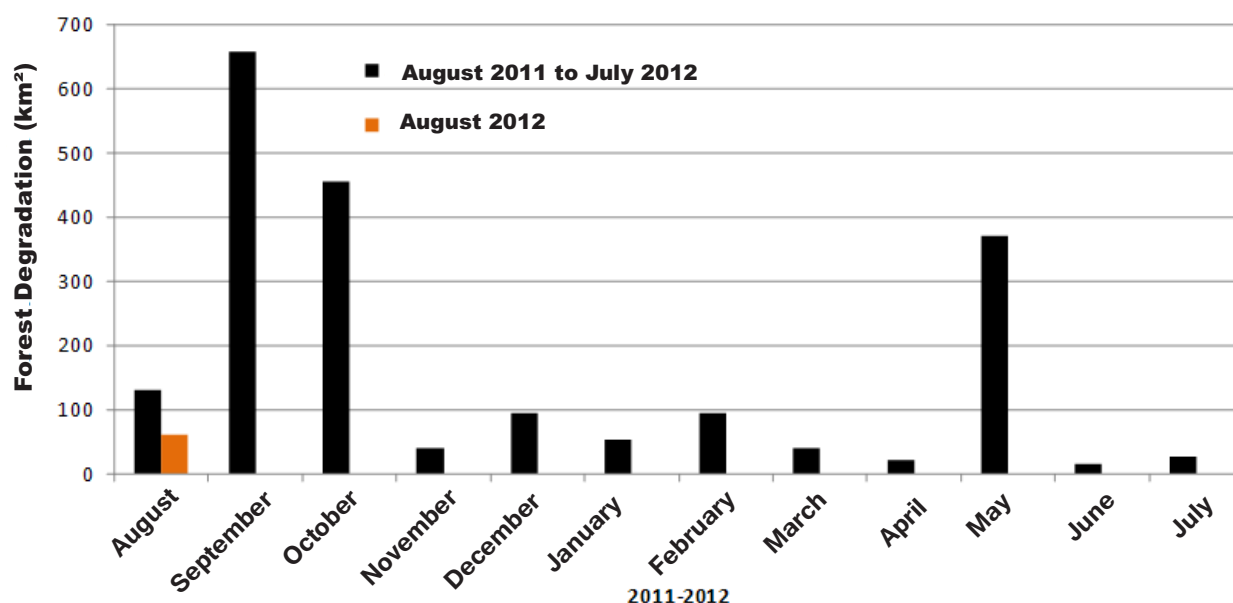


Figure 4: Forest degradation from August 2011 to August 2012 in Legal Amazon (Source: Imazon/SAD)

All states of Amazon but Pará present forest degradation compared to August 2011 (Table 2).

Table 2: Evolution of forest degradation across the states of Legal Amazon in August 2010, compared to August 2011 (Source: Imazon/SAD).

State	August 2011	August 2012	Variation (%)
Mato Grosso	77	21	-73
Pará	28	32	+16
Rondônia	9	4	-46
Amazonas	9	7	-78
Roraima	6	0	-100
Acre	2	0	-100
Tocantins	0	0	-
Amapá	-	-	-
Total	131	60	-54

* Data from the state of Maranhão was not analyzed.

Carbon Affected by the Deforestation

In April 2012, the 232 square kilometers of deforestation detected by SAD in Legal Amazon endangered 1.2 million tons of carbon (with a margin of error of 342 tons). This amount of endangered

carbon results in emissions of 4.5 million tons of equivalent CO₂ (Figure 6). This represents a reduction of 66% compared to August 2011 when the endangered forest carbon was 13.6 million tons.

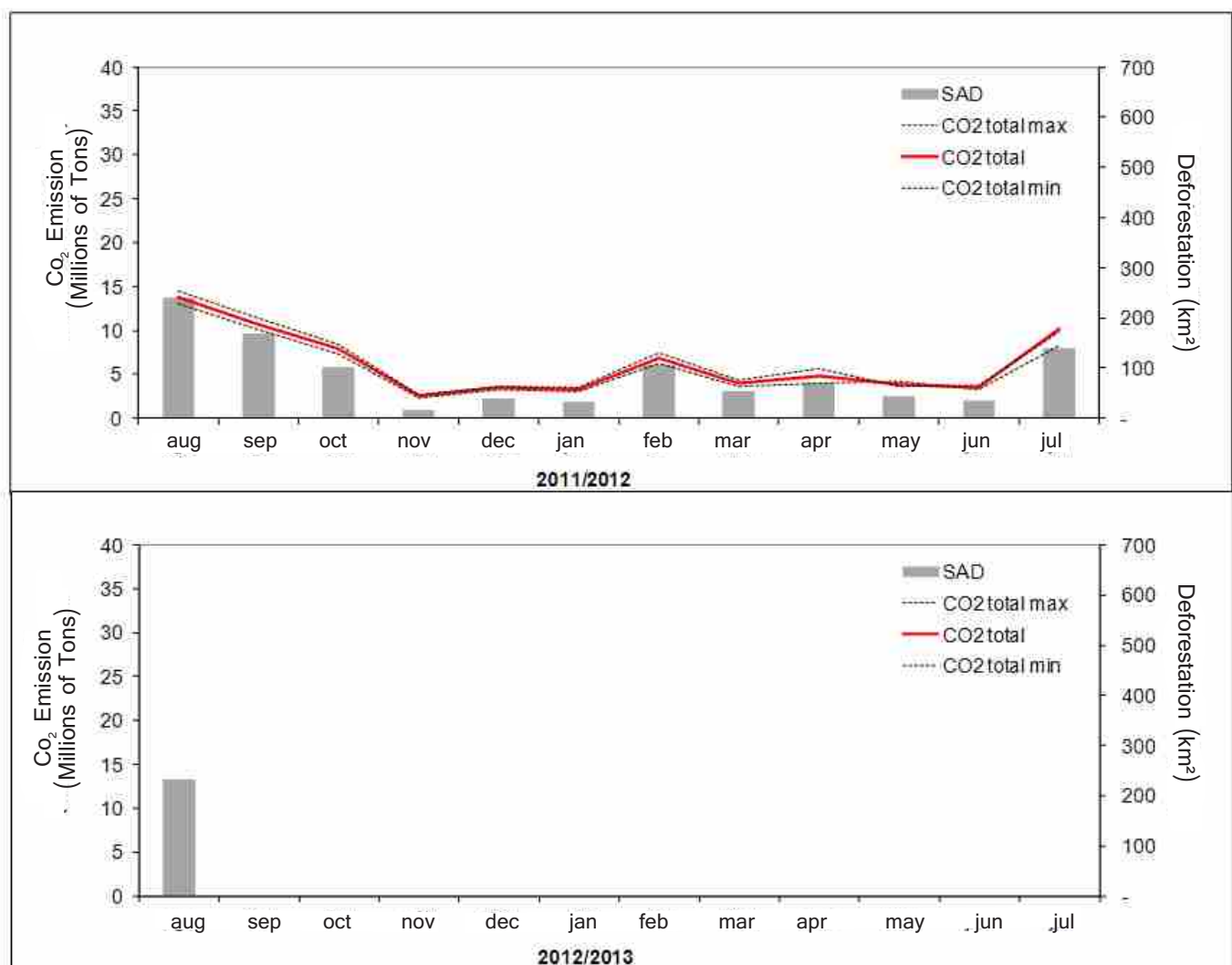


Figure 6: Deforestation and emissions of total equivalent carbon dioxide (CO₂) from August 2011 to August 2012, in Legal Amazon (Source: Imazon).

Deforestation Geography

In August 2012, most (53.5%) deforestation took place either in private areas or under different stages of ownership. The remaining deforestation was

registered in Conservation Units (22%) Indigenous lands (0.5%) and Land Reform Settlements (26%) (Table 3).

Table 3: Deforestation by agrarian category in August 2012, in Legal Amazon (Source: Imazon/SAD).

Category	August 2012	
	km ²	%
Agrarian Reform Settlement	56	24
Conservation Units	50	22
Indigenous Lands	1,5	0,5
Private, Owned and in Abeyance ³	124,5	53,5
Total (km²)	232	100

Agrarian Reform Settlements

SAD has recorded 9 square kilometers of deforestation in Agrarian Reform Settlements in August 2012. The ten settlements affected the most by deforestation were PA Rio Juma (Apuí, Amazonas), PDS Caracol (Trairão, Pará), PEDS Terra Nossa (Altamira; Pará), PA Jurena (Cotriguaçu, Mato

Grosso), PA Acari (Novo Aripuanã, Amazonas), PA Arapari (São Félix do Xingu, Pará), PA Santa Julia (Novo Progresso, Pará), PA Monte (Lábrea, Amazonas), PA Nova Cotriguaçu (Cotriguaçu, Mato Grosso), and PDS Laranjal (Jacareacanga, Pará).

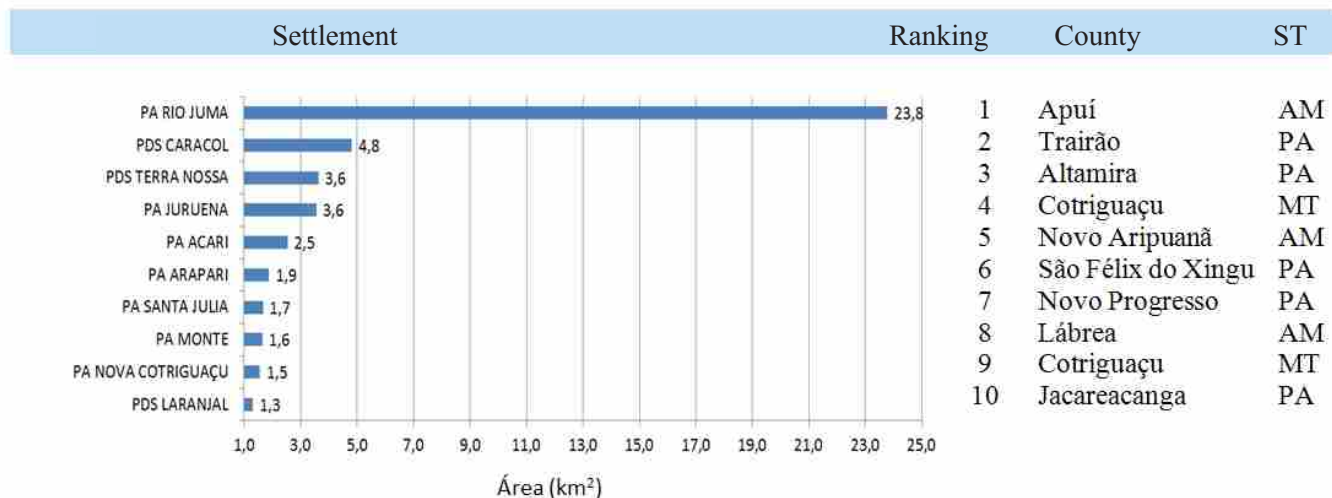


Figure 7: Land Reform Settlements deforested in August 2012 in Legal Amazon (Source: Imazon/SAD).

² Includes private areas (titled or not) and unprotected public forests.

Protected Areas

SAD has detected 50 square km of deforestation in Conservation Units (Figure 8). Deforested Conservation Units were: Flona do Jamanxim (Pará), APA Triunfo do Xingu (Pará), Florex Rio Preto – Jacundá (Rondônia), Flona de Itaituba II (Pará), Flona de Altamira (Pará), Flona de Saracá – Taquera (Pará), Esec de Cuniã

(Rondônia), Flota Atimary (Acre), and Flona Pau Rosa (Amazonas). As far as Indigenous Lands is concerned, in August a deforestation of 1.5 square km was detected in Terra Cachoeira Seca do Iriri (Pará) (Figure 9).

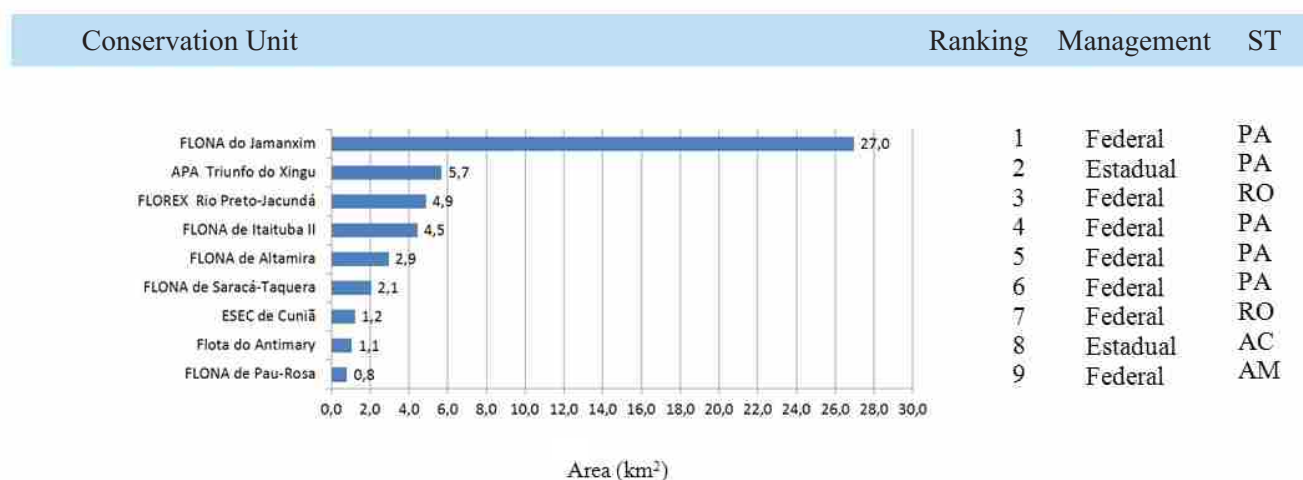


Figure 8: Conservation Unit deforested in Legal Amazon in August 2012 (Source: Imazon/SAD).

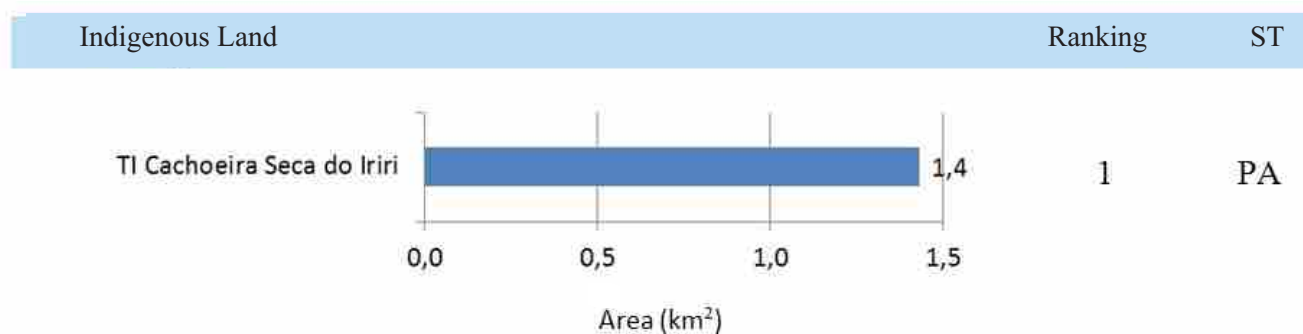


Figure 9: Deforested Indigenous lands in Legal Amazon in August 2012 (Source: Imazon/SAD).

Critical Municipalities

In August 2012 the counties deforested the most were: Novo Progresso (PA); Apuí (AM) and Porto Velho

(RO) (Figures 10 and 11).

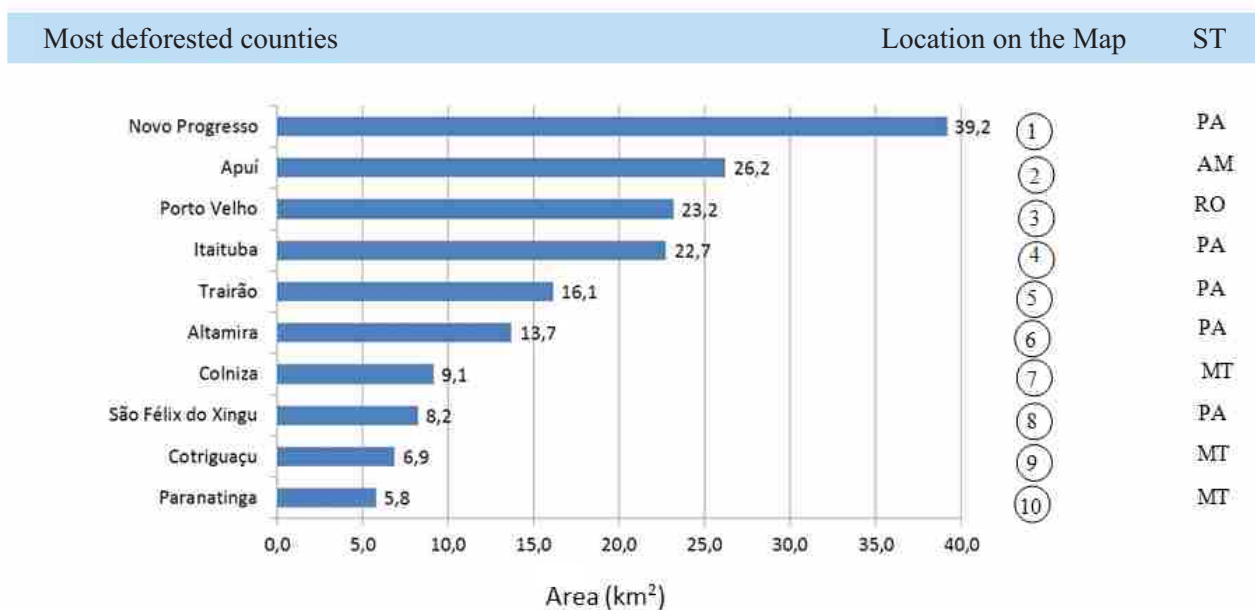


Figure 10: Counties deforested the most in Legal Amazon in August 2012 (Source: Imazon/SAD).

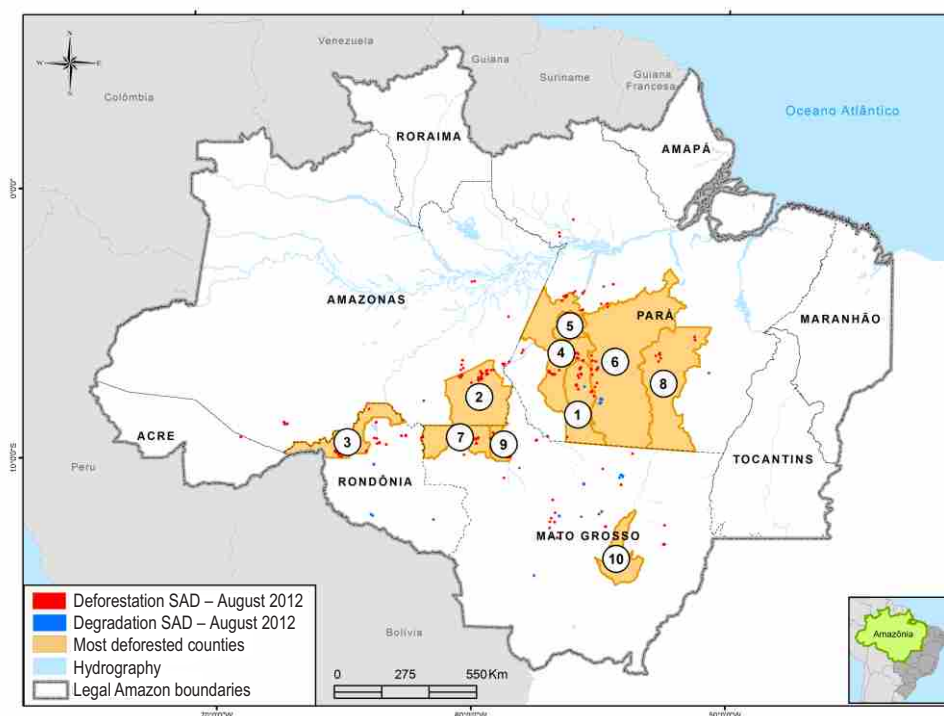


Figure 11: Counties with the largest deforested areas in August 2012 (Source: Imazon/SAD).

Coverage by clouds and Shade

In August 2012, it was possible to monitor, along with SAD, 84% of Legal Amazon forest area. The remaining 16% of forest territory were covered by clouds what hampered the detection of deforestation and forest degradation. The states with

larger cloud coverage were Roraima (77%), Amapá (68%), Pará (21%), and Amazonas (9%). In virtue of that, data related to deforestation and forest degradation in August 2012 may be underestimated (Figure 12).

* Data related to Maranhão that integrates Legal Amazon was not analyzed.

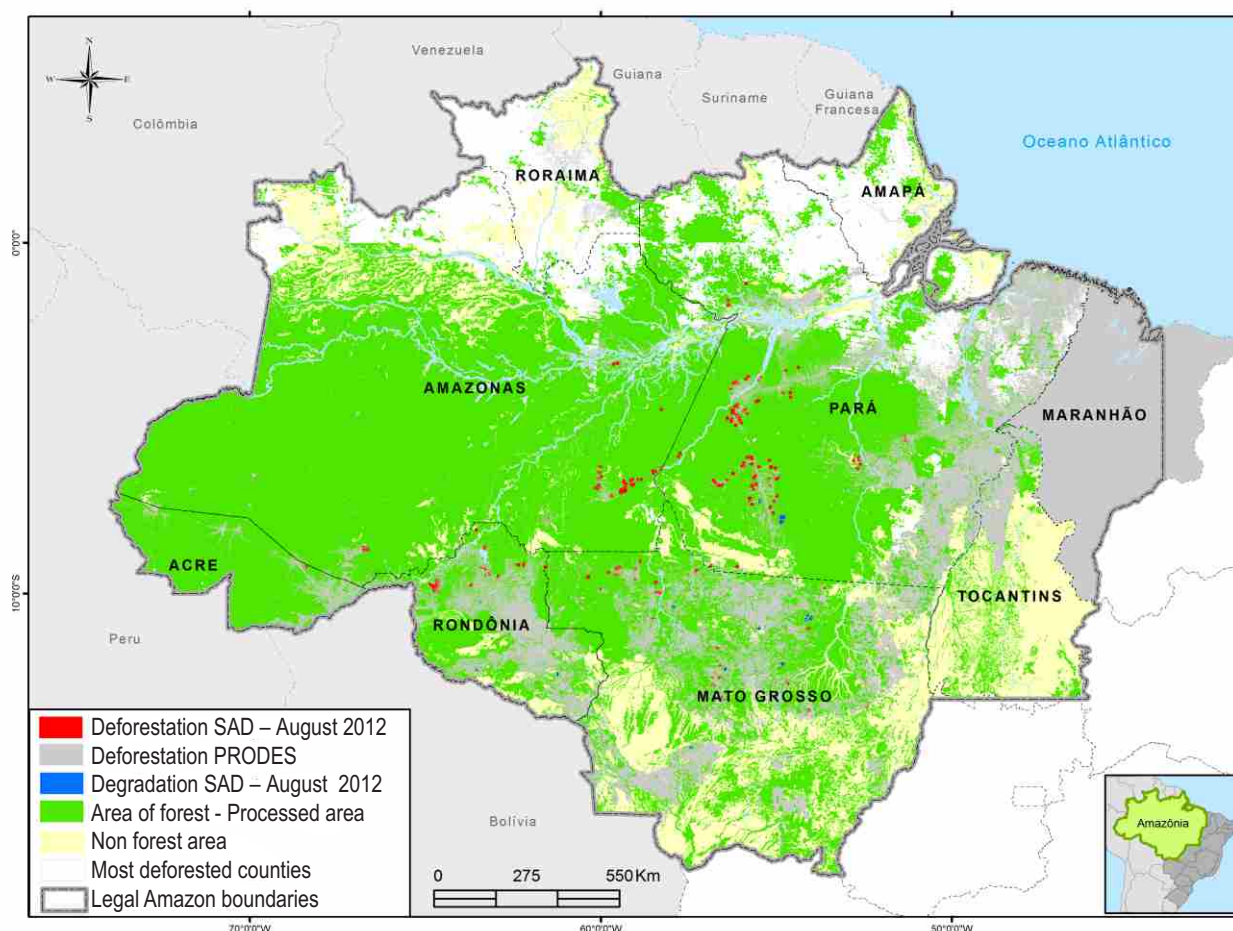


Figure 12: Area covered by clouds and shadows in August 2012 in Legal Amazon.

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_t(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%).

BAS₀: 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. Morton¹, M.H. Sales², C.M. Souza, Jr.², B. Griscom³. 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:

General Coordination: Antônio Fonseca, Heron Martins, Carlos Souza Jr, and Adalberto Veríssimo (Imazon)

Team: Marcio Sales (Modeling and Statistics), Rodney Salomão, Amintas Brandão Jr. (Geoprocessing), João Siqueira, Marcelo Justino and Júlia Ribeiro (Image Interpretation), Kátia Pereira and Victor Lins (ImazonGeo), Bruno Oliveira e Stefânia Costa (Communication)

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/>

Support:

David & Lucille Packard Foundation through CLUA
(Climate Land Use Alliance)
Gordon and Betty Moore Foundation
Fundo Vale

Partnerships:

Secretary of State for the Environment of Pará (EMS)
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
Instituto Centro de Vida (ICV- Mato Grosso)