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ABSTRACT

In February 2011, SAD detected 63 square kilometers of deforestation in the Legal Amazon. This represented a reduction of 28% in comparison to February 2010 when the deforestation totaled 87 square kilometers.

From August 2010 to February 2011 accumulated deforestation reached 925 square kilometers, similar to the previous period (August 2009 to February 2010), which was of 924 square kilometers.

In February 2011, most deforestation occurred in the states of Rondonia, 56 percent, and Para, 30 percent. The rest of deforestation occurred in the states of Mato Grosso, with 11 percent, and Roraima, 3 percent.

Degraded forests in Legal Amazon totaled 113 square kilometers in February 2011. Compared to February 2010, when degradation reached 99 square kilometers, it was an increase of 14 percent. Most forest degradation occurred in Rondonia (74 percent), far from Mato Grosso (15 percent), Para (7 percent), and Amazonas (4 percent).

Forest degradation accumulated from August 2010 to February 2011 totaled 3,836 square

kilometers. Compared to the August 2009 to February 2010, it was a dramatic increase of 304 percent, when forest degradation reached 950 square kilometers.

In February 2011, deforestation as detected by SAD compromised some 4.7 million ton of CO² equivalent, which represents a decrease of 18 percent when compared to February 2010. From August 2010 to February 2011, deforesting has compromised 56 million ton of CO² equivalent, a reduction of 6.5 percent when compared to the period from August 2009 to February 2010, when forest carbon affected by deforesting was some 60 million ton of nCO² equivalent.

SAD was able to monitor only 12 percent of the forest area in the Legal Amazon in February 2011. The remaining 88 percent was covered by clouds, which made difficult monitoring the region especially in the states of Acre, Amapa, Amazonas, Mato Grosso, and Para, which have more than 90 percent of their forest area obscured by clouds. For this reason, deforesting and degradation data in February may be underestimated.

Deforestation Statistics

According to Imazon's Deforestation Alert System (SAD), deforesting (i.e., total forest suppression causing soil exposure) totaled 63 square kilometers in the Legal Amazon in February 2011¹,

(Figures 1 and 2). This represented a reduction of 28 percent in deforestation when compared to February 2010, when deforestation reached 87 square kilometers.

Accumulated deforestation from August 2010 to February 2011, period corresponding to the first seven months of deforesting measurement official calendar, reached 925 square kilometers. This figure is similar to the deforesting accumulated in August 2009 to February 2010, which totaled 924 square kilometers.

In February 2011, Rondonia contributed with 56 percent of total deforested area in the Legal Amazon (Figure 3). The state was followed by Para with 30 percent, Mato Grosso with 11 percent, and Roraima with 3 percent.

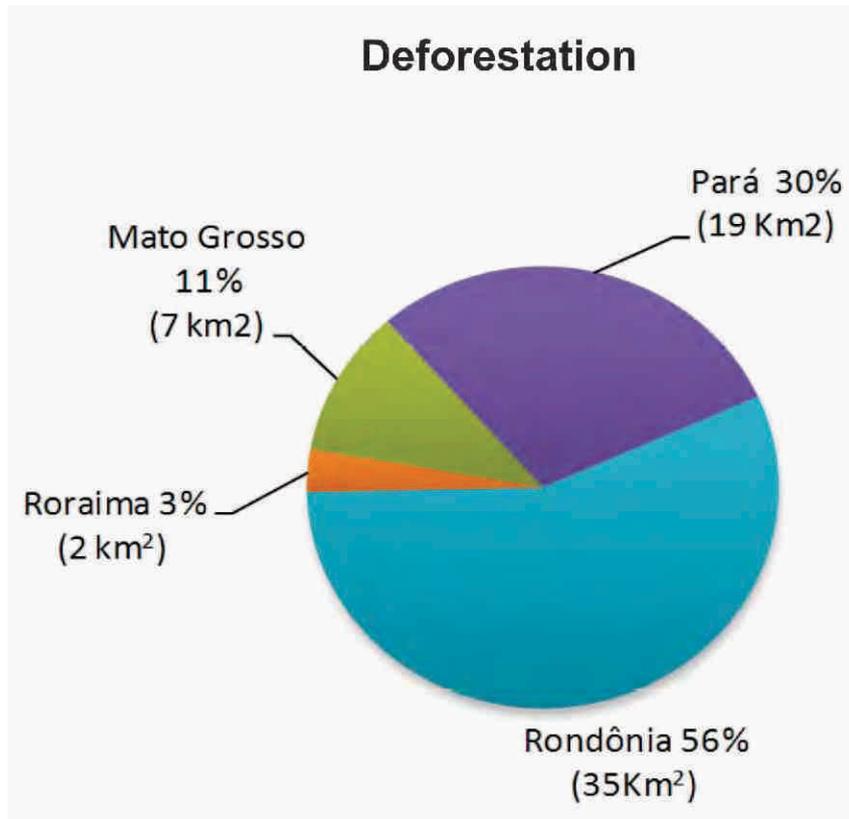


Figure 3. Deforesting (in percent) in the states within Legal Amazon in February 2010 (Source Imazon/SAD)

Considering the first seven months of the current deforestation calendar (from August 2010 to February 2011), Mato Grosso ranks first with 28 percent of all deforestation in this period. It is followed by Para with 27 percent, Rondonia with 24 percent, and Amazonas with 13 percent. These four states were accountable for 93 percent of the deforestation occurred in the Legal Amazon in this period. The remaining (7 percent) of the deforesting occurred in the states of Acre, Roraima, and Tocantins.

Deforesting figures from August 2010 to February 2011 is similar to deforesting from August

2009 to February 2010 (see Table 1). In relative terms, there was an increase in Tocantins (+ 2,642 percent), Rondonia (+ 122 percent), Acre (+ 66 percent), Mato Grosso (35 percent), and Amazonas (33 percent). In the other hand, there was a reduction of 86 percent in Roraima, and 43 percent in Para.

In absolute terms, Mato Grosso leads the ranking of accumulated deforestation with 263 square kilometers, followed closely by Para (253 square kilometers), Rondonia (225 square kilometers), and Amazonas (120 square kilometers).

¹ Deforesting measurement official calendar begins in August and ends in July.

Table 1. Deforestation evolution in the states within Legal Amazon from August 2009 to February 2010, and from August 2010 to February 2011 (Source: Imazon/SAD).

State	August 2009 to February 2010	August 2010 to February 2011	Variation (%)
Acre	33	54	+ 64
Amazonas	90	120	+ 33
Mato Grosso	195	263	+ 35
Pará	442	253	- 43
Rondônia	101	225	+ 123
Roraima	47	7	- 85
Tocantins	-	4	-
Amapá	15	-	-
Total	924	925	0

* Data from state of Maranhão was not analyzed.

Forest Degradation

SAD recorded 113 square kilometers of degraded forests (intensely explored forests in terms of wood extraction and/or forest fire) in February 2011 (Figures 2 and 4). Compared to February 2010, there was an increase of 14 percent, when forest degradation

reached 99 square kilometers. From the 113 kilometers of degraded forest, the majority occurred in Rondonia (74 percent), followed by Mato Grosso (15 percent), Para (7 percent), and Amazonas (4 percent).

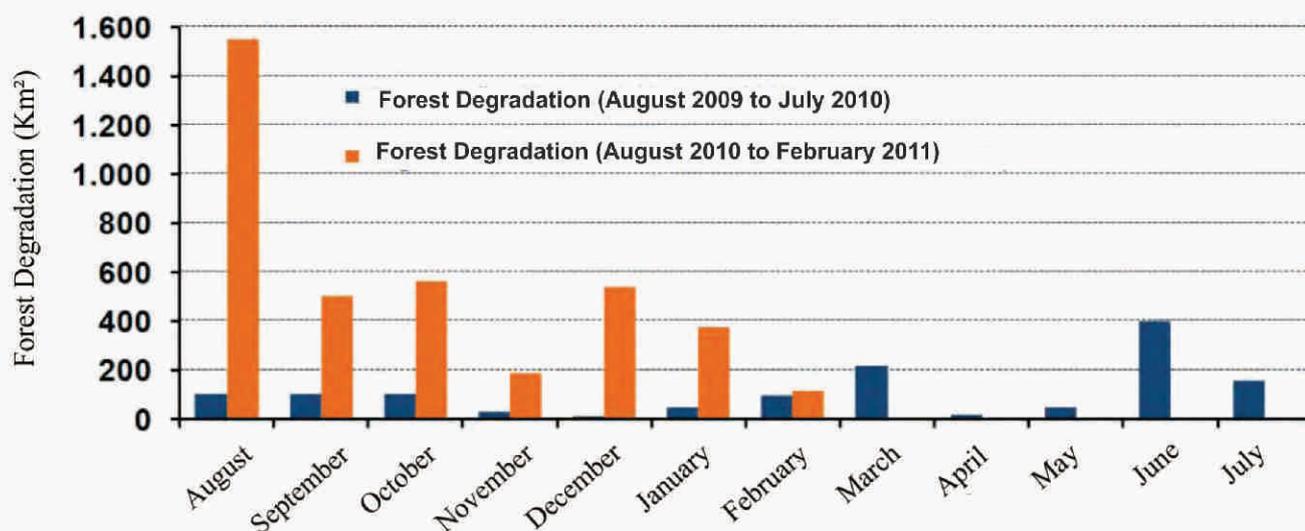


Figure 4. Forest Degradation in the Legal Amazon from August 2009 to February 2011 (source: Imazon/SAD)

Forest Degradation

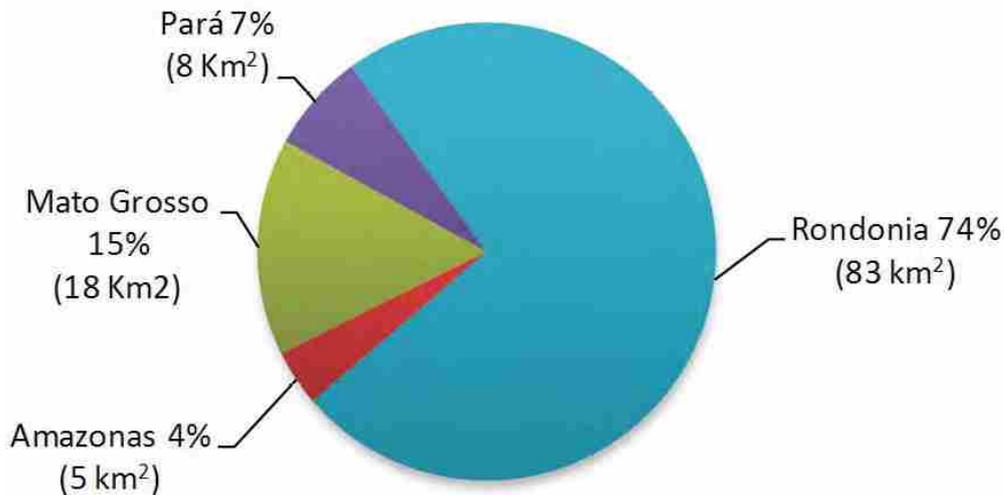


Figure 5. Forest Degradation (in percent) in the states within Legal Amazon in February 2011 (Source Imazon/SAD)

Forest degradation accumulated from August 2010 to February 2011² (first seven months of the deforesting measurement official calendar) reached 3,836 square kilometers. This figure shows an expressive increase of 304 percent in the forest degradation accumulated in this period when compared to August 2009 to February 2010, which totaled 950 square kilometers (Table 2).

In relative terms, Tocantins had a significant increase of 2,500 percent however in absolute figures the increase was very small, to 26 square kilometers from August 2010 to February 2011, from 1 square kilometer from August 2009 to February 2010. Other states have also contributed for the increase of forest

degradation: Amazonas (+ 576 percent), Acre (+ 504 percent), Rondonia (+ 370 percent), Mato Grosso (+ 364 percent), and Para (+150 percent). In the other hand, Roraima had a 75 percent reduction in forest degradation.

Mato Grosso leads the ranking with 57 percent of all degraded forest areas accumulated from August 2010 to February 2011. Next comes Para, with 20 percent, and Rondonia, with 15 percent. The three states are accountable for 92 percent of forest degradation in the Legal Amazon during that period. The remaining 8 percent occurred in Amazonas, Acre, Tocantins, and Roraima.

² Deforesting measurement official calendar begins in August and ends in July.

Tabela 2. Evolução da degradação florestal entre os Estados da Amazônia Legal de agosto de 2009 a novembro de 2009 e de agosto de 2010 a novembro de 2010 (Fonte: Imazon/SAD).

State	August 2009 to February 2010	August 2010 to February 2011	Variation (%)
Acre	24	145	+ 504
Amazonas	21	142	+ 576
Mato Grosso	474	2198	+ 364
Pará	300	749	+ 150
Rondônia	122	491	+ 302
Roraima	8	85	+ 963
Tocantins	1	26	+ 2.500
Amapá	1	-	-
Total	950	3.836	+ 304

* Data from state of Maranhao was not analyzed.

Carbon Affected by Deforestation

In February 2011, the 63 square kilometers of SAD-detected deforestation compromised 1.3 million ton of carbon (with a margin of error of 194,000 ton). This amount of affected carbon results in 4.7 million ton of CO² equivalent (Figure 6). This figure represents a decrease of 18 percent when compared to February 2010, when affected carbon totaled 1.6 million ton. Such deforestation-affected carbon reduction was proportional to the 28 percent of SAD-detected deforestation for this month.

Forest carbon compromised by deforestation in the period comprising August 2010 and February 2011 (first seven months of the deforesting measurement official calendar) was of 15.3 million ton (with margin of error of 364,000 ton), which represented some 56 million ton of CO² equivalent (Figure 6). In comparison to the same period of the previous year (August 2009 to February 2010), there was a reduction of 6.5 percent in the amount of carbon compromised by deforesting.

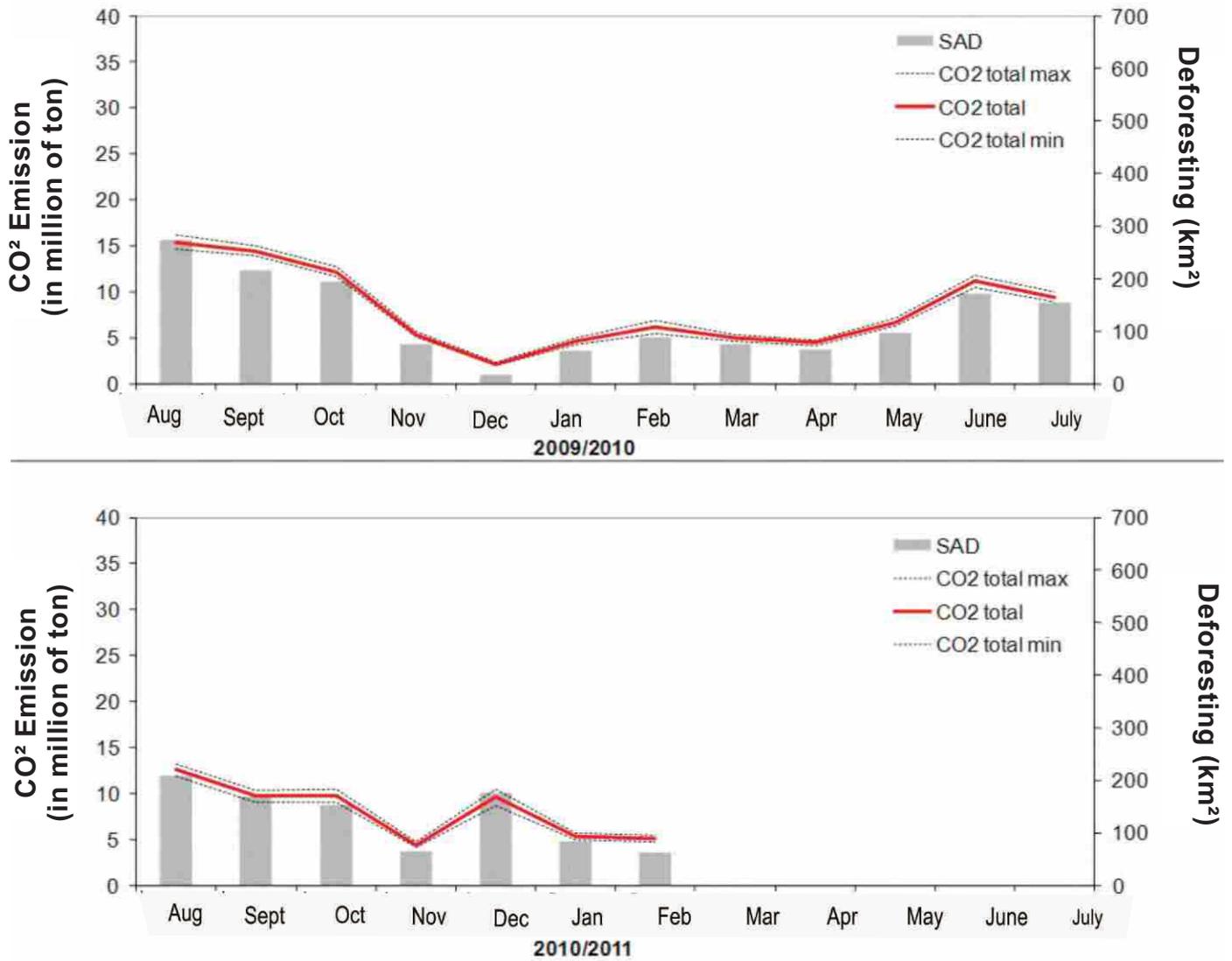


Figure 6. Total deforesting and CO² equivalent emission from August 2009 to February 2011 in the Legal Amazon (Source: Imazon).

Geography of Deforestation

In relation to the land issue, the majority of deforesting registered in February 2011 occurred in private areas or in areas with different ownership status. The remaining deforestation was registered in

Preservation Units (24 percent), followed by Land Reform Settlements (14 percent), and Indigenous Land (2 percent, see Table 3).

Table 3. Deforesting by ownership category in December 2010 in Legal Amazon (Source: Imazon/SAD).

Category	February 2011	
	km ²	%
Land Reform Settlement	9	14
Preservation Units	15	24
Indigenous Land	1	2
Private, Owned, and Vacant ³	39	60
Total (km²)	63	100

Land Reform Settlements

SAD registered 9 square kilometers in Land Reform Settlements during February 2011. Settlements most affected by deforesting were Santa Maria - II (Machadinho D'Oeste; Amazonas), Mãe e Menininha

(Altamira; Pará), and Manah (Santana do Araguaia; Pará; see Figure 7).

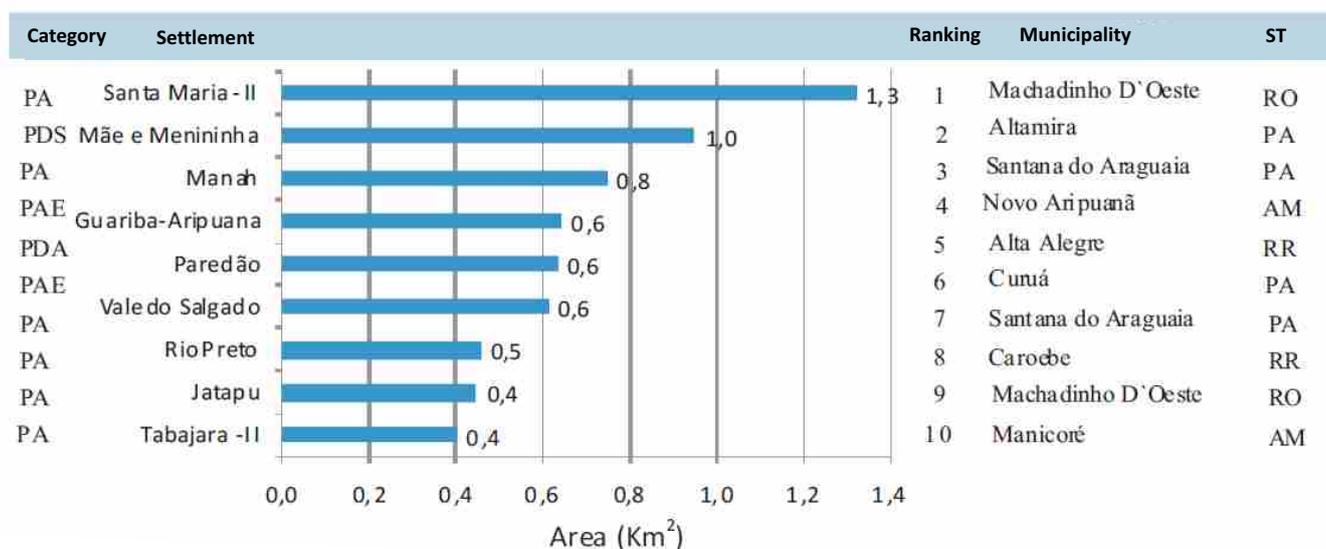


Figure 7. Land Reform Settlements most affected by deforesting in February 2011 in the Legal Amazon (Source: Imazon/SAD).

³ Includes private areas (owned or not) and unprotected public forests.

Protected Areas

SAD detected 15 square kilometers of deforesting in Preservation Units (Figure 8). Preservation units affected by deforestation were in Rondonia: Florex Rio Preto-Jacunda, APA Rio Pardo,

and Resex Jaci-Parana. In case of Indigenous Land, deforestation was detected only in Uru-eu-Wau-Wau, in Rondonia, in the same month (Figure 9).

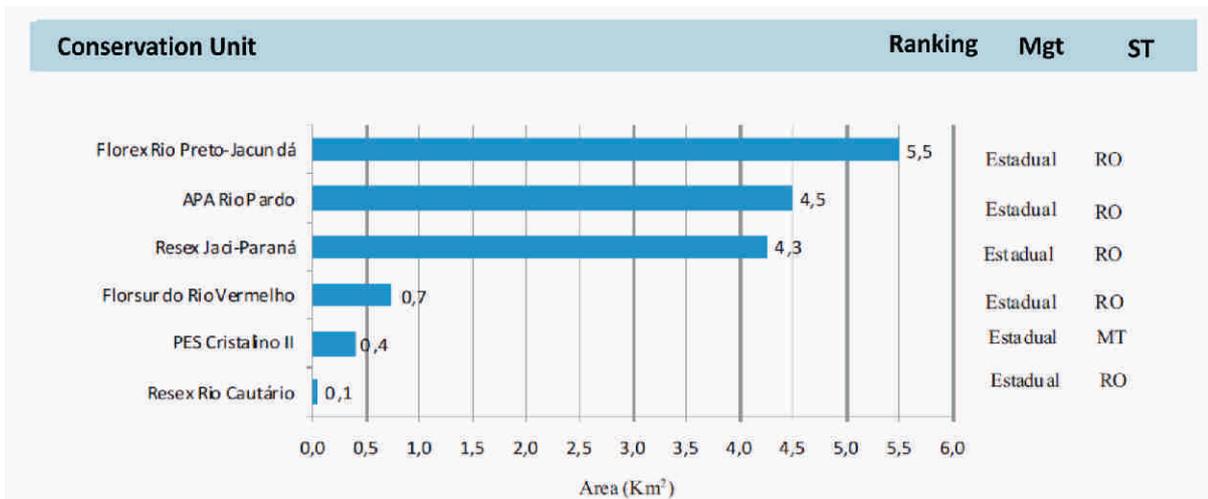


Figura 8. Unidades de Conservação mais desmatadas na Amazônia Legal em novembro de 2010 (Fonte: Imazon /SAD).

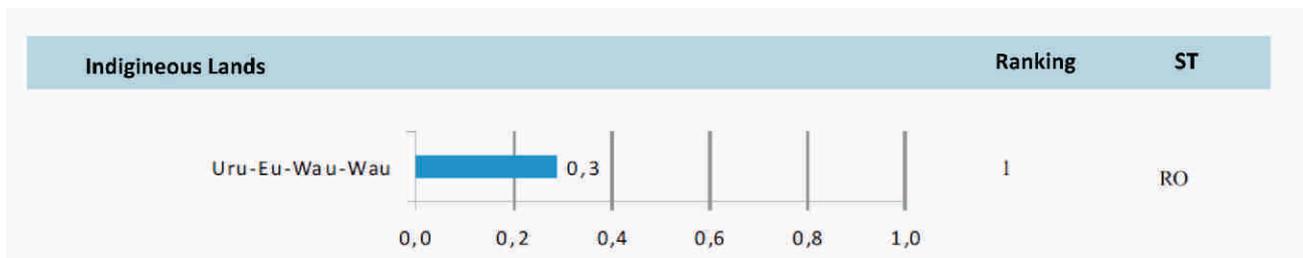


Figure 9. Deforested Indigenous Land in Legal Amazon in February 2011 (Source: Imazon/SAD).

Critical Municipalities

In February 2010, cities most affected by deforestation were Porto Velho, in Rondonia, Rondon

do Para (Para), and Candeias do Jamari, in Rondonia (see Figures 10 and 11).

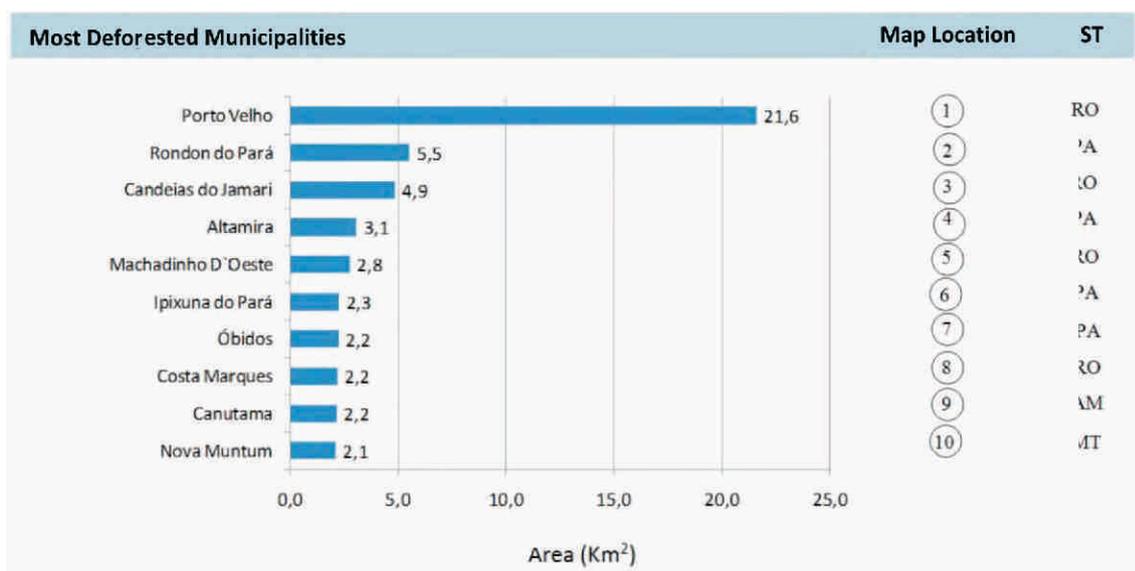


Figure 10. Cities mostly affected by deforestation in Legal Amazon in February 2011 (Source: Imazon/SAD).

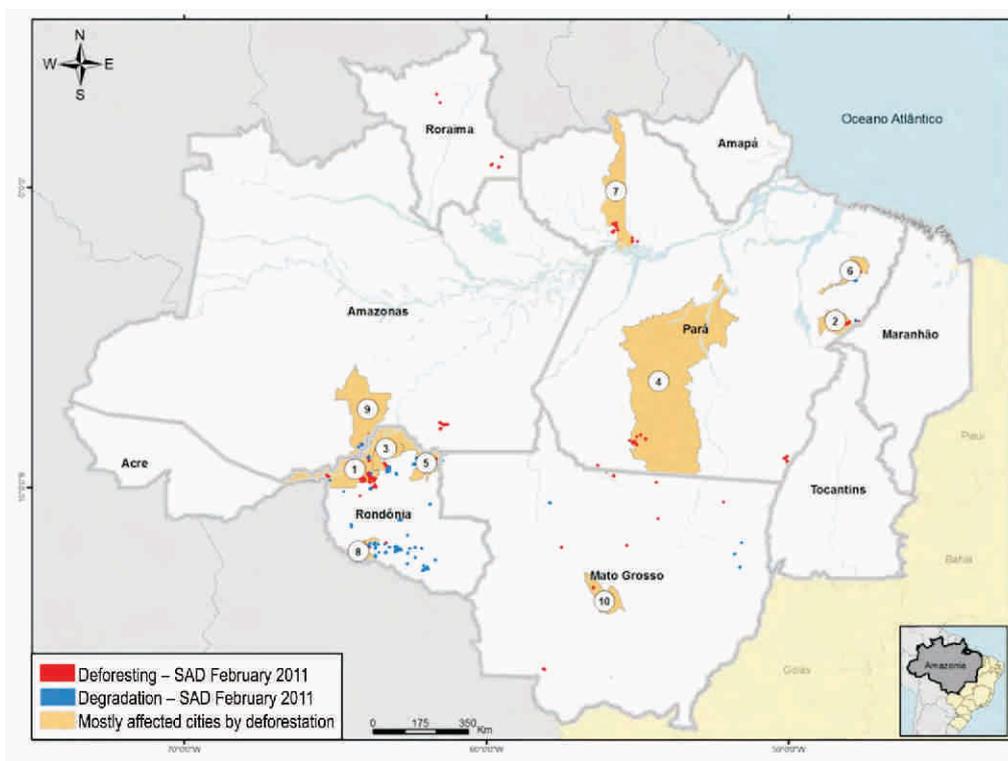


Figure 11. Cities mostly affected by deforestation in in February 2011 (Source: Imazon/SAD).

Clouds and Shadows

Only 12 percent of Legal Amazon forest area was monitored in February 2011. The remaining 88 percent was covered by clouds, which caused monitoring to be difficult especially in Para, Mato Grosso, Amapa, Amazonas, and Acre (Figure 12). These states had more than 90 percent of their forest

area obscured by clouds. For this reason, deforestation data for these states may be underestimated in February 2011. The rainy season goes from December to March in the Amazon Basin, making satellite monitoring difficult.

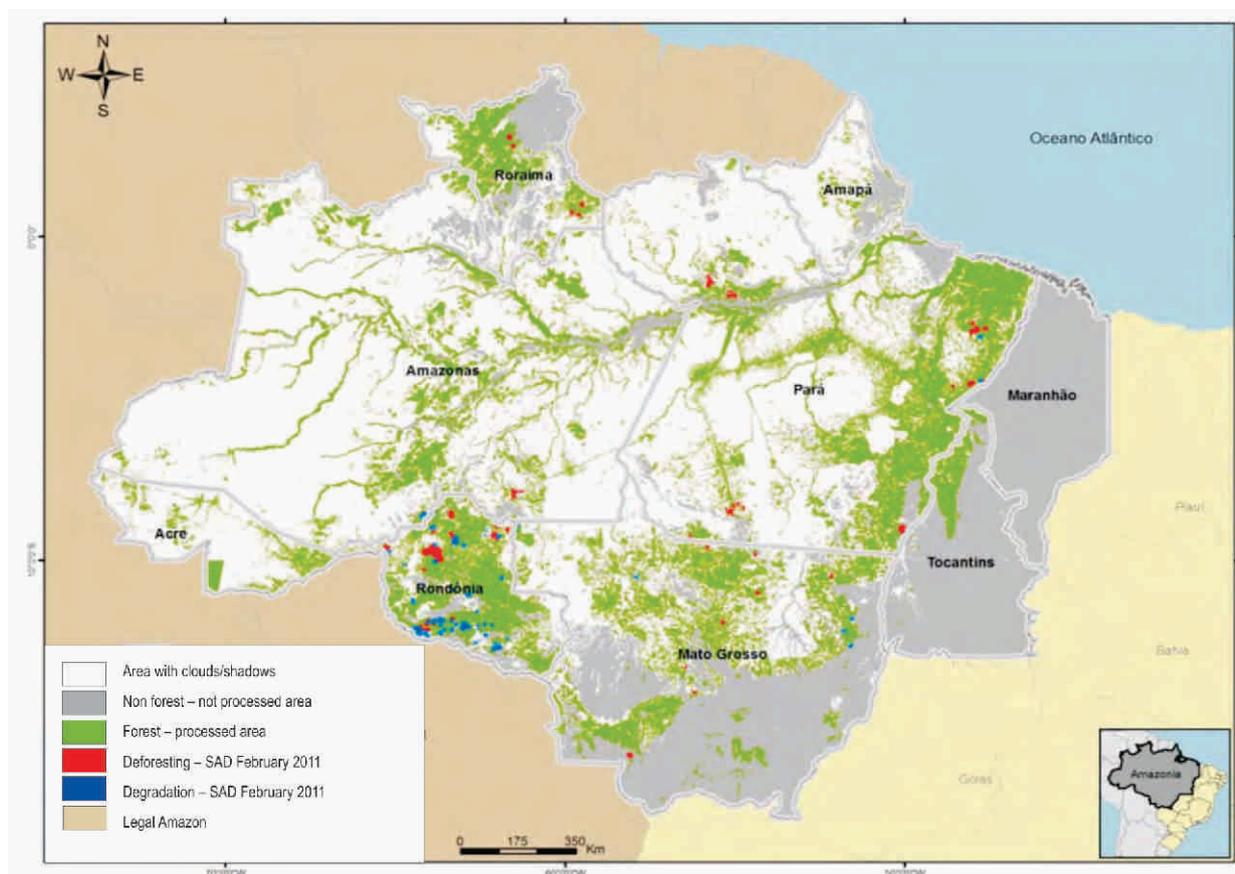


Figure 12. Clouded or shadowed areas in Legal Amazon in February 2011.

Section I: SAD 3.0

Since August 2009, SAD presented some innovations. First, a graphic interface was created to integrate all the image processing programs used in the SAD. Secondly, we began computing the deforestation in areas that were covered by clouds in the previous months under a new class. Lastly, the deforestation and degradation were detected with pairs of NDFI images in a change detection algorithm. The main methodology continues to be the same as SAD 2 as shown below.

SAD generates temporary MODIS images on a daily basis from the MOD09GQ and MOD09GA products for cloud filtration. Then, a fusion technique for different spectral resolution bands, that is, with pixels of different sizes, is used. In this case, the 5 bands scale with a pixel of 500 meters of the MODIS was changed to 250 meters. This allowed the improvement of the spectral pixel mixture model, providing the ability to estimate the abundance of Vegetation, Soils and Non-Photosynthetic components (NPV) (Vegetation, Soil and Shade) to calculate the NDFI with the equation below.

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

Where VGs is the Vegetation component normalized for shade given by:

$$\text{VGs} = \text{Vegetation} / (1 - \text{Shade})$$

NDFI varies from -1 (pixel with 100% of exposed soil) to 1 (pixel with > 90% with forest vegetation). Therefore, we have a continuous image showing the transition of deforested areas, passing through degraded forest until it reaches forests without signs of disturbance.

This month the detection of the deforestation and degradation had different NDFI images of consecutive months. Therefore, a reduction in the NDFI values between -200 and -50 indicated possibly deforested areas and between -49 and -20 with signs of degradation.

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

SAD is already operating in the state of Mato Grosso since August 2006 and in Legal Amazon since April 2008. This bulletin presents the monthly data generated by SAD from August 2006 to July 2010.

Section II: Carbon affected by the deforestation

Since January 2010, the affected carbon (that is, the forest carbon subject to emissions due to burning and decomposition of forest biomass waste) estimates from the deforestation detected by SAD in Legal Amazon have been reported.

The carbon estimates are generated based on the combination of SAD deforestation maps with simulations of the spatial biomass distribution for the Amazon. A carbon emission estimation model called Carbon Emission Simulator (CES) was developed based on the stochastic simulation (Morton et al, in prep.). One thousand (1000) spatial biomass distribution simulations in the Amazon were generated using a geostatic model (Sales et al., 2007), and these biomass simulations were transformed into C-stocks using biomass conversion factors for C from literature, according to the formula below:

$$C_t = \sum C(S)_t$$
$$C_t(S) = S_d \times [(BVAS - BPF) \times (1 - fc) \times (t = 0) + (BAS_0 \times pd \times e^{-pd \times t})]$$
$$BPF = ff * AGLB$$
$$BAS_0 = bf * AGLB$$

where:

t: time (month)

C_t : Carbon emitted in month t.

$C_t(S)$: Carbon emitted from a deforested polygon at time t.

S_d : Deforested area:

BVAS: Biomass aboveground at the deforested region SD.

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

fc: coal fraction (3 to 6%).

BAS_0 : Underground biomass before deforestation.

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

$pd \times e^{-pd \times t}$: Monthly decomposition rate of underground biomass after deforestation.

To apply the CES model using the SAD data, only the carbon affected by the deforestation was considered, which is the fraction of forest biomass made up of carbon (50%) subject to instant emissions caused by forest fires from the deforestation and/or future decomposition of the remaining forest biomass. Also, the CES model was modified to estimate the forest carbon affected by the deforestation on a monthly scale. Lastly, the simulations enabled the estimation of the affected carbon uncertainty, represented by the standard deviation (+/-2 fold) the simulations of the carbon affected each month.

Apply the value 3.68 to convert the carbon values for CO equivalent.

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.

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Data Source:

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

INPE Data - Deforestation (PRODES)

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

Support

CLUA

Fundo Vale

Partnerships

Environmental State Secretariat of Pará (SEMA)

Environmental Secretariat of Mato Grosso (SEMA)

Federal Public Ministry of Pará

State Public Ministry of Pará

State Public Ministry of Roraima

State Public Ministry of Amapá

State Public Ministry of Mato Grosso

Instituto Centro de Vida (ICV- Mato Grosso)