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SUMMARY

In November 2011, most part (71 %) of the forest area of Legal Amazon were covered by clouds. This compromised the detection of the deforestation and forest degradation for this month through the images of the MODIS used by SAD. Only 16 km² of deforestation were detected in November 2011 in Legal Amazon under these conditions.

From the 16 km² of deforestation detected in November 2011, 9 square kilometers (59%) occurred in Amazonas, 4 square kilometers (24%) in Pará, 2 square kilometers (12%) in Mato Grosso, and less than 1 square kilometers in Rondônia and Acre.

The deforestation accumulated in the period of August 2011 to November 2011, corresponding to the first four months of the current Deforestation Calendar, has reached 527 square kilometers. There was a 12% reduction regarding the same previous period (August 2010 to November 2010) when the deforestation totaled 597 square kilometers.

The degraded forests in Legal Amazon totaled 40 square kilometers in November 2011. Most part (63%) occurred in Mato Grosso followed by Pará (16%), Rondônia (16%) and Amazonas (5%).

The forest degradation accumulated in the period of August 2011 to November 2011 totaled 1.285 square kilometers. Regarding the previous period (August 2010 to November 2010) there was a reduction of 54%, when the forest degradation totaled 2.787 square kilometers.

In November 2011, the deforestation detected by SAD compromised 2.5 million tons of equivalent CO₂. In the accumulated period (August 2011 - November 2011) the emission of equivalent CO₂ related to the deforestation totaled 34 million tons which represents a reduction of 4% regarding the previous period (August 2010 to November 2010).

Deforestation Statistics

The deforestation detection (total suppression of the forest with soil exposition) performed by the Deforestation Alert System (SAD) from Imazon was compromised by the coverage of clouds in November 2011. Approximately 71% of the forest area of Legal Amazon were covered by clouds in the MODIS images

used by SAD. This way, only 16 km² of deforestation were detected in November 2011 in Legal Amazon under these conditions (Figure 1 and Figure 2).

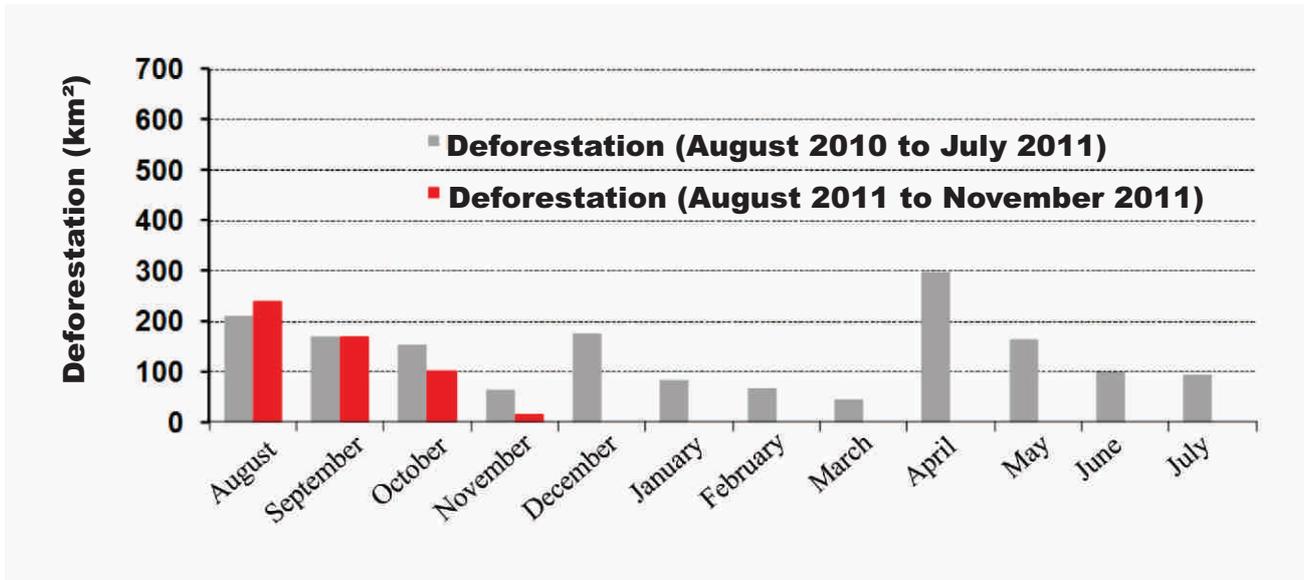


Figure 1. Deforesting from August 2010 to November 2011 in Legal Amazon (Source: Imazon/SAD).

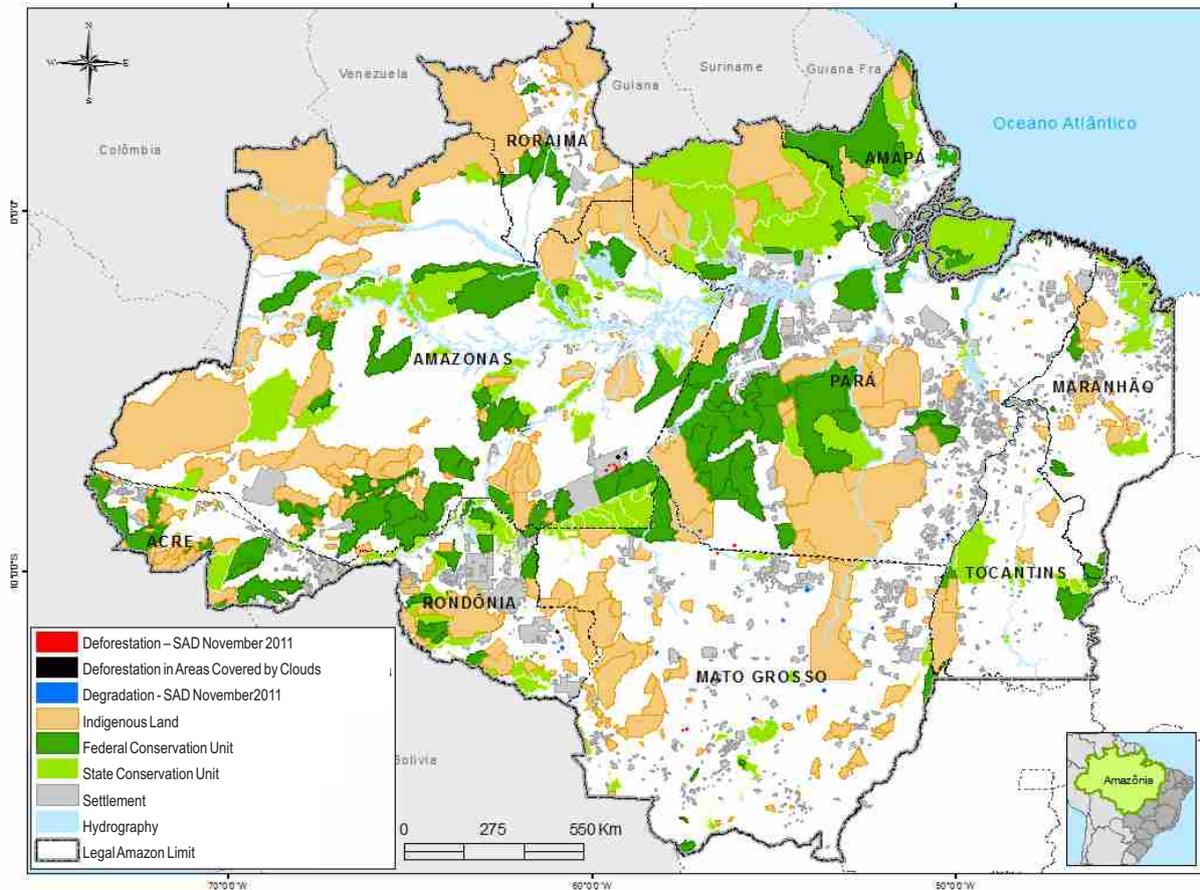


Figure 2. Deforesting and Forest Degradation in November 2011 at Legal Amazon (Source: Imazon/ SAD).

*The recent deforestation might have occurred in June or previous months, however, it was only possible to detect it now, when there were no clouds over the region.

The deforestation accumulated in the period of August 2011 to November 2011, corresponding to the four first months of the official calendar of Deforestation measuring, has reached 527 square kilometers. There was a 12% reduction in the deforestation regarding the previous period (August 2010 to November 2010) when it reached 597 square

kilometers.

In November 2011, Amazonas led with 59% of deforestation, followed by Pará (24%) Mato Grosso (12%), Acre (3%) and Rondônia (2%) (Figure 3).

Deforestation

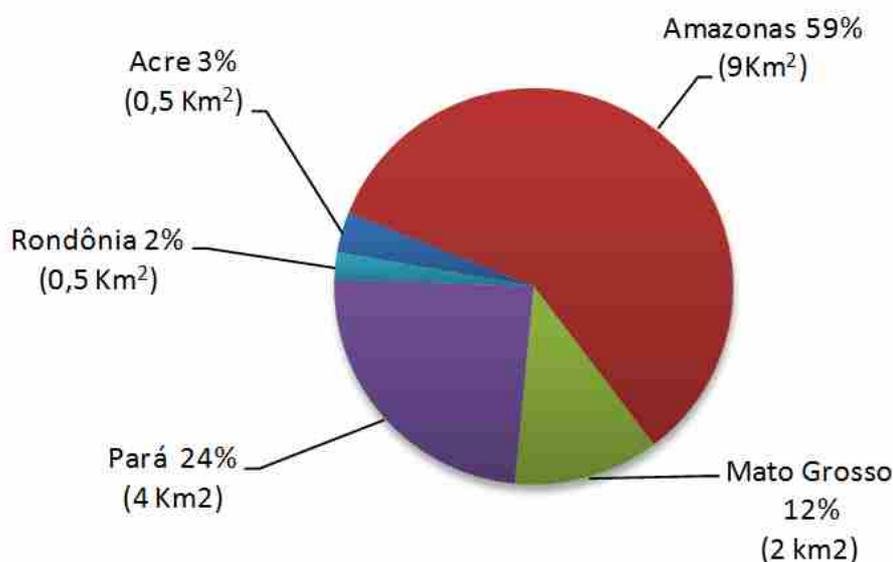


Figure 3. Deforestation (%) in the states of Legal Amazon in November 2011 (Source: Imazon/SAD).

Considering the first four months of the current deforestation calendar (August 2011 to November 2011), The state of Pará leads the ranking with 43% of the total deforested in the period. Following is Rondônia with 22%, followed by Mato Grosso with (19%) and Amazonas with (9%). These four states were responsible for 93% of the deforestation occurred in Legal Amazon in this period. The rest (7%) of deforestation occurred in Acre and Roraima and Tocantins and Amapá.

There was a 12% reduction of the deforestation occurred in August 2011 to November 2011 when compared to the previous period (August 2010 to

November 2010) (Table 1). In relative terms, there was a 60% reduction in Acre, 45%, in Amazonas, and 35% in Mato Grosso. On the other hand, there was a 267% increase in Tocantins, 175% in Roraima, 16% in Rondônia and 9% in Pará.

In absolute terms, Pará leads the accumulated deforestation ranking with 225 square kilometers, followed by Rondônia (114 square kilometers), Mato Grosso (100 square kilometers), Amazonas (49 square kilometers), Acre (17 square kilometers), Roraima (11 square kilometers) and Tocantins (11 square kilometers).

¹ The official deforestation measuring calendar begins in August and ends in July.

Table 1. Evolution of the deforestation between the States of Legal Amazon from August 2010 to November 2010 and from August 2011 to November 2011 (Source: Imazon/SAD).

State	August 2011 to November 2011	August 2011 to November 2011	Variation (%)
Acre	42	17	-60
Amazonas	89	49	-45
Mato Grosso	154	100	-35
Pará	207	225	+9
Rondônia	98	114	+16
Roraima	4	11	+175
Tocantins	3	11	+267
Amapá	-	-	-
Total	597	527	-12

* Data from Maranhão were not analyzed

Forest Degradation

In November 2011, SAD registered only 40 square kilometers of degraded forests (forest intensely explored by lumbering activities and or/ burning) (Figures 2 and 4). The monitoring of forest degradation was compromised due to the great coverage of clouds in the MODIS in November 2011 (71% of the forest

area of Legal Amazon).

From the 40 square kilometers of degraded forests detected by SAD in November, (63%) occurred in Mato Grosso followed by Pará 16%, Rondônia 16% and Amazonas 5% (Figure 5).

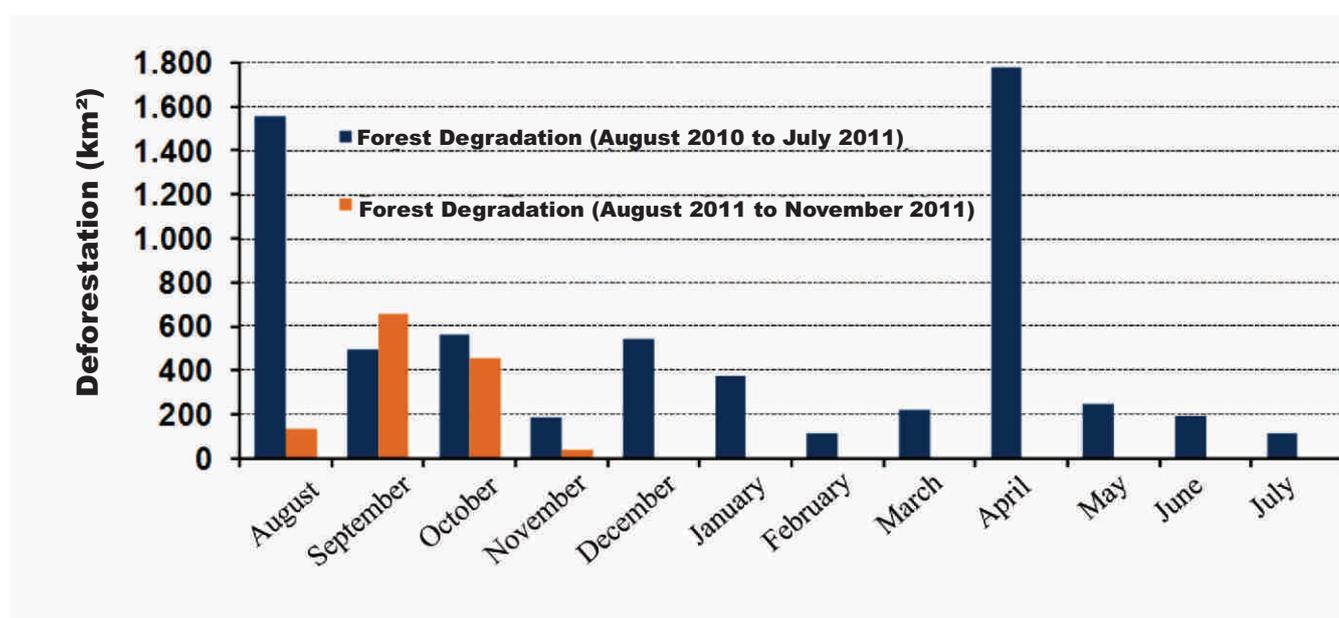


Figure 4. Forest Degradation from August 2010 to November 2011 at Legal Amazon (Source: Imazon/SAD).

Forest Degradation

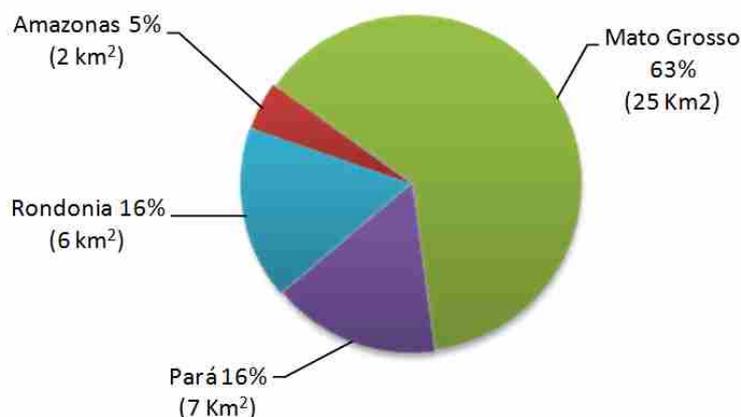


Figure 5. Forest Degradation (%) in the States of Legal Amazon in November 2011 (Source: Imazon/SAD).

The forest degradation accumulated in the period of August 2011 to November 2011 totaled 1.285 square kilometers. This represents a reduction of 54% in the forest degradation accumulated in this period (August 2011 to November 2011) regarding the same previous period (August 2010 to November 2010) when the forest degradation totaled 2.787 square kilometers (Table 2).

Acre presented a 98% reduction in the forest degradation between August 2011 and November 2011 compared to August 2010 to November 2010. The reduction was more expressive in Amazonas (-79%), Rondônia (-76%) and Pará (-73%).

Mato Grosso leads the ranking of forest

degradation with 77% of the total in the period of August 2011 to November 2011. Following comes Pará with 15%. These three states were responsible for 92% of the forest degradation in Legal Amazon during this period. The rest (8%) occurred in Rondônia and Amazonas.

In absolute terms, Mato Grosso also leads the accumulated deforestation ranking with 994 square kilometers, followed by far by Pará (194 square kilometers), Rondônia (71 square kilometers), Amazonas (17 square kilometers), Roraima (6 square kilometers), and Acre (3 square kilometers).

Table 2. Evolution of the forest degradation among the States of Legal Amazon from August 2010 to November 2010 and from August 2011 to November 2011 (Source: Imazon/SAD).

State	August 2010 to November 2010	August 2011 to November 2011	Variation (%)
Acre	122	3	-98
Amazonas	82	17	-79
Mato Grosso	1.529	994	-35
Pará	729	194	-73
Rondônia	299	71	-76
Roraima	2	6	+200
Tocantins	24	-	-
Amapá	-	-	-
Total	2.787	1.285	-54

* Data from Maranhão were not analyzed

² The official deforestation measuring calendar begins in August and ends in July.

Carbon Affected by the Deforestation

In November 2011, the 16 square kilometers of deforestation detected by SAD in the Legal Amazon compromised 684 thousand tons (with error radius of 94 thousand tons of carbon). This amount of affected carbon results in 2.5 million tons of equivalent CO² (Figure 6).

The forest carbon compromised by the deforestation in the period of August 2010 to November 2011 was 9.4 million tons (with error radius of 195 thousand tons), which represented approximately 34 million tons of equivalent CO² (Figure 6). Regarding the same period of the previous

year (August 2009 to November 2010) there was a 4% increase in the amount of carbon compromised by the deforestation. The relative increase (4%) of the forest carbon affected by the deforestation in the period of August 2011 to November 2011 regarding the previous period (August 2010 to November 2011) was less than the reduction of 12% of the deforestation detected by SAD during the same period. This suggests that the deforestation this year is occurring in areas with less stocks of forest carbon.

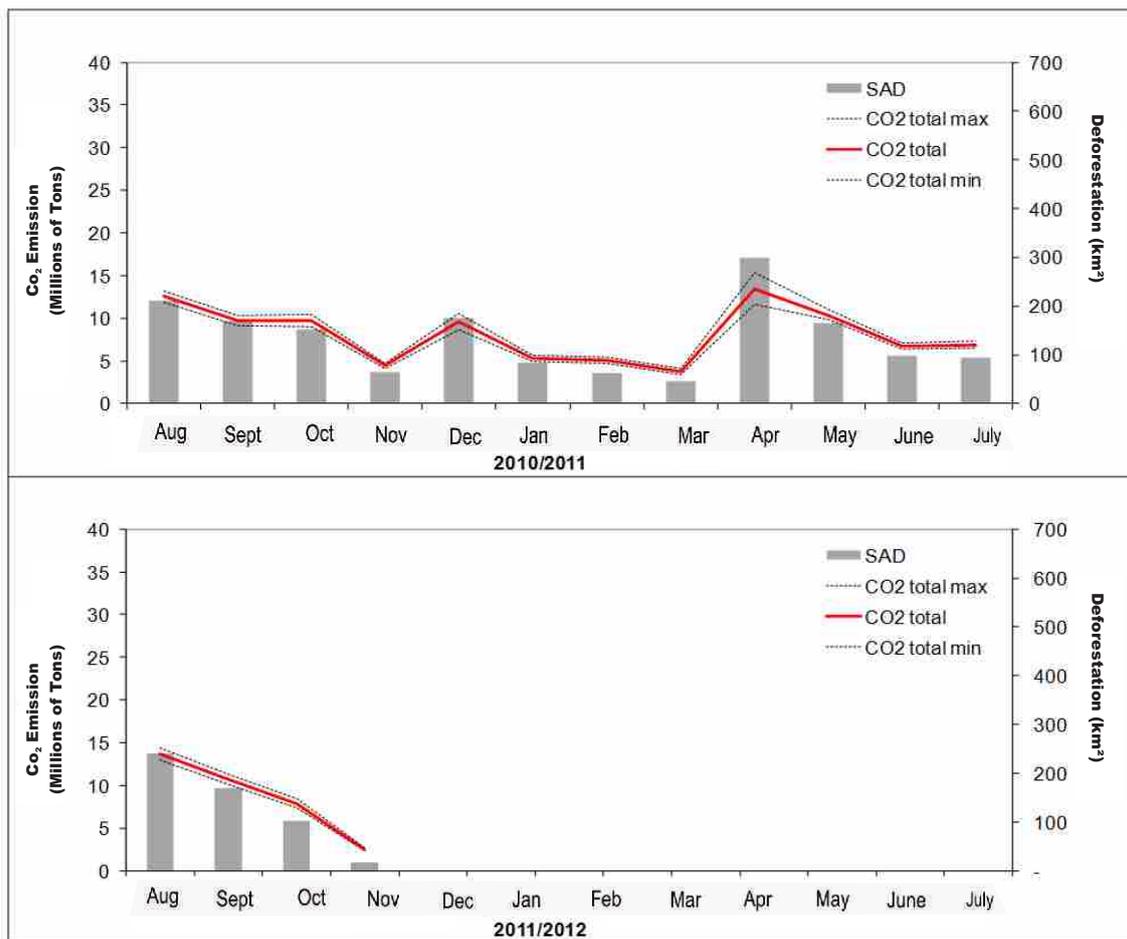


Figure 6. Deforestation and emission of Carbon Dioxide (CO²) total equivalent from August 2010 to November 2011 in Legal Amazon (Source: Imazon).

Deforestation Geography

In relation to the Land situation, in November 2011, most part (69%) of the deforestation occurred in land reform settlements. The rest of deforestation was

registered in private areas or under several stages of ownership (29%) and Conservation units (2%) (Table 3).

Table 3. Deforestation by land category in November 2011 in Legal Amazon (Source: Imazon/SAD).

Category	November 2011	
	km ²	%
Agrarian Reform Settlement	10,7	69
Conservation Units	0,5	2
Indigenous Lands	-	-
Private, Owned and in Abeyance ³	4,5	29
Total (km ²)	16	100

Agrarian Reform Settlements

SAD registered 11 square kilometers of deforestation in the Land Reform Settlements during November 2011. The most affected settlements were

Rio Juma (Apuí; Amazonas), Juruti Velho (Juruti; Pará), and Pedro Peixoto (Plácido de Castro; Acre). (Figure 7).

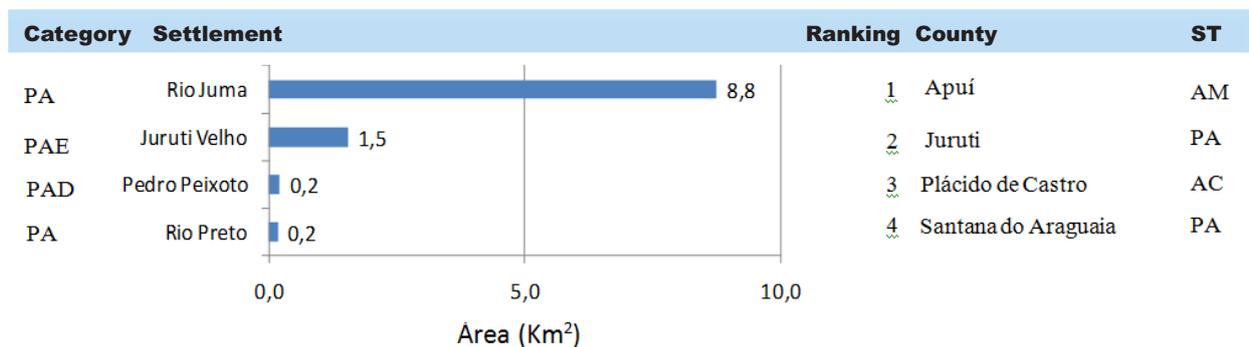


Figure 7. Most deforested Agrarian Reform Settlements in November 2011 at Legal Amazon (Source: Imazon/SAD). PA (Settlement Project), PAE (State Settlement Project), PAD (Directed Settlement Project).

³ Includes private areas (owned or not) and non protected public forests

Protected Areas

Because of the cloud coverage in November 2011, SAD detected less than 1 square kilometer in the Flona de Itaituba II (Pará) (Figure 8). There was no

deforestation detection in the Indigenous lands in November 2011.

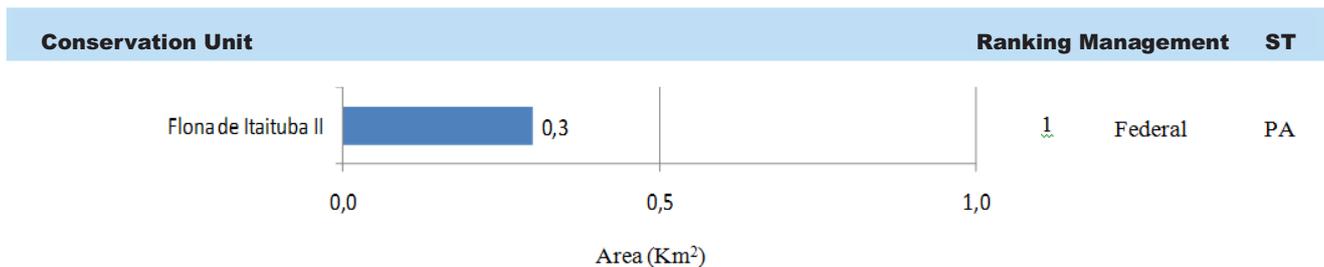


Figure 8. Most deforested Conservation Units at Legal Amazon in November 2011 (Source: Imazon /SAD).

Critical Municipalities

In November 2011, the most affected municipalities were Apuí (Amazonas), Juruti (Pará),

Santo Afonso (Mato Grosso) (Figures 9 and 10).

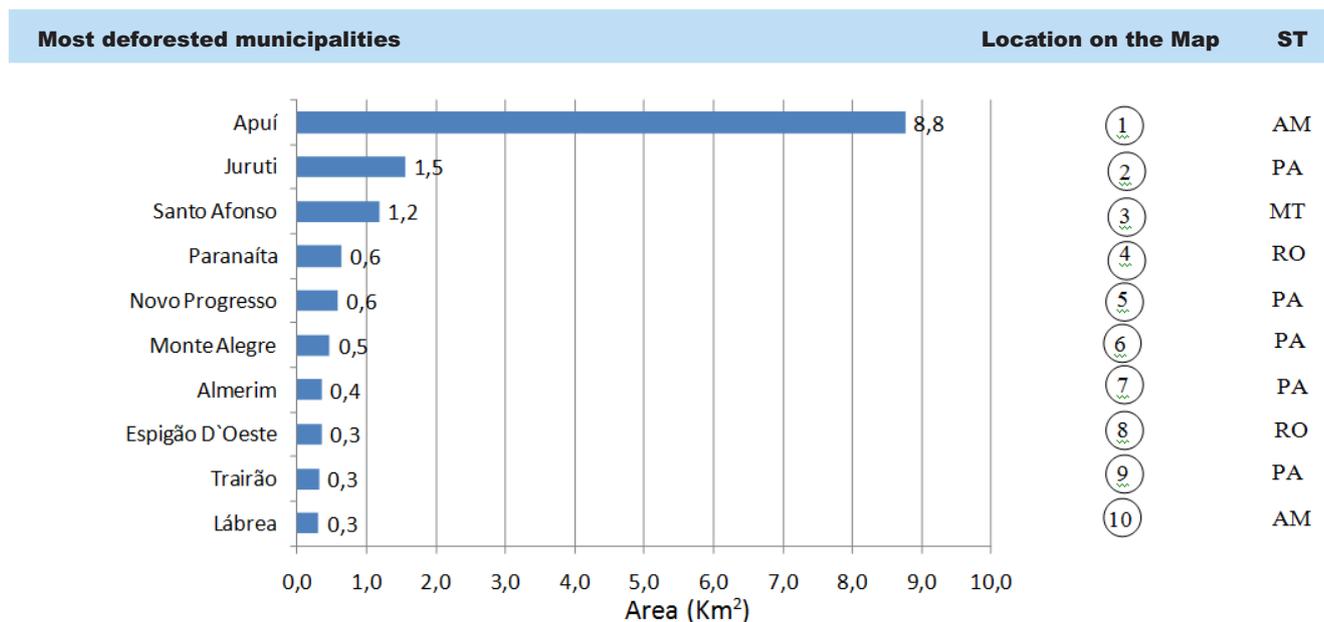


Figure 9. Most deforested counties at Legal Amazon in November 2011 (Source: Imazon /SAD).

The deforestation in Areas Covered by Clouds might have occurred in November or previous months, however, it was only possible to detect it now, when there were no clouds over the region.

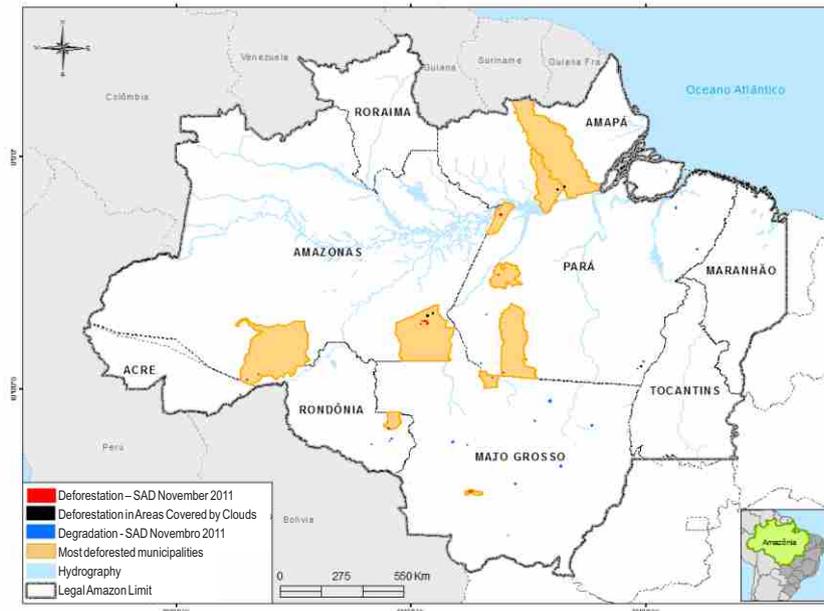


Figure 10. Most deforested counties in November 2011 (Source: Imazon/SAD).

Coverage by clouds and Shade

In November 2011, it was possible to monitor with SAD only 29% of the forest area in Legal Amazon. The other 71% were covered by clouds which made it difficult to detect the deforestation and the forest degradation. Most part of the States of Legal Amazon had over 70% of their areas covered

by clouds: Roraima (89%), Pará (73%), Amapá (73%), Amazonas (72%) and Mato Grosso (70%). Because of that, the deforestation and degradation information in November 2011 may be underestimated. (Figure 11).

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

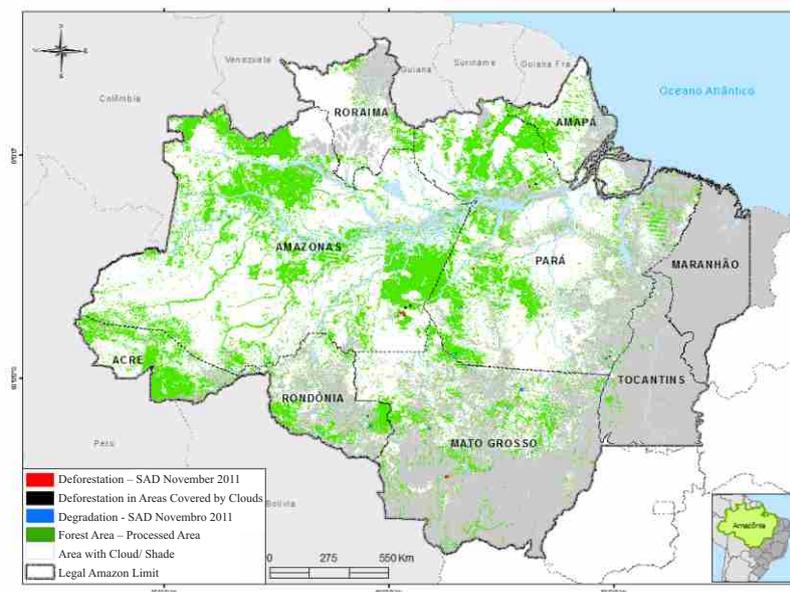


Figure 11. Area with cloud and shade in November 2011 in Legal Amazon

The deforestation in Areas Covered by Clouds might have occurred in November or previous months, however, it was only possible to detect it now, when there were no clouds over the region.

Validation of the SAD data using Landsat and Cbers images

The data from SAD are validated with CBERS and Landsat images (thinner spatial resolution) available by the Instituto Nacional de Pesquisas Espaciais (Inpe) – National Institute for Space Research. In November 2011, it was not possible to confirm with the Landsat images the deforestation detected due to the great occurrence of clouds in the Landsat and CBERS images available in the period.

Frame I: SAD 3.0

Since August 2009, SAD presented some new features. First we created a graphic interface to integrate all the image processing programs used with SAD. Second, we started to compute the deforestation in areas that were covered by clouds in the previous months in a new class. Last, the deforestation and the degradation are detected with pairs of NDFI images in a change detection algorithm. The main methodology remains the same as SAD 2 as described below.

SAD generates the temporal mosaic of daily MODIS images of the products MOD09GQ and MOD09GA for the filtering of the clouds. Next, we use a fusion technique of different spectral resolution bands, i.e., with pixels of different sizes. In this case we changed the scale of 5 bands with 500 meter pixels of the MODIS for 250 meters. This allowed the improvement of the spectral model of pixel mixing, providing the capacity of estimating the abundance of vegetation, soil and Vegetation photosynthetically non active (NPV - Non-Photosynthetic components (Vegetation, Soil and Shade) to calculate the NDFI, with the equation below:

$$\text{NDFI} = (\text{VGs} - (\text{NPV} + \text{Solo})) / (\text{VGs} + \text{NPV} + \text{Solo})$$

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

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

The NDFI varies from -1 (pixel with 100% of exposed soil) to 1 (pixel with > 90% of forest vegetation). This way, we start having a continuous image that shows the transition of deforested areas, going through degraded forests, until we reach the forests without signs of disturbance.

The deforestation and degradation detection spent this month with the difference of NDFI images of the consecutive months. This way, there is a reduction of the NDFI values between -200 and -50 indicating the areas possibly deforested and between -49 and -20 with signs of degradation.

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

SAD is already operational in the State of Mato Grosso since August 2006 and at Legal Amazon since April 2008. In this Bulletin, we presented the monthly data generated by SAD from August 2006 to August 2010.

Frame II: Carbon Affected by the Deforestation

Since January 2010 we report the estimates of the compromised carbon (i.e., forest carbon subject to the emission due to the burning and the decomposition of residues in the forest biomass) resulting from the detected deforestation by SAD in the Legal Amazon.

The carbon estimates are generated based on the combination of SAD's deforestation maps with simulation of the spatial distribution of biomass to the Amazon. We developed an estimate model of carbon emissions, as base in a stochastic simulation (Morton et al, in prep.), denominated Carbon Emission Simulator (CES). We generate 1000 simulations of spatial distribution of biomass in the Amazon using a geostatistic model (Sales et al., 2007), and transform these simulation of biomass in stocks of C using conversion factors of biomass for C from the literature, according to the formula below:

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

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

$$BPF = ff * AGLB$$

$$BAS_0 = bf * AGLB$$

where:

t: time (month)

C_t: Carbon emitted in the month t.

C_t(S): Carbon emitted of a deforested polygon in time t.

S_D: 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 SAD's data, we considered only the carbon compromised by the deforestation, i.e., the fraction of forest biomass composed by carbon (50%) subject to instantaneous emissions due to forest burnings by the deforestation and/ or future decomposition of the remaining forest biomass. In addition, we adapted the CES model to estimate the forest carbon compromised by the deforestation in monthly scale. Lastly, the simulation allowed to estimate the uncertainty of the compromised carbon, represented by the standard deviation (+/- 2 times) from the simulation of carbon affected in each month. For the conversion of carbon values to equivalent CO₂ we applied the value of 3.68.

References:

D.C. Morton¹, M.H. Sales², C.M. Souza, Jr.², B. Griscom³. Baseline Carbon Emissions from Deforestation and Forest Degradation: A REDD 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 Modelling, 205(1-2), 221-230.

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Data Source:

The deforestation statistics are generated from SAD's data (Imazon);
INPE data- Deforestation (PRODES)
<http://www.obt.inpe.br/prodes/>

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Partnerships

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Secretaria de Meio Ambiente do Mato Grosso (SEMA)
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