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SUMMARY

In December 2012, most part (88 %) of the forest area of the Brazilian Amazon was 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 33 km² of deforestation were detected in the Brazilian Amazon under these conditions.

Pará led with 45% of the 33 km² of deforestation detected in January 2012, followed by Rondônia (33%), Mato Grosso (12%), Amazonas (9%) and Acre (1%).

The deforestation accumulated in the period of August 2011 to January 2012, corresponding to the first six months of the current Deforestation Calendar, has reached 600 square kilometers. There was 30% reduction regarding the same previous period (August 2010 to January 2011) when the deforestation totaled 856 square kilometers.

The degraded forests in the Brazilian

Amazon totaled 54 square kilometers in January 2012. Pará was responsible for 50% of the forest degradation followed by Mato Grosso (42%), Rondônia (7%) and Amazonas (1%).

The forest degradation accumulated in the period of August 2011 to January 2012 totaled 1.433 square kilometers. Regarding the previous period (August 2010 to January 2011) there was a reduction of 61%, when the forest degradation totaled 3.700 square kilometers.

In January 2012, the deforestation detected by SAD compromised 3.2 million tons of equivalent CO₂. In the accumulated period (August 2011 - January 2012) the emissions of equivalent CO₂ related to the deforestation totaled 40 million tons which represents a reduction of 38% regarding the previous period (August 2010 to January 2011).

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 January 2012. Approximately 88% of the forest are from the

Brazilian Amazon was covered by clouds in the MODIS images used by SAD. This way, only 33 square kilometers of deforestation were detected in January 2012 in the Brazilian Amazon (Figure 1 and Figure 2).

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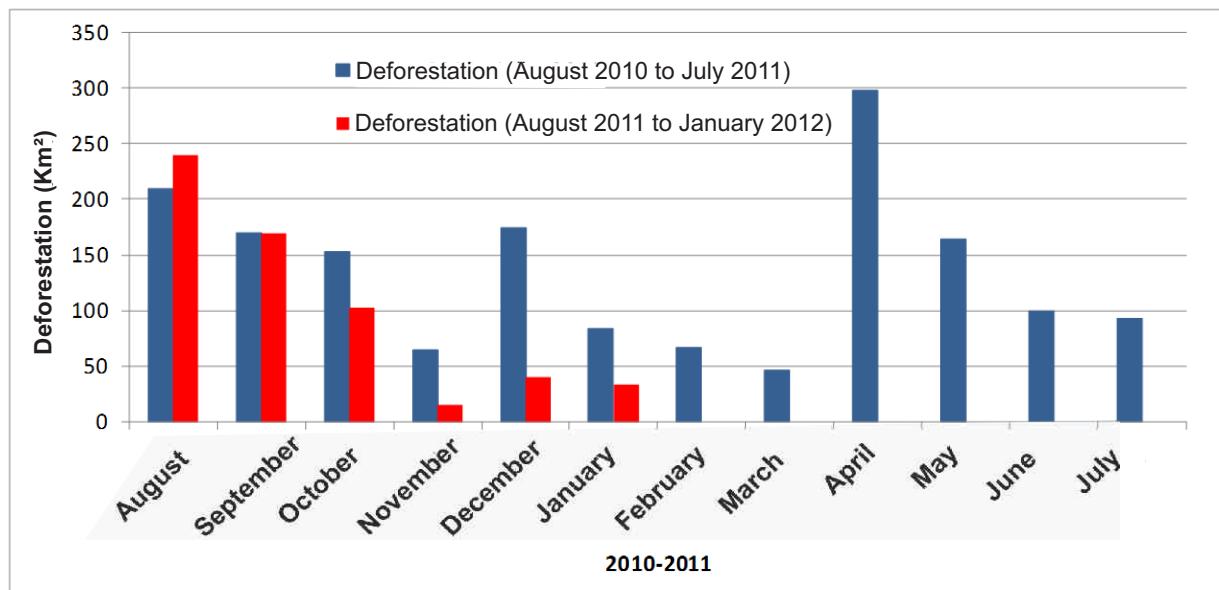


Figure 1. Deforesting from August 2010 to January 2012 in Legal Amazon (Source: Imazon/SAD).

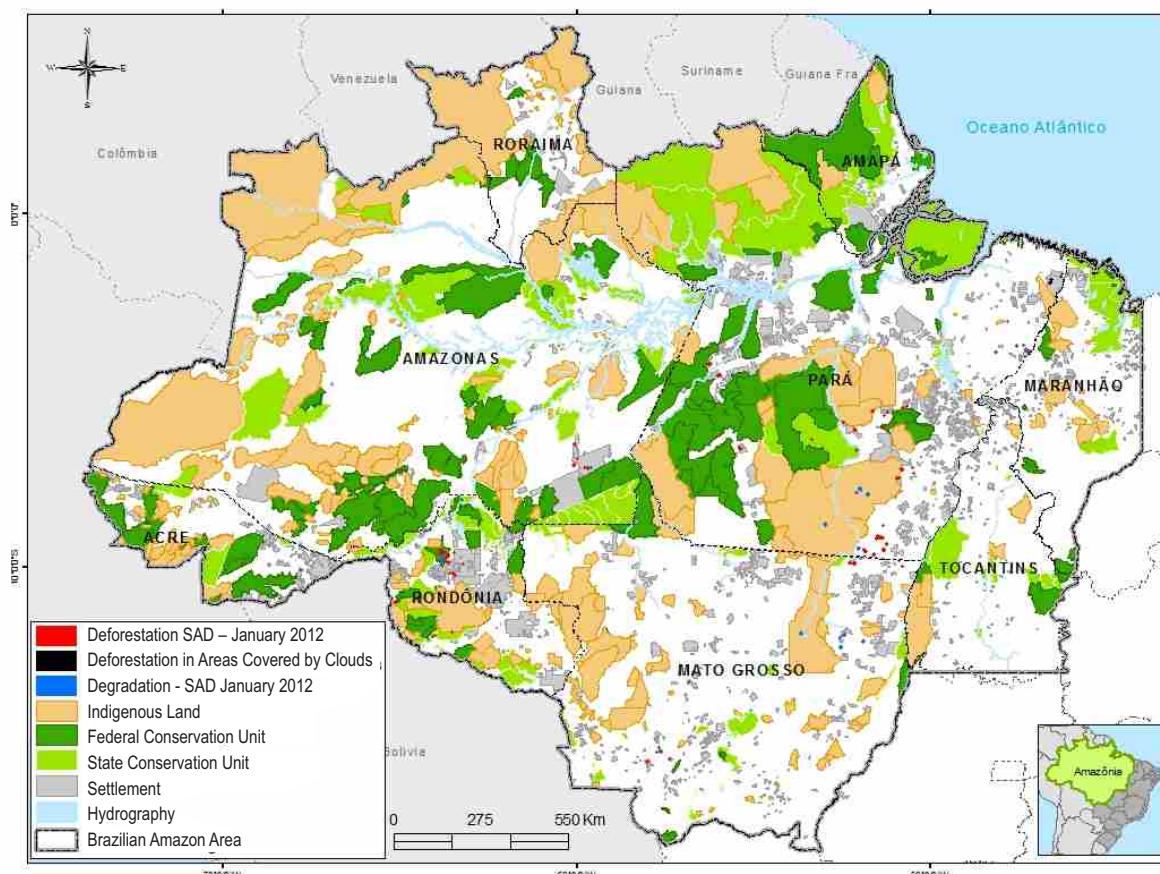


Figure 2. Deforestation and Forest Degradation in January 2011 at Legal Amazon (Source: Imazon/ SAD).

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

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The deforestation accumulated in the period of August 2011 to January 2012, corresponding to the six first months of the official calendar of Deforestation measuring, has reached 600 square kilometers. There was a 30% reduction in the deforestation regarding the previous period (August 2010 to January 2012) when it reached 856 square kilometers.

In January 2012, Pará was responsible for 45% of the deforestation , followed by Rondônia (33%) Mato Grosso (12%), Amazonas (9%), Acre (1%) (Figure 3).

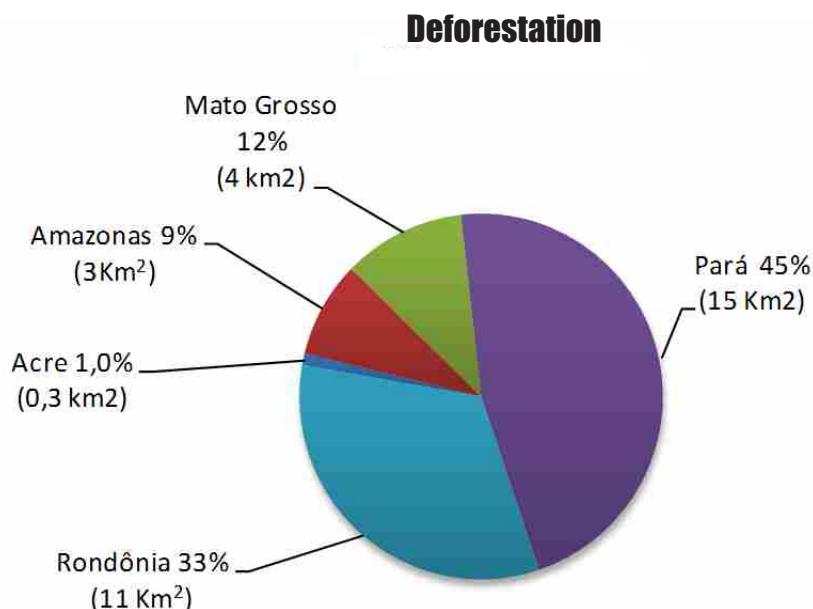


Figure 3. Deforestation (%) in the states of the Brazilian Amazon in January 2012 (Source: Imazon/SAD).

Considering the first six months of the current deforestation calendar¹ (August 2011 to January 2012), Pará leads the ranking with 41% of the total deforested in the period. Following is Rondônia with 22%, followed by Mato Grosso with 21% 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 30% reduction of the deforestation occurred in August 2011 to January 2012 when compared to the previous period (August 2010 to January 2011) (Table 1). In relative terms, there was a

64% reduction in Acre, 55%, in Amazonas, 50% in Mato Grosso, and 31% in Rondônia. On the other hand, there was a 183% increase in Roraima, 104% in Tocantins, 6% in Pará.

In absolute terms, Pará leads the accumulated deforestation ranking with 246 square kilometers, followed by Rondônia (130 square kilometers), Mato Grosso (128 square kilometers), Amazonas (53 square kilometers), Acre (18 square kilometers), Roraima (14 square kilometers) and Tocantins (11 square kilometers).

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

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Table 1. Evolution of the deforestation between the States of the Brazilian Amazon from August 2010 to January 2011 and from August 2011 to January 2012 (Source: Imazon/SAD).

State	August 2010 to January 2011	August 2011 to January 2012	Variation (%)
Acre	49	18	-63
Amazonas	119	53	-55
Mato Grosso	256	128	-50
Pará	233	246	+6
Rondônia	189	130	-31
Roraima	5	14	+180
Tocantins	5	11	+120
Amapá	-	-	-
Total	856	600	-30

* Data from Maranhão were not analyzed.

Forest Degradation

In January 2012, SAD registered only 54 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 January 2012 (88% of the forest area

of the Brazilian Amazon).

From the 54 square kilometers of degraded forests detected by SAD in January 2012, Pará was responsible for 50%, followed by Mato Grosso (42%), Rondônia (7%) and Amazonas (1%) (Figure 5).

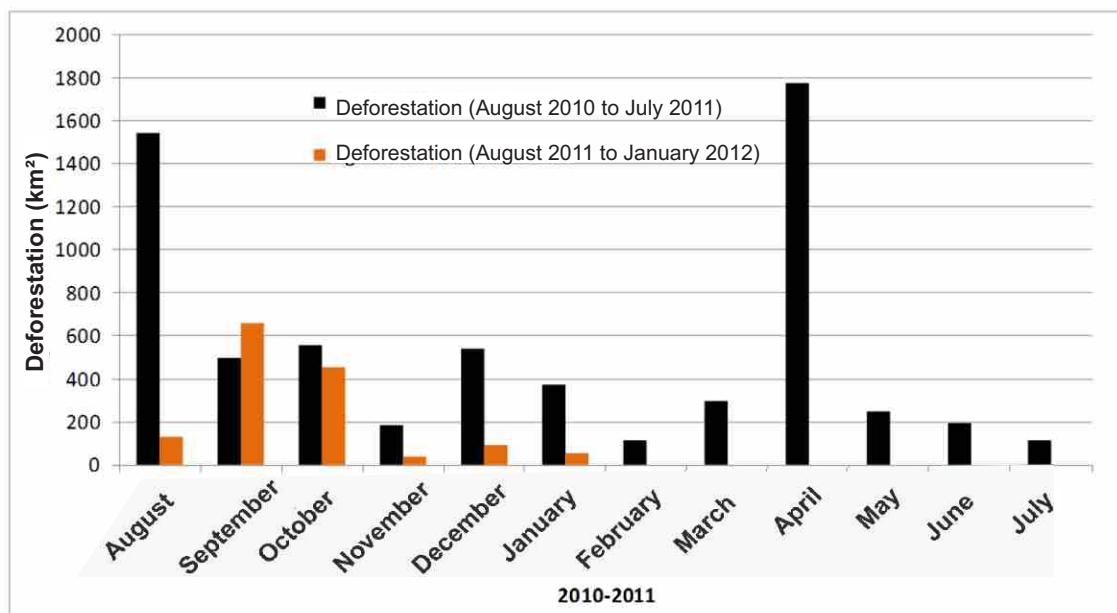


Figure 4. Forest Degradation from August 2010 to January 2012 at the Brazilian Amazon (Source: Imazon/SAD).

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Forest Degradation

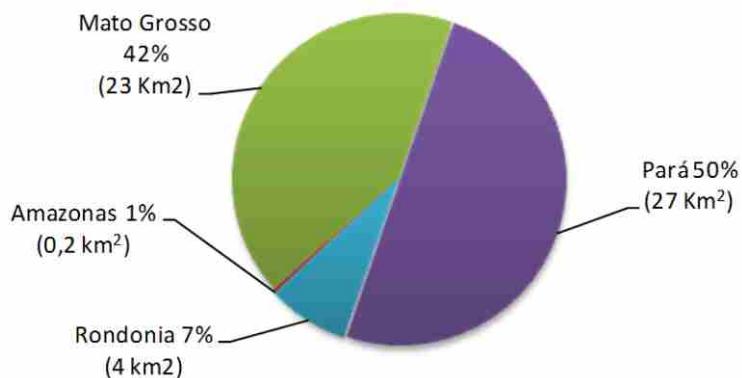


Figure 5. Forest Degradation (%) in the States of the Brazilian Amazon in January 2012 (Source: Imazon/SAD).

The forest degradation accumulated in the period of August 2011 to January 2012 totaled 1.433 square kilometers. This represents a reduction of 61% in the forest degradation accumulated in this period (August 2011 to January 2012) regarding the same previous period (August 2010 to January 2012) when the forest degradation totaled 3.700 square kilometers (Table 2). Most largest reductions occurred in Acre (-98%), Amazonas (-86%),

Rondônia (-85%) and Pará (-69%).

In absolute terms, Mato Grosso leads the accumulated deforestation ranking with 1.103 square kilometers (77%), followed by far by Pará with 227 square kilometers (16%), and the rest, Rondônia (75 square kilometers), Amazonas (19 square kilometers), Roraima (6 square kilometers), and Acre (3 square kilometers).

Table 2. Evolution of the forest degradation between the States of the Brazilian Amazon from August 2010 to January 2011 and from August 2011 to January 2012 (Source: Imazon/SAD).

State	August 2010 to January 2011	August 2011 to January 2012	Variation (%)
Acre	143	3	-98
Amazonas	136	19	-86
Mato Grosso	2.170	1.103	-49
Pará	737	227	-69
Rondônia	486	75	-85
Roraima	2	6	+200
Tocantins	26	-	-
Amapá	-	-	-
Total	3.700	1.433	-61

*Data from Maranhão were not analyzed.

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

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Carbon Affected by the Deforestation

In January 2012, the 33 square kilometers of deforestation detected by SAD in the Legal Amazon compromised 891 thousand tons (with error radius of 126 thousand tons of carbon). This amount of affected carbon results in 3.2 million tons of equivalent CO² (Figure 6).

The forest carbon compromised by the deforestation in the period of August 2011 to January 2012 was 11 million tons (with error radius of 229 thousand tons), which represented approximately 40 million tons of equivalent CO² (Figure 6). Regarding

the same period of the previous year (August 2010 to January 2011) there was a 38% reduction in the amount of carbon compromised by the deforestation. The reduction (38%) of the forest carbon affected by the deforestation in the period of August 2011 to January 2012 regarding the previous period (August 2010 to January 2011) was larger than the reduction of 30% 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.

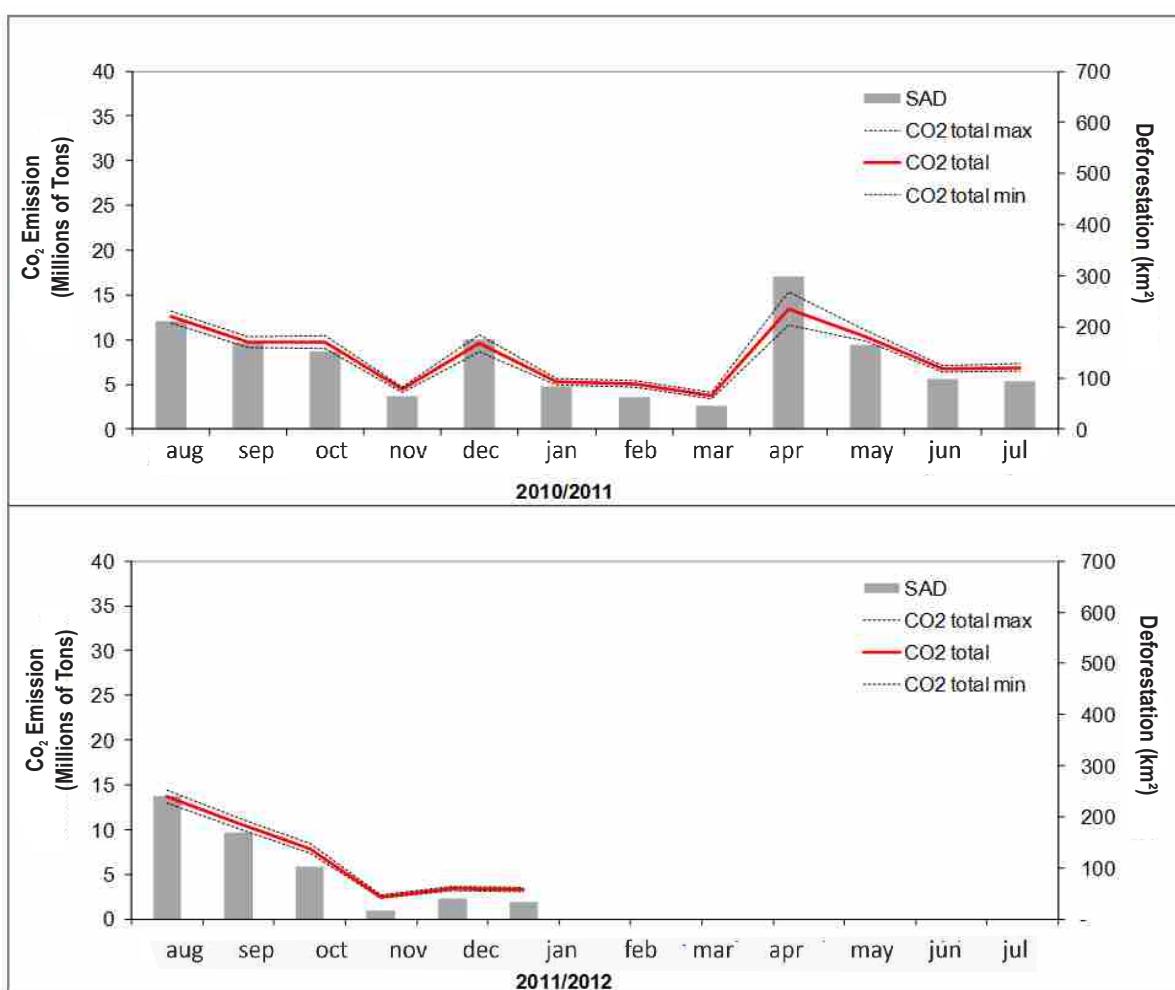


Figure 6. Deforestation and emission of Carbon Dioxide (CO²) total equivalent from August 2010 to January 2012 in Legal Amazon (Source: Imazon).

Deforestation Geography

Regarding the land situation, in January 2012, the great majority (54,5%) of deforestation occurred in private areas or under many stages of ownership. The rest

of the deforestation was registered in Agrarian Reform Settlements (27%), Conservation Units (17%) and Indigenous Lands (1.5%). (Table 3).

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

Category	January 2012	
	km ²	%
Agrarian Reform Settlement	9	27
Conservation Units	5,5	17
Indigenous Lands	0,5	1,5
Private, Owned and in Abeyance ³	18	54,5
Total (km²)	33	100

Agrarian Reform Settlements

SAD registered 9 square kilometers of deforestation in the Agrarian Reform Settlements during January 2012. The most affected settlements by the

deforestation were Floresta Gurupi (Ulianópolis; Pará), Marechal Dutra (Alto Paraíso; Rondônia), and Rio Juma (Apuí; Amazonas). (Figure 7).

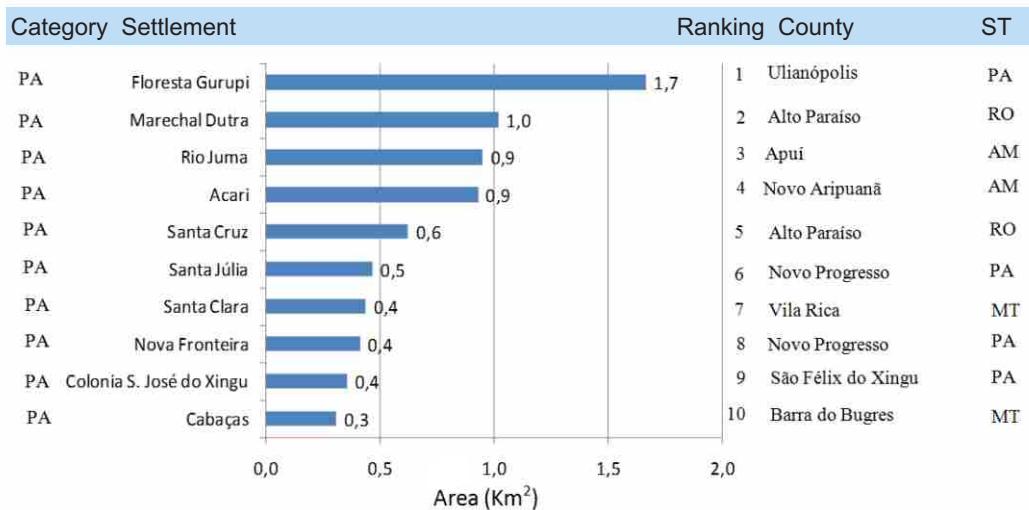


Figure 7. Most deforested Land Reform Settlements in January 2012 at the Brazilian Amazon (Source: Imazon/SAD).

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

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Protected Areas

SAD detected 5,5 square kilometers of deforestation in the Conservation Unit (Figure 8). The Conservation Units that suffered deforestation were: APA do Rio Pardo (Rondônia); APA Triunfo do Xingu (Pará); and APA do Lago do Amapá (Acre). In

the case of the Indigenous Lands, in January 2012 less than 1 square kilometer was detected in the Indigenous land of Apyterewa (Pará) (Figure 9).

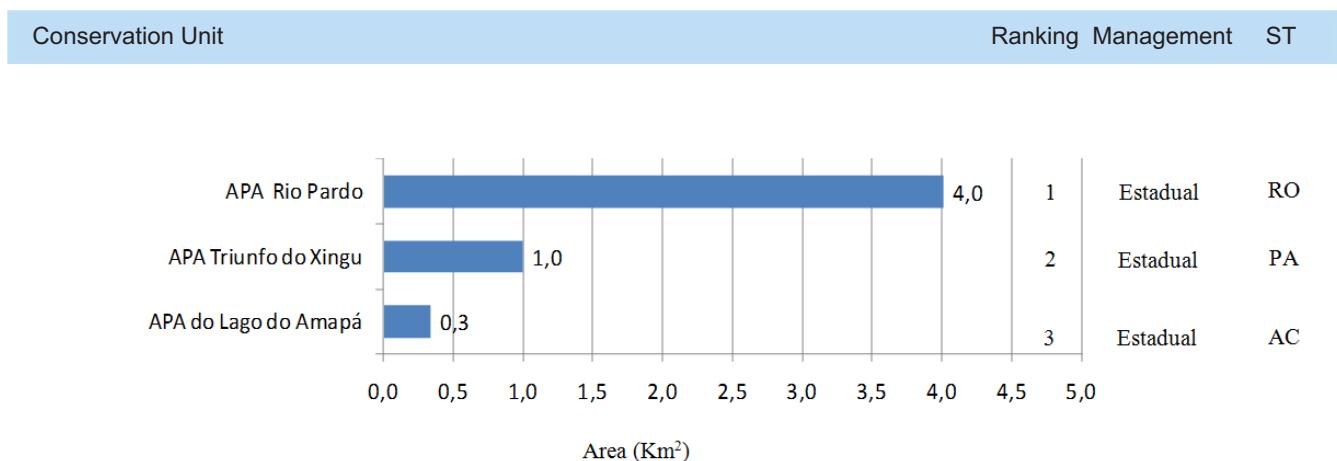


Figure 8. Most deforested Conservation Units in the Brazilian Amazon in January 2012 (Source: Imazon/SAD).

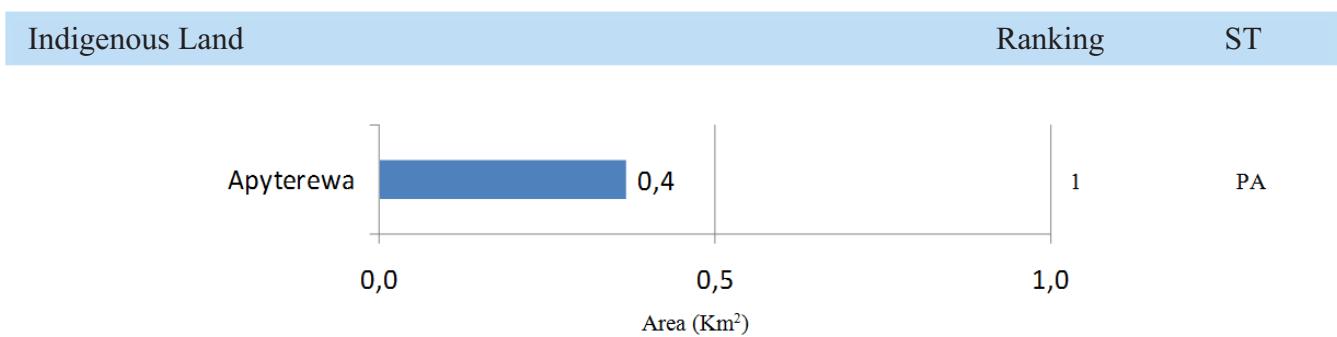


Figure 9. Most deforested Indigenous Lands in the Brazilian Amazon in January 2012 (Source: Imazon /SAD)

Critical Municipalities

In January 2012, the most deforested counties were: Porto Velho (Rondônia); São Félix do Xingu

(Pará), and Cumaru do Norte (Pará) (Figures 10 and 11).

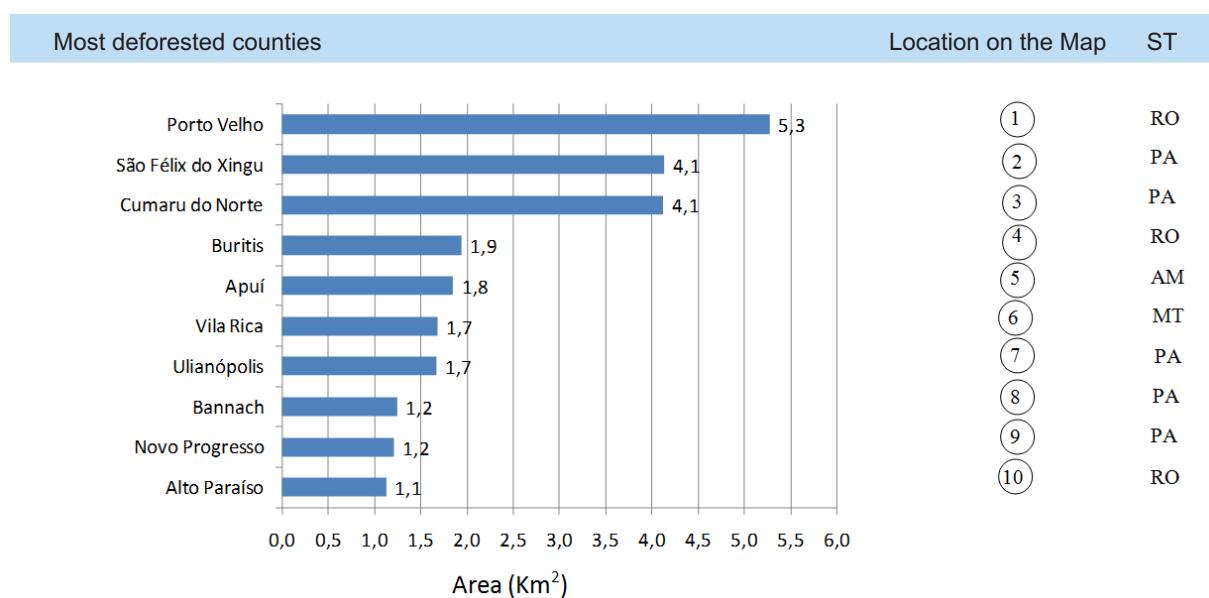


Figure 10. Most deforested counties in the Brazilian Amazon in January 2012 (Source: Imazon/SAD).

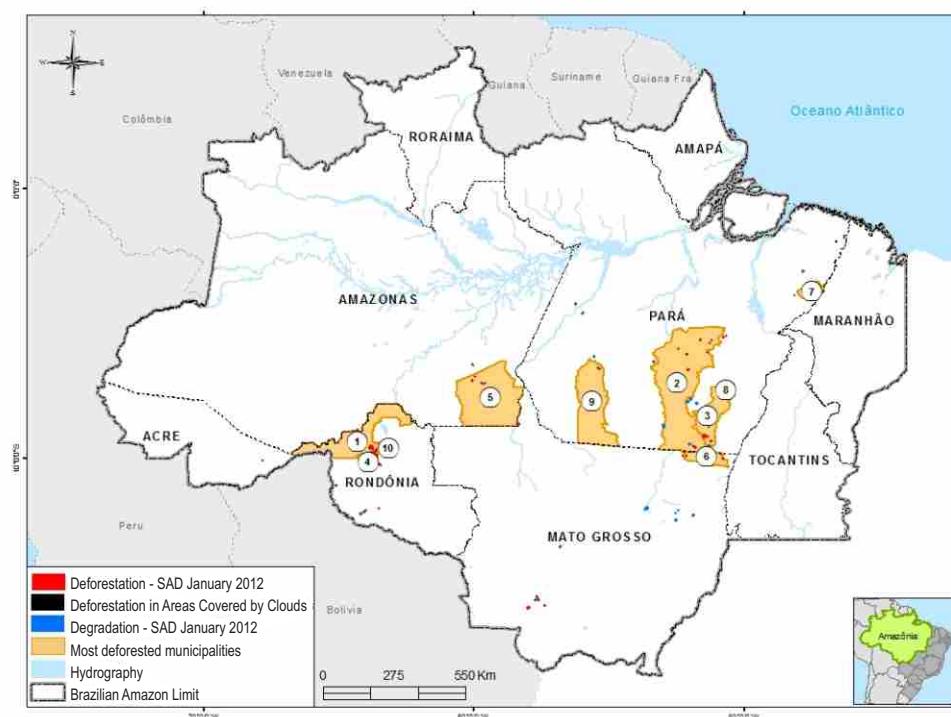


Figure 11. Most deforested counties in January 2012 (Source: Imazon/SAD).

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Coverage by clouds and Shade

In January 2012, it was possible to monitor with SAD only 12% of the forest area in Legal Amazon. The other 88% were covered by clouds which made it difficult to detect the deforestation and the forest degradation. Most part of the States of the Brazilian Amazon had over 80% of their areas covered by

clouds: Amapá (99%), Acre (95%), Roraima (91%), Mato Grosso (89%), Pará (87%), Amazonas (86%), Rondônia (82%), Tocantins (80%). Because of that, the deforestation and degradation information in January 2012 may be underestimated. (Figure 12).

*The part of Maranhão that integrates the Brazilian Amazon was not analyzed

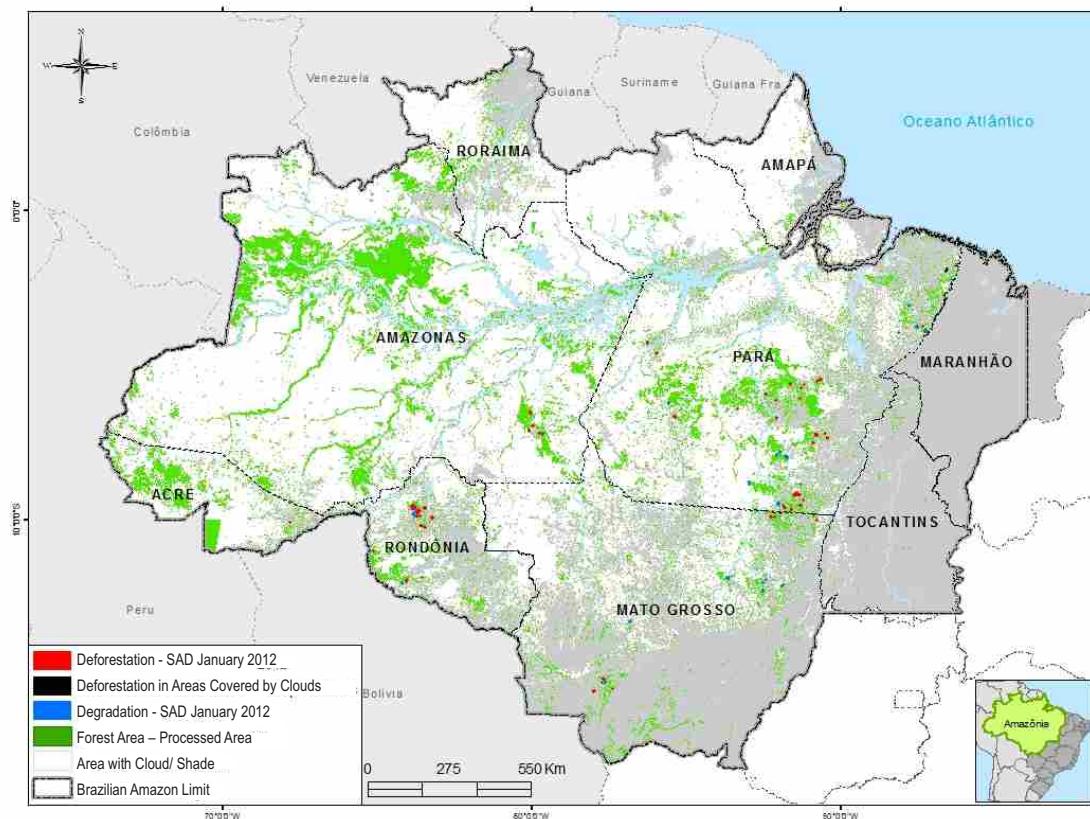


Figure 12. Area with cloud and shade in January 2012 in Legal Amazon

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

Frame I: SAD 3.0

Since August 2009, SAD presented some new features. First we created an 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:

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

$$BPF = ff * AGLB$$

$$BAS_0 = bf * AGLB$$

where:

t: time (month)

Ct: Carbon emitted in the month t.

Ct(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 x e^(-pd x 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

Secretaria de Estado de Meio Ambiente do Pará (SEMA)
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