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SUMMARY

In May 2013, SAD detected 84 km² of deforestation in the Legal Amazon with a cloud cover that 46% of the territory. This represented an increase of 97% compared to May 2012, when the deforestation totaled 42.5 km² and the cloud cover was 54%.

The accumulated deforestation from August 2012 to May 2013 totaled 1654 km². There was an increase of 89% over the previous period (August 2011 to May 2012), when deforestation amounted 873 km².

In May 2013, the majority (61%) of the deforestation occurred in Mato Grosso, followed by Pará (29%), Rondônia (7%), Amazonas (2%) and Acre (1%).

The degraded forests in Legal Amazon

totalled 74.5 km² in May 2013. Compared to May 2012, when the degradation of forests totaled 370.5 km², a reduction of 80%.

The accumulated forest degradation in the period (August 2012 to May 2013) reached 1293 km². In the previous period (August 2011 to May 2012), when degradation totaled 1960 km², a reduction of 34%.

In May 2013, the deforestation detected by SAD pledged the equivalent of 1.5 million tons of CO². Accumulated in the period (August 2012 to May 2013) the equivalent emissions of CO² committed to deforestation totaled 93 million tons, representing an increase of 54% over the previous period (August 2011 to May 2012).

Deforestation Statistics

According to the SAD, the deforestation (total suppression of forest to other alternative land

uses) reached 84 km² in May 2013 (Figure 1 and Figure 2).

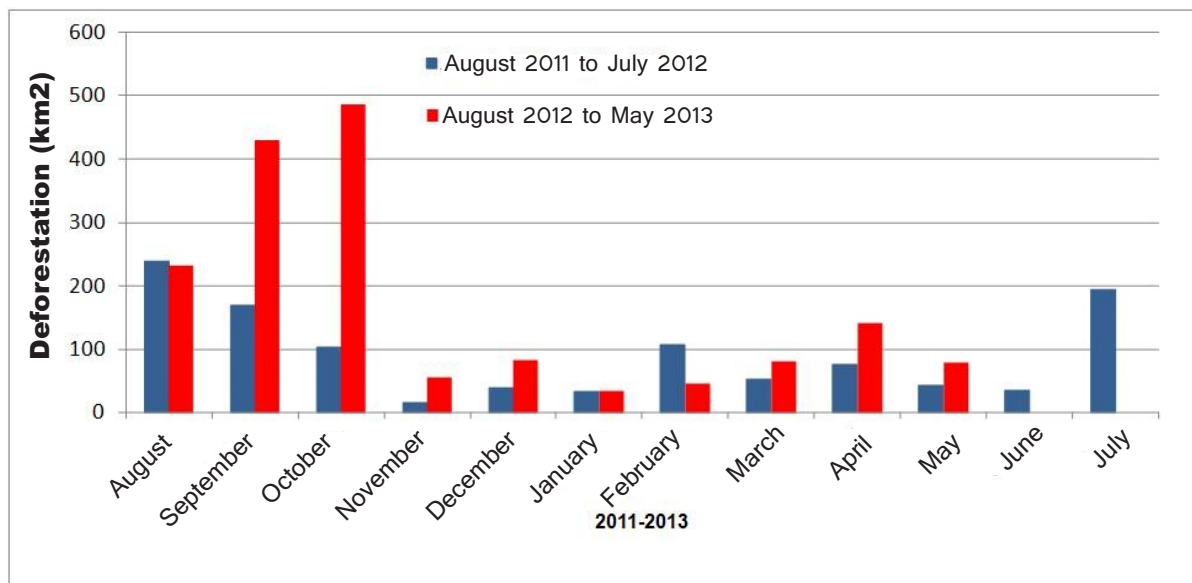


Figure 1. Deforestation of August 2012 to May 2013 in the Legal Amazon (Source: Imazon/SAD).

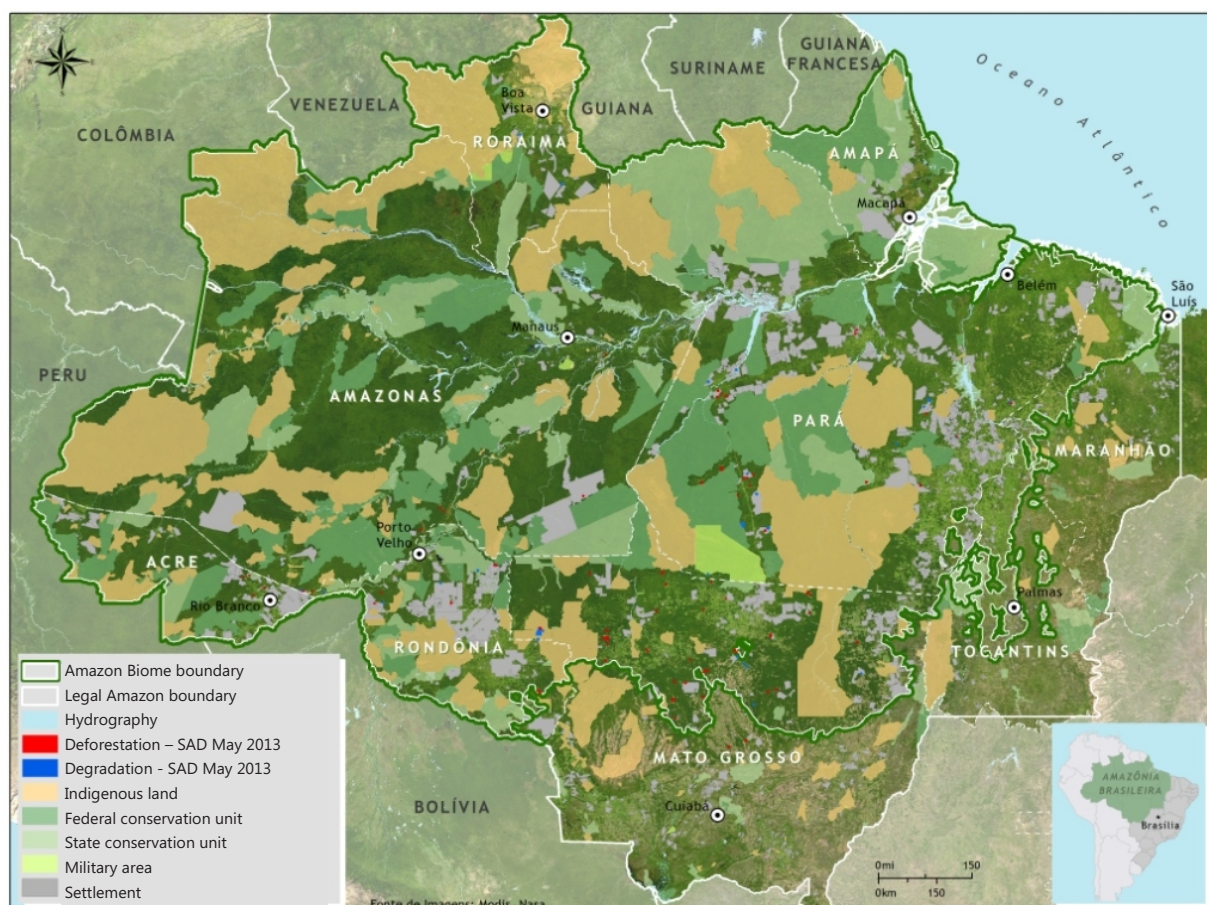


Figure 2. Deforestation and Forest Degradation in May 2013 in the Legal Amazon (Source: Imazon/SAD).

The accumulated deforestation in the period of August 2012 to May 2013, corresponding to the ten months of the official calendar of measuring deforestation reached 1654 km². There was an increase of 89% of deforestation in the previous period (August

2011 to May 2012) when it reached 873 km².

In May 2013, the majority (61%) of the deforestation occurred in Mato Grosso followed by Pará (29%), Rondônia (7%), Amazonas (2%) and Acre (1%).

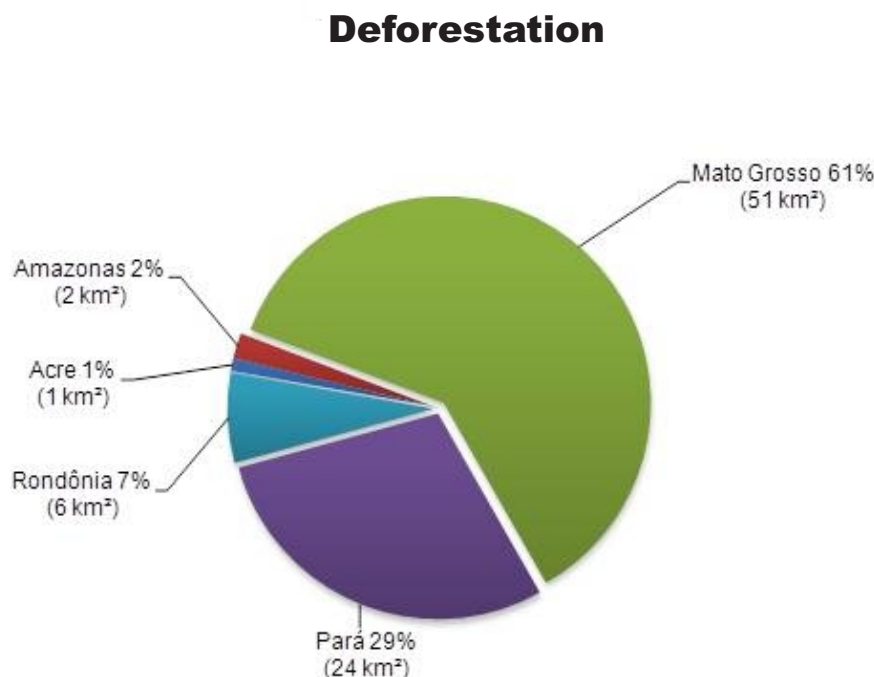


Figure 3. Percentage of deforestation in the Legal Amazon Stated in May 2013 (Source: Imazon/SAD).

Considering the accumulated deforestation in the ten months of the current calendar deforestation (August 2012 to May 2013), Pará leads the ranking with 41% of the total deforested. Then appears the Mato Grosso with 32%, with 14% Rondônia and Amazonas with 10%. These four states accounted for 97% of deforestation occurred in Amazon in this period.

In relative terms, there was a reduction in Acre (-29%) and Roraima (-44%). On the other

hand, there was an increase in Amazonas (+140%), Pará (+134%), Mato Grosso (+82%), Tocantins (+74) and Rondônia (37%).

In absolute terms, the Pará leads the ranking of accumulated deforestation with 674 km², followed by Mato Grosso (532 km²), Rondônia (226 km²), Amazonas (171 km²), Tocantins (24 km²), Acre (14 km²) and Roraima (13 km²).

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

Table 1. Evolution of deforestation among the States of the Legal Amazon from August 2011 to May 2012 and August 2012 to May 2013 (Source: Imazon/SAD).

State	August 2011 to May 2012	August 2012 to May 2013	Variation (%)
Pará	288	674	+134
Mato Grosso	292	532	+82
Rondônia	165	226	+37
Amazonas	71	171	+140
Roraima	23	13	-44
Acre	20	14	-29
Tocantins	14	24	+74
Amapá	-	-	-
Total	873	1654	89

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

Forest Degradation

In May 2013, SAD recorded 74.5 km² of degraded forests (forests intensively exploited by

logging and/or burning) (Figures 2 and 4).

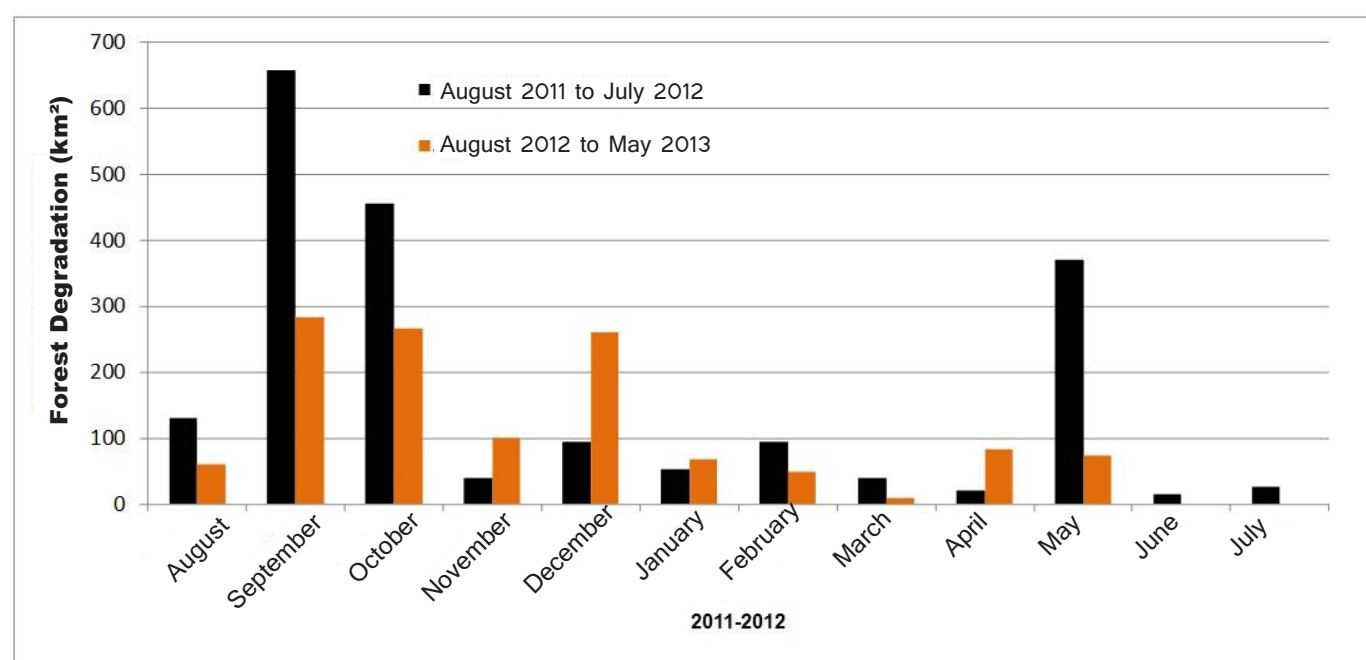


Figure 4. Forest Degradation from August 2012 to May 2013 in the Legal Amazon (Source: Imazon/SAD).

Forest degradation accumulated in the period August 2012 to May 2013 reached 1.293km².

In absolute terms, the Mato Grosso leads the ranking of forest degradation accumulated

with 704km² (54%), followed by Pará with 443km² (34%). The rest (12%) occurred in Rondônia (100km²), Tocantins (25km²) and Amazon (11km²).

Table 2. Evolution of forest degradation among the Legal Amazon States from August 2011 to May 2012 and August 2012 to May 2013 (Source: Imazon / SAD).

State	August 2011 to May 2012	August 2012 to May 2013	Variation (%)
Mato Grosso	1.580	704	-55
Pará	235	443	+88
Rondônia	97	100	+3
Amazonas	29	11	-61
Roraima	15	7	-53
Acre	3	3	-
Tocantins	-	25	-
Amapá	-	-	-
Total	1.960	1.293	-34

* Data from the state of Maranhão was not analyzed.

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

Carbon Affected by the Deforestation

In May 2013 the 78km² of deforestation detected by SAD in Amazon pledged 1.5 million tons of carbon (with a margin of error of 391 tons of carbon). This amount of carbon affected resulting in 5.5 million tons of CO₂ equivalent (Figure 6).

The forest carbon compromised by deforestation from August 2012 to May 2013 was

25.5 million tons (with a margin of error of 580 thousand tons), representing around 93 million tons equivalent of CO₂ (Figure 6). Compared to the same period last year (August 2010 to May 2011) when forest carbon committed was 16.5 million tons increased by 54% for carbon compromised by deforestation.

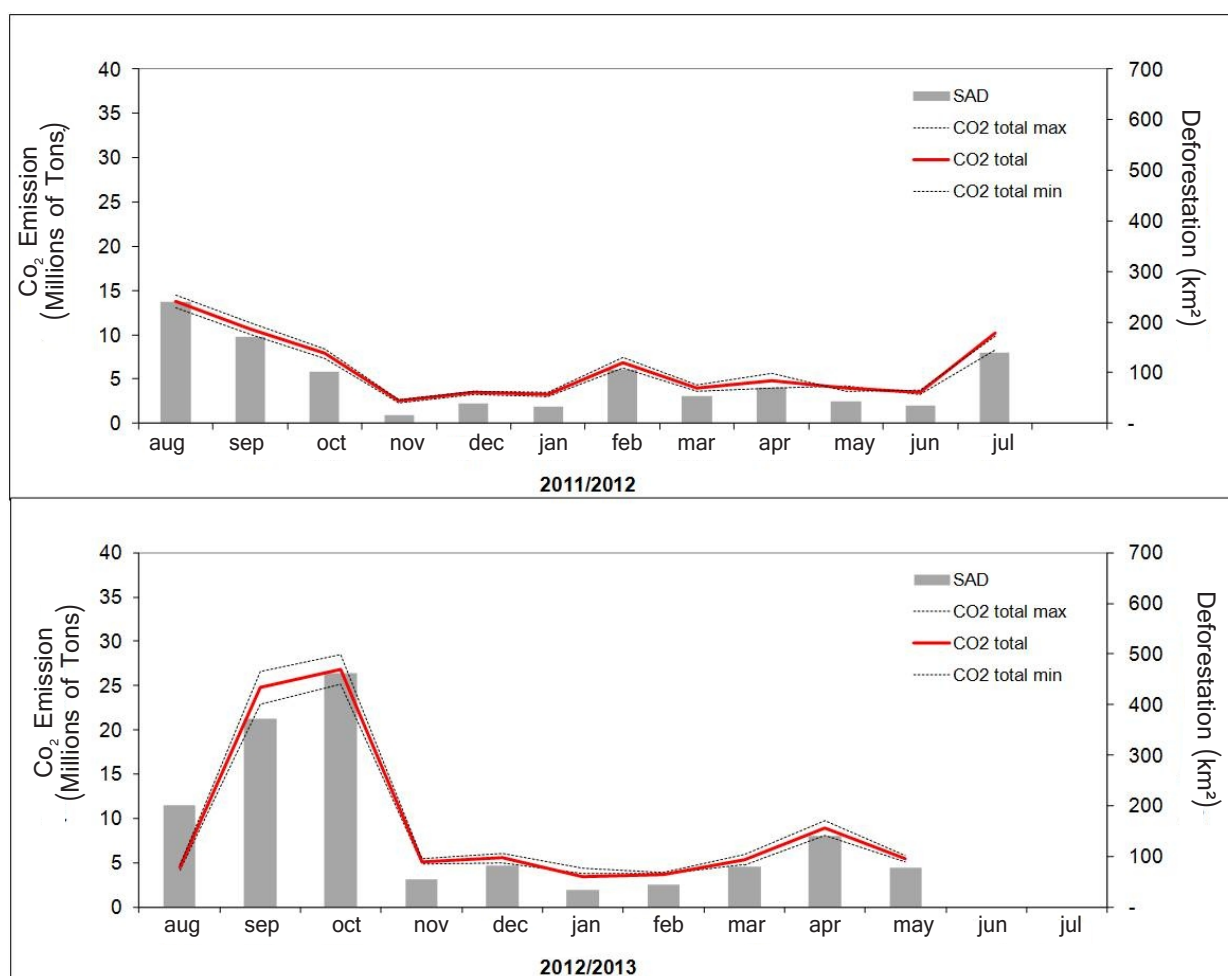


Figure 5. Deforestation and emissions of Carbon Dioxide (CO₂) total equivalent of August 2011 to May 2013 in the Legal Amazon (Source: Imazon).

Deforestation Geography

In May 2013, the vast majority (85%) of the deforestation occurred in private or under various stages of ownership. The rest of deforestation was

registered in Land Reform Settlements (10.5%), Conservation Units (1%) and Indigenous Lands (3.5%) (Table 3).

Table 3. Deforestation by land category in May 2013 in the Legal Amazon (Source: Imazon/SAD).

Category	May 2013	
	km ²	%
Agrarian Reform Settlement	9	10,5
Conservation Units	1	1
Indigenous Lands	3	3,5
Private, Owned and in Abeyance ³	71	85
Total (km²)	84	100

Reform Settlements

The SAD registered 9km² of deforestation in Land Reform Settlements in May 2013 (Figure 6). Settlements were most affected by

deforestation PA Lajes (Machadinho D'Oeste, Rondônia), PA Tapurah / Itanhangá (Itanhangá, Pará) and PDS Esperança (Altamira, Pará).

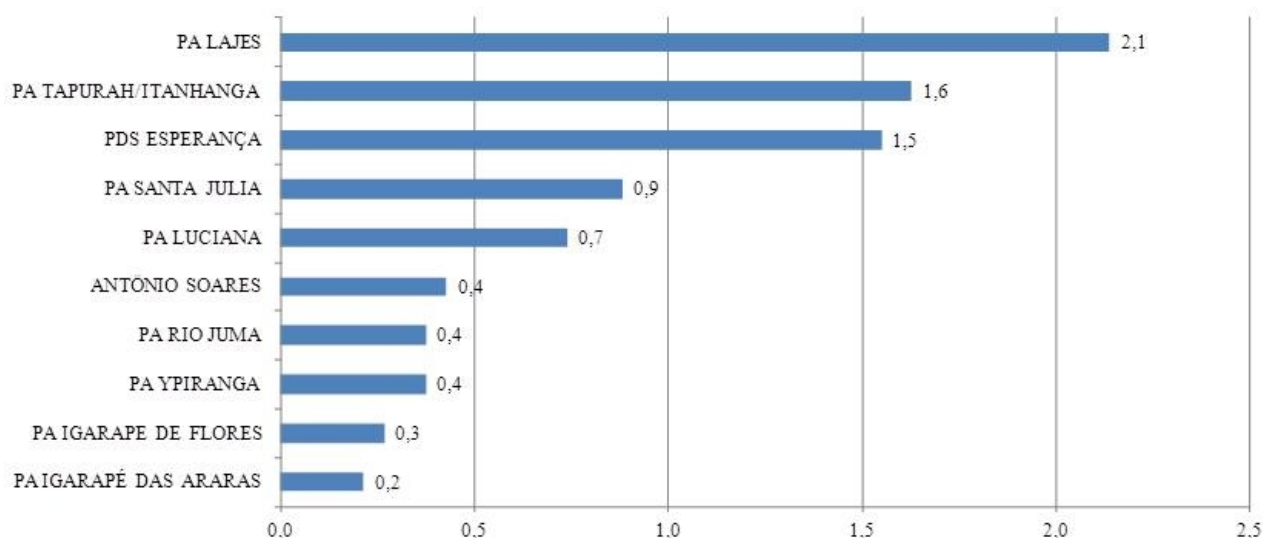


Figure 6. Reform Settlements cleared in May 2013 in the Legal Amazon (Source: Imazon/SAD)

Protected Areas

In May 2013, SAD detected 1km² of deforestation in protected areas APA Triunfo do Xingu (Pará) and FLOTA of Antimary (Acre).

Indigenous Lands

In May 2013, SAD detected only 3km² of deforestation on Terras Indígenas Florex Zoró (MT).

Municipalities Critics

In May of 2013 the most deforested municipalities were: Itaituba (Pará) and Nova Maringá (Mato Grosso) (Figure 7 and 8).

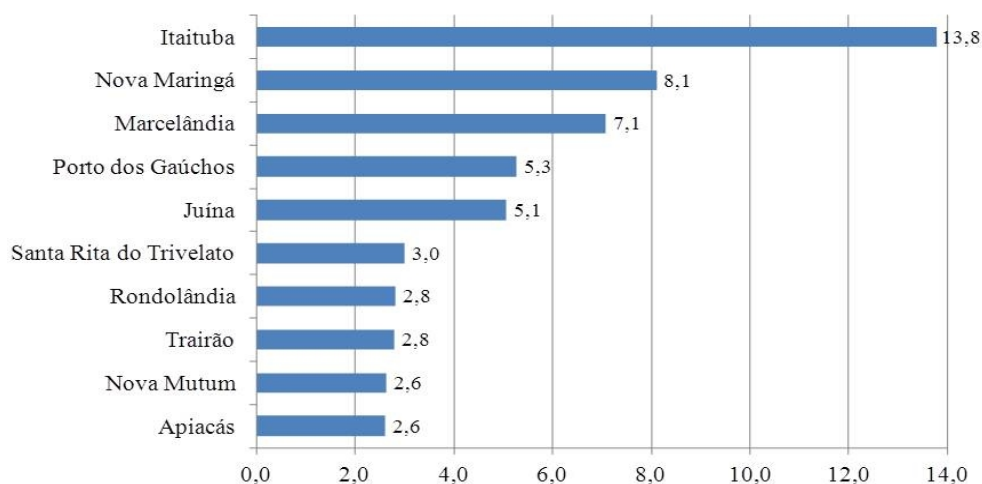


Figure 9. Most deforested municipalities in the Legal Amazon in May 2013 (Source: Imazon/SAD).

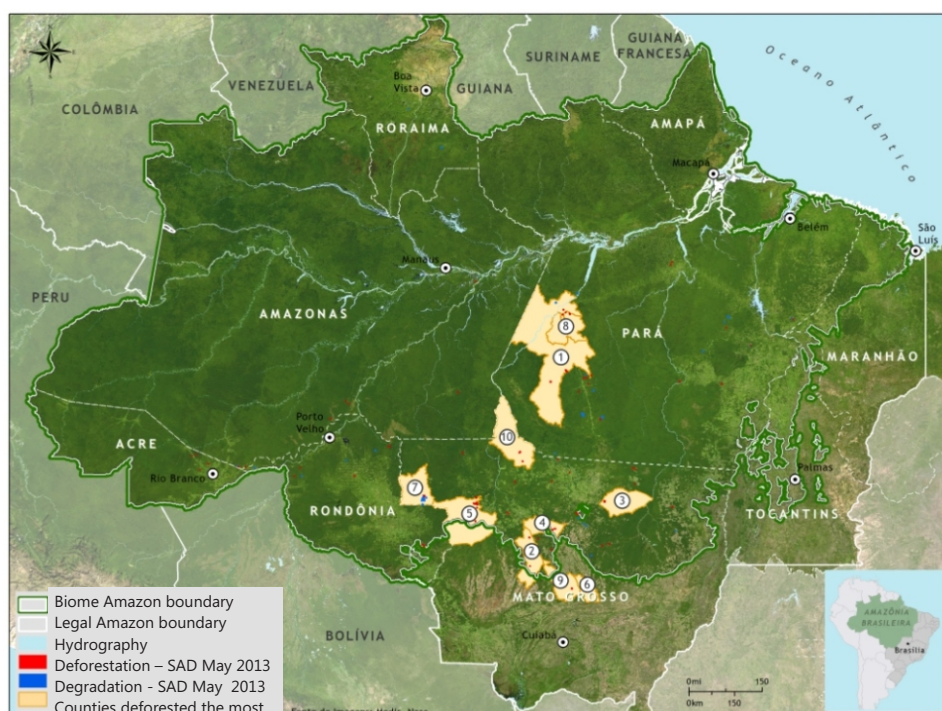


Figure 10. Most deforested municipalities in May 2013 (Source: Imazon / SAD).

Coverage by clouds and Shade

In May 2013 it was possible to monitor the SAD 54% of the forest area in the Legal Amazon. The other 46% of the forest area was covered by clouds, which hampered the detection of deforestation and forest degradation. The states

with the largest cloud cover were Roraima (78%), Amapá (72%) and Pará (49%). As a result, data from deforestation and forest degradation in May 2013 may be underestimated (Figure 9).

* Data related to the state of Maranhão, that integrates Legal Amazon, was not analyzed.

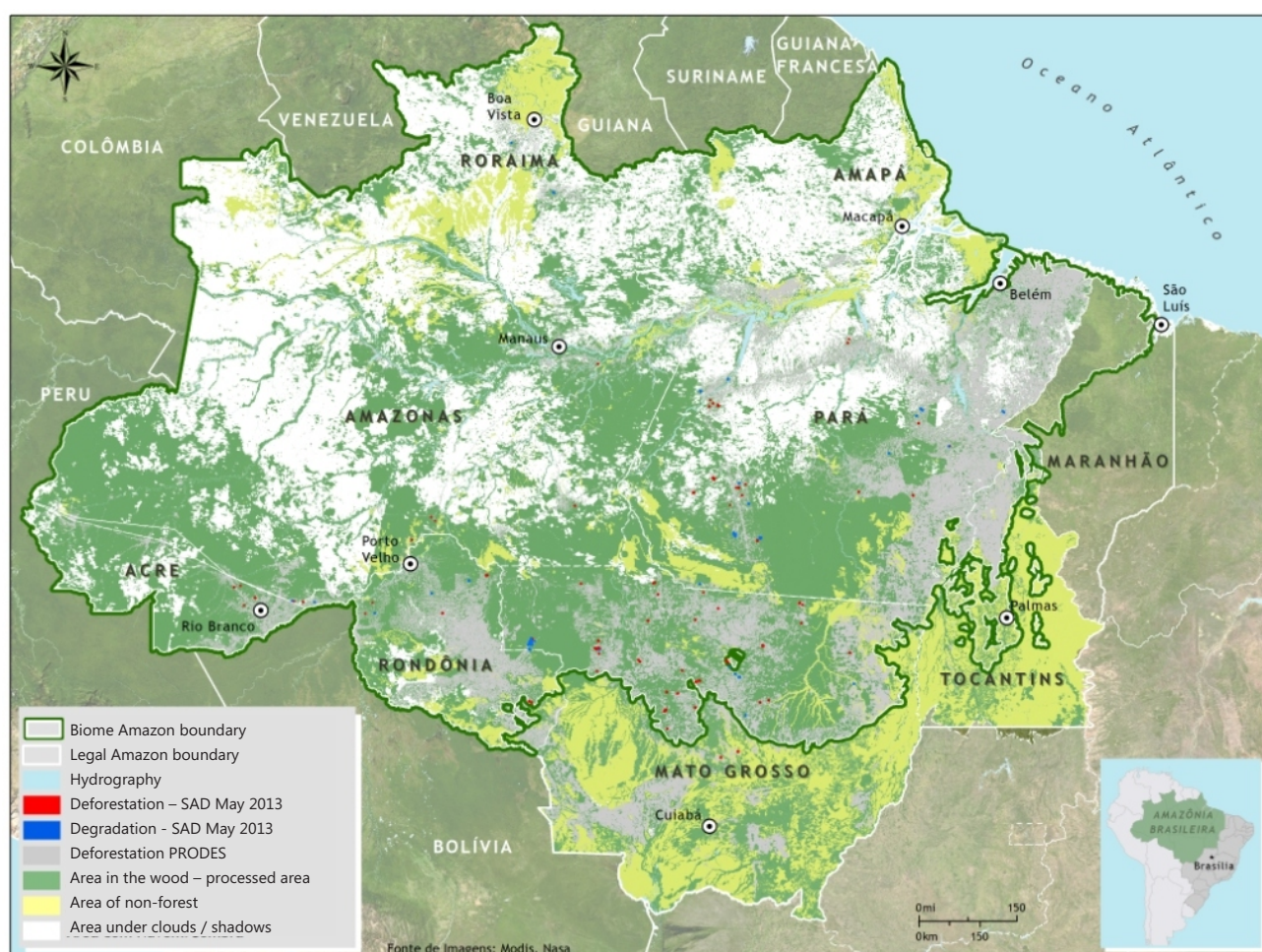


Figure 11. Area with cloud and shade in May 2013 in the Legal Amazon.

Google SAD-EE

Since June 2012 the detection of alerts of deforestation and forest degradation has been carried out in the Google's Earth Engine – EE – platform, with the new version: SAD EE. This system was developed in

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

Table I: SAD 3.0

Since August 2009, SAD has been introducing some news. First, we created a graphical interface to integrate all image processing programs used in SAD. Second, we started computing deforestation in areas that were covered by clouds in the previous months, under a new class. Finally, deforestation and degradation are detected with pairs of NDFI images in a change detection algorithm. The main method remains the same as SAD 2, as described here below.

SAD generates a temporal mosaic of daily MODIS images of MOD09GQ and MOD09GA products to filter the clouds. Afterwards, we used a technique of different spectral resolution band merge, i.e., pixels of different sizes. In that case, we changed the 500 meter 5-band scale of MODIS to 250 meters. This allowed to enhance the spectral model of pixel mixture, thus supplying ability to estimate the abundance of vegetation, soils and non-active photo-synthetically vegetation (NPV, for Non-Photosynthetic, in English) components (vegetation, soil and Shadow) so to be able to calculate the NDFI with the following equation:

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

Where VG is the standardized component of vegetation for shadow given by:

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

NDFI ranges from -1 (pixel with 100% of exposed soil) to 1 (pixel with >90% with forest vegetation). Thus, we could have a continuous image showing the transition from deforested areas, crossing the degraded forests, reaching the forest with no warning signs of disturbance.

Detection of both deforestation and degradation was shown this month with the difference of NDFI images related to the consecutive months. Hence, a reduction in NDFI values ranging from -200 to -50 indicates possibly cleared areas, and a reduction ranging from -49 to -20 indicates signs of degradation.

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

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

Table II: Carbon affected by deforestation

Since January 2010 we have been reporting the estimates of carbon endangered (i.e., of forest carbon subject to emissions due to burnings and decomposition of forest biomass residues) arising from the deforestation detected by SAD in Legal Amazon.

Carbon estimates are generated based on the combination of SAD deforestation maps and simulations of spatial distribution of biomass for Amazonia. We have developed a model of estimates of carbon emissions based on stochastic simulation (Morton et al, in prep.), named Carbon Emission Simulator (CES). We generated 1000 simulations of biomass spatial distribution in Amazon using a geo-statistic model (Sales et al., 2007), and transformed such biomass simulations in C stocks using biomass conversion factors for C – as stated in 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 S_D.

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.

In order to apply CES model using data from SAD, we considered only the carbon endangered by deforestation, i.e., the fraction of forest biomass consisting of carbon (50%) subject to instantaneous issuances due to burnings of forests by deforesting and/or the future decomposition of the remaining forest biomass. Furthermore, we have adapted the CES model so to be able to estimate – on monthly basis - the forest carbon endangered by deforestation. Finally, simulations have allowed us to estimate the uncertainty of carbon endangered, represented by the standard deviation (± 2 times) of the simulations of carbon affected every month.

To convert carbon values into CO₂ equivalent, we applied a 3.68 value.

References:

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Sales, M.H. et al., 2007 - Improving spatial distribution estimation of forest biomass with geo-statistics: A case study for Rondônia, Brazil. *Ecological Modeling*, 205(1-2), 221-230.

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Data Source:

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

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State Prosecutor of Amapá

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