

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

SUMMARY

In November 2012, half part (50%) of the Legal Amazon forest area was covered by clouds, mainly the states of Acre and Mato Grosso with, respectively, 81% and 77% of clouds covering. This compromised the deforestation and the forest degradation detection for this month through the MODIS images used by SAD.

In these conditions, only 55 square km of deforestation were detected in November 2012 in the Legal Amazon. This represented a 258% increase compared to November 2011 when deforestation summed 16 square kilometers for a cloud covering of 71% of the whole Amazon forest area. This clouds covering difference may compromise the comparison between the months of November 2012 and 2011.

Accumulated deforestation from August 2012 to November 2012 summed 1.206 square kilometers up. A 129% increase was observed compared to the former period [August 2011 to November 2011], when deforestation summed 527 square kilometers.

In November 2012, most part of

deforestation (42%) occurred in the State of Pará, and then in Rondônia (25%) and Amazonas (24%). The remaining occurred in Roraima (4%) and Tocantins (1%).

Degraded forests in Legal Amazon summed 100 square km in November 2012. Compared to November 2011, when the forest degradation summed 40 square kilometers, an increase of 154% was observed.

Accumulated forest degradation in the period (August 2012 to November 2012) summed 711 square kilometers. Compared to the former period (August 2012 to November 2011), when forest degradation summed 1285 square kilometers, a 45% reduction was noticed.

In November 2012, SAD detected a deforestation involving 1.5 million tons of equivalent CO₂. For the accumulation of the period (from August 2012 to November 2012) the compromised equivalent CO₂ emissions summed 60 million tons representing a 32% reduction compared to the former period (August 2011 to November 2011).

Deforestation Statistics

According to SAD, the deforestation (forest total suppression for other alternative uses of the soil)

has reached 55 square km in November 2012 (Figure 1 and Figure 2).

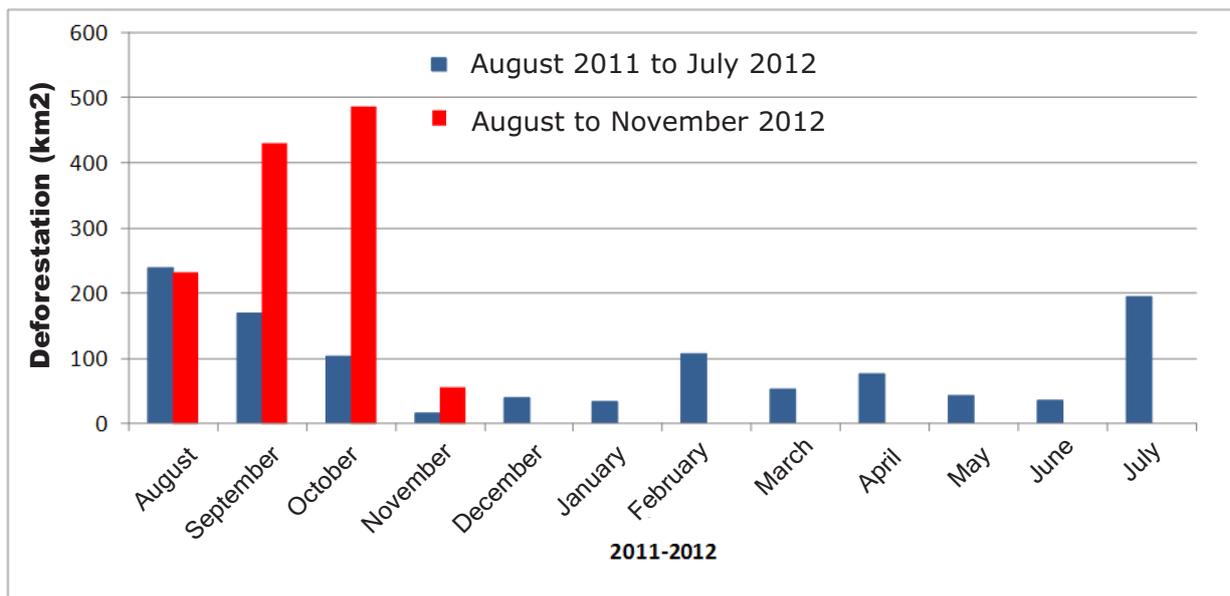


Figure 1: Deforestation from August 2011 to November 2012 in Legal Amazon (Source: Imazon/SAD)

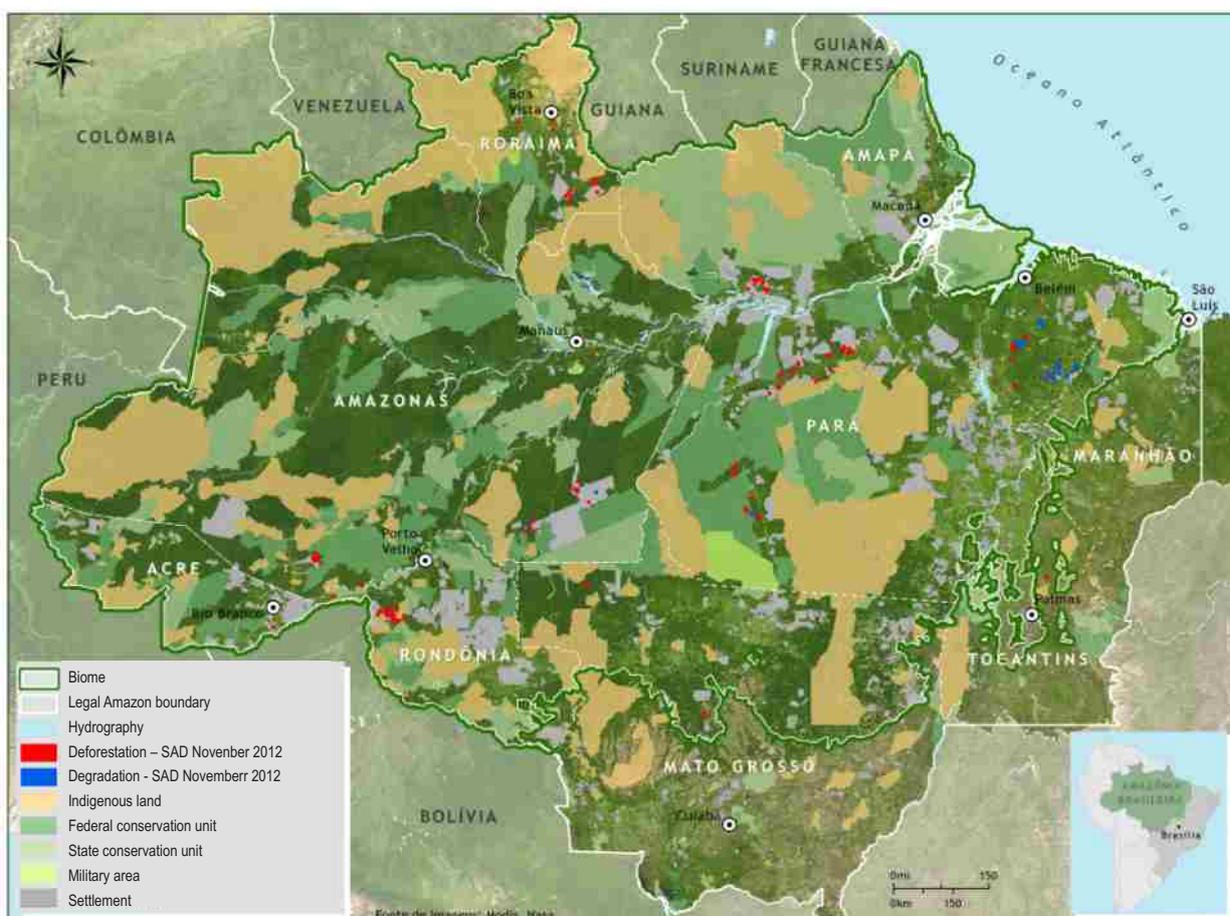


Figura2. Desmatamento e Degradação Florestal em novembro de 2012 na Amazônia Legal (Fonte: Imazon/ SAD).

Accumulated deforestation in the period from August 2012 to November 2012, corresponding to four months of the official calendar of deforestation measurement, reached 1,206 square kilometers. A 129% increase of deforestation was observed, compared to the former period [from August 2011 to November 2011], when it reached 527 square kilometers.

In November 2012, most part (42%) of the deforestation occurred in the State of Pará, then in Rondônia (25%) and Amazonas (24%). The remaining occurred in Roraima (4%) and Tocantins (1%). It was not possible to detect the deforestation in Acre and Mato Grosso due to the high cloud covering during the month, respectively 81% and 77%.

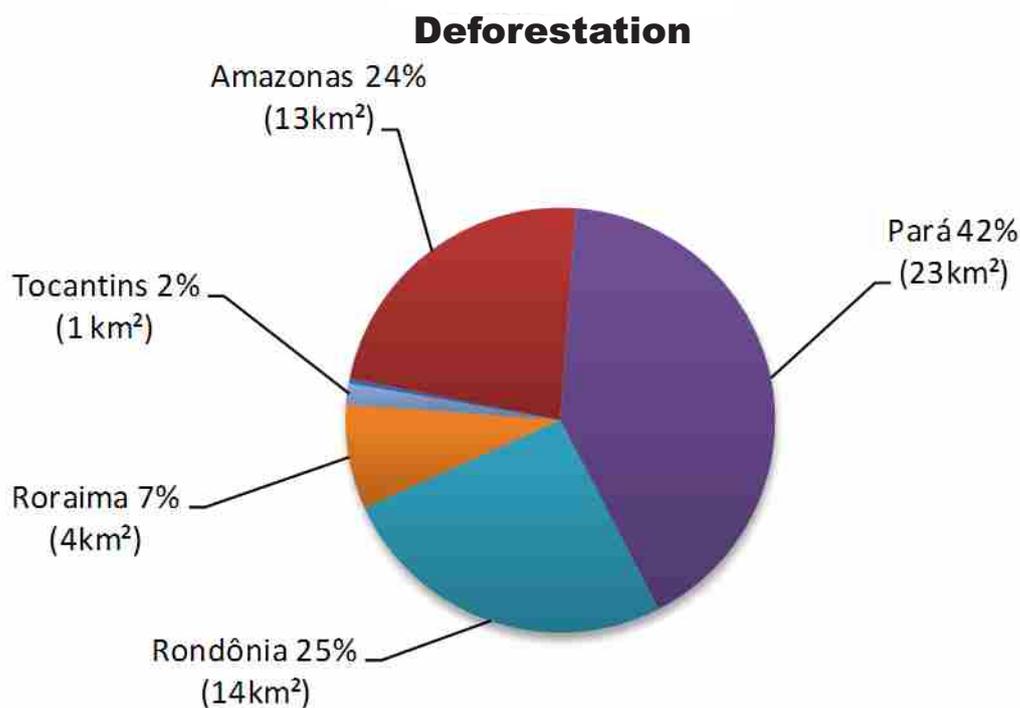


Figure 3: Percentage of deforestation in the states of Legal Amazon, in November 2012 (Source: Imazon/SAD)

Taking into account the accumulated deforestation during the four months of the current deforestation calendar [August 2012 to November 2012], the State of Pará leads the ranking with 51% of the deforested total. Then come Mato Grosso with 21%, followed by Rondônia with 13% and Amazonas with 12%. Those four states are accountable for 97% of deforestation occurred in Legal Amazon during that period.

Relatively, only a 34% reduction was observed in the State of Roraima, and a 43% in the State of Acre. On

the other hand, a 201% increase was observed in Amazonas, 173% in the State of Pará, 149% in Mato Grosso, 98% in Tocantins, and 39% in Rondônia. In absolute terms, Pará leads the ranking of accumulated deforestation with 613 square kilometers, followed by Mato Grosso (249 square km), Rondônia (159 square km), Amazonas (147 square km), Tocantins (21 square km) and Acre (10 square km).

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

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

State	August 2011 to November 2011	August 2012 to November 2012	Variation (%)
Pará	225	613	+173
Mato Grosso	100	249	+149
Rondônia	114	159	+39
Amazonas	49	147	+201
Roraima	11	7	-34
Acre	17	10	-41
Tocantins	11	21	+98
Amapá	-	-	-
Total	527	1.206	+129

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

Forest Degradation

In November 2012, SAD recorded 100 square km of degraded forests (forests that are

extremely exploited by wood activities and/or burnings] (Figures 2 and 4).

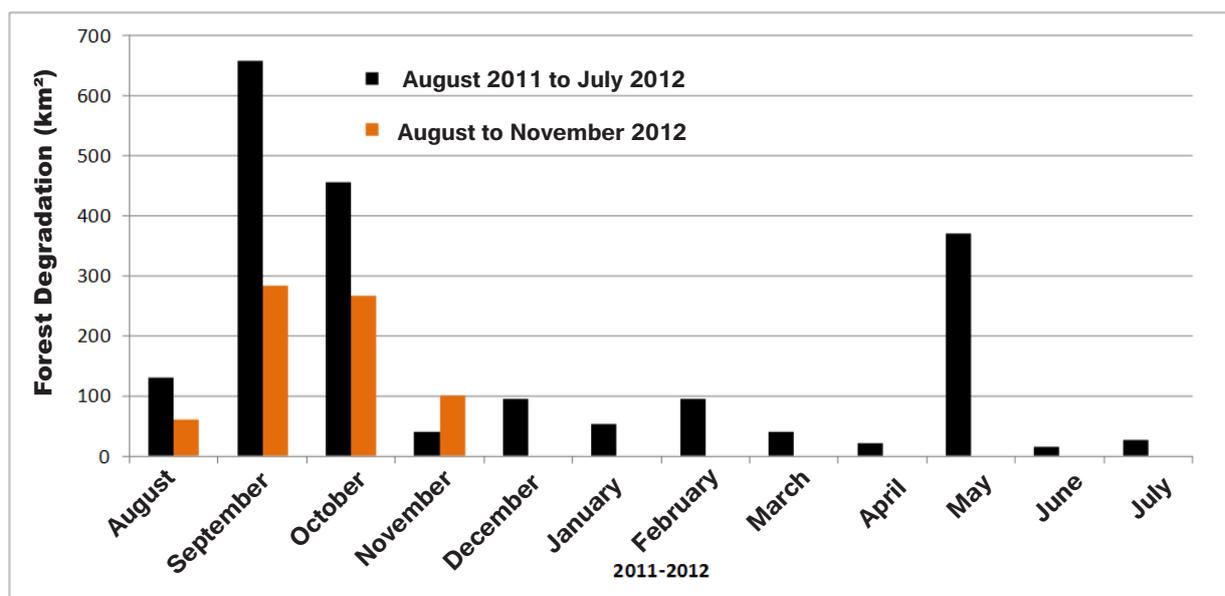


Figure 4: Forest degradation from August 2011 to November 2012 in Legal Amazon (Source: Imazon/SAD)

The forest degradation accumulated on the period from August 2012 to November 2012 reached 711 square km.

In absolute terms, Pará leads the ranking of accumulated forest degradation with 345 square km

(49%), followed by the State of Mato Grosso with 283 square km (40%). The remaining (11%) took place in the states of Rondônia (48 square km), Tocantins (25 square km), and Amazonas (10 square km).

Tabela 2. Evolução da degradação florestal entre os Estados da Amazônia Legal de agosto de 2011 a novembro de 2011 e de agosto de 2012 a novembro de 2012 (Fonte: Imazon/SAD).

State	August 2011 to November 2011	August 2012 to November 2012	Variation (%)
Mato Grosso	994	283	-72
Pará	194	345	+78
Rondônia	71	48	-32
Amazonas	15	10	-43
Roraima	6	-	-100
Acre	3	-	-100
Tocantins	-	25	-
Amapá	-	-	-
Total	1.285	711	+45

* Data from the state of Maranhão was not analyzed.

² The official calendar of deforestation measurements starts in August and ends in July

Carbon Affected by the Deforestation

In November 2012, the 55 square kilometers of deforestation detected by SAD in Legal Amazon endangered 1.5 million tons of carbon (with a margin of error of 32 thousand tons). This amount of endangered carbon may result in emissions of 5 million tons of equivalent CO₂ (Figure 6).

Deforestation-endangered forest carbon in the period from August 2012 to November 2012 was of 6.5

million tons (with a margin of error of 392 thousand tons), what represented about 60 million tons of equivalent CO₂ (Figure 6). Compared to the same period of the former year (August 2011 to November 2011), when endangered forest carbon was of 9.5 million ton, a 32% reduction was observed in the quantity of carbon endangered by deforestation.

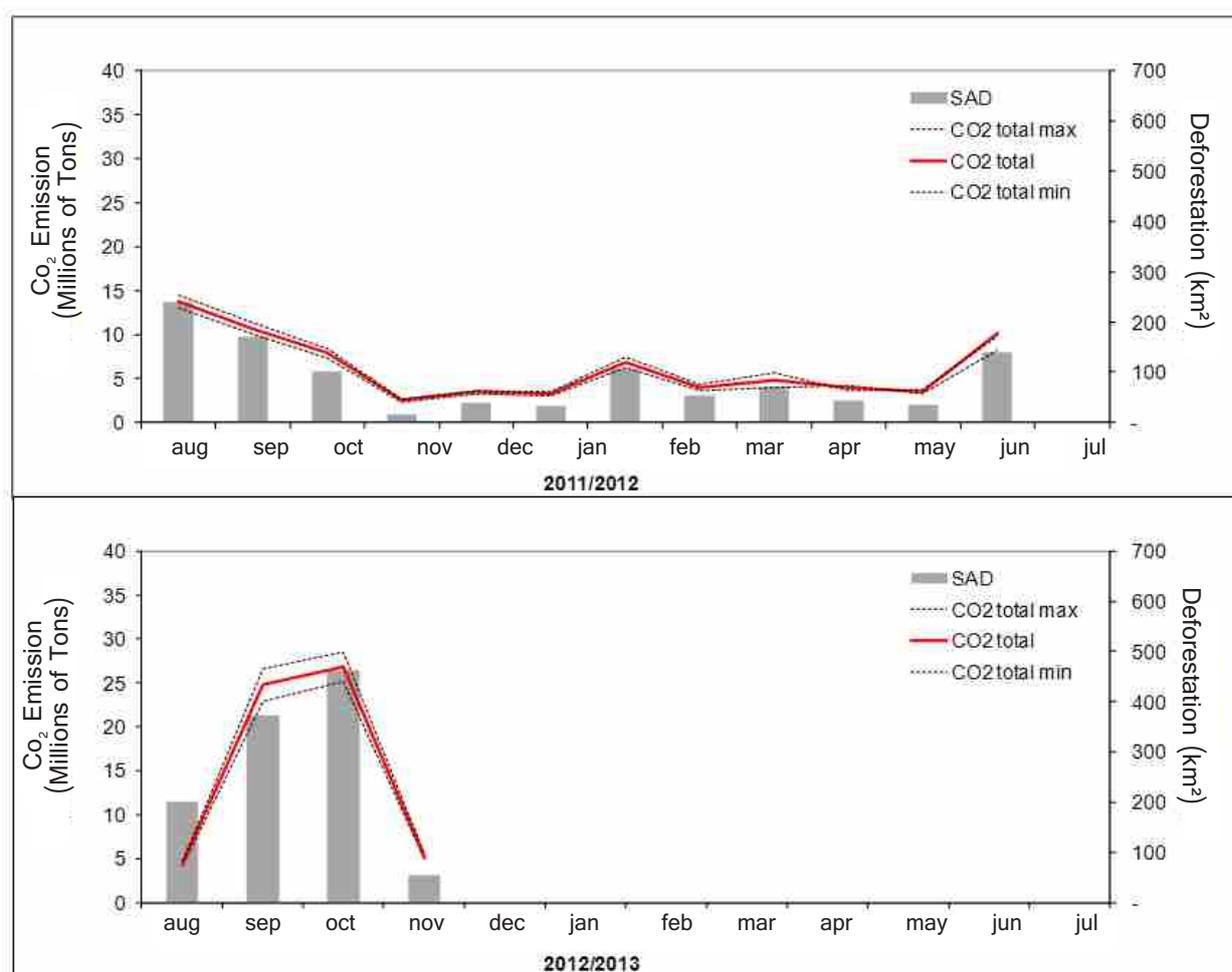


Figure 6: Deforestation and emissions of total equivalent carbon dioxide (CO₂) from August 2011 to November 2012, in Legal Amazon (Source: Imazon).

Deforestation Geography

In November 2012, most (56%) of deforestation took place either in private areas or under different stages of ownership. The remaining

deforestation was registered in Conservation Units (1%), Indigenous lands (1%) and Land Reform Settlements (42%) (Table 3).

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

Category	December 2012	
	km ²	%
Agrarian Reform Settlement	23	42
Conservation Units	0,5	1
Indigenous Lands	0,5	1
Private, Owned and in Abeyance ³	31	56
Total (km²)	55	100

Agrarian Reform Settlements

SAD has recorded 23 square kilometers of deforestation in Agrarian Reform Settlements in November 2012 (Figure 7). The 10 settlements affected the most by deforestation were PA Monte (Lábrea; Amazonas), PA Igarapé Azul (Nova Mamoré, Rondônia), PA Rio Juma (Apuí, Amazonas), PA

Cruzeirão (Óbidos, Pará), PA Surubim (Medicilândia, Pará), PAE Guariba-Aripuanã (Nova Aripuanã, Amazonas), PA Serra Grande (Costa Marques, Rondônia), PA Pau Brasil (Nova Mamoré, Rondônia), PA Bom Sucesso (São Luís, Roraima) and PA Paraíso (Rurópolis, Pará).

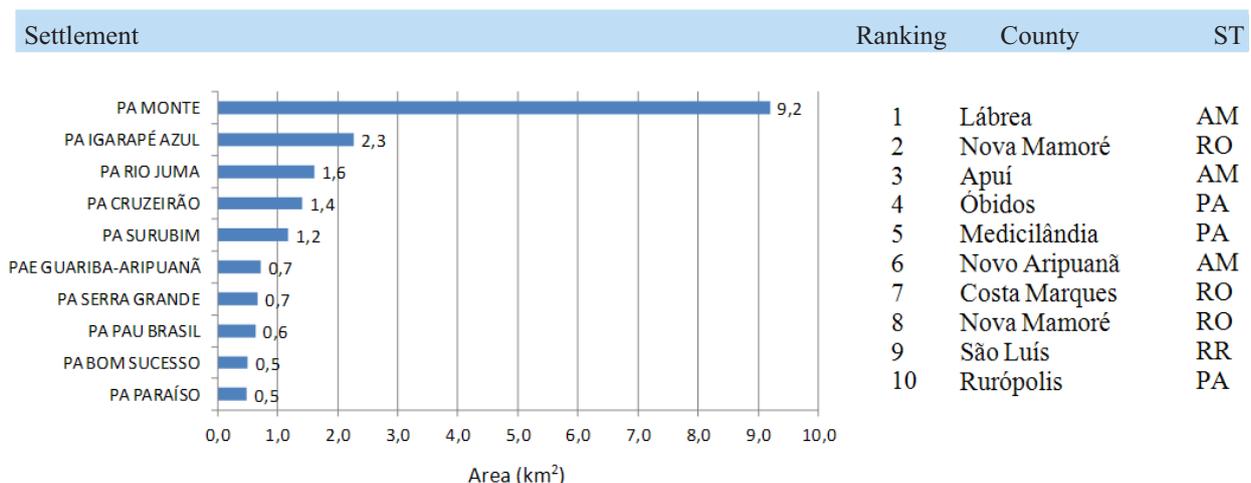


Figure 7: Agrarian Reform Settlements deforested the most in November 2012 in Legal Amazon (Source: Imazon/SAD).

³ includes private areas (titled or not) and unprotected public forests.

Protected Areas

In the month of November, due to the high clouds covering, SAD has detected 0.5 square km of deforestation only in the FLONA do Jamanxim (Pará). As far as

Indigenous Lands are concerned, in November 2012, a deforestation of 0.5 square km was identified in the Lands of Cachoeira Seca do Iriri (Pará) e Karipuna (Rondônia).

Critics Counties

In November 2012 the counties deforested the most were: Nova Mamoré (Rondônia) and Lábrea

(Amazonas) (Figures 8 and 9).

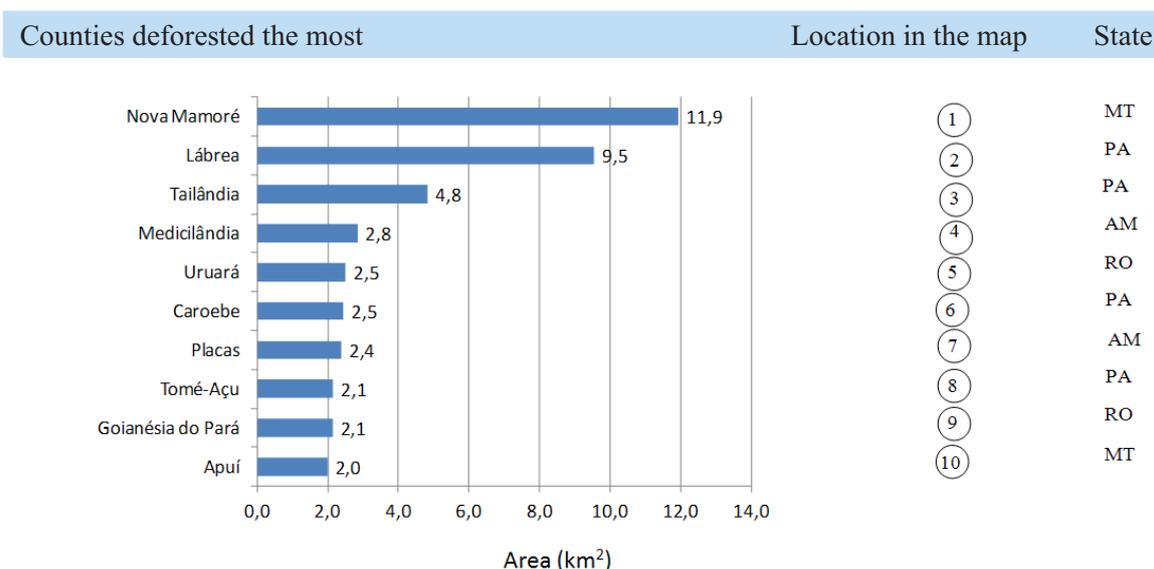


Figure 10: Counties deforested the most in Legal Amazon in November 2012 (Source: Imazon/SAD).

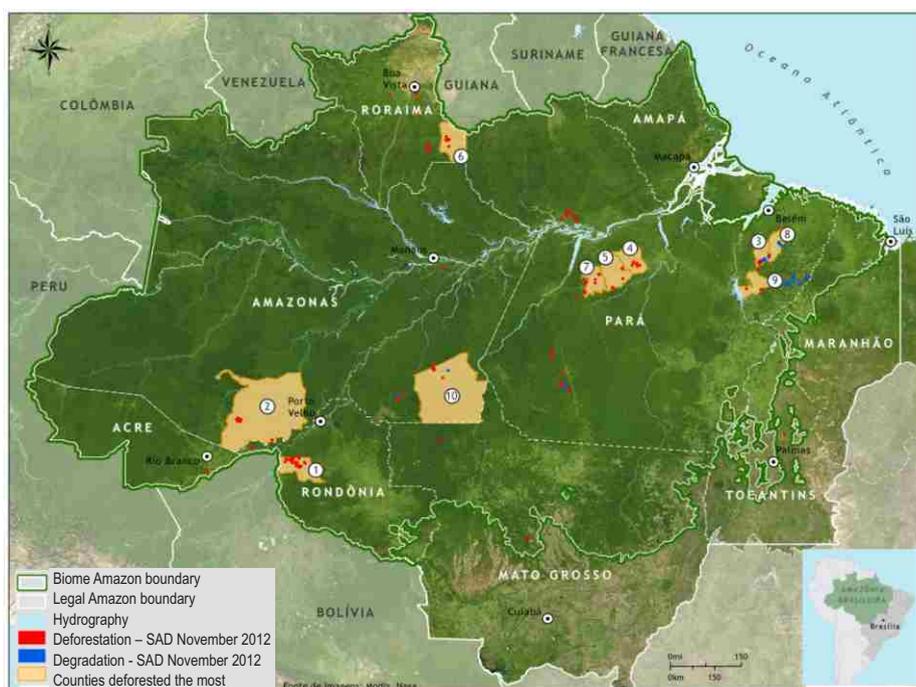


Figure 11: Counties deforested the most in November 2012 (Source: Imazon/SAD).

Coverage by clouds and Shade

In November 2012, it was possible to monitor, along with SAD, 50% of Legal Amazon forest area. The remaining 50% of forest territory were covered by clouds what hampered the detection of deforesting and forest degradation. The states with larger clouds

coverage were: Acre (81%), Mato Grosso (77%), Rondônia (76%) and Amapá (67%). In virtue of that, data related to both deforestation and forest degradation in November 2012 may be underestimated (Figure 10).

*The part of the state of Maranhão, that integrates Legal Amazon, was not analyzed.

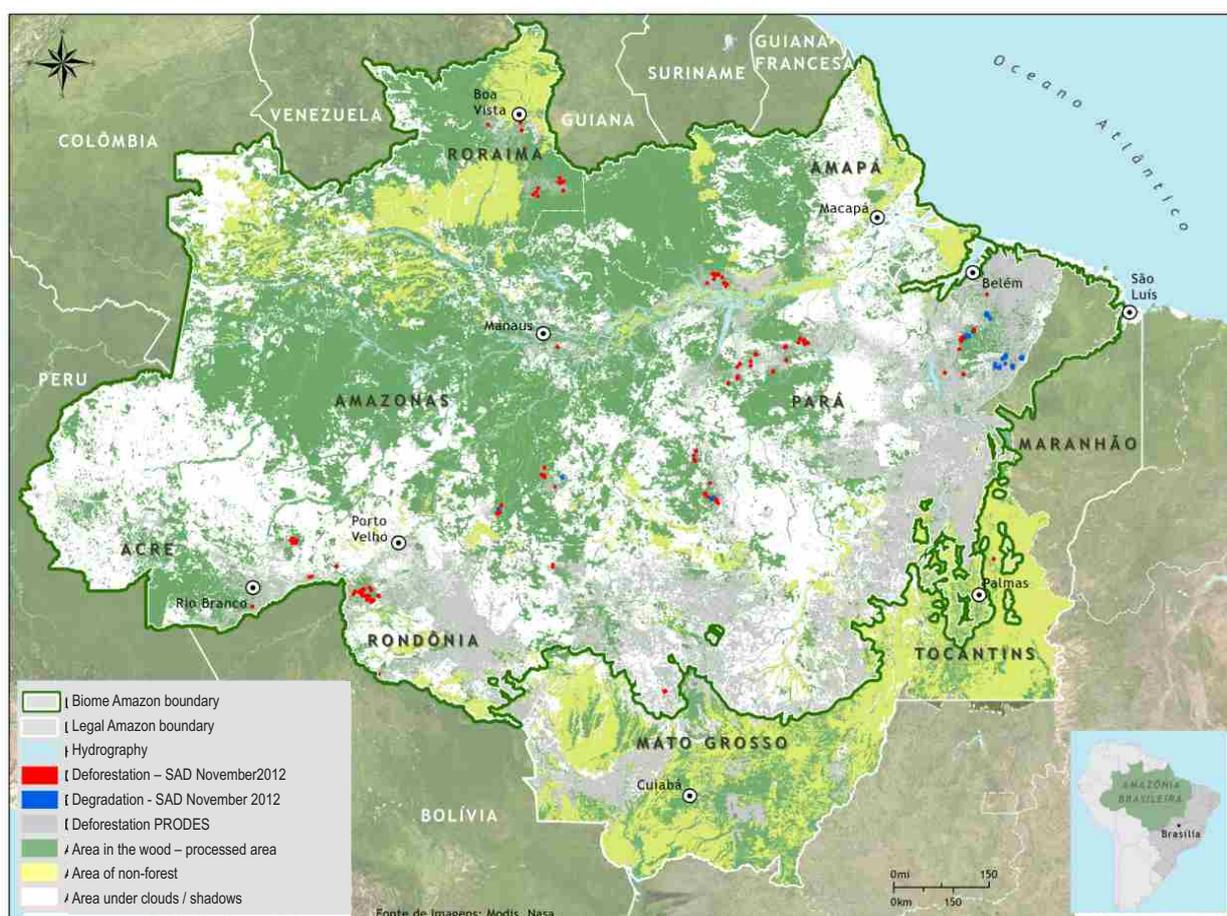


Figure 12: Area covered by clouds and shadows in November 2012 in Legal Amazon.

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.

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.

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:

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 – undergoing preparation.

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.

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)