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ABSTRACT

In September 2010, SAD detected 170 square kilometers of deforestation in Legal Amazon. This represented a 21% reduction in relation to September 2009 when the deforestation reached 216 square kilometers.

The accumulated deforestation from August 2010 to September 2010 has totalized 380 square kilometers. Comparing with the previous period from August 2009 to September 2009 when the deforestation reached 489 square kilometers there was a reduction of 22%.

In September 2010 approximately 48% of deforestation occurred in Mato Grosso. The rest occurred in (18%) followed by Rondônia (14%), Amazonas (11%), Acre (7%), Roraima (1%) and Tocantins (1%).

The accumulated deforestation from August 2010 to September 2010 resulted in a commitment of 6 million tons of CO₂ equivalents, which are subject to direct and future emissions by burning and decomposition. It represents a reduction of 25% in relation to the previous period (August 2009 to September 2009) when forest carbon affected by deforestation was about 29 million tons of CO₂ equivalent.

The degraded forests in Legal Amazon totaled 500 square kilometers in September 2010. Comparing with the previous period of September 2009 there was an increase of 141% when the forest degradation totaled 202 square kilometers. The Forest degradation occurred especially in Mato Grosso (85%).

The forest degradation accumulated from August 2010 to September 2010 totaled 2.055 square kilometers. It represented an extremely expressive increase (213%) comparing with the previous period (August 2009 to September 2009) when the forest degradation totaled 657 square kilometers.

In September 2010, it was possible to monitor with SAD 83% of the area with forest coverage in Legal Amazon.

Deforestation Statistics

According to the Imazon's Deforestation Alert System (SAD), the deforestation, (i.e., the areas with clearcut, i.e., total suppression of the Forest with soil exposition) in September 2010 at Legal Amazon has reached 170 square kilometers (Figure 1 and Figure 2). This represented a 21% reduction in September's 2010 deforestation regarding the deforestation detected in September 2009 when it reached 216 square kilometers.



Forest Transparency

Legal Amazon

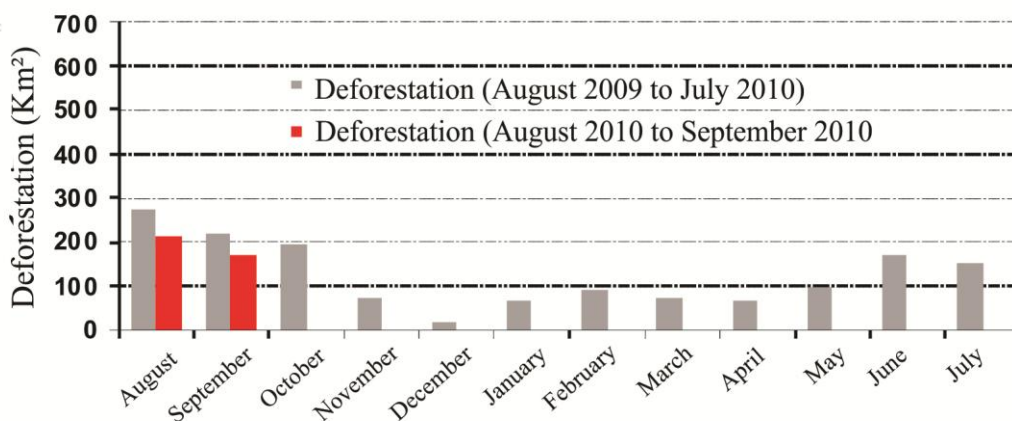


Figure 1. Deforesting from August 2009 to September 2010 in Legal Amazon (Source: Imazon/SAD).

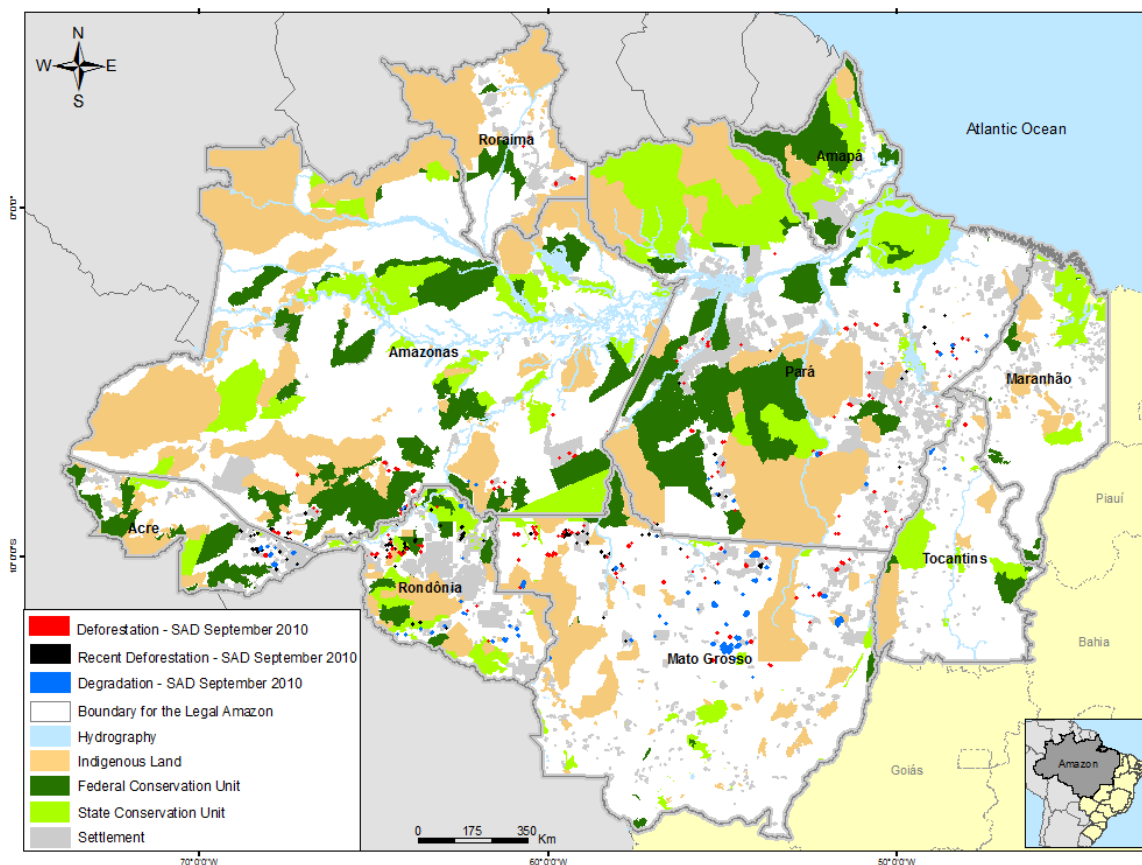


Figure2. Deforesting and Forest Degradation in September 2010 at Legal Amazon (Source: Imazon/SAD).

The deforestation accumulated in the period of August 2010 and September 2010, corresponding to the two first months of the official calendar of Deforestation measuring, has reached 380 square kilometers. It represents a drop of 22% in the accumulated deforestation of this period (August 2009 to September 2010) in relation to the same period of the previous year (August 2009 to September 2009) when the deforestation totaled 489 square kilometers.

In September 2010 approximately 48% of the deforestation occurred in the State of Mato Grosso. Followed by Pará with 18%, Rondônia with 14%, Amazonas with 11% and Acre 11%. The rest occurred in Tocantins (1%) and Roraima (1%). (Figure 3).

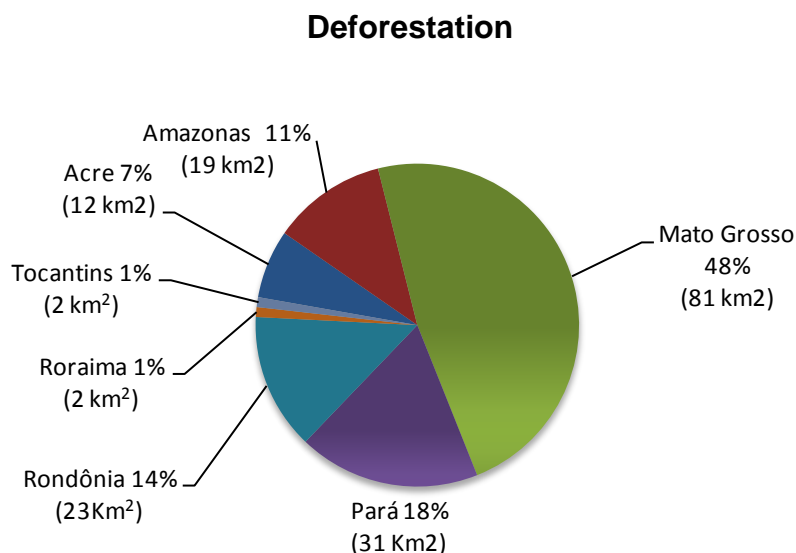


Figure 3. Deforestation (%) in the States of Legal Amazon in September 2010 (Source: Imazon/SAD).

Considering the first two months of the current deforestation calendar (August 2010 to September 2010), Pará leads the deforestation ranking with 46% of the total deforestation registered in the period. It is followed by Mato Grosso with 28%, Amazonas with 11% and Rondônia with 9%. These four states were responsible for 93% of the deforestation occurred in Legal Amazon during this period. Negative emphasis in the increase in the participation of Amazonas in the total composition of deforestation in Legal Amazon, overcoming the State of Rondônia. The others 7% of total deforestation occurred in Acre, Roraima, Amapá, and Tocantins.

Comparing the deforestation occurred in August 2010 to September 2010 with the same period of the previous year (August 2009 to September 2009), there was a reduction of 22% in the deforestation of Legal Amazon (Table 1). In relative terms, this reduction was more expressive in Roraima (-80%), followed by Rondônia (-47%), Amazonas (-37%) and Pará (-36%). On the other hand, there was an increase of 98% in Mato Grosso and 14% in Acre.

In absolute terms, Pará leads the accumulated deforestation ranking with 174 square kilometers, followed by Mato Grosso (105 square kilometers), Amazonas (40 square kilometers), Rondônia (34 square kilometers) and Acre (24 square kilometers).

Table 1. Evolution of the deforestation between the States of Legal Amazon from August 2009 to September 2009 and from August 2010 to September 2010 (Source: Imazon/SAD).

State	August 2009 to September 2010	August 2010 to September 2010	Variation (%)
Acre	21	24	+ 14
Amazonas	63	40	- 37
Mato Grosso	53	105	+ 98
Pará	270	174	- 36
Rondônia	64	34	- 47
Roraima	9	2	- 80
Tocantins	-	2	-
Amapá	9	-	-
Total	489	380	- 22

*Data from Maranhão were not analyzed.

Forest Degradation Statistics

In September 2010, SAD registered 500 square kilometers of degraded forests (forests intensely explored by wood and/or burning activities) (Figures 2 and 4). It corresponds to a significant increase of 147% regarding the same period of the previous year (September 2009) when the forest degradation totaled 202 square kilometers. From this total, the majority (85%) of this degradation occurred in Mato Grosso, followed by far by Pará (4%), Rondônia (4%), Acre 93%) and Amazonas (1%) (Figure 5).

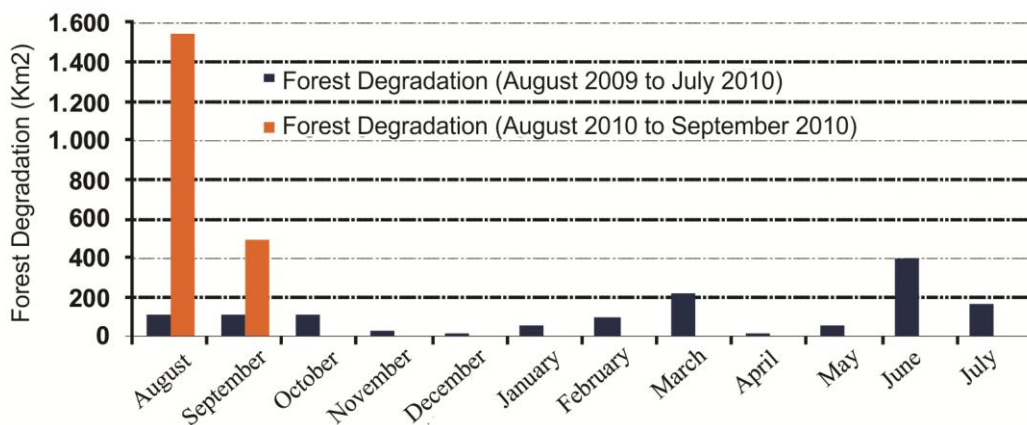


Figura 4. Forest Degradation from August 2009 to September 2010 in Legal Amazon (Source: Imazon/SAD).

Forest Degradation

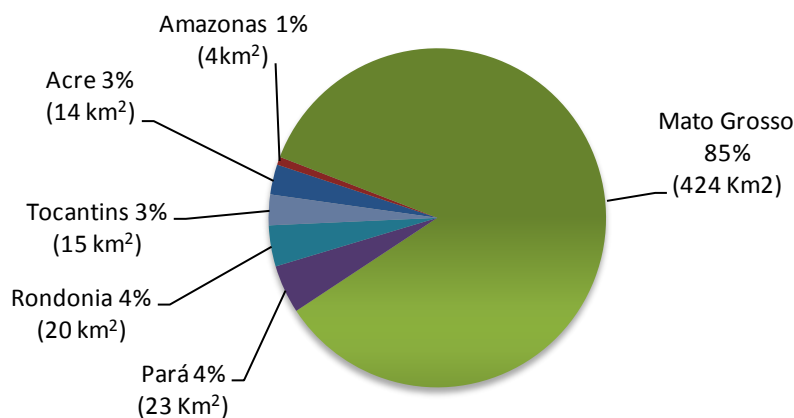


Figura 5. Forest Degradation (%) of the States of Legal Amazon in September 2010 (Source: Imazon/SAD).

The forest degradation accumulated from August 2010 to September 2010¹ (first two months of the official deforestation measurement calendar), totaled 2.055 square kilometers. It represents an extremely expressive increase of 213% in the forest degradation accumulated in this period (August 2010 to September 2010) in relation to the same period of the previous year (August 2009 to September 2009) when forest degradation totaled 657 square kilometers (Table 2). Tocantins presented in relative terms and expressive increase of 2.448%, however, in absolute terms the increase was not expressive raising from 1 square kilometer between August 2009 and September 2009 to 21 square kilometers from August 2010 to September 2010. Other states also contributed to the increase in forest degradation: Mato Grosso (+ 318%), Amazonas (+194%), Pará (+142%), and Rondônia (136%).

Mato Grosso leads the ranking with 55% of the total degraded forest areas accumulated from August 2010 to September 2010. Next comes Pará with 30% and Rondônia with 10%. These three states were responsible for 95% of the forest degradation in Legal Amazon during this period. The other 5% occurred in Amazonas, Acre and Tocantins.

In absolute terms, Mato Grosso lead the accumulated forest degradation ranking with 1.135 square kilometers followed by Pará (614 square kilometers), Rondônia (209 square kilometers), Amazonas (51 square kilometers), Acre (25 square kilometers) and Tocantins (21 square kilometers).

Table 2. Evolution of the forest degradation between the states of Legal Amazon from August 2009 to September 2009 and from August 2010 to September 2010 (Source: Imazon/SAD).

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

State	August 2009 to September 2010	August 2010 to September 2010	Variation (%)
Acre	20	25	+ 27
Amazonas	17	51	+ 194
Mato Grosso	272	1.135	+ 318
Pará	254	614	+ 142
Rondônia	89	209	+ 136
Roraima	4	-	-
Tocantins	1	21	+ 2.448
Amapá	1	-	-
Total	657	2.055	+ 213

*Data from Maranhão were not analyzed.

Carbon Affected by Deforestation

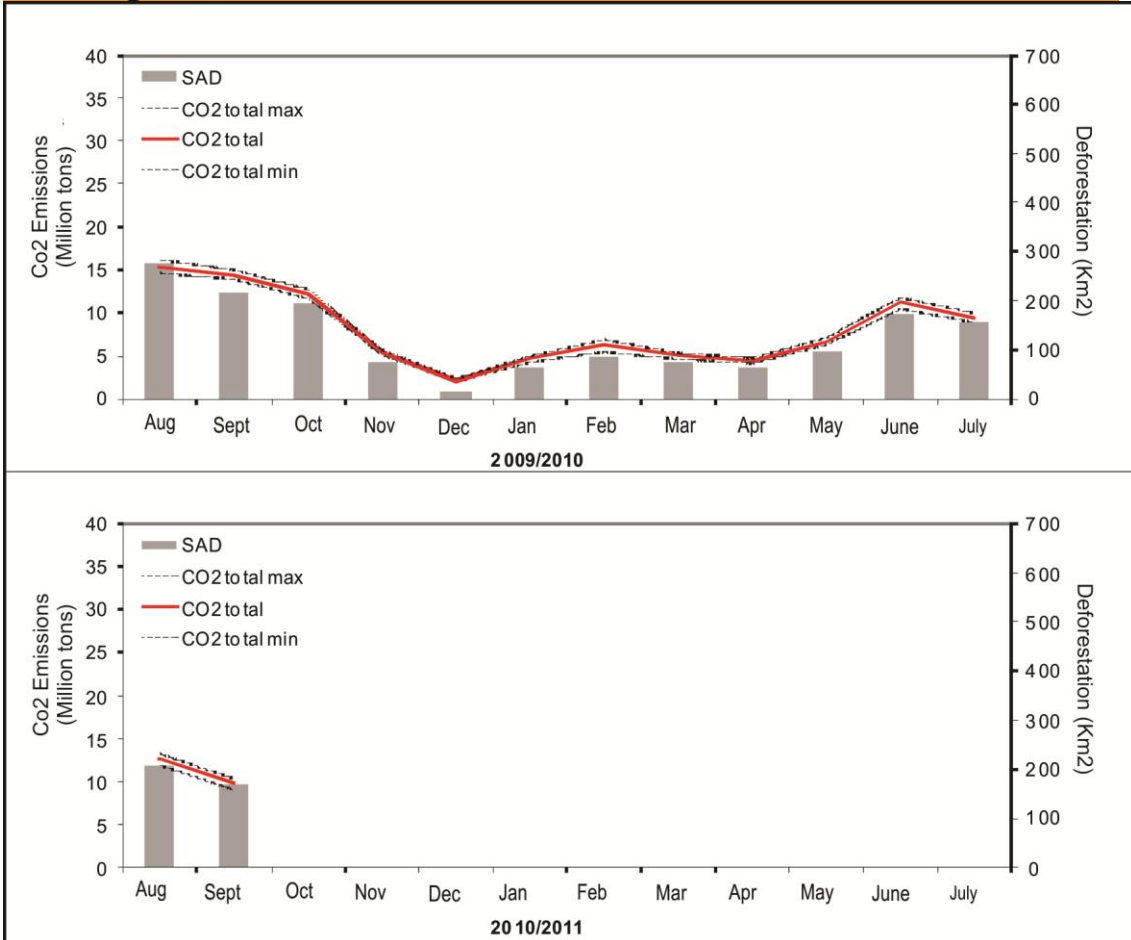
Since January 2010 we reported the estimates of compromised carbon (i.e., forest carbon subject to the emissions due to burnings and decomposition of residues of the forest biomass) from the deforestation detected by SAD in the Legal Amazon. Information about the method on the estimate of compromised forest carbon by deforestation is summarized on Board II.

In September 2010, the 170 square kilometers of deforestation detected by SAD in Legal Amazon compromised 2,6 million tons (with margin of error of 361 thousand tons) of carbon. This amount of affected carbon results in 9,5 million tons of CO² equivalent (Figure 6). It represents a drop of 13% in relation to September 2009 when the affected forest carbon was 3,9 million tons.

The compromised forest carbon by the deforestation from August 2010 to September 2010 (two first months of the current deforestation calendar) was 6 million tons (with margin of error of 704 thousand tons), which represented approximately 22 million tons of CO² equivalent (Figure 6). In relation to the same period of the previous year (August 2009 to September 2009) there was a 25% reduction on the amount of compromised carbon by deforestation. The same occurred in the relative reduction of the forest carbon affected by deforestation which was also 22% comparing both periods.

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Legal Amazon



Figur6. Deforestation and Carbon Dioxide Emissions (CO₂) total equivalent from August 2009 to September 2010 in legal Amazon (Source: Imazon).

Geography of Deforestation

Regarding the land title status, in September 2010, the majority (75%) of deforestation occurred in areas under different stages of ownership. The remaining deforestation was registered in Agrarian Reform settlements (14%), followed by Conservation Units (9%) and Indigenous Lands (2%) (Table 3).

Table 3. Deforestation by land title category in September 2010 in Legal Amazon (Source: Imazon/ SAD).

Category	September 2010	
	km ²	%
Agrarian Reform Settlements	24	14
Conservation Units	15	9
Indigenous Lands	3	2
Private, Owned and Vacant ²	128	75
Total (km²)	170	100

Agrarian Reforms Settlements

SAD registered 24 square kilometers in the Agrarian Reform Settlements during September 2010. The most affected settlements by deforestation were Santa Terezinha II (Nova Ubiratã; Mato Grosso), Monte (Lábrea; Amazonas), and Tocantins (Boca do Acre; Amazonas) (Figure 7).

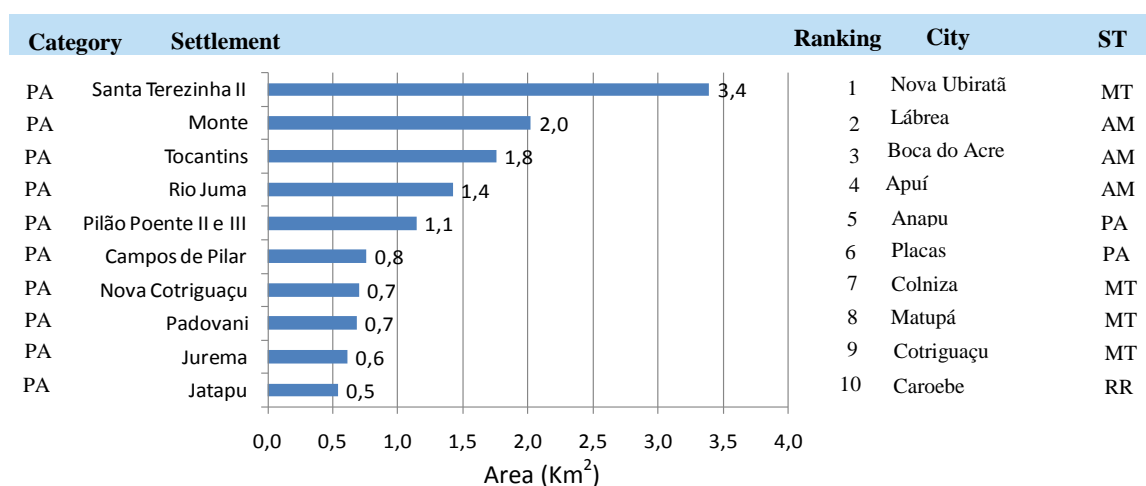


Figure 7. Most affected Agrarian Reform Settlements in September 2010 in Legal Amazon (Source: Imazon/SAD).

² Includes private areas (titled or not) and non protected public forests.

Protected Areas

SAD detected 15 square kilometers of deforestation in Conservation Unit (Figure 8). The Conservation Units which suffered more deforestation are located in Rondônia: Resex do Rio Jaci-Paraná, Flona do Bom Futuro and Florsu Mutum.

In the case of Indigenous Lands in September 2010 only three square kilometers were detected. The most affected ones were Jacareúba/Katawixi (Amazonas), Kayabi (Pará) and Zoró (Mato Grosso) (Figure 9).

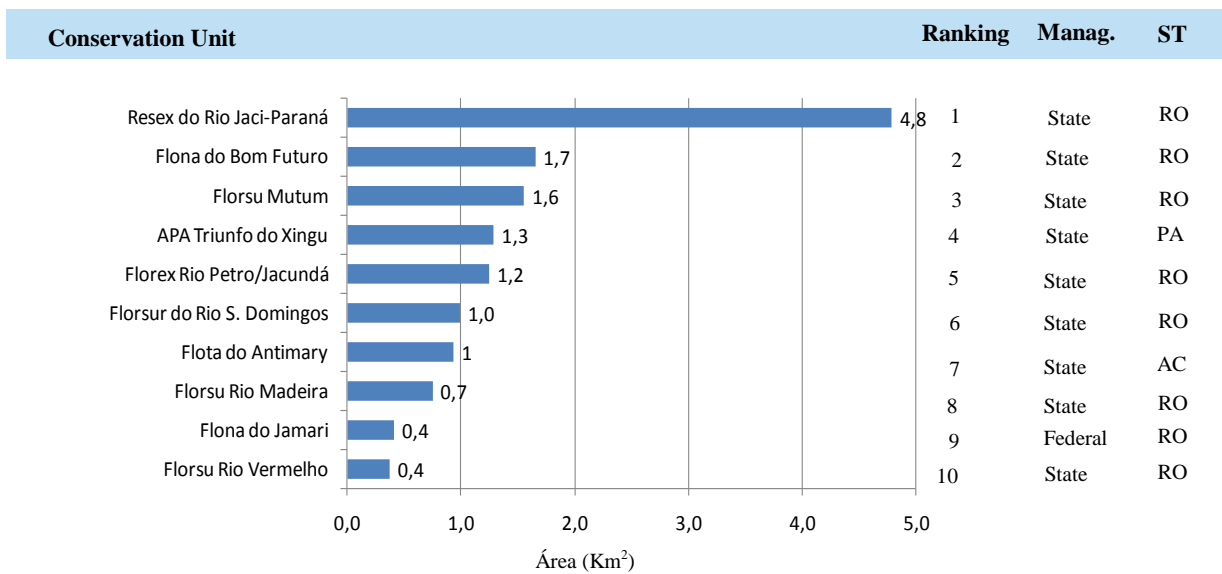


Figure 8. Most Affected Conservation Units in Legal Amazon In September 2010 (Source: Imazon /SAD).

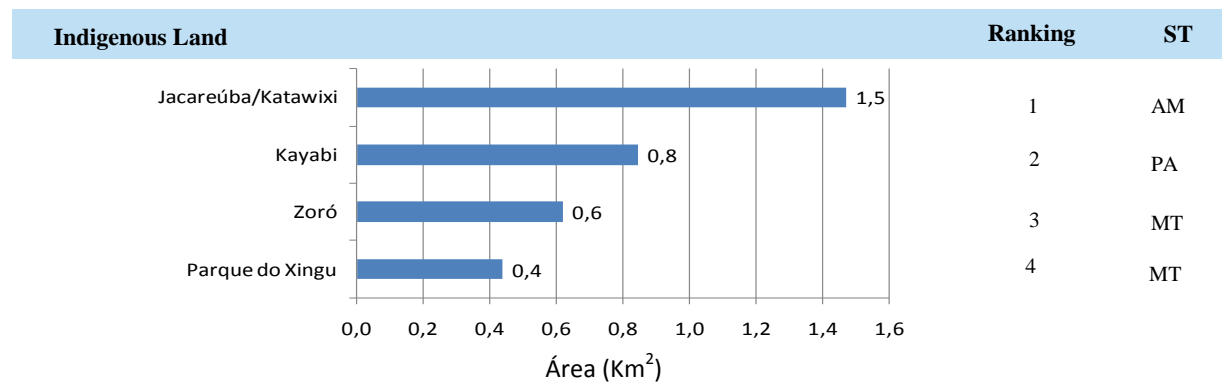


Figure 9. Most affects Indigenous Lands in Legal Amazon in September 2010 (Source: Imazon /SAD).

Critical Cities

In September 2010, the most affected cities were: Colniza (Mato Grosso), Feliz Natal (Mato Grosso) and Porto Velho (Rondônia) (Figure 10 and 11).

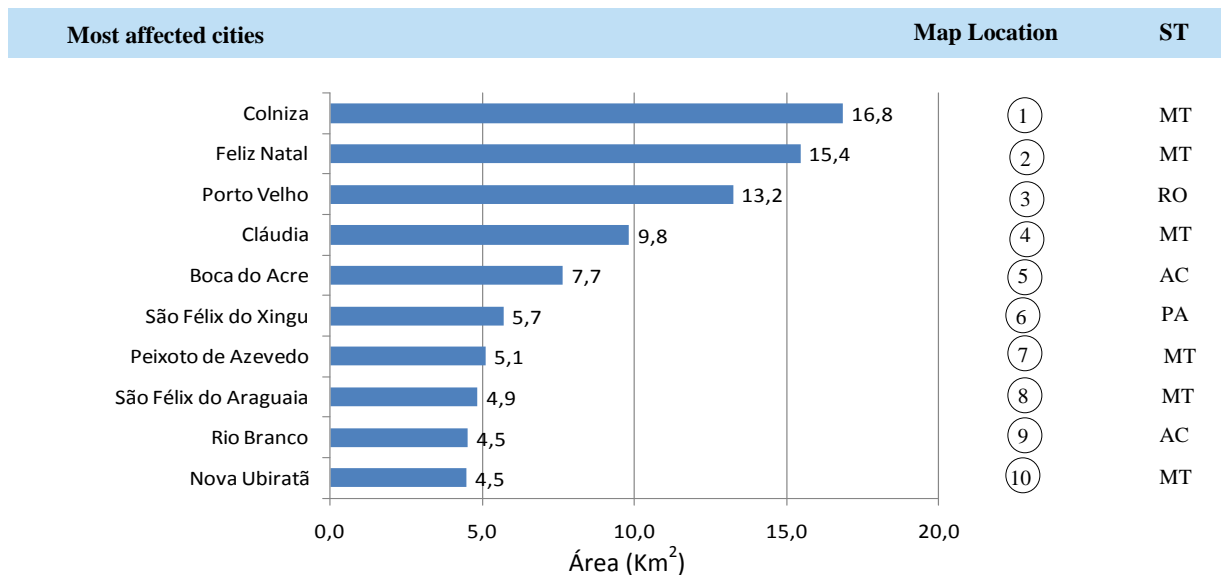


Figure 10. Most affected cities in Legal Amazon in September 2010 (Source: Imazon /SAD).

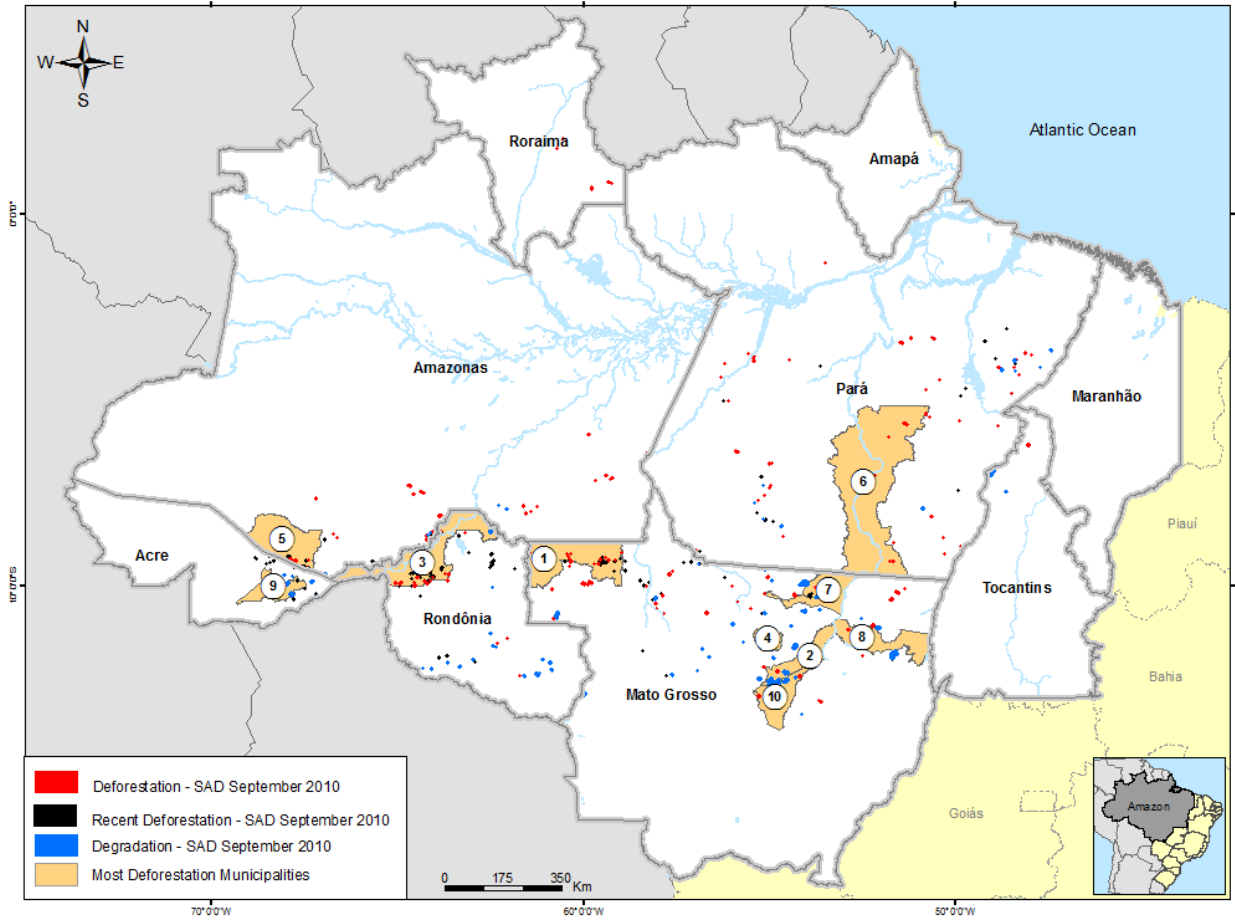


Figure 11. Most affected cities in September 2010 (Source: Imazon/SAD).

Cloud and Shade Cover

In September 2010, it was possible to improve 83% of the area with forest cover in Legal Amazon, since only 17% of the area was covered by clouds (Figure 12).

* The area of Maranhão which integrates Legal Amazon was not analyzed.

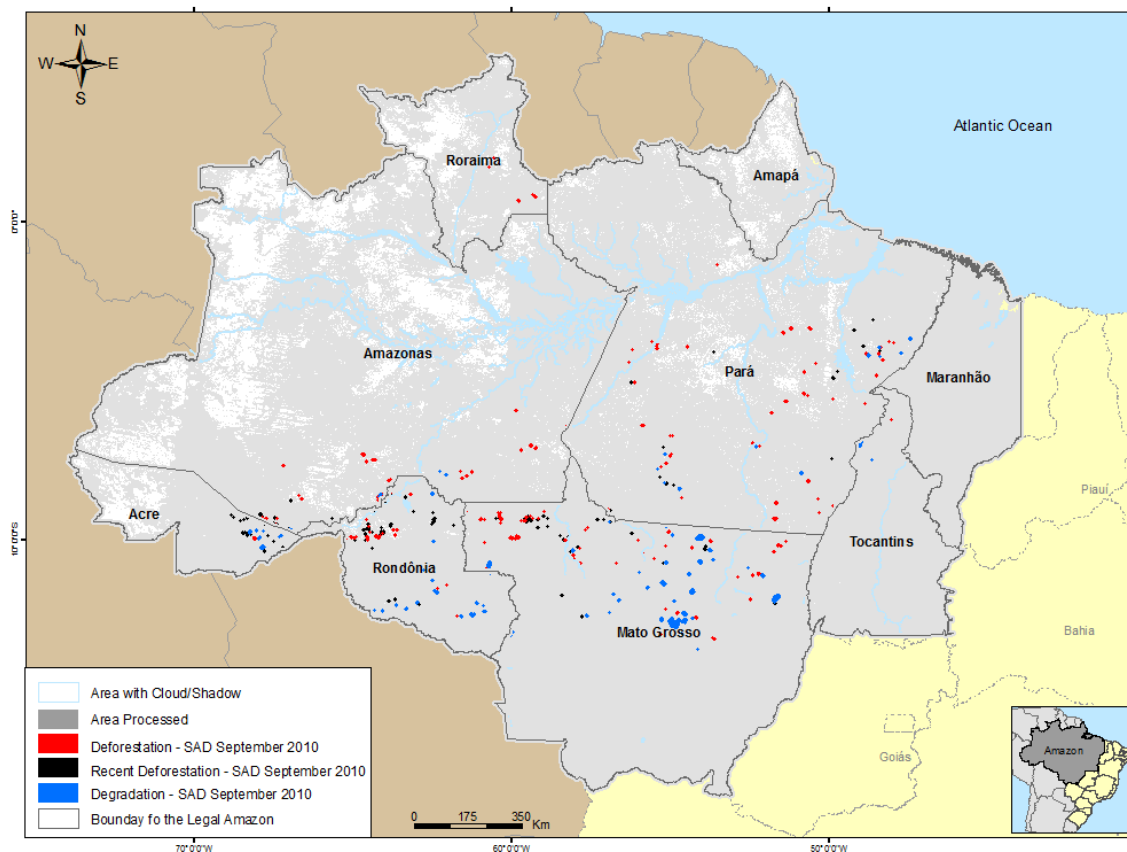


Figure 12. Area with cloud and shade in September 2010 in Legal Amazon.

SAD Data Validation using Landsat and Cbers Images

The SAD data are validated with CBERS and Landsat Images (finer space resolution) available by the Instituto Nacional de Pesquisas Espaciais – National Space Research Institute (Inpe). The available images are used right after the analyzed month by SAD. All the deforestation polygons detected by SAD are verified using detailed images. Deforestations smaller than 6,25 hectares, i.e., below the SAD’s detection capacity are not included in the statistics, in case they are detected in the more detailed resolution. However, if it is confirmed that they are false deforestation signs by SAD, they are removed from the monthly statistics.

In September 2010, 85% of the deforestation detected by SAD was confirmed with Landsat images (Figure 13). The other 15% were not confirmed due to the great occurrence of clouds in the Landsat and CBERS images available at the period.

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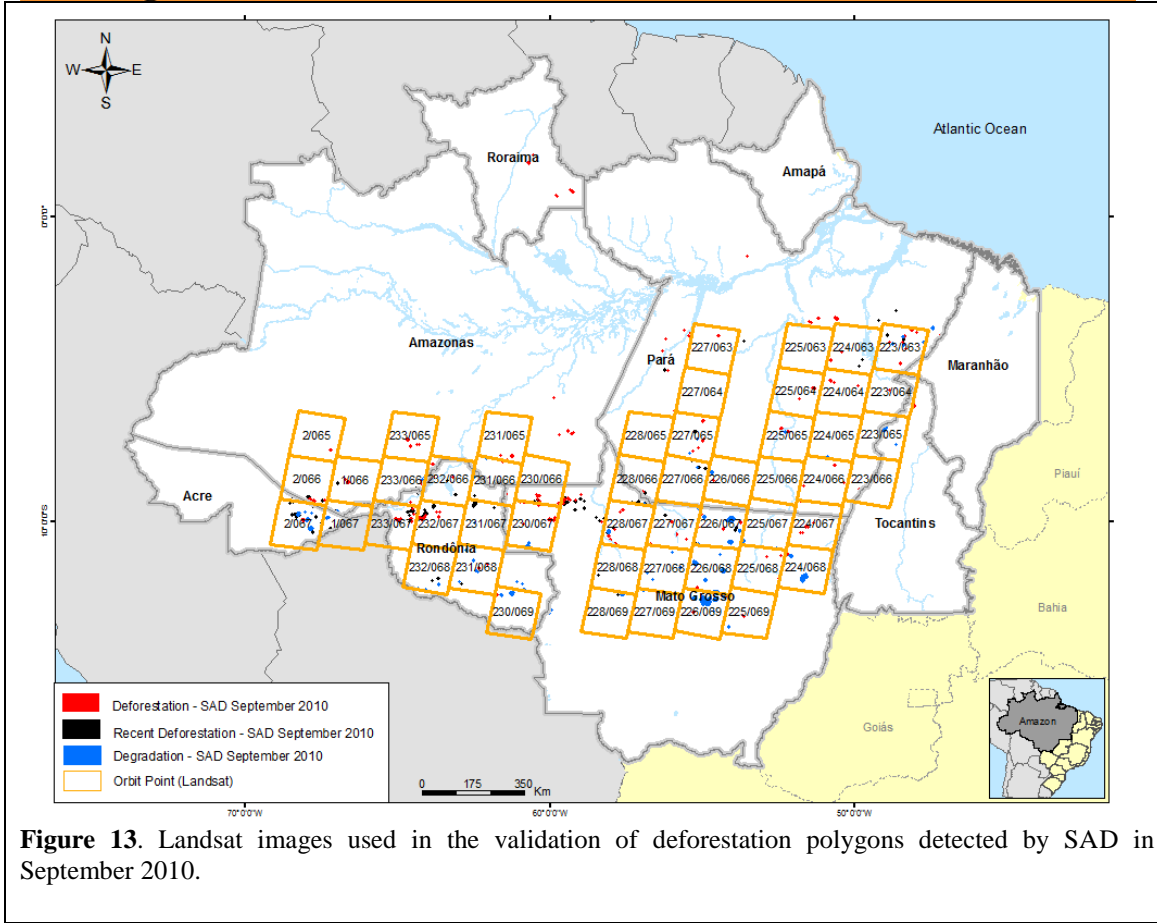


Figure 13. Landsat images used in the validation of deforestation polygons detected by SAD in September 2010.



Board I: SAD 3.0

Since August 2009, SAD has presented some news. First we created a graphic interface to integrate all the image processing programs used in the SAD. Second, we started recording the deforestation in areas covered by clouds in the previous months in a new class. Last, the deforestation and degradation are detected with image pairs NDFI in a change detection algorithm. The main method is still the same as SAD 2 as described below.

SAD generates the daily image time mosaic MODIS of the MOD09GQ and MOD09GA products for the filtering of the clouds. Next, we use a fusion technique of bands in different spectral resolutions, i.e., with pixels of different sizes. In this case we changed the scale of the 5 bands with 500 meter pixels of MODIS for 250 meters. It allowed us to improve the spectral model of pixel mix, providing a capacity of estimating the abundance of the vegetation, Soils and Non-Photosynthetic vegetation (NPV) components (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 per shade given by:

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

O NDFI varia de -1 (pixel com 100% de solo exposto) a 1 (pixel com > 90% com vegetação florestal). Dessa forma, passamos a ter uma imagem contínua que mostra a transição de áreas desmatadas, passando por florestas degradadas, até chegar a florestas sem sinais de distúrbios.

A detecção do desmatamento e da degradação passou esse mês com a diferença de imagens NDFI de meses consecutivos. Dessa forma, uma redução dos valores de NDFI entre -200 e -50 indica áreas possivelmente desmatadas e entre -49 e -20 com sinais de degradação.

O SAD 3.0 Beta é compatível com as versões anteriores (SAD 1.0 e 2.0), porque o limiar de detecção de desmatamento foi calibrado para gerar o mesmo tipo de resposta obtida pelo método anterior.

O SAD já está operacional no Estado de Mato Grosso desde agosto de 2006 e na Amazônia Legal desde abril de 2008. Nesse boletim, apresentamos os dados mensais gerados pelo SAD de agosto de 2006 a setembro de 2010.

Board II: Carbons affected by deforestation

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:

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

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

$$BPF = ff * AGLB$$

$$BAS_0 = bf * AGLB$$

where:

t: time (month)

C_t : Carbon emitted in 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.



Notes:

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Team: Marcio Sales (Modeling and Statistics), Rodney Salomão, Amintas Brandão Jr., João Victor (Geoprocessing) e Adriana Fradique (Communication)

Data Sources:

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

INPE Data- Deforestation (PRODES)

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

Support

Fundação David & Lucille Packard

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Fundo Vale

Partnerships:

Secretaria de Estado de Meio Ambiente do Pará (SEMA)

Secretaria de Meio Ambiente do Mato Grosso (SEMA)

Ministério Público Federal do Pará

Ministério Público Estadual do Pará

Ministério Público Estadual de Roraima

Ministério Público Estadual do Amapá

Ministério Público Estadual de Mato Grosso

Instituto Centro de Vida (ICV- Mato Grosso)