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SUMMARY

In September 2011, SAD detected 170 square kilometers of deforestation in Legal Amazon. This value was equivalent to the detected deforestation in September 2010. From this total, 46% occurred in Pará, followed by Rondônia (24%), Mato Grosso (17%), Amazonas (9%), and the rest in Acre, Roraima and Tocantins. ON its turn, the cities that suffered the most with deforestation were Altamira (PA) and Porto Velho (RO).

The deforestation accumulated in the period of August 2011 to September 2011, corresponding to the first two months of the current Deforestation Calendar, has reached 410 square kilometers. There was light 8% increase regarding the same previous period (August 2010 to September 2010) when the deforestation totaled 380 square kilometers.

The degraded forests in Legal Amazon totaled 658 square kilometers in September 2011. Regarding September 2010 there was an expressive increase of 33% when the forest degradation totaled 496 square kilometers.

The great majority (79%) occurred in Mato Grosso, followed by far by Pará (15%), Rondônia (5%), and the rest in Amazonas and Acre. The forest degradation accumulated in the period of August 2011 to September 2011 totaled 789 square kilometers. Regarding the previous period (August 2010 to September 2010) there was an expressive increase of 61%, when the forest degradation totaled 2.040 square kilometers.

In September 2011, the deforestation detected by SAD compromised 10,6 million tons of equivalent CO2, which represents an 10.5% increase regarding September 2010. In the accumulated period (August 2011 – September 2011) the equivalent C02 emissions compromised by the deforestation totaled 24 million tons, which represents a 10% increase regarding the previous period (August 2010 to September 2010).

In September 2011, the coverage of clouds was reduced and with that, it was possible to monitor 74% of legal Amazon.

Deforestation Statistics

According to the Imazon's Deforestation Alert System (SAD), the deforestation, (i.e., the total suppression of the forest with soil exposition) in September 2011 at Legal Amazon has reached 173 square kilometers (Figure1 and Figure 2). This was equivalent to the deforestation detected in September 2010 (170 square kilometers).

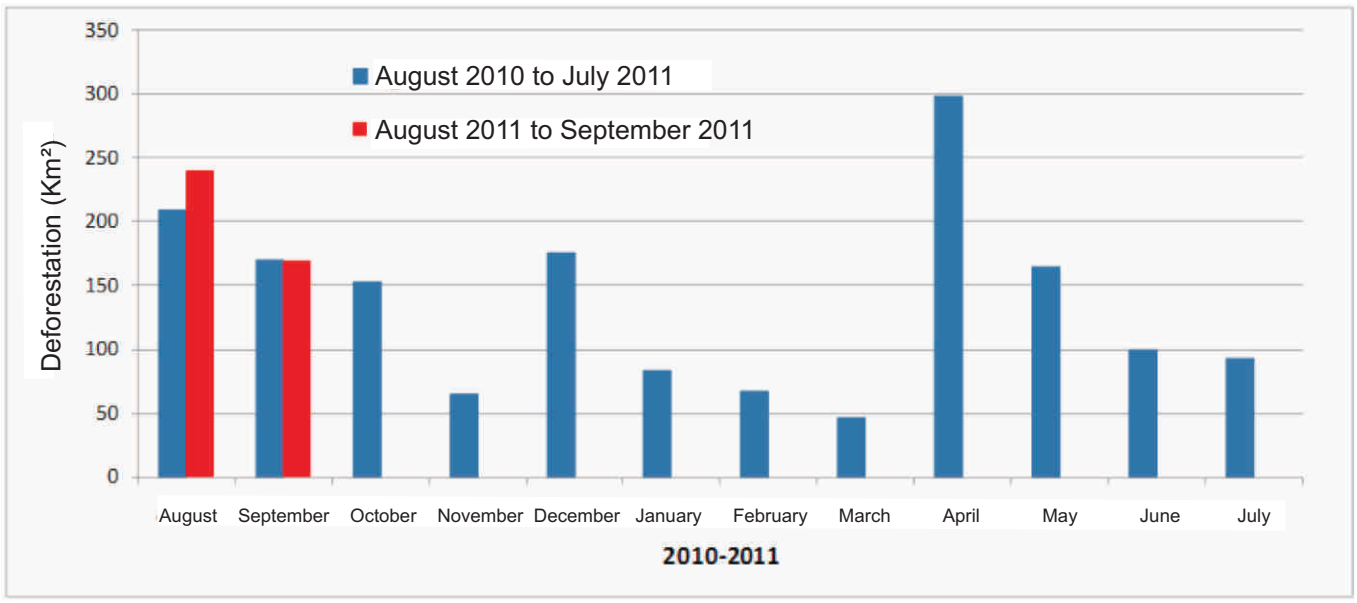

Figure 1. Deforesting from August 2010 to September 2011 in Legal Amazon (Source: Imazon/SAD).

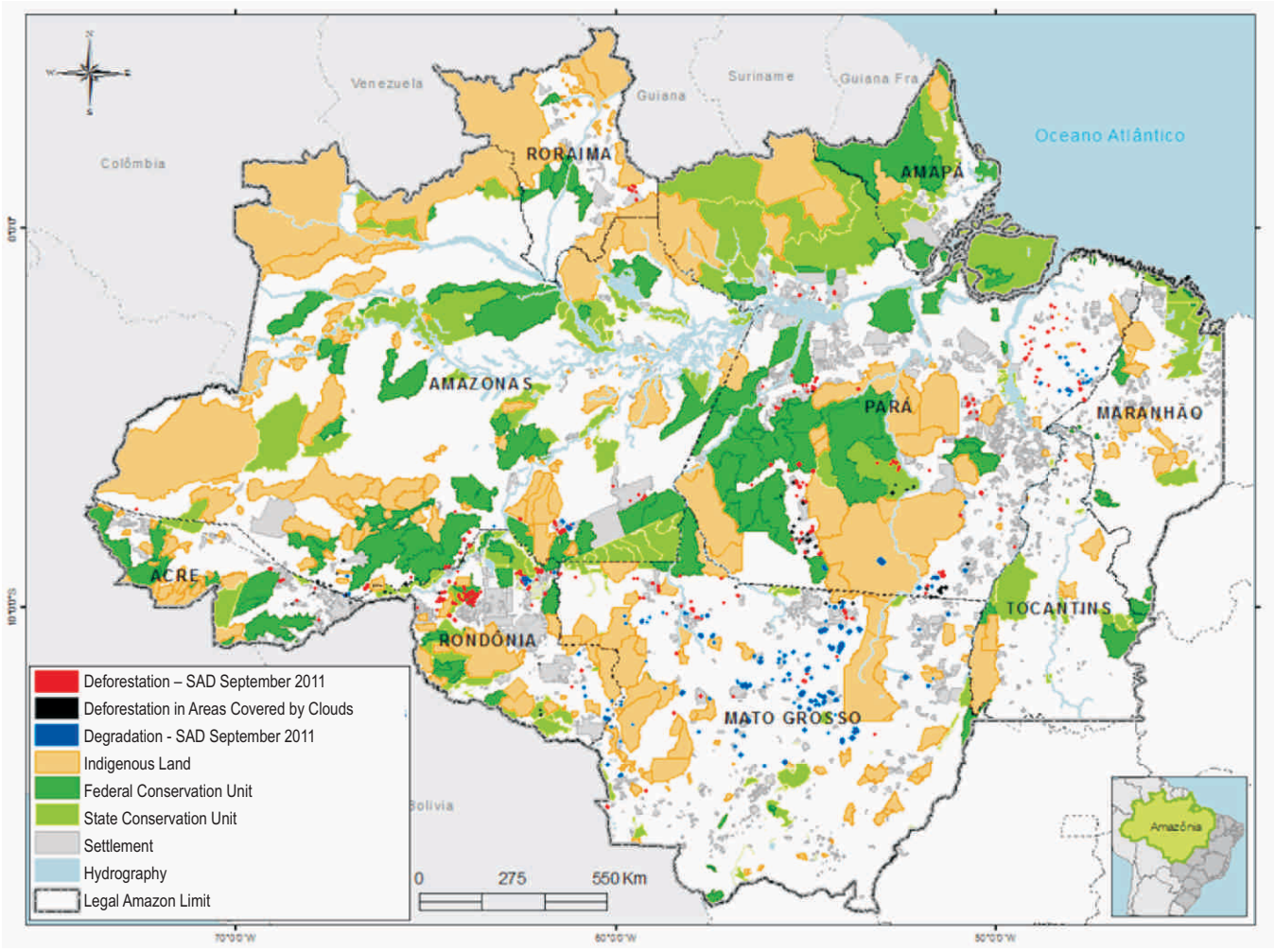

Figure2. Deforesting and Forest Degradation in September 2011 at Legal Amazon (Source: Imazon/ SAD).

*The deforestation in areas covered by clouds 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 and September 2011, corresponding to the two first months of the official calendar of Deforestation measuring, has reached 410 square kilometers. There was a light 8% increase in the deforestation regarding the previous period (August 2010 to September 2010) when the deforestation totaled 380 square kilometers.

In September 2011, Pará led the deforestation with 46% , followed by Rondônia (24%) Mato Grosso (17%), Amazonas (9%), Acre (2%), Roraima (1.5%) and Tocantins (0,5%) (Figure 3).

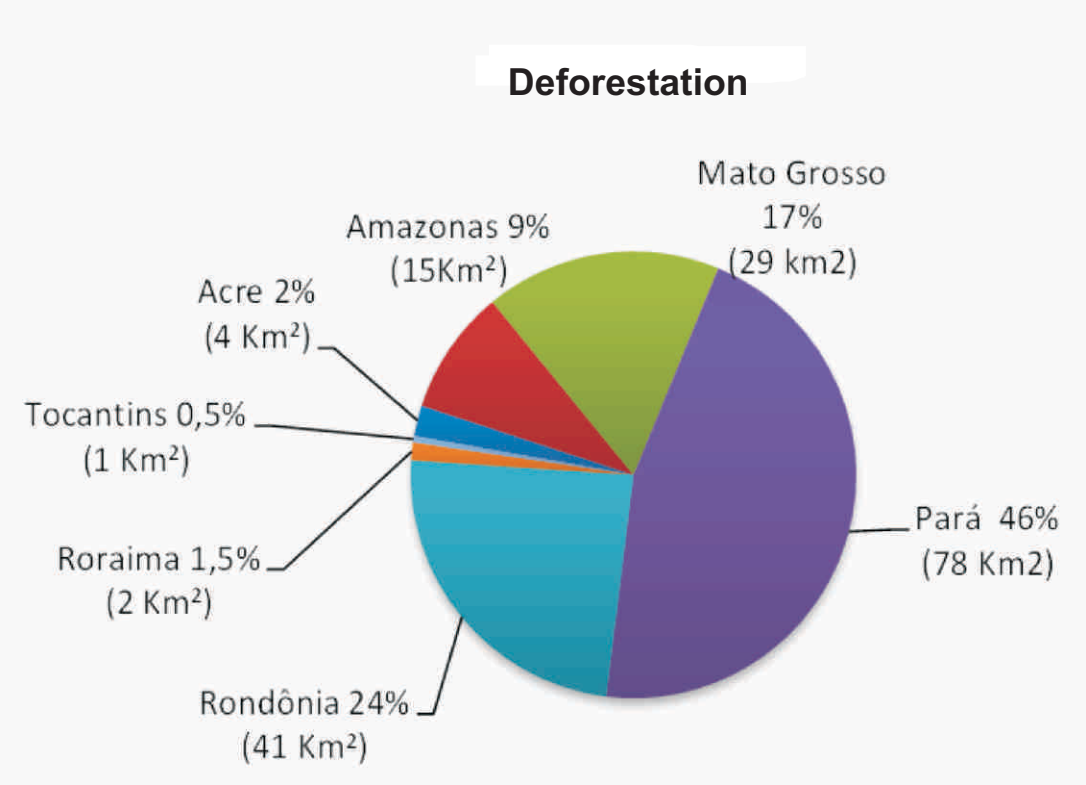

Figure 3. Deforestation (%) in the states of Legal Amazon in September 2011 (Source: Imazon/SAD).

Considering the first two months of the current deforestation calendar[1] (August 2011 to September 2011), Pará leads the ranking with 48% of the total deforested in the period. Following is Rondônia with 21%, followed by Mato Grosso with (16%) and Amazonas with (9%). These four states were responsible for 94% of the deforestation occurred in Legal Amazon in this period. The rest (6%) of deforestation occurred in Acre and Roraima and Tocantins and Amapá.

There was an 8% increase in the deforestation occurred from August 2011 to September 2011 when compared to the previous period (August 2010 to September 2011) (Table 1). In relative terms, there was an 300% increase in Roraima, 156% in Rondônia, 33% in Tocantins, 15%, and 14% in Pará. On the other hand, there a a 42% reduction in Acre, 39% in Mato Grosso and 5% in Amazonas.

In absolute terms, Pará leads the accumulated deforestation ranking with 196 square kilometers, followed by Rondônia (87 square kilometers), Mato Grosso (64 square kilometers), Amazonas (38 square kilometers), Acre (14 square kilometers), Roraima (8 square kilometers) and Tocantins (4 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 September 2010 and from August 2011 to September 2011 (Source: Imazon/SAD).

State	August 2011 to September 2010	August 2011 to September 2010	Variation (%)
Acre	24	14	-42
Amazonas	40	38	-5
Mato Grosso	105	64	-39
Pará	172	196	+14
Rondônia	34	87	+156
Roraima	2	8	+300
Tocantins	3	4	+33
Amapá	-	-	-
Total	**380**	**411**	**+8**

* Data from Maranhão were not analyzed.

Forest Degradation

In September 2011, SAD registered 658 square kilometers of degraded forests (intensively explored forests by lumbering and/ or burning activities) (Figures 2 and 4). From the total, the great majority (79%) occurred in Mato Grosso, followed by Pará (15%), Rondônia (5%), and 0,9% in Amazonas and 0,1% in Acre.

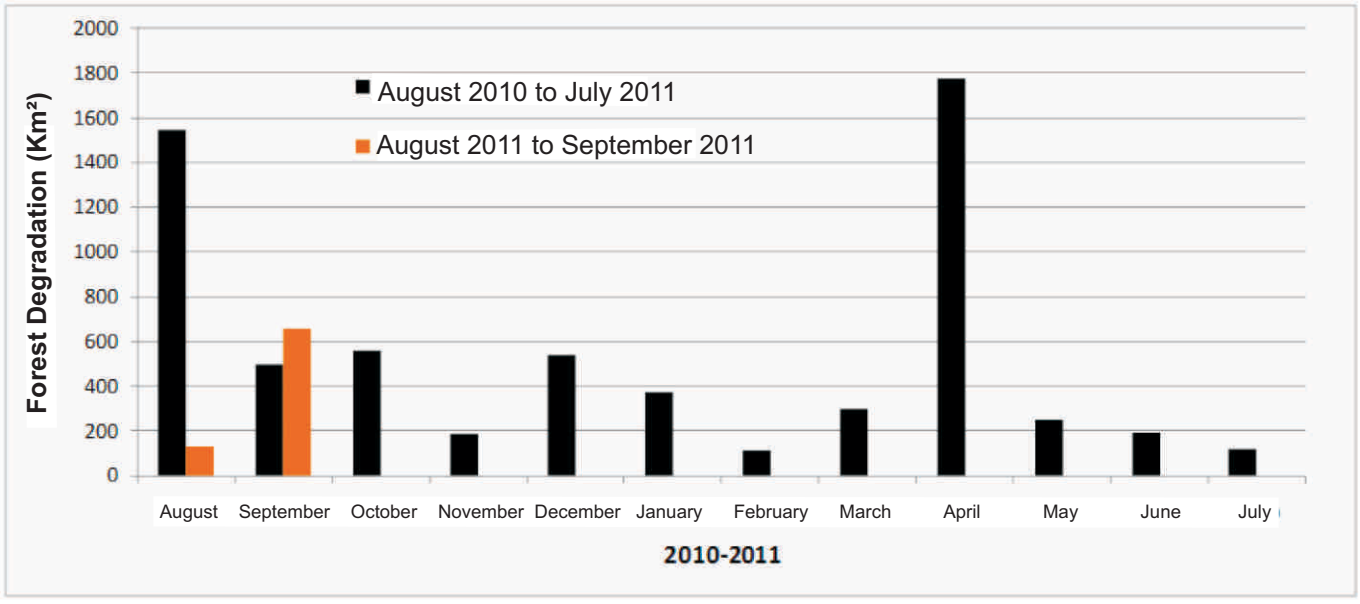

Figure 4. Forest Degradation from August 2010 to September 2011 at Legal Amazon (Source: Imazon/SAD).

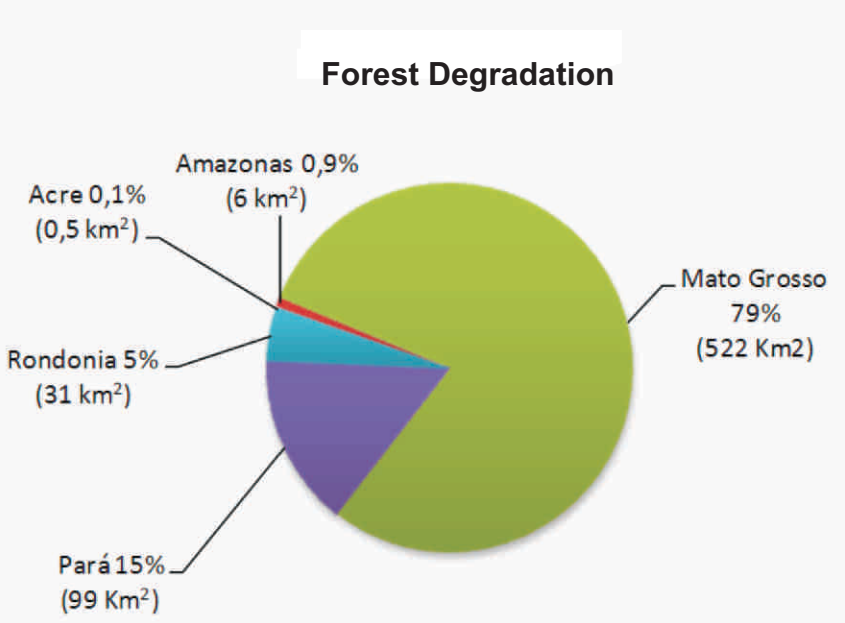

Figure 5. Forest Degradation (%) in the States of Legal Amazon in September 2011 (Source: Imazon/SAD).

The deforestation accumulated in the period of August 2011 to September 2011[2], (two first months of the official calendar of Deforestation measuring) has reached 789 square kilometers. This represents a reduction of 61% in the forest degradation accumulated in this period (August 2011 to September 2011) regarding the same previous period (August 2010 to September 2010) when the forest degradation totaled 2.040 square kilometers (Table 2).

Acre presented a 88% reduction in the forest degradation between August 2011 and September 2011. 2011 compared with August 2010 to September 2010. In Rondônia the reduction was of 81 and 79% in Pará followed by Amazonas with a drop of 70% and Mato Grosso 47%.

Mato Grosso leads the ranking of forest degradation with 76% of the total in the period of August 2011 to September 2011. Following comes Pará with 16%. These three states were responsible for 92% of the forest degradation in Legal Amazon during this period. The rest (8%) occurred in Rondônia, Amazonas, Acre and Roraima.

In absolute terms, Mato Grosso also leads the accumulated deforestation ranking with 599 square kilometers, followed by Pará (127 square kilometers), Rondônia (40 square kilometers), Amazonas (15 square kilometers), Roraima (6 square kilometers), and Acre 3 square kilometers).

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

State	August 2010 to September 2010	August 2011 to September 2011	Variation (%)
Acre	25	3	-88
Amazonas	50	15	-70
Mato Grosso	1.128	599	-47
Pará	611	127	-79
Rondônia	206	40	-81
Roraima	-	6	-
Tocantins	20	-	-
Amapá	-	-	-
Total	**2.040**	**790**	**-61**

* 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 September 2011, the 170 square kilometers of deforestation detected by SAD in the Legal Amazon compromised 2.9 million tons (with error radius of 332 thousand tons) of carbon. This amount of affected carbon results in 10.6 million tons of equivalent CO^2 (Figure 6). This represents an increase of 10.5% regarding September 2010 when the affected forest carbon was 2.6 million tons.

The forest carbon compromised by the deforestation in the period of August 2011 to September 2011 (two first months of the current deforestation calendar) was 6.6 million tons (with error radius of 146 thousand tons), which represented approximately 24 million tons of equivalent CO^2 (Figure 6). Regarding the same period of the previous year (August 2010 to September 2010) there was a 10% increase in the amount of carbon compromised by the deforestation. The relative increase of 10% of the forest carbon affected by the deforestation in the period of August 2011 to September 2011 regarding the previous period (August 2010 to September 2010) was equivalent to the relative increase of 9% of the deforestation detected by SAD during the same period.

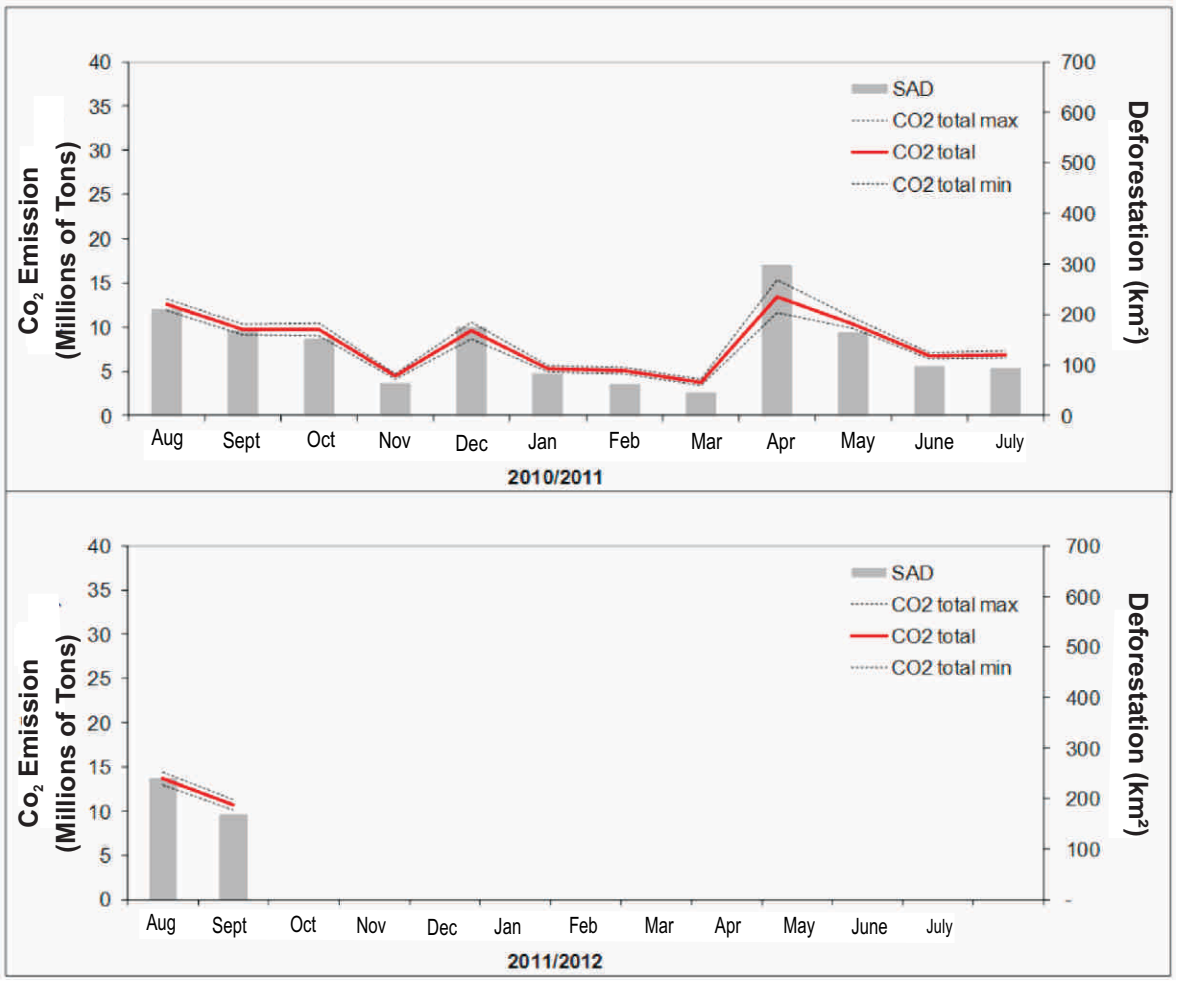

Figure 6. Deforestation and emission of Carbon Dioxide (CO^2) total equivalent from August 2010 to August 2011 in Legal Amazon (Source: Imazon).

Deforestation Geography

Regarding the land situation, in September de 2011, the majority (64%) of deforestation occurred in private areas or under many stages of ownership. The rest of the deforestation was registered in Agrarian Reform Settlements (16%), Conservation Units (19,5%) and Indigenous Lands (0,5%) (Table 3).

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

Category	September 2011	
	km²	%
Agrarian Reform Settlement	27,5	16
Conservation Units	32	19,5
Indigenous Lands	0,5	0,5
Private, owned and abeyance[3]	110	64
Total (km²)	170	100

Agrarian Reform Settlement

SAD registered 16 square kilometers in the Land Reform Settlements during September 2011. The most affected settlements by deforestation were Terra Nossa (Altamira; Pará), Vida Nova II (Peixoto Azevedo; Mato Grosso), and Vida Nova (Peixoto Azevedo; Mato Grosso). (Figure 7).

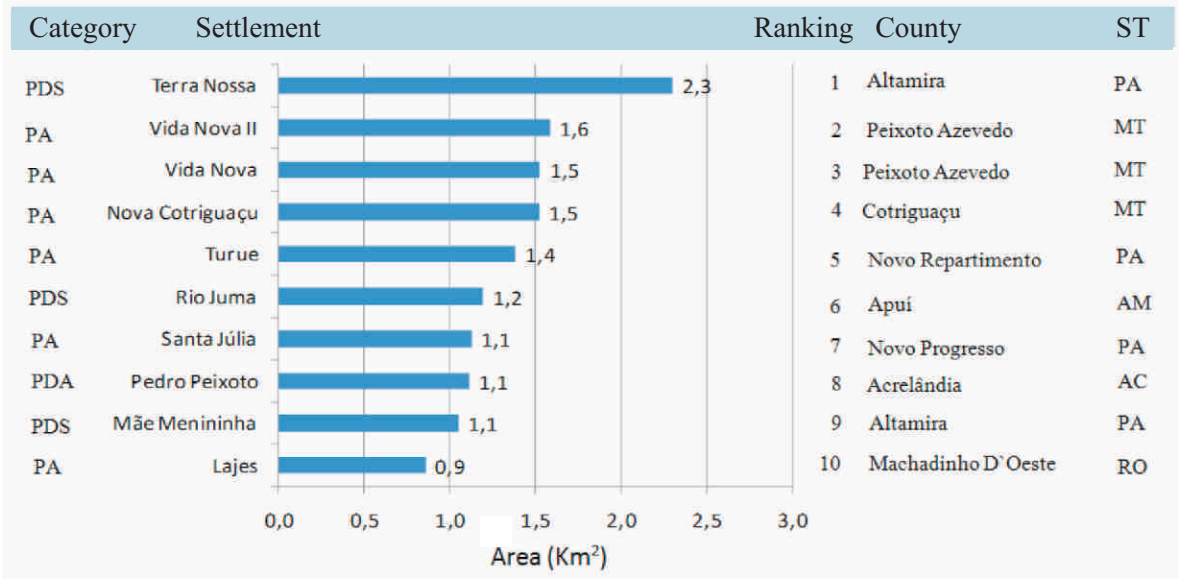

Figure 7. Most deforested Land Reform Settlements in September 2011 at Legal Amazon (Source: Imazon/SAD). PA (Registry _____ Project), PDA (Sustainable Development Project), and PDA (Settlement Development Project).

[3] Agrarian Reform Settlements

Protected Areas

SAD detected 32 square kilometers of deforestation in the Conservation Units (Figure 8). The Conservation Units that suffered deforestation were APA Rio Pardo (Rondônia), Flona de Altamira (Pará), Florex Rio Preto-Jacundá (Rondônia). In the case of the Indigenous Lands, in September 2011 were detected only 1 square kilometer. The most deforested Indigenous Lands were Cachoeira Seca do Iriri (Pará), Paraná (Mato Grosso) and Baú (Pará) (Figure 9).

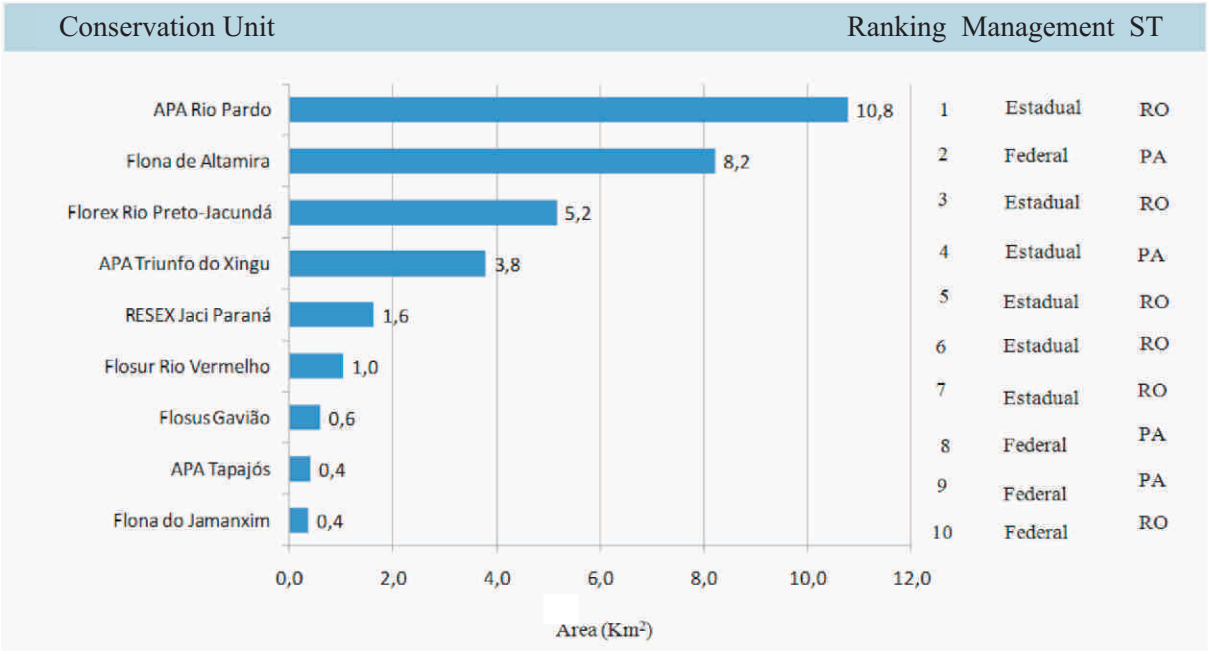

Figure 8. Most deforested Conservation Units at Legal Amazon in September 2011 (Source: Imazon /SAD).

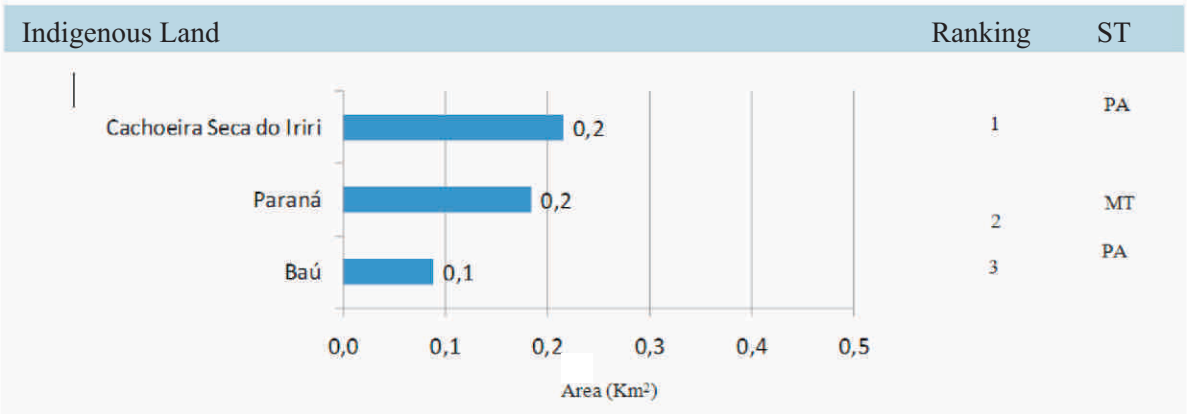

Figure 9. Most deforested Native Lands at Legal Amazon in September 2011 (Source: Imazon /SAD).

Critical Municipalities

In September 2011, the most deforested counties were: Altamira (Pará), Porto Velho (Rondônia), São Félix do Xingu (Pará) (Figure 10 and 11).

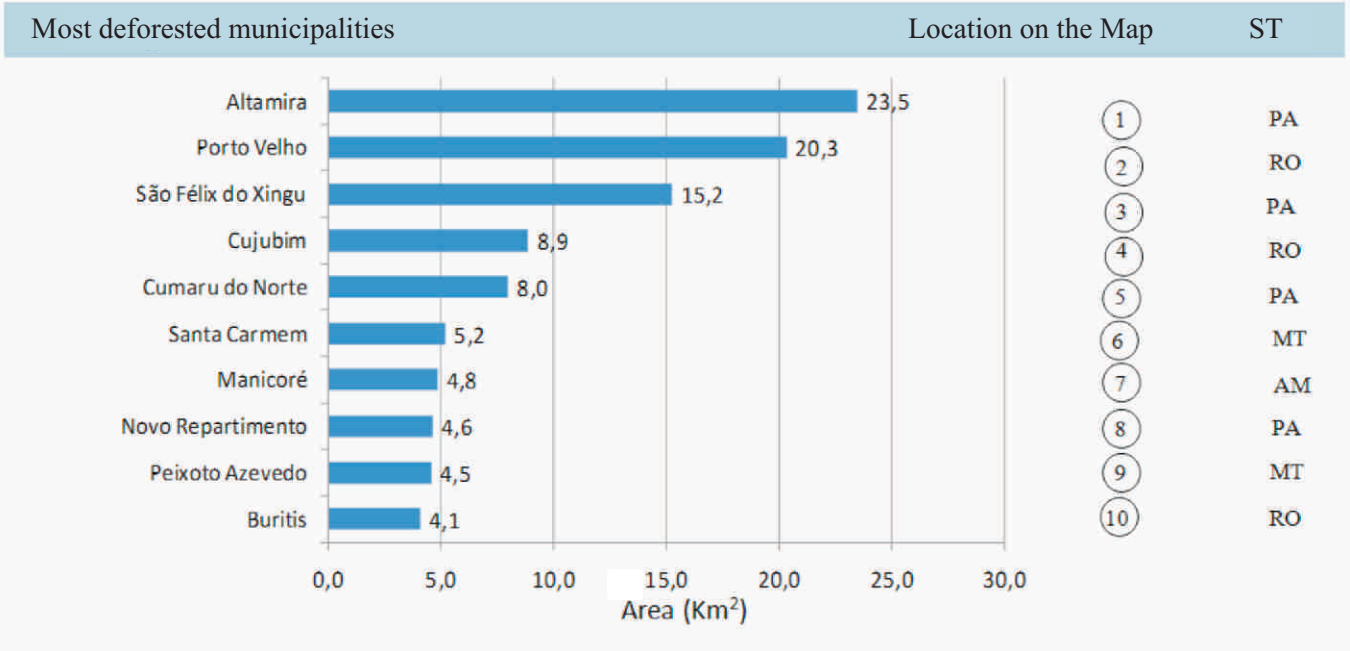

Figure 10. Most deforested counties at Legal Amazon in September 2011 (Source: Imazon /SAD).

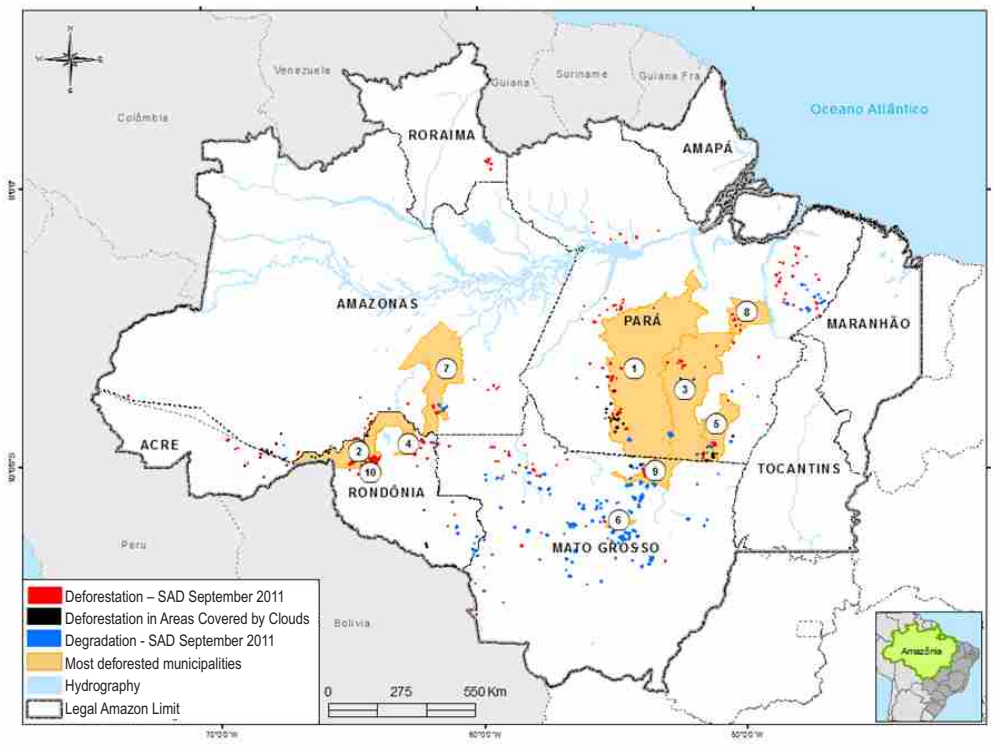

Figure 11. Most deforested counties in September 2011 (Source: Imazon/SAD).

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

Coverage by clouds and Shade

In September 2011, it was possible to monitor with SAD only 74% of the forest area in Legal Amazon. The other 26% of the territory was covered by clouds, which complicated the monitoring especially in Amapá which presented over 77% of their forest areas covered (Figure 12).

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

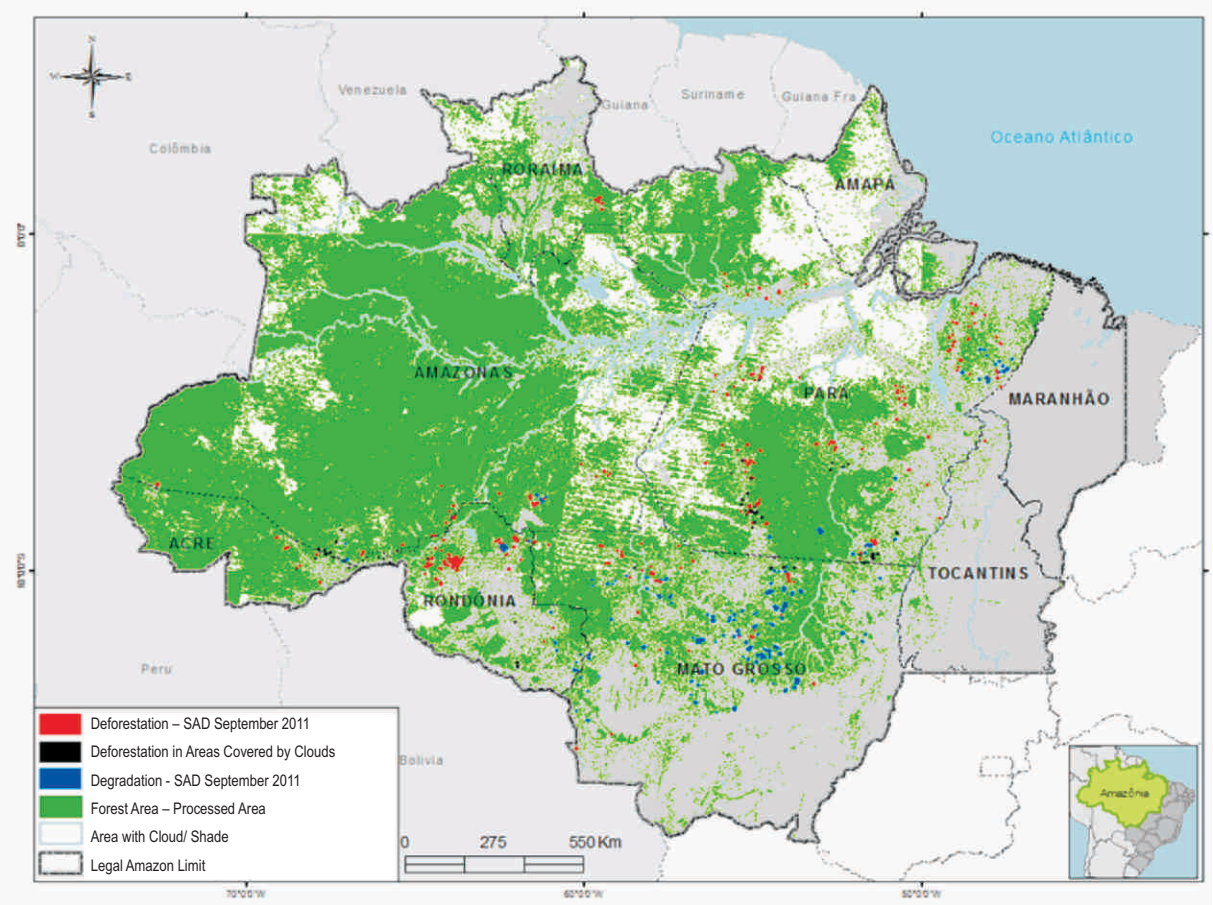

Figure 12. Area with cloud and shade in September 2011 in Legal Amazon

*The deforestation in areas covered by clouds might have occurred in August 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. The images used are the ones available right after the analyzed month by SAD. All the deforestation polygons detected by SAD are verified using the detailed images.

In August September, 87% of the deforestation detected by SAD were confirmed with the Landsat images (Figure 13). The other 13% were not confirmed due to the great occurrence of clouds in the Landsat and CBERS images available in the period.

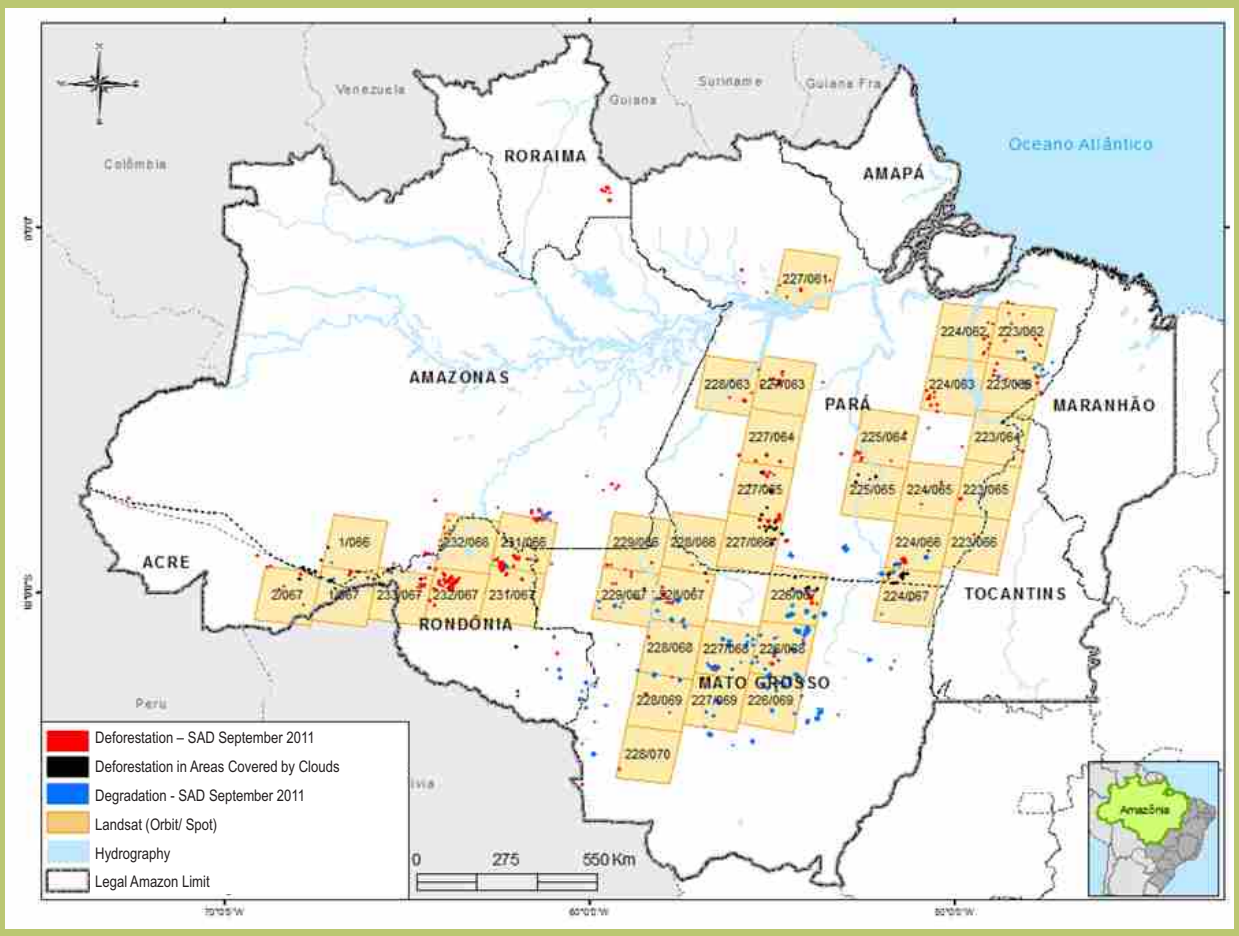

Figure 13. Landsat images used in the validation of the deforestation polygons detected by SAD in September 2011.

*The recent deforestation might have occurred in August 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 photosintetically non active (NPV - Non-Photosynthetic components (Vegetation, Soil and Shade) to calculate the NDFI, with the equation below:

$$NDFI = (VGs - (NPV + Solo)\ (VGs + NPV + Solo)$$

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

$$Vegetation/(1 - Shade)$$

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 sonce 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 bel

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

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

$$BPF = ff * AGLB$$

$$BAS_0 = bf * AGLB$$

where:

t: time (month)

Ct: 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%).

BAS_0: Biomass below the soil before the deforestation.

pd: monthly decomposition parameter of the biomass below the soil after the deforestation (0.0075).

$pd \times e^{(-pdxe)}$: 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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Team: Marcio Sales (Modeling and statistics), Rodney Salomão, Amintas Brandão Jr., João Victor (Geoprocessing) e Bruno Oliveira (Communication)

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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