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SUMMARY

The deforestation accumulated in the period of August 2010 and April 2011, corresponding to the nine first months of the official calendar of Deforestation measuring, has reached 1270 square kilometers. There was 19% increase regarding the same previous period (August 2009 to April 2010) when the deforestation totaled 1.065 square kilometers.

In April 2011, SAD detected 298 square kilometers of deforestation in Legal Amazon. It represented a 362% increase regarding April 2010 when the deforestation totaled 65 square kilometers. The great majority (81%) occurred in Mato Grosso as it already had been reported at the SAD Warning. The rest occurred in Pará (7%), Rondônia (7%) and Amazonas (5%).

The degraded forests totaled 1.776 square kilometers in April 2011. The great majority (81%) of this degradation occurred in Mato Grosso followed by far by Rondônia (18%) and the rest in Pará and Amazonas.

The forest degradation accumulated in the period of August 2010 to April 2011 totaled 5.832 square kilometers. Regarding the previous period (August 2009 to April 2010) when the forest degradation totaled 1.263 square kilometers, there was an expressive increase (361%).

In April 2011, the deforestation detected by SAD compromised 3.6 million tons of equivalent CO₂ which represents an increase of 203% regarding April 2010. In the accumulated period (August 2010 to April 2011) the deforestation compromised 73.6 million tons of equivalent CO₂ and represented an increase of 5.7% regarding the previous period (August 2009 to April 2010).

It was possible to monitor with SAD only 31% of the forest area in Legal Amazon in April 2011. The other 69% were covered by clouds which complicated the monitoring in the region e in the region especially in Pará, Amazonas and Amapá.

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 April 2010 at Legal Amazon has reached 298 square kilometers (Figure 1 and Figure 2). This represented an

increase of 362% of deforestation of April 2011 regarding the deforestation detected in April 2010 when the deforestation reached 65 square kilometers.

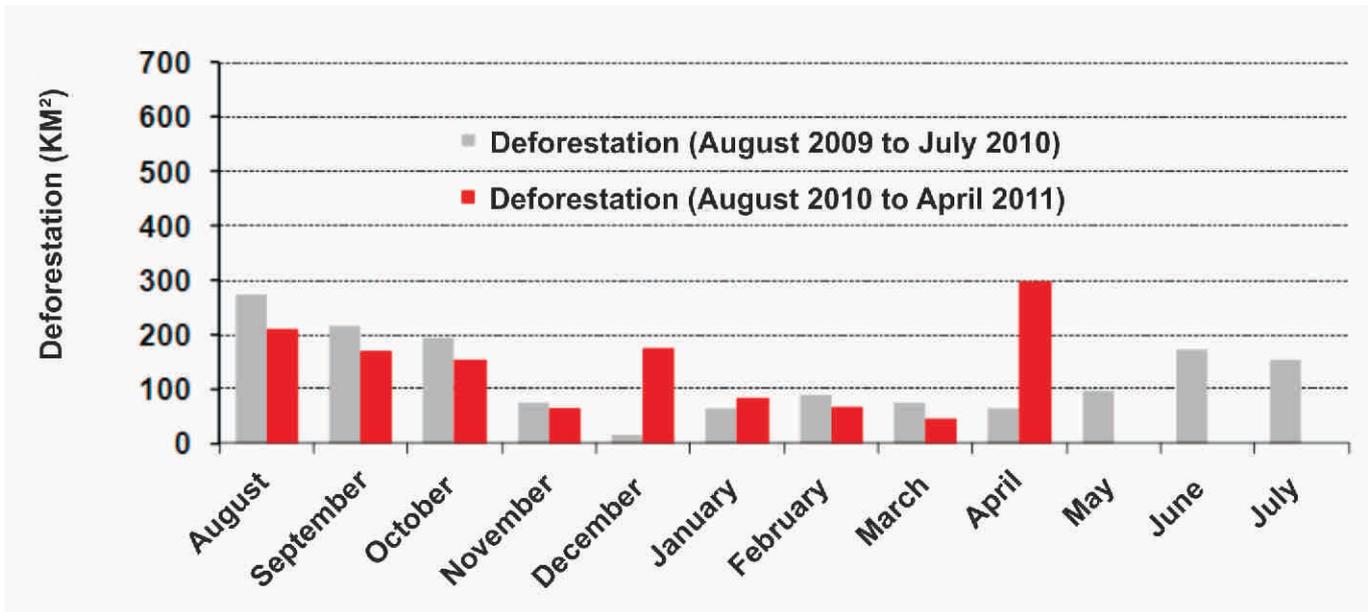


Figure 1. Deforesting from August 2009 to April 2011 in Legal Amazon (Source: Imazon/SAD).

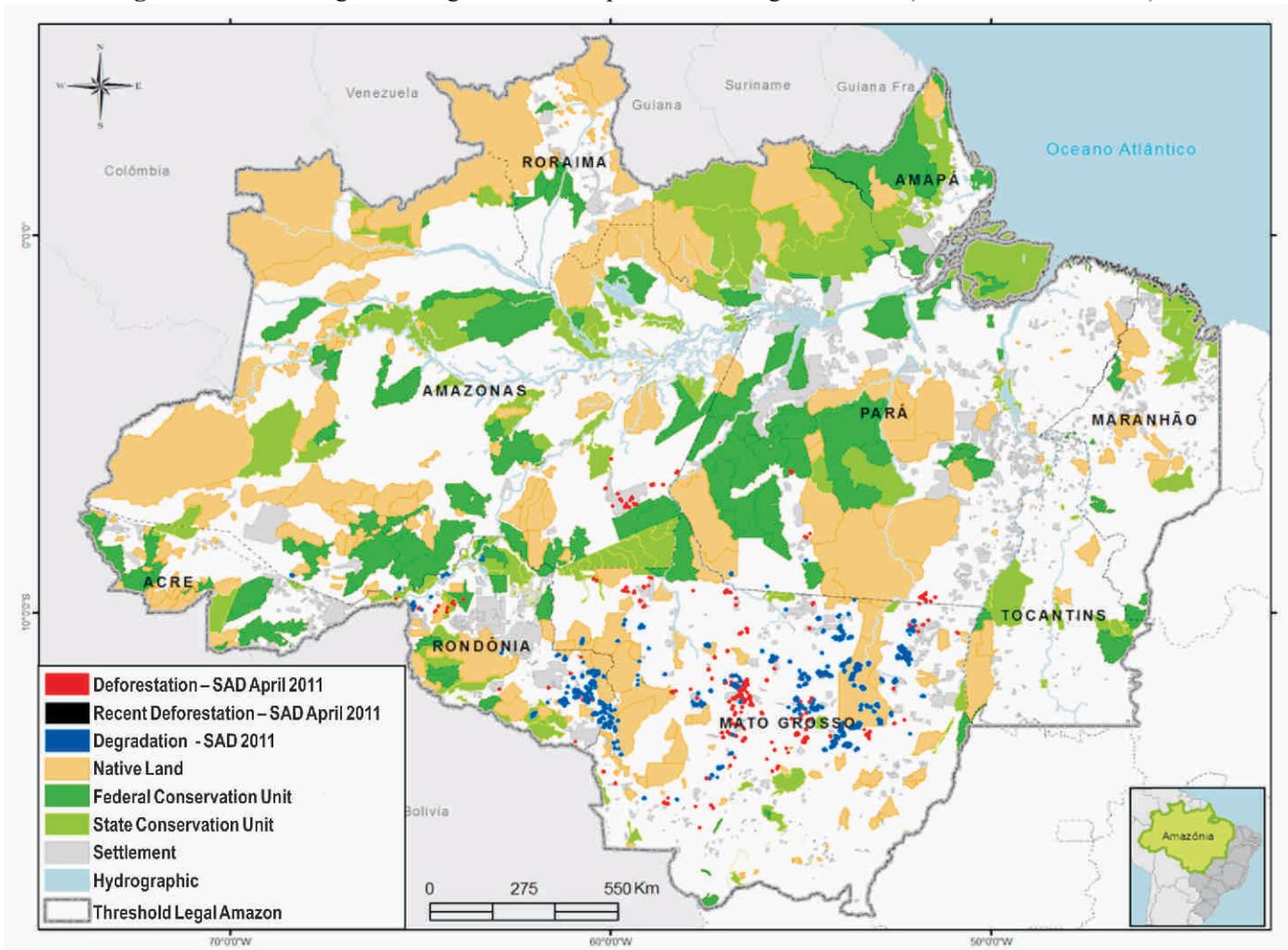


Figure2. Deforesting and Forest Degradation in April 2011 at Legal Amazon (Source: Imazon/ SAD).

The deforestation accumulated in the period of August 2010 to April 2011¹, corresponding to the nine first months of the official calendar of Deforestation measuring, has reached 1.270 square kilometers. There was 19% increase in the deforestation regarding the same previous period (August 2009 to April 2010) when the deforestation totaled 1065 square kilometers.

In April 2011, the great majority (81%) of the deforestation occurred in Mato Grosso (Figure 3). The rest of the deforestation occurred in Pará (7%), Rondônia (7%) and Amazonas (5%). The deforestation in Pará was smaller in April 2011 probably because the intense coverage of the clouds in the region (81% of coverage of the clouds in the forest area).

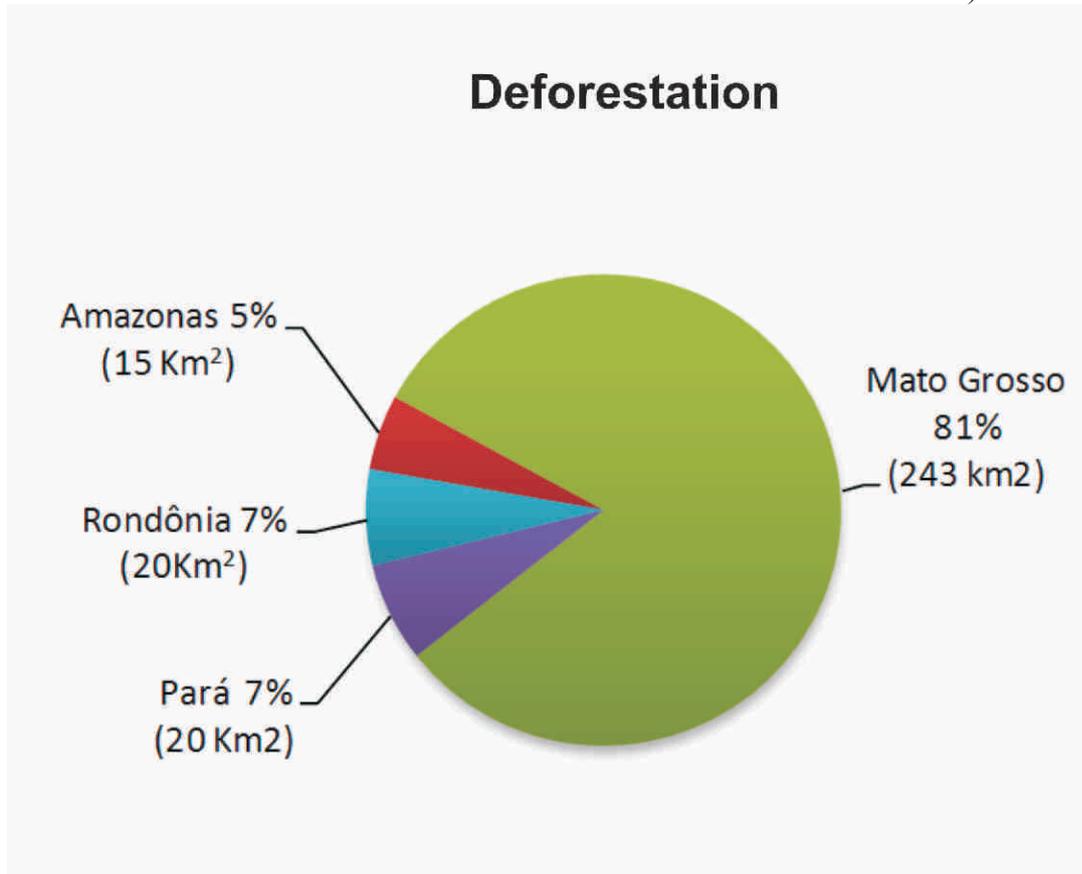


Figure 3. Deforestation (%) in the states of Legal Amazon in April 2011 (Source: Imazon/SAD).

Considering the first nine months of the current deforestation calendar (August 2010 to April 2011), Mato Grosso leads the ranking with 41% of the total deforested in the period. Following is Rondônia and Pará with 22% each and Amazonas with 11%. These four states were responsible for 95% of the deforestation occurred in Legal Amazon in this period. The rest (5%) of deforestation occurred in Acre and Roraima.

There was a 19% increase in the deforestation occurred from August 2010 to April 2011 when

compared to the previous period (August 2009 to April 2010) (Table 1). In relative terms, there was a 515% increase in Tocantins, 145% in Rondônia, 96% in Mato Grosso, 49% in Acre, and 42% in Amazonas. On the other hand, there was a 84% reduction in Roraima and 44% in Pará.

In absolute terms, Mato Grosso leads the accumulated deforestation ranking with 517 square kilometers, followed by Rondônia (277 square kilometers), Pará (274 square kilometers), and Amazonas (135 square kilometers).

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

Table 1. Evolution of the deforestation between the States of Legal Amazon from August 2009 to April 2010 and from August 2010 to April 2011 (Source: Imazon/SAD).

State	August 2009 to April 2010	August 2010 to April 2010	Variation (%)
Acre	37	55	+ 49
Amazonas	95	135	+ 42
Mato Grosso	263	517	+ 97
Pará	491	274	- 44
Rondônia	113	277	+ 145
Roraima	50	8	- 84
Tocantins	1	4	+ 300
Amapá	15	-	-
Total	1.065	1.270	+ 19

* Data from Maranhão were not analyzed

Forest Degradation

In April 2011, SAD registered 1.776 square kilometers of degraded forest (intensively explored forests by lumbering and/ or burning activities) (Figures 2 and 4). From the total, the majority (81%) of

this degradation occurred in Mato Grosso, followed by far by Rondônia (18%), Pará (0,8%), and Amazonas (0,2%).

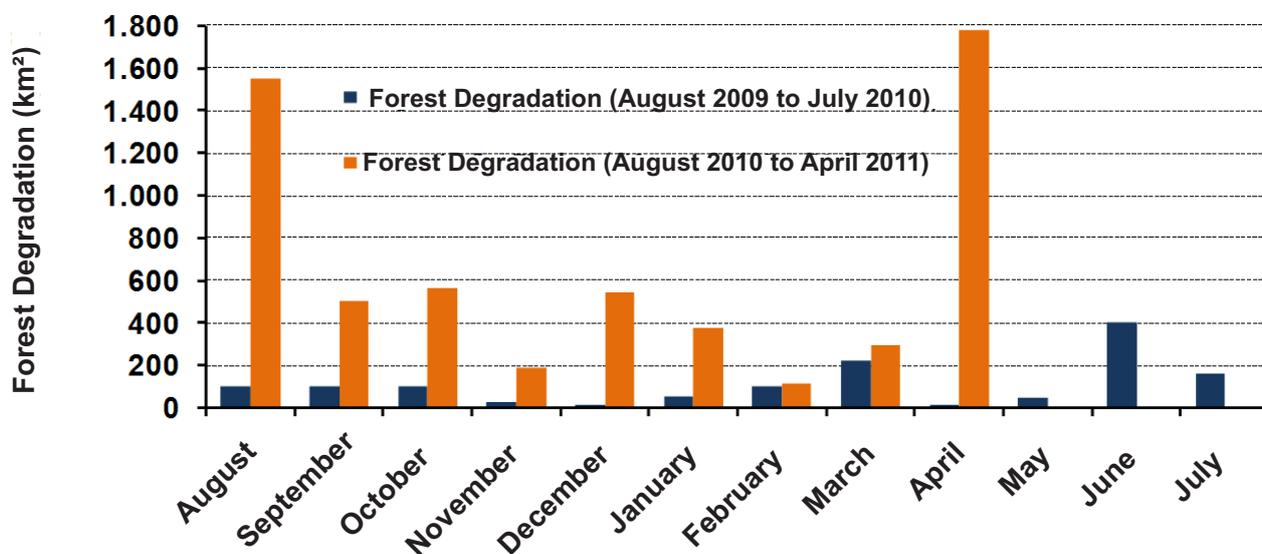


Figure 4. Forest Degradation from August 2009 to April 2011 at Legal Amazon (Source: Imazon/SAD).

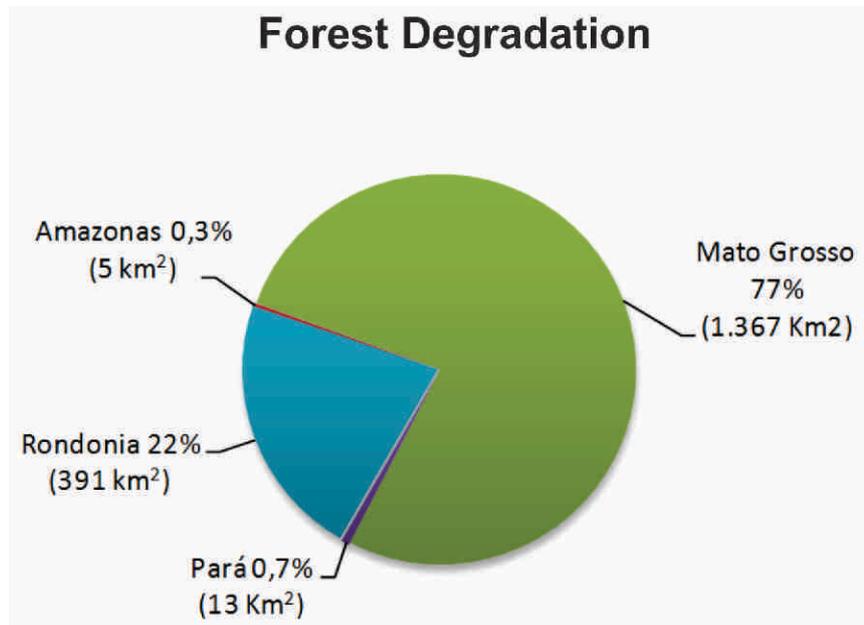


Figure 5. Forest Degradation (%) in the States of Legal Amazon in April 2011 (Source: Imazon/SAD).

The deforestation accumulated in the period of August 2010 to April 2011², (nine first months of the official calendar of Deforestation measuring) has reached 5.832 square kilometers. This represents an extremely expressive increase of 361% in the forest degradation accumulated in this period (August 2010 to April 2011) regarding the same period of the previous year (August 2009 to April 2010) when the forest degradation totaled 1.263 square kilometers (Table 2).

Tocantins presented in relative terms an expressive increase of 3.262%, however, in absolute terms; the increase was very reduced passing only 1 square kilometer between August 2009 to April 2010 to 27 square kilometers from August 2010 to April 2011. Other states also contributed for the increase of the forest degradation: Amazonas (+ 601%), Mato Grosso (+ 411%), Rondônia (+372), and Pará (+ 217). On the

other hand, Roraima presented a reduction of 80% in the forest degradation.

Mato Grosso leads the ranking of forest degradation with 62% of the total in the period of August 2010 to April 2011. Following comes Rondônia with 17% and Pará with 16%. These three states were responsible for 94% of the forest degradation in Legal Amazon during this period. The other 6% occurred in Amazonas, Acre, Tocantins and Roraima.

In absolute terms, Mato Grosso leads the accumulated deforestation ranking with 3.591 square kilometers, followed by Rondônia (966 square kilometers), Pará (953 square kilometers), Amazonas (148 square kilometers), Acre (145 square kilometers), (Tocantins 27 square kilometers) and Roraima (2 square kilometers).

² The official deforestation measurement calendar begins in the month of August and ends in the month of July.

Table 2. Evolution of the forest degradation between the States of Legal Amazon from August 2009 to April 2010 and from August 2010 to April 2011 (Source: Imazon/SAD).

State	August 2009 to April 2010	August 2010 to April 2010	Variation (%)
Acre	24	145	+ 504
Amazonas	21	148	+ 605
Mato Grosso	703	3.591	+ 411
Pará	301	953	+ 217
Rondônia	205	966	+371
Roraima	8	2	-75
Tocantins	1	27	+ 2.600
Amapá	1	-	-
Total	1.264	5.832	+ 361

* Data from Maranhão were not analyzed.

Carbon Affected by the Deforestation

In April 2011, the 298 square kilometers of deforestation detected by SAD in the Legal Amazon compromised 3.6 million tons (with error radius of 976 thousand tons) of carbon. This amount of affected carbon results in 13,2 million tons of equivalent CO² (Figure 6). This represents an increase of 203% regarding April 2010 when the affected forest carbon was 1.2 million tons. This increase in the carbon affected by the deforestation was so expressive as the 362% increase in the deforestation detected by SAD this month.

The forest carbon compromised by the deforestation in the period of August 2010 to April 2011 (nine first months of the current deforestation calendar) was 20 million tons (with

error radius of 336 thousand tons), which represented approximately 73.6 million tons of equivalent CO² (Figure 6). Regarding the same period of the previous year (August 2009 to April 2010) there was an 5.7% increase in the amount of carbon compromised by the deforestation. The relative increase (5.7%) of the forest carbon affected by the deforestation in the period of August 2010 to April 2011 regarding the previous period (August 2009 to April 2010) was less than the relative increase of 19% 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.

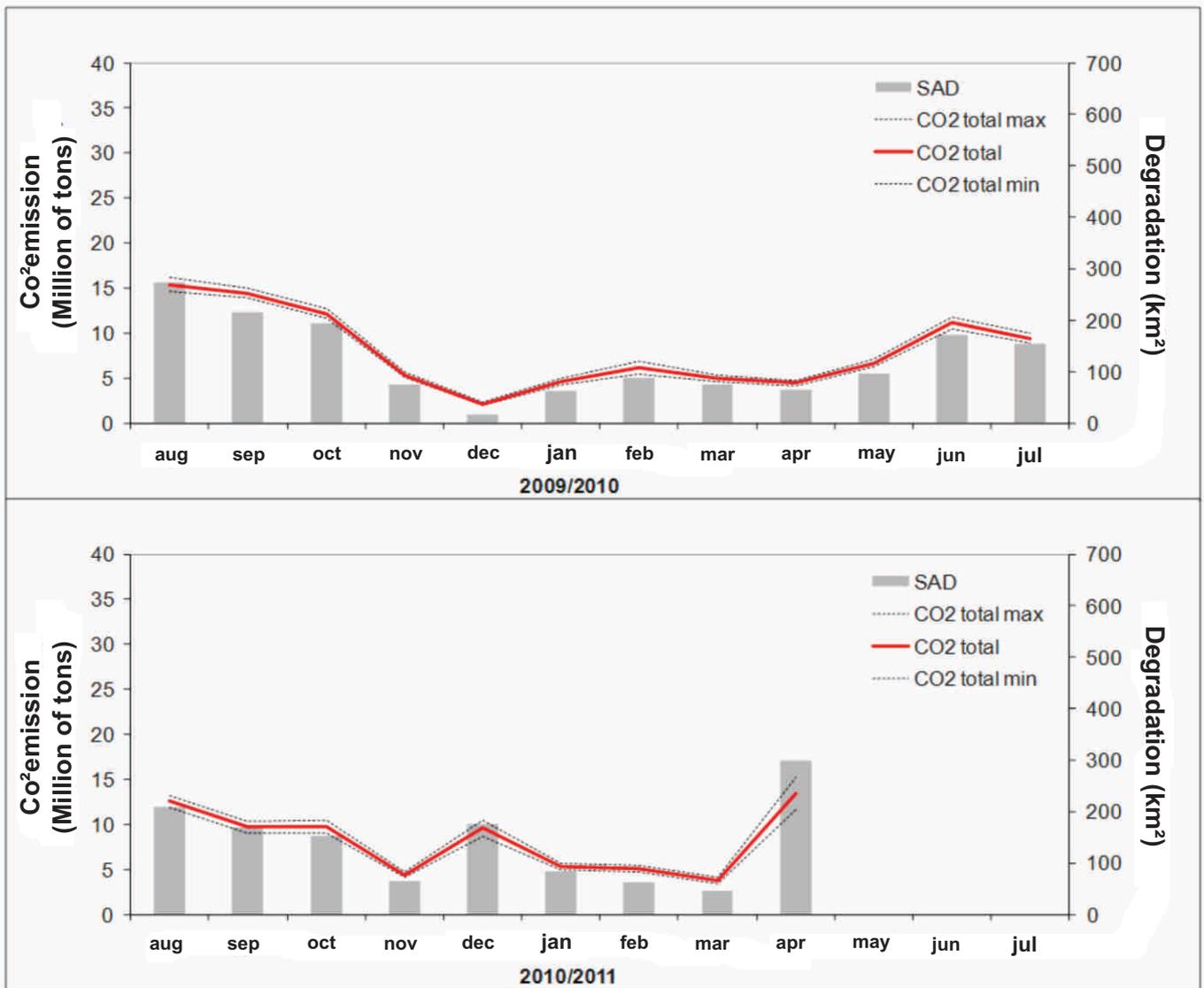


Figure 6. Deforestation and emission of Carbon Dioxide (CO²) total equivalent from August 2009 to April 2011 in Legal Amazon (Source: Imazon).

Deforestation Geography

Regarding the land situation, in April de 2011, the great majority (87%) of deforestation occurred in private areas or under many stages of ownership. The

rest of the deforestation was registered in Land Reform Settlements (7%), Conservation Units (5%), Native Lands (1%) (Table 3).

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

Category	April 2011	
	km ²	%
Assentamento de Reforma Agrária	21	7
Unidades de Conservação	15	5
Terras Indígenas	1	1
Privadas, Posse & Devolutas ³	261	87
Total (km²)	298	100

Land Reform Settlements

SAD registered only 21 square kilometers in the Land Reform Settlements during April 2011. The most affected settlements by the deforestation were

Tapurah/Itanhanga (Itanhagá, Mato Grosso), Rio Juma (Apuí, Amazonas), and Juruti Velho (Juruti, Pará) (Figure 7).

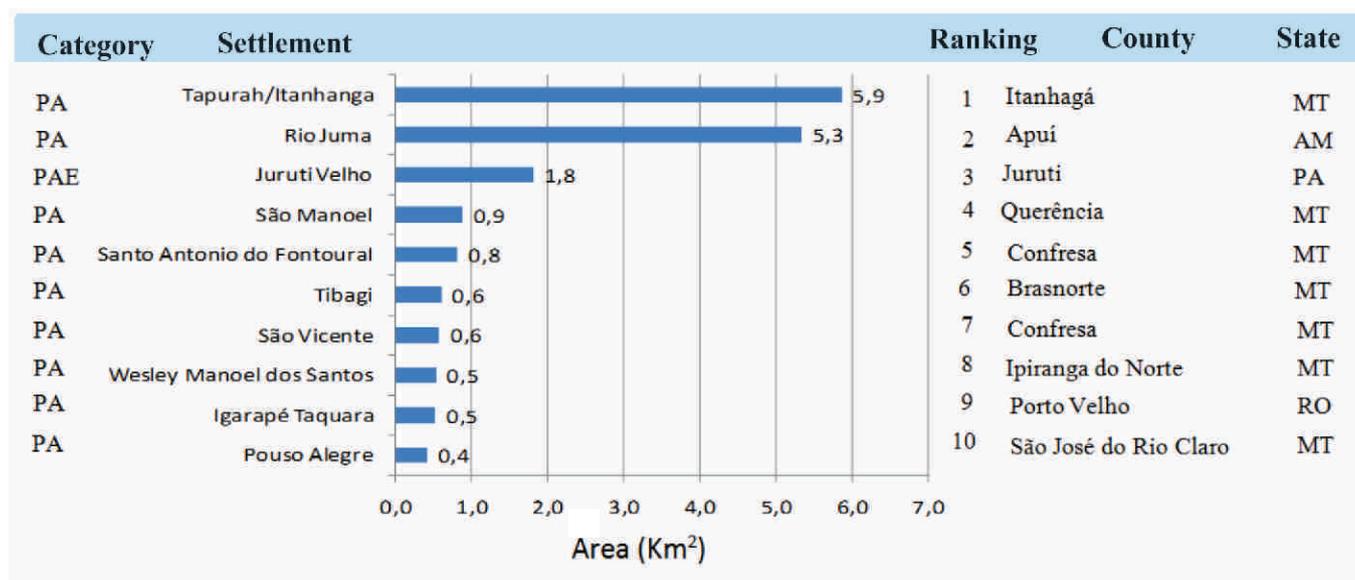


Figure 7. Most deforested Land Reform Settlements in April 2011 at Legal Amazon (Source: Imazon/SAD).

³ It includes private areas (owned or not) and non protected public forests.

Protected Areas

SAD detected 15 square kilometers of deforestation in the Conservation Unit (Figure 8). The Conservation Units that suffered deforestation were: Flona de Altamira (Pará), Resex Jaci Paraná (Rondônia), and Resex Guariba-Roosevelt (Mato

Grosso). In the case of the Native Lands, in April 2011 were detected only 1 square kilometer. The deforested Native Lands were Myky (Mato Grosso) and Karipuna (Rondônia) (Figure 9).

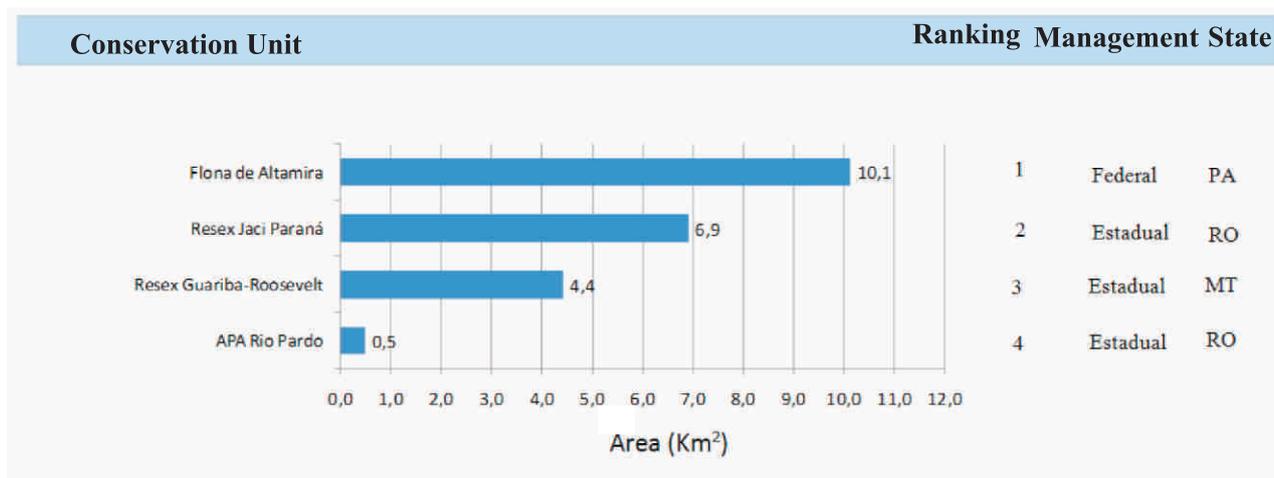


Figura 8. Unidades de Conservação mais desmatadas na Amazônia Legal em abril de 2011 (Fonte: Imazon /SAD).

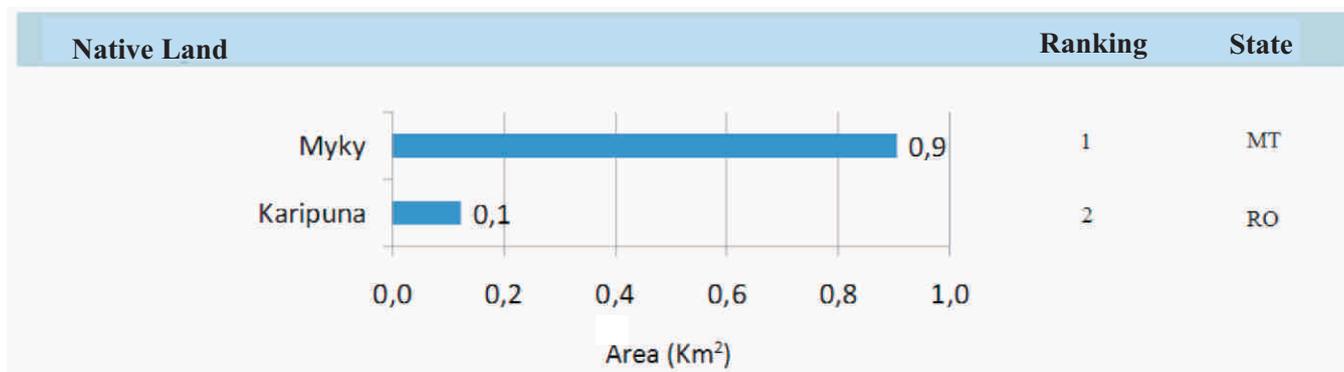


Figure 8. Most deforested Conservation Units at Legal Amazon in April 2011 (Source: Imazon /SAD).

Critical Counties

In April 2011, the most deforested counties were: Nova Ubitatã (Mato Grosso), Porto dos Gaúchos

(Mato Grosso) and Itanhangá (Mato Grosso) (Figures 10 and 11).

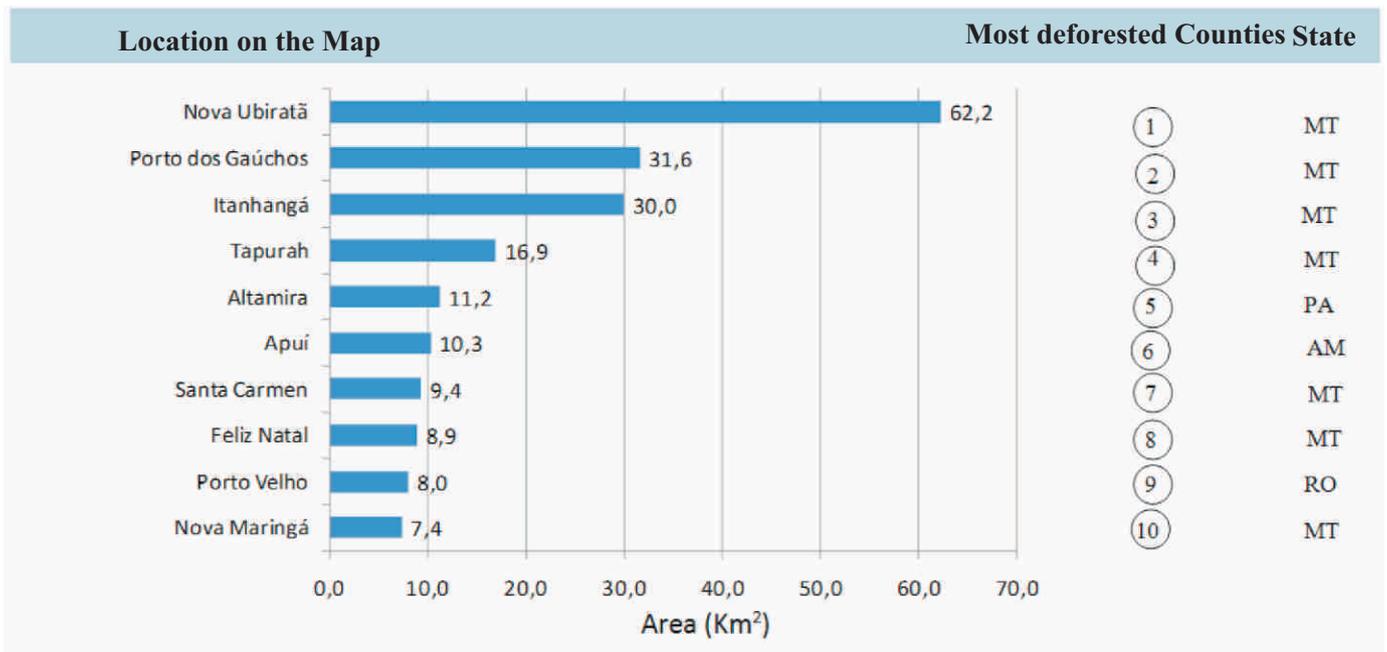


Figure 10. Most deforested counties at Legal Amazon in April 2011 (Source: Imazon /SAD).

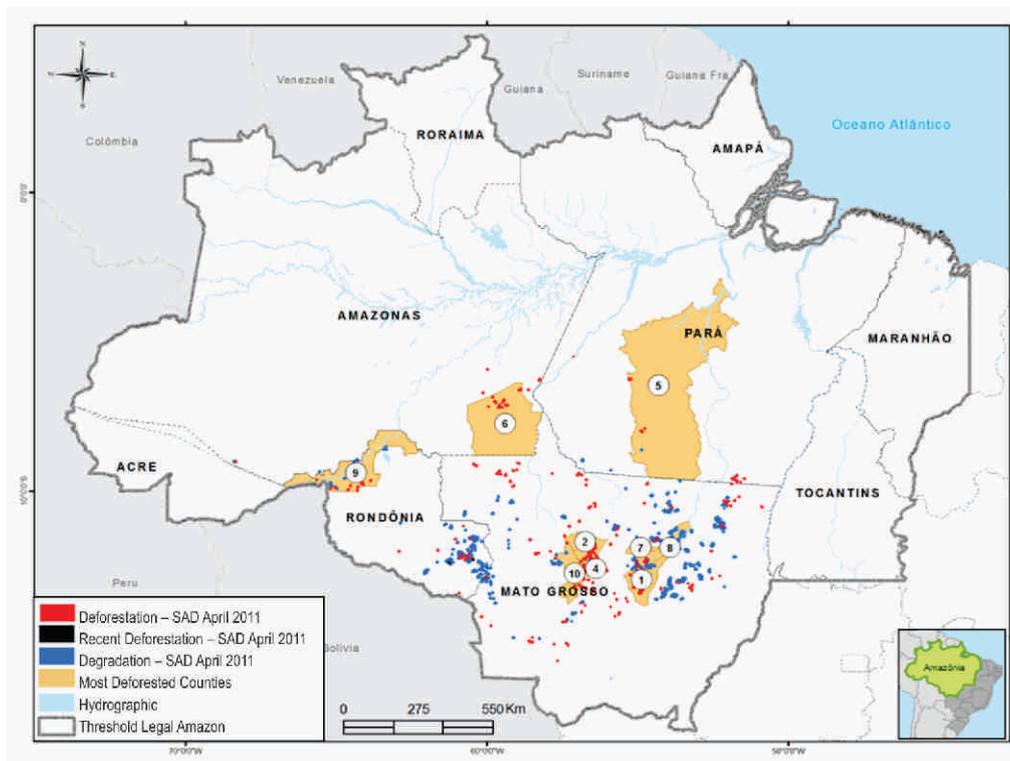


Figure 11. Most deforested counties in April 2011 (Source: Imazon/SAD).

Coverage by clouds and Shade

In April 2011, it was possible to monitor with SAD only 31% of the forest area in Legal Amazon. The other 69% of the territory was covered by clouds, which complicated the monitoring especially in Pará, Amazonas and Apá (Figure 12). These states had over 70% of their forest territory covered by clouds. Because of that, the deforestation data of these States

may be underestimated in April 2011. The period of December to April is characterized as a rainy period in the Amazon region with a lot of clouds, which complicates the monitoring of the deforestation through satellite images.

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

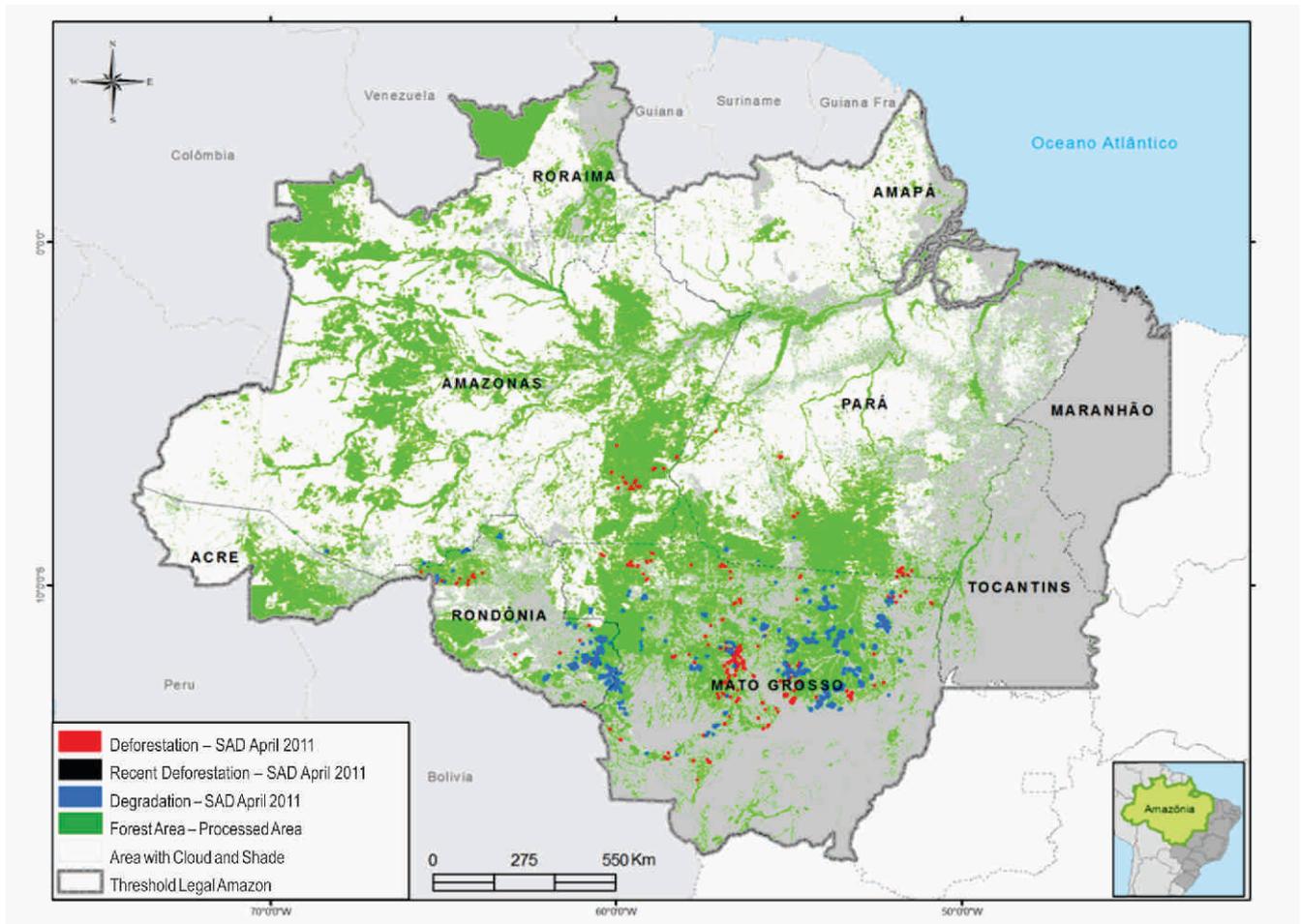


Figure 12. Area with cloud and shade in April 2011 in Legal Amazon

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. Deforestations smaller than 6.25 hectares, i.e., below SAD's detection capacity, are not included in the statistics, in case they occur in more detailed images. However, if SAD detects false signals of deforestation, they will be removed from the monthly statistics. In April 2011, 86% of the deforestation detected by SAD were confirmed with the Landsat images (Figure 13). The other 14% were not confirmed due to the great occurrence of clouds in the Landsat and CBERS images available in the period.

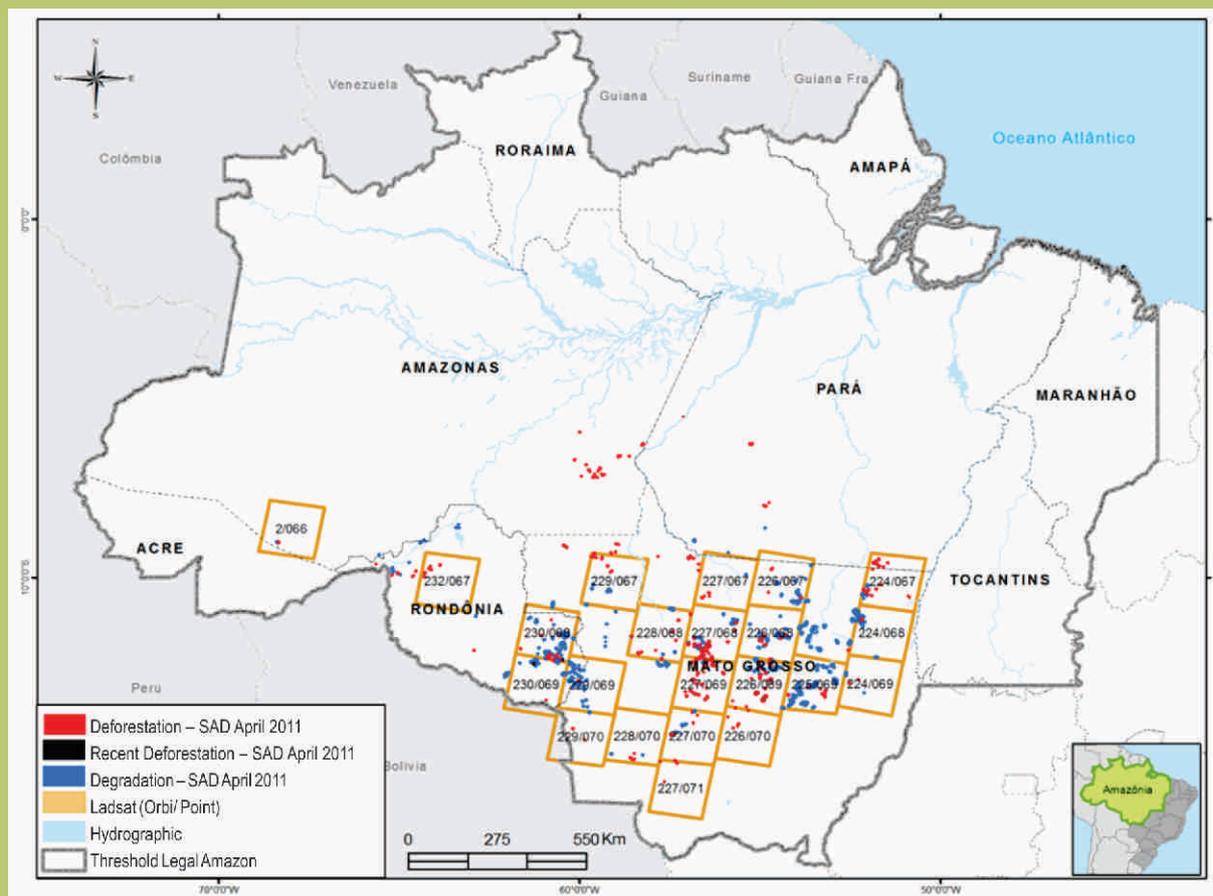


Figure 13. Landsat images used in the validation of the deforestation polygons detected by SAD in April 2011.

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:

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

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 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:

$$C_t = \sum C(S)_t$$
$$C_t(S) = S_D \times \left[BVAS - BPF \right] \times (1 - fc) \times (t == 0) + \left(BAS_0 \times pd \times e^{(-pd \times t)} \right)$$
$$BPF = ff * AGLB$$
$$BAS_0 = bf * AGLB$$

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).

$pd \times e^{(-pd \times t)}$: monthly decomposition rate of the biomass below the soil after the deforestation.

For the application of the CES model using SAD 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: 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 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/>

Support

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Fundação Gordon & Betty Moore

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