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SUMMARY

In July 2011, SAD detected 93 square kilometers of deforestation in Legal Amazon. It represented a 40% reduction regarding July 2010 when the deforestation totaled 155 square kilometers. From this total, 41% occurred in Pará, followed by Mato Grosso (23%), Rondônia (18%), Amazonas (14%), and the rest in Amapá, Acre and Tocantins.

The deforestation accumulated in the period of August 2010 to July 2011, corresponding to the twelve months of the current Deforestation Calendar, has reached 1.628 square kilometers. There was 9% increase regarding the same previous period (August 2009 to July 2010) when the deforestation totaled 1.488 square kilometers.

The degraded forests in Legal Amazon, totaled 116 square kilometers in July 2011. This accumulated Forest degradation in the Period of

August 2010 to July 2011 totaled 6.389 square kilometers. Regarding the previous period (August 2009 to July 2010) there was an expressive increase (241%), when the forest degradation totaled 1.873 square kilometers.

In July 2011, the deforestation detected by SAD compromised 6.6 million tons of equivalent CO₂ which represents a reduction of 27% regarding July 2010. In the accumulated period (August 2010 - July 2011) the deforestation compromised 97.5 million tons of equivalent CO₂ and represented an increase of 1% regarding the previous period (August 2009 to July 2010).

In July 2011, the cloud coverage was reduced and it was possible to monitor 82% 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 July 2011 at Legal Amazon has reached 93 square kilometers (Figure 1 and Figure 2). This represented a

decrease of 40% of deforestation of July 2011 regarding the deforestation detected in July 2010 when the deforestation reached 155 square kilometers.

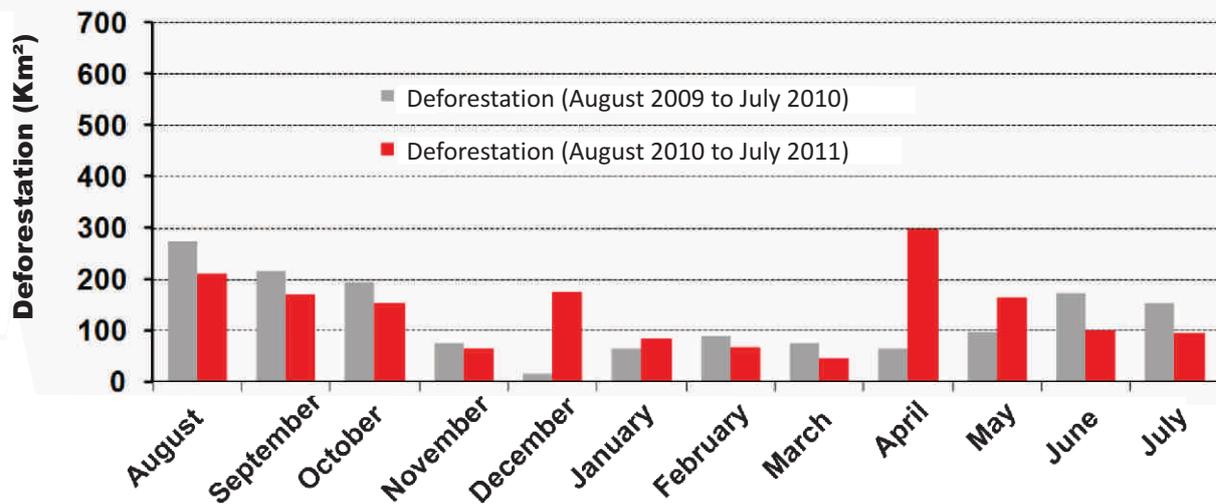


Figure 1. Deforesting from August 2009 to July 2011 in Legal Amazon (Source: Imazon/SAD).

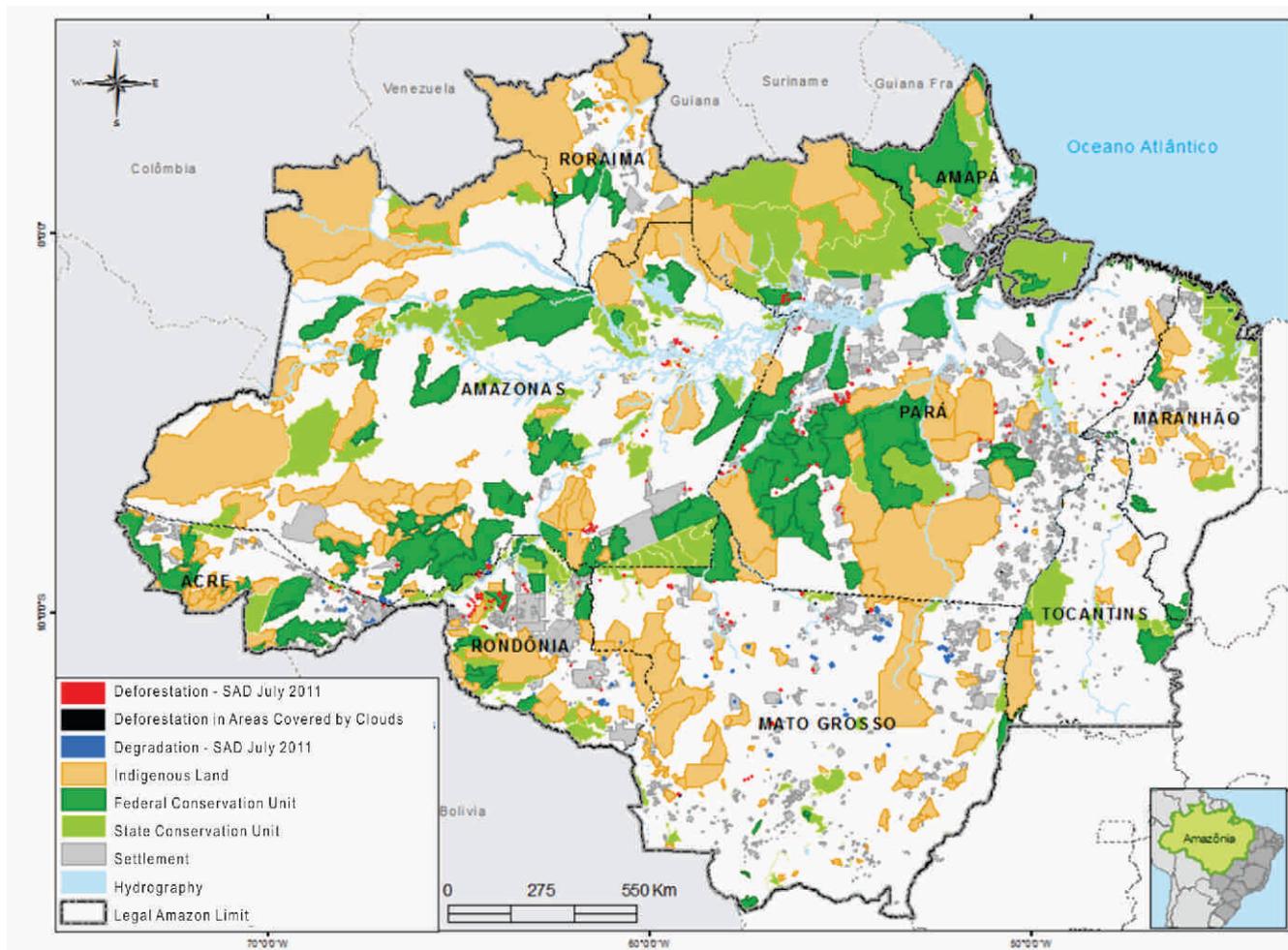


Figure2. Deforesting and Forest Degradation in June 2011 at Legal Amazon (Source: Imazon/ SAD).

*The recent deforestation might have occurred in July 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 2010 to July 2011¹, corresponding to the twelve months of the official calendar of Deforestation measuring, has reached 1.628 square kilometers. There was a 9% increase in the deforestation regarding the same previous period (August 2009 to July 2010) when the deforestation totaled 1.488 square kilometers.

In July 2011, Pará led the deforestation with 41% , followed by Mato Grosso (23%) and Rondônia (18%), Amazonas (14%), Amapá (2%), Acre (1.5%) and Tocantins (0,5%) (Figure 3).

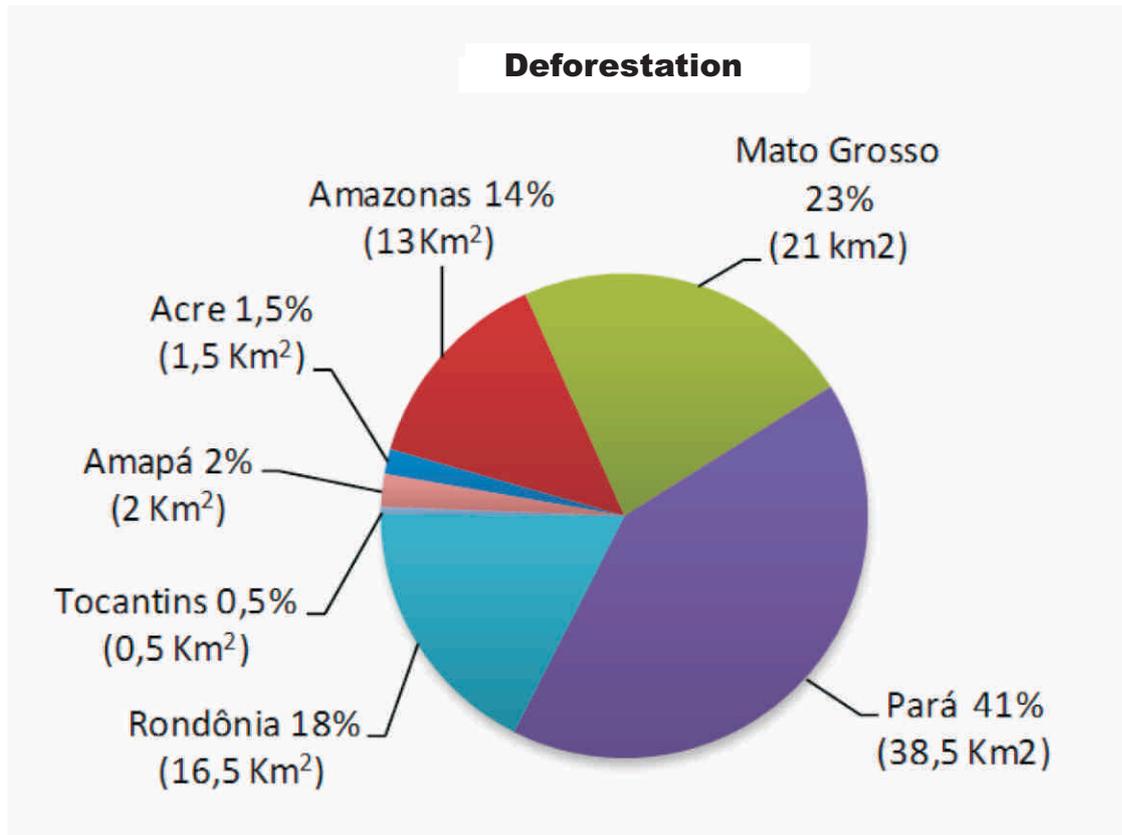


Figure 3. Deforestation (%) in the states of Legal Amazon in July 2011 (Source: Imazon/SAD).

Considering the twelve months of the current deforestation calendar (August 2010 to July 2011), Mato Grosso leads the ranking with 37% of the total deforested in the period. Following is Pará with 26%, followed by Rondônia with 21% 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 and Tocantins and Amapá.

There was a 9% increase in the deforestation occurred from August 2010 to July 2011 when compared to the previous period (August 2009 to July 2010) (Table 1).

In relative terms, there was a 800% increase in Tocantins, 106% in Rondônia, 76% in Mato Grosso, 15% in Amazonas, and 6% in Acre. On the other hand, there was a 84% reduction in Roraima and 40% in Pará. In absolute terms, Mato Grosso leads the accumulated deforestation ranking with 603 square kilometers, followed by Pará (423 square kilometers), Rondônia (338 square kilometers), and Amazonas (187 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 2009 to July 2010 and from August 2010 to July 2011 (Source: Imazon/SAD).

State	August 2009 to July 2010	August 2010 to July 2011	Variation (%)
Acre	54	57	+ 6
Amazonas	162	187	+ 15
Mato Grosso	342	603	+ 76
Pará	700	423	- 40
Rondônia	164	338	+ 106
Roraima	51	8	- 84
Tocantins	1	9	+ 800
Amapá	15	2	- 87
Total	1.489	1.627	+ 9

* Data from Maranhão were not analyzed.

Forest Degradation

In July 2011, SAD registered 116 square kilometers of degraded forests (intensively explored forests by lumbering and/ or burning activities) (Figures 2 and 4). From the total, the majority (59%) of

this degradation occurred in Mato Grosso, followed by Acre (14%), Amazonas (13%), Rondônia (13%), and Pará (1%).

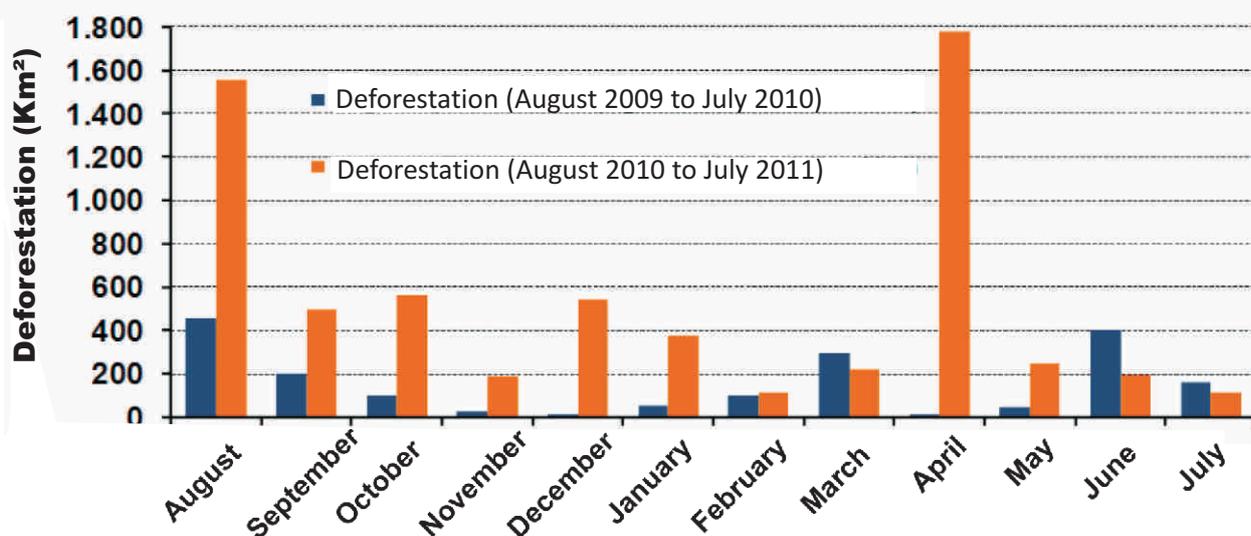


Figure 4. Forest Degradation from August 2009 to July 2011 at Legal Amazon (Source: Imazon/SAD).

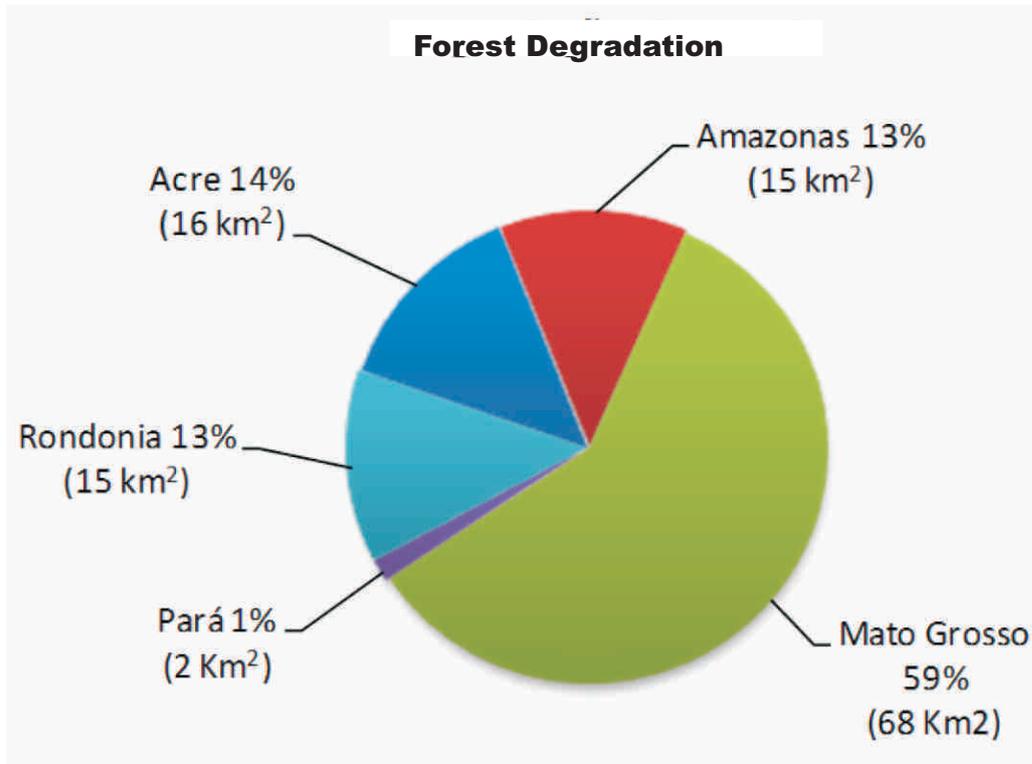


Figure 5. Forest Degradation (%) in the States of Legal Amazon in July 2011 (Source: Imazon/SAD).

The deforestation accumulated in the period of August 2010 to July 2011, (twelve months of the official calendar of Deforestation measuring) has reached 6.389 square kilometers. This represents an extremely expressive increase of 241% in the forest degradation accumulated in this period (August 2010 to July 2011) regarding the same period of the previous year (August 2009 to July 2010) when the forest degradation totaled 1.873 square kilometers (Table 2).

Tocantins presented in relative terms an expressive increase of 1.450%, however, in absolute terms the increase was reduced going from only 2 square kilometers between August 2009 to July 2010 to 31 square kilometers from August 2010 to July 2011. In Amazonas there was an increase of 543%, in Acre 426%, in Mato Grosso 393%, and in Rondônia 391%. In Pará, the degradation had a relatively small increase: 34%. On the other hand, Roraima presented a reduction

of 75% in forest degradation.

Mato Grosso leads the ranking of forest degradation with 60% of the total in the period of August 2010 to July 2011. Following comes Rondônia and Pará with 17% each. 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 also leads the accumulated deforestation ranking with 3.847 square kilometers, followed by Pará (1.077 square kilometers), Rondônia (1.076 square kilometers), Amazonas (193 square kilometers), Acre (163 square kilometers), (Tocantins 31 square kilometers) and Roraima (2 square kilometers).

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

Tabela 2. Evolução da degradação florestal entre os Estados da Amazônia Legal de agosto de 2009 a julho de 2010 e de agosto de 2010 a julho de 2011 (Fonte: Imazon/SAD).

State	August 2009 to July 2010	August 2010 to July 2011	Variation (%)
Acre	31	163	+ 426
Amazonas	30	193	+ 543
Mato Grosso	781	3.847	+ 393
Pará	803	1.077	+ 34
Rondônia	219	1.076	+ 391
Roraima	8	2	- 75
Tocantins	2	31	+ 1.450
Amapá	1	-	- 100
Total	1.875	6.389	+ 241

* Data from Maranhão were not analyzed.

Carbon Affected by the Deforestation

In July 2011, the 93 square kilometers of deforestation detected by SAD in the Legal Amazon compromised 1.8 million tons (with error radius of 218 thousand tons) of carbon. This amount of affected carbon results in 6.6 million tons of equivalent CO² (Figure 6). This represents a reduction of 27% regarding July 2010 when the affected forest carbon was 2.5 million tons.

The forest carbon compromised by the deforestation in the period of August 2010 to July 2011 (twelve months of the current deforestation calendar) was 26.5 million tons (with error radius of 467 thousand tons), which represented approximately 97.5

million tons of equivalent CO² (Figure 6). Regarding the same period of the previous year (August 2009 to July 2010) there was a 1% increase in the amount of carbon compromised by the deforestation. The relative increase (0.9%) of the forest carbon affected by the deforestation in the period of August 2010 to July 2011 regarding the previous period (August 2009 to July 2010) was less than the relative increase of 9% of the deforestation detected by SAD during the same period.

This suggests that the deforestation this year occurred in areas with less stocks of forest carbon.

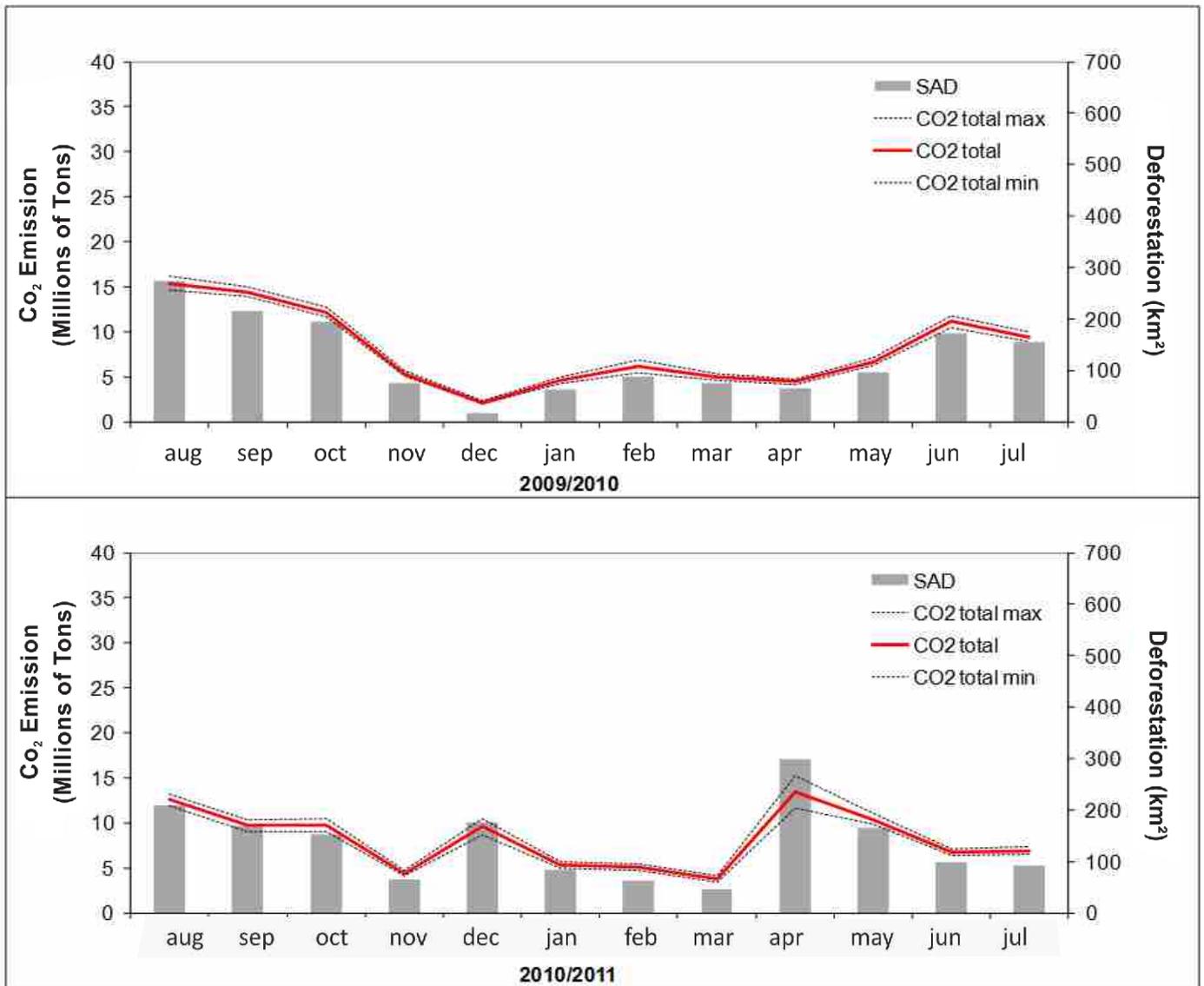


Figure 6. Deforestation and emission of Carbon Dioxide (CO₂) total equivalent from August 2009 to July 2011 in Legal Amazon (Source: Imazon).

Deforestation Geography

Regarding the land situation, in July de 2011, the great 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 (17%), Conservation Units (18%) and Indigenous Lands (1%) (Table 3).

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

Category	June 2011	
	Km ²	%
Agrarian Reform Settlement	16	17
Conservation Units	17	18
Indigenous Lands	1	1
Private, Owned and Abeyance	59	64
Total (km²)	93	100

Agrarian Reform Settlements

SAD registered 16 square kilometers in the Agrarian Reform Settlements during July 2011. The most affected settlements by the deforestation were

Terra Nossa (Altamira; Para), Paraíso (Rurópolis; Para), e Matupi (Manicoré; Amazonas) (Figure 7).

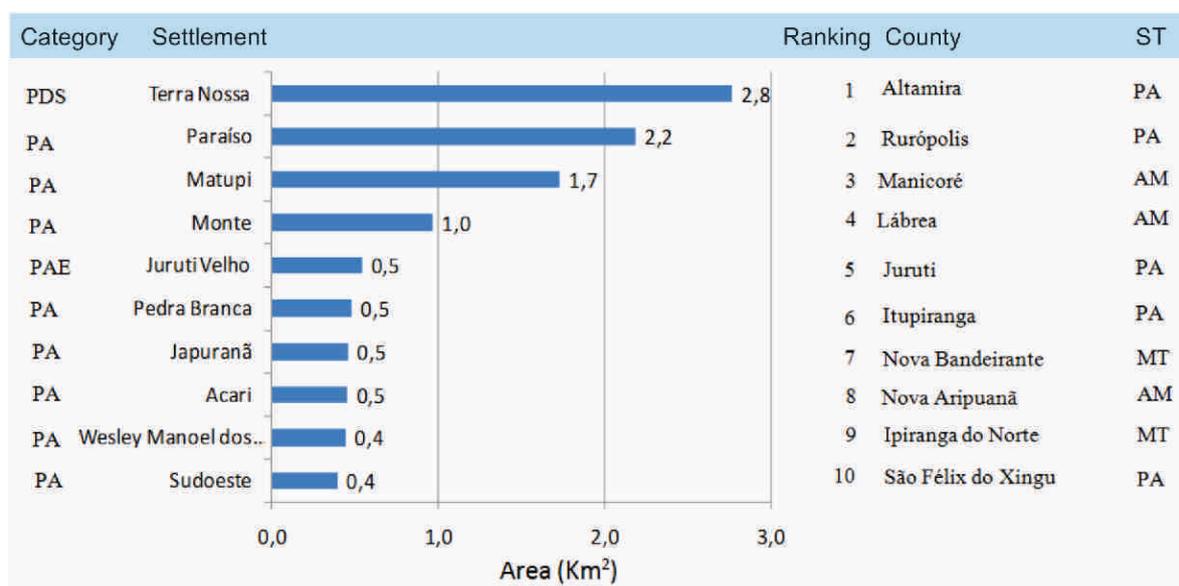


Figure 7. Most deforested Agrarian Reform Settlements in July 2011 at Legal Amazon (Source: Imazon/SAD). PA (Registry Project), PDA (Sustainable Development Project), and PAE (Agroextractivist Registry Project).

³ Includes private areas (owned or not) and non protected public forests

Protected Areas

SAD detected 17 square kilometers of deforestation in the Conservation Units (Figure 8). The Conservation Units that suffered deforestation were Flona Saracá-Taquera (Para), APA Rio Pardo (Rondônia), and Resex Jaci Paraná (Rondônia). In the

case of Indigenous Lands, in July 2011 it was detected only 1 square kilometer. The deforested Indigenous Lands were Cachoeira Seca do Iriri (Para), and Rio Urubu (Amazonas) (Figure 9).

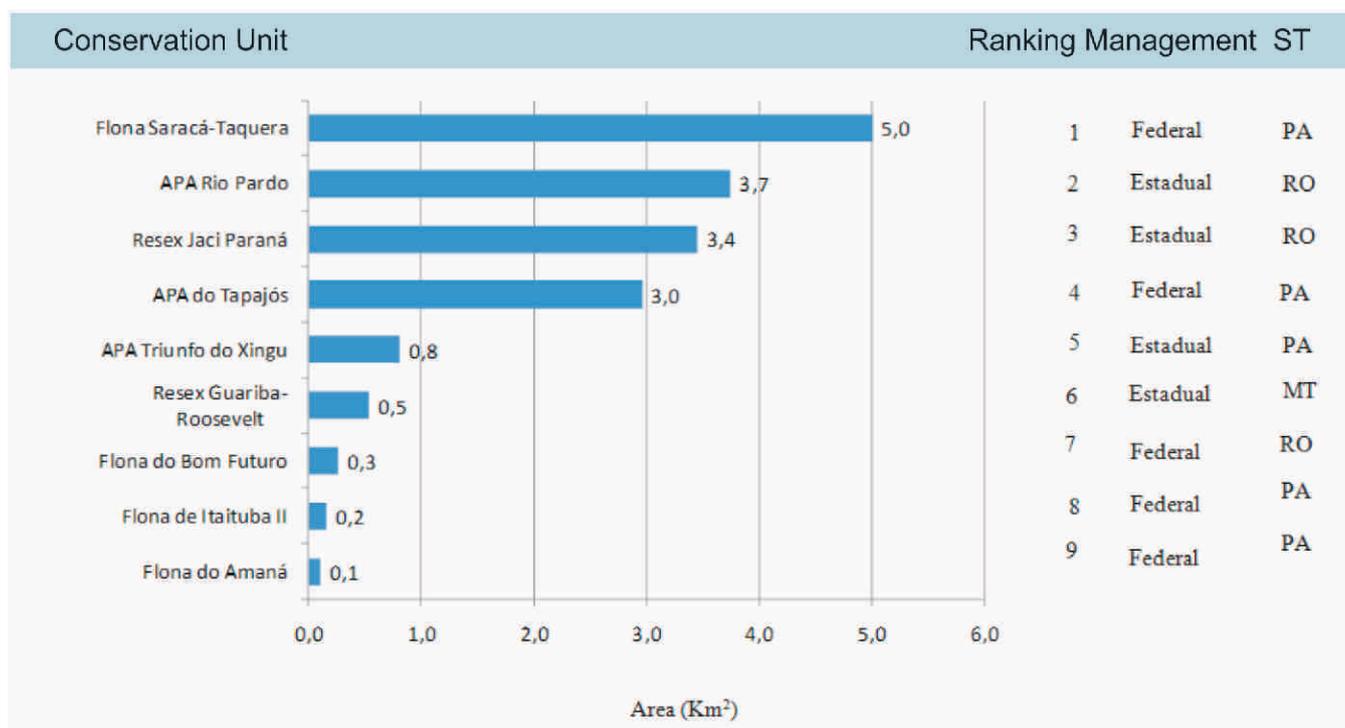


Figure 8. Most deforested Conservation Units at Legal Amazon in July 2011 (Source: Imazon /SAD).

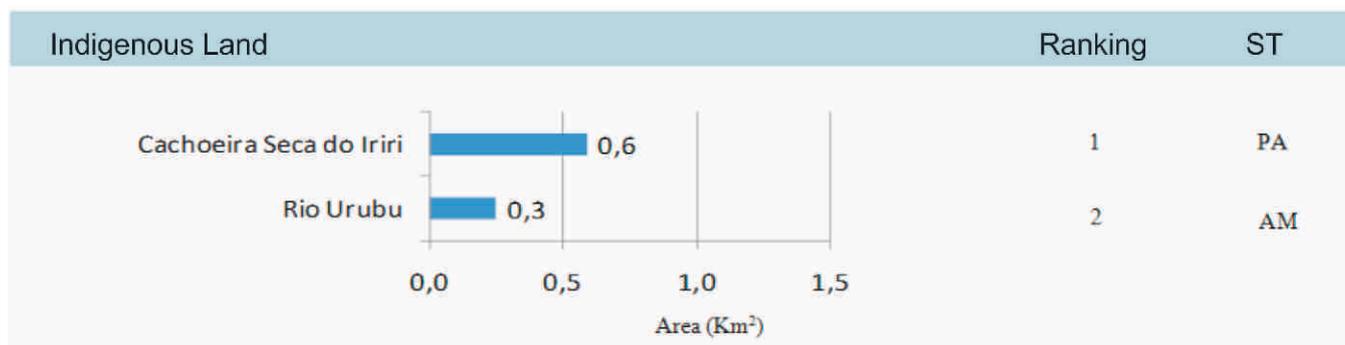


Figure 9. Most deforested Native Lands at Legal Amazon in July 2011 (Source: Imazon /SAD).

Critical Counties

In July 2011, the most deforested counties were: Porto Velho (Rondônia), Oriximiná (Pará) and

Colniza (Mato Grosso) (Figure 10 and 11).

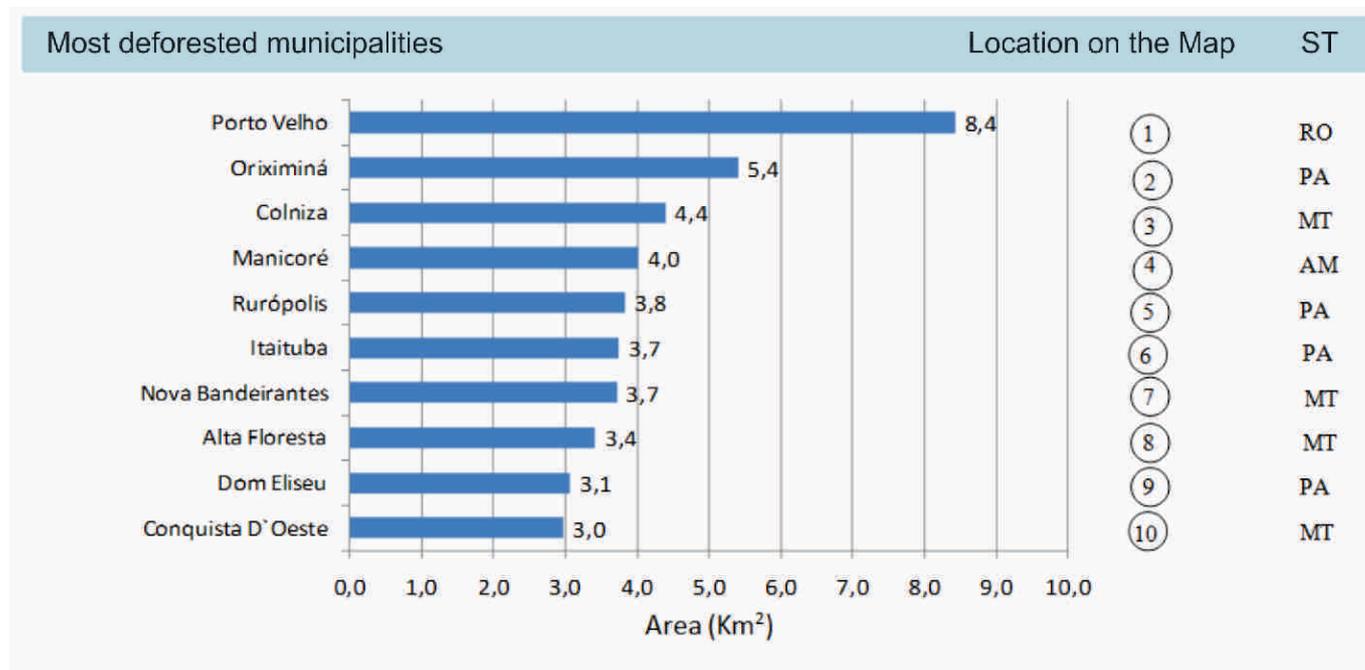


Figure 10. Most deforested municipalities at Legal Amazon in July 2011 (Source: Imazon /SAD).

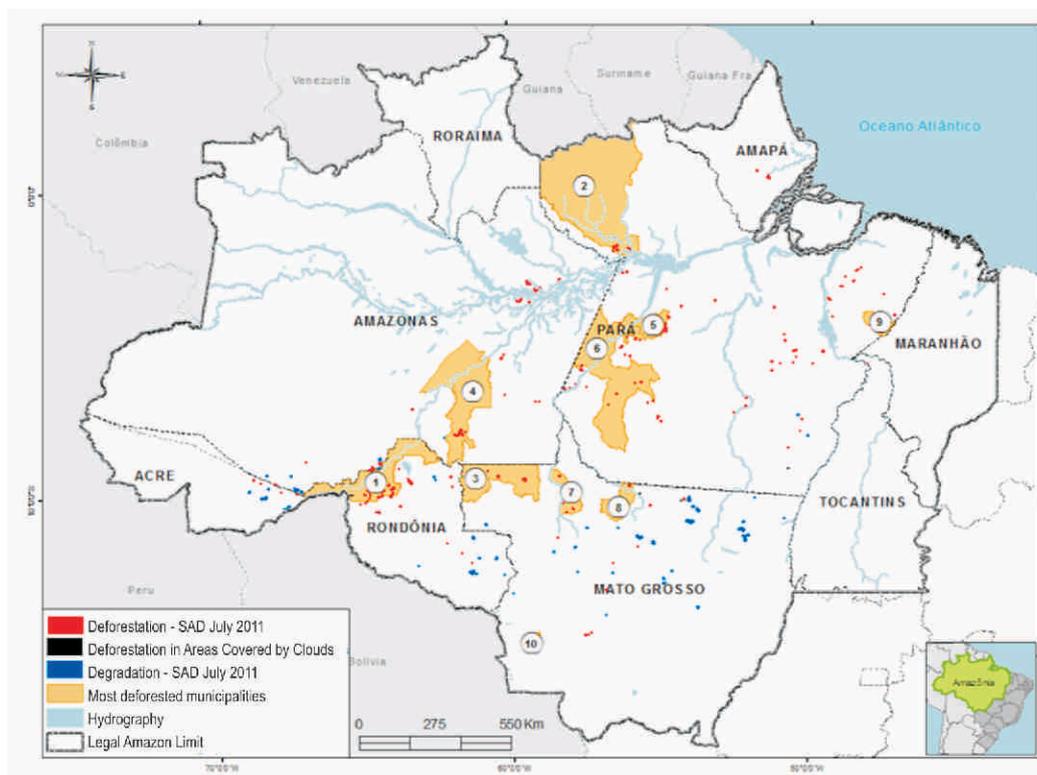


Figure 11. Most deforested counties in July 2011 (Source: Imazon/SAD).

*The recent deforestation 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.

Coverage by clouds and Shade

In July 2011, it was possible to monitor with SAD only 82% of the forest area in Legal Amazon. The other 18% of the territory was

covered by clouds, which complicated the monitoring especially in Roraima which had over 82% of their forest areas covered (Figure 12).

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

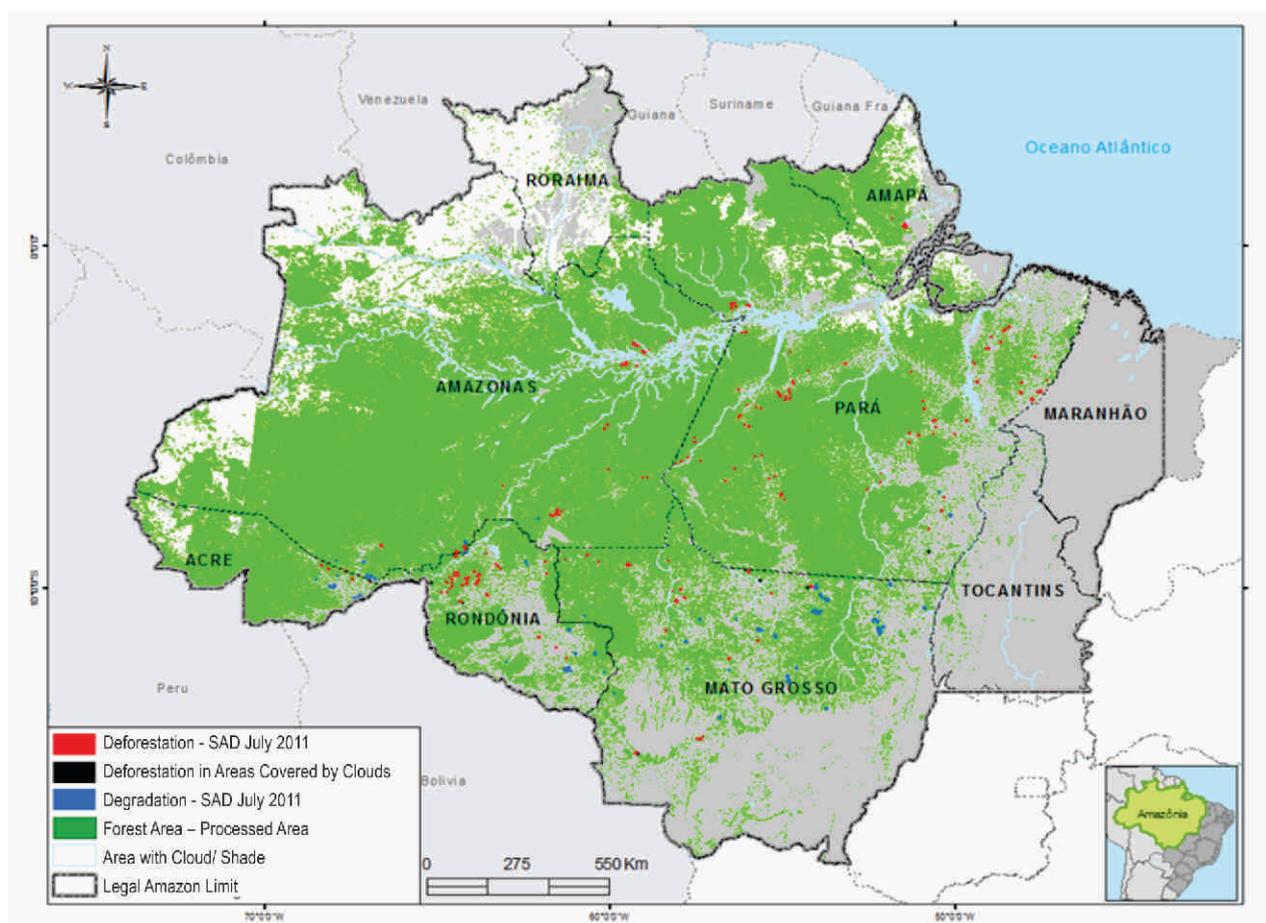


Figure 12. Area with cloud and shade in July 2011 in Legal Amazon

*The recent deforestation 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.

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 June 2011, 79% of the deforestation detected by SAD were confirmed with the Landsat images (Figure 13). The other 21% were not confirmed due to the great occurrence of clouds in the Landsat and CBERS images available in the period.

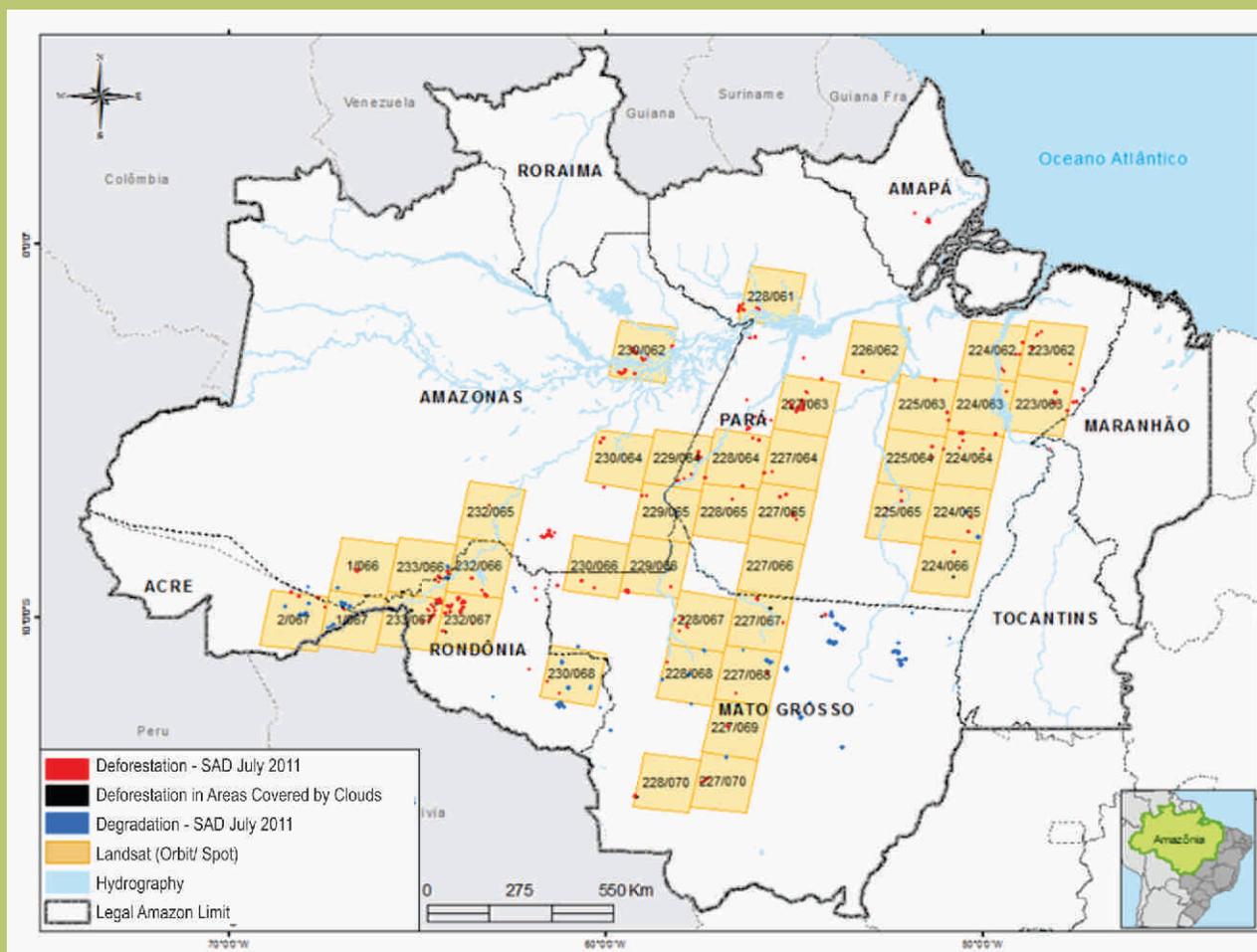


Figure 13. Landsat images used in the validation of the deforestation polygons detected by SAD in July 2011.

*The recent deforestation 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.

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:

$$\text{NDFI} = (\text{VGs} - (\text{NPV} + \text{Solo})) / (\text{VGs} + \text{NPV} + \text{Solo})$$

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'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 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)

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.

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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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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Fundo Vale

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