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SUMMARY

In April 2012, the Sistema de Alerta de Desmatamento (SAD - Deforestation Alert System) has detected 71 square km of deforestation in the Legal Amazon. This represented a decrease of 76% compared to April 2011 when deforestation totaled 298.3 square km. Due to the high cloud cover, it was possible to monitor only 20% of forest area in the Legal Amazon in April 2012, whereas that in April 2011, 31% were monitored in the same area.

The accumulated deforestation from August 2011 to April 2012 totaled 830 square km. There was a reduction of 35% over the previous period (August 2010 to April 2011) when deforestation totaled 1268 square kilometers.
In April 2012, the majority (71%) of the deforestation occurred in Mato Grosso. Then appears Rondônia with 18% and Amazonas with 5%. The remainder (6%) occurred in Pará, Roraima and Acre.

The degraded forests in the Amazon amounted to only 21 square kilometers in April 2012. Compared to April 2011, when forest degradation totaled 1,776 square km, there was a reduction of 99%. The degradation was detected only in Mato Grosso.

The forest degradation accumulated in the period (August 2011 to April 2012) reached 1589 square kilometers. In the previous period (August 2010 to April 2011), when degradation amounted to 5887 square kilometers, a reduction of 73%.

In April 2012, the deforestation detected by SAD endangered 4.8 million tons of CO2 equivalent. In the accumulated of the period (August 2011 - April 2012) the equivalent CO_2 emissions endangered with deforestation totaled 58.2 million tons, representing a reduction of 24% over the previous period (August 2010 to April 2011

Deforestation Statistics

According to SAD, deforestation (total suppression of forest to other alternative land uses) reached 71 square kilometers in April 2012 (Figure 1 and Figure 2). This represented a decrease of 76% compared to April 2011 when deforestation totaled 298.3 square km.
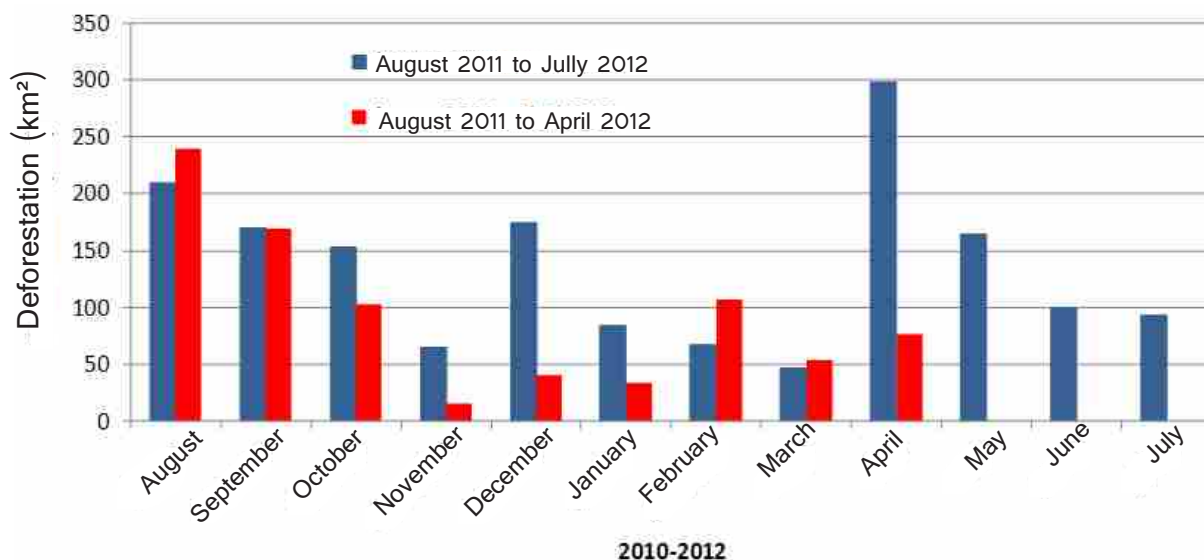
Figure 1. Deforestation August 2010 to April 2012 in the Legal Amazon (Source: Imazon/SAD). Imazon/SAD).
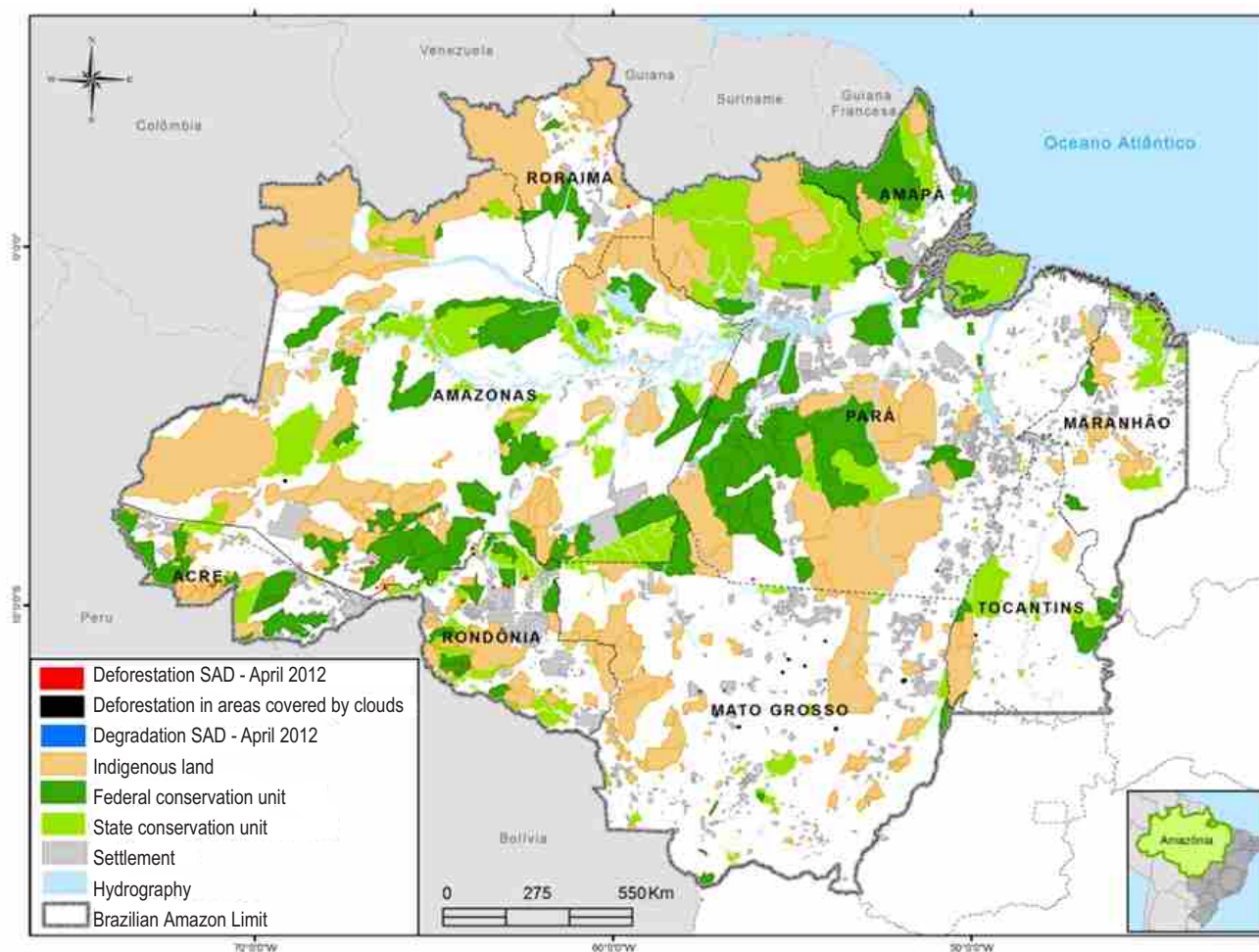

Figure 2. Deforestation and degradation from August 2010 to April 2012 in the Legal Amazon (Source: Imazon/SAD).

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

The accumulated deforestation from August 2011 to April 2012, corresponding to nine months of the official calendar of measuring deforestation, reached 830 square km. There was a 35% reduction in deforestation over the previous period (August 2010 to April 2011) when it reached 1268 square kilometers.

In April 2012, the majority (71%) of the deforestation occurred in Mato Grosso, followed by Rondônia (18.5%), Amazonas (5%), Pará (2%), Roraima (1.5%), Tocantins (1%) and Acre (1%) (Figure 3).
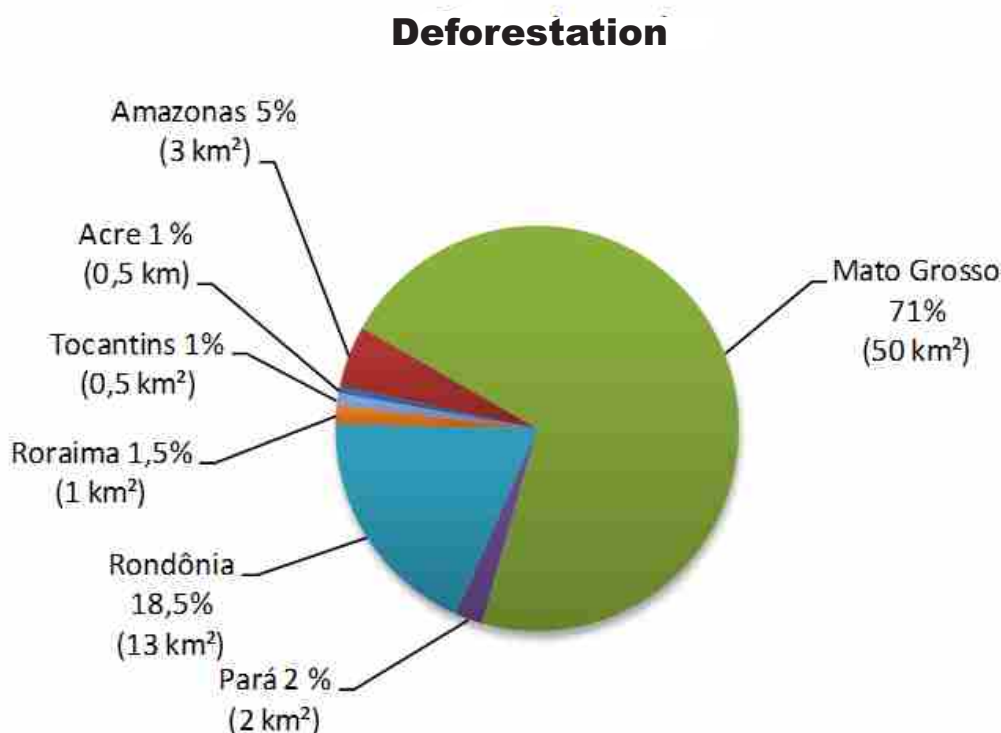

Figure 3. Percentage of deforestation in the Amazon in April 2012 (Source: Imazon/SAD).

Considering the accumulated deforestation in the nine months of the current calendar year of deforestation (August 2011 to April 2012), Mato Grosso leads the ranking with 34% of total deforestation. Then is Pará with a 32%, Rondônia with 19% and Amazonas with 8%. These four states accounted for 93% of Amazon deforestation occurred in that period.

There was a 35% reduction in deforestation occurred from August 2011 to April 2012 compared with the previous period (August 2010 to April 2011) (Table 1). In relative terms, occurred a reduction of

61% in Acre, 51% in Amazonas, 46% in Mato Grosso, 42% in Rondônia and 2% in Pará. On the other hand, there was an increase of 188% in Roraima and 120% in Tocantins.

In absolute terms, Mato Grosso leads the ranking of accumulated deforestation with 280 square kilometers, followed by Pará (267 square kilometers), Rondônia (161 square kilometers), Amazonas (69 square kilometers), Roraima (23 square kilometers), Acre (19 square kilometers) and Tocantins (11 square kilometers).

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

Table 1. Evolution of deforestation among states in the Amazon from August 2010 to April 2011 and August 2011 to April 2012 (Source: Imazon/SAD).

State	August 2010 to April 2011	August 2011 to April 2012	Variation (%)
Acre	49	19	-61
Amazonas	141	69	-51
Mato Grosso	516	280	-46
Pará	273	267	-2
Rondônia	276	161	-42
Roraima	8	23	+188
Tocantins	5	11	+120
Amapá	-	-	-
Total	**1.268**	**830**	**-35**

* Data from Maranhão were not analyzed.

Forest Degradation

In April 2012, the SAD recorded 21 square kilometers of degraded forest (heavily exploited forests by logging activities and/or burned) (Figures 2 and 4). Over the same period last year (April 2011) there was a reduction of 99% when forest degradation reached 1776 square kilometers. All areas of degradation in April occurred in Mato Grosso.
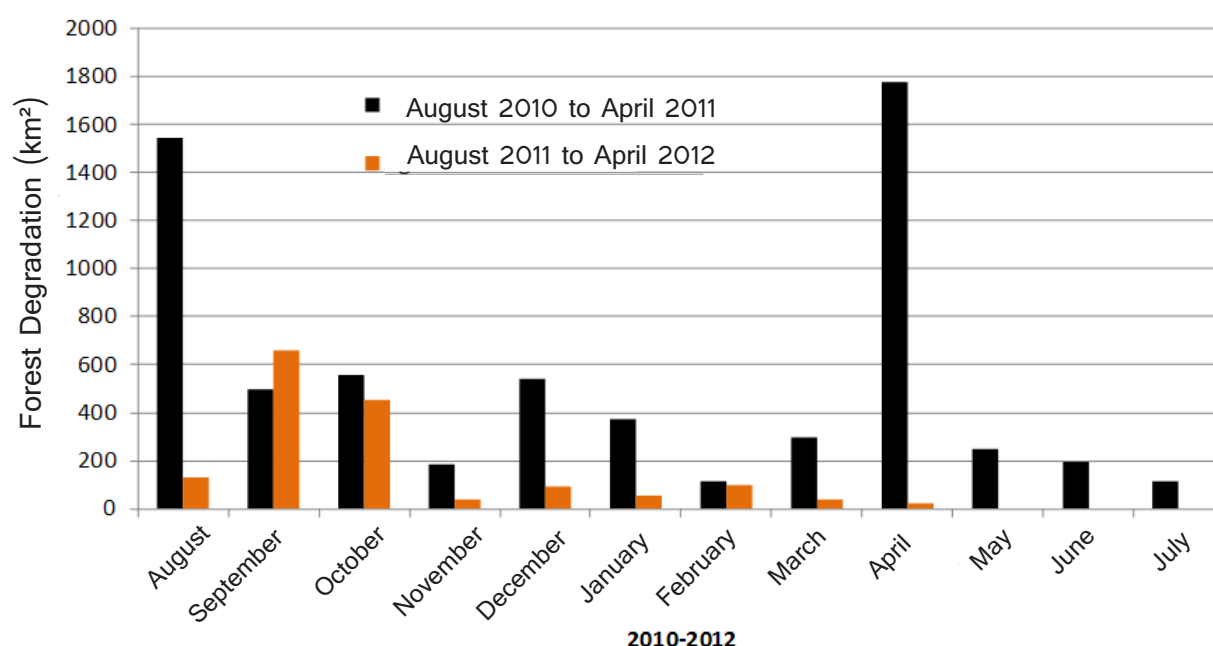

Figure 4. Forest degradation from August 2010 to April 2012 in the Legal Amazon (Source: Imazon/SAD).

The forest degradation accumulated in the period from August 2011 to April 2012 reached 1589 square kilometers. This represents a 73% reduction in forest degradation accumulated during this period (August 2011 to April 2012) over the same period of last year (August 2010 to April 2011) when the forest degradation totaled 5887 square kilometers (Table 2). The largest reductions were in Acre (-98%), Rondônia (-91%), Amazonas (-82%), Mato Grosso (-68%) and Pará (-69%).

In absolute terms, the Mato Grosso leads the ranking of forest degradation, with an accumulated total of 1217 square kilometers (77%), distantly followed by Pará with 235 square kilometers (15%). The remainder (8%) occurred in Rondônia (93 square kilometers), Amazonas (26 square kilometers), Roraima (15 square kilometers), and Acre (3 square kilometers).

Table 2. Evolution of forest degradation among states in the Amazon from August 2010 to April 2011 and August 2011 to April 2012 (Source: Imazon/SAD).

State	August 2010 to April 2011	August 2011 to April 2012	Variation (%)
Acre	143	3	-98
Amazonas	146	26	-82
Mato Grosso	3.771	1.217	-68
Pará	758	235	-69
Rondônia	1.041	93	-91
Roraima	2	15	+650
Tocantins	26	-	-
Amapá	-	-	-
Total	**5.887**	**1.589**	**-73**

* Data from Maranhão were not analyzed.

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

Carbon Affected by the Deforestation

In April 2012, the 71 square kilometers of deforestation detected by SAD in the Amazon endangered 1.3 million tons of carbon (with a margin of error of 229,000 tons of carbon). This amount of endangered carbon may result in emissions of 4.8 million tons of CO_2 equivalent (Figure 6).

The carbon from forest endangered by deforestation from August 2011 to April 2012 was 15.3 million tons (with a margin of error of 331,000 tons), representing approximately 58.2 million tons of CO_2 equivalent (Figure 6). Over the same period last year (August 2010 to April 2011) there was a 24% reduction in the amount of carbon endangered by deforestation. The reduction (24%) of forest carbon endangered by deforestation from August 2011 to April 2012, compared to previous period (August 2010 to April 2011), was less than the 35% reduction of deforestation detected by SAD during the same period.
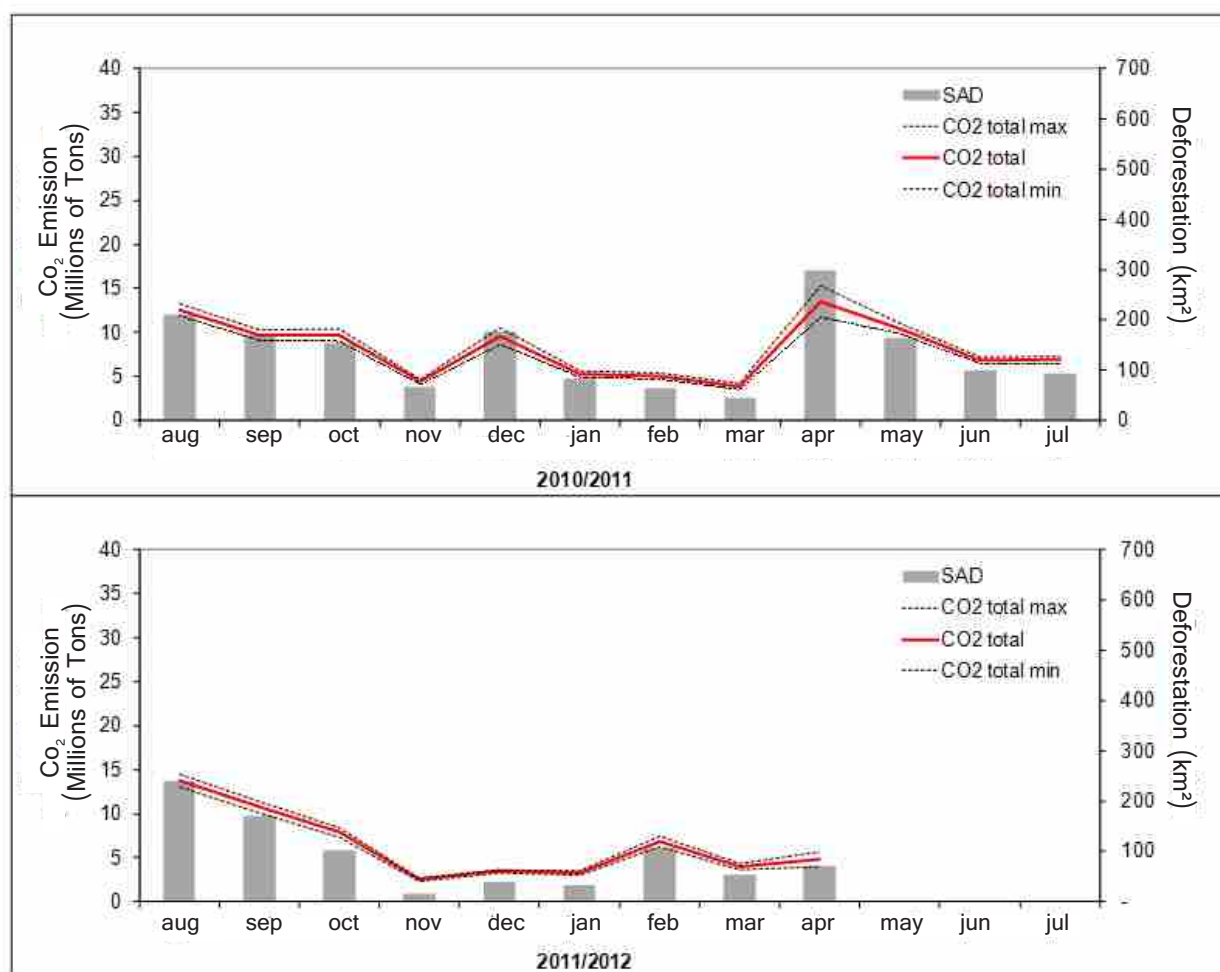

Figure 6. Deforestation and emissions of carbon dioxide (CO_2) equivalent total in August 2010 to April 2012 in the Legal Amazon (Source: Imazon).

Deforestation Geography

In April 2012, the majority (82.5%) of the deforestation occurred in private areas or under various stages of ownership. The rest of deforestation was registered in conservation areas (12.5%) Indigenous land (4%) and Land Reform Settlements (1%) (Table 3).

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

Category	April 2012	
	km²	%
Agrarian Reform Settlement	0,5	1
Conservation Units	9	12,5
Indigenous Lands	3	4
Private, Owned and in Abeyance³	58,5	82,5
Total (km²)	71	100

Agrarian Reform Settlements

The SAD recorded only 0.5 square kilometer of deforestation in Land Reform Settlements in April 2012. The settlements that have been affected by deforestation were Monte (Lábrea, Amazonas) and Domingos Oliveira Bezerra (Santana do Araguaia, Pará) (Figure 7).
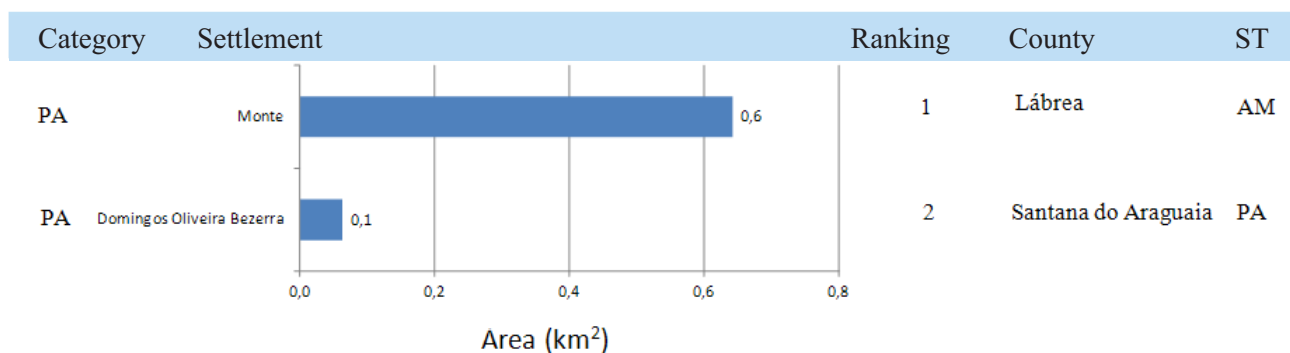

Category	Settlement		Ranking	County	ST
PA	Monte	0,6	1	Lábrea	AM
PA	Domingos Oliveira Bezerra	0,1	2	Santana do Araguaia	PA

Area (km²)

Figure 7. Land Reform Settlements in April 2012 deforested in the Amazon (Source: Imazon/SAD). PA (Settlement Project).

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

Protected Areas

SAD detected 9 square kilometers of deforestation in the Conservation Unit (Figure 8). The Conservation Units deforested were Resex of the Cautário River (Rondônia), Florex of the Rio Preto Jacundá (Rondônia) and Florsu of the Madeira River (B) (Rondônia), Resex of the Jaci Parana (Rondônia), Parna of the Sierra of the Cutia (Rondônia), Flona of the Jamari (Rondônia). In the case of Indigenous Lands, in April 2012, was detected three square kilometers of deforestation in indigenous lands of Manoki (Mato Grosso) and of Kaxarari (Rondônia) (Figure 9).
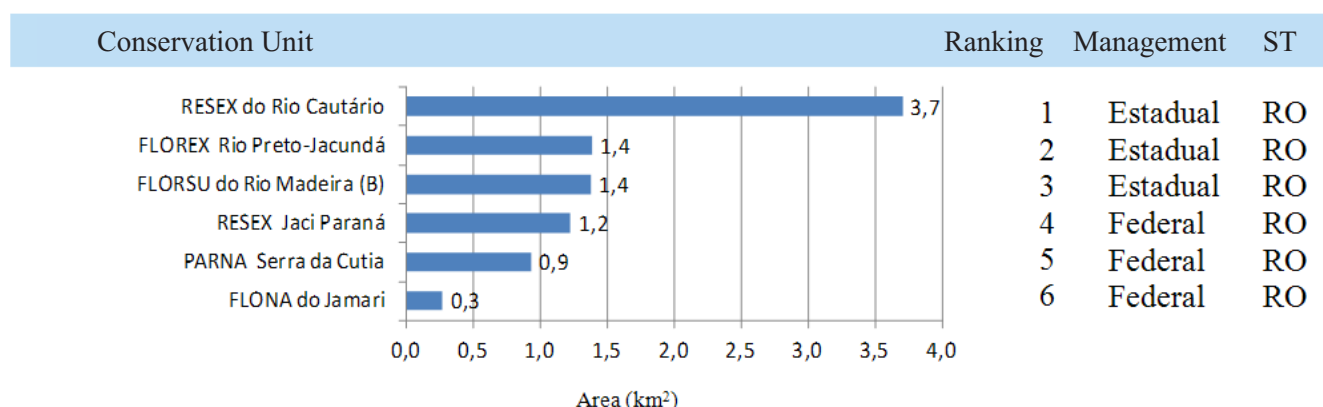
Conservation Unit		Ranking	Management	ST
RESEX do Rio Cautário	3,7	1	Estadual	RO
FLOREX Rio Preto-Jacundá	1,4	2	Estadual	RO
FLORSU do Rio Madeira (B)	1,4	3	Estadual	RO
RESEX Jaci Paraná	1,2	4	Federal	RO
PARNA Serra da Cutia	0,9	5	Federal	RO
FLONA do Jamari	0,3	6	Federal	RO

Figure 8. Conservation Unit area deforested in the Amazon in April 2012 (Source: Imazon/SAD).

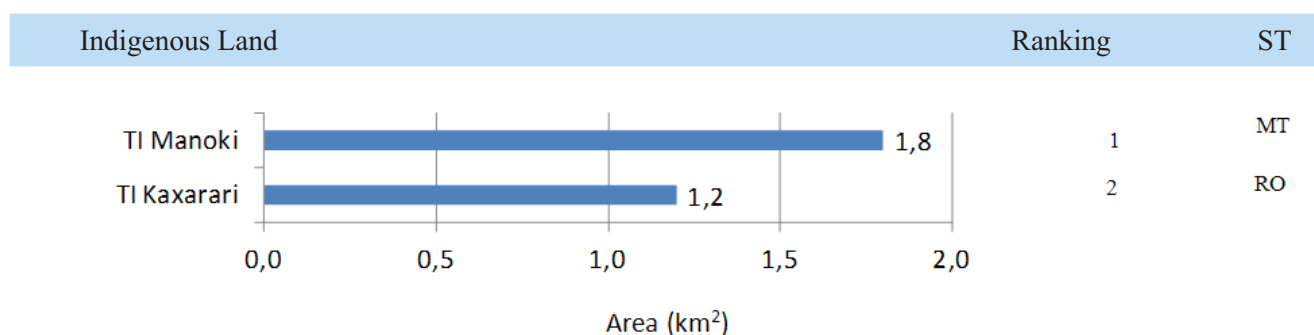| Indigenous Land		Ranking	ST
TI Manoki	1,8	1	MT
TI Kaxarari	1,2	2	RO

Figure 9. Indigenous land deforested in the Amazon in April 2012 (Source: Imazon/SAD). Imazon /SAD).

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Critical Municipalities

In April 2012, the most deforested counties were: Bom Jesus do Araguaia (Mato Grosso); Gaúcha do Norte (Mato Grosso); and Guajará Mirim (Rondônia) (Figures 10 e 11).
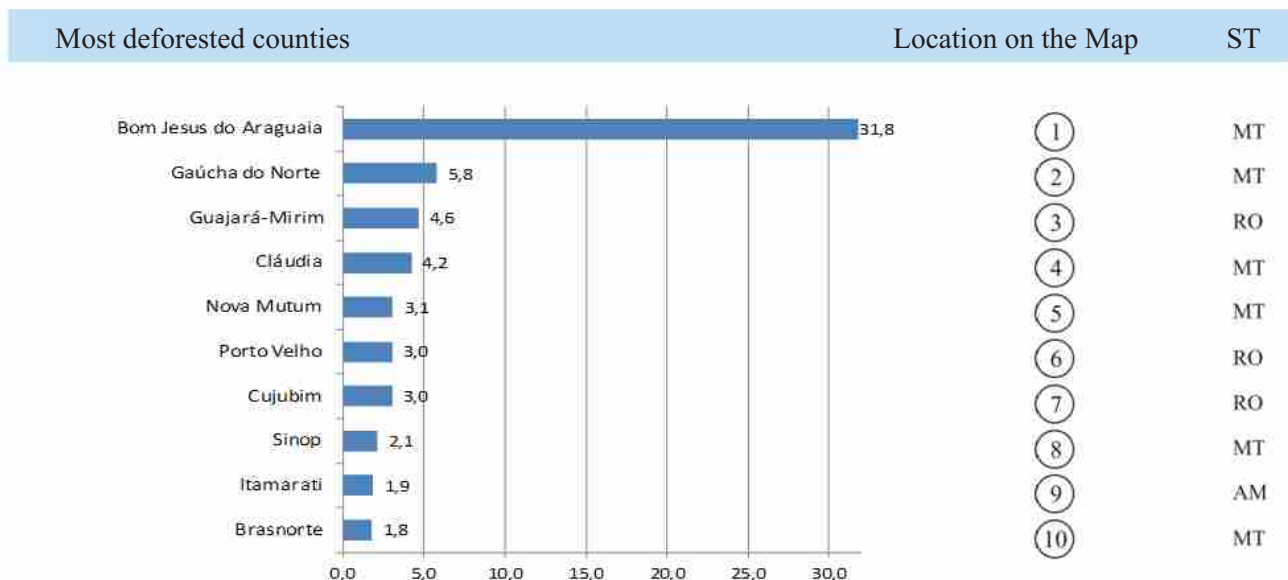
Most deforested counties	Location on the Map	ST
Bom Jesus do Araguaia — 31,8	1	MT
Gaúcha do Norte — 5,8	2	MT
Guajará-Mirim — 4,6	3	RO
Cláudia — 4,2	4	MT
Nova Mutum — 3,1	5	MT
Porto Velho — 3,0	6	RO
Cujubim — 3,0	7	RO
Sinop — 2,1	8	MT
Itamarati — 1,9	9	AM
Brasnorte — 1,8	10	MT

Figure 10. Most deforested counties in the Amazon in April 2012 (Source: Imazon/SAD).
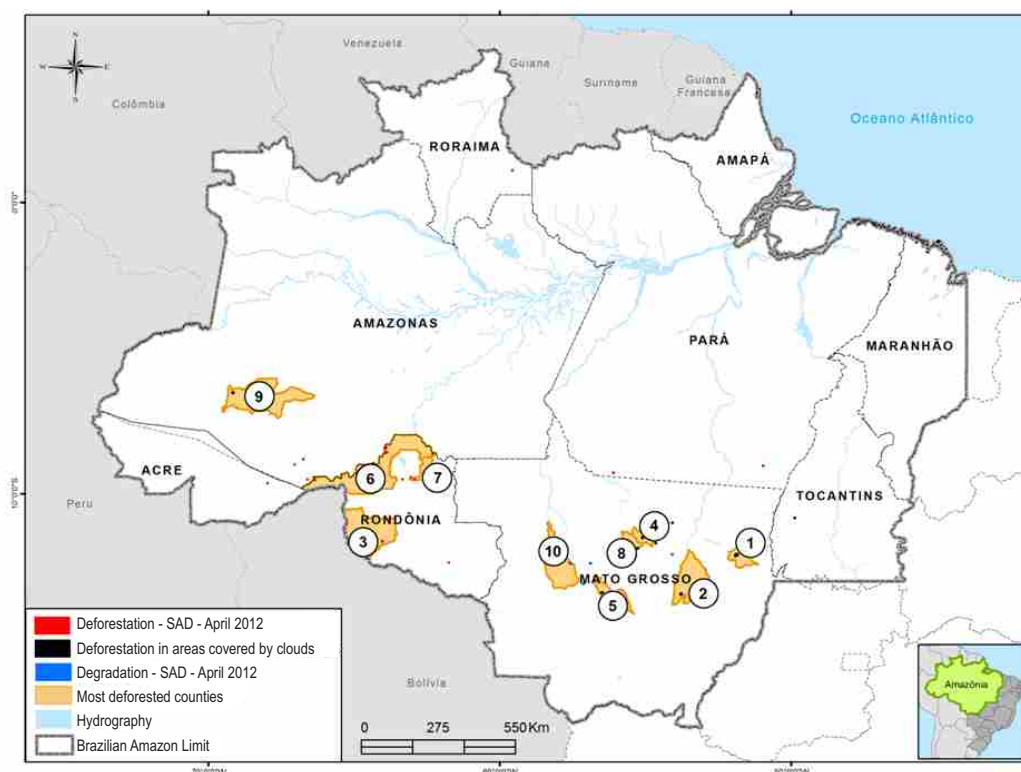
Figure 11. Counties with largest deforested areas in April 2012 (Source: Imazon/SAD).

*The deforestation in areas covered by clouds may have occurred in March 2012 or previous months, but it was only possible to detect it now when there were less clouds in the specifically observed area.

Coverage by clouds and Shade

In April 2012, it was possible to monitor with SAD only 20% of forest area in the Amazon. The other 80% of forest area was covered by clouds which hampered the detection of deforestation and forest degradation. The states with greater cloud cover were Amapá (97%), Roraima (93%), Acre (92%) and Pará (89%). The other states had less than 65% of the territory covered by clouds. As a result, data from deforestation and forest degradation in April 2012 may be underestimated (Figure 12). The period from December to April is characterized as a rainy season in the Amazon region, which make it difficult to monitor deforestation through satellite imagery operating in the optical range of the electromagnetic spectrum.

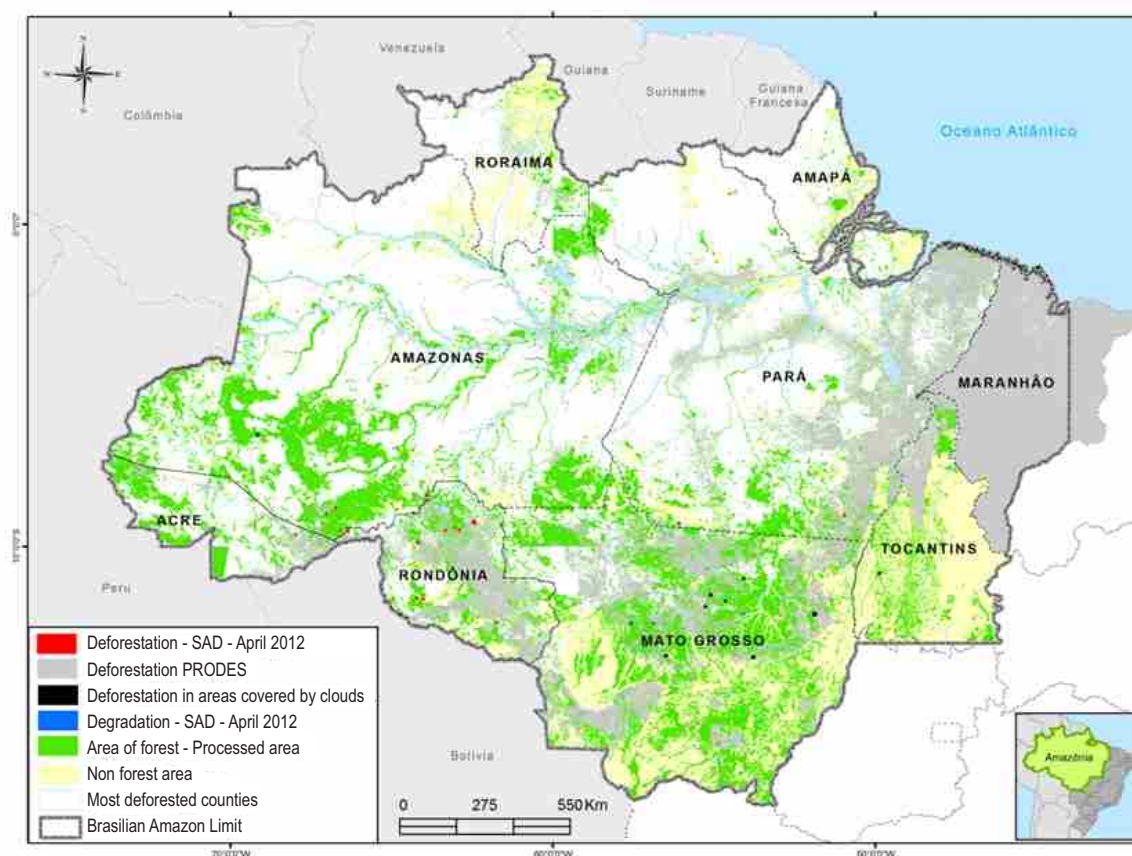* The portion of Maranhão that integrates the Amazon was not analyzed.

Figure 12. Area with clouds and shadow in April 2012 in the Amazon.

*The deforestation in areas covered by clouds may have occurred in March 2012 or previous months, but it was only possible to detect it now when there were less clouds in the specifically observed area.

Table I: SAD 3.0

Since August 2009, the SAD had some news. First, we created a graphical interface for integrating all image processing programs used in the SAD. Second, we begin to compute the deforestation in areas that were covered by clouds in the previous months in a new class. Finally, deforestation and degradation are detected with pairs of NDFI images in a change detection algorithm. The primary method remains the same as the SAD 2 as described below.

The SAD generates temporal mosaic of daily MODIS of the products MOD09GQ and MOD09GA for filtering of the clouds. In the following, we used a technique of the fusion of different resolution spectral bands, e.g., pixels of different sizes. In that case, we change the scale of five bands with 500 meters MODIS pixels to 250 meters. This allowed to improve the spectral model of mixed pixels, providing the ability to estimate the abundance of vegetation, soil and vegetation not Photosynthetically Active (NPV of English - Non-Photosynthetic) components (vegetation, soil and Shadow) to calculate the NDFI with the equation below:

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

Where VGs is the standard component of vegetation for shadow given by:
$$Vgs = Vegetation/(1 - Shadow)$$

The NDFI ranges from -1 (pixel with 100% of exposed soil) to 1 (pixel with >90% with woody vegetation). Thus, we get a continuous image that shows the transition from deforested, degraded forests through until you reach the forest with no warning signs of disturbance.

The detection of deforestation and degradation began this month with the difference of NDFI images of consecutive months. Thus, a reduction in NDFI values between -200 and -50 indicates possibly cleared areas and between -49 and -20 with warning signs of degradation.

The SAD 3.0 Beta is compatible with previous versions (SAD 1.0 and 2.0), because the threshold detection of deforestation was calibrated to generate the same type of response obtained by the previous method.

SAD is already operating in the State of Mato Grosso since August 2006 and in the Legal Amazon since April 2008. In this report, we present the data generated by the SAD monthly from August 2006 to April 2012.

Table II: Carbon Affected by Deforestation

Since January 2010 we reported the estimates of carbon endangered (e.g., subject to the forest carbon emissions due to burning and decomposition of forest biomass residues) from deforestation detected by SAD in the Amazon.

The carbon estimates are generated based on the combination of deforestation maps of the SAD with simulations of the spatial distribution of biomass for Amazonia. We develop a model of the estimates of carbon emissions, based on stochastic simulation (Morton et al, in prep.), called Carbon Emission Simulator (CES). We generated 1000 simulations of the spatial distribution of biomass in the Amazon using a geostatistic model (Sales et al., 2007), and transformed these biomass simulations in C stocks using conversion factors for biomass for C of the literature, according to the formula below:

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

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

$$BPF = ff * AGLB$$

$$BAS_0 = bf * AGLB$$

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).

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

For the application of the CES model using data from SAD, we consider only the carbon endangered by deforestation, e.g. the fraction of forest biomass composed of carbon (50%) subject to instantaneous emissions due to burning of forests by logging and/or further decomposition of remaining forest biomass. In addition, we adapted the model to estimate the CES for the forest carbon endangered by deforestation in a monthly scale. Finally, the simulations allowed to estimate the uncertainty of carbon endangered, represented by the standard deviation (+/- 2 times) of the simulations of carbon affected in each month.

For the conversion of carbon to CO equivalent value of the applied 3.68:2

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 Modeling, 205(1-2), 221-230.

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