Monitoring burned area, its associated carbon emissions and forest fire risk

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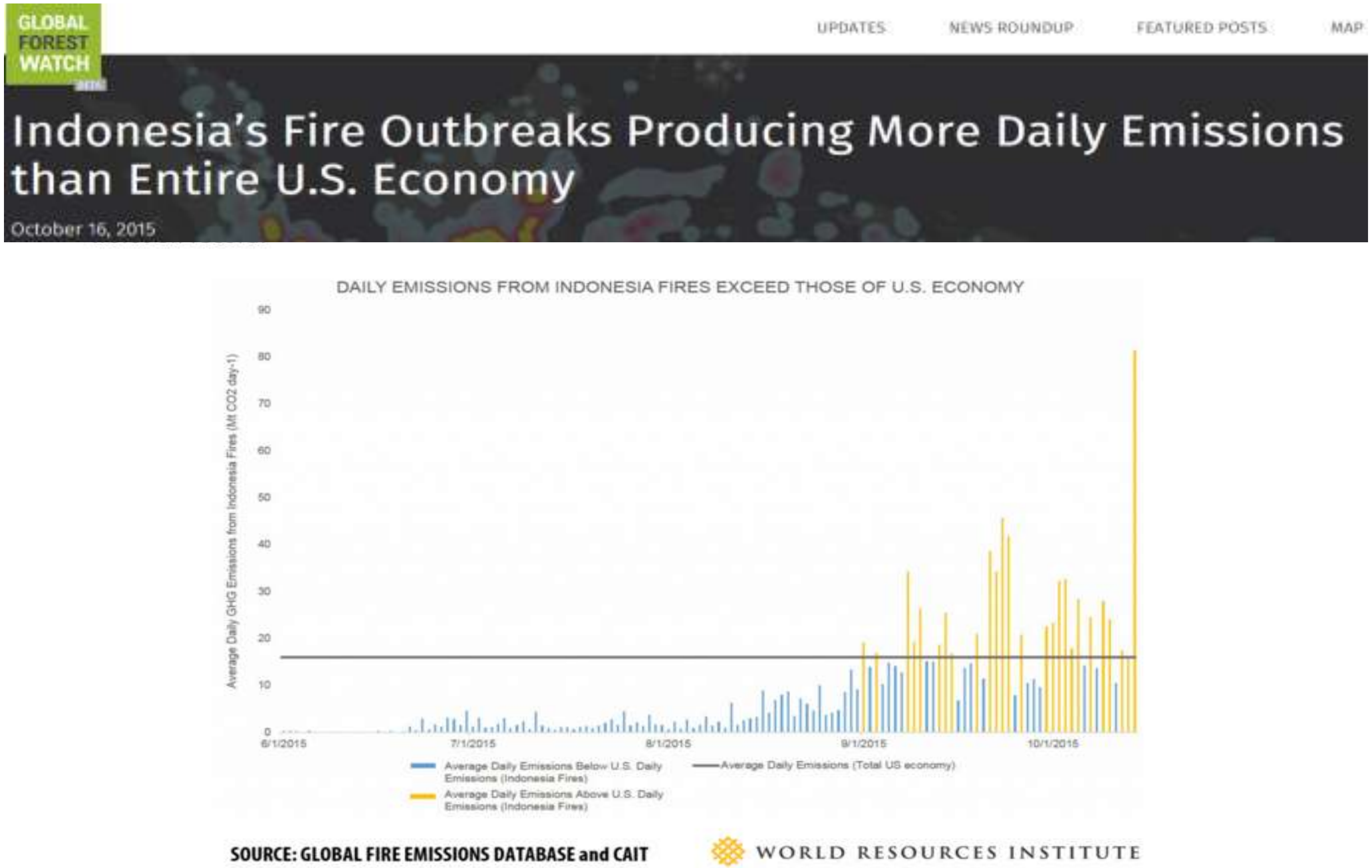
Maranhão:

UNICEUMA, UFMA, ICMBio

M Gloor (University of Leeds), S.Saatchi (JPL-NASA), Y. Malhi (University of Oxford)

La Red Latinoamericana de Teledetección e Incendios Forestales 17 Nov 2015

Overview



Biomass burning in South America emits on average 15 % of total global fire emissions

1. **Monitoring burned area**
2. **Carbon Emissions**
3. **Fire risk**

1. Monitoring burned area

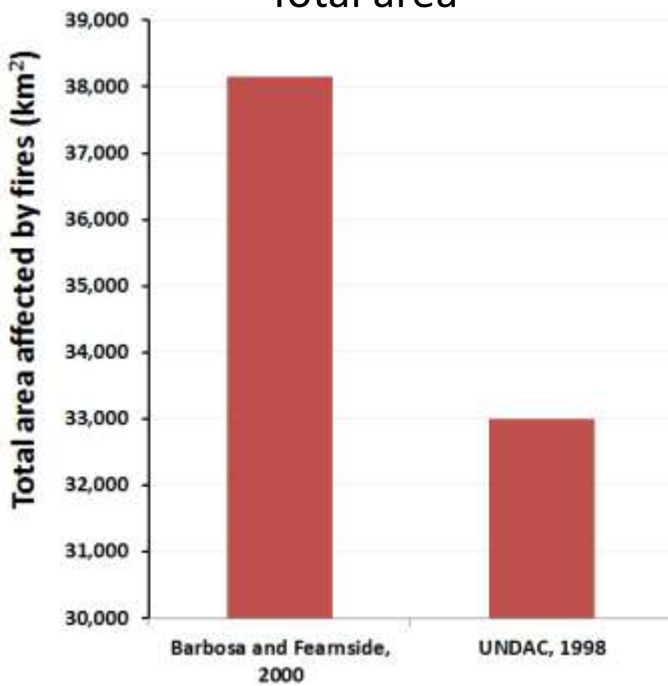
Overview

1. What we know about fire regime in SA?

We have some estimates of burned area with contrasting results…..

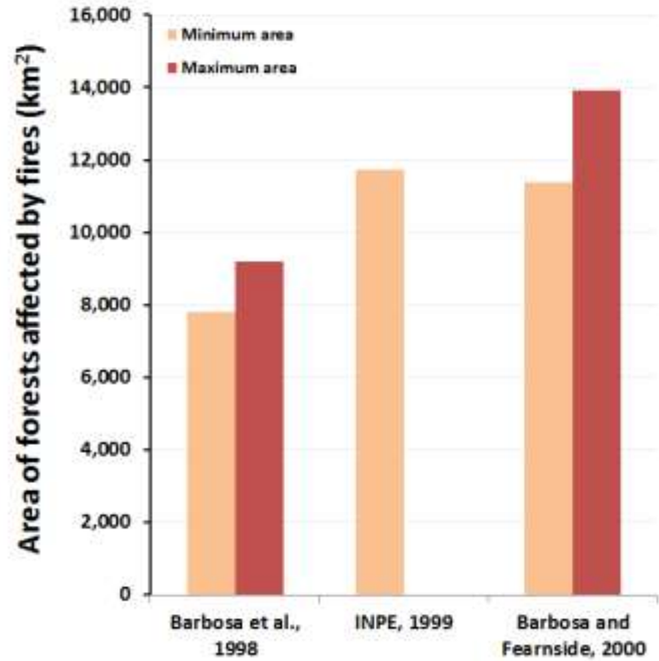
During the El Niño event in 1997-1998 in Roraima:

Total area



13.5% difference

Forests affected area



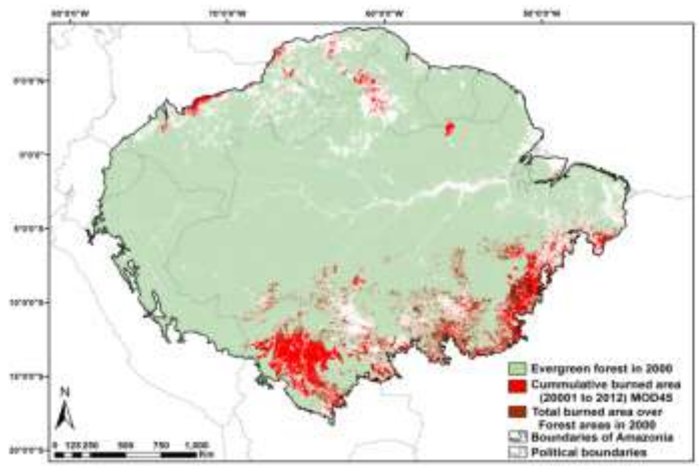
43% difference from min to max estimates

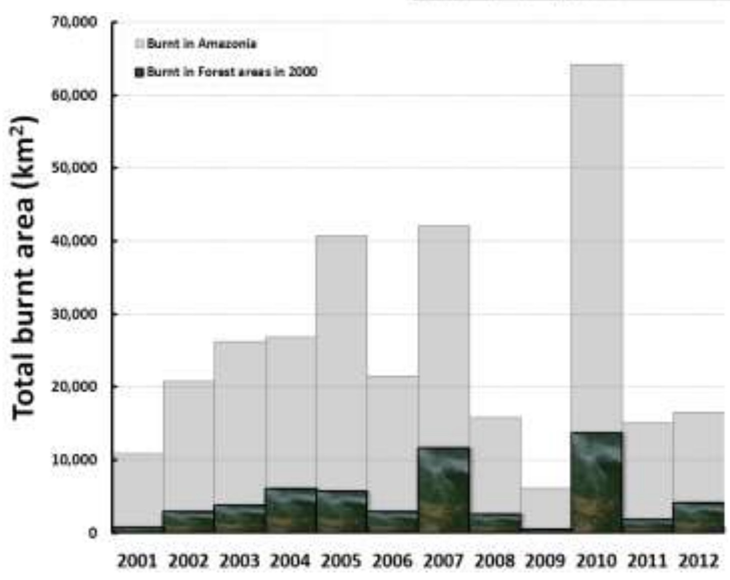
Anderson adaptation

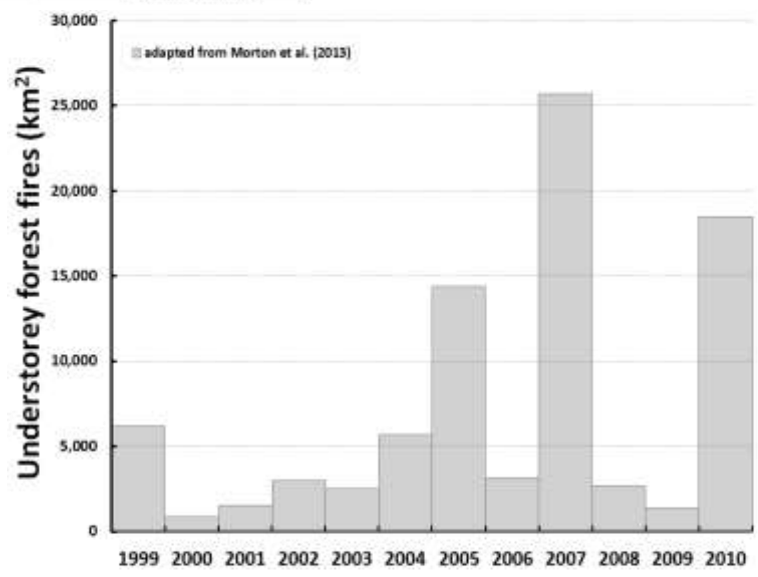
Overview

1. What we know about fire regime in SA?

And only MODIS-based products with a consistent temporal coverage (2000 onwards)





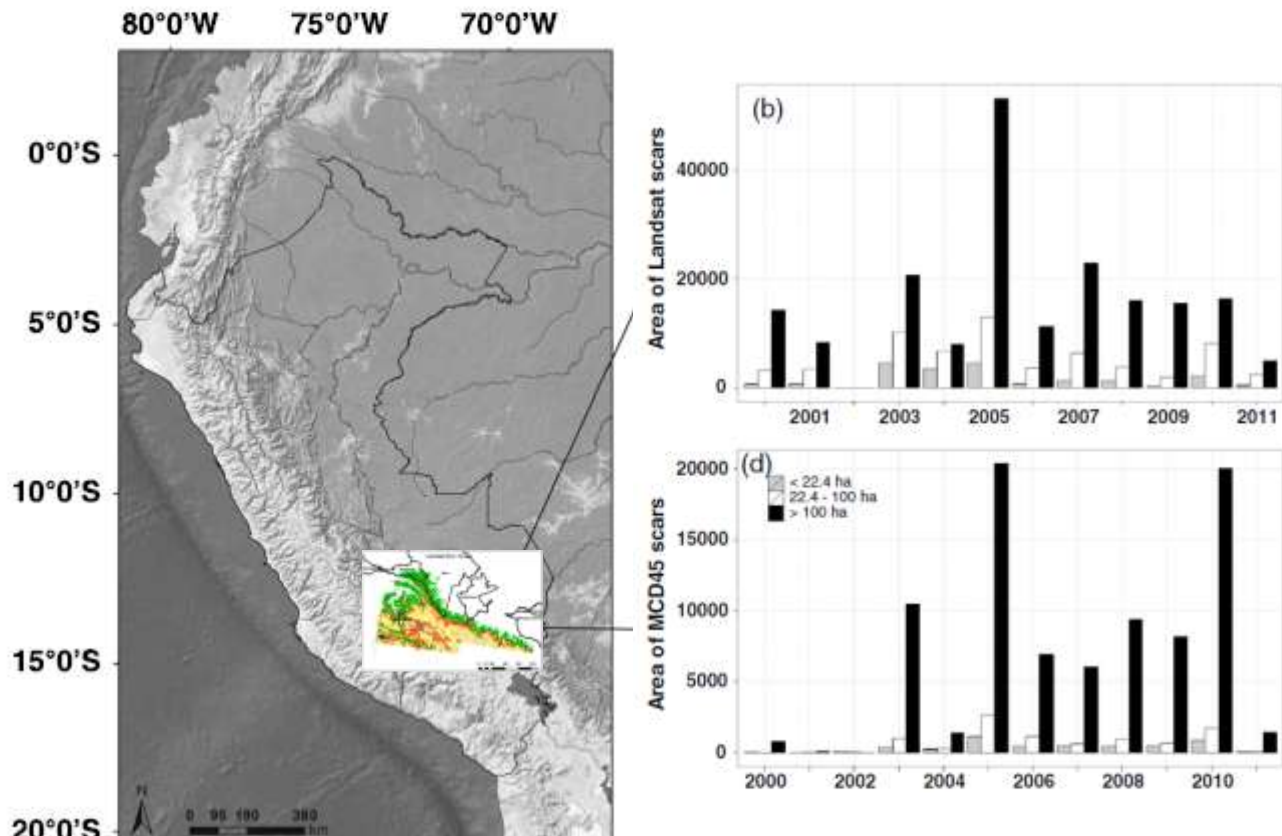


Anderson et al, book chapter

Overview

1. What we know about fire regime in SA?

And only MODIS-based products with a consistent temporal coverage (2000 onwards) AND
We know that it underestimates the total burned area



Total burned area LT:
272,000 ha

Total burned area MODIS:
98,860 ha

FRI for the area is 37 years for grasslands, which is within the range reported for grasslands, and 65 years for forests

Oliveiras, Anderson et al., 2014, Global Biogeoch. Cycles

1. Quantifying burned areas

ACTA AMAZONICA

2005

Detecção de cicatrizes de áreas queimadas baseada no modelo linear de mistura espectral e imagens índice de vegetação utilizando dados multitemporais do sensor MODIS/TERRA no estado do Mato Grosso, Amazônia brasileira

Liana Oighenstein ANDERSON[1], Luiz Eduardo Oliveira e Cruz de ARAGÃO[2], André de LIMA[1], Yosio Edemir SHIMABUKURO[1]

RESUMO
O objetivo desta pesquisa foi avaliar os dados do sensor MODIS para detectar e monitorar cicatrizes de áreas recém queimadas. Utilizamos imagens da reflectância de superfície do sensor MODIS: produto MOD09 (dia 5 de outubro) e produto MOD13A1 (meses de outubro e novembro). Foi avaliada também uma série temporal de um ano dos índices de vegetação (IV) EVI e NDVI (produto MOD13A1). Uma imagem do sensor ETM+ (dia 5 de outubro) foi utilizada como base para a delimitação dos polígonos amostrais e avaliação dos dados MODIS devido a sua melhor resolução espacial. A metodologia focou na aplicação do modelo linear de mistura

Applied Geography
Volume 34, May 2012, Pages 239–246

2012

Land use and land cover changes determine the spatial relationship between fire and deforestation in the Brazilian Amazon

André Lima[a], Thiago Sanna Freire Silva[a], Luiz Eduardo Oliveira e Cruz de Aragão[b], Ramon Morais de Feitas[a], Marcos Adami[a], Antônio Roberto Formaggio[a], Yosio Edemir Shimabukuro[a]
Show more

doi:10.1016/j.apgeog.2011.10.013

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Abstract
An increased frequency of droughts is predicted for the Amazon rainforest in the 21st century, which, combined with deforestation, could exacerbate fire occurrence in the

IEEE GEOSCIENCE AND REMOTE SENSING LETTERS, VOL. 2, NO. 3, JULY 2005 315

2005

Assessment of Deforestation in Near Real Time Over the Brazilian Amazon Using Multitemporal Fraction Images Derived From Terra MODIS

Liana O. Anderson, Yosio E. Shimabukuro, Ruth S. Defries, and Douglas Morton

***Abstract*—We present a methodology for rapidly assessing deforestation over the Amazon region needed for policy intervention. We use soil fraction images generated from Moderate Resolution Imaging Spectroradiometer (MODIS) data at 250-m spatial resolution. Results showed reasonable agreement with higher resolution Landsat data ($r^2 = 0.73$) for our study area. MODIS data are promising for near real-time deforestation monitoring, previously not practical with Landsat data.**

***Index Terms*—Amazon region, deforestation, fraction images, Moderate Resolution Imaging Spectroradiometer (MODIS) sensor.**

pixel value is a mixture of spectral response from different targets within each pixel, and it is more evident in medium or low spatial resolution images. Several techniques, such as modeling and empirical estimations, have been applied to depict subpixel heterogeneity in land cover from remotely sensed data [3], [4].

Fraction images derived from different remote sensing data have been used for monitoring reforested areas [5], deforestation [6], land cover change [7], and vegetation classification [8]. These images derived from a linear spectral mixing model constitute synthetic bands containing information about proportions

International Journal of Remote Sensing
Volume 30, Issue 6, 2009

2009

Fraction images derived from Terra Modis data for mapping burnt areas in Brazilian Amazonia

DOI: 10.1080/01431160802509058

Y. E. Shimabukuro[a*], V. Duarte[a], E. Arai[a], R. M. Freitas[a], A. Lima[a], D. M. Valeriano[a], I. F. Brown[b] & M. L. R. Maldonado[b]

pages 1537-1546

Remote Sensing **2014**, *6*(9), 8002-8025; doi:10.3390/rs6098002

Open Access

2014

Article

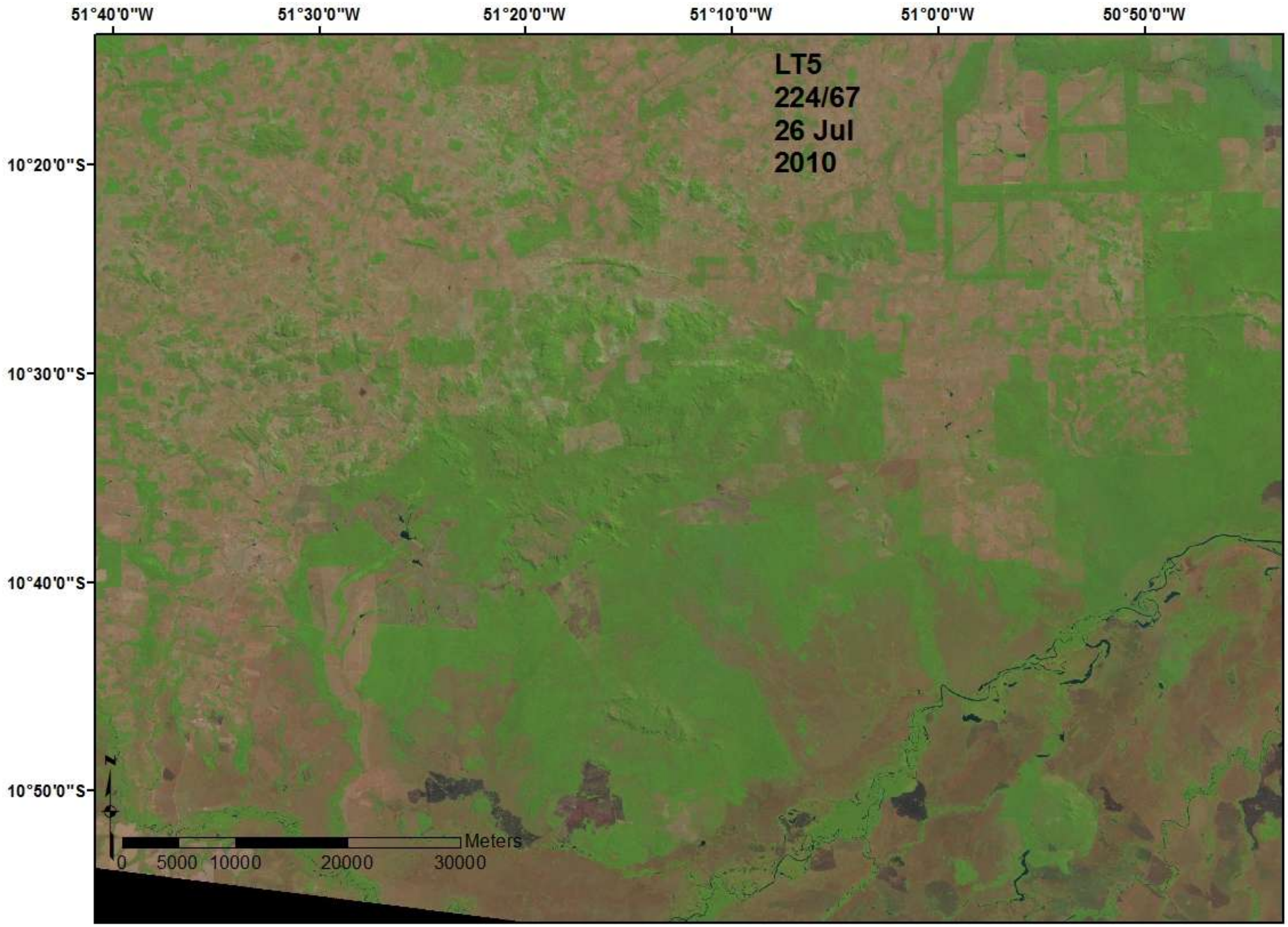
Analysis and Assessment of the Spatial and Temporal Distribution of Burned Areas in the Amazon Forest

Francielle da Silva Cardozo [1,*], Gabriel Pereira [2], Yosio Edemir Shimabukuro [1] and Elisabete Caria Moraes [1]

1 Remote Sensing Division (DSR), National Institute for Space Research (INPE), Av. dos Astronautas, 1758, Jd. Granja, CEP: 12227-010, Sao Jose dos Campos, Brazil; E-Mails: yosio@dsr.inpe.br

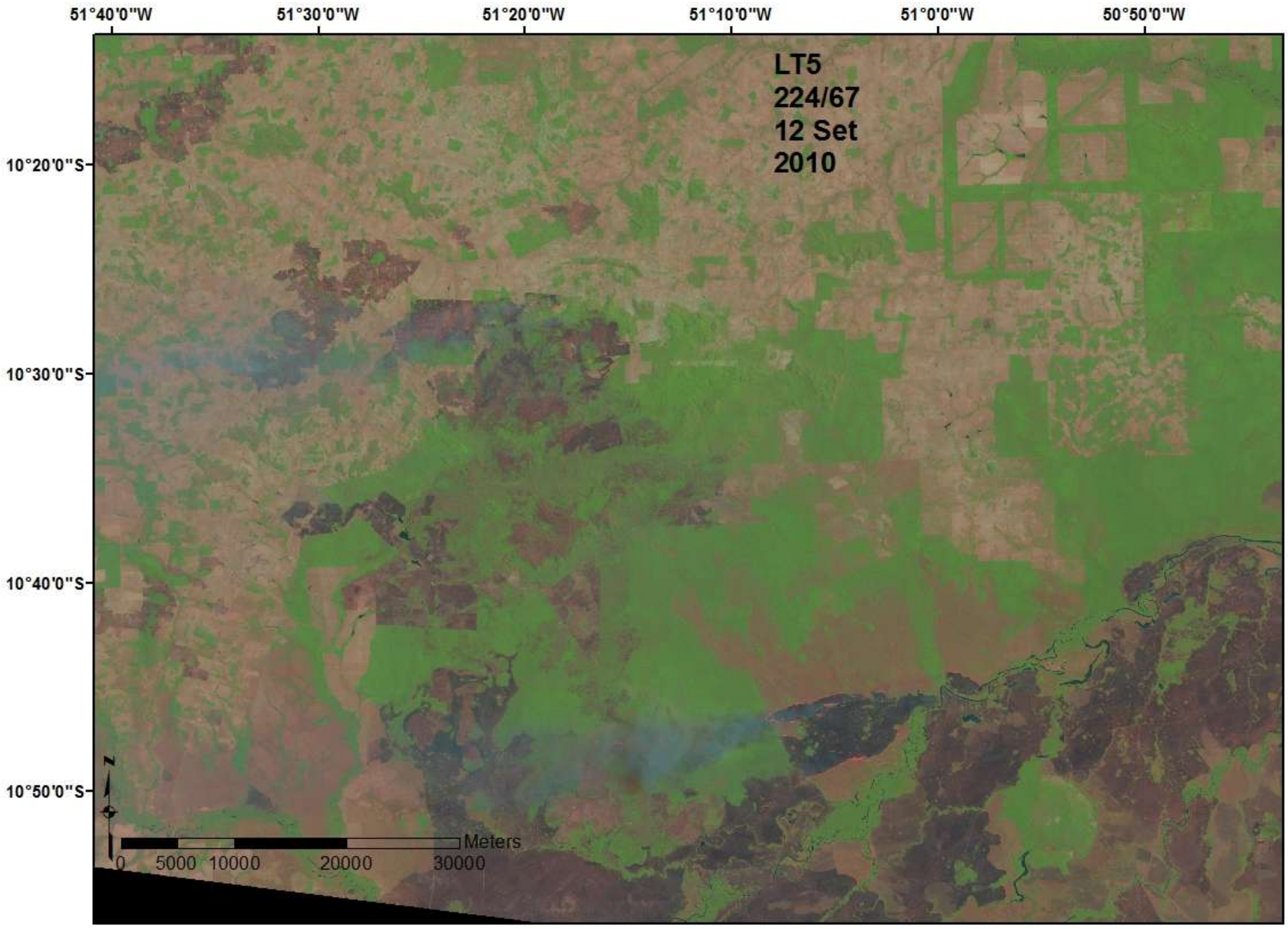
1. Quantifying burned areas

Landsat 5 – TM Surface Reflectance RGB 543, 26th Jul 2010



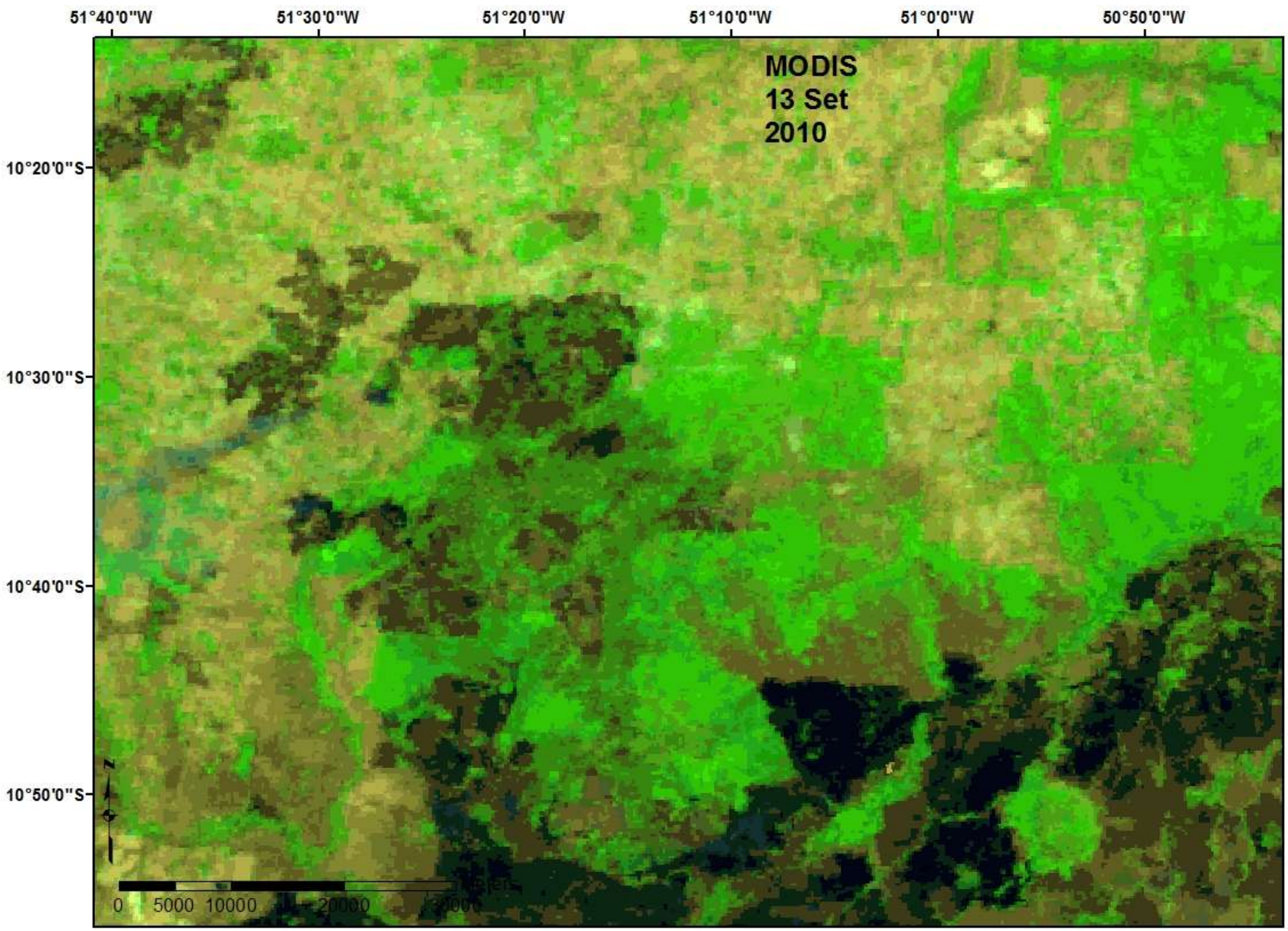
1. Quantifying burned areas

Landsat 5 – TM Surface Reflectance RGB 543, 12th Sep 2010



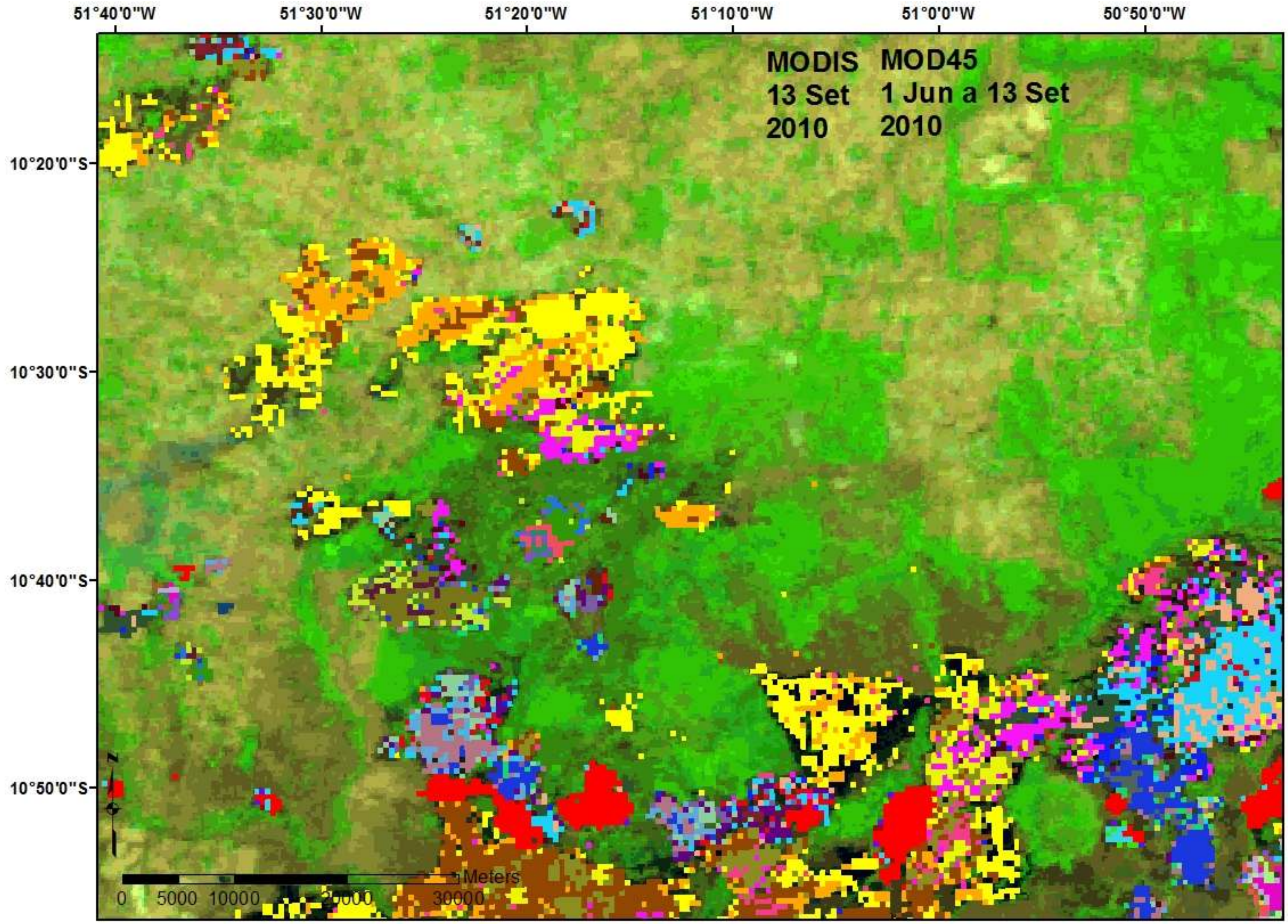
1. Quantifying burned areas

Product MOD09 – Surface Reflectance RGB 126, 13th Set 2010



1. Quantifying burned areas

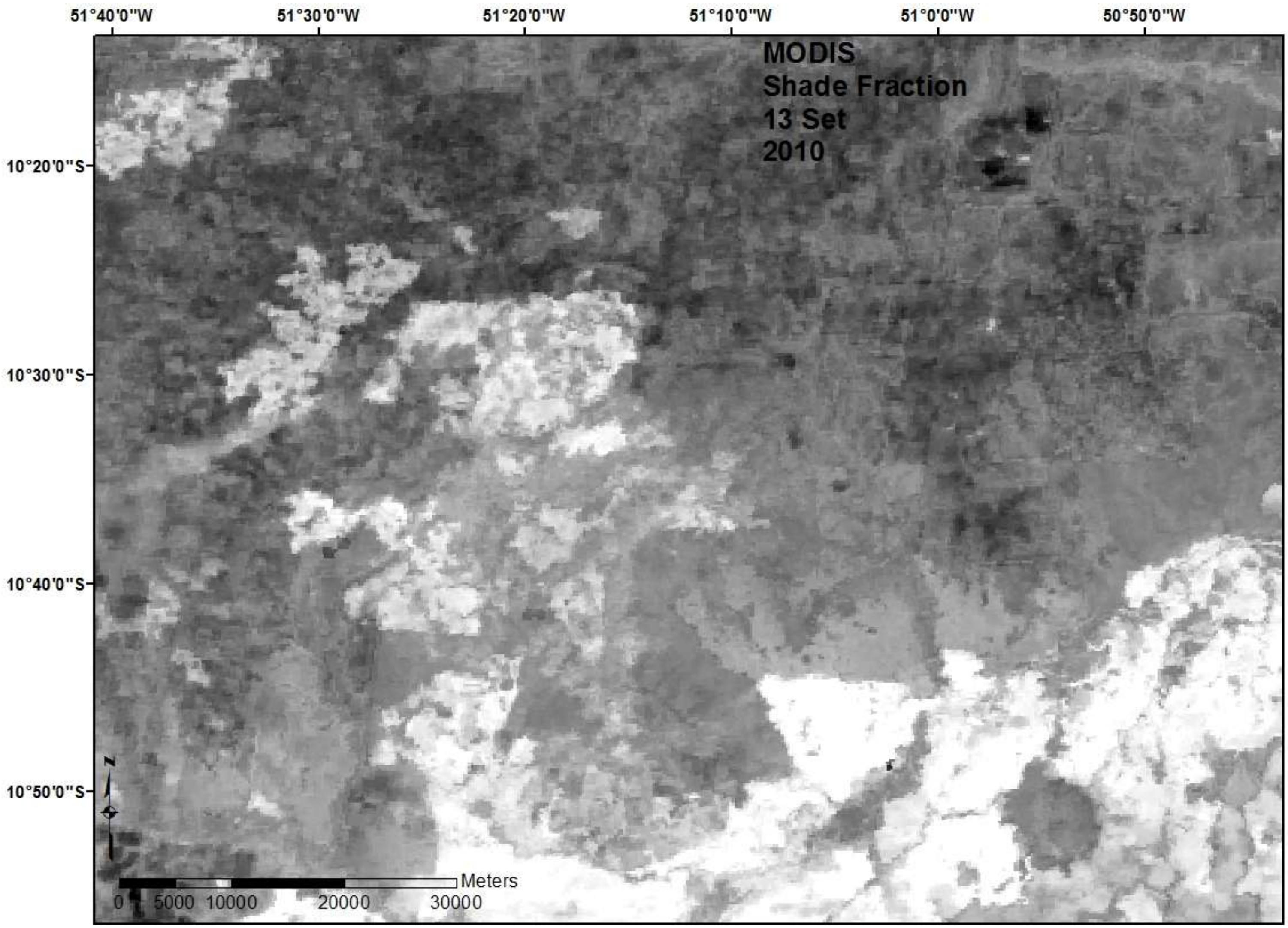
Product MOD45 - MODIS Burned Area Product



Subestimativa de áreas afetadas pelo fogo

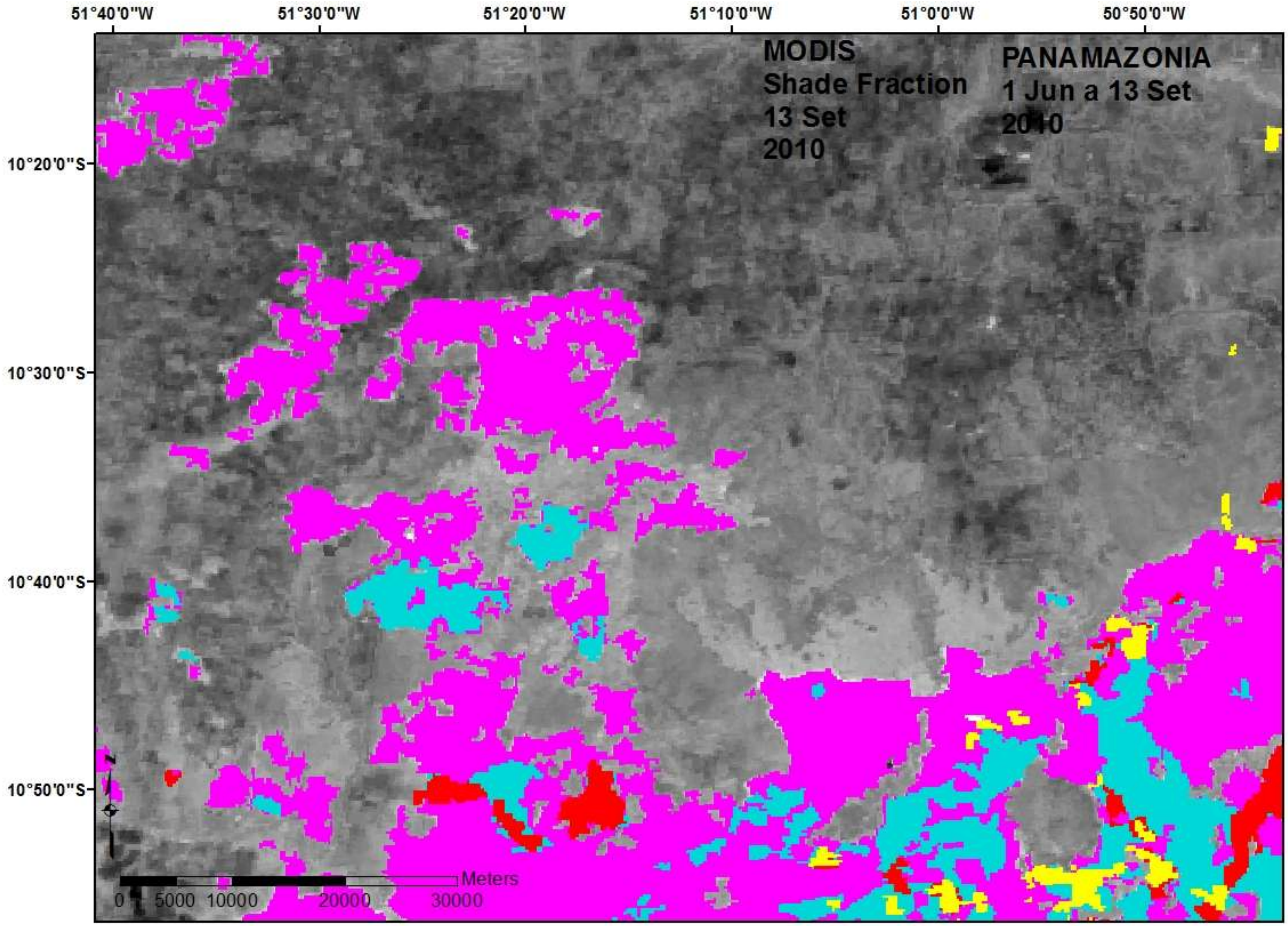
1. Quantifying burned areas

Shade fraction image based on the Product MOD09 – 13 Sept 2010



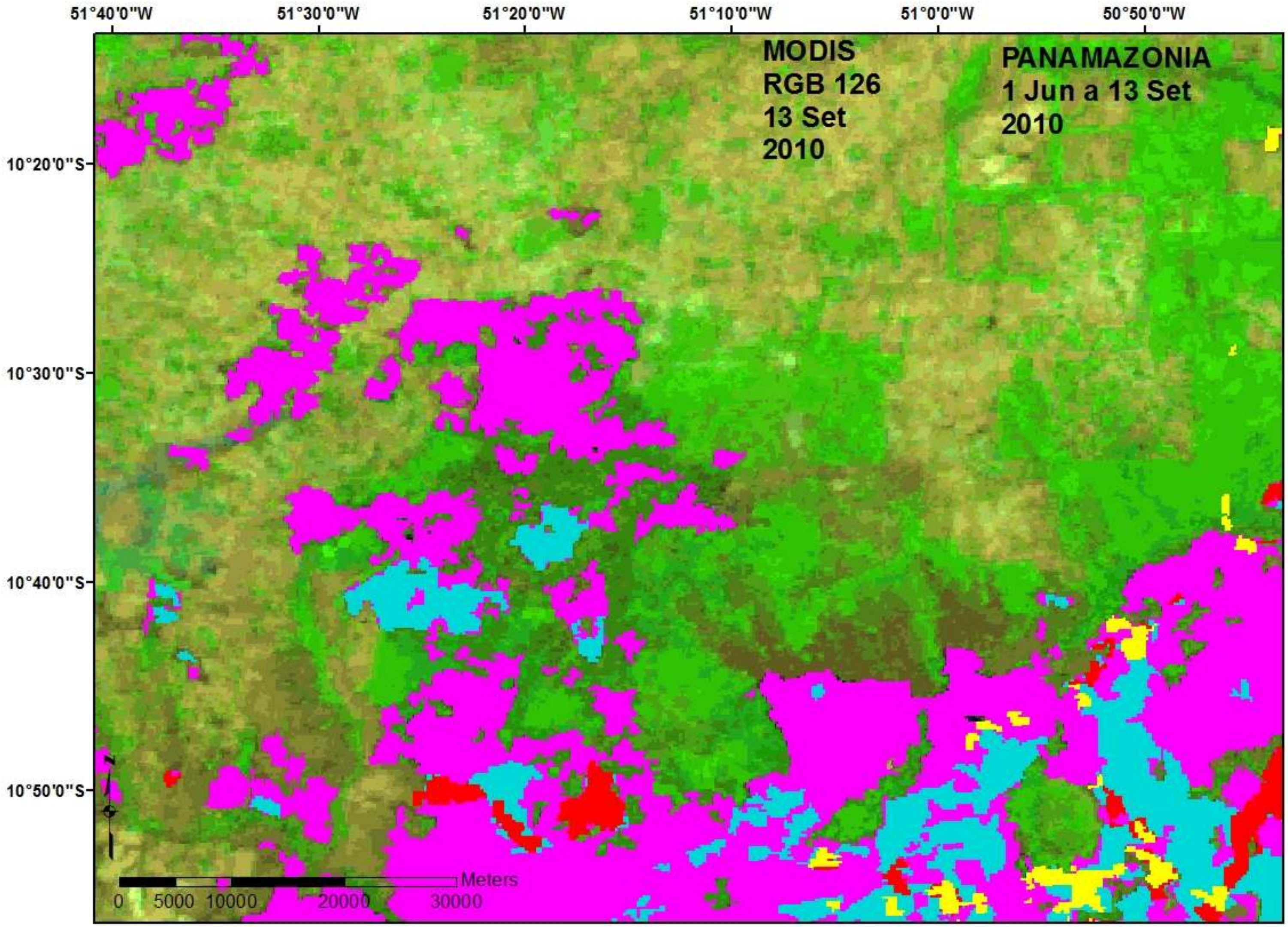
1. Quantifying burned areas

Burned area classification – 13 Sept 2010



1. Quantifying burned areas

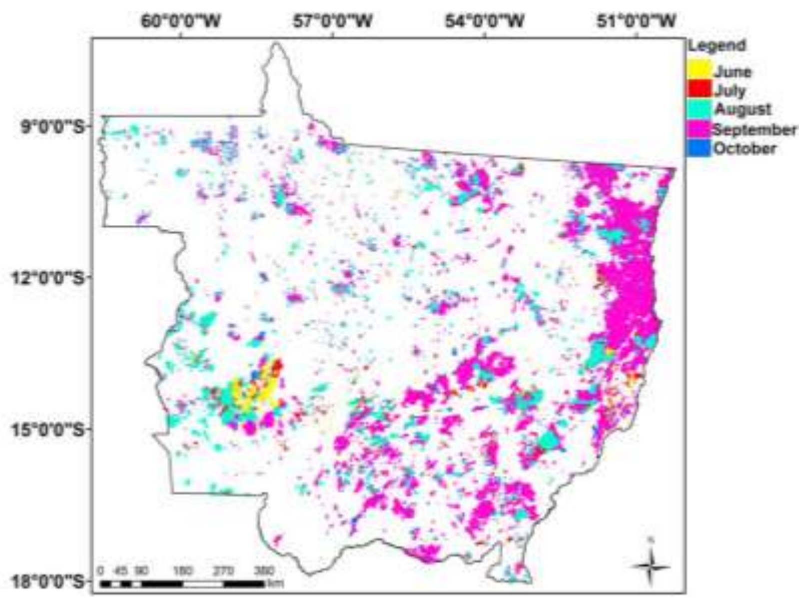
Cummulative Burned area based on our method – 13 Sept 2010



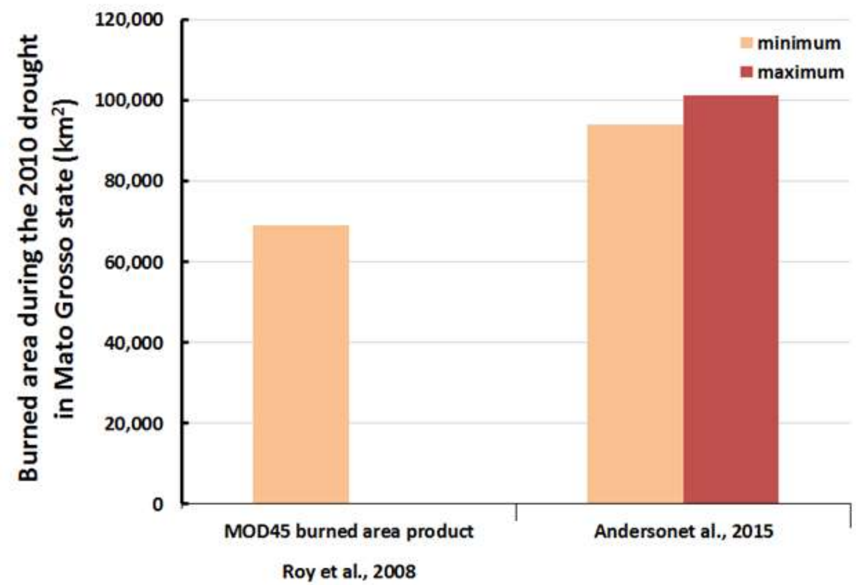
Overview

1. What we know about fire regime in SA?

And only MODIS-based products with a consistent temporal coverage (2000 onwards) AND
We know that it underestimates the total burned area



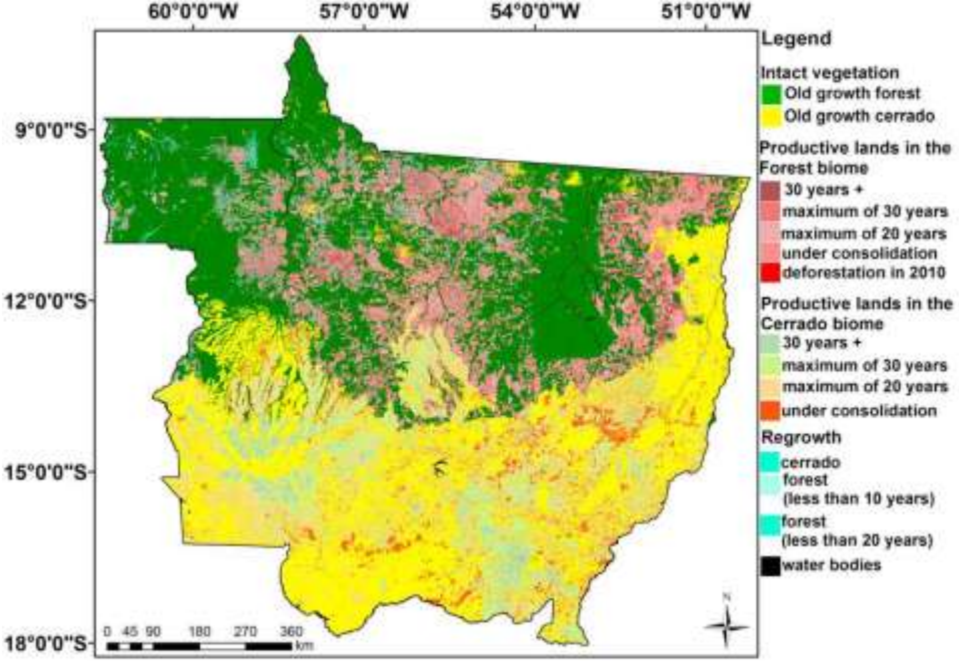
Cummulative burned area
During the 2010 drought



~30% difference, same sensor

31% to 33% of the total pristine vegetation remaining in Mato Grosso burnt in 2010.

Anderson et al 2015, Gblobal Biogeochm. Cycles.
Anderson et al 2015 under review RS



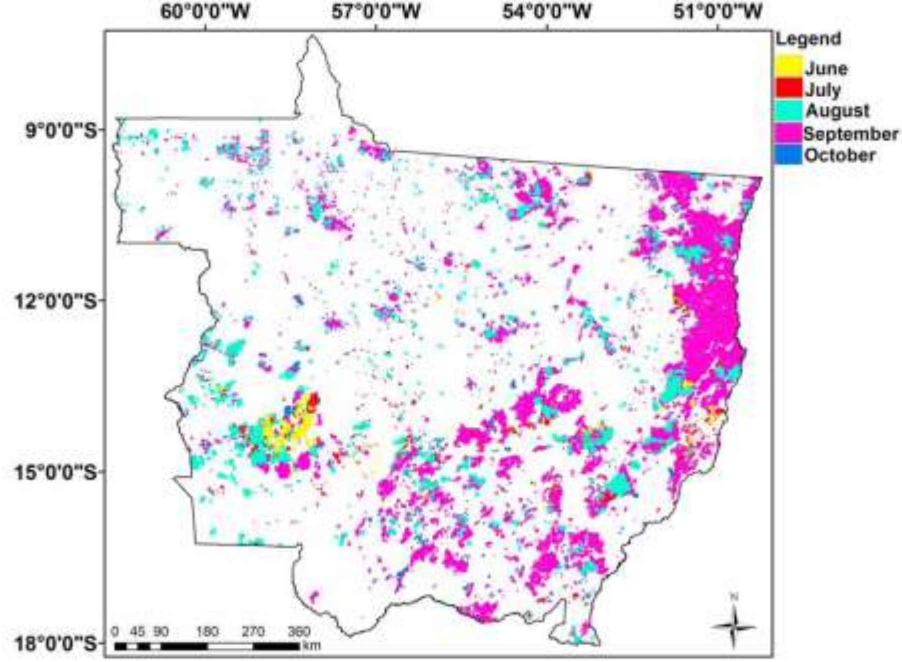


Table 2. Biomass of Affected Area, Biomass Loss, Gross, and Committed C Emissions Due to Fires Per Land Cover Type During the Dry Season in 2010[a]

-	Biomass ($Mg\ ha^{-1}$) of the Affected Areas Mean (±Error)	Biomass Loss Due to Fires ($Mg\ ha^{-1}$) Mean (±Error)	Gross C Emission in 2010 (Tg) (±Total Error)	Committed C Emission (Tg) (±Total Error)	Total Carbon Loss (Tg) (±Total Error)	% of Carbon Loss -
Intact vegetation						
Old-growth forest	176.3 (±34.63)	51.63 (±19.6)	5.05 (±1.92)	27.2 (±10.4)	32.3 (±12.28)	37.87
Old-growth cerrado	40.23 (±33.43)	11.71(±4.79)	34.1 (±13.9)	-	34.1 (±13.94)	39.98
Productive lands in the forest biome						
Permanent productive for 30 years +	53.69 (±33.27)	15.65 (±6.40)	0.46 (±0.19)	-	0.46 (±0.19)	0.54
Permanent productive for maximum of 30 years	68.42 (±33.67)	19.95 (±8.16)	0.99 (±0.40)	-	0.99 (±0.40)	1.16
Permanent productive for maximum of 20 years	105 (±34.62)	30.61 (±12.5)	5.13 (±2.10)	-	5.13 (±2.09)	6.01
Under consolidation (productive for 10 years or less)	105 (±34.76)	17.29 (±7.07)	5.02 (±2.05)	-	5.02 (±2.053)	5.89
Deforestation in 2010	208.9 (±33.24)	60.91 (±23.0)	4.78×10^{-3} $(\pm 1.81 \times 10^{-4})$	3.01×10^{-2} $(\pm 2.71 \times 10^{-2})$	9.56×10^{-3} $(\pm 3.61 \times 10^{-3})$	0.01
Productive lands in the cerrado biome						
Permanent productive for 30 years +	27.17 (±32.09)	7.92 (±3.24)	1.00 (±0.41)	-	1.00 (±0.41)	1.17
Permanent productive for maximum of 30 years	33.5 (±32.39)	9.76 (±3.99)	1.22 (±0.49)	-	1.22 (±0.49)	1.43
Permanent productive for maximum of 20 years	31.14 (±32.22)	9.08 (±3.71)	1.99 (±0.81)	-	1.99 (±0.81)	2.33
Under consolidation (productive for 10 years or less)	31.14 (±32.61)	9.29 (±3.80)	9.75×10^{-2} $(\pm 1.22 \times 10^{-2})$	-	9.75×10^{-2} (±0.21)	0.11
Regrowth						
			(±3.87 × 10 [illegible])	(±2.09 × 10 [illegible])	(±2.47 × 10 [illegible])	
Forest regrowth (less than 10 years)	148.8 (±34.82)	49.74 (±18.9)	0.30 (±0.11)	1.64 (±0.62)	1.95 (±0.74)	2.29
Deforestation in 2010 on less than 10 years regrowth	131.2 (±34.76)	85.27 (±0.0)	0.45 (±0.0)	0.45 (±0.0)	0.91 (±0.0)	1.07
Total	-	-	56.1 (±22.5)	29.4 (±10.0)	85.3 (±33.2)	100

[a]The error associated with the biomass of affected areas was derived from the AGB error map from *Saatchi et al.* [2011]. The errors associated with biomass loss, carbon loss, and emissions were derived from the Monte Carlo simulations.

31% to 33% of the total pristine vegetation remaining in Mato Grosso burnt in 2010.

1. Quantifying burned areas

Determining confidence interval and Accuracy

OPEN ACCESS

Remote Sens. **2015**, *6*, 1-x manuscripts; doi:10.3390/rs60x000x

remote sensing

ISSN 2072-4292

www.mdpi.com/journal/remotesensing

Article

Development of a Point-based method for Map Validation and Confidence Interval Estimation: A case study of Burned Areas in Amazonia

Liana Oighenstein Anderson [1,2,3†*], David Cheek [2,†], Luiz E.O.C. Aragão [3,4], Luae Andere [3], Brenda Duarte [3], Natália Salazar [3], André Lima [3], Valdete Duarte [3] and Egidio Arai [3]

[1] National Center for Monitoring and Early Warning of Natural Disasters – Cemaden. Parque Tecnológico de São José dos Campos, Estrada Doutor Altino Bondensan, 500, São José dos Campos - São Paulo, Brasil, 12247-016. E-Mail: liana.anderson@cemaden.gov.br

[2] Environmental Change Institute, University of Oxford, Oxford, OX1 3QY, UK 7 E-Mail:

1. Quantifying burned areas

Determining confidence interval and Accuracy

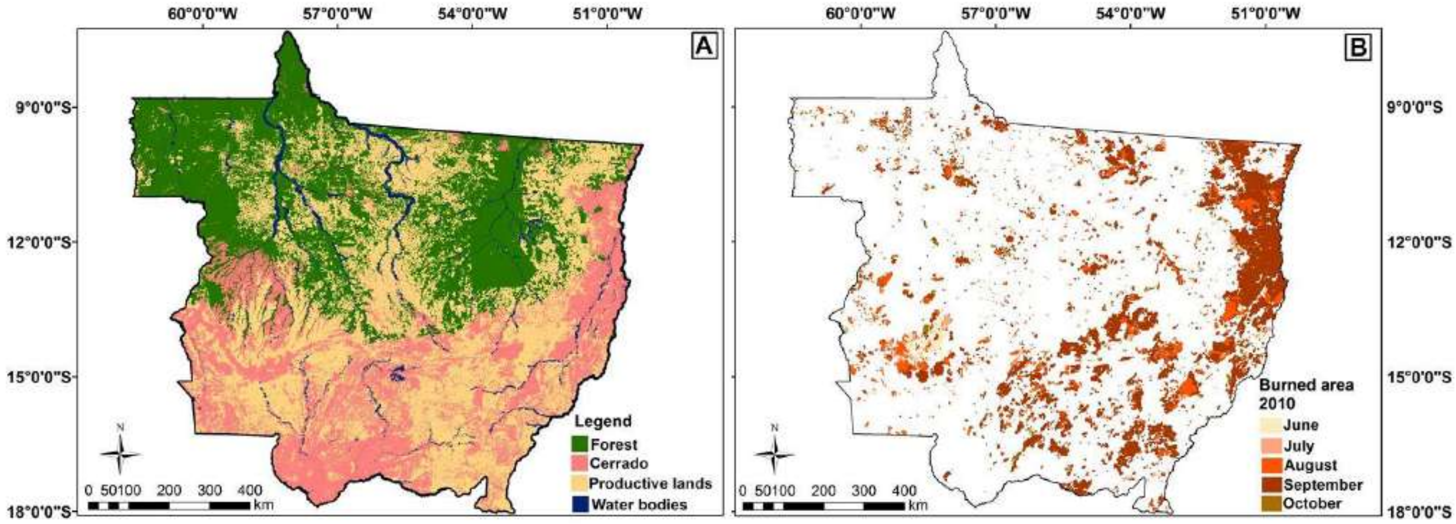


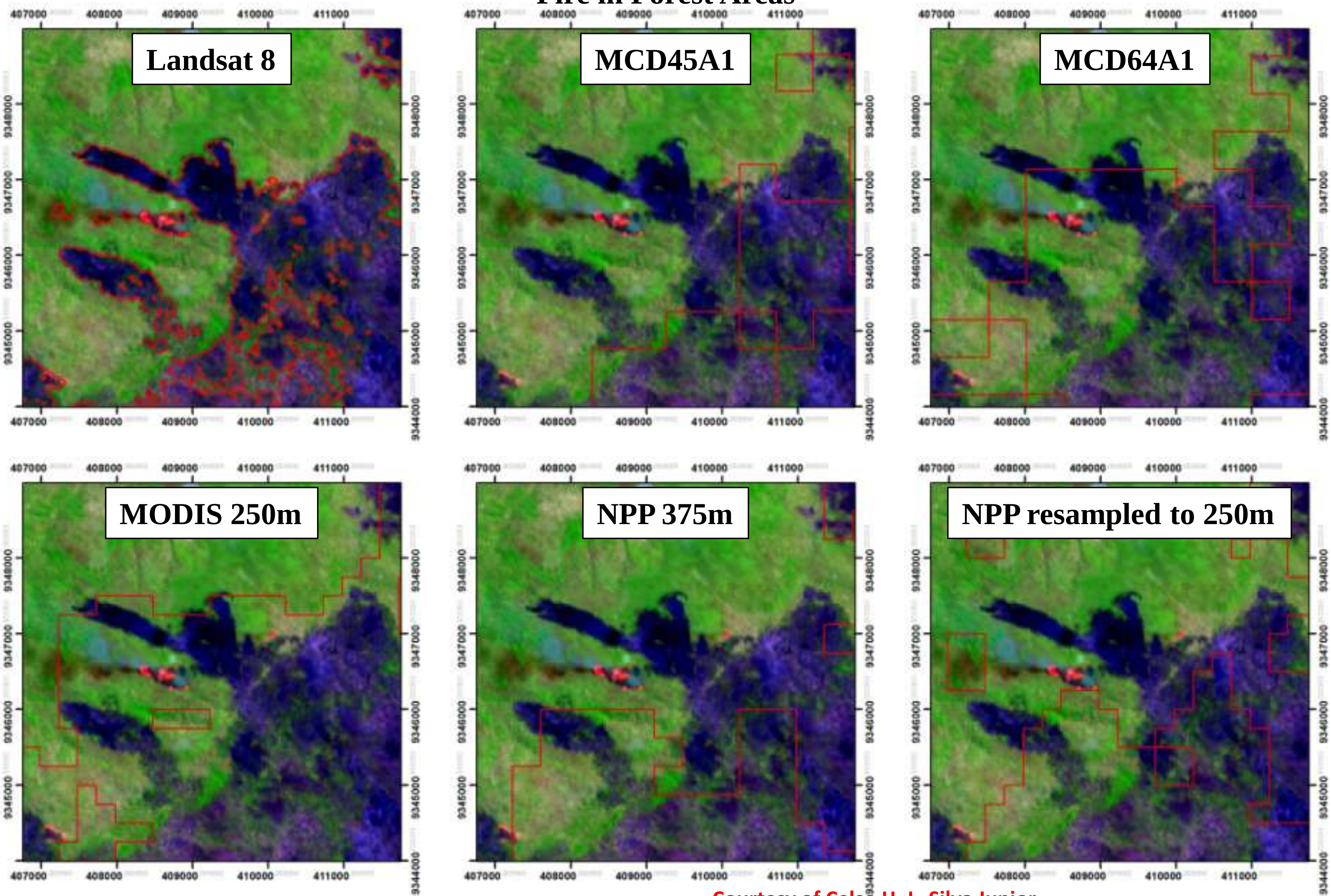
Figure 1: (**a**) Land cover classes in 2010 for Mato Grosso state. The forest class encompasses forests and forests regrowth, while non-forests are all the other land cover types; (**b**) Mapped burned areas from June to mid-October 2010.

By considering the area uncertainty provided by the validation scheme, the old growth forest area burned ranged from 13,678 km^2 to 13,929 km^2. The extent of the 2010 forest fires in Mato Grosso are close to southern Amazonian intact forests that were affected by fires in 2010 for the first time (13,570 km^2), or 73% to 75% of all understory forest fires mapped for 2010 in southern Amazonia (18,499 km^2) [55].

Non-forests burned areas were estimated to have affected from 78,089 km^2 to 83,107 km^2, an area approximately 6 times larger than the estimates of the 2010 burned forests. It has been

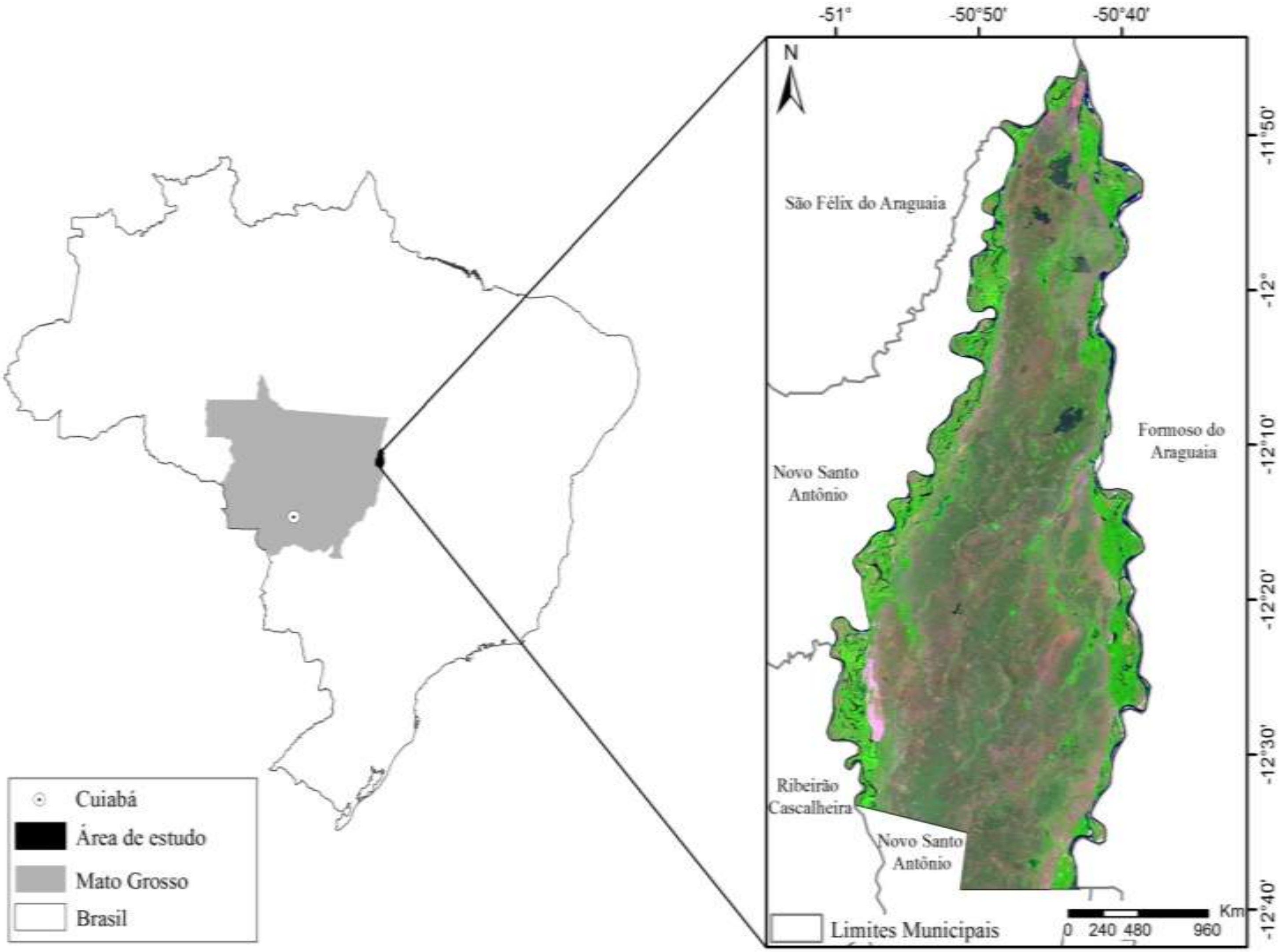
1. Quantifying burned areas

Fire in Forest Areas



Courtesy of Celso H. L. Silva Junior

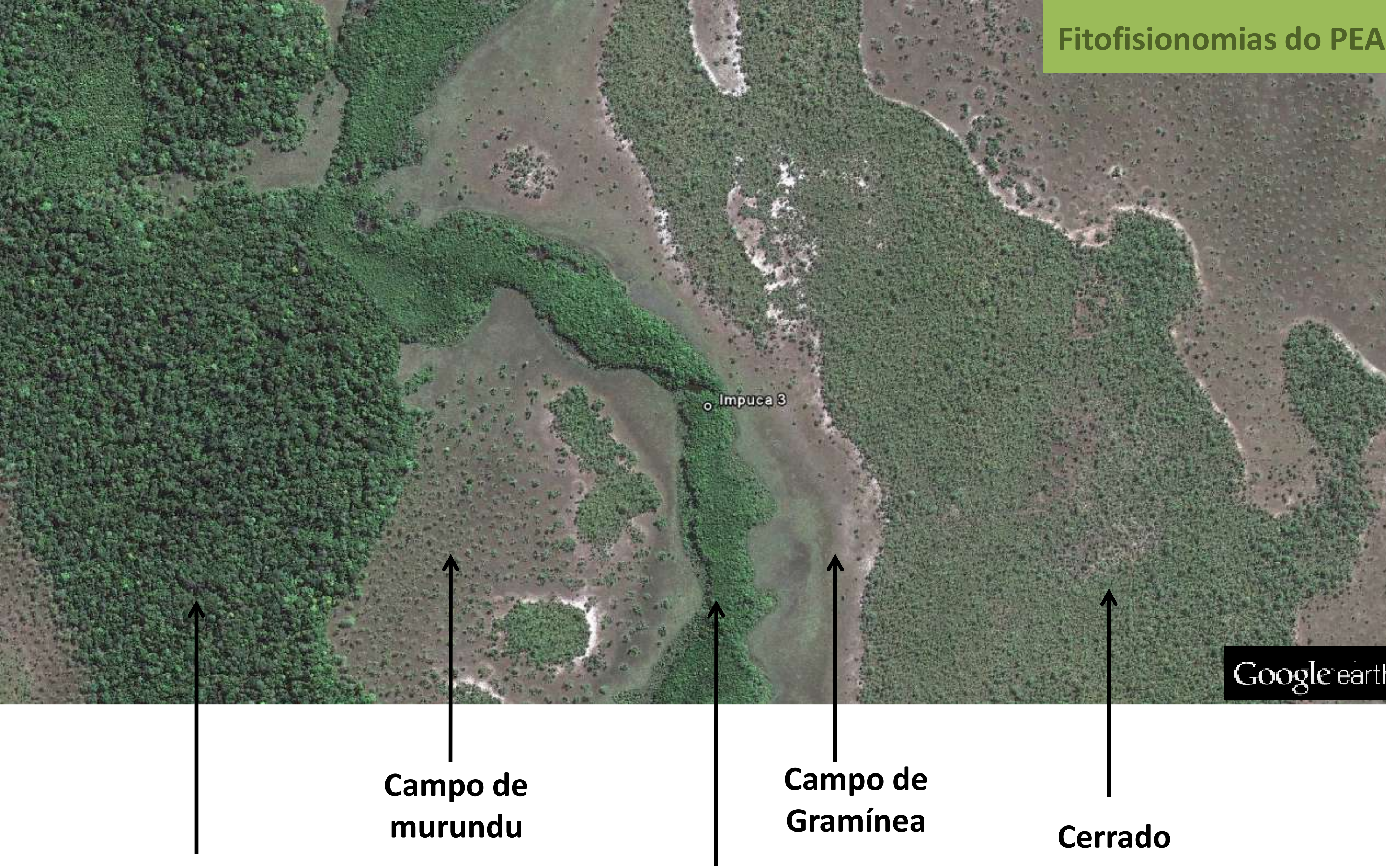
Área de estudo



Parque Estadual do Araguaia no Mato Grosso. Composição colorida (RGB) 5, 4, 3 da imagem do Landsat-7/ETM+, da órbita/pontos: 233/68 e 69 de 18/07/2001.

Courtesy Lais Neves

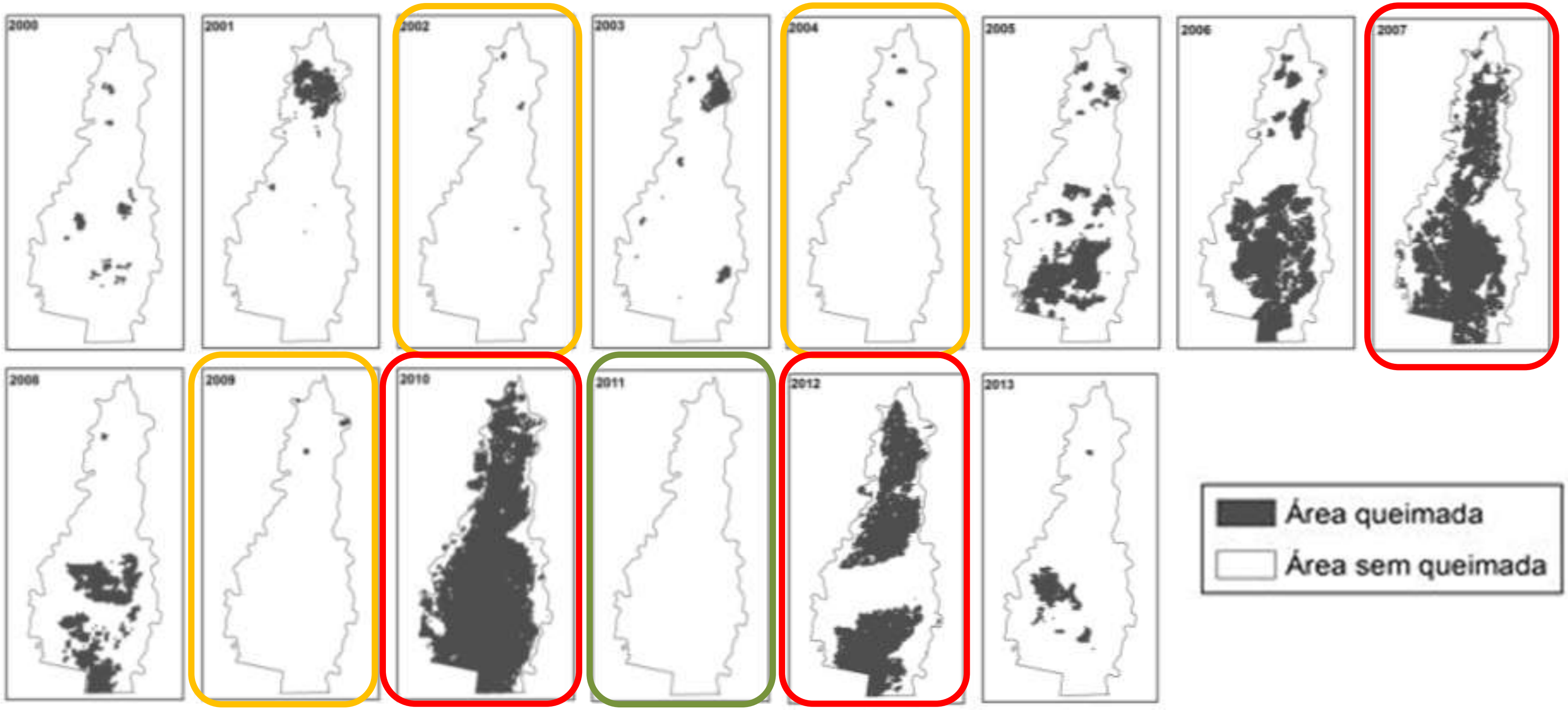
Fitofisionomias do PEA



Courtesy Lais Neves

Padrão temporal dos incêndios

129.540 ha

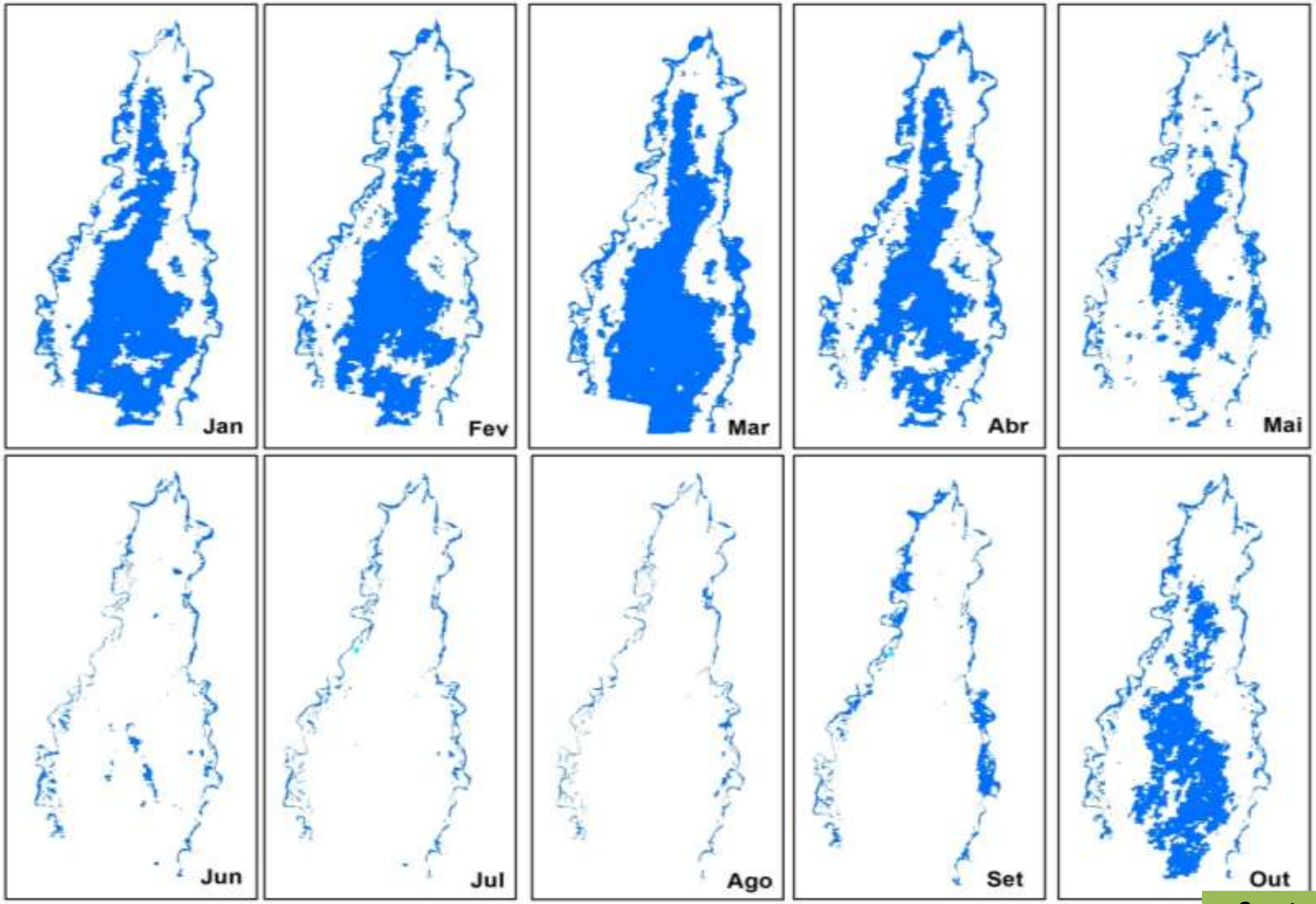


186.374 ha

108.779 ha

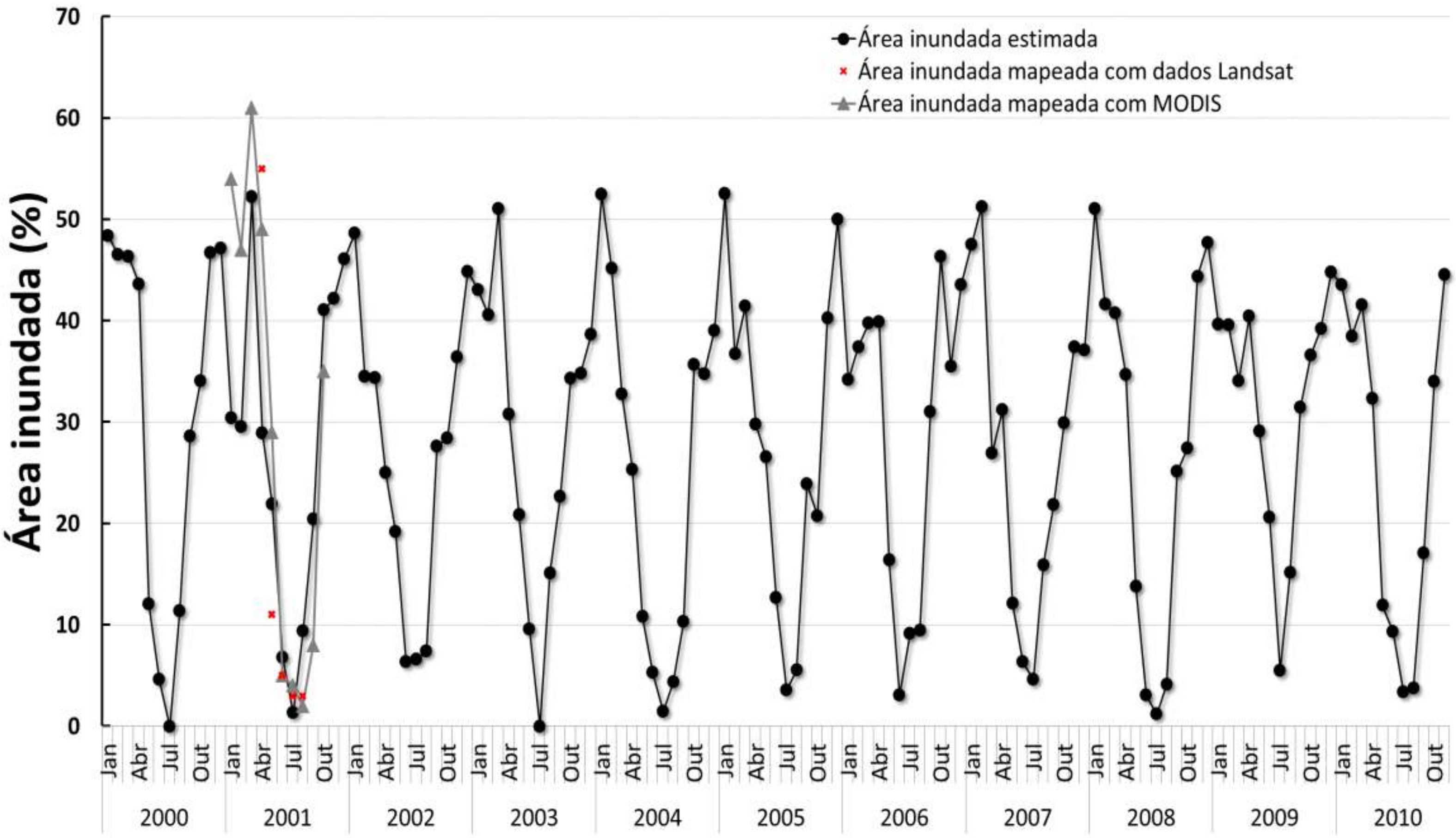
Courtesy Lais Neves

Dinâmica de Inundação



Courtesy Lais Neves

Extrapolação da área inundada



Série histórica de inundação do Parque Estadual do Araguaia entre 2000 e 2010.

Courtesy Lais Neves

2. Carbon emission from fires

Brazilian National Plan on Climate Change

Decree number 7.390/2010

PROJECTION TO THE YEAR 2020: of 0,87 Pg C
*TARGET AIMED FOR 2*020: 0,53 Pg C to 0,55 Pg C, from which 0,25 Pg C is the projected emission from deforestation in the Amazon.

Our aircraft measurements:

During the 2011 anomalous wet year: fires were responsible for 0.30±0.10 Pg C (higher than the projected reductions aimed from deforestation)
During the extreme dry year of 2010: fires were responsible 0.51±0.12 Pg C, an emission close to the total reduction planed by the Brazilian government for the year 2020.

[Gatti, …Anderson et al., Nature 2014]

Overview

To understand the role of fires on C emissions and effectively support and drive the *development of mitigation strategies, including fire prevention and management*, it is necessary to **break down emissions** into natural forest and savannah fires, land management fires and deforestation-related fires.

Moreover, it is important to quantify the role of the different fire types, as only *wildfires in denser vegetation* or fires associated with deforestation represent a long-term net source of CO_2 to the atmosphere.

2. Quantifying the associated C emissions

In summary, our model of gross emission follows:

$$\mathbf{F} = \boldsymbol{\lambda}_{\mathbf{(ldcover)}} \cdot \mathbf{B}_{\mathbf{i(x,y)}} \cdot \mathbf{(1-} \boldsymbol{\alpha}_{\mathbf{(x,y)}}\mathbf{)}\ \mathbf{dA}_{\mathbf{(x,y)}},$$

$$F' = \lambda'_{(ldcover)} \cdot B'_{i(x,y)} \cdot (1- \alpha'_{(x,y)})\ dA'_{(x,y)}\ \textit{(Monte Carlo)}$$

where:

F (ton yr^{-1}) is carbon the gross emission (immediate flux to the atmosphere).

$\boldsymbol{\lambda}_{\mathbf{(ldcover)}}$ is the 'decay or release constant (yr^{-1}) specific to each land cover type (ha).

$\mathbf{B}_{\mathbf{i(x,y)}}$ is the pre-burn biomass density (Mg ha^{-1}) for the pixel at location (x,y)

$\boldsymbol{\alpha}$ is the slope of the Equation 1 ($\alpha = 0.7084$)

$\mathbf{dA}_{\mathbf{(x,y)}}$ is the burned area (in ha) at pixel with location (x,y).

Anderson et al., 2015 Global Biogeoch. Cycles

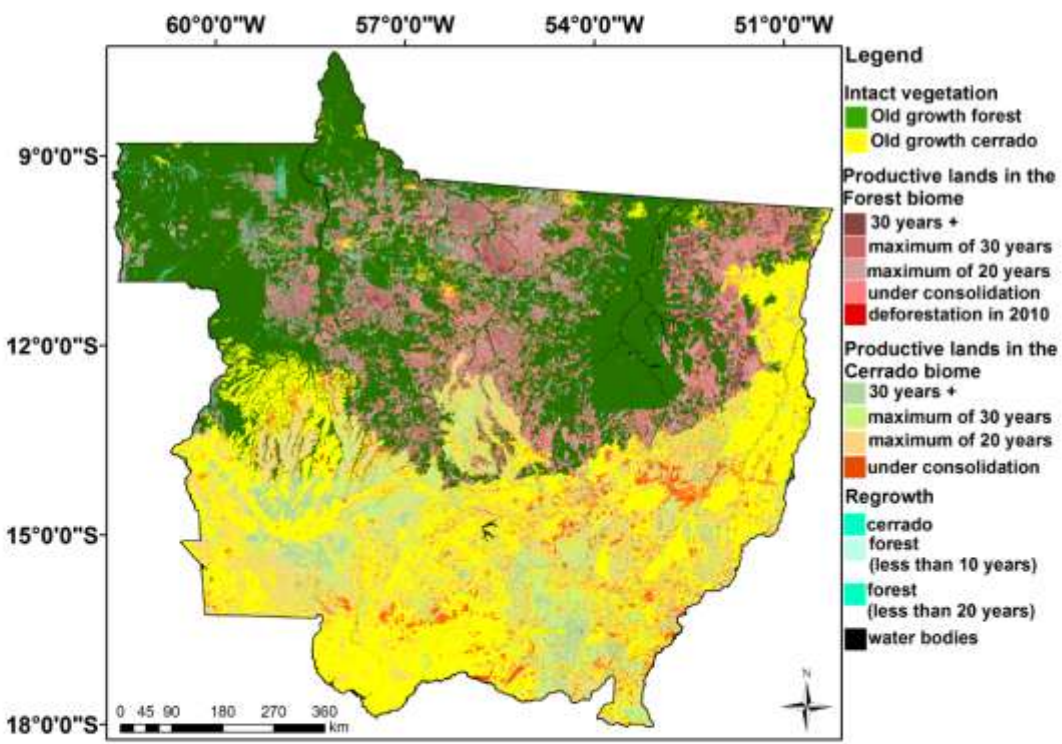
2. Quantifying the associated C emissions

In summary, our model of gross emission follows:

$$F = \boxed{\lambda_{(ldcover)}} \cdot B_{i(x,y)} \cdot (1- \alpha_{(x,y)})\, dA_{(x,y)},$$

$\lambda_{(ldcover)}$ is the 'decay or release constant (yr^{-1}) specific to each land cover type (ha).

Identification of land cover type has an accuracy of 80% (i.e. in 80% of the cases the land classification is correct, with a confidence interval from 74% to 87%) > Varying randomly this parameter uniformly distributed.



Anderson et al., 2015 Global Biogeoch. Cycles

2. Quantifying the associated C emissions

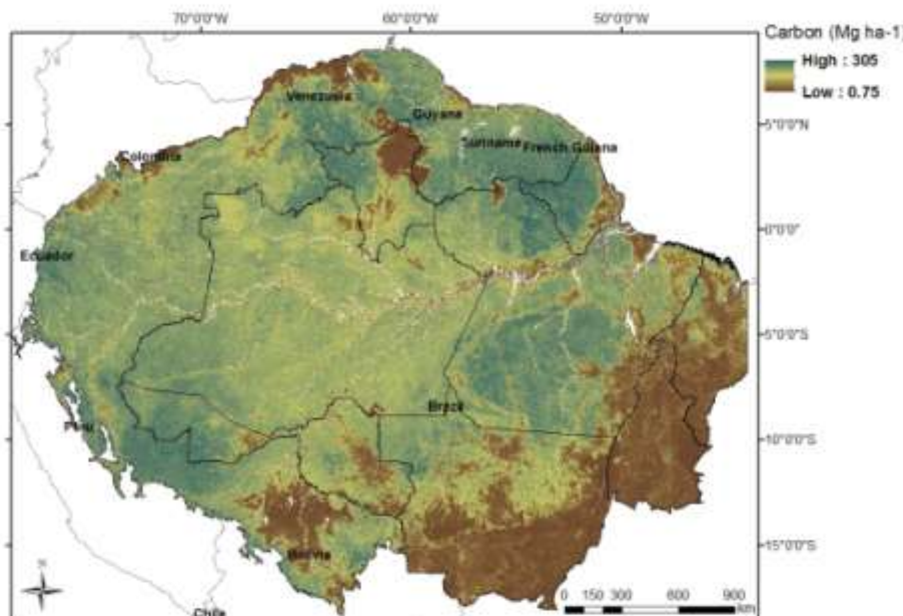
In summary, our model of gross emission follows:

$$F = \lambda_{(ldcover)} \cdot B_{i(x,y)} \cdot (1- \alpha_{(x,y)})\, dA_{(x,y)},$$

where:

$B_{i(x,y)}$ is the pre-burn biomass density (Mg ha^{-1}) for the pixel at location (x,y) provided by Saatchi et al. [2011].

Forest and non-forest pixels > varying randomly this parameter with an approximately normally distributed.



Saatchi et al., PNAS, 2011.

Anderson et al., 2015 Global Biogeoch. Cycles

2. Quantifying the associated C emissions

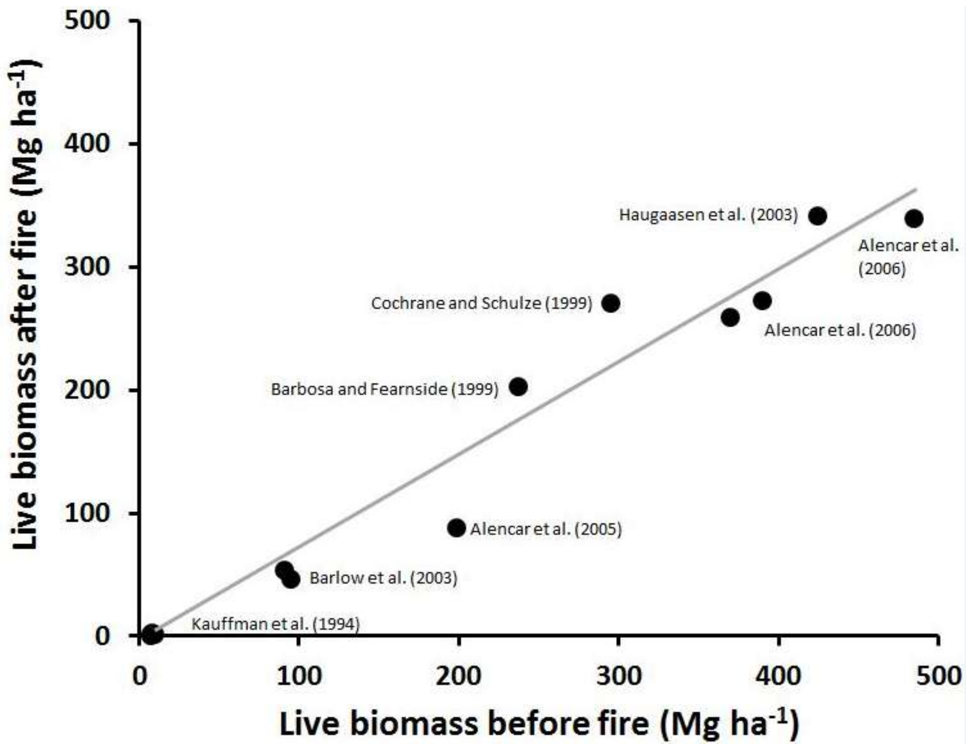
In summary, our model of gross emission follows:

$$F = \lambda_{(ldcover)} \cdot B_{i(x,y)} \cdot (1- \alpha_{(x,y)})\, dA_{(x,y)},$$

where:

α is the slope of the Equation $B_f = 0.7084 * B_i$ (B = biomass, $_f$= final, $_i$= initial)

α *± 0.034 (Mg Mg⁻¹) slope and its uncertainty is estimated using a linear regression which takes into account both x and y errors [York et al., 2004,* Unified equations for the slope, intercept, and standard errors of the best straight line. Am. J. Phys. 72 (3)]



Anderson et al., 2015 Global Biogeoch. Cycles

2. Quantifying the associated C emissions

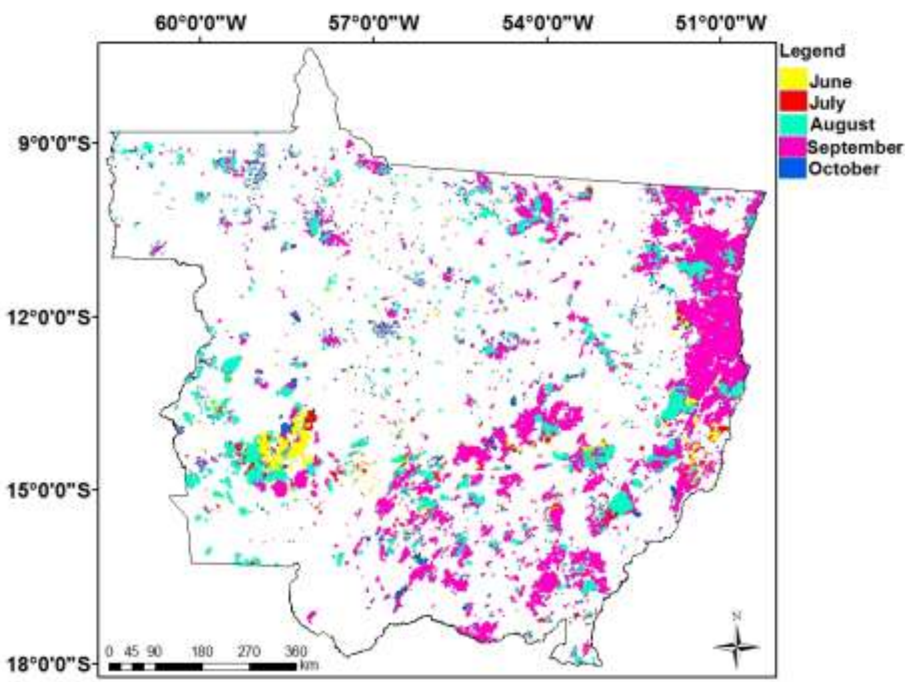
In summary, our model of gross emission follows:

$$F = \lambda_{(ldcover)} \cdot B_{i(x,y)} \cdot (1- \alpha_{(x,y)})\, dA_{(x,y)},$$

where:

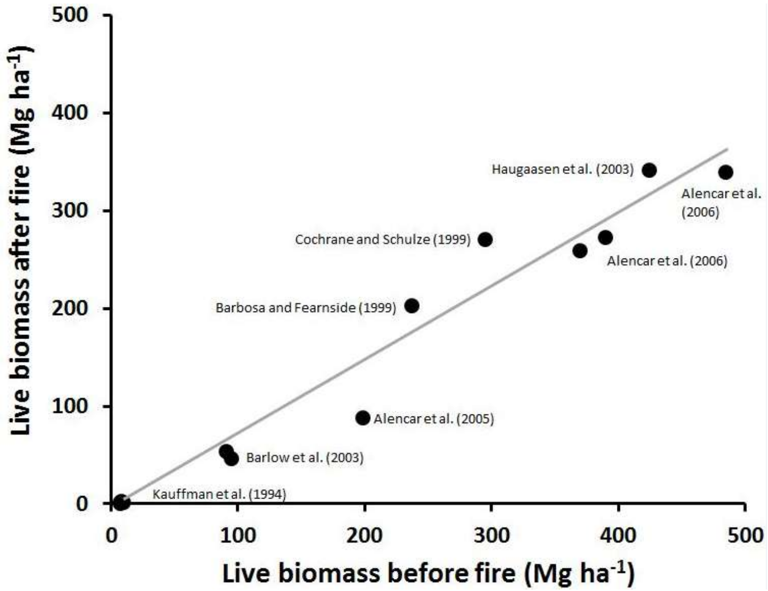
$dA_{(x,y)}$ is the burned area (in ha) at pixel with location (x,y).

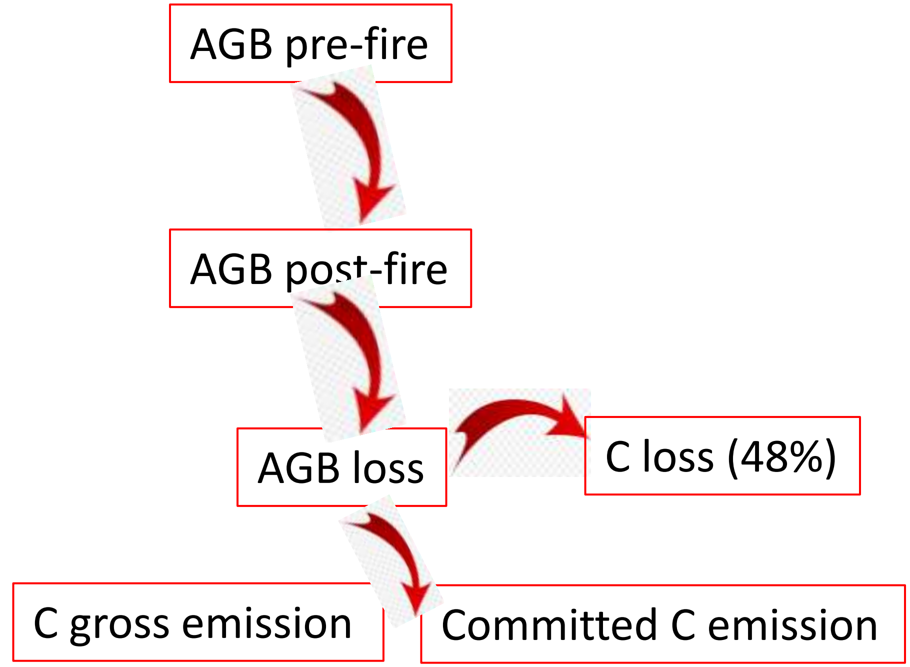
An accuracy of 99.2% (confidence interval of 97.67% to 99.48%) for forests and an accuracy of 96.93% (confidence interval of 93.76% to 98.92%) for the non-forest classes > Varying randomly this parameter uniformly distributed.



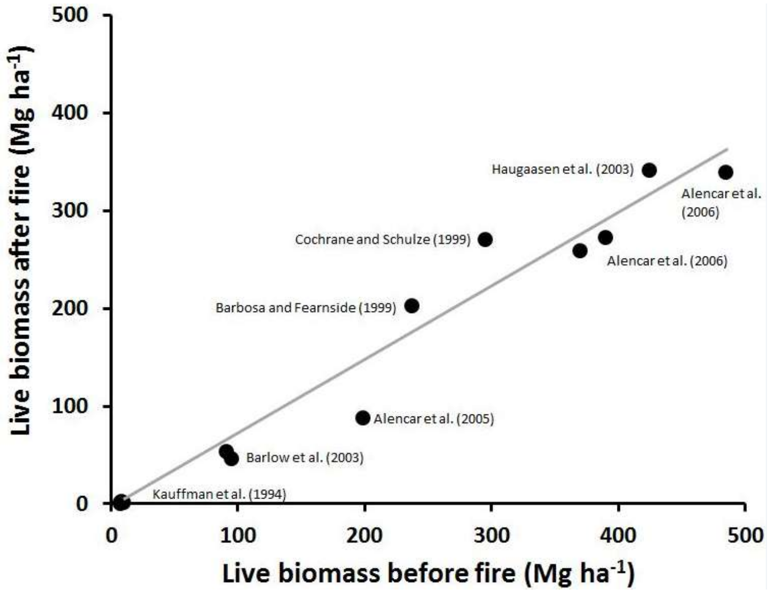
Anderson et al., 2015 Global Biogeoch. Cycles

Detailing the C emission model





Detailing the C emission model



AGB pre-fire

AGB post-fire

AGB loss

C loss (48%)

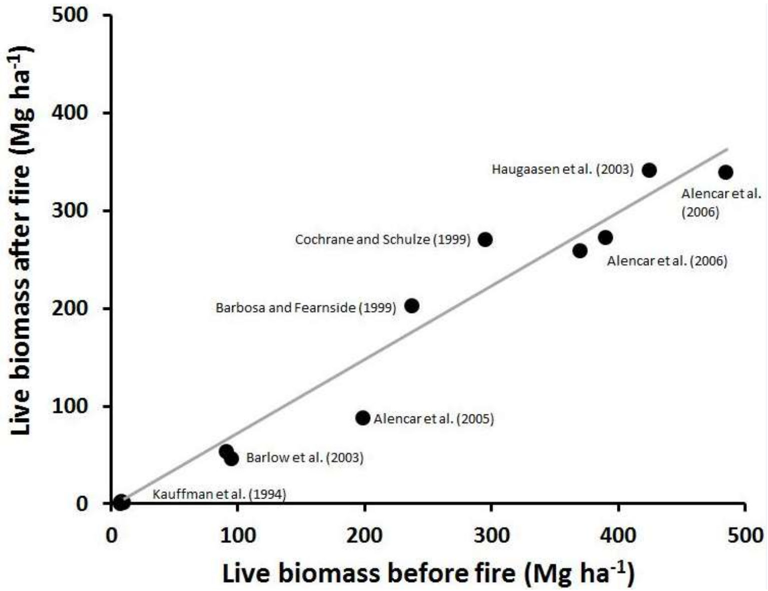
C gross emission

Committed C emission

C gross emission

- Forests: 1st year of decomposition due to tree mortality
- 50% of deforestation in forest
- 100% of pastures, agriculture and cerrado

Detailing the C emission model



AGB pre-fire

AGB post-fire

AGB loss

C loss (48%)

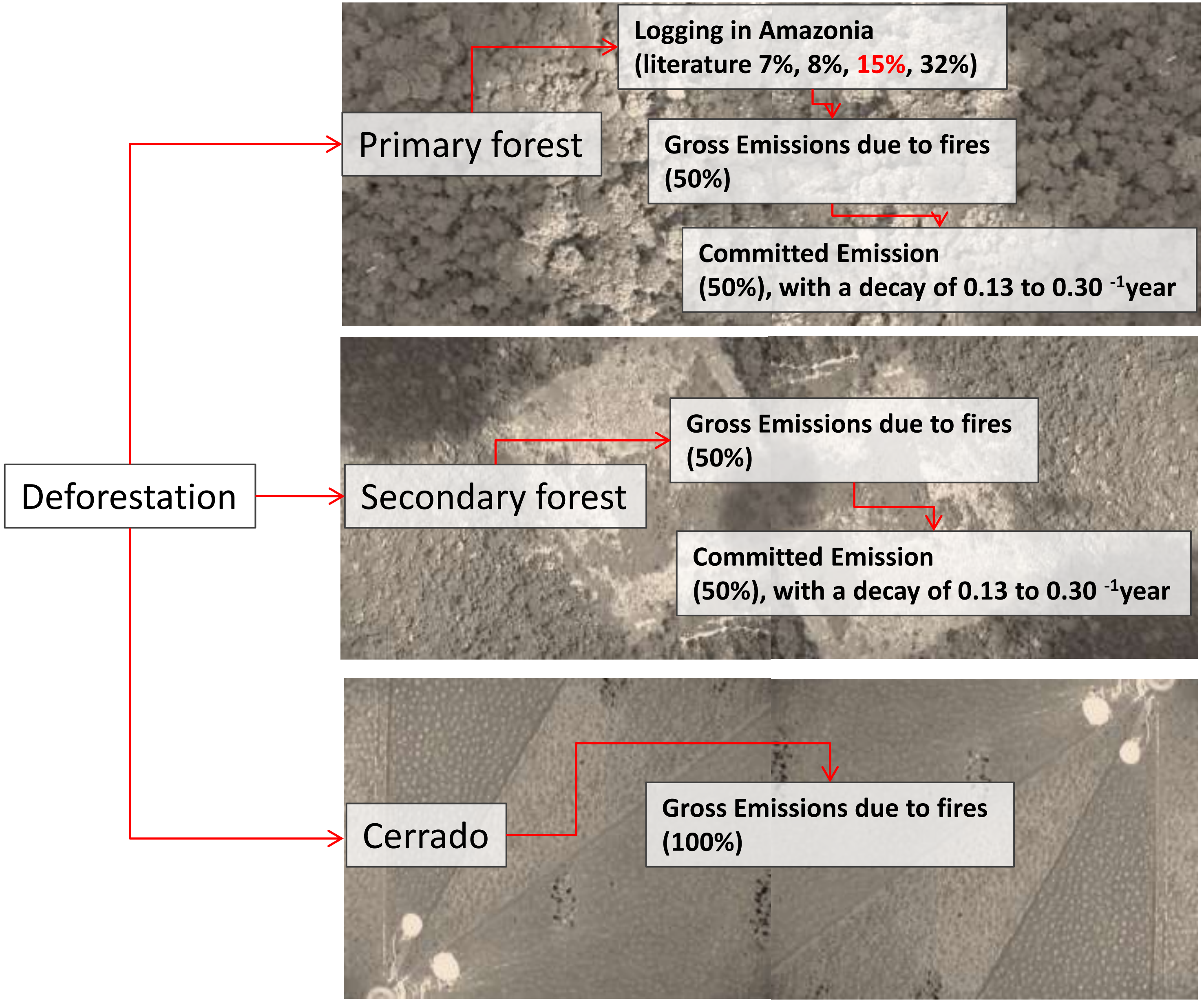
C gross emission

Committed C emission

Committed C emission

- Forests: rest of C in the decomposition pool due to tree mortality
- 50% of deforestation in forest

Detailing the C emission model



2. Quantifying the associated C emissions

	Biomass (Mg ha^{-1}) of the affected areas **Mean (± error)**	Biomass loss due to fires (Mg ha^{-1}) **Mean (± error)**	Gross C emission in 2010 (Tg) **(±Total error)**	Committed C emission (Tg) **(±Total error)**	Total Carbon loss (Tg) **(±Total error)**	**% of Carbon loss**
Intact vegetation						
Old growth Forest	176.3 (±34.63)	51.63 (±19.6)	5.05 (±1.92)	27.2 (±10.4)	**32.3 (±12.28)**	37.87
Old growth Cerrado	40.23 (±33.43)	11.71(±4.79)	34.1 (±13.9)		34.1 (±13.94)	39.98
Productive lands in the Forest biome						
Permanent productive for 30 years +	53.69 (±33.27)	15.65 (±6.40)	0.46 (±0.19)		0.46 (±0.19)	0.54
Permanent productive for maximum of 30 years	68.42 (±33.67)	19.95 (±8.16)	0.99 (±0.40)		0.99 (±0.40)	1.16
Permanent productive for maximum of 20 years	105 (±34.62)	30.61 (±12.5)	5.13 (±2.10)		5.13 (±2.09)	6.01
Under consolidation (productive for 10 years or less)	105 (±34.76)	17.29 (±7.07)	5.02 (±2.05)		5.02 ($\pm 2.05^{3}$)	5.89
Deforestation in 2010	208.9 (±33.24)	60.91 (±23.0)	4.78×10^{-3} ($\pm 1.81 \times 10^{-4}$)	3.01×10^{-2} ($\pm 2.71 \times 10^{-2}$)	9.56×10^{-3} ($\pm 3.61 \times 10^{-3}$)	0.01
Productive lands in the Cerrado biome						
Permanent productive for 30 years +	27.17 (±32.09)	7.92 (±3.24)	1.00 (±0.41)		1.00 (±0.41)	1.17
Permanent productive for maximum of 30 years	33.5 (±32.39)	9.76 (±3.99)	1.22 (±0.49)		1.22 (±0.49)	1.43
Permanent productive for maximum of 20 years	31.14 (±32.22)	9.08 (±3.71)	1.99 (±0.81)		1.99 (±0.81)	2.33
Under consolidation (productive for 10 years or less)	31.14 (±32.61)	9.29 (±3.80)	9.75×10^{-2} ($\pm 1.22 \times 10^{-2}$)		9.75×10^{-2} (±0.21)	0.11
Regrowth						
Cerrado	37.51 (±32.55)	9.42 (±3.01)	9.21×10^{-2} ($\pm 3.76 \times 10^{-2}$)		9.21×10^{-2} ($\pm 3.76 \times 10^{-2}$)	0.11
Forest regrowth (less than 20 years)	208.1 (±34.11)	43.38 (±16.4)	1.03×10^{-3} ($\pm 3.87 \times 10^{-4}$)	5.53×10^{-3} ($\pm 2.09 \times 10^{-3}$	6.56×10^{-3} ($\pm 2.47 \times 10^{-3}$)	0.01
Forest regrowth (less than 10 years)	148.8 (±34.82)	49.74 (±18.9)	0.30 (±0.11)	1.64 (±0.62)	1.95 (±0.74)	2.29
Deforestation in 2010 on less than 10 years regrowth	131.2 (±34.76)	85.27 (±0.0)	0.45 (±0.0)	0.45 (±0.0)	0.91 (±0.0)	1.07
Total			**56.1 (±22.5)**	**29.4 (±10.0)**	**85.3 (±33.2)**	**100**

3. Fire risk

Overview

Brazil

Vast Amazon wildfire destroys forest in Brazil and threatens uncontacted tribe

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theguardian

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The blaze, which has burned for two months on indigenous land and spread across 100km at its peak, is suspected to have been started by illegal loggers

Jonathan Watts in Rio de Janeiro

Friday 30 October 2015 10.30 GMT

Informativo CENAD nº 560 – 14/10/2015 - Tarde

AMAZONAS
O Governo do Amazonas decretou ontem (13/10) Estado de Emergência em 12 cidades por causa do número de incêndios. A decisão foi publicada no Diário Oficial do Estado (DOE).
A vigência do decreto será de 90 dias e abrange as cidades de: Manaus, Autazes, Caapiranga, Careiro, Careiro da Várzea, Iranduba, Itacoatiara, Manacapuru, Manaquiri, Novo Airão, Presidente Figueiredo e Rio Preto da Eva.

AMAPÁ
A defesa civil Estadual informou a ocorrência de um incêndio que destrói uma área de reflorestamento na Vila Operária, próximo ao município de Serra do Navio. A grande quantidade de fumaça está afetando a população. Até o momento não há registro de desabrigados ou desalojados.
Fonte: CEDEC/AP

RIO GRANDE DO SUL
Atualização dos dados:
60 municípios atingidos
50.168 pessoas atingidas
5.795 pessoas desalojadas
3.475 pessoas em abrigos
10.212 residências atingidas

Taquari: 08 famílias em abrigos.
Estrela: 23 famílias em abrigos.
Rio Pardo: 30 famílias desabrigadas e 150 desalojadas.

Fonte: CEDEC/RS

PARANÁ e **SANTA CATARINA:** não houve alteração dos dados.

Atenciosamente,

Monitoramento e Operações / CENAD / SEDEC / MI
0800 644 0199 **(Plantão 24h)**

CENAD DEFESA CIVIL BRASIL BRASIL

BRASIL Acesso à informação

Ministério da
Integração Nacional

3. Fire risk

Target variable

Fire Risk (FR)

Context variables: exhibit any kind of relationship with the target variable and may exhibit relationships among themselves

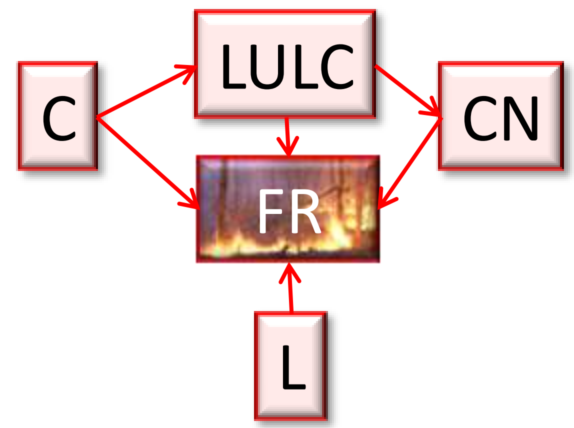
Climatic variables (C)

Land use and land cover variables (LULC)

Census data (CN)

Local information (L)

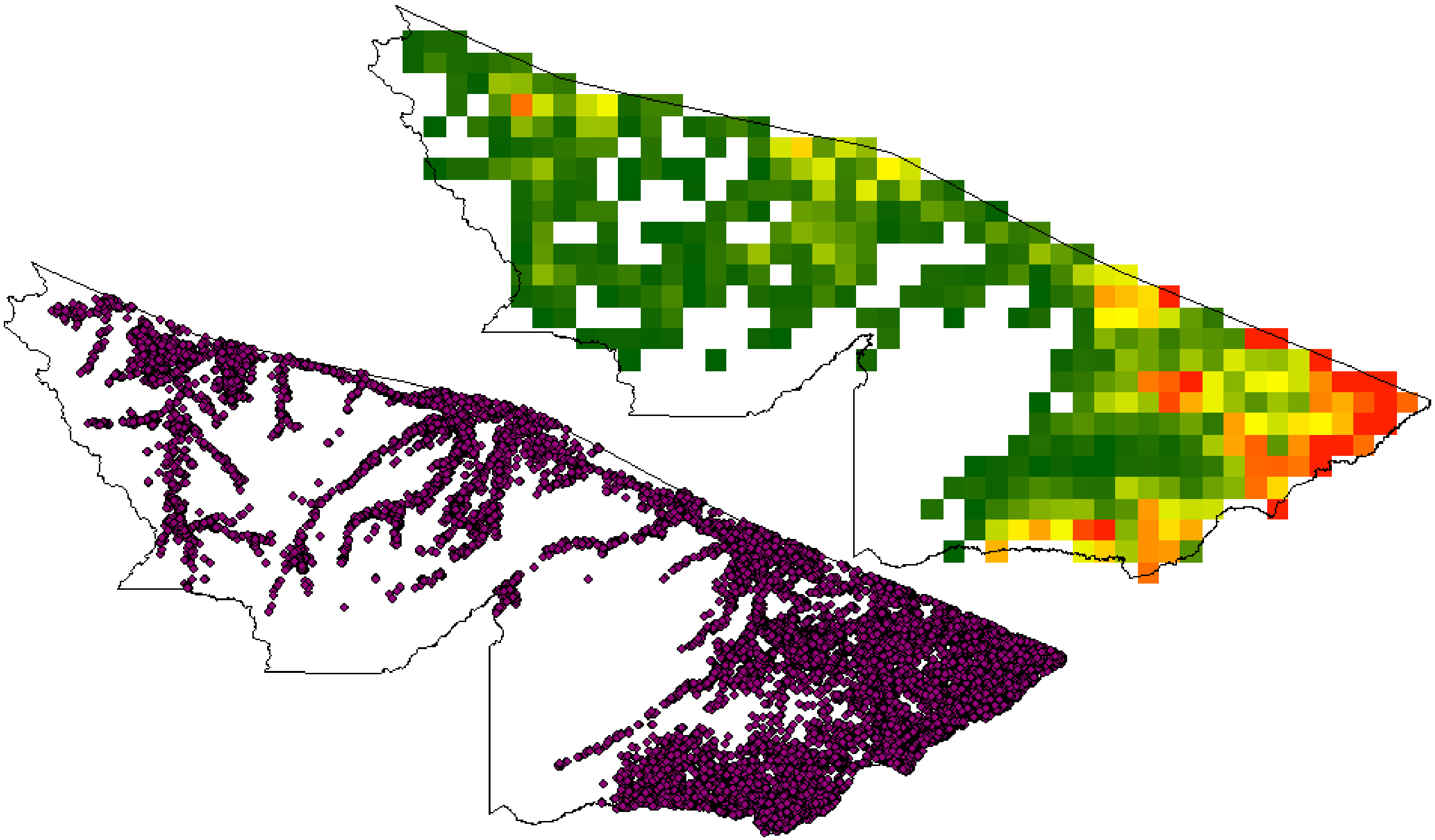
Bayesian Network model



Simplified Directed Acyclic Graph – DAG of my Fire Risk Model

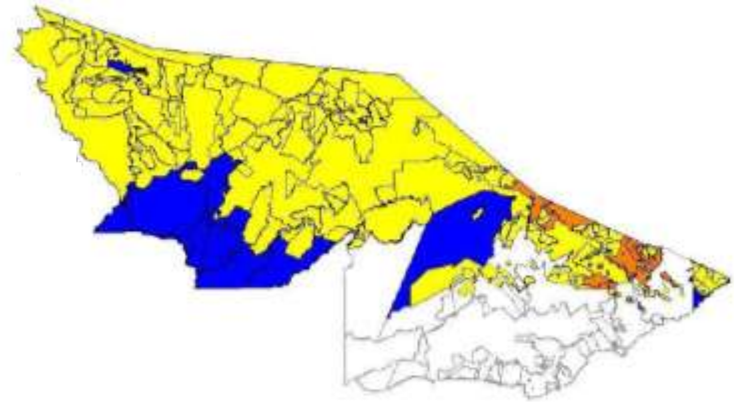
3. Fire risk

Pilot project: Acre State



Anderson et al, 2015 in prep.

3. Fire risk



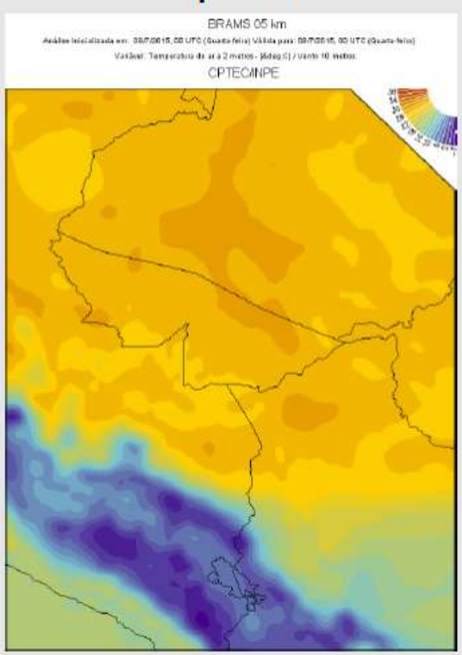
Pilot project: Acre State

$$B = 0{,}05H - 0{,}1(T - 27)$$

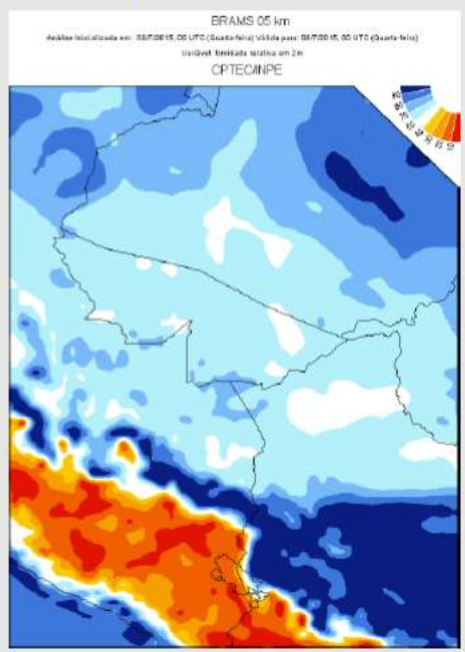
B = índice de Angstron
H = umidade relativa do ar em %
T = temperatura do ar em °C

Dados: Sistema Regional de Modelagem Atmosférica **BRAMS**
5x5 Km

Temperatura



Umidade Relativa



Processamento TerraMA²

NÍVEL DE ALERTA

VALOR RISCO	ALERTA
3	Observação
2,5	Atenção
2	Alerta
1,5	Alerta Máximo

RESULTADOS

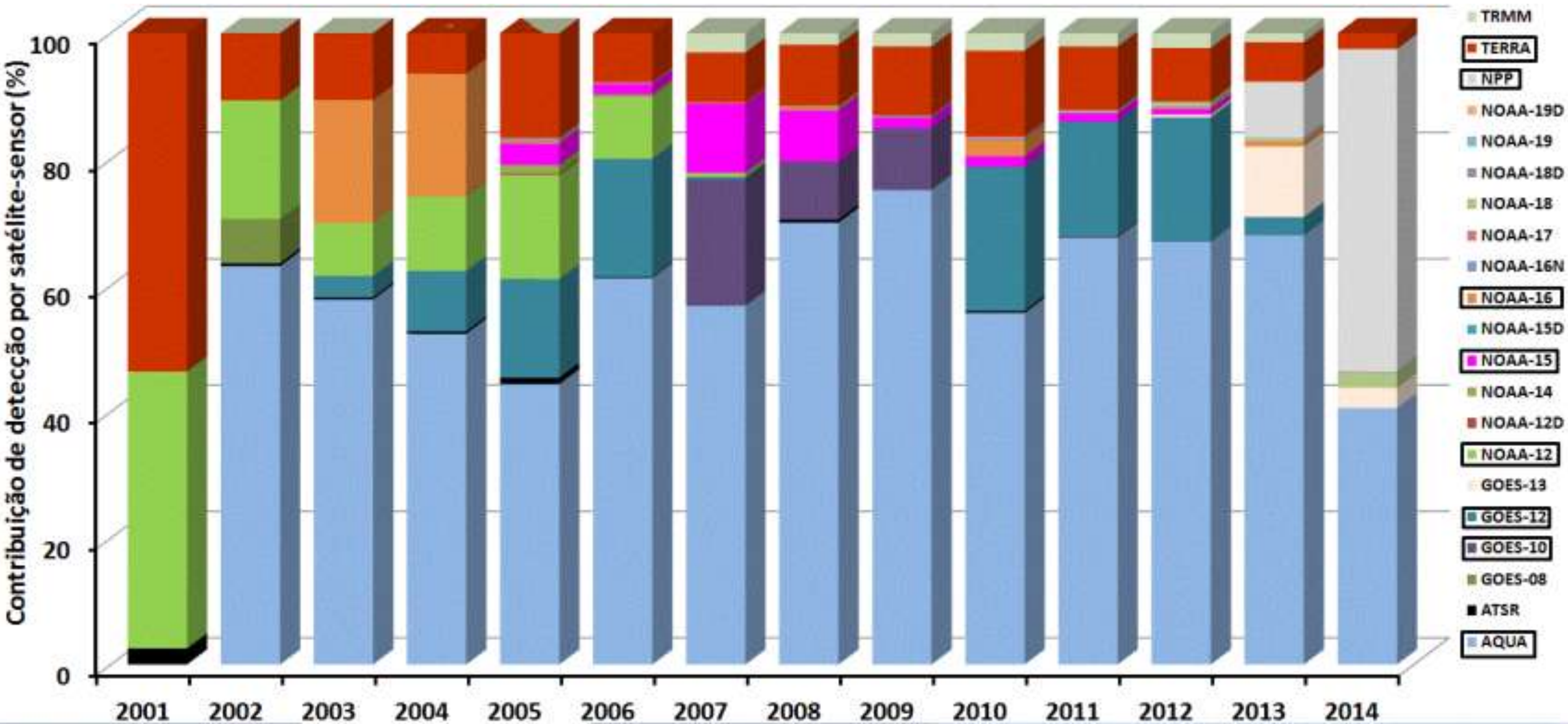
Envio de notificação por e-mail;
Mapas de Risco;
Acesso informação internet

*Sistema automático
*Funcionamento 24h

Courtesy: Alan Pimentel

3. Fire risk

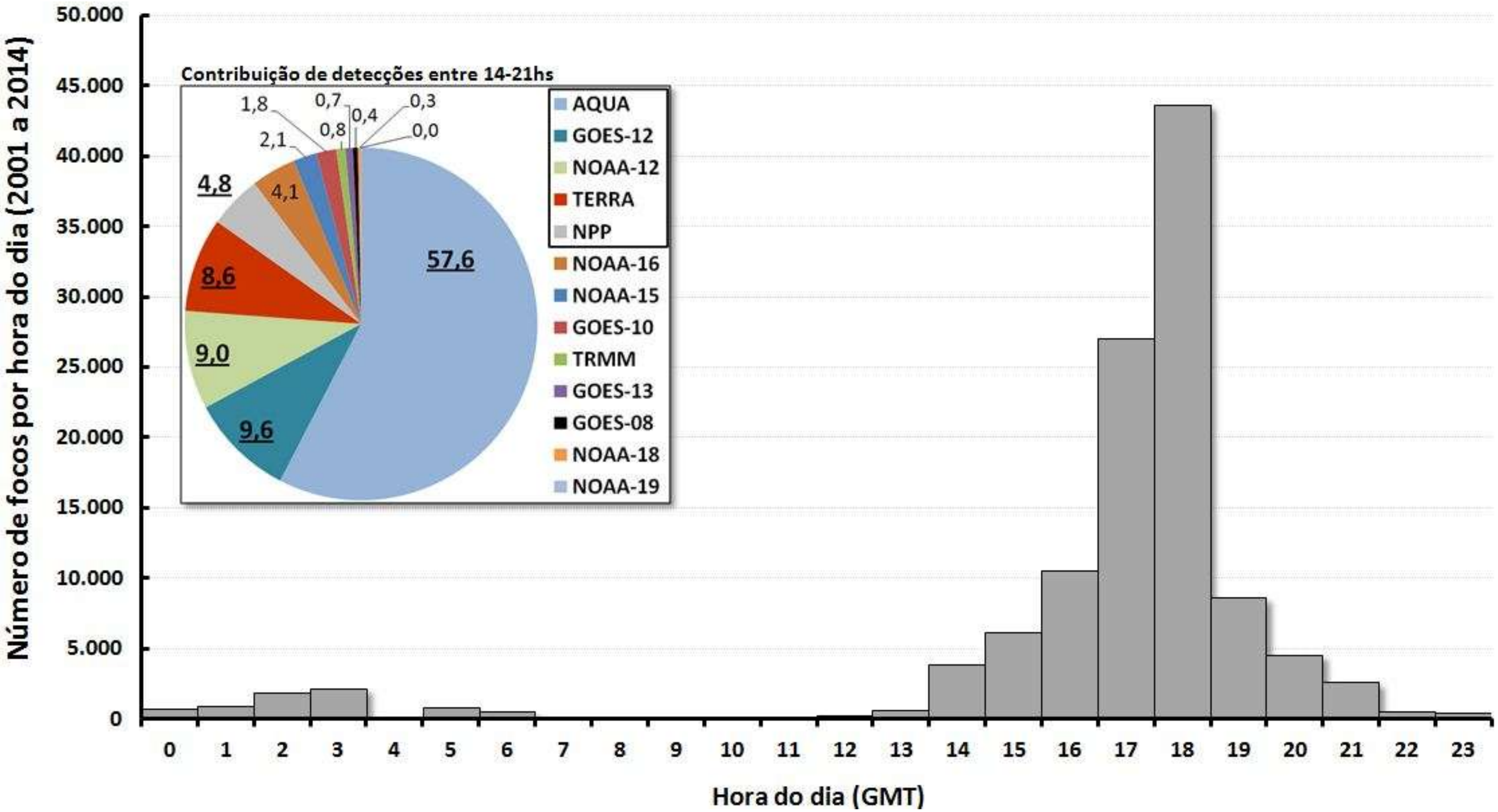
Pilot project: Acre State



Anderson et al, 2015 in prep.

3. Fire risk

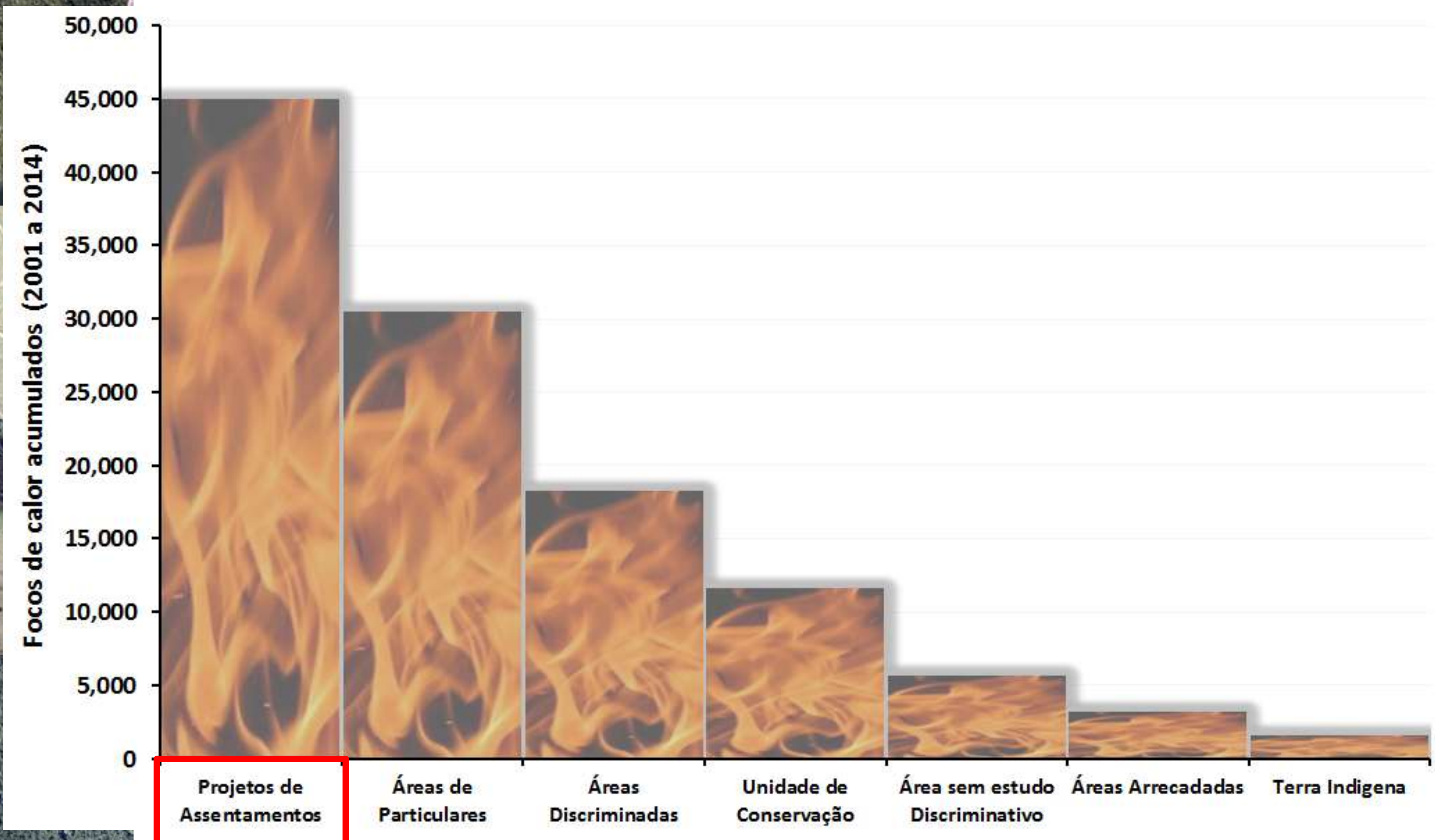
Pilot project: Acre State



Anderson et al, 2015 in prep.

3. Fire risk

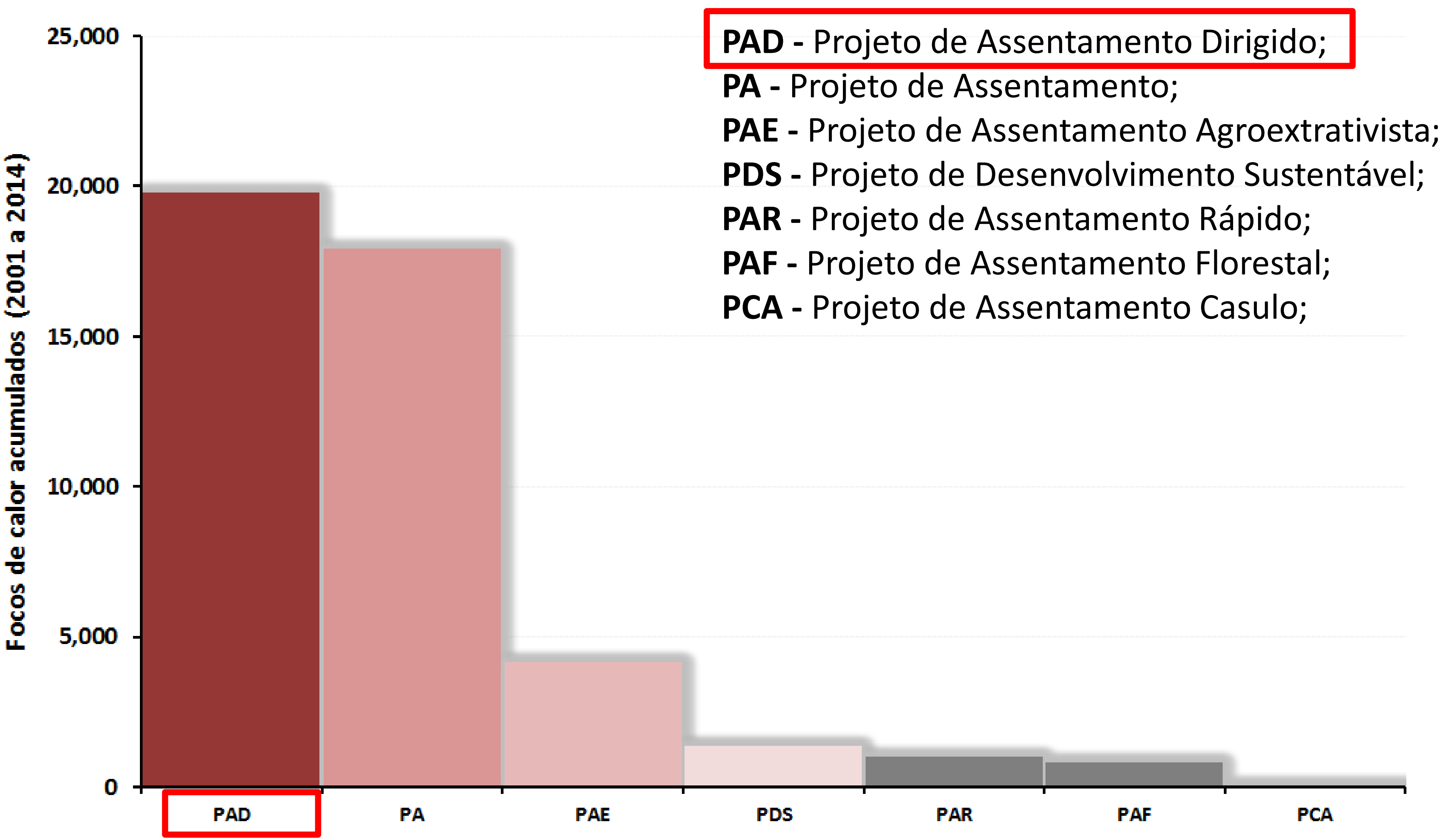
Pilot project: Acre State



Anderson et al, 2015 in prep.

3. Fire risk

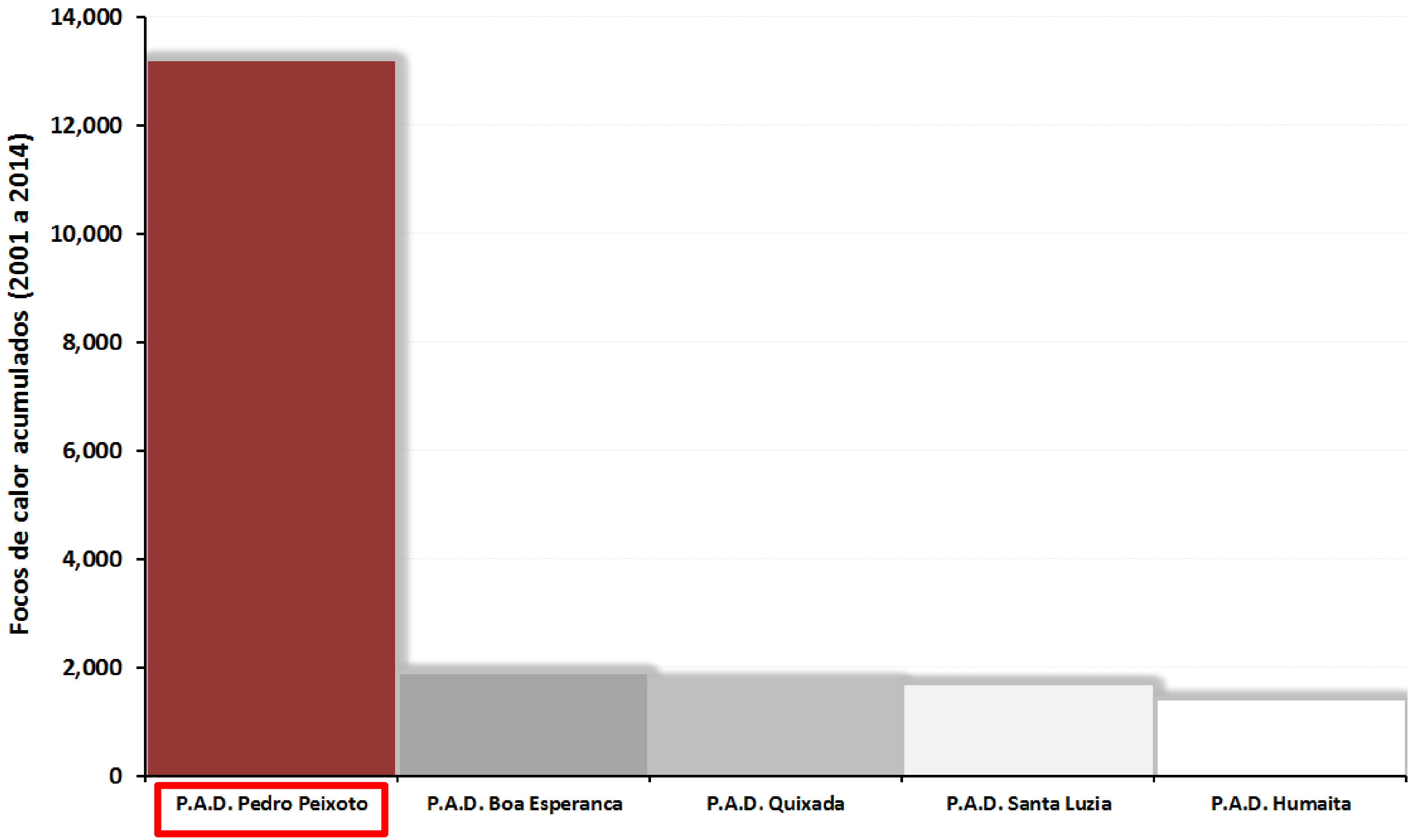
Pilot project: Acre State



Anderson et al, 2015 in prep.

3. Fire risk

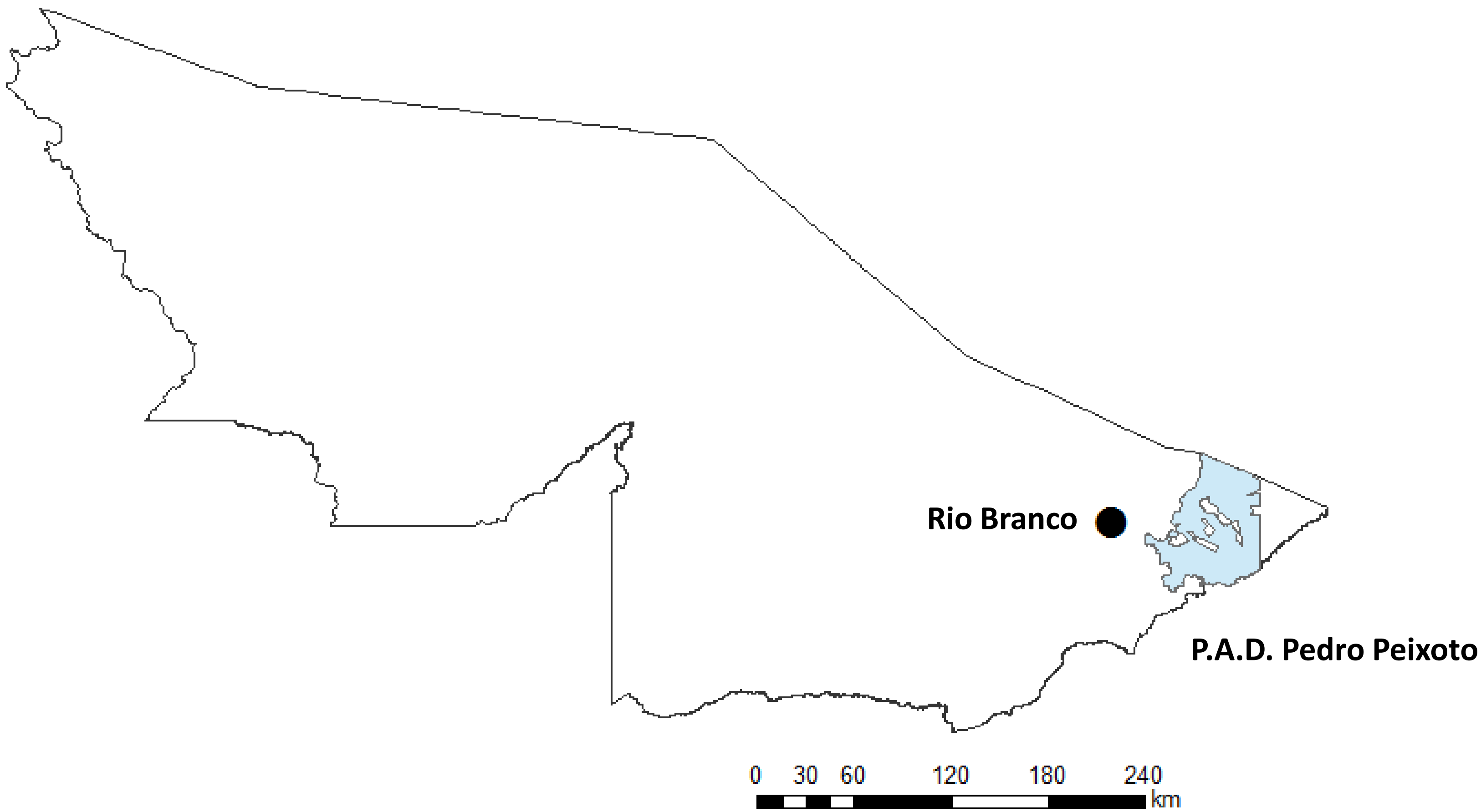
Pilot project: Acre State



Anderson et al, 2015 in prep.

3. Fire risk model

Pilot project: Acre State



3. Fire risk

Pilot project: Acre State

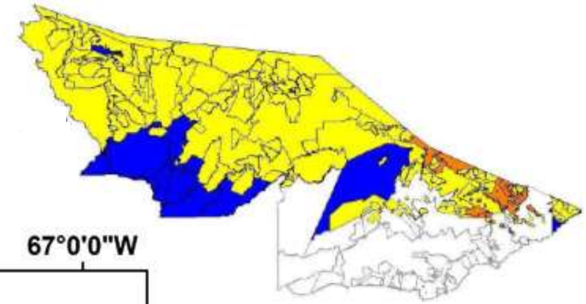
Analise de tendencia + analise do historico de uso (long-term e recente)

TABELA 3 Tabela de ordenamento de risco de incêndios baseando-se somente no histórico de ocorrência de fogo em cada unidade fundiária.

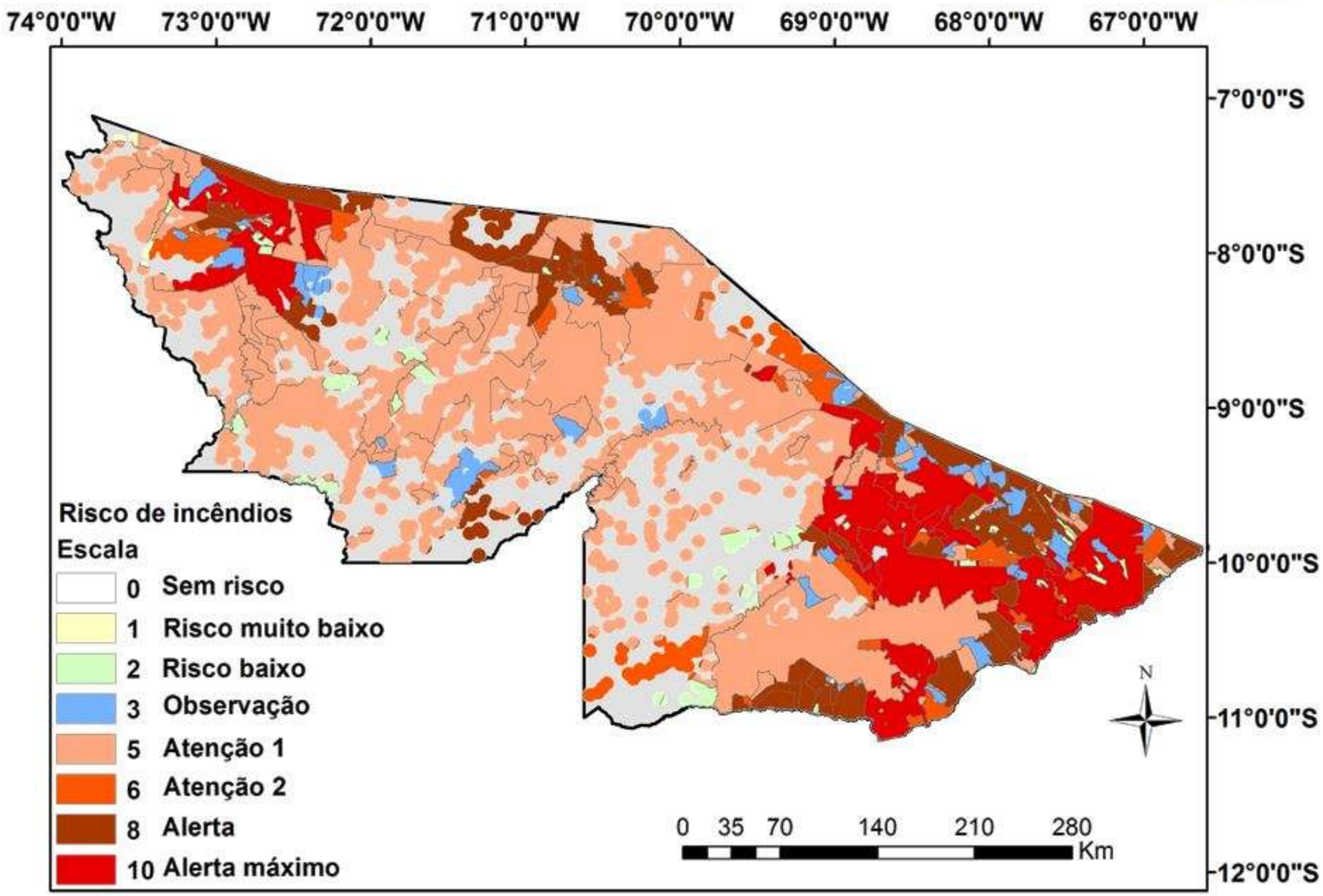
Risco de Incêndio	Escala	Observação
Alerta máximo	10	Tendência de aumento de focos de calor tanto entre 2000 e 2014 quanto entre 2010 e 2014, p<0.05 Ou Tendência de aumento ou diminuição de focos de calor entre 2010 e 2014 não significativa a 99.5%, mas com mais de 500 ocorrências de focos de calor entre 2010 e 2014.
Alerta	8	Tendência de aumento de focos de calor tanto entre 2000 e 2014 quanto entre 2010 a 2014, p<0.1 Ou Tendência de aumento ou diminuição de focos de calor entre 2010 a 2014 não significativa a 99.5%, mas com 100 – 499 ocorrências de focos de calor entre 2010 e 2014.
Atenção 2	6	Tendência de aumento de focos de calor entre 2010 e 2014, p<0.1 Ou Entre 60 a 99 observações de focos de calor entre 2010 e 2014.
Atenção 1	5	Tendência de aumento de focos de calor entre 2000 e 2014, p<0.1 Ou Entre 41a 59 observações de focos de calor entre 2010-2014.
Observação	3	Entre 11 e 40 focos entre 2010-2014.
Risco baixo	2	até 10 focos entre 2010-2014
Risco muito baixo	1	até 5 focos entre 2006-2014
Sem risco	0	Sem observação de focos de calor na série histórica (2000 a 2014) Ou a mais de 5 km de distância de qualquer foco de calor registrado entre 2000 e 2014.

Anderson et al, 2015 in prep.

3. Fire risk



Pilot project: Acre State



Fire risk as a product of the observations of fire pixels: trend, historical use and number of observations

Anderson et al, 2015 in prep.

Integrative multidisciplinar project at Cemaden

Pilot project: Acre State

Cemaden Pluviômetros nas Comunidades
(Silvia Saito e Victor Marchezini)

<u>Modelagem atmosférica</u>
<u>(Christopher Castro)</u>

<u>Impactos na saúde</u>
<u>(Luciana Londe)</u>

<u>Riscos de incêndios</u>
<u>(Liana e</u>
<u>Missae Yamamoto)</u>

Modelagem hídrica, geodinâmica e de mobilidade
(Conrado Rudorff, Marcio Moraes Leonardo Barcelar e Márcio Andrade)

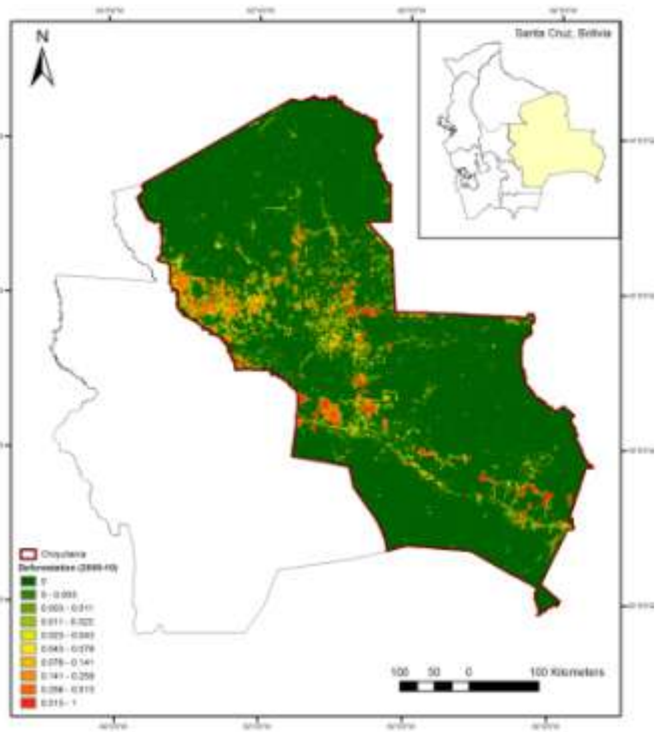
Cemaden Educação
(Rachel Trabjer e Victor Marchezini)

<u>Atores locais: Governo Estadual, IMC, SEMA, Secretaria educação, Projeto Piscicultores, Sala de situação-AC, Defesa civil, Bombeiros</u>

<u>Websites: http://www.cemaden.gov.br/pluviometros/</u> http://educacao.cemaden.gov.br/

3. Fire risk

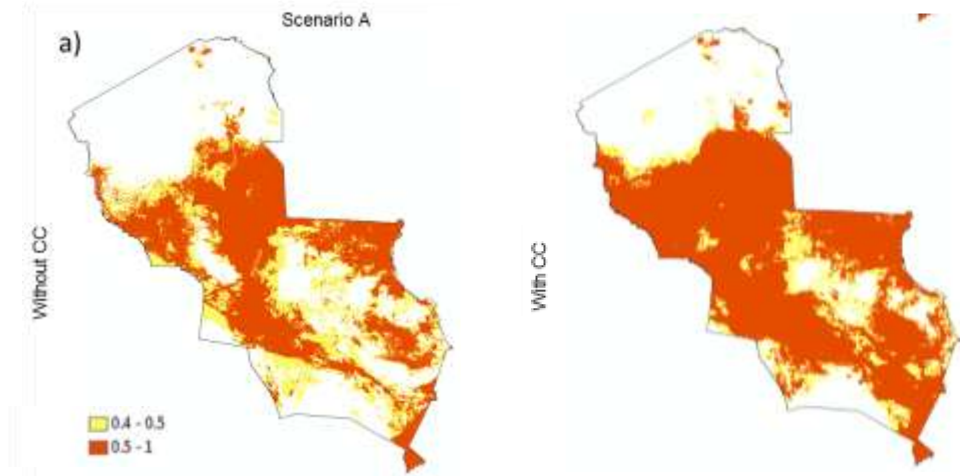
Pilot project: Chiquitania region in the Department of Santa Cruz, Bolivia



Fire risk for 2025

Business as usual

Rapid growth + CC



important determinants of wildfire risk in this region are distance to roads, deforestation and density of human settlements. Severely dry conditions alone increased the area of high wildfire risk by 69%, affecting all categories of land use and land cover. the interactions between dry climatic conditions and rapid frontier expansion can increase the risk of wildfire even further.

Devisscher, **Anderson** et al, 2015 sub PLoS

Perspectives

What should be done for improving the understanding and the monitoring of fire and its associated impacts?

1. Burned area:

- Our product under development at TREES laboratory INPE: improved detection of forests affected by fires
- CPTEC in developing a burned area product for the cerrado region based on Landsat images, potentially for other areas in SA
- Other initiatives: local, regional and global

2. Fire associated GHG emissions

- Increase the network of forests impacted by fires monitoring plots in SA for long term C stock assessment
- Improve the spatial representation of biomass decomposition decay
- Implement the emissions and C loss of forest areas affected by multiple fires

3. Fire risk

- To improve the understanding of local historical and economic drives for the use of fire
- To introduce local programmes for the understanding, adapting and mitigating the occurrence and impacts of fires
- Increase policy enforcement and monitoring systems

Cemaden
Centro Nacional de Monitoramento
e Alertas de Desastres Naturais

http://www.liana-anderson.org/

Tropical Ecosystems and Environmental Sciences Laboratory
TREES

http://trees-research.weebly.com/

Fire on Starry Night

Ronald Guerin