

Monitoring Program for Amazon and Other Biomes

# Advances and Perspectives of the Monitoring System of INPE



MINISTÉRIO DA CIÊNCIA, TECNOLOGIA, INOVAÇÕES E COMUNICAÇÕES  
**INSTITUTO NACIONAL DE PESQUISAS ESPACIAIS**

MINISTÉRIO DA  
CIÊNCIA, TECNOLOGIA,  
INOVAÇÕES E COMUNICAÇÕES



## 1. Monitoring Projects

1. PRODES

2. DETER

3. TERRACLASS

## 2. Evolution



# Monitoring Projects

## DETER

Alert system for detecting forest removal and degradation

Since 2004, daily

## PRODES

Monitoring and quantifying primary forest removal in the Amazon

Since 1988, annual

## AMAZON Monitoring

Land Use  
Land Cover  
Deforestation  
Fire

## QUEIMADAS

Fire Monitoring  
Identifying and quantifying burned areas and fire risk

Since 1985, daily

## TerraClass

Land Use and Land cover in the Amazon

Since 1991, >2 years





1. Monitoring Projects

**1. PRODES**

2. DETER

3. TERRACLASS

2. Evoluton

# PRODES Project



Starting dry season  
(~July)



Ending dry season  
(~september to november)



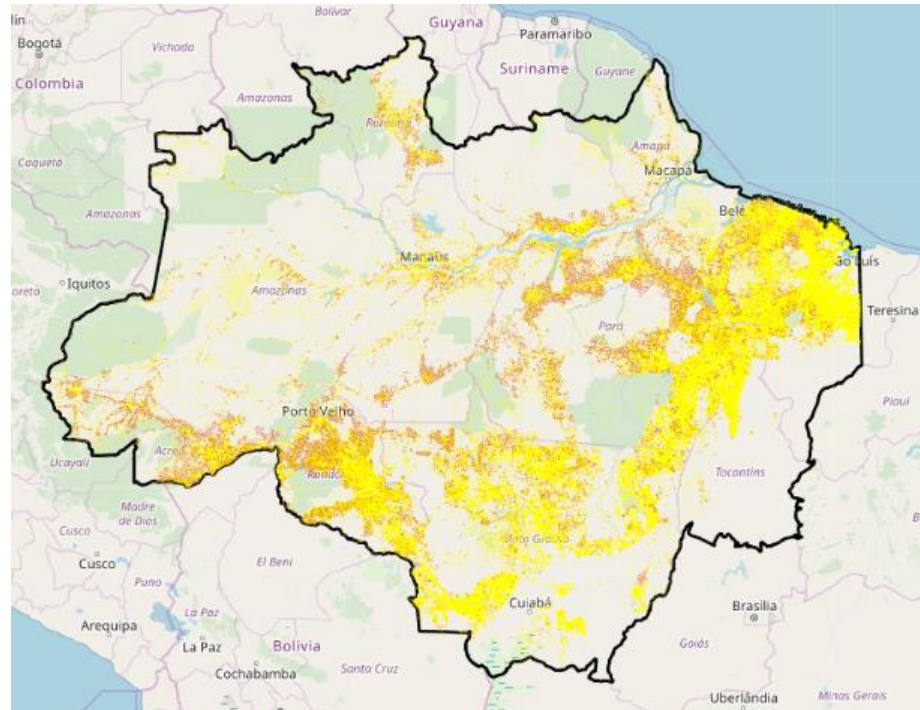
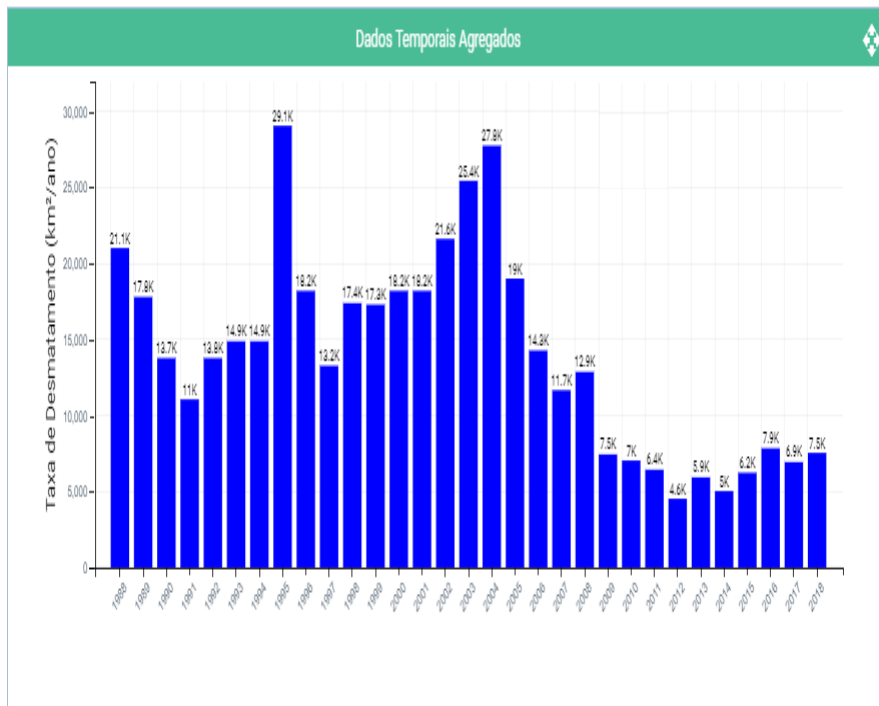
annual increase of deforestation  
medium resolution (Landsat class ~ 20-30 m)  
minimum mapping unit 6.25 ha

Visual interpretation  
Team with extensive experience



## Clear-cut deforestation until 2019 $\cong$ 796.000 km<sup>2</sup> (19,9%)

<http://terrabrasilis.dpi.inpe.br>





## 1. Monitoring Projects

1. PRODES

**2. DETER**

3. TERRACLASS

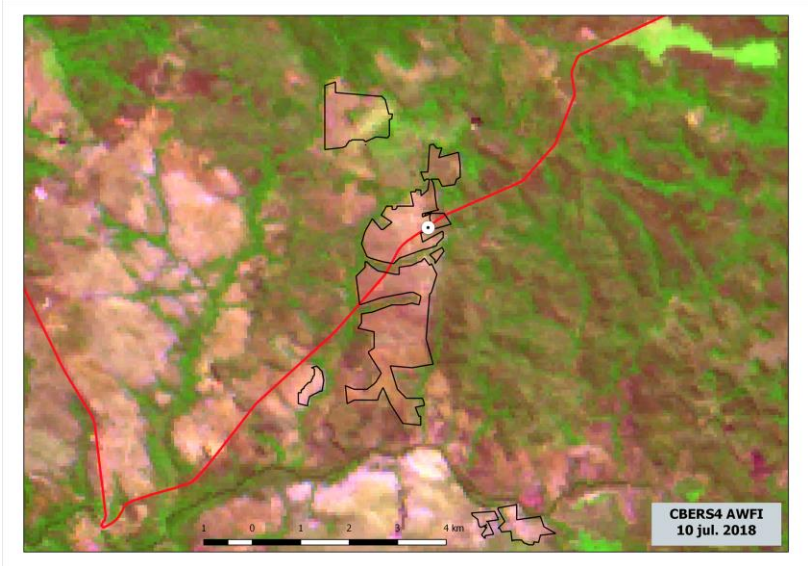
2. Evoluton

# DETER Project



daily increase of deforestation  
low resolution (~ 60 m)  
minimum mapping unit 3 ha

Visual interpretation  
Team with extensive experience





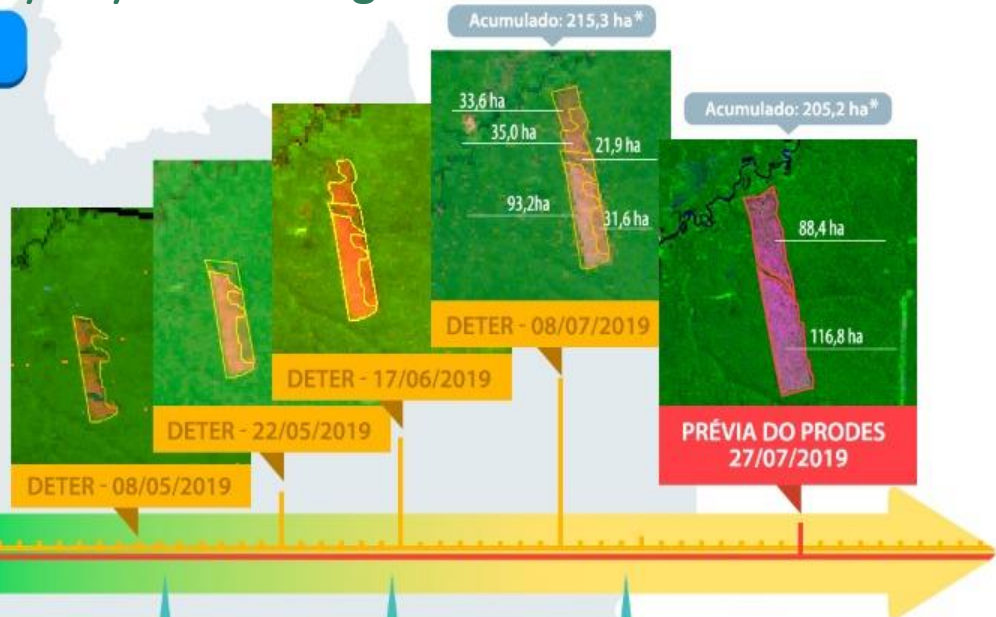
# DETER Project

## Day by day monitoring

### COMO O INPE DETECTA ALERTAS DE DESMATAMENTO



PRODES - 24/07/2018



DIÁRIO

ANUAL

- PRODES - MAPAS ANUAIS  
LANDSAT 8 / OLI
- DETER - ALERTAS DIÁRIOS  
CBERS 4 / WFI - CLASSE CORTE RASO
- IMAGENS PLANET  
FONTE: WWW.PLANET.COM



AGOSTO 2018



MAIO 2019



JUNHO 2019



JULHO 2019

HUMAITÁ, AMAZONAS, BRASIL  
COORDENADAS: 7.778445° S, 63.480613° W

\* Diferença de área acumulada atribuída aos tipos de sensores usados pelo DETER e PRODES.

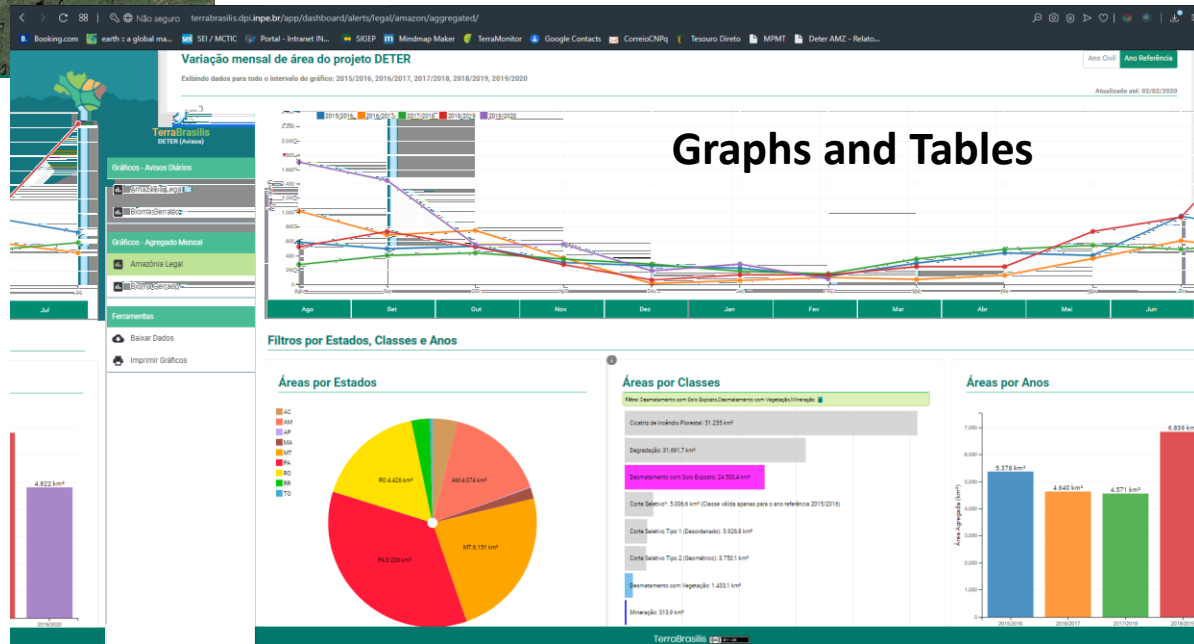
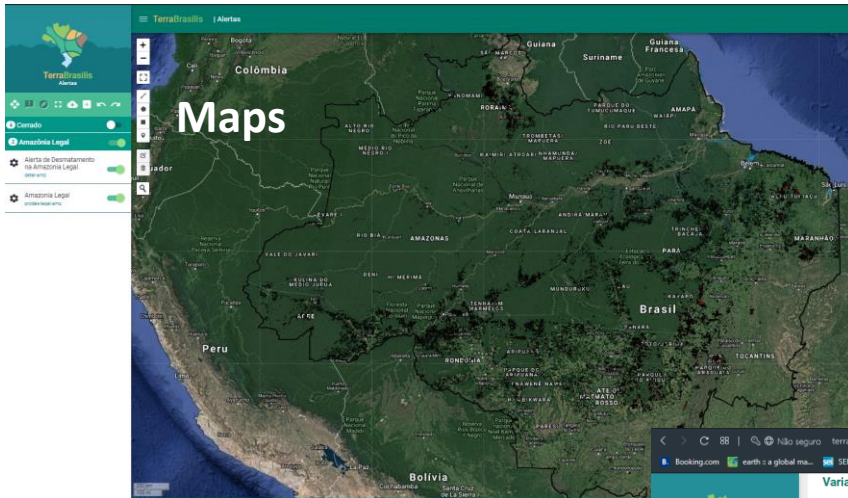


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# DETER Project

## Data dissemination



## Graphs and Tables

<http://terra-brasilis.dpi.inpe.br>





## 1. Monitoring Projects

1. PRODES

2. DETER

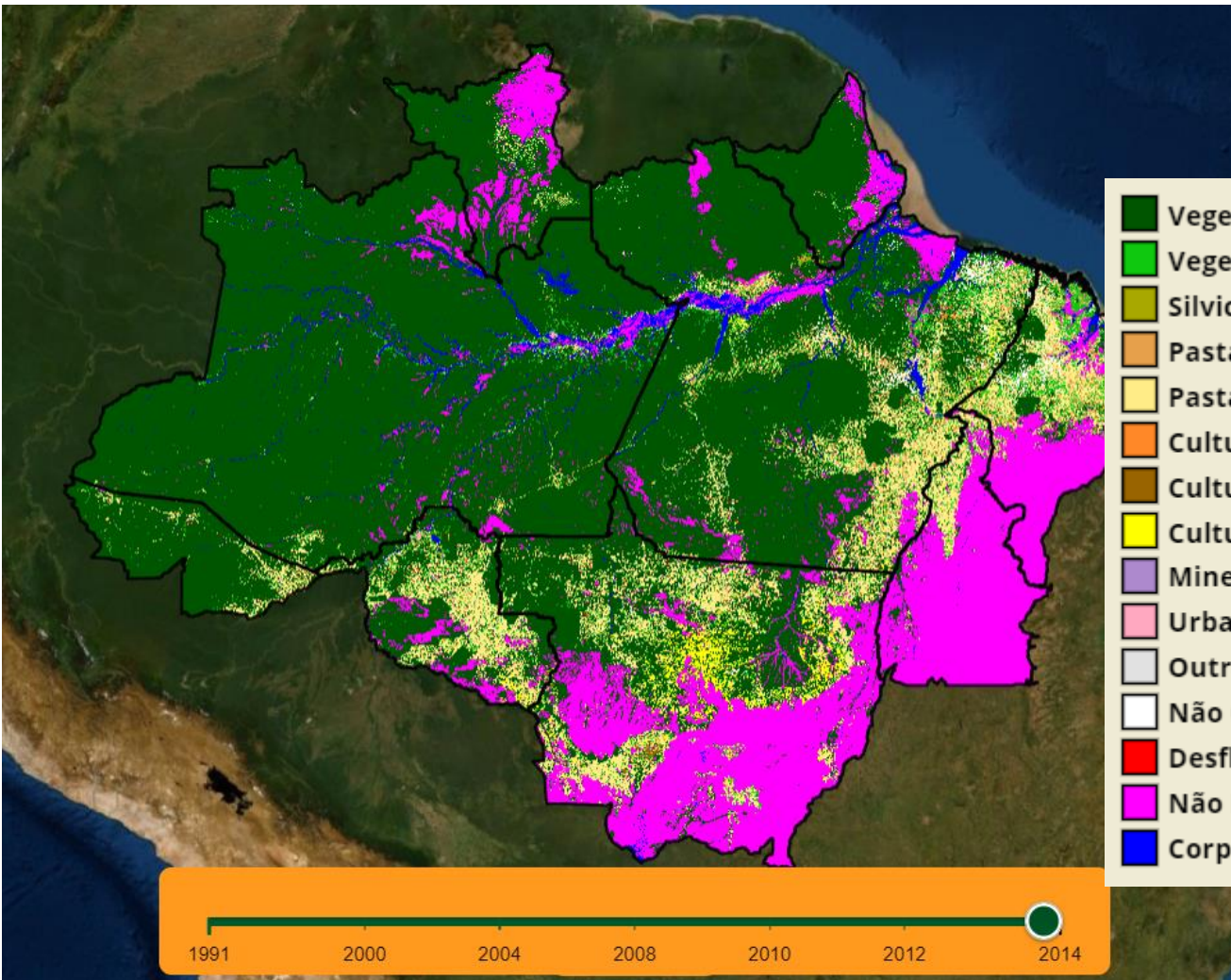
**3. TERRACLASS**

## 2. Evoluton

# TerraClass Project (INPE + EMBRAPA)

## Land Use and Land Cover in Amazon

[www.terraclass.gov.br](http://www.terraclass.gov.br)

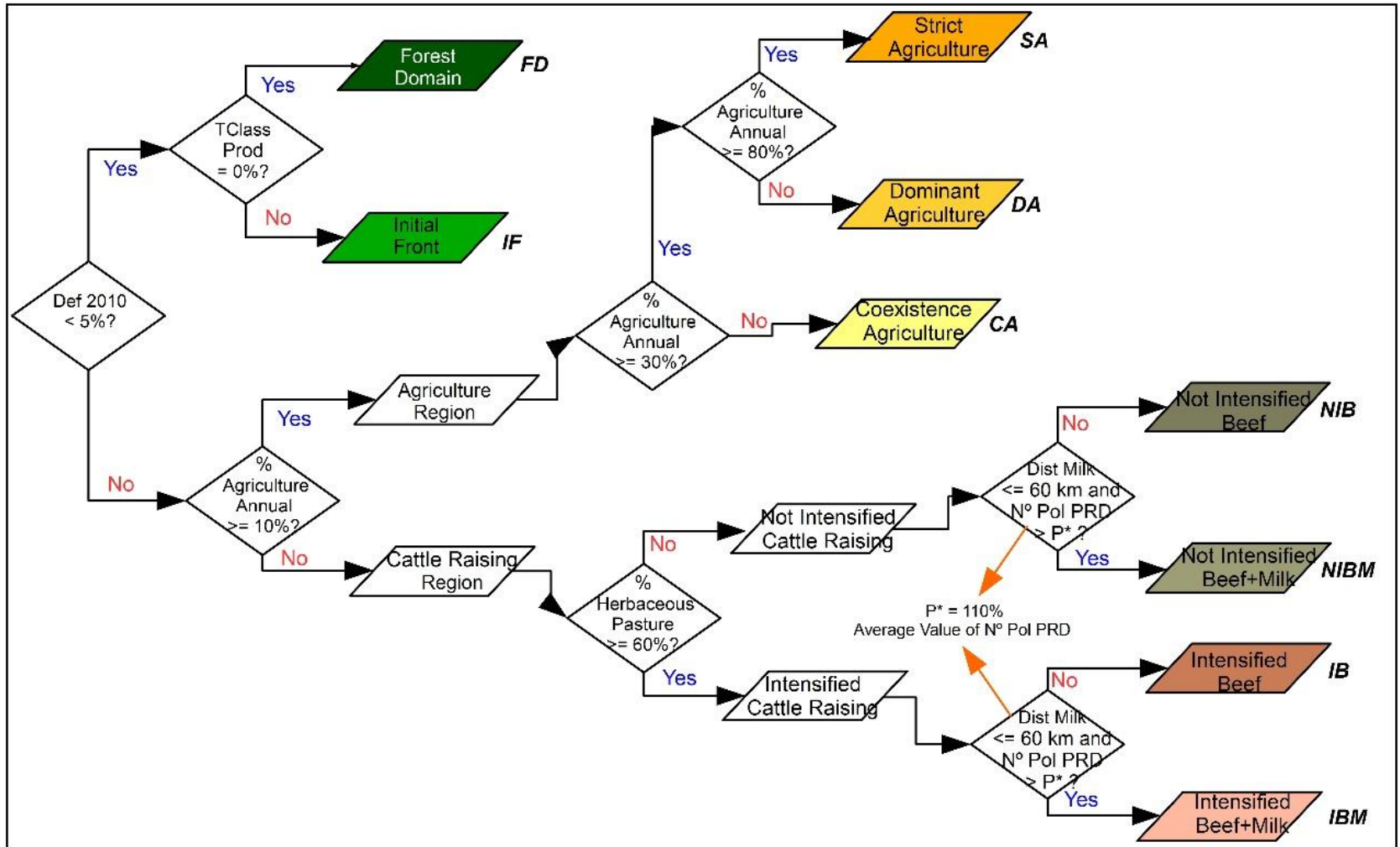


Vegetação Natural Florestal Primária	
Vegetação Natural Florestal Secundária	24,0%
Silvicultura	0,4%
Pastagem Cultivada Arbustiva	13,7%
Pastagem Cultivada Herbácea	49,6%
Cultura Agrícola Perene	0,2%
Cultura Agrícola Semiperene	0,3%
Cultura Agrícola Temporária	5,6%
Mineração	0,2%
Urbanizada	0,7%
Outros	0,9%
Não Observado	3,9%
Desflorestamento No Ano	0,6%
Não Floresta	
Corpo D'água	

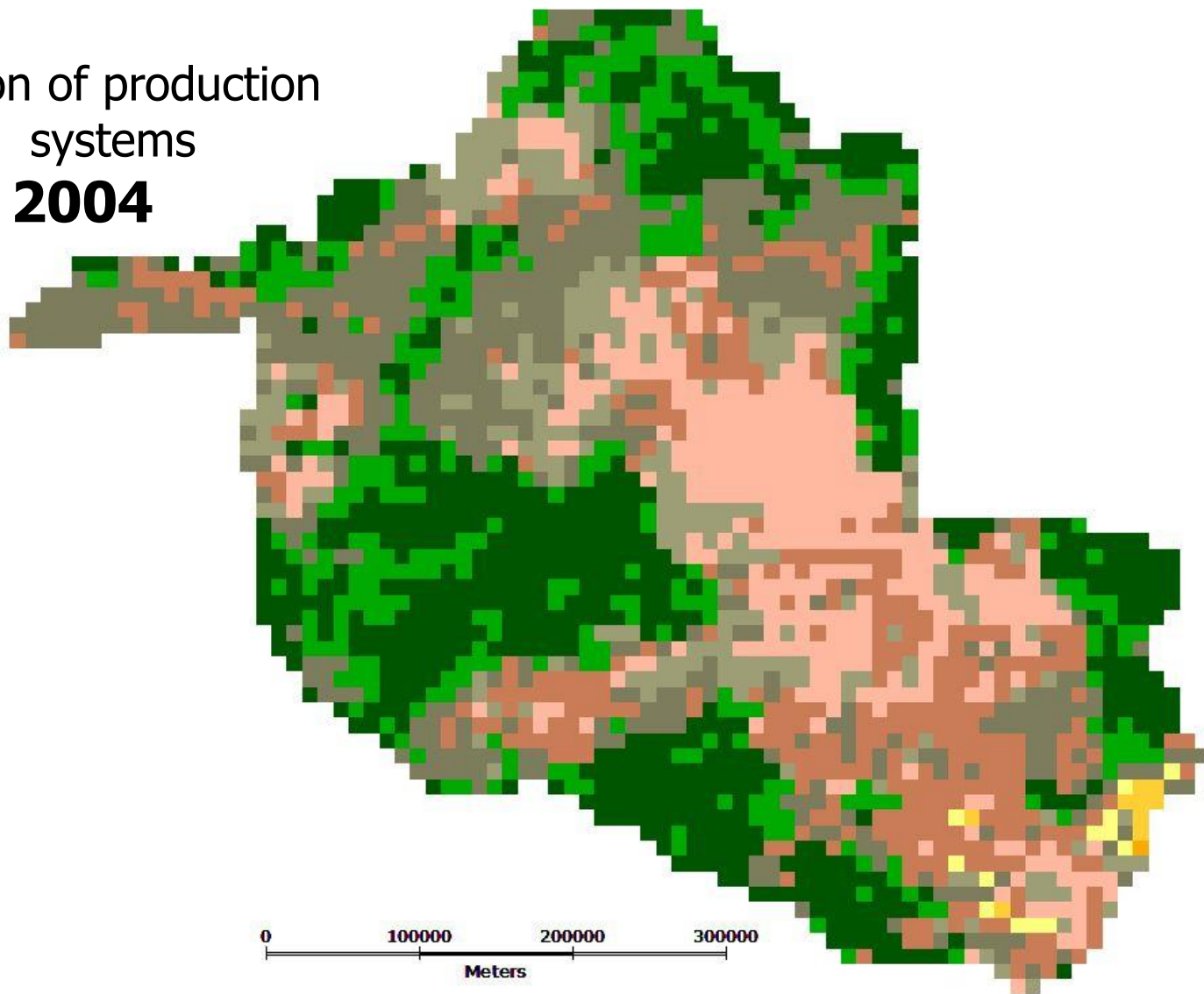


# TerraClass Project (INPE + EMBRAPA)

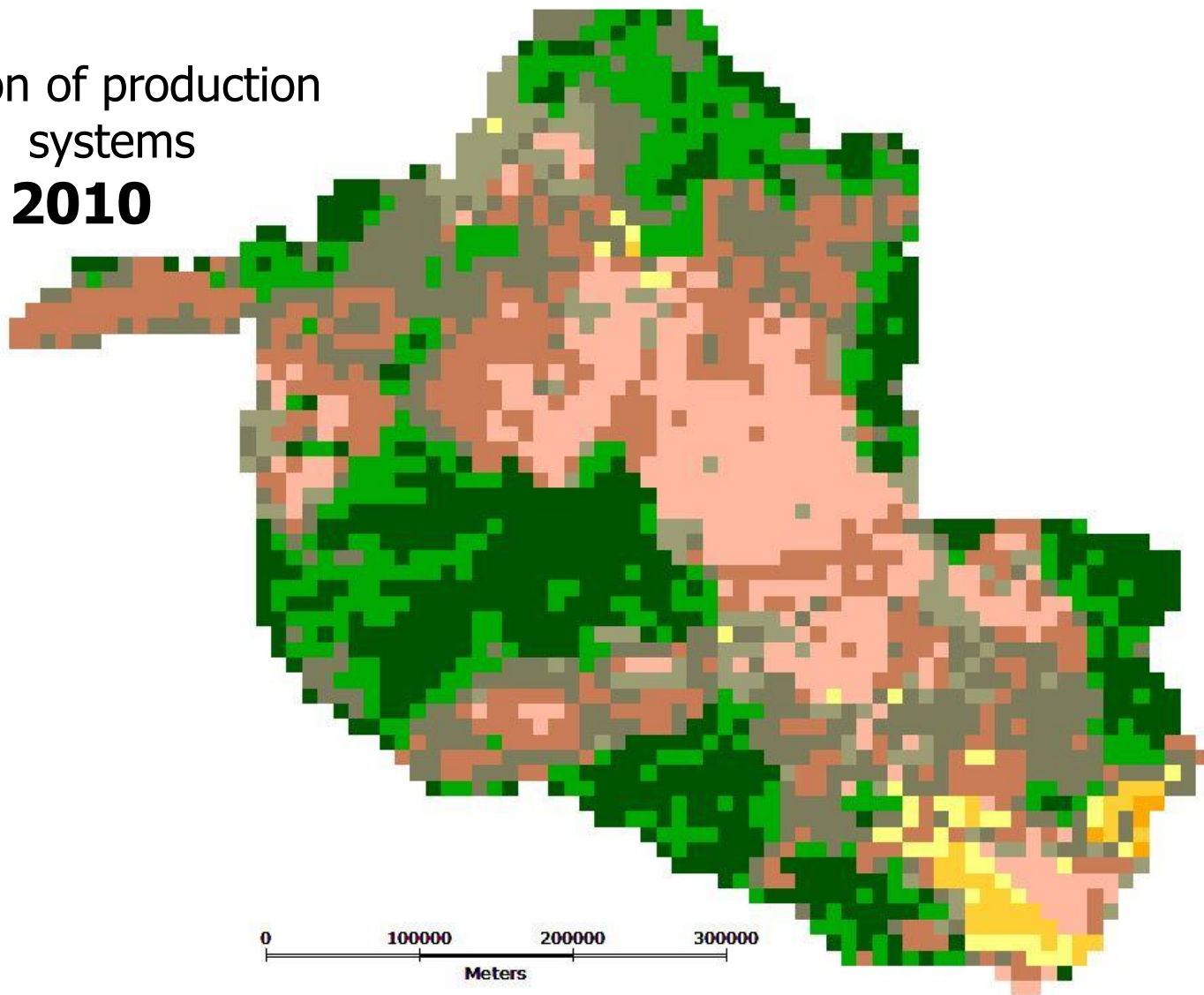
## Landscape Analysis classification at cell scale



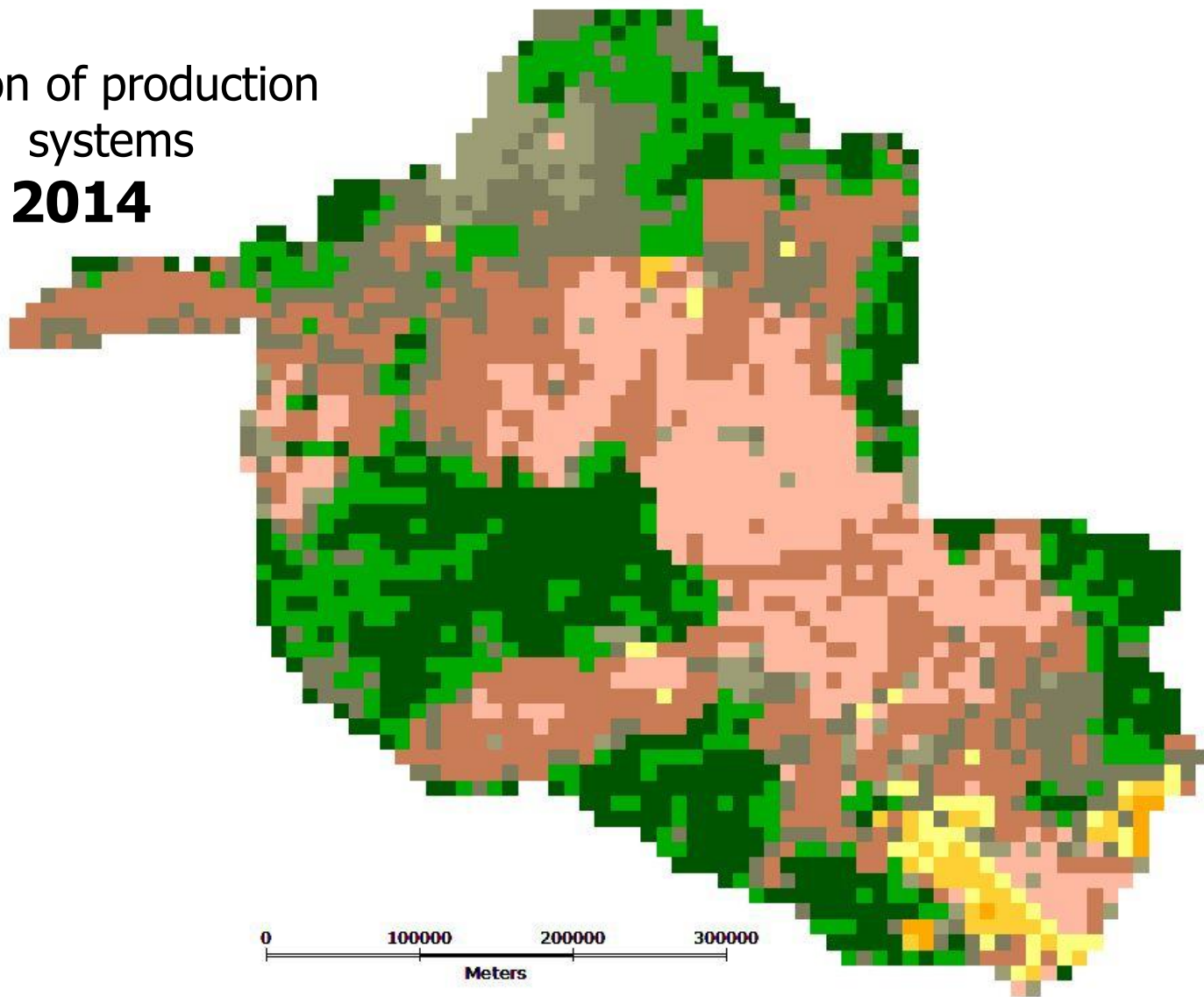
## Evolution of production systems **2004**



## Evolution of production systems **2010**



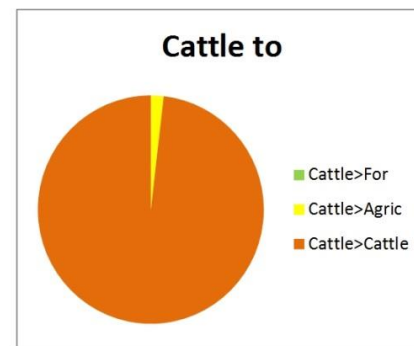
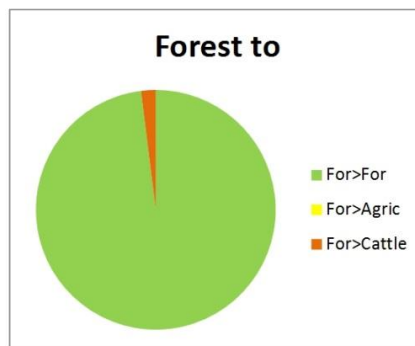
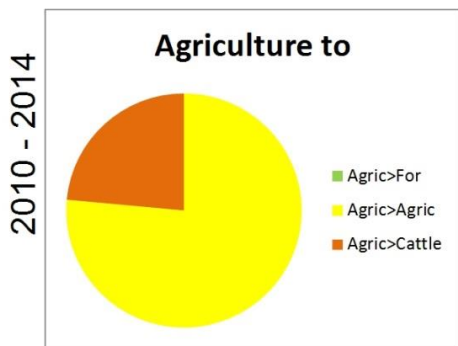
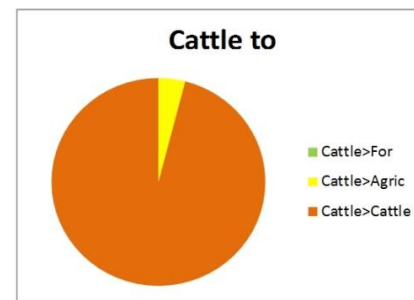
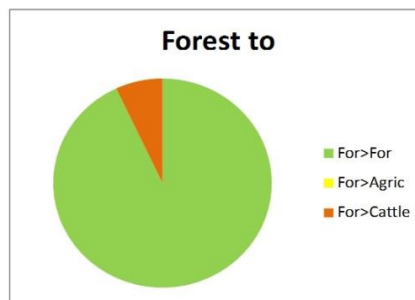
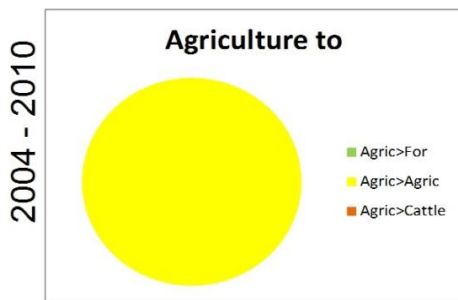
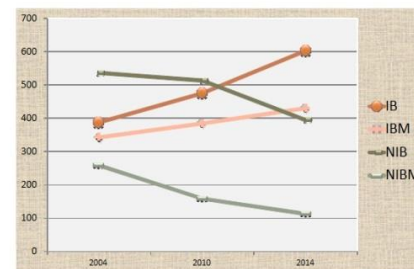
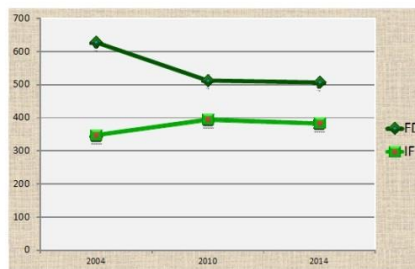
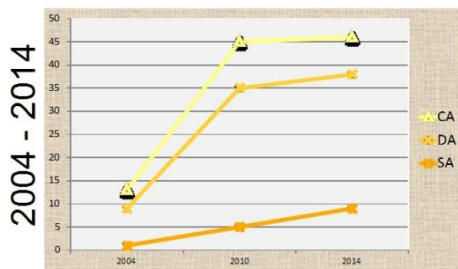
## Evolution of production systems **2014**





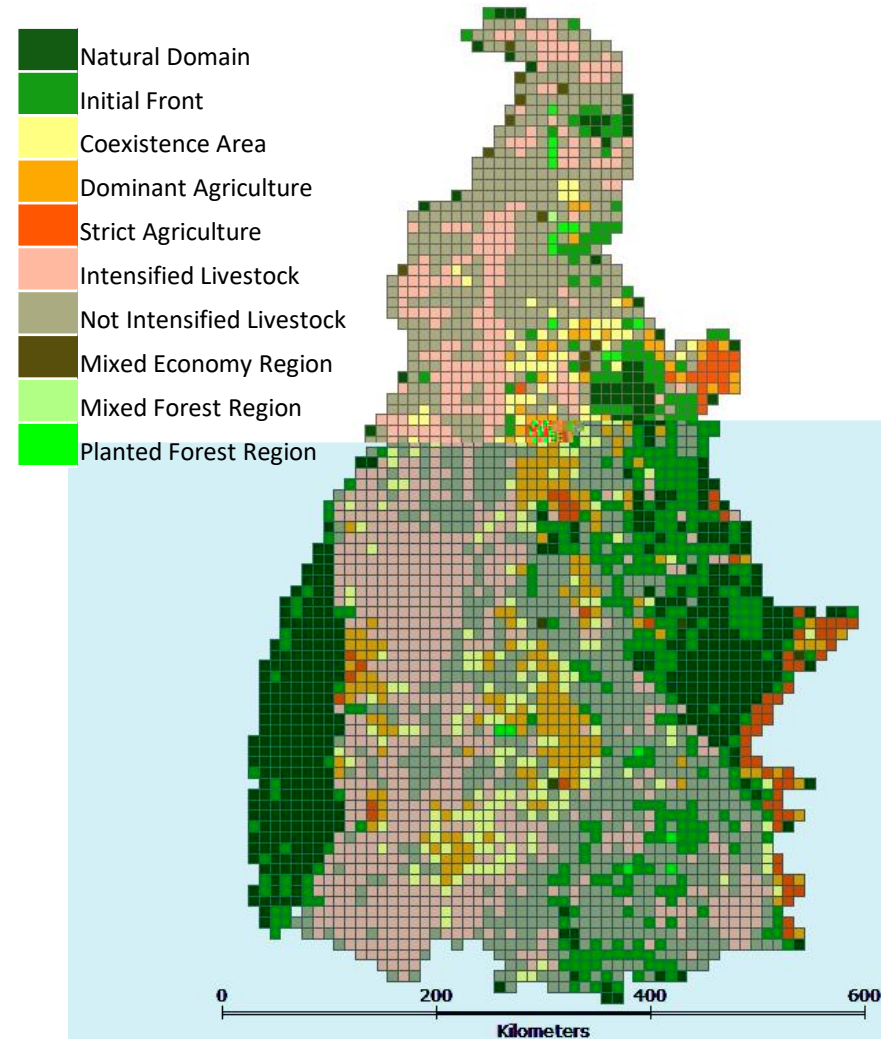
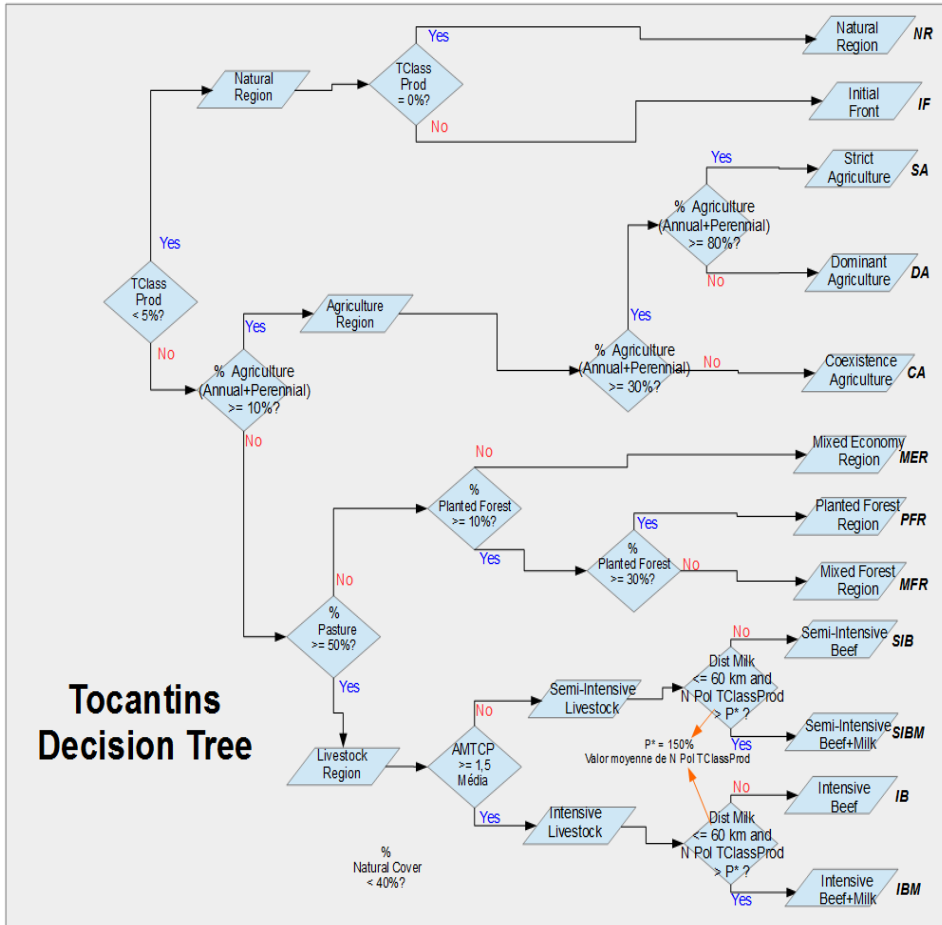
# TerraClass Project (INPE + EMBRAPA)

## Evolution of production systems 2004 - 2014



# TerraClass Project (INPE + EMBRAPA)

## Adapting Decision Tree Tocantins



## 1. Monitoring Projects

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# Evolution

## Images

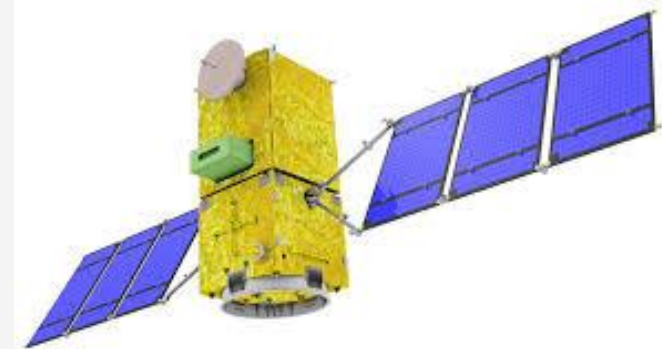
coordinates 3.9106, -51.9559 (Lat, Long) during december/2019

Image	Data do imageamento						
Cbers-4 - MUX	6						
Cbers-4 - WFI	3	12	15	18	23	26	29
Landsat-8 - OLI	1	17					
Sentinel-2 - MSI	5	10	15	20	25	30	

+

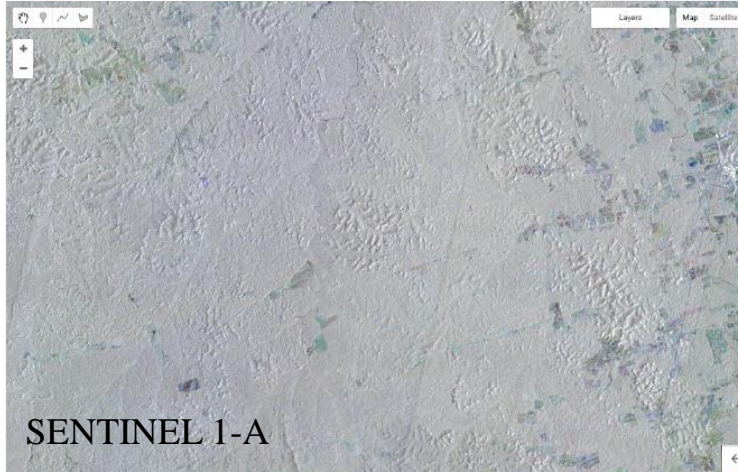


CBERS-4A



AMAZÔNIA-1

## methodologies



Cor	Sequencia	Interpretação
Azul		Aumento T3
Verde		Aumento T2, queda T3
Vermelho		Queda T2
Amarelo		Queda T3
Magenta		Queda T2, volta T3
Ciano		Aumento T2
Preto		Sem sinal
Branco		Sem variação
Cinza		Sem variação

	Forest Monitor		Deter	
	# polígonos	área km2	# polígonos	área km2
mês				
nov/19	852	203.5	277	36.6
dez/19	252	12.2	81	11.6
Total	1104	215.7	358	48.3

Forest Monitor

Start Date: 2019/11/08 | Last Date: 2019/11/22

Q Results: 10

- Sentinel-2 - MSI - (20MRT) 2019-11-09
- Planet (Daily) 2019-11-10
- Planet (Daily) 2019-11-10
- Planet (Daily) 2019-11-10
- Planet (Daily) 2019-11-08
- Planet (Daily) 2019-11-08
- Planet (Daily) 2019-11-08

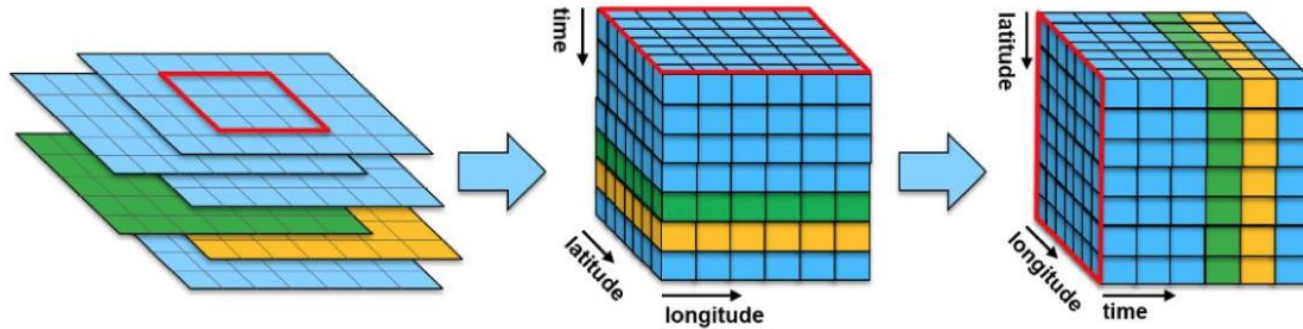
Opacity: AREA TESTE, MASCARA, PRODES 2018/2019, DETER 2018/2019

Timeline: 2019-11-8 | 2019-11-12 | 2019-11-21

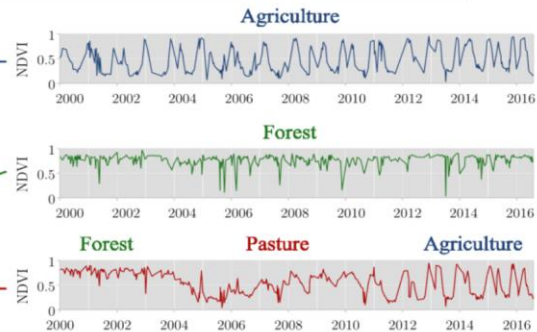
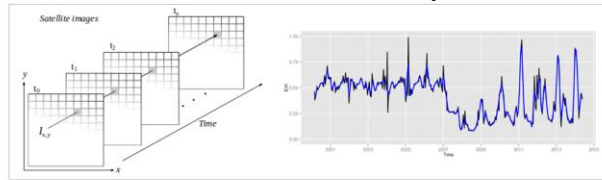
# Evolution

## Technology

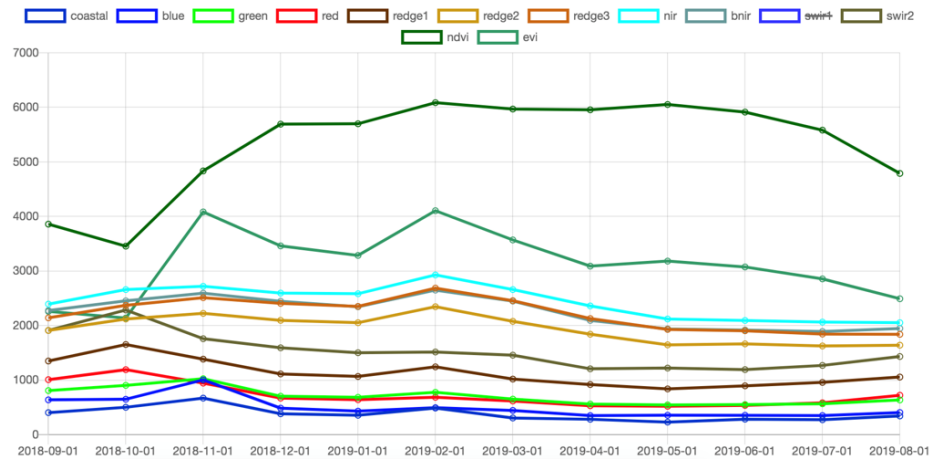
Brazilian Data cube



### Time series analysis



### Big Data



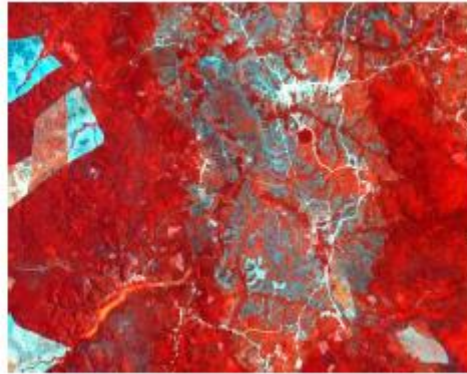
## Technology

deep learning techniques

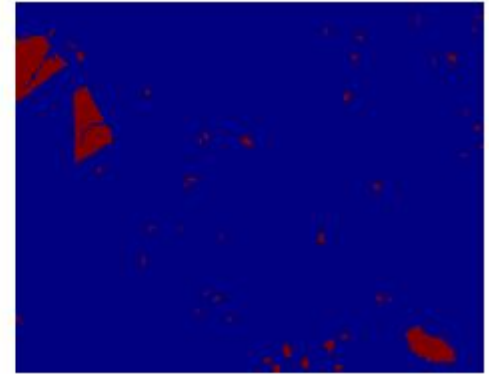
Evaluation of Deep Learning techniques for deforestation detection in the Brazilian Amazon and Cerrado biomes from remote sensing imagery



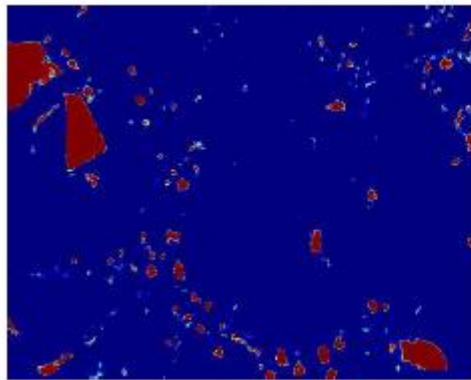
T1 - 2017



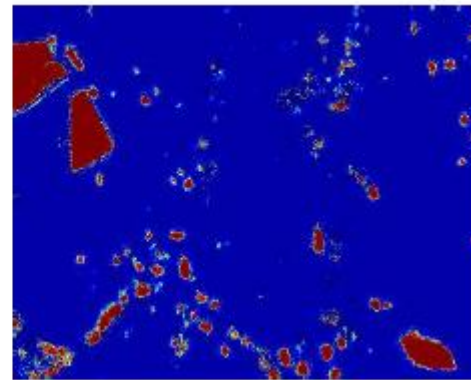
T2 - 2018



Reference



Siamese Network



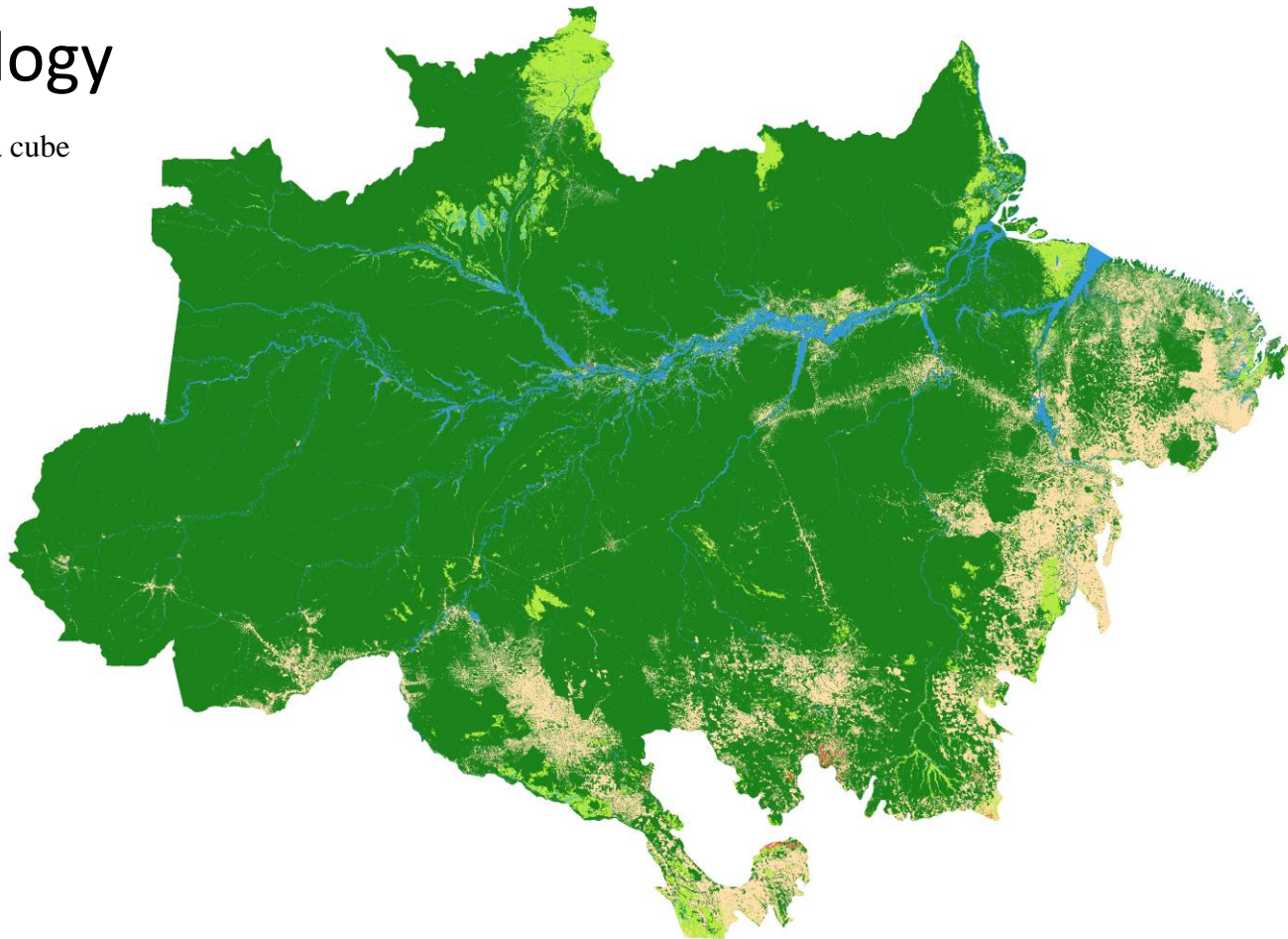
Convolutional SVM

Source: Ortega et al. (2020)

## Technology

Brazilian Data cube

# 2001



- |                        |                    |                           |
|------------------------|--------------------|---------------------------|
| 3. Water-Bodies        | 100. Cotton-Fallow | 130. Pasture              |
| 7. Forest-Amazon-Biome | 104. Millet-Cotton | 141. Urban-Area           |
| 51. Savanna            | 106. Soy-Millet    | 121. Secondary-Vegetation |
| 78. Seasonal-Wetland   | 108. Soy-Cotton    | 95. Fallow                |
| 99. Soy-Fallow         | 109. Soy-Corn      | 97. Sugarcane             |

Source: Camara et al. (2020)  
and Simoes et al. (2020b)

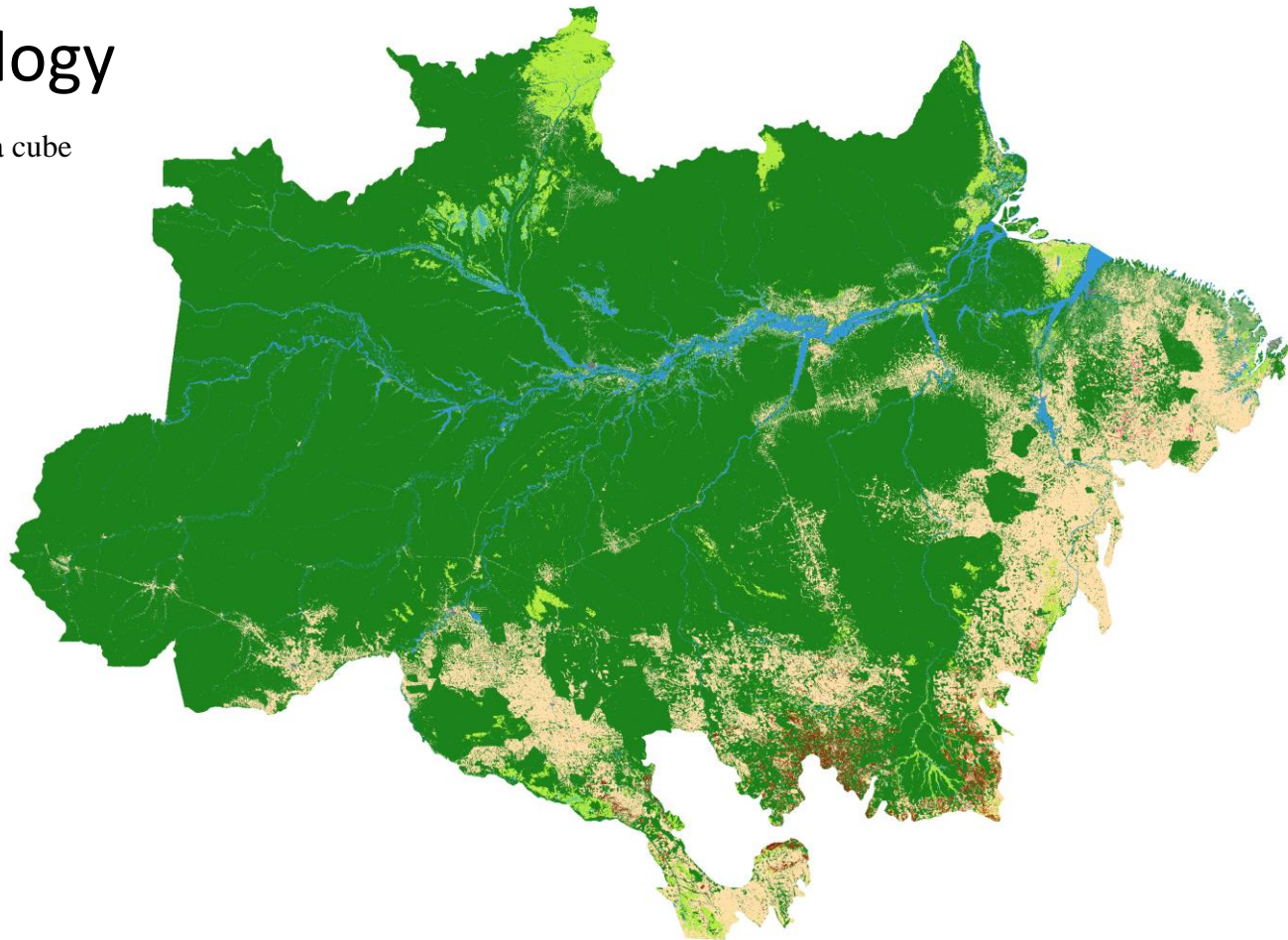




## Technology

Brazilian Data cube

# 2018



- |                        |                    |                           |
|------------------------|--------------------|---------------------------|
| 3. Water-Bodies        | 100. Cotton-Fallow | 130. Pasture              |
| 7. Forest-Amazon-Biome | 104. Millet-Cotton | 141. Urban-Area           |
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| 78. Seasonal-Wetland   | 108. Soy-Cotton    | 95. Fallow                |
| 99. Soy-Fallow         | 109. Soy-Corn      | 97. Sugarcane             |

K-fold = 0,96

Source: Camara et al. (2020)  
and Simoes et al. (2020b)



An aerial photograph of a dense tropical forest. The forest is composed of various types of trees, with a prominent, large, bright green tree canopy in the center. The surrounding forest is a mix of darker and lighter green hues, indicating a diverse ecosystem. The text is overlaid on the central part of the image.

Thank you for your attention!  
Questions? Remarks?