

Amazon and Cerrado satellite monitoring projects: challenges and technological perspectives



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Fundação Getúlio Vargas – Escola de Matemática Aplicada
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INPE: from data to knowledge



SATELLITES

Earth and Space Observation



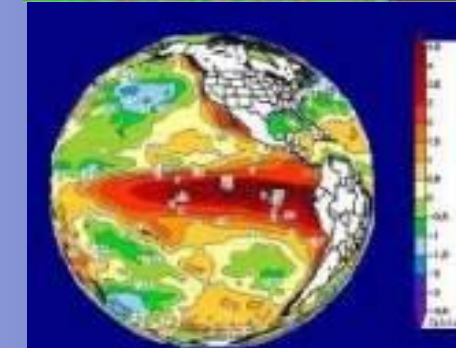
LAND SYSTEMS

Satellite Control, reception and dissemination of spatial data



KNOWLEDGE GENERATION

R & D for Space and Environment

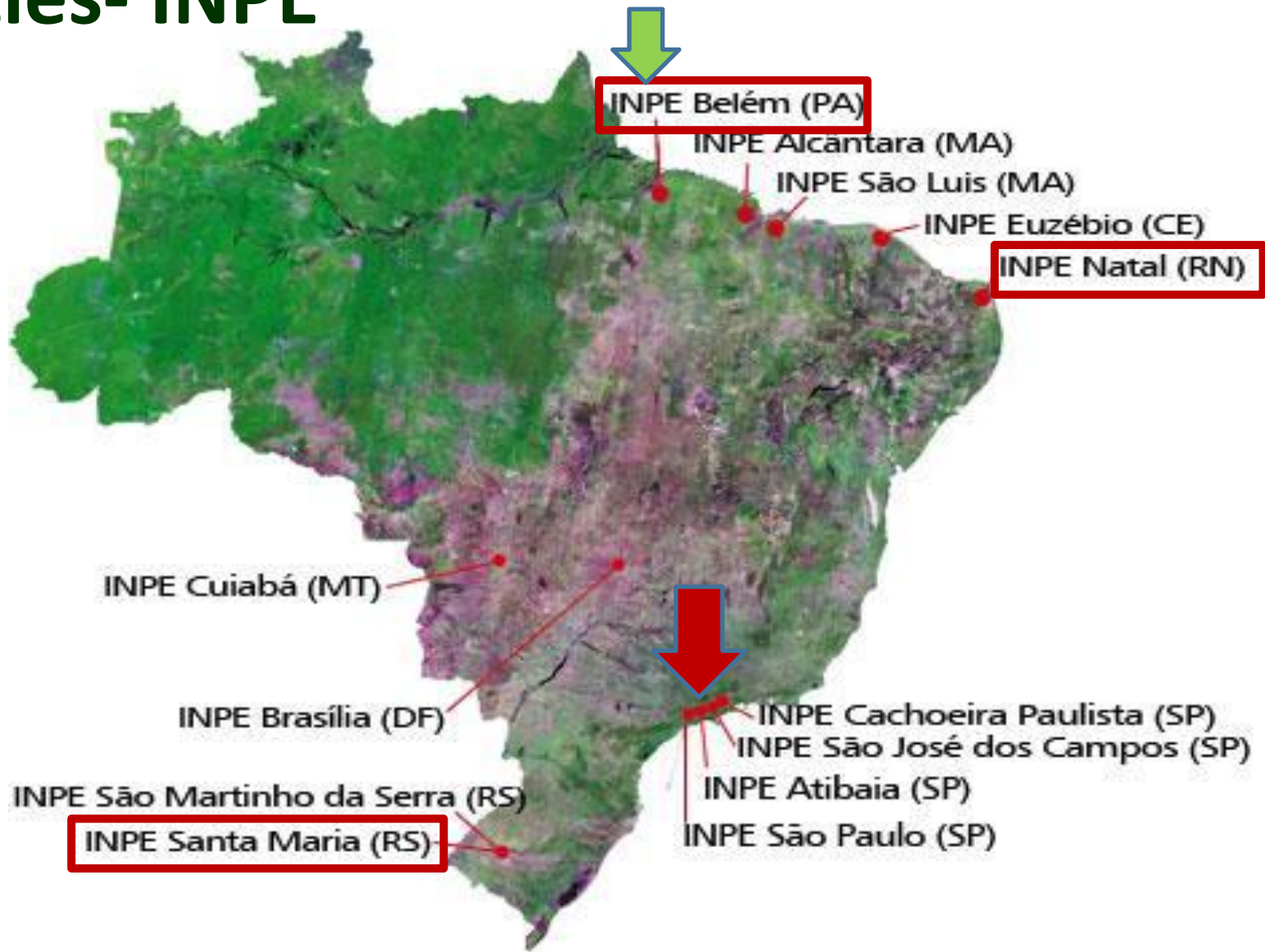


INFORMATION ACCESS

Products to society



Facilities- INPE



Amazon Regional Center



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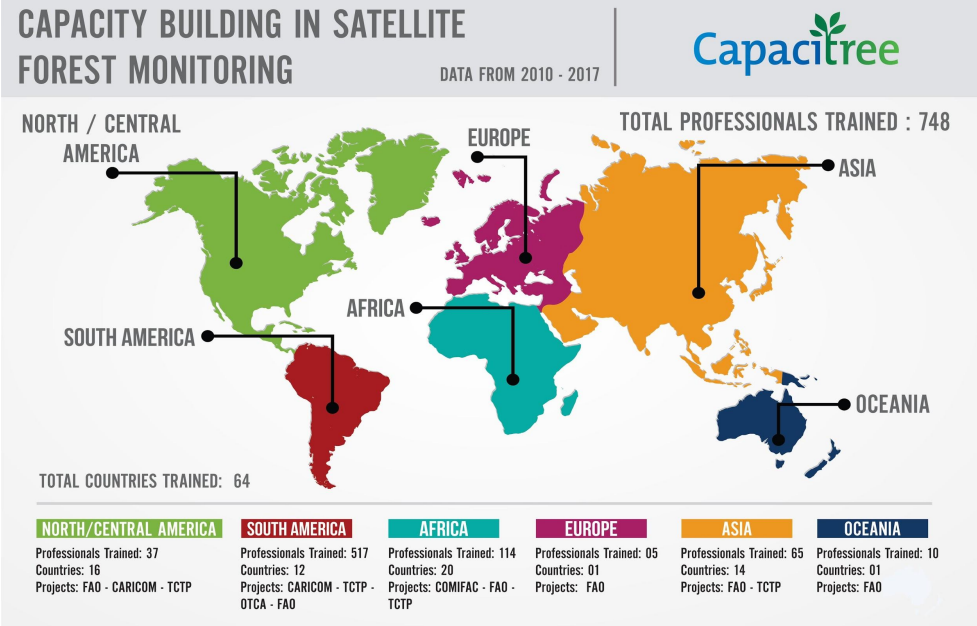


CRA
CENTRO REGIONAL
DA AMAZÔNIA
INPE

Amazon Regional Center: Projects



www.inpe.br/cra



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Amazon Monitoring Projects – INPE e partners

	Satélites e Resoluções Espaciais	Frequência	Área mínima	Alvo	Objetivo
PRODES	LSAT TM/ CBERS CCD (30 m) IRS-LISS (23m) DMC (32m)	anual	6.25 ha	Corte raso	Taxa de desflorestamento (1988)
DEGRAD	LSAT TM/ CBERS CCD (30 m) IRS-LISS (23m) DMC (32m)	anual	6.25 ha	Degradação (cicatrices queimadas)	Quantificar degradação (2008)
DETEX	LSAT TM/ CBERS CCD (30 m) IRS-LISS (23m) DMC (32m)	Sob demanda	6.25ha	Corte seletivo	Corte seletivo (2007)
DETER-A	MODIS - TERRA (250 m) CBERS – WFI (260m)	diário	25.00 ha	degradação Corte raso alertas	Vigilância (since 2004)
DETER-B	IRS-AWiFS - 56m CBERS-WFI – 60m	diário	6.25ha (3ha)	Degradação corte raso	Vigilância (desde 2014)
DETER-C	LSAT TM/ CBERS CCD (30 m) IRS-LISS (23m) DMC (32m)	diário	6.25 ha	Degradação corte raso	Vigilância (desenv.)
TERRA CLASS	LSAT TM/ CBERS CCD (30 m) IRS-LISS (23m) DMC (32m)	Bi-Anual	6.25ha	Corte raso mapeado pelo PRODES	Uso e cobertura (desde 1991)



Biomes Strategy



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Brazilian Biomes Environmental Monitoring Program (PMABB) Administrative Ruling nº 365, of November 27, 2015



Objective: to map and monitor the vegetation. The program focuses on mapping and monitoring deforestation, including its rate, vegetation cover and land use assessment, fire monitoring, vegetation restoration and selective logging

Institutions:
INPE
EMBRAPA
IBAMA



Source: IBGE

Timeline – 2016 -2020

Fundings – Government, Amazon Fund, WB/CF/FIP, WB/GEF, DE-GIZ, UK-DEFRA



Institutional Arrangements - PMABBs

Tipos de mapeamentos propostos

	Uso e Cobertura			Desmatamento		Fogo	
Amazônia	Extração Seletiva	Uso e Cobertura da Terra	Recuperação	Deteccão	Desmat.	Focos de queima	Área queimada
Cerrado		Uso e Cobertura da Terra	Recuperação	Deteccão	Desmat.	Focos de queima	Área queimada
Pantanal		Uso e Cobertura da Terra			Desmat.	Focos de queima	Área queimada
Mata Atlântica		Uso e Cobertura da Terra	Recuperação		Desmat.	Focos de queima	Área queimada
Pampa		Uso e Cobertura da Terra			Desmat.	Focos de queima	Área queimada
Caatinga		Uso e Cobertura da Terra			Desmat.	Focos de queima	Área queimada

Legenda:	Tempo Real	Anual	Bienal
Frequência do monitoramento			

And the other Biomes?

- Caatinga
- Pantanal
- Pampa
- Mata Atlântica



**Data since 2000 –BNDES-Biomas Project
INPE/Funcate/BNDES (Amazon Fund)**



Focus of this presentation

- Projects in operational mode running at Amazon Regional Center related to Amazon and Cerrado Biomes Monitoring

DETER Amazônia

DETER Cerrado

DETER: Early warning system of deforestation and forest degradation using remote sensing techniques



DETER AMAZÔNIA



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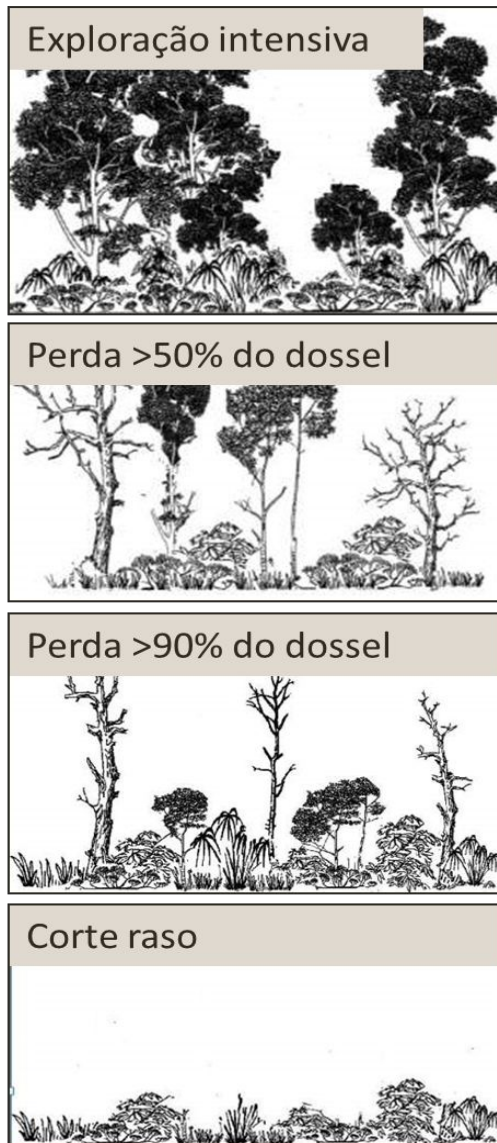
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**PÁTRIA AMADA
BRASIL**
GOVERNO FEDERAL

Projects: PRODES and DETER



time



DETER
(deforestation process)



PRODES
(deforested)

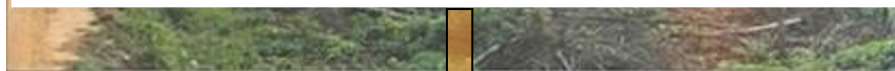
PRODES Project

Clear cutting deforestation since 1988
Landsat “class” satellite images – 30m spatial resolution
Minimum area: 6,25 ha

Clear cut: beginning during dry season



Total clear cut: end of dry season

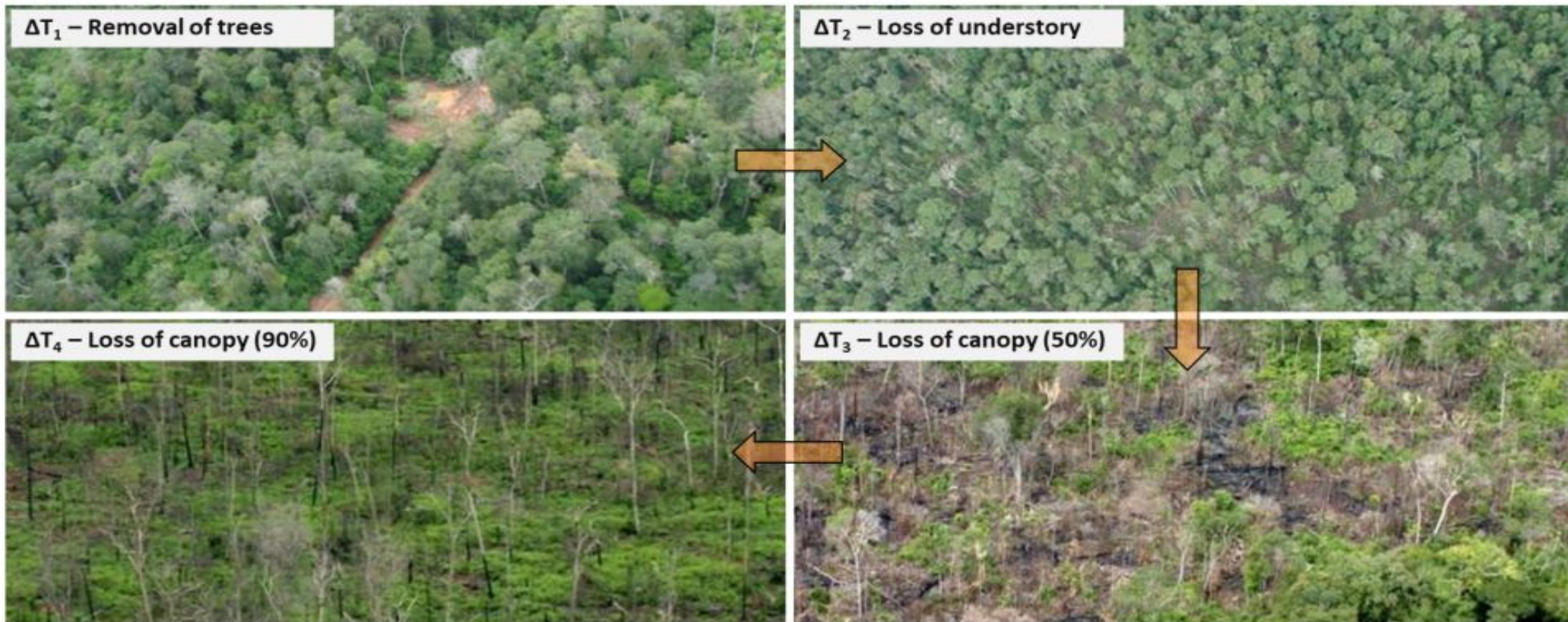


DETER Project

Deforestation and forest degradation

2004 – 2017: MODIS/Terra Aqua, 250m, minimum area > 25 ha

2014 – today: WFI/CBERS-4, 64m, minimum area > 3 ha



DETER-A

MODIS (Terra)

250m

DETER-B

AWiFS (ResourceSat-2)

56m

DETER-B

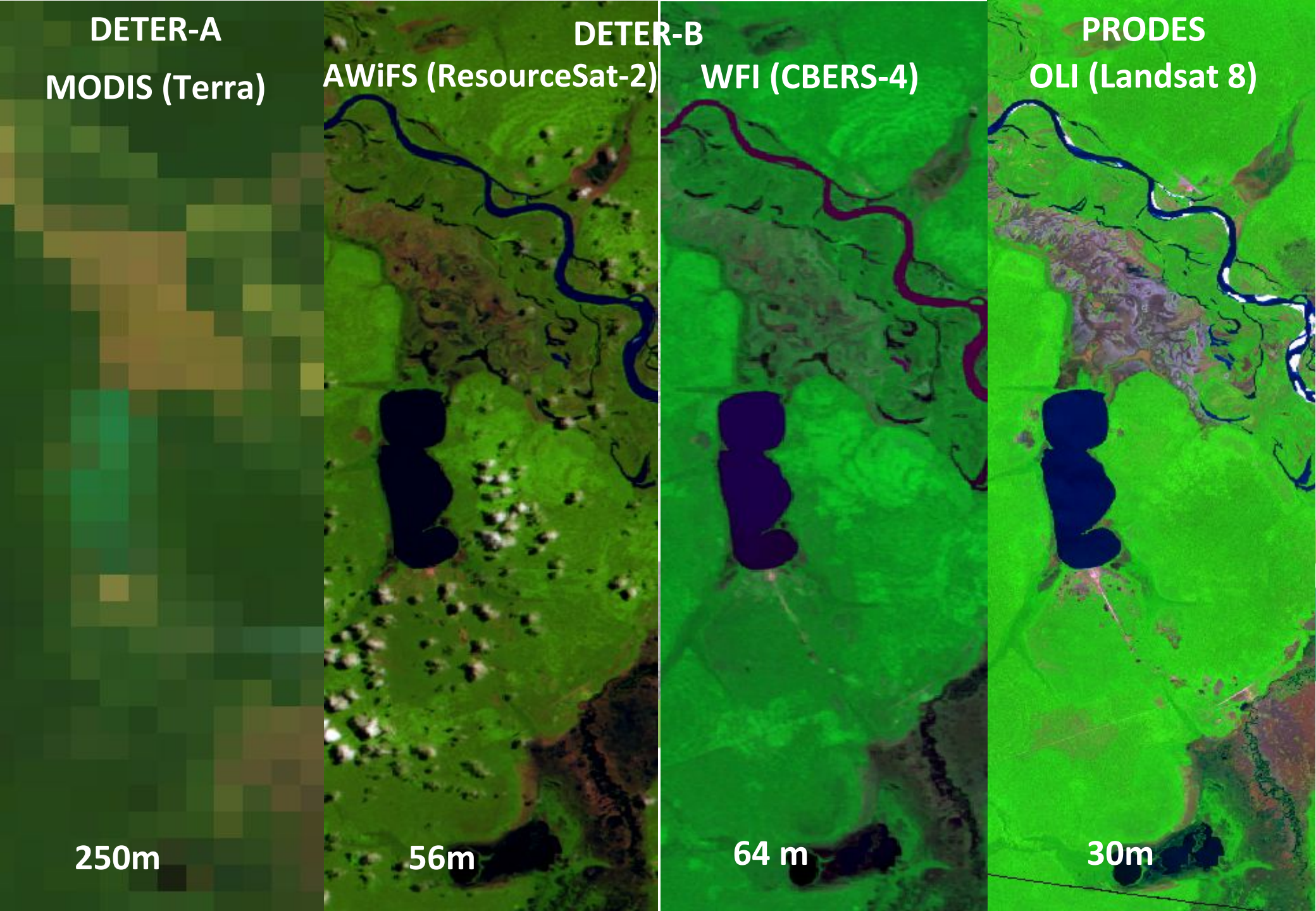
WFI (CBERS-4)

64 m

PRODES

OLI (Landsat 8)

30m



DETER Project – Classes

CLASSES – LEVEL 1

**DEFORESTATION
(WARNINGS)**

DEGRADATION

FOREST LOGGING

CLASSES – LEVEL 2

Deforestation with soil exposed

Deforestation with vegetation

Mining

Degradation

Forest fire scar

Selective logging (disordered)

Selective logging (Geometric)



Amazon Monitoring Projects – updated!

	Satélites e Resoluções Espaciais	Frequência	Área mínima	Alvo	Objetivo
PRODES	LSAT TM/ CBERS CCD (30 m) IRS-LISS (23m) DMC (32m)	anual	6.25 ha	Corte raso	Taxa de desflorestamento (1988)
DETER					
DETER					
DETER					
DETER					
In development					
TERRA	LSAT TM/ CBERS CCD (30 m)	Bi-Anual	6.25ha	Corte raso	Uso e cobertura

Other institutions – EMBRAPA, IBAMA



DETER Amazônia

- Visual interpretation of images based on 5 principal elements: **shape, tonality, texture, color and context;**
- Polygons digitalized directly from computer, over the color composition of digital images;
- Data from PRODES Project from one year before are using as a mask of exclusion and not is possible to map new polygons.



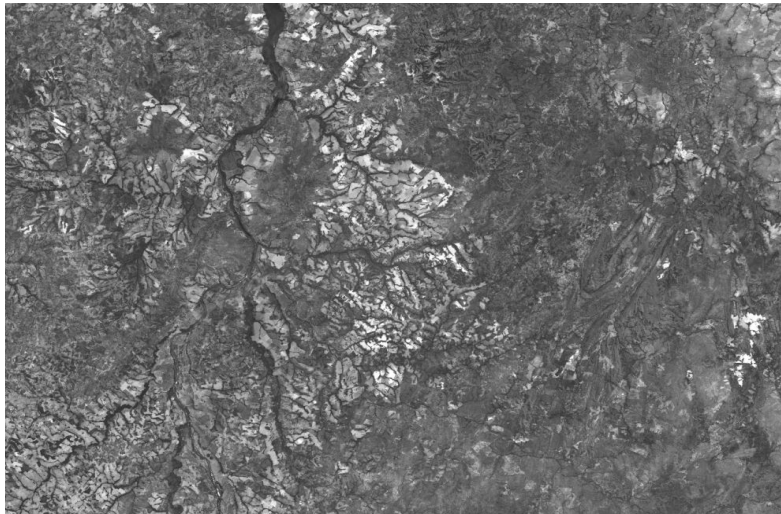
Digital Image Processing



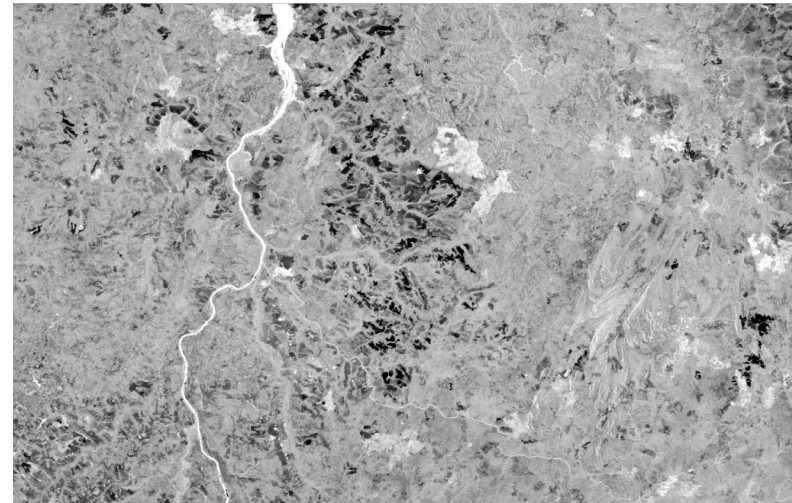
Original image



Contrast image

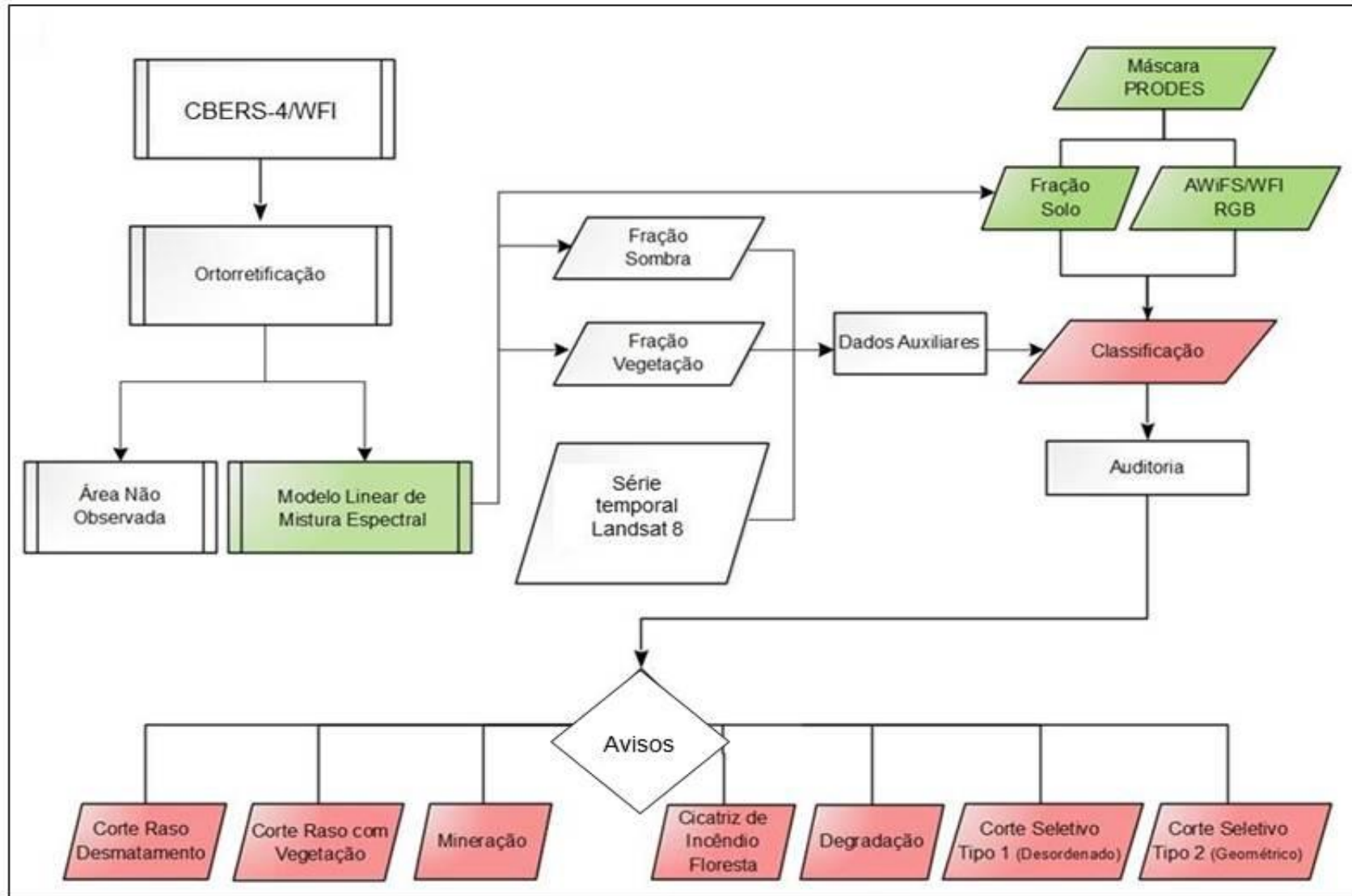


Soil fraction image



Shadow fraction image

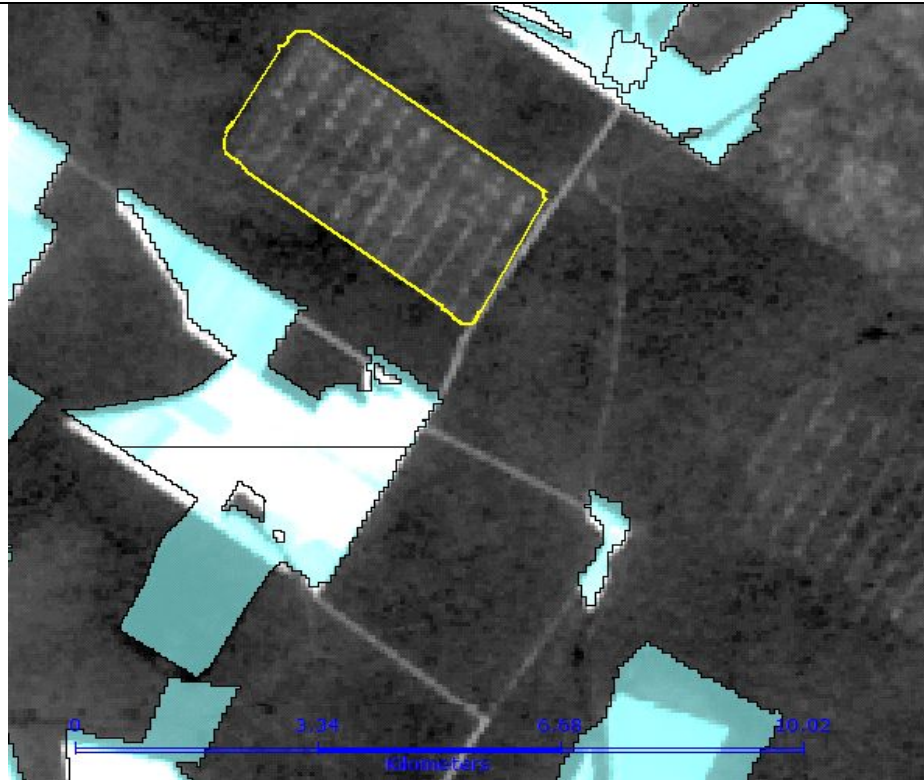
Fluxogram – Methodology of DETER Amazônia



Importance of DETER Project

Continuous mapping of land cover change

Geometric Selective Logging



Data: 08 de Agosto de 2015

Clear Cut deforestation



Data: 04 de Abril de 2016

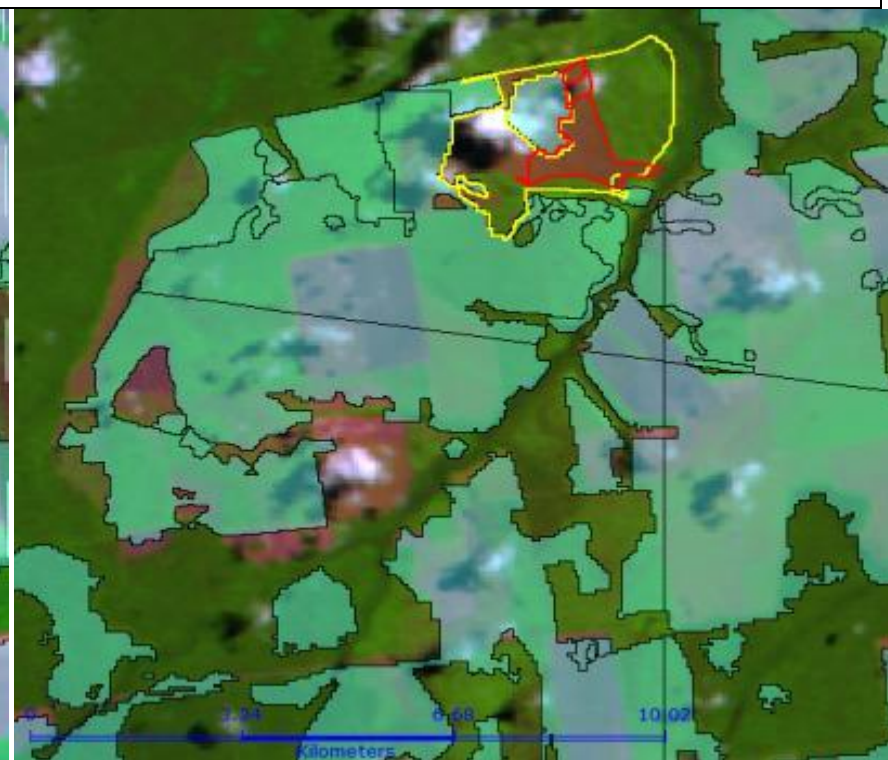
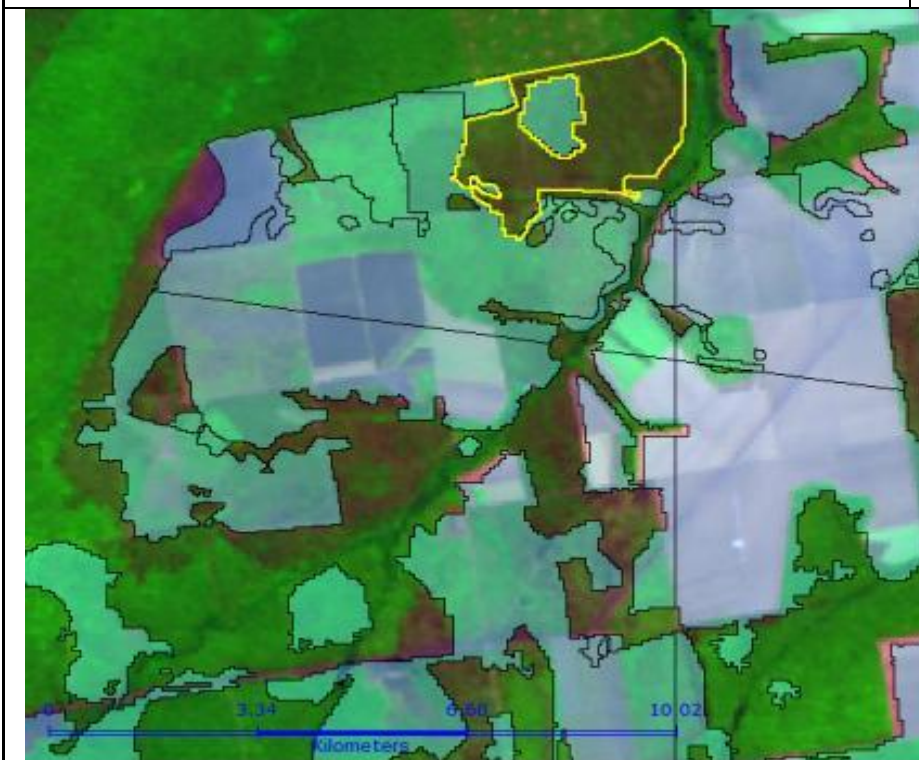


Importance of DETER Project

Continuous mapping of land cover change

Forest Fire Scar

Clear cut deforestation



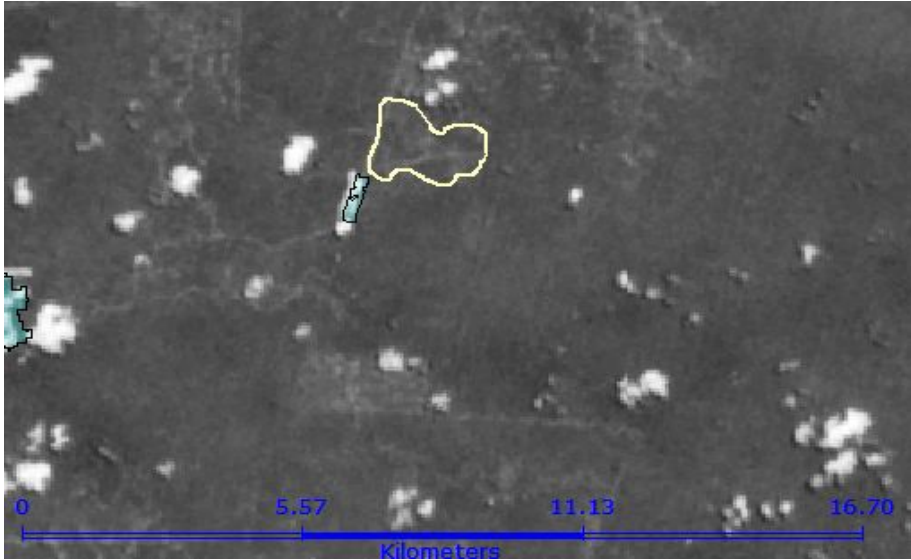

Data: 08 de Agosto de 2015

Data: 30 de Março de 2016



Importance of DETER Project

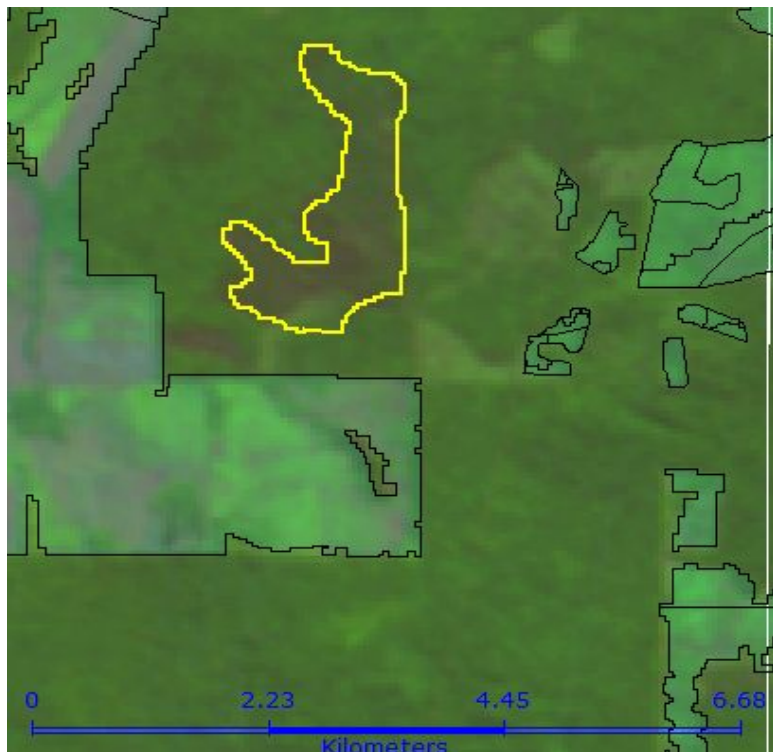
Continuous mapping of land cover change

Disordered Selective Logging	Clear Cut deforestation
	
Data: 16 de Outubro de 2016	Data: 27 de Julho de 2017

Importance of DETER Project

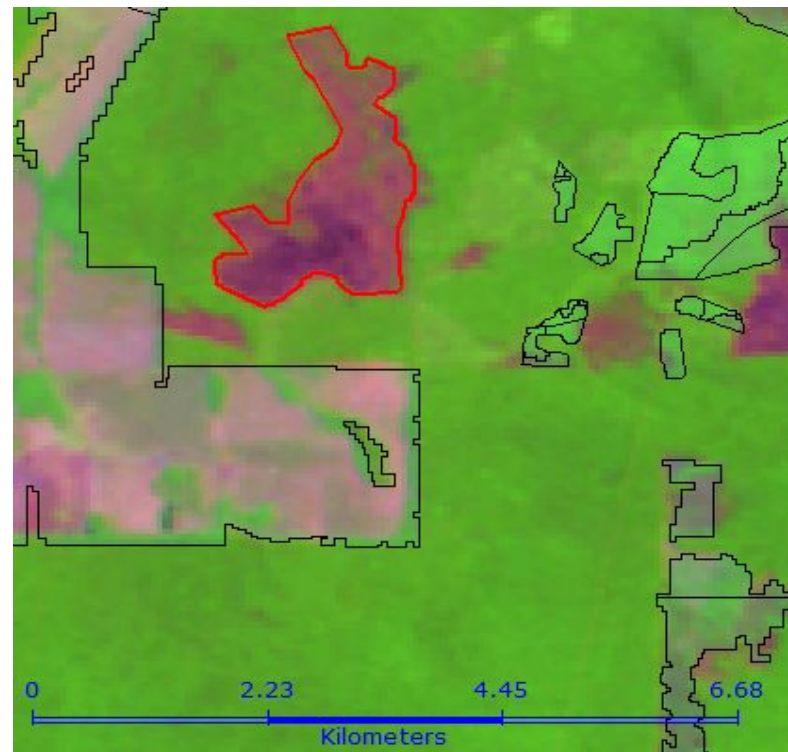
Continuous mapping of land cover change

Forest Degradation



Data: 18 de Junho de 2017

Clear Cut deforestation



Data: 16 de outubro de 2017

DETER CERRADO



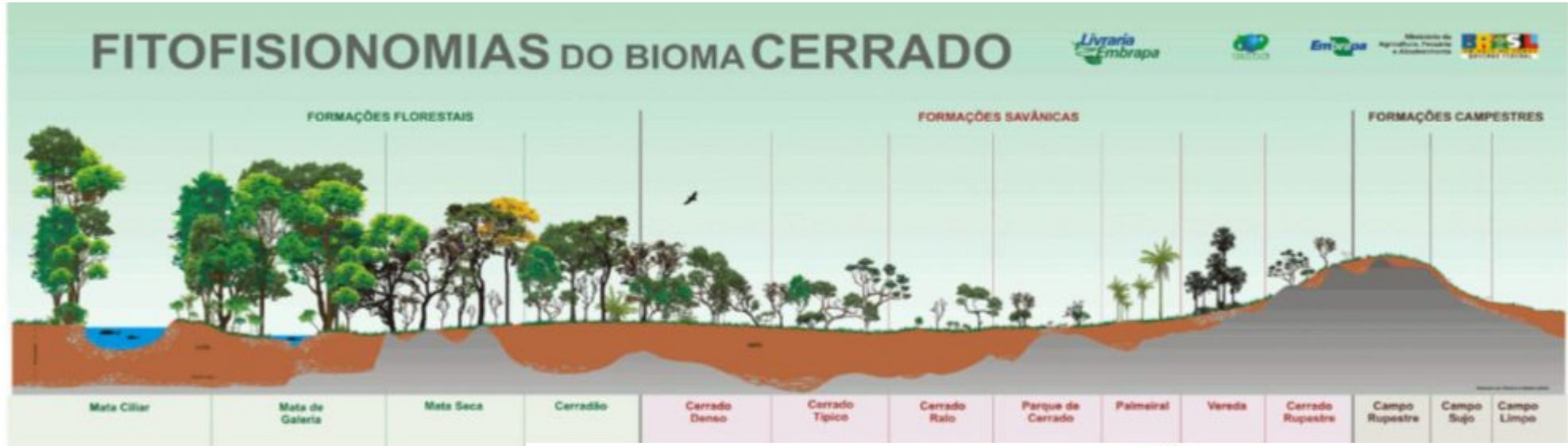
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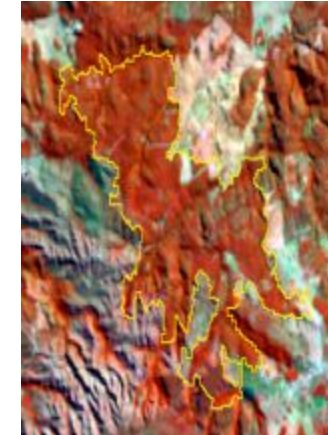
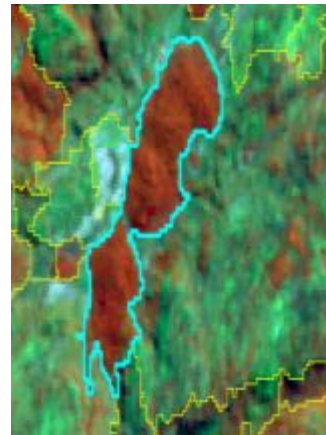
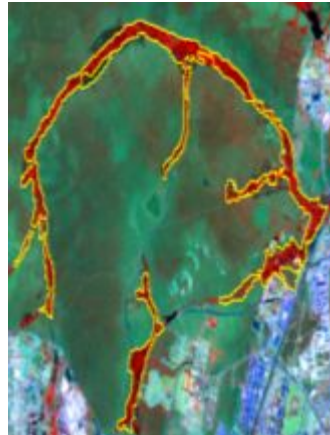
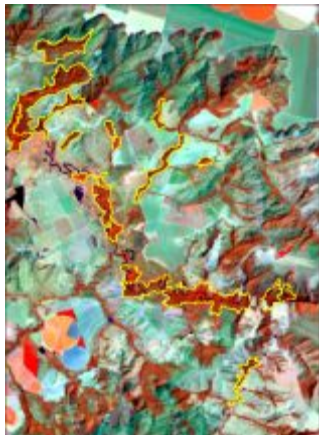
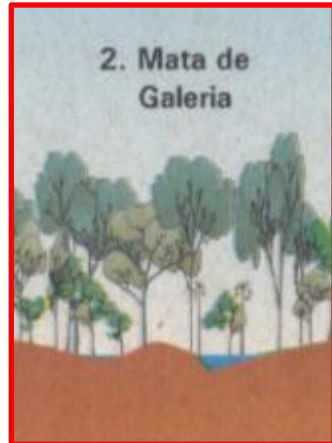
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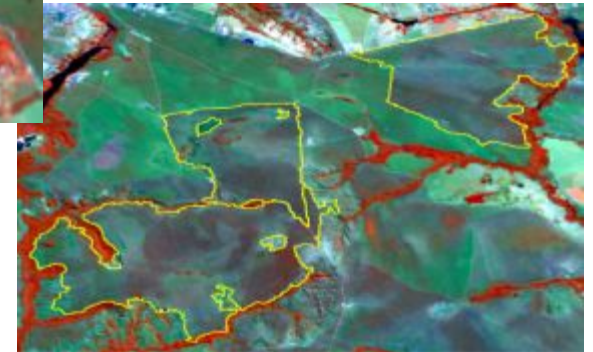
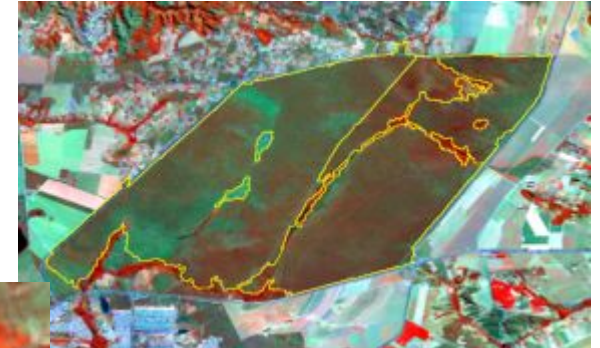
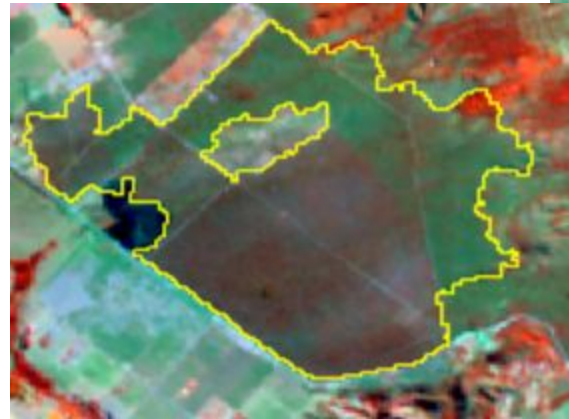
Cerrado Biome



Forest Formation



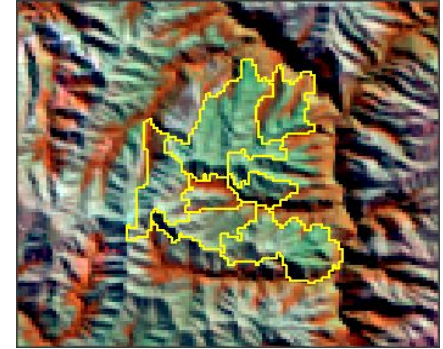
Savânicas Formation



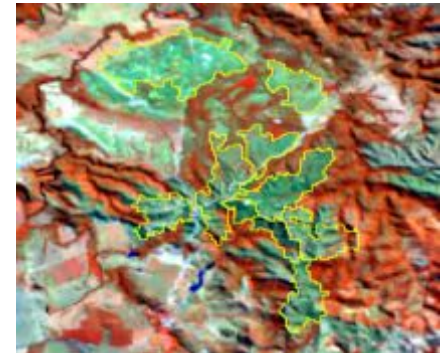
Country Formation



6- Campo sujo



7- Campo limpo



8- Campo Rupestre

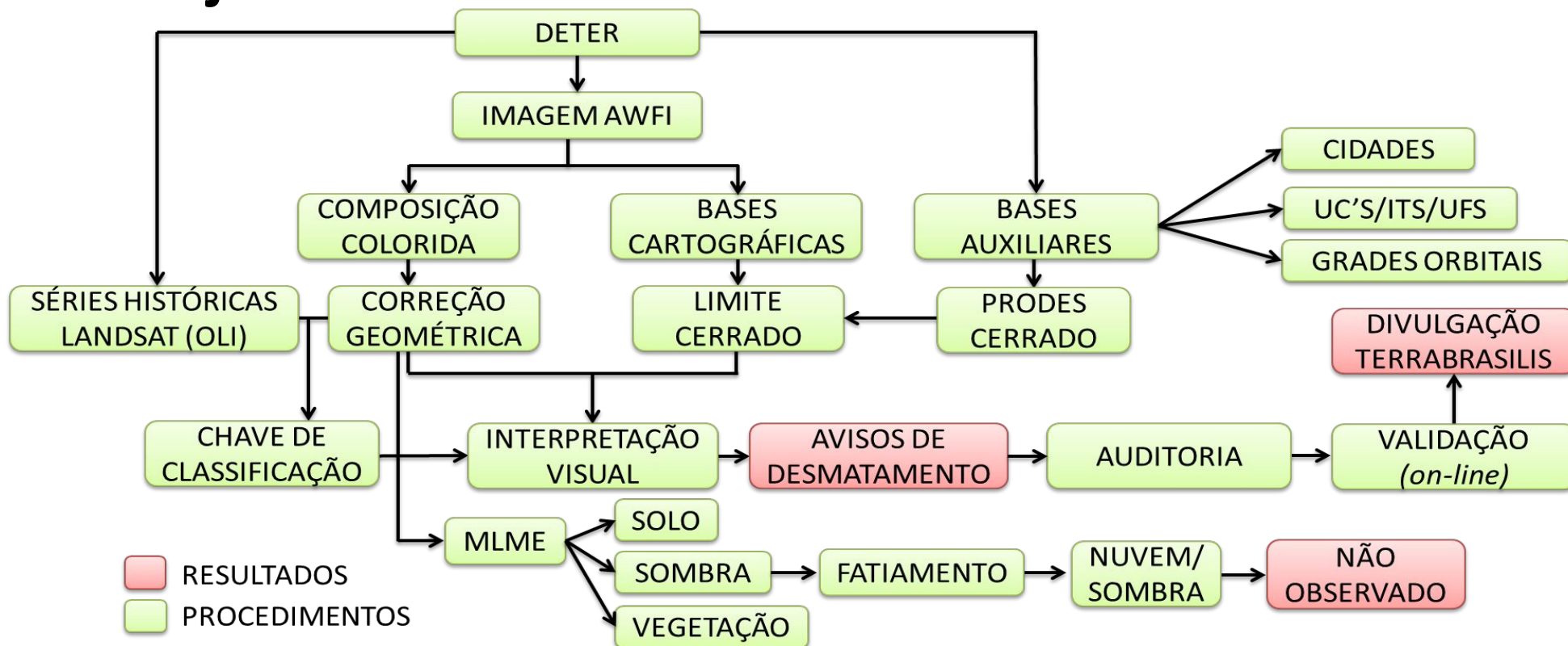


Methodology of DETER Cerrado

- Visual interpretation of images based on 5 principal elements: shape, tonality, texture, color, and context;
- Polygons digitalized directly from the computer, over the color composition of digital images;
- Only “deforestation” areas are mapped over different phytophysionomies from Cerrado



Fluxograma – methodology of DETER Cerrado Project



DISSEMINATION DATA



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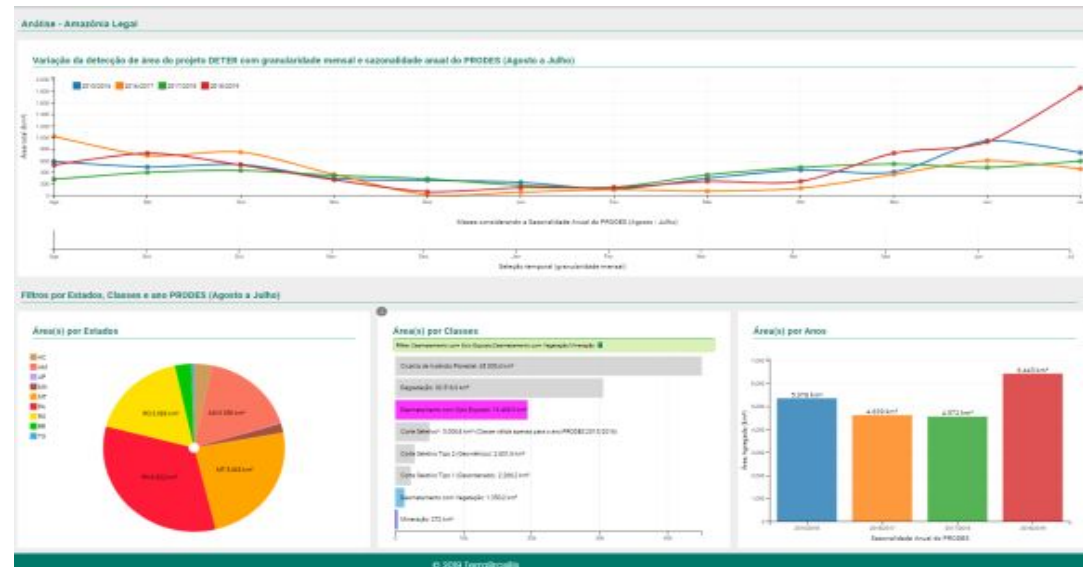
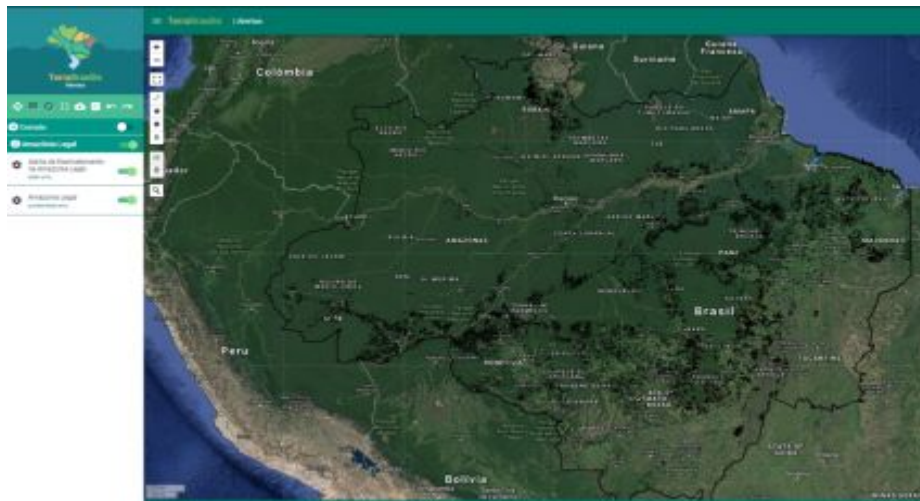
Data dissemination - Webportal

TerraBrasilis

Plataforma desenvolvida pelo INPE para organização, acesso e uso de dados geográficos no monitoramento ambiental



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



DETER Project

Continuous Monitoring



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



Public Data Dissemination



DECRETO Nº 6.666, DE 27 DE NOVEMBRO DE 2008 Institui, no âmbito do Poder Executivo federal, a Infraestrutura Nacional de Dados Espaciais – INDE, e dá outras providências.



Disseminação Dados Públicos



Academia

Até 30/07/2019: 1.135 artigos em 389 periódicos referenciados



Compliance



PLANO NACIONAL SOBRE MUDANÇA DO CLIMA PNMC

19 de Maio de 2009

Políticas Públicas



What is necessary to create a Monitoring Project?

- Demand
- Extensive research
- Capacity Building
- Replicable Methodology
- Institutional Arrangments
- Public Policies Generation
- Free access to data
- National and international Commitments
- Governance, Independence and Sovereignty



Challenges of Monitoring related to technologies to generate data

- Data processing of different sensors (medium / high spatial resolution? Medium / high temporal resolution? Hyperspectral? SAR? LIDAR?)
- Time Series analysis (Online Platforms)
- Improve the automation of processes and processing: cloud processing, Deep/Machine Learning, Pattern recognition...
- Development of Portals and WebGIS, WebServers to dissemination of data – user´s demand
- Free Software development to process different data from remote sensing techniques



Monitoring Project - INPE

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