MINISTÉRIO DA CIÊNCIA E TECNOLOGIA
INSTITUTO NACIONAL DE PESQUISAS ESPACIAIS

Forest Monitoring Systems in Brazil

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Seminar for Climate Change and Forests
International Conference Hall – Waseda University, Japan
February 7th– 8th , 2013

Summary of Presentation

- Brazilian forest monitoring systems:
  - Annual wall-to-wall assessment of the gross deforestation rate
    - PRODES, Brazilian Legal Amazonia
    - Use of satellite imagery of moderate resolution (30 meters)
  - Annual wall-to-wall assessment of the forest degradation
    - DEGRAD/DETEX, Brazilian Legal Amazonia
    - Use of satellite imagery of moderate resolution (30 meters)
  - *Near* real time detection of deforestation and forest degradation
    - DETER, Brazilian Legal Amazonia
    - Use of satellite imagery of coarse resolution (250 meters)
- Present status

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Annual Wall-to-Wall Estimate of the Gross Deforestation Rate in Amazonia - PRODES

PRODES: Annual Rate of Gross Deforestation in Amazonia - Overview

Coverage: Wall-to wall

Frequency: Yearly

Integration period: Aug-Jul

Resolution – Landsat-class (Landsat, CBERS, DMC, SPOT)

Method: Visual interpretation

Minimum mapping area: 6.25 ha

Delivery Schedule:

1st estimate -90% of previous year, ~100 Scenes : November

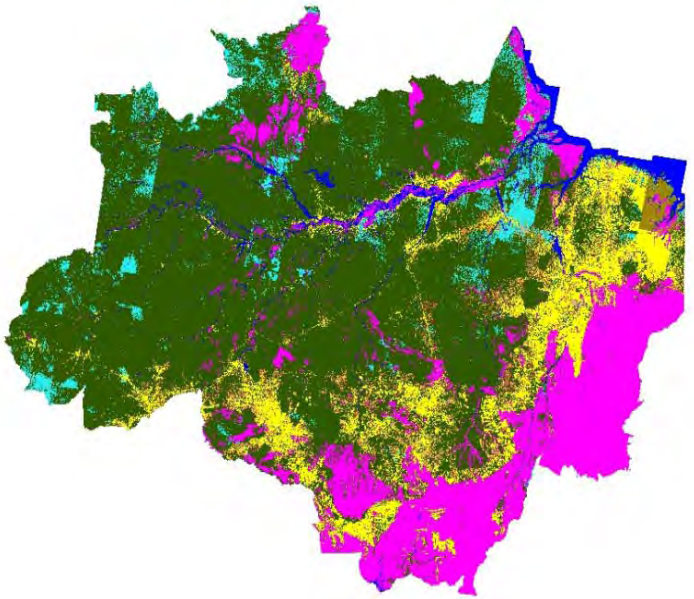
Complete map: April, next year

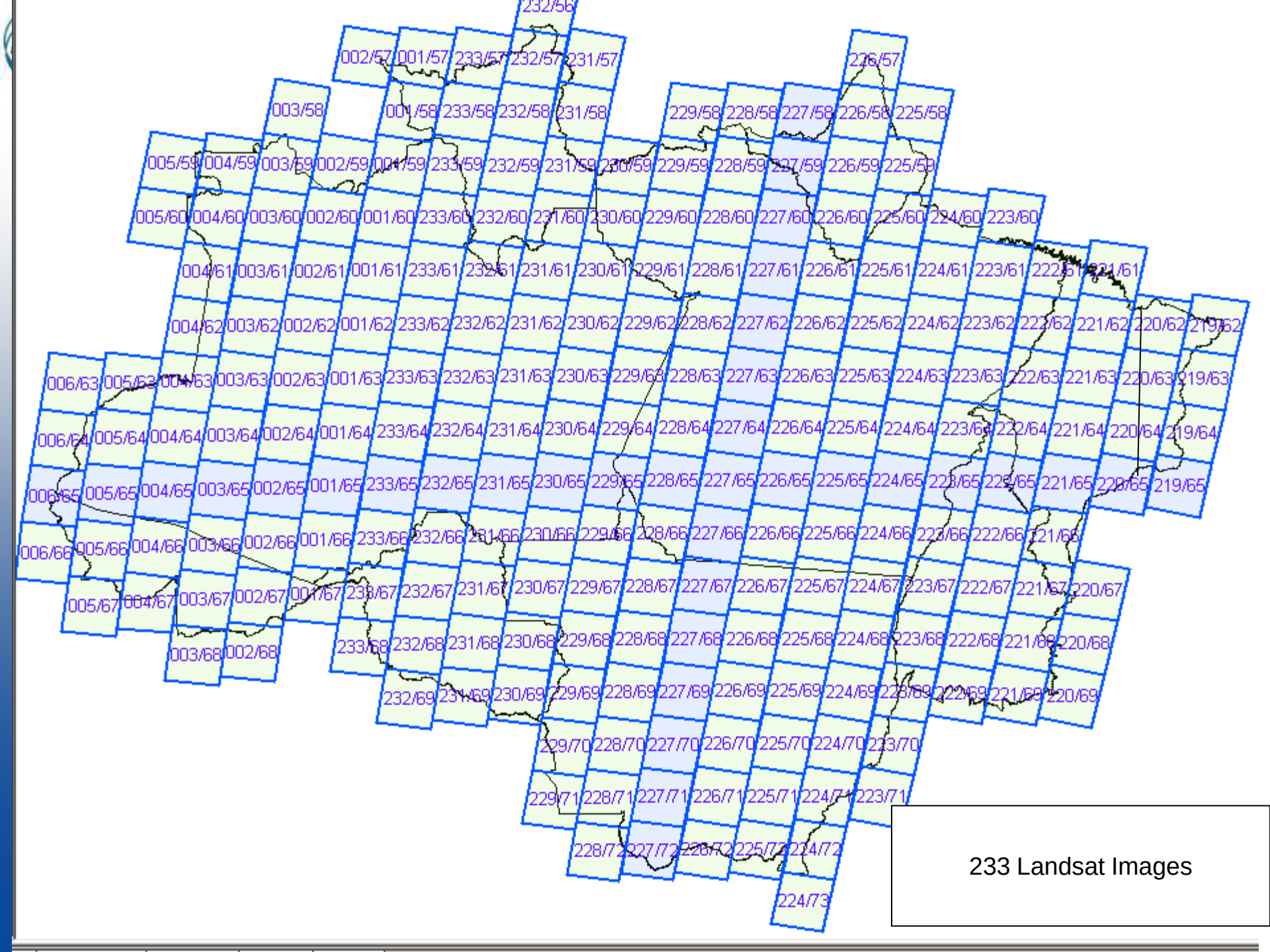
Brazilian Legal Amazon Region: 5 million km^2

Original forest cover: 4 million km^2

Present gross deforested area: 730.000 km^2

Proportion of secondary forest: 19% (130.000 km^2)




233 Landsat Images

PRODES: Rate of Gross Deforestation in Amazonia – a Brief history

1988-2002 – Annual assessments on a regular basis

1:250.000 Landsat Color composites

Visual interpretation

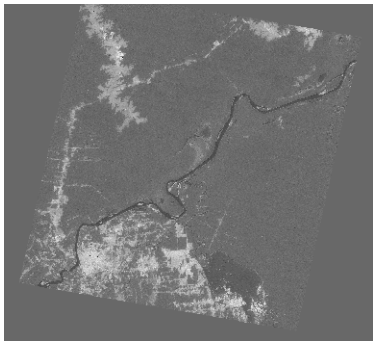
Digital area calculation

PRODES: Rate of Gross Deforestation in Amazonia – a Brief history

Three bands color composite

INPE's new development in the 90's

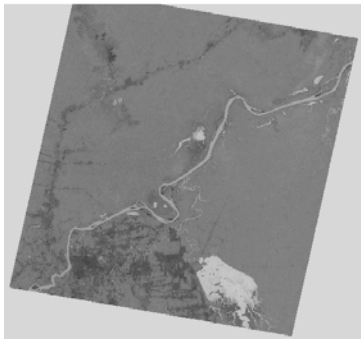
SPRING – Geographic Information Processing System



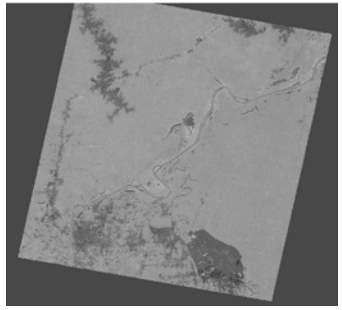
SOIL

Features applied to PRODES:

- **Linear Mixing Model**
- **Image Segmentation**
- **Object Oriented Classification**
- **Raster and Vector Edition**



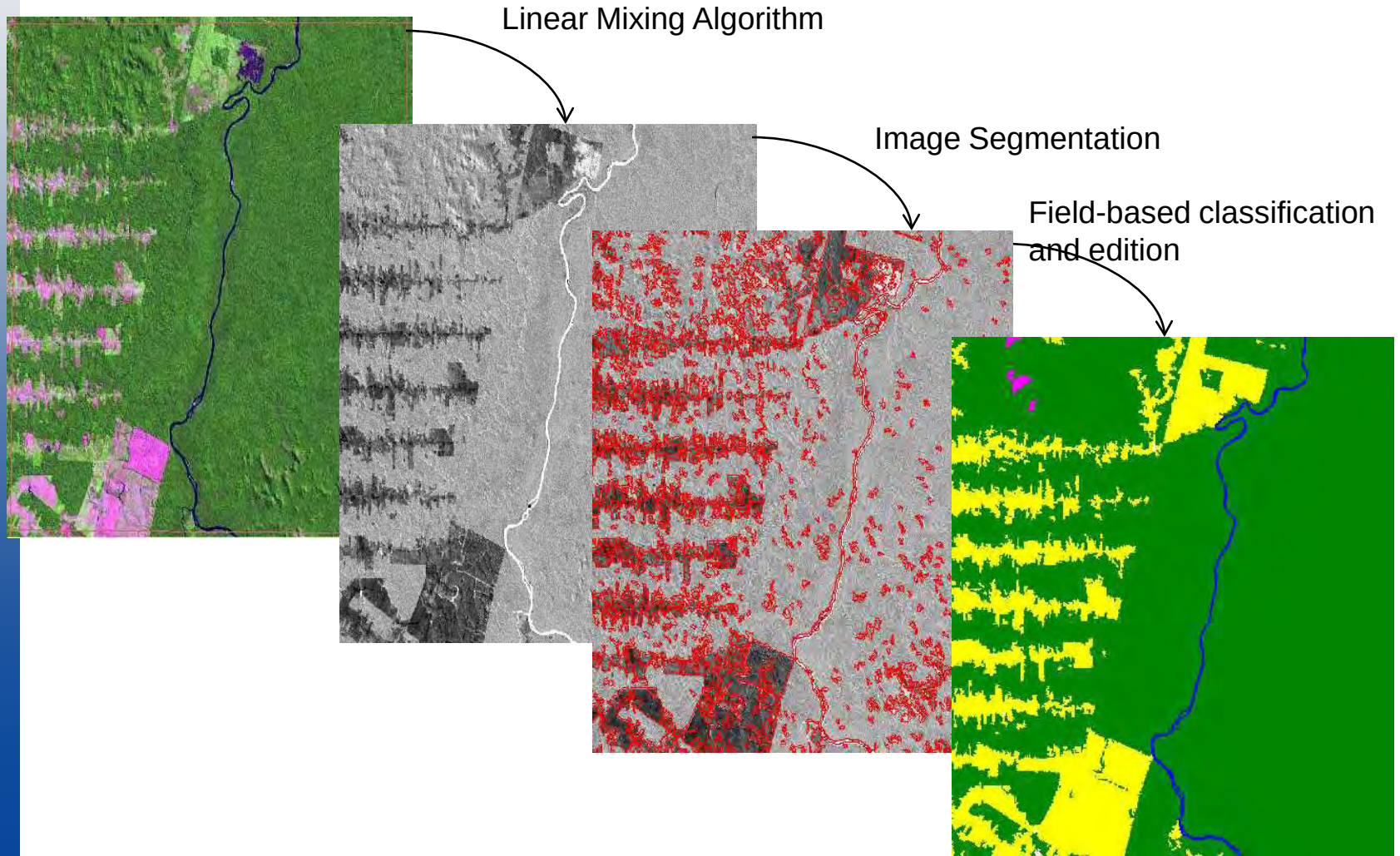
SHADOW

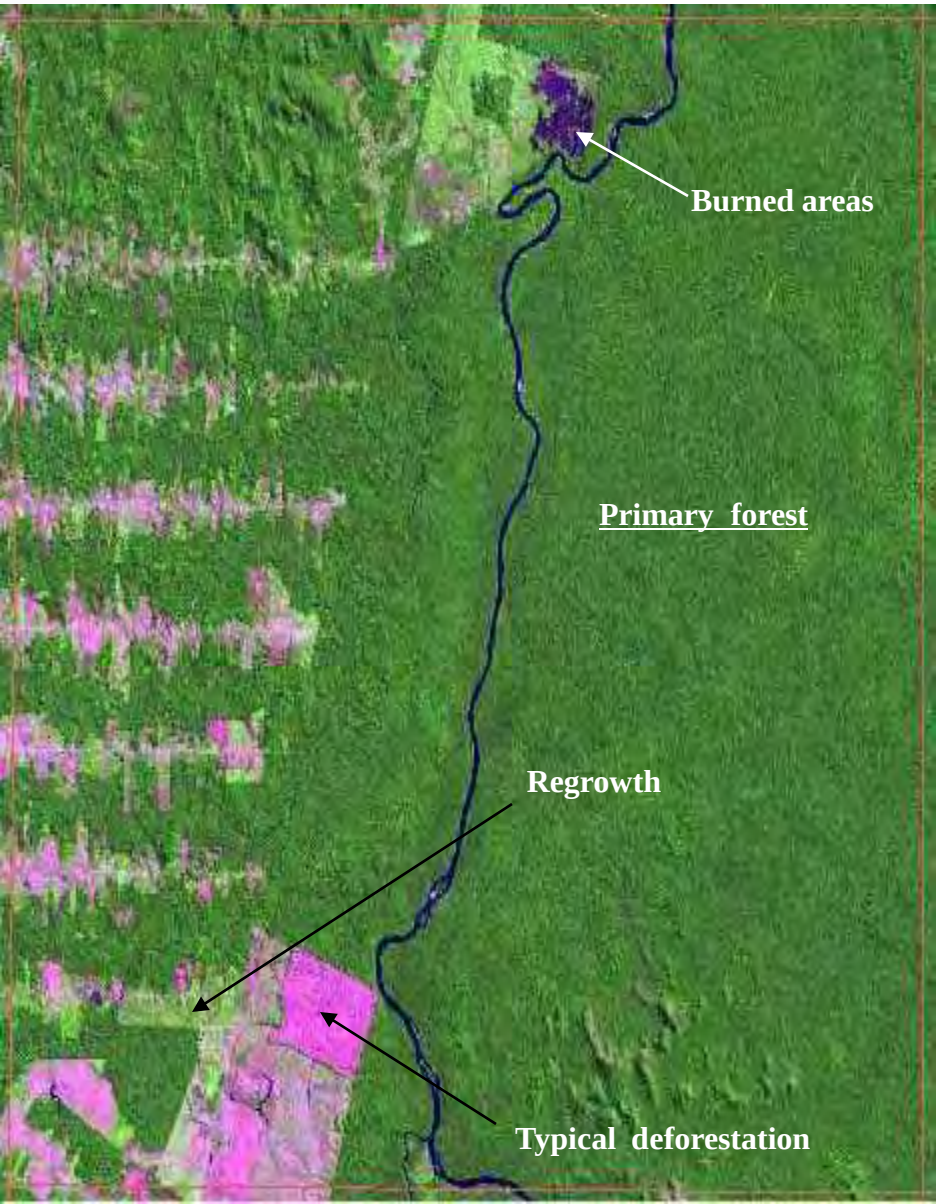


GREEN VEGETATION

PRODES: Rate of Gross Deforestation in Amazonia – a Brief history

1997-2005 – SPRING based digital Landsat image analysis




Burned areas
Primary forest
Regrowth
Typical deforestation

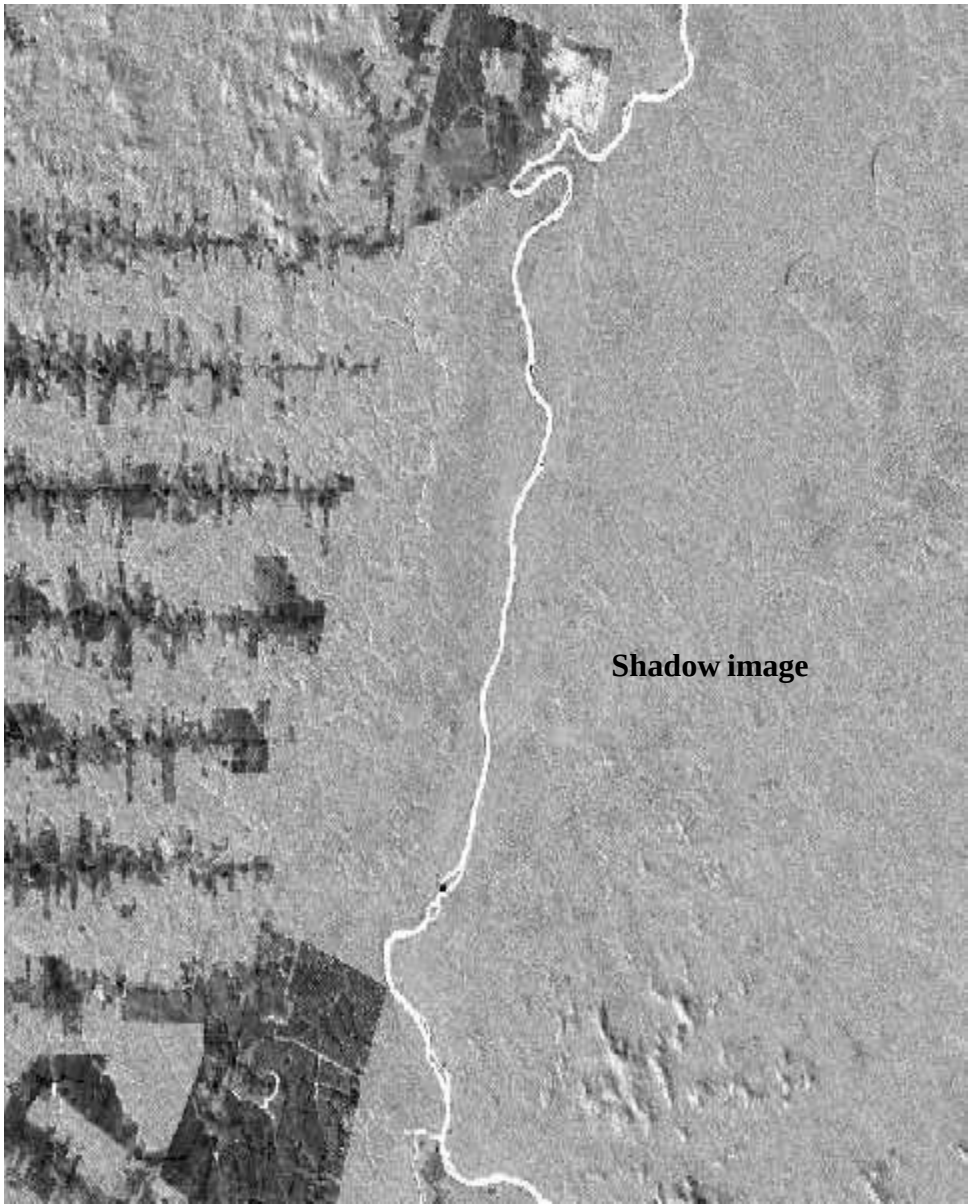
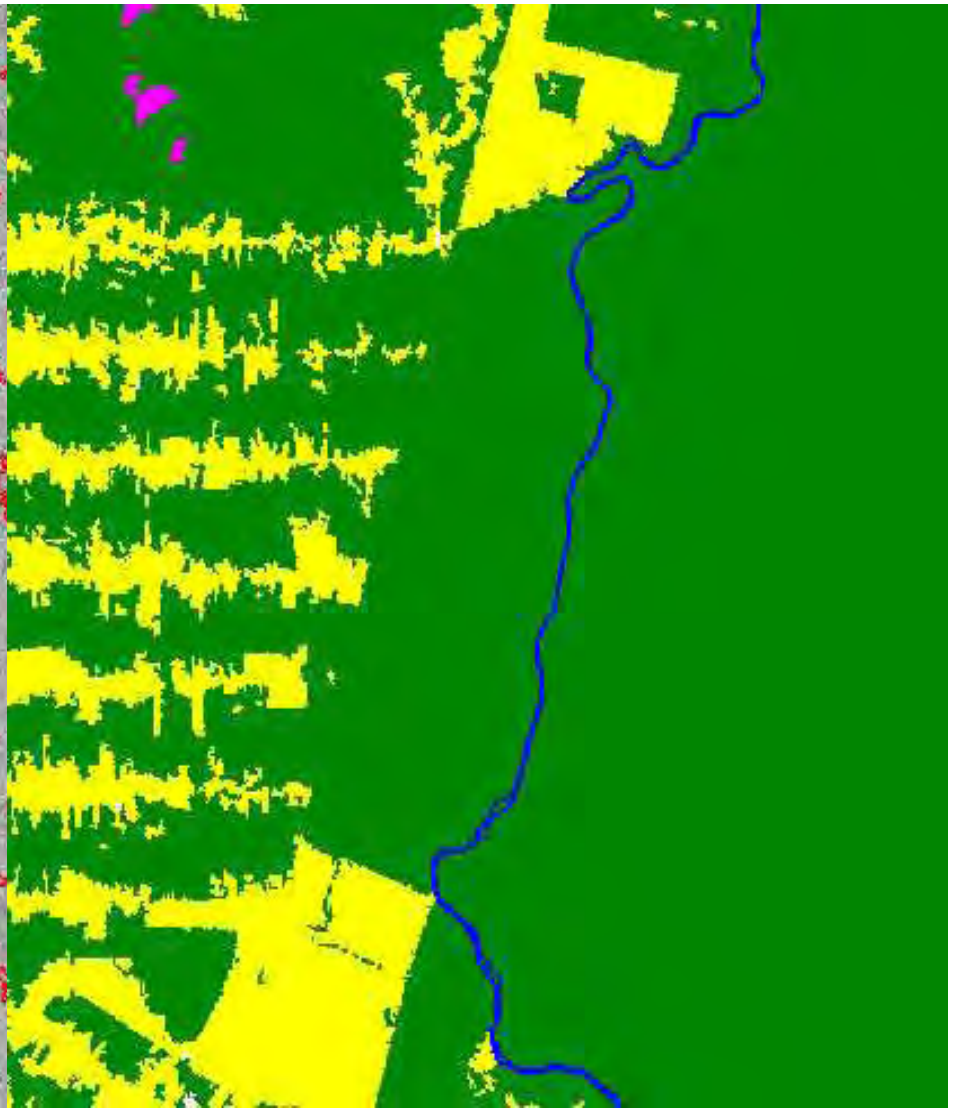
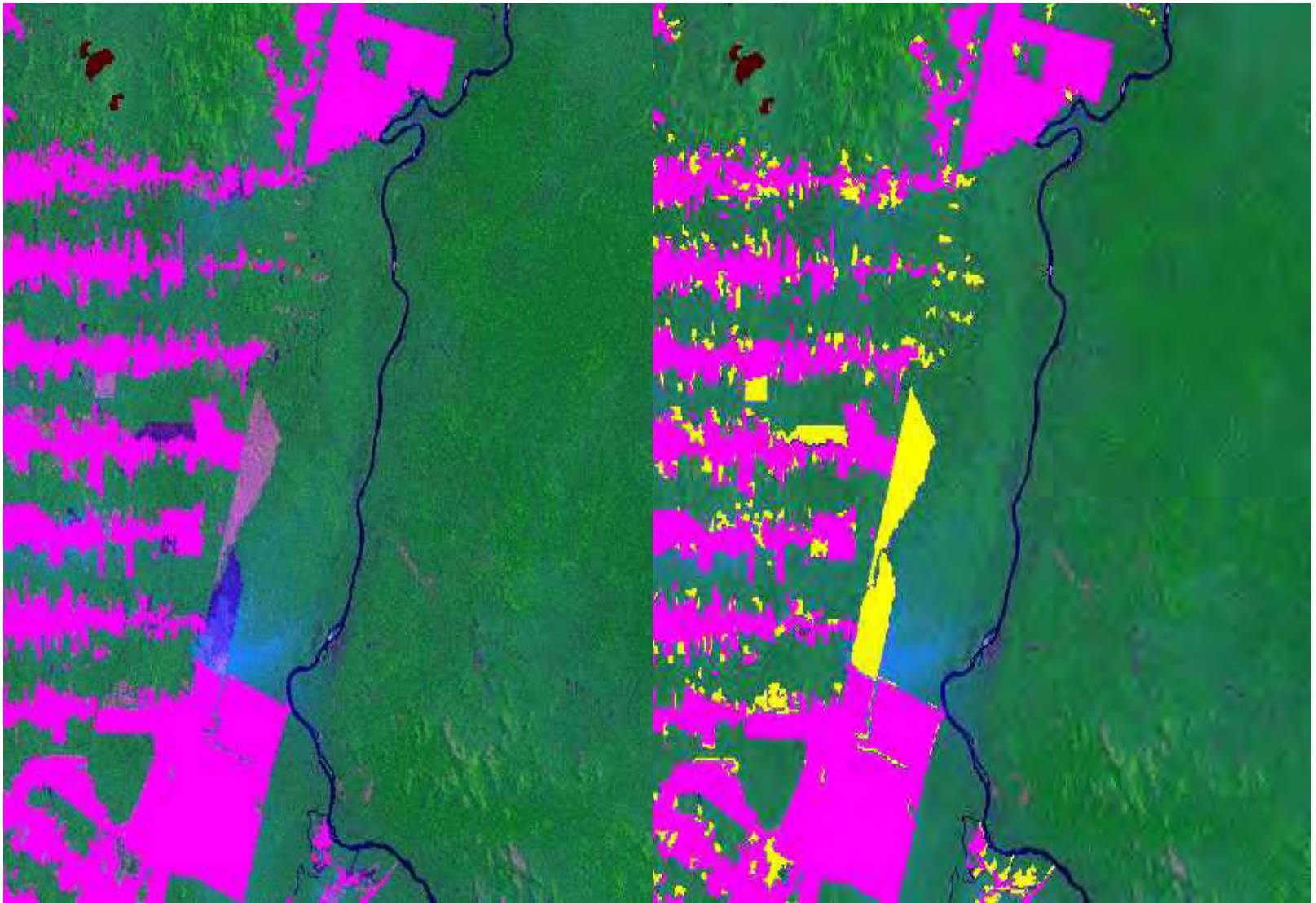

Shadow image

Image segmentation and classification



Change detection with masking of previous deforestation



PRODES: INPE's Amazon Monitoring Program
A brief history

2005-Present: Visual intepretation in TerraAmazon GDBM Platform

<u>TerraAmazon overview:</u>

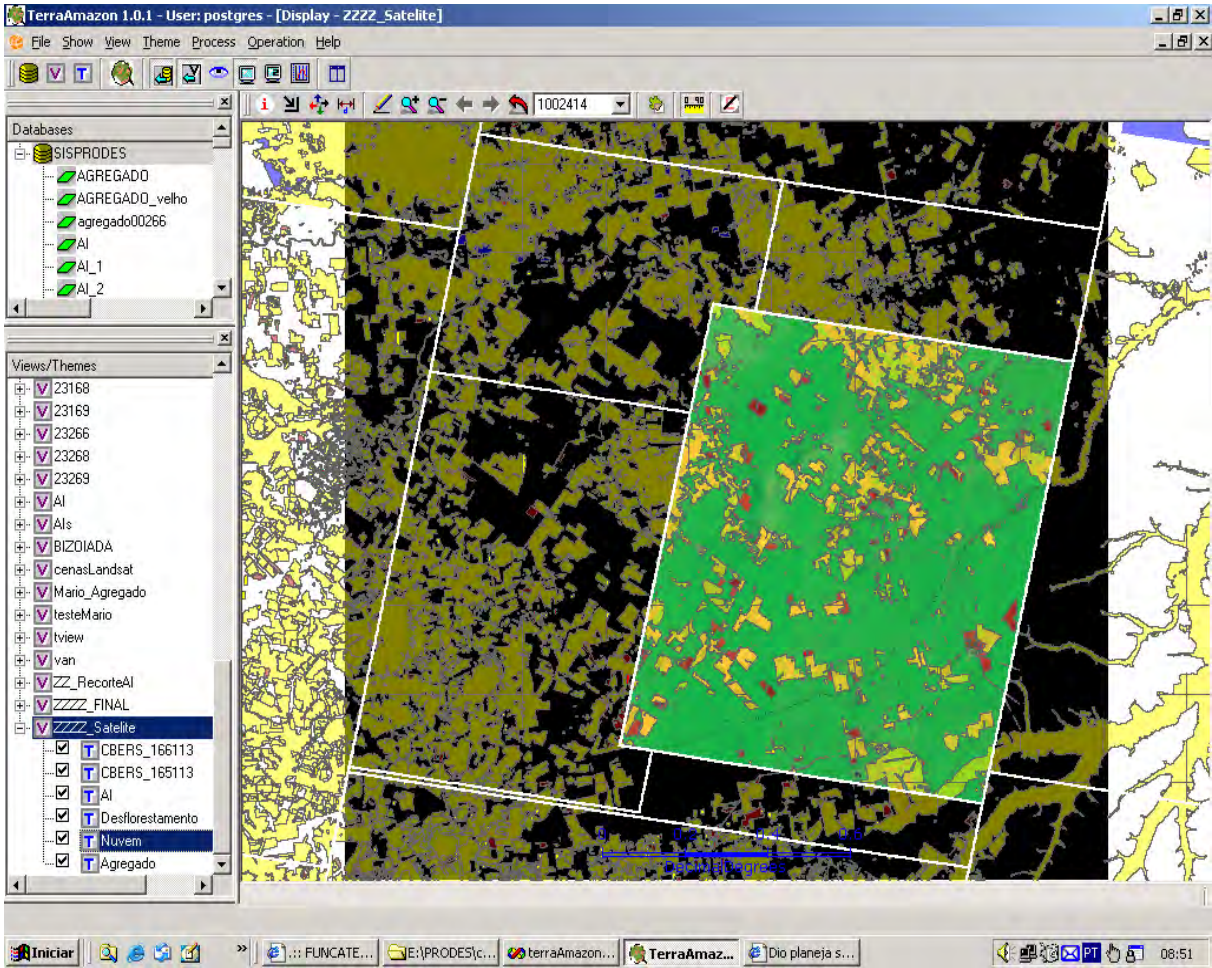
Alllows multisource and multitemporal data

Allows multiple interpreters

Real-time GDB update

Lock-in lock-out control

TerraLib open code



PRODES: Rate of Gross Deforestation in Amazonia – a Brief history

2005-Present: Visual intepretation in TerraAmazon GDBM Platform

<u>TerraAmazon overview:</u>

Tbyte level GDB

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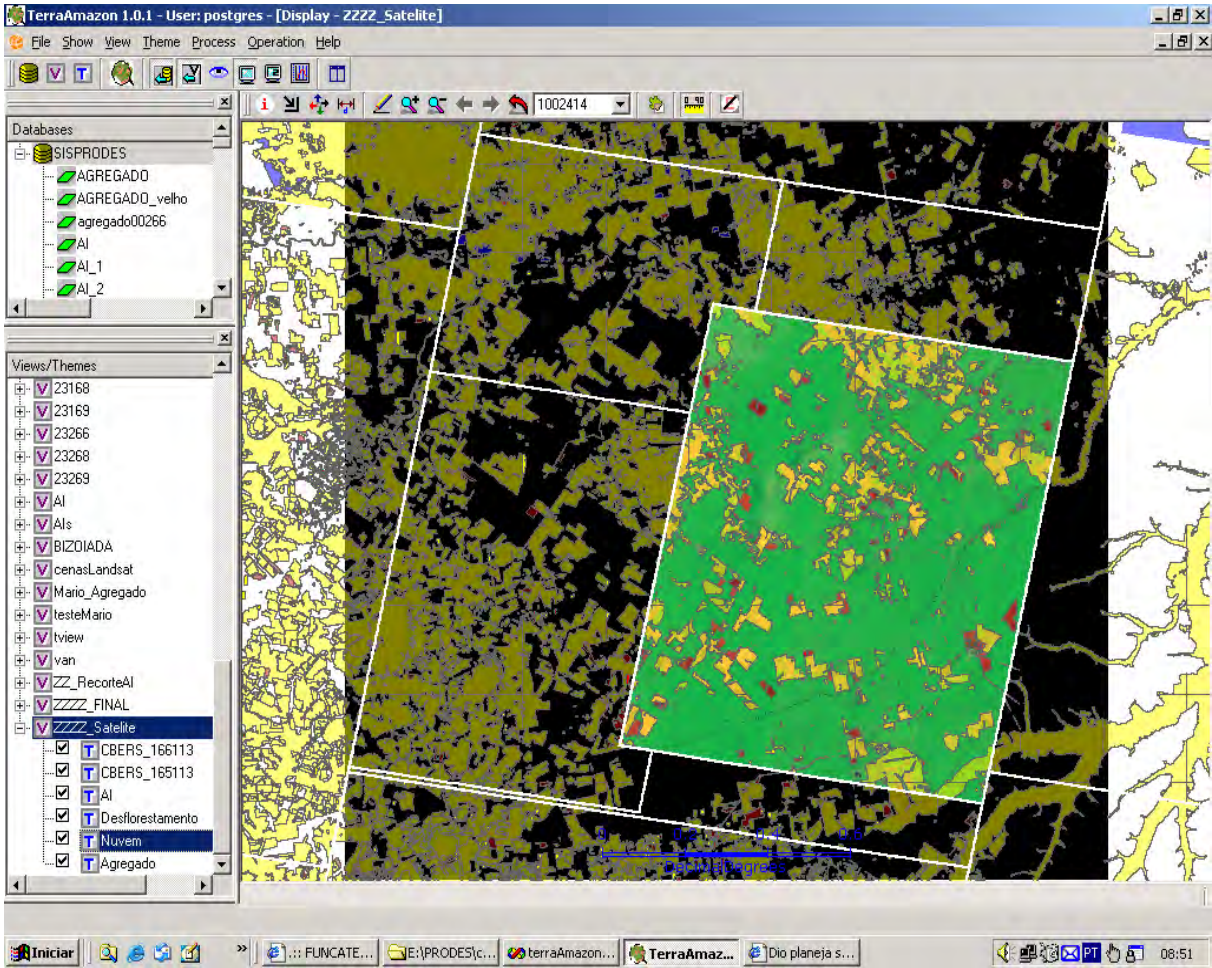
•Interpretation time:

(SPRING) DIP+Ed:20 hs

(TerraAmazon) VI: 5-10 hs

I



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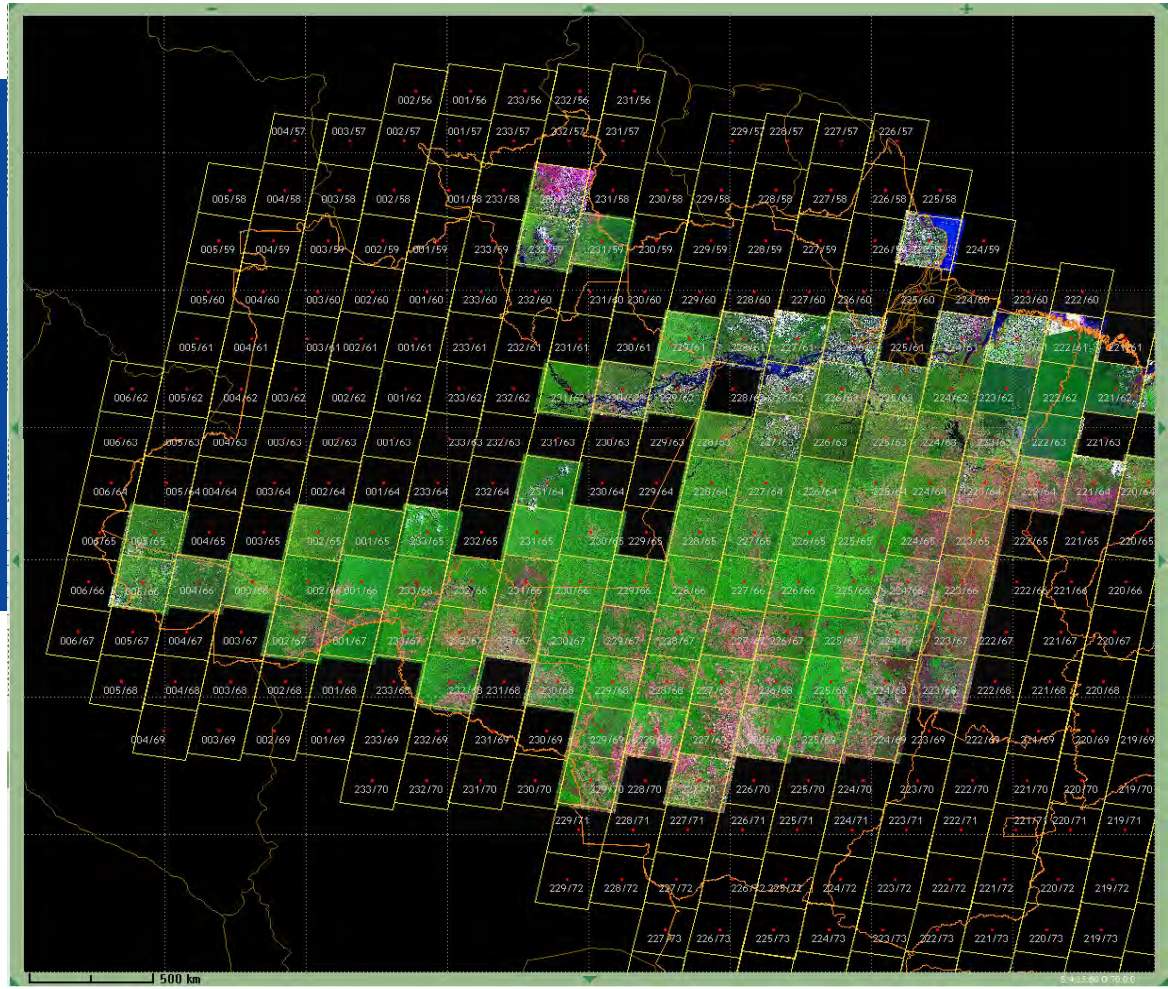
PRODES schedule:



1st Semester:

April :Complement of 2011 inventory

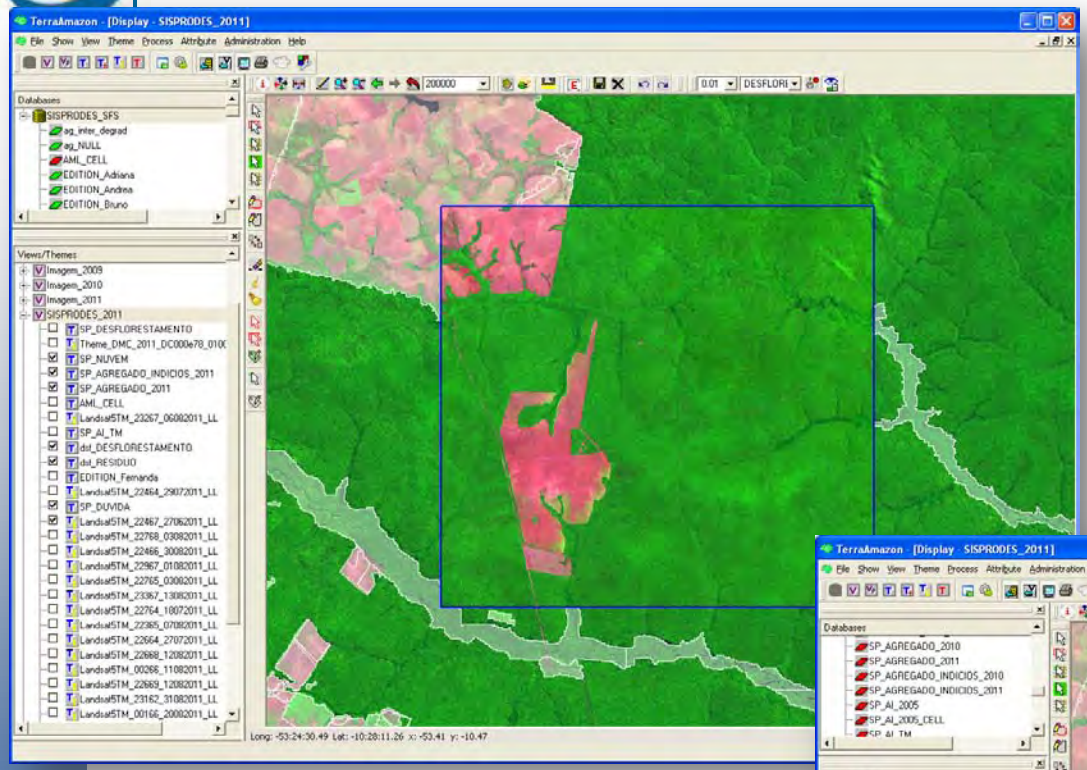
2nd Semester

First deforestation estimate

Data Acquisition: Jun-Sep

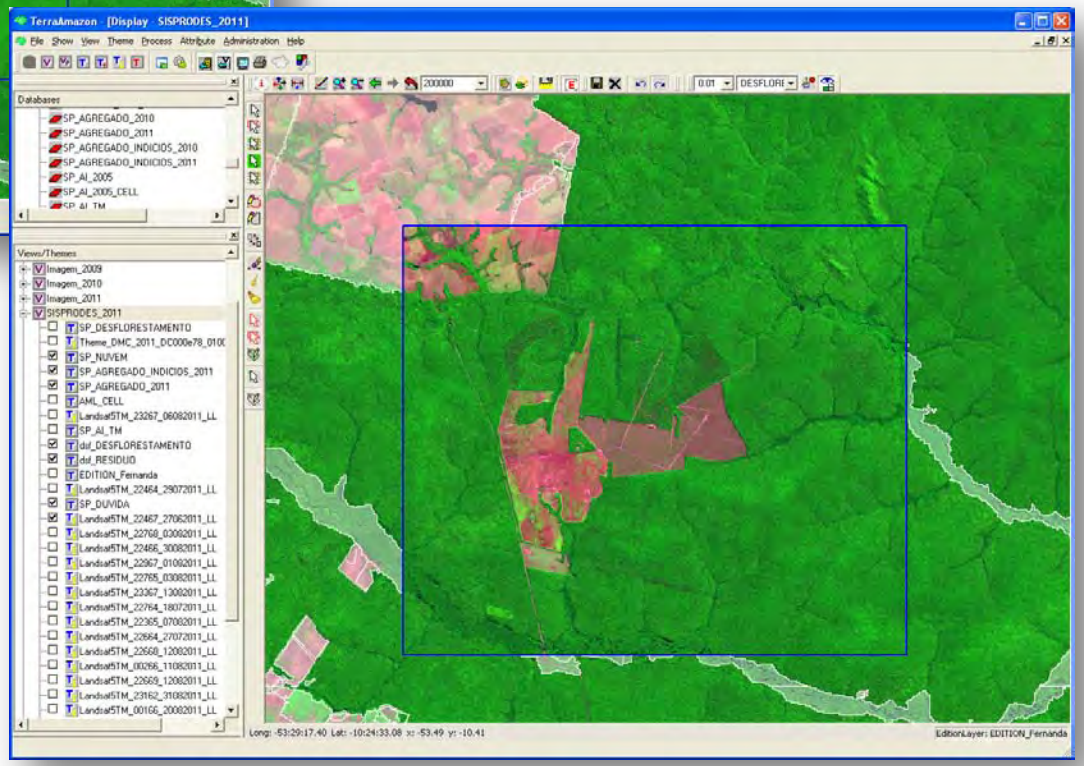
Product delivery: November

o 53 30 38 s 10 24 45 - Peixoto de Azevedo/MT - Landsat 225/67

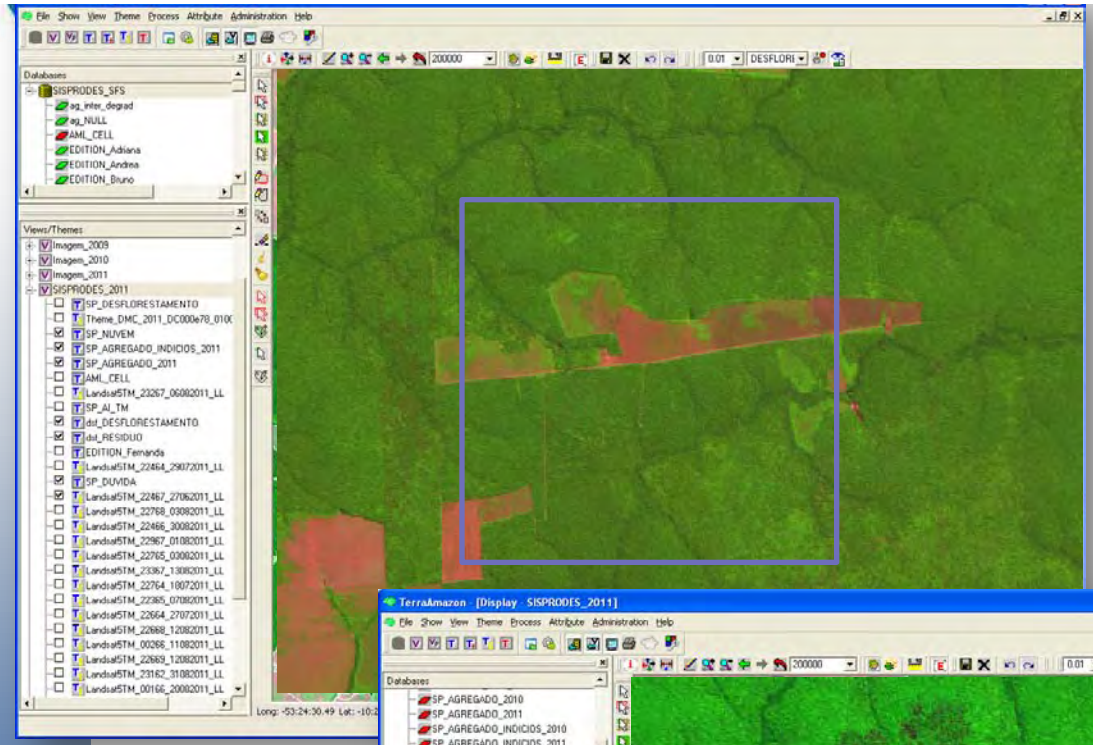


Set/2010

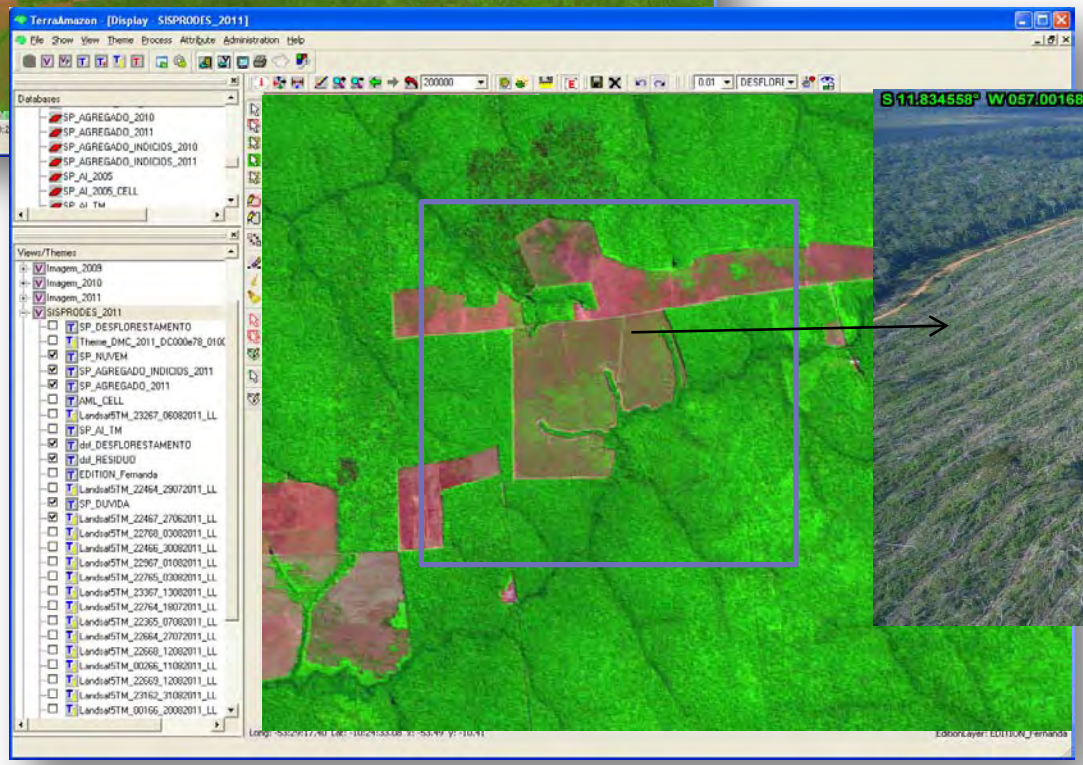
Jul/2011



o 57 00 05 s 11 49 48 - Porto dos Gaúchos/MT - Landsat 227/68

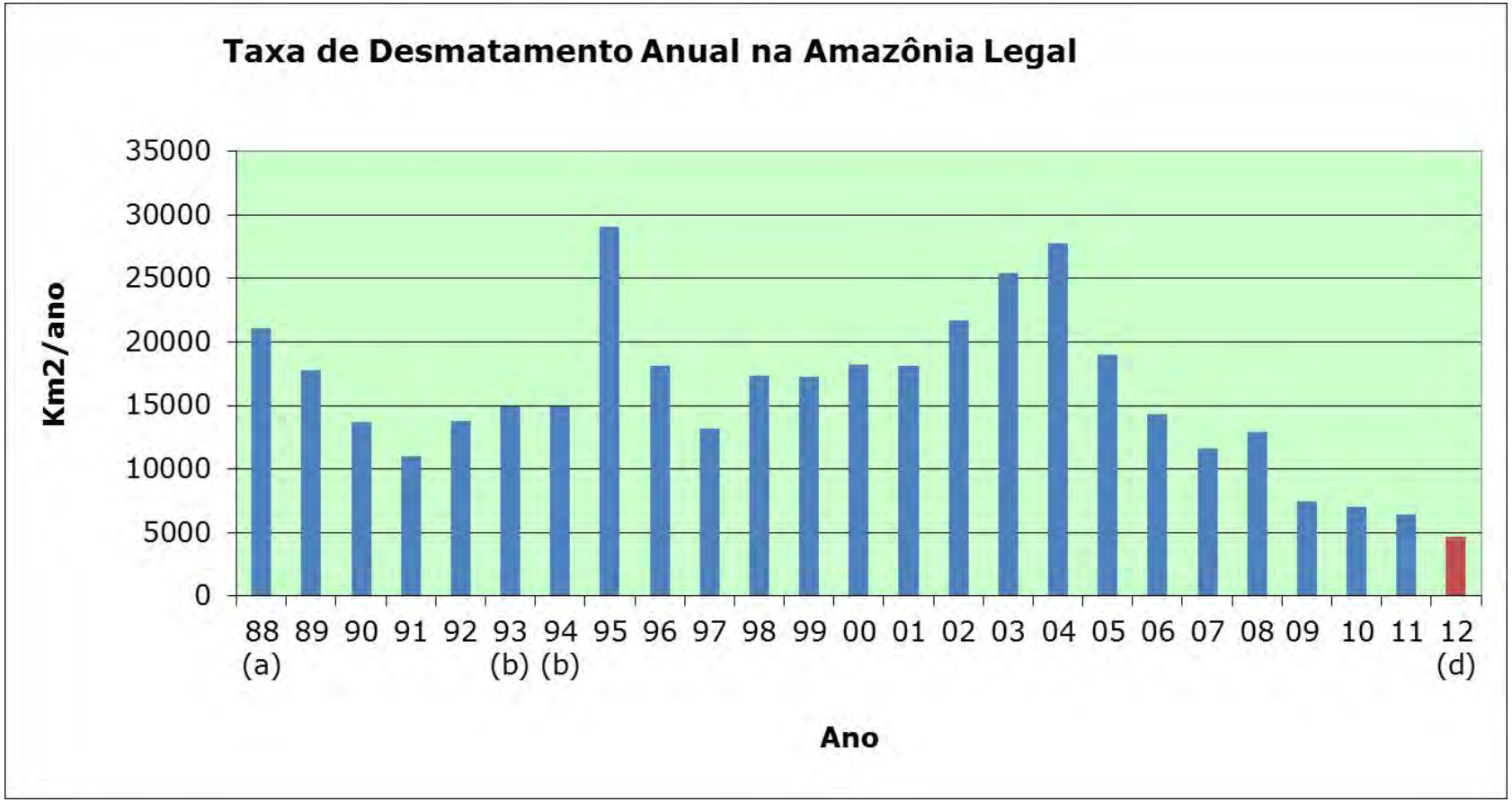


Jun/2010

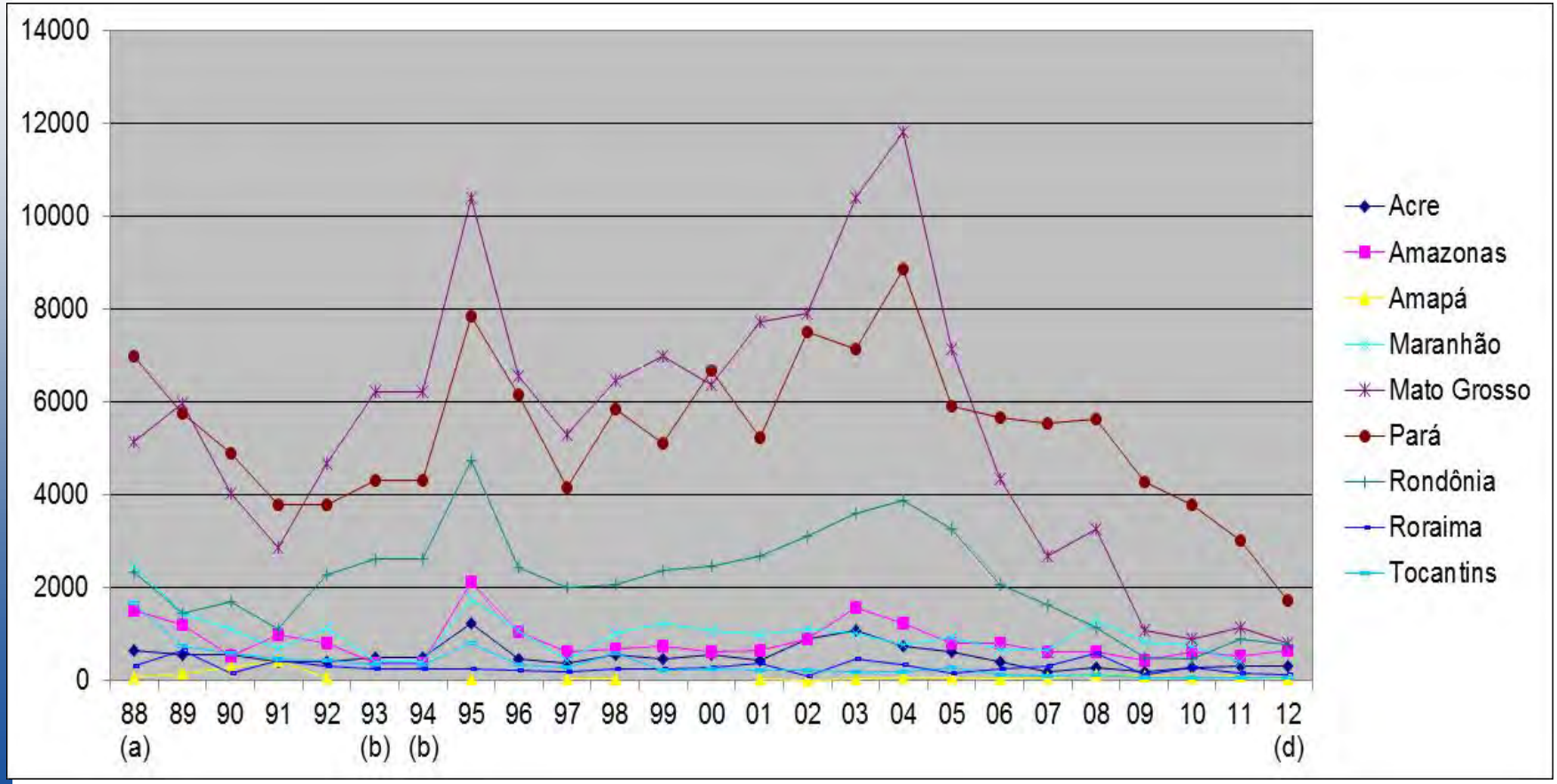


Ago/2011

Annual Gross Deforestation Rates from 1988 to 2012 (km^2/year)

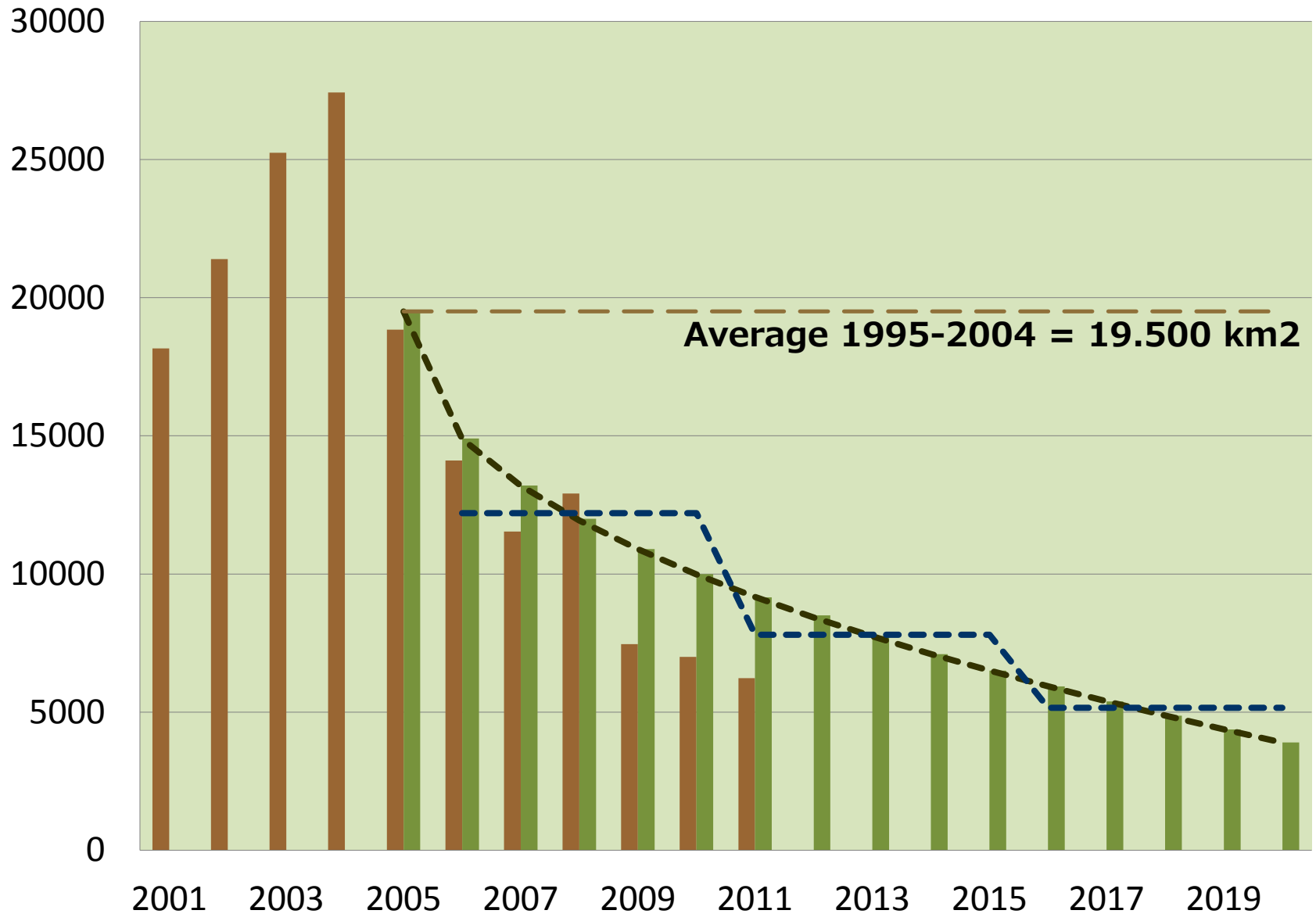


Annual Deforestation Rate per State in Amazonia 1988 – 2012 (km2/year)

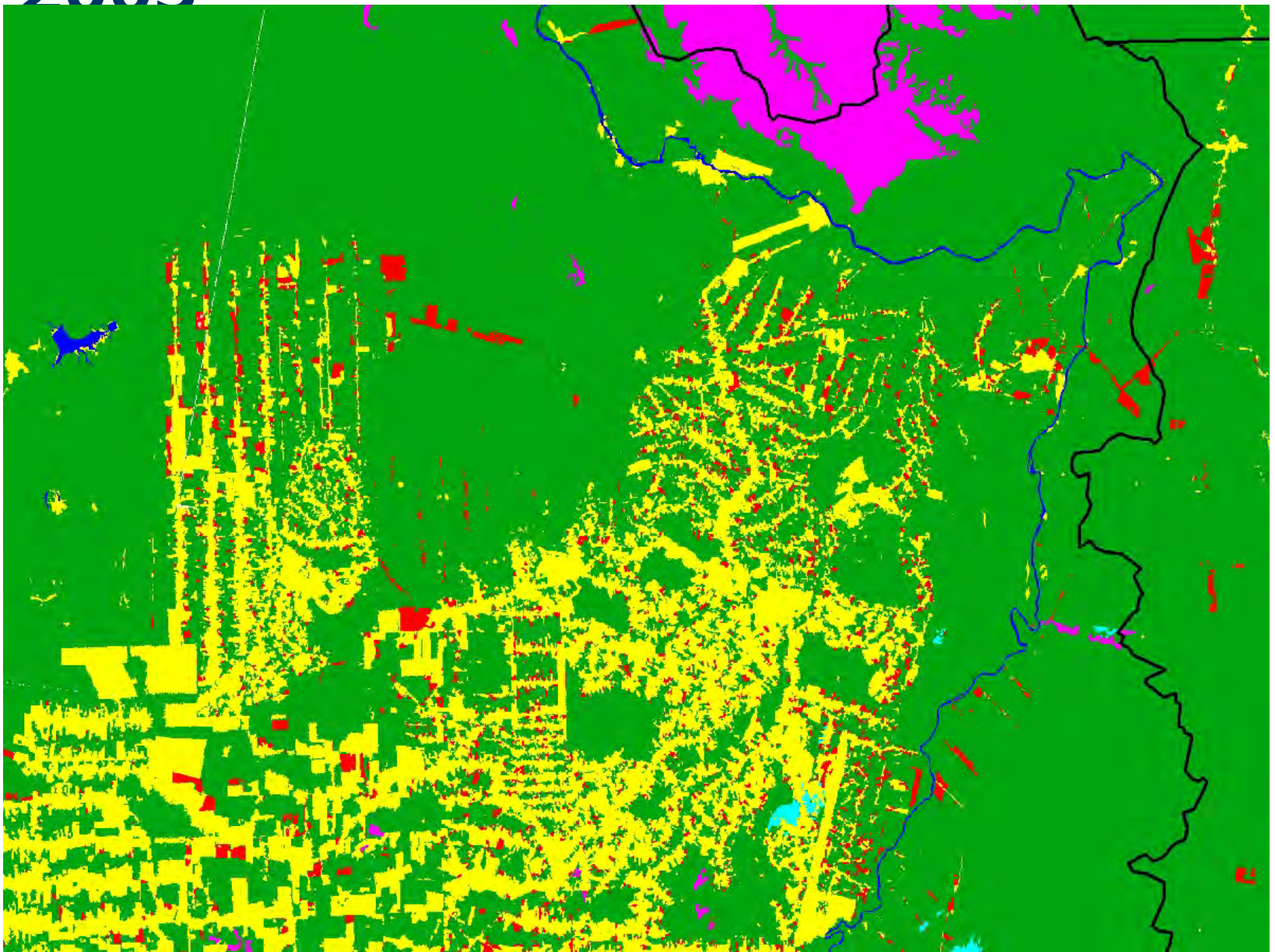


PRODES: Rate of Gross Deforestation in Amazonia – Internet Access

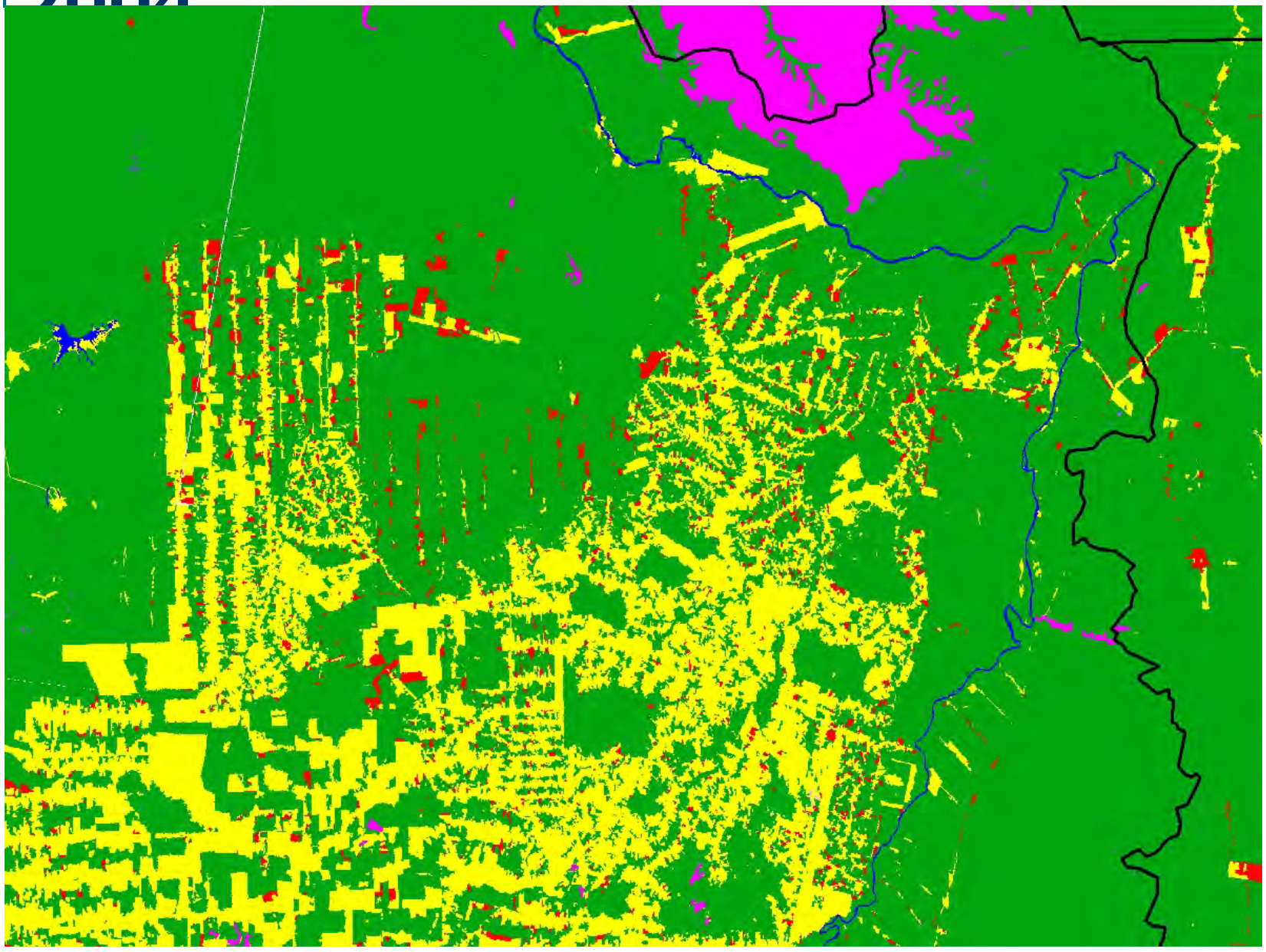
Full access to source images,maps and statistics


30000
25000
20000
15000
10000
5000
0
2001
2003
2005
2007
2009
2011
2013
2015
2017
2019
Average 1995-2004 = 19.500 km2

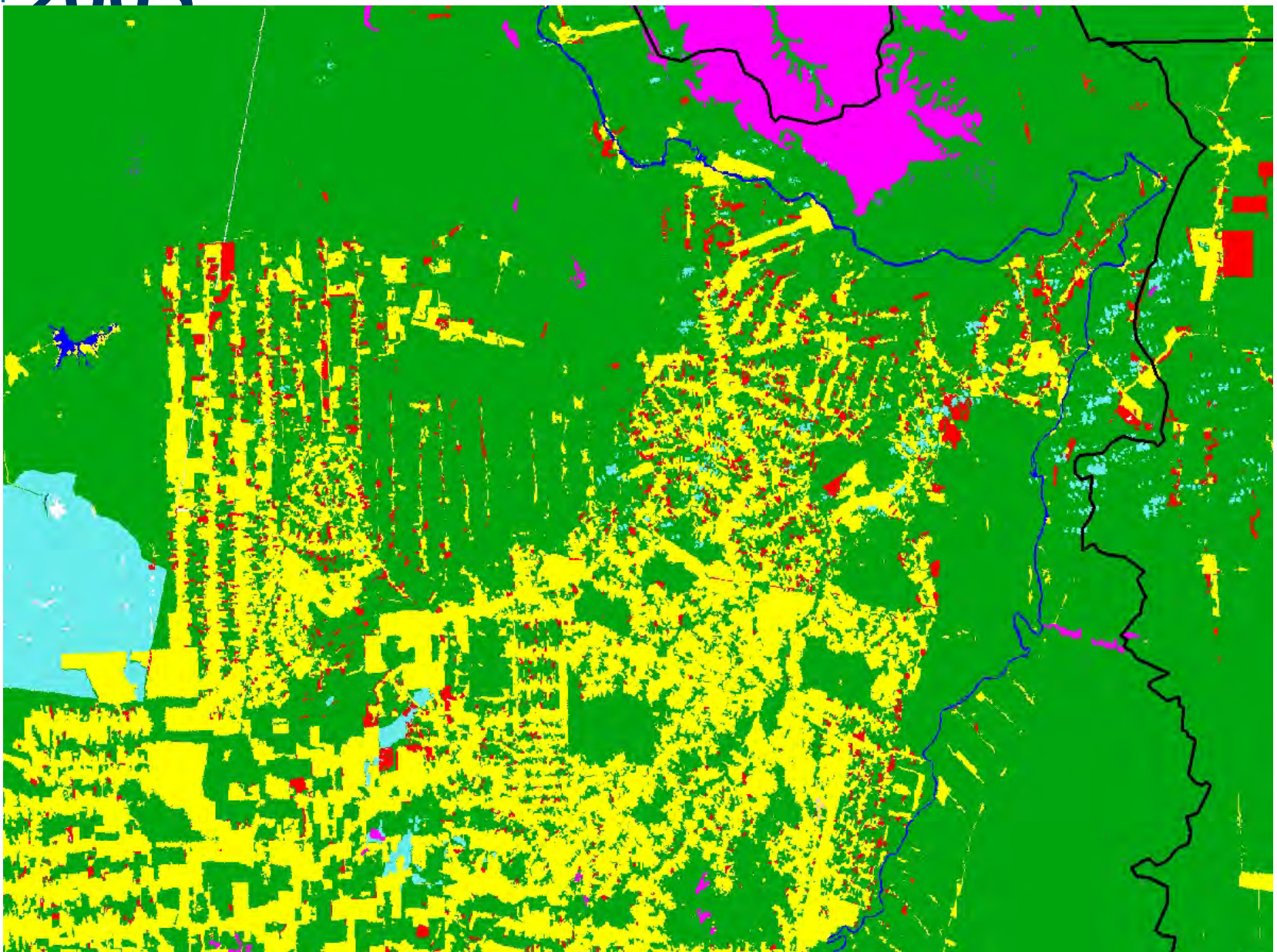
Deforestation in Rondônia (detail) – 2003

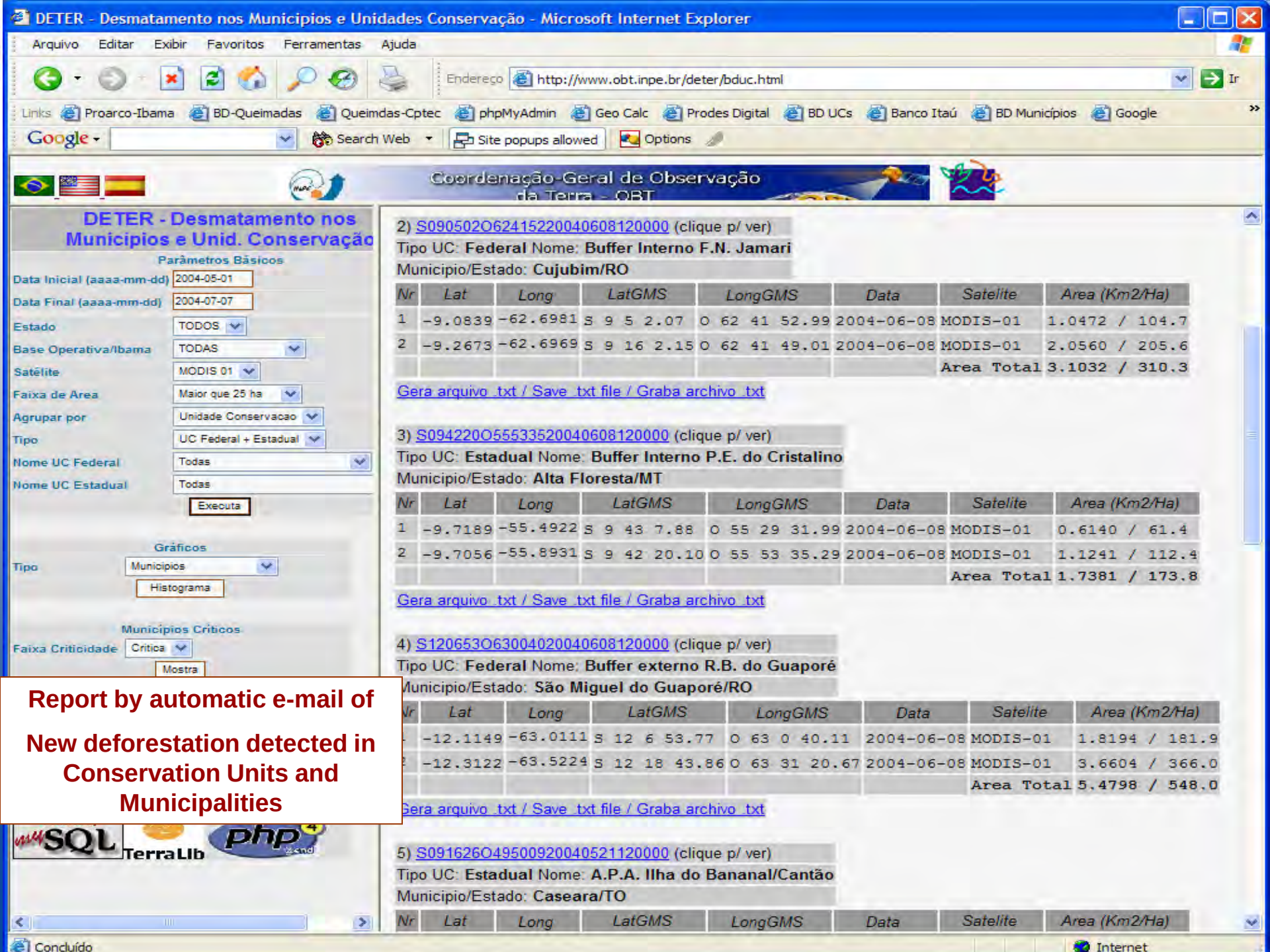


Deforestation in Rondônia (detail) – 2004

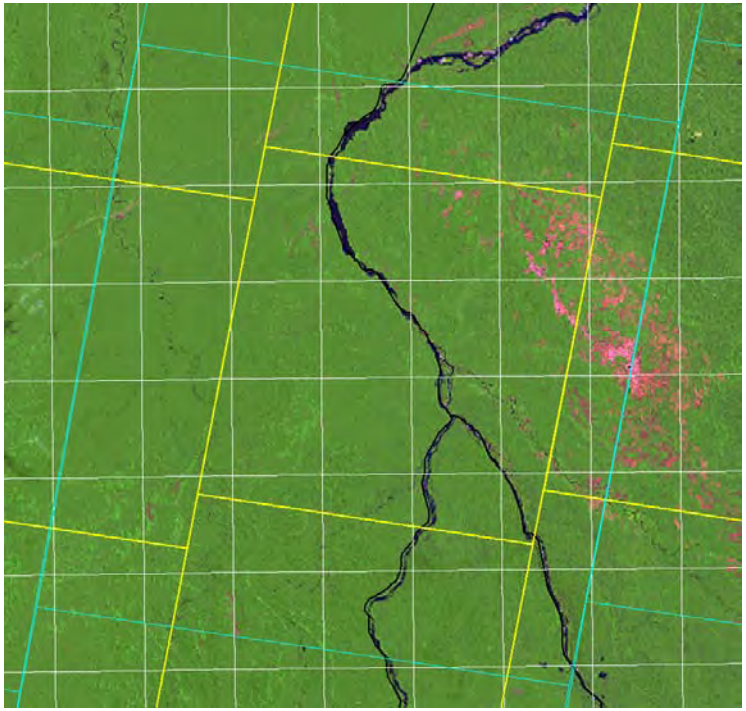


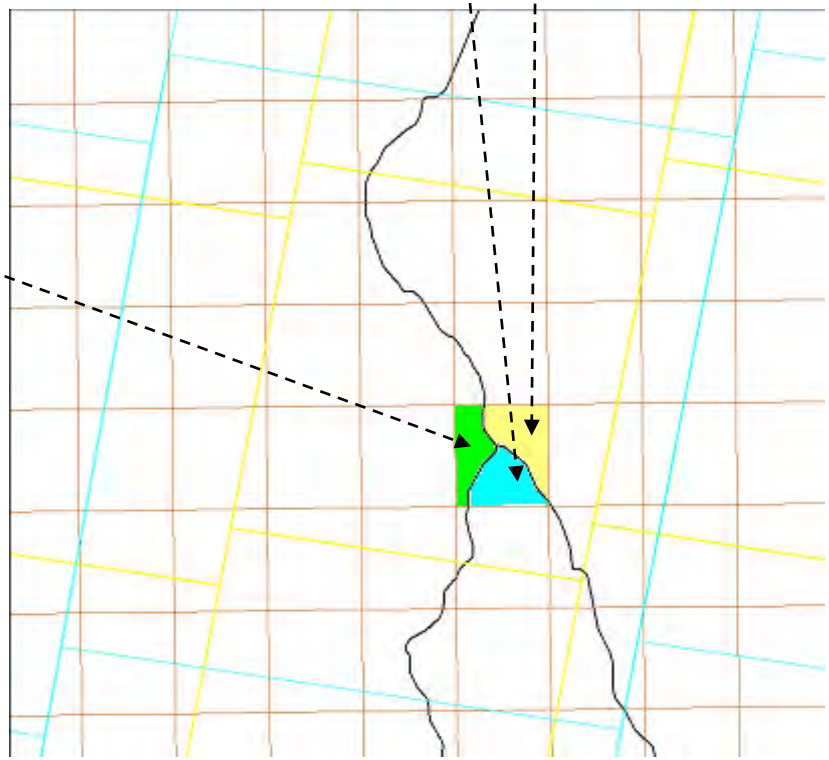
Deforestation in Rondônia (detail) – 2005




DETER - Desmatamento nos Municipios e Unidades Conservação - Microsoft Internet Explorer
Arquivo Editar Exibir Favoritos Ferramentas Ajuda
Endereço http://www.obt.inpe.br/deter/bduc.html
Ir
Links Proarco-Ibama BD-Queimadas Queimdas-Cptec phpMyAdmin Geo Calc Prodes Digital BD UCs Banco Itaú BD Municípios Google
Google Search Web Site popups allowed Options
Coordenação-Geral de Observação da Terra - OBT
DETER - Desmatamento nos Municipios e Unid. Conservação
Parâmetros Básicos
Data Inicial (aaaa-mm-dd) 2004-05-01
Data Final (aaaa-mm-dd) 2004-07-07
Estado TODOS
Base Operativa/Ibama TODAS
Satélite MODIS 01
Faixa de Area Maior que 25 ha
Agrupar por Unidade Conservacao
Tipo UC Federal + Estadual
Nome UC Federal Todas
Nome UC Estadual Todas
Executa
Gráficos
Tipo Municipios
Histograma
Municipios Criticos
Faixa Criticidade Critica
Mostra
Report by automatic e-mail of
New deforestation detected in Conservation Units and Municipalities
MySQL
TerraLib
PHP
2) S090502O62415220040608120000 (clique p/ ver)
Tipo UC: Federal Nome: Buffer Interno F.N. Jamari
Municipio/Estado: Cujubim/RO
Nr Lat Long LatGMS LongGMS Data Satelite Area (Km2/Ha)
1 -9.0839 -62.6981 S 9 5 2.07 O 62 41 52.99 2004-06-08 MODIS-01 1.0472 / 104.7
2 -9.2673 -62.6969 S 9 16 2.15 O 62 41 49.01 2004-06-08 MODIS-01 2.0560 / 205.6
Area Total 3.1032 / 310.3
Gera arquivo .txt / Save .txt file / Graba archivo .txt
3) S094220O55533520040608120000 (clique p/ ver)
Tipo UC: Estadual Nome: Buffer Interno P.E. do Cristalino
Municipio/Estado: Alta Floresta/MT
Nr Lat Long LatGMS LongGMS Data Satelite Area (Km2/Ha)
1 -9.7189 -55.4922 S 9 43 7.88 O 55 29 31.99 2004-06-08 MODIS-01 0.6140 / 61.4
2 -9.7056 -55.8931 S 9 42 20.10 O 55 53 35.29 2004-06-08 MODIS-01 1.1241 / 112.4
Area Total 1.7381 / 173.8
Gera arquivo .txt / Save .txt file / Graba archivo .txt
4) S120653O63004020040608120000 (clique p/ ver)
Tipo UC: Federal Nome: Buffer externo R.B. do Guaporé
Municipio/Estado: São Miguel do Guaporé/RO
Nr Lat Long LatGMS LongGMS Data Satelite Area (Km2/Ha)
-12.1149 -63.0111 S 12 6 53.77 O 63 0 40.11 2004-06-08 MODIS-01 1.8194 / 181.9
-12.3122 -63.5224 S 12 18 43.86 O 63 31 20.67 2004-06-08 MODIS-01 3.6604 / 366.0
Area Total 5.4798 / 548.0
Gera arquivo .txt / Save .txt file / Graba archivo .txt
5) S091626O49500920040521120000 (clique p/ ver)
Tipo UC: Estadual Nome: A.P.A. Ilha do Bananal/Cantão
Municipio/Estado: Caseara/TO
Nr Lat Long LatGMS LongGMS Data Satelite Area (Km2/Ha)
Concluído
Internet

Multidata approach





LANDSAT

CBERS

SISPRODES

State boundaries

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Monitoring the State of the Forest: DEGRAD e DETEX

UM PAÍS DE TODOS
GOVERNO FEDERAL


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562_27092007_2
267_27082007_1
467_310706
862_311006_v2
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OR_2007_ENTREGA_M
006x2007
07_inter_FP
663_19082008
0808_SLxVg_90_50_M_
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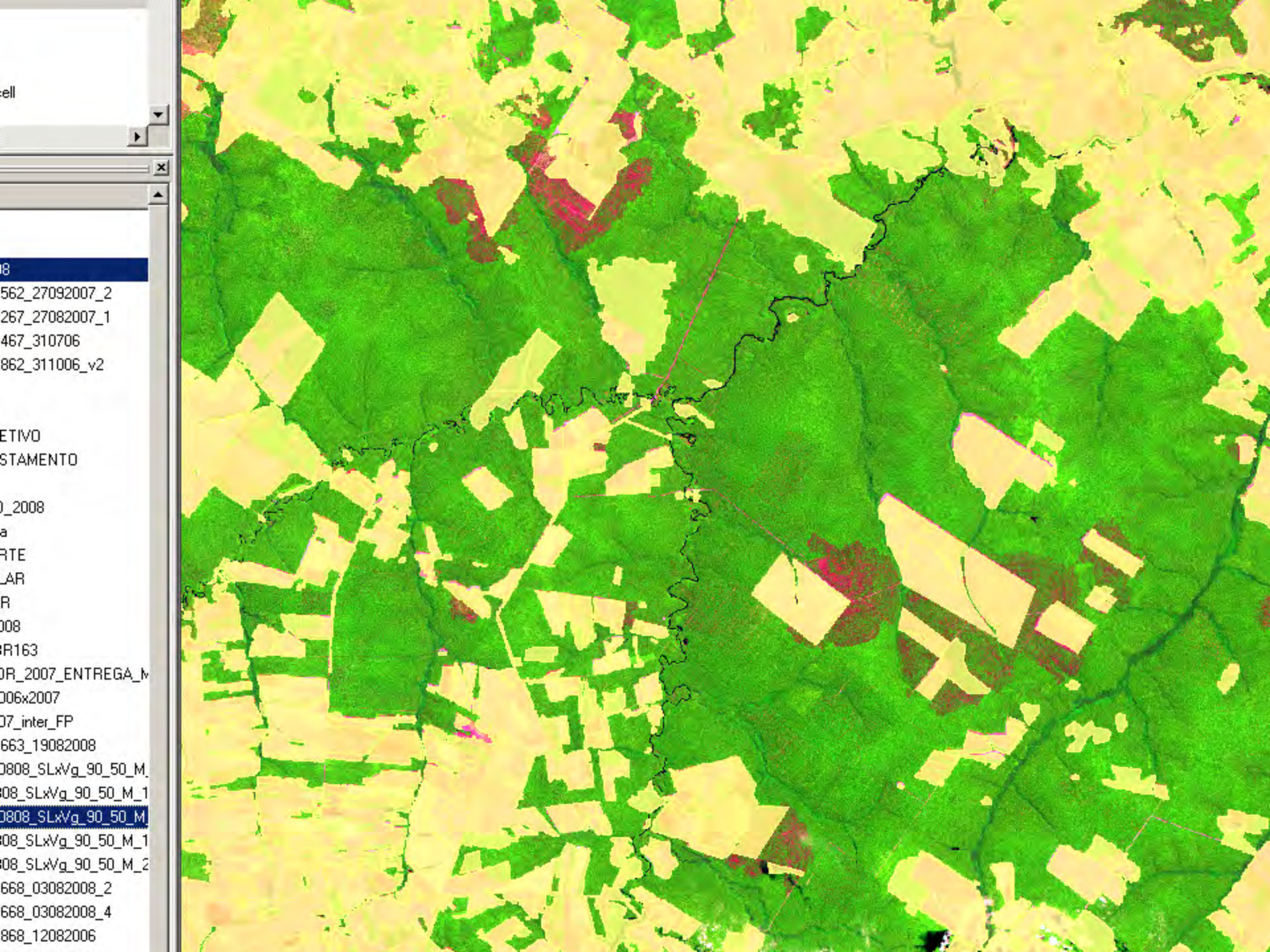
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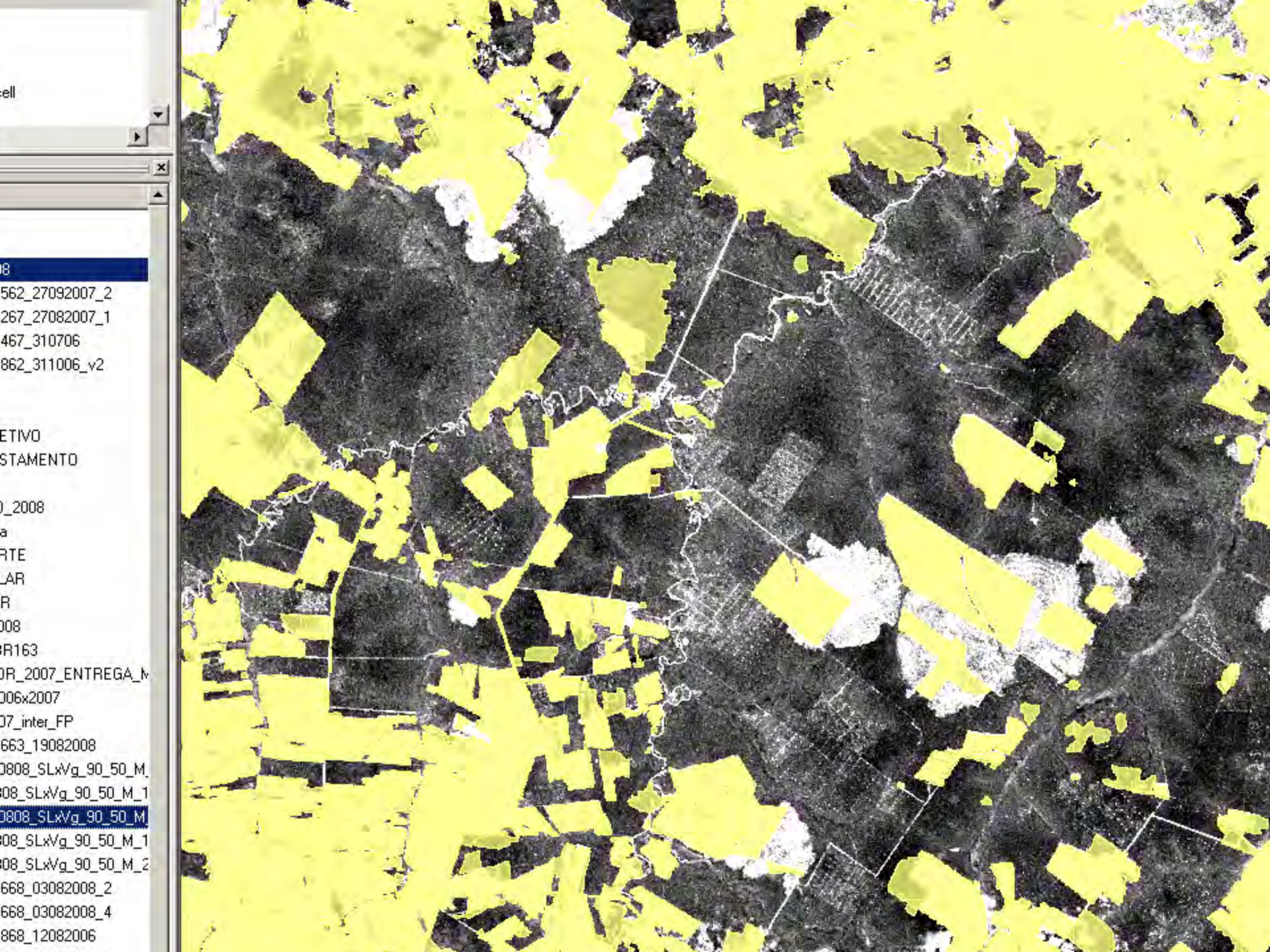
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OR_2007_ENTREGA_M
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07_inter_FP
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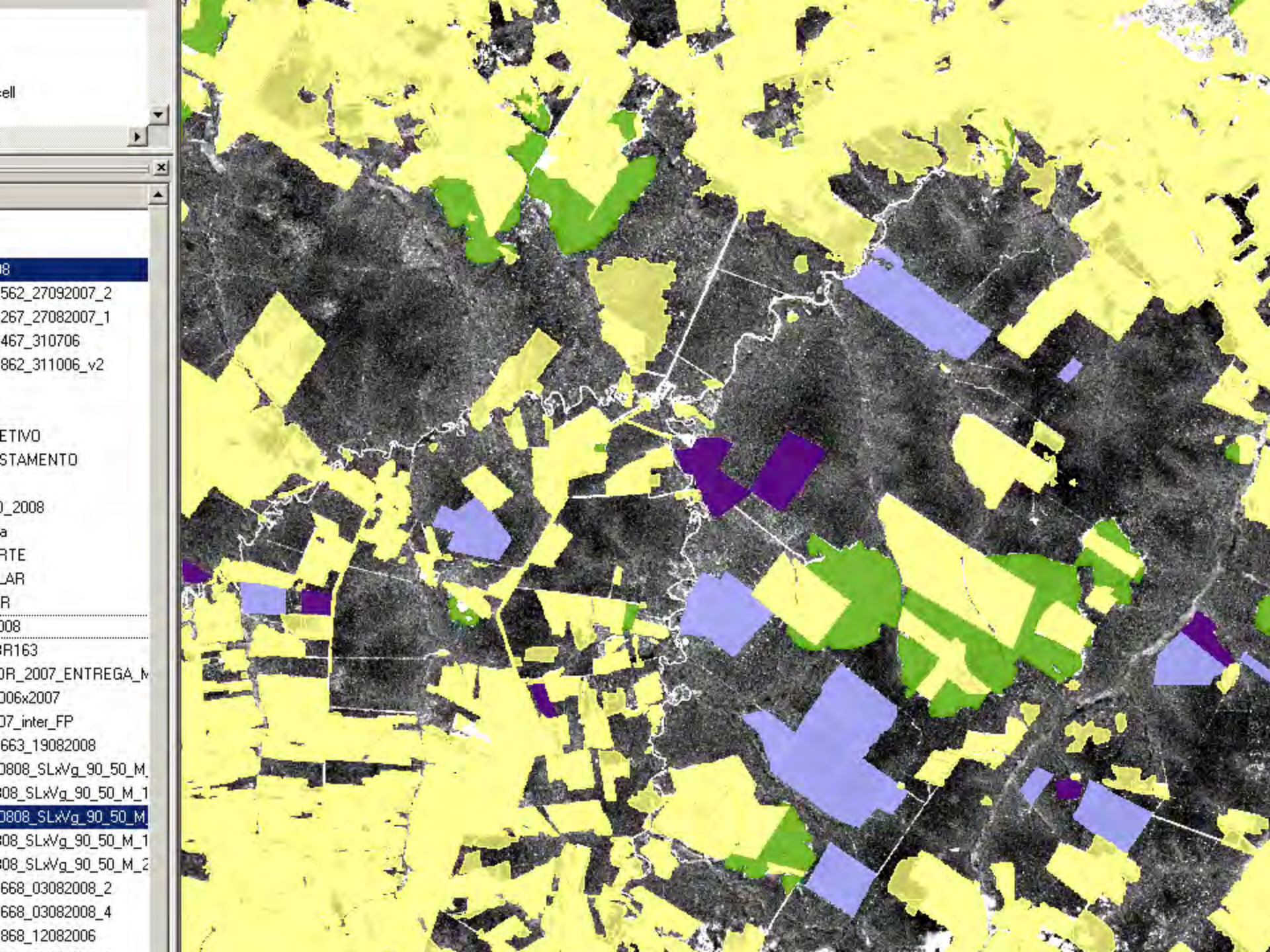
668_03082008_4
868_12082006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862_311006_v2
ETIVO
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R163
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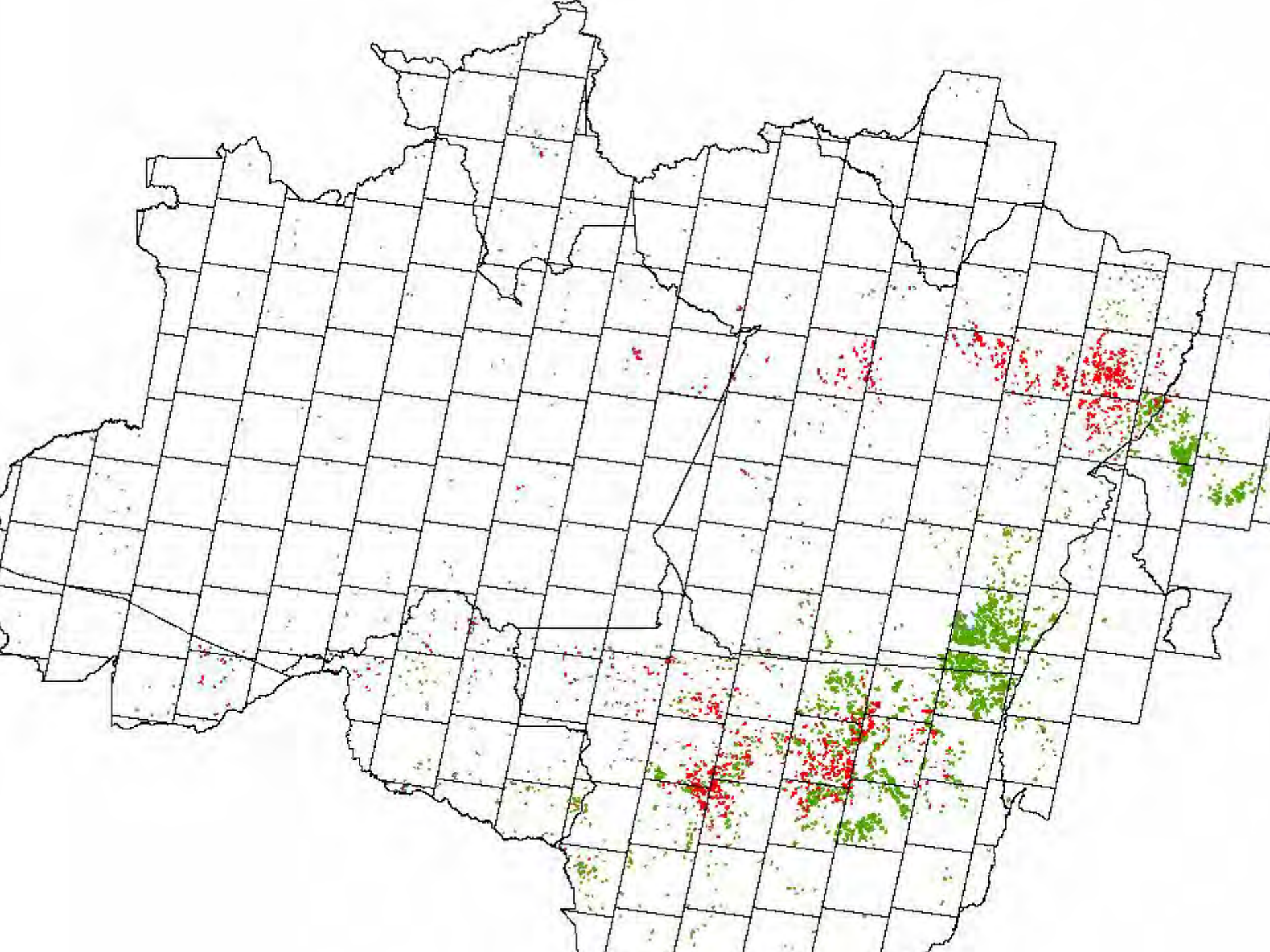

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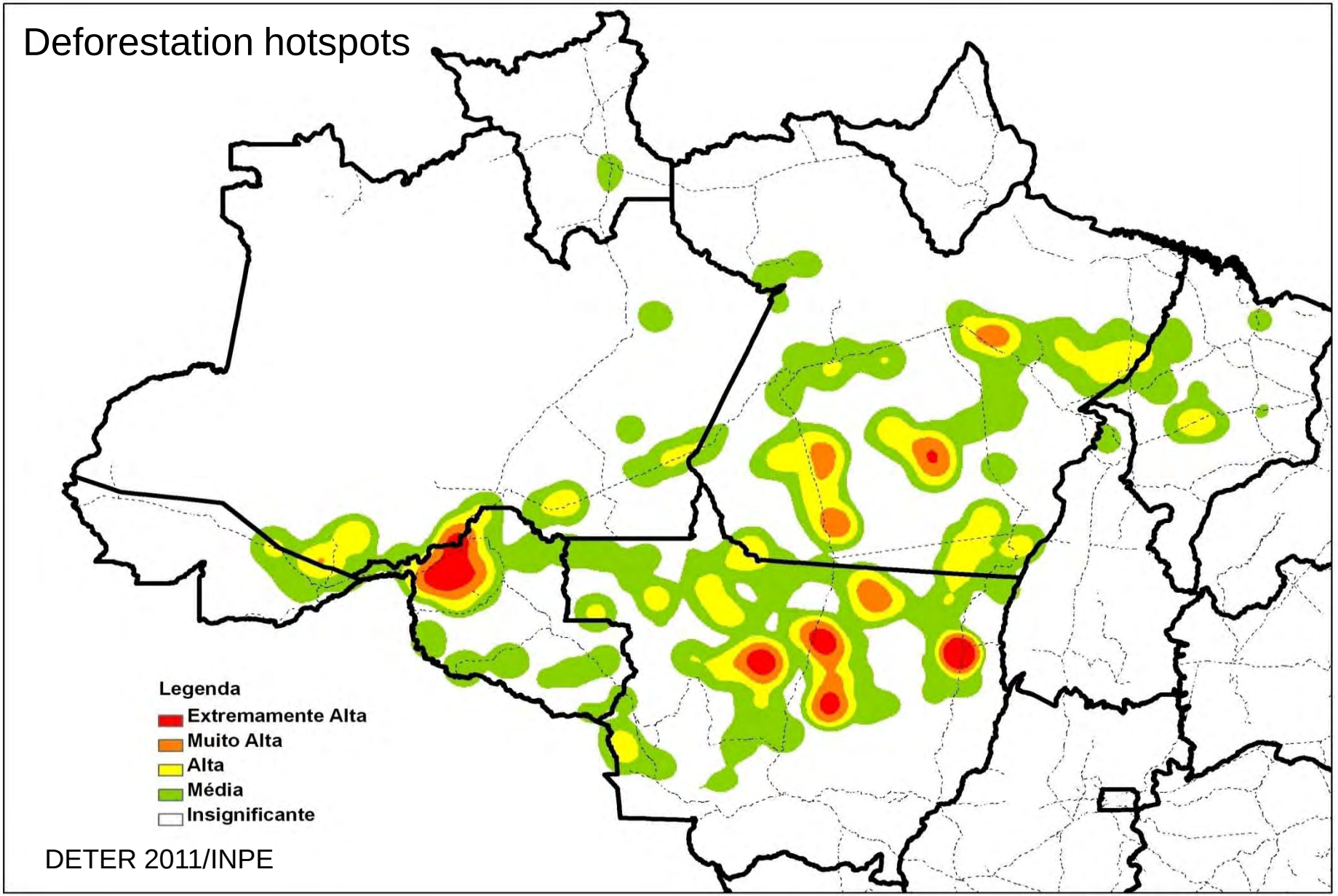
Near Real Time Monitoring of the Legal Amazonia - DETER

Deforestation hotspots



DETER 2011/INPE

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Near Real Time Monitoring of the Legal Amazonia - DETER

Carbon maps for Brazilian Amazonia

- Largest source of uncertainty regarding carbon emissions from deforestation is the spatial distribution of biomass.
- Differences in emission estimates can be on the order of 20% using our baseline model parameters.
- Estimates based on submodels B1 (Saatch et al., 2007), B3 (MCT, 2010) and B4 (Saatchi et al., 2011a,b) are relatively similar at the regional level, those based on B2 (Nogueira et al., 2008) are significantly higher.
- This difference could be even higher if the same percentage of BGB in relation to AGB in all the submodels.
  - Root to shoot ration is 20% in B2, 28% in B3 and 30% in B1–B4.
- The emission estimate differences would increase to 30% as BGB contribution in B2 would be larger.

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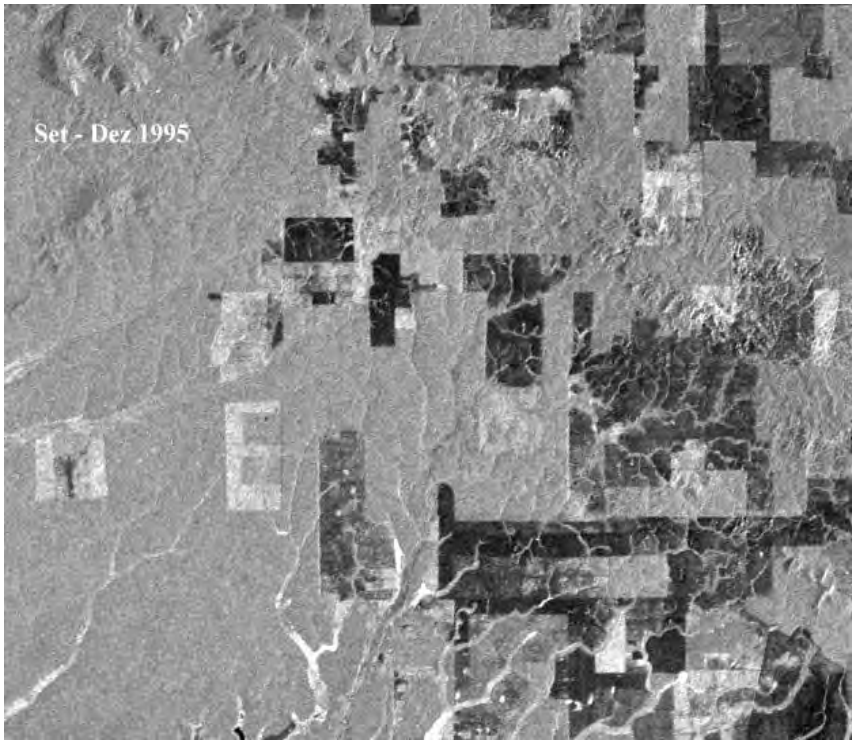
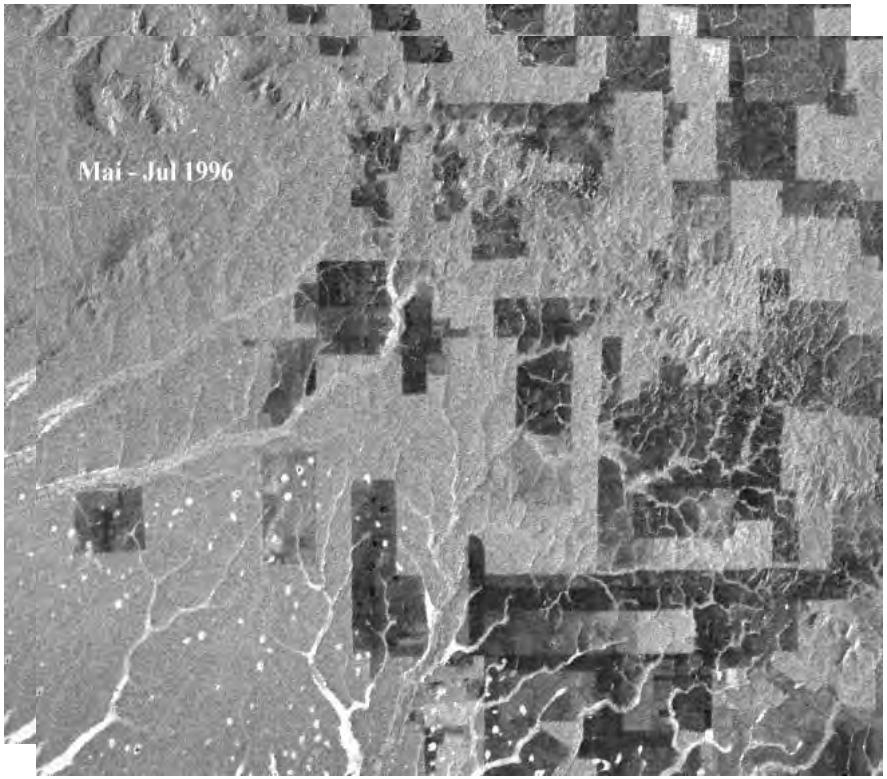
DETER-R : Assimilation of PALSAR data in the Deforestation and Forest Degradation Warning System

Examples of L-band deforestation detection capability from JERS-1 GRFM Mosaics





Examples of L-band deforestation detection capability from ALOS/PALSAR

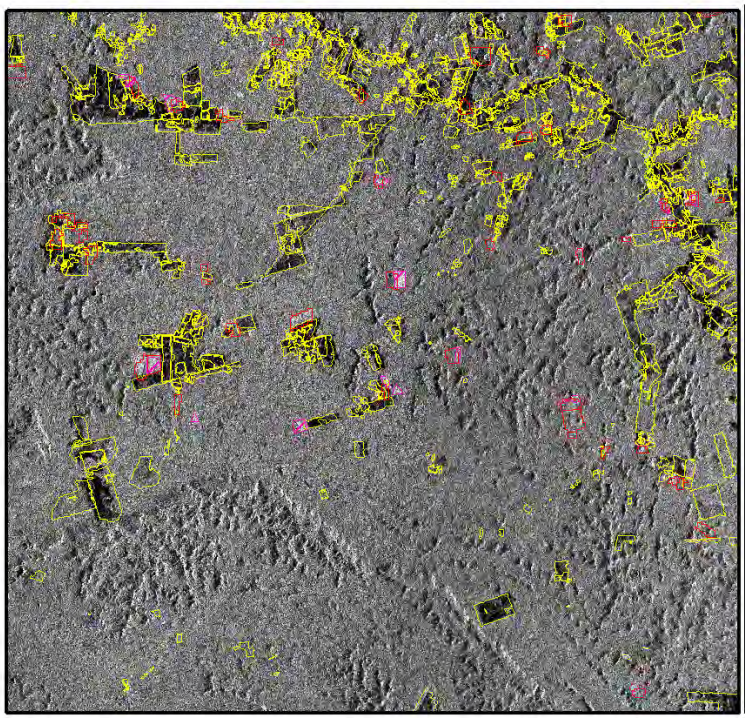


Imagem ALOS de 23/08/2007

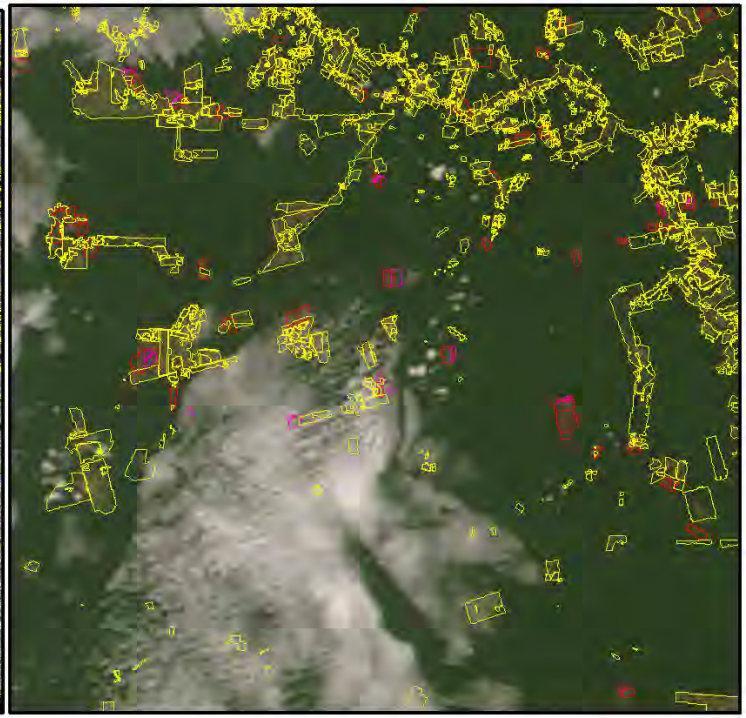
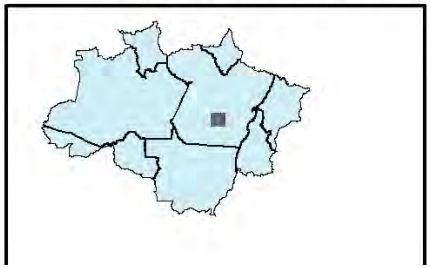


Imagem MODIS de 28/09/2007

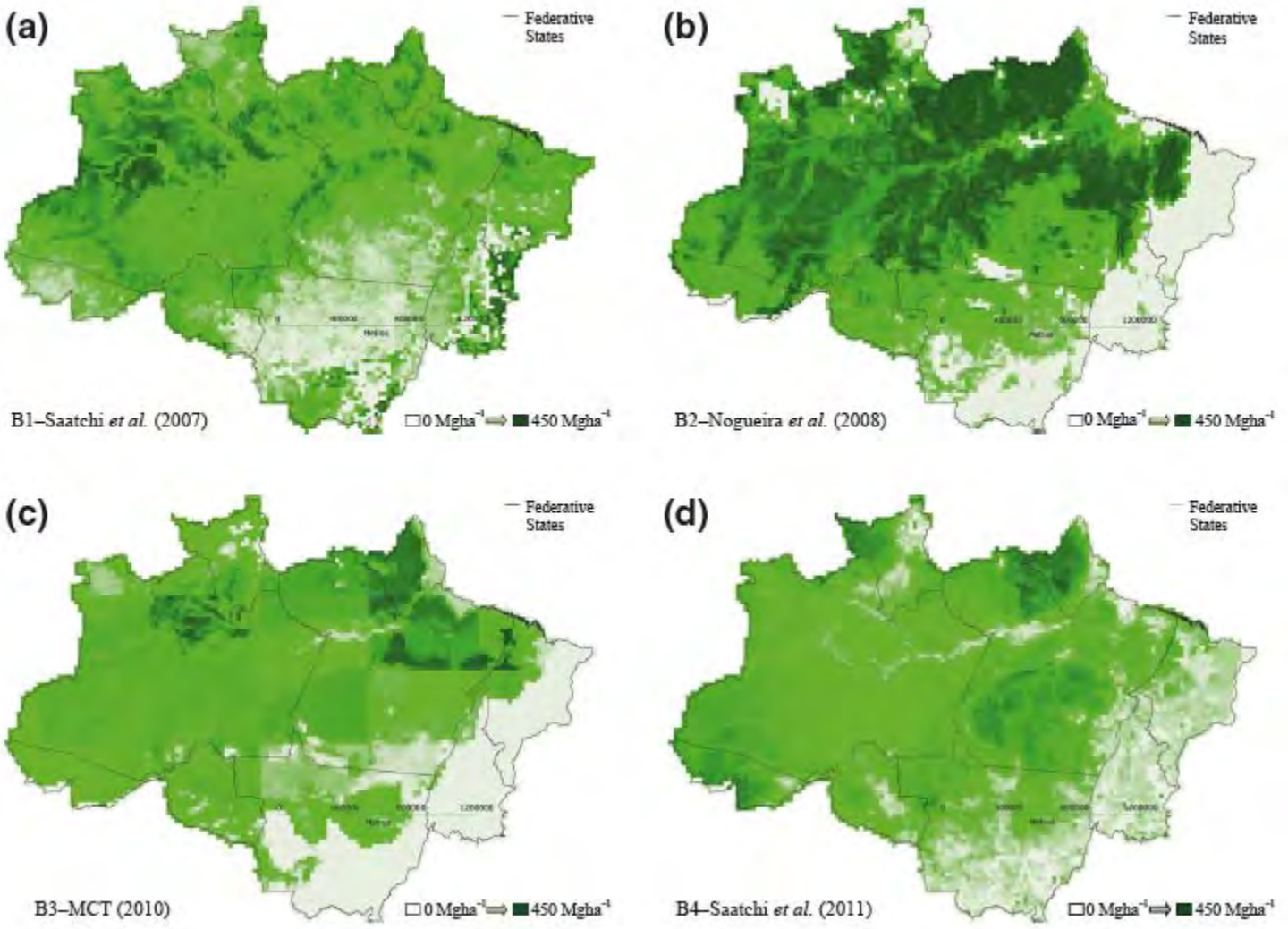


Legenda

- Detecções com uso do ALOS
- DETER acumulado 2007
- PRODES 2000 a 2006

Modeling the spatial and temporal heterogeneity of deforestation-driven carbon emissions: the INPE-EM framework applied to the Brazilian Amazon

Global Change Biology (2012), doi: 10.1111/j.1365-2486.2012.02782.x


(a)
Federative States
B1–Saatchi et al. (2007)
0 Mgha-1 ⇒ 450 Mgha-1
(b)
Federative States
B2–Nogueira et al. (2008)
0 Mgha-1 ⇒ 450 Mgha-1
(c)
Federative States
B3–MCT (2010)
0 Mgha-1 ⇒ 450 Mgha-1
(d)
Federative States
B4–Saatchi et al. (2011)
0 Mgha-1 ⇒ 450 Mgha-1

Carbon maps for Brazilian Amazonia

- Largest source of uncertainty regarding carbon emissions from deforestation is the spatial distribution of biomass.
- Differences in emission estimates can be on the order of 20% using our baseline model parameters.
- Estimates based on submodels B1 (Saatch et al., 2007), B3 (MCT, 2010) and B4 (Saatchi et al., 2011a,b) are relatively similar at the regional level, those based on B2 (Nogueira et al., 2008) are significantly higher.
- This difference could be even higher if the same percentage of BGB in relation to AGB in all the submodels.
  - Root to shoot ration is 20% in B2, 28% in B3 and 30% in B1–B4.
- The emission estimate differences would increase to 30% as BGB contribution in B2 would be larger.

Future – challenges for REDD+

- Within Brazil
  - Expansion of the deforestation and forest degradation systems to include all biomes: national system
  - Adapt the present monitoring system to the specificities of other biomes
  - Data availability – some biomes require satellite data of finer spatial resolution (less than 5 meters)
  - Implement a national forest inventory
  - Going beyond fiscalization and law enforcement
  - Definition of reference emission level for all biomes (RL for Amazonia used only historical

Future – challenges for REDD+

- Within Brazil
  - When conservation (mantainence of carbon stock) can be considered a mitigation activity and not BAU?
  - Estimating carbon stock change beyond IPCC tier 1 method and conservativeness for all biomes.
  - How to treat natural disturbances?


Thank you