

Monitoramento Ambiental e Florestal

Carlos Souza Jr., Ph.D.

Pesquisador Sênior

souzajr@imazon.org.br



Embrapa

Monitoramento por Satélite

Workshop: Geointeligência
em Agricultura e Meio Ambiente
08 de maio



MundoGEO



#connect



LatinAmerica 2014

Conferência e Feira de Geomática e Soluções Geoespaciais

7 a 9 de Maio de 2014

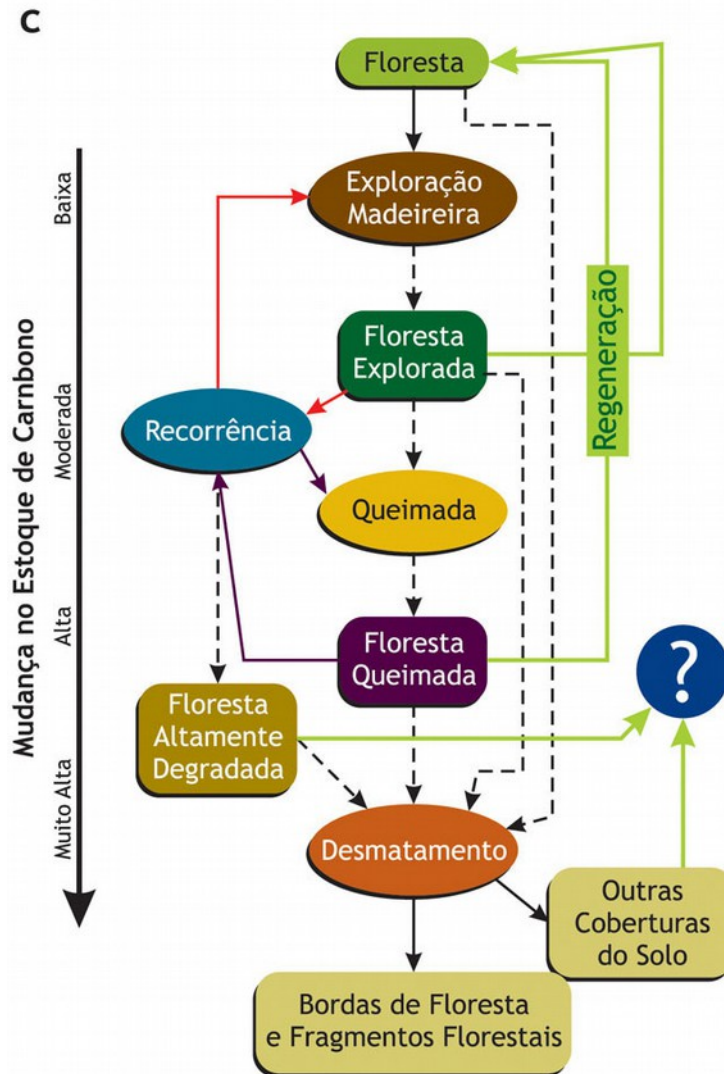
Centro de Convenções Frei Caneca - São Paulo (SP) - Brasil



ideias para monitoramento ambiental florestal

1. Monitorando a história do pixel
2. ‘Clouds’ para o processamento de imagens:
 - Google Earth Engine (EE)
 - SAD EE
 - Global Forest Watch
 - SAD+
3. Monitoramento colaborativo (*crowdsourcing*)

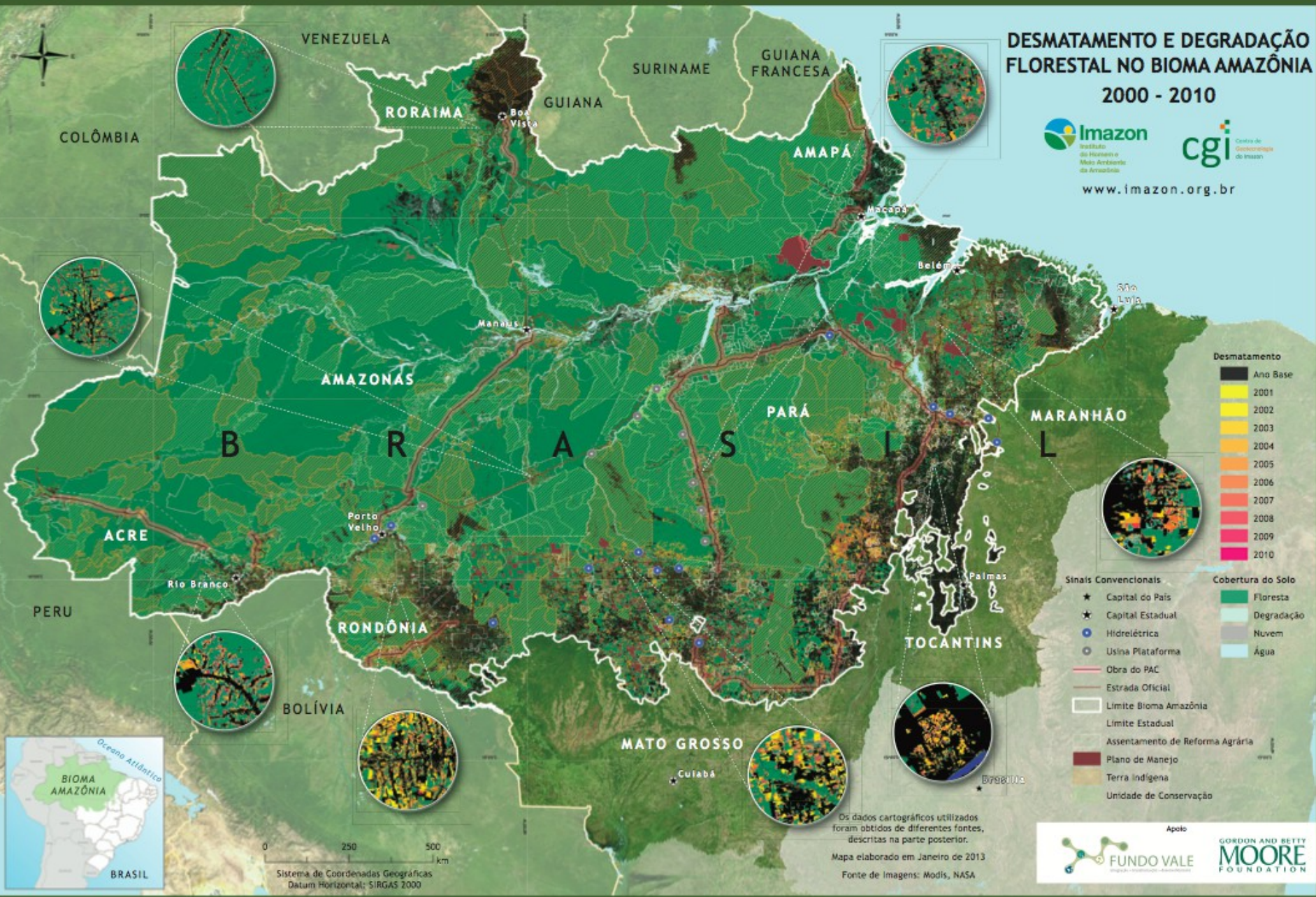
Monitorando a história do pixel...



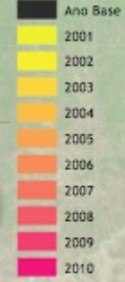
DESMATAMENTO E DEGRADAÇÃO FLORESTAL NO BIOMA AMAZÔNIA 2000 - 2010



www.imazon.org.br



Desmatamento



Sinais Convencionais

- ★ Capital do País
- ★ Capital Estadual
- Hidrelétrica
- Usina Plataforma
- Obra do PAC
- Estrada Oficial
- Limite Bioma Amazônia
- Limite Estadual
- Assentamento de Reforma Agrária
- Plano de Manejo
- Terra Indígena
- Unidade de Conservação

Cobertura do Solo

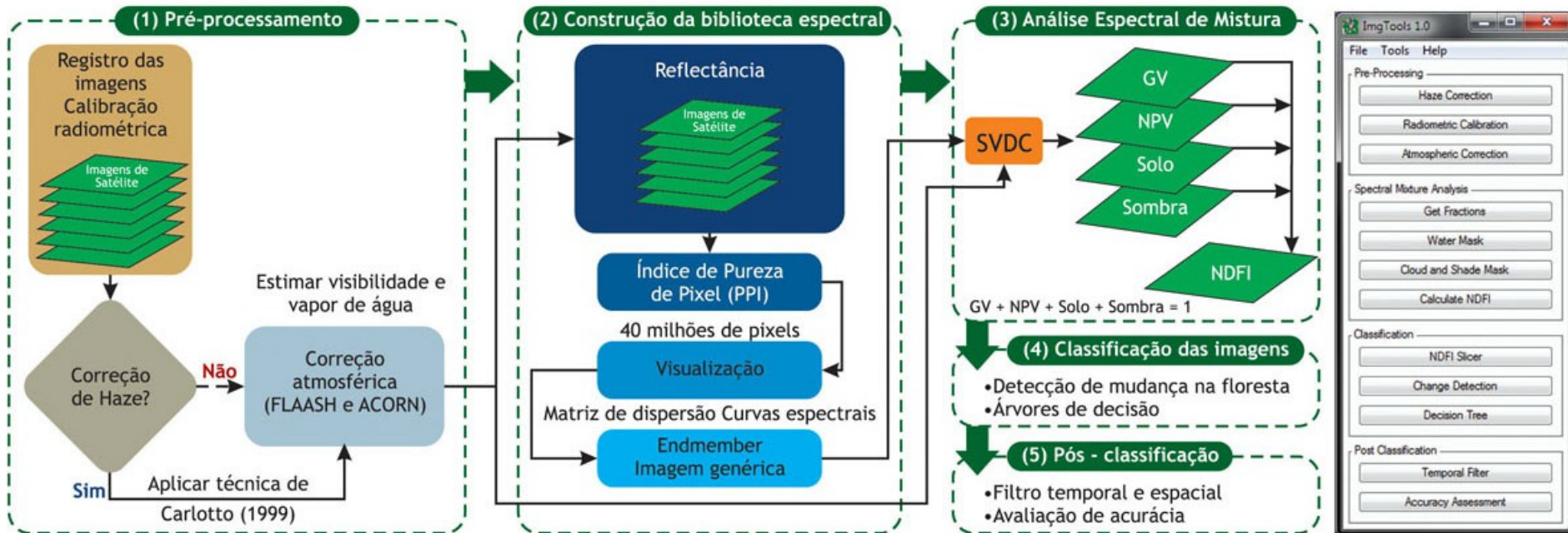
- Floresta
- Degradação
- Nuvem
- Água

Os dados cartográficos utilizados foram obtidos de diferentes fontes, descritas na parte posterior.
 Mapa elaborado em Janeiro de 2013
 Fonte de Imagens: Modis, NASA



0 250 500 km
 Sistema de Coordenadas Geográficas
 Datum Horizontal: SIRGAS 2000

ImgToolsSoftware

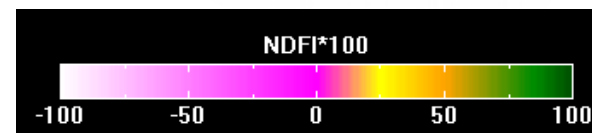
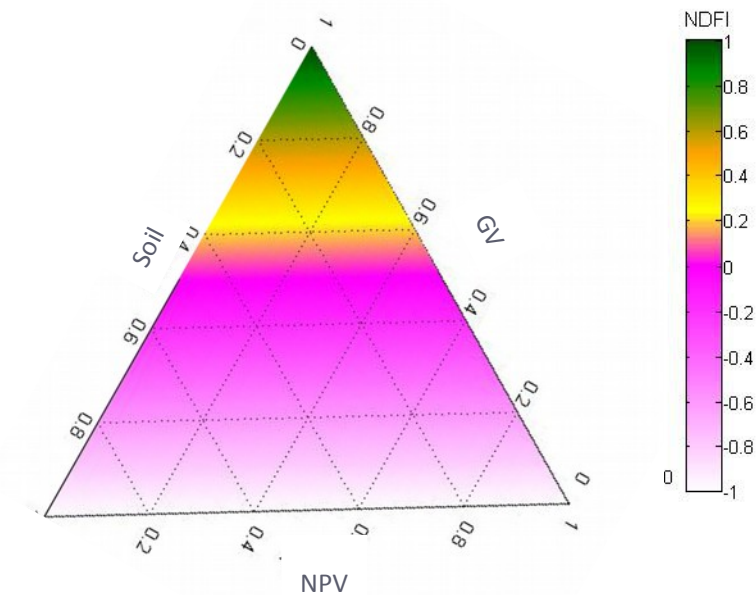
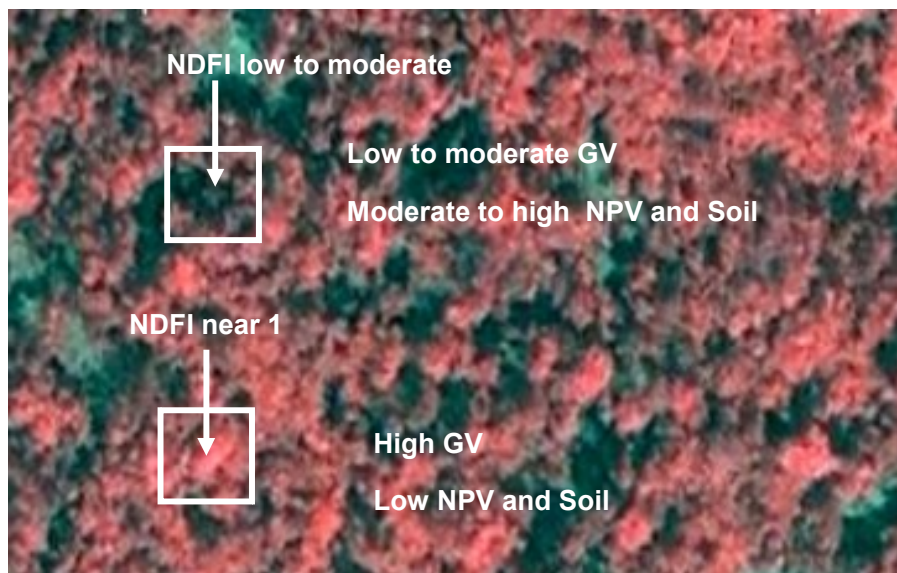


Modelagem Espectral de Mistura e NDFI

$$\text{NDFI} = \frac{\text{GV}_{\text{Shade}} - (\text{NPV} + \text{Soil})}{\text{GV}_{\text{Shade}} + \text{NPV} + \text{Soil}}$$

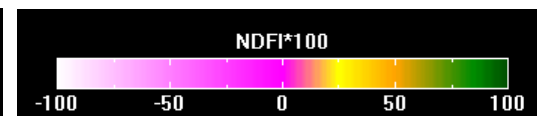
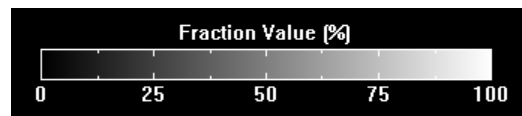
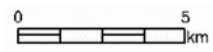
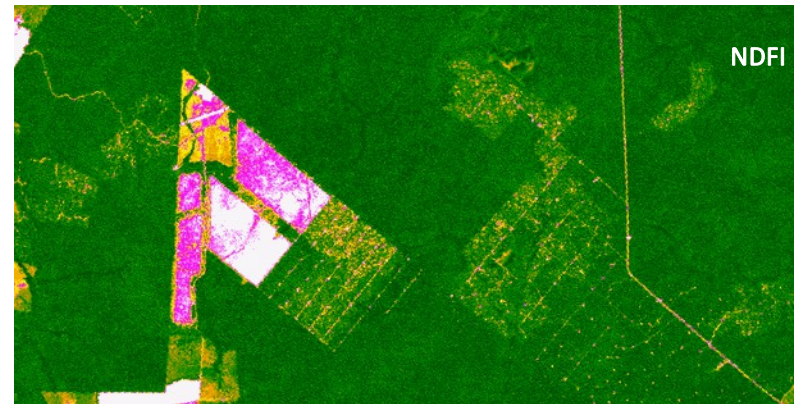
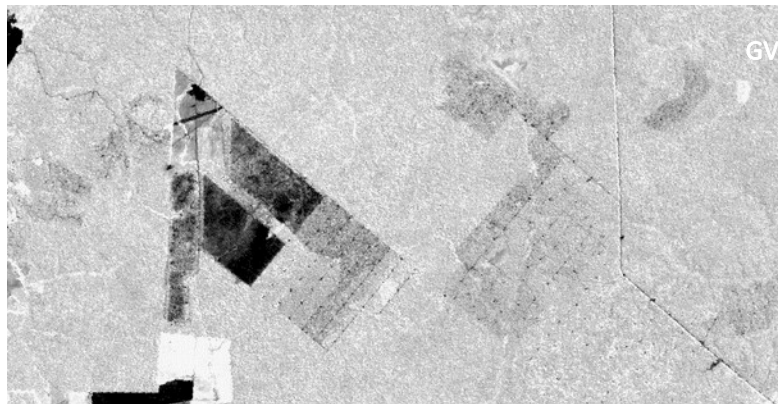
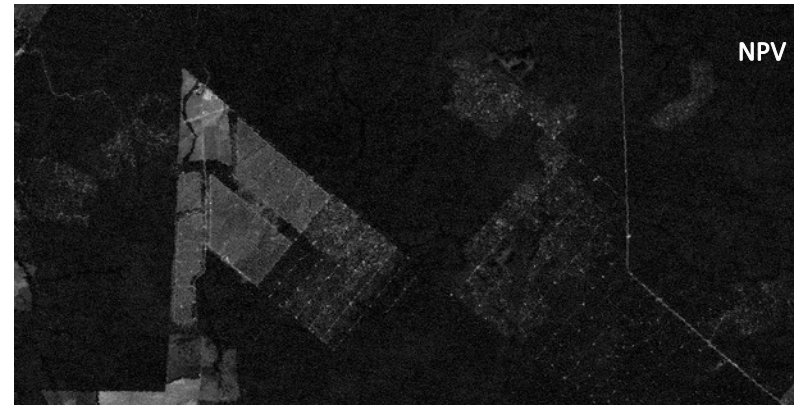
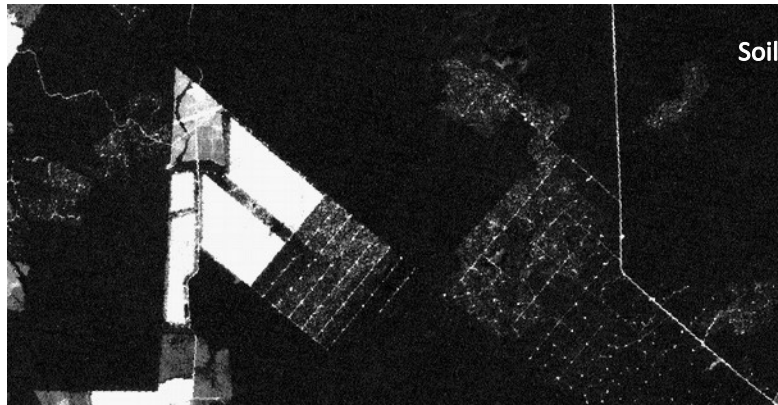
$$\text{GV}_{\text{Shade}} = \frac{\text{GV}}{100 - \text{Shade}}$$

$$-1 \leq \text{NDFI} \leq 1$$

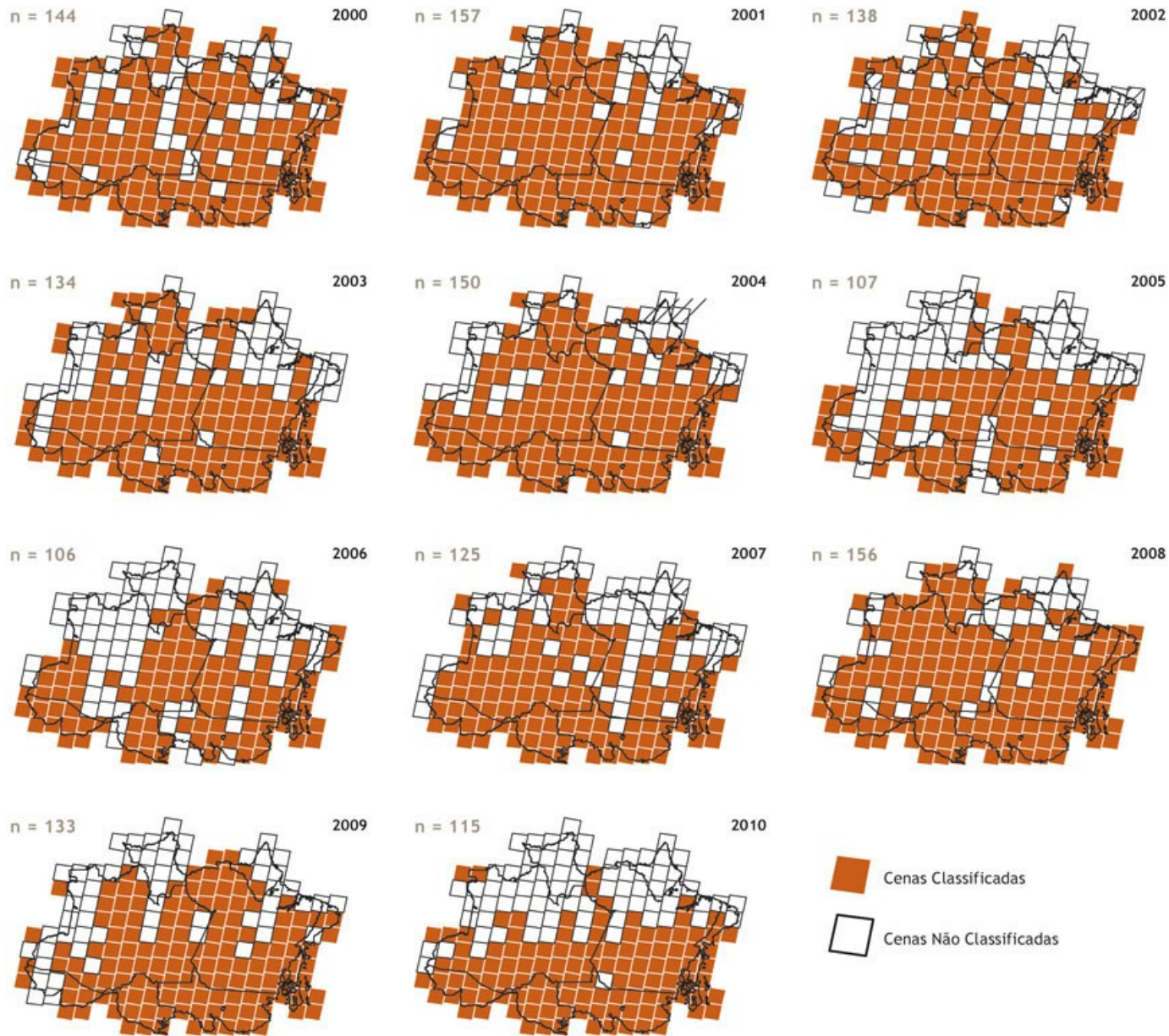


Imagens Fração e NDFI

a) Paragominas, Pará State - 223/62

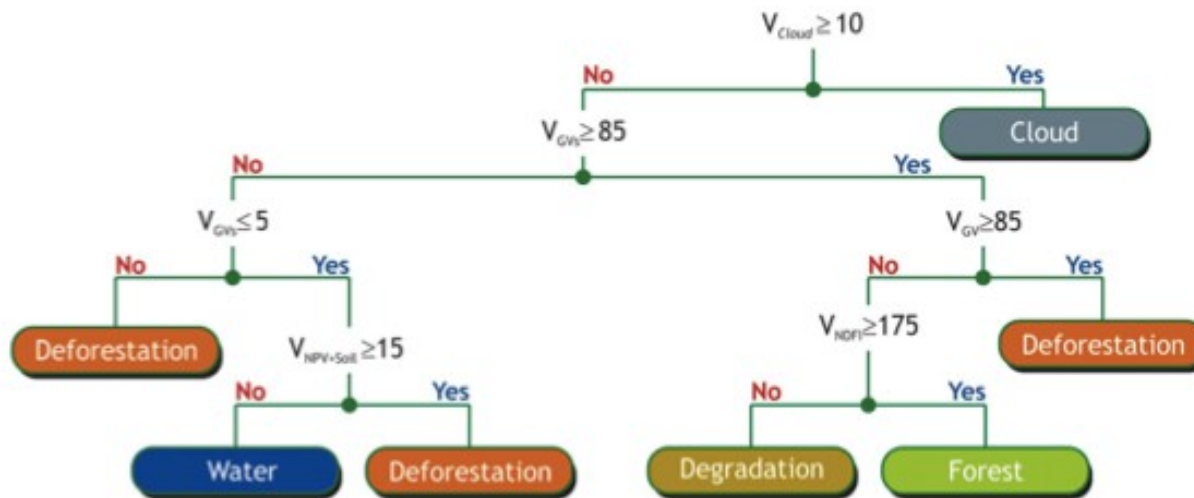


Abrangência do Mapeamento

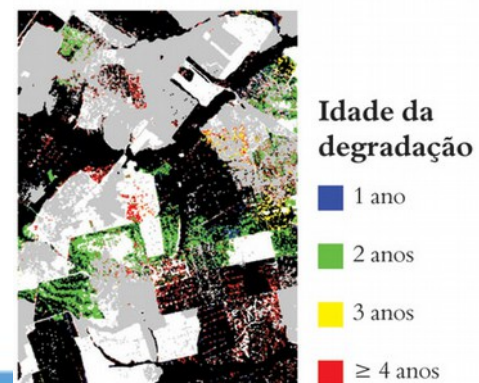
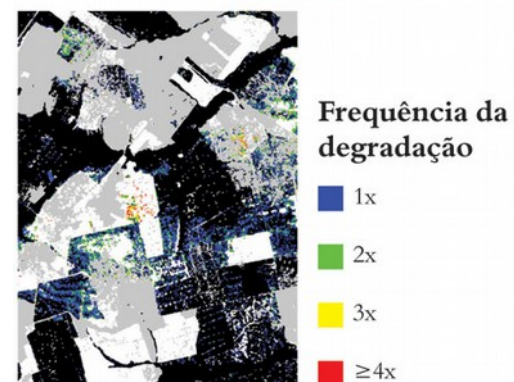
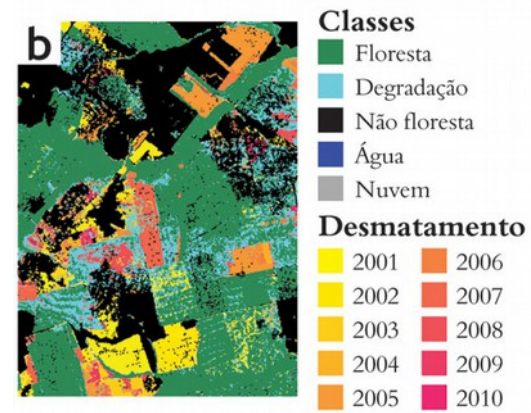
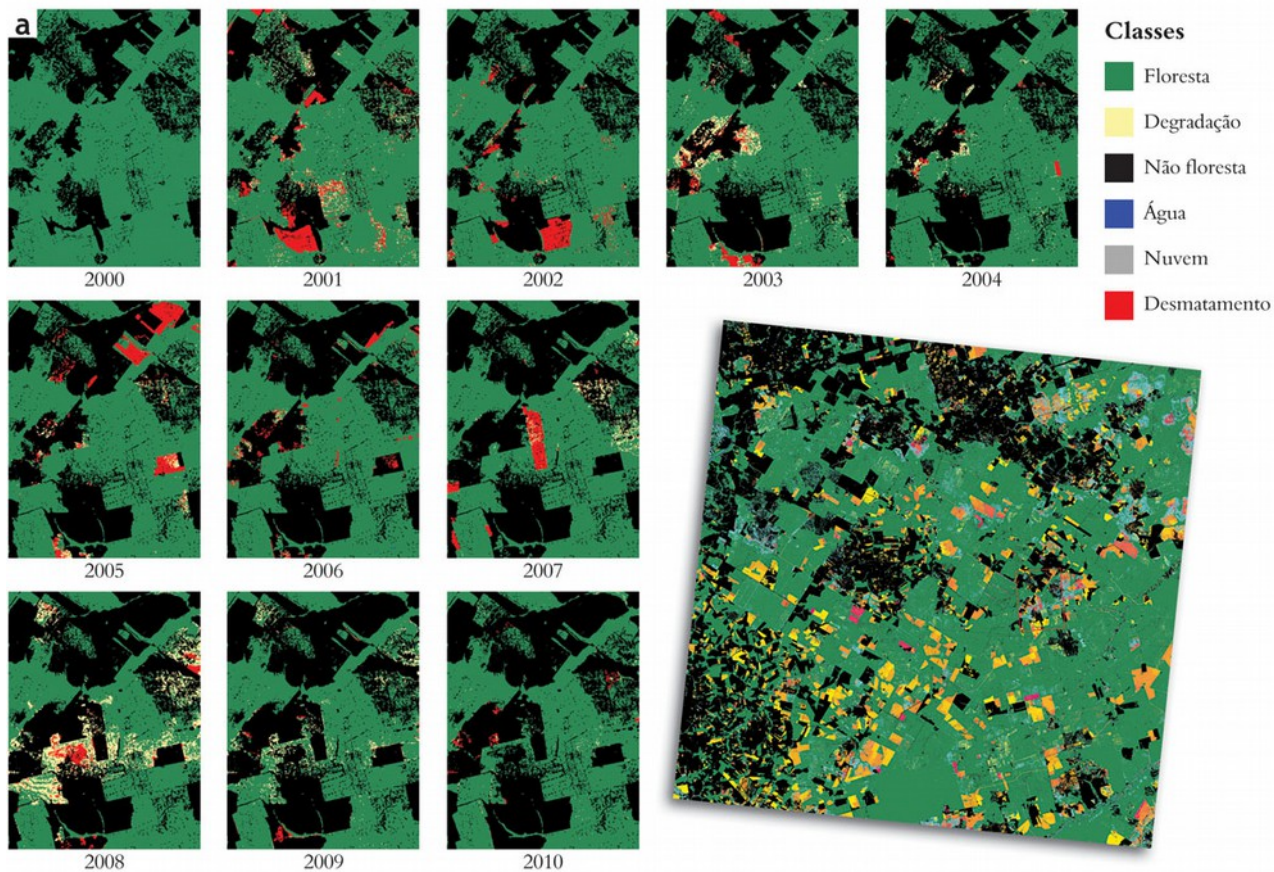


Árvore de Decisão (Knowledgebased Decision Tree)

Figure 4. Empirical decision tree used for classifying deforestation and forest degradation. NDFI variable was rescaled to 0–200, meaning that $V_{\text{NDFI}} \geq 175$ translates to $V_{\text{NDFI}} \geq 0.75$.

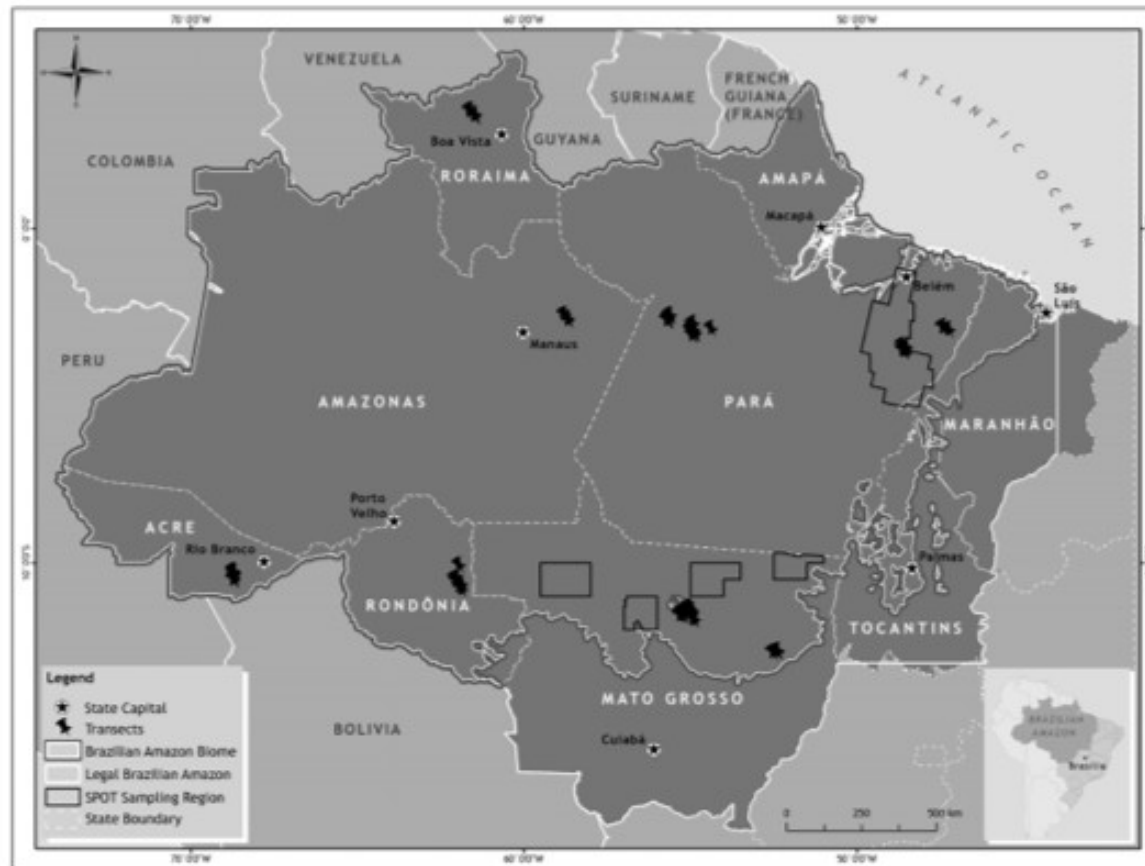


Dinâmica da Cobertura Florestal



Análise de Acurácia

Figure 5. Location of SPOT very high-resolution imagery and forest transects used for accuracy assessment of forest, deforestation and forest degradation classes.



Análise de Acurácia

Table 1. Accuracy assessment of the classification results using high spatial resolution SPOT data only (a), SPOT and forest transects (b) and the impact of applying corrections to the SPOT reference data on the accuracy results (c).

(a)

Reference Data (SPOT)

Land Cover Class	Forest	Degradation	Deforestation	Row Total	User's Accuracy	User's Standard Deviation
Forest	884	2	22	908	0.97	0.006
Degradation	6	20	14	40	0.50	0.080
Deforestation	60	14	432	506	0.85	0.016
Column Total	950	36	468	1,454	-	-
Producer's Accuracy	0.93	0.56	0.92	-	-	-
Producer's Standard Deviation	0.008	0.084	0.013	-	-	-
Overall Accuracy = 0.92 (0.007)						

(b)

Reference Data (SPOT + Transects)

Land Cover Class	Forest	Degradation	Deforestation	Row Total	User's Accuracy	User's Standard Deviation
Forest	942	11	22	975	0.97	0.005
Degradation	8	102	14	124	0.82	0.035
Deforestation	60	14	432	506	0.85	0.016
Column Total	1,010	127	468	1,605	-	-
Producer's Accuracy	0.93	0.80	0.92	-	-	-
Producer's Standard Deviation	0.008	0.036	0.013	-	-	-
Overall Accuracy = 0.92 (0.007)						

Análise de Acurácia

(c)

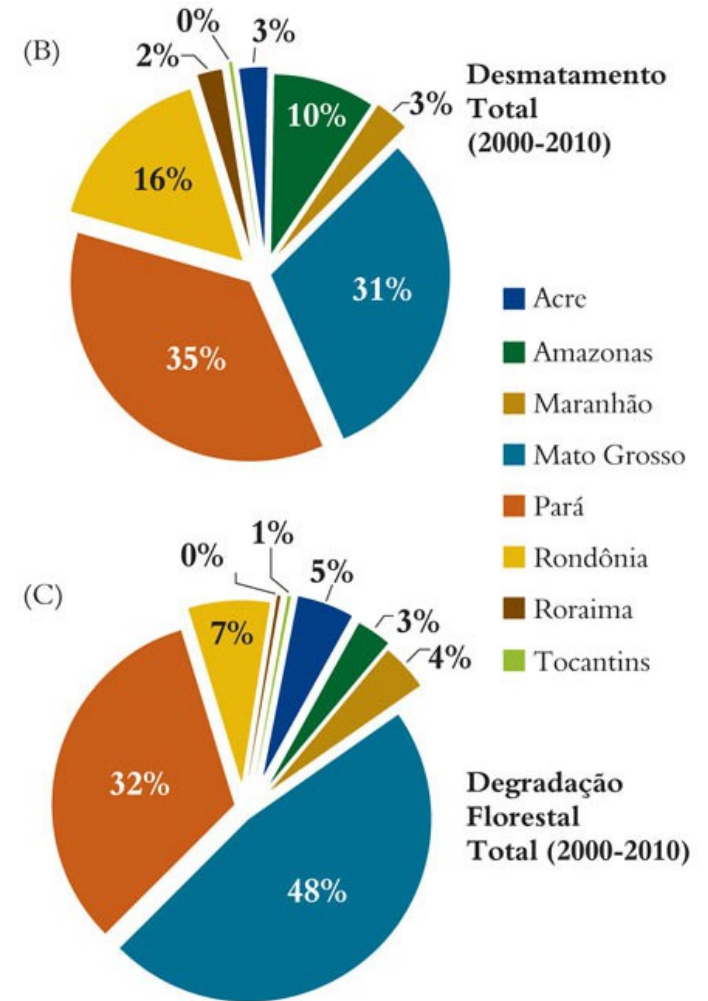
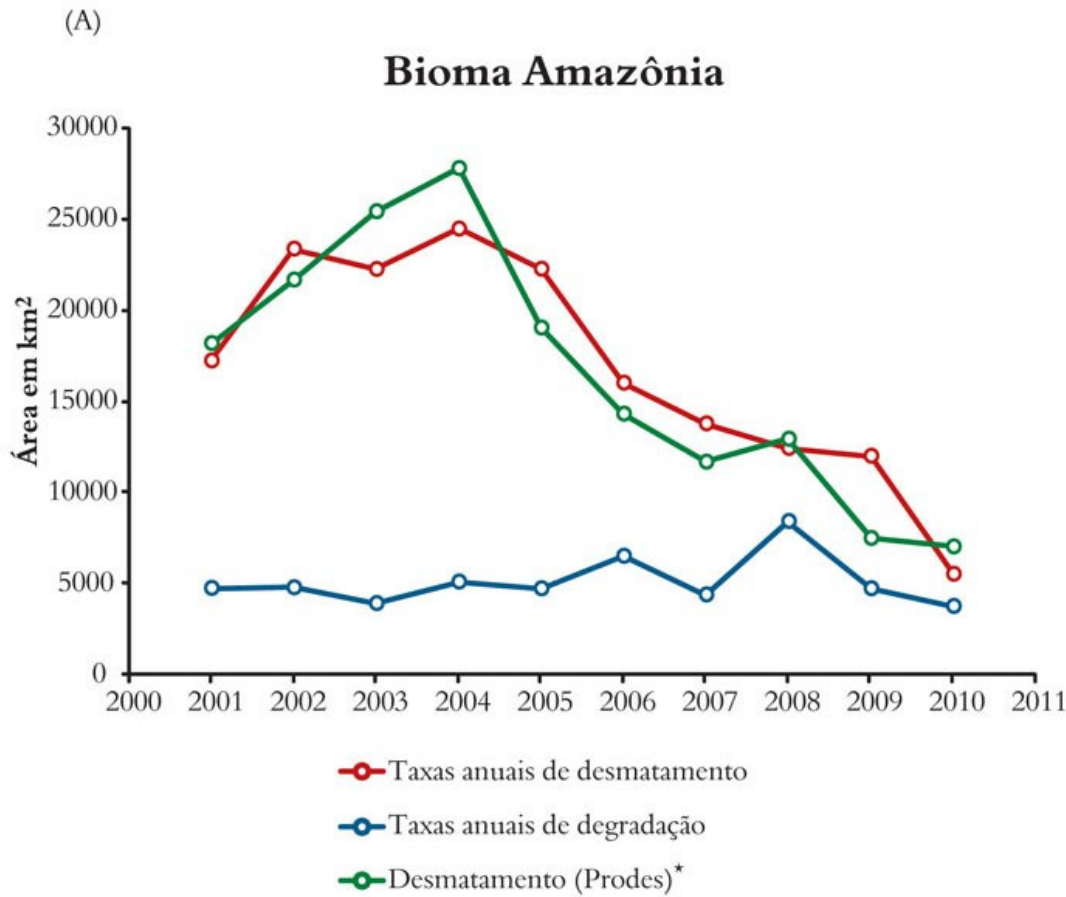
Influence of Reference Data (SPOT) "Corrections" on Map Accuracy

Version	Correction to Reference Data Set	Number of Samples	% Overall Agreement
1	None	1,725	0.79
2	Geocorrection	1,644	0.83
3	Geocorrection; Map edge	1,600	0.86
4	Geocorrection; Mixed pixel; Map edge	1,594	0.86
5	Geocorrection; Change pixel	1,502	0.89
6	Geocorrection; Change pixel; Mixed pixel	1,498	0.89
7	Geocorrection; Change pixel; Mixed pixel; Map edge	1,454	0.92

Excluded Samples

Reason for Exclusion	Number of Samples
No Data	3
Geocorrection	81
Change pixel	142
Mixed pixel	4
Map edge	44
Cloud	21
Water	231

Resultados



* Fonte: Instituto Nacional de Pesquisas Espaciais - INPE (http://www.obt.inpe.br/prodes/prodes_1988_2012.htm)

NovasPlataformasdeMonitoramento: Google Earth Engine

The screenshot shows a web browser window with the URL <https://earthengine.google.org/#intro/Amazon>. The page features the Google logo and a search bar. Below the navigation menu, the main content area displays a large satellite image of the Amazon rainforest in Brazil, showing a grid of deforested areas. A timeline at the bottom of the image allows users to view the progression from 1984 to 2012. A scale bar indicates 50 km and 20 mi. A small inset map shows the location of Rondônia in Brazil. The page includes a 'Share or Embed' button and a descriptive paragraph about the timelapse.

Google Earth Engine

<https://earthengine.google.org/#intro/Amazon>

Search anywhere (e.g. "Las Vegas") to see its timelapse...

Send feedback Sign in

Earth Engine > Landsat Annual Timelapse 1984-2012

Home Data Catalog Workspace

50 km
20 mi

2012
Fast 1984 2012

Now viewing: Amazon Deforestation, Brazil


Share or Embed

Explore a global timelapse of our planet, constructed from Landsat satellite imagery. The Amazon rainforest is shrinking at a rapid rate to provide land for farming and raising cattle. Each frame of the timelapse map is constructed from a year of Landsat satellite data, constituting an annual 1.7-terapixel snapshot of the Earth at 30-meter resolution. The Landsat program, managed by the USGS, has been acquiring images of the Earth's surface since 1972. Landsat provides critical scientific information about our changing planet.

<https://earthengine.google.org/#intro/Amazon>

amazon

Novas Plataformas de Monitoramento: Google Earth Engine



Google Earth Engine

<https://earthengine.google.org/#intro/AmazonNDFI>

Google

Search Places or Keywords...

Send feedback Sign in

Earth Engine > Precomputed Datasets

Home Data Catalog Workspace

Now viewing: NDFI over the Amazon

<https://earthengine.google.org/#intro/AmazonNDFI>

Carlos Souza - AMAZON

Fractions of green vegetation, soil, and non-photosynthetic vegetation are extracted and then combined into a new index called NDFI, or Normalized Difference Fraction Index. NDFI is designed to detect not only deforestation but also forest degradation and is used in AMAZON's SAD (Sistema de Alerta de Desmatamento) system for monitoring forest change.

Data SIO, NOAA, U.S. Navy, NGA, GEBCO
US Dept of State Geographer
© 2014 Google
© 2014 Inav/Geosistemas SRL

Google earth
Termos de Uso

mazon

NovasPlataformasdeMonitoramento: Google Earth Engine

The screenshot displays the Google Earth Engine Playground interface. At the top, the browser address bar shows the URL: <https://ee-api.appspot.com/5cd0550954fca96220fdf3ea9af2a10b>. The page title is "Earth Engine Playground".

The interface is divided into several sections:

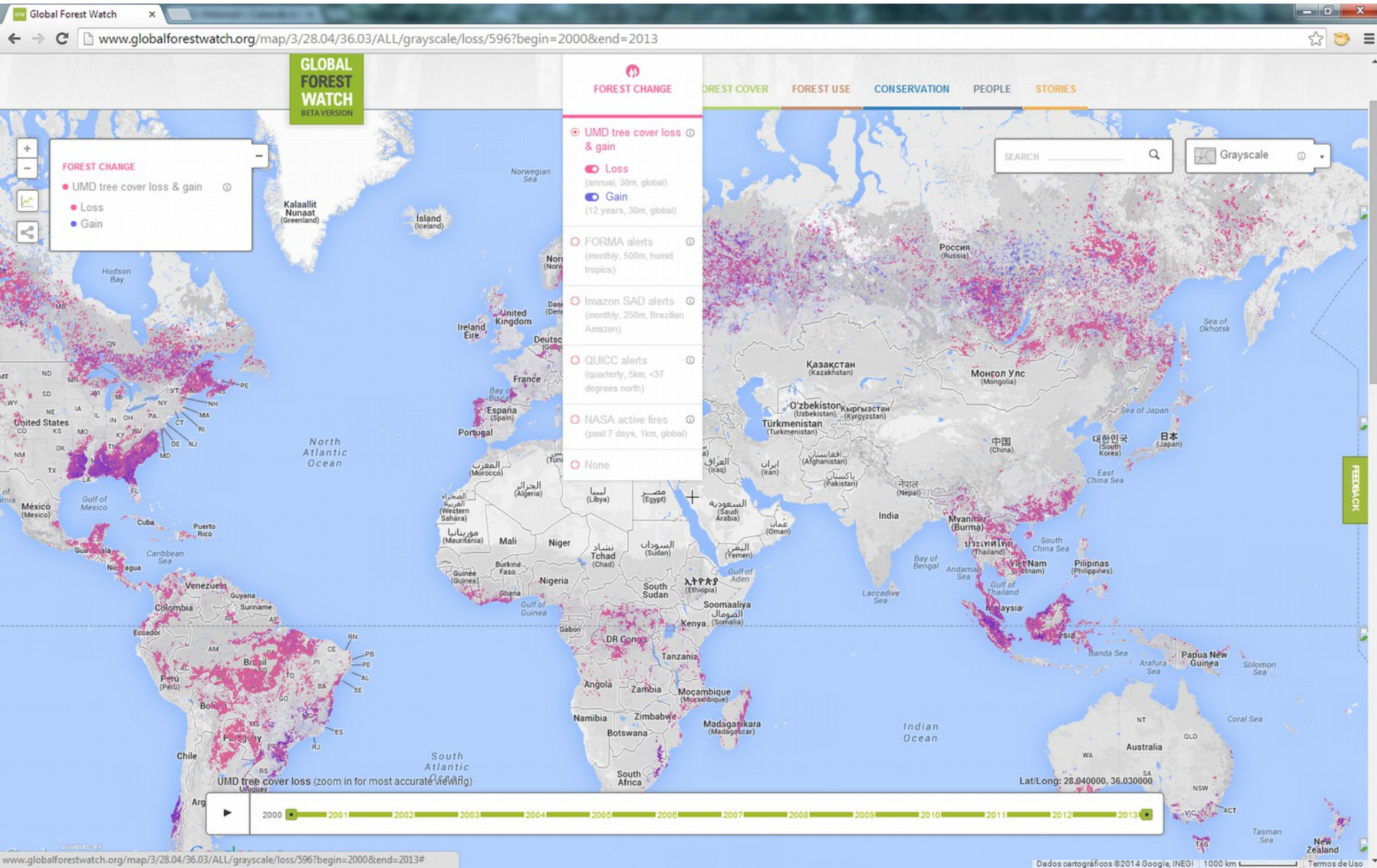
- Examples/Docs:** A sidebar on the left lists various examples such as "Saved Code", "Feature Collection", "Buffer", "Computed Area Filter", "Count Features", "Distance", and "From Fusion Table". The "Saved Code" section is expanded to show "Landsat get fraction and ndfi".
- Edit Code:** A central code editor displays the following JavaScript code:

```
1 // Landsat get fraction and ndfi
2 // Define endmembers
3 // var endmembers = [[ 119.0, 475.0, 169.0, 6250.0, 2399.0, 675.0],
4 //                       [1514.0, 1597.0, 1421.0, 3053.0, 7707.0, 1975.0],
5 //                       [1799.0, 2479.0, 3158.0, 5437.0, 7707.0, 6646.0]];
6
7 var endmembers = [[ 119.0, 475.0, 169.0, 6250.0, 2399.0, 675.0],
8                   [1514.0, 1597.0, 1421.0, 3053.0, 7707.0, 1975.0],
9                   [1799.0, 2479.0, 3158.0, 5437.0, 7707.0, 6646.0],
10                  [4031.0, 8714.0, 7900.0, 8989.0, 7002.0, 6607.0]];
11
```
- Console:** A panel on the right shows the output of the code execution:

```
Lng, Lat: -91.57379,30.28539
- EE Surface Reflectance
  B1: 287
  B2: 385
  B3: 220
  B4: 2866
  B5: 1256
  B7: 439
  atmos_opacity: 293
  QA: 2144
```
- Map:** A large map area in the center shows a satellite view of a landscape with a color-coded overlay representing surface reflectance. The map includes labels for roads (e.g., Ronald Reagan Hwy, Par Rd 810), lakes (e.g., Lake Charles, Lake Maurepas), and geographical features (e.g., Lacassine National Wildlife Refuge).
- Layers/Map/Satellite:** A control panel at the bottom right allows switching between "Layers", "Map", and "Satellite" views.

The bottom right corner of the interface features the Amazon logo and copyright information: "Map data ©2014 Google Terms of Use Report a map error".

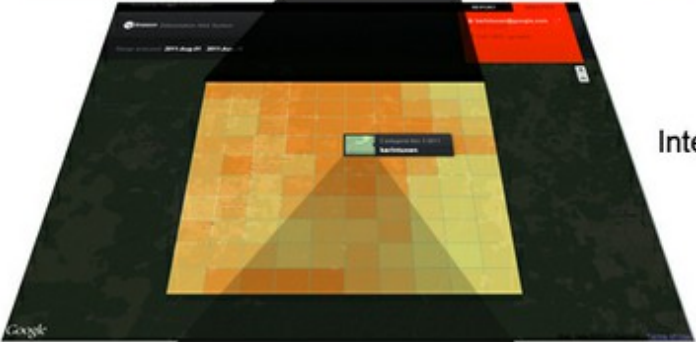
NovasPlataformasdeMonitoramento: Global Forest Watch



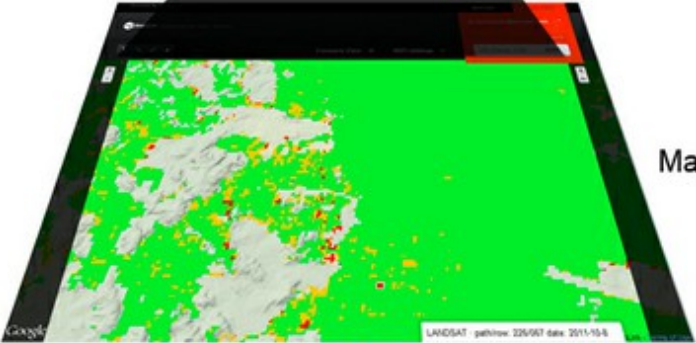
Novas Plataformas de Monitoramento: SAD EE



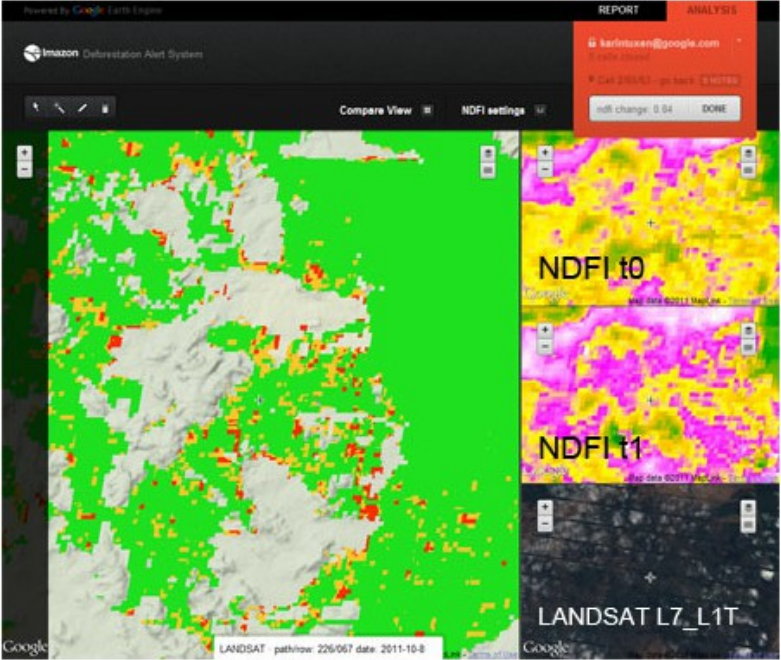
Mega-cells



Intermediate cells



Map-cells



Novas Plataformas de Monitoramento: SAD+

amazon

sad-ee.appspot.com/analysis#cell/0/0/0

Powered By Google Earth Engine

Amazon Deforestation Alert System

Ranges analyzed: 2012-May-01 - 2012-May-31

ANALYSIS REPORT

csouza608

0 cells closed

Global map

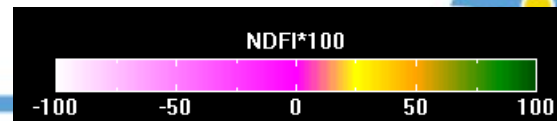
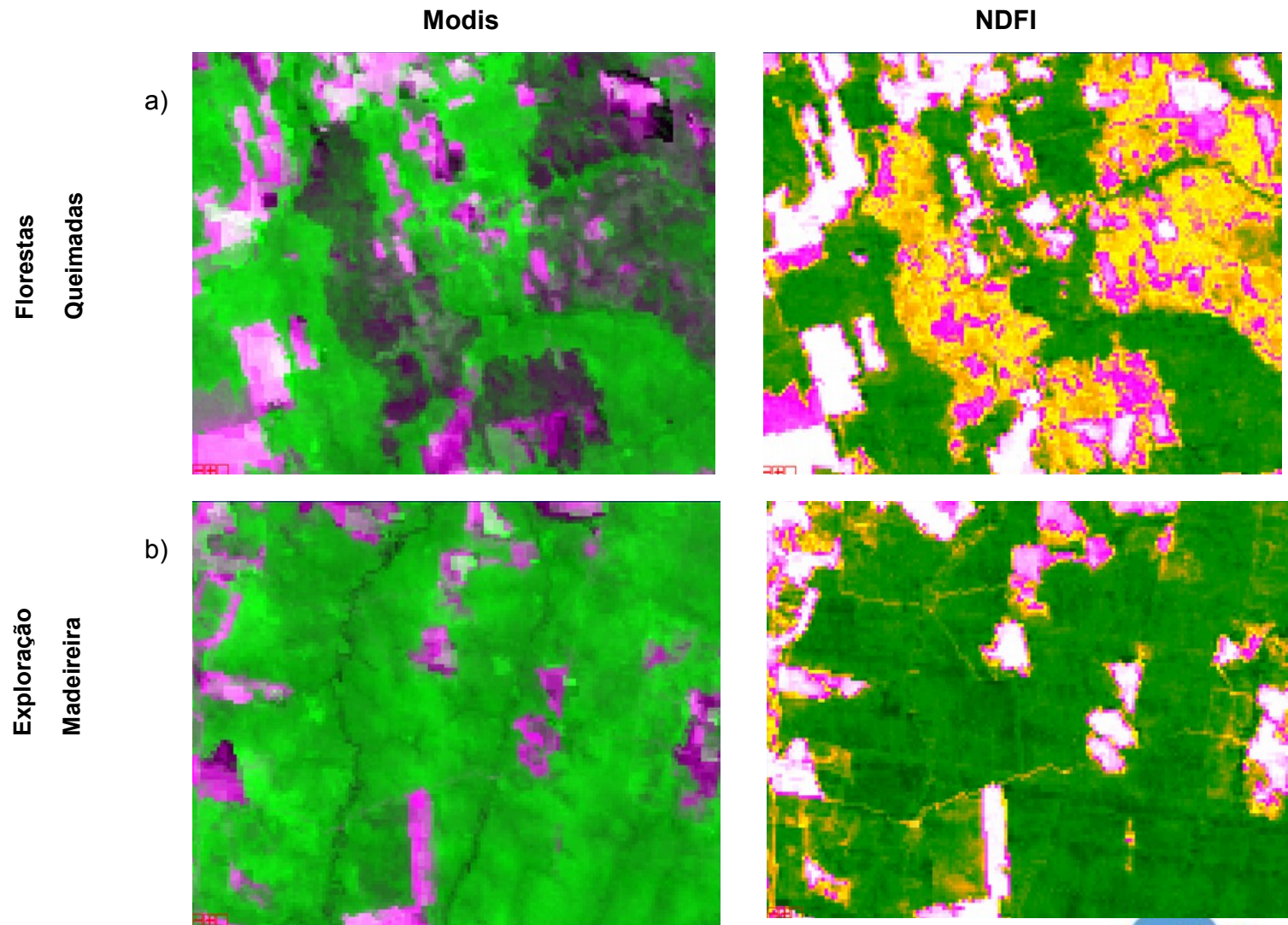
401/7400 (0%) GENERATE

- Multi-sensor
- Escala global
- Observações de campo
- Monitoramento "Crowdsourcing"
- Acesso via GFW

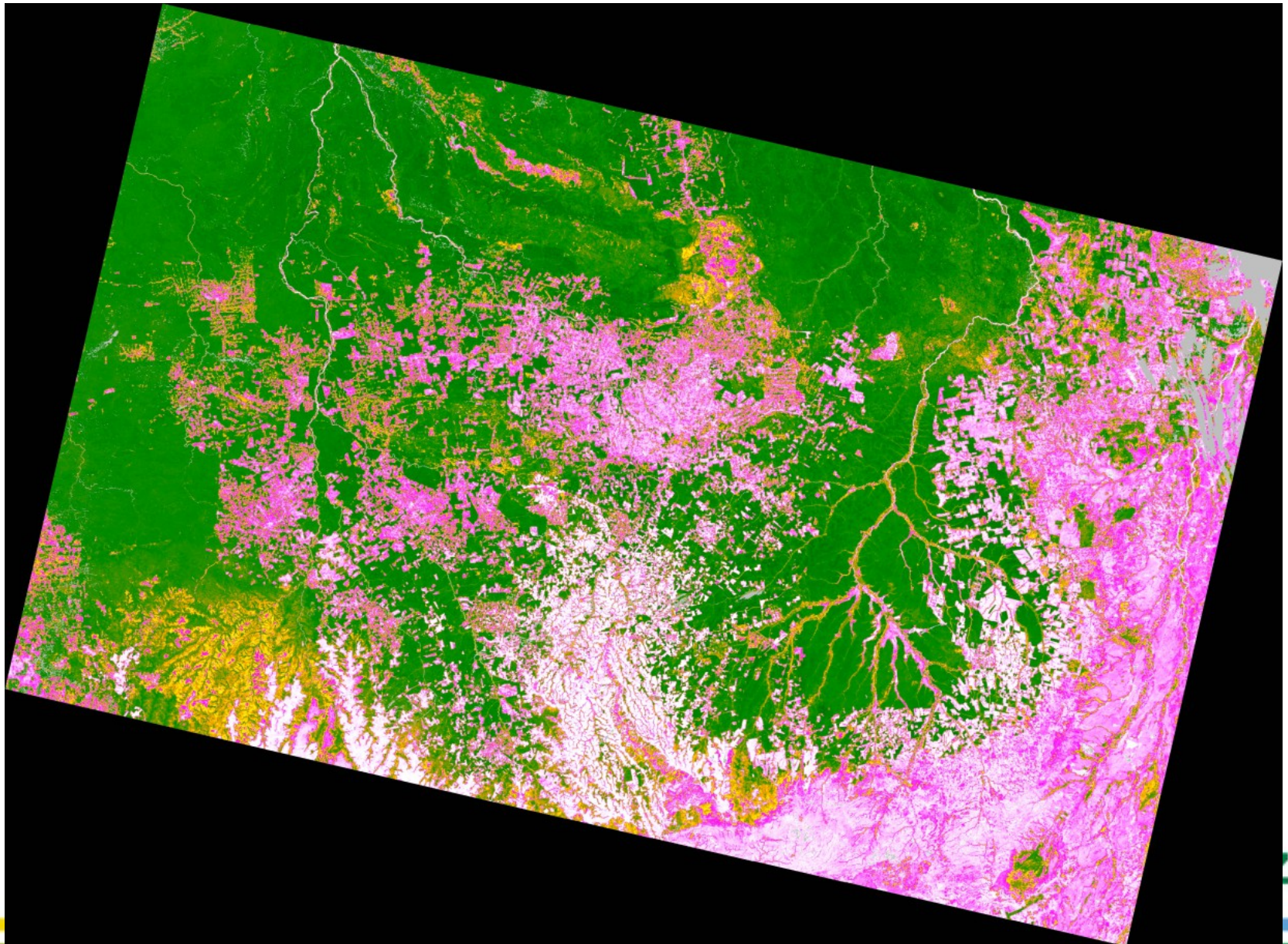
Google

Map data ©2012 Google, INEGI, Inav/Geosistemas SRL, LeadDog Consulting, MapLink, Mapcity, Tele Atlas - Terms of Use

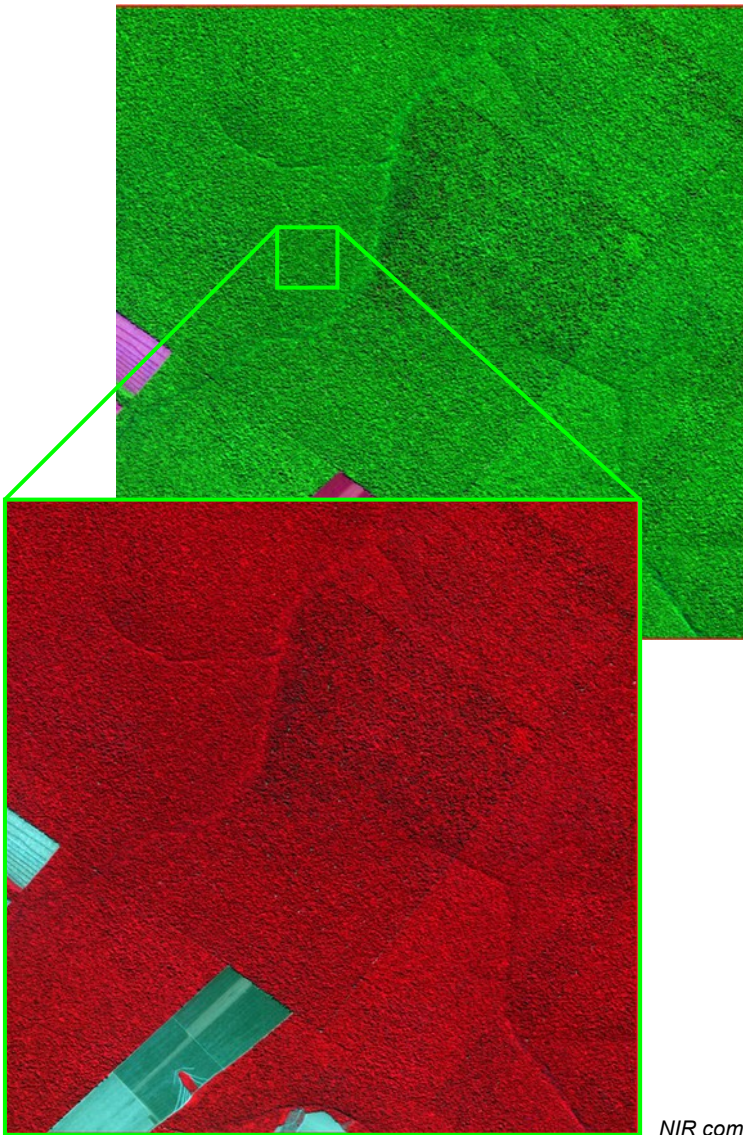
Multi-Sensor: NDFI – MODIS



Multi-Sensor: NDFI-MERIS

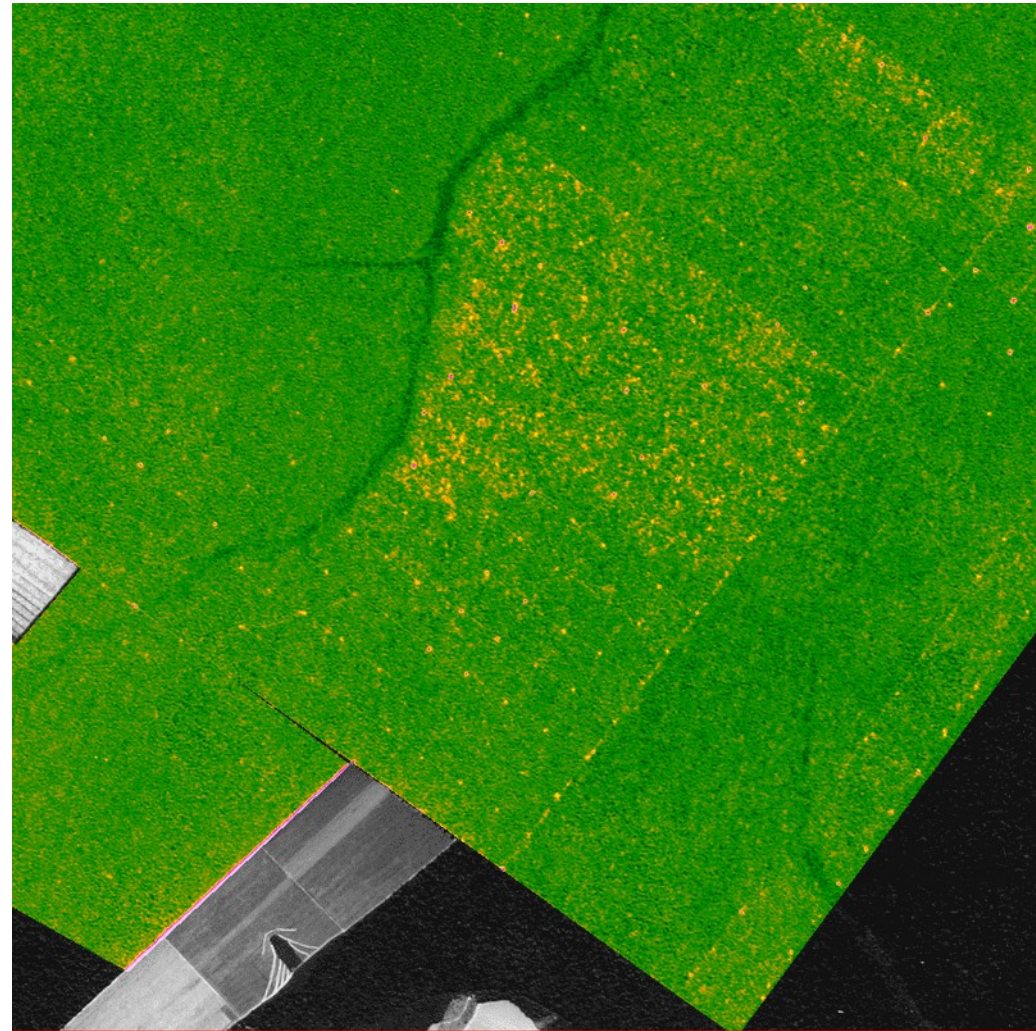


Multi-Sensor: NDFI-SPOTImage



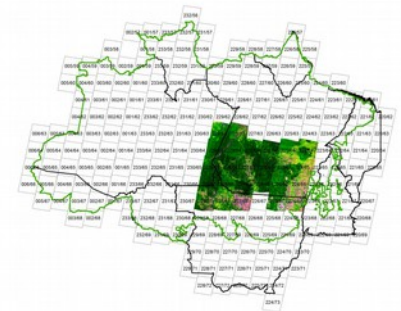
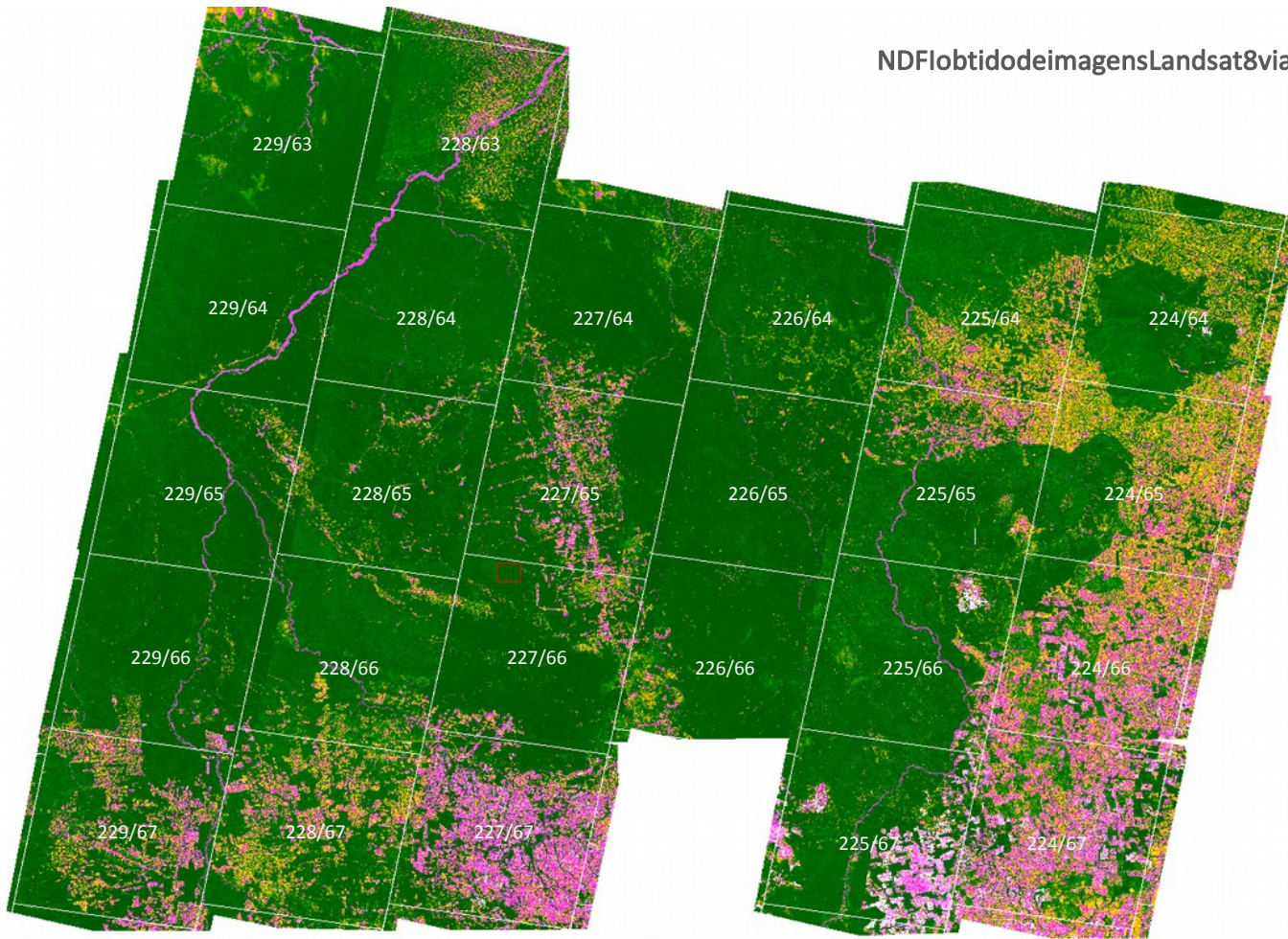
NIR composite image

NDFI map



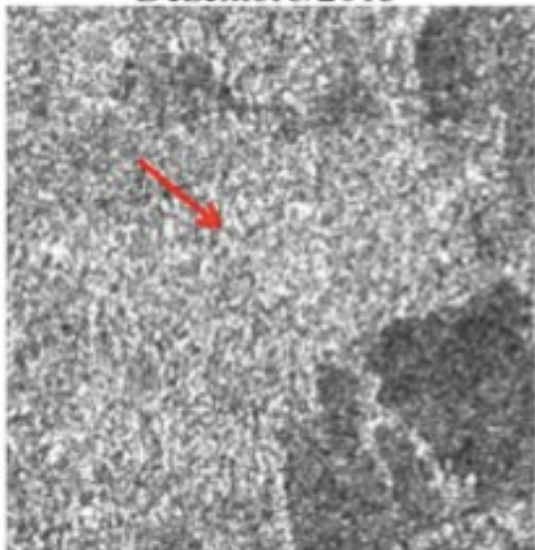
Multi-Sensor:Landsat8

NDFIobtidoemagensLandsat8viaImgTools

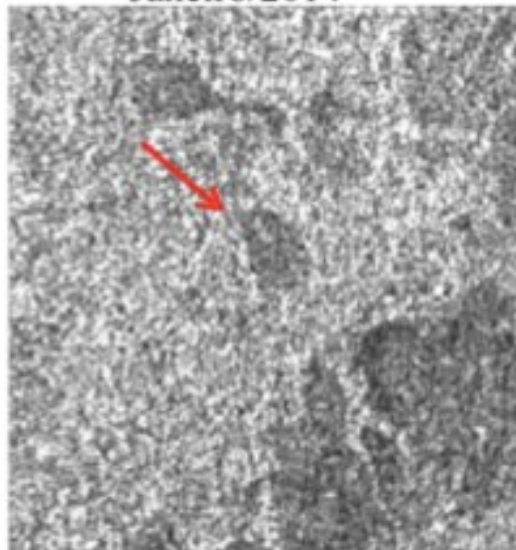


Multi-Sensor:ImagensCosmo-SkyMed

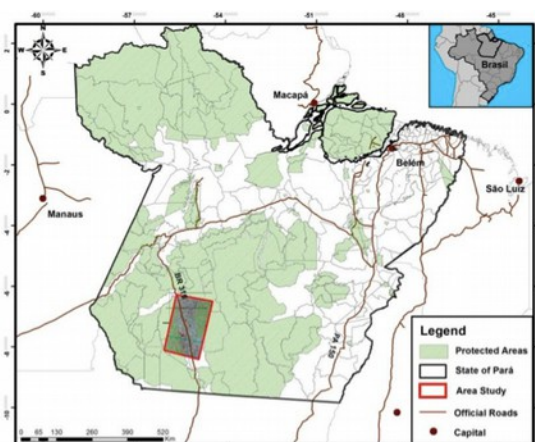
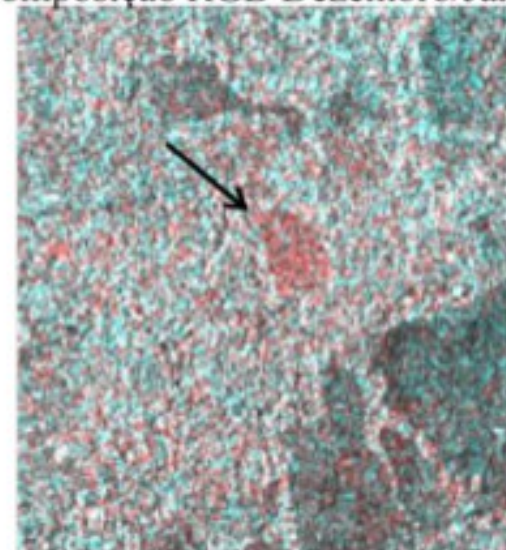
Dezembro/2013



Janeiro/2014



Composição RGB Dezembro/Janeiro



Scansar—wideregion: 100km x 100km; pixel 30m

Coberturamensal:novembro2013 a julho2014

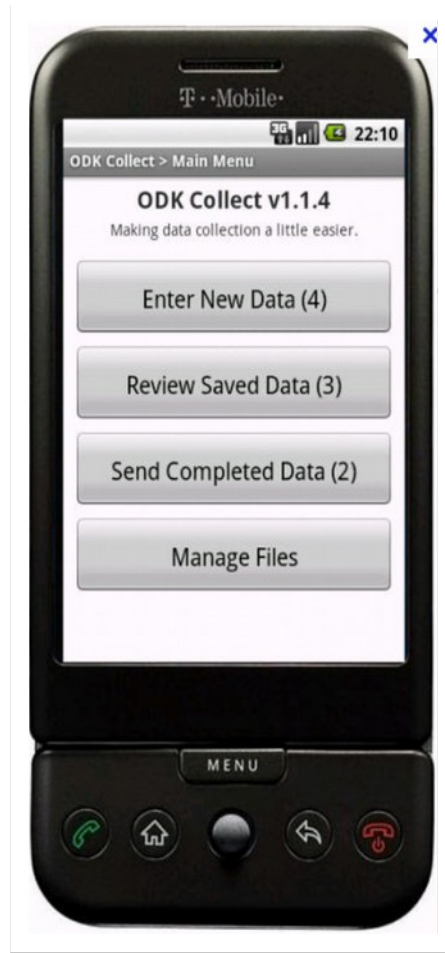
Observações de Campo



Integração Satélite e Campo

Open Data Kit (ODK)

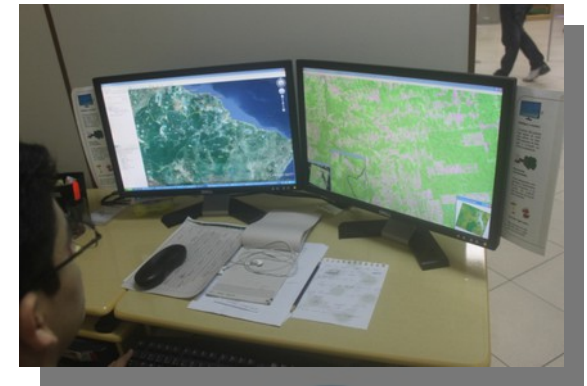
Verificação no campo



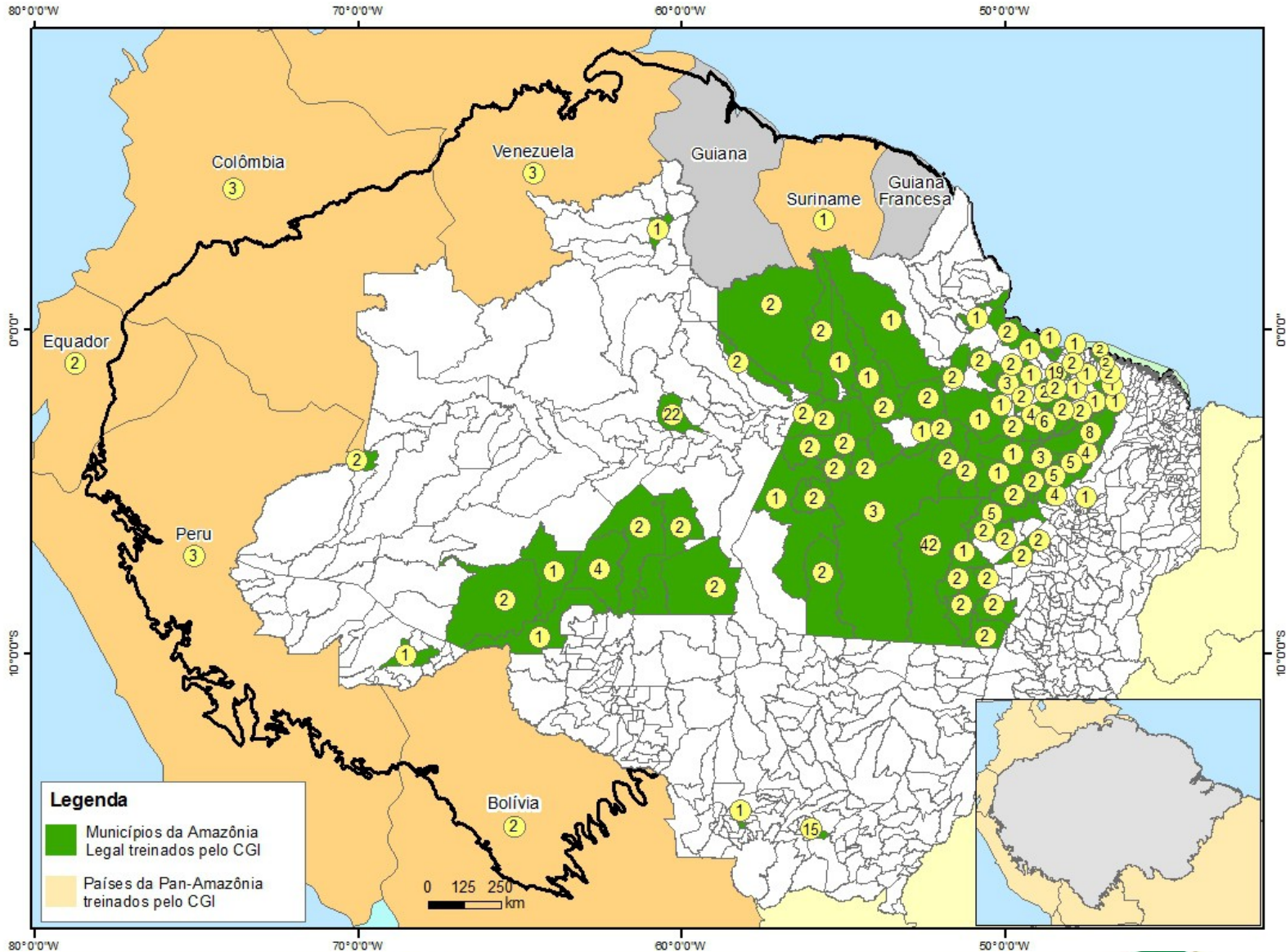
Cloud



Análise e relatórios...



Monitoramento Crowdsourcing



Monitoramento Crowdsourcing

- Processamento na “cloud” ...
- Multi-sensor...
- Cubo de imagens vs. cenas...
- Muitas fontes de mapas...
- Integração com dados de campo...
- Protocolos de validação de mapas...
- Acesso rápido à informação...



Foto: [RBDesign](#)

Geocrowdsourcing...

Equipe:

Antônio Victor Fonseca

Marcelo Justino

Heron Martins

João Victor Siqueira

WildsonQueiroz



Imazon

Instituto
do Homem e
Meio Ambiente
da Amazônia

Colaboradores:

Beto Veríssimo

Marcio Sales

Júlia Ribeiro

Victor Lins

Rodney Salomão

Bruno Oliveira

Denis Conrado



www.imazon.org.br



USAID
FROM THE AMERICAN PEOPLE



FUNDO VALE
integração > transformação > desenvolvimento

skoll
FOUNDATION



Climate and Land Use Alliance
Cultivating solutions for people and the planet