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PREDICTING THE EFFECTS OF GLOBAL CHANGE ON FOREST BIODIVERSITY IN THE CONGO BASIN

Forest degradation estimation using remote sensing:
a case study on Central African Republic

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cirad

Context:

- IPCC recommends to reduce the CO_2 emissions

- Avoiding forest degradation (REDD+) mechanism is proposed

- It still needs a tool for degradation estimation at large scale

- It still need a tool to estimate re-vegetalization

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Objective:

Evaluate the bare soil (tracks) and their re-vegetalization time after logging

Hypothesis:

Re-vegetalization of bare soil depends on substratum nature and track types

Need:

A multi-temporal processing chain has to be developed to estimate bare soil within the forest

Harvesting

Log yard

Tracks and roads

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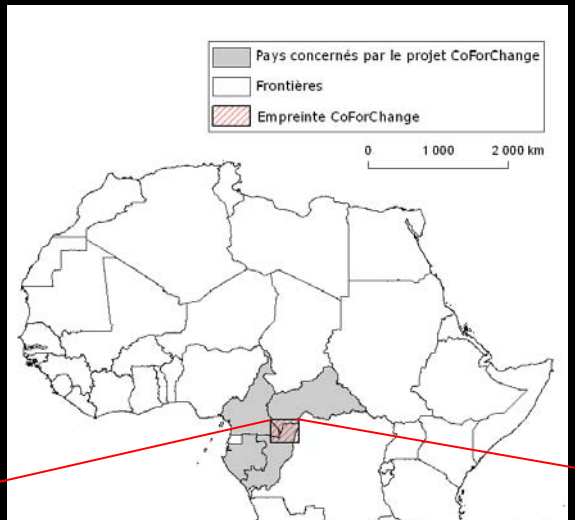
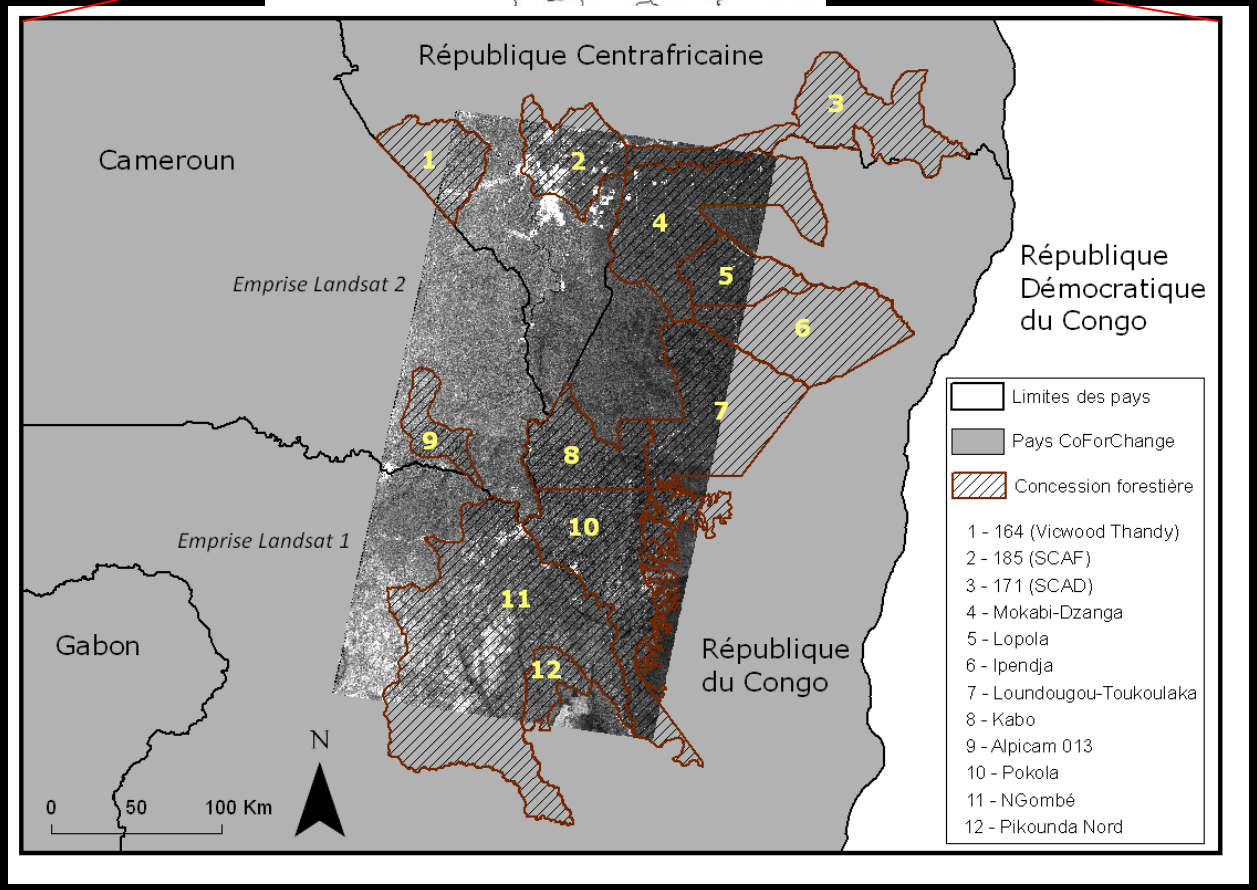
Study area





Material

- **Landsat Images**
  - 30m pixel spatial resolution
  - 180km by 180 km image coverage (3.24 Mha)
  - Multi-spectral data (from green to shortwave infrared)
  - Long term archive (from 1984 to now)
- **Processing modules**
  - ORFEO Toolbox (CNES)
- **Computing**
  - Shell script developed in C++

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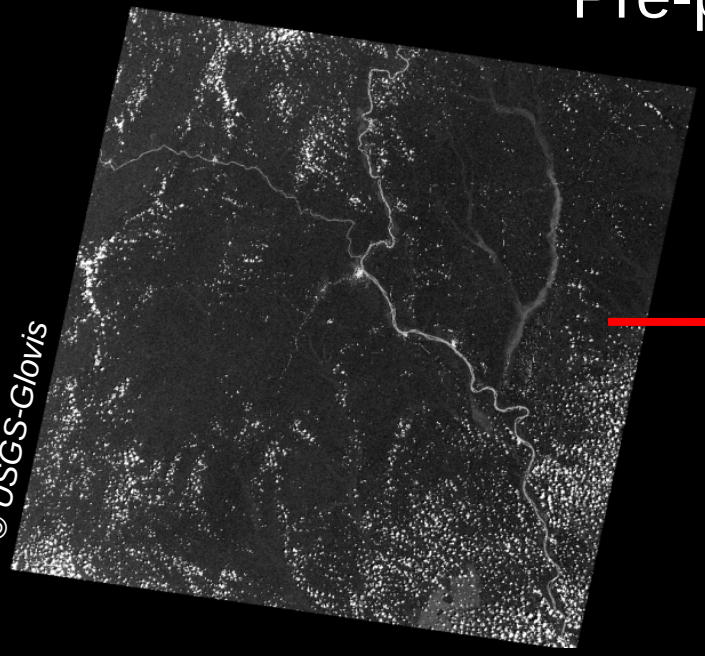
Pre-processing



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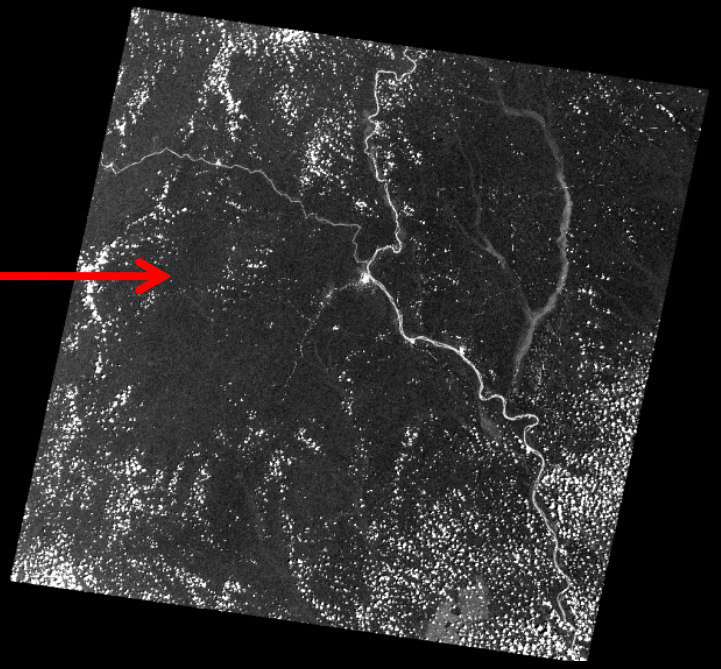


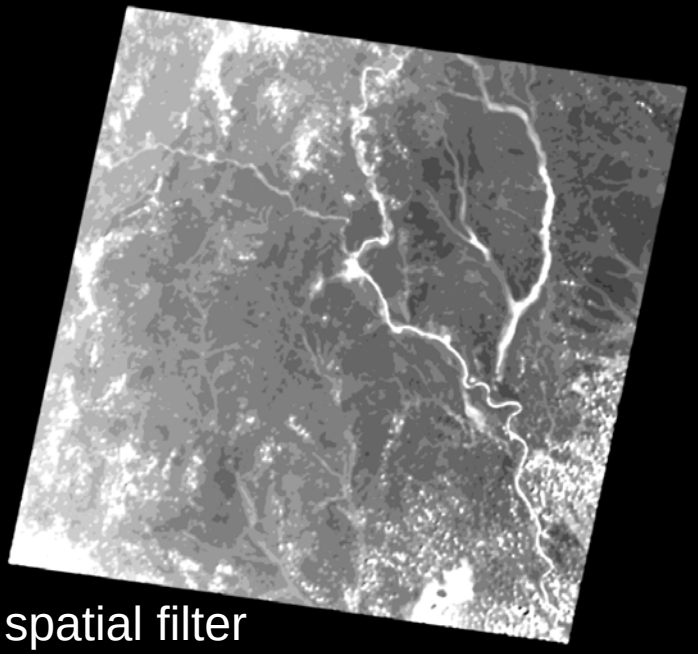
1 - Radiometric calibration

2 - Spectral indices processing

NDVI = (NIR – Red) / (NIR + Red)

GR = (Green – Red) / (Green + Red

NDVI + GR



Local contrast improved by the median spatial filter

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Processing

3 – Bare soil identification
using Red, GR, NDVI+GR channels

4 - Cloud and water masking
using Blue and SWIR channels

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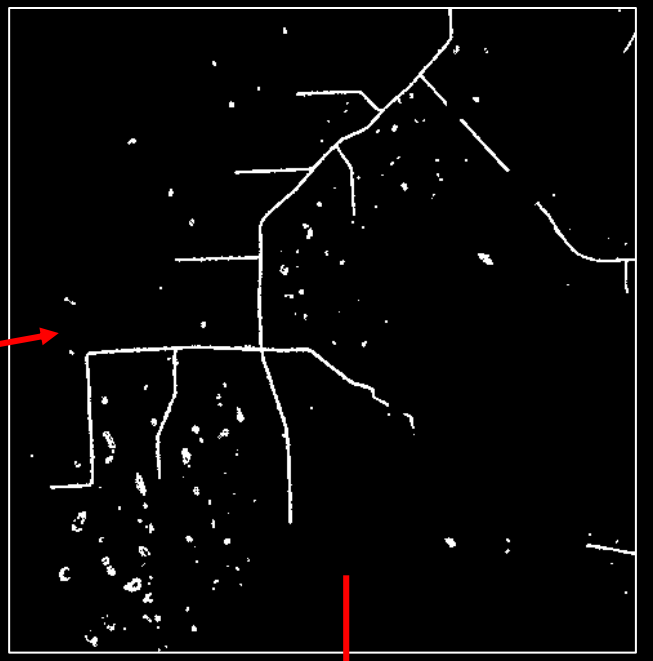
Processing

5 - morphological filter



50 pixels size with an elongation rate of 3

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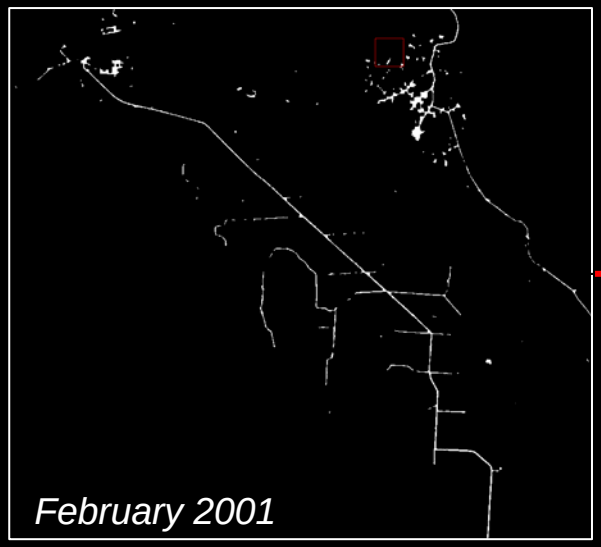
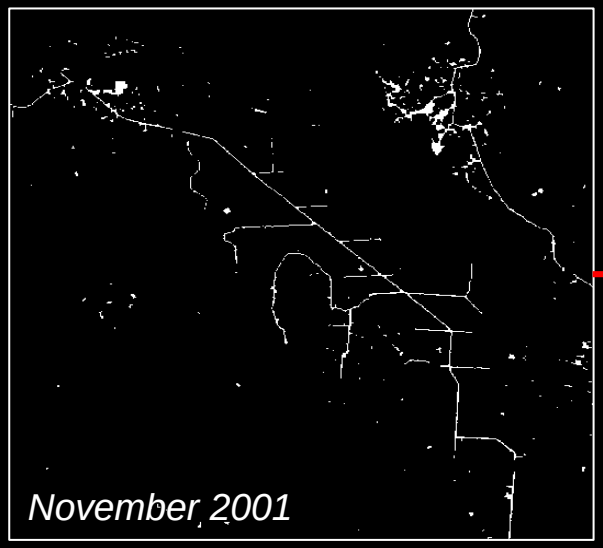
Processing

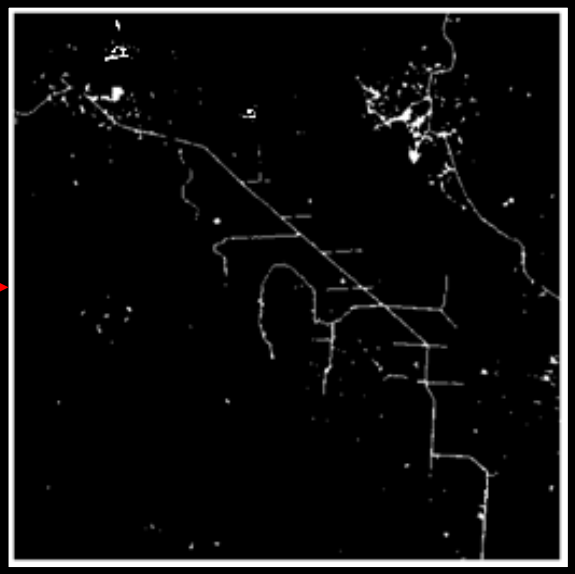


February 2001



November 2001

6 – Yearly synthesis



Annual bare soil mapping in 2001

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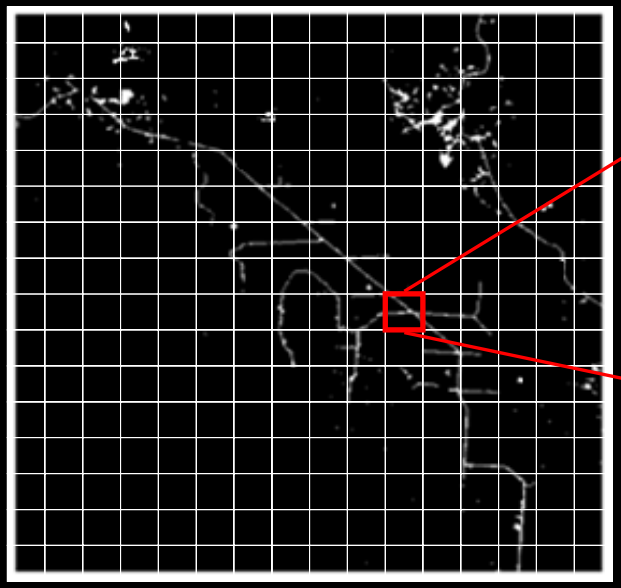
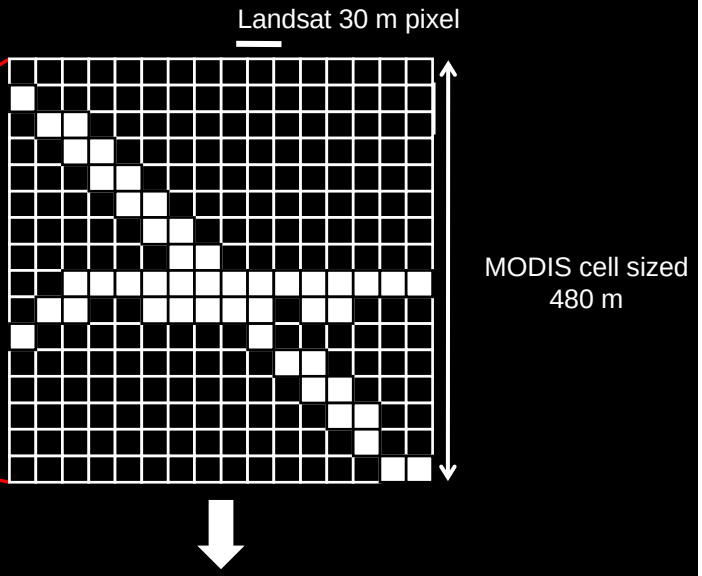
Processing

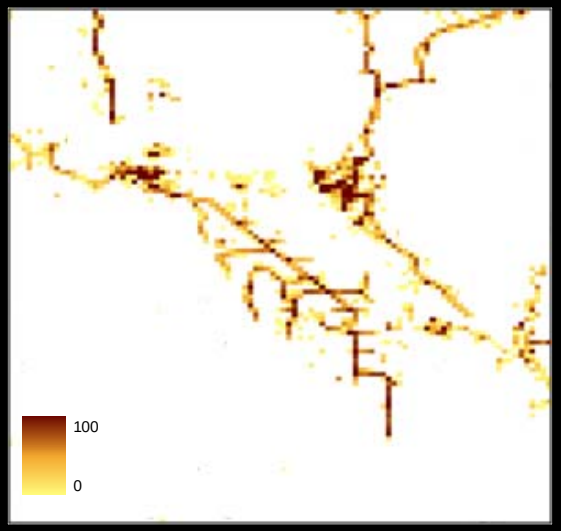
7 – Spatial synthesis



Annual bare soil mapping in 2001

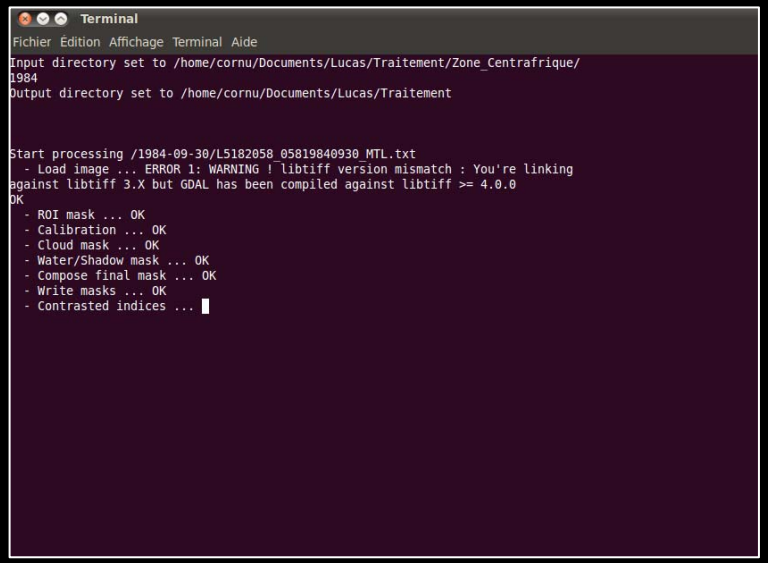


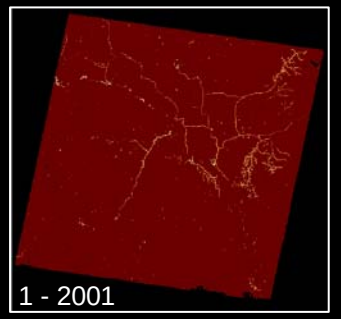
47 bare soil pixels detected
on a surface of 256 pixels
= 18% of bare soil

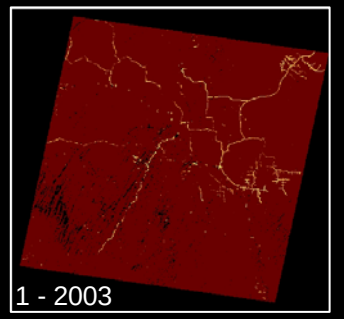


Spatial indication of bare soil in 2001

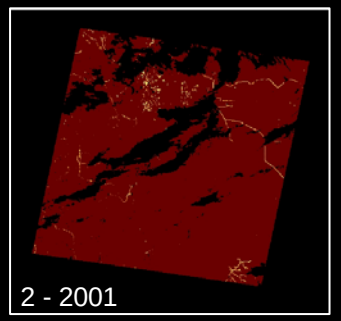
Automated workflow

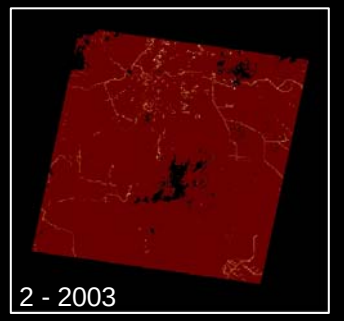






Test zone 1
1990
2000
2001 (3)
2002 (2)
2003





Test zone 2
1986
1987
1990
1994
2001
2002 (2)
2003

1 – corresponding ENVI functions to ORFEO modules
2 – organization of ORFEO modules in a C++ script
3 – run of the script on Linux environment

Processing of test zones databases to produce yearly bare soil index.
From 79 images only 16 were used mainly due to SLC problem from 06/2003.

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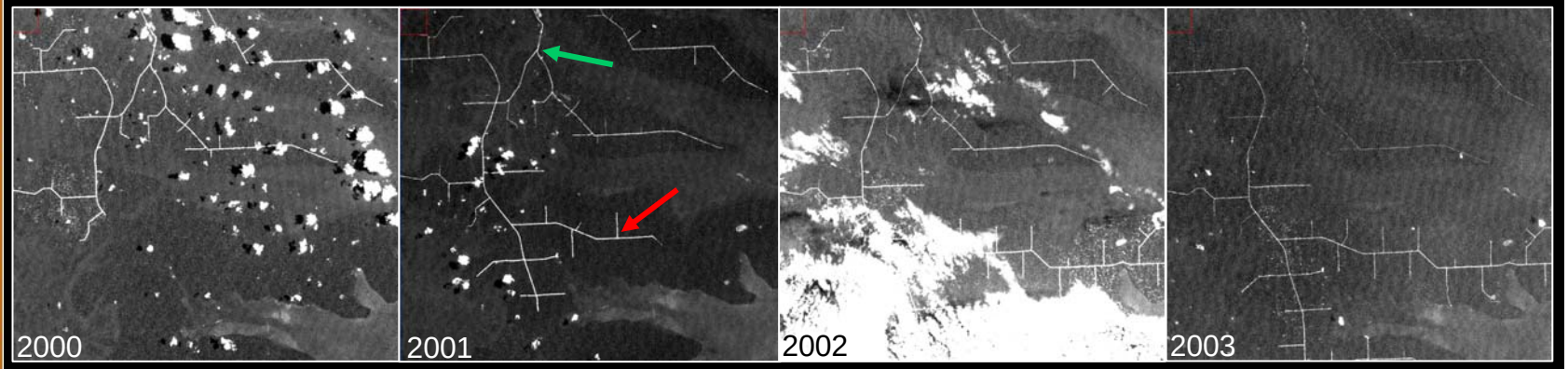
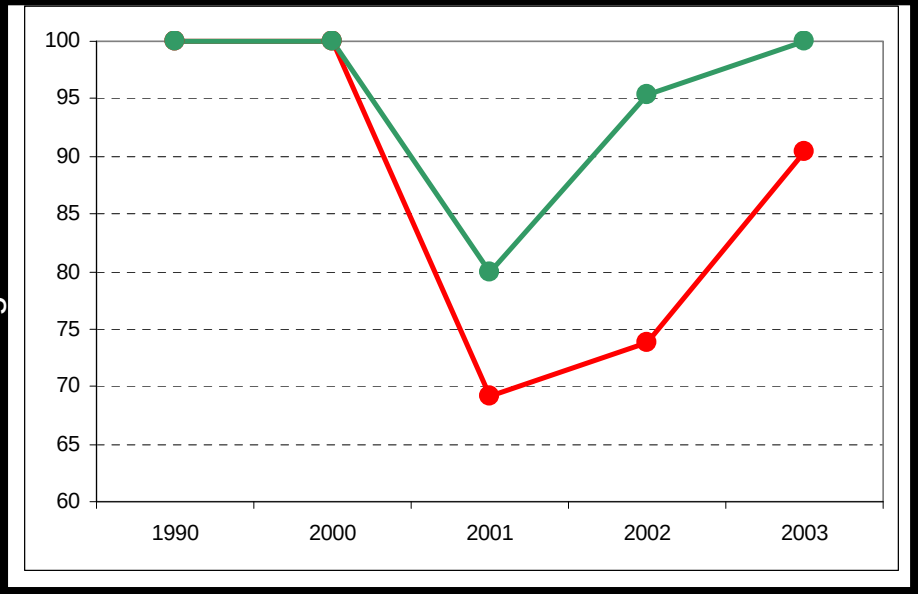
Pixel monitoring (test zone n°1)



Bare soil index

0% 31% 26% 10%



Bare soil index decreasing 2/3 in 2 years

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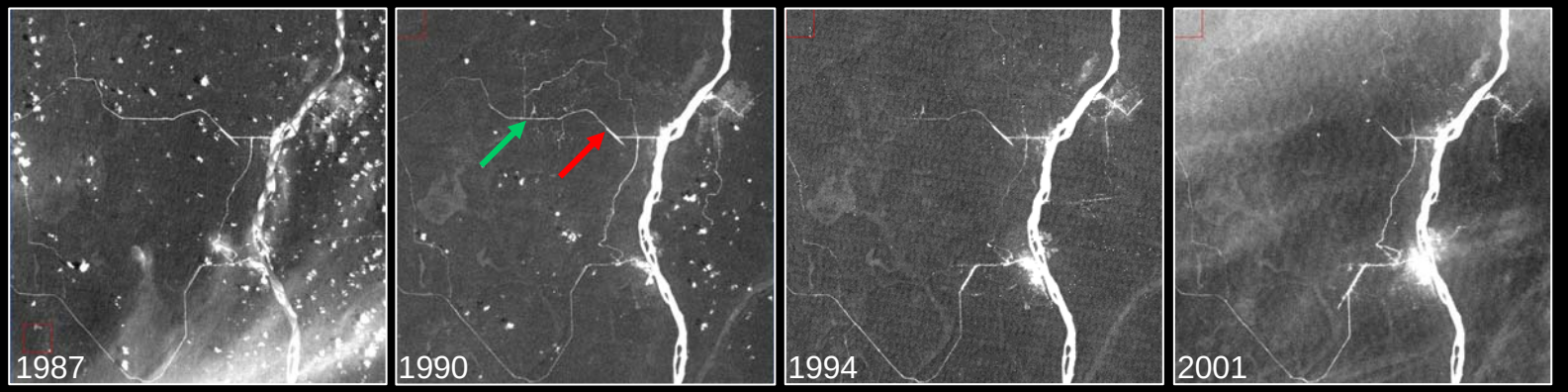
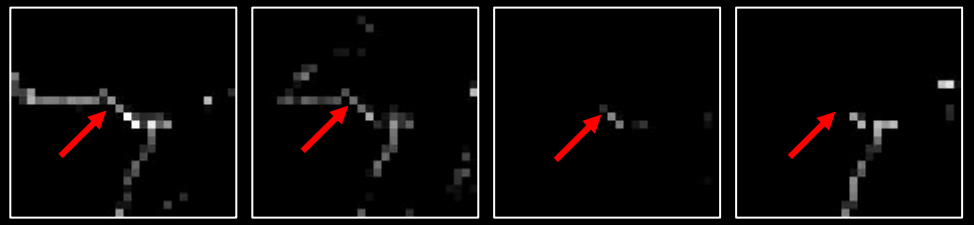
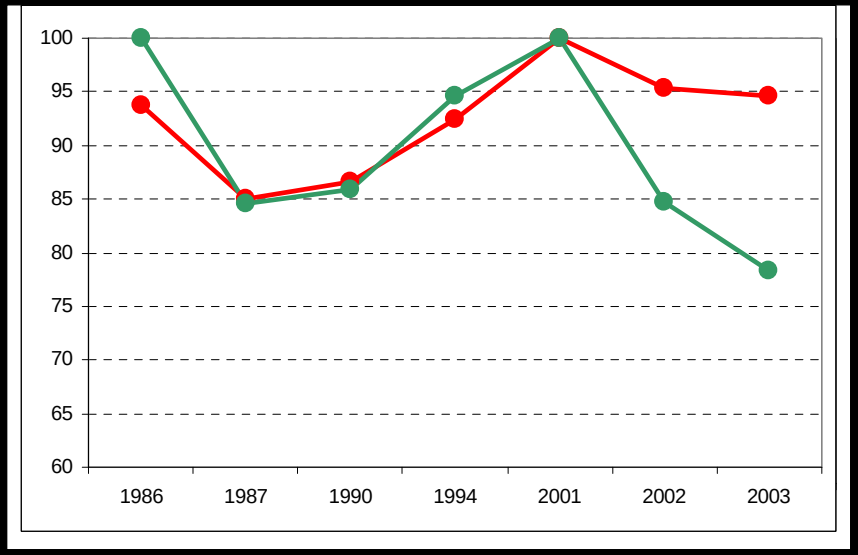
Pixel monitoring (test zone n°2)





Bare soil index

15% 13% 7% 0%



Bare soil index decreasing 1/2 in 7 years

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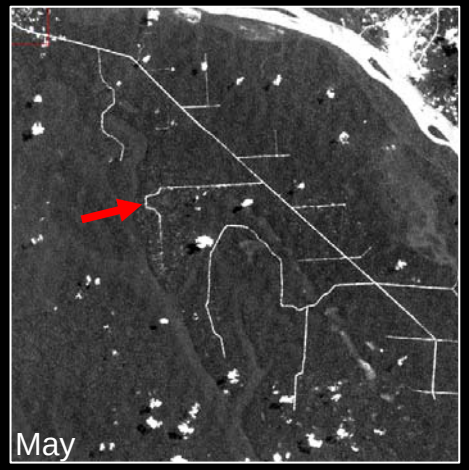
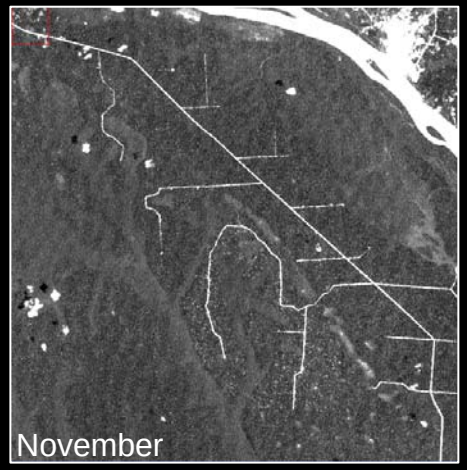
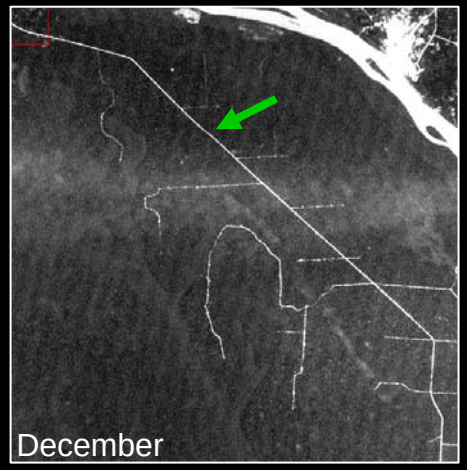
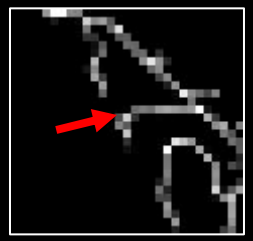
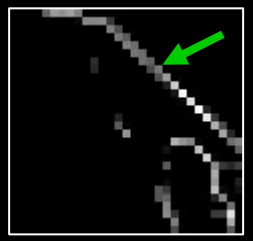
Pixel monitoring (intra-annual)

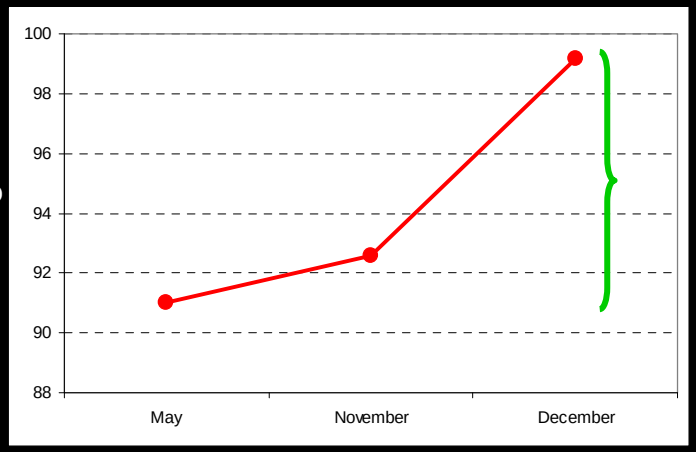




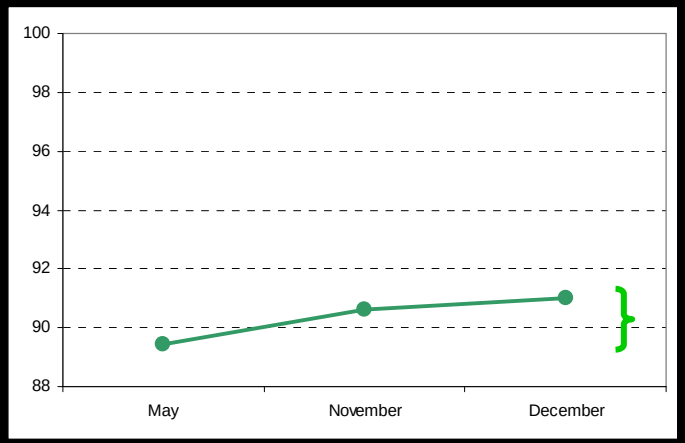








8%



1,5%

Discussion

Zone test n° 1: Bare soil index decreasing 2/3 in 2 years (fast re-vegetalization)

- Quartzite geologic substratum
- track located in a secondary network

Zone test n° 2: Bare soil index decreasing 1/2 in 7 years (slow re-vegetalization)

- Carnot sandstone geologic substratum
- track located close to a village (re-used)

Intra-annual analysis pointed that:

- On a secondary track, bare soil index decrease for 8% in 8 month (fast)
- On a main track, bare soil index decrease only for 1,5% in 8 month (slow)

Perspectives

• Improving the processing by adding modules (re-sampling, atmospheric correction, post-2003 Landsat mosaic)

• Statistical analysis of temporal profiles for all pixels to determine evolution types

• Processing of a larger number of images from Landsat archives

• After satellite reception station installed in Libreville adding a Spot, Pleiades and Sentinel modules from ORFEO

• Combine bare soil index (from tracks) with logging activities (using 20m Spot imagery processing by Pithon *et al*., 2012) in order to obtain a better estimation of global forest degradation

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Thanks for your attention