

*Changes in Land Use and Forest Biomass in Central Africa  
March 20th and 21st, Libreville, Gabon*

# Forest degradation estimation using remote sensing

Valéry GOND, Stéphane GUITET, Guillaume CORNU  
Lucas BOURBIER, Sophie PITHON



## Objectives:

Development of tools to measure the degradation of harvested tropical forests:

(1) road network monitoring and (2) canopy gaps detection

## Mean

Use of remote sensing in order to estimate, at large scale, forest degradation and re-vegetalization

## Outcome:

These tools have to facilitate the post-harvesting control



Harvesting



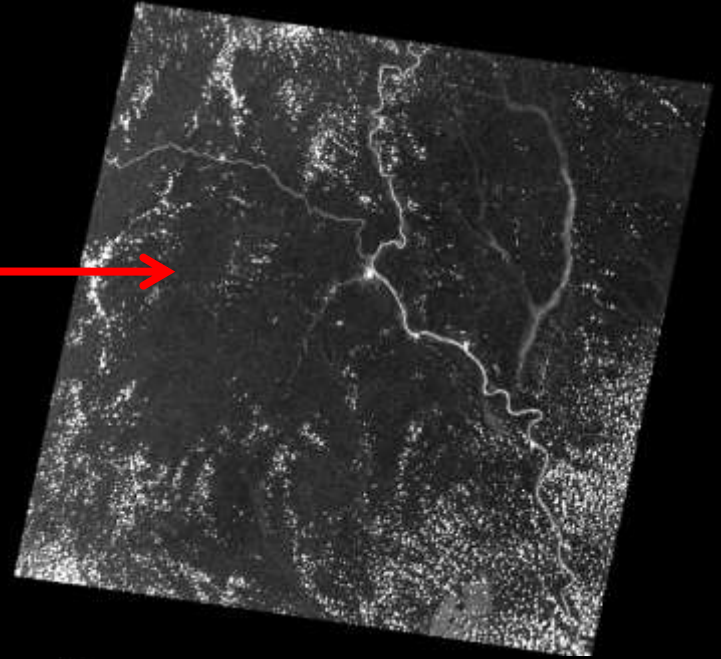
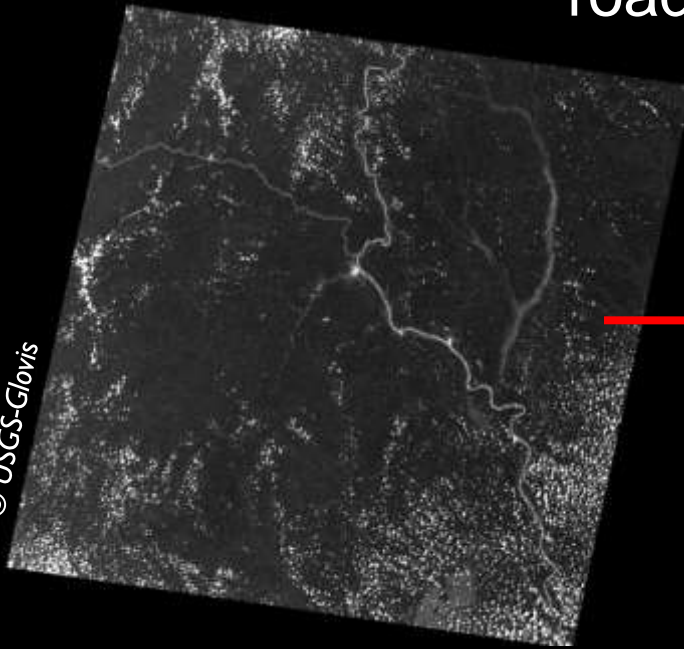
Log yard



Tracks and roads

# road network monitoring

© USGS-Glovis



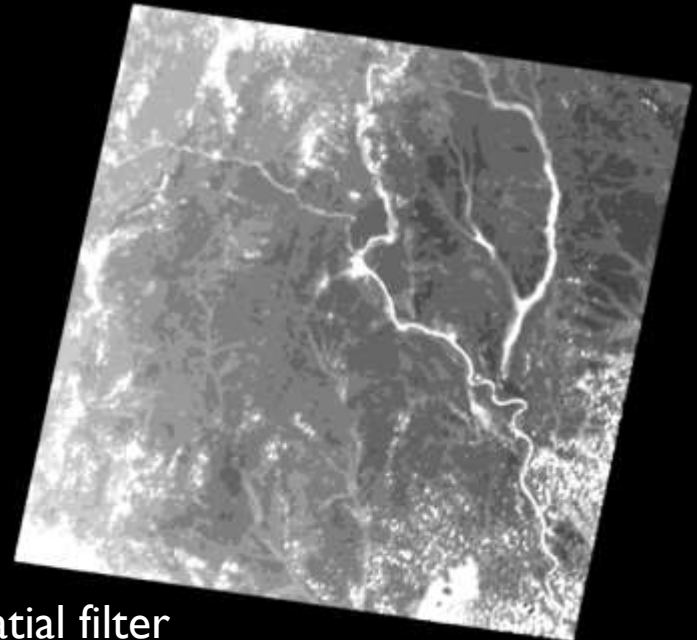
1 - Radiometric calibration

2 - Spectral indices processing

$$\mathbf{NDVI} = (\mathbf{NIR} - \mathbf{Red}) / (\mathbf{NIR} + \mathbf{Red})$$

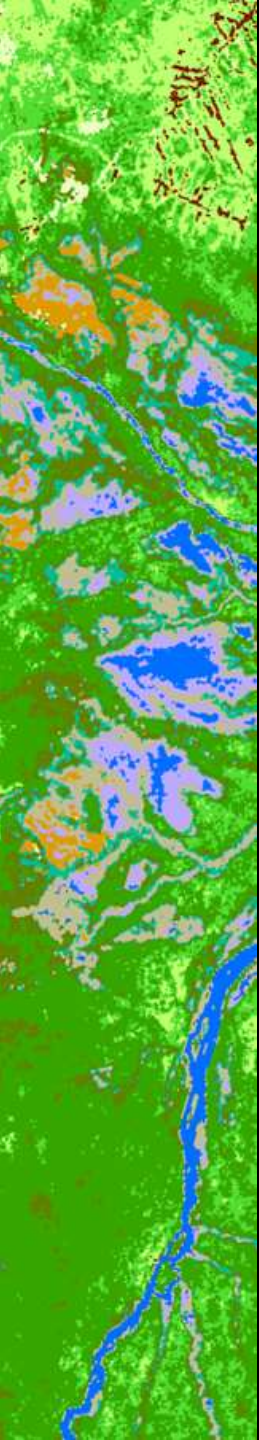
$$\mathbf{GR} = (\mathbf{Green} - \mathbf{Red}) / (\mathbf{Green} + \mathbf{Red})$$

**NDVI + GR**



Local contrast improved by the median spatial filter

# Processing



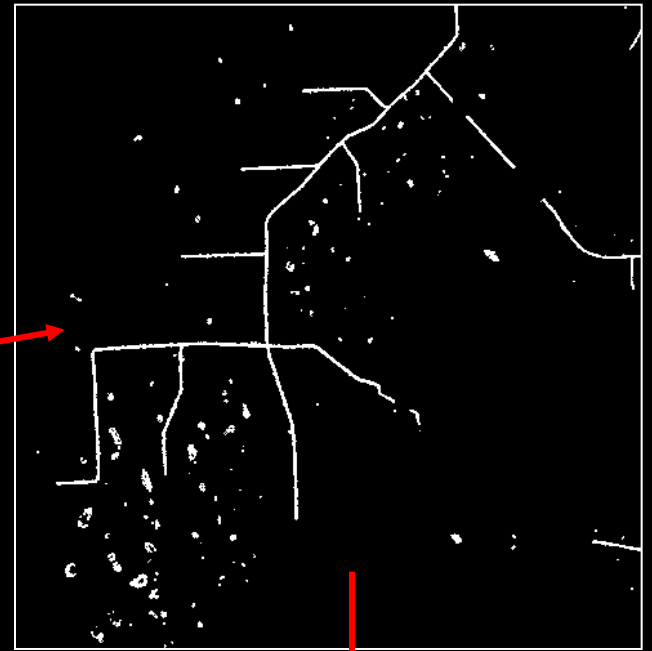
3 – Bare soil identification  
using Red, GR, NDVI+GR channels

4 - Cloud and water masking  
using Blue and SWIR channels



# Processing

5 - morphological filter

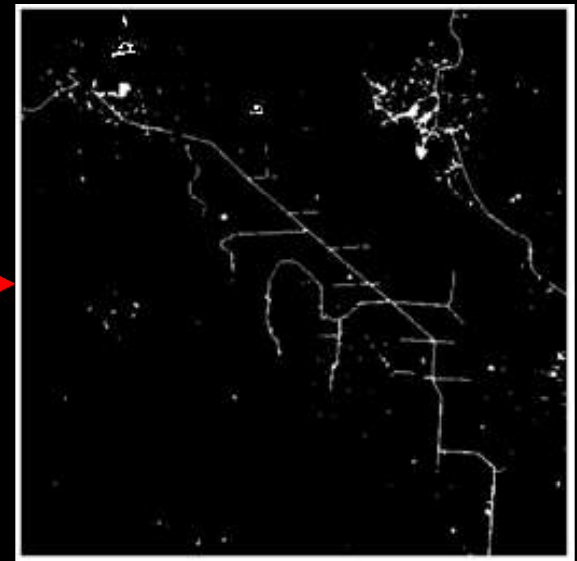
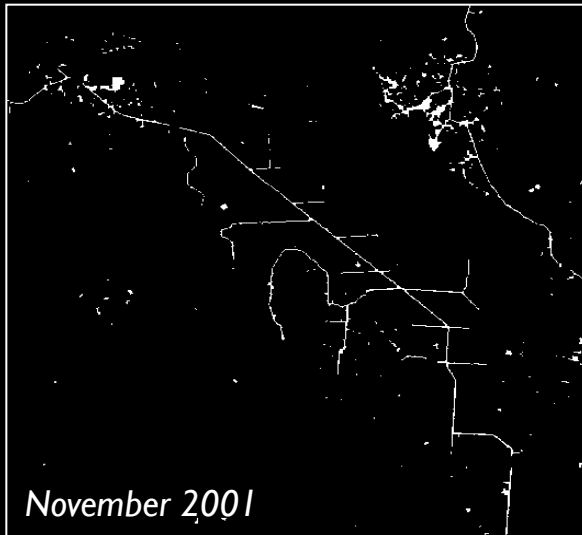
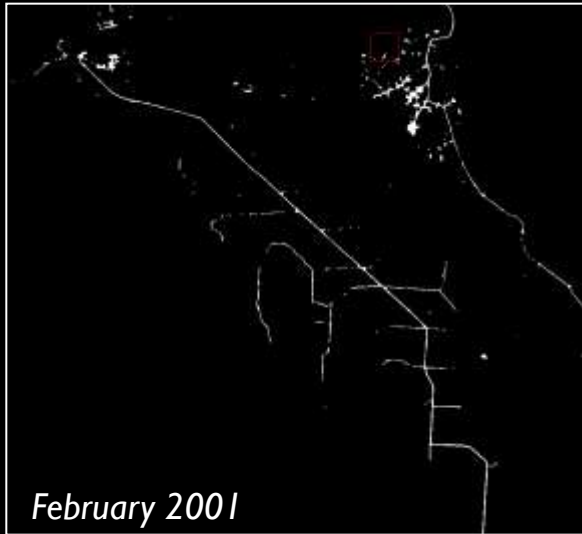


50 pixels size with an elongation rate of 3



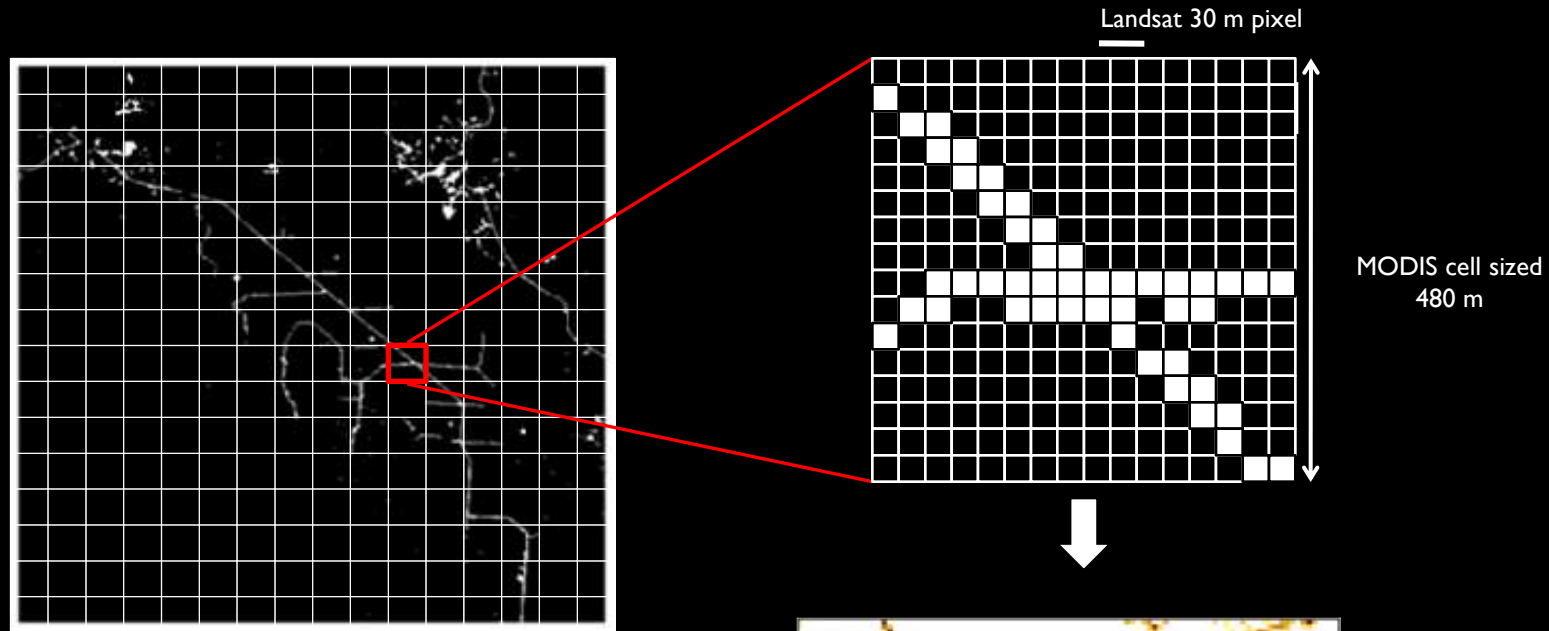
# Processing

6 – Yearly synthesis



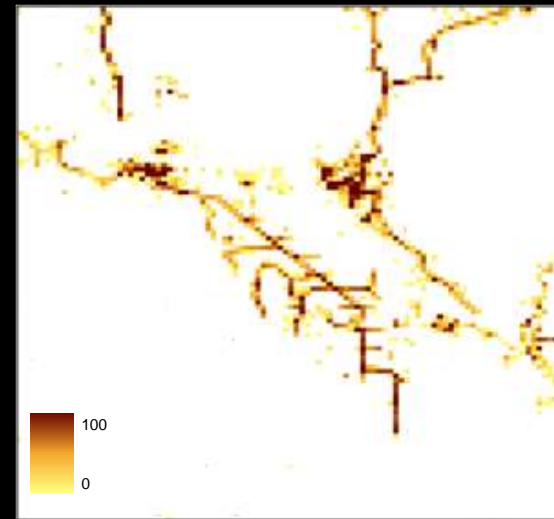
# Processing

## 7 – Spatial synthesis



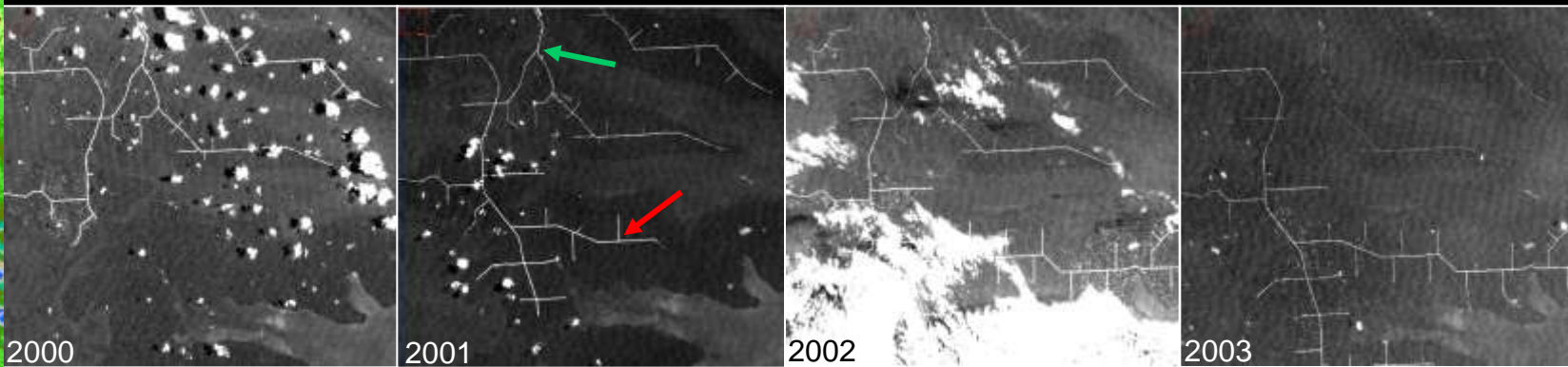
*Annual bare soil mapping in 2001*

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

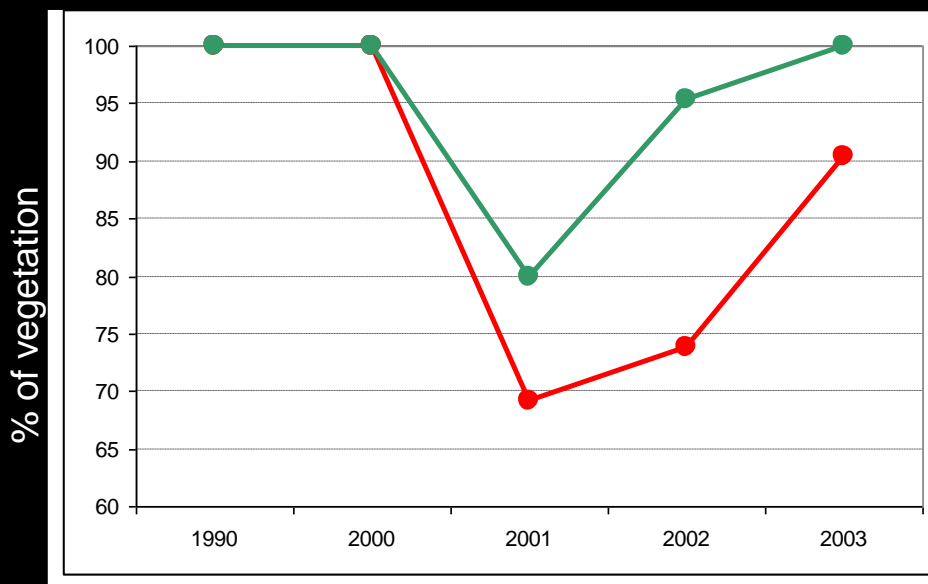


*Spatial indication of bare soil in 2001*

# Cell monitoring



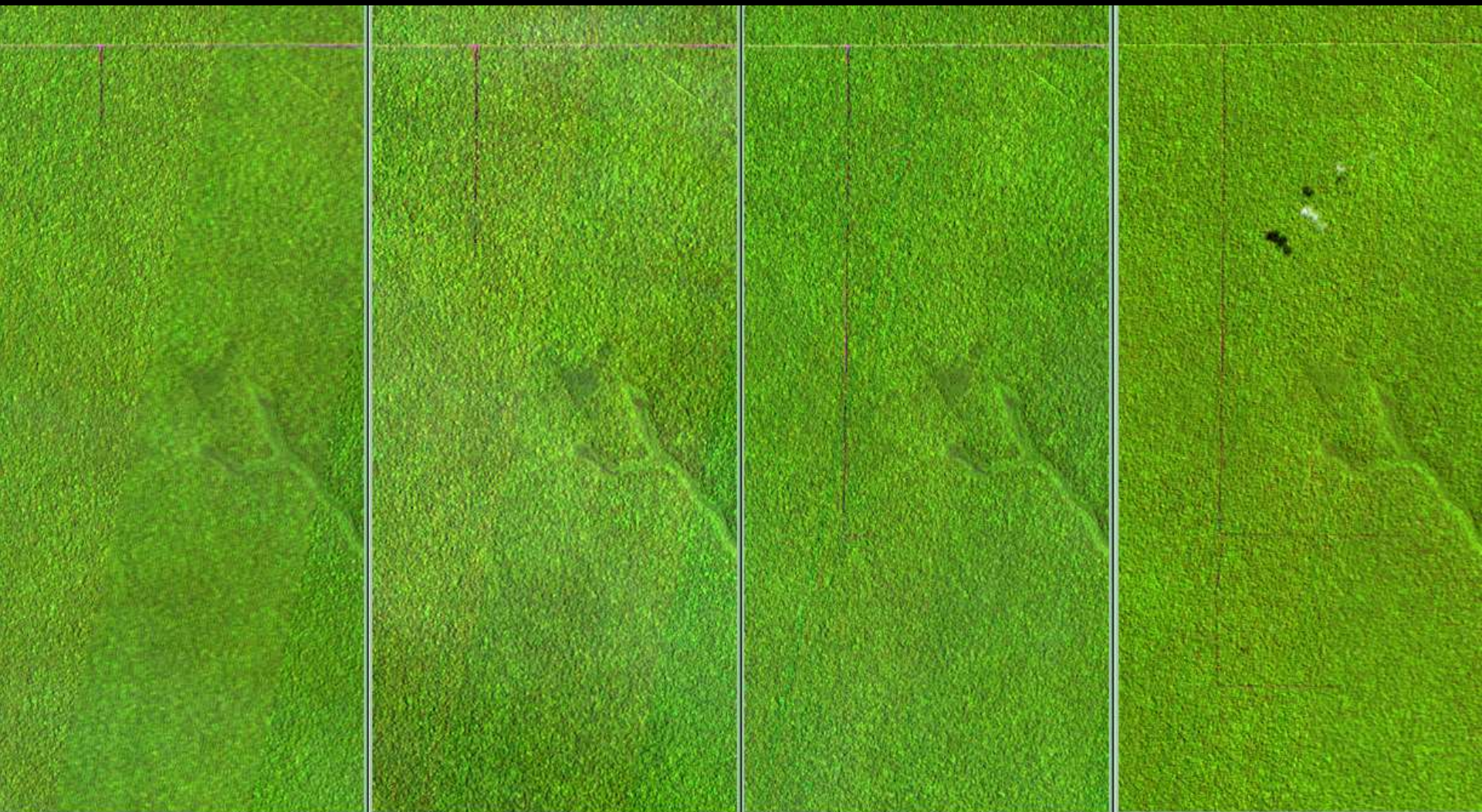
Bare soil index



Bare soil index decreasing 2/3 in 2 years



# Monitoring logging activities using Sentinel 2



March 4<sup>th</sup>

April 3<sup>rd</sup>

April 13<sup>th</sup>

June 2<sup>nd</sup>

30 days

10 days

50 days

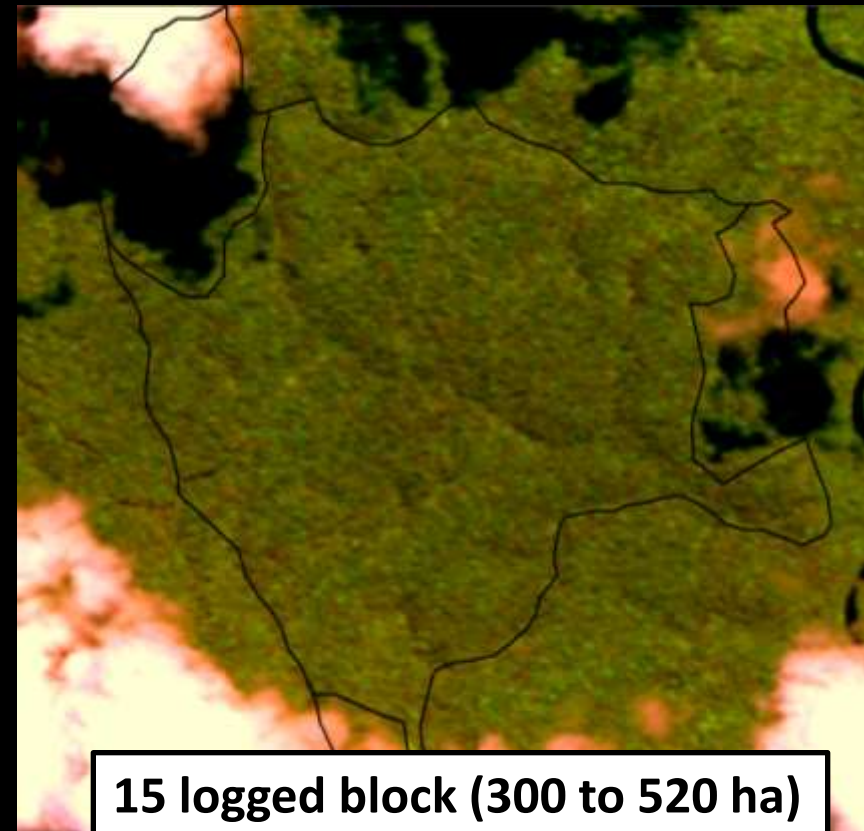
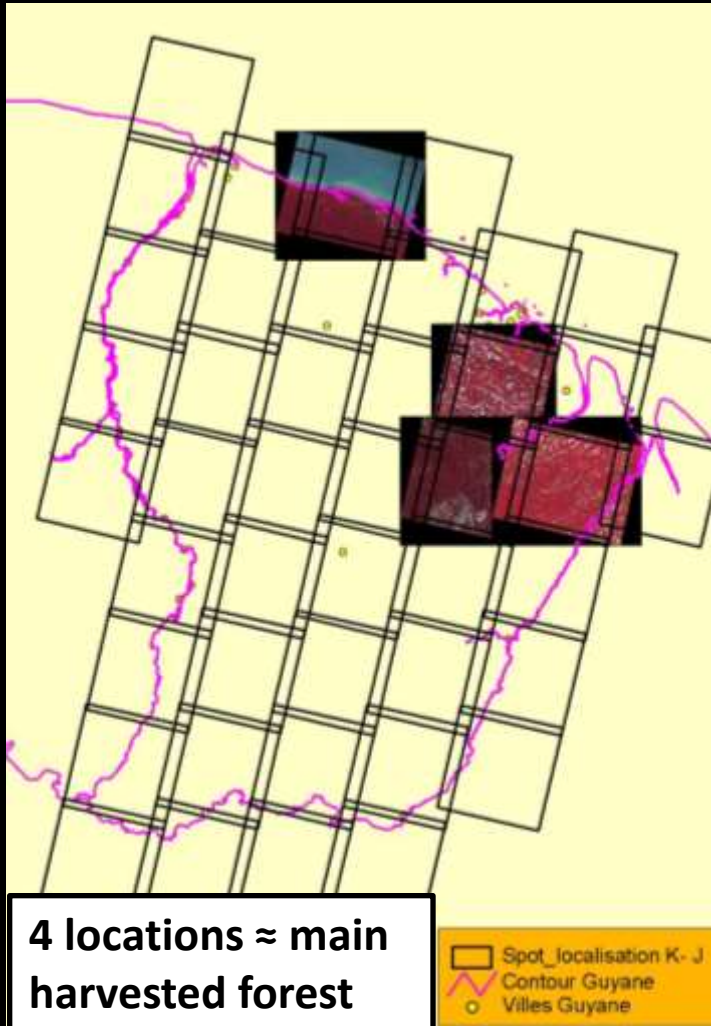
Opening

Logging

Location: North Congo  
Spot-4 (Take-5) experiment

# canopy gaps detection

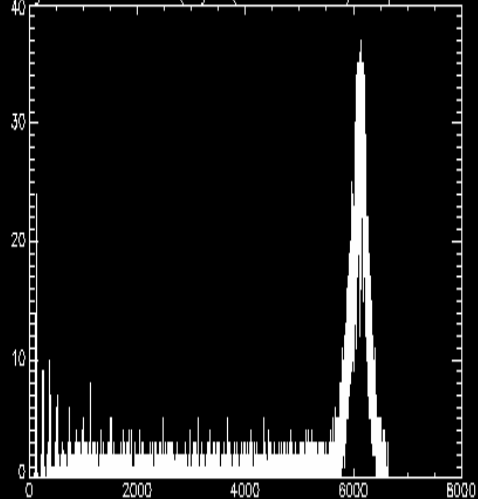
Medium spatial resolution optical satellite images produced by SPOT 5 and 4 (10 and 20 meters)



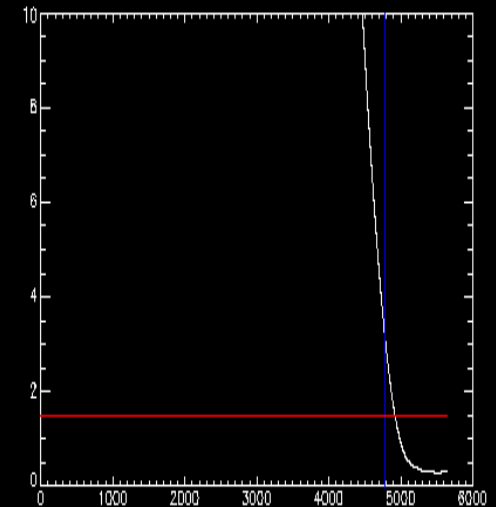
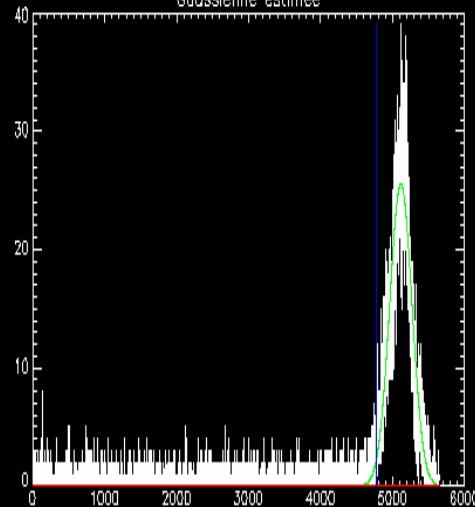
# Remote sensing process

- Filter : Canopy (majority) vs. gap (minority) – all others objects are manually eliminated (clouds, shadows, water, etc...)
- Using 2 index NDVI (photosynthetic activity) and NDWI (moist content)
- Modeling a Gaussian distribution (least squares method) = detect a divergence threshold – significant difference between G function and effective histogram

Histogramme: ROI Mask (Layer (Band 1:NDVI.tif):compa\_20091012)



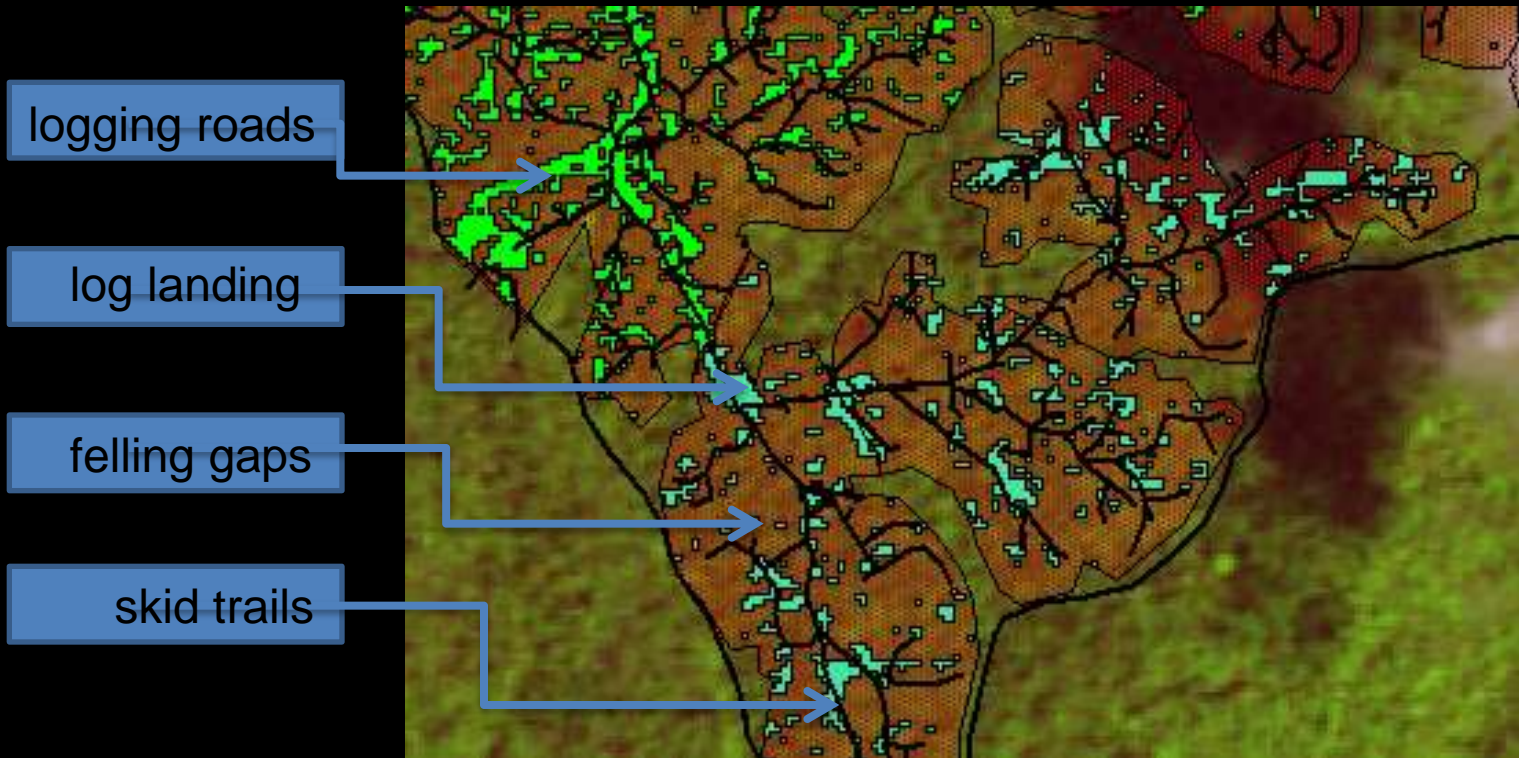
Gaussienne estimee



Pixels values histogram → Gaussian function estimation → K divergence threshold

# Results : impacts map

red : harvested area – black : skid trails tracks green/blue : openings



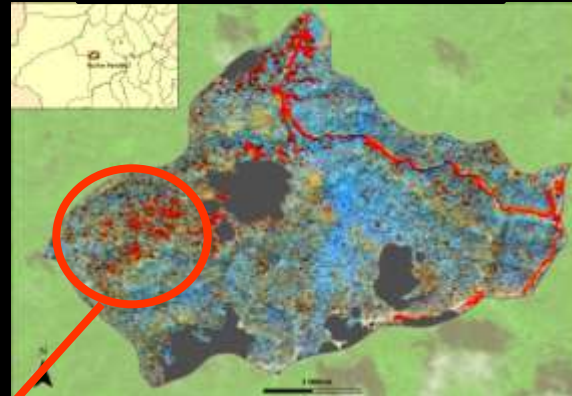
- Visible during 6 months to one year
- For a two years long logging operation – complete impacts can be mapped from the cumulative information collected on at least 6 images

# Monitoring logging activities : logging impacts

SPOT-5, RFE-65 plot  
November 7<sup>th</sup>, 2010



Multi-index color composite  
(NDVI, NDWI and MIR)

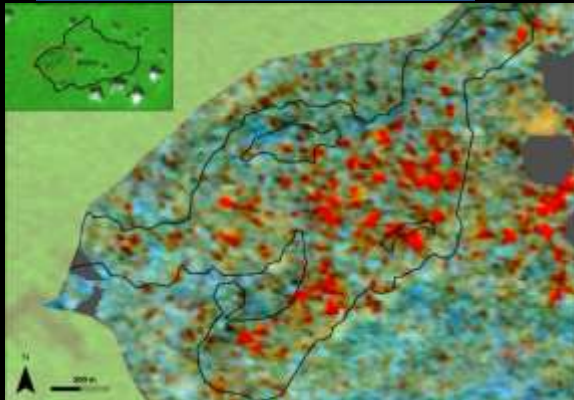


In French Guiana, 10.000 ha are exploited per year

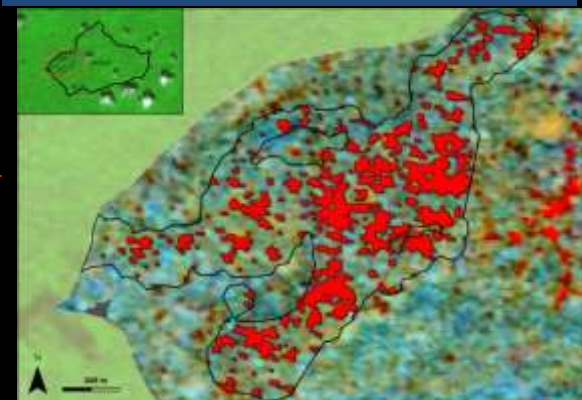
Thanks to the SEAS reception station these areas are regularly monitored using SPOT-5 (10m)

Development of a Timber Quality Index within the certification framework (PEFC and FSC)

Production Unit (78ha)



Impacted areas digitalization



From Spot / Sentinel-2

20,8ha impacted (26,6%)

Timber statistics

3,9 trees/ha and 19,8 m<sup>3</sup>/ha (5m<sup>3</sup>/tree)

Timber Quality index

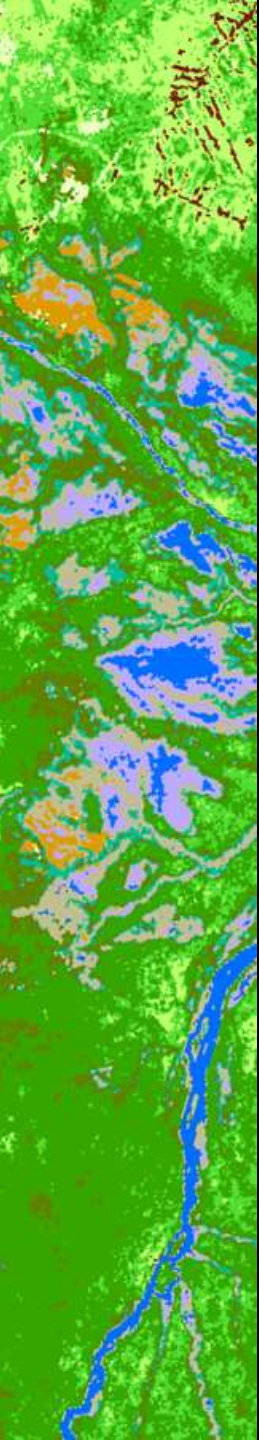
675m<sup>2</sup> impacted per tree  
134m<sup>2</sup> impacted per m<sup>3</sup>

From logger

308 trees for 1550 m<sup>3</sup>

# Conclusions and perspectives

- Possibility to extract precise information on road network and gap-logging using medium resolution data
- Possibility to use Sentinel-2 (2014) for a regular and systematic monitoring
- Need to scale-up to regional, continental monitoring using MODIS (250m), Proba-V (100m) or Sentinel-2 (10, 20 and 60m)
- Need to develop Radar as a complement to monitor degradation activities all year long in tropical forests



Thanks for your attention

