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

Forest degradation estimation using remote sensing

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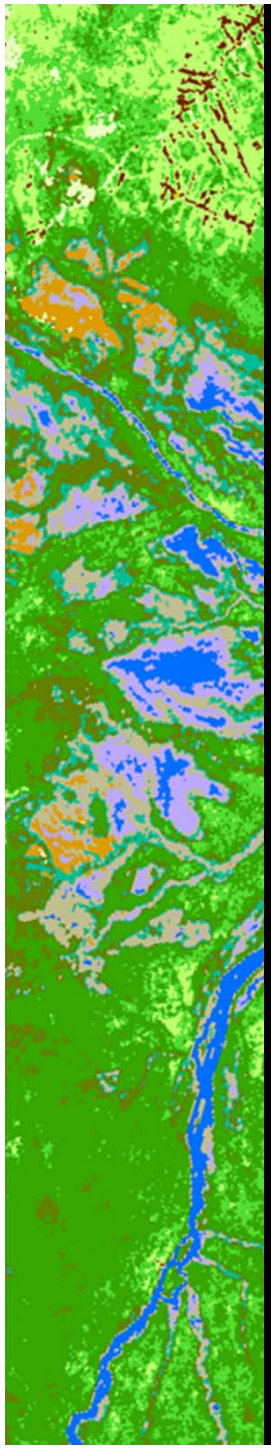
Lucas BOURBIER, Sophie PITHON



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

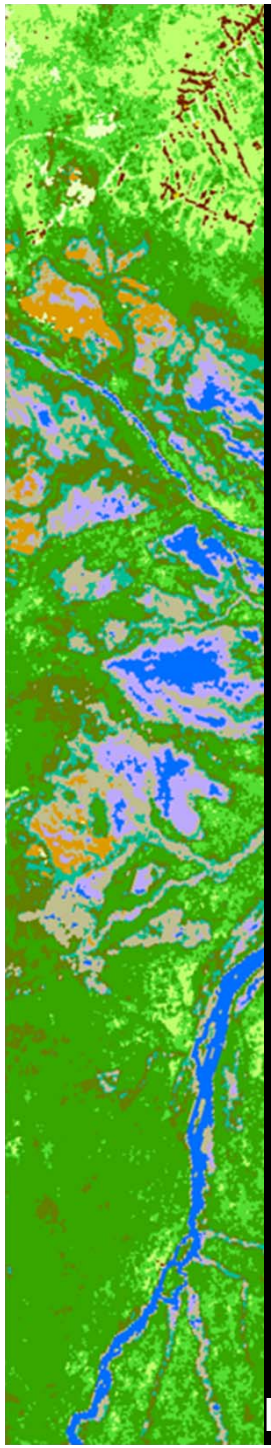
Outcome:

These tools have to facilitate the post-harvesting control

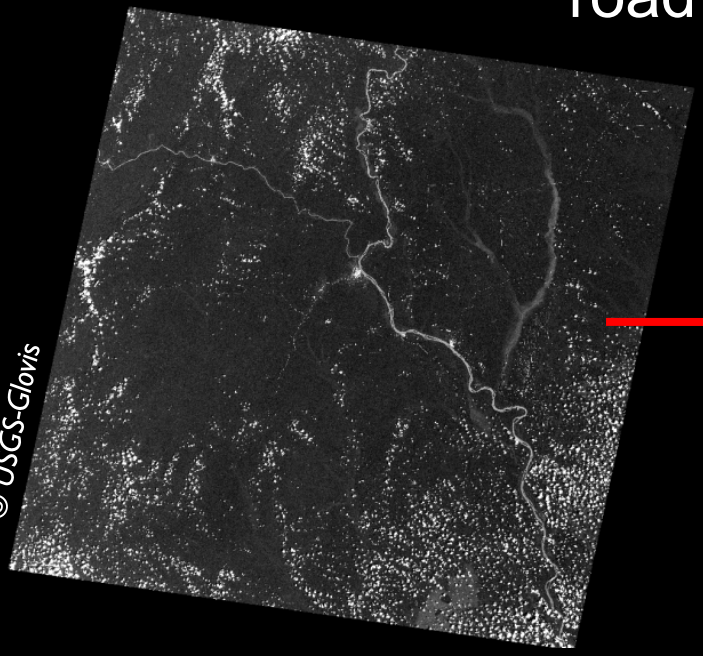
Harvesting

Log yard

Tracks and roads



road network monitoring



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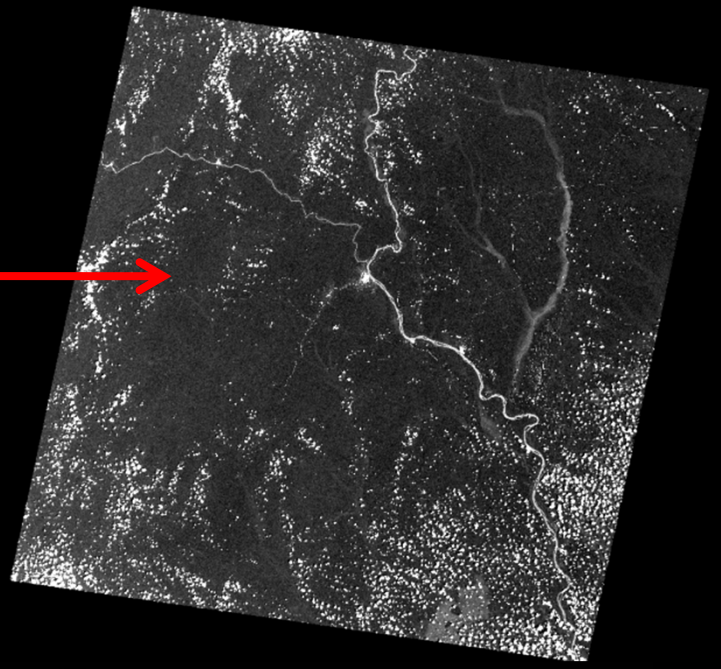


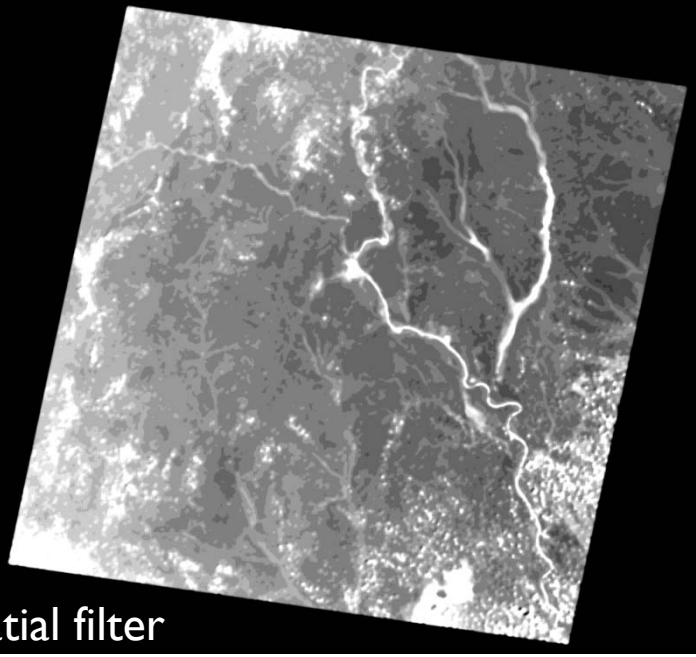
1 - Radiometric calibration

2 - Spectral indices processing

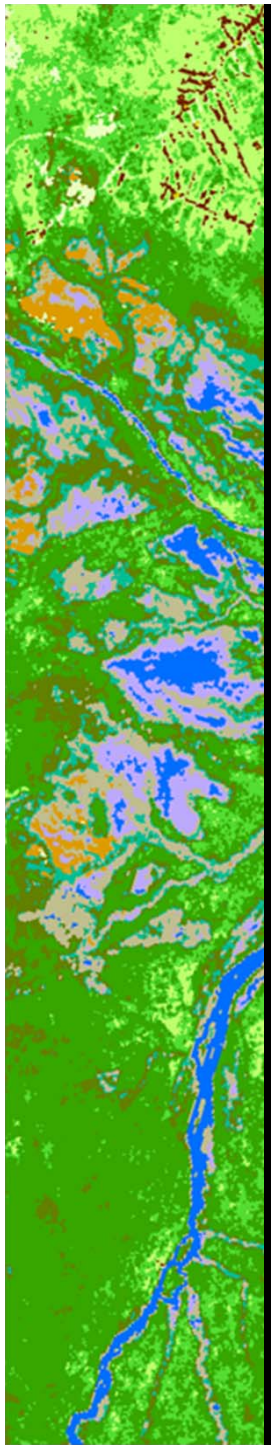
NDVI = (NIR – Red) / (NIR + Red)

GR = (Green – Red) / (Green + Red)

NDVI + GR



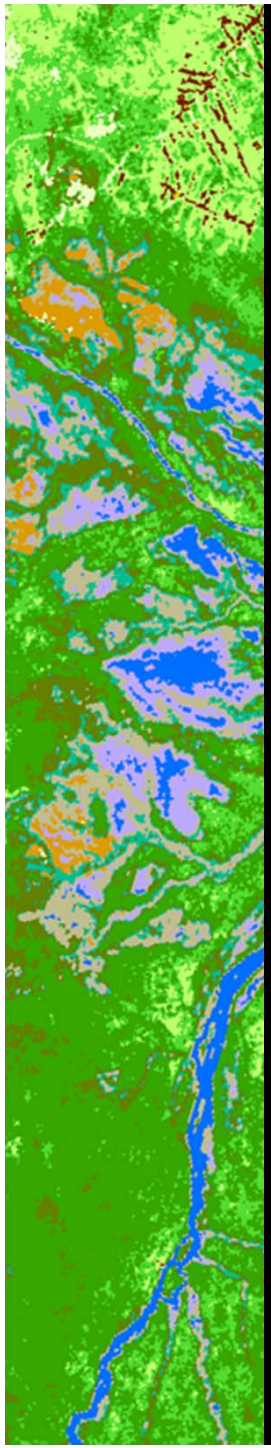
Local contrast improved by the median spatial filter



Processing

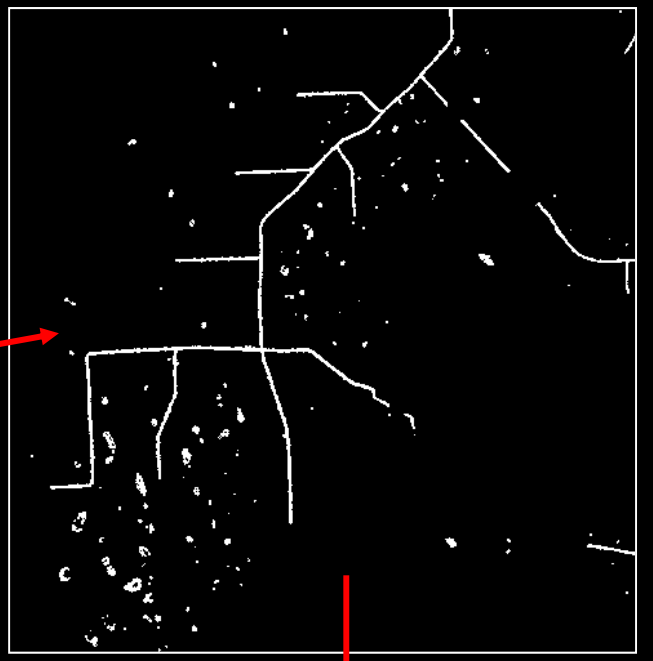
3 – Bare soil identification
using Red, GR, NDVI+GR channels

4 - Cloud and water masking
using Blue and SWIR channels

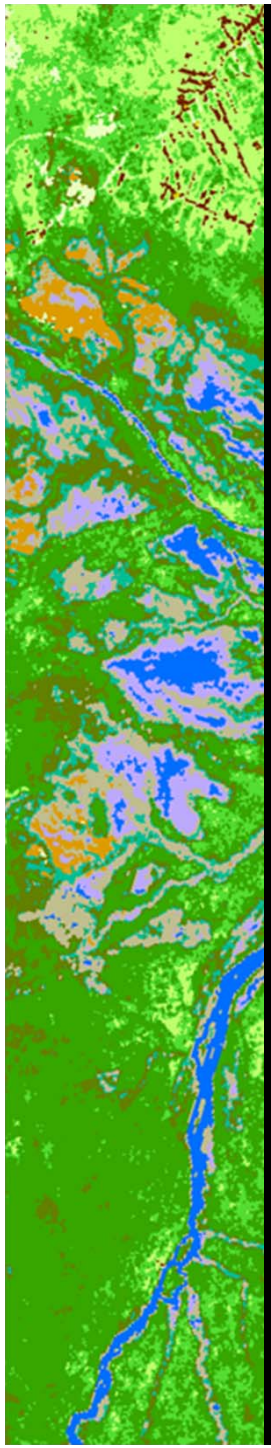


Processing

5 - morphological filter

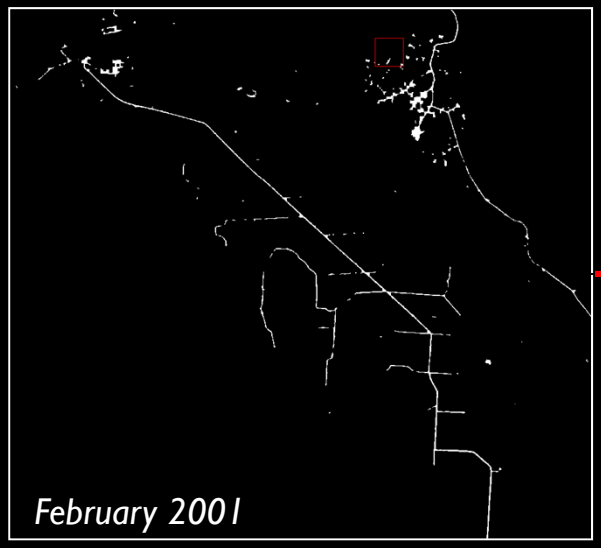


50 pixels size with an elongation rate of 3

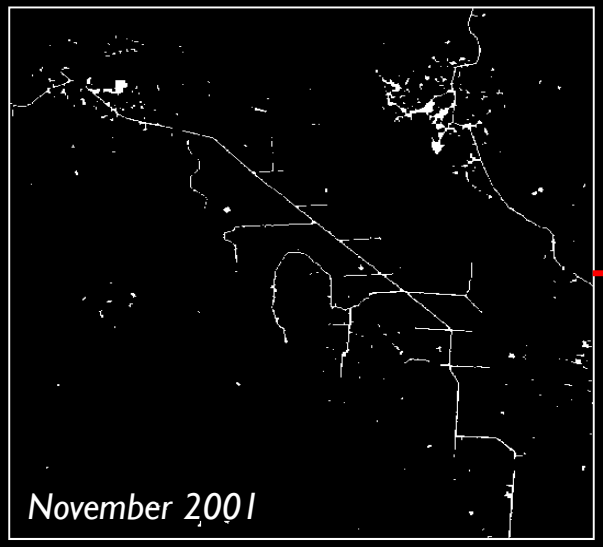


Processing

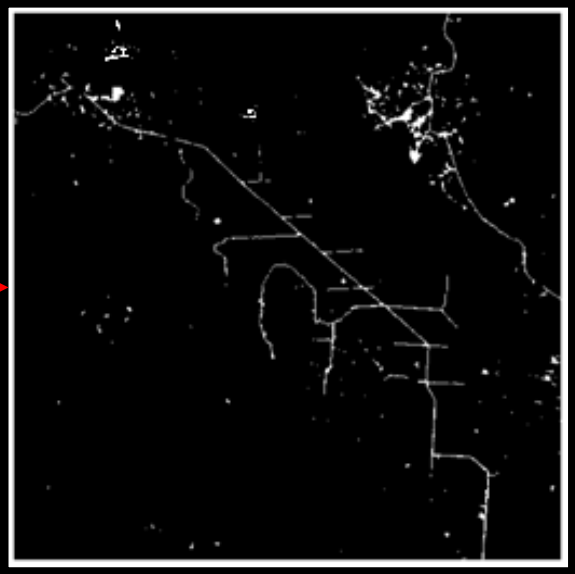
6 – Yearly synthesis



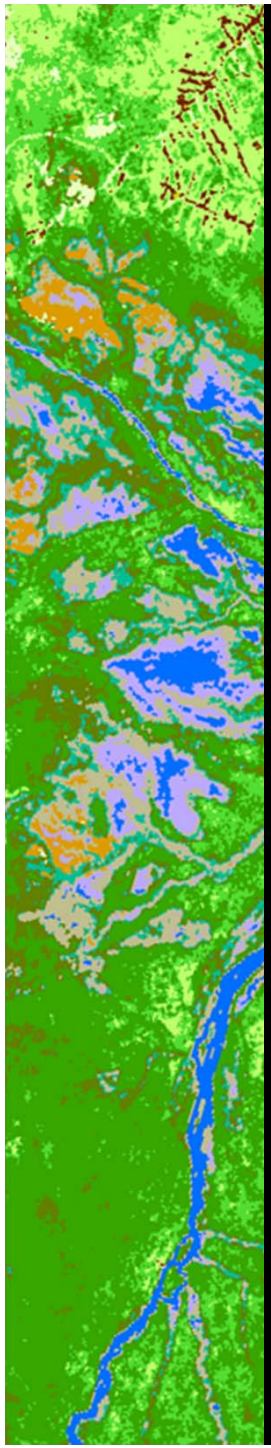
February 2001



November 2001

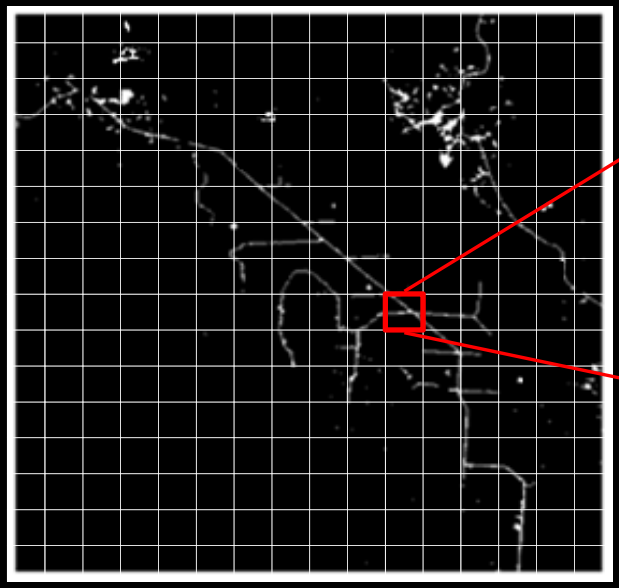


Annual bare soil mapping in 2001

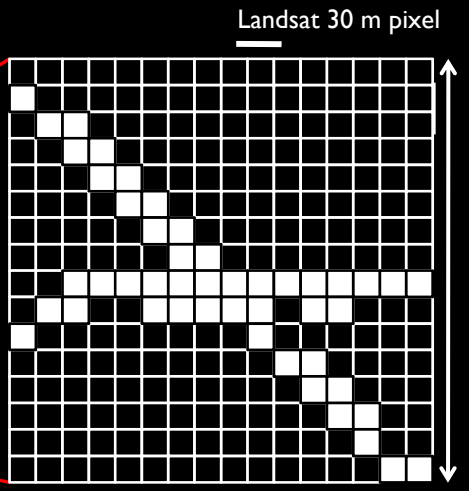


Processing

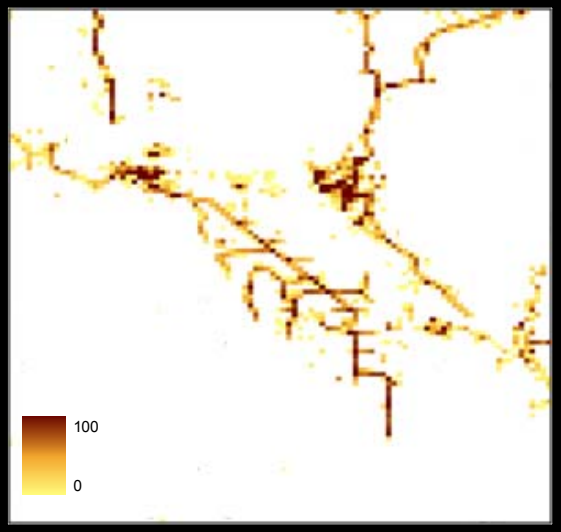
7 – Spatial synthesis



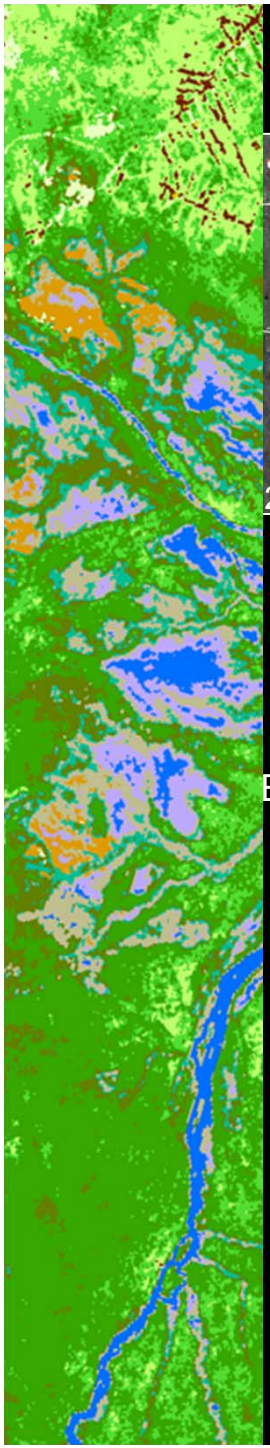
Annual bare soil mapping in 2001



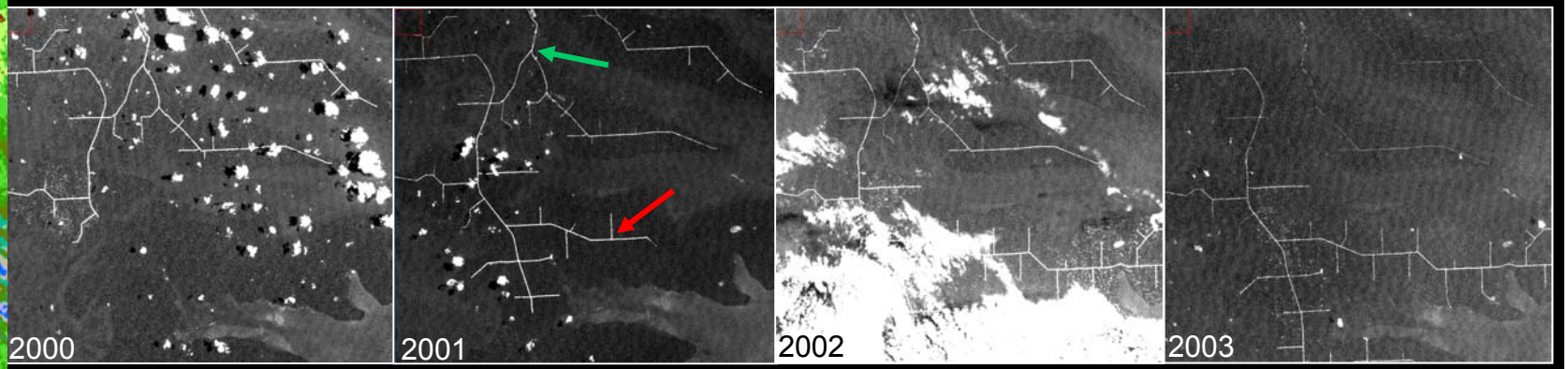
47 bare soil pixels detected
on a surface of 256 pixels
= 18% of bare soil



Spatial indication of bare soil in 2001



Cell monitoring

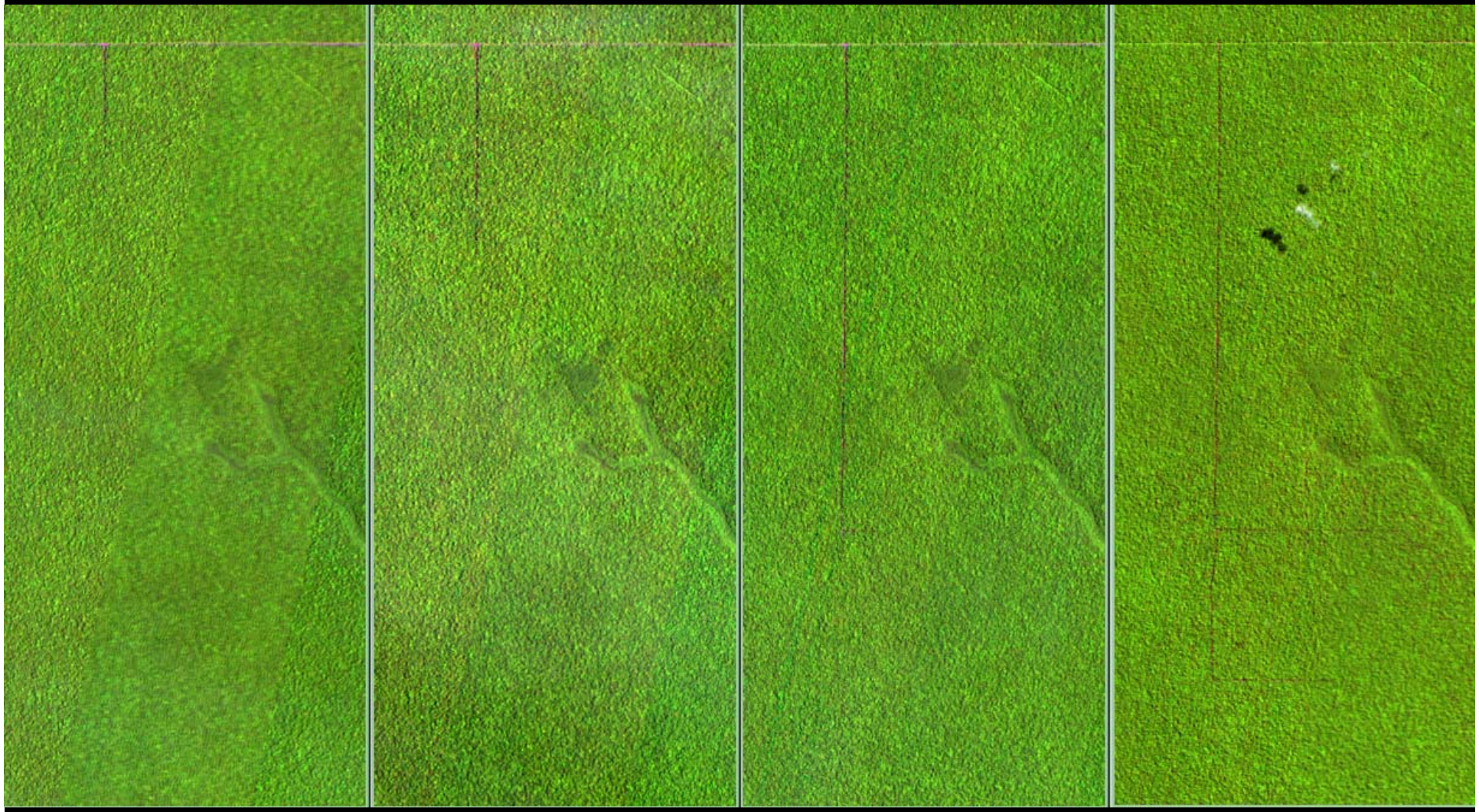


Bare soil index

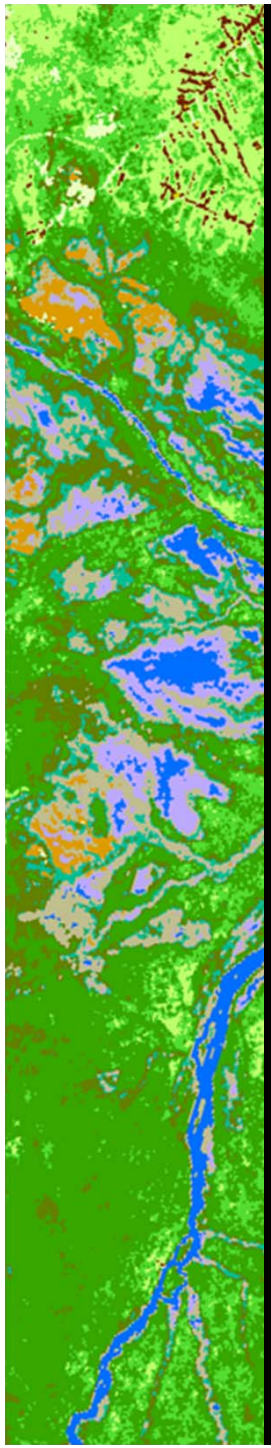
0% 31% 26% 10%

Bare soil index decreasing 2/3 in 2 years

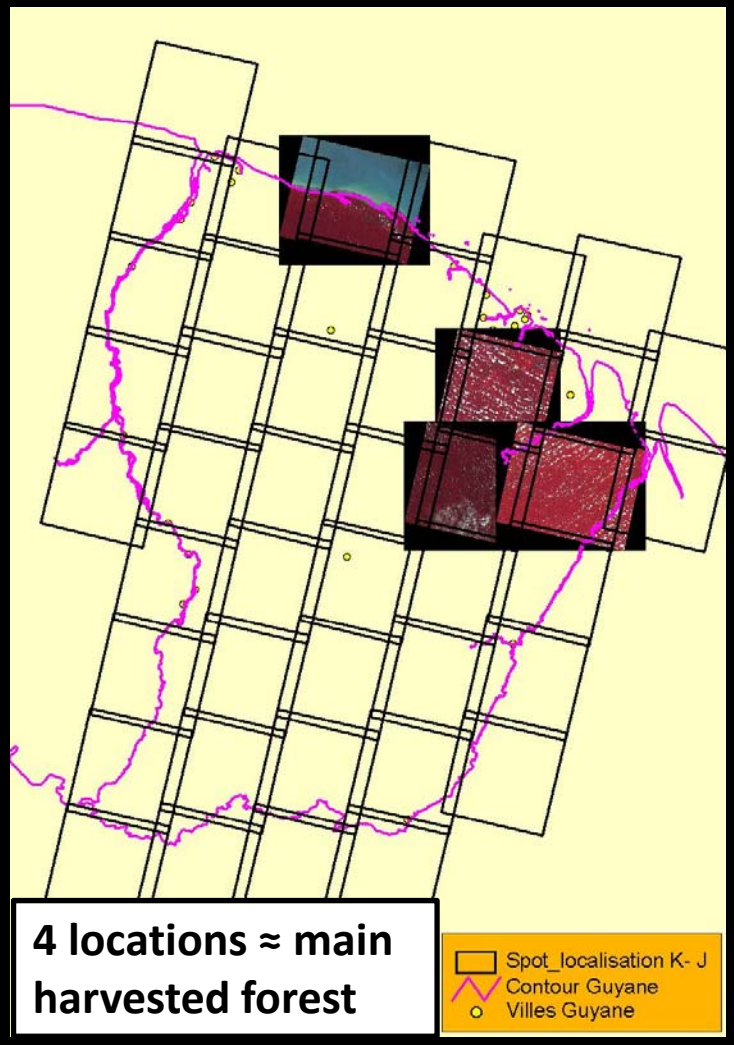
Monitoring logging activities using Sentinel 2



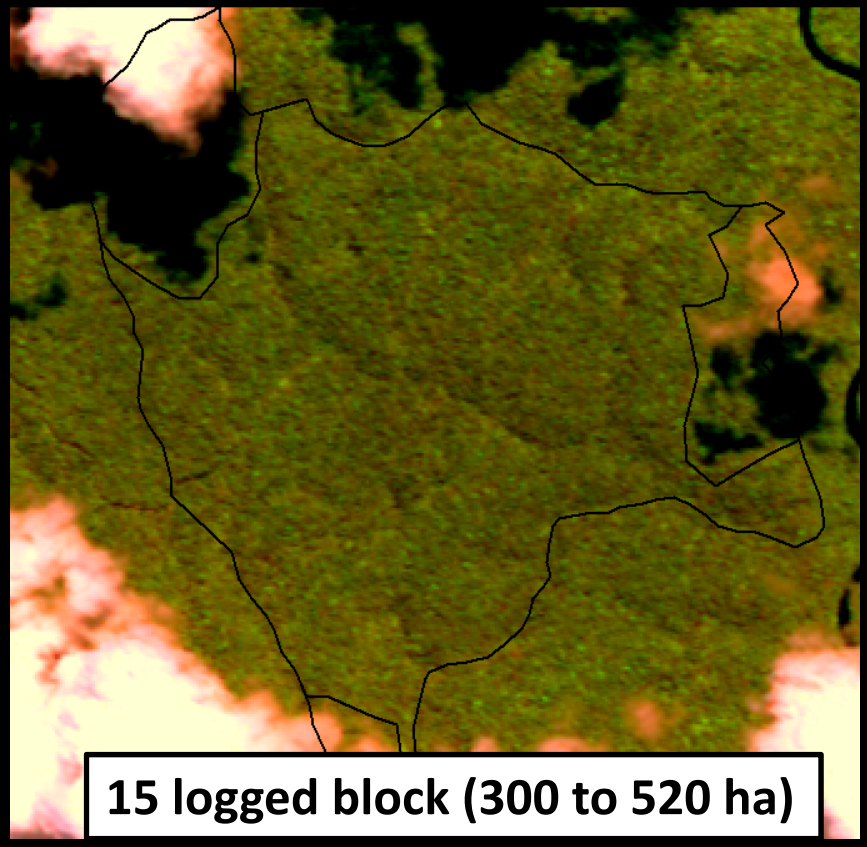
Location: North Congo
Spot-4 (Take-5) experiment

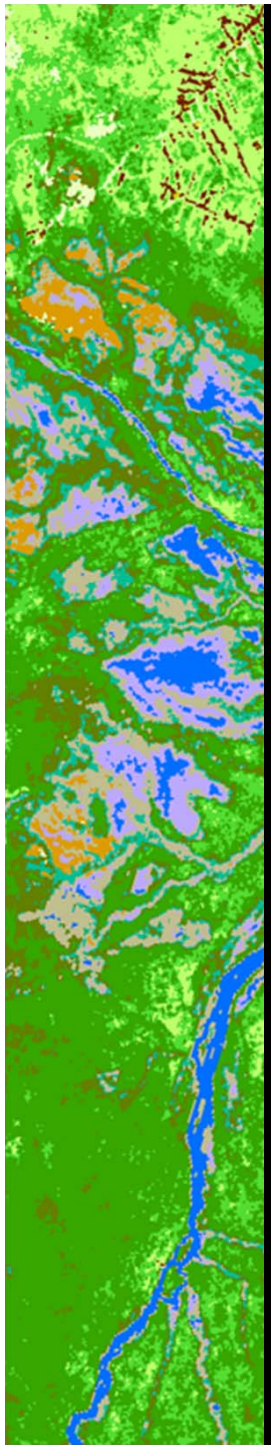


canopy gaps detection



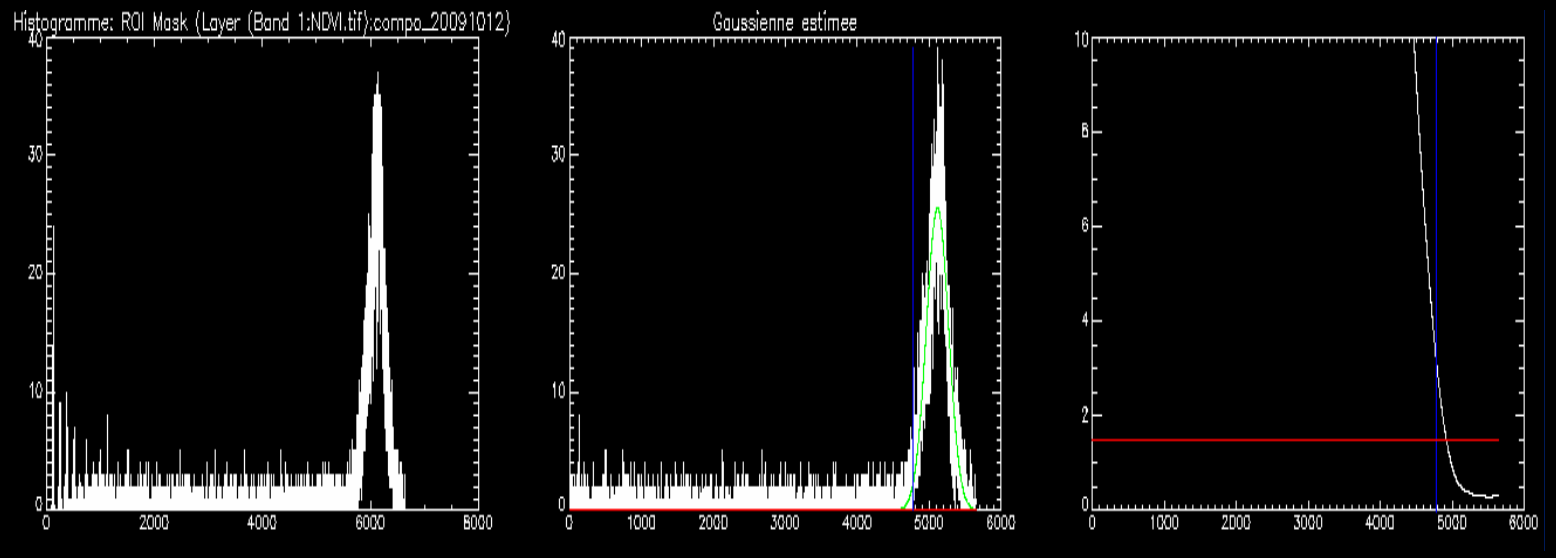
Medium spatial resolution optical satellite images produced by SPOT 5 and 4 (10 and 20 meters)



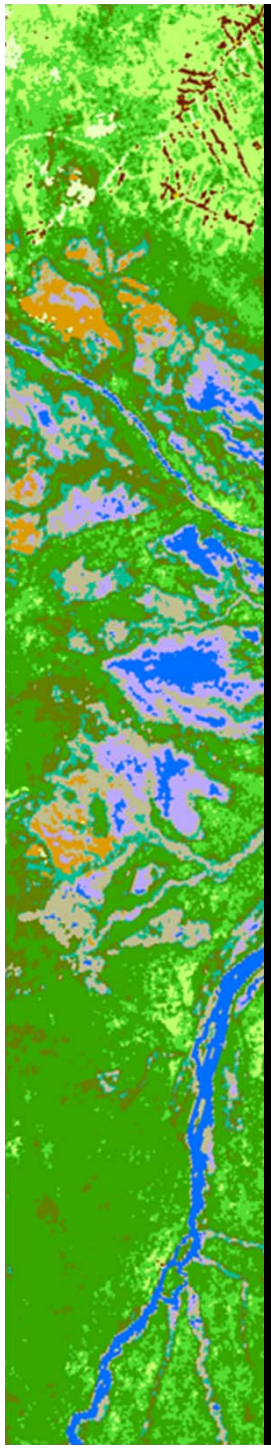


Remote sensing process

- 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



Pixels values histogram → Gaussian function estimation → K divergence threshold



Results : impacts map

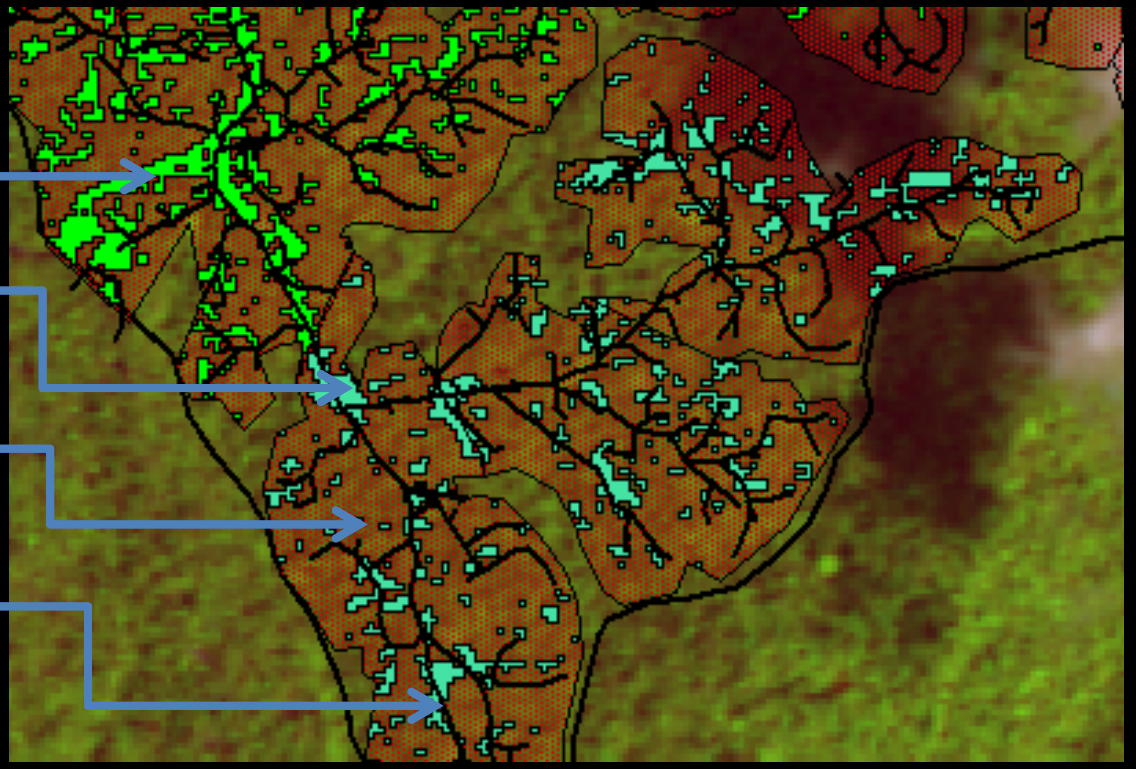
red : harvested area – black : skid trails tracks green/blue : openings

logging roads

log landing

felling gaps

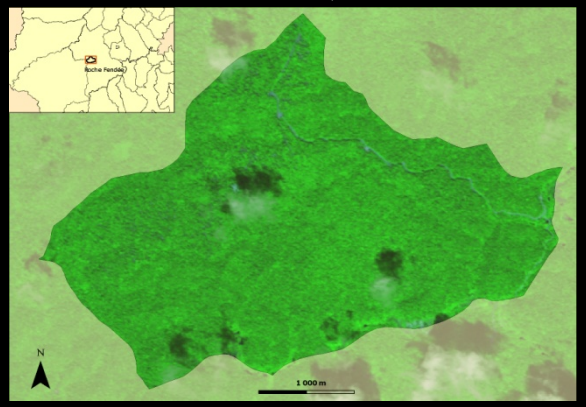
skid trails



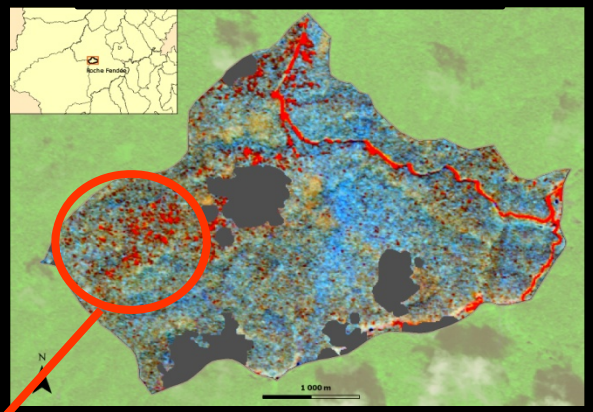
- Visible during 6 months to one year
- For a two years long logging operation – complete impacts can be mapped from the cumulative information collected on at least 6 images

Monitoring logging activities : logging impacts

SPOT-5, RFE-65 plot
November 7th, 2010



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

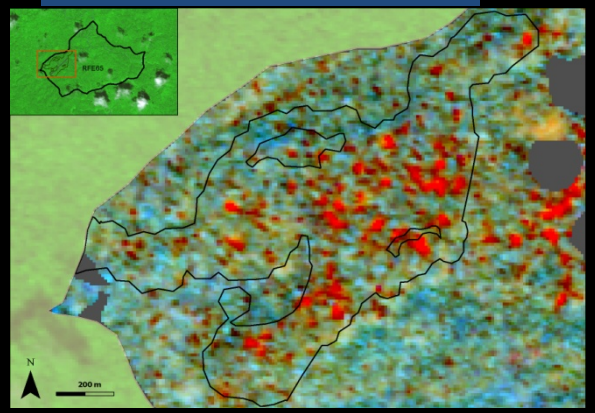


In French Guiana, 10.000 ha are exploited per year

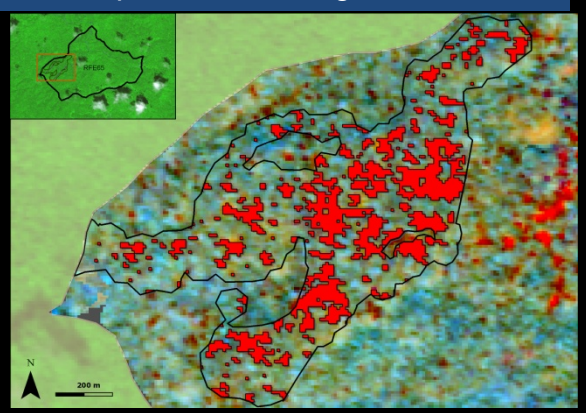
Thanks to the SEAS reception station these areas are regularly monitored using SPOT-5 (10m)

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%)

From logger

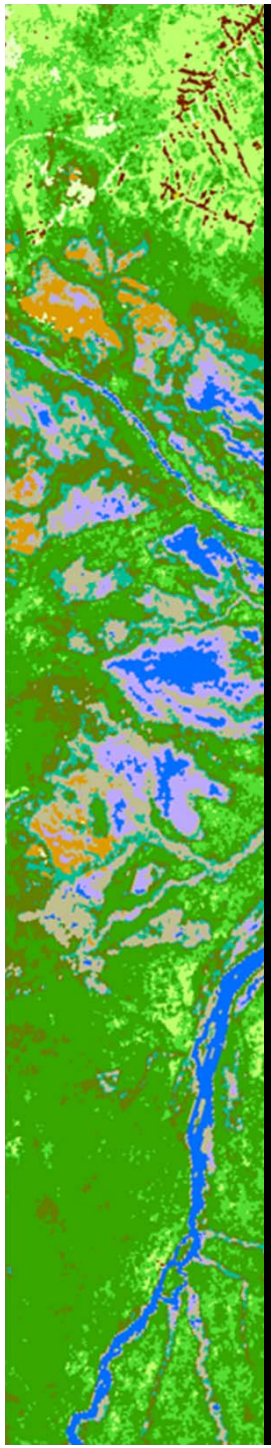
308 trees for 1550 m^3

Timber statistics

3,9 trees/ha and 19,8 m^3/ha (5m^3/tree)

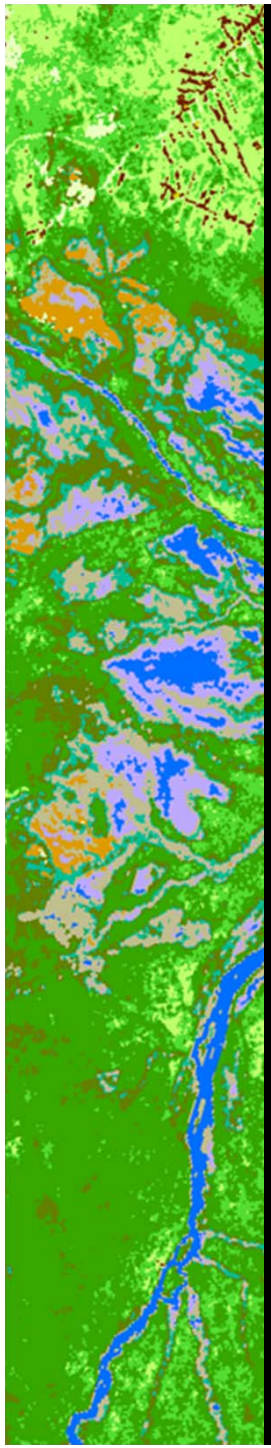
Timber Quality index

675m^2 impacted per tree
134m^2 impacted per m^3



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 Sentienl-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