

Near-real time forest disturbance monitoring in Gabon from 2015 to 2016 using a combination of Landsat and Sentinel 2 imagery

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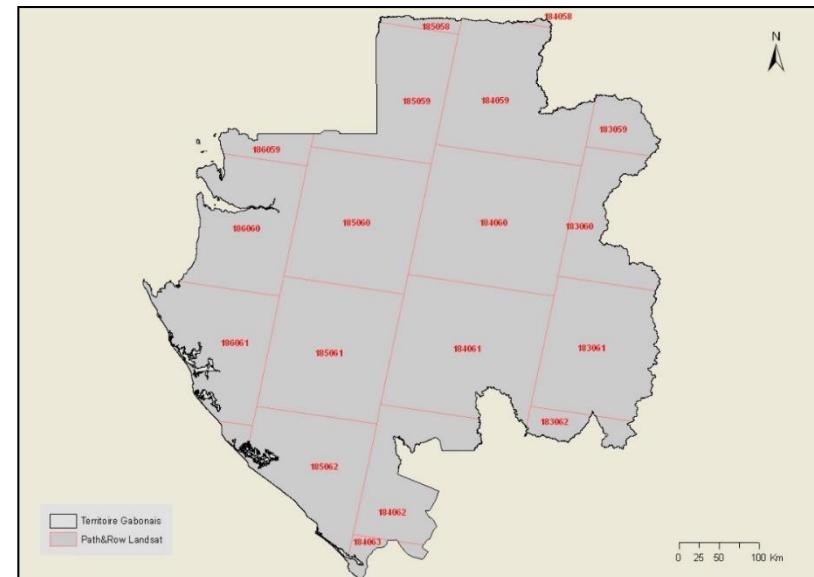


- The use of Earth Observation is recommended for estimating activity data to quantify GHG as part of UNFCCC
- Forest cover maps should not be used directly for providing forest cover and forest cover change statistics
- But, wall to wall maps provide valuable additional information compared with pure sampling approach
- Combination of forest cover map with reference sampled data can reduce uncertainty level substantially
- Baseline data was produced for Gabon for 1990, 2000 & 2010
- Knowledge transfer to produce 2015 update and near-real time monitoring of forest disturbance to detect illegal logging activities when they occur

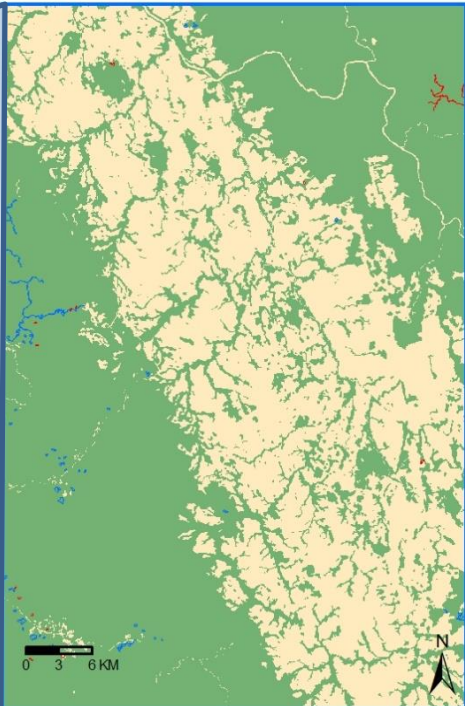
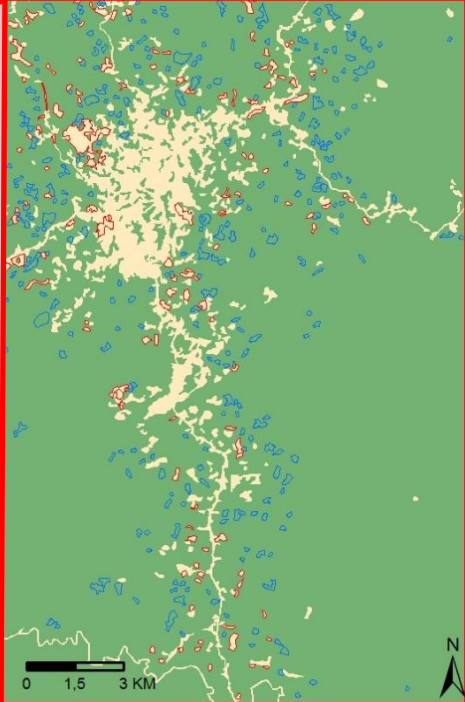
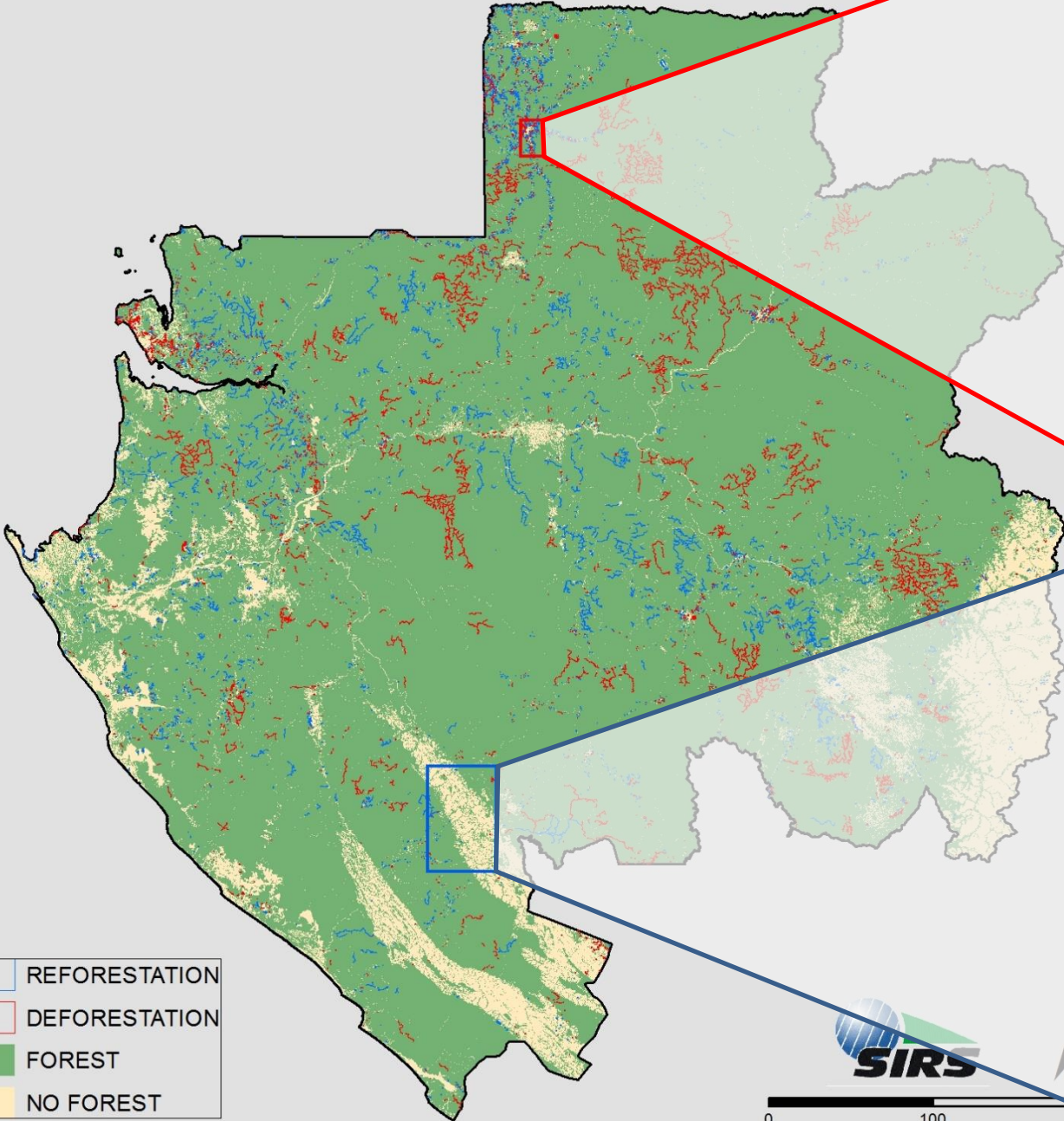


- Gabonese Agency of Space Observations Studies (AGEOS)
- Created in 2010
- Knowledge centre inaugurated in 2015 with ground X band receiving station now part of Landsat network
- Development of a national forest monitoring system

Forest definition: Minimum 1ha area,
30% Crown cover and
5m height at maturity
Tree plantations are excluded



FOREST COVER CHANGE MAP 2000/2010



- REFORESTATION
- DEFORESTATION
- FOREST
- NO FOREST



Knowledge Transfer

- Recruitment of MSc level staff at AGEOS specialised in geo-information and remote sensing for environmental monitoring
- Series of training / production workshops during 2015
- QC done by SIRS
- Gabon 2015 Forest cover map update now produced by AGEOS staff based on locally received Landsat 8 data



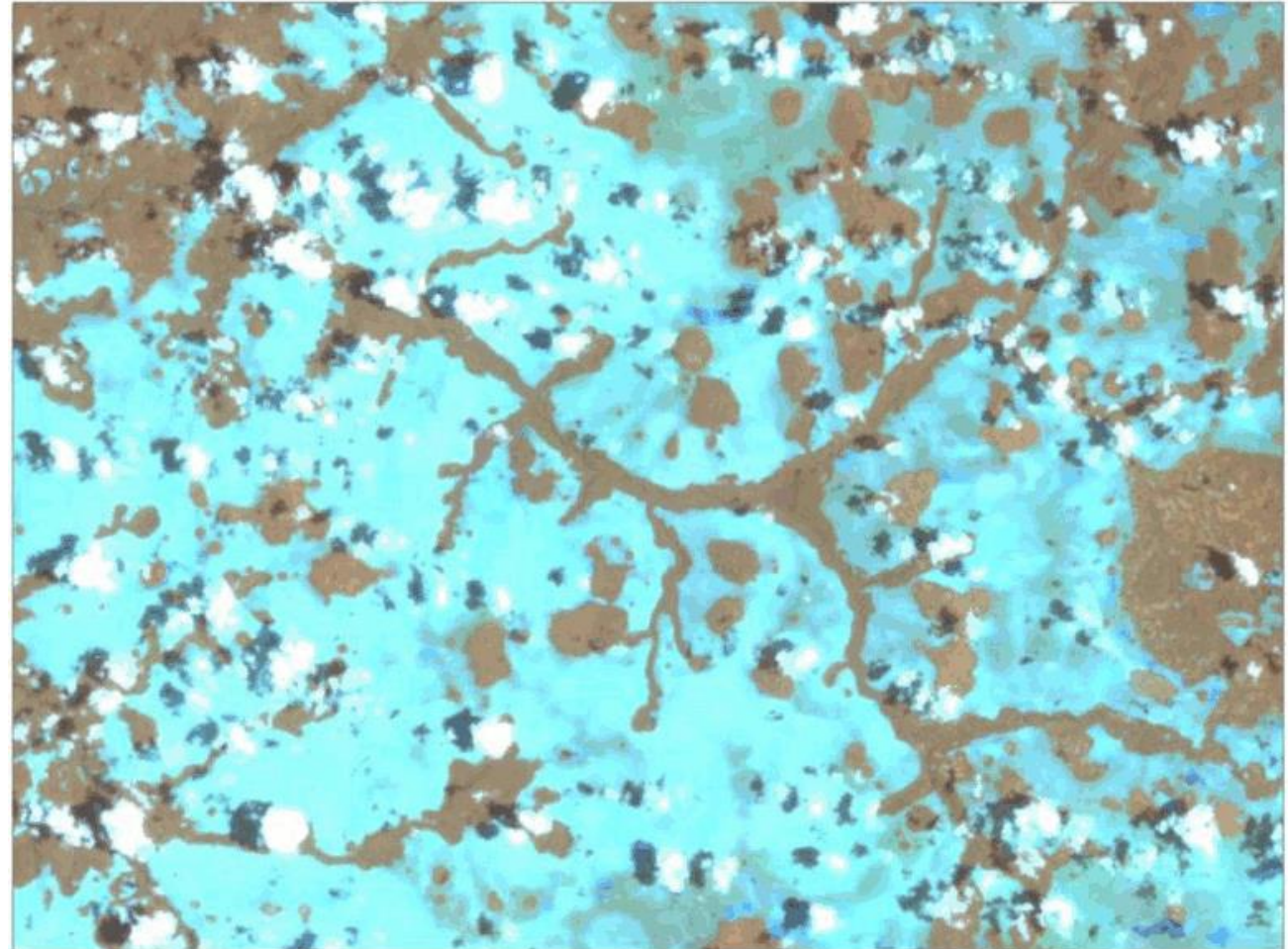
<http://www.presidence-gabon.ga/actualite/lageos-publie-cartographie-couvert-forestier-gabonais>



National Forest Cover and Cover Change Methodology



- Landsat used as main data source
- Need to use several images to obtain complete coverage
- Each image processed and classified separately
- Final classification produced by integrating individual classification results starting with the image closest to the reference year

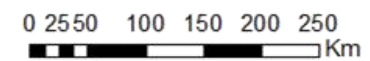
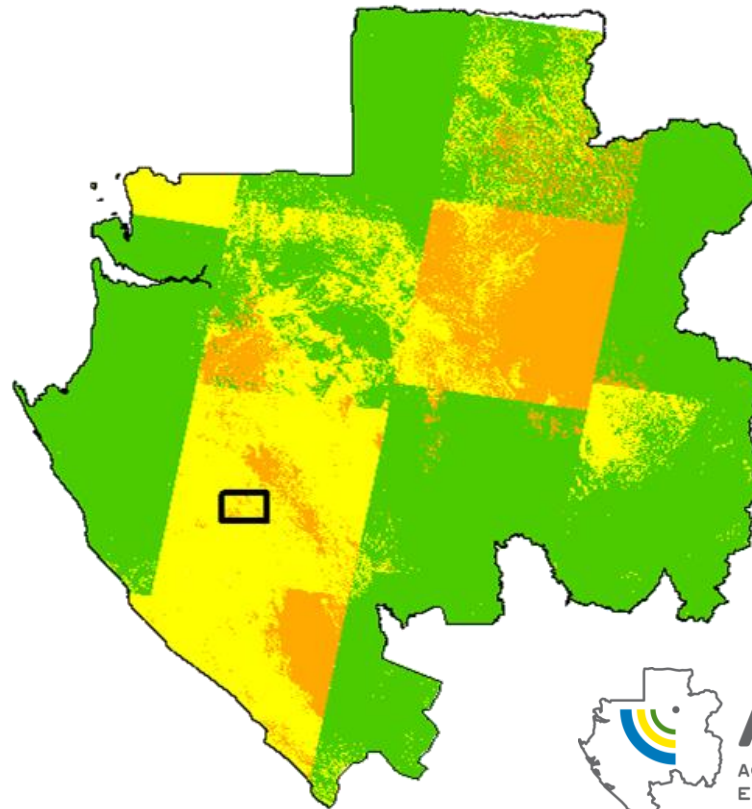


EO Data Input - 2015



Landsat 8 used for production
S2 used for accuracy assessment

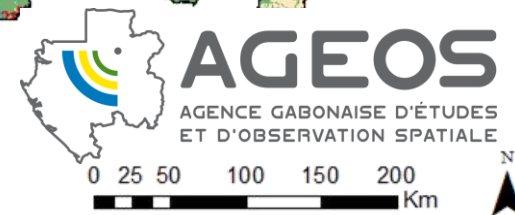
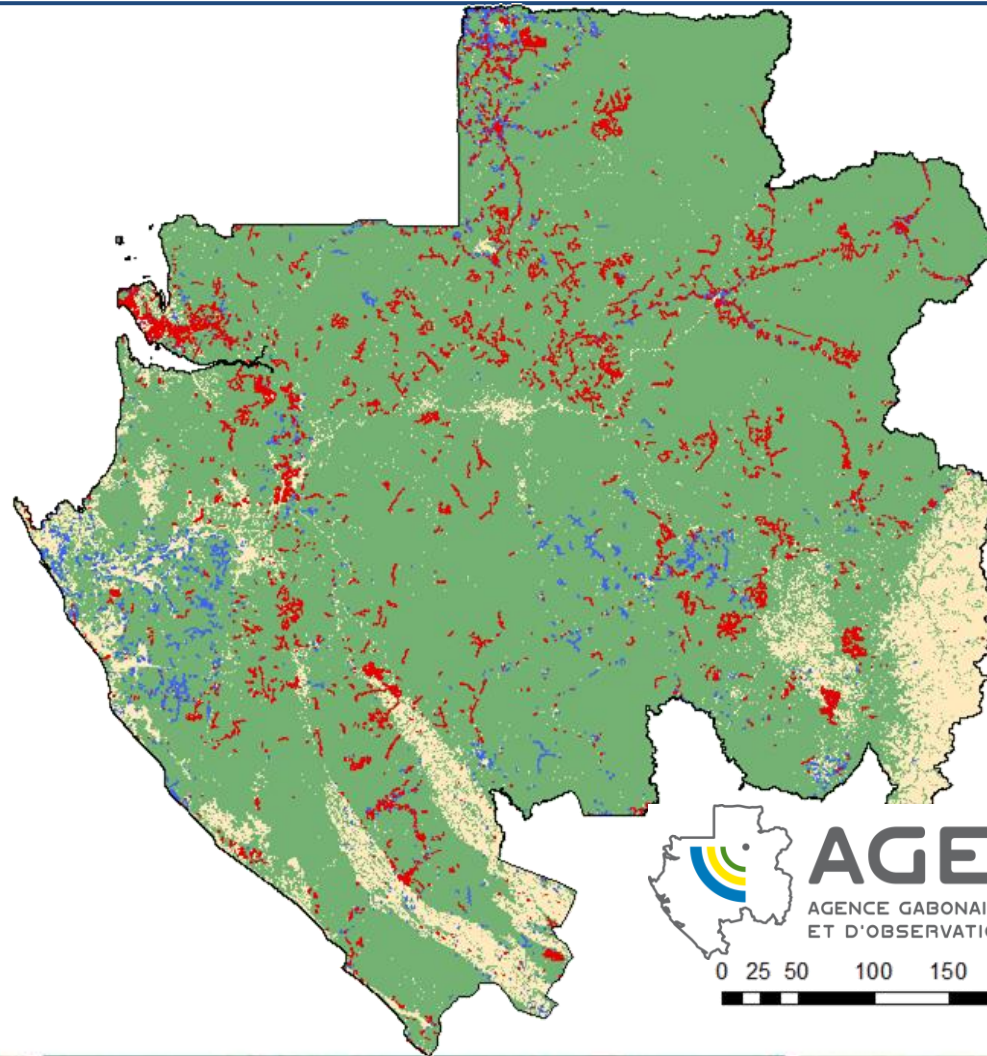
Data Acquisition	Coverage
2016	4%
2015	59%
2014	23%
2013	14%



Gabon Land Cover 2015 and change 2010-2015



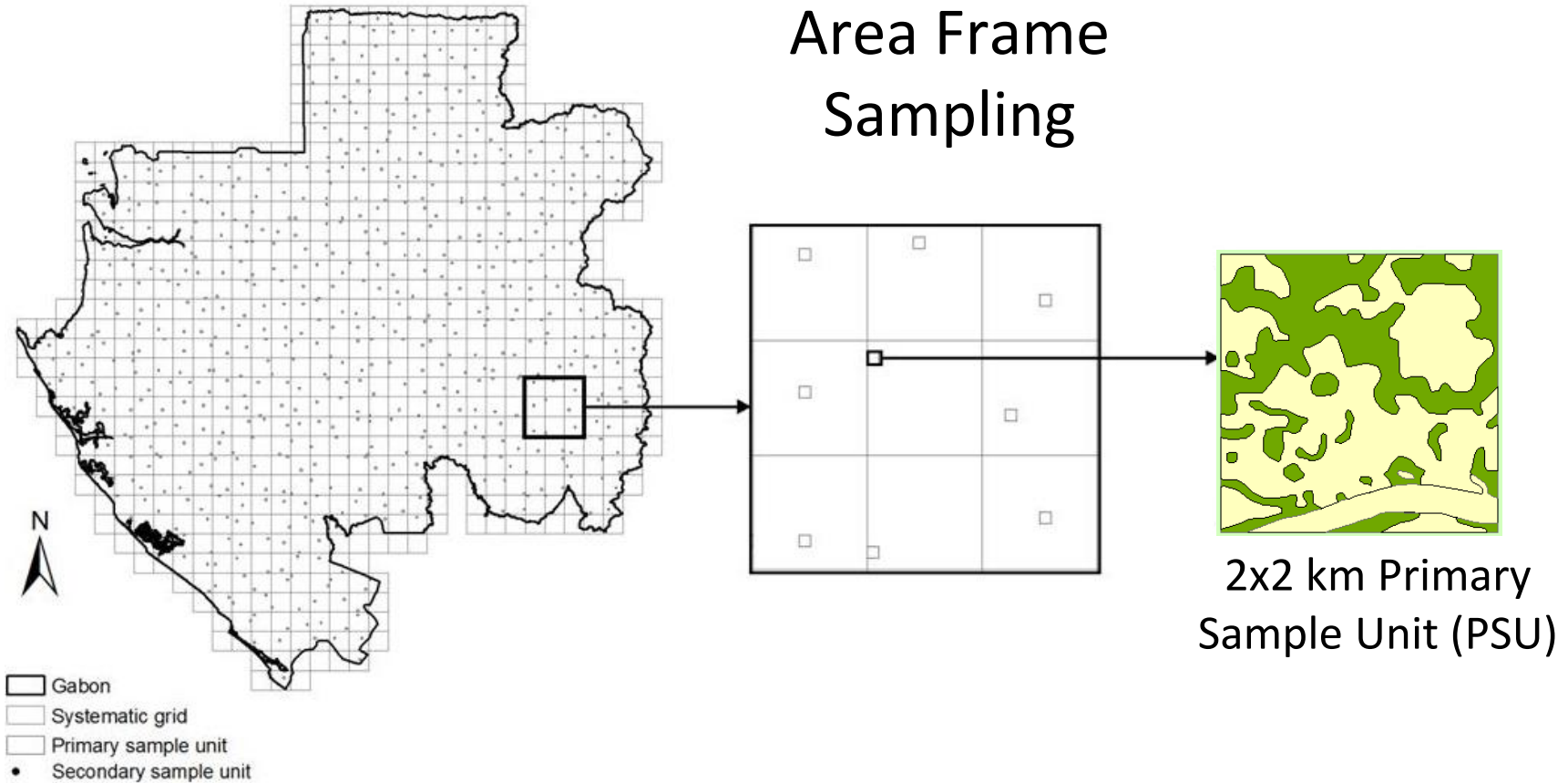
- LandCover 2015**
- Forest
 - Non Forest
- 2010 - 2015 Change**
- Regeneration
 - Forest loss



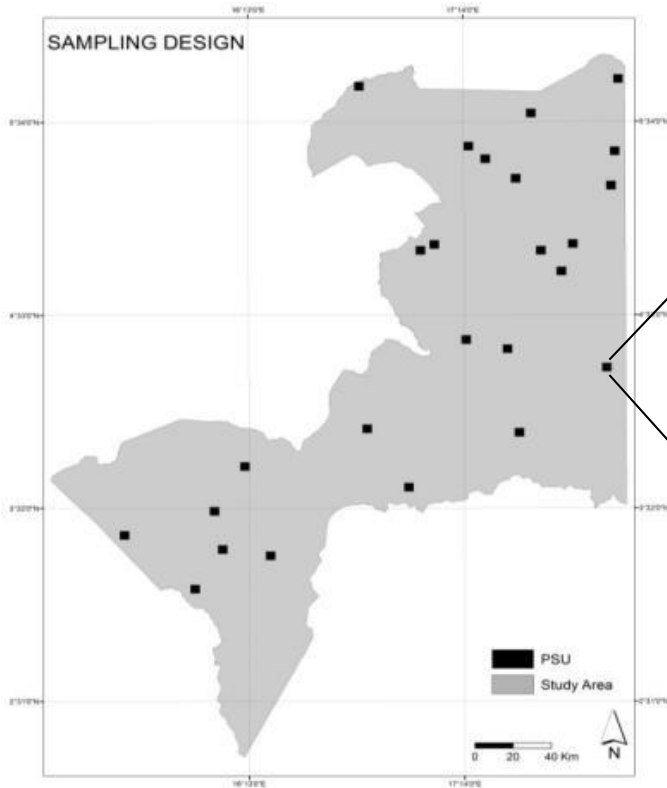
Accuracy assessment: sample design



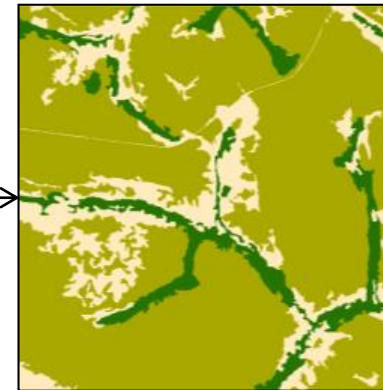
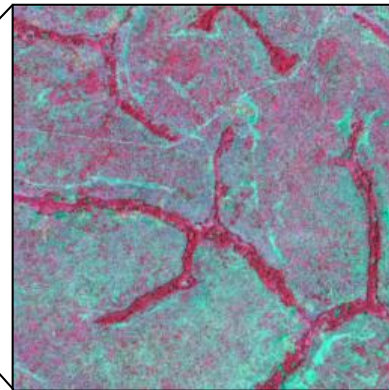
Area Frame Sampling



Accuracy Assessment: response design



Independent visual interpretation
of PSU using VHR as Ground truth



Accuracy Assessment: analysis Gabon 2015



	F	NF	TOTAL	Producer Accuracy	Commission (%)
F	27673	240	27913	99,14%	0,86%
NF	353	2183	2536	86,08%	13,92%
TOTAL	28026	2423	30449	Overall Accuracy:	98,05%
User Accuracy	98,74%	90,09%			
Omission (%)	1,26%	9,91%			

Fichet LV, Sannier C, Massard K. Makaga E., Seyler F (2014) Assessing the Accuracy of Forest Cover Map for 1990, 2000 and 2010 at National Scale in Gabon. IEEE Journal of Selected Topics in Applied Earth Observation and Remote Sensing. 7, 1346 - 1356.

<http://dx.doi.org/10.1109/JSTARS.2013.2271845>



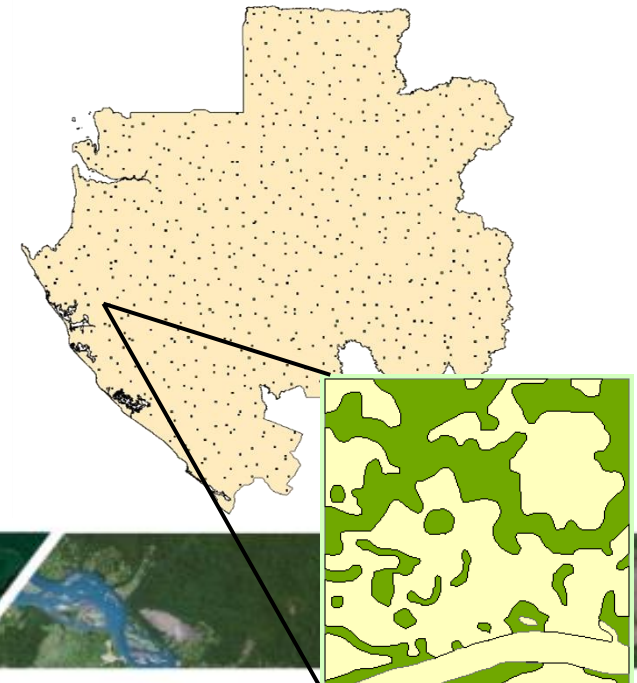
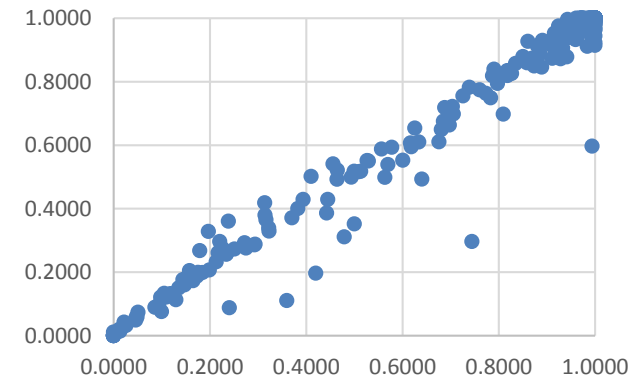
Uncertainty estimates



- Forest cover and forest cover change estimates can be produced based on samples alone (Direct estimate)
- Observations from reference samples and the map can be combined to improve the precision of estimates (Model Assisted Regression):

$$\hat{\mu}^{\text{MAR}} = \hat{\mu}^{\text{map}} - \text{Bias}(\hat{\mu}^{\text{map}})$$
$$\text{Var}(\hat{\mu}^{\text{MAR}}) = \frac{1}{m(m-1)} \sum_{i=1}^m (\Delta_i - \bar{\Delta})^2$$

Classified vs Reference Forest Proportion



Sannier C, McRoberts R A, Fichet LV and Massard K. Makaga R. (2014) Using the regression estimator with Landsat data to estimate proportion forest cover and net proportion deforestation in Gabon. ForestSat 2012 Special Issue. Remote Sensing of Environment. <http://dx.doi.org/10.1016/j.rse.2013.09.015>



Gabon Forest cover change



- Over **23.5 million ha of forest** or more than 88% of Gabon in 2010 with uncertainty $\pm 0,25\%$ at 95% CI
- **Net Deforestation** between 1990 and 2000 around 87 000ha ($\pm 29 000$ ha) or 0,34% over 10 years
- For 2000-2010, net deforestation around **26 000ha** but this is close to not being statistically different from 0 at 95%CI.
- **Natural forest regeneration** is substantial in Gabon:
~ 5,000ha/year
- **Gross deforestation** was reduced by 1/3 from 1990-2000 to 2000-2010
- From 2010 to 2015, gross deforestation almost at the level of 1990-2000 in just 5 years due to economic development
→ Need for more regular monitoring



Gabon Land Cover 2015 and change 2010-2015



Rubber Plantation



Special Economic Zone

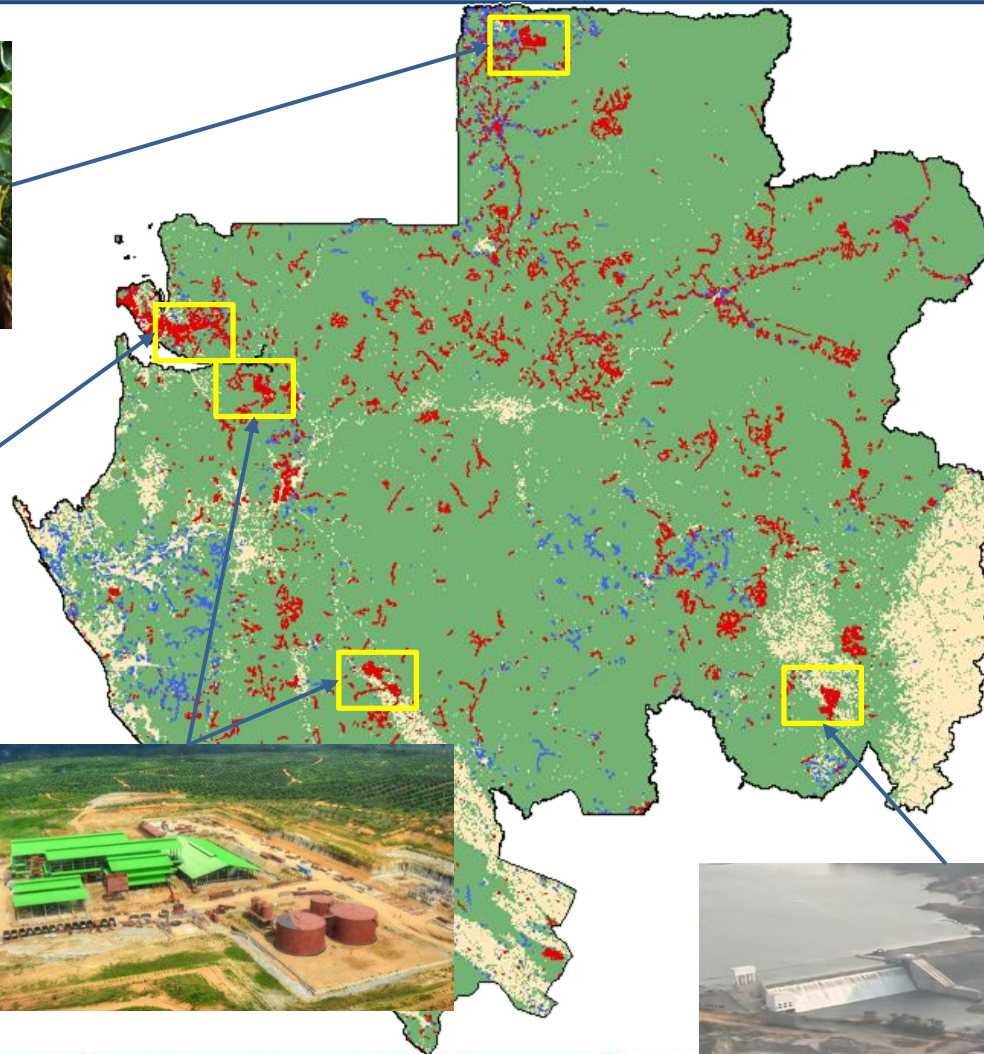


Development of large agri-business and infrastructure projects

Oil Palm Plantations





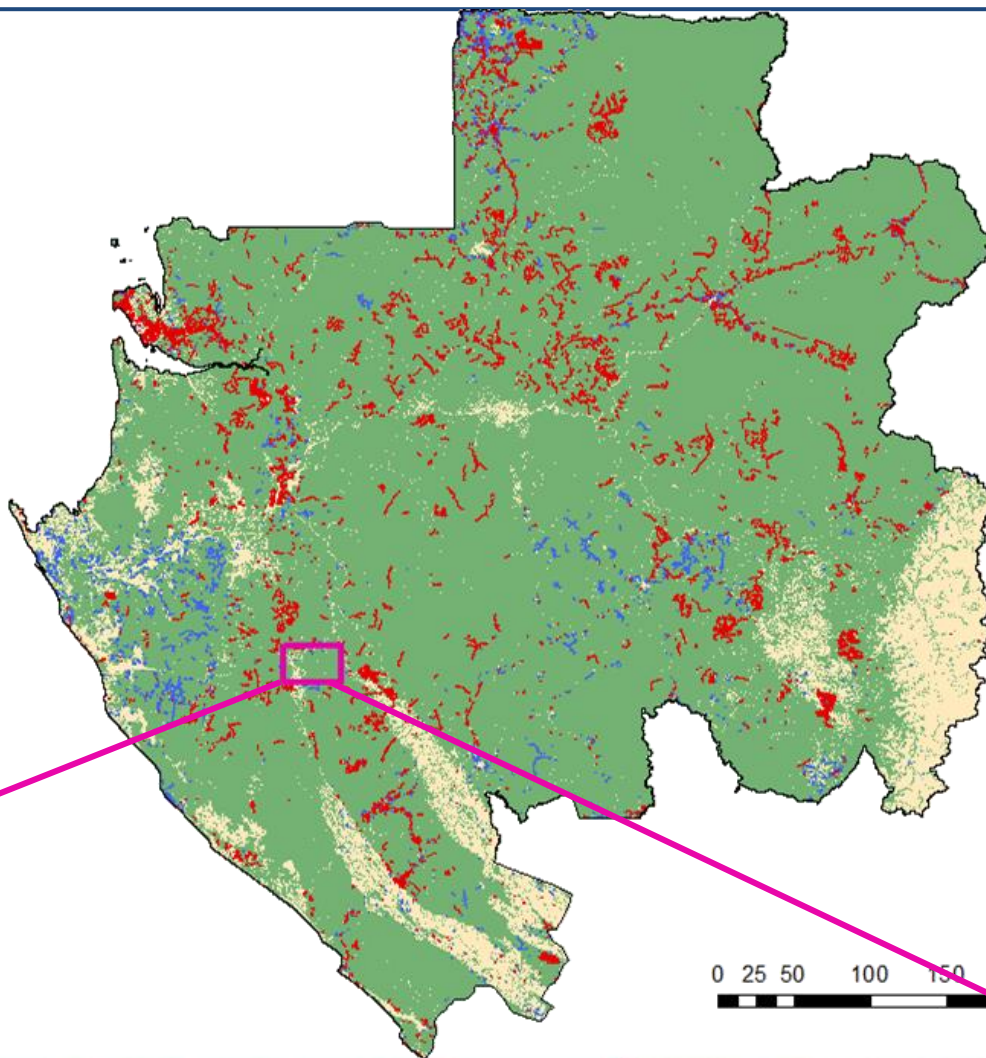
Hydropower Dam

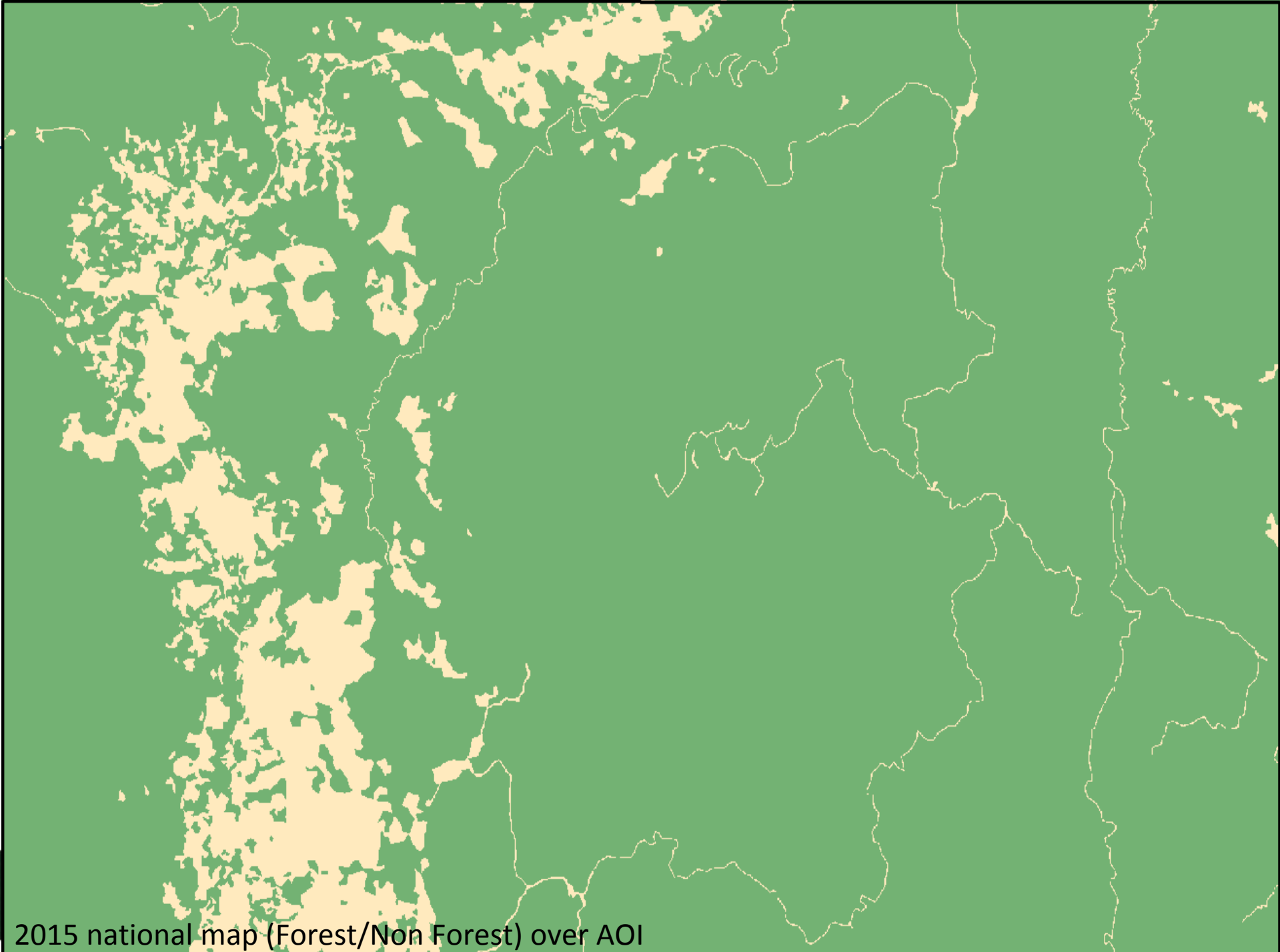


Gabon Land Cover 2015 and change 2010-2015 with near real-time monitoring AOI

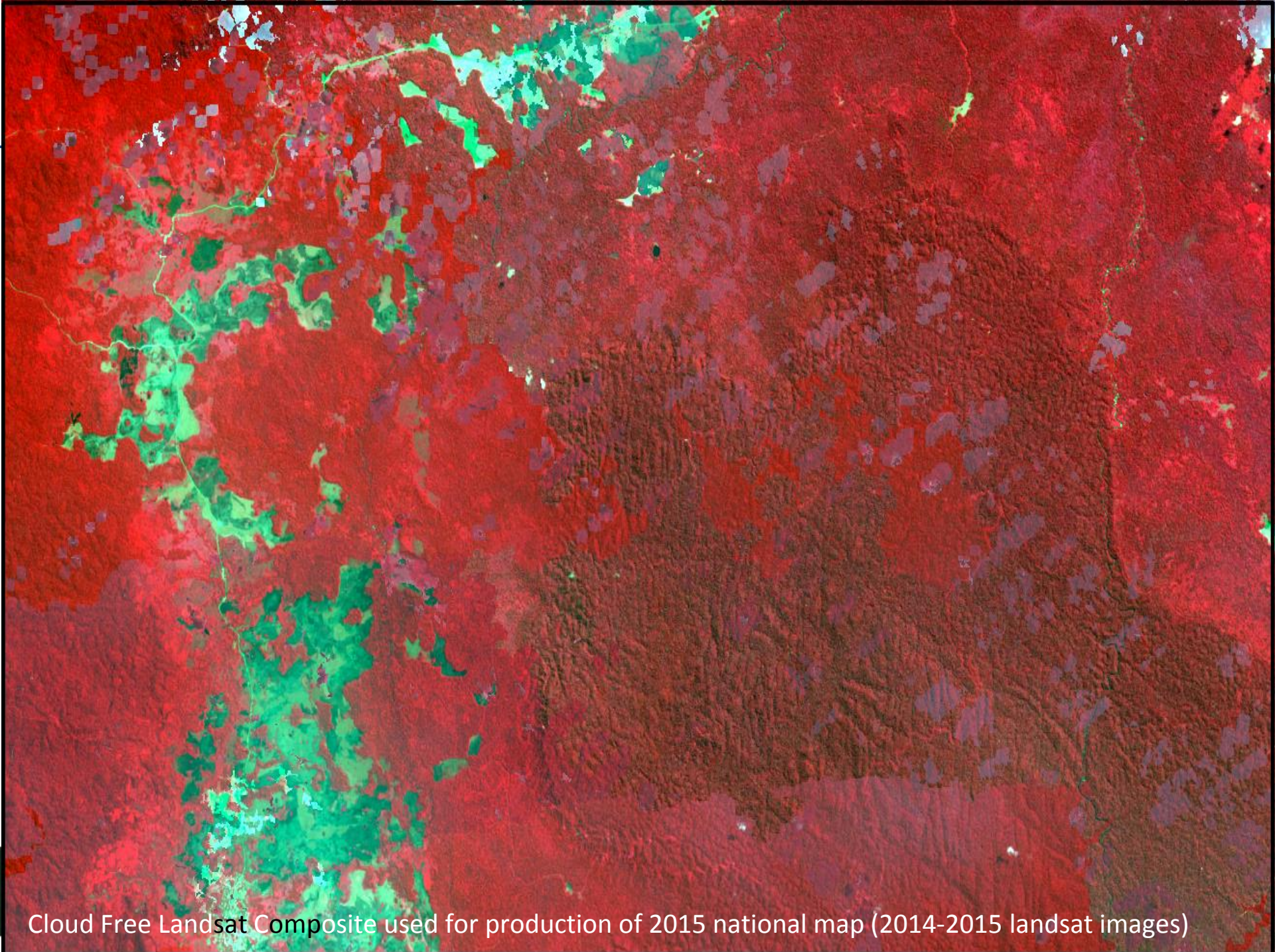


-  AOI
- 2010 - 2015 Change**
-  Regeneration
-  Forest loss
- LandCover 2015**
-  Forest
-  Non Forest

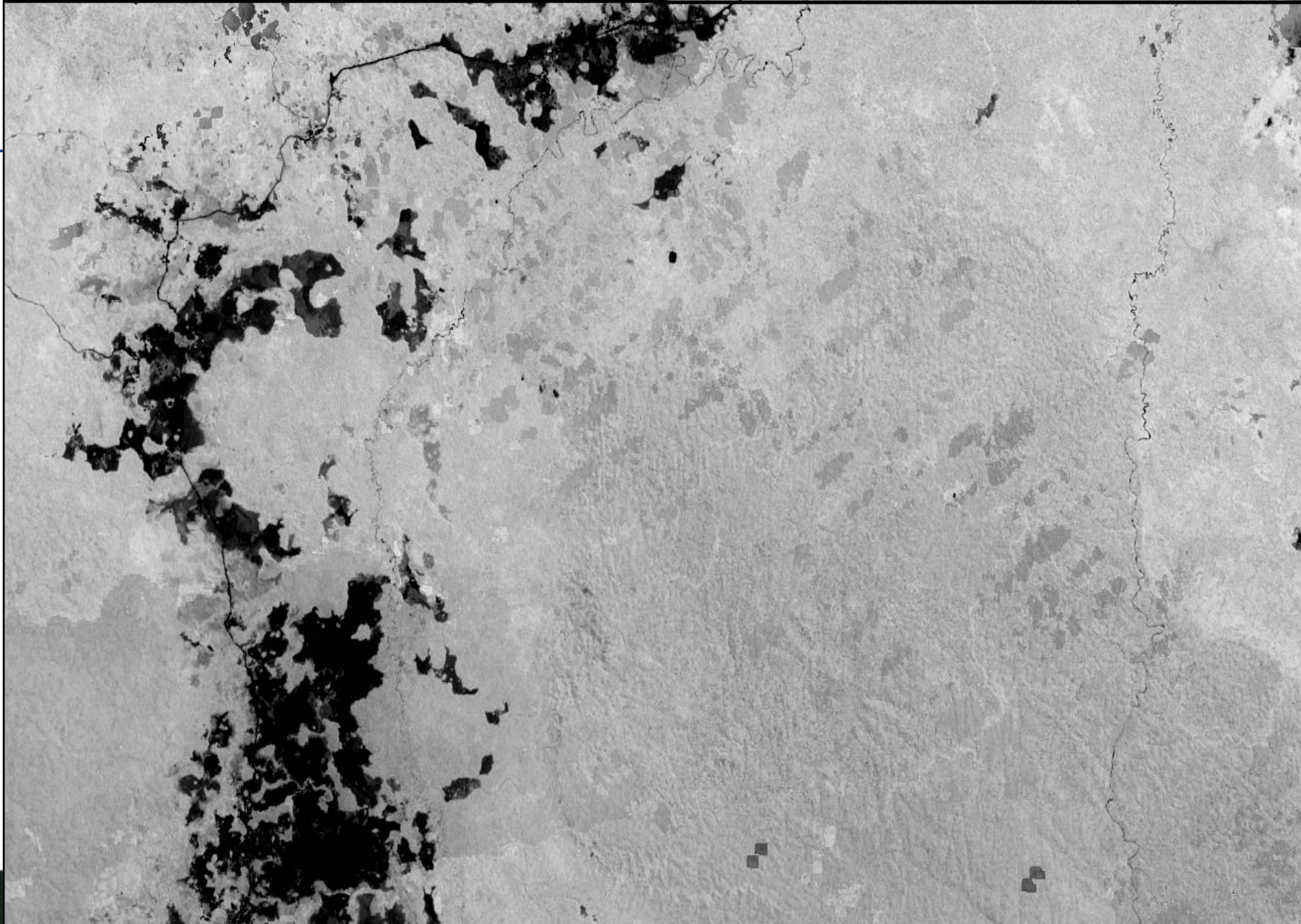




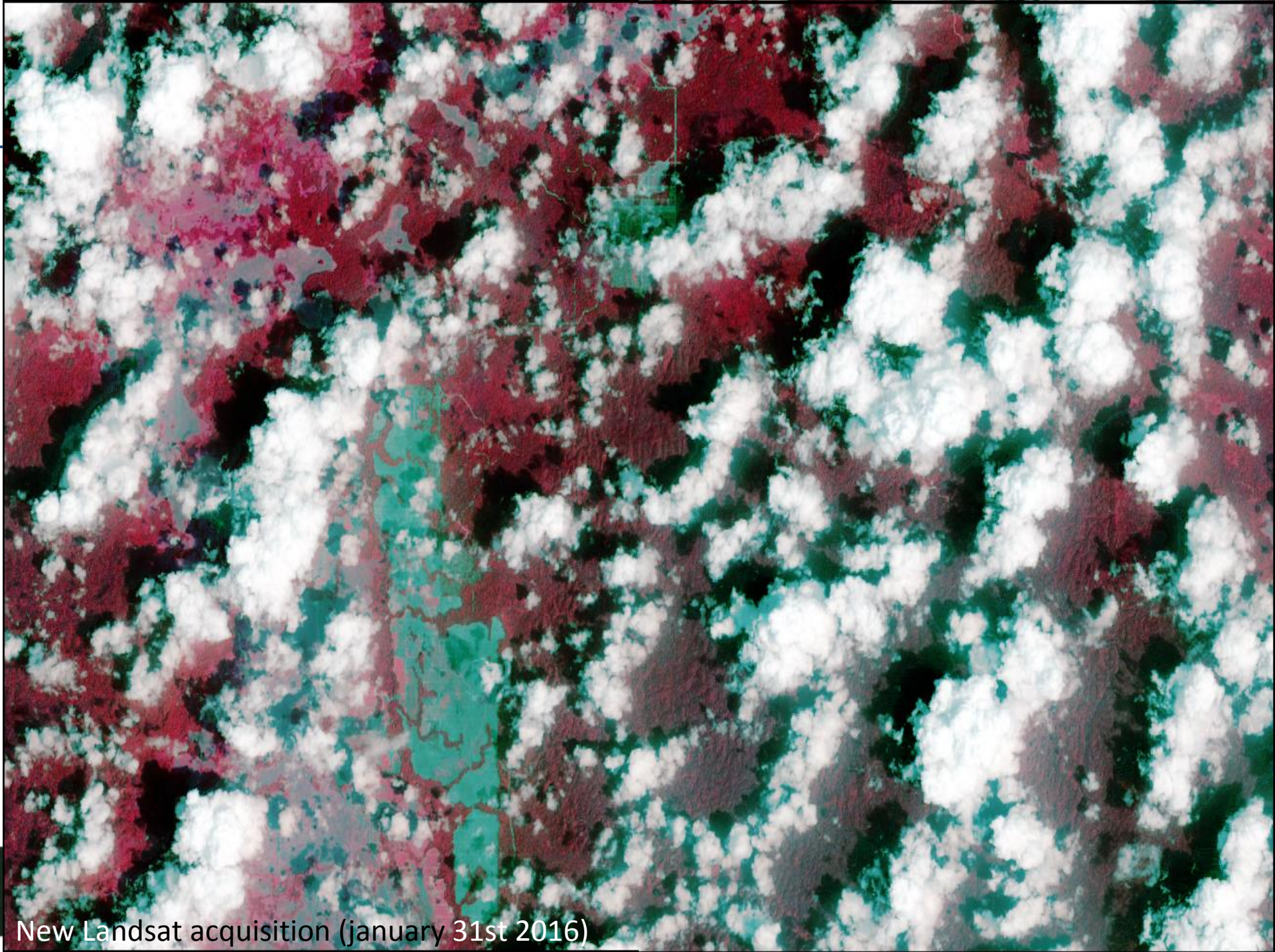
2015 national map (Forest/Non Forest) over AOI



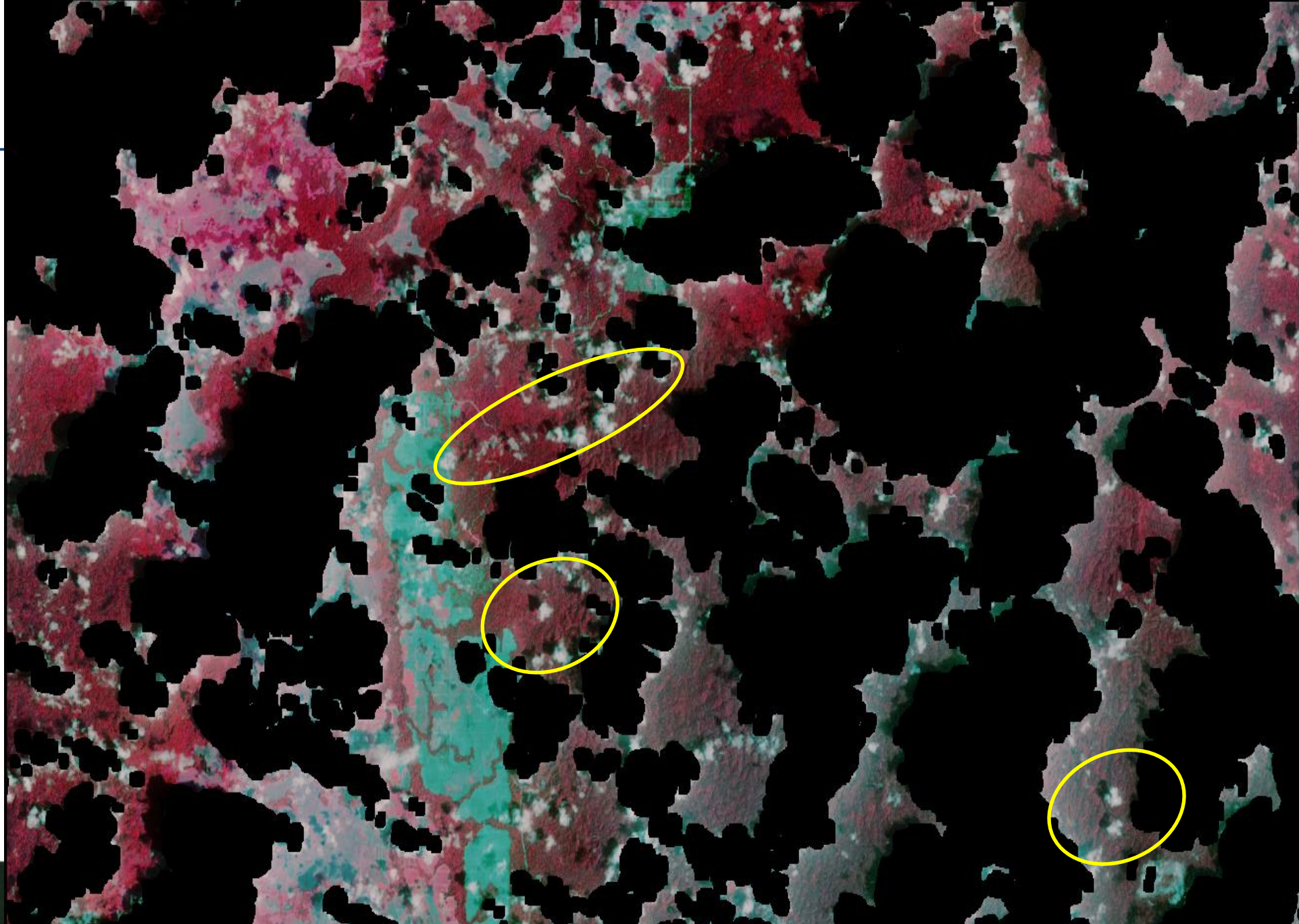
Cloud Free Landsat Composite used for production of 2015 national map (2014-2015 landsat images)



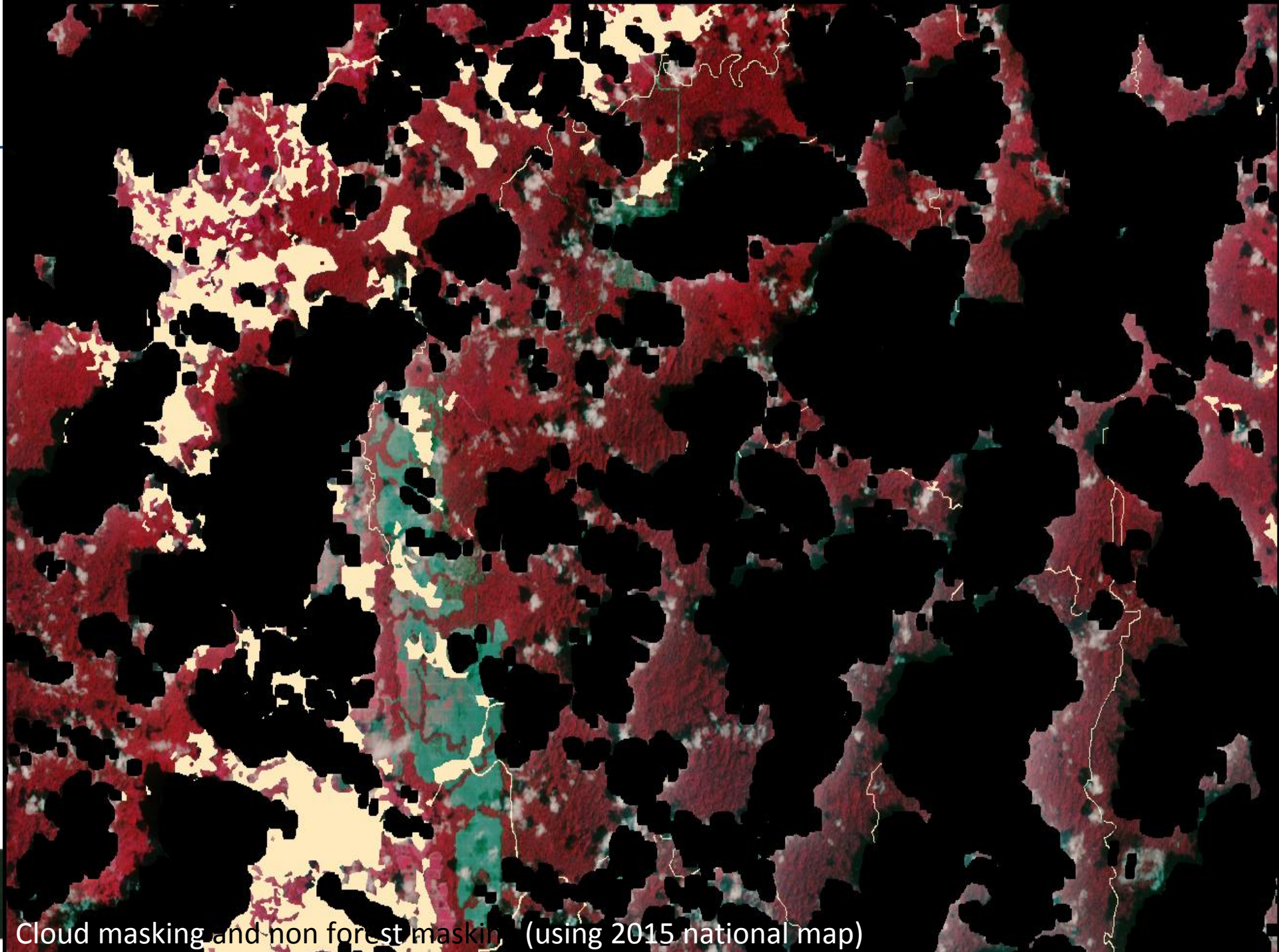
NDVI extracted from Cloud free landsat composite (= NDVI REFERENCE)



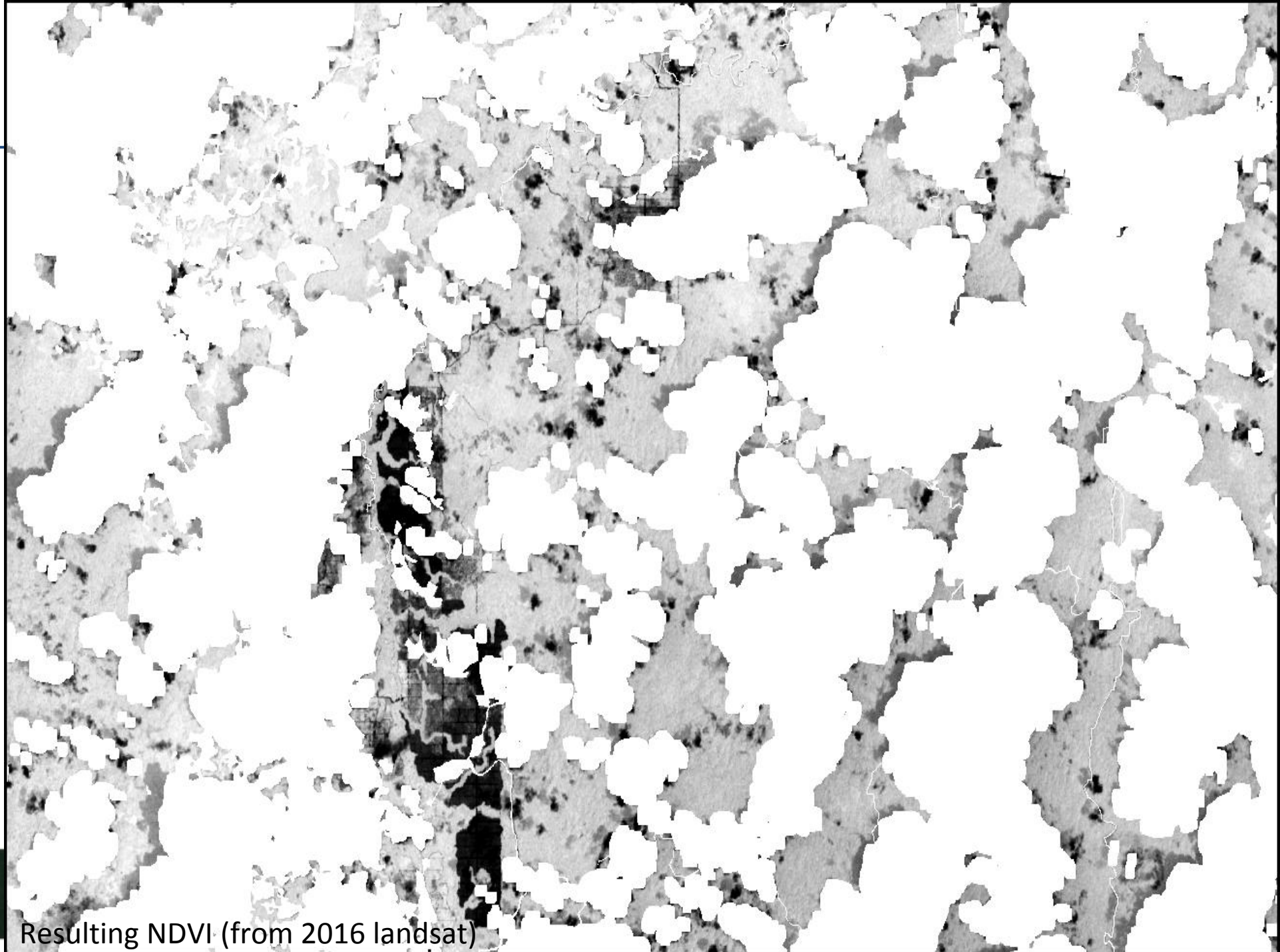
New Landsat acquisition (january 31st 2016)



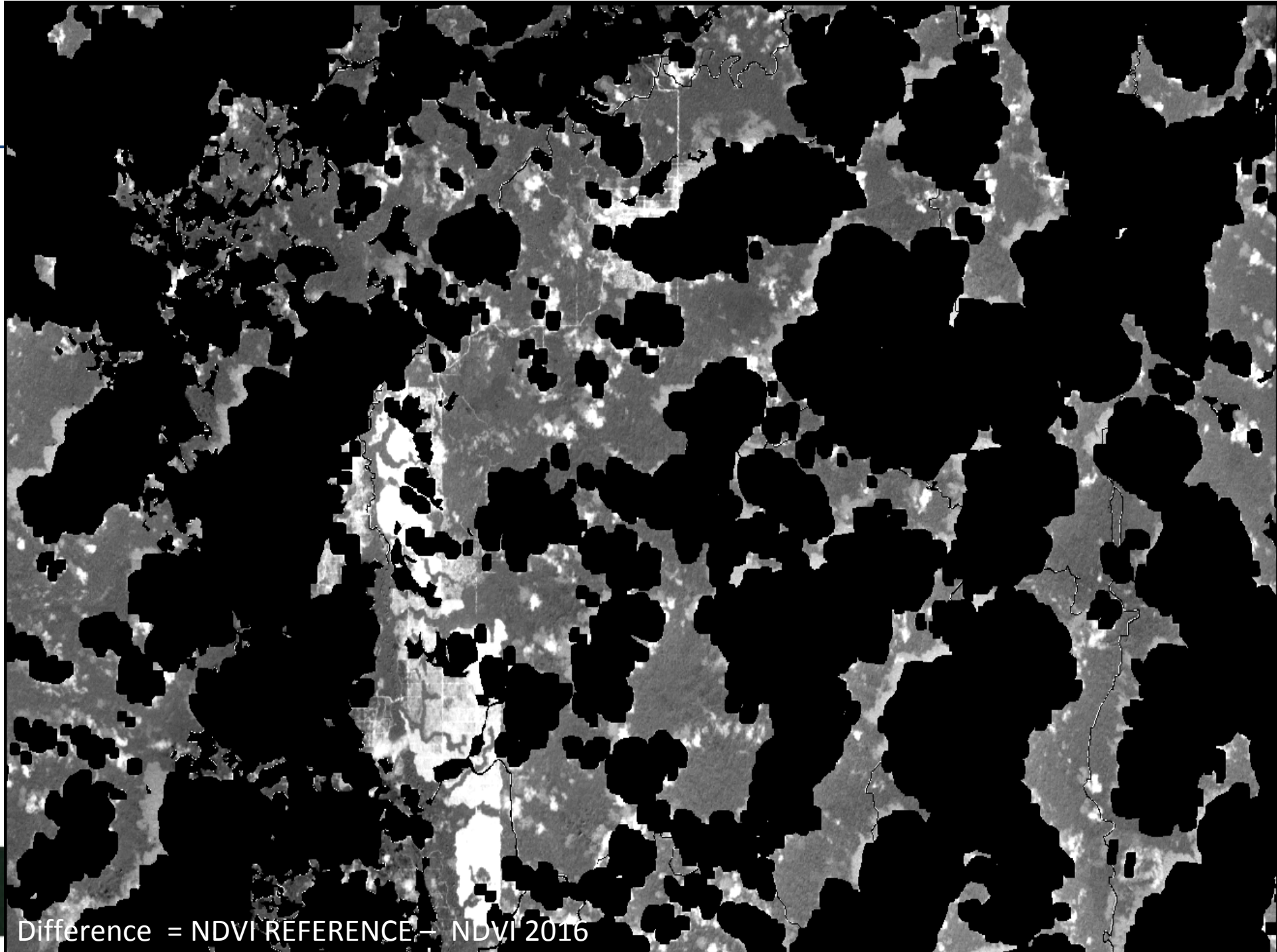
Cloud masking using USGS Cfmask (clouds and clouds shadows not fully masked)

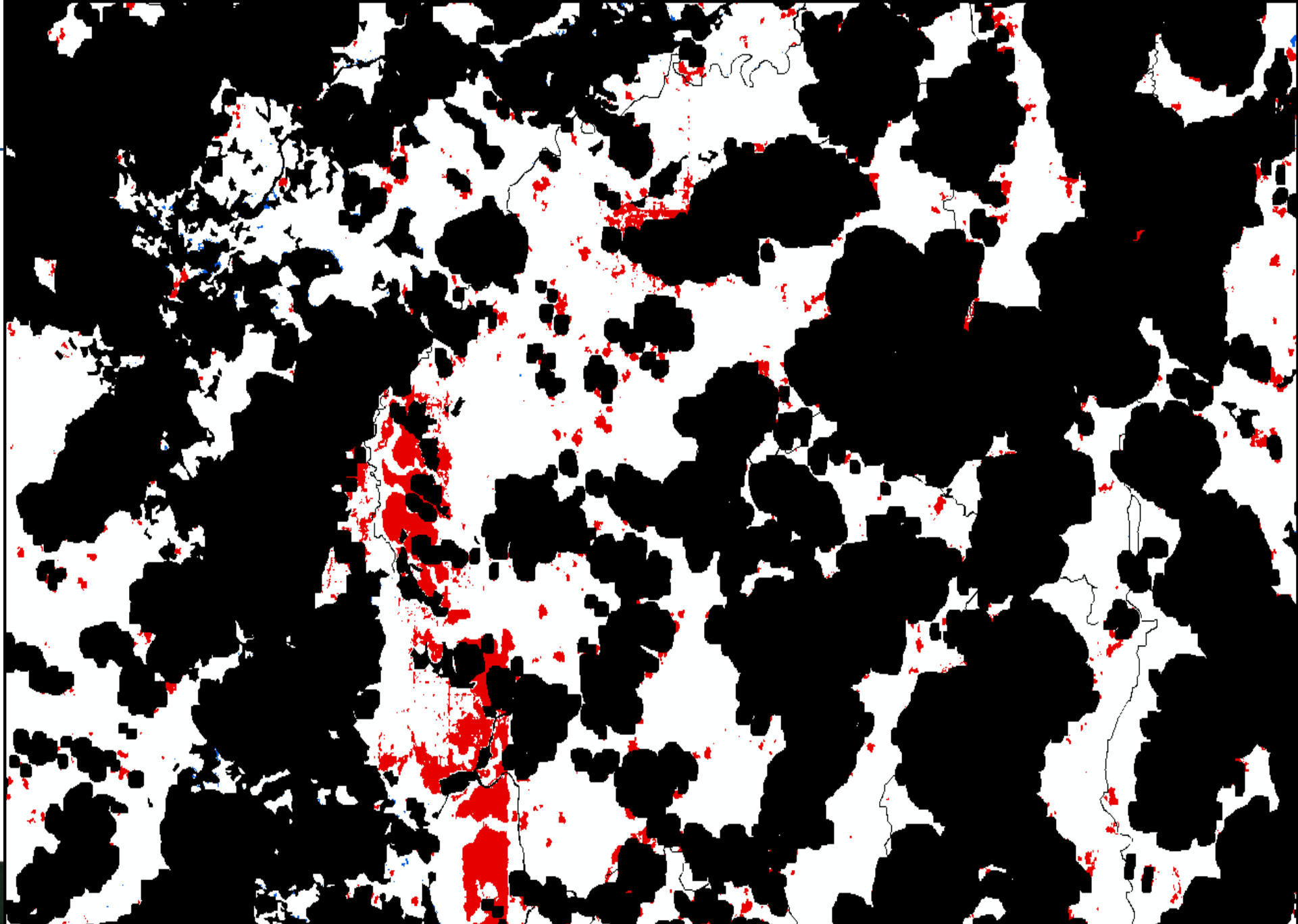


Cloud masking and non forest masking (using 2015 national map)

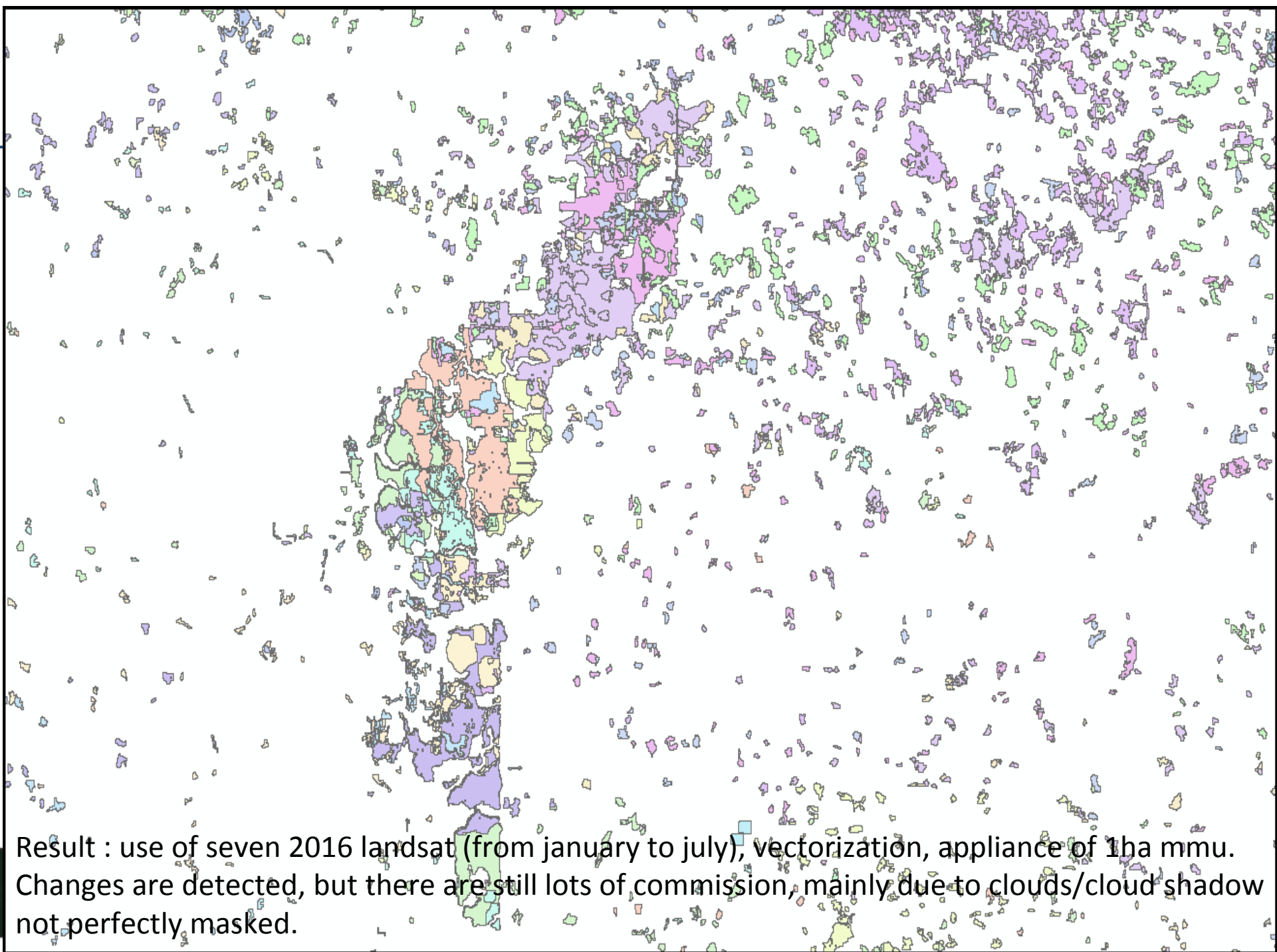


Resulting NDVI (from 2016 landsat)





« Thresholded » ndvi difference (e.g. only lowest and highest values are kept)



Result : use of seven 2016 landsat (from january to july), vectorization, appliance of 1ha mmu.
Changes are detected, but there are still lots of commission, mainly due to clouds/cloud shadow
not perfectly masked.

Conclusions



1. **Forest cover mapping update** is now **operational** and **knowledge transfer** effective
2. **Near-real time methodology** is pre-operational mainly due to **pre-processing constraints** of input data
3. **Cloud and cloud shadow masking** from processed Landsat data inadequate particularly in Gabon. Identification of 'clear pixels' needs further research
4. **Adequately pre-processed EO data** (TOA & accurate cloud and cloud shadow mask) would facilitate technology and know-how transfer
5. **Non-seasonal nature of forest** and **lack of historical dense time series** in Gabon means that a **simple method** for detecting forest disturbance provide similar results to more sophisticated approaches
6. Method developed is compatible with an **annual forest monitoring system**





EOMonDis
GAFAG



Thank you for Listening

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