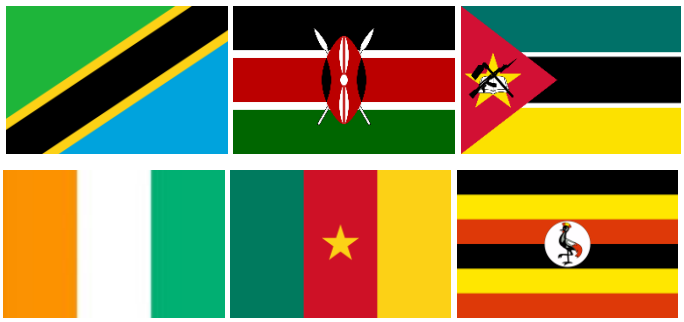
European Commission

JRC TECHNICAL REPORTS

ReCaREDD Project

Forest Degradation Monitoring Workshop – ISPRA 11-15 July 2016



H. Eva, C. Bodart, & A. Verhegghen

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Joint Research Centre

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Contact information
Name: Hugh Eva
Address: Joint Research Centre, Via Enrico Fermi 2749, TP 260, 21027 Ispra (VA), Italy
E-mail: hugh.eva@jrc.ec.europa.eu
Tel.: +39 0332 78 5016

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ReCaREDD Project

Forest Degradation Monitoring Workshop – ISPRA 11-15 July 2016

Hugh Eva, Catherine Bodart & Astrid Verhegghen

With contributions from

Jean Daniel MENDOMO BIANG
Ministère des Forêts et de la Faune, Cameroun

Dibi Hyppolite N'DA & Tchimou Vincent ASSOMA
Centre universitaire de recherche et d'application de la télédétection, Cote d'Ivoire

Jamleck NDAMBIRI & Eunice MAINA
Kenya Forest Service

Joaquim MACUACUA
National Directorate of Forestry, Ministry of Land, Environment and Rural Development
Mozambique

Nurdin CHAMUYA & Jared OTIENO
Tanzania Forest Service

John DIISI
Uganda Forest Authority

Fortunate Muyambi BENDA
IGAD Climate Prediction & Applications Centre (ICPAC), Kenya

Siro ABDALLAH
Regional Centre for Mapping of Resources for Development (RCMRD), Kenya

Silvia CARBONI, Bill LAURANCE, Andreas LANGNER, Cozmin LUCAU, Dario SIMONETTI, Hans Jürgen STIBIG, Peter SPRUYT, Peter VOGT

European Commission, Joint Research Centre

Silvia Carboni, Vincent Assouma, John Diisi, Eunice Maina, Jared Otieno, Fortunate Benda, Jamleck Ndambiri, Hugh Eva, Nurdin Chamuya, Hyppolite N'da, Astrid Verhegghen, Abdalla Siro, Joaquim Macuacua, Catherine Bodart

A ReCaREDD regional workshop at the JRC Ispra, 11-15 July 2016. Participants from Cameroon, Ivory Coast, Kenya, Mozambique, Tanzania, Uganda and two regional centres RCMRD & ICPAC took part in the workshop – including training and practical sessions on processing and interpreting satellite images for forest monitoring and ground data collection.

The workshop was organised and presented by Hugh Eva, Catherine Bodart and Astrid Verhegghen

For further information on ReCaREDD activities in Africa:

Technical contact:	Hugh Eva	hugh.eva@jrc.ec.europa.eu
Administrative contact:	Frédéric Achard	frederic.achard@jrc.ec.europa.eu

Abstract

A ReCaREDD regional workshop at the JRC Ispra, 11-15 July 2016. Participants from Cameroon, Ivory Coast, Kenya, Mozambique, Tanzania, Uganda and two regional centres RCMRD & ICPAC took part in the workshop – including training and practical sessions on processing and interpreting satellite images for forest monitoring and ground data collection.

The workshop brought together a group of experts from partner countries in Africa to take part in a capacity building and information sharing workshop dedicated to reducing barriers for forest degradation monitoring in the tropics. A main part of the workshop was dedicated to the provision and processing of Sentinel-2 data.

The JRC and the partners worked together to select test sites and methods for carrying out pilot studies for forest degradation monitoring.

Topics covered in the workshop

- National forest programs and perspectives
- Review of potential satellite sensors for detecting forest degradation
- Review of methods for detecting and quantifying degradation with satellite data
- Interactive sessions on the JRC open source tool for working with satellite data
- Interactive review of high resolution Sentinel-2 data
- New tools for ground data collection – drones and very high precision GPS

The principle results of the workshop

- Selection of test sites for each country
- A preliminary assessment of methods for monitoring degradation

The institutes represented

Cameroon	*Ministère des Forêts et de la Faune*
Ivory Coast	*Centre universitaire de recherche et d'application de la télédétection*
Kenya	*Kenya Forest Service*
Mozambique	*National Directorate of Forestry, Min. of Land, Environment and Rural Development*
Tanzania	*Tanzania Forest Service*
Uganda	*Uganda Forest Authority*

Regional Centres

IGAD[1] Climate Prediction & Applications Centre (ICPAC), Kenya

Regional Centre for Mapping of Resources for Development (RCMRD), Kenya

[1] Intergovernmental Authority on Development

Table of contents

Abstract iii

1. Introduction 1

2. Approaches for Monitoring of Forest Degradation- JRC 3

3. Advances in field data collection 12

3.1. High precision GPS systems – Cozmin Lucau 12
3.2. Drone technology – Peter Spruyt 13
4. Country Presentations 15

4.1. Cameroon - Jean Daniel Mendomo Biang 16
4.2. Ivory Coast - Hyppolite Dibi & Vincent Assoma 26
4.3. Kenya - J. Ndambiri & Eunice Maina 37
4.4. Mozambique - Joaquim A. Macuácua 48
4.5. Tanzania – Nurdin Chamuya & Jared Otieno 60
4.6. Uganda – John Diisi 65
5. Next Steps – Pilot Studies 73
5.1. Proposed Methods 85
5.2. Next Steps – Country Pilot Studies 86
5.2.1. Cameroon 86
5.2.2. Ivory Coast 87
5.2.3. Kenya 88
5.2.4. Mozambique 88
5.2.5. Tanzania 89
5.2.6. Uganda 90
List of Figures 91

1. Introduction

Background

The ReCaREDD[2] project is hosted by the European Commission's Joint Research Centre, funded by the EU overseas cooperation service DG DEVCO. Its goal is to enhance the ability of institutions in partner countries to report on forest degradation, in a reliable and cost-efficient manner. Further objectives are to develop, share and adapt appropriate monitoring methods and to provide direct assessments of the status and evolution of tropical forest cover in support to forest policies and national and international negotiations on emission reductions. ICPAC and RCMRD are partners in the EU funded MESA (Monitoring Environment and Security in Africa) project, and therefore are the primary points of contract for ReCaREDD activities in East Africa.

In this framework the JRC is running a set of workshops to inform partner institutions and train them in techniques for monitoring and assessing forest degradation using remote sensing and field surveys.

1.1. Overview and Goals

ReCaREDD – To develop in partnership a strategy, guidelines and tools for exploiting Remotely Sensed data in conjunction with field measurement with the aim of detecting and quantifying forest degradation.

In the context of supporting forest monitoring the workshop goals were to:

- Reinforce the capacity to process, interpret and extract data from satellite data
- Outline options and strategies for national forest agencies on how to monitor forest change – sample or wall to wall

In the specific context of ReCaREDD

- Collect information for each of the partner countries on:
  - Locations of forest degradation
  - Drivers of degradation
  - Spatial and temporal nature of degradation
  - ***Select specific test sites for monitoring with satellite data***
- Country presentations on current forest monitoring capacities – and where institutions such as the JRC and partners can help most
- Presentation of current FOROBS work on degradation monitoring
- Potential use of SENTINEL 2 data in the context of degradation monitoring
- Provide JRC software for processing of satellite data for land cover change monitoring

[2] ReCaREDD Reinforcing Capacities for REDD

Results

- Enhancing the capacity of partners to exploit satellite data (IMPACT)
- Introduction of partners to methods to characterise spatial changes in forest cover (GuidosToolkit)
- Foster cooperation between different forest services and regional centres
- Selection of test sites for pilot studies
- Provide countries with options for monitoring forest degradation
- Demonstrate advances in field data collection
- Set in progress the possibility of defining a program for a pilot study

2. Approaches for Monitoring of Forest Degradation- JRC

Compiled by ***Hans Jürgen Stibig*** from the contributions of:

F. Achard, R. Beuchle, C. Bodart, H.D. Eva, R. Grecchi, A. Langner, D. Simonetti, H-J Stibig, C. Vancutsem, A. Verheggen

- **REDD+ mechanism requires monitoring of forest change in order to estimate GHG emissions(em)/removals from forests**
  - change in biomass due to change in forest area (deforestation/reforestation)
  - change in biomass within forest (degradation – amelioration processes)
- Possible approach:

  Activity Data (forest area) & Emission Factor *ef* (tC/ha)

  Δ forest area x *ef* =*em*
- If forest area degraded is known one could similarly apply:

  Δ_2 forest area$_{deg}$ x ef$_{fodeg}$ = *em*$_{fodeg}$
- **Need to reliably identify forest areas affected by degradation**
- **To what extent can RS provide this information?**

Definition of Forest Degradation

There is no internationally agreed definition of "forest degradation"

FAO: *"The reduction of the capacity of a forest to provide goods and services"*
..but there are more than 50 other definitions of forest degradation…

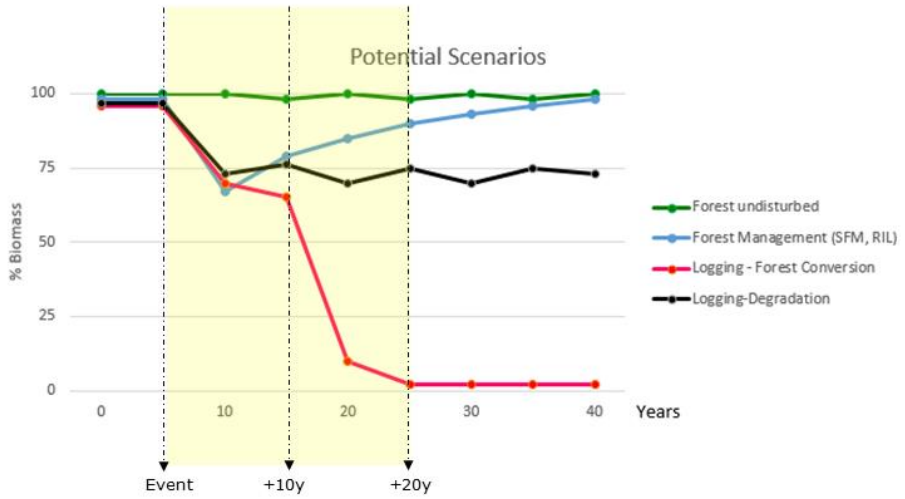
REDD+ context is on carbon stocks

UNFCCC/IPCC: *"A direct human-induced long-term loss (persisting for X years or more) of at least Y% of forest carbon stocks [and forest values] since time T and not qualifying as deforestation or an elected activity under Article 3.4 of the Kyoto Protocol."*

Proposal for 'workable' definition?

e.g. LEAF Workshop 2015 BKK: *"The reduction in forest carbon stocks by at least 10% and persisting for 5 years or more."*

Importance of Time Scale



Remote Sensing Limitations

- Not all processes of 'forest degradation' can be detected by RS
- Remote Sensing offers one option for monitoring of forest degradation processes ➡ *there are also other approaches e.g. field inventory!*
- RS (optical) can detect forest degradation only if reflected in a change of forest canopy – relation to biomass to be done
- Main focus on evergreen and semi-evergreen forest cover
  for dry deciduous forests (open, seasonal) consistent detection canopy changes remain difficult, except for forest conversion and fire impact

Possible Approach

- Proposed RS Approach (as long as forest degradation definition not fixed):
  - Identify Forest Canopy '*Disturbance*' expected to cause biomass change
  - Decide based on *temporal aspect and context knowledge* whether ‚forest degradation'

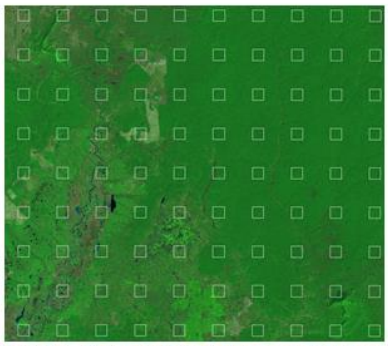
- REDD+ reporting requires assessment of change between t_1, t_2, t_3 ....
  - Change assessment needs to be done consistently for the different reference periods (historical, present and future dates t_1, t_2, t_3 ....)
  - For historical reference dates there can be an obstacle when aiming at using existing historical maps produced by different methodology or when satellite imagery are available for a date in the past

Sampling (1)

Sampling can be an efficient option, implementing change assessment (t_1,t_2,t_3) only for sample units >> less demanding in terms of time & cost

Sampling Units:
- Points: (visual) change interpretation (t_1, t_2, t_3 ....) at sample points
- Boxes: area change mapping within sampling boxes

Design:
- Systematic sampling
- Stratificatied sampling and distribution of sampling units in different strata at different intensity



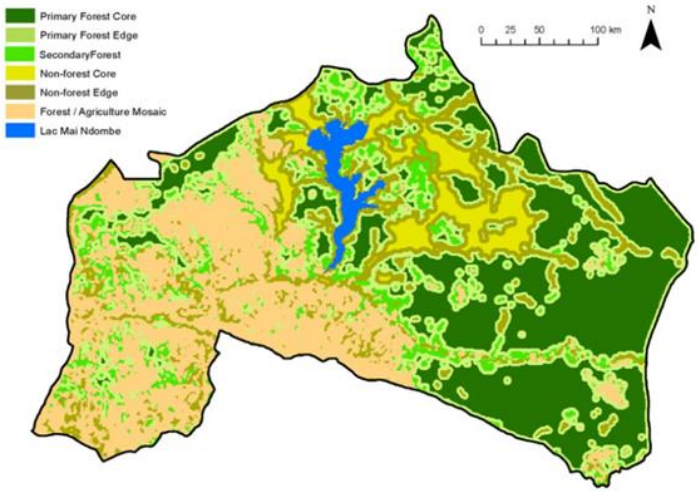
Example: Systematic sampling with 'boxes'

Sampling (2)

Example stratified sampling

- Start from forest map with categories like:
  - forest
  - degraded forest
  - non-fores

Example DRC



Source: Forest Carbon Partnership Facility (FCPF) - ER-PD proposal
https://www.forestcarbonpartnership.org/democratic-republic-congo

Commission

Sampling (3)

Example DRC

Example stratified sampling (cont'd)

- Statistical distribution of sample units with different sampling intensity / strata
- Change assessment within sample units
- Statistical estimate of total change

Source: Forest Carbon Partnership Facility (FCPF) - ER-PD proposal
https://www.forestcarbonpartnership.org/democratic-republic-congo

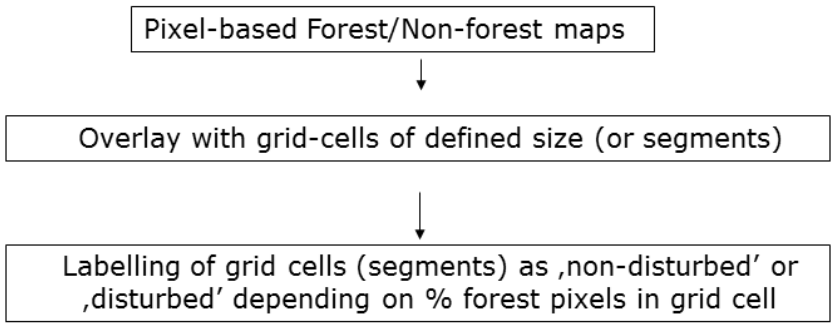
1. Visual manual assessment of disturbance from satellite imagery

➢ Delineation of ‚intact' and ‚non-intact' forest canopies
(analogue to IFL approach (Intact Forest Landscapes– www.intactforests.org)
- Identification of openings and infrastructure, buffering around forest edges, forest within buffer as non-intact or potentially degraded

➢ Review of existing forest maps
- adding ‚disturbance attributes' to existing mapping units (polygons)
  (Existing forest maps often include polygons as forest where there is visible disturbance or opening of canopies)

Challenges:
- consistent mapping through time periods
- availability of historical maps

2. Generation of pixel based forest/non-forest maps and mapping of forest/non-forest proportions within grid-cells (or segments)



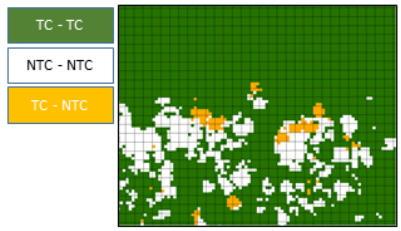
Advantage of grid-cell approach: consistent monitoring unit over time, segments or polygons shapes may change

Example: Degradation assessment based on proportions of forest/non-forest pixels

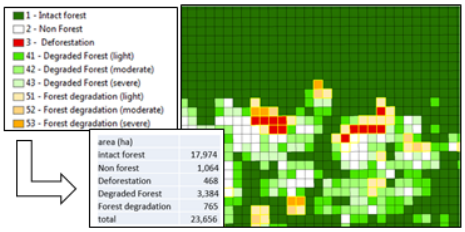
Definition of forest degradation based on forest definition
Forest = Tree cover > 30 %; Minimum area of 1ha

1: Landsat map (2 dates T0 - T1): Tree cover – Non Tree Cover
Counting of pixels in each cell (Grid of 3*3 pixels of 0.81 ha):

X_{TC-TC} =number of pixels that stayed TC
$X_{NTC-NTC}$ = number of pixels that stayed NTC
X_{TC-NTC} = number of pixels that changed from TC to NTC

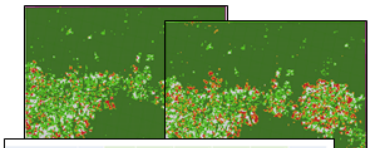


2: Classification of each cell based on
X_{TC-TC} $X_{NTC-NTC}$ X_{TC-NTC}
Intact Forest
Degraded Forest
Deforestation
Non-Forest



area (ha)	
Intact forest	17,974
Non forest	1,064
Deforestation	468
Degraded Forest	3,384
Forest degradation	765
total	23,656

3: Track over time: add a second time period T1-T2 over the same grid (record of state for each cell)



	1	2	3	4	5	
Intact forest	1	20830		406		954	22190
Non forest	2		1314				1314
Deforestation	3		578				578
Degraded Forest	4			253	3443	482	4178
Forest degradation	5			296	389	260	945
		20830	1892	955	3832	1696	29205

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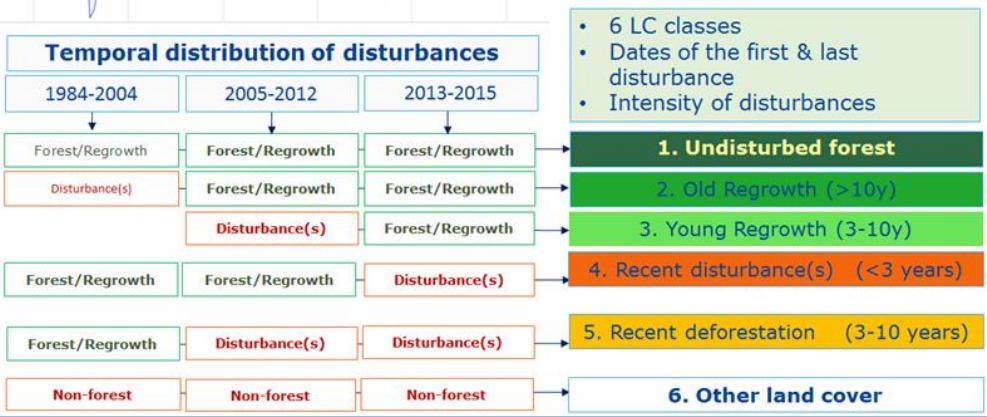
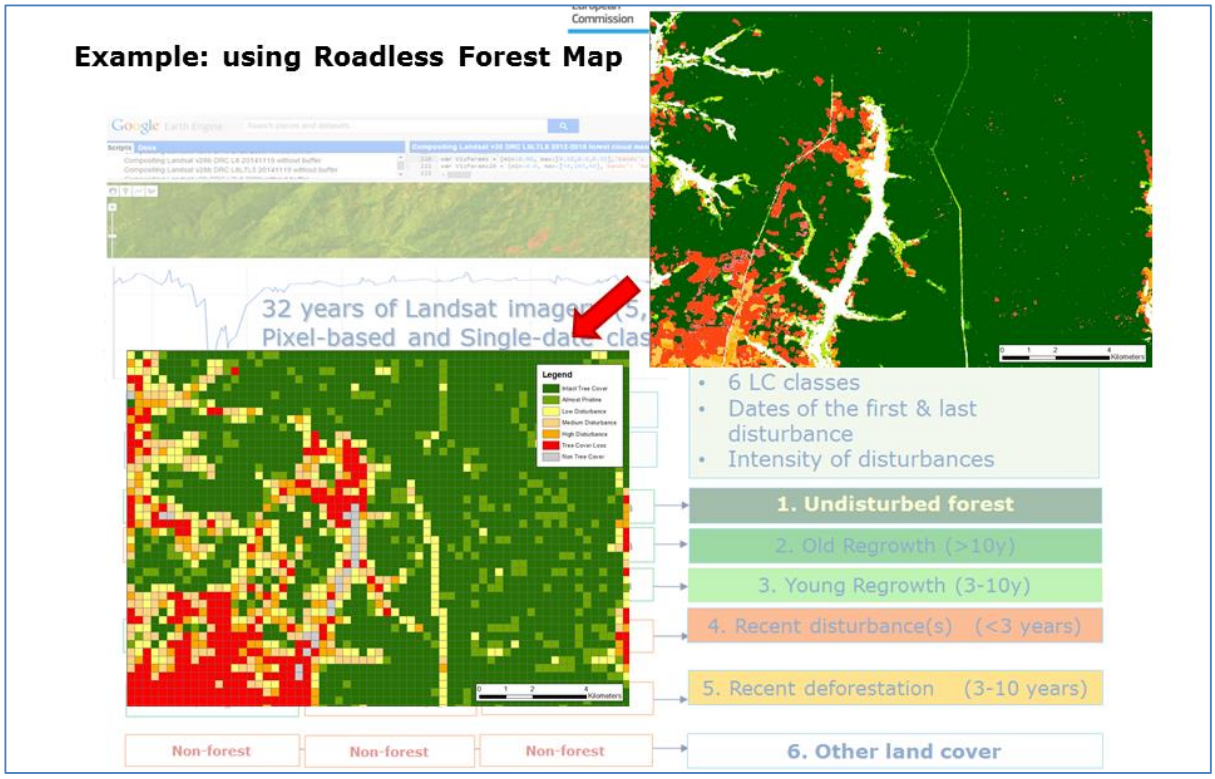
Example: using Roadless Forest Map

Vancutsem, C., Achard, F., 2016, Mapping Intact and Degraded Humid Forests over the Tropical Belt from 32 Years of Landsat Time Series, 2016 European Space Agency Living Planet Symposium, 9-13 May 2016





3. Sub-pixel classification of forest proportions from SMA or other Indexes

- Define Forest-Non Forest Mask
- Calculate indexes from satellite imagery

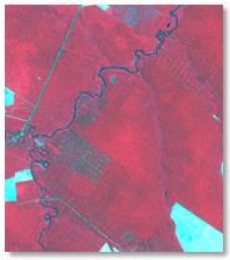
  e.g. - Soil Fraction Index

  - Burnt Area Index (NBR)
- Relate index values to disturbance intensity (non-forest portions),
- defining thresholds to create disturbance classes

Area estimation: for example within grid cells assigning ‚non-disturbed' or ‚disturbed' category according to % non-forest pixels contained in grid-cell

Advantage: consistent monitoring over time based on grid cells, transparent measurement due to automated approach

Example: Assessing selective logging and forest fires in Brazilian Amazon using medium resolution satellite images



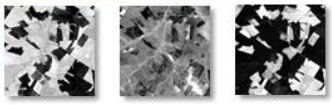
LANDSAT

Soil fraction image

1. Spectral Mixture Analysis

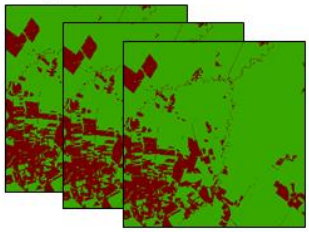
(Shimabukuro and Smith 1991)

Fraction images (vegetation, shadow, soil) enhance information in each component while reducing data dimensionality



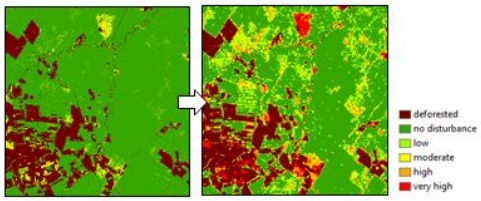
Logging mapping by threshold

2. Object-based annual Forest Masks



3. Combination of both approaches

Use of 300m grid to derive disturbance intensity



Grecchi et al. An integrated remote sensing and GIS approach for monitoring areas affected by selective logging in the Brazilian Amazon (Int J Appl Earth Obs Geoinf Accepted).

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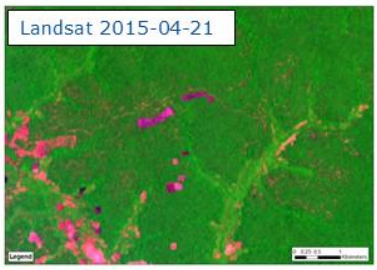
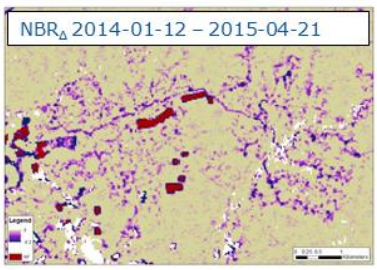
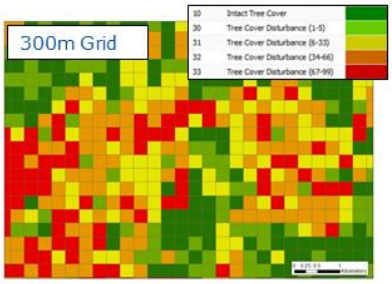
Example: Forest Degradation Monitoring by Crown Cover Disturbance Detection in Evergreen Forests (SE-Asia)

1. Recent openings in canopy cover can be detected using the Normalized Burned Ratio (NBR = (NIR-SWIR2)/(NIR+SWIR2))
2. Self-referencing for
   - avoiding atmospheric disturbances or other artifacts (moving kernel)
   - inter-annual comparison (differentiation of change from already existing openings)
3. Disturbance data is translated into degradation information (zonal statistics over regular grid)







Langner et al. 2016 Monitoring Forest Degradation for a Case Study in Cambodia -Comparison of Landsat 8 and Sentinel-2 Imagery- Proc. 'Living Planet Symposium 2016', Prague, Czech Republic, 9–13 May 2016 (ESA SP-740, August 2016)

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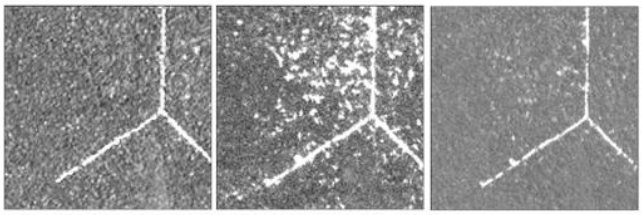
Example: Testing Indexes for Logging Concession in Congo

Temporal resolution of selective logging activities

Before logging
07/10/2012 - Spot 5

After logging
05/02/2013 - RE

4 months later
26/05/2013 - RE

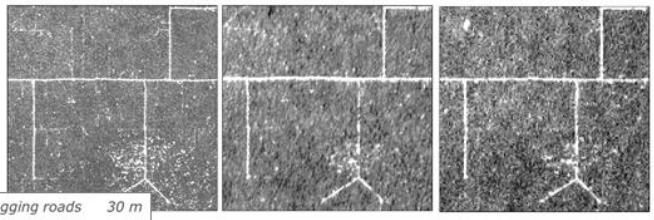


Spatial resolution of selective logging activities

5 m - 05/02/2013
Rapideye (RED band)

20 m - 16/02/2013
SPOT4Take5 (RED band)

30 m - 24/12/2012
Landsat 7 (RED band)



Logging roads	*30 m*
Skidtrails	*5 m*
Logging gaps	*5 m*

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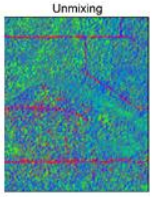
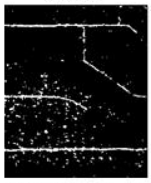
Unmixing

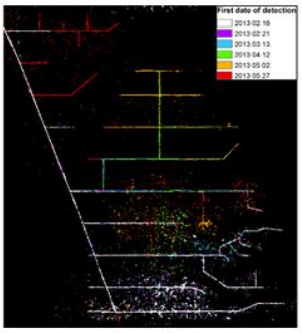


NDVI

Anomalies



	Rapideye	Spot 4 and 5
Blue	X	
Green	X	X
Red	X	X
RedEdge	X	
NIR	X	X
SWIR		X
GR	X	X
NDVI	X	X
RedEdgeNDVI	X	
RedEdgeRatio	X	
SAVI	X	X
NBR		X
Fraction soil	X	X
Fraction vegetation	X	X
Fraction shadow	X	X
Hue	x	X
Sat	X	X
Val	x	X



Verheggen, A., et al., 2015, Assessing forest degradation from selective logging using time series of fine spatial resolution imagery in Republic of Congo, IGARSS 2015

3. Advances in field data collection

3.1. High precision GPS systems – Cozmin Lucau

The JRC demonstrated the differences in the accuracy and precision of ground points and tracks collected using conventional GPS systems (*e.g.* Garmin C60), which have an accuracy of (at best) ~ 7m, compared with new systems (*e.g.* Trimble Geo 7X) which have 50cm accuracy.

Working with the Tanzania Forest Survey, the JRC team had noted in a previous technical report (Hojas and Eva 2014) the difficulties in collocating ground data referenced with conventional GPS systems with satellite imagery. in reviewing data collected in Tanzania.

The JRC demonstrated these differences by outlining a portion of the open space between two buildings at the Ispra site (Figure 1). The outline of the lawn surface and two shrubs (right hand side of the central path) and the location of two tree trunks was recorded with a Garmin C60 (Figure 1 top) and with the high precision Trimble Geo 7X (Figure 1 bottom)

Figure 1: GPS points and track made with conventional Garmin C60 (top) and high precision Trimble Geo 7X (bottom).

One can clearly see the improvement in the location and rendering of the outlines and points. The C60 was used twice to record the trunk position of the two trees. We note that the two positions are not consistent. The new units have a review panel, so as to verifify the quality of the data collected, attributes can easily be added to the data collected, and the unit collects and exports point, line and area features. In the field this means that the area of a unit can already be recorded without waiting for post data processing.

Forest agencies need way up the costs of such systems (c. € 5000 per unit) against the improvements bought in ground data collection.

3.2. Drone technology – Peter Spruyt

A demonstration was given to the participants on the operation and results of a flight survey using an Ebee Sensefly

Figure 2: The Sensefly and flight control program

The flight is pre-programed on a PC and the drone is autonomous in effecting the flight plan and data collection. Data can be collected in a number of different spectral channels. Once completed the set of individual photos are mosaicked into an orthomap.

These data can be used to complete 'one-off' baseline maps of protected areas, or in more operational mode to survey areas at risk of illegal activities.

Flight details
Average ground sample distance : 4 cm
Flight altitude : 114 m
Number of images : 28
Overlap/sidelap : 60% / 75%
area covered : 0,1436 km^2

Output after processing

Ortho-mosaic
Digital surface model

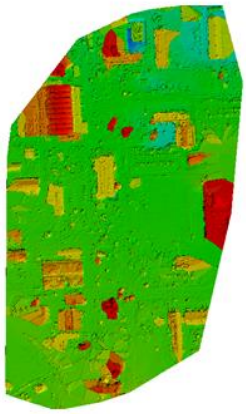


Figure 3: Flight plan and details with results

4. Country Presentations

A set of presentations were made by the participants on the current state of the forest by country and on the monitoring capacities of national institutions.

Jean Daniel Mendomo Biang	*Cameroon*
Dibi Hyppolite N'da & Tchimou Vincent Assoma	*Ivory Coast*
Jamleck Ndambiri & Eunice Maina	*Kenya*
Joaquim Macuacua	*Mozambique*
Nurdin Chamuya & Jared Elly Otieno	*Tanzania*
John Diisi	*Uganda*
Fortunate Muyambi Benda & Siro Abdallah	*The Regional Perspective*

4.1. Cameroon - Jean Daniel Mendomo Biang

CAMEROON NATIONAL FOREST MONITORING SYSTEM

Presented by

MENDOMO BIANG Jean Daniel

Ministry of Forestry and Wildlife

1

OUTLINE

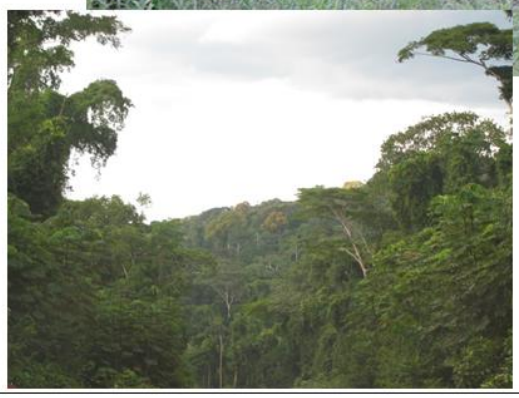
CURRENT SITUATION

- State of forest
- Existing data

NFMS

- Identification/stratification of forest types
- Monitoring of each stratified forest
- Identification of parameters to estimate carbon stocks
- Assessment of carbon stock and uncertainty
- Implementation system
- Quality Assurance and Quality Control

2



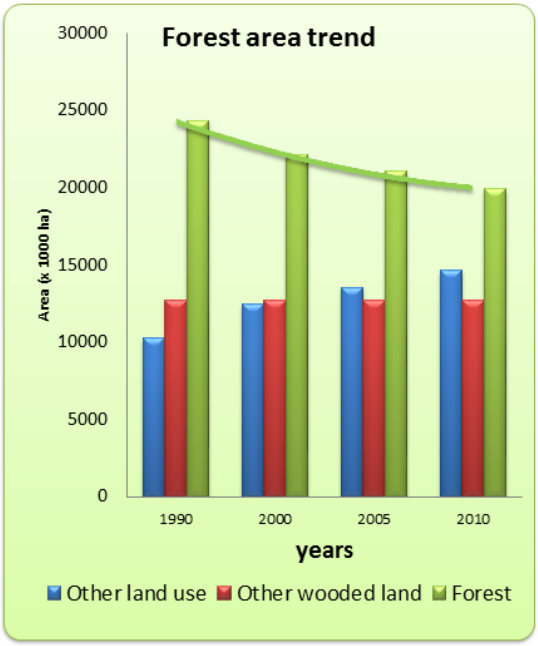
CURRENT SITUATION

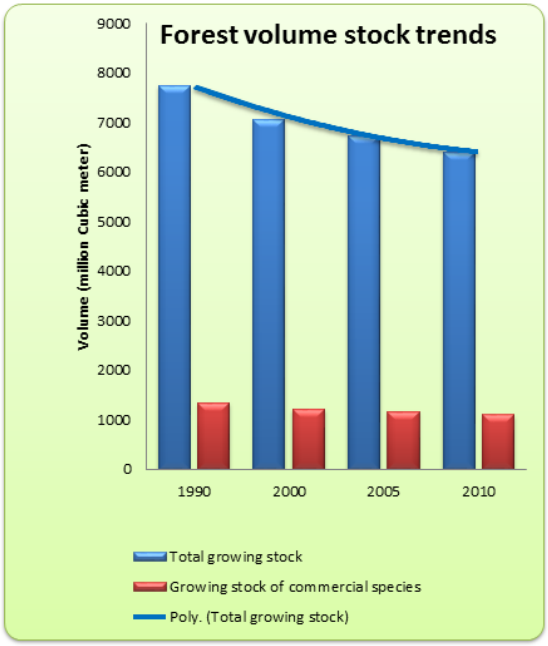
3

- **Country area:**
  - 47,565,000 ha;
- **Population:**
  - Approximately 20 million inhabitants;
  - Density of density 42 inhabitants/km²;
- **Climate**
  - Average temperature:
    - 26°C in the South;
    - 30°C in the North;
  - Coast, desert, mountains, rainforest, and savannah;
- **Forestry**
  - Forest Area : approx 22 million ha
  - Forest Types: Tropical rainforest; Semi deciduous rainforest; Savannah;
  - Forest Ownership: State + Community property
  - Deforestation: approx. 200,000 hectares yearly

4

–Forest area trend



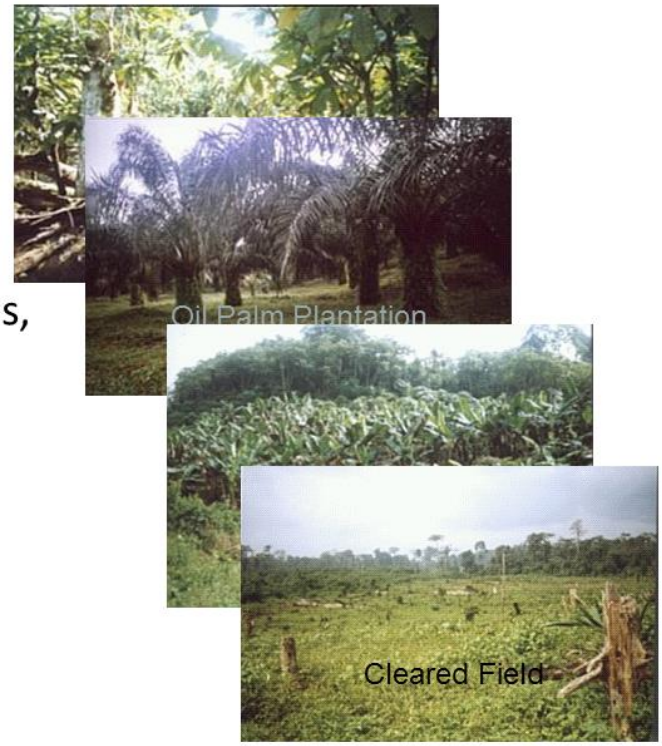


5

(FRA 2010, Country report)

–Drivers of DF and DD:

- Firewood,
- Industrial logging,
- Mining,
- Population growth,
- Construction of roads,
- Bushfires
- Inheritance system that can lead to land fragmentation, and forest cover degradation



6

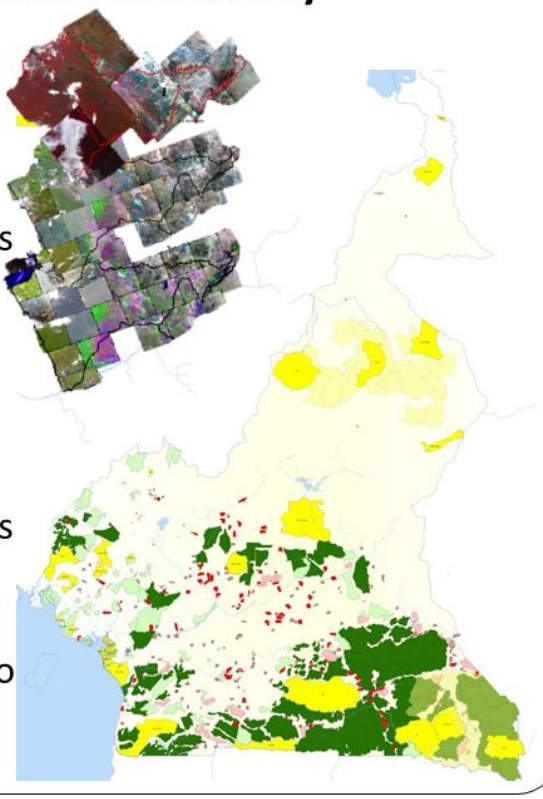
–Definition of forest

- **Forest Law (Article 2)**:
  - Lands with a vegetative cover;
  - Dominant trees, shrubs and other species;
  - Provide non-agricultural products.
- **According to FRA 2005:**
  - Minimum of 0.5 ha;
  - trees height greater than 5 meters;
  - canopy cover more than 10%.

7

Existing data and data availability

- Map:
  - Forest stratification;
  - Topographic map;
  - Land use map;
  - Forest/Non-Forest cover Maps for years 1990, 2000 and 2005;
- Image data:
  - Landsat 1990 and 2000;
  - ASTER 2007;
  - ALOS and ASTER 2010;
  - Few aerial photographs (years non specify)
- Parameter
  - Allometric equation (DBH to stem volume)



8

ACTION PLAN FOR NFMS

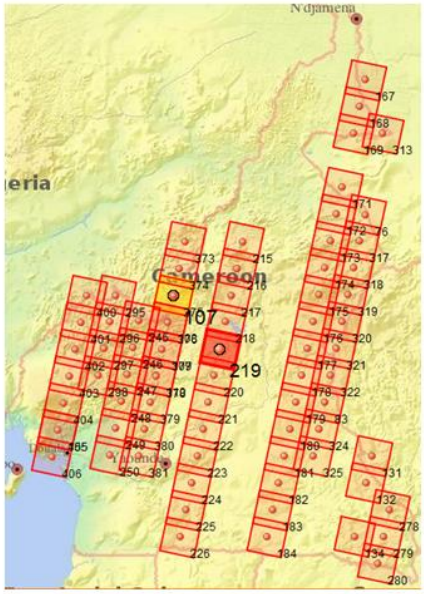


9

Identification/stratification of forest

- **Stratification indicators:**
  - Forest type/vegetation;
  - Agro climatic zones;
  - Phonological characteristic.
- **Materials**
  - Moderate resolution data (ASTER, ALOS (Palsar), SPOT);
  - Topographic Maps
  - Soil Map
  - Terrestrial Data
  - Remote Sensing and GIS Softwares
- **Methodology of stratification**
  - Terrestrial Survey
  - Remote-sensing technics
  - Accuracy Assessment

ALOS

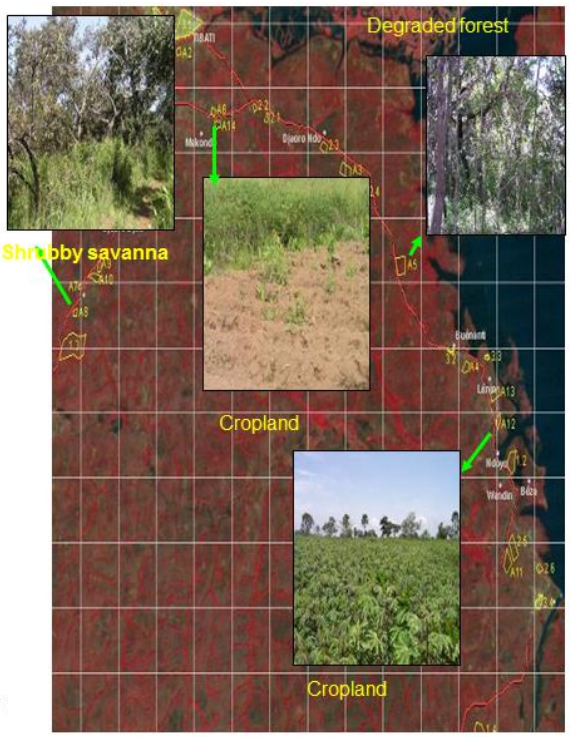


ASTER ($80/Scene)
ALOS (500 €/ Scene)
SPOT (2500 € / Scene)

10

Identification/stratification of forest

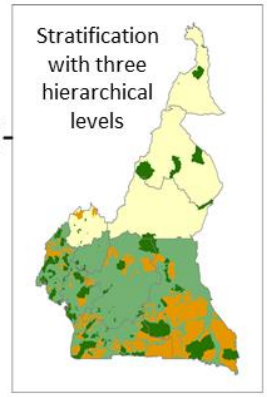
- **Terrestrial Survey**
  - Land use and land cover
  - Ground Control Points (GCP)
  - Training/accuracy assessment data
  - Classification scheme
- **Remote-sensing technics**
  - Accuracy level of 80%;
  - wall-to-wall assessments;
  - Training areas (ground truth)
  - Validation/Verification
- **Accuracy Assessment**
  - High resolution imagery
  - Aerial photograph;
  - Sub area units;
  - Ground Control Points (GCPs);
  - Confusion matrices.

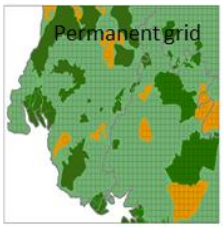


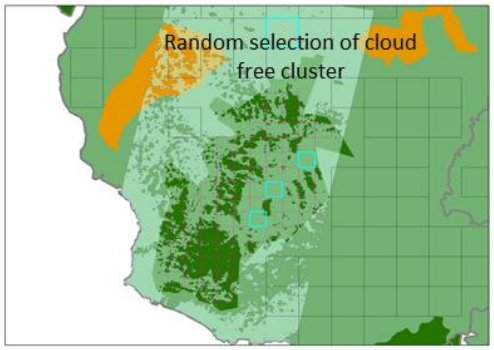
11

Monitoring of each stratified forest (activity data)

- Regional, project or specific level;
- Methodology of activity data:
  - Supervised classification of multi-date image;
  - Stratified simple random sampling design;
  - Hierarchical with three levels of strata;
  - Random selection of non-cloudy clusters of coincident scenes
  - Permanent grid of either 5x5km or 2.5x2.5 km clusters
    - Depending on strata size and cloud frequency.

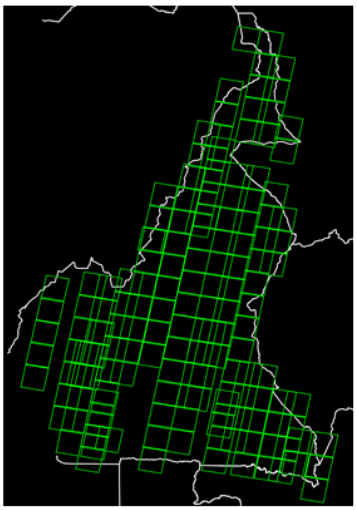


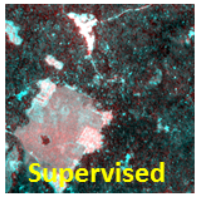




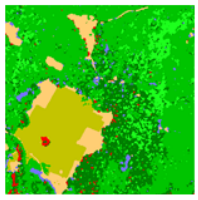
12

Monitoring of each stratified forest (2/2)





classification



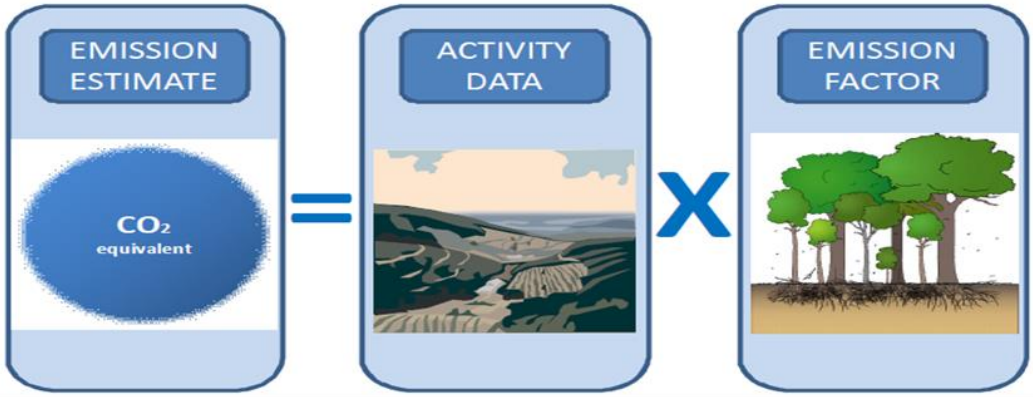
Forest Non-forest

- Accuracy level of 80%
- Standardized analysis for each strata
  - Net/brut deforestation, Net/ brut reforestation,
  - Aggregation for different hierarchical levels
  - Accuracy Assessment as presented above;
- 25 RS/GIS specialists.
- Materials
  - Moderate resolution data
  - Terrestrial Data
  - Remote Sensing and GIS

13

Identification of parameter to estimate carbon stocks

- **Parameter**
  - **Stem volume (Cameroon allometric equation - use DBH -);**
  - **Above Ground Biomass (IPCC default values);**
- **Destructive samples for establishment of parameter;**
- **Overall, the basic concept of carbon accounting to be developed will follow the model above:**

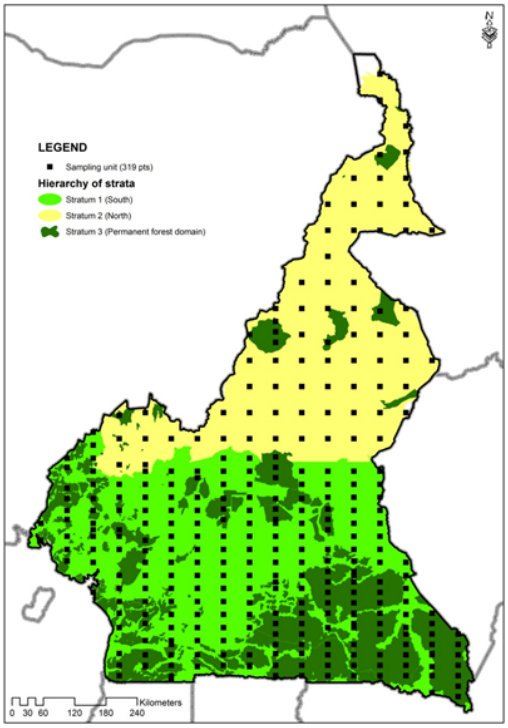


14

Assessing carbon stocks

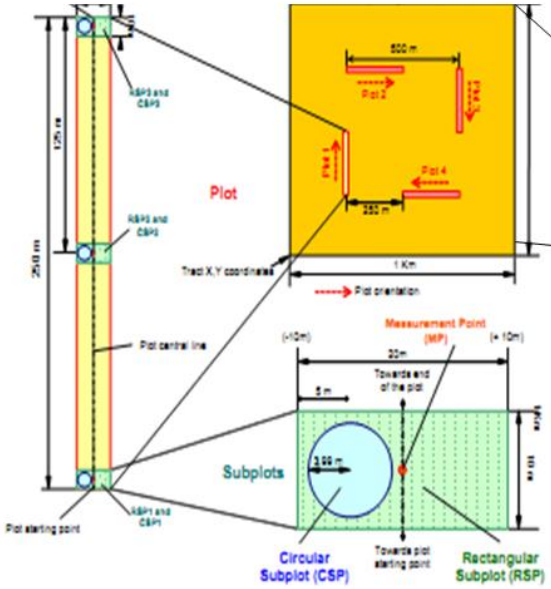
- Ground truth
- New national forest inventory;
- Methodology
  - Stratified systematic sampling design;
  - Hierarchical with three levels of strata;
  - Square sampling unit of 1 km x 1 km
  - Rectangular plot of 20 m x 250 m;
  - Different grid area per stratum
  - 319 SU

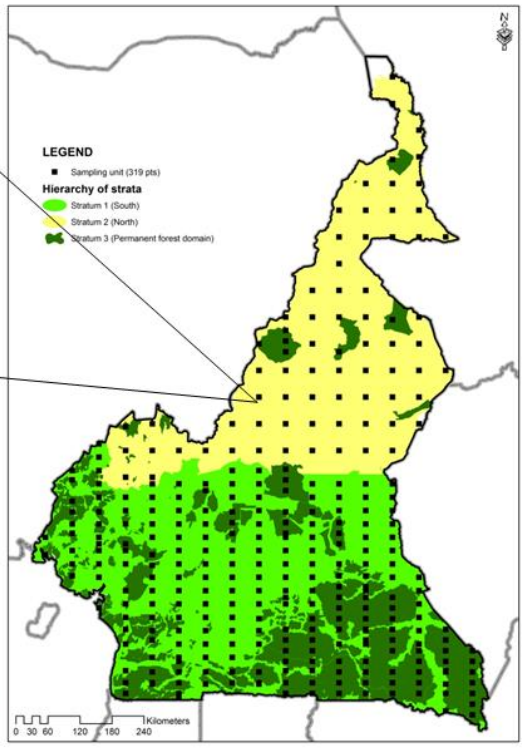
Stratum	Distance	# of SU
PFD	50x20 km	111
NPFD North	50x50 km	67
NPFD South	50x25 km	141
Country level		319



15

Permanent sample Plot design





16

Assessing carbon stocks

- Minimum accuracy level of 80%
- Confidence level of 95%
- Acceptable error rate of ± 5%;
- Several material needed
  - GPS, compass, tree height and land slope measuring, measuring tape, etc… ;
- 25 technical staff.
- Data collection/measurement
  - Land use;
  - Land cover;
  - Tree diameter;
  - Tree height;
  - Tree regeneration;
  - Soil measurement;
  - Etc.

17

Quality Assurance/Quality Control

- Quality Control
  - National steering committee :
    - Department of Forest;
    - Regional office of Forestry administration.
  - Designated member experienced in the relevant field;
  - Manual of procedures for activity data and carbon factor
- Quality Assurance
  - Involvement of independent body
  - Manual of procedures for activity data and carbon factor
  - Technical committee comprising:
    - representative of MINEP;
    - representative of Forestry University;
    - representative of MINREST;
    - Representative of an international forestry research center

18

Conclusion

Challenge	Opportunity
• Fund rising	• External support
• Capacity bulding	• External technical support • Involvment of specialize NGO and Research institute
• Mitigate awarness on REDD	• Senzitisation • Political lobbying
• Synergy among actor and dualism on REDD activities	• Interministerial committee

19

4.2. Ivory Coast - Hyppolite Dibi & Vincent Assoma

République de Côte d'Ivoire

Université Félix Houphouët Boigny

Centre Universitaire de Recherche et d'Application en Télédétection

ETAT DES CONNAISSANCES SUR LA DEFORESTATION ET LA DÉGRADATION FORESTIÈRE EN COTE D'IVOIRE

Présenté par :

Dr. DIBI N. Hyppolite

Laboratoire de Botanique (UFR Biosciences)

Centre Universitaire de Recherche et d'Application en Télédétection : CURAT (UFR STRM)

n_dibihyppolite@yahoo.fr / +225 07 86 63 34

République de Côte d'Ivoire

Université Félix Houphouët Boigny

Centre Universitaire de Recherche et d'Application en Télédétection

Le Centre Universitaire de Recherche et d'Application en Télédétection CURAT
Ecole Doctorale Africaine de Télédétection (Master & Doctorat)

Master Sciences et Technologies : Mention Télédétection et SIG / 4 Parcours

MASTER II

Climat, Environnement et Développement Durable (CE2D)	Aménagement et Gestion des Terres et des Ecosystèmes (AGTE)	Eau, Agriculture et Sécurité alimentaire (EASA)	Analyse et Traitement d'Images Numériques (MOTIN)

MASTER I

Début de spécialisation (UE aux Choix)

UE Fondamentales et méthodologiques dédiés à la Télédétection, à l'Informatique et aux SIG

PLAN DE LA PRESENTATION

République de Côte d'Ivoire

Université Félix Houphouët Boigny

Centre Universitaire de Recherche et d'Application en Télédétection

INTRODUCTION

1. Localisation de la déforestation /la dégradation forestière
2. Causes connues dans ces différentes zones
3. Historique et évolution attendue de la déforestation/dégradation forestière
4. Stratégie et outils actuellement utilisés pour le suivi de la déforestation/dégradation forestière
5. Attentes au plan technique pour améliorer le suivi de la déforestation/la dégradation forestière

CONCLUSION

République de Côte d'Ivoire

Université Félix Houphouët Boigny

Centre Universitaire de Recherche et d'Application en Télédétection

INTRODUCTION

Le succès de la Côte d'Ivoire repose sur l'agriculture

DEVELOPPEMENT ECONOMIQUE

République de Côte d'Ivoire

Université Félix Houphouët Boigny

Centre Universitaire de Recherche et d'Application en Télédétection

INTRODUCTION

Traduction du choix politique opéré par les dirigeants de la Côte d'Ivoire au lendemain de l'indépendance

1. Premier producteur mondial de cacao depuis les années 1980 jusqu'à nos jours

2. Performance agricole, résultat : (1) soutien politique, (2) . formation soutenue des cadres dans le domaine agricole, (3) recherche, (4) encadrement technique renforcé du monde agricole

3. Côte d'Ivoire longtemps considérée comme un modèle de développement économique dans la sous-région

5

République de Côte d'Ivoire

Université Félix Houphouët Boigny

Centre Universitaire de Recherche et d'Application en Télédétection

INTRODUCTION

2016

Il est aujourd'hui difficile de dire avec exactitude quelles sont surfaces forestières encore intactes

En effet, données n'ont pas les mêmes bases de calcul.

- De **15 à 2,5 millions** d'hectares de forêt entre 1900 et 1996 (Aubreville, 1959; Arnaud et Sournia, 1980; Lanly, 1982; SODEFOR,1996; Païvien *et al.*, 1992 et FRA, 2005)
- Le FRA (2010), affirme que le territoire de la Côte d'Ivoire était occupé par plus de **10 millions** d'hectares de forêt,
- Alors que certains auteurs affirment qu'en 2012, les forêts couvraient 32,7% des terres ivoiriennes (soit environ **10 millions** ha) (http://www.statistiques-mondiales.com/cote_divoire.htm)

INTRODUCTION

2016

Il est aujourd'hui difficile de dire avec exactitude quelles sont surfaces forestières encore intactes

Au-delà de la guerre des chiffres, c'est des millions d'hectares de forêts qui disparaissent chaque années

Selon le GIEC (2004), la déforestation et la dégradation des forêts ont représenté 17% des émissions globales de gaz à effet de serre, et 28% des seules émissions de CO2

INTRODUCTION

- Prise de conscience des menaces qui planent sur les ressources forestières de la Côte d'Ivoire,
- Plusieurs actions politiques, d'investissement et de terrain qui n'ont pas inversé cette tendance,
- Plus récemment, la Côte d'Ivoire s'est engagée dans la REDD+, qui est un mécanisme censé récompenser les efforts des pays arrivant à maintenir leur couvert forestier dans de bonnes conditions.

République de Côte d'Ivoire

Université Félix Houphouët Boigny

Centre Universitaire de Recherche et d'Application en Télédétection

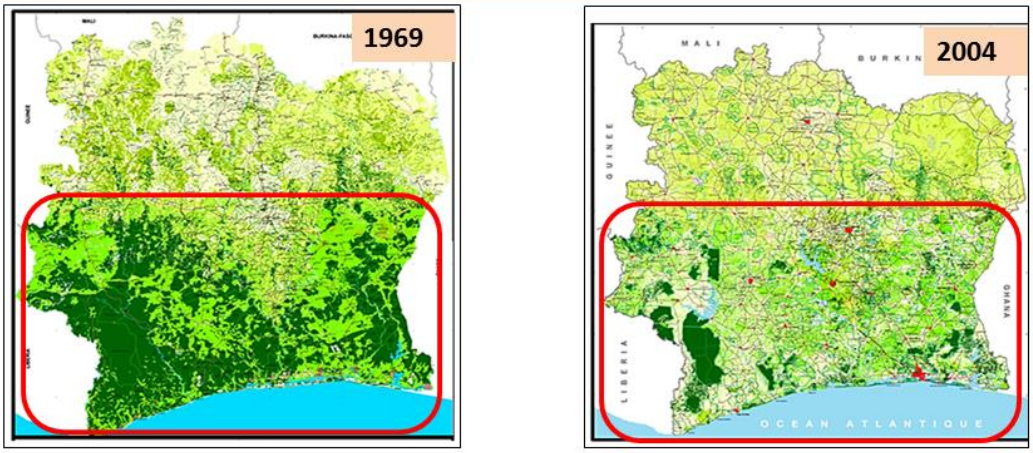
INTRODUCTION

Engagement du pays dans la REDD+
Activité du projet ReCaREDD objectifs:

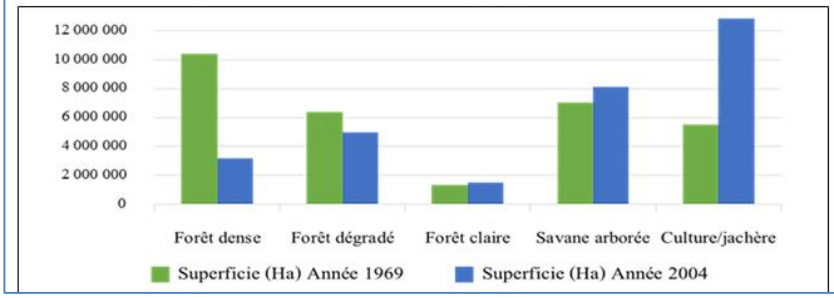
- renforcer les capacités des institutions dans les pays partenaires et les réseaux existants, dans leur capacité à rapporter les efforts de réduction des émissions de gaz à effet de serre liées à la dégradation forestière à la déforestation,

- fournir des évaluations directes de l'état et de l'évolution du couvert forestier pour les politiques forestières nationales et les négociations internationales.

1. Localisations de la déforestation/la dégradation forestière



Carte d'occupation des sols entre 1969 et 2004 (BDGéo200©, Base de Données Cartographiques à l'échelle de 1/200 000 BNETD)



Localisation de la dégradation forestière et de la déforestation essentiellement dans la zone sud du pays

2. Causes connues dans ces différentes zones

Causes directes

- Agriculture
- Feux
- Exploitation forestière
- Exploitation Minière
- Urbanisation
- Infrastructures diverses (routes, barrages…)

cacao

Zone sud

hévéa

Zone sud

anacarde

Zone nord

2. Causes connues dans ces différentes zones

Causes indirectes

- Accroissement démographique
- Pauvreté
- Sécurité foncière,
- Manque de réelle engagement politique.
- Manque de financement du secteur.
- Etc,

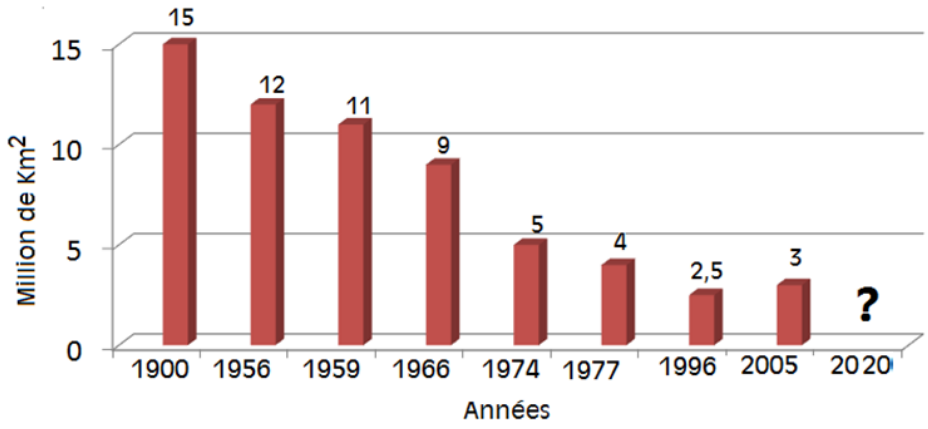
Manque de réelle engagement politique

Accroissement démographique

Pauvreté

Sécurité foncière

3. Historique et l'évolution attendue de la déforestation/la dégradation forestière



Baisse de la superficie des forêts Ivoiriennes

1900 - 2005

Baisse de 83% des surfaces de forêts ivoiriennes

Données historiques de 1990 et 2000 existent

Au Centre de Cartographie et de Télédétection (CCT) mais avec une qualité temporelles pas trop précis.

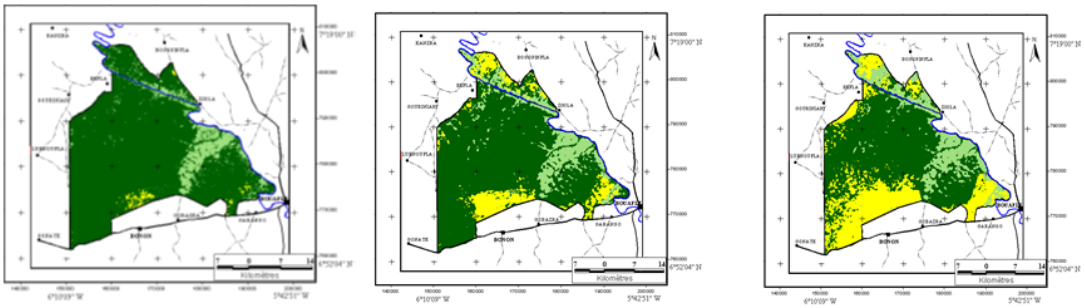
3. Historique et l'évolution attendue de la déforestation/la dégradation forestière

Évolution attendue de la déforestation/dégradation

- L'élaboration du niveau de référence en cours dans le cadre de la REDD+,
- Quelques difficultés compte tenue des techniques d'inventaire et de cartographie non homogènes, pas fait à la lumière des contraintes REDD+.

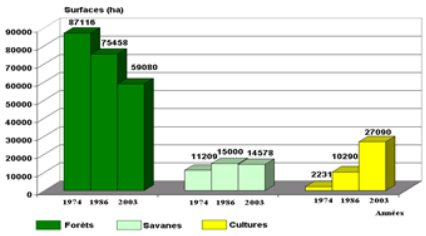
3. Historique et l'évolution attendue de la déforestation/la dégradation forestière

Quelques exemples sur de petites surfaces : travaux de N'Da et *al*, 2008 sur la dynamique de la végétation du Parc National de la Marahoué de 1974 à 2003

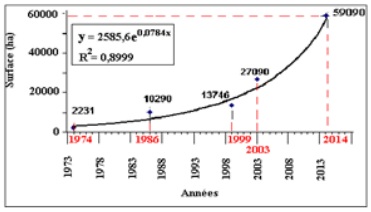


1974 **1986** **2003**

Dynamique de la végétation du Parc National de la Marahoué de 1974 à 2003

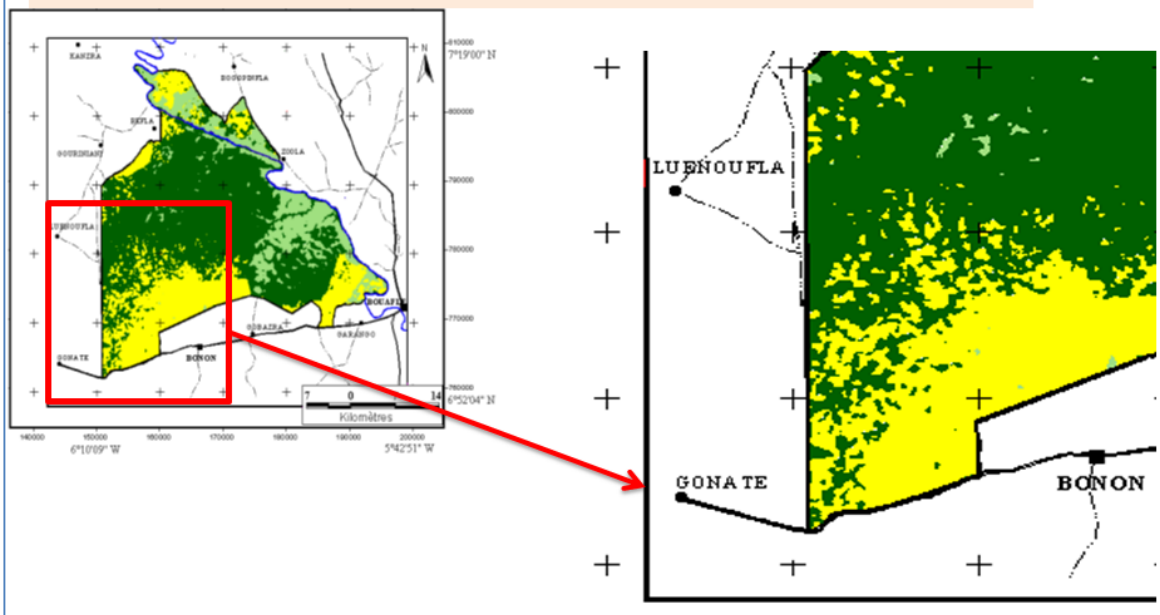


Dynamique de la couverte végétale



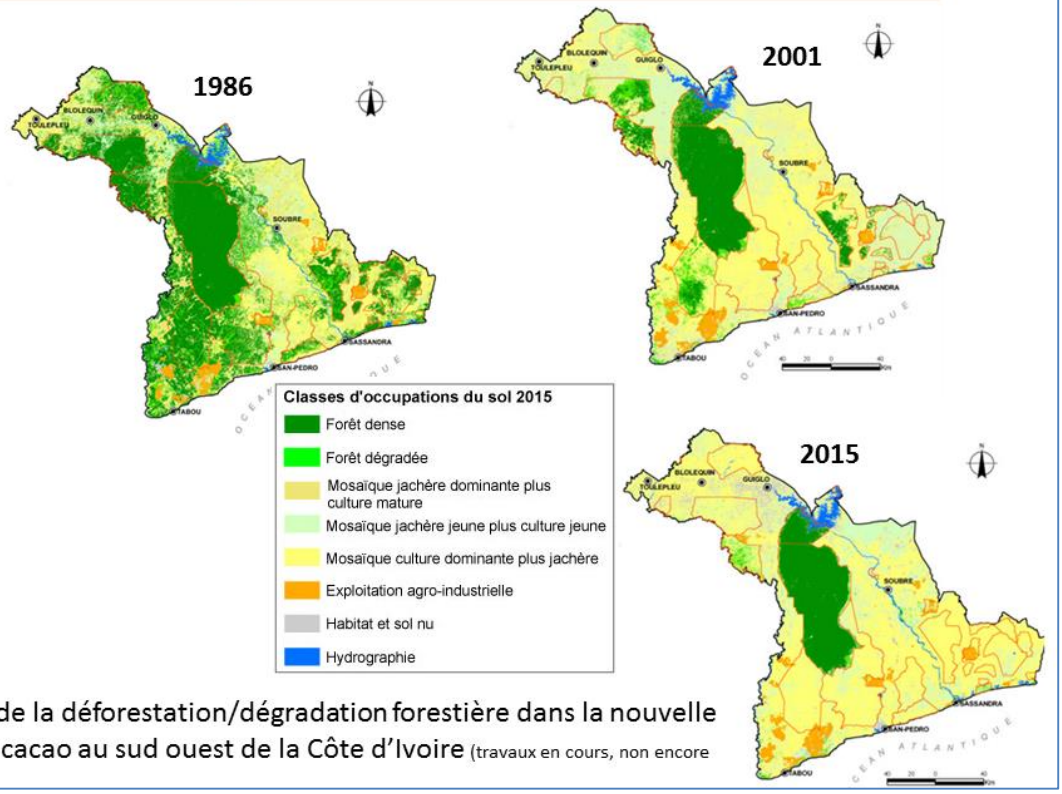
Tendance évolutive des pertes de surfaces forestières

4. Les différentes structures spatiales sous lesquelles la déforestation/dégradation forestière se manifeste



Evolution de la déforestation/dégradation forestière en front pionnier sous la pression agricole (cacaoculture) dans le Parc National de la Marahoué

4. Les différentes structures spatiales sous lesquelles la déforestation/dégradation forestière se manifeste



Evolution de la déforestation/dégradation forestière dans la nouvelle Boucle du cacao au sud ouest de la Côte d'Ivoire (travaux en cours, non encore publiés)

4. Les différentes structures spatiales sous lesquelles la déforestation/dégradation forestière se manifeste

Occupation du sol	1986		2001		2015	
	Km²		Km²		Km²	
Forêt	19363,23	46,78%	8571,4	20,70 %	5444,94	13,15 %
Forêt dégradée	3489,82	8,43 %	3377,93	8,16 %	3147,64	7,60 %
Mosaïque Jachère dominante + culture mature	7502,91	18,13%	16379,65	39,56 %	8234,97	19,88 %
Mosaïque Jachère dominante + culture jeune	3482,4	8,41 %	3117,44	7,53 %	9625,67	23,24 %
Mosaïque culture dominante + jachère	4183,29	10,11 %	6194,86	14,96 %	10899,75	26,32 %
Habitat et sol nu	166,85	0,40 %	231,56	0,56 %	501,62	1,21 %
Hydrographie	516,64	1,25 %	562,86	1,36 %	568,75	1,37 %
Exploitation Agroindustrielle	697,39	1,68 %	967,55	2,34 %	981,04	2,37 %

5. Stratégie et outils actuellement utilisés pour le suivi de la déforestation/la dégradation forestière

- **Stratégie en construction avec le processus REDD+**
  - Système National de Surveillance des Forêts (MNV)
  - Inventaire des Gaz à effet de serre
  - Inventaire forestier National
  - Pour les aires protégées, avant la REDD+ existence de quelques données d'inventaire forestière et de cartographie da la dynamique végétales
- **Outils actuels**
  - Images satellitaires gratuites (Landsat généralement), SPOT (couverture gratuite sur côte d'Ivoire) , MODIS, ASTER, SENTINEL, …..
  - Collecte données de terrain
  - Logiciels propriétaires : ENVI, ERDAS, ArcGIS, …….
  - Logiciels propriétaires : Qgis, GRACE, ILWIS, OTB,……

6. Attentes sur le point technique pour améliorer le suivi de la déforestation/la dégradation forestière

- **Enrichissement par des méthodologies éprouvées dans le suivi de la dynamique forestière et simulation des tendances évolutives,**
- **Acquisition de logiciels robustes, permettant de traiter dans des délais plus raisonnables et mettre en évidence la déforestation et la dégradation forestière,**
- **Facilitation de l'acquisition des données d'observation de la terre.**

CONCLUSION

Beaucoup d'espoir pour cette séance de formation

4.3. Kenya - J. Ndambiri & Eunice Maina

STATUS OF KENYA'S FOREST DEFORESTATION AND DEGRADATION MONITORING

By J. Ndambiri
Eunice Maina

July , 11-15, 2016

- Kenya Forest Service is a state corporation established by an act of parliament in Kenya.
- Mandate is to sustainably conserve and Manage forest resources in the country for the current and future Generations.
- Kenya is signatory to most forest related conventions and agreements including IPCCC, CBD,CCD,UNFCC among others.

2

INTRODUCTION CONTD

- Kenya has developed a climate change policy and strategy and there already exists a climate change and adaptation Act to guide in implementation of IPCC requirements .
- A REDD+ strategy and readiness proposal is available in our country and currently activities related to establishment of Forest Reference levels are ongoing

3

- Land cover maps with reference year of 1990 are currently being prepared and capture about 10 classifications that include:
- Dense forests
- Moderate forests
- Open forests
-

4

- Annual cropland
- Perennial cropland
- Open grasslands
- Wooded grasslands
- Open Water
- Vegetated watersheds

5

- Currently work ongoing on land cover attribution and by August this year it will be completed

6

Forest Degradation/Deforestation

Forest degradation- is the changes within the forest which negatively affect the structure or function of the stand or site, and thereby lower the capacity to supply products and/or services.

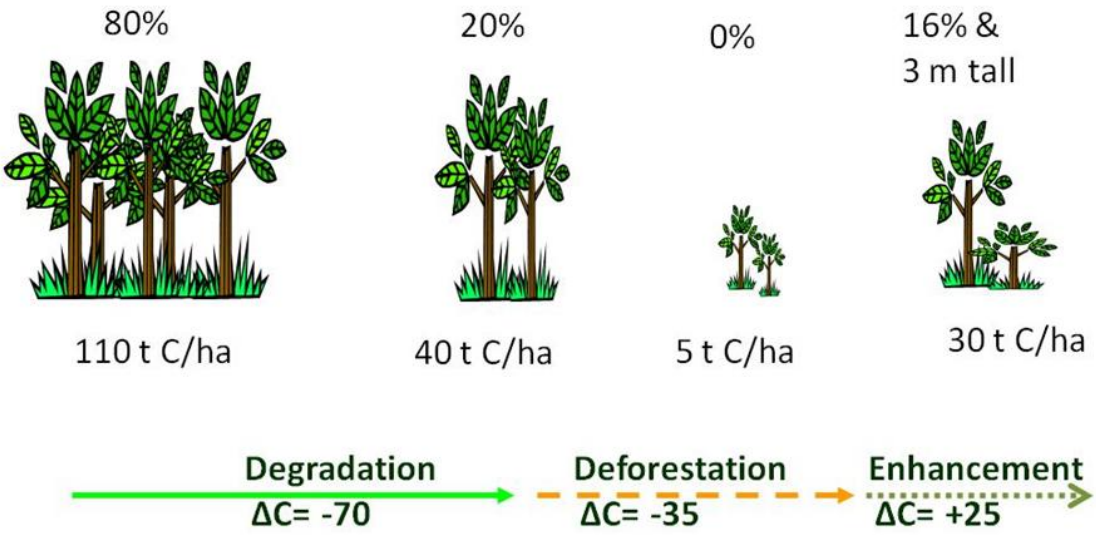
Deforestation- Deforestation is the conversion of forest to another land use

Ref. FAO (2001) – Global Forest Resources Assessment 2000

- **DRIVERS OF DEFORESTATION AND FOREST DEGRADATION**

- clearance for agriculture,
- unsustainable utilization
- poor governance
- Forest fires

Illustration of various changes in forest cover, and corresponding dummies for emissions and removals of carbon



ADDRESSING DRIVERS OF DEFORESTATION AND DEGRADATION

Direct Drivers		
Forest Products Extraction • Timber (legal, illegal) • Wood fuel - fuelwood charcoal • Non-timber	**Agricultural Expansion** • Shifting cultivation (slash and burn) • Permanent cultivation • Plantations • Migration, resettlement	**Infrastructure Expansion** • Transport (road) • Market (sawmills, furniture, processing plants) • Mining, hydropower, tourism

Indirect Drivers			
Socio-Demographic & Cultural Factors • Natural Increment (fertility, mortality) • Migration (in / out migration) • Population Density •Population Distribution • Life Cycle features	**Economic Market & Technological Factors** • Market Growth & Commercialization • Economic Structures • Urbanization & Industrialization • Special Variables (e.g. price increases, comparative cost advantage)	**Policy-Institutional-Governance Factors** • Formal Policies (e.g. on economic development, credit) • Policy Climate (e.g. corruption, mismanagement) • Property Rights (e.g. land Ownership)	**Other Factors** •Biophysical drivers (floods, landslides, fire, calamities, etc.)

10

Initiatives to address Monitoring degradation / Deforestation

- Kenya Forest Service as (KFS) the agency charged with the mandate of ensuring sustainable management and conservation of forest resources in the country spearheaded the process assuming specific monitoring responsibilities.
- KFS through the Forest Preservation Programme (FPP) enhanced its forest resource assessment capabilities through Mapping of forest resources

11

Forest management Plans

- This is a framework that provides the direction required for organizational set up in carrying out sustainable management of forests.
- According to Forest Act, 2005 a management plan is a systematic framework that shows all activities to be undertaken in forest or part of it during a period of at least 10 years

12

Forest Information Management System

- UVIO Forest Management Information System (FMIS) has been developed to Support mid to large scale forestry organizations.
- The system is web based and it can manage large databases as well as manipulation for informed information related to inventory activities, track silvi-cultural operations, store and manipulate forest geo database

13

Forest Fires Management

- Most of the forests, especially the highly productive ones, including both indigenous and plantations, are located in the relatively high fire-prone areas
- Wildland fires continue to be one of the biggest threats to forests in Kenya.
- Kenya forest service was able to acquire Modis satellite images of 2000 to 2015 on fire. The institution now have up to date fire data on Gazetted forest, natural forest and private forest at the Forest Information System.

14

Participatory Community Forest Management

- In this approach, local communities and other stakeholders participate in management of forest resources as provided for by the Forest Act 2005.
- Adopting Community-Based Forest Management as the National Strategy to ensures communities residing adjacent to the forests participate in monitoring illegal activities in the forest thereby playing a big role in influencing reduction in forest degradation.

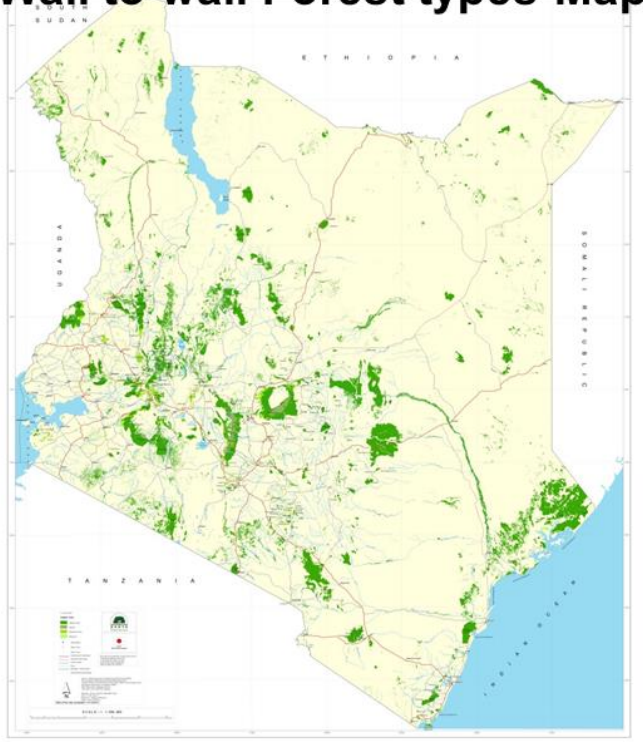
15

Use of GIS and Remote Sensing Technology

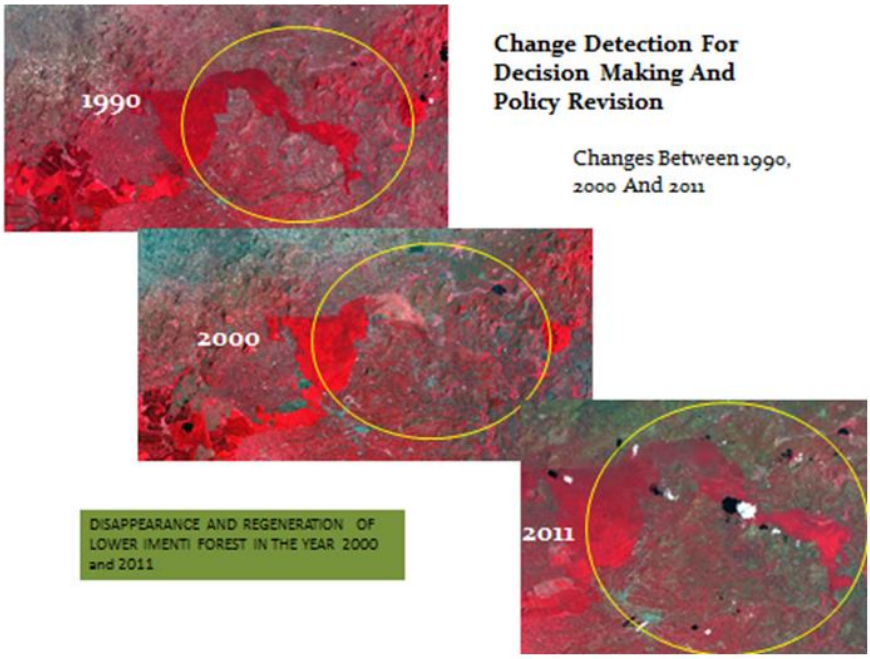
- Wall to wall forest cover mapping
  - ✓ Alos AVNIR 2 (2010)
  - ✓ ETM LANDSAT +
  - ✓ dmc
- Forest change Mapping
  3 Epochs
  - ✓ 1990-2000
  - ✓ 2000-2010
  - ✓ 1990-2010
- Forest Land use change mapping
- Historical Trends analysis

16

Wall to wall Forest types Map



Use of satellite Imagery for change mapping

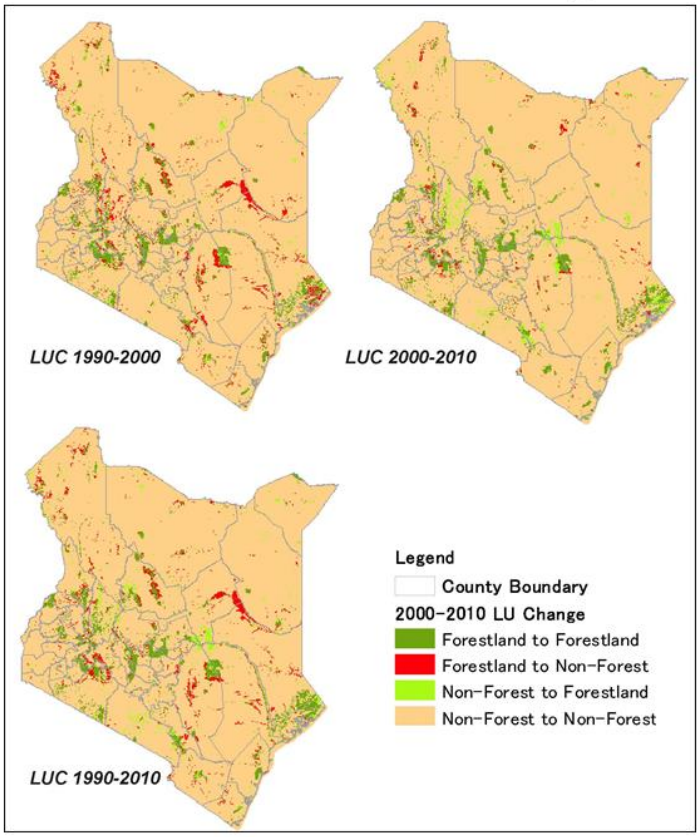


Change Detection For Decision Making And Policy Revision

Changes Between 1990, 2000 And 2011

DISAPPEARANCE AND REGENERATION OF LOWER IMENTI FOREST IN THE YEAR 2000 and 2011

Forest Land cover change



Historical Trend Analysis

LU/Year	Area in % of Total Area of Kenya						Total
	Forestland	Cropland	Grassland	Settlements	Wetland	Otherland	
1990	7.89	15.64	72.19	0.10	2.49	1.70	100.00
2000	5.90	16.32	72.43	0.15	2.54	2.66	100.00
2010	6.99	16.88	70.95	0.21	3.20	1.76	100.00

Technical needs for monitoring deforestation and degradation

- Human Capacity building at higher levels in applications of GIS and Remote Sensing in Forestry.
- High resolution imagery at close temporal intervals for monitoring deforestations and degradations ,fires Pest and diseases.
- GIS and Remote Sensing software licenses

4.4. Mozambique - Joaquim A. Macuácua

República de Moçambique
Ministério da Terra, Ambiente e Desenvolvimento Rural
Direcção Nacional de Florestas

Ideas on degradation in the Republic of Mozambique

Joaquim A. Macuácua
Department of Inventory of Forest Resources
National Directorate of Forestry (DINAF)
Ministry of Land, Environment and Rural Development

JRC Ispra
ReCaREDD Workshop
Angera, Italy, July 11, 2016

Mozambique general information:

Total area of the country: 801 590 km^2 ;

- Tropical forest domaned by Miombo, mopane and other ecosystems such as acacias, etc;
- Forest area: 41 million ha (51%);
- Deforestation rate: 0.58% (219.000 ha/year);
- 3 national forest mapping done (1980,1994, 2007);

Target area of on going project

Cabo Delgado Province with 7,789,700ha) (Northern part)

- Miombo forest ecosystem

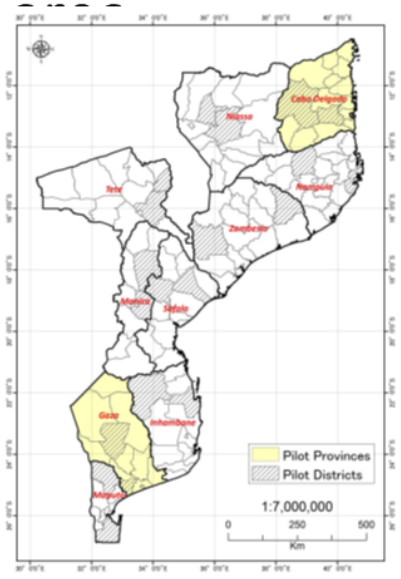
Gaza Province with 7,570,900ha (Southern part)

- Mopane forest ecosystem

Pilot Districts

Two districts from each of ten provinces were also selected as a pilot study area

Project



2

Definition of Forest degradation

- To define the level of forest degradation in Mozambique still a big challenge, due to the different ways of forest exploitation and main drivers of forest degradation.

3

Scope of REDD + activities

Which of the following REDD + activities should be included?

1. Reducing Emissions from Deforestation
2. Reducing Emissions from Forest Degradation
3. Conservation of forest carbon stocks
4. Sustainable Forest Management
5. Enhancement of Forest Carbon Stocks

It is necessary to take into account:

- The Historical Changes, forest motivators, policies and / or plans to be implemented;
- A national monitoring system (monitoring capacity);
- A step by step approach adopted under the UNFCCC;

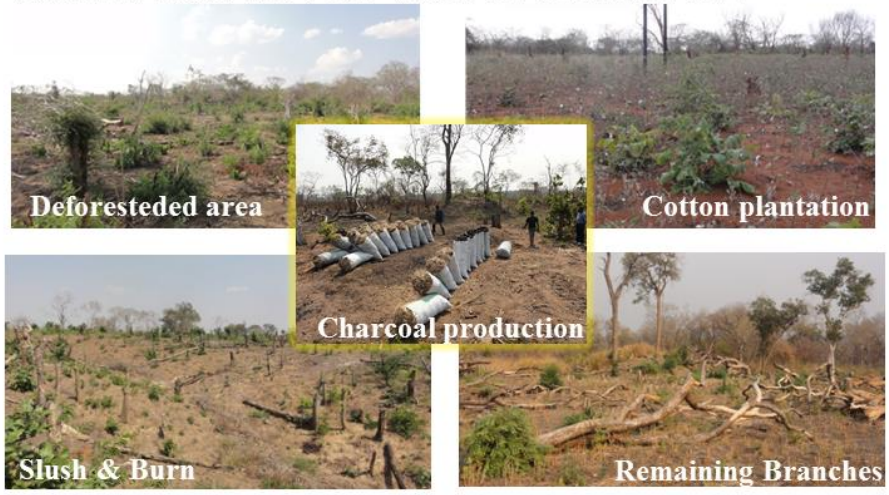
4

Main drivers of deforestation which brings a quick forest cover Changes (losses)

- Commercial agriculture;
- Shifting cultivation;
- Charcoal production and fire wood;
- Urban expansion;
- Mining;
- Livestock;
- Slush and burning;

5

Some examples of activities that contribute for deforestation



6

Main drivers of forest degradation (for some forest species)

- Forest exploitation (selective to important species for timber production obeying minimum DHP);
- Material constructions for rural house (mostly used trees with small DHP);
- Wild fire;

7

Lessons Learned from setting a FRL

- Identifying historical trends of forest changes
- Identification of drivers of forest change

Selection of the REDD + activities

- Fixing a FREL / FRL taking into account the benefit of the distribution of REDD +

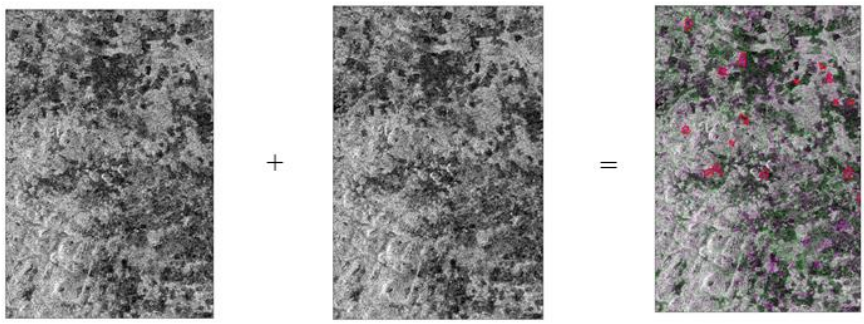
Selecting the scale of a FREL / FRL

- Ensure consistency with the Biannual Update Report (BUR)

8

The objective related to Deforestation mapping

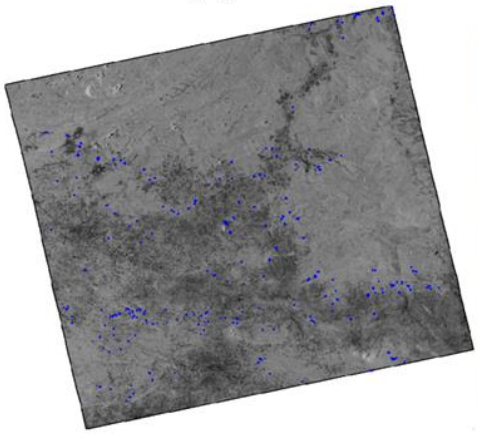
- We utilize the PALSAR-2 mosaic dataset to obtain a grasp of the current status of forest distribution in order to contribute to REDD+ activities in Mozambique taking into account to the major changes.



IMG-HV_ALOS_2014 + IMG-HV-ALOS_2015 = Mosaic IMG-HV-ALOS_2014 and 2015

9

1. **Ancuabe** district (**Cabo Delgado** Province) by visual interpretation



ALOS-2 image : 26/07/2015

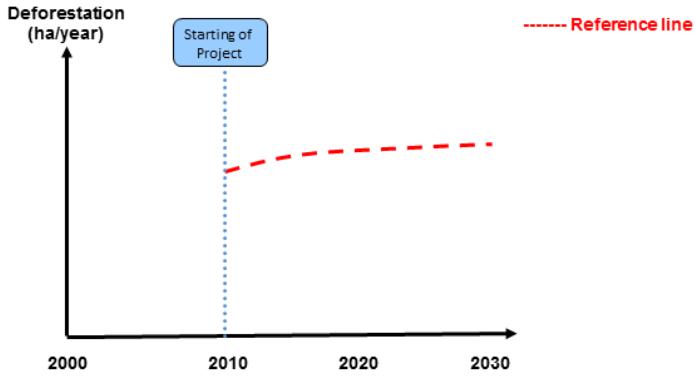
Deforestation :
05/Out/2014 – 26/July/2015

Area	Num. of deforestation	Total Area (ha)	Ave. Area (ha)
0.0 – 0.5 ha	44	15.18	0.38
0.5 -1.0 ha	77	57.88	0.75
1.0 -2.0 ha	61	88.49	1.45
2.0 – 5.0 ha	30	86.19	2.87
5.0 – 10.0 ha	10	61.00	6.10
10.0 – 20.0 ha	2	24.28	12.24
20.0 – 50.0 ha	0	0.00	0.00
Total	224	333.21	1.49

10

Reference line and real deforestation

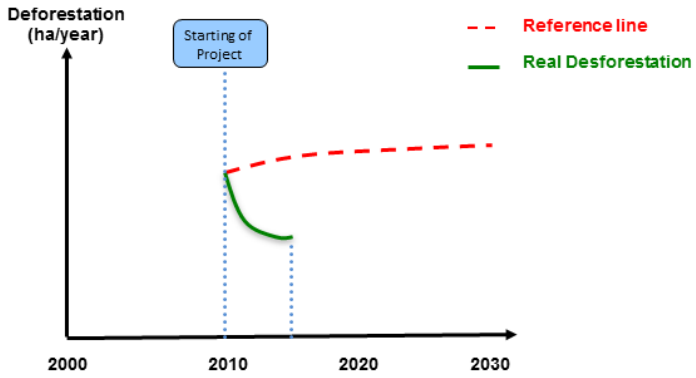
What is deforestation without the REDD Mechanism? Must be established a baseline



11

Reference line and real deforestation

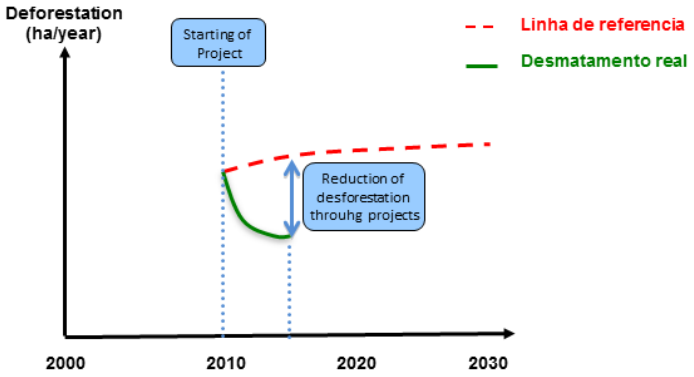
And compare every 5 years the reference line with the actual deforestation to measure the impact of the project



12

Reference line and real deforestation

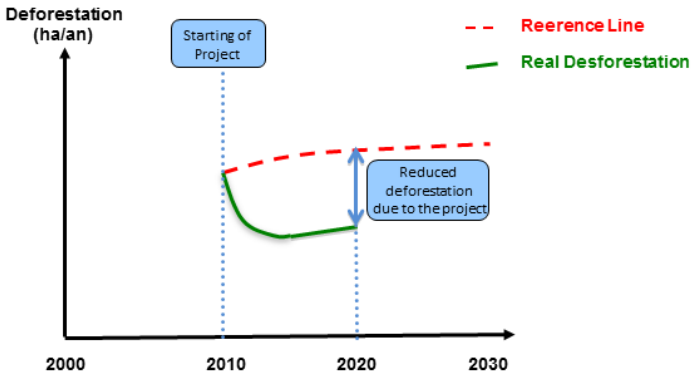
And compare every 5 years the reference line with the actual deforestation to measure the impact of the project



13

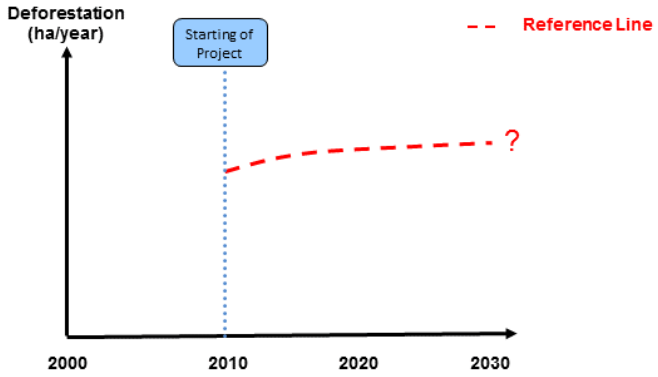
Reference line and real deforestation

And compare every 5 years the reference line with the actual deforestation to measure the impact of the project



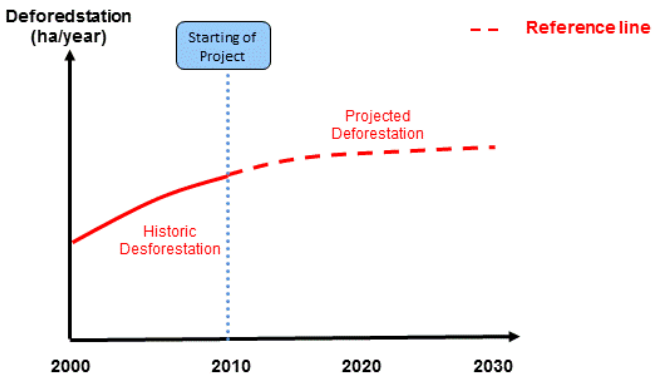
14

Steps to establish a reference line



15

It all starts with the historical deforestation



16

Establishment of Sustainable Forest Resource Information Platform for Monitoring REDD+ in Mozambique

17

Project outline and objectives

The project is intended to contribute to Establishment of a REDD+ system in Mozambique **(i)** developing a forest resource information platform, **(ii)** developing an infrastructure for measurement, reporting, and verification (MRV) using that platform, **(iii)** forming Reference Emissions Levels or Reference Levels (REL/RL) for deforestation and forest degradation, and **(iv)** development data sets for estimation of forest biomass and carbon volumes. Also implementing regular and appropriate monitoring of forest resources after completion of the project;

The project has financial support of **JICA** and technical support of consultants teams of Japan;

Budget of USD $5.5 million

Period of the project 5 years (2013 - 2018);

18

Results and significant findings thus far

Output 1: Database System functioning as the Forest Resources Information Platform is already established;

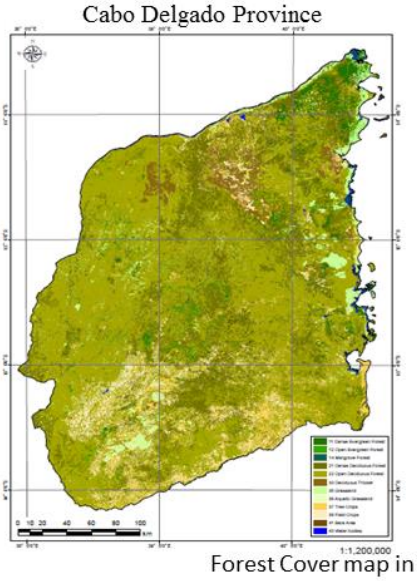
Output 2: Basis of MRV for the Forest Resources Information Platform are under development already concluded the mapping of the two provinces using ALOS data;

Output 3: RELs/RL for the Forest Resource Information Platform are under development;

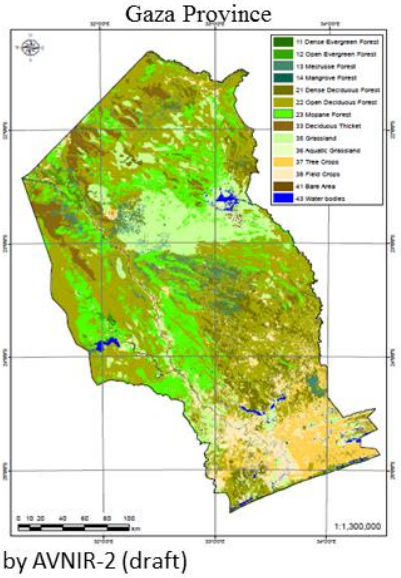
Output 3: Data set of biomass and carbon estimation is on going almost concluded one province (Gaza)

19

Cabo Delgado Province



Gaza Province



Forest Cover map in 2008 by AVNIR-2 (draft)

20

Other anticipated results

• In a view of activities scheduled the forest cover maps using Japanese Grant Aid four provinces are expected to be completed by **February 2017**. Other two provinces will be completed in **October 2017**;

• And the rest of maps will be delivered by **February 2018**;

Satellite data source:
• mapping using Landsat 8 imagery covering the entire country on going to produce the updated based map;

•Using of Drone for coming projects for forest monitoring;

21

Other activities on going

- End of Readiness Preparation Program for REDD+ funded by FCPF;
  - Developing National strategy;
  - National Safeguards;
  - Study in drivers of deforestation;
  - Strategic Environmental and Social Assessment (SESA) under REDD+;

22

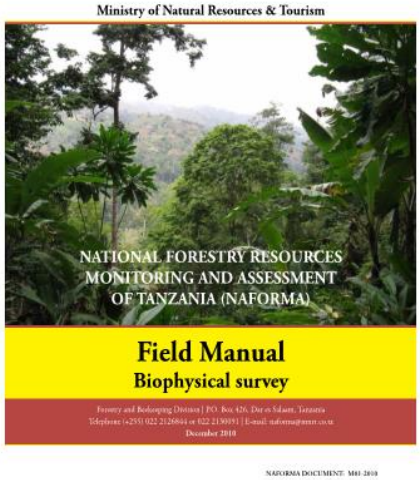
Challenges

- To obtain high resolution satellite images;
- Periodical update of forest cover map;
- Periodical biomass assessment for carbon stocks estimation;
- Permanent Monitoring of the forest resources;
- Start to use Sentinel satellite images for forest monitoring;

23

4.5. Tanzania – Nurdin Chamuya & Jared Otieno

Tanzania Forest Degradation determination efforts



By Nurdin Chamuya & Jared Otieno (TFS)

Forest Degradation Monitoring Workshop Organized by JRC at ISPRA, ITALY, 11-15, July 2016

Introduction

FOREST OWNERSHIP		
	Area (Milloni Ha)	%
Forest and Wildlife reserves	16.835	35
Local authority	3.367	7
Village land	21.645	45
Private sector	3.367	7
Unreserved Forest Land	2.405	5
Others	0.481	1
Total	48.1	100

NAFORMA and Degradation determination

- It has a huge amount of raw data on forest removals (from 3420 sample plots)
- Removal data collection was done: Dead wood measurement and stumps (NAFORMA biophysical manual)
- During the implementation of NAFORMA, data on stump diameter and height were taken (next the slide)
- Data on when the removal (date) and possible use were taken: basing on local people's experience
- Removal date and possible use data were based on ocular estimations or personal guesses.
- PSP (850 clusters) countrywide

Dead Wood parameters				
Object	**Definition**	**Source**	**Format**	**Notes**
Cluster Number	Cluster ID in TZ	Inventory plan	Number	
Plot number	Plot number with the cluster	Inventory plan	Number 1-10	On shared plot, add A or B
Species code			Number	
Species name		Field observation	Text	Record spp's name if possible
Dialect			Text	
Diameter 1	**Diameter at at the stump part of stem**	**Field measurement**	**Number: Unit cm Accuracy: 1cm**	**If bark exists, record above bark**
Diameter 2	**Diameter at the top of stem**	**Field measurement**	**Number: Unit cm Accuracy: 1cm**	
Length	**Measure length of wood part**	**Field measurement**	**Number: Unit cm Accuracy: 1cm**	
Number of	Number of similar size dead	Field	Number	

Causes of Removals

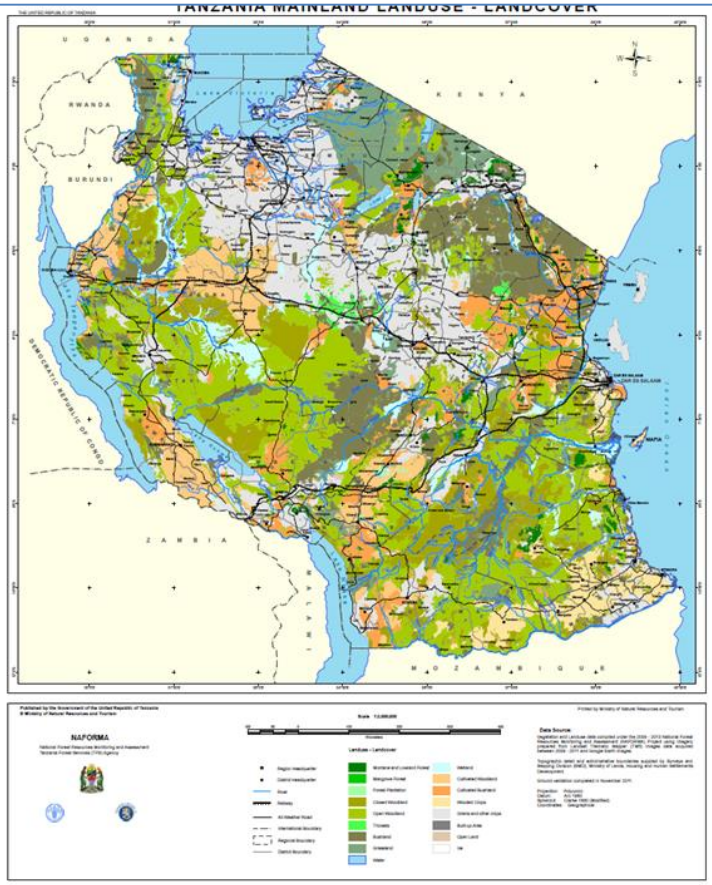
- Shifting cultivations
- Uncontrolled charcoal and timber extraction
- Uncontrolled grazing
- Forest fires
- Infrastructure expansions

The removal data

- The removal data collected are stored in the open Foris calc data base
- However, not yet analyzed
- Reasons being
  - Lack of capacity
  - Lack of accurate species distribution
  - Lack of species allometric models
- So, NAFORMA project has not determined the degradation rate for Tanzania
- Working on National Reference emission levels (UNFCCC)

What TFS has done so far

- Re-measurement and taking all the data taken during NAFORMA first phase implementation (including Stump Diameter and height)
- JRC pilot study (Kisarawe and Iringa) to determine degradation of two sites Development of Allometric models for almost all vegetation types
- Re-running the whole NAFORMA data is on the way between FAO and TFS using the developed models
- Collaborate with FAO experts mission to TZ (August) training on data analysis
- Established National Carbon Monitoring Centre



Recommendations

- TFS welcomes all affordable technology that can help determine and map forest degradation
- TFS will strengthen collaborations with other stakeholders (National, Regional and International) to determine and map forest degradation
- Periodic update of forest cover maps

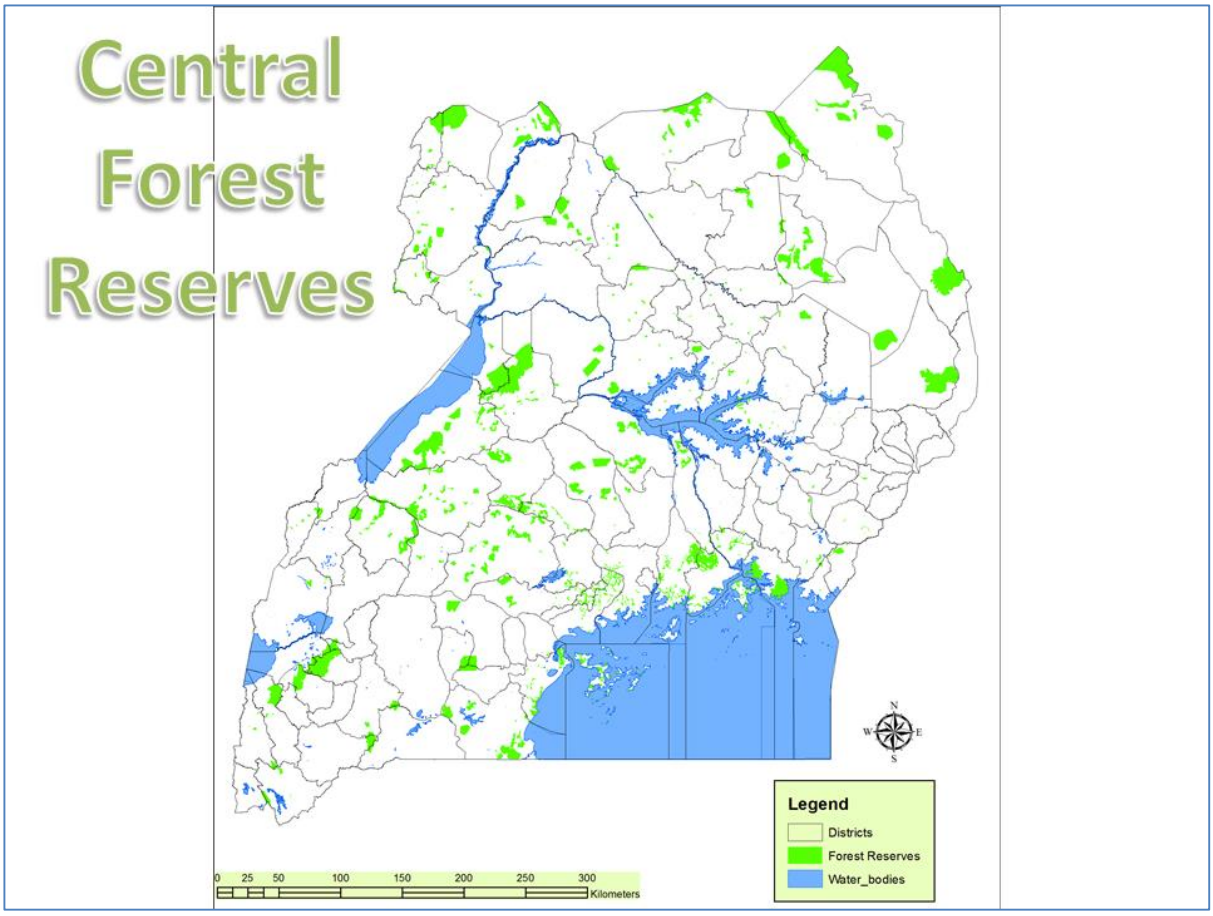
4.6. Uganda – John Diisi

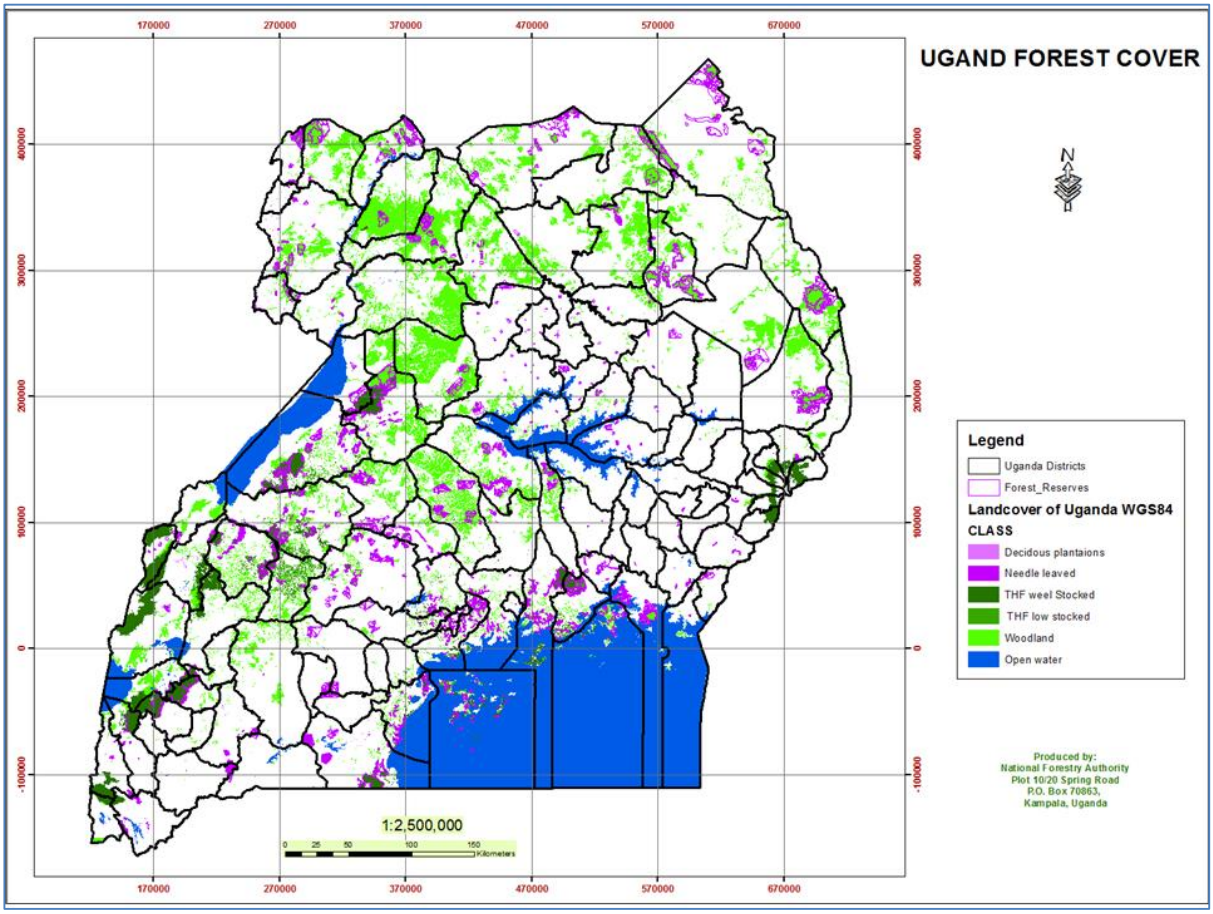
Forest Degradation Monitoring in Uganda

By
John Diisi
National Forestry Authority
July 2016m Ispra

Mandate

- The National Forestry and Tree Planting Act 2003, provides for the **conservation, sustainable management and development** of forests for the benefit of the people of Uganda, and declaration of Forest Reserves for purposes of protection and production of forests and forest produce respectively.


Central
Forest
Reserves
Legend
Districts
Forest Reserves
Water_bodies
0 25 50 100 150 200 250 300
Kilometers


UGAND FOREST COVER
Legend
Uganda Districts
Forest_Reserves
Landcover of Uganda WGS84
CLASS
Decidous plantaions
Needle leaved
THF weel Stocked
THF low stocked
Woodland
Open water
1:2,500,000
Produced by:
National Forestry Authority
Plot 10/20 Spring Road
P.O. Box 70863,
Kampala, Uganda

Forest Ownership

- Central Forest Reserves are managed by National Forestry Authority
- Local Forest Reserves are managed by District Local Governments
- Forests in National Parks and Wildlife reserves are managed by Uganda Wild life Authority
- Forests on private land are managed by land owners

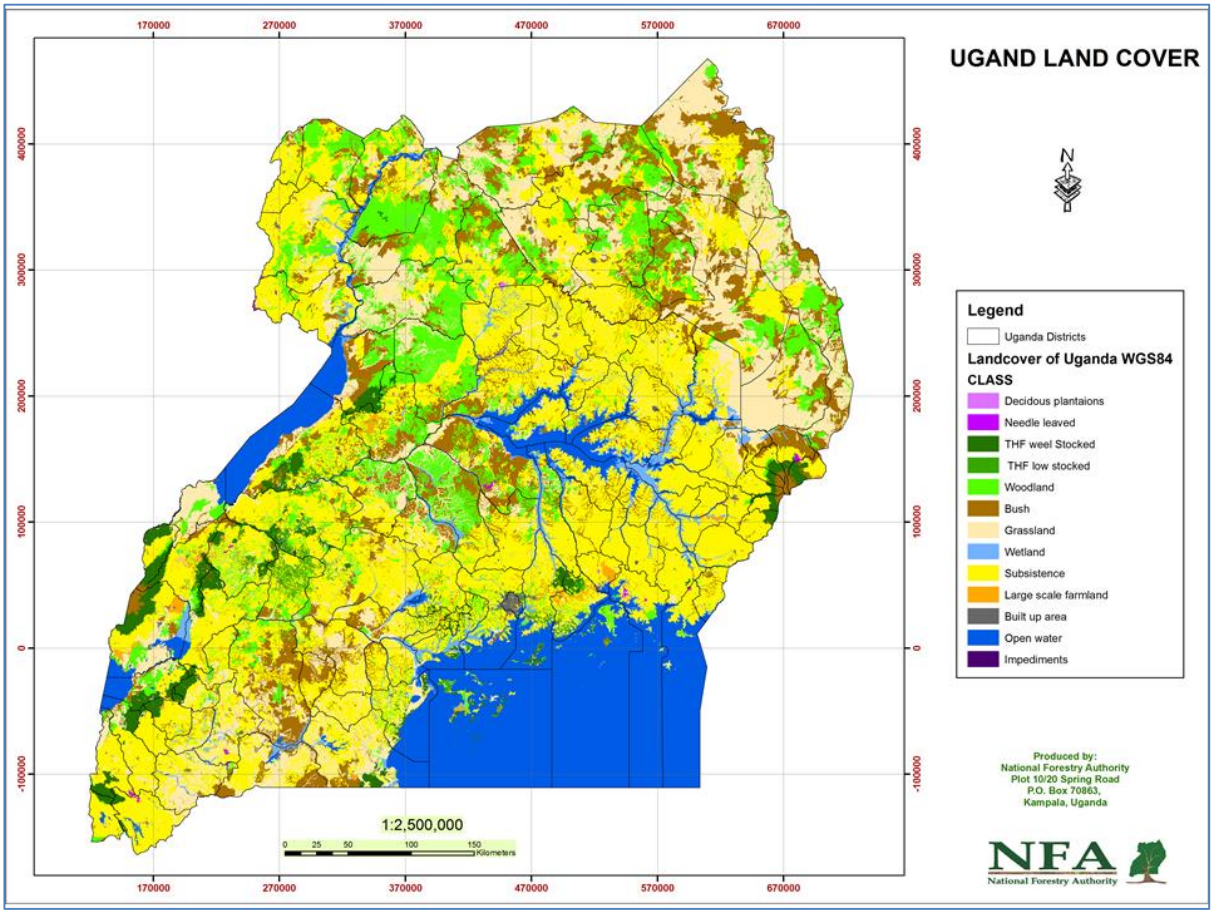
Land Cover Mapping

- National Forestry Authority has mapped land cover of Uganda for the years 1990, 2000, 2005, 2010 and 2015
- Harmonisation of the 5 epochs just completed.
- Original objective of mapping was to establish extent of areas with woody biomass of potential for wood fuel
- Classification used is home made and has 13 major classes
- The 1st 5 classes are forest classes

National Biomass Classification

- 1 **Broad leaved plantations**
- **2 Coniferous plantations**
- **3 Tropical High Forest – well stocked**
- **4 Tropical High Forest – low stocked**
- **5 Woodlands**
- 6 Bush
- 7 Grassland
- 8 Wetlands
- 9 Subsistence Farmland
- 10 Commercial Farmland
- 11 Built up area
- 12 Open Water
- 13 Impediments


Degraded


UGAND LAND COVER
170000
270000
370000
470000
570000
670000
400000
300000
200000
100000
0
-100000
N
Legend
Uganda Districts
Landcover of Uganda WGS84
CLASS
Decidous plantaions
Needle leaved
THF weel Stocked
THF low stocked
Woodland
Bush
Grassland
Wetland
Subsistence
Large scale farmland
Built up area
Open water
Impediments
1:2,500,000
0 25 50 100 150
Kilometers
Produced by:
National Forestry Authority
Plot 10/20 Spring Road
P.O. Box 70863,
Kampala, Uganda
NFA
National Forestry Authority

Biomass Inventory

- It is done to establish biomass stocking levels of each class
- 50m by50m Sample plots are systematically spread around the country on a 5km by 10km grid
- Analysis of plot biomass leads to biomass stocking per land cover class

Forest Degradation

- Loss of quality of a forest- woody biomass, biodiversity, canopy opening
- Mapping can show a forest that has moved from a forest of high stocking to that of low stocking-eg from THF to woodland
- Change in canopy closure can also be mapped
- Logging is not well licensed and is hard to monitor
- There is a mechanism in place to enable monitoring of extraction of forest products

SUPPLY FOREST AND NON FOREST PRODUCTS AND SERVICES

1. Volume of timber harvested in plantations under license (m^3)
2. Volume of timber harvested in Tropical High Forests under license (m^3)
3. Volume of sawn timber supplied from NFA sawmills
4. No of utility poles
5. No. of construction poles
6. Volume of fire wood sold (stacked M^3).

Drivers of Forest Degradation

- Fuel wood extraction
  - Charcoal
  - Firewood
- Logging/pit sawing
- Others- Infrastructure dvpt, migrations..
- ----------
- Monitoring mechanism does not address illegal wood extraction

Going on…..

- It is still difficult to quantify forest degradation in Uganda
- Reporting on Forest Degradation is not part of our REDD preparation
- It (FD) is still at proxy level rather than hard fact.

5. The Regional Options – Fortunate Benda

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Regional Options for Forest Degradation

Muyambi Fortunate
Forest Monitoring Expert
IGAD/MESA Thema

MESA
Monitoring for Environment and Security in Africa

Introduction

Changes in forest carbon stocks can be detected through monitoring of deforestation (conversion of forests to some other cover type), forest degradation (forests that remain forests), and/or reforestation (restoration of forests). Techniques for monitoring deforestation and resultant changes to forest carbon stocks are widespread and well published. However, techniques for monitoring degradation and reforestation are relatively untested in developing countries despite their inclusion in current UNFCCC REDD+ negotiations.

Globally, there are very few examples of operational monitoring systems designed to detect forest degradation. In short, degradation is direct human-induced activity that leads to a long-term reduction in forest carbon stocks in forests that remain forests through time (IPCC 2003).

Most globally established definitions of degradation reflect a negative change in the forest's structure, function and capacity to provide goods and services (Wertz-Kanounnikoff 2008). The lack of successfully implemented monitoring systems is largely a function of the significant technical and financial capacity required to design and implement such systems

FAO (2002) defines forest degradation as: The reduction of the capacity of a forest to provide goods and services.

Drivers of Forest Degradation

The identification of drivers and activities associated with forest degradation is an important aspect of the assessment, as these dictate the spatial and temporal pattern and intensity of degradation. In turn, these attributes are important considerations for the design and implementation of an effective degradation monitoring system.

This assessment classifies drivers of forest degradation as direct (proximate) and indirect (underlying). Direct drivers are activities occurring in the forest that directly affect conditions. Indirect drivers can consist a myriad of factors, including poverty, land use and economic policies, and regulations.

The primary direct driver of forest degradation are identified as tree harvest for a variety of uses: commercial lumber (e.g., logs or cuts sold for lumber or other commercial products), domestic lumber (e.g., planks and beams for local house building), commercial fuelwood (e.g., fuel wood for crop drying and brick making) and domestic fuelwood (e.g., fuel wood for cooking and heating).

Indirect drivers of forest degradation included land use regulations for family forests, housing improvement policies, national and international market demands, and insufficient intergovernmental coordination, market knowledge, and information sharing.

Approaches for monitoring forest degradation

Assessment of options for monitoring biomass/carbon change in degraded forests. Three basic monitoring approaches for monitoring forest degradation were identified:

- Predictive modeling,
- Remote sensing, and
- Ground-based field measurements

Predictive Modeling

Predictive modeling can be used stratify forested land according to the risk of degradation by predicting the probability of occurrence of a degrading activity in a particular location. This information can then be used to interpret canopy cover changes detected through imagery classification. If the biomass loss associated with a particular activity can be quantified (such as through ground-based field measurements), then modeling can serve as the basis for a 'gain-loss' approach to carbon accounting as defined by the IPCC.

Modeling may also be able to predict changes in biomass from degradation activities such as fire or fuel wood gathering that may not immediately result in detectable changes in overstory canopy cover, and it may serve as a surrogate for remote sensing data if there are gaps in imagery coverage for the area or if a remote sensing system has not been implemented.

Remote sensing Techniques

Remote sensing is used to detect changes in forest canopy cover over time, which can then be related to biomass changes by incorporating ground-based field measurements. Satellite imagery must be of sufficient resolution to detect changes in canopy in forests caused by degradation activities, i.e. canopy cover changes that are of insufficient scale to cause the land cover classification to change from forested to deforested. Imagery platform sensors are of two general types: those using active sensors such as LiDAR or radar, and those with passive sensors such as LandSat or RapidEye and Sentinel2.

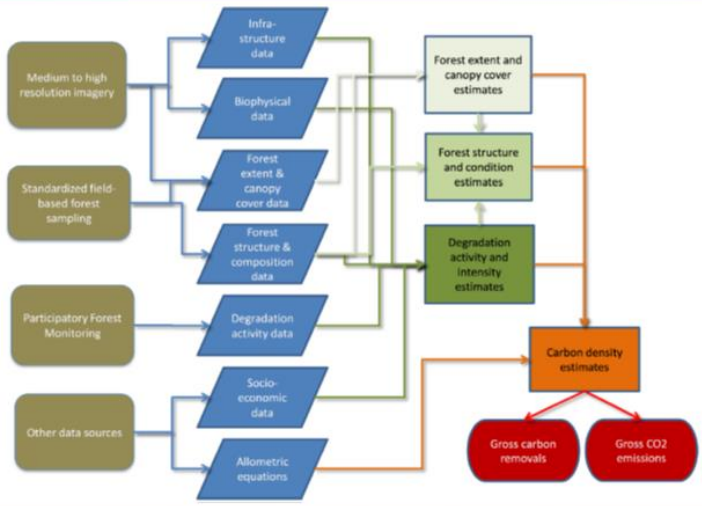
High resolution imagery provides the finest detail for detecting canopy changes; however, it is usually expensive to acquire and process, and the spatial and/or temporal coverage of a large landscape may be insufficient. Low and medium resolution imagery is less expensive, or even free, but detecting small changes in forest canopy cover can be problematic. Some degradation activities such as fuel wood gathering or fire may not result in overstory canopy disturbance, and therefore may not be detectable by remote sensing.

High resolution imagery may also be used for detecting indirect evidence of degradation activities, such as logging tracks and landings that could serve as infrastructure data for degradation risk modeling.

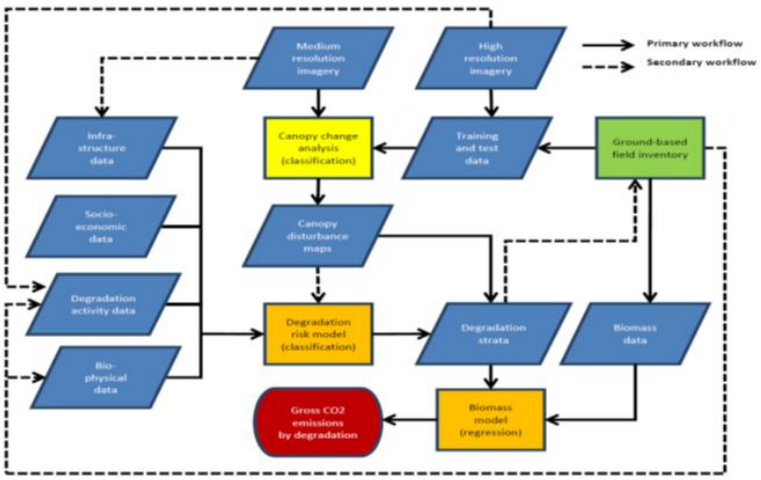
Remote sensing Techniques

Ground-based field measurement of vegetation and site data is normally from a system of permanent or temporary sample plots. Interpretation of sample plot data relies on statistical analyses to assess biomass stocks and changes on the sample landscape. Forest inventories use established, repeatable methods and if used exclusively for carbon accounting they can be considered a 'stock difference' approach in IPCC terms. Forest inventory data may also be used in the 'gain-loss' accounting by providing supporting data for spatial modeling and/or remote sensing monitoring approaches.

A systematic inventory of permanent plots usually provides the most reliable and precise data if the sample grid is of sufficient density

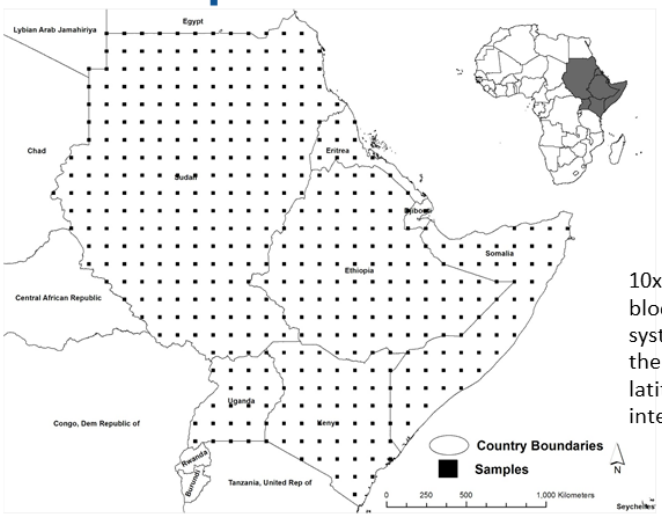


Conceptual design of the integrated monitoring system workflows to assess biomass/carbon stock change resulting from forest degradation.



Options for Regional Forest Degradation Monitoring

The samples



10x10km Landsat image blocks located on a systematic grid covering the region at 1 degree latitude and longitude intersections

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Forest degradation

Forest degradation is the persistent reduction of canopy cover and/or carbon stocks in a forest due to human activities such as animal grazing, fuel extraction, timber removal etc. that do not result in conversion of forest to non forest.

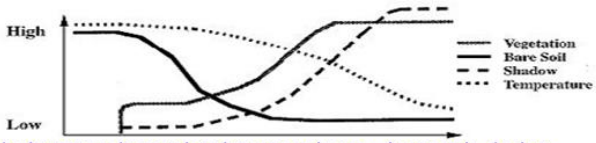
- To effectively determine the forest degradation, base year has to be established where the canopy density has to be modeled say after 10 yrs and difference established to determine the canopy reduction

Using Forest Canopy Density (FCD) methodology to determine degradation

FCD concept and indices

Indices used for assessment are;

- Shadow Index (SI)-The shadow index is formulated through extraction of the low radiance of visible bands.
- Advanced vegetation Index (AVI)-examine the characteristics of chlorophyll-a
- Bare soil Index(BI)-formulated with medium infrared information.
- Thermal Index (TI)-infrared band of TM data (shielding effect + evaporation)

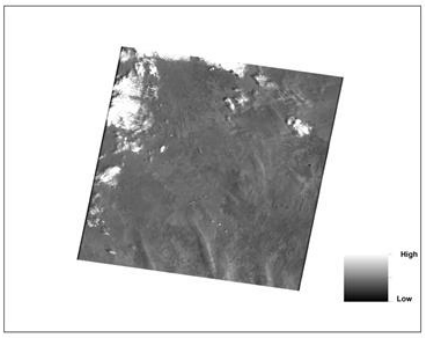


- Veg& shadow strongly correlated; Increase in veg – increase in shadow

Bare soil Index (BI)

(Formulated with medium infrared information)

$$BI \quad \frac{(B4 + B2) - B3}{(B4 + B2) + B3}$$

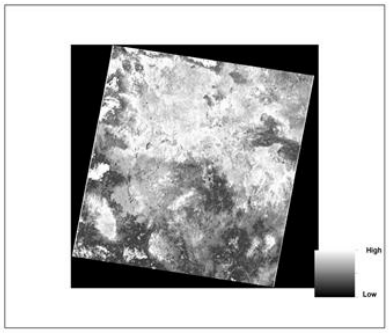


The darker the image the more closed the canopy of its vegetation

Advanced vegetation Index (AVI)

Examine the characteristics of chlorophyll-a

$$AVI = \{(B4+1)(256-B3)(B4-B3)\}^{1/3}$$

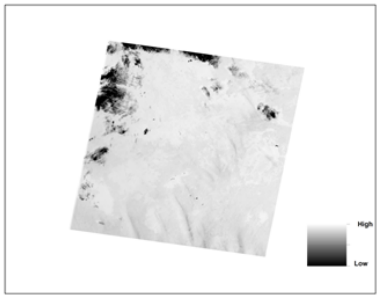


The darker colour represents areas which have a higher advanced vegetation Index

Shadow Index (SI)

The shadow index is formulated through extraction of the low radiance of visible bands.

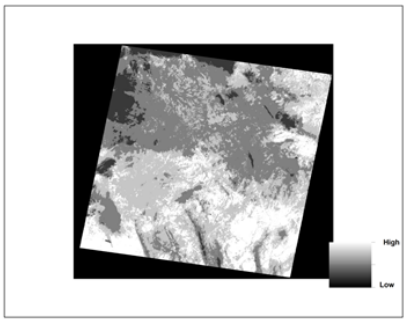
$$SI = \sqrt{(256 - B2)(256 - B3)}$$



Shows areas with more shadows (higher shadow index) in lighter colour that surrounding areas

Thermal Index (TI)

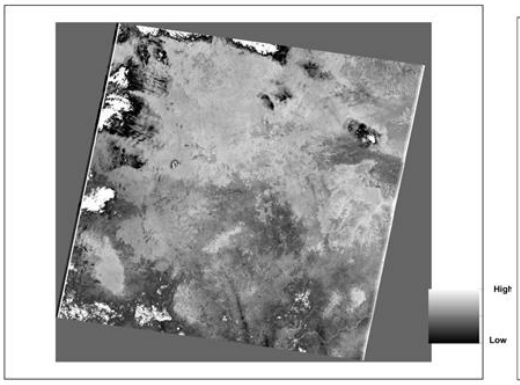
Infrared band of TM data (shielding effect + evaporation)



Shows areas with cooler temperature (lower temperature index) with darker colour

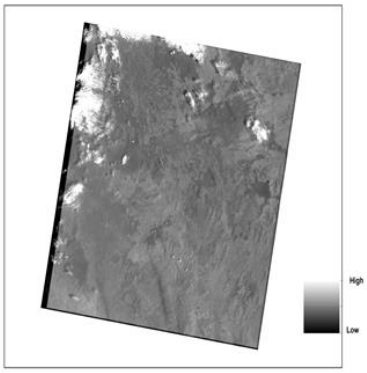
Vegetation Density Map (VDM)

Vegetation Density (VD) = Shadow Index (SI) + Advanced Index (AVI)



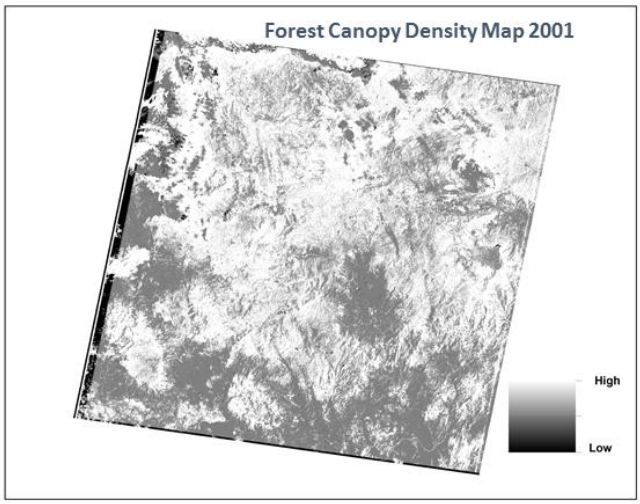
Scaled Shadow Index (SSI)

Scaled Shadow Index (SSI) = Bare Soil Index (BI)) + Thermal Index (TI)



Integration Process to Forest Canopy Density

$FCD = (VD \times SSI + 1)^{1/2} - 1$



Carry out the accurate assessment combining with ground truthing

Indices combination and Forest density

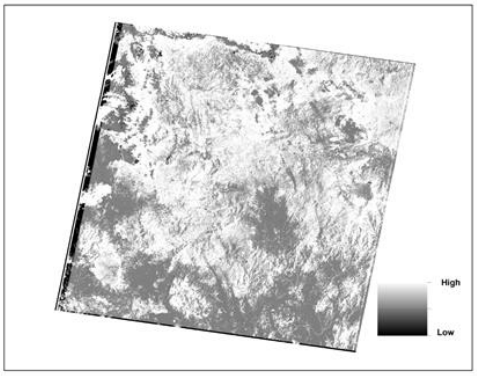
	Hi- FCD	Low-FCD	Grass Land	Bare Land
AVI	Hi	Mid	Hi	Low
BI	Low	Low	Low	Hi
SI	Hi	Mid	Low	Low
TI	Low	Mid	Mid	Hi

FCD Classifications

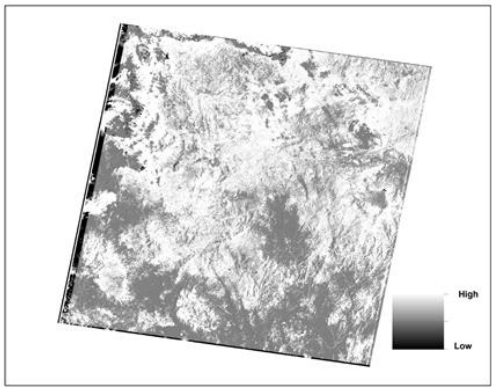
The suggested classes for this classification are as follows

- High Forest (HF).....**[71-100%]**
- Medium forest (MF).....**[41-70%]**
- Low Forest (LF).....**[10-40%]**
- Grassland
- Bare Soil
- Water Bodies

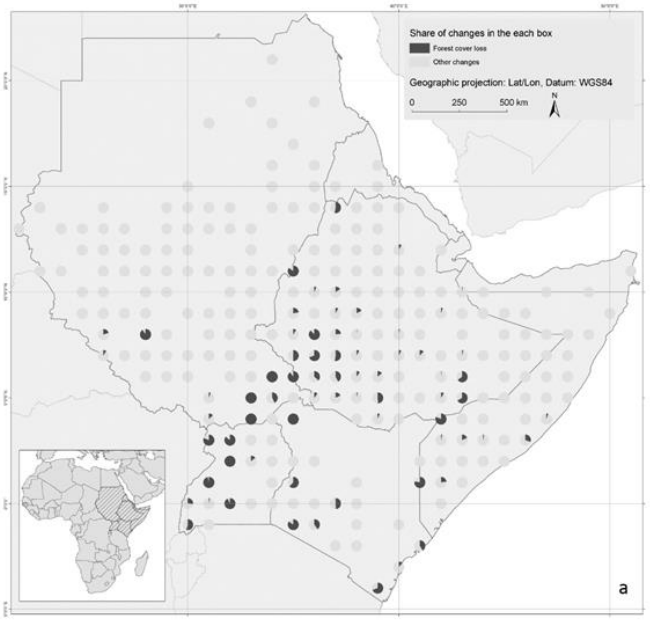
Forest Canopy Density Map 2000



Forest Canopy Density Map 2010



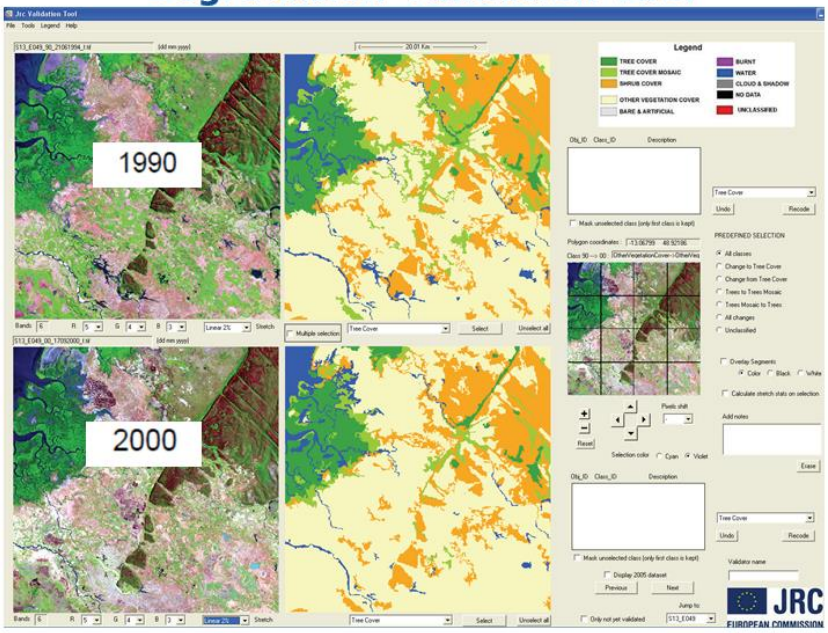
Degradation = Change in Forest Canopy Density



Output

Degradation rate Year x- Year y

Degradation Validation Tool



6. Next Steps – Pilot Studies

6.1. Proposed Methods

A limited test exercise is proposed, whereby national agents supported by JRC technical staff, will produce forest degradation maps based on satellite data for a set of test areas – to be determined by the national staff.

- The reference and commitment periods have to be set *e.g.* 2000-2010 and 2010-2015

- The analysis will be based on already existing products of forest change

- A method to detect the different types of degradation will be tested for the reference and commitment periods

- The extraction of data will be based on a set grid which corresponds to the national minimum mapping unit

- The basis for determining forest degradation will be based on the national definition of forest (percentage cover MMU and tree height)

An initial 'look up' table approach will be used to provide emissions factors

Selection of test sites

Review Existing maps of forest change

An initial review will be undertaken to determine which or which combination of existing products could be used as an input into mapping forest degradation. The products include:

- Global tree cover change map by UMD

- Roadless forests by JRC

- National forest change maps where available

Identification of special cases (e.g. fuel wood, logging)

Activity data

For each of the two assessment periods (historical and commitment) the activity data should come from the analysis of a reference frame units, classed as forest units at the start of the period that have reduced their forest proportion during the period, without falling below the forest threshold (these would be deforested). The only data which covers the full temporal and spatial dynamics of the product is the original Landsat data series.

Once the test sites are selected, the JRC will help in the acquisition of Sentinel 2 data for the partners.

Validation

To ensure confidence in the product and process a validation exercise is mandatory. This also allows the possibility of calibrating the activity data in a regression estimator procedure. Such an exercise provides a number of challenges as we are dealing with a multi-date product with is based on changes at pixel level within a reference frame.

A rigorous protocol is required to ensure that the validation is carried out in an unbiased way.

Emissions factors

Simple lookup table by biome will be used in a first step– this can be changed later for more accurate field data

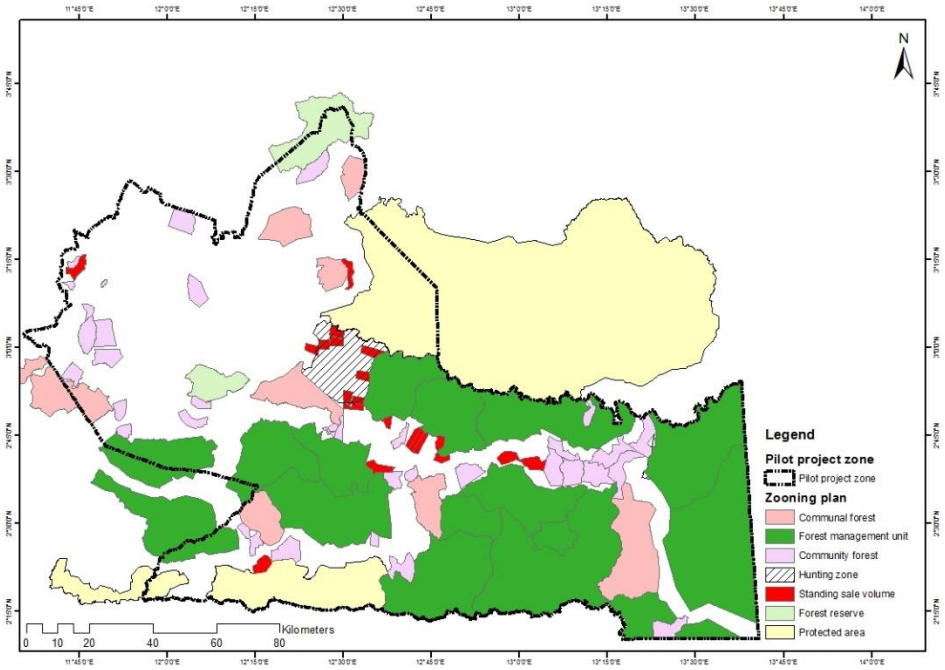
6.2. Country Pilot Studies

Participants were asked to propose areas within their countries for pilot case studies. These are not definitive until agreed to by national officials.

6.2.1. Cameroon

Jean Daniel MENDOMO BIANG
Direction des Forets – Ministère des Forêts et de la Faune (MINFOF)

The technical operational unit of Ngoyla Mintom, where there is a trinational initiative: (Cameroon, Congo and Gabon). There is a diversity of actors:
Logging companies; Mining industries; Protected areas; Agroindustry; Hydroelectric dam; Highway construction. The area is among the last remaining intact forests in the country.



6.2.2.Ivory Coast

Dibi Hyppolite N'DA & Tchimou Vincent ASSOMA

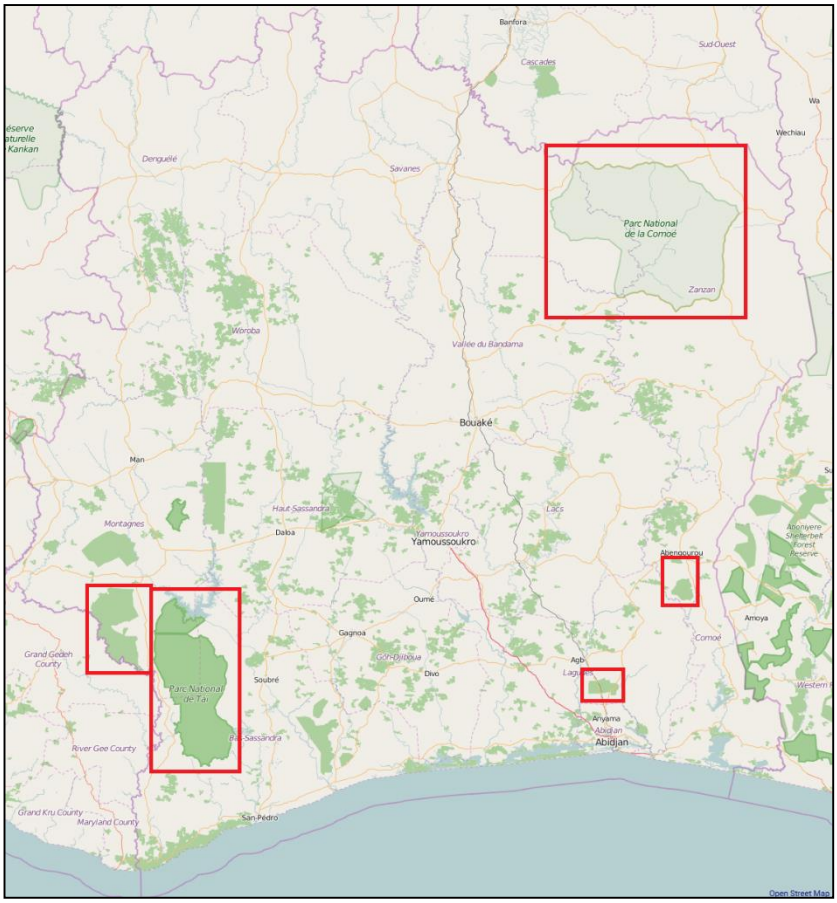
Yapo-Abbe FC and its peripheral: Foret Classé heavily infiltrated in the social crisis, forest strongly now cleared

Taî National Park and its peripheral : Largest forest and more or less well preserved

Goin débé Foret Classé and its peripheral: Heavily infiltrated in the social crisis, almost total disappearance of the forest.

Bossemtié Foret Classé and its peripheral: Heavily infiltrated in the social crisis, forest strongly now cleared.

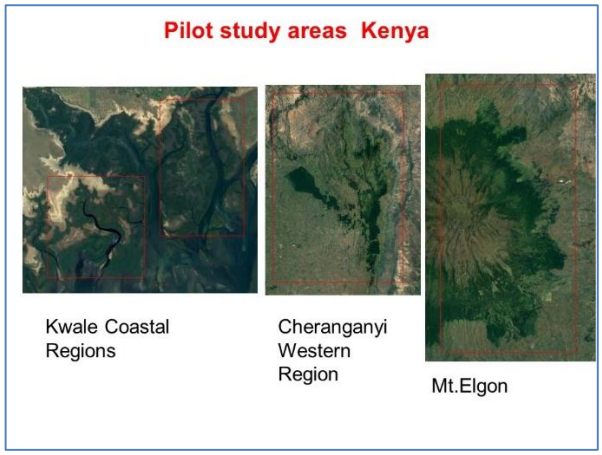
Comoé National Park and its peripheral: Heavily infiltrated in the social crisis, forest strongly now cleared.



6.2.3. Kenya

J.K NDAMBIRI & Eunice MAINA

Three sites proposed in different ecosystems



6.2.4. Mozambique

Joaquim MACUACUA

Pilot study areas

1 - South of Sofala province Mucheve forest reserve which is being been invaded by the community carrying out agriculture at small scale and forest exploitation;

2 - Zambezia province in some forest concession areas;

6.2.5.Tanzania

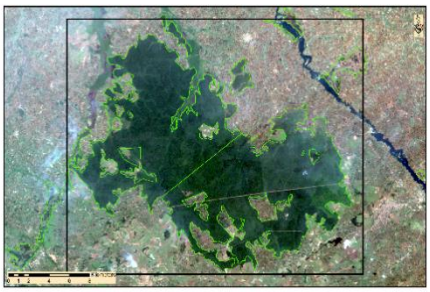
Nurdin CHAMUYA & Jared OTIENO

Three areas selected – one large study area to the west of the country and two smaller ones selecting specific forest areas

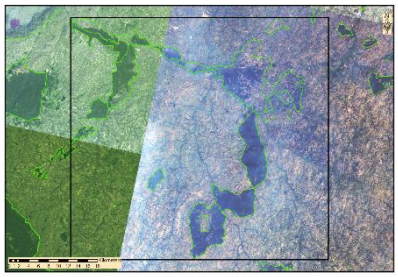
6.2.6. Uganda

John DIISI

Uganda Priority 1- Pilot study areas- Mabira

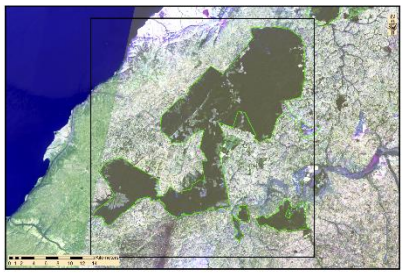


Priority 2 Pilot Study – Kagombe -Currently under degradation -Exposed to high population pressure -Efforts going on to save the forest



Priority 3 Pilot Study – Bugoma

-Facing threat from future coming oil and gas activities and surrounding communities



List of Figures

Figure 1: GPS points and track made with conventional and high precision GPS 13
Figure 2: The Sensefly and flight control program 13
Figure 3: Flight plan and details with results 14

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