UN-REDD PROGRAMME

MRV requirements from an implementation perspective

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FAO Forestry, UN-REDD

21 September 2015
Bonn, Germany

FAO and its role in REDD+

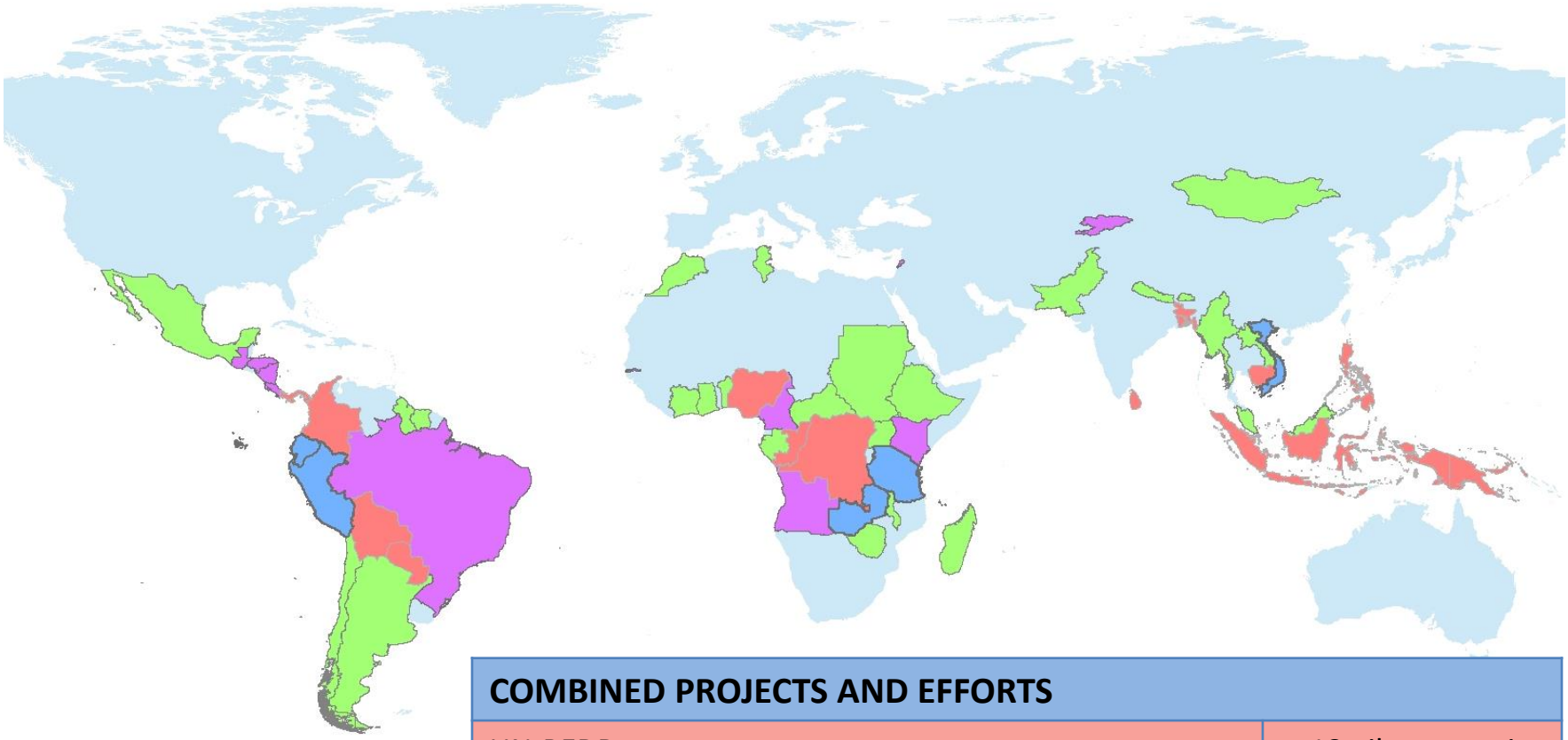
- FAO's key role in REDD+ readiness is to help countries develop, implement and operationalize their National Forest Monitoring System (NFMS)
- FAO also assists countries in conceptualizing and implementing REDD+ activities and in the development of policies and measures

Key principles of FAO's support

- National ownership
- Alignment with the UNFCCC process
- Step-wise approach that allows for improvement over time
- Builds upon existing capacities, available data and systems in place
- Use of open-source, freely available data and tools as much as possible
- Strengthening of national capacities (learning-by-doing)
- No one-fits-all approach: country tailoring is key

FAO'S RESPONSE- main outputs

Country support for NFMS (58 countries)



COMBINED PROJECTS AND EFFORTS	
UN-REDD (Norway, CE, Denmark, Spain, Japan, Luxemburg)	18 pilot countries
UN-REDD (Norway, CE, Denmark, Spain, Japan, Luxemburg)	32 countries
FAO-Finland (Finland)	5 countries
NFMA (Sweden, Finland, USA, Brazil, Angola, FAO TCP, GEF)	19 countries

* Several countries are supported by more than one programme (e.g. Vietnam)

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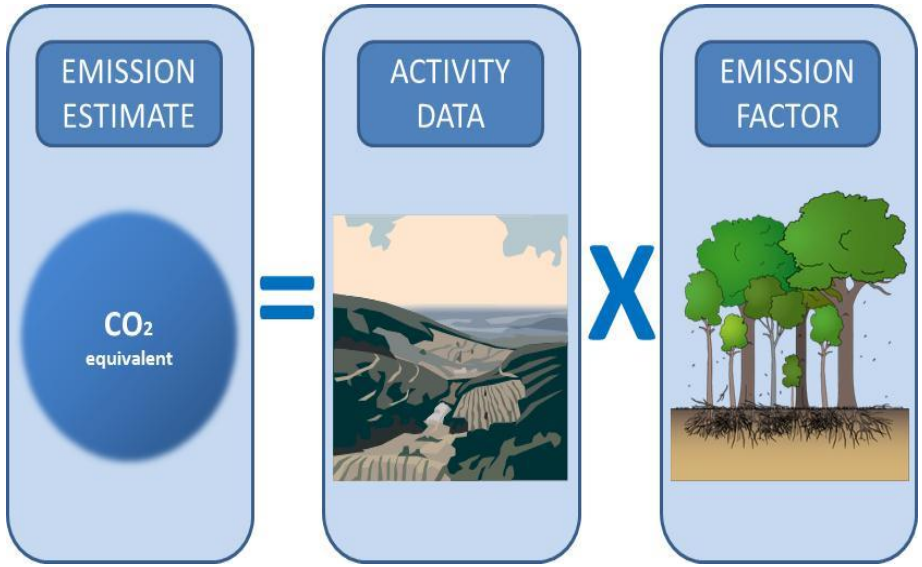
A simple concept for calculating emissions

Emissions in CO_2 eq. calculated by:

- The emissions and removals estimates through the national GHG inventory can be calculated through
- Collecting Activity Data through a satellite-based land monitoring system
- Using emission factors (e.g default IPCC Tier 1) or gather information to obtain emission factors through the national forest inventory (NFI)



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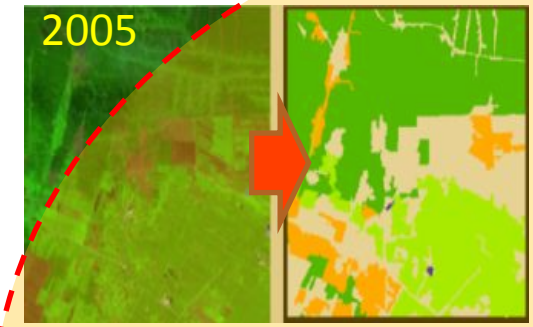
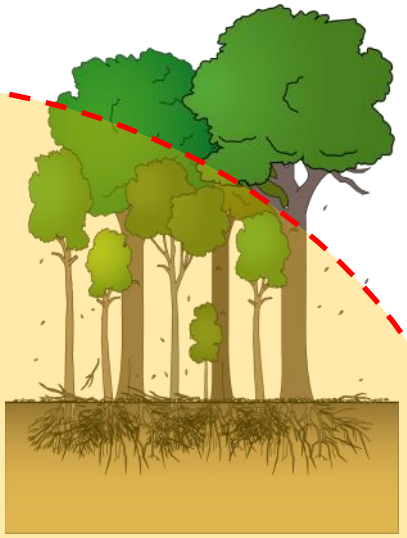
MRV for REDD+

IPCC method for Emission Estimates





CO_2

	FL Wet evergreen	FL Moist evergreen	FL Moist semi-deciduous	FL South-east subtype	FL North-west subtype	FL North-west subtype	FL Dry semi-deciduous	Agricultural land	Savanna	Shrub Ticket	Settlements	Wetlands	Other land	Unclassified	Final Area
FL Wet evergreen	51														51
FL Moist evergreen		42													42
FL Moist semi-deciduous			60												60
FL South-east subtype				52											52
FL North-west subtype					12										12
FL North-west subtype						2									2
FL Dry semi-deciduous							25		2						27
Agricultural land	5	2				2	3	1							13
Savanna			1			3	1		20						25
Shrub Ticket					1					12					13
Settlements						1		10			25				36
Wetland									0			2			2
Other land								5					25		30
Unclassified								9						10	19
Initial Area	56	44	61	52	13	8	29	25	22	12	25	17	25	10	
Net change (Δ = T0-T1)	-5	-2	-1	0	-1	-6	-2	-12	3	1	11	-15	5	9	0

MEASUREMENT

Area change data from satellite remote sensing

Forest carbon stock change data from a national forest inventory

Inventory of greenhouse gas **emissions** from the forest sector

ACTIVITY DATA

EMISSION FACTOR

EMISSIONS ESTIMATE

Activity data

-Several ways to generate:

sample based and **spatially exhaustive**

-**Samples**

Generate estimates

Allow careful interpretation at each sample point

Large errors possible for rare classes (e.g. change classes)

-**Spatially exhaustive mapping**

Generate estimates

Cartographically useful product

Errors (bias)

-Maps combined with sample-based reference data

Estimates with lower standard errors (even maps not perfect)

Preliminary results from sample-based assessments of all IPCC categories suggest that conversion of FL to OL accounts for majority of LUC (emissions?)

Activity data

Mainly through satellite data for deforestation

No common approach yet for forest degradation, several countries experimenting

Deforestation:	Degradation:
• Medium-resolution imagery (Landsat) • High-resolution imagery • Land registry (cadaster)	• High-resolution imagery (RapidEye) • Testing Landsat-NDVI combination • Timber records or management plans (volume harvested, species, collateral damage, skid trails, …) • Fuelwood extraction statistics

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Forest degradation

- Definition issue: measurements by RS needs detectable biophysical properties
- Cost-benefit analysis for monitoring
- Forest degradation monitoring
  - Experimental
  - Time series needed
  - First step: focus on areas most likely to significant degradation
  - Likely imprecise measurements
  - In relation to MMU
- Data sources: Optical Landsat, HR data (RapidEye), and active sensors (radar/lidar)
- Cost of HR data always to be evaluated against extra info obtained for reporting

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Snapshot of data used and needs

Country	Data use	Topic
VietNam	SPOT, Landsat, RapidEye	Deforestation, request for degradation imagery
Ecuador	Landsat, RapidEye	
DRC	SPOT, Landsat	Request for degradation imagery
Tanzania, Zambia	Landsat, RapidEye	
Pacific island states	DigitalGlobe	
Bhutan, Mongolia	SPOT, ALOS (AVNIR-2)	
PNG	Landsat, RapidEye	HR requests
Cambodia	MODIS, Envisat ASAR	Request terrestrial lidar and radar data

So not such a thing as one method fits all

Experience in-country

- **Access to technology is quite limited,** particularly for remote-sensing technologies and data
- The basics are often missing (e.g. steady electricity, high-speed internet, performing computers, software packages)
- Certain **technologies are costly** (e.g. HR images, Lidar, commercial software packages), limiting large-scale deployment and sustainability

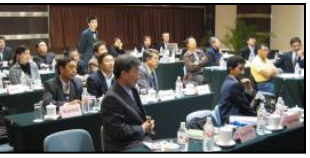
- Not promote specific tools/data sets but provide overview of available options
- Help governments make informed decisions (World bank Decision tool)
- Support country decisions and tailor best available approaches while maintaining consistency and comparability of results
- Heavy reliance on complex & costly technology may not be in all developing countries' best interest
- Open source, free software and data set that meet REDD+ requirements are available. If not, new tools can be developed

FAO experience in National Forest Monitoring

- Decades of experiences supporting countries on forest monitoring
- Assist countries to manage & analyse own data
- Country needs and constraints paramount
- Build on experience of best-of-class systems
- Build capacity through automation of key processes:

Continuous development and updating of manuals and guidelines

Expert consultation & networking



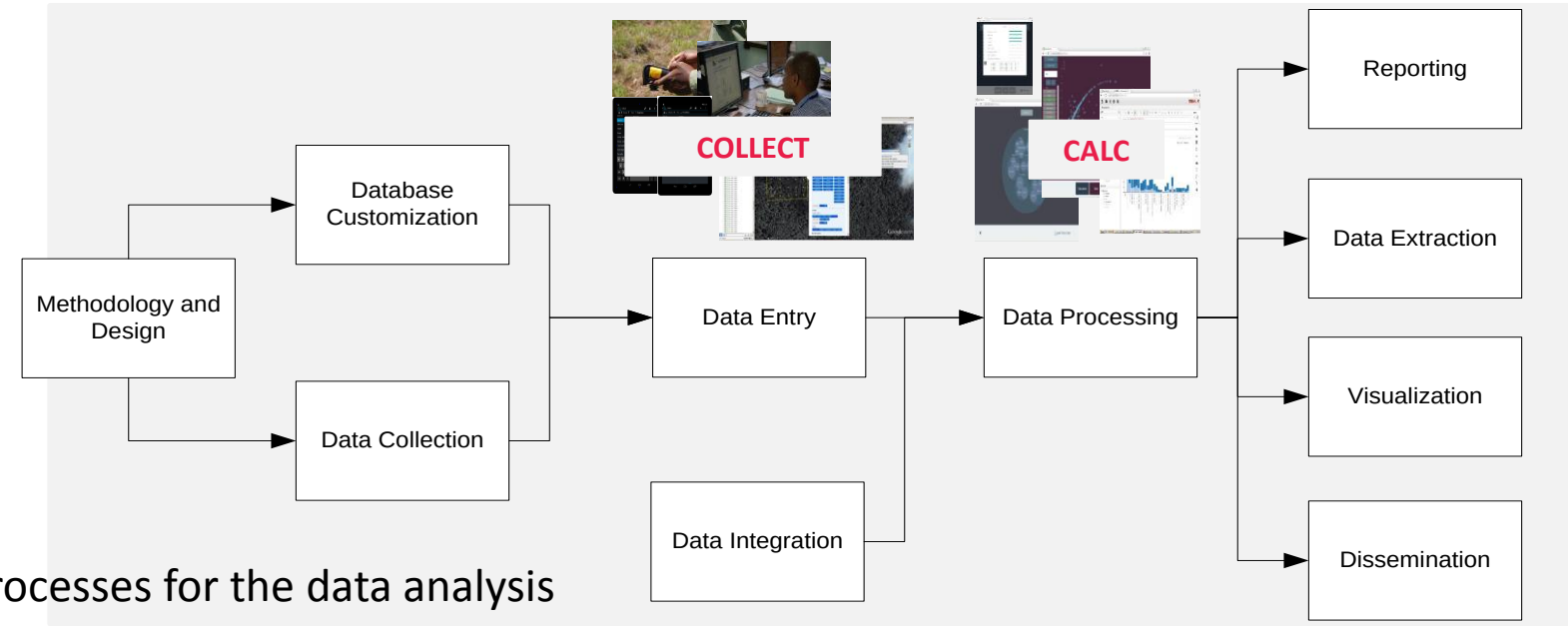
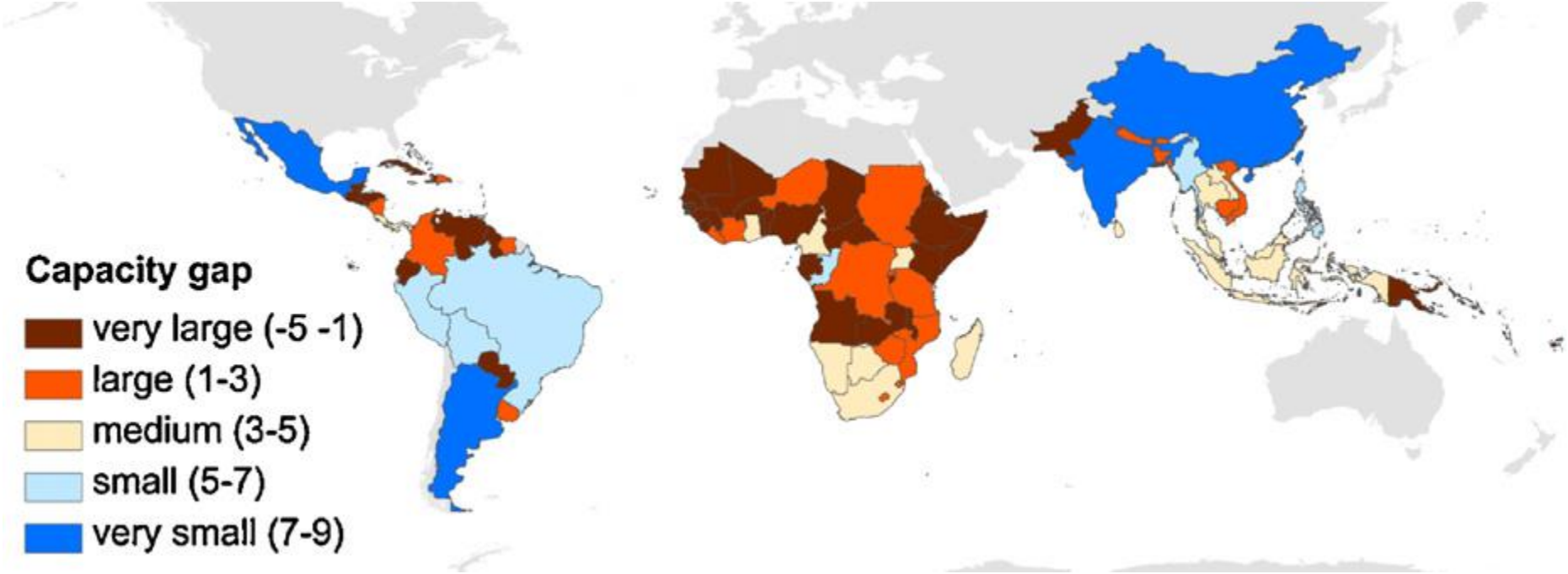


Fig.8: Key processes for the data analysis

Where are the Capacity gaps for REDD+?



- Very large capacity gaps in forty nine countries (brown), mostly in Africa
- while only four countries had very small capacity gap (blue).

Source: Romeijn et. al. 2012 Assessing capacities of non-Annex I countries for national forest monitoring in the context of REDD+ . Environmental Science and Policy 19–20 (2012) 33–48.

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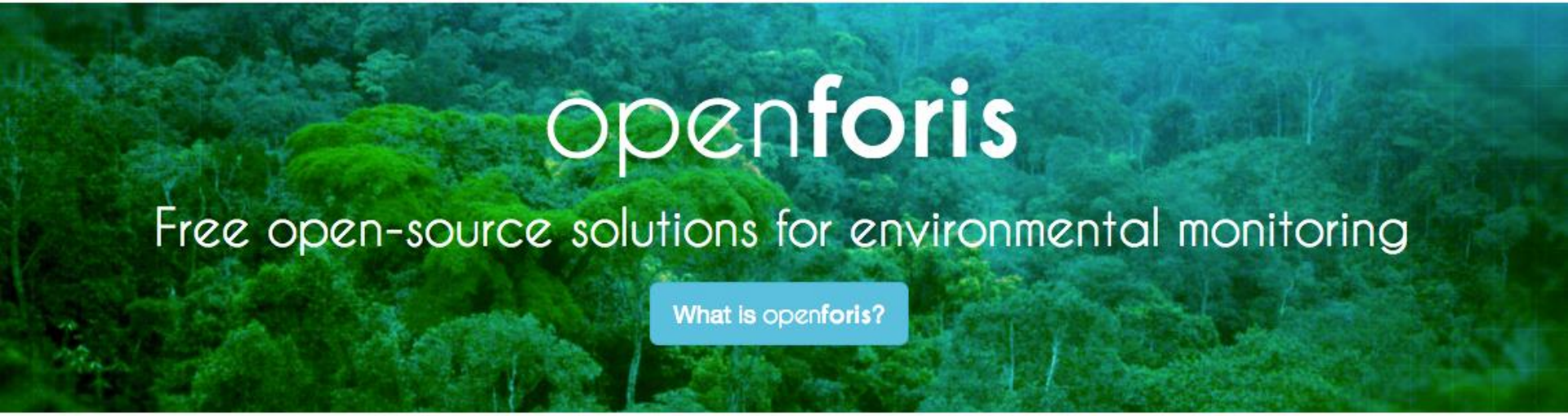
Image Processing



Collect

Collect Mobile

Collect Earth

Calc

Geospatial Toolkit

Open Foris
Satellite data processing

Open source image processing

Linux / Mac / Cygwin compatible

Command line

Pixel or object-based image analysis

Updated regularly

Wiki and example exercises

OPENFORIS

www.openforis.org

http://www.fao.org/forestry/fma/openforis/en/

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Problem – Actual Situation

- Data is free but still disaggregated and can be non-intuitive to search, query and download
- Software is free but complicated to maintain
- Computers are cheaper but infrastructure required for high performance processing is challenging for developing nations
- Internet is ubiquitous but many ministry departments have challenges to access

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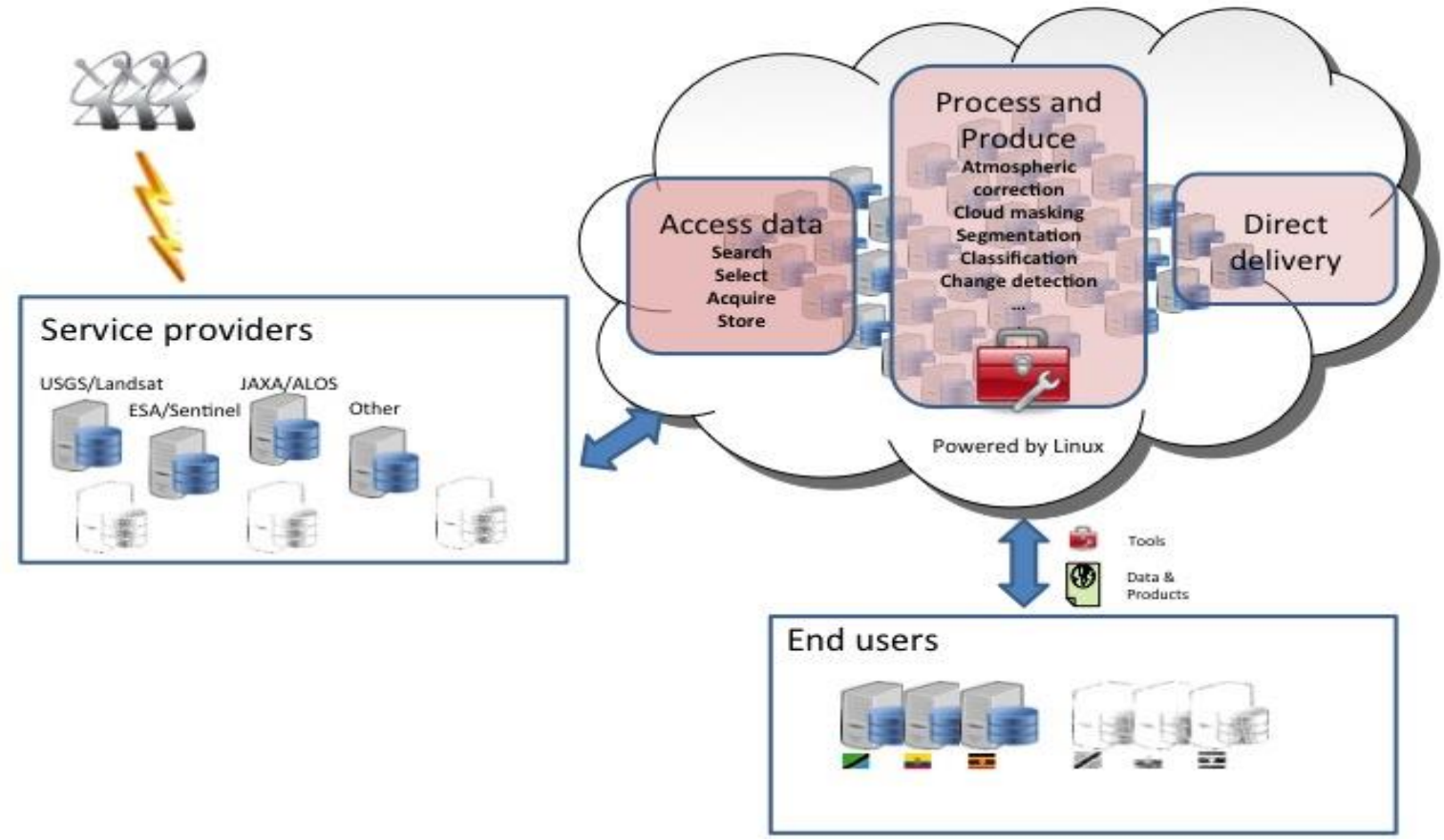
SEPAL Cloud computing structure

FAO Space Data and Product management System

(SEPAL)



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Main Points

- SEPAL is a MRV catalyst
- Allows easy and fast query, access and processing of earth observation data
- Expandable with user inputs
- Efficient processing anywhere in the world

UN-REDD PROGRAMME SEPAL Image Search and Access

Dashboard/Search Results

Reset Search

Enter Area of Interest (Lat/Long or Path/Row entry required)

Path/Row

Lat/Long

Enter additional criteria

Choose a dataset

Landsat 4-8 Combined

Enter Date Range (required)

Starting

1980-01-01

Ending

2015-01-14

Search these months only (ex. 03/12/2008-05/15/2009 will return records for March, April and May of 2008 and 2009)

Enter Cloud Cover

Sort by : -select-

Select All

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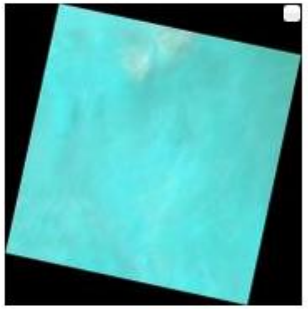
Sensor: LANDSAT_ETM_SLC_OFF
Date: 2014-11-09
Path: 177
Row: 61
Cloud Cover : 6.39



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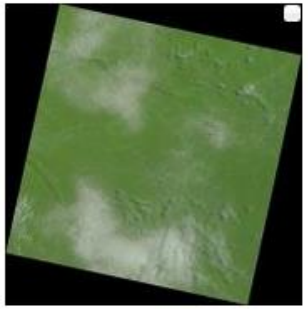
Cloud Cover : 9.91



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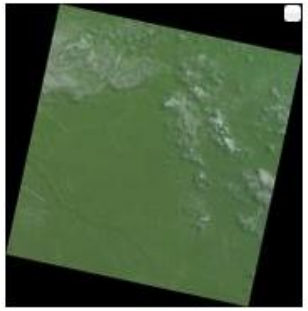
Cloud Cover : 28.35



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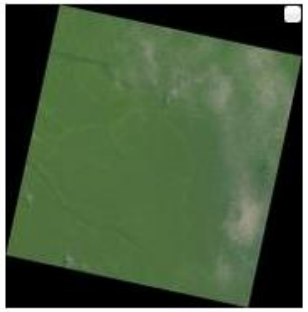

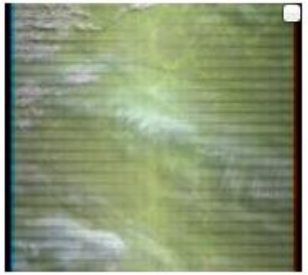

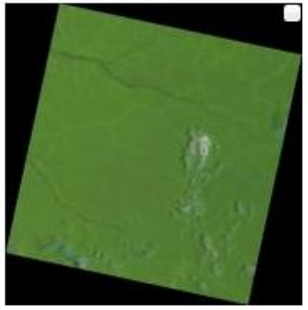

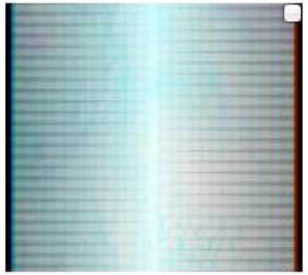

RS data used in countries

- RS data (mainly satellite data) used in

-**training**: both in-country, HQ and INPE (so free access needed)
-**AD**: forest area detection (changes)
-**NFI** design (multisource inventory design and stratification)
-**Other**: R(E)L, Location of households for surveys (HR), Use of HR for field plot location, Mapping of co-benefits, Biodiversity mapping

- Main RS data needs from countries:

-data availability and cost analysis
-data acquisition (actual purchase)
-data (pre)processing
-generation of statistics
-accuracy assessment
-web dissemination

RS trainings, technical consultations and remote support

Capacity building

- One or two weeks training in country
- 10 to 20 technical experts from Ministries
- Experts from FAO **(FRA, FAO-FIN & UN-REDD, BMU)**
- Free available software and open-source tools (TerraAmazon & Open Foris)

Technical consultations

- Remote or in country review and support to national satellite forest monitoring

Results

- Development of methodologies for forest monitoring adapted to national context and documented in the OpenForis wiki or national report
- National estimate of forest cover and forest cover change
- Independent national assessment of map accuracy
- Knowledge exchange and network building
- Autonomous and sustainable capacities to manage, process and analyze satellite data

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RS using MGD document

- Easy-to-understand language and exercices package: no one fits all approach
- Overview methodologies and data requirements for RS using OpenForis and other open source initiatives
- Advantages and disadvantages methodologies
- Use of global products and linkages with other initiatives (WWF, WRI, USAID, Silvacarbon)
- Coordination and collaboration for RS capacity building
- MGD modules developed/under development

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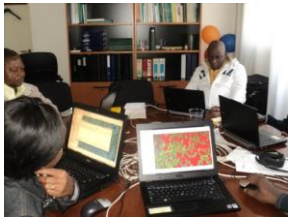
Country experience using MGD

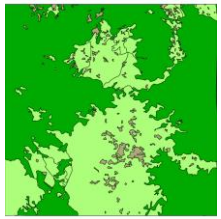
- MGD very useful but not directly usable for all three MRV pillars: MGD interactive portal in development
- In-country assistance to direct needs, mostly in line with MGD (decision and country ownership)
- New hands-on documents and exercises developed by FAO for knowledge transfer
- Country needs are key and driving factor
- Needs: highly dynamic and fastly changing: quick adaptation is needed
- Constant follow-up and help-desk is key
- Concrete collaborations proposal with Silvacarbon as part of GFOI capacity building harmonization

FAO-INPE collaboration

TerraAmazon introduced in developing countries:

- Free-of-charge and supported by analysis and programming teams in Brazil (Funcate) and FAO HQ
- Training on software utilities and Brazilian national forest monitoring techniques at INPE CRA Amazonia, Belem, Brazil
- Close collaboration BMU ICI, UN-REDD and INPE
  - 2015: Plug-ins (LCCS) in TerraAmazon
- Training material for radar training (first training end 2015)
- Follow-up and country implementation in FAO-HQ/country



Use of global data for national use

- **Hansen data** in the REDD+ context :
  1) Is available, so countries can use it when there is no other data available;
  2) The quality of the data at local scales vary from place to place
  3) Countries have the choice to use them as
  - a) their national product without modification,
  - b) their national product with some modification,
  - c) an input to their national product,
  - d) a validation dataset for their national product

- FAO Forestry : **Landsat data** for generating estimates of LCLU change at national scales. The **results** we get from our assistance to National counterparts should be **at least similar in nature to those obtained by Hansen et al**. (GFW also), maybe with a bit more focus on land use instead of solely land cover.

- FAO Forestry : **quantitative assessments of all products** intended for use as activity data inputs. This includes **performing accuracy assessments and area adjustments** to provide estimates on LC/LU and change.

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Accuracy Assessment

All maps have errors (bias)

- we must correct for these

Reference data are required

- of higher quality than data used to make map;
- can be 'better' data, or 'better' interpretation

Accuracy assessment is NOT about assessing accuracy…per se

- accuracy is a relative term…what is acceptable?

Purpose is to generate new area estimates

- which correct for the bias in the map
- which can be used alone to generate estimates
- which can be used with map to generate 'better' estimates
- which generate area estimates with confidence intervals

Strong collaboration with GFOI-Silvacarbon (Boston university), MGD component: proposal for online-training and joint workshops

Good practices for assessing accuracy of land change

Remote Sensing of Environment 148 (2014) 42–57

Contents lists available at ScienceDirect

Remote Sensing of Environment

journal homepage: www.elsevier.com/locate/rse

Review

Good practices for estimating area and assessing accuracy of land change

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ABSTRACT

The remote sensing science and application communities have developed increasingly reliable, consistent, and robust approaches for capturing land dynamics to meet a range of information needs. Statistically robust and transparent approaches for assessing accuracy and estimating area of change are critical to ensure the integrity of land change information. We provide practitioners with a set of "good practice" recommendations for designing and implementing an accuracy assessment of a change map and estimating area based on the reference sample data. The good practice recommendations address the three major components: sampling design, response design and analysis. The primary good practice recommendations for assessing accuracy and estimating area are: (i) implement a probability sampling design that is chosen to achieve the priority objectives of accuracy and area estimation while also satisfying practical constraints such as cost and available sources of reference data; (ii) implement a response design protocol that is based on reference data sources that provide sufficient spatial and temporal representation to accurately label each unit in the sample (i.e., the "reference classification" will be considerably more accurate than the map classification being evaluated); (iii) implement an analysis that is consistent with the sampling design and response design protocols; (iv) summarize the accuracy assessment by reporting the estimated error matrix in terms of proportion of area and estimates of overall accuracy, user's accuracy (or commission error), and producer's accuracy (or omission error); (v) estimate area of classes (e.g., types of change such as wetland loss or types of persistence such as stable forest) based on the reference classification of the sample units; (vi) quantify uncertainty by reporting confidence intervals for accuracy and area parameters; (vii) evaluate variability and potential error in the reference classification; and (viii) document deviations from good practice that may substantially affect the results. An example application is provided to illustrate the recommended process.

Current activities of accuracy assessment

- Case studies
  - Tanzania, Zambia, Democratic Republic of Congo, Republic of Congo, Kenya, Ecuador, Panama
- Practical use cases, 'cookbook' methods

- UN-REDD FAO guidance document 'Accuracy assessment' for countries

- Integrating open source software and methods
  - R scripts, Excel Spreadsheets, QGIS instructions

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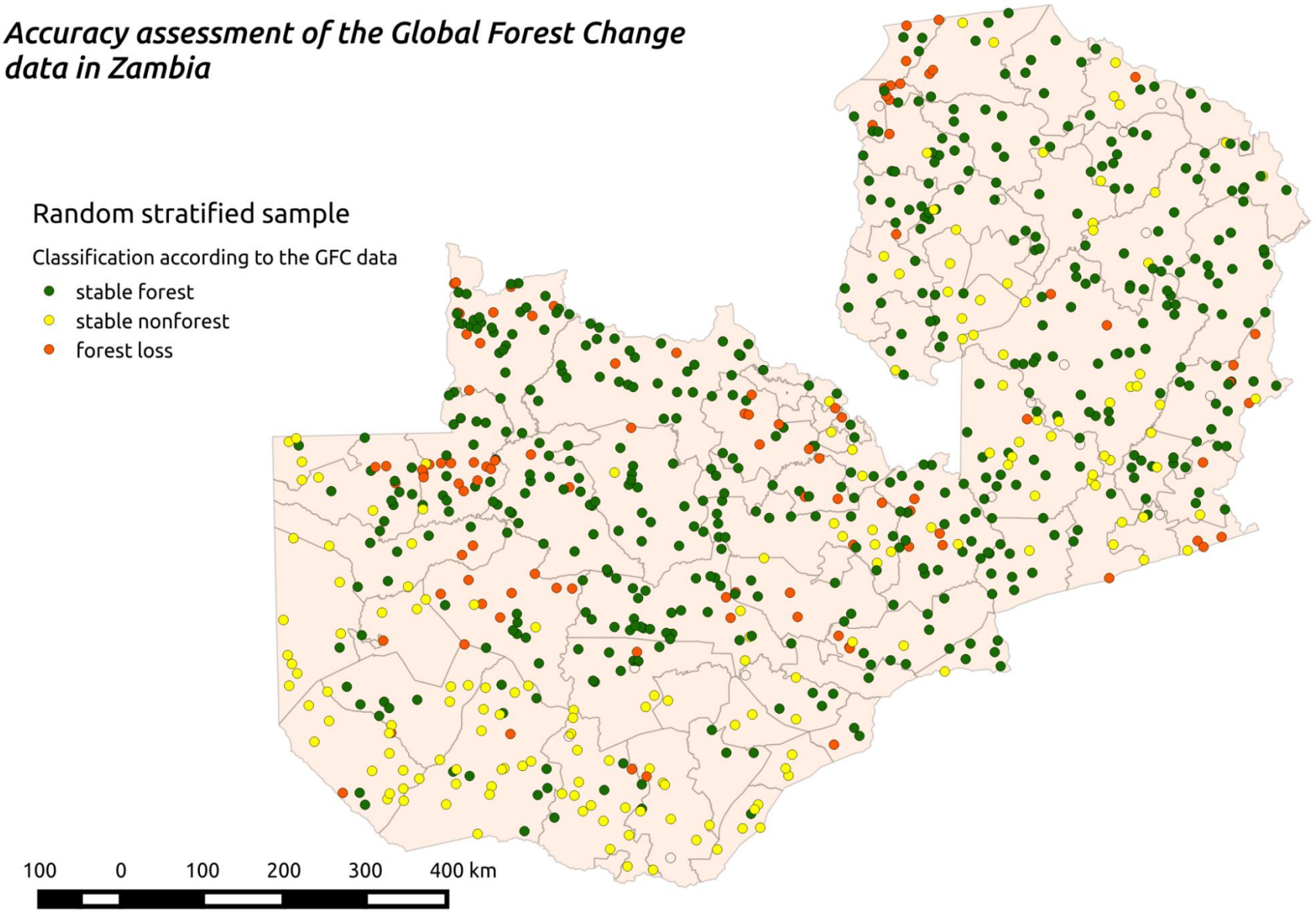
Zambia

Accuracy assessment of the Global Forest Change data in Zambia



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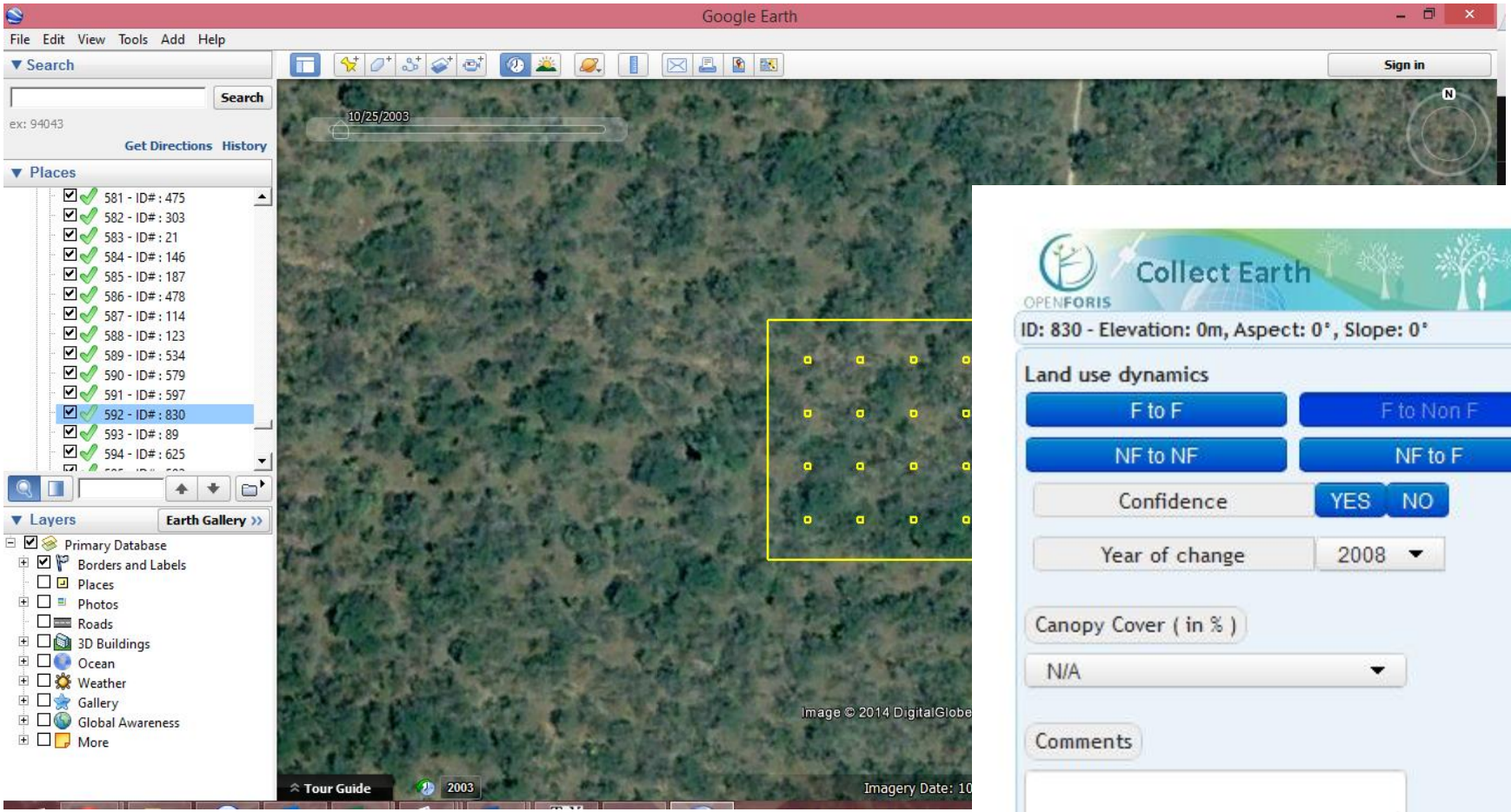
Zambia



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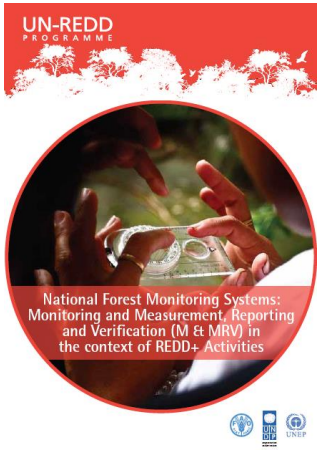
Lessons learned

- **A few dedicated individuals can make all the difference**
  - Use of international advisors hand-in-hand with national technicians
- **Need to see capacity building in broader terms**
  - Training of resilient national institutions and consultants
  - Mandate of institutions should be clear
- **Integration NFI and RS**
- **On-the-job training is key, in-country training**
  - Trainings are geared towards producing results
  - Essential to get faster delivery
- **Sharing data and data access is crucial and key**
- **Near-real time monitoring for early deforestation/degradation warning (e.g. Global Forest Watch), not for reporting of AD purposes**
- **Resilience is often at risk**
  - Easy to develop quickly elements of NFMS, but resilience will be lacking
  - Long-term commitment is required by government and partners in order to secure sustainability

Useful supporting materials

UN-REDD: National Forest Monitoring Systems (NFMS):

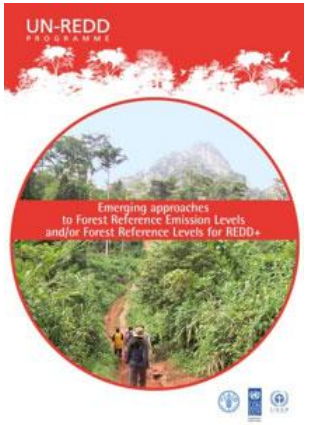
- Monitoring and Measurement, Reporting and Verification (M & MRV) in the context of REDD+ Activities



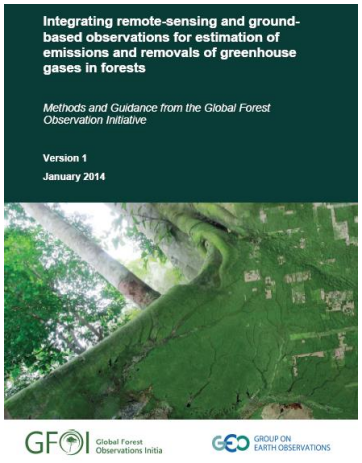
UN-REDD: Emerging Approaches to Forest Reference Emission Levels and/or Forest Reference Levels for REDD+ (2013)

Forest reference levels (2015)

- presents examples of REDD+ Forest Reference Emission Levels and/or Forest Reference Levels being developed by countries



GEO – GFOI: Integrating remote-sensing and ground-based observations for estimation of emissions and removals of greenhouse gases in forests. *Methods and Guidance from the Global Forest Observation Initiative*



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Thank You for your attention!

www.fao.org/forestry

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