GOFC-GOLD
Global Observation of Forest Cover and Land Dynamics
Land Cover Project Office

esa

Land Use/Cover Data, Methods and Products Update by GOFC-GOLD Land Cover Project Office

Brice Mora

International LCLUC Regional Science Meeting in Southeast Asia

Yangon, January 12-18, 2016

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GOFC-GOLD LC-IT activities

Outline

- Integrating regional biomass maps using national reference datasets
- Interactive Community-based Tropical Forest Monitoring Using Emerging Technologies
- Satellite data time-series analysis for forest cover change detection
- REDD+ training materials
- Sourcebook for Biodiversity Monitoring in Tropical Forests with Remote Sensing Data and Methods
- Integrating Earth observation and genomics technologies for the monitoring of biodiversity changes in degrading tropical forests

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GOFC-GOLD LC-IT activities

- Integrating regional biomass maps using national reference datasets

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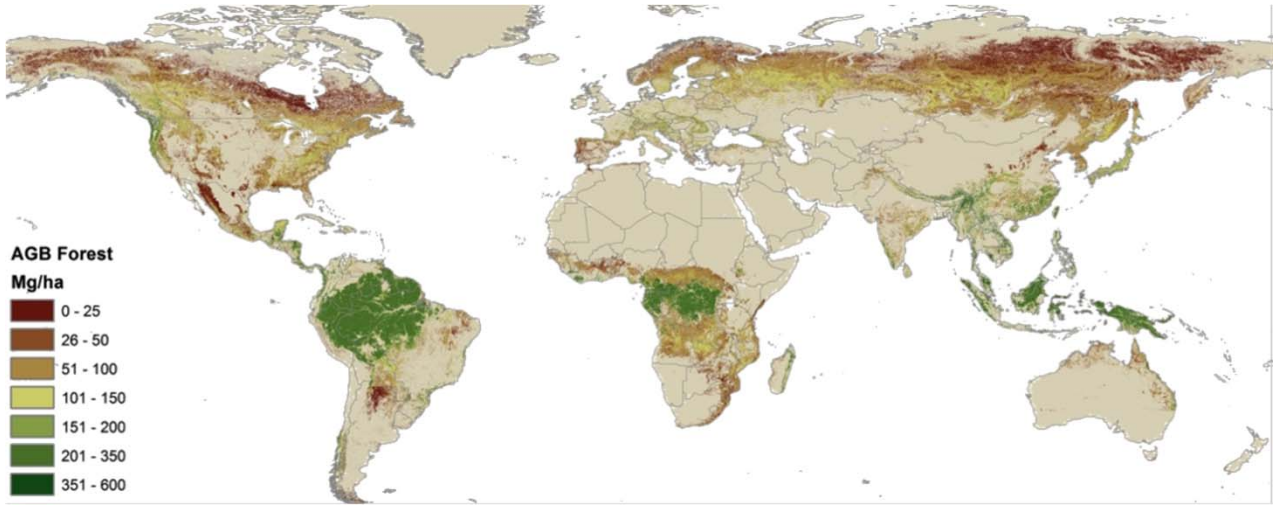
Integrating regional biomass maps using national reference datasets

Dr. Valerio Avitabile et al., Wageningen University (NL)



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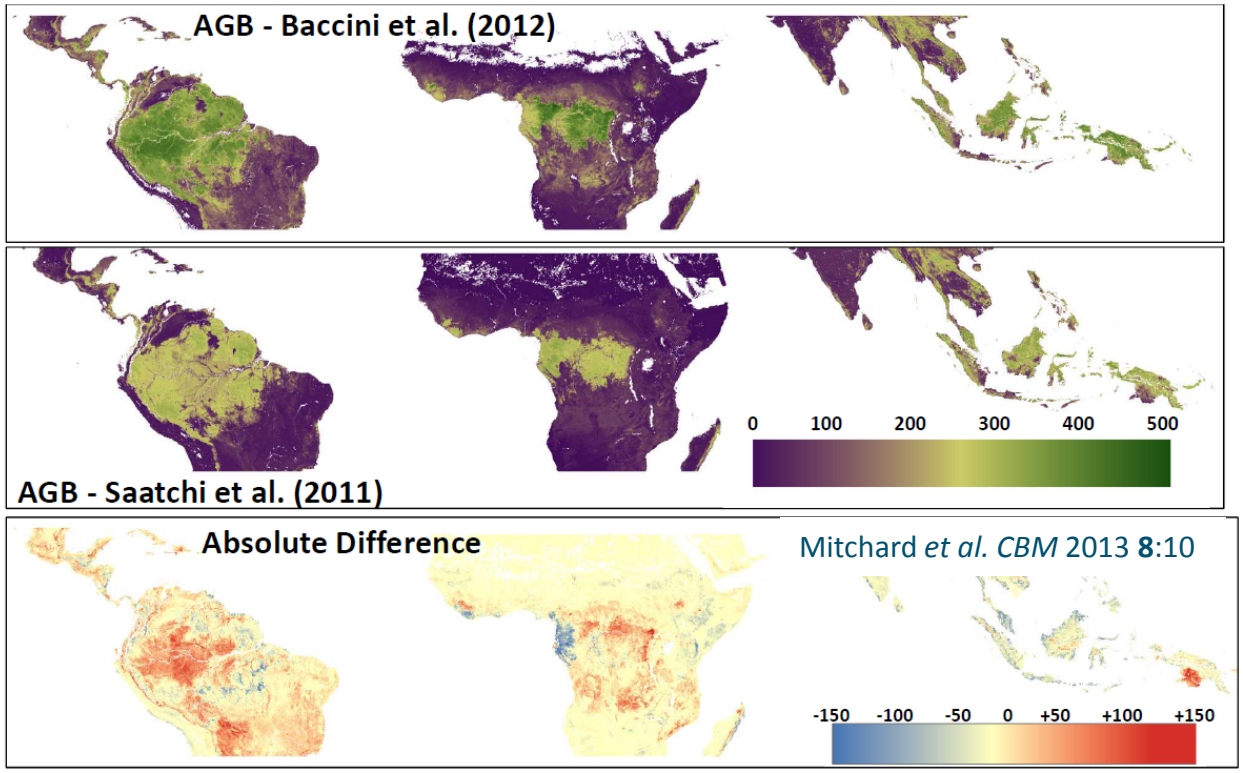
Status of forest biomass mapping

- Tier 1: IPCC Default AGB values: high uncertainty = low carbon credits
- Tier 1-2: Pantropical biomass maps: Saatchi (2011) & Baccini (2012)

  Pros: Include forest height and use consistent methodology

  Cons: Use continental allometric equations → may introduce bias locally?



Mitchard *et al. CBM* 2013 **8**:10

IPCC Tier 1 AGB values

TABLE 4.7
ABOVE-GROUND BIOMASS IN FORESTS

Domain	Ecological zone	Continent	Above-ground biomass (tonnes d.m. ha^{-1})
Tropical	Tropical rain forest	Africa	310 (130-510)
		North and South America	300 (120-400)
		Asia (continental)	280 (120-680)
		Asia (insular)	350 (280-520)
	Tropical moist deciduous forest	Africa	260 (160-430)
		North and South America	220 (210-280)
		Asia (continental)	180 (10-560)
		Asia (insular)	290
	Tropical dry forest	Africa	120 (120-130)
		North and South America	210 (200-410)
		Asia (continental)	130 (100-160)
		Asia (insular)	160
	Tropical shrubland	Africa	70 (20-200)
		North and South America	80 (40-90)
		Asia (continental)	60
		Asia (insular)	70
	Tropical mountain systems	Africa	40-190
		North and South America	60-230
		Asia (continental)	50-220
		Asia (insular)	50-360
Subtropical	Subtropical humid forest	North and South America	220 (210-280)
		Asia (continental)	180 (10-560)
		Asia (insular)	290
	Subtropical dry forest	Africa	140
		North and South America	210 (200-410)
		Asia (continental)	130 (100-160)
		Asia (insular)	160
	Subtropical steppe	Africa	70 (20-200)
		North and South America	80 (40-90)
		Asia (continental)	60
		Asia (insular)	70
	Subtropical mountain systems	Africa	50
		North and South America	60-230
		Asia (continental)	50-220
		Asia (insular)	50-360

Towards Tier 2: a fusion approach

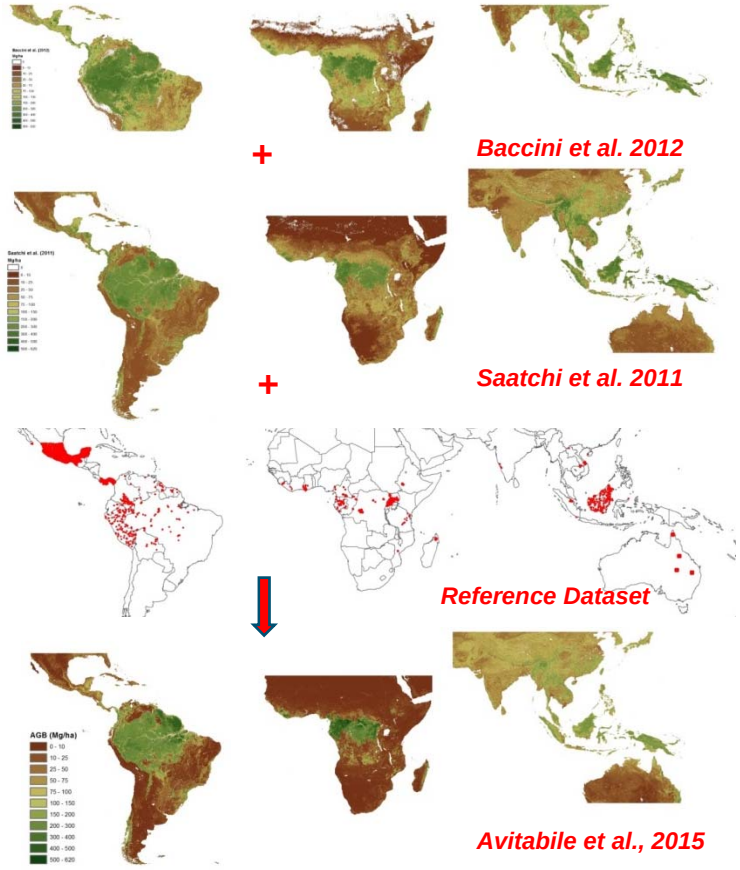
Produce a nationally-calibrated biomass map by:

- Combining regional biomass maps
- Using existing reference data
- Bias removal and Weighted average by strata

$$f(s) = \sum_{i=1}^{p} w_i(s) \cdot (z_i(s) - v_i(s))$$

- Weights computed by the Error Covariance of input maps

$$w(s)^T = \left(\mathbf{1}^T \mathbf{C}(s)^{-1} \mathbf{1}\right)^{-1} \mathbf{1}^T \mathbf{C}(s)^{-1}$$

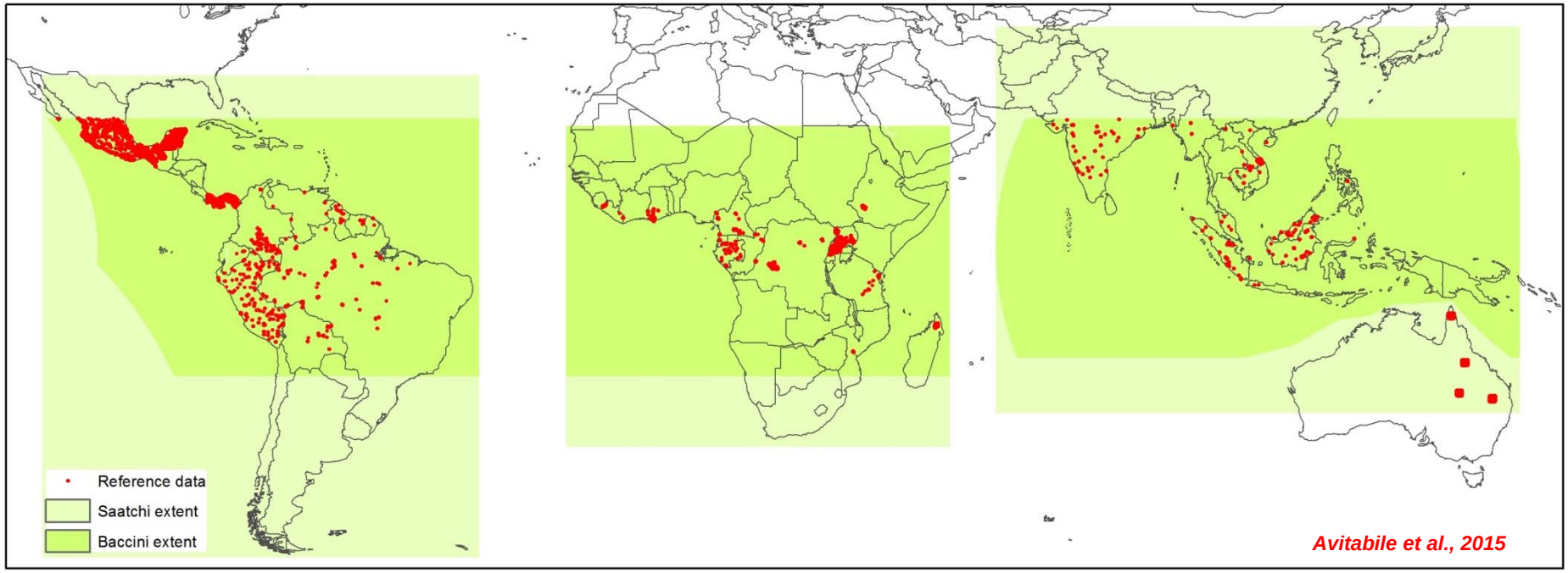


A new reference dataset

Reference data: field plots & high-res. biomass maps

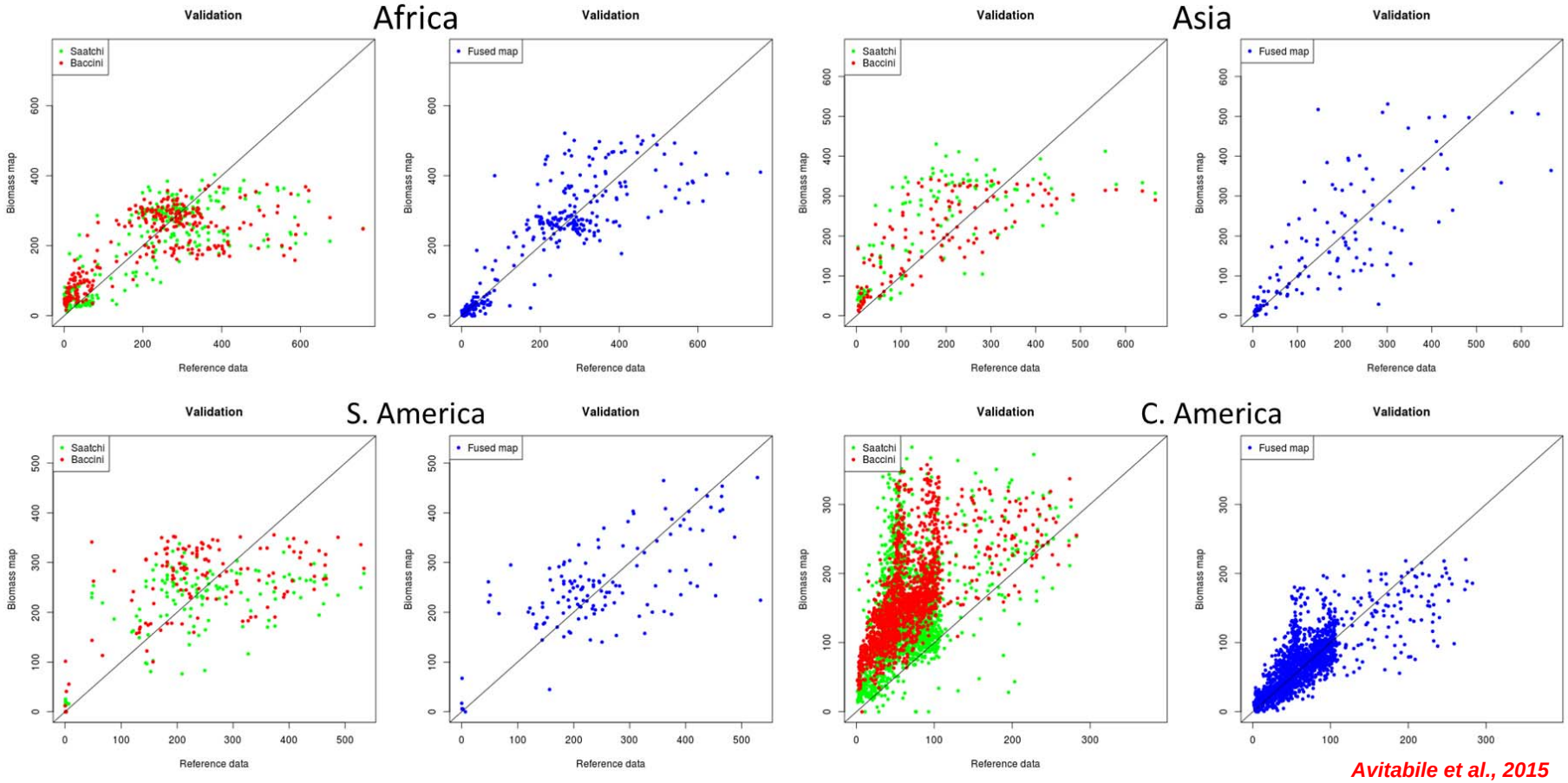
Quality criteria:

1. Reliability: metadata complete, good accuracy & methodology
2. C pool: Aboveground biomass, DBH > 10 cm
3. Acquisition: after year 2000
4. Min. Resolution/Area: Maps: ≤ 100 m ; Plots: > 0.1 ha



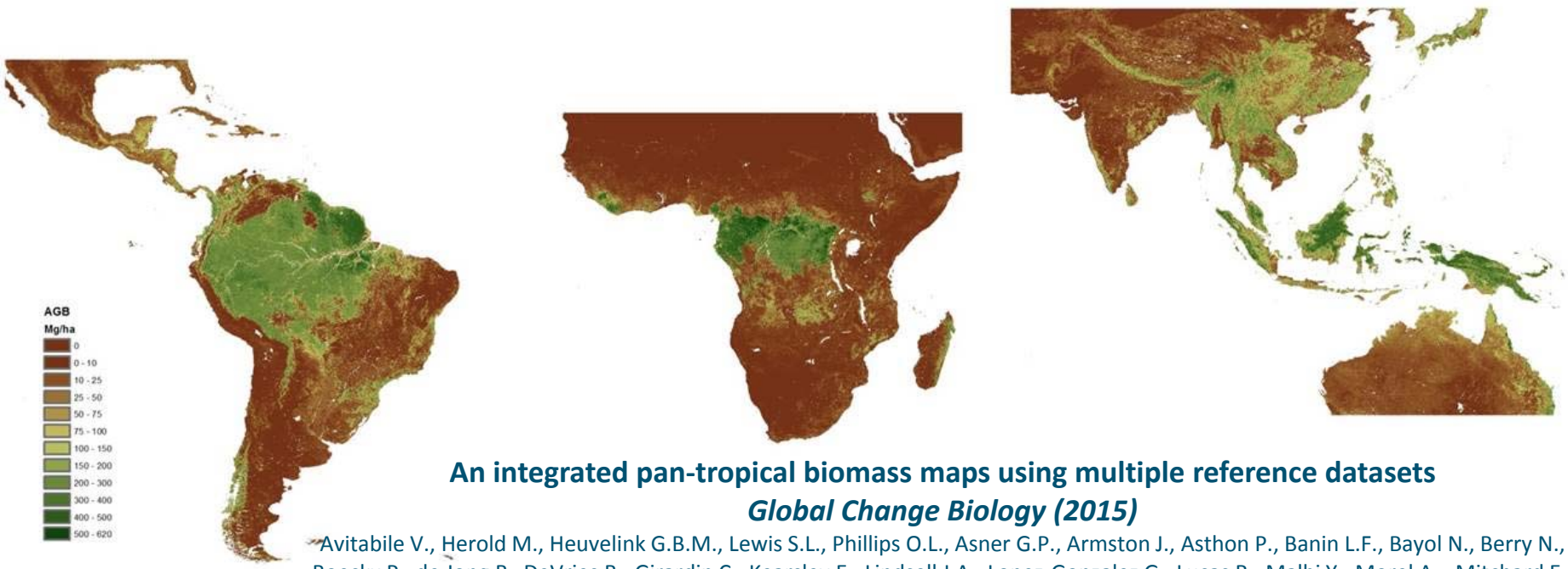
Validation using independent data

- Baccini and Saatchi maps tend to underestimate at high biomass values (saturation) and overestimate at low biomass values at continental level
- Fused map still presents some errors but the regional bias is removed



Avitabile et al., 2015

Result: a new pantropical biomass map



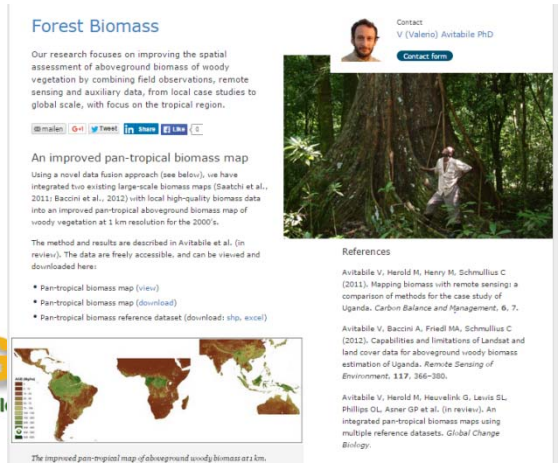
An integrated pan-tropical biomass maps using multiple reference datasets

Global Change Biology (2015)

Avitabile V., Herold M., Heuvelink G.B.M., Lewis S.L., Phillips O.L., Asner G.P., Armston J., Asthon P., Banin L.F., Bayol N., Berry N., Boeckx P., de Jong B., DeVries B., Girardin C., Kearsley E., Lindsell J.A., Lopez-Gonzalez G., Lucas R., Malhi Y., Morel A., Mitchard E., Nagy L., Qie L, Quinones M., Ryan C.M., Slik F., Sunderland, T., Vaglio Laurin G., Valentini R., Verbeeck H., Wijaya A., Willcock S.

The fused biomass map is online!

www.wageningenur.nl/grsbiomass



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Future directions

National scale

- This approach can be easily applied at national level, using national data (as forest inventory) to calibrate regional/global biomass maps

Global scale

- Extending the reference database to the boreal region for validation of upcoming global biomass maps, as
    - ESA GlobBiomass (http://globbiomass.org/)

GOFC-GOLD LC-IT activities

- Interactive Community-based Tropical Forest Monitoring Using Emerging Technologies

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Interactive Community-based Tropical Forest Monitoring Using Emerging Technologies

Arun Kumar Pratihast (PhD), Wageningen University

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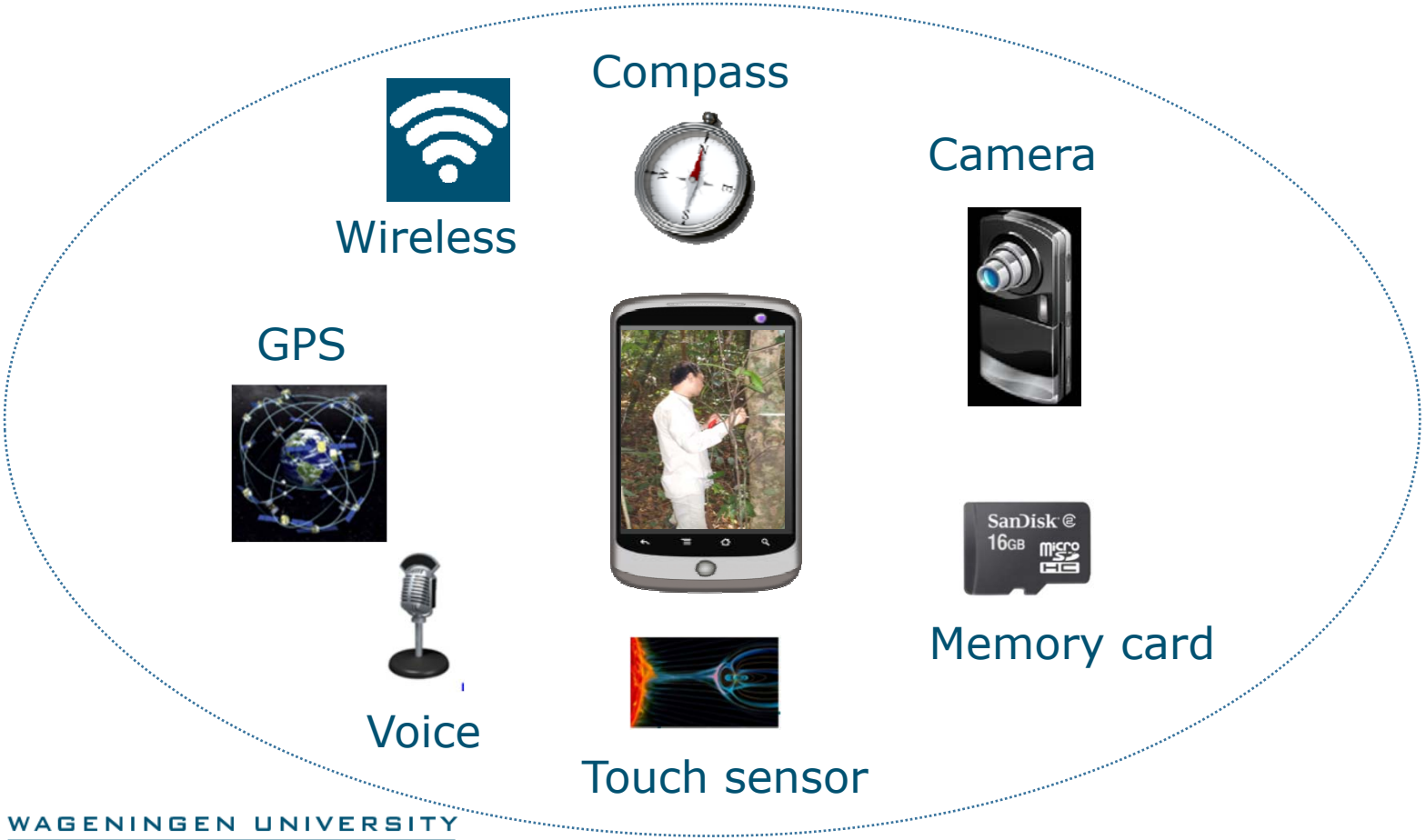
Community-based monitoring

- Communities can provide important data streams:
  - Track changes and human activities
  - Forest inventory-type measurements
  - Revisit time and long-term monitoring
  - As independent data sources
- Some issues:
  - Confidence on data collection procedure
  - Maybe spatially constraint (local!)
  - Requires validation and quality control

Mobile device for forest monitoring

- More than 5 billion mobile users in world
- 2 billion smartphones users



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Source : I.T.U. 2015

Study sites

Vietnam

Tra Bui commune

Ethnic minority

Ethiopia

Kafa

Local rangers

Peru

Puerto Occuppa

Indigenous people

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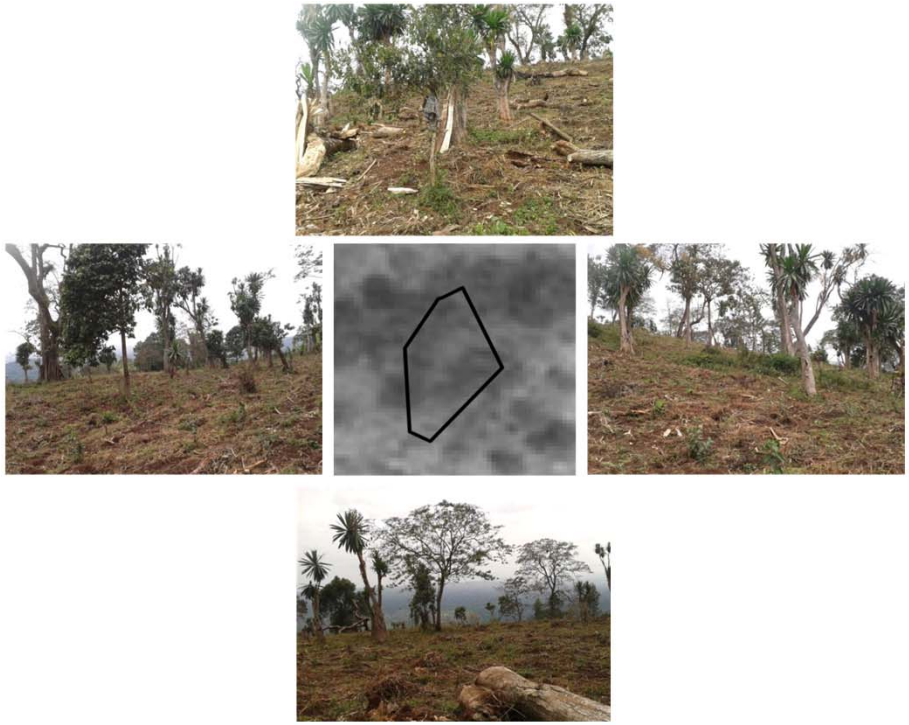
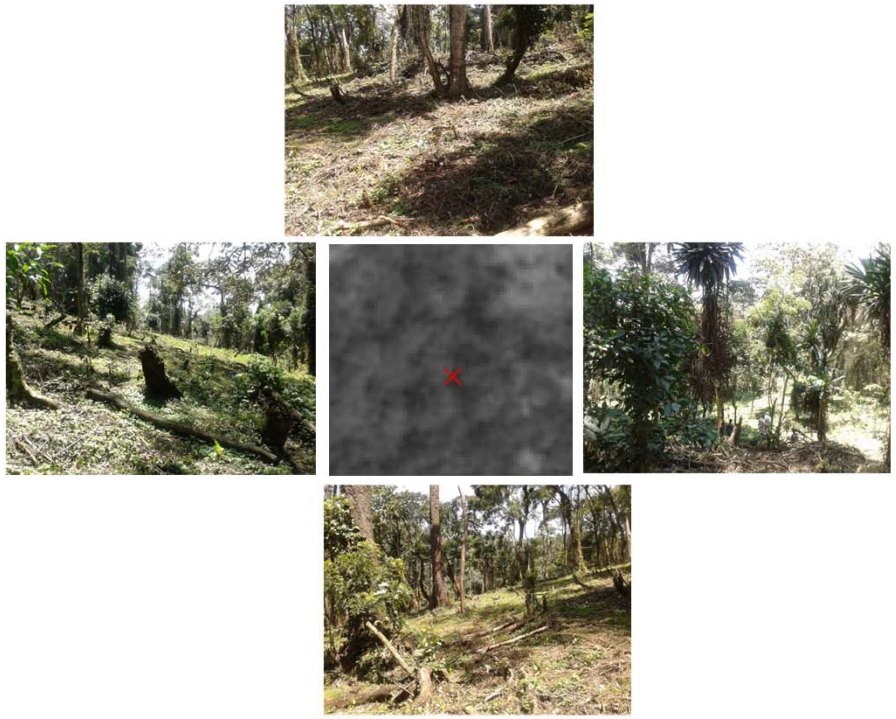
Mapping results of forest change

Deforestation



Degradation



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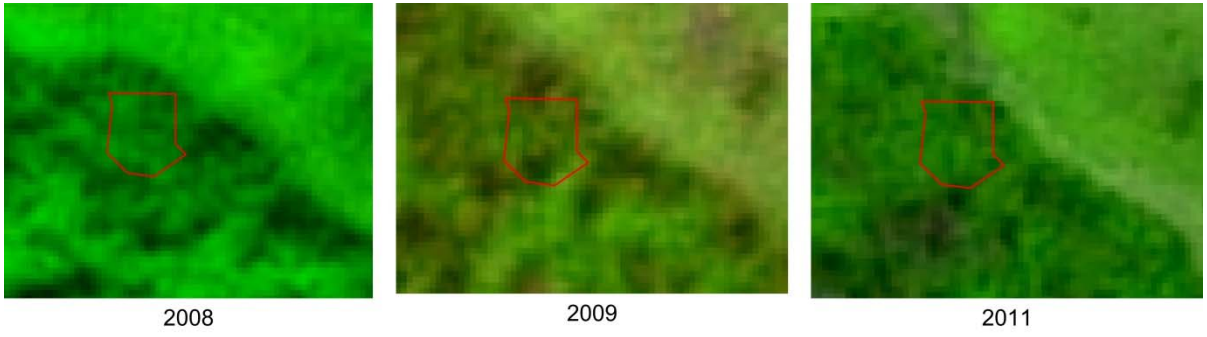
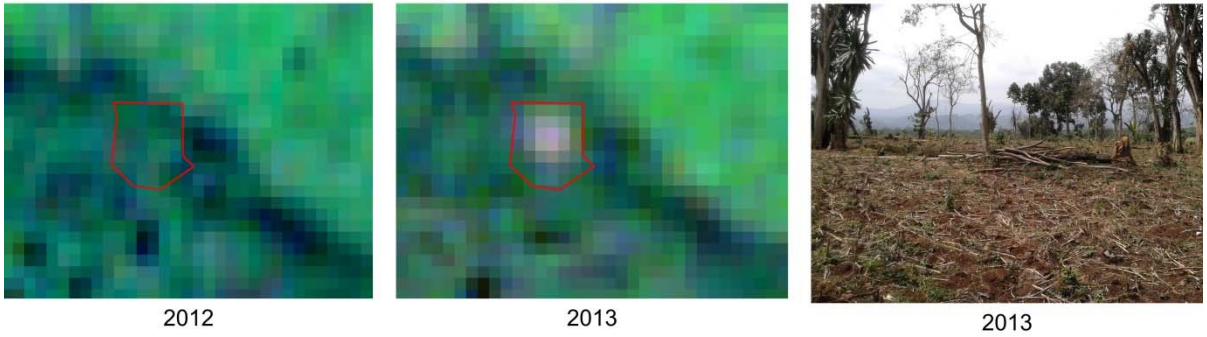
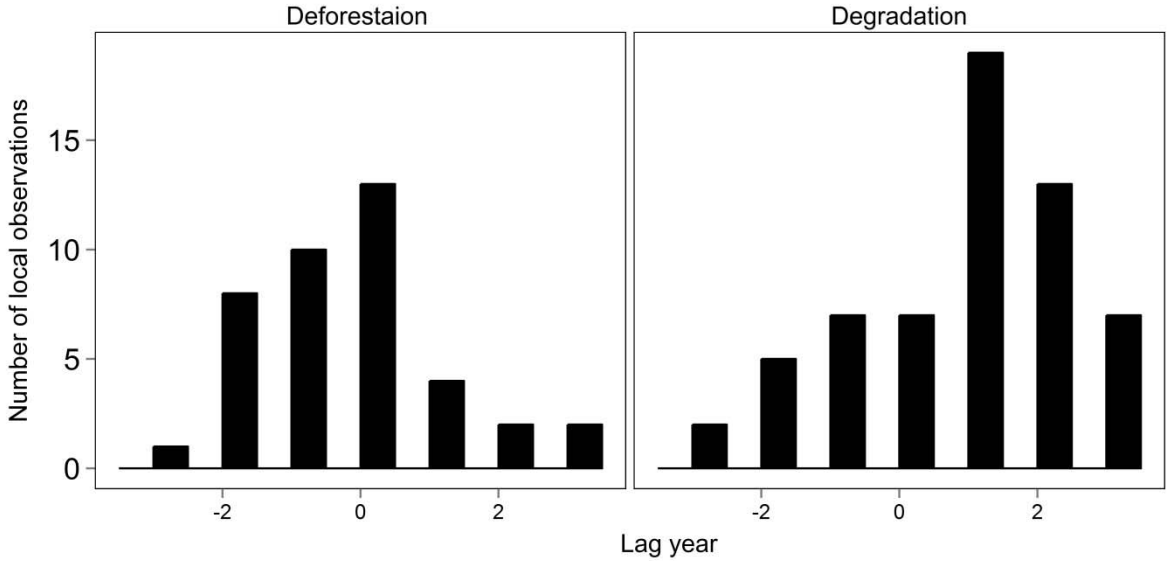




Time of Change:

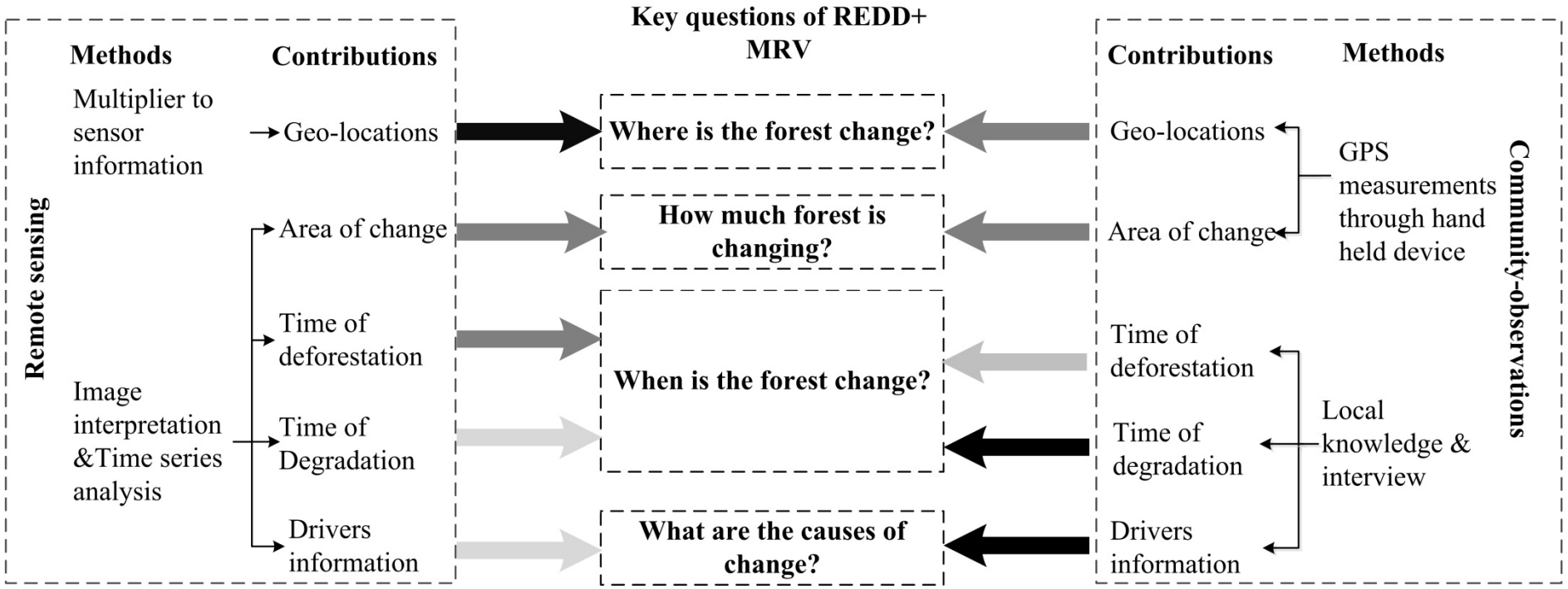
How do local forest change reports compare with remote sensing based estimates?



With remote sensing, we can only 'see' changes at the canopy level (limited ability to detect degradation)

However, local reports are often subject to bias, especially when changes are gradual and complex

Complementarity of Data Streams



The relative strength of contribution of each data stream to the REDD+ MRV objectives is indicated by shade (dark = strong; light = limited)

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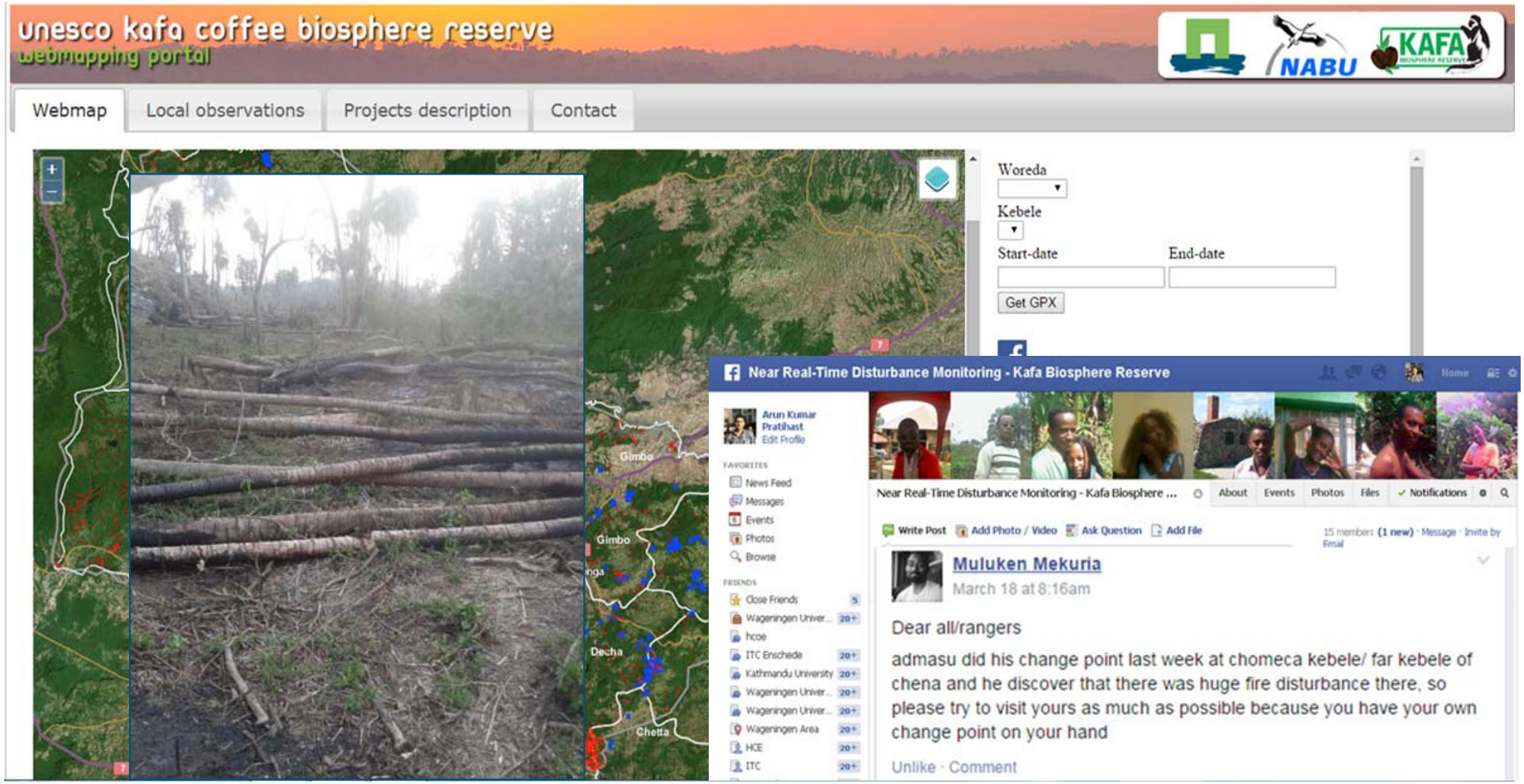
Near-real time forest monitoring results



www.cbm.wur.nl

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Conclusion

- Community-based forest monitoring is necessary for better forest management
- Emerging technologies help to
  - ensures stakeholder participation and interaction in forest monitoring process
  - improve data accuracy
  - effectiveness of monitoring program

References

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- Pratihast, A.K. , Herold, M. , Avitabile, V., de Bruin, S., Bartholomeus, H., Jr., Carlos, Ribbe, L. (2012). Mobile Devices for Community-Based REDD+ Monitoring: A Case Study for Central Vietnam, Sensors 13. p. 21-38.
- Pratihast, A., DeVries, B., Kooistra L., de Bruin, S., Avitabile, V., Herold, M. Combining satellite data and community-based observations for forest monitoring. 2014. Forests 5, p.2464-2489.

GOFC-GOLD LC-IT activities

- Satellite data time-series analysis for forest cover change detection

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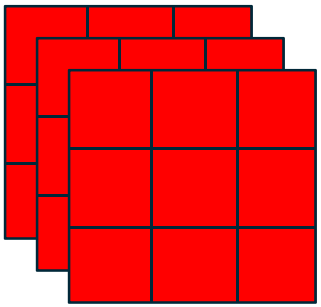
BFAST Spatial

Background

- Developed by Loic Dutrieux, Ben Devries, Jan Verbesselt, at Wageningen U.
- Includes a set of utilities and wrappers to perform change detection on satellite image time-series (Landsat and MODIS).
- Includes pre-processing steps and functions for spatial implementation of BFASTmonitor change detection (pre-processing raw surface reflectance Landsat data, inventorying and preparing data for analysis, production and formatting of results).
- Package available on GitHub repository: https://github.com/dutri001/bfastSpatial



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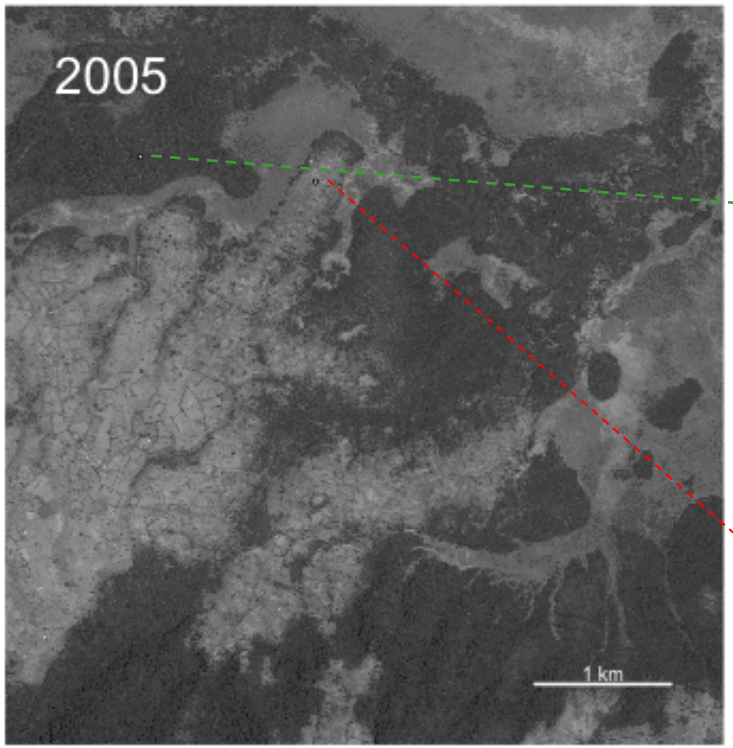
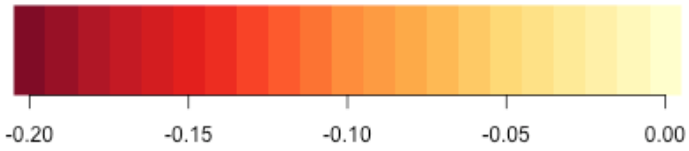
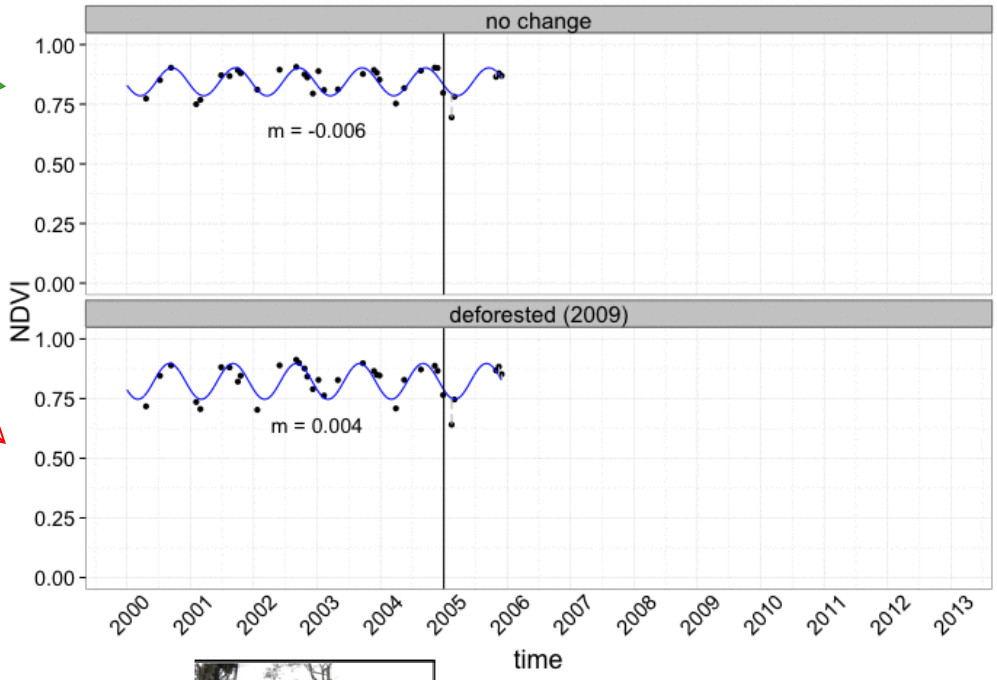
BFAST Spatial: in-Migration (Kafa, Ethiopia)

Image background: SPOT5 (Feb 2011, 2.5m)



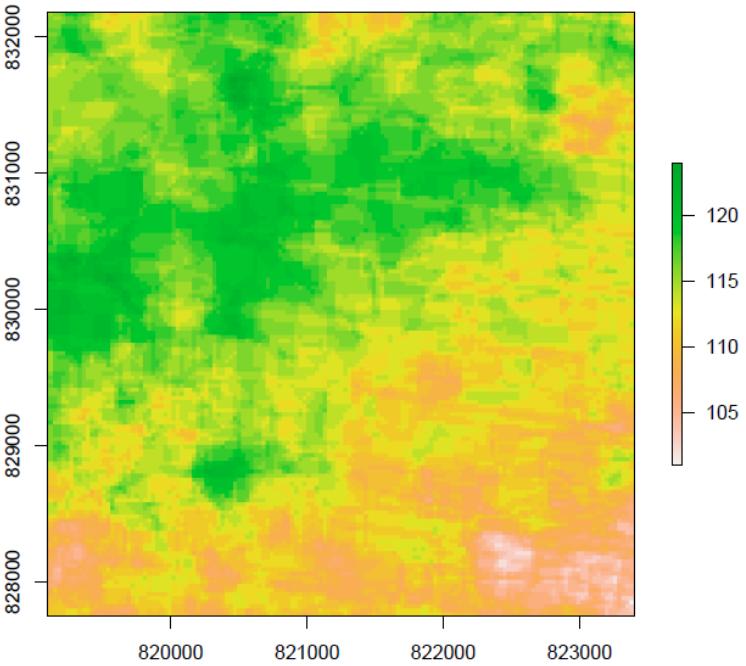




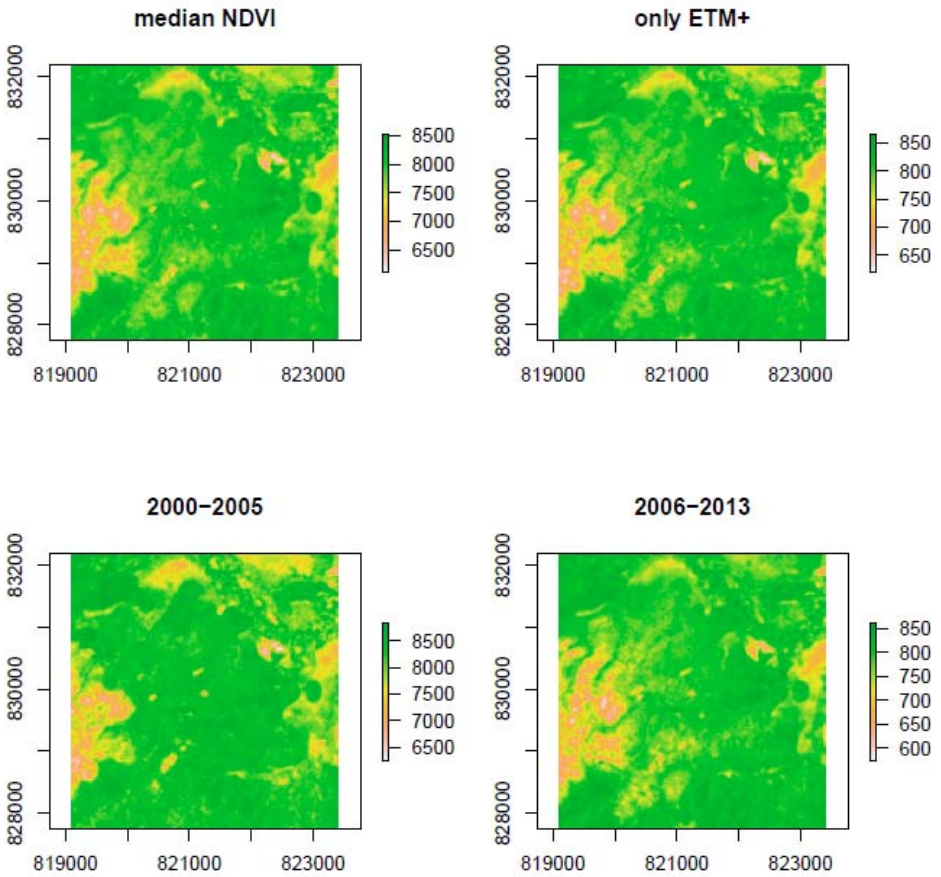
BFAST Spatial

Utilities

- Number of valid observations (cloud cover)



- Summary statistics of the dataset (NDVI, other spectral index)



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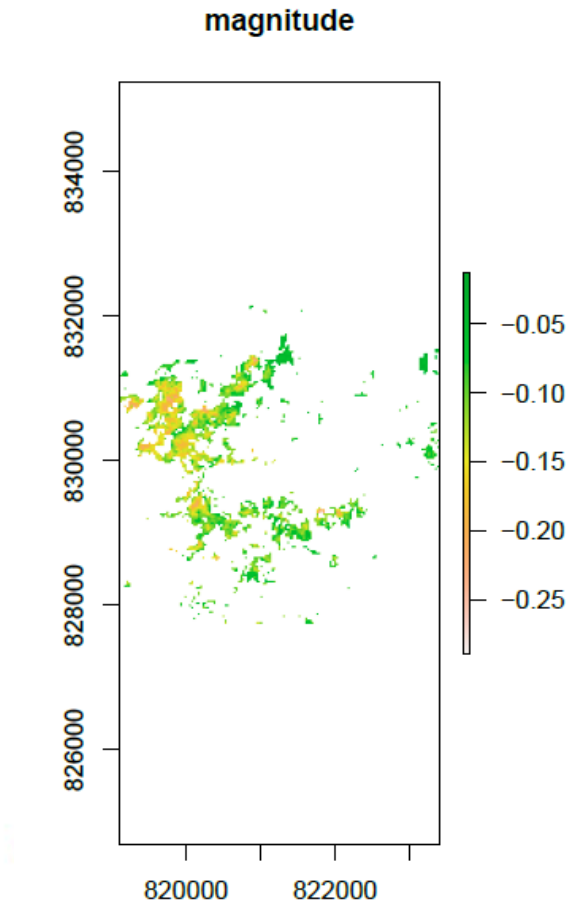
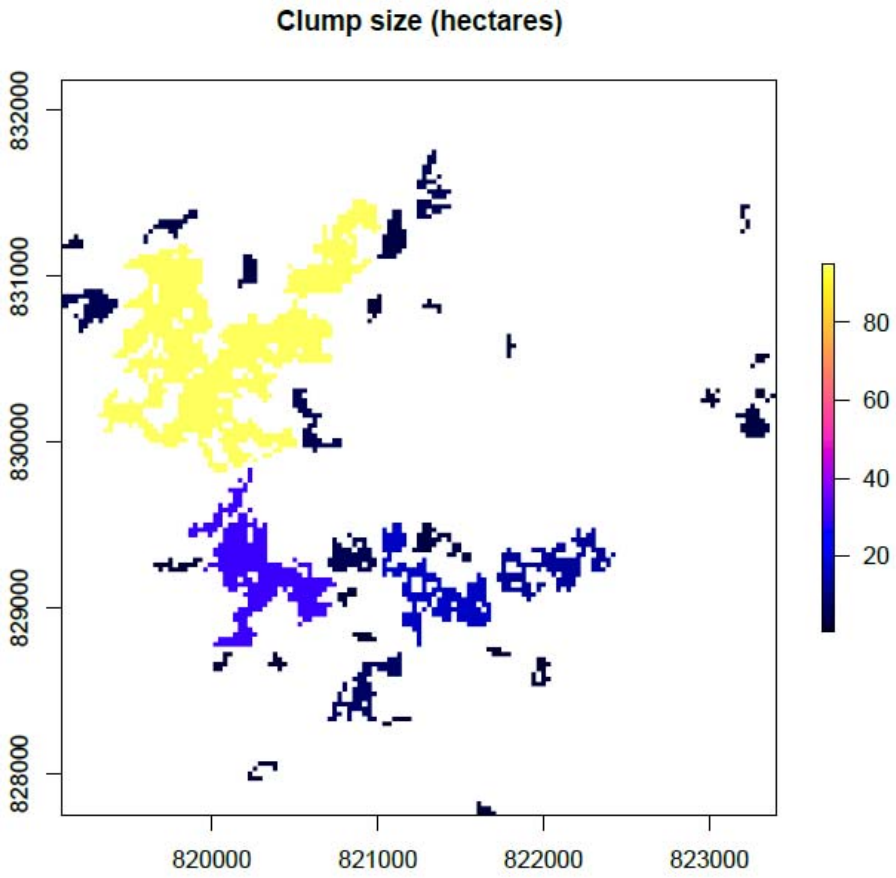
BFAST Spatial

Utilities

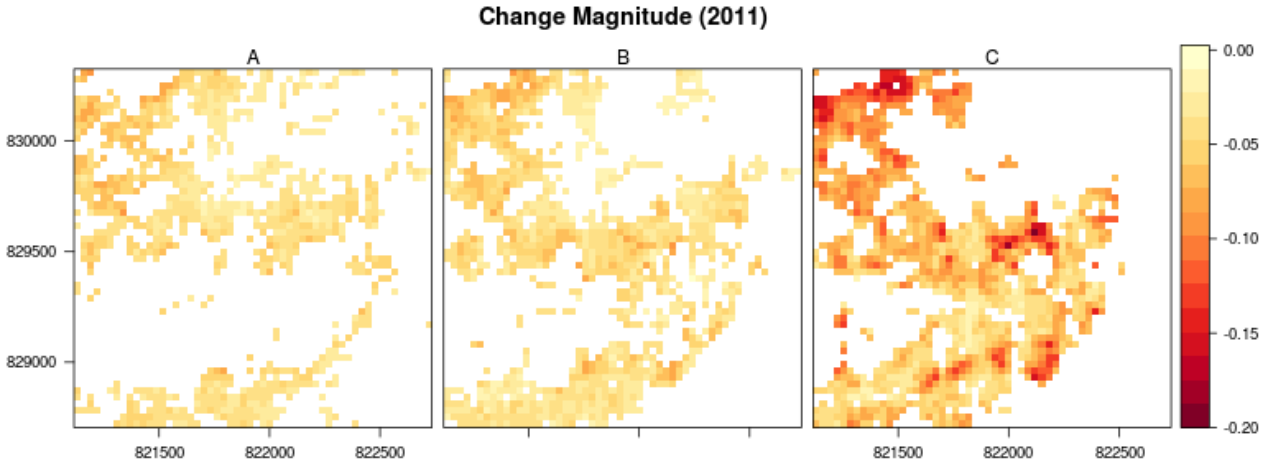
- Magnitude of change



- Area of change



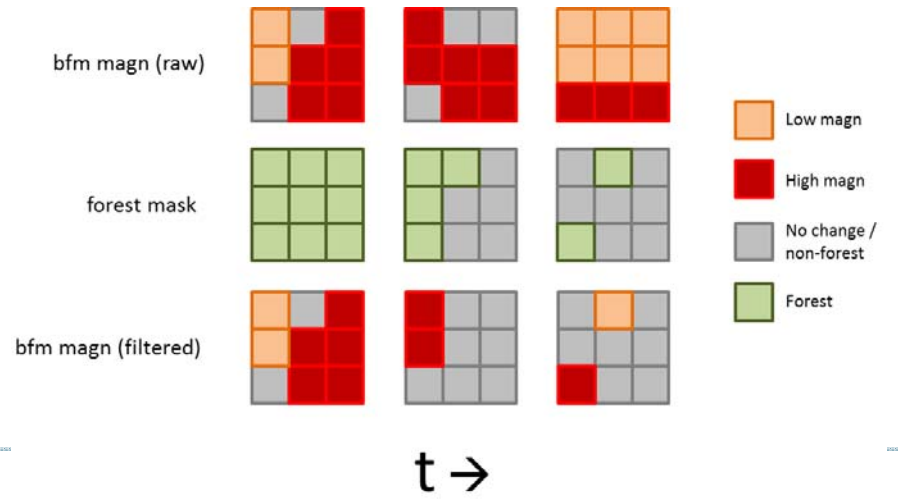
BFAST Spatial: study case (Kafa, Ethiopia)



Above: all breakpoints detected in 2011 using:

(A) a 3-year monitoring period window
(B) a 2-year monitoring period window
(C) a 1-year monitoring period window

An iterative 1-year monitoring window was used to allow for interpretation of breakpoints using a consistently defined magnitude metric



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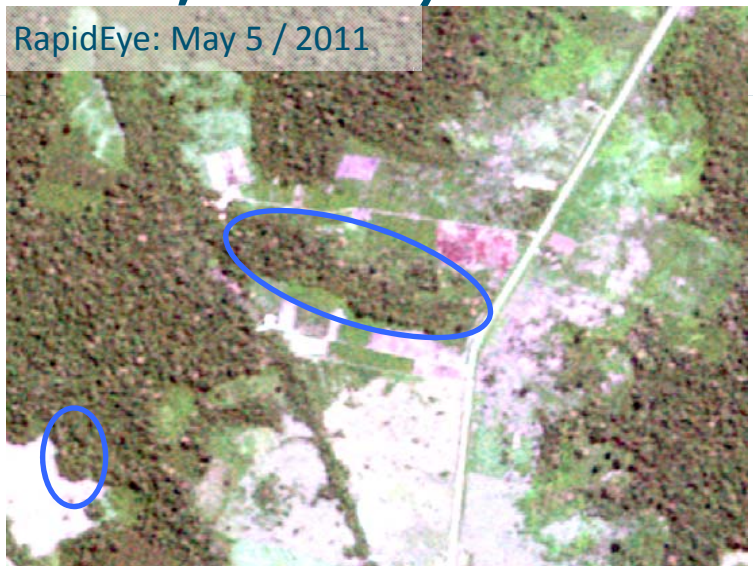
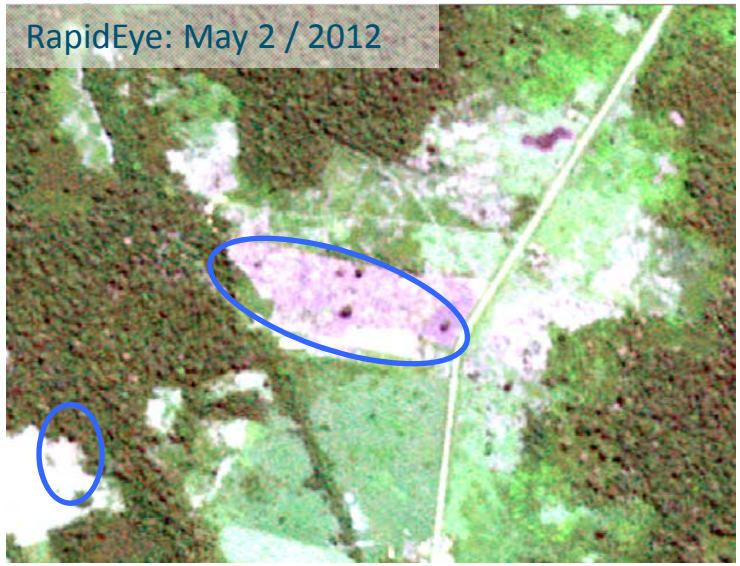
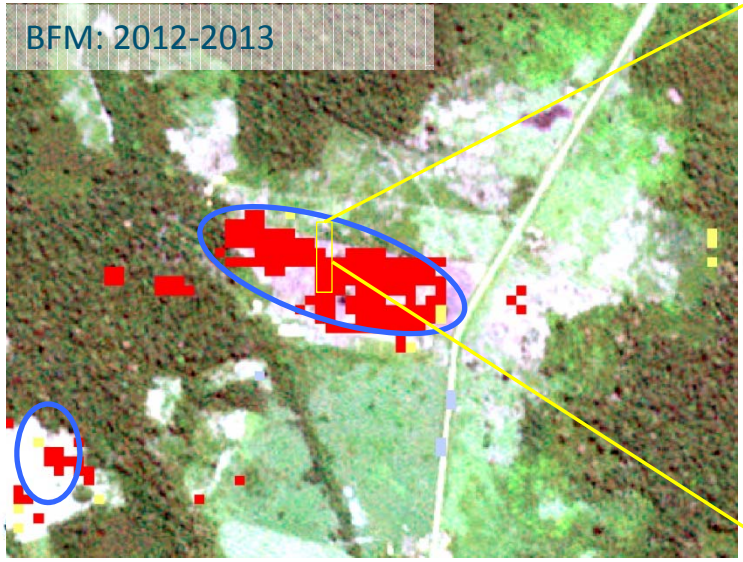
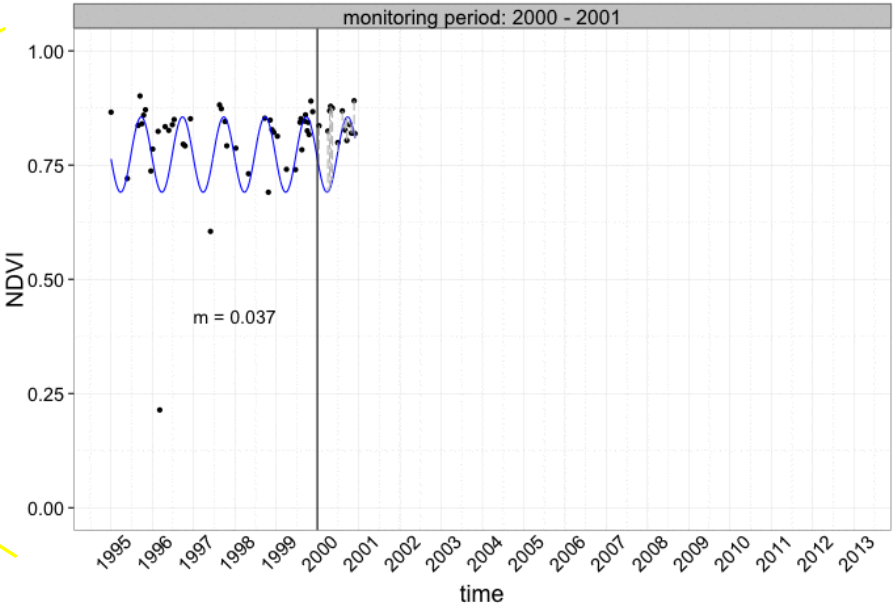
BFAST Spatial: Clear-Cutting (Madre de Dios, Peru)









BFAST (Spatial)

Discussion

- BFAST(Spatial) is a significant step toward operational semi-automated forest cover-change detection methods
- Still at the R&D stage, however first operational implementations started
- Depending on area of interest, proper time-series not easy to obtain (archive size, cloud cover)
- Advent of Sentinel data will be beneficial to time-series change detection algorithms (Sentinel-1: SAR, and -2: optical)
- Computer intensive when applied over large areas

References

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GOFC-GOLD LC-IT activities

- REDD+ training materials

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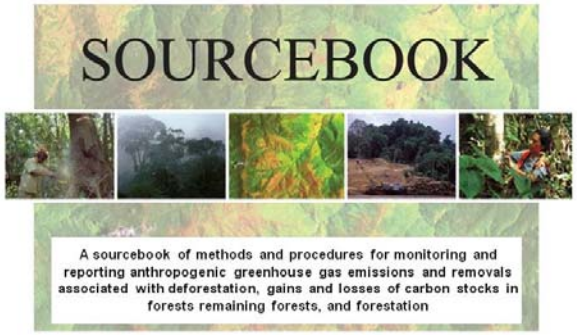
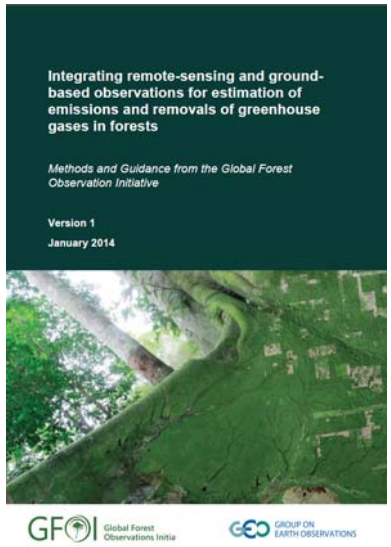
Objectives of training materials





- Respond to the need for technical assistance and guidance for countries to develop capacities and implement REDD+ monitoring and reporting
- Provide a set of modular training materials that can be used in combination with complementary guidance documents (i.e. IPCC GPG, GOFC-GOLD Sourcebook, GFOI MGD, WB FCPF documents, FAO/UN-REDD documents)
- Based on GOFC-GOLD Sourcebook, building upon the GOFC-GOLD expert network, supported by independent review process
- For developing countries and capacity development efforts

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GOFC-GOLD
Global Observation of Forest and Land Cover Dynamics

FOREST CARBON PARTNERSHIP FACILITY

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  - Marco Van der Linden
- GOFC-GOLD LC PO & Wageningen University
  - Martin Herold - Overall project leader
  - Brice Mora - Coordination and cooperation with international experts and institutions
  - Erika Romijn - Coordination of the technical and organizational implementation

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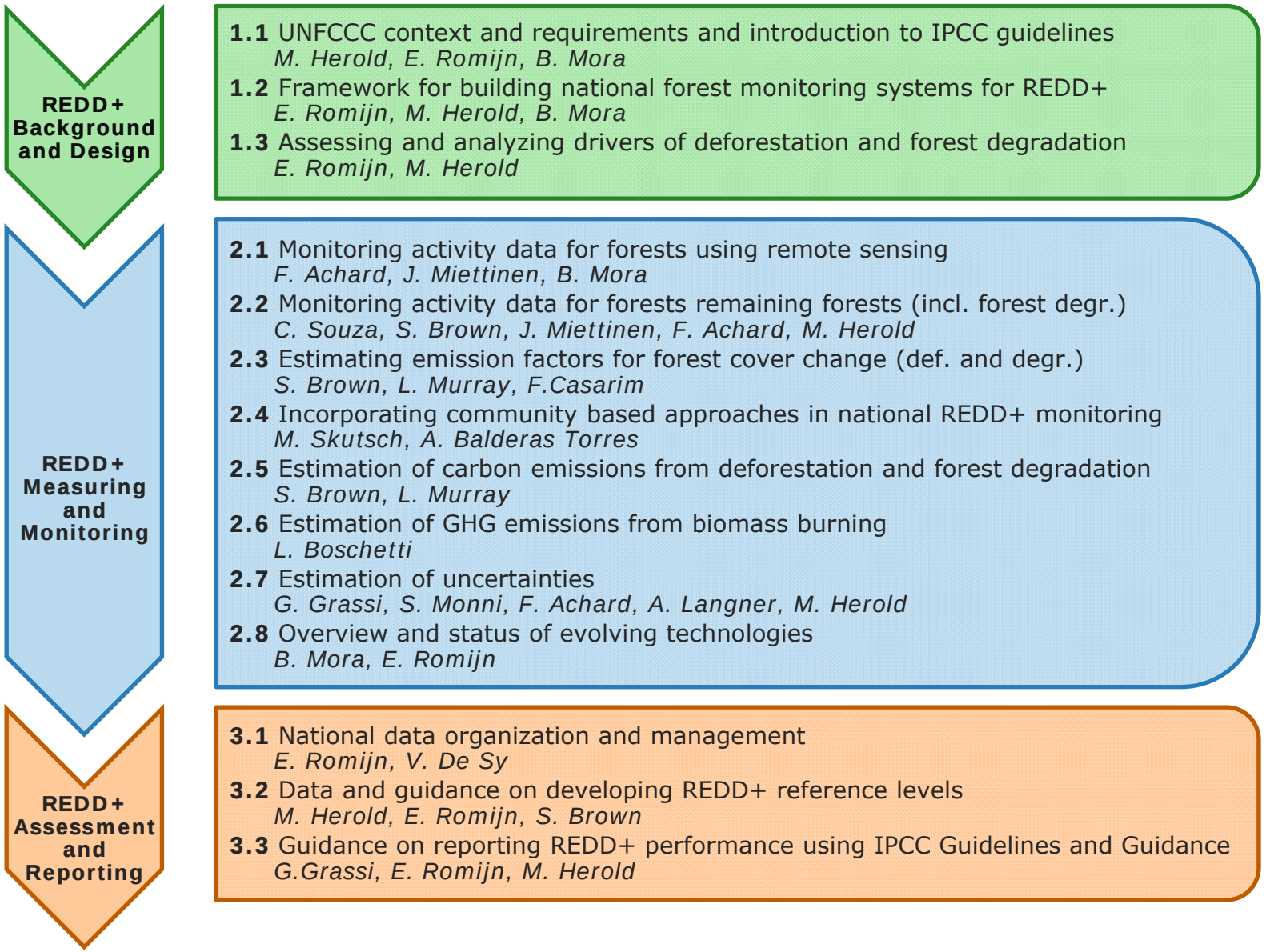
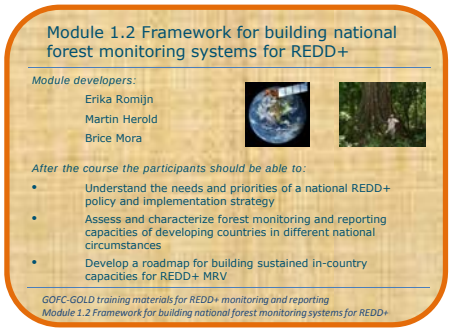
Naikoa Aguilar-Amuchastegui, Valerio Avitabile, Veronique De Sy, Sandro Federici, Carly Green, Inge Jonckheere, Ben de Jong, Gabrielle Kissinger, Pham Manh Cuong, Ron McRoberts, Anthea Mitchel, Jim Penman, Rosa Maria Roman Cuesta, Arief Wijaya, Sylvia Wilson

Overview of Modules REDD+ training materials



Set up of Modules & Target users

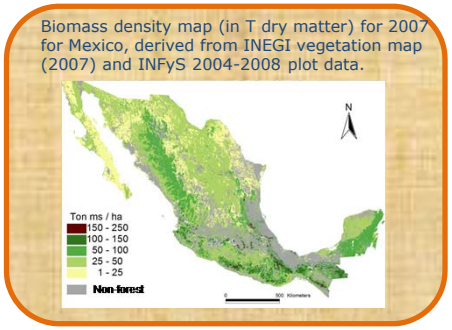
Background lectures



Background lectures
Introducing and presenting the background; relevance of topic & overview of possible methodological options and approaches

Intended for: REDD+ national and international policy makers; Project managers and Technical staff

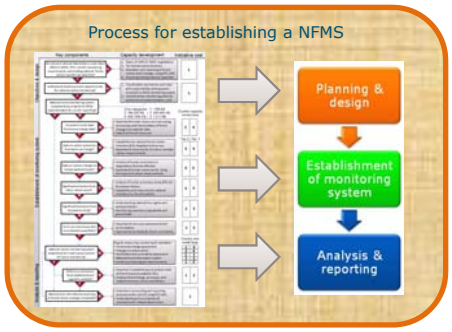
Country examples



Practical examples
Of successful implementation activities in developing countries; experiences presenting different national circumstances

Intended for: MRV project managers & Designers and Technical staff

Practical exercises



Practical exercises and short tutorials
To reinforce the topic and/or to provide simple hands-on exercises for implementation

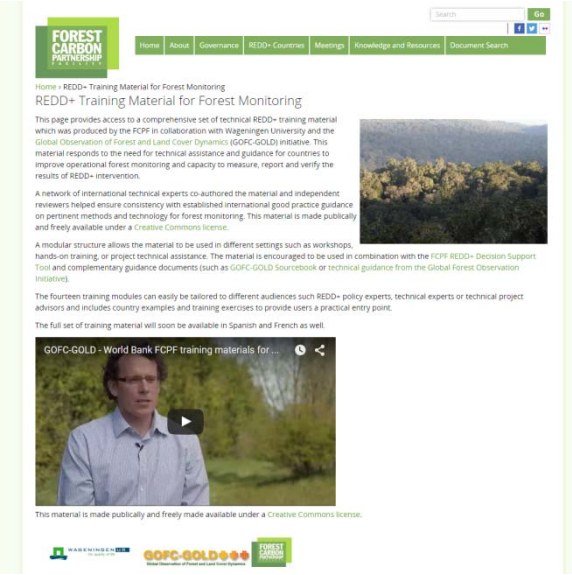
Intended for: Technical staff

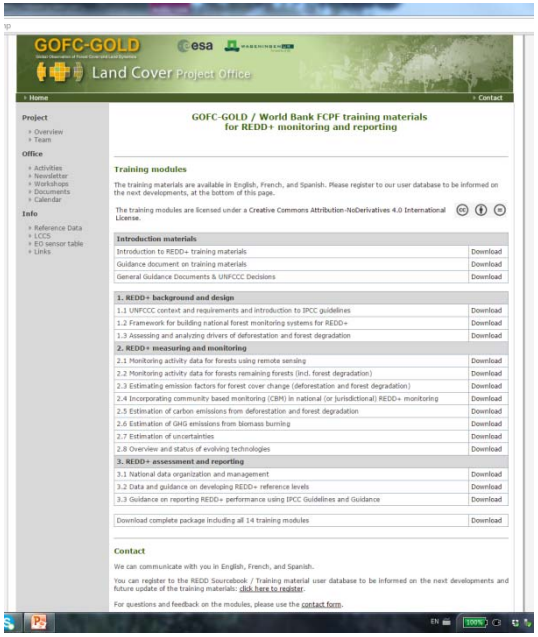
Availability and Access

- **English version (full package)**
- **French version (lectures and country examples)**
- **Spanish version (lectures and country examples)**

http://www.gofcgold.wur.nl/redd/Training_materials.php

https://www.forestcarbonpartnership.org/redd-training-material-forest-monitoring





Distribution License of Training Materials

- Allowing commercial use of the materials
- Restricting distribution of adaptations

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Phase 2 – Next steps

- Implement and evaluate four regional workshops including a 1-week course implementation of the training materials
    - In close collaboration with other training and capacity building initiatives (SylvaCarbon and UN-REDD)
- Consolidate the modules based on feedback and provide an updated Version 2 of the training materials
- Organize a series of webinars, including 1 inaugural seminar and a series of 14 webinars covering the 14 different modules

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GOFC-GOLD LC-IT activities

- Integrating Earth observation and genomics technologies for the monitoring of biodiversity changes in degrading tropical forests

WAGENINGEN UR
For quality of life

Integrating Earth observation and genomics technologies for the monitoring of biodiversity changes in degrading tropical forests

Kalkidan Ayele, PhD student

Study area: Kaffa region, Ethiopia

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GOFC-GOLD
Global Observation of Forest and Land Cover Dynamics

Objectives

Aims to employ an integration of Earth Observation (EO) and Metabarcoding techniques to develop, implement, test, and demonstrate approaches to quantify the effect of forest degradation and ecosystem characteristics on the biodiversity of the selected study area, Kafa biosphere reserve, Ethiopia.

Terrestrial LiDAR (TLS)

Credit: Alavaro Lau Sarmiento
PhD candidate, WUR

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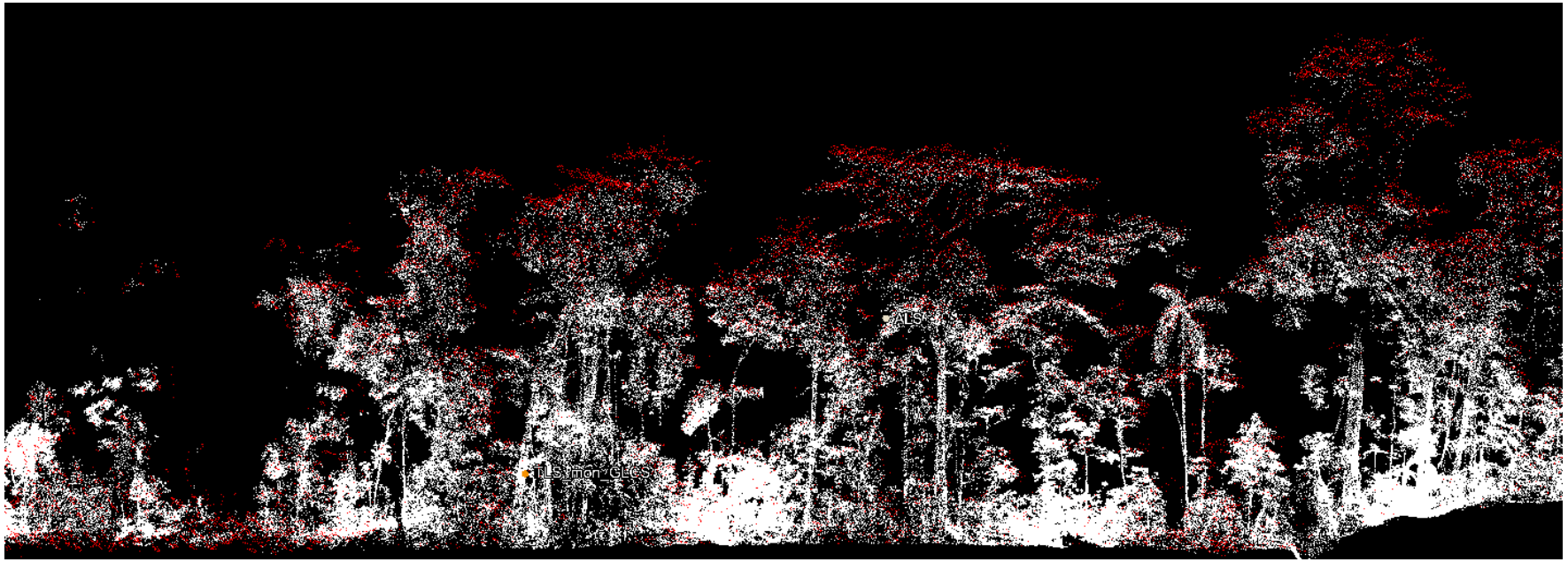
GOFC-GOLD
Global Observation of Forest and Land Cover Dynamics

TLS and Airborne Laser Scanner data alignment



TLS pointcloud (white) and ALS pointcloud (red) – Tambopata05 plot

Credit: Alavaro Lau Sarmiento
PhD candidate, WUR

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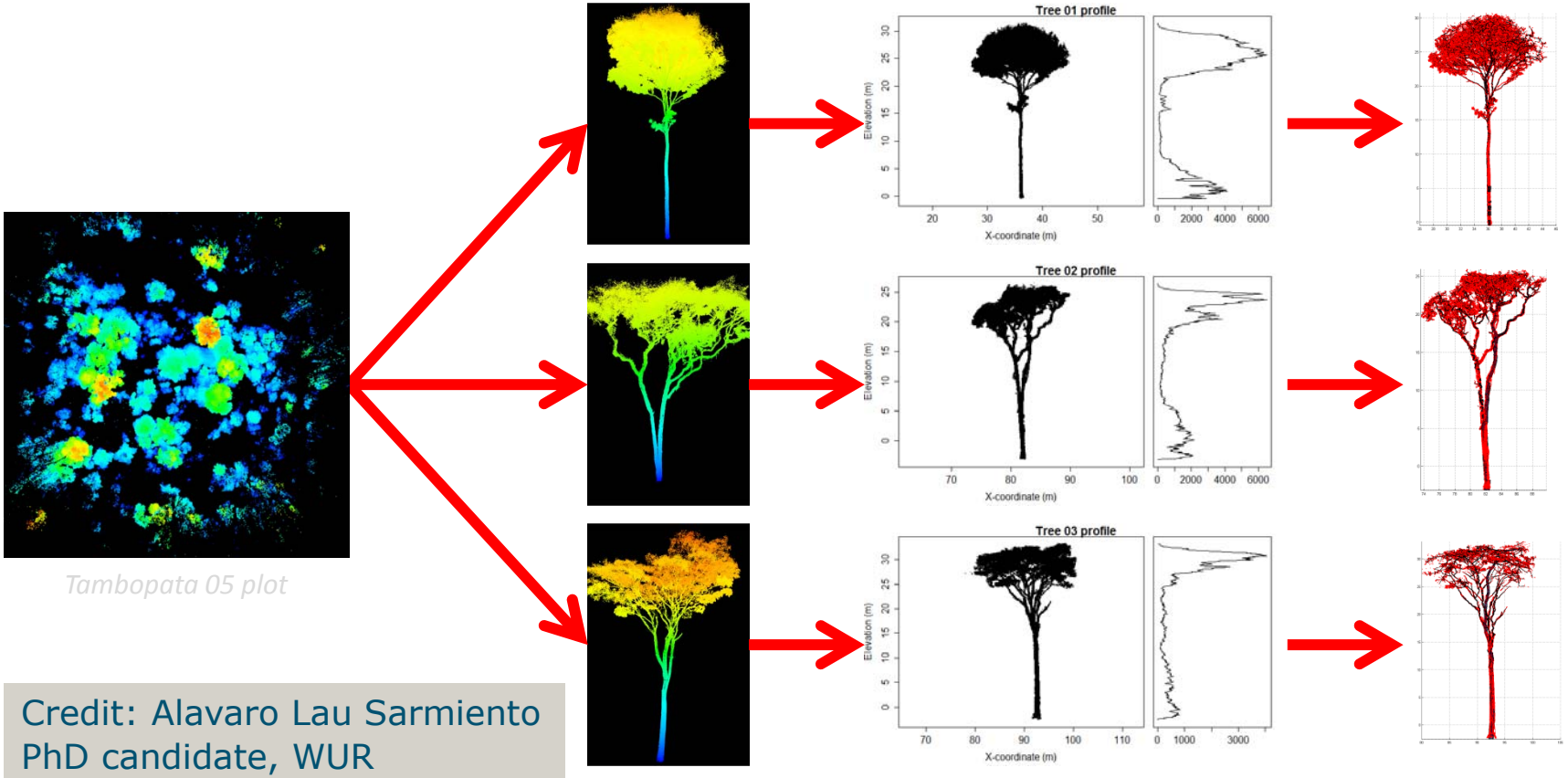
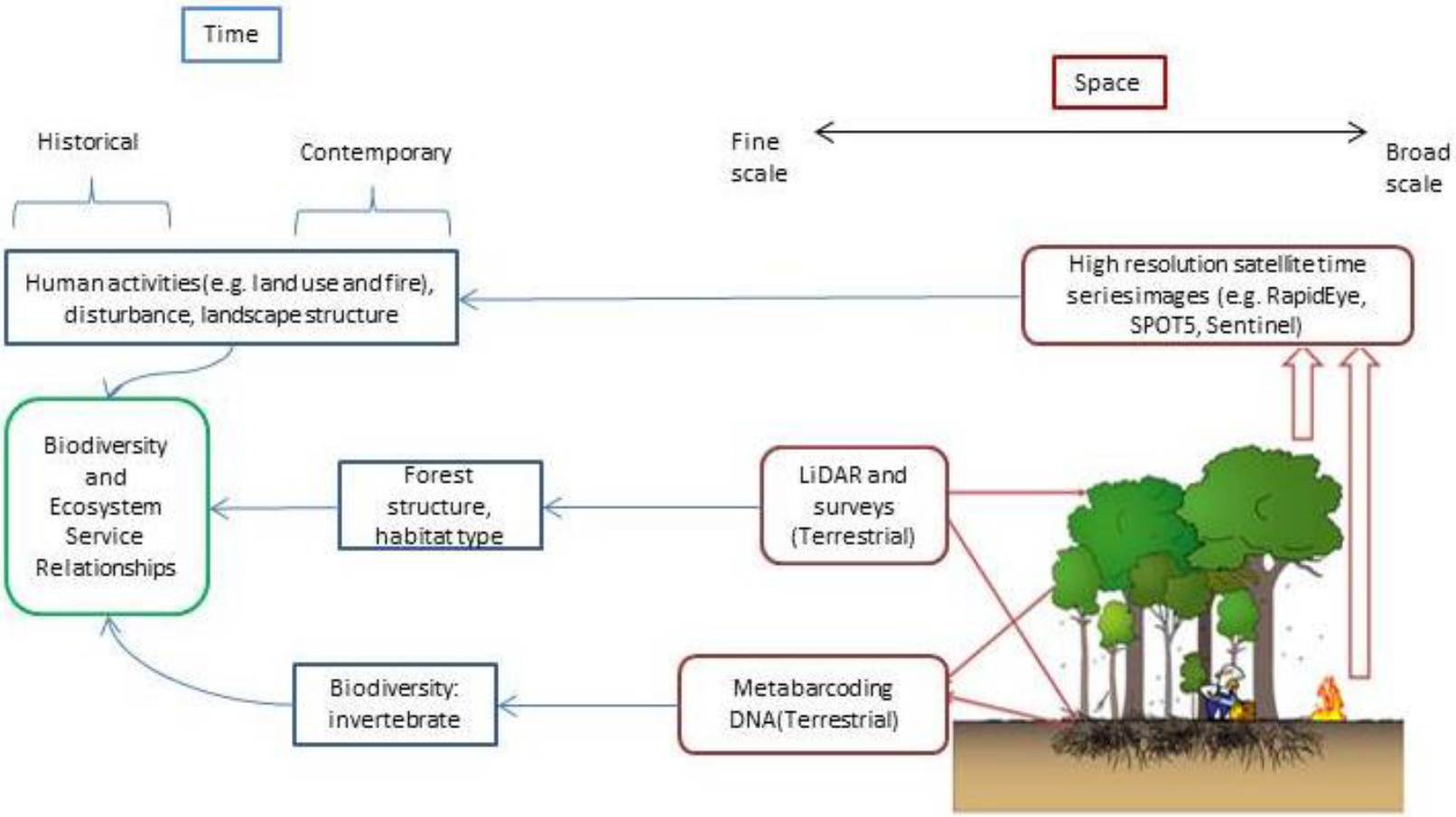
Modelling individual tropical trees



Tambopata 05 plot

Credit: Alavaro Lau Sarmiento
PhD candidate, WUR

Monitoring Biodiversity change

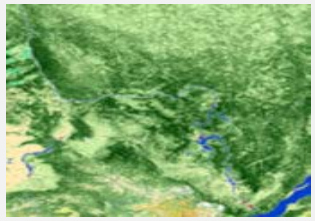


GOFC-GOLD LC-IT activities

- Sourcebook for Biodiversity Monitoring in Tropical Forests with Remote Sensing Data and Methods

SOURCEBOOK

UNCBD COP 13



A SOURCEBOOK OF METHODS AND PROCEDURES FOR MONITORING ESSENTIAL BIODIVERSITY VARIABLES IN TROPICAL FORESTS WITH REMOTE SENSING

GOFC-GOLD
Global Observation of Forest and Land Cover Dynamics

GEOBON

Sourcebook for Biodiversity Monitoring in Tropical Forests with Remote Sensing Data and Methods

- Need to present RS data and methods, including good practices, in support of policy targets (UNCBD Aichi targets, UNFCCC REDD+ mechanism (co-benefits)) to countries.

- Need to support development of the relevant EBVs (e.g., Ecosystem extent and fragmentation, habitat structure), as part of the BON-in-a-Box toolkits.

GOFC-GOLD
Global Observation for Forest and Land Cover Dynamics
Land Cover Project Office

GEO BON

Sourcebook for Biodiversity Monitoring in Tropical Forests with Remote Sensing Data and Methods

Purpose: guide biodiversity monitoring via RS to inform national and sub-national policy and decisions, convention commitments and targets

Target Users: project managers, technical level practitioners in national, sub-national government agencies, academic institutions, NGOs, assuming audience has a background on RS.

Focus: validated RS techniques, integration of *in situ* and RS observations, present and discuss sampling approaches, evolving technologies presented separately, list available datasets.

Approach: structured around relevant Essential Biodiversity Variables (EBVs), living document (updated every year), complementary to other initiatives (GEO Handbook, CBD Tech. reports, ZSL-GIZ report).

Sourcebook for Biodiversity Monitoring in Tropical Forests with Remote Sensing Data and Methods

Contributors: GOFC-GOLD Land Cover Office, GEO BON, European Space Agency, Wageningen University, Twente University, Würzburg University, Jena University, EC Joint Research Centre, Woods Hole Research Center, IIASA, Earthwatch, DLR Germany, Resources For the Future, Universidad de Medellín, CONABIO, ISSIA CNR, IRSTEA, University Bangalore, Helmholtz Centre for Environmental Research – UFZ, Bari University, Universidad Nacional de Colombia, Instituto Humboldt, University of Saint Andrews, Oak Ridge National Laboratory.

Time schedule:
Fall 2015: first draft ready
Winter 2015/2016: internal & external reviews
Spring/summer 2016: round of update
Fall 2016: V1 published online for UNCBD COP-13

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Land Cover Project Office

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