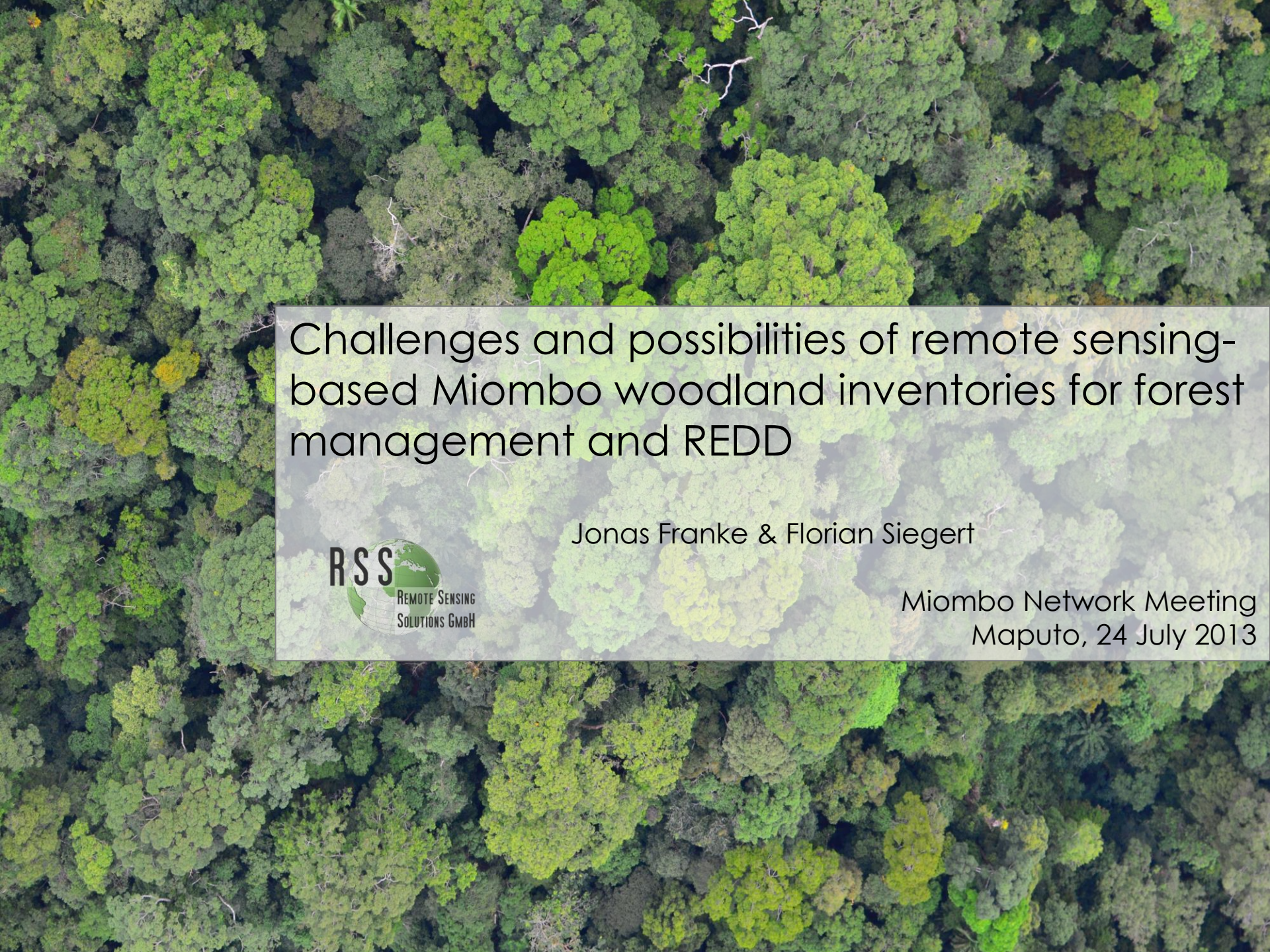


Challenges and possibilities of remote sensing-based Miombo woodland inventories for forest management and REDD

Jonas Franke & Florian Siegert

RSS
Remote Sensing Solutions GmbH

Miombo Network Meeting
Maputo, 24 July 2013

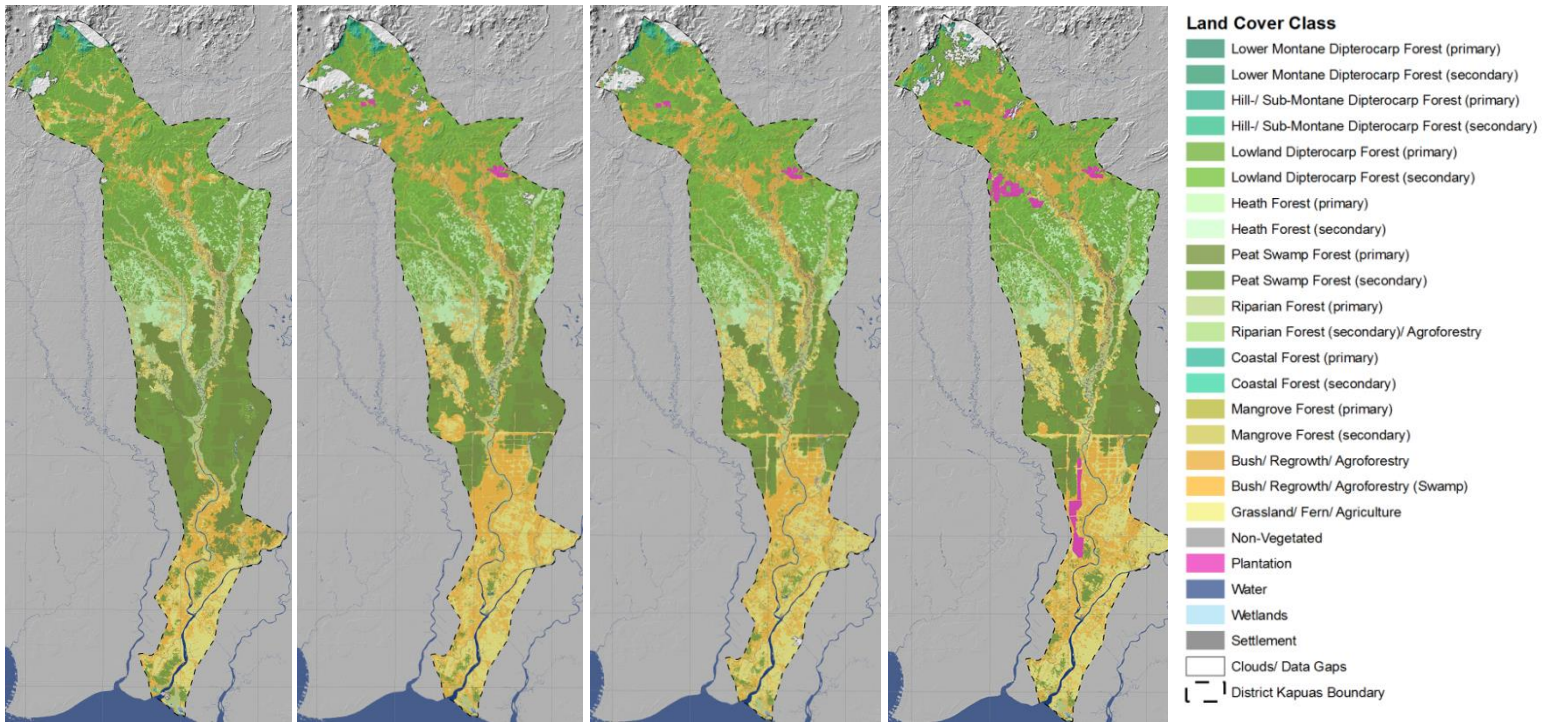
The main role of remote sensing in the context of REDD

A valuable tool to:

- Establish a reference emission level (REL) through a historical land-/forest cover assessment
- Support monitoring, reporting and verification (MRV)

Historical baseline assessment

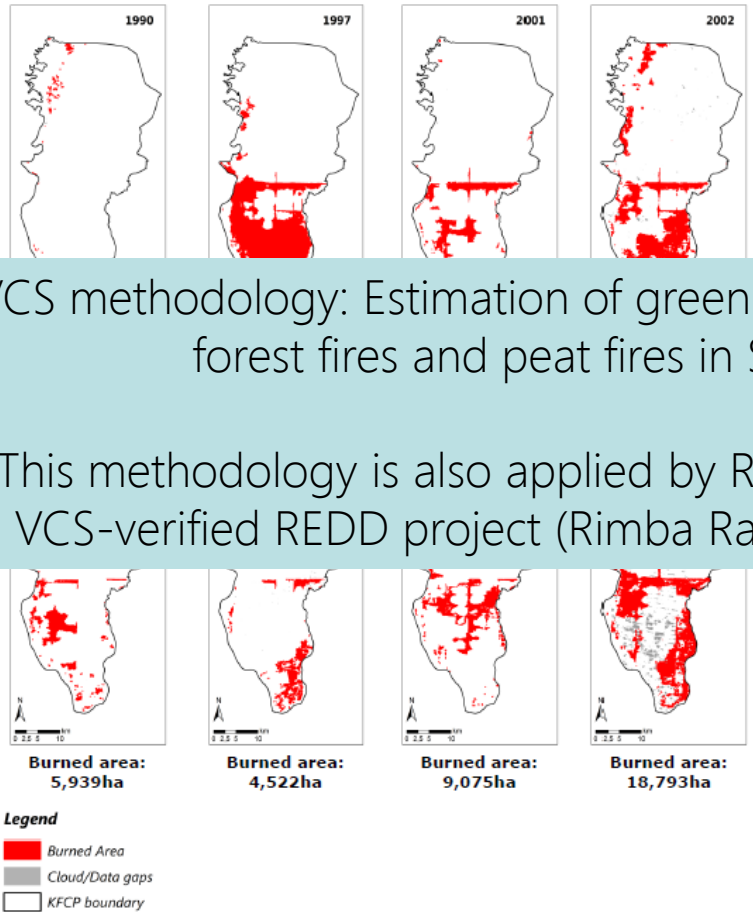
Kapuas district, Central Kalimantan, Indonesia



This historical land cover assessment was conducted by RSS in the framework of the REDD demonstration activities of the Kalimantan Forests and Climate Partnership (KFCP); funded by AusAID

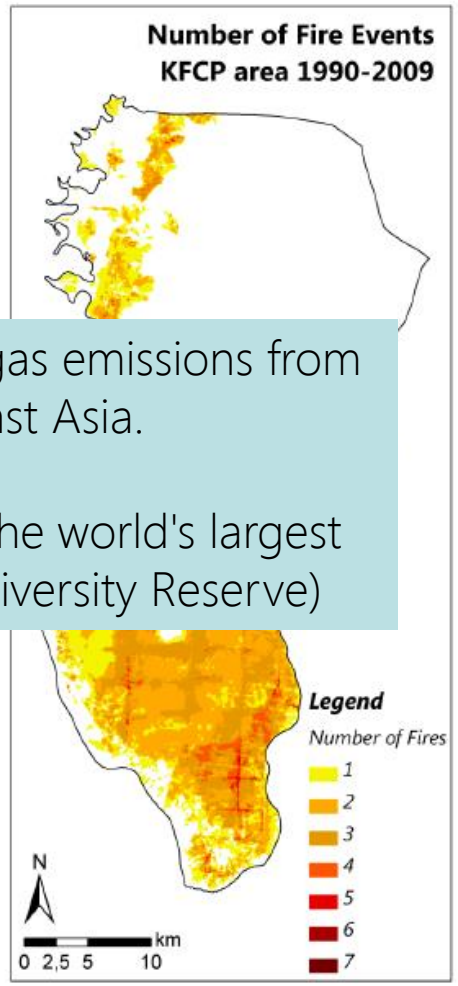
Estimating Emissions from Forest Fires

- Historical assessment of burned areas using Landsat data
- Emission estimates via burned area and burned land cover



VCS methodology: Estimation of greenhouse gas emissions from forest fires and peat fires in Southeast Asia.

This methodology is also applied by RSS for the world's largest VCS-verified REDD project (Rimba Raya Biodiversity Reserve)



The main role of remote sensing in the context of REDD

A valuable tool to:

- Establish a reference emission level (REL) through a historical land-/forest cover assessment
- Support monitoring, reporting and verification (MRV)

Deforestation vs. Forest Degradation

Deforestation:

- Rapid and abrupt land cover transformation through clearing or fire
- Binary transformation from forest (1) to non-forest (0)
- Easy to detect by remote sensing

Forest Degradation:

- Slow and subtle change in forest cover through e.g. selective logging
- Continuous characteristics between forest and non-forest
- Detection by remote sensing is challenging
- Often the initial phase in the process of land cover transformation to complete deforestation

RapidEye – high-resolution satellite data

- 5 satellites
- 5 spectral bands
- 5 m pixel size (ortho-rectified)

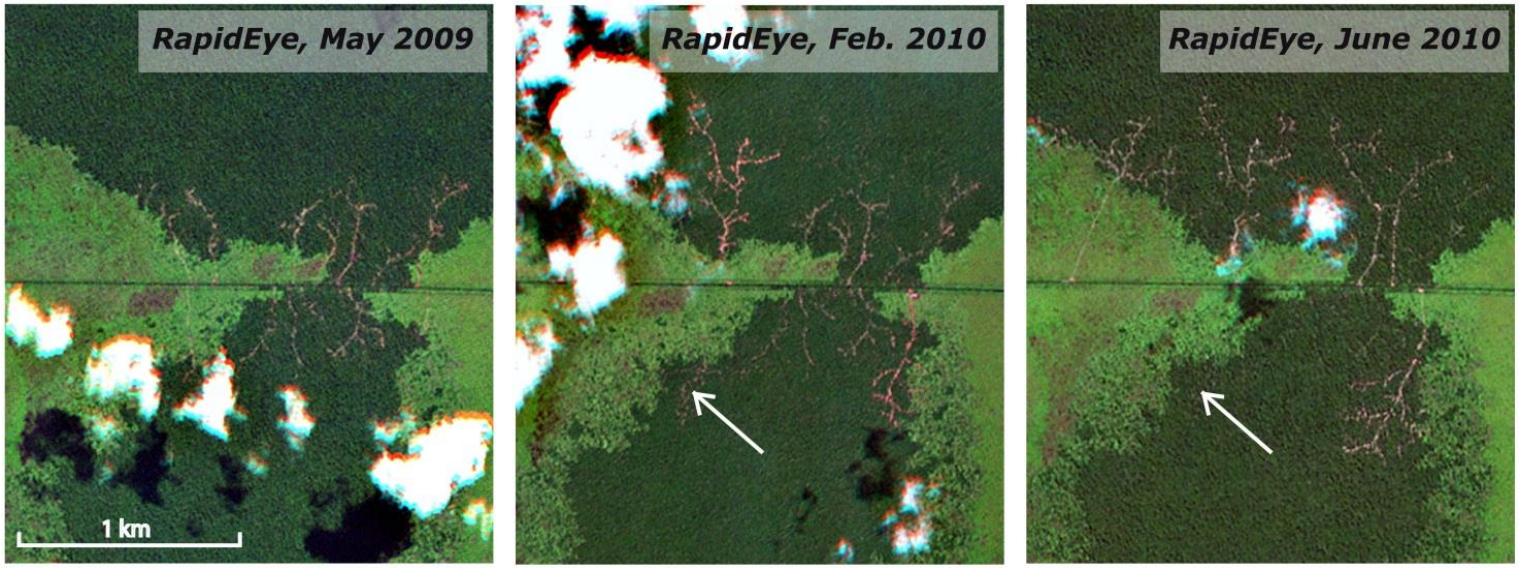
- 5.000.000km² per day
- 3000 km per satellite & orbit
- 77km swath (Nadir)

Illustration of the 5 satellites in orbit
Source: RapidEye AG

Example: Deforestation

Example: forest degradation

RapidEye time series



RapidEye time series shows the progress of illegal logging.

RS-based benchmark of Miombo forests

Mecuburi Forest Reserve, Mozambique

EC FP7-project REDD-FLAME

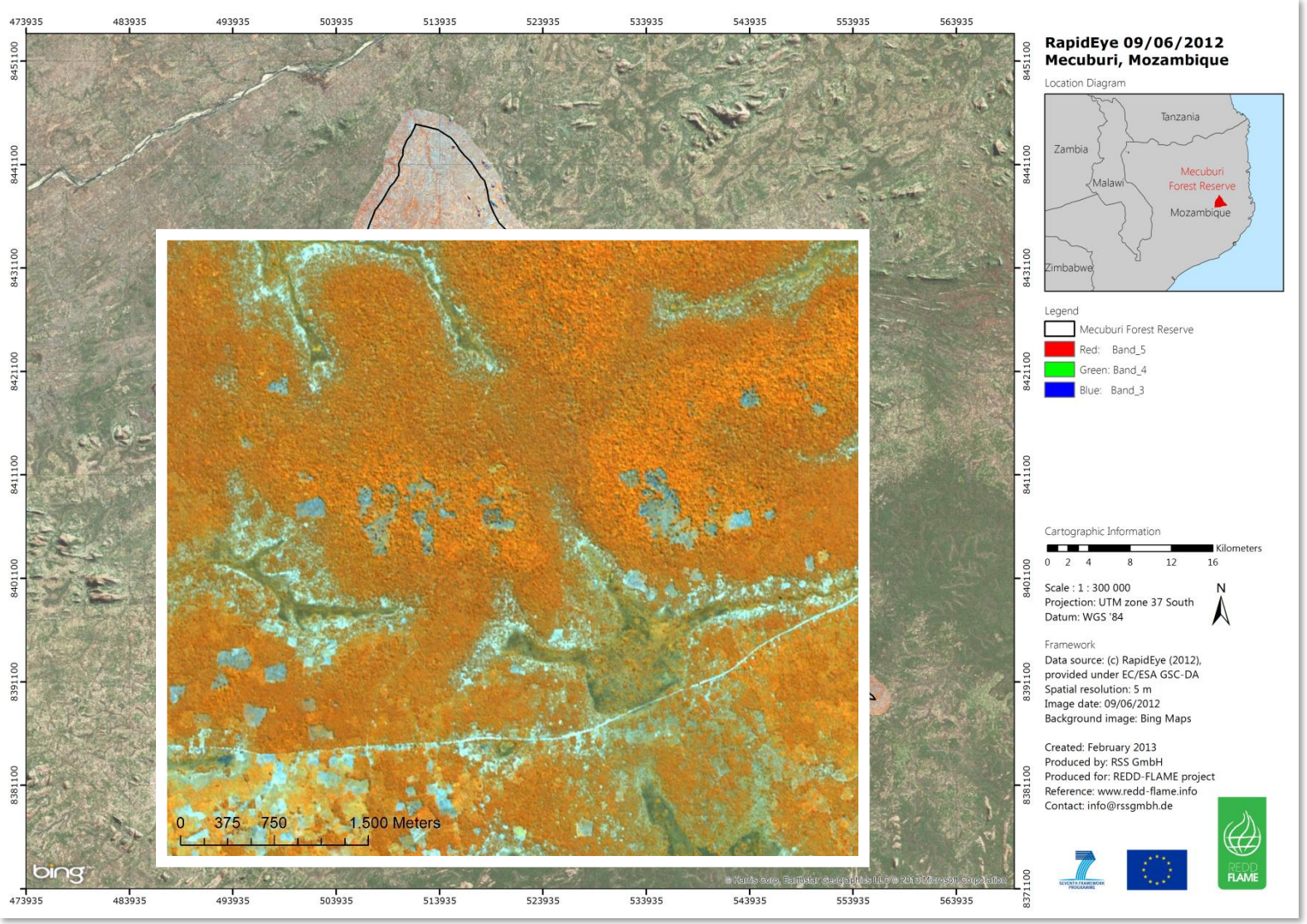
In cooperation with (among other partners) Almeida A. Sitoe, Faculty of Agronomy and Forestry, Eduardo Mondlane University, Maputo

Specific characteristics of Miombo woodland:

- Very complex ecosystem with small-scale land cover patches
- Small agricultural conversions, logging concession, selective logging, fuelwood harvesting and charcoal production
- Fires occur frequently, but it depends on the fire intensity if it affects the forest canopy
- Massive seasonal effects that have to be considered for remote sensing approaches
- Phenological effects such as drop of leaves and fires in the dry season complicates remote sensing monitoring

RapidEye image of the Mecuburi Forest Reserve

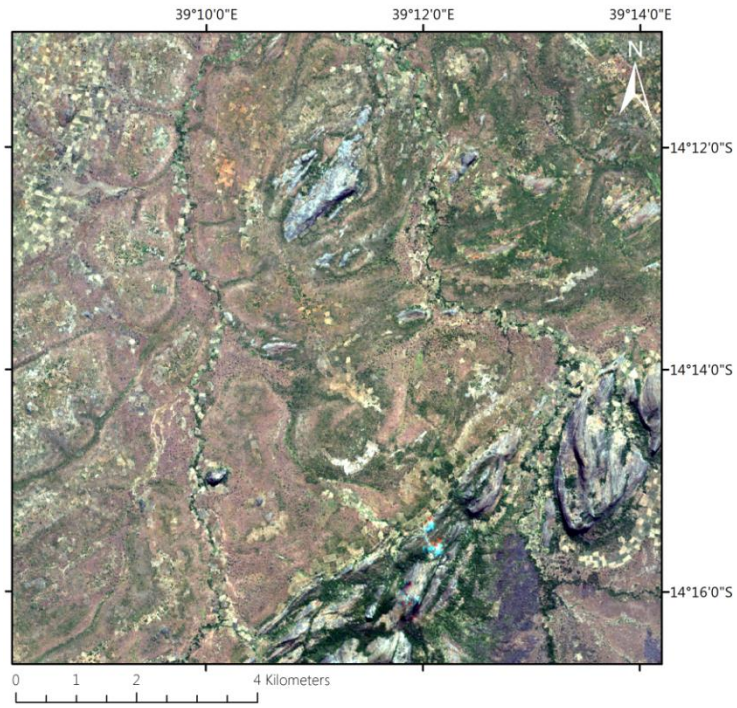
Area: 2,500 km^2



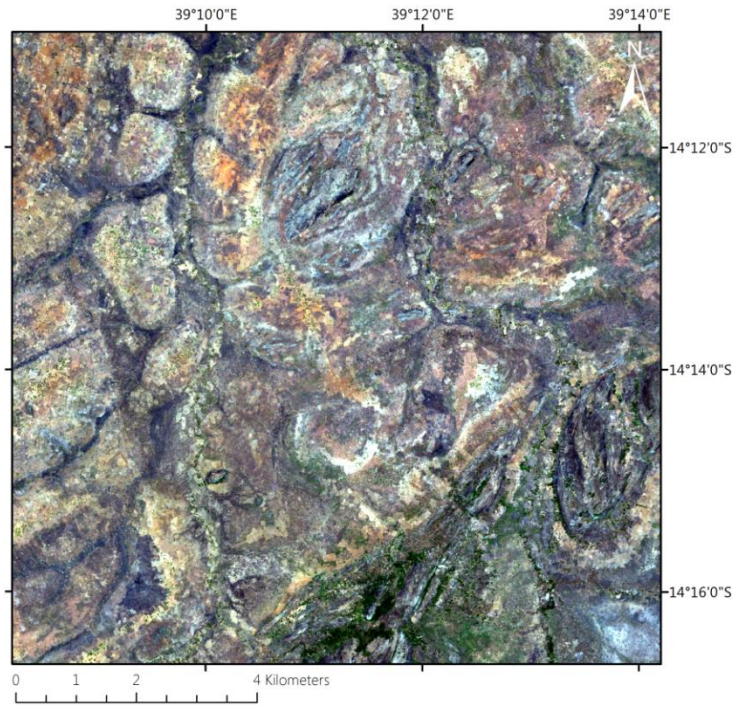
RS-based benchmark of Miombo forests

Example for seasonal effects

RapidEye (true color RGB) 26/07/2010



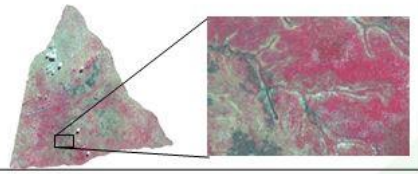
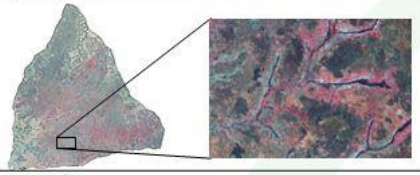
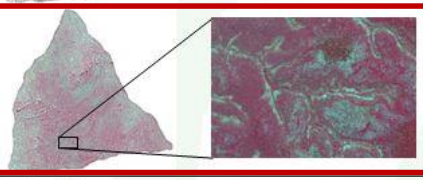
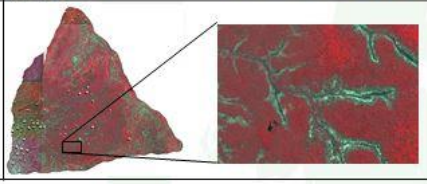
RapidEye (true color RGB) 02/11/2010



Example for the seasonal effects on remote sensing data.
There is a enormous difference in images between July 2010 and November 2010.

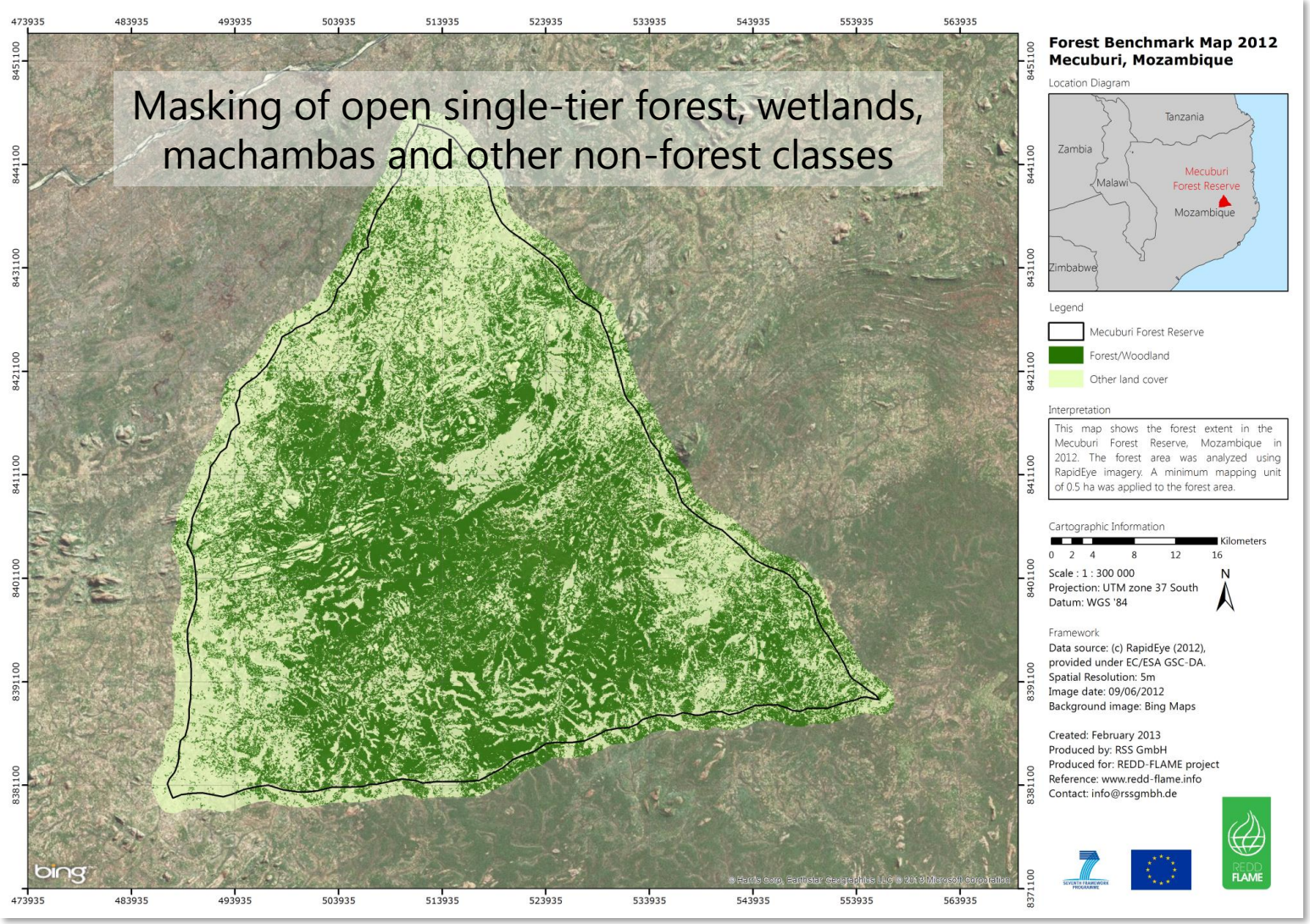
RS-based benchmark of Miombo forests

RapidEye Images and Miombo Phenology

Observation period	Image overview/zoom	Use
07-2010		Not suitable due to seasonal effects
11-2010		Not suitable due to seasonal effects
10-2011		Not suitable due to seasonal effects
06-2012		Forest Benchmark
09-2012		Burned area mapping
04-2013		Refining Forest Benchmark & Forest Cover Change

RS-based benchmark of Miombo forests

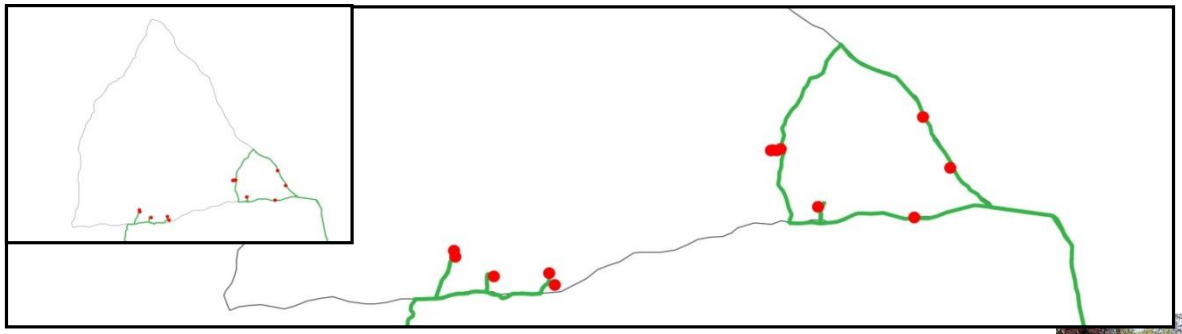
Miombo benchmark map 2012



RS-based benchmark of Miombo forests

Accuracy Assessment by field validation

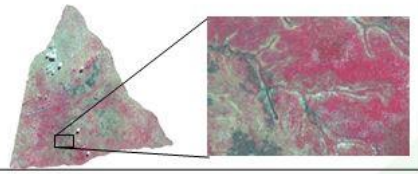
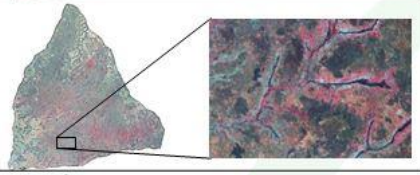
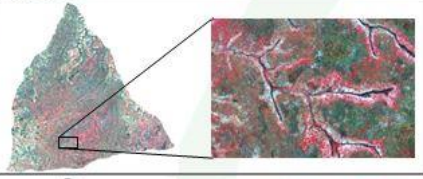
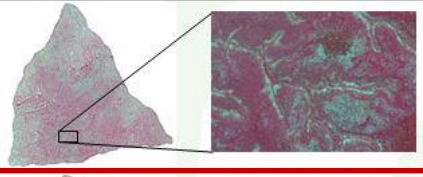
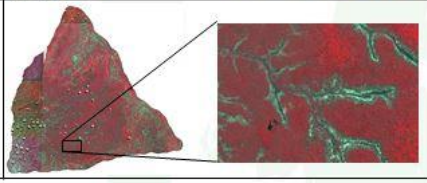
Field evaluation was performed in November 2012 by REDD-FLAME project partner RSAC in the company of Sosdito Mananze of UEM and Aly Awasse, Community Forest & Wildlife Management Unit Coordinator in the Provincial Forest & Wildlife Service, Nampula



Photos: T. Pearson (RSAC)

RS-based benchmark of Miombo forests

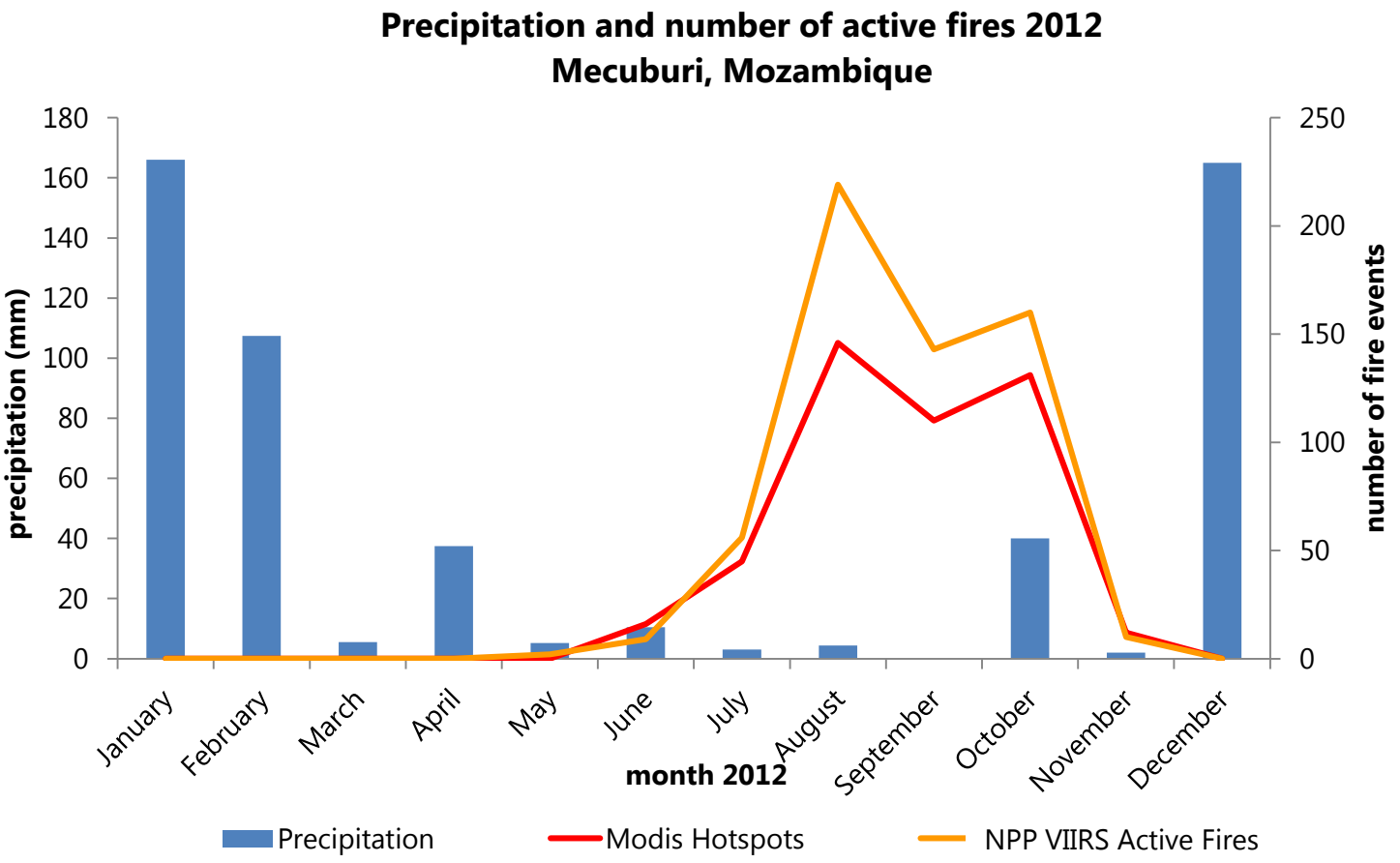
RapidEye Images and Miombo Phenology

Observation period	Image overview/zoom	Use
07-2010		Not suitable due to seasonal effects
11-2010		Not suitable due to seasonal effects
10-2011		Not suitable due to seasonal effects
06-2012		Forest Benchmark
09-2012		Burned area mapping
04-2013		Refining Forest Benchmark & Forest Cover Change

RapidEye-based burned area mapping

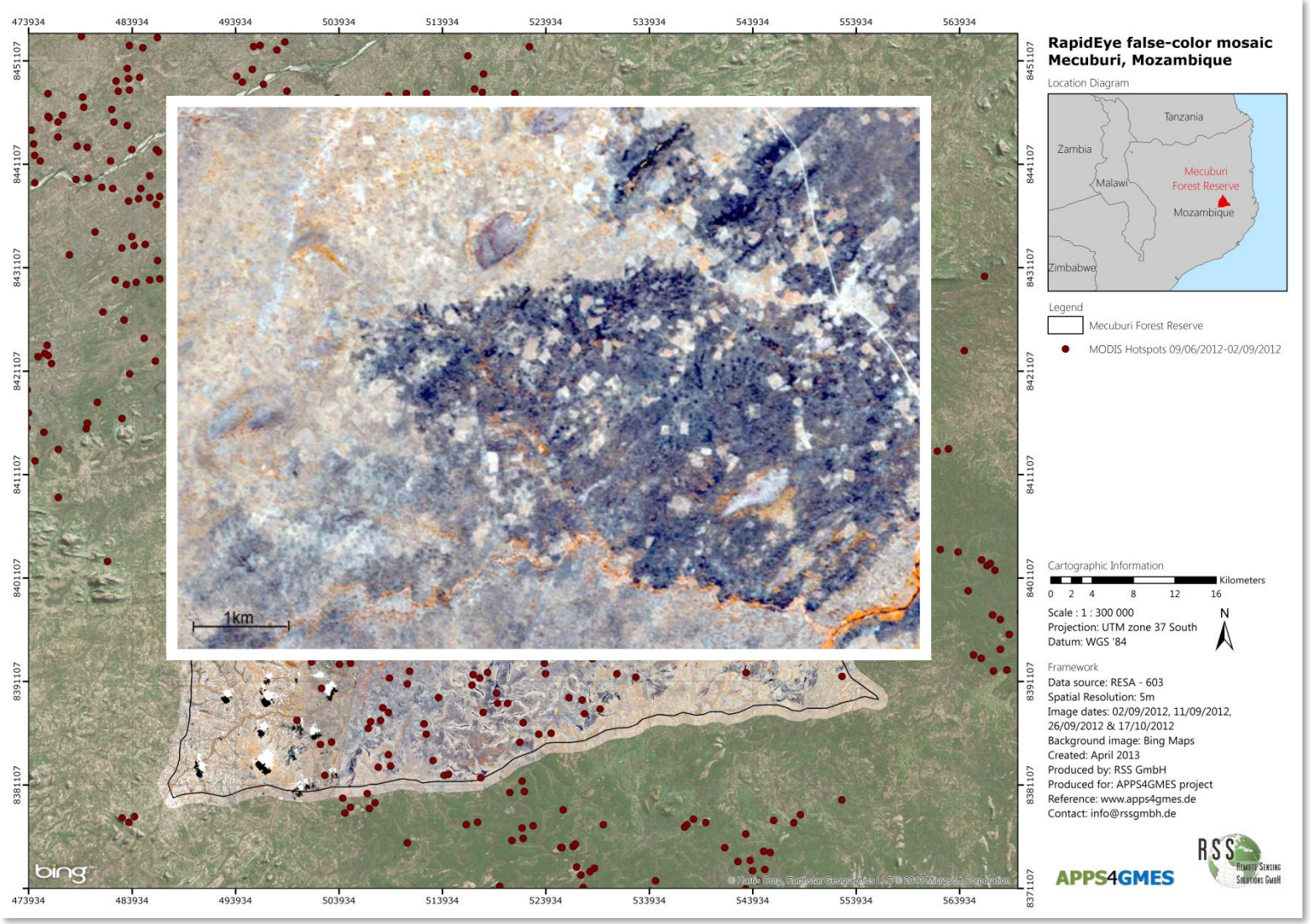
Comparison MODIS hotspots & NPP active fires

APPS4GMES



RapidEye-based burned area mapping

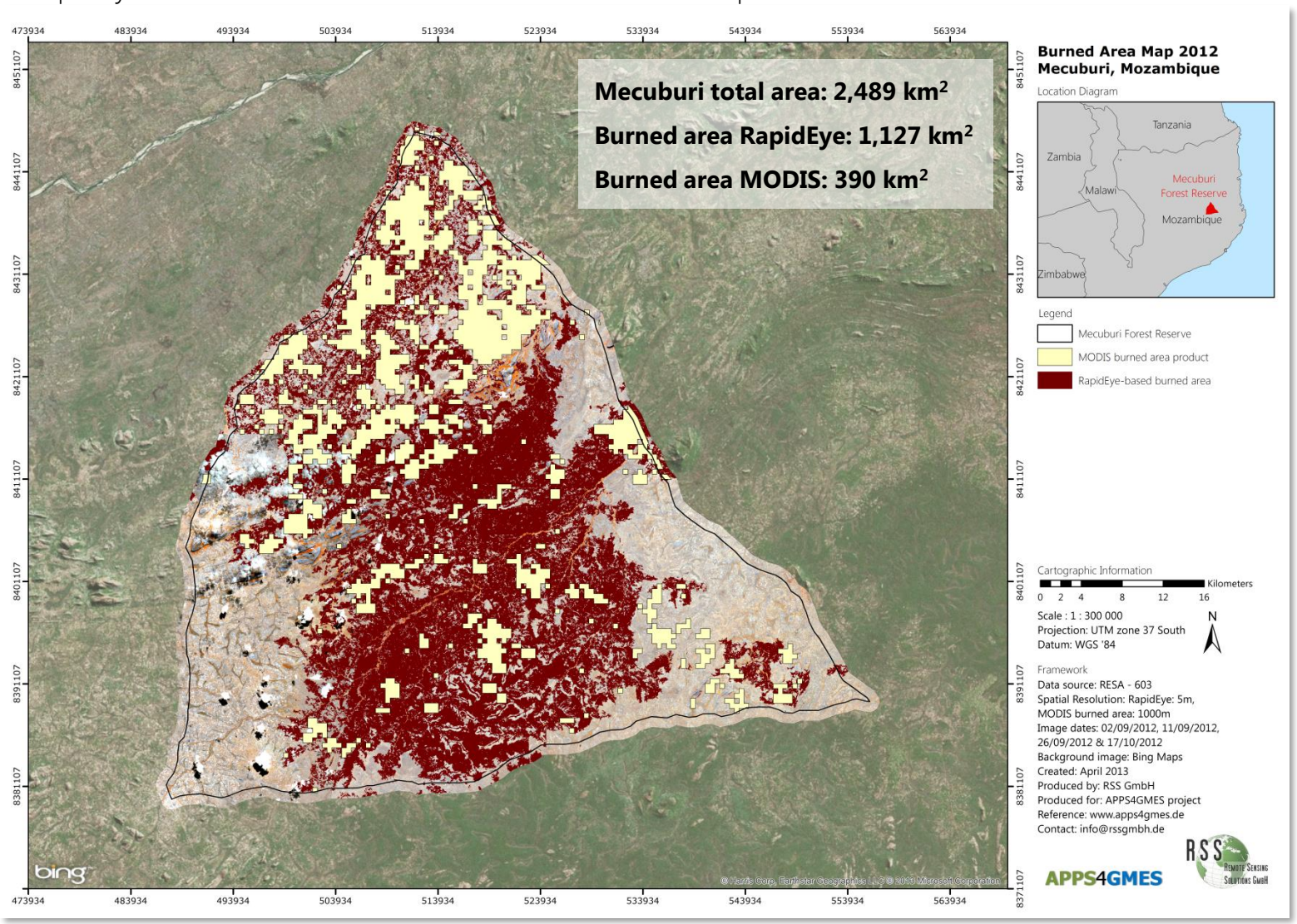
RapidEye image and MODIS hotspots



RapidEye-based burned area mapping

Making use of high-resolution data

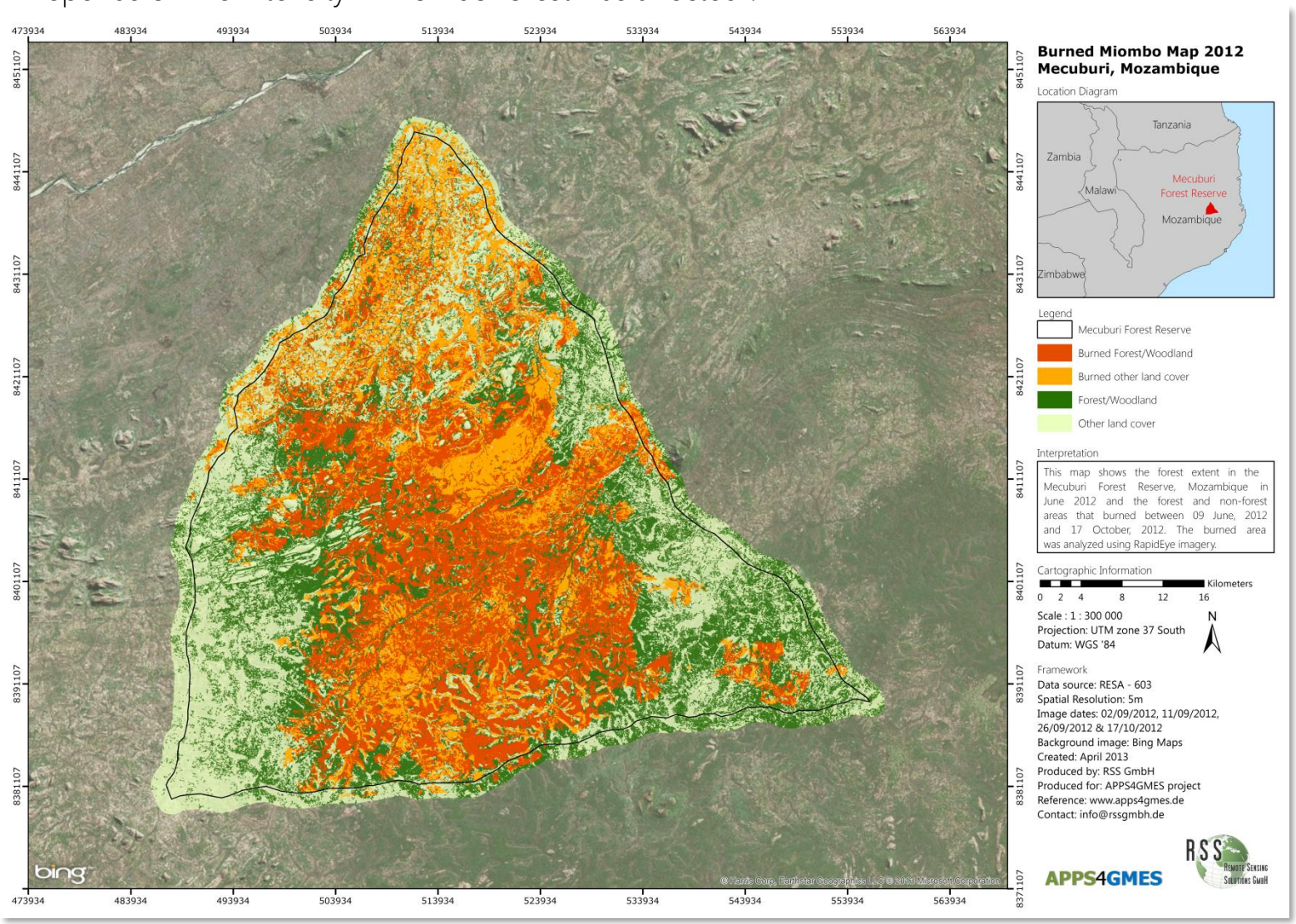
RapidEye-based burned area and MODIS burned area product



RapidEye-based burned area mapping

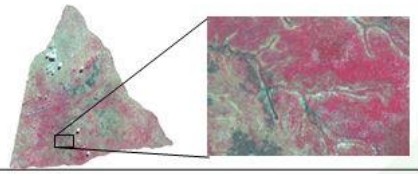
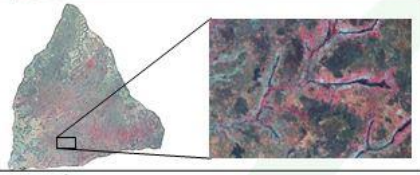
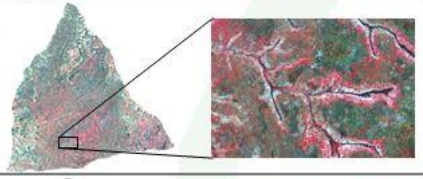
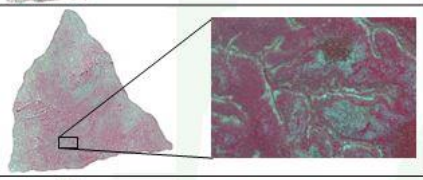
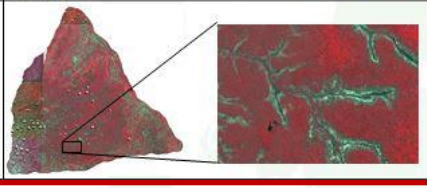
Burned Miombo Map 2012

Depends on fire intensity if Miombo forest was affected !



RS-based benchmark of Miombo forests

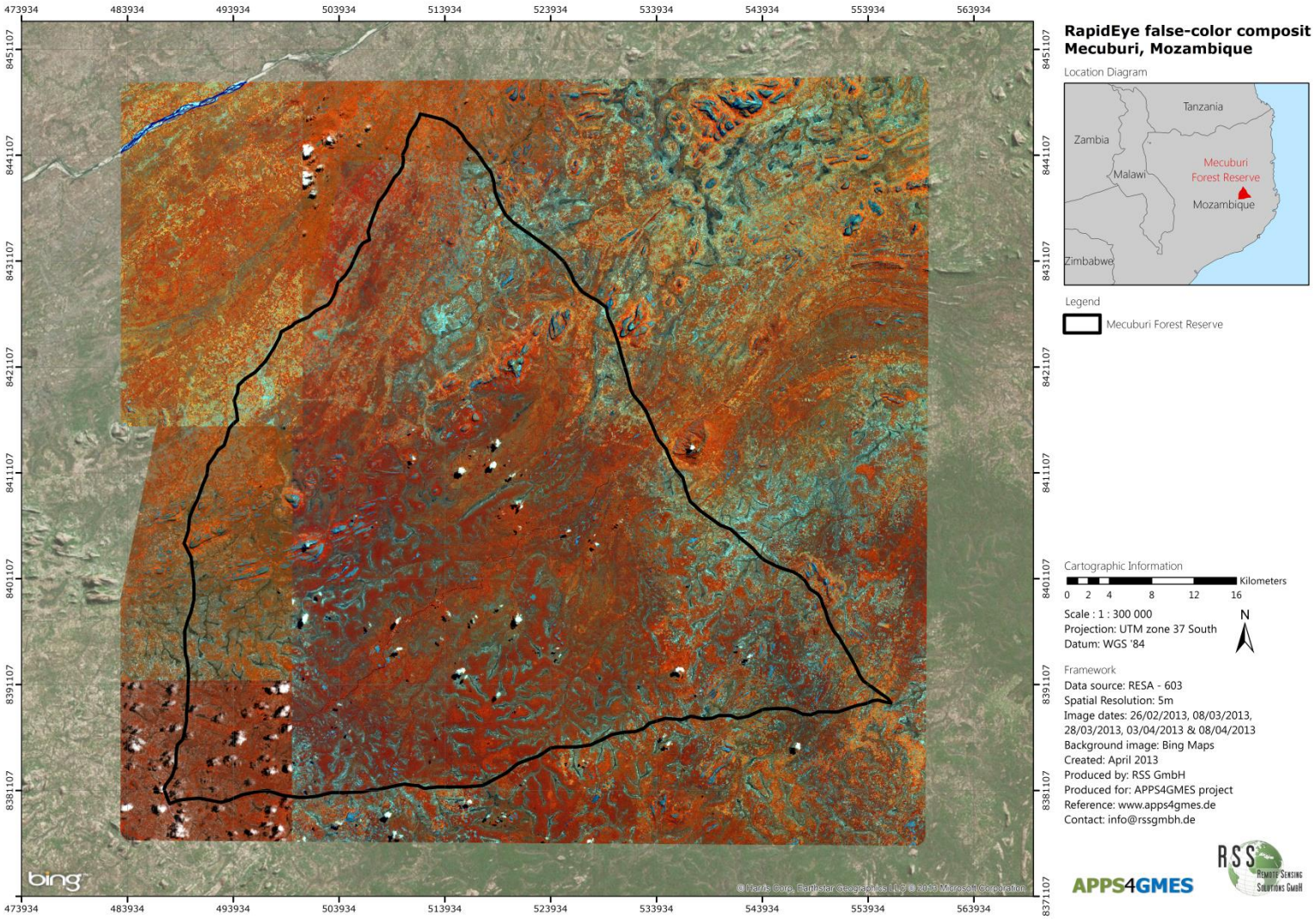
RapidEye Images and Miombo Phenology

Observation period	Image overview/zoom	Use
07-2010		Not suitable due to seasonal effects
11-2010		Not suitable due to seasonal effects
10-2011		Not suitable due to seasonal effects
06-2012		Forest Benchmark
09-2012		Burned area mapping
04-2013		Refining Forest Benchmark & Forest Cover Change

RapidEye-based burned area mapping

Refining the benchmark and mapping change

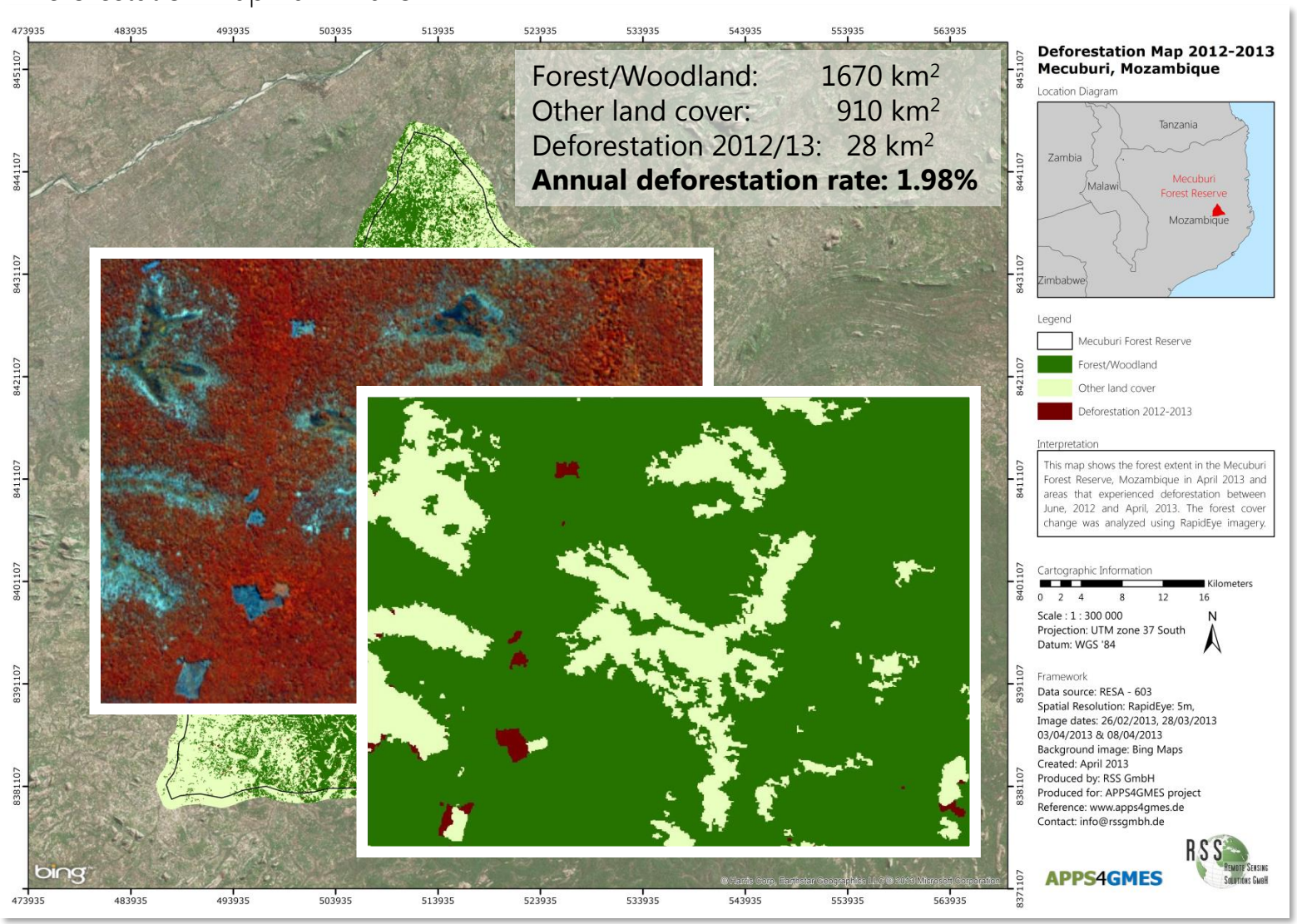
RapidEye image mosaic March/April 2013



RapidEye-based burned area mapping

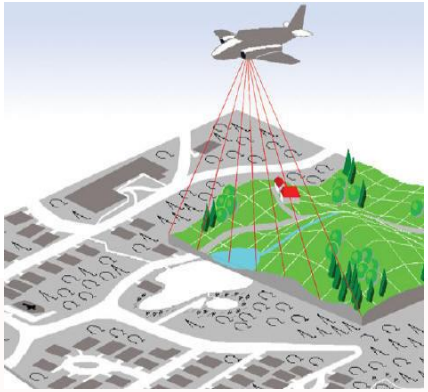
Refining the benchmark and mapping change

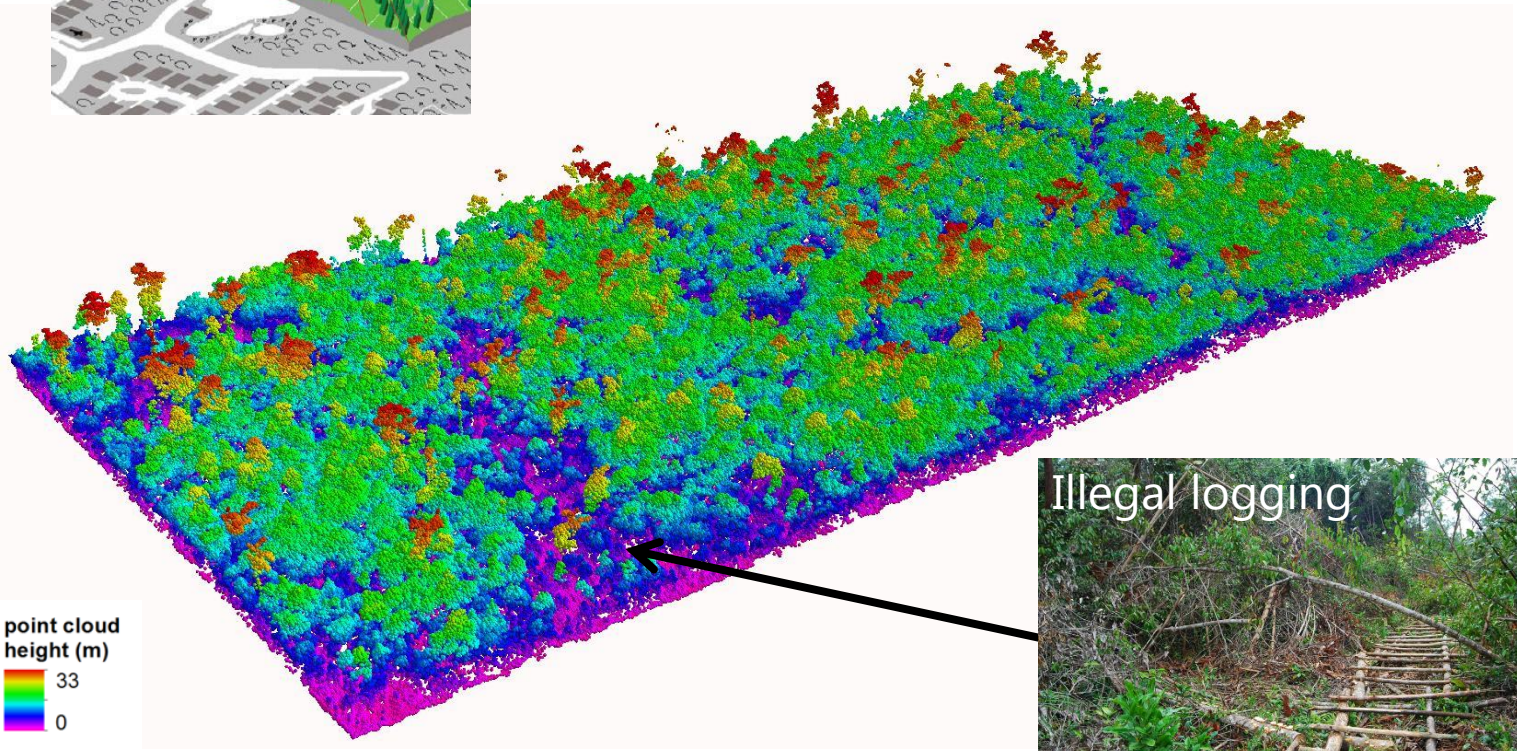
Deforestation Map 2012-2013



LiDAR (Light Detection and Ranging)

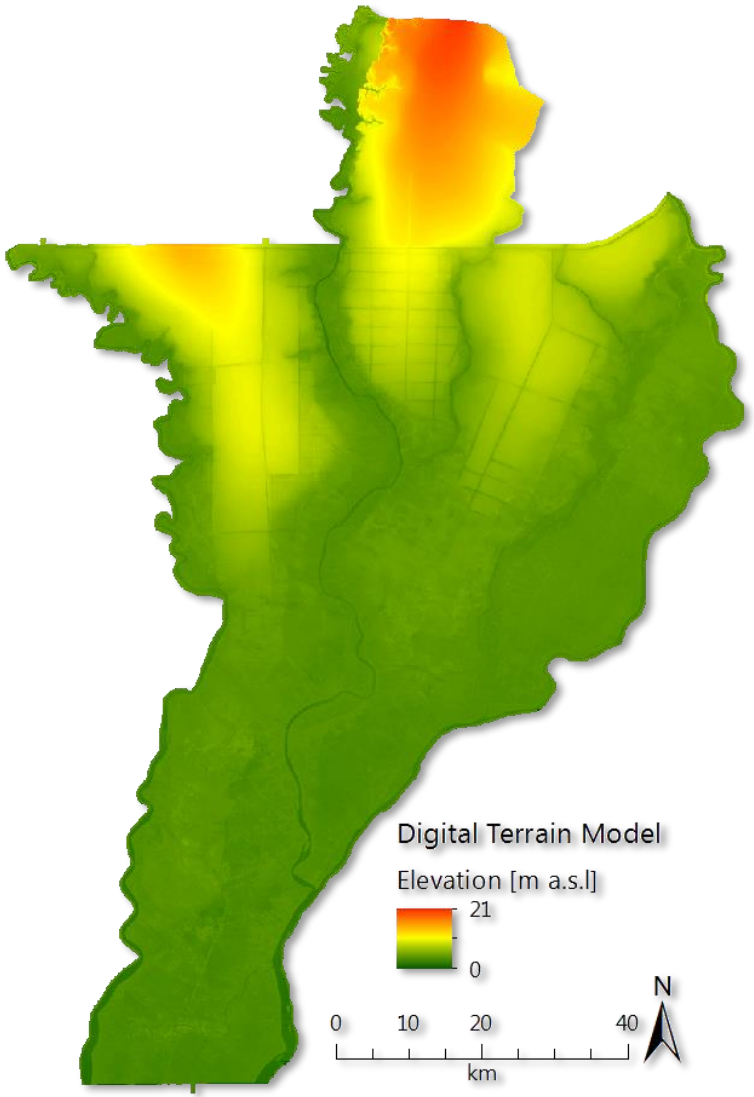
Applications for forest monitoring

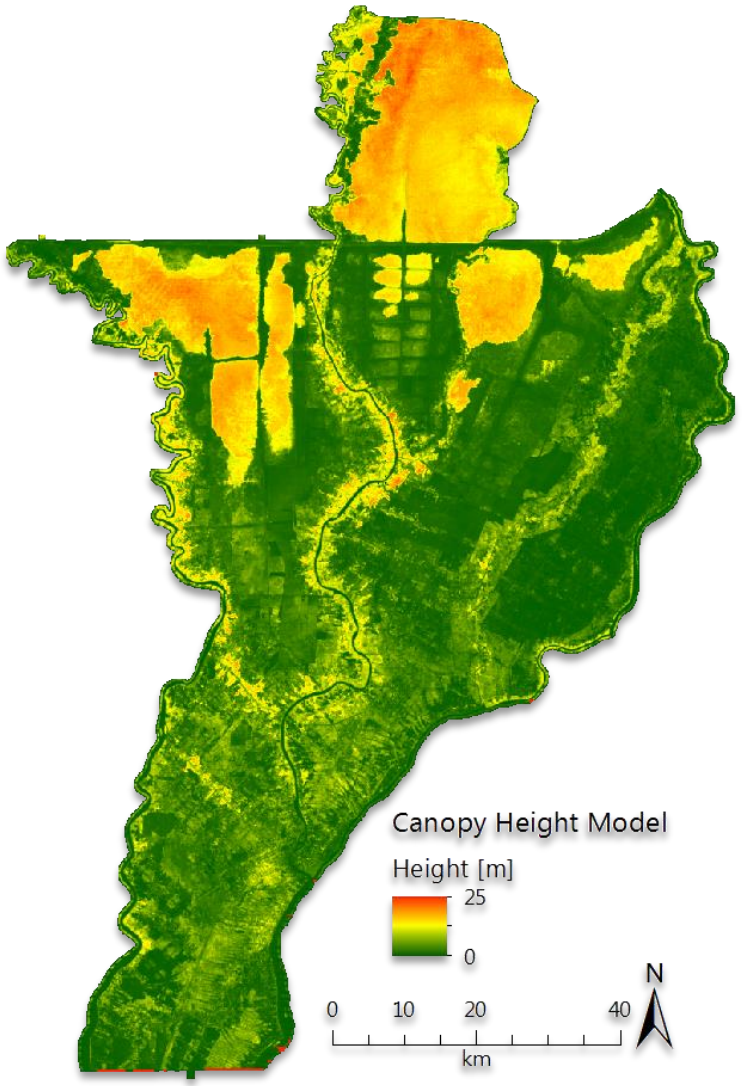




LiDAR (Light Detection and Ranging)

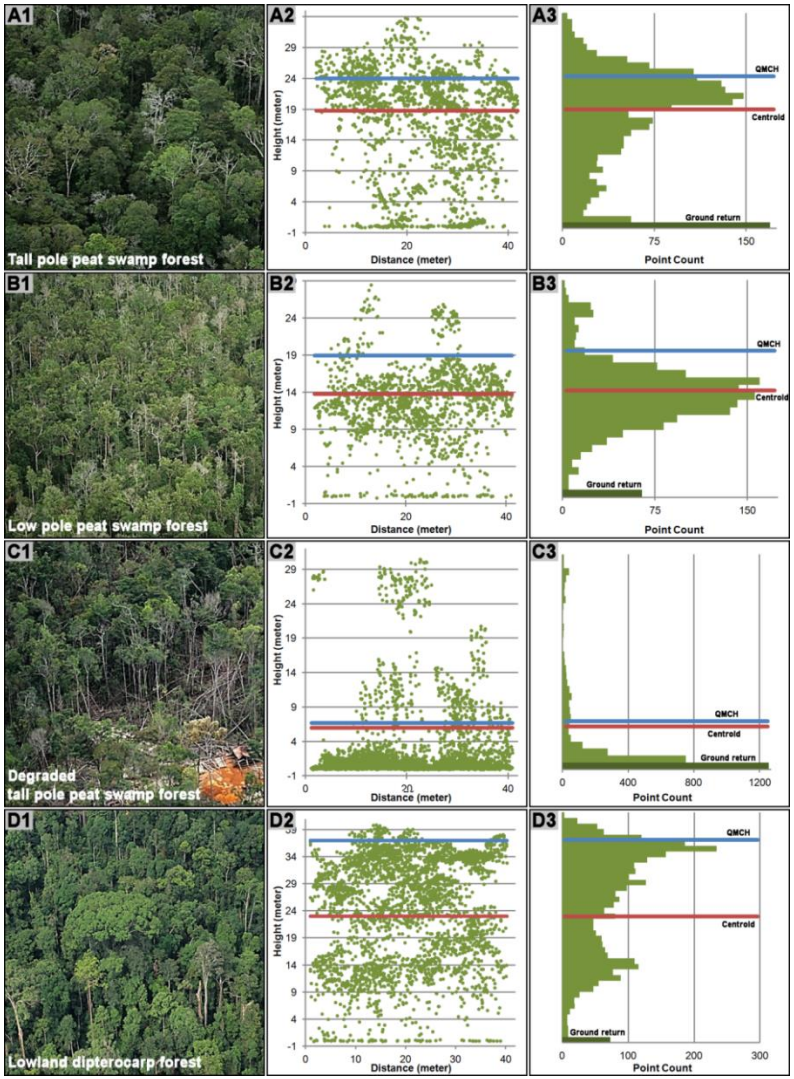
DTM and canopy height model

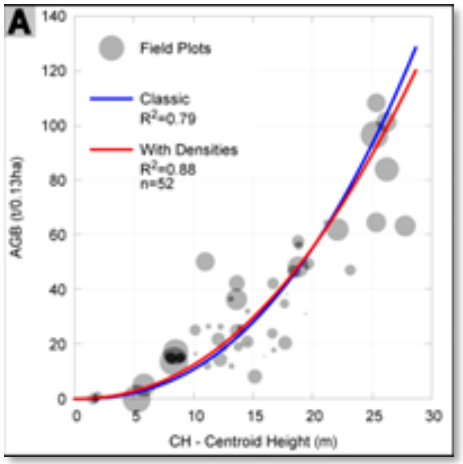




LiDAR (Light Detection and Ranging)

Height metrics for forest characterization





Jubanski et al. 2012

Conclusion

- Remote sensing is an integral part of REDD+ MRV (Measurement, Reporting and Verification) systems
- Historical baseline, current benchmark and future monitoring of forest cover and carbon stock is possible
- Ground-based forest inventories are very important for RS-based monitoring
- Low resolution fire products are very helpful for identifying fire clusters
- High-resolution data provide more reliable assessments of patterns of fire occurence
- High resolution RapidEye data proofed to be very suitable to monitor Miombo forest and its changes at small spatial scales
- The period for acquiring satellite data is most crucial due to seasonal effects of Miombo forest (phenology, fire occurence and fast regrowth)
- „End-of-wet-season-imagery" is required for Miombo forest/woodland mapping (benchmark and change monitoring) and „end-of-dry-season-imagery" is required for detailed burned land cover mapping
- LiDAR can provide precise measures of forest structure and estimates of carbon stock
- An upscaling approach using field plots, LiDAR transects and large-area coverage of satellite data is recommended

Thank you for your attention...

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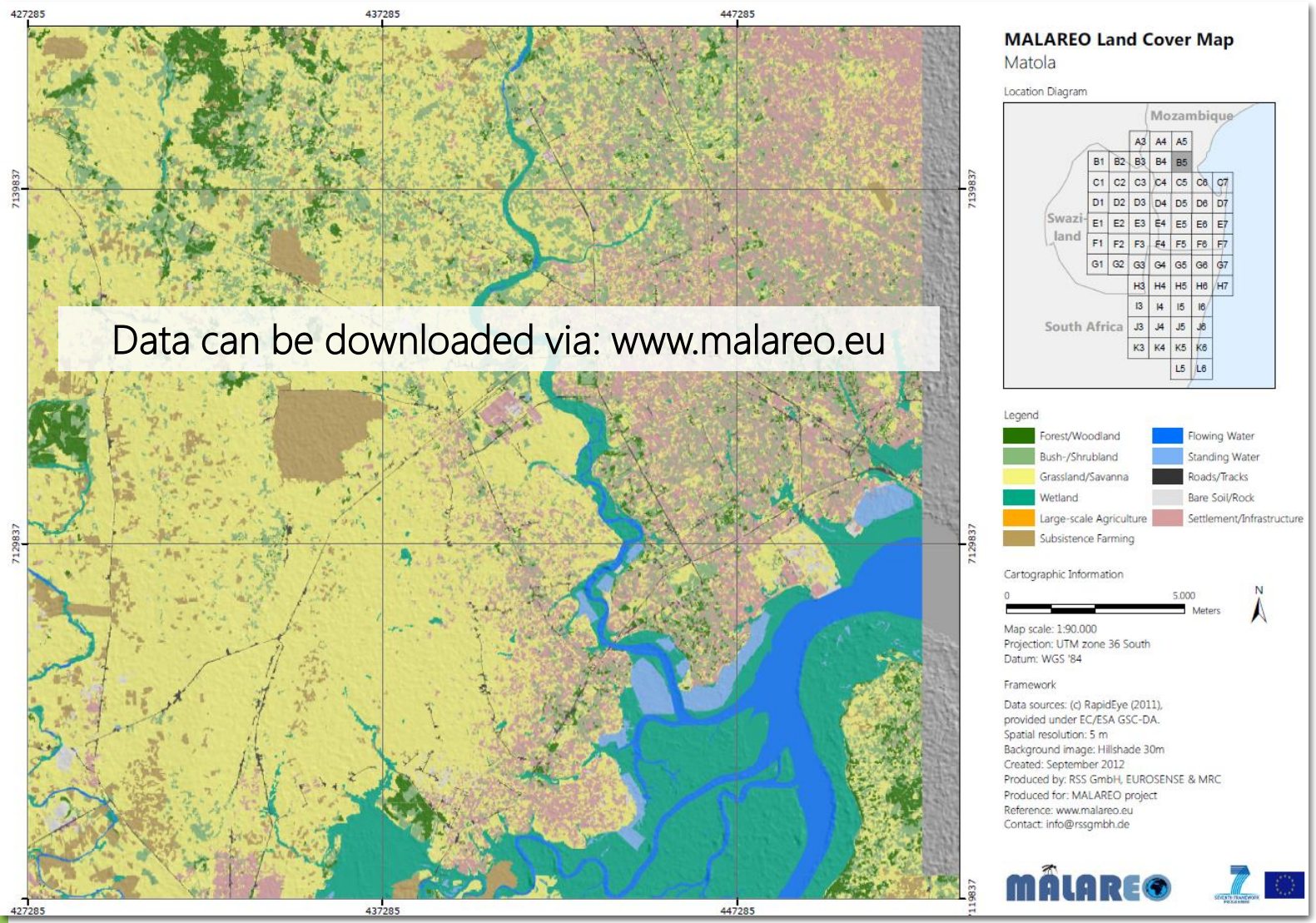
franke@rssgmbh.de
siegert@rssgmbh.de
www.rssgmbh.de

RS-based benchmark of other forests

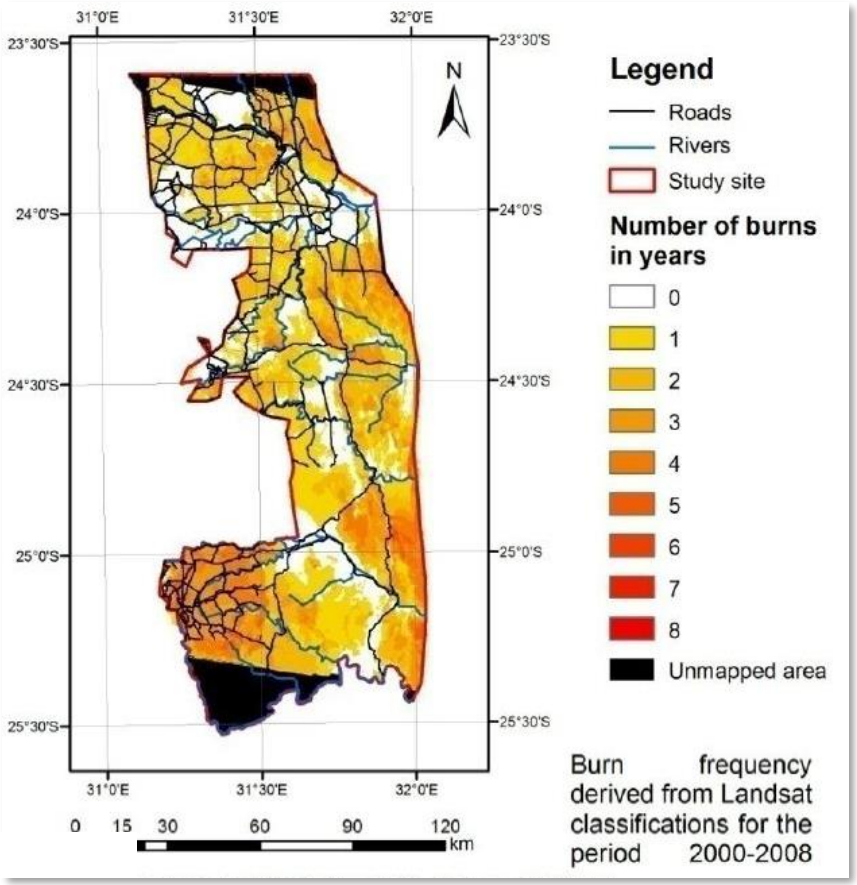
Forest extent mapped with RapidEye (2011)



WIFI - WildFire Impact Evaluation by RS

(Kruger National Park, South Africa)

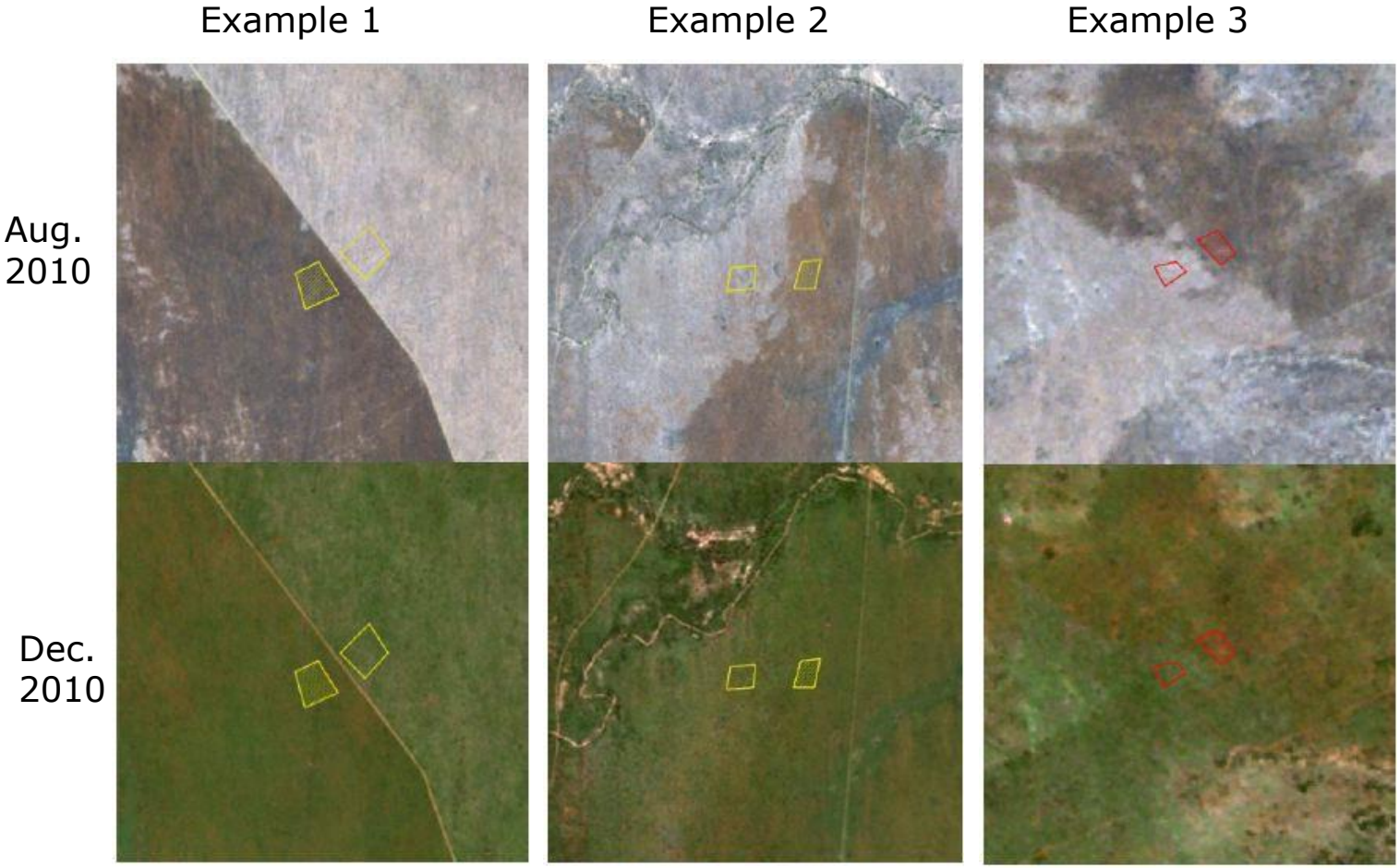
- Landsat-based fire history (classification of 21 LS scenes)
- In cooperation with Navashni Govender (Program Manager: Fire Ecology & Biogeochemistry)



RapidEye-based burned area mapping

Temporal monitoring aspects

Very fast regrowth in wet season



Selected satellite sensors suitable for REDD+

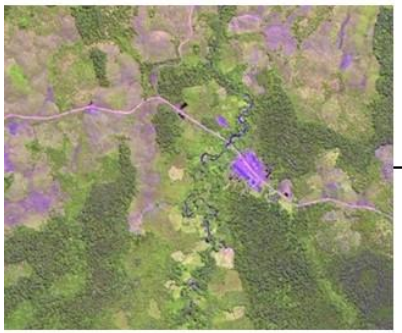
Resolution and coverage	Mission	Number of bands	Spatial Resolution	Swath Width	Revisit time
Very high resolution Small spatial coverage	WorldView-2	9 bands	PAN: 0,46 m MS: 1,84 m	16,4 km	1-6 days
	Ikonos-2	5 bands	Pan :1m MS: 4 m	11 km	
	GeoEye	5 bands	PAN: 0,41 m MS: 1,65 m	15.2 km	
	QuickBird	5 bands	PAN: 0,61 m MS: 2,44 m	16,5 km	
	Pleiades	5 bands	PAN: 0.5 m MS: 2 m	20 km	
High resolution Moderate spatial coverage	RapidEye	5 bands	6.5 m	78 km	daily
	SPOT 5 / 6	4 bands	Pan: 5 m (2.5) MS: 10 m	60 km	2-3 days
Medium resolution Large spatial coverage	Landsat 7ETM+/ 8	7-11 bands	PAN: 15 m, MS: 30 m	185 km	16 days

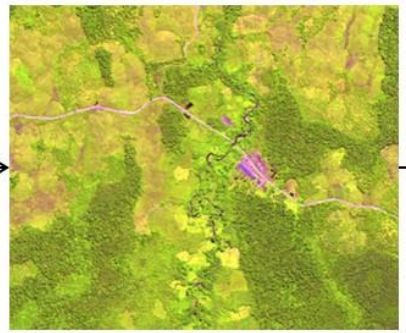
Forest Benchmark Mapping

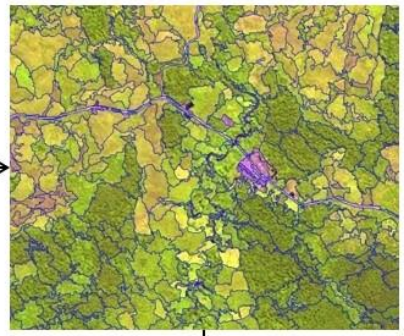
From image to information

Atmospheric correction

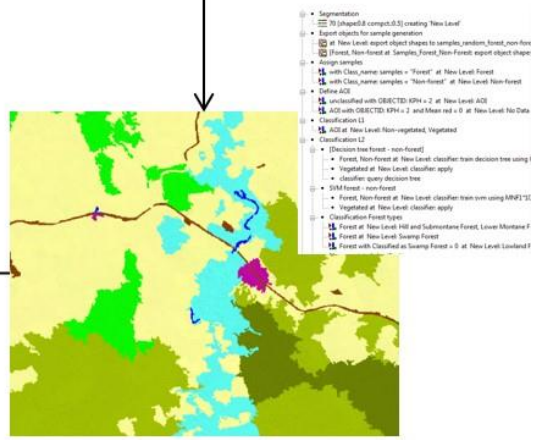
Image segmentation



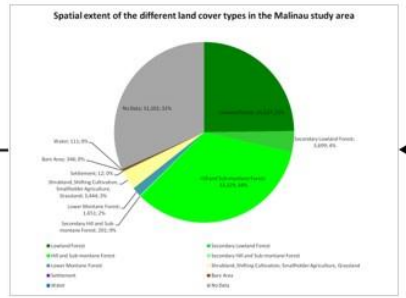


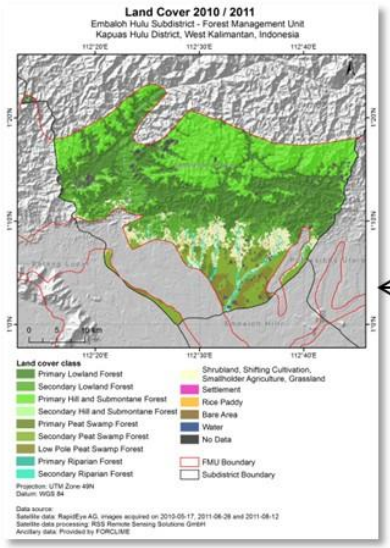


Ruleset classification



Spatial analysis

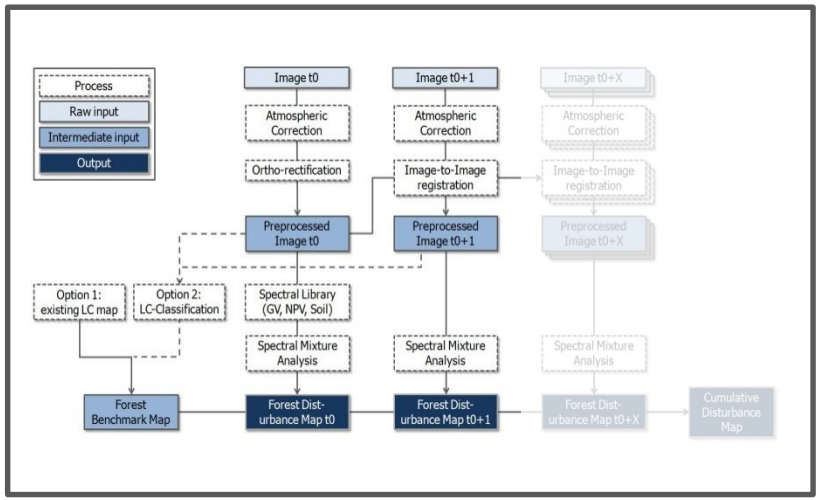




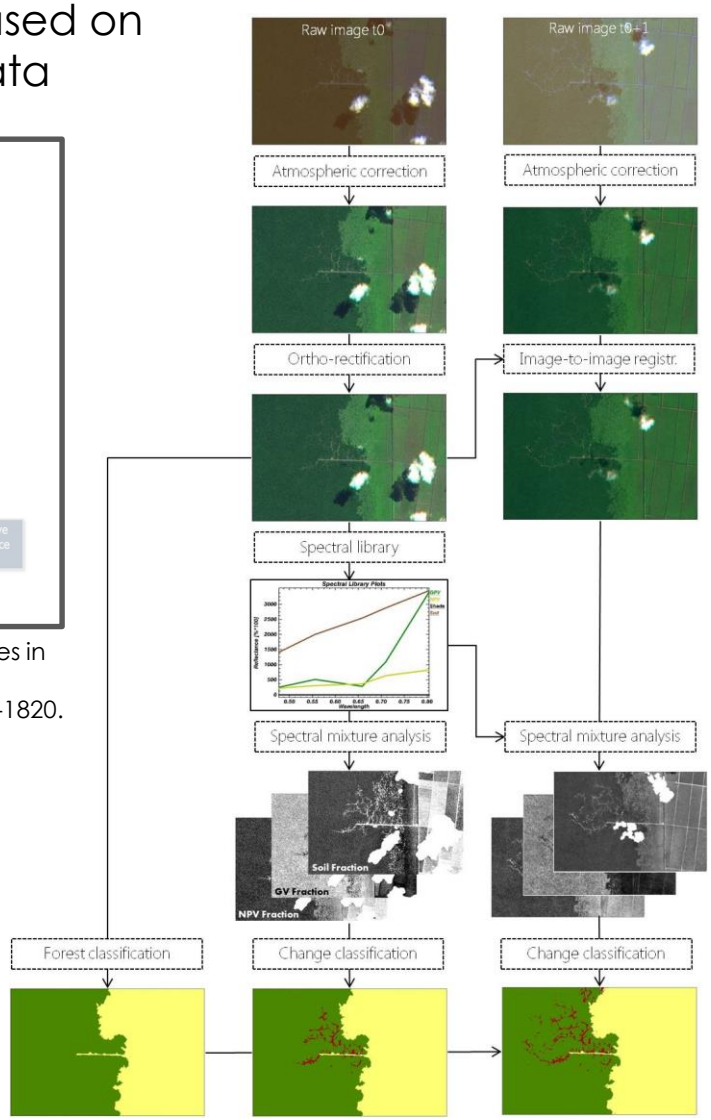
Monitoring fire and selective logging activities

RapidEye time series analysis

Forest change detection system based on optical high-resolution RapidEye data



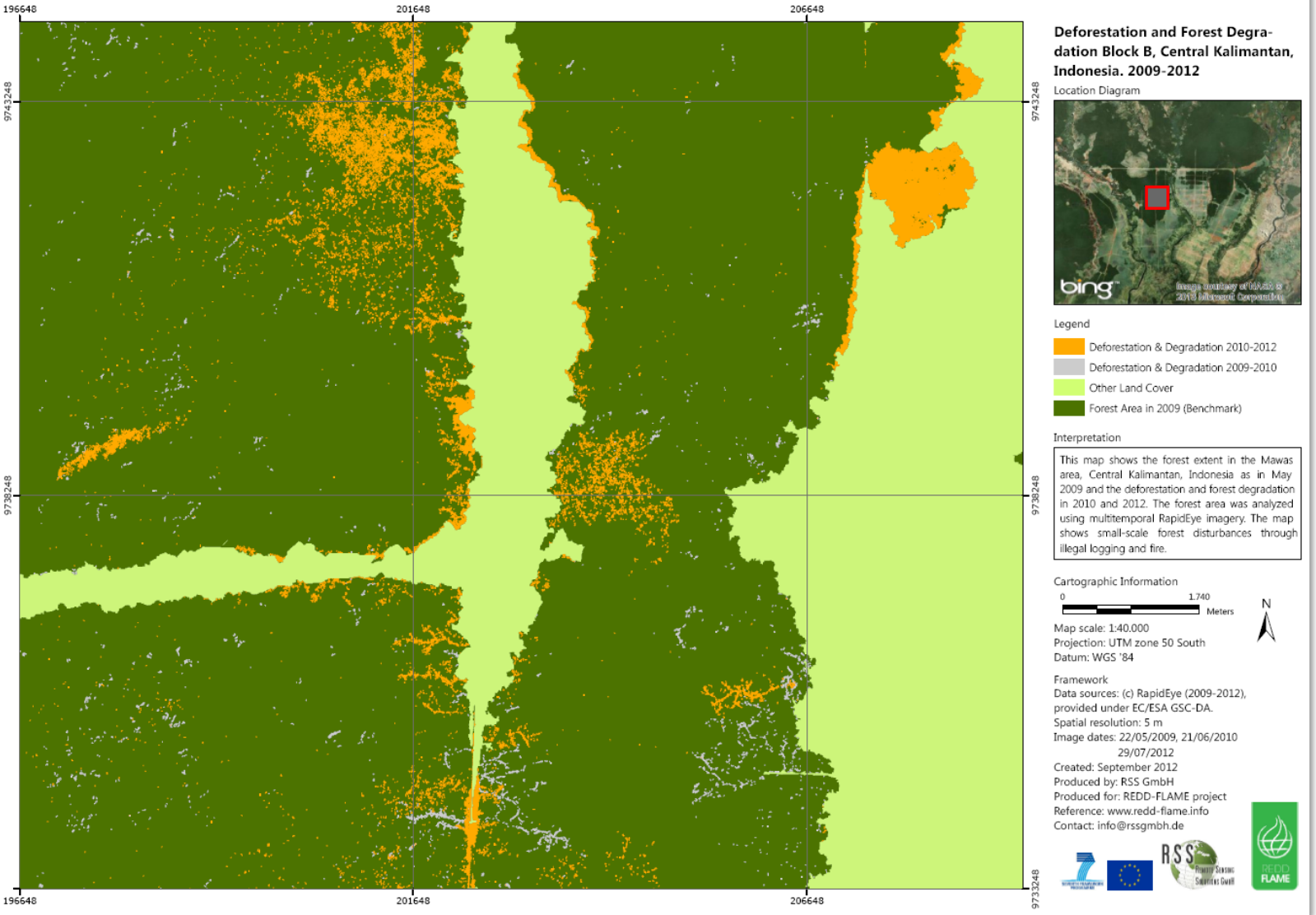
Franke et al. (2012): Monitoring fire and selective logging activities in tropical peat swamp forests. IEEE Journal of Selected Topics in Applied Earth Observations and Remote Sensing, Vol. 5(6), 1811-1820.



Activity data on D&D:

Monitoring fire and selective logging activities

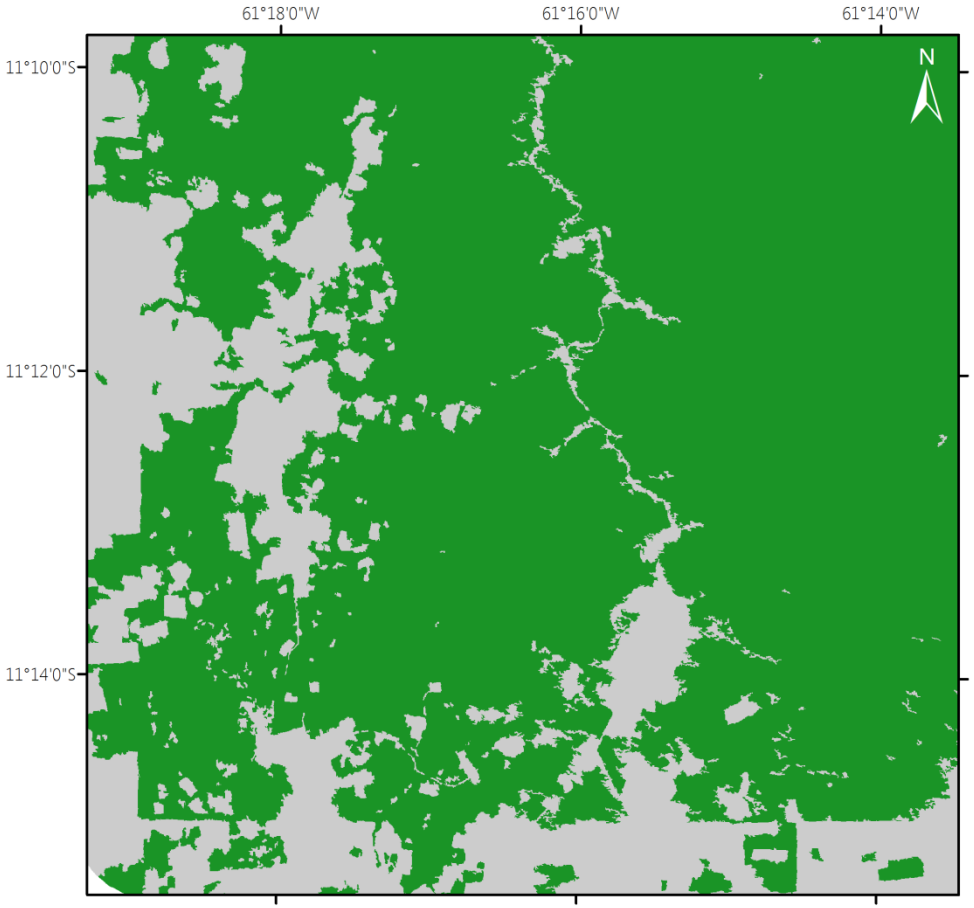
RapidEye time series analysis



Monitoring fire and selective logging activities

Example REDD demonstration site in Brazil

Sete de Setembro Indigenous Land, Mato Grosso, Brazil
Forest Monitoring 2009 - present



Legend

- Forest
- Other land cover

Data Source:
RapidEye, acquired on
09/07/2009 and 13/08/2009

(c) RapidEye (2011), provided
under EC/ESA GSC-DA

Projection:
WGS 1984, UTM Zone 20S

Processing:
Project: REDD-FLAME
Production: Remote Sensing Solutions GmbH

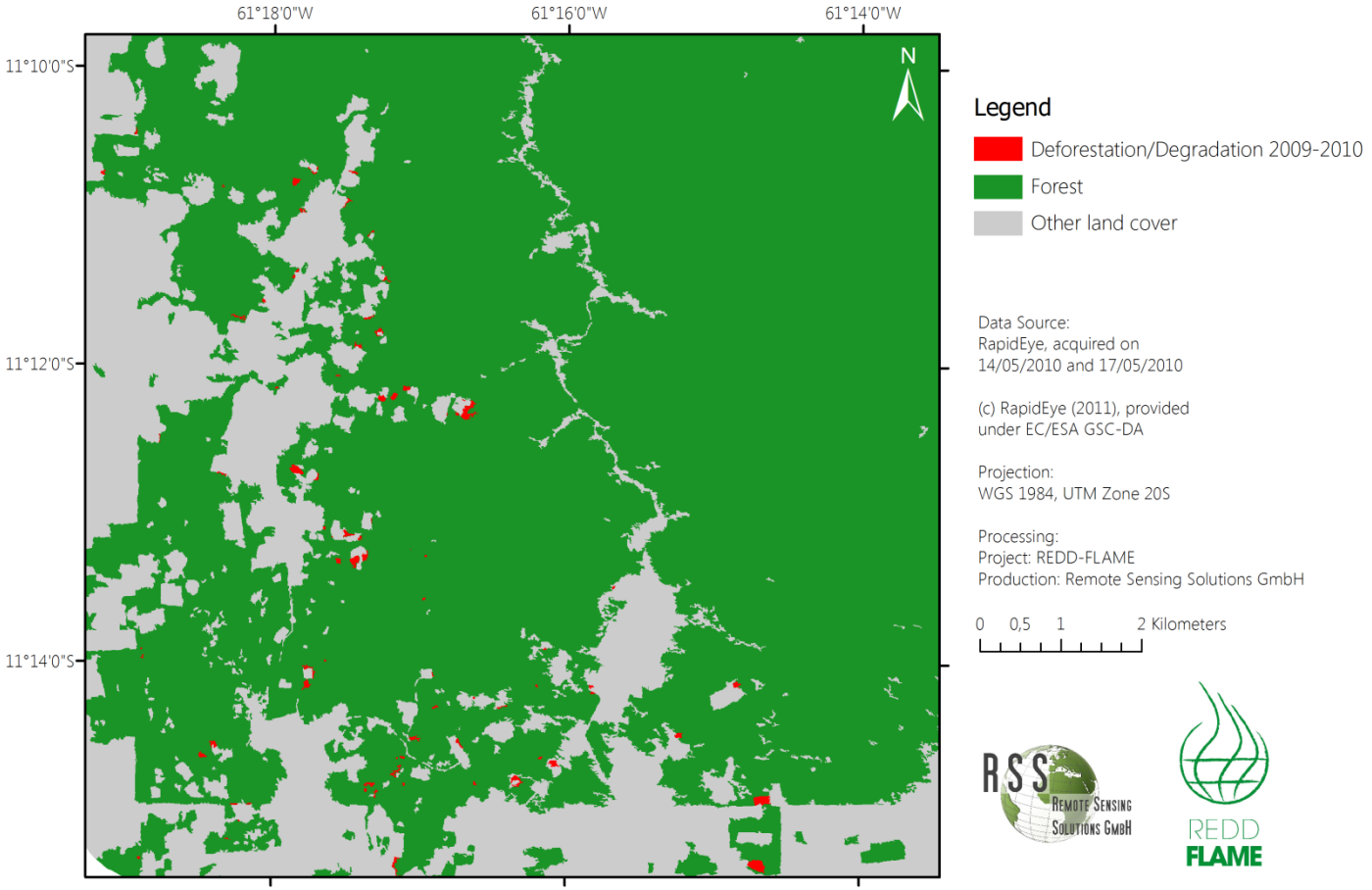
0 0,5 1 2 Kilometers

REDD FLAME

Monitoring fire and selective logging activities

Example REDD demonstration site in Brazil

Sete de Setembro Indigenous Land, Mato Grosso, Brazil
Forest Monitoring 2009 - present



Monitoring fire and selective logging activities

Example REDD demonstration site in Brazil

Sete de Setembro Indigenous Land, Mato Grosso, Brazil
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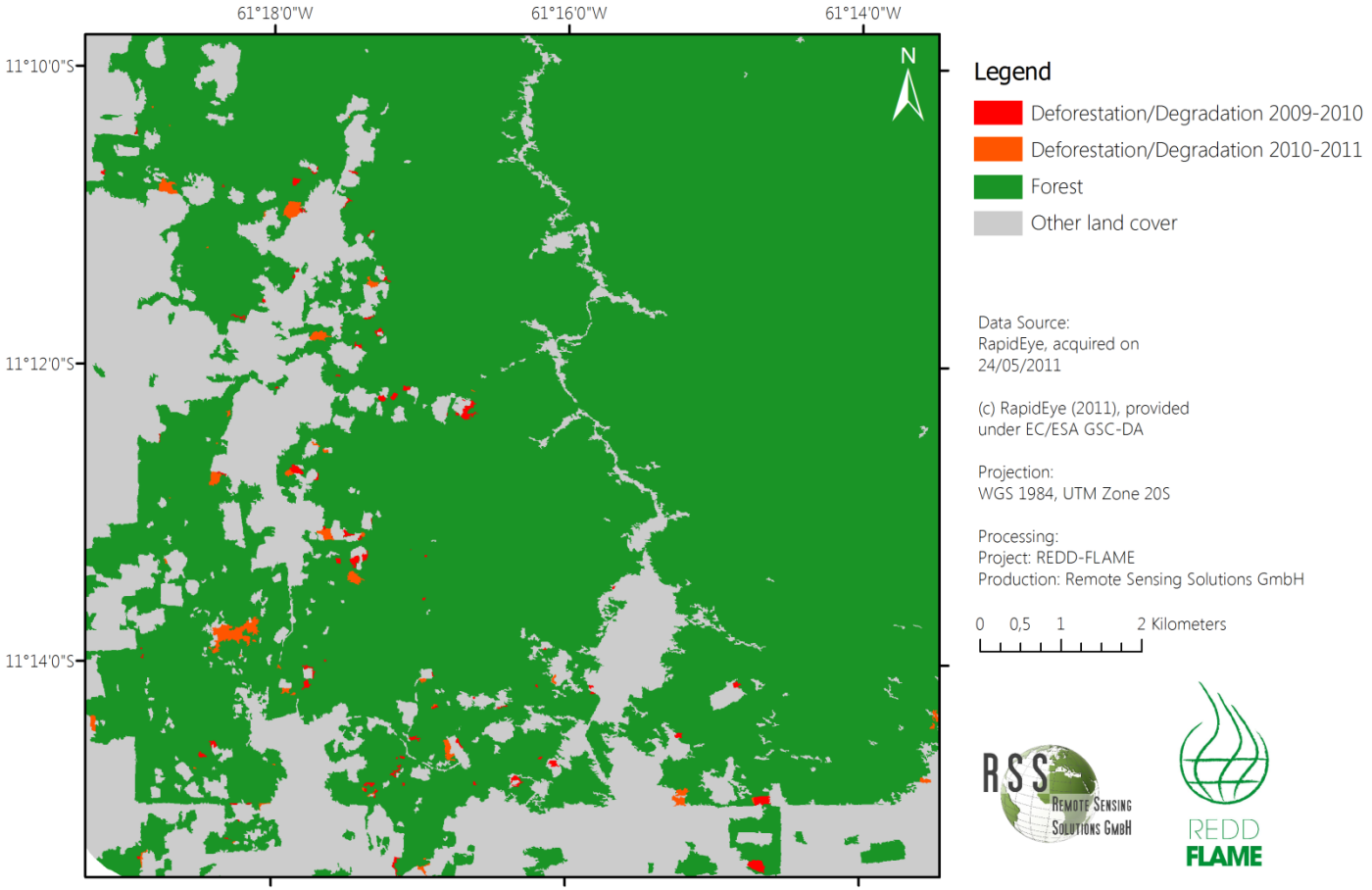
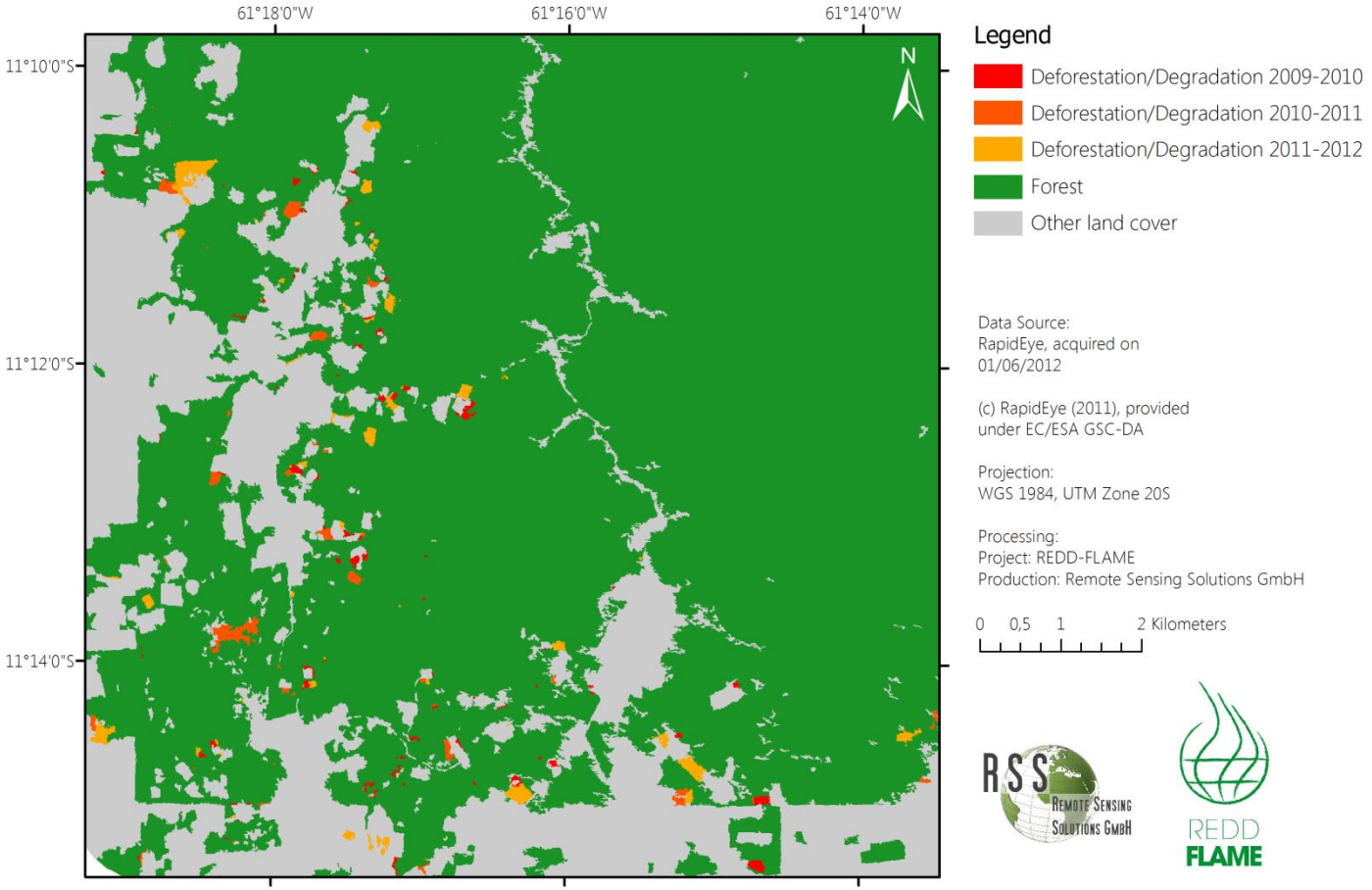


Monitoring fire and selective logging activities

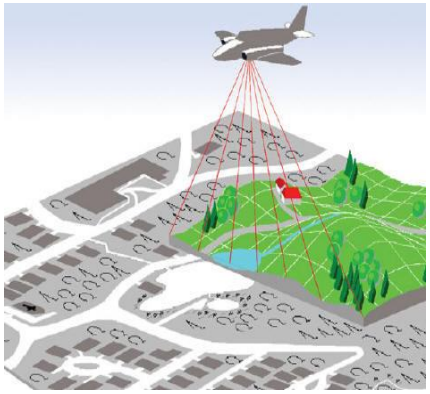
Example REDD demonstration site in Brazil

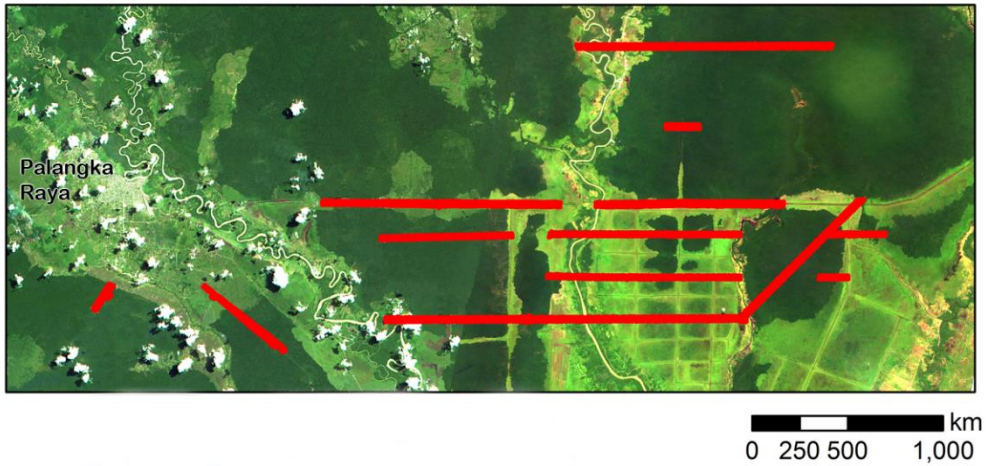
Sete de Setembro Indigenous Land, Mato Grosso, Brazil
Forest Monitoring 2009 - present

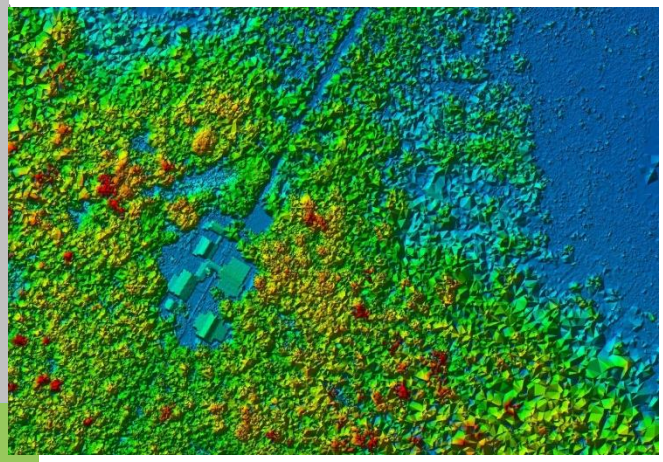


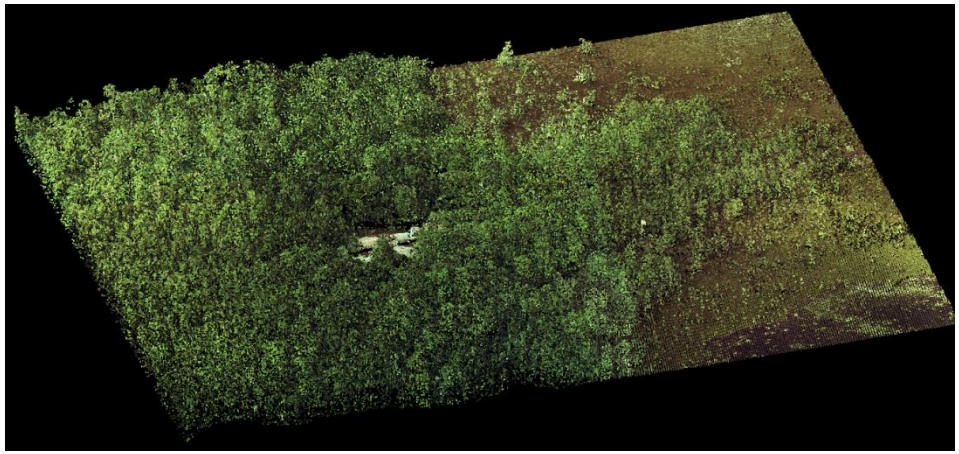
Forest structure and biomass estimation using LiDAR

Extensive data sets have been analyzed of 2007 and 2011

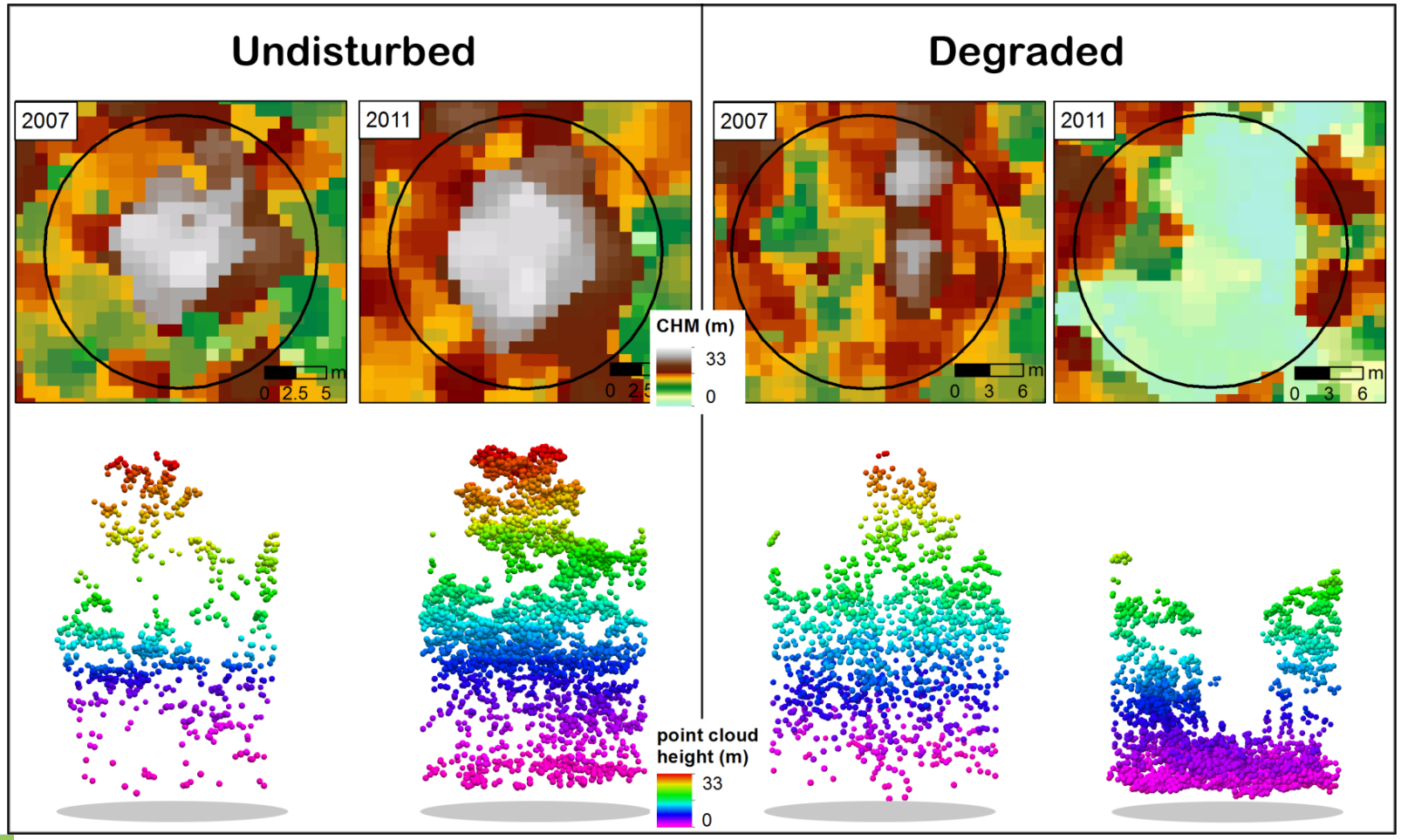








Small scale forest degradation



LiDAR

Absolute tree heights derived from LiDAR