OBIA for combining LiDAR and multispectral data to characterize forested areas and land cover in tropical region

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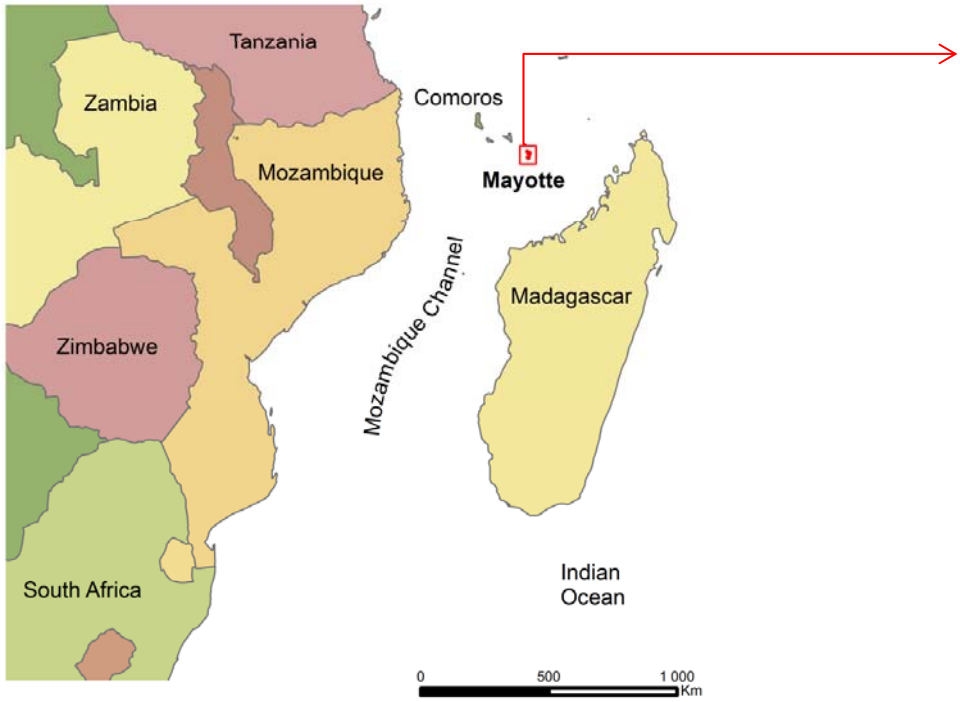
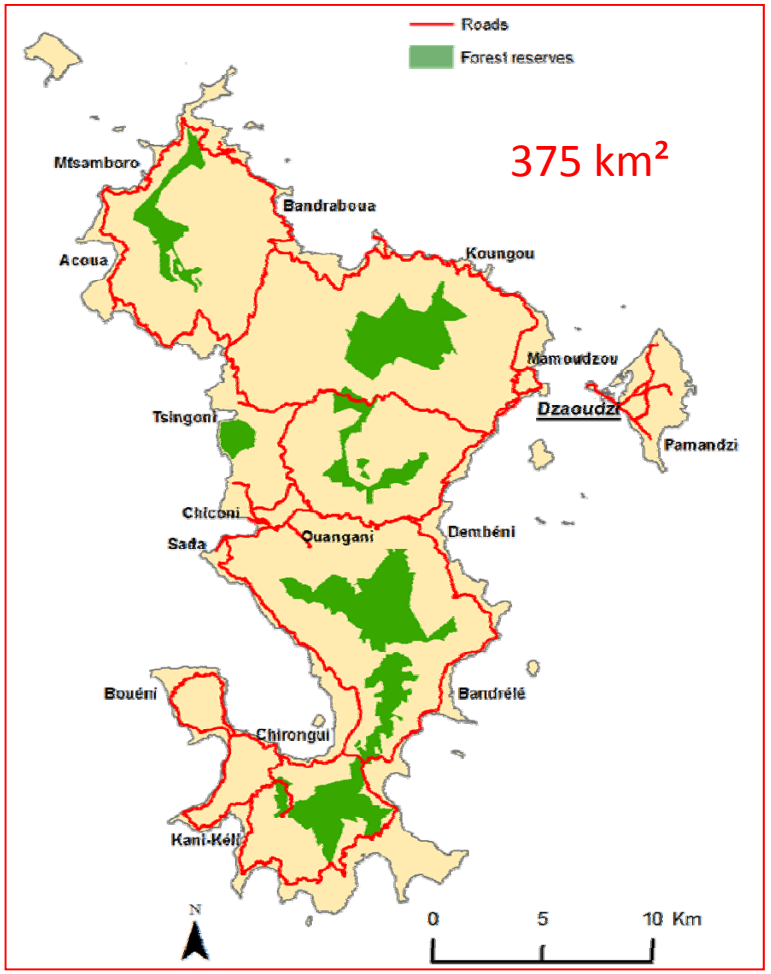
ONEMA
The French National Agency for Water and Aquatic Environments

Study area





French territory : overseas department

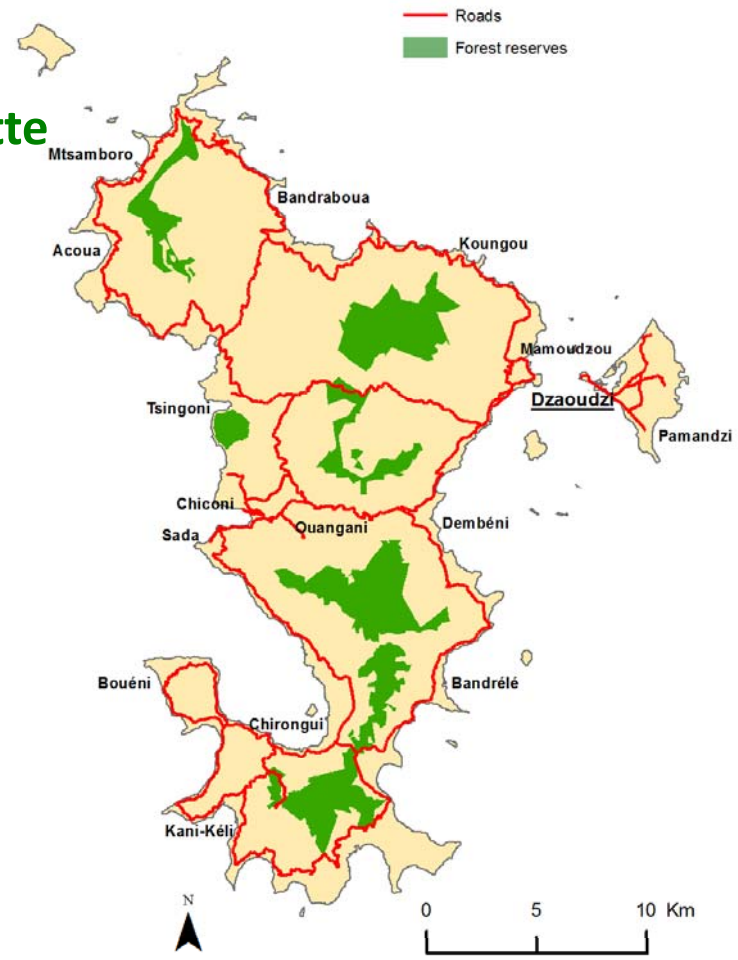
- **Mayotte is an island of the Comoro Archipelago located at the entrance of the Mozambique Channel**

Forest areas in Mayotte

- Since 2002, five forest reserves were established to preserve biodiversity of Mayotte

(5550 ha = 15% of the territory)

- Forest complexes are more or less degraded inside reserves because of old and actual human pressures



Agricultural activity in reserves
(direct human pressure)

Forest areas in Mayotte

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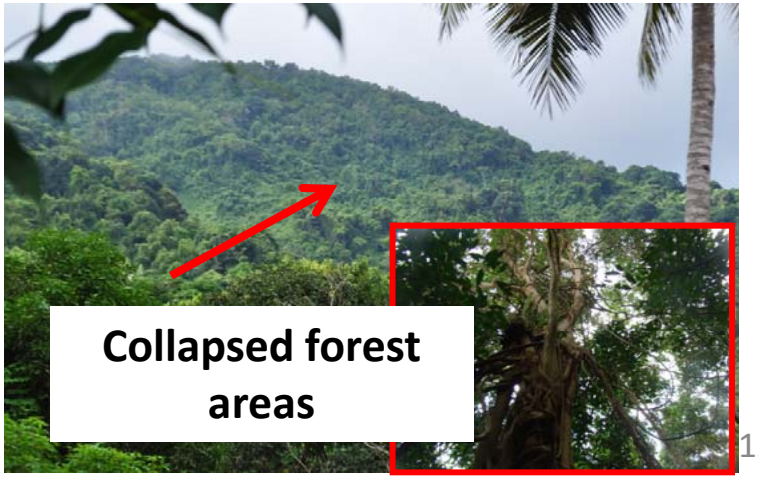
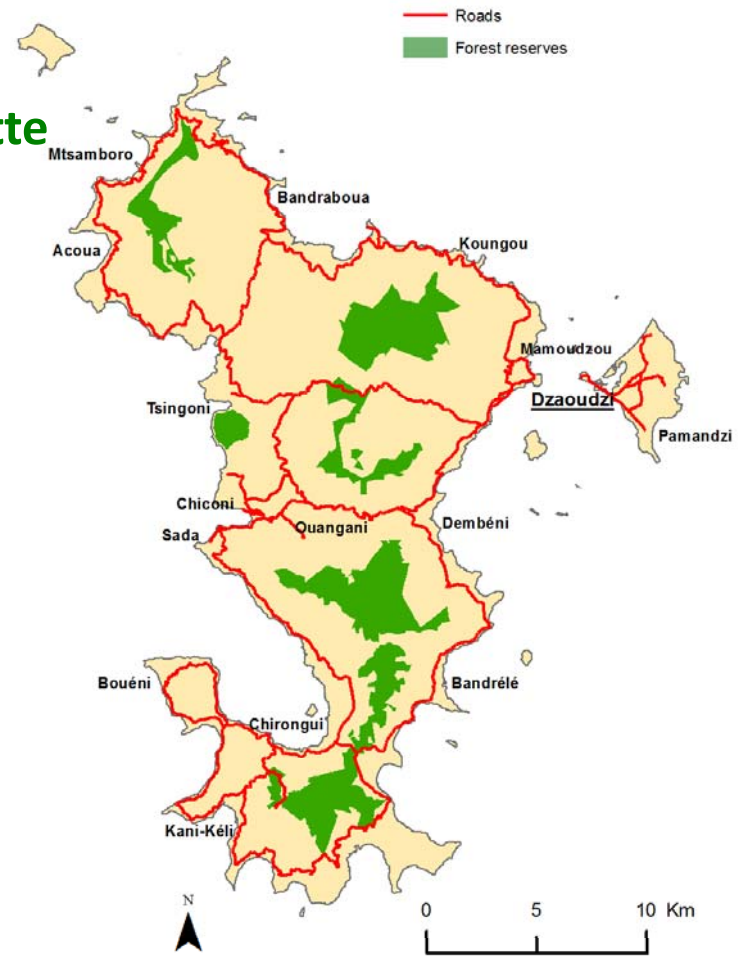
Presence of Lianas Invasive specie
(indirect human pressure)





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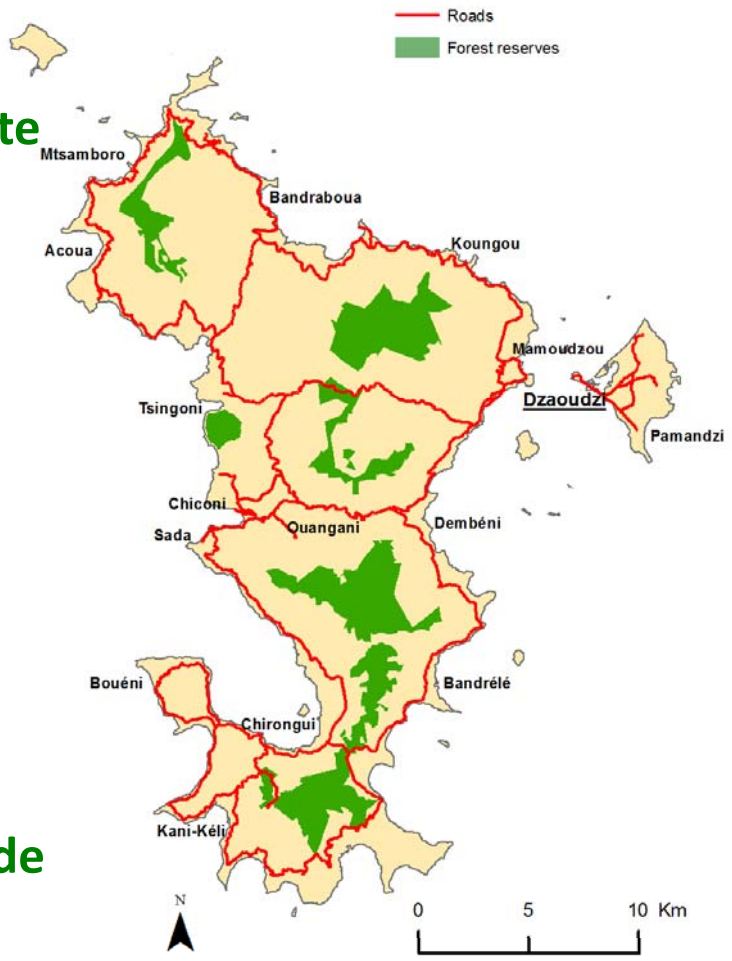


Managers need spatial information about :

1- status (degraded or not) of forest areas inside reserves

2- presence of human pressures inside and outside reserves

to prioritize preservation and restoration strategies

Objective: Mapping forest types, their status, and human pressures

❑ Classification scheme

Forest types inside reserve …. and their status

Canopy height :[5-10] m

Canopy height : ≥10 m

} **Not degraded / potentially degraded**

Other forested areas

Mangrove

Forest plantation (reforestation)

Need to Lidar & multispectral remotely sensed data

Human pressures (direct and indirect)

Collapsed forest area induced by lianas

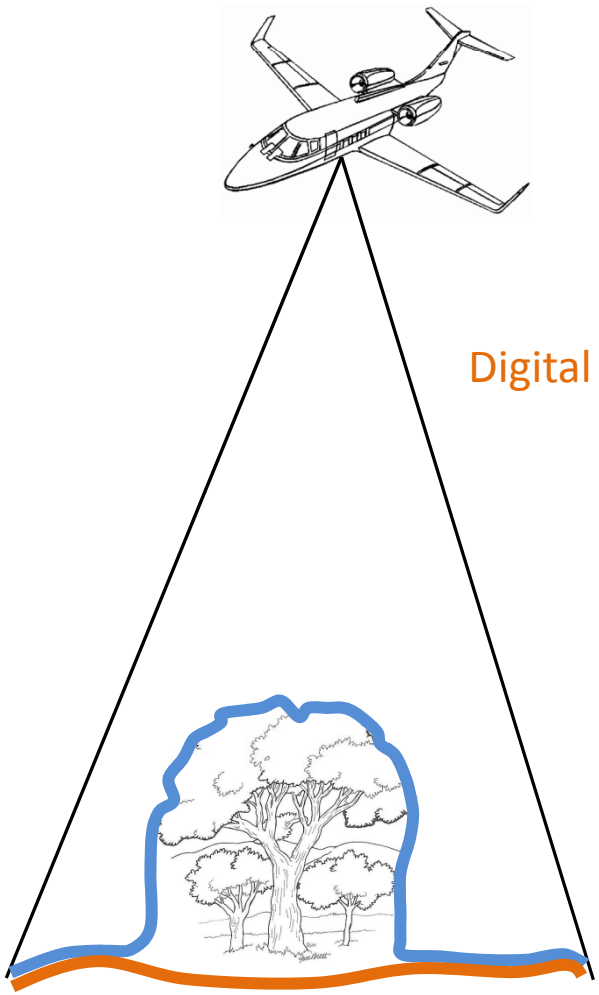
Eroded areas (bare soil / herbaceous / fern)

Artificial surfaces (urban and agricultural)

Other land cover classes

Natural Low vegetation / Shrub cover / bare soil / bare saline soil / beach dune / water …

Lidar data



Lidar cloud points
1 x 1 m, October 2008

DTM
Digital Terrain Model

difference

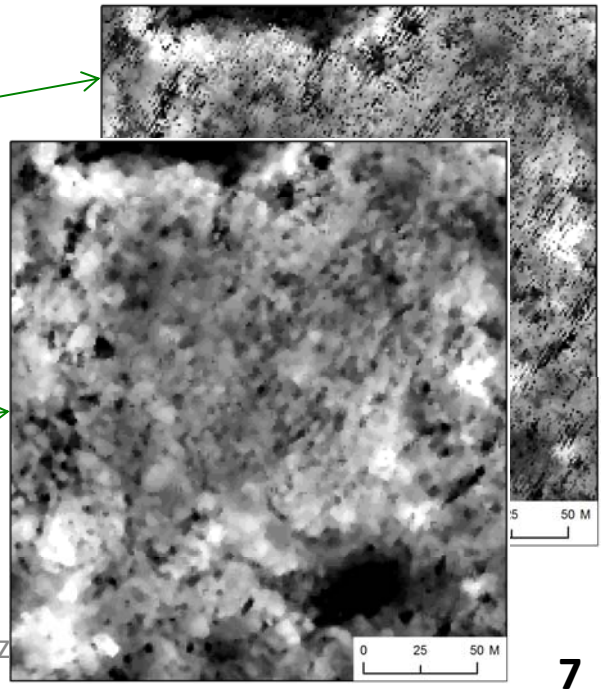
DSM
Digital Surface Model

DHM
Digital Height Model

Median filter
(3×3 m)

Popescu *et al.*, *2002*

DCM
Digital Canopy Model



Multispectral data

Spot 5 XS

Green, Red, Near Infra-Red and Medium infra-Red

10 x 10 m, June 2005

End of wet season

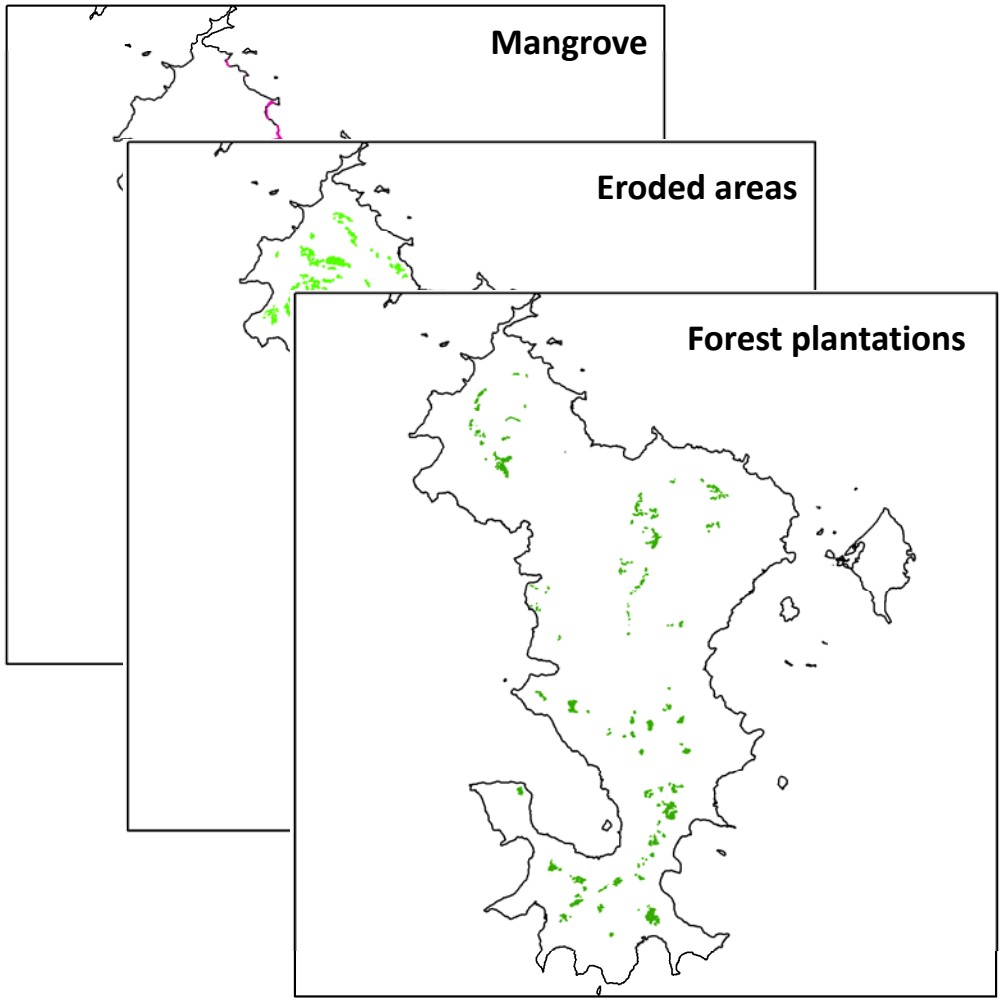
Aerial photographies (orthophotos)

Blue, Green, Red, and Near Infra-Red

0.5 x 0.5 m, November 2008

Dry season

Thematic data



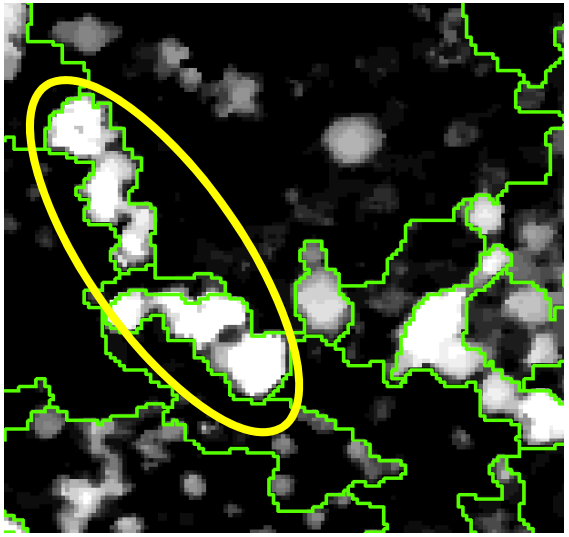
- Mangrove
- Eroded areas
- Forest plantations
- Collapsed forest areas with liana
- Artificial surfaces (Built up area, Main road, Mine dump....)

Resulting from :
1- available topographic data or
2- previous photo-interpretation studies based on multispectral images

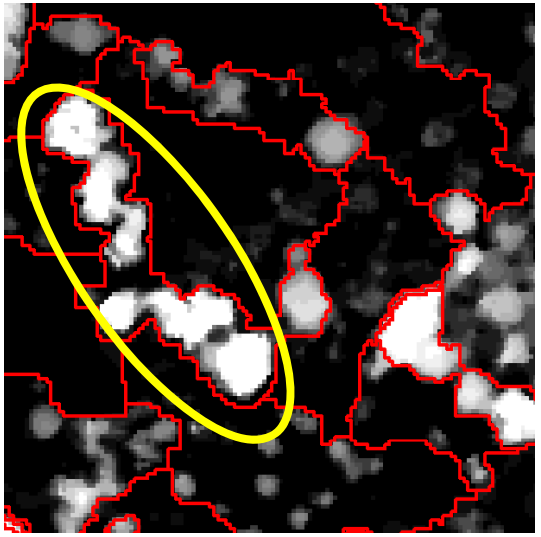
Two pre-processing on DCM data

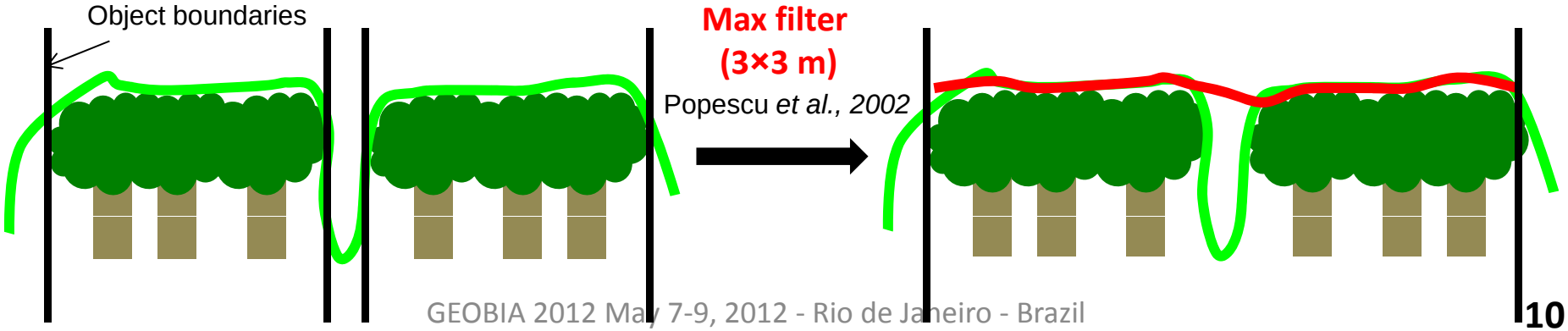
- **1-For improving segmentation of forest type**

Based on DCM



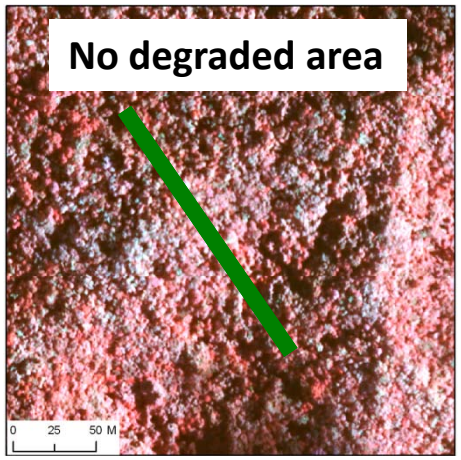
Based on Max filter and DCM

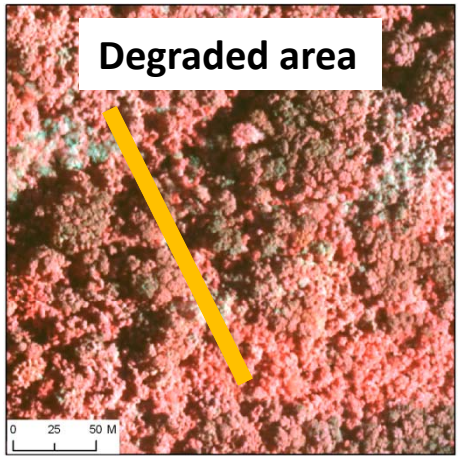




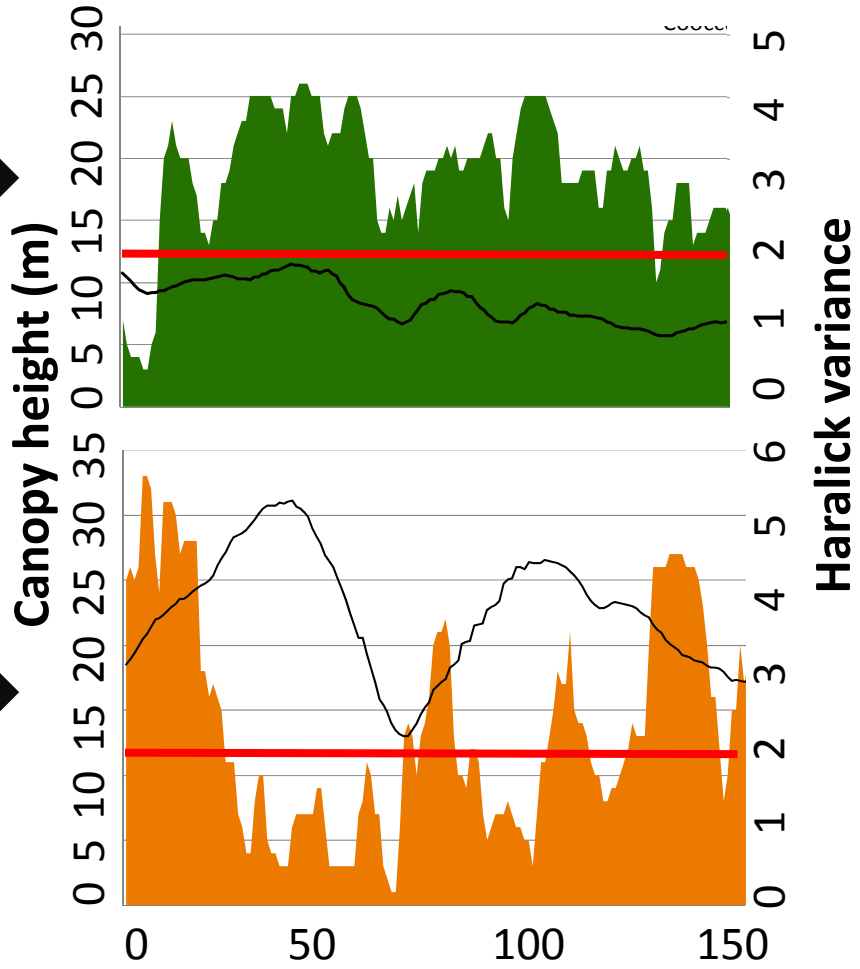
Two pre-processing on DCM data

- 2- For enhancing the classification of forest types status (degraded or not)





DCM profile on transect



Haralick texture : GLCM variance all directions

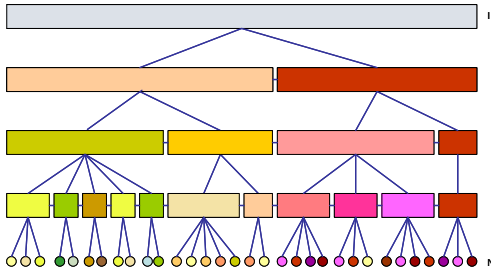
51 m x 51 m.

> 2 potentially degraded

< 2 not degraded

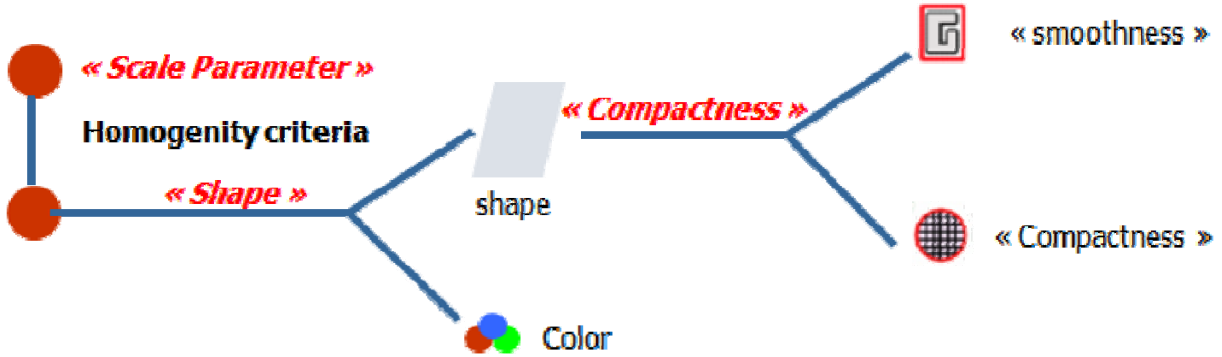
Image classification technique

- **OBIA**
  - Multi-level segmentation approach

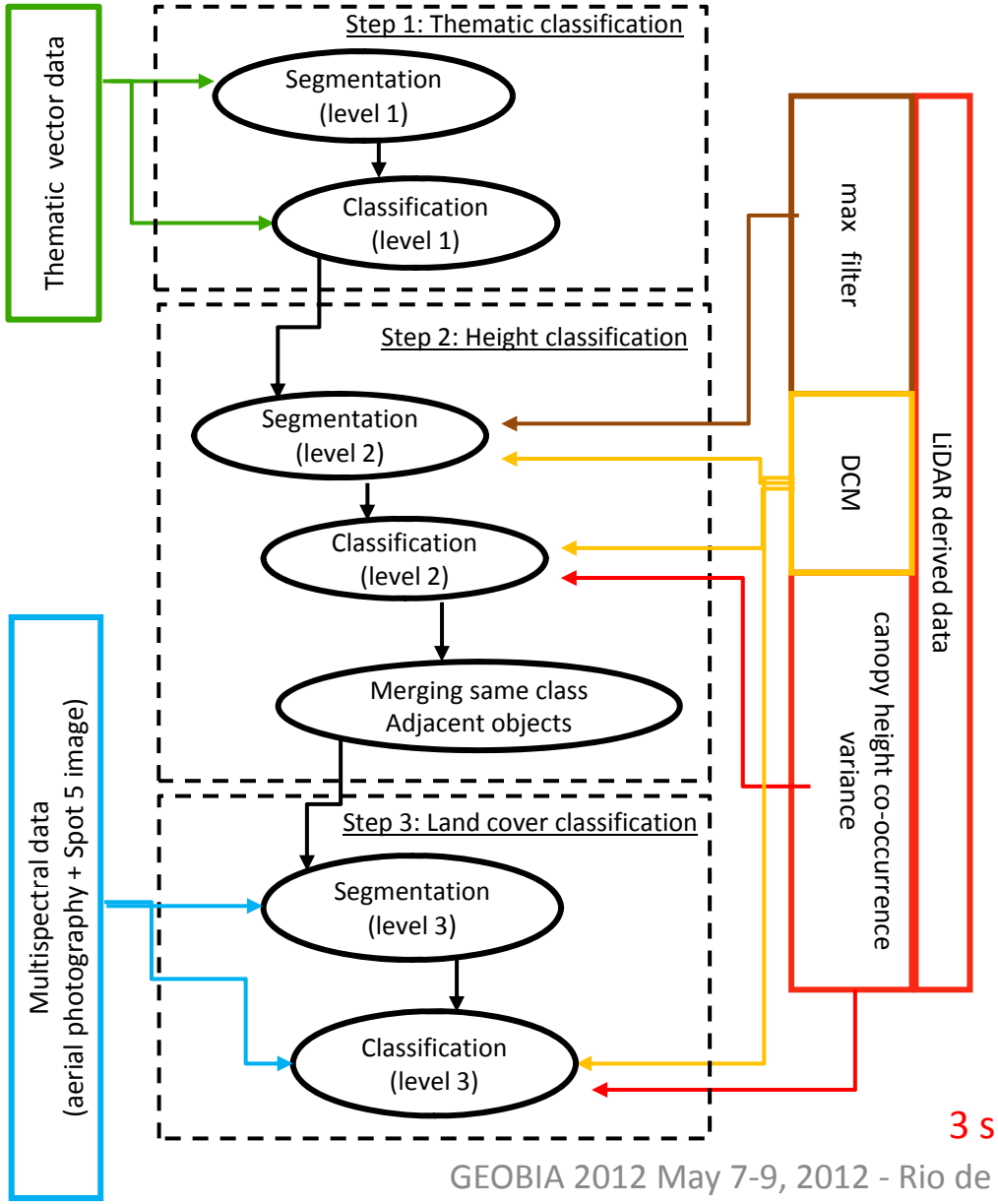


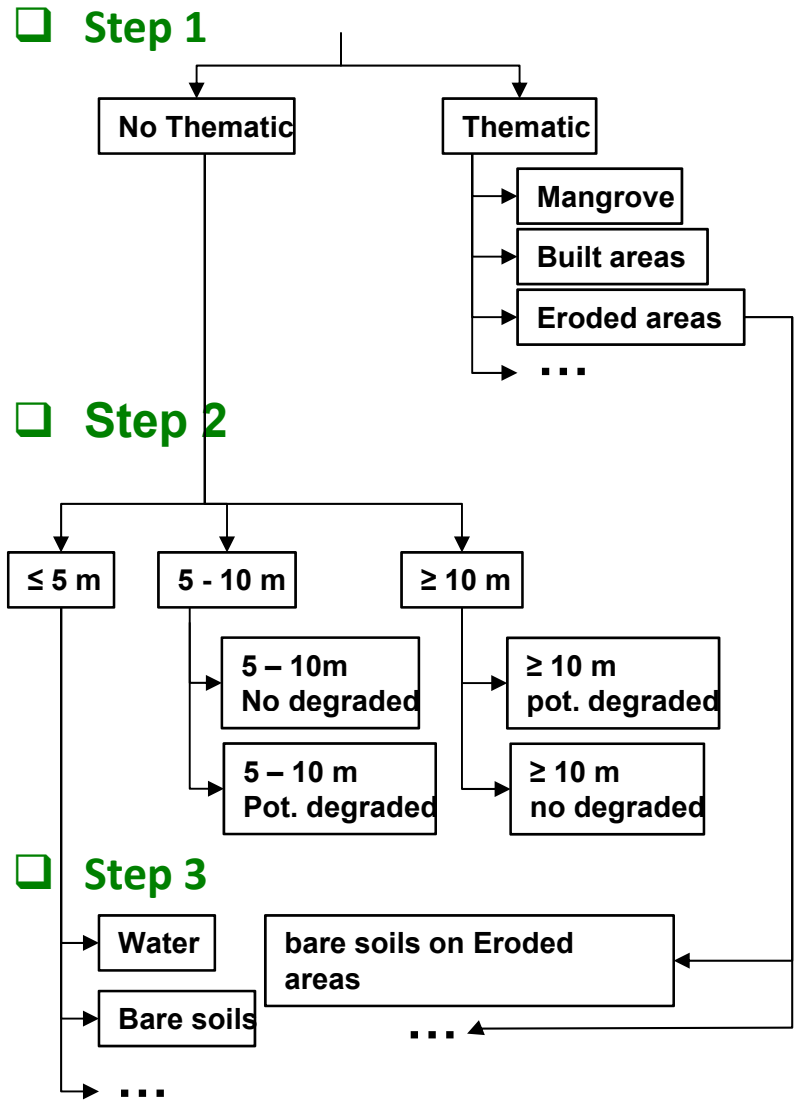
  - Classification based on expert knowledge rules

- **Software**
  - eCognition 8 using multi-resolution algorithm (region growing technique)



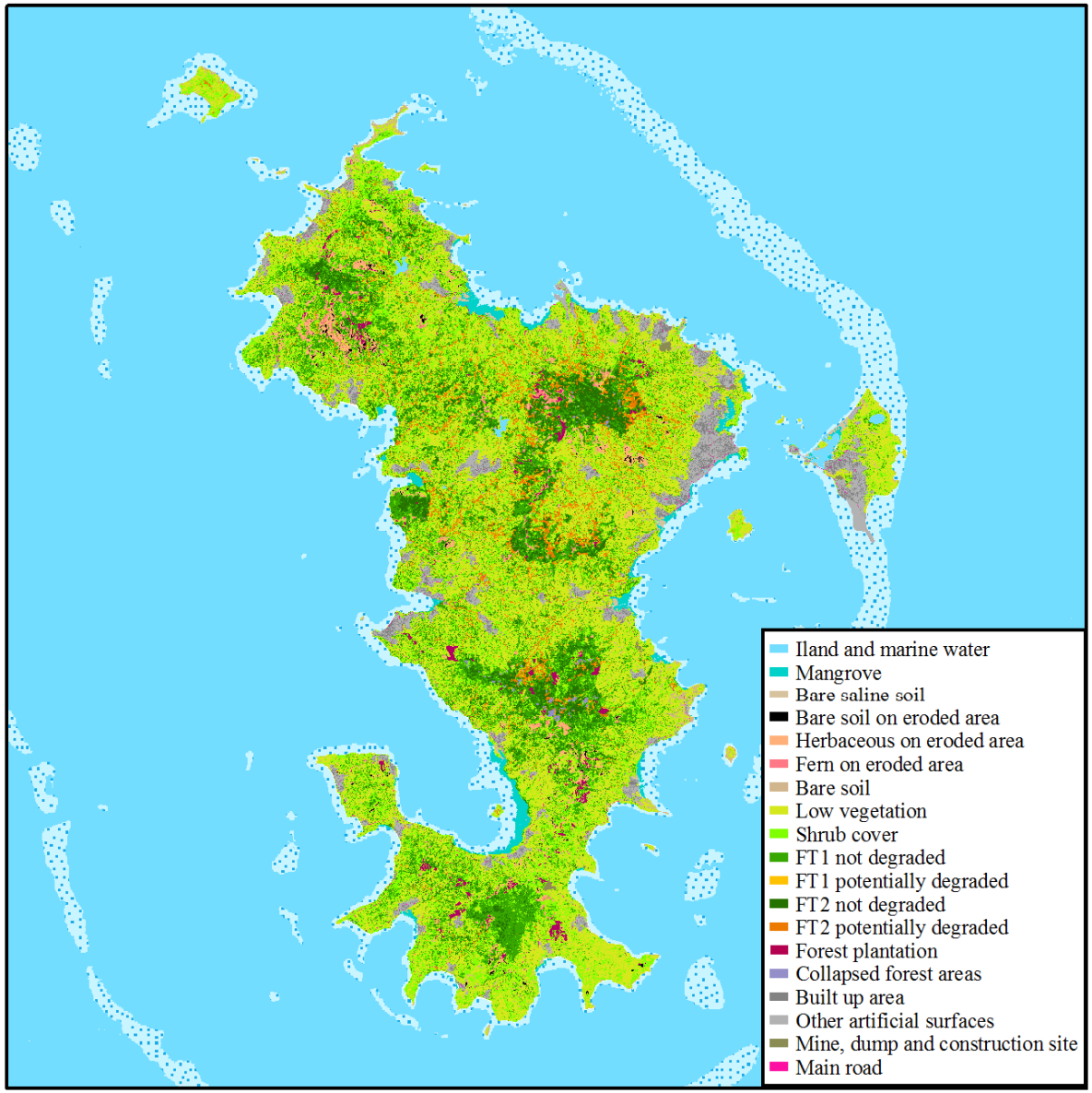
OBIA workflow





3 successive segmentation-classification processes

Map accuracy



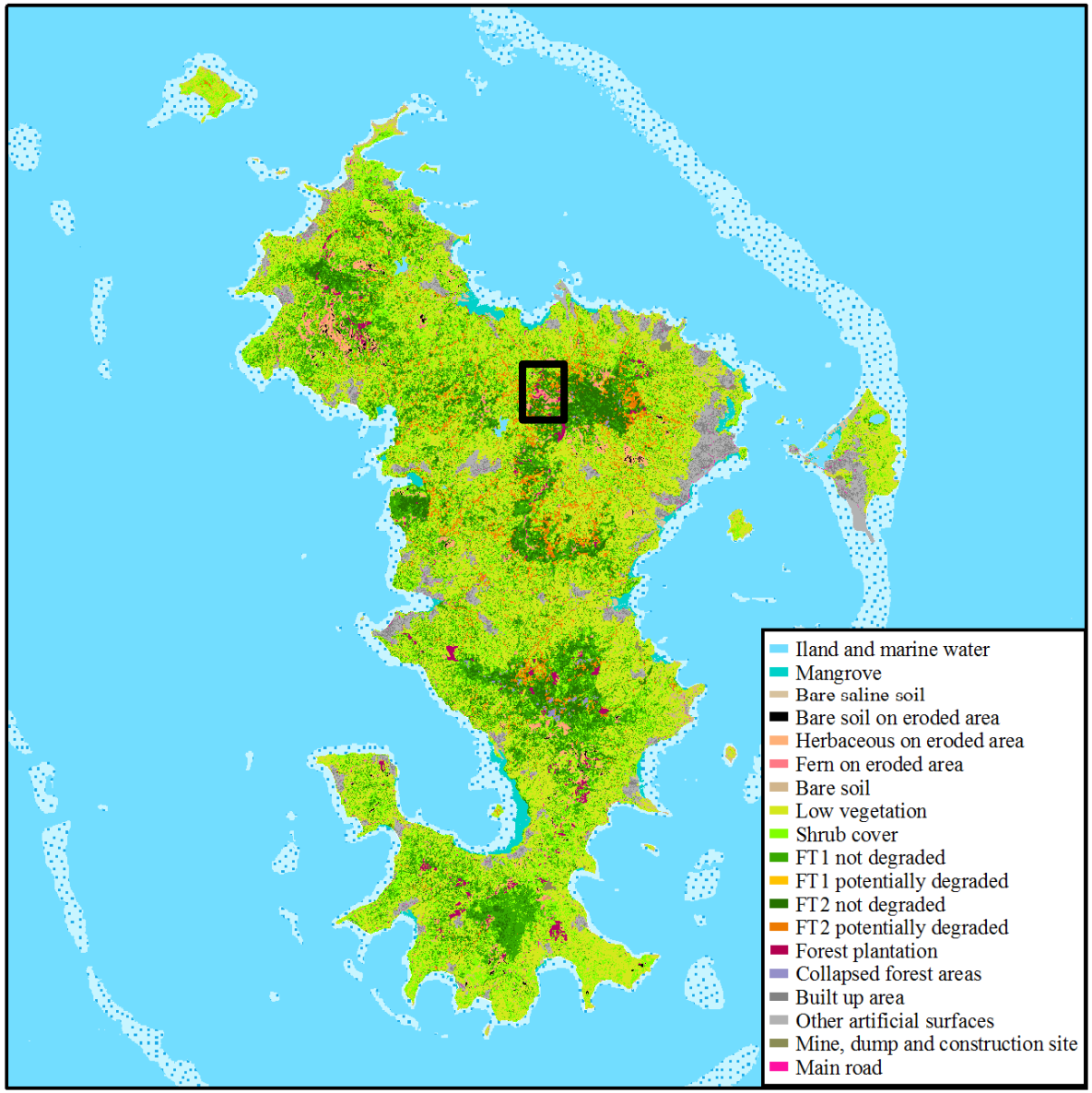
Control data derived from field measurements

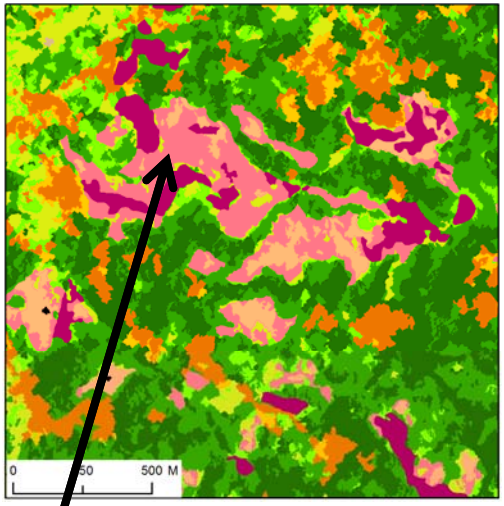
August and October 2009 and January 2010

- **Global accuracy** : 84 %
- Kappa index : 80 %

- Highly accurate results for (more than 80%)
  - forest types
  - shrub and low vegetation
- Poorest accuracy for (less than 80 %)
  - bare soil on eroded area
  - herbaceous on eroded area

Interest for forest managers





Precise localization of eroded areas within reserves

Support managers in prioritization of reforestation strategies

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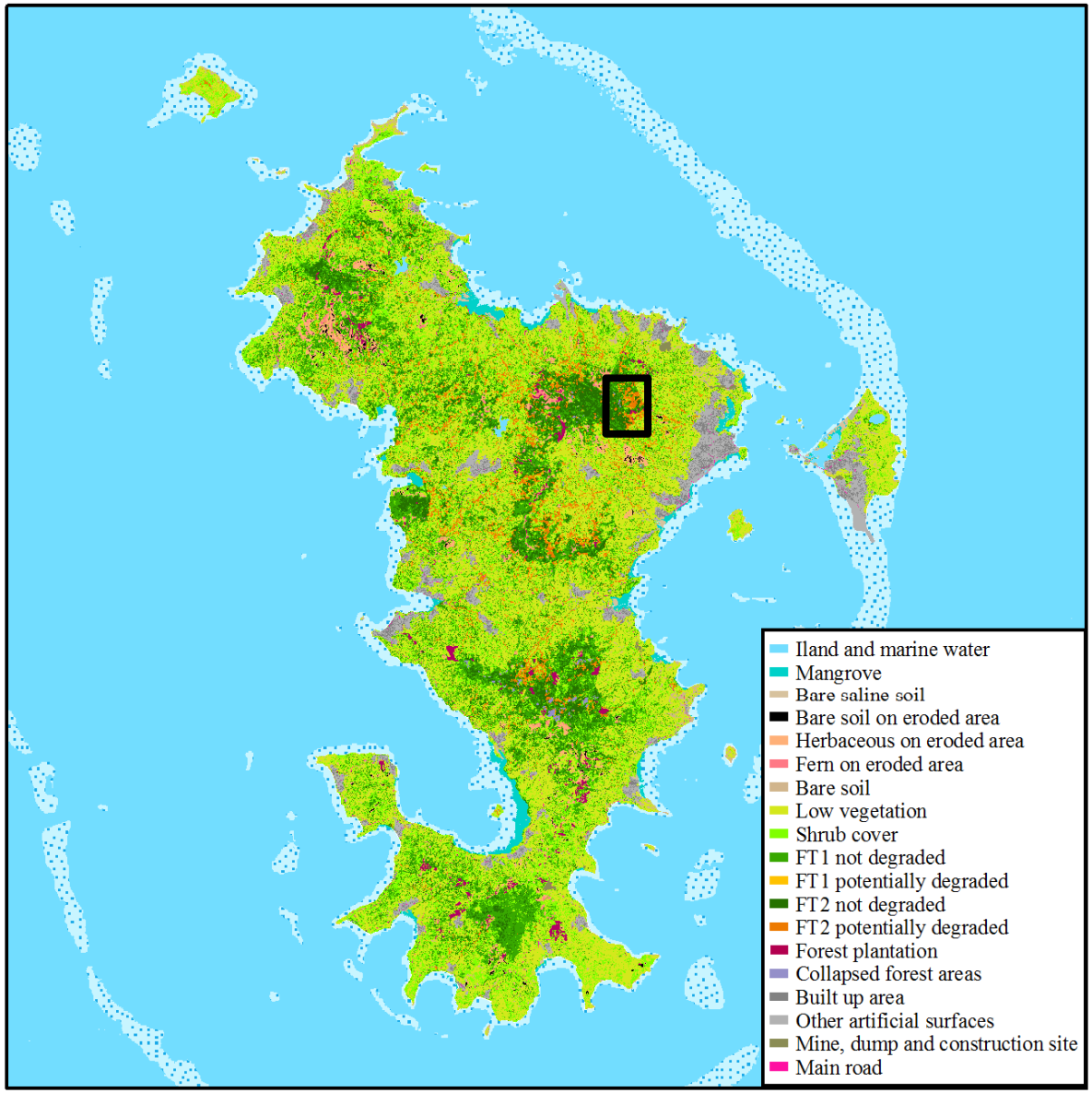
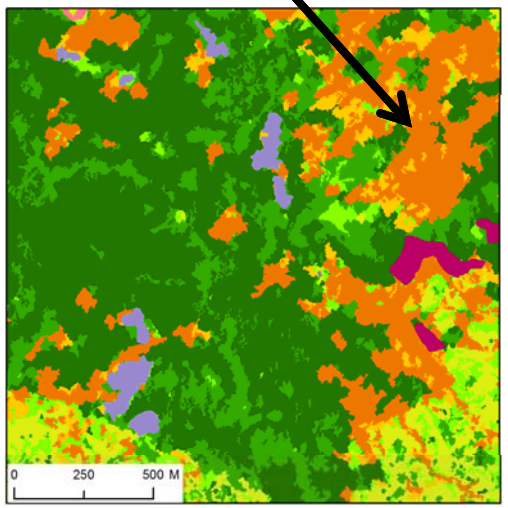
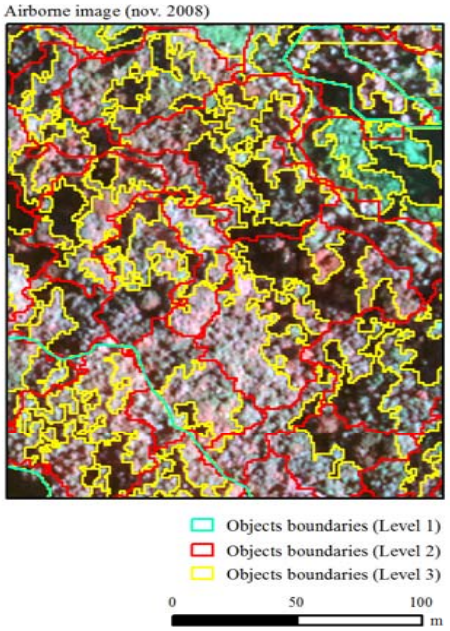


Support managers in prioritization of forest restoration strategies (cutting fruit tree, promoting local species)

Precise localization of forested areas potentially degraded (due to agricultural activity in this example)



Conclusion



=> OBIA is a suitable framework for exploiting multisource information, in segmentation process as well as in the classification process

=> LiDAR data was found particularly favorable for characterizing forest types in a tropical context, due to the information it provides on canopy height and its heterogeneity

Outlook

=> discriminating forest types according to their composition (deciduous, evergreen or mixed)

we have attempted in this study with these data but …

- **Spot 5 satellite image was not acquired at the suitable date (June month) for discriminating deciduous to evergreen**
- **A high radiometric heterogeneity between the numerous orthophotos**
- **A High presence of shadows on orthophotos**

Exploring more radiometric VHSR images acquired at suitable period and acquisition conditions : quickbird or pleiades images for example

GEOBIA 2012

Rio de Janeiro Brazil

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Thanks for your attention!