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

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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)

- Eroded areas result from slash and burn cultivation
- Clearing of local species
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

  Presence of Lianas: Invasive specie (indirect human pressure)

Collapsed forest areas
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

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

Other forested areas
- Mangrove
- Forest plantation (reforestation)

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
- **DSM** Digital Surface Model
- **DHM** Digital Height Model
- **DCM** Digital Canopy Model

*Popescu et al., 2002*
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

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Two pre-processing on DCM data

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

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)
Step 1: Thematic classification

- No Thematic
- Thematic
  - Mangrove
  - Built areas
  - Eroded areas

Step 2: Height classification

- ≤ 5 m
- 5 - 10 m
- ≥ 10 m
  - ≤ 5 m
    - No degraded
  - 5 - 10 m
    - Pot. degraded
  - ≥ 10 m
    - ≥ 10 m
      - Pot. degraded
      - ≥ 10 m
        - no degraded

Step 3: Land cover classification

- Water
- Bare soils
  - bare soils on Eroded areas
  - ...
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

Method

Result

Conclusion

Precise localization of eroded areas within reserves

Support managers in prioritization of reforestation strategies

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Interest for forest managers

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.
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Thanks for your attention!