Canopy textural properties from metric resolution imagery: Validation, sensitivity and perspectives within REDD.

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Programme Pilote de recherches:
Biodiversité, Changements globaux et Santé dans les forêts tropicales humides

• Part of a broader effort from IRD in central Africa:
  ▪ Tropical forest as a focal object for interdisciplinary research ;
  ▪ Consequences of global change on biodiversity, resources and health;
  ▪ Possibly set up permanent research platforms.

• Yaoundé workshop 10/2009

➤ Call for partnerships...
Need to quantify canopy structure

• Valuable for:
  ▪ Carbon dynamics and forest degradation assessment;
  ▪ Forest ecology (allometry rules, gap dynamics, etc.);
  ▪ Forest-climate interaction (gas and vapor exchange);
  ▪ Forest types, etc.

• Difficult to measure in the field,
  ▪ Approached via indirect estimates (DBH);
  ▪ Limited representativeness.
Remote sensing methods

• **Limitation** of pixelwise optical and radar:
  - Saturation for high biomass levels (>250 t/ha);
  - Unable to detect degradation.

• High cost of airborne sensors (e.g. LiDAR).

• Potential of **VHR imagery** (Quickbird, Ikonos, etc.) but operational methodologies to be developed.
RCA: GeoEye pansharpened G-NIR-B
Peaks at dominant frequencies

Fourier periodograms: quantification of image texture

Proisy et al. RSE (2007)

French Guiana
**2D Fourier transform textural ordination (FOTO)**

- 2D Fourier transform
- Radial power spectrum (r-spectrum)

  = Proportions of the image variance accounted for by successive frequency bins, across azimuthal orientations.

- Principal components of image r-spectra dataset

  = Identification of main axes of textural variation in the image dataset.

**Workflow:**

1. **Imagery** (metric optical) Forest cover
2. **Unit-windows** 100 - 150 m sides
3. Fourier analysis r-spectra computation
4. Frequencies
5. **Table of r-spectra**
6. Separation into homogeneous acquisition groups
7. **Global standardisation**
8. **Partitioned standardisation**
9. **PCA ordination**
10. **Texture indices** (PCA 1, PCA 2)
11. Relation of Texture indices with forest parameters for a set of (DART) stands
12. **Inverted forest parameter** (e.g., mean crown size)
Textural ordination: principal axes of variation

FOTO analysis on aerial photographs in French Guiana

Proisy et al. RSE (2007)

Biomass prediction using Ikonos imagery in mangrove stands; French Guiana

\[ AG \text{ Biomass} = 187.4 - 19.6 \cdot PC1 + 26.1 \cdot PC2 - 20.9 \cdot PC3 \]

\[ r = 0.92, \text{rmse}=33, s=16.8\% \ (n=26) \]

No saturation!
Radiative transfer models

- Testing the effect of acquisition conditions
- Mitigation: partitioning method

a. Ikonos VHR.
b. LIDAR
c-d. Hillshade models
Extreme configurations: typical examples

Hillshade effects on LiDAR surface models

Barbier et al. RSE (2010)
Bi-directional texture distribution

- ‘Hotspot’ effect on texture,
- Alleviated by partitioning approach.

Barbier et al. RSE (2010)
Large scale application
maps of apparent crown size and canopy heterogeneity

Amazonia

Barbier et al. GEB (2010)
Validation: the Canopy project

- Texture analysis: The FOTO method (IRD).
- Field validation: Large forest inventory database across Central Africa (FRM).
- Software development: Convivial interface in ArcGis (Nev@ntropic).

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Large scale validation: test sites

- **FRM test sites**
- **Possible PPR sites**
Imagery
- **Planet Action**: Spot 5, Formosat, Kompsat
- **Others**: Quickbird, Ikonos, GeoEye, Orbview

Field Data
- Geolocalized plots of 0.5 ha
- Forest concessions above 50,000 ha
- Inventoried surface areas around 1%
- All trees above 10-20 cm diameter
- Destructive biomass sampling (upcoming)
Perspectives

• Quantification of forest canopy structure.

• Valuable insights into:
  - Degradation level;
  - Biomass and carbon, with no saturation;
  - Other forest structural attributes.

• Large scale application and repeatable.

• Effect of acquisition conditions mitigated.

• Relative low cost.