Challenges for MRV in agroforestry systems using remote sensing techniques

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Contents

- Agroforestry and REDD+
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Agroforestry has received increased attention in the REDD+ context:

- Potentials for increased carbon sequestration by planting trees on farms
- Intensification to prevent deforestation
- Small and medium size farm systems produce food, fodder, fuel, timber on the same area while conserving and improving soils
Project to promote development of coffee – banana - tree systems in Latin America:

“Improving small farm production and marketing of bananas under trees”

- funded by GIZ
- coordinated by Bioversity International
- project sites in Costa Rica, Honduras, Nicaragua and Peru

Research question of WP1: Methods for mapping agroforestry systems
Can remote sensing images be used to identify and characterize small holder shaded coffee with banana for use in extrapolation of field research and for identification of research and development priorities?
Definition of Agroforestry System

„Complex land use with features both from forest and agricultural systems“ (Welham et al. 2010)

„Deliberate introduction and management of trees into farming systems“ (Minang et al. 2011)“

„ Systems and practices where woody perennials are deliberately integrated with crops or animals in the same land management unit, either at the same time or in sequence with each other“ (ICRAF 1993)

forest trees, fruit trees, rubber trees?
palm and bamboo vegetation?
shrubs?
Definition of Agroforestry System

Generally accepted FAO forest definition:

Land spanning more than 0.5 hectares with trees higher than 5 meters and a canopy cover of more than 10 percent, or trees able to reach these thresholds in situ. It does not include land that is predominantly under agriculture or urban land use. (FRA, 2010)

• quantitative biophysical land cover criterium
• qualitative socio-economic land use criterium
• potential criterium

FAO distinguishes 6 classes:

- Forest (FOREST)
- Other Land (OL)
- Other Land with Tree Cover (OLTC)
- Other Wooded Land (OWL)
- Water (WATER)
- Trees outside forests (TOF)

Agroforestry systems are split into 4 classes
Spatial Arrangement of Agroforestry Systems

1. Border tree planting

2. Alternate rows and strips

3. Random mix

4. Vertical stratification

Umrani and Jain (2010)
Hasanuzzaman (2012)
Temporal Sequence of Agroforestry Systems

1. Shifting cultivation

2. Taungya

Long-term forest transition curve (CIFOR):

Umrani and Jain (2010)
Classification of Agroforestry Systems

Dominance of biophysical land cover (in percent)

- **Silviculture**
- **Livestock production**
- **Crop production**

- sp = silvopasture
- sa = silvoagriculture
- as = agrosilviculture
- ps = pastoral silviculture
- asp = agrosilvopasture
- sap = silvoagropasture
Case study: Comparison of two optical sensors:

1. High spectral resolution airborne MASTER, 25 reflective bands, GSD=10m

Costa Rica (Martignoni 2011)
Case study: Comparison of two optical sensors:

1. High spectral resolution airborne MASTER, 25 reflective bands, GSD=10m
2. High spatial resolution satellite GeoEye-1, 5 bands, GSD = 0.5m
Field data collection

Sketch map (A4) of LUC plot visited by field team:
Digitized sketch maps overlaid on color composites:

GeoEye-1, RGB=341
5.2.2010

Master, RGB=491
11.3.2005
Training Stage

GeoEye-1, RGB=341
5.2.2010

Master, RGB=491
11.3.2005
Documentation of land cover classes with geotagged digital photos

GeoEye-1, RGB=341
5.2.2010

Tree plantation
Training Stage

Documentation of land cover classes with geotagged digital photos

GeoEye-1, RGB=341
5.2.2010

Tree crown cover
Training Stage

Documentation of land cover classes with geotagged digital photos

GeoEye-1, RGB=341
5.2.2010

Coffee with Poró (Erythrina peoppigiana)
Object-based classification of spaceborne GeoEye-1 image

Automatic segmentation and interactive selection of polygons

GeoEye-1, RGB=341, 5.2.2010
Original airborne MASTER image over Turrialba (left) and standard Maximum Likelihood supervised classification results using the radiance-at-sensor MASTER image, 25 spectral bands, (Martignoni 2011).

Maximum Likelihood (ML) algorithm leads to the best LUC classification overall accuracy (77%) as compared to Gaussian Mixture and Support Vector Machine (SVM). Shade coffee agroforestry systems were classified with similar degree of confidence though it was not possible to detect with certainty the presence of bananas and plantains.
Conclusions

1. Individual tree crowns can be identified using high spatial resolution optical remote sensors.

2. An agroforestry classification scheme based on continuous tree crown cover is proposed.

3. Satellite remote sensing technology is an efficient monitoring tool for agroforestry systems and forests if
   - access to high resolution satellite images is given,
   - hard- and software is available,
   - technical and institutional capacities are enhanced,
   - field measurements and observations are integrated.
References


