Integrated use of multi-mode and multi-angle SAR data for land cover identification in the tropics

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Study Area:

Former area: Singapore
→ Test site of first study
Restricted in land cover types

Central Sumatra (Riau)
→ Variety of vegetation types
- Primary / secondary lowland Dipterocarpaceae forests
- Peat swamp forests
- Degraded forest types
- Acacia plantations
- Oil palm plantations
ALOS PALSAR Data:

**Fine beam data**
- HH polarization
- 6.25m spatial resolution
- 41.5 degree incident angle
- Acquisition date: 30-06-2006

**Polari metric mode data**
- HH, HV, VH, VV polarization
- 12.5m spatial resolution
- 21.5 degree incident angle
- Acquisition date: 08-05-2007

*End of wet / start of dry season*
ALOS Data Preprocessing:

Resolution merge
- 12.5m → 6.25m

Layer stacking
- No geolocation problem (FB - PM)

Filtering
- Lee Sigma filter 51x51

Subset
- SPOT reference data
- HH/HH differencing
**SPOT 4 Reference Data:**

**SPOT 4 Image**
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**ISODATA Classification**
- 100 clusters, visually grouped
- Ancillary data (peat map, SRTM)

**Filtering (< 0.1 ha)**

- Primary lowland forest
- Degraded low and forest
- Peat swamp forest
- Degraded peat
- Swamp vegetation
- Degraded Swamp
- Acacia plantation
- Oil palm plantation
- Clearance
- Secondary forest
- Shrub
- Major town
- Settlement
- Paved
- Water
- Clouds

Reference Data:

ISODATA Classification
- 100 clusters, visually grouped
- Ancillary data (peat map, SRTM)

Filtering (< 0.1 ha)
ALOS Data Classification:

Training areas from SPOT 4
- Different areas used for validation
  - Degraded lowland forests
  - Degraded peat swamp forests
  - Secondary forests
  - Acacia plantations
  - Oil palm plantations
  - Clearances
  - Towns / paved areas
  - Water

Maximum Likelihood
- Filtering < 0.1 ha
### ALOS Data Validation:

- 550 random points
  - 50 points per land cover class
  - 150 additional points (area)

### Intersection ALOS – SPOT

- Manual revision (fast LC changes)

### Accuracy results

<table>
<thead>
<tr>
<th>ALOS</th>
<th>Acacia</th>
<th>Cleara</th>
<th>Degrad</th>
<th>Oil palm</th>
<th>Secon</th>
<th>Town, Water</th>
<th>Grand Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acacia plantation</td>
<td>68</td>
<td>10</td>
<td>5</td>
<td>6</td>
<td>11</td>
<td>8</td>
<td>108</td>
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<tr>
<td>Clearance</td>
<td>5</td>
<td>173</td>
<td>1</td>
<td>1</td>
<td>15</td>
<td>11</td>
<td>2</td>
</tr>
<tr>
<td>Degraded lowland</td>
<td>8</td>
<td>23</td>
<td>18</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>52</td>
</tr>
<tr>
<td>Degraded peat</td>
<td>1</td>
<td>1</td>
<td>42</td>
<td>1</td>
<td>3</td>
<td></td>
<td>48</td>
</tr>
<tr>
<td>Oil palm</td>
<td>6</td>
<td>8</td>
<td>3</td>
<td>52</td>
<td>1</td>
<td>9</td>
<td>2</td>
</tr>
<tr>
<td>Secondary forest</td>
<td>2</td>
<td>3</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>5</td>
</tr>
<tr>
<td>Town / paved</td>
<td></td>
<td></td>
<td></td>
<td>11</td>
<td></td>
<td></td>
<td>11</td>
</tr>
<tr>
<td>Water</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>33</td>
<td></td>
<td>33</td>
</tr>
<tr>
<td>Grand Total</td>
<td>87</td>
<td>192</td>
<td>33</td>
<td>72</td>
<td>79</td>
<td>18</td>
<td>31</td>
</tr>
</tbody>
</table>

Total: 550 points
Factors biasing classification results

Almost no intra-annual effects
- Geographic position (tropical area)

Different acquisition dates (10 months)
- Fast land cover changes in that area
- Local weather conditions at different dates
- Differences in water level
Analysis of results:

Overall accuracy

- Error of single band data

- Similar results (order of accuracies) as for the study area in Singapore
Analysis of results:

Overall accuracy

Error of multi-mode data

<table>
<thead>
<tr>
<th>Mode</th>
<th>Accuracy</th>
</tr>
</thead>
<tbody>
<tr>
<td>FB-HH</td>
<td>43.45</td>
</tr>
<tr>
<td>PM-HH</td>
<td>44.55</td>
</tr>
<tr>
<td>PM-HV</td>
<td>51.64</td>
</tr>
<tr>
<td>PM-VH</td>
<td>51.64</td>
</tr>
<tr>
<td>PM-VV</td>
<td>37.45</td>
</tr>
<tr>
<td>4-PM</td>
<td>66.91</td>
</tr>
</tbody>
</table>
Analysis of results:

Overall accuracy

Error of multi-angle data

Synergistic effects when combining Multi-mode + Multi-angle data

Overall accuracy

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<tr>
<td>FB-HH</td>
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</tr>
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<td>37.45</td>
</tr>
<tr>
<td>4-PM</td>
<td>66.91</td>
</tr>
<tr>
<td>FB-4-PM</td>
<td>73.64</td>
</tr>
</tbody>
</table>
Analysis of results:

Secondary - Degraded forest
Low accuracy due to confusion of classes

Town / paved
Underrepresentation due to misclassification with Clearances + (young) Plantations

Integrated use of multi-angle and multi-mode data greatly increased land cover identification accuracy
Thank you very much!

Vielen Dank!