Accuracy assessment of land cover change products – MODIS/Landsat

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Challenges, or why to avoid this work

• Requires time 1 and time 2 reference information
  – Difficult to anticipate where change will occur
  – Even more difficult retrospectively

• Change is a typically rare, spatially non-random occurrence
  – NFI-like data not adequate
Defining change

• Spatial dimension
  – Minimum mapping unit of change

• Thematic definition of change
  – Conversion between covers
  – Modification of existing cover

• Temporal context
  – Permanent/semi-permanent, ephemeral, interannual
Reference data

<table>
<thead>
<tr>
<th></th>
<th>Forest to Forest</th>
<th>Non-forest to Non-forest</th>
<th>Forest to Non-forest</th>
</tr>
</thead>
<tbody>
<tr>
<td>Forest to Non-forest</td>
<td>95</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Non-forest to Forest</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Stratum augmented spatially to test for false negatives

Stratum disproportionately sampled
Hotspot map change into change probability strata

Stratified samples

Low change | Medium change | High change

Low change | Medium change | High change

SDSU
Sampling frame for populating change/no change strata

Figure 6: a) A 1km x 1km grid overlaid on DFCM-derived forest likelihood (white = non-forest to dark green = forest) and change (red) from 2000 to 2005 for a site in eastern DRC. b) For the same area, the change stratum color coded based on the proportion of change within each block (white = no change, green = low change, yellow = medium change and red = high change). The per-pixel change (red on larger map) will be buffered and another set of blocks will be added as the ‘buffered change’ stratum. Both strata will serve to target sampling in areas critical for field validation.
Available data for assessing accuracy

• Algorithm level confidence measures
  – Training accuracies
  – Spectra

• Independently-derived data
  – Spatially explicit reference data at same or finer scale (sample-based or wall-to-wall)
  – Inventory data / statistical databases (quantity)
  – Narrative on drivers of change (contextual information, qualitative or quantitative)
Temperate forest Landsat training data vs. regression tree outputs with MODIS

\[ y = 1.2806x + 0.5971 \]
a) Training from MODIS
b) Raw DN imagery
c) DOS-adjusted
d) Anistropy-adjusted
A. Upper Xingu River Basin in Mato Grosso state, 54.05°W, 12.58°S

B. Lower Xingu River Basin in Para state, 53.61°W, 5.65°S

C. Lower Tapajos River Basin in Para State, 54.80°W, 2.61°S

D. Southern Mato Grosso state, 53.83°W, 14.65°S
MODIS change analysis verification using independent datasets

PRODES data for Brazilian Amazon

Annual deforestation, km²

- Acre
- Amapa
- Amazonas
- Maranhão
- Mato Grosso
- Para
- Rondônia
- Roraima
- Tocantins

2001
2002
2003
2004
2005
MODIS change analysis verification using independent datasets

MODIS data for Brazilian Amazon – 80% probability threshold

- Acre
- Amapá
- Amazonas
- Maranhão
- Mato Grosso
- Para
- Rondônia
- Roraima
- Tocantins

Annual deforestation, km²

MODIS change analysis validation using independent datasets

NFDP burned areas data for Canada

Comparison of annual burned area for Canada

- NFDP
- MODIS

Area burned, thousand ha

- 2000-01
- 2001-02
- 2002-03
- 2003-04
- 2004-05
MODIS change indicator map, resampled to 20km by 20km blocks
Decrease of forest cover in Indonesia 2000-2005: data verification sample blocks

Verification sample blocks
- Low forest cover change
- Medium forest cover change
- High forest cover change

MODIS analysis – SDSU/SUNY-ESF
Landsat analysis – SDSU/MoF
MODIS pre-processing – NASA/UMd/SDSU
Landsat data provision – USGS/GFW/UMd
Indonesia land cover – MoF
Landsat sample blocks
SE Ratio: SRS / Stratified

<table>
<thead>
<tr>
<th>Biome</th>
<th>SE</th>
<th>n</th>
<th>SRS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Boreal</td>
<td>2.07</td>
<td>120</td>
<td>514</td>
</tr>
<tr>
<td>Indonesia</td>
<td>2.04</td>
<td>76</td>
<td>316</td>
</tr>
<tr>
<td>Dry Tropics</td>
<td>1.51</td>
<td>120</td>
<td>274</td>
</tr>
<tr>
<td>Tropics</td>
<td>1.16</td>
<td>72</td>
<td>97</td>
</tr>
<tr>
<td>Indo (AVHRR)</td>
<td>1.10</td>
<td>75</td>
<td>91</td>
</tr>
</tbody>
</table>
Indonesia forest clearing, 1990 to 2005

- **1990’s**
  - ENSO fires of 1997-98
  - Oil palm expansion
  - Stable central government and growing economy

- **2000**
  - Economic crisis
  - Oil palm policy reform / slowed expansion
  - Less fire and easily accessible lowland forest
Congo Basin forest cover loss

0.21%/yr UCL
Duveiller et al. 2007

0.17%/yr SDSU 2007

1990 - 2000
y = 0.97x + 340
R² = 0.862**

y = 0.99x + 13710
R² = 0.921**
QuickBird crown cover likelihood map at MODIS scale compared to the *in-situ* field measurements
**Analysis and Discussion**

QuickBird data rescaled to match the field data for the 18 pixels of the 2 field sites

Field Measurements vs. Quickbird 50% threshold and rescaled Quickbird 50% threshold

![Graph showing field measurements vs. Quickbird 50% threshold and rescaled Quickbird 50% threshold.](image)

- **QB 50**
  - Equation: $y = 0.6867x + 25.518$
  - $R^2 = 0.9248$
- **QB 50 Rescaled**
  - Equation: $y = x - 0.0148$
  - $R^2 = 0.9248$

Quickbird 50 rescale mean: 75.76
Quickbird 50 mean: 77.56