Comparative analysis and fusion for improved global biomass mapping

Valerio Avitabile
(Centre for Geo-Information, Wageningen University)
valerio.avitabile@wur.nl

With contribution of:
Andreas Langner
(Forest Resources and Climate Unit, JRC)
andreas.langner@jrc.ec.europa.eu

AGB Forest Mg/ha
0 - 25
26 - 50
51 - 100
101 - 150
151 - 200
201 - 300
351 - 600
Implementation of REDD+ requires Activity Data and Emission Factors

Default Emission Factors (IPCC Tier 1): high uncertainty, low credibility

Lack of technical/financial capacities: Majority of developing countries use Tier 1

Saatchi (2011) & Baccini (2012) biomass maps improve Tier 1 values
- Source of data is comprehensible → increased transparency/credibility

Comparison for Africa:
- Overall good correlation ($R^2 = 0.86$)
- Saatchi > Baccini in low biomass ecozones
- Red Circle: similar AGB for Saatchi but different for Baccini
- Variability of field data (e.g. Mai-Ndombe) (depend on allometric eq.)
- Assessment with various field data is problematic

Forest map Globcover2009; FAO eco zones
Spatial analysis of forest biomass databases

• Comparison with IPCC Tier 1 (Ruesch & Gibbs 2008) for Africa
  - IPCC values > Saatchi / Baccini (except for Tropical mountain systems by Baccini)
  - IPCC vs. Saatchi ($R^2 = 0.50$) ; IPCC vs. Baccini ($R^2 = 0.51$)

• Interpretation of the results
  - Red circle: eco zones with similar AGB for Saatchi but different for Baccini
  - Saatchi has larger spatial coverage than Baccini (includes subtropical zones)
  - Results can vary strongly on local scale
    → Simple preference of one map not possible

• Spatial disagreement of biomass maps

Credit: A. Langner (JRC)
A new biomass reference dataset

<table>
<thead>
<tr>
<th>Field plots</th>
<th>Biomass maps</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Screening</td>
<td>Visual analysis with Google Earth</td>
</tr>
<tr>
<td></td>
<td>Areas with ground data</td>
</tr>
<tr>
<td>2. Upscaling</td>
<td>Average Biomass @ 1Km</td>
</tr>
<tr>
<td></td>
<td>Aggregation @ 1Km</td>
</tr>
</tbody>
</table>

- **Data after initial quality selection**
  - Plots: 1091
  - Maps: 2765

- **Data suitable for scaling**
  - Plots: 909
  - Maps: 525

- **1 km reference pixels**
  - Plots: 396
  - Maps: 271
A fusion approach

Combining biomass maps (Baccini, Saatchi) using Reference data by:
- Bias removal and Weighted average by error strata
- Weights computed by the Error Covariance of input maps

RMSE=83 T/ha
RMSE=119 T/ha
RMSE=133 T/ha
RMSE=119 T/ha
Results for undisturbed forest and savannah

Congo basin – Undisturbed forest
RAINFOR network (Leeds Univ.)

Saatchi, Baccini

Eastern Africa (Uganda, Mozambique)
Woodland and Savannah

Saatchi, Baccini
Application at national level

- The fusion approach can be easily applied at national / local level, using forest inventory data to improve (sub)national biomass mapping
Improving biomass and emission estimation

1. Acquire existing data in under-represented areas
   ● Congo basin: plots/maps in Disturbed and Secondary forests (?)

2. Acquire new quality data
   CIFOR Global Comparative Study (GCS):
   ● Cameroon: EF for peatlands
   ● Gabon: Use of the Terrestrial Laser Scanning (TLS)
What’s new in Peatland and GHG emission measurements
Emission Factors (EF)

- **New IPCC EFs for Peatland**

<table>
<thead>
<tr>
<th>Land Use</th>
<th>CO2 –C (t ha⁻¹ y⁻¹)</th>
<th>CH₄ (kg ha⁻¹ y⁻¹)</th>
<th>N₂O (kg N ha⁻¹ y⁻¹)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Deg Forest</td>
<td>5.3</td>
<td>4.9</td>
<td>--</td>
</tr>
<tr>
<td>Croplands</td>
<td>14</td>
<td>7.0</td>
<td>5.0</td>
</tr>
<tr>
<td>Rice</td>
<td>9.4</td>
<td>143</td>
<td>0.4</td>
</tr>
<tr>
<td>Oil Palm</td>
<td>11</td>
<td>0.0</td>
<td>1.2</td>
</tr>
<tr>
<td>Acacia</td>
<td>20</td>
<td>2.7</td>
<td>2.4</td>
</tr>
<tr>
<td>Sago</td>
<td>1.5</td>
<td>26</td>
<td>3.3</td>
</tr>
</tbody>
</table>

- **Other ongoing activities in Africa**
  - Kenya: CH₄ in plantations, LUC in Mau Forest
  - Cameroon: EF in wetlands (starting)
  - Biomass in Zambia (Miombo)
Gabon: Terrestrial Laser Scanning (TLS)

Field plots in Lope National Park for:

1. Vertical plant profiles
2. Biomass stock density

Collaboration:
Wageningen University (WUR)
University College London (UCL)
CIFOR
Gabon: Terrestrial Laser Scanning (TLS)

www.lidar.wur.nl
Thank you for your attention!

And thanks to the co-authors:

valerio.avitabile@wur.nl

Wageningen University
Laboratory of Geo-Information Science and Remote Sensing