Forest-Observation-System.net – towards a global harmonised in-situ data repository for forest biomass datasets validation

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Klaus Scipal (ESA)
Comparison of three biomass maps for Europe:
White color - all map agree on low biomass,
black - all agree on high biomass

Red: Gallaun
Green: Thurner
Blue: Kindermann
3 Spaceborne Missions to measure forest structure

These missions will deliver measurements of:

• forest height
• forest biomass
• biomass change

Question:

1. Are we able to make best use of these missions?
2. Will users trust remote sensing products?
The 1st Mission?
Global Reference Data
The good news: We don’t need to start from scratch

**RAINFOR** (Red Amazonica de Inventarios Forestales)
500 biomass & dynamics plots

**AfriTRON** (African Tropical Forest Observation Network)
> 250 biomass plots

**CTFS-ForestGEO**
61 large dynamic plots, ca. 30 tropical

**TmFO** (Tropical managed Forest Observatory)
ca. 490 biomass plots
These networks have a long history and experience building on a network of cooperating partners and mutual trust.
IIASA network:
Forest Observatories Partnership
The Background of FOS
(Forest-Observation-System.net)

- Forest-Observation-System.net (FOS) is a “Cyberinfrastructure” to collect and disseminate ground data.
- FOS aims at building an interface between well established, existing ecological networks and the EO community.
- FOS focus is on high quality datasets that are fit for the EO purpose (e.g. geocoded data, plots with a history, etc.) based on traceable and documented requirements.
- FOS collects, but does not distribute tree level data. FOS only distributes aggregated plot level data.
- FOS data is available free & open in a unified format.
FOS schedule

Phase 1 (2016-2017) – Demonstration
- Set up the infrastructure & web portal
- Establish a collaboration with RAINFOR, AfriTRON and CTFS-ForestGEO
- Run the web portal in a Demo mode including first data

Phase 2 (2018 - 2021) – Implementation
- Identify and establish collaboration with other networks (TmFO, AusCover and others).
- Interface upgrade (search, download, etc.)
- Expand to host airborne LiDAR-based biomass maps
- Journal articles – contributor recognition and acknowledgement
FOS: http://forest-observation-system.net
FOS *in situ* data

• What are we looking for:
  – Data from permanent plots with the min size of 0.25 ha (preferably 1 ha or large)
  – Every tree (over 10 cm dbh) got species identification and DBH is measured

• Output data at plot level:
  – General characteristics (relief, forest type, disturbances, tree species)
  – Canopy height (top, Lorey's)
  – Above ground live biomass (estimated by allometric model $AGB=f(\rho,D,H)$)
## Distribution of sample plots by participating networks

<table>
<thead>
<tr>
<th>Network</th>
<th>Number of plots</th>
<th>Number of sub-plots</th>
<th>Area, ha</th>
</tr>
</thead>
<tbody>
<tr>
<td>AfriTRON</td>
<td>46</td>
<td>178</td>
<td>45</td>
</tr>
<tr>
<td>AusCover</td>
<td>4</td>
<td>4</td>
<td>3</td>
</tr>
<tr>
<td>CTFS-ForestGEO</td>
<td>2</td>
<td>300</td>
<td>75</td>
</tr>
<tr>
<td>IIASA</td>
<td>126</td>
<td>258</td>
<td>78</td>
</tr>
<tr>
<td>RAINFOR</td>
<td>52</td>
<td>288</td>
<td>72</td>
</tr>
<tr>
<td>T-Forces</td>
<td>3</td>
<td>12</td>
<td>3</td>
</tr>
<tr>
<td>TmFO</td>
<td>17</td>
<td>500</td>
<td>125</td>
</tr>
<tr>
<td>unaffiliated</td>
<td>24</td>
<td>105</td>
<td>27</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>274</strong></td>
<td><strong>1645</strong></td>
<td><strong>428</strong></td>
</tr>
</tbody>
</table>
Smithsonian STFS-ForestGEO site in Panama divided by 0.25 ha plots

H max: 35–56 m
H mean: 22–35 m
AGB: 119–415 t/ha
ArfiSAR field complain 2016, Gabon

PlotCode: LNL-07
CountryName: Gabon
Altitude: 306 m
Slope: 7 deg
PlotArea: 1.02 ha
Network: AfriTRON Link: http://forestplots.net
PI: Simon Lewis, Nicolas Labrière
ForestStatus: Secondary forest, maturing (>50yr)
YearEstablished: 2016
YearLastCensus: 2016
H Average: 19 m; H Max: 45
AGB Local HD: 332.1 t/ha
AGB Feldpausch: 343.2 t/ha
AGB Chave: 331.6 t/ha

Taxonomic Identification
187 (65 %) - Aucoumea klaineana
78 (12 %) - Sacoglottis gabonensis
53 (7 %) - Lophira alata
22 (2 %) - Dialium lopense
25 (2 %) - Barteria fistulosa
Post-fire forest dynamics and coarse woody debris decomposition investigation

PlotCode: RK-10 (1)
CountryName: Russia
PlotArea: 0.25 ha
Network: IIASA/IF
Link: http://forest.akadem.ru/PerSyst/
PI: V.V. Ivanov, E. F. Vedrova, L. V. Mukhortova
Year: 2007
Image: RK 10

H Average: 10.3 m
AGB Local HD: 73.93 t/ha
Wood Density: 0.495 t/m³

Taxonomic Identification
2736 (96 %) - Pinus sylvestris
85 (2 %) - Pinus sibirica
86 (2 %) - Larix gmelinii
Three 0.25 ha plots in the Caucasus Fir-Beech forest

H mean = 22-29m
H max = 48-57m
AGB = 500-700 t/ha
From individual tree measurements to plot-level biomass

Dmitry Schepaschenko, 16/5/2019
Airborne Lidar-based biomass maps

https://forest-observation-system.net

Biomass maps legend:
- 1 - 20 Mg dm / ha
- 21 - 50
- > 51 - 100

Resources:
- Tropics by WUR reference
- Pan Boreal reference
- IIASA hybrid biomass reference

PLOT INFORMATION

RABI (8_8)
Gobon
Network: CTFS-ForestGEO Link
Plot: Dr. Alfonso Alonso, Dr. Lisa Korte, Mr. Hervé Memlaghe
Established: 2009
Plot area: 0.25 ha
Census: 2011

Measurements:
- AGB Chave: 322.30 t/ha
- AGB Feldpausch: 355.20 t/ha
- H Lerey Feldpausch: 34.80 m
- H Lerey Chave: 32.00 m
- H Max Feldpausch: 46.60 m
- H Max Chave: 46.10 m
- Min DBH: 1 cm
- Wood Density: 0.68 t/m³

Download data
Only logged in users are allowed to download.
Comparison of FOS plot data with global maps

Kindermann et al., 2008

\[ y = 0.2639x + 65.429 \]
\[ R^2 = 0.14 \]

Hu et al., 2016

\[ y = 0.418x + 160.57 \]
\[ R^2 = 0.24 \]

Santoro et al., 2018

\[ y = 0.335x + 134.42 \]
\[ R^2 = 0.20 \]

GFW, 2018

\[ y = 0.2318x + 222.87 \]
\[ R^2 = 0.17 \]
What next?

• Gathering existing data: AusCover, TmFO, GEDI cal/val, etc.
• Collecting more data:
  – ESA ForestScan project
  – RSF Russian Forest Carbon Observatory
• Providing access to the data: ESA CCI Biomass, ESA EDAV, etc.
• Update BIOMASS r-package for temperate & boreal
• Publications:
  – Jerome Chave et al. 2019 “Ground Data are Essential for Biomass Remote Sensing Missions” *Surveys in Geophysics*
  – Dmitry Schepaschenko et al. FOS data paper (under review)
  – *MDPI Remote Sensing* special issue
    “Forest Biomass and Carbon Observation with Remote Sensing”
Thank you for your attention
Forest-Observation-System.net