Assessing biomass maps in Europe with harmonized statistics and plots

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Overview

- Context: the JRC BIOMASS study
- Data:
  - Statistics and plots
  - Biomass maps
- Comparison:
  - Maps vs. statistics
  - Maps vs. plots
- Conclusions and next steps
The JRC Biomass assessment study

- The Joint Research Centre (JRC) is the science and knowledge service of the European Commission (EC)

- The JRC has a long term mandate to assess:
  - global and EU biomass supply and demand
  - flows and sustainability
  - for all sources and all uses
  - scenarios and projections till 2050
Harmonized data

The harmonized forest biomass dataset

Collaboration with European NFIs (26 countries) to develop comparable forest biomass data, using:

- Harmonized definition
- Common estimator

26 countries with harmonized data

Harmonized Biomass definition
Harmonized biomass

Statistics:
- Based on ~500,000 plots
- Provide: Mean & Total Biomass (±SE)
  - By species group
  - At sub-national level
- Harmonized stats:
  - Total stock: +4% than national stats
  - Signif. difference for 14 countries

Plots:
- Subset of 22,166 plots
- Geolocation @ 1km

<table>
<thead>
<tr>
<th>Total biomass stock (Tg)</th>
<th>National definition</th>
<th>Harmonized definition</th>
<th>Difference definition (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>National estimator</td>
<td>16,234</td>
<td>16,907</td>
<td>4.1%</td>
</tr>
<tr>
<td>Common estimator</td>
<td>16,213</td>
<td>16,846</td>
<td>3.9%</td>
</tr>
<tr>
<td>Difference estimator (%)</td>
<td>-0.13%</td>
<td>-0.36%</td>
<td>3.8%</td>
</tr>
</tbody>
</table>
Biomass maps for Europe:

- Thurner et al. 2014
- Barredo et al. 2012
- Gallaun et al. 2010
- Kindermann et al. 2008
Maps vs. Stats

Total biomass at sub-national level

<table>
<thead>
<tr>
<th></th>
<th>Barredo</th>
<th>Gallaun</th>
<th>Kindermann</th>
<th>Thurner</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Bias (Tg)</strong></td>
<td>-1</td>
<td>-13</td>
<td>-2</td>
<td>-10</td>
</tr>
<tr>
<td><strong>r^2</strong></td>
<td>0.95</td>
<td>0.93</td>
<td>0.97</td>
<td>0.89</td>
</tr>
<tr>
<td><strong>RMSE (Tg)</strong></td>
<td>22</td>
<td>28</td>
<td>16</td>
<td>33</td>
</tr>
<tr>
<td><strong>Rel RMSE (%)</strong></td>
<td>37%</td>
<td>48%</td>
<td>28%</td>
<td>56%</td>
</tr>
</tbody>
</table>

Avitabile & Camia (in review)
**Maps vs. Stats**

Mean biomass at sub-national level

![Graph showing the comparison of biomass maps and harmonized statistics at sub-national level. The graph includes scatter plots for different authors (Barredo, Gallaun, Kindermann, Thurner) with various metrics such as Bias (Tg), $r^2$, RMSE (Tg), and Rel RMSE (%). The values are as follows:

<table>
<thead>
<tr>
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<th>Kindermann</th>
<th>Thurner</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Sub-national</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bias (Tg)</td>
<td>-31</td>
<td>-44</td>
<td>-42</td>
<td>-29</td>
</tr>
<tr>
<td>$r^2$</td>
<td>0.71</td>
<td>0.66</td>
<td>0.68</td>
<td>0.73</td>
</tr>
<tr>
<td>RMSE (Tg)</td>
<td>46</td>
<td>57</td>
<td>54</td>
<td>52</td>
</tr>
<tr>
<td>Rel RMSE (%)</td>
<td>36%</td>
<td>45%</td>
<td>43%</td>
<td>41%</td>
</tr>
</tbody>
</table>

**Avitabile & Camia (in review)**
Maps vs. Plots

Differences between plots and pixels

**Spatial mismatch**
- NFI plot area: < 1 ha
- NFI released: 1 Km
- Biomass maps: 1 Km

Remove plots:
- in heterogeneous pixels (tree cover)
- not representative of the pixel

**Temporal mismatch**
- NFI plots cycle: 2001 - 2013
- Biomass maps: 2000 or 2010

Update plot biomass:
- Use IPCC growth rates (Mg/ha/yr)
- Update to the year of the maps
Maps vs. Plots

Relevance of plot screening

- Remove plots not representative of the pixels
- Increase the accuracy statistics
- Maintain the properties of the original dataset:
  - Spatial distribution
  - Frequency distribution

Accuracy improvements

<table>
<thead>
<tr>
<th>Maps accuracy</th>
<th>selected vs. all plots</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bias</td>
<td>-58%</td>
</tr>
<tr>
<td>RMSE</td>
<td>-19%</td>
</tr>
<tr>
<td>Rel. RMSE</td>
<td>-27%</td>
</tr>
<tr>
<td>R²</td>
<td>+44%</td>
</tr>
</tbody>
</table>

Spatial distribution

Frequency distribution

Harmonized plots

Avitabile & Camia (in review)
## Maps vs. Plots

### Barredo vs. Reference data

<table>
<thead>
<tr>
<th>N. plots</th>
<th>Bias (Mg/ha)</th>
<th>RMSE (Mg/ha)</th>
<th>Rel RMSE (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>501</td>
<td>-12</td>
<td>87</td>
<td>63%</td>
</tr>
</tbody>
</table>

### Gallaun vs. Reference data

<table>
<thead>
<tr>
<th>N. plots</th>
<th>Bias (Mg/ha)</th>
<th>RMSE (Mg/ha)</th>
<th>Rel RMSE (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>356</td>
<td>-6</td>
<td>82</td>
<td>72%</td>
</tr>
</tbody>
</table>

### Kindermann vs. Reference data

<table>
<thead>
<tr>
<th>N. plots</th>
<th>Bias (Mg/ha)</th>
<th>RMSE (Mg/ha)</th>
<th>Rel RMSE (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>502</td>
<td>-17</td>
<td>88</td>
<td>64%</td>
</tr>
</tbody>
</table>

### Thurner vs. Reference data

<table>
<thead>
<tr>
<th>N. plots</th>
<th>Bias (Mg/ha)</th>
<th>RMSE (Mg/ha)</th>
<th>Rel RMSE (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>405</td>
<td>-25</td>
<td>89</td>
<td>64%</td>
</tr>
</tbody>
</table>

### Selected plots

- Avitabile & Camia (in review)
Towards a spatially-explicit, harmonized biomass assessment in EU

• **NFI data**
  - Key source of data, reliable stats up to sub-national level
  - Plots: large amounts, statistical sampling
  - Country-specific design, usually provide only growing stock volume
  - Plots: Large amounts, small area, usually not released

• **Harmonized data**
  - Derived from NFI data for 26 countries
  - Harmonized biomass stats and plots at sub-national scale
  - Temporal differences among countries (NFI cycles)
  - Plots: Subset, geolocation @ 1km, not released
• **Biomass maps**
  - Total stocks similar (but lower) compared to statistics
  - Overestimation at low biomass - Underestimation at high biomass
  - Likely due to calibration with mean values, limited sensitivity of satellite signal
  - Differences increase National -> Sub-national -> Pixel

• **Next steps / needs:**
  - Better integration of NFI data with biomass maps
    - Spatially: maps with higher resolution (1 ha), plots with precise location
    - Temporally: adjust data to a reference year
    - Thematically: consistent forest and biomass definitions
  - Towards a biomass map consistent with NFI Statistics
  - Relevance of mapping forest available for wood supply
Thanks