IIASA experience in analyzing global forest datasets

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Marie Curie
FP7-MC-IIF: SIFCAS

Independent monitoring
GHG emission
Modeling Biomass Supply at Global Scale
An Integrated Modeling Approach

Scenarios:
[POP, GDP, Energy demand, GHG emissions, ...]

POLES: [projections of energy demand and supply, technology development, CO2 emissions, CO2 abatement policies and carbon values]

G4M: [geographically explicit forest biomass growth, Afforestation, Deforestation, harvest, supply curves]

GLOBIOM: [Trade and competition between regions, competition between sectors]

EPIC: [Agriculture, crop production, environmental factors, biogeochemistry]

Source: IIASA (2011)
Available Global Forest Datasets

- Land cover (e.g. MODIS LC, GlobCover, GLC2000, CCI LC, GlobeLand30)
- Vegetation Continuous Fields (MODIS VCF, FAO world’s forest map)
- Landsat-based forest cover (Sexton et al., 2013; Hansen et al., 2013)
- Radar-based (e.g. JAXA PALSAR forest mask)
- Hybrid (e.g. GLC-SHARE by FAO)
- Biomass (by Saatchi et al., 2011; Baccini et al., 2012; Santoro et al., 2015; Avitabile et al. 2015, etc.)
JAXA PALSAR forest mask
25 m resolution

Visualization of Global Land Cover, Biomass, Photos, etc.

Crowdsourcing of Land Cover (Google Earth, Bing Maps)

Geo-Wiki

Creation of Hybrid Land Cover Maps

Validation of Land Cover Maps

In-situ Data via Geo-Wiki Pictures app

Serious Games (Cropland Capture)
Geo-Wiki.org – demonstration and validation tool

- European Forest (Corine): 140 Mg dm/ha
- Pan-boreal by Gamma/FSUJ: 100 m³/ha
- European Forest (JRC): 120 Mg dm/ha
- Europe by JR: 40 m³/ha
- Global Forest by IIASA: 30 Mg dm/ha
- European Forest (GLC2000): 160 Mg dm/ha
- Pan-Boreal: 60 Mg dm/ha
- European Forest (GlobCover): 160 Mg dm/ha
Estimation of forest cover using Geo-Wiki and high resolution Google Earth imagery

where 55% of 1km pixel area is estimated to be forest cover with tree cover of 90% stocking in this example.
Geo-Wiki training (~18K) and validation (~2K) points
International Forest Biomass Network: Towards a Global Biomass Data Repository

- Support Calibration/Validation of the ESA BIOMASS mission
- Elaborate a Live Biomass database accessible for the entire community
- Populate the database with the data from several multinational networks (RAINFOR, ArtiTRON, etc.)
Global Forest Mask: synergy of remote sensing and crowd-sourcing

Forest cover
(1km res.)

Modis VCF

Landsat based products

Land cover
(GLC, GlobCover, Modis, Regional)

Geo-Wiki training points

Forest probability

Forest cover, %
Independent validation of different forest maps

Forest recognition accuracy, %

- Hybrid “best guess”
- Hansen’s FC
- Landsat VCF
- MODIS VCF
- Regional mosaic
- MODIS LC
- GlobCover
- GLCNMO
- GLC2000

Percentage forest cover (correlation, $R^2$)

Source: Schepaschenko et al., 2015 In: Remote Sensing of Environment
Comparison of forest area estimated by the model and FAO FRA national statistics
Hybrid forest map (central Africa) calibrated by FAO FRA statistics

A – national statistics

B – continental statistics

Source: Schepaschenko et al., 2015 In: Remote Sensing of Environment
Welcome to Laco-Wiki

LACO-Wiki is a new web-based solution for validating land cover and land use maps. Using a variety of reference layers including satellite and aerial imagery from Google and Bing as well as OpenStreetMap, validation is a simple four-step process. After uploading your dataset, generate and validate the samples and create a report with the accuracy assessment.

Share your validated samples with us and you will help to build an open database that can be used to improve future land cover and land use maps.

Upload a dataset
You can upload your own maps for validation in either vector or raster format. Currently accepted formats are shape files and geoTIFFs in a WGS84 projection. Once uploaded you can design a customized legend for display. Additional datasets can also be uploaded to help you in the validation process.

Validate your map
Using reference information such as satellite imagery, you can validate your sample using your own legend, either by selecting the class, confirming the class or correcting incorrectly classified ones. You can validate the samples by yourself or you can share any validation session to distribute the work.

Generate a validation sample
Once you have uploaded your map, you can create sets of validation samples using random, stratified or systematic sampling. You can specify the size of each sample or be guided by calculations of the minimum sample size needed based on the required confidence levels for your project.

Report on the accuracy
After validation you can download the raw data, the confusion matrix and generate a customized report on accuracy assessment, choosing from a set of different quality indicators including overall accuracy, omission and commission errors, kappa, average mutual information (AMI) and more.
Experience of developing a hybrid forest map for Poland and Ukraine

Marie Curie individual grant FP7-MC-IIF: SIFCAS
Spatial comparison of input datasets
GlobeLand30, Hansen’s tree cover, JAXA forest map

Forest score is a number of products identifying forest and varies from 0 to 1
Examples of maps classification errors

Wetlands classified by Hansen as high percent forest
Examples of maps classification errors

GlobeLand30 says that it is forest instead of bare land.

JAXA forest map says that it is forest instead of urban area.
Forest area of Poland and Ukraine, 2010

<table>
<thead>
<tr>
<th>Forest data</th>
<th>Poland M ha</th>
<th>Ukraine M ha</th>
</tr>
</thead>
<tbody>
<tr>
<td>National Inventory Reports</td>
<td>9.3</td>
<td>9.6</td>
</tr>
<tr>
<td>GlobeLand30</td>
<td>8.8</td>
<td>8.7</td>
</tr>
<tr>
<td>JAXA forest map</td>
<td>10.4</td>
<td>11.3</td>
</tr>
<tr>
<td>Hansen’s tree cover map</td>
<td>10.8</td>
<td>11.3</td>
</tr>
</tbody>
</table>

Difference, M ha:
- GlobeLand30: -0.6
- JAXA forest map: -1.1
- Hansen’s tree cover map: -0.9
Example of forest loss/gain 2000-2010

Hansen

Ukrainian LC (SIGMA)

GlobeLand30

Not correct!
Collected Geo-Wiki data:

Ukraine:
~10 K training points and
~6 K testing points

Poland:
~6 K training points and
~2 K testing points
Forest cover map of Poland, 2010
Accuracy, sensitivity and specificity analysis of the Polish map

- **JAXA map**:
  - Accuracy: 83.2%
- **Globeland 30m**:
  - Accuracy: 82.6%
- **Hansen’s map**:
  - Accuracy: 89%
- **A hybrid map**:
  - Accuracy: 91.2%

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- **Specificity**
  - JAXA map: 72.2%
  - Globeland 30m: 80.5%
  - Hansen’s map: 87%
  - A hybrid map: 86.1%

- **Sensitivity**
  - JAXA map: 91.6%
  - Globeland 30m: 85.5%
  - Hansen’s map: 91.3%
  - A hybrid map: 95.6%
REDD-PAC
(Policy Assessment Center)

• Partner Institutions: IIASA (coordinator) UNEP-WCMC INPE/IPEA COMIFAC

• Support 8 countries: Brazil, Democratic Republic of Congo, Vietnam, China, Uganda, Peru, Ecuador and the Philippines

• This research project aims to help initiate:
  – national REDD+ action planning
  – design and support a fair, efficient and effective international REDD+ architecture.
Datasets used to compute future deforestation and related emissions with GLOBIOM

- Land cover maps
- Past land cover changes
- Agricultural statistics (crops and livestock)
- Biomass maps
- (others: infrastructures, population, …)
Consistent land use-land cover map to improve projections of future deforestation

<table>
<thead>
<tr>
<th>GIS data</th>
<th>IBGE statistics</th>
</tr>
</thead>
<tbody>
<tr>
<td>MODIS</td>
<td></td>
</tr>
<tr>
<td>SOS Mata Atlantica</td>
<td></td>
</tr>
<tr>
<td>IBGE land cover map</td>
<td>All Brazil</td>
</tr>
</tbody>
</table>

**Legal Amazon**
- Cropland
- Pasture
- Other natural land
- Forest
- Wetlands
- Not relevant

**Mata Atlantica biome**
- Cropland + pasture + other natural land
- Forest (SOS Mata Atlantica)
- Wetlands
- Not relevant

**Rest of Brazil**
- Cropland + pasture + other natural land
- Forest
- Wetland
- Not relevant

Building a consistent land use-land cover map for Brazil combining:
- Remote-sensing data
- Statistics
- Protected areas

**Land cover by simulation unit** + **Protected areas and indigenous reserves** → **Consistent land cover-land use map by simulation unit** → **Land use by municipality**
Consistent land use / land cover map to improve projections of future deforestation

Important uncertainty in initial cropland allocation in the Congo Basin due to small patches of cropland and cloud cover
Validation of model results over 2000-2010

**PRODES/INPE**

16.53 Mha

**GLOBIOM-Brazil projection**

16.93 Mha

Model produces consistent estimate of deforestation (2000-2010)
Validation of model results over 2000-2010

- Cumulated deforestation over 2000-2010 in the Congo Basin (in 1000 hectares)

<table>
<thead>
<tr>
<th></th>
<th>CongoBIOM</th>
<th>Hansen</th>
<th>FACET</th>
<th>GAF</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cameroon</td>
<td>650</td>
<td>495</td>
<td></td>
<td></td>
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<tr>
<td>DRC</td>
<td>3723</td>
<td>6849</td>
<td>3642</td>
<td></td>
</tr>
<tr>
<td>Congo</td>
<td>160</td>
<td>340</td>
<td>164</td>
<td>184</td>
</tr>
</tbody>
</table>

- Deforestation by 1st administrative level over 2000-2010

Important uncertainties also in historical deforestation.
Emissions from deforestation

- Several biomass maps are used to compute future emissions from deforestation:
  - Baccini et al.
  - Saatchi et al.
  - FAO-FRA downscaled by Kindermann et al.
  - Avitabile et al. (fusion pantropical map) ➔ has to be added to our results
  - + other local maps if available
Possible collaboration

- Participate (with your students) in crowdsourcing campaigns
- Get involved in sharing *in situ* data within International Forest Biomass Network
- Validate maps using Laco-Wiki
- Let’s collaborate in data analysis and producing new maps of better accuracy
Thank you for your attention

More information:
http://geo-wiki.org

http://www.iiasa.ac.at/web/home/research/modelsData/Geo-Wiki/Geo-Wiki.en.html

More readings:

