Global Land Cover Mapping and its application in SDGs

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Global Land Cover Mapping

Land cover datasets play a significant role in a variety of geographical studies, such as sustainable urban development, global climate change detection, natural resources management.

Global land cover datasets:
- USGS (1km)
- UMD (1km)
- BU (1km)
- GLC 2000 (1km)
- GLOBCOVER (300m)
- GlobeLand30 (30m)
A 30m Earth Land Cover Map, covering the land between 80° N and 80° S.

A POK-based operational approach

2 versions: -2000 -2010

Global Overall Accuracy of 2010: 93%

GlobeLand30 Online Service

Providing open access to GlobeLand30, such as browsing, data downloading, etc.

www.globeLand30.org

Geo-Tagging

Tagging - Wrong, changed, detailed class
China county-provincial-city level; Other countries-provincial level
Defined area statistics
Global cultivated land area in 2010 is 19.39 million square kilometers, accounting for 14.03% of surface area.

www.globeland30.org
GlobeLand30 was donated by China to the United Nations, as a contribution towards sustainable development and combating climate change.


Utilized by UNEP for World Conservation Monitoring, providing an important metric for monitoring biodiversity.
Continuous Updating / Refinement

Increasing users and applications: UN-2030 Agenda and SDGs

More than 6000 users from 118 countries

Further data optimization:
- more classes: i.e. detailed wetland classes
- up-to-date versions: 2015 version in process
- finer resolutions (for small island areas)
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Global Land Cover Mapping

GLC in SDGs

Standardization Requirements

Suggestions
Agreed in Sept. 2015, 17 Goals and 167 indicators in total.
Resolved to free humanity from poverty, secure a healthy planet for future generations, and build peaceful, inclusive societies as a foundation for ensuring lives of dignity for all.

- **Level 1**: 4 economical goals, goal 8-10, 12
- **Level 2**: 8 social goals, goal 1-5, 7, 11, 16
- **Level 3**: 4 environmental goals, goal 6, 13-15

Goal 15: Biodiversity, Forest and Desertification
According to the research of IAEG-SDGs Working Group on Geospatial Information, the computation of some SDG indicators need to integrate the geospatial data and statistical data.

- **Tier I**: 1.1.1; 4.5.1; 9.c.1; 14.5.1; **15.1.1**; 15.1.2
- **Tier II**: 5.2.2; 5.4.1; 11.2.1; **11.3.1**; 15.4.1
- **Tier III**: 1.4.2; 2.4.1; 5.a.1; 5.a.2; 6.3.2; 6.5.2; 6.6.1; 9.1.1; 11.7.1; 11.7.2; 14.2.1; **15.3.1**

Example of core geospatial data
Analytical models, metrics and tools need to be developed for computing or deriving SDG indicators/indices from geospatial data or combination with statistical data.

How to select and integrate data from various source?
SDG Indicator 15.1.1: Forest area as a proportion of total land areas

\[ F = \frac{S_f}{S} \times 100\% \]

- **Sf**: Total area of forest;
- **S**: Total area of land.

**Forest in GlobeLand30**: Lands covered with trees, with vegetation cover over 30%, including deciduous and coniferous forests, and sparse woodland with cover 10 - 30%, etc.

**Forest in China Land Use Map**: Lands covered with trees, bamboos, shrubs, and mangrove forests along the coast.
SDG Indicator 11.3.1: Ratio of land consumption rate to population growth rate

Single index

\[ R = \frac{\ln(Urb_{(t+n)}/Urb_t)/y}{\ln(Pop_{(t+n)}/Pop_t)/y} \]

- Popt : Total population within the city in the past/initial year;
- Popt+n : Total population within the city in the current/final year;
- Urb_t : Total areal extent of the urban agglomeration in km^2 for past/initial year;
- Urb_(t+n) : Total areal extent of the urban agglomeration in km^2 for current year;
- y: The number of years between the two measurement periods.

Three-dimensional indexes

\[ R = \frac{LPI \times f1 + LGI \times f2 + LCI \times f3}{f1 + f2 + f3 = 3} \]

- \( LPI = \frac{\ln(Pop_{(t+n)}/Pop_t)/y}{\ln(Gdp_{(t+n)}/Gdp_t)/y} \)
- \( LGI = \frac{\ln(Gdp_{(t+n)}/Gdp_t)/y}{\ln(C02_{(t+n)}/C02_t)/y} \)
- \( LCI = \frac{\ln(C02_{(t+n)}/C02_t)/y}{\ln(Pop_{(t+n)}/Pop_t)/y} \)

- y: The number of years between the two measurement periods;
- Gdp_t / Gdp_(t+n) : Total GDP within the city in the initial/final year;
- Pop_t / Pop_(t+n) : Total population within the city in the initial/final year;
- C02_t / C02_(t+n) : Total CO2 within the city in the initial/final year.
SDG 11.3.1: Single Index

Taking a country as a basic unit, integrate population and urban area data into the single index formula and get the result.

Population data

World bank data

Population in 2000

Population in 2010

Urban areas

Artificial surface in 2010

Artificial surface in 2000

GlobeLand30 data

Single index

based on the country unit

Artificial in GlobeLand30: Lands modified by human activities.
Local Land Use map: residential, industrial, commercial land?
SDG 11.3.1: 3D Indexes

Geospatial information such as that available from GlobeLand30, appropriately augmented with socio-economic data, such as multifarious World Bank statistics, can be combined using three-dimensional indexes to address the 11.3.1 indicator.

- The change of artificial surface per capita population
- The change of artificial surface per capita GDP
- The change of artificial surface per capita carbon emissions
SDG Indicator 15.3.1: proportion of land that is degraded over total land area

three sub-indicators:

- Land cover and changes in land cover
- Land productivity
- Carbon stocks above and below ground

Method 1: CORINE Land Cover

- Geographic database.
- Service of the European Copernicus program (EEA).
- Photo-interpretation of satellite images.
- Scale: 1:100 000 – Land cover represented by polygons of 25 ha.
- Nomenclature: 44 categories of land cover.
- Every 6 years (2000, 2006 and 2012).

From: Ministry of ecology and solidarity transition, France
Global Land Cover Mapping

GLC in SDGs

Standardization Requirements

Suggestions
The calculation results of SDG indicators are affected by the selection of land cover or land use data.

- International or national data;
- Different land cover classification system;
- Land cover or Land use data;

Results are difficult to compare.
International (Global) Data: may have higher consistency across space, thereby allowing a better comparability across countries and easier data handling as a single dataset.

National data: generated by national experts and can be expected to be more accurate and have a better thematic resolution than global products.

Need to integrate heterogeneous datasets.
Inconsistent Classification Systems

The inconsistency range from discrepancies associated with structure, principle, threshold, and scale, including:

- Terminological inconsistency
  - synonyms, acronyms, abbreviations, spelling variants, etc.

- Semantic inconsistency
  - semantic overlap of existing heterogeneous lc classification systems

- Cartographical inconsistency
  - legend translation
### UNEP/FAO Classification

<table>
<thead>
<tr>
<th>Code</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Tree Cover, broadleaved, evergreen (LCES &gt;15% tree cover, tree height &gt;3m)</td>
</tr>
<tr>
<td>2</td>
<td>Tree Cover, broadleaved, deciduous, closed</td>
</tr>
<tr>
<td>3</td>
<td>Tree Cover, broadleaved, deciduous, open (open 15-40% tree cover)</td>
</tr>
<tr>
<td>4</td>
<td>Tree Cover, needle-leaved, evergreen</td>
</tr>
<tr>
<td>5</td>
<td>Tree Cover, needle-leaved, deciduous</td>
</tr>
<tr>
<td>6</td>
<td>Tree Cover, mixed leaf type</td>
</tr>
<tr>
<td>7</td>
<td>Tree Cover, regularly flooded, fresh water (freshwater)</td>
</tr>
<tr>
<td>8</td>
<td>Tree Cover, regularly flooded, saline water (daily variation of water level)</td>
</tr>
<tr>
<td>9</td>
<td>Mosaic: Tree cover / Other natural vegetation</td>
</tr>
<tr>
<td>10</td>
<td>Tree Cover, burnt</td>
</tr>
<tr>
<td>11</td>
<td>Shrub Cover, closed-open, evergreen</td>
</tr>
<tr>
<td>12</td>
<td>Shrub Cover, closed-open, deciduous</td>
</tr>
<tr>
<td>13</td>
<td>Herbaceous Cover, closed-open</td>
</tr>
<tr>
<td>14</td>
<td>Sparse Herbaceous or sparse Shrub Cover</td>
</tr>
<tr>
<td>15</td>
<td>Regularly flooded Shrub and/or Herbaceous Cover</td>
</tr>
<tr>
<td>16</td>
<td>Cultivated and managed areas</td>
</tr>
<tr>
<td>17</td>
<td>Mosaic: Cropland / Tree Cover / Other natural vegetation</td>
</tr>
<tr>
<td>18</td>
<td>Mosaic: Cropland / Shrub or Grass Cover</td>
</tr>
<tr>
<td>19</td>
<td>Bare Areas</td>
</tr>
<tr>
<td>20</td>
<td>Water Bodies (natural &amp; artificial)</td>
</tr>
<tr>
<td>21</td>
<td>Snow and Ice (natural &amp; artificial)</td>
</tr>
<tr>
<td>22</td>
<td>Artificial surfaces and associated areas</td>
</tr>
</tbody>
</table>

### GlobCover Classification

<table>
<thead>
<tr>
<th>Code</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>11</td>
<td>Post-flooding or irrigated croplands</td>
</tr>
<tr>
<td>14</td>
<td>Rainfed croplands</td>
</tr>
<tr>
<td>20</td>
<td>Mosaic Cropland (50-70%) / Vegetation (grassland, shrubland, forest) (20-50%)</td>
</tr>
<tr>
<td>30</td>
<td>Mosaic Vegetation (grassland, shrubland, forest) (50-70%) / Cropland (20-50%)</td>
</tr>
<tr>
<td>40</td>
<td>Closed to open (&gt;15%) broadleaved evergreen and/or semi-evergreen forest (&gt;5m)</td>
</tr>
<tr>
<td>50</td>
<td>Closed (&gt;40%) broadleaved deciduous forest (&gt;5m)</td>
</tr>
<tr>
<td>60</td>
<td>Open (15-40%) broadleaved deciduous forest (&gt;5m)</td>
</tr>
<tr>
<td>70</td>
<td>Closed (&gt;40%) needle-leaved deciduous evergreen forest (&gt;5m)</td>
</tr>
<tr>
<td>90</td>
<td>Open (15-40%) needle-leaved deciduous or evergreen forest (&gt;5m)</td>
</tr>
<tr>
<td>100</td>
<td>Closed to open (&gt;15%) mixed broadleaved and needle-leaved forest (&gt;5m)</td>
</tr>
<tr>
<td>110</td>
<td>Mosaic Forest/Shrubland (50-70%) / Grassland (20-50%)</td>
</tr>
<tr>
<td>120</td>
<td>Mosaic Grassland (50-70%) / Forest/Shrubland (20-50%)</td>
</tr>
<tr>
<td>130</td>
<td>Closed to open (&gt;15%) shrubland (&lt;5m)</td>
</tr>
<tr>
<td>140</td>
<td>Closed to open (&gt;15%) grassland</td>
</tr>
<tr>
<td>150</td>
<td>Sparse (&gt;15%) vegetation (woody vegetation, shrubs, grassland)</td>
</tr>
<tr>
<td>160</td>
<td>Closed (&gt;40%) broadleaved forest regularly flooded - Fresh water</td>
</tr>
<tr>
<td>170</td>
<td>Closed (&gt;40%) broadleaved semi-evergreen and/or evergreen forest regularly flooded - Saline water</td>
</tr>
<tr>
<td>180</td>
<td>Closed to open (&gt;15%) vegetation (grassland, shrubland, woody vegetation) on regularly flooded or waterlogged soil - Fresh, brackish or saline water</td>
</tr>
<tr>
<td>190</td>
<td>Artificial surfaces and associated areas (urban areas &gt;50%)</td>
</tr>
<tr>
<td>200</td>
<td>Bare areas</td>
</tr>
<tr>
<td>210</td>
<td>Water bodies</td>
</tr>
<tr>
<td>220</td>
<td>Permanent snow and ice</td>
</tr>
<tr>
<td>Type</td>
<td>Definition</td>
</tr>
<tr>
<td>--------------------</td>
<td>-----------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Cultivated land</td>
<td>Lands used for agriculture, horticulture and gardens, including paddy fields, irrigated and dry farmland, vegetation and fruit gardens, etc.</td>
</tr>
<tr>
<td>Forest</td>
<td>Lands covered with trees, with vegetation cover over 30%, including deciduous and coniferous forests, and sparse woodland with cover 10 - 30%, etc.</td>
</tr>
<tr>
<td>Grassland</td>
<td>Lands covered by natural grass with cover over 10%, etc.</td>
</tr>
<tr>
<td>Shrubland</td>
<td>Lands covered with shrubs with cover over 30%, including deciduous and evergreen shrubs, and desert steppe with cover over 10%, etc.</td>
</tr>
<tr>
<td>Wetland</td>
<td>Lands covered with wetland plants and water bodies, including inland marsh, lake marsh, river floodplain wetland, forest/shrub wetland, peat bogs, mangrove and salt marsh, etc.</td>
</tr>
<tr>
<td>Water bodies</td>
<td>Water bodies in the land area, including river, lake, reservoir, fish pond, etc.</td>
</tr>
<tr>
<td>Tundra</td>
<td>Lands covered by lichen, moss, hardy perennial herb and shrubs in the polar regions, including shrub tundra, herbaceous tundra, wet tundra and barren tundra, etc.</td>
</tr>
<tr>
<td>Artificial Surface</td>
<td>Lands modified by human activities, including all kinds of habitation, industrial and mining area, transportation facilities, and interior urban green zones and water bodies, etc.</td>
</tr>
<tr>
<td>Bareland</td>
<td>Lands with vegetation cover lower than 10%, including desert, sandy fields, Gobi, bare rocks, saline and alkaline lands, etc.</td>
</tr>
<tr>
<td>Perennial snow or ice</td>
<td>Lands covered by permanent snow, glacier and icecap.</td>
</tr>
</tbody>
</table>
Land cover-oriented

National Geographical Status Survey by China:
- Images interpretation (better than 1m resolution) + field survey
- Land cover-oriented, 12 classes, 58 sub-classes, 133 3rd classes

Current national geographical status

Forest and grass cover
Land use-oriented

National Land Survey by China:

-Land use-oriented: newly published standards, 12 classes, 73 sub-classes.
ISO/TC 211 Standardization

- **19144-1**: Classification System Structure
- **19144-2**: Land Cover Meta Language

Not a specific classification system, but a description of classification system.
Contents

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GLC in SDGs

Standardization Requirements

Suggestions
Suggestions

- Continue to develop/improve land cover-related ISO/TC 211 standards to meet with the increasing requirements of SDGs monitoring and other applications.
- Set up task force through international cooperation (inviting both experts from developed and developing countries, both land cover data providers and users) to re-examine/define the scope of land cover related ISO/TC 211 standards and to conduct future work.
Thank you for your attention!

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