Informing SDG Indicators with Land Cover and Change (LCC)

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Contents

- Background
- An Example
- Discussion
A Workshop on Analysis and Application of Global Land Cover Information

From 24th and 25th September, 2016, co-organized jointly by ISPRS Global Mapping WG, GEO Global Land Cover Activity and NGCC

Supporting SDGs with Global Land Cover Information

Land cover information Support to SDGs

- 13 of 17 SDGs are related to Land cover and land use
- Direct measures of some Indicators and indirect support to others.
- Contribute to progress on the Targets, which will show up in the Indicators.

[CheeHai TEO. Beijing, 2016, 9]
Direct/indirect Measure using LCC

- Direct measure using land cover data
- Further Indicators that could be informed by existing land cover data
- More to be potentially informed as technology evolves

[André Obregón, 2016, 9]

Major Outputs from the Workshop

- Further investigate how LCC information can contribute to the measurement and monitoring of the SDG indicators
- Develop effective approaches to visualise SDG indicators and communicate with end users and policy makers
  - Prototyping a dynamic map atlas with a series of examples showing how LCC and geo-spatial information can contribute to the SDGs process.
- Preparing a special issue in ISPRS J PE&RS to
- Ring all the major actors together by asking them to write a series of scientific and technological papers for the
Three Ingredients

The understanding and formulation of the indicators, approach or methodology and as well as prepared data are three major ingredients.

17 Goals
169 Targets
230 Indicators

Understanding and formulation of indicators
Approach/Methodology
Geospatial and statistical data

Contents

1. Background
2. An Example
Discussion
Indicator 11.3.1

11.3. By 2030, **enhance inclusive and sustainable urbanization** and capacity for participatory, integrated and sustainable human settlement planning and management in all countries.

11.3.1 **Ratio of land consumption rate to population growth rate**

- Land cover, population, and other statistical data

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Land Consumption/Population Growth

- Population in Beijing has increased by 7 million from 2000 to 2010.
- Land consumption (*artificial surface = urban, rural, industrial, roads, etc.*) in Beijing has expanded about 1.4 times in the past 10 years.
- Population increasing and urban expansion may lead to shortage of land resources.
- Improving Land use efficiency and land population-carrying capacity are important for the sustainable use of land resource.
Definition of Indicator 11.3.1

**Ratio(r) of land consumption rate to population growth rate**

1. **Land consumption (Lc)**: Conversion of open space or farmland to artificial surface (residential, commercial, office, or other developed land uses) (CMAP, 2016).

2. **Land consumption rate (Lcr)**: The change in land consumption over a unit time period. (CMAP, 2016).

3. **Population growth (Pg)**: The increase in the number of individuals in a population.

4. **Population growth rate (Pgr)**: The change in population over a unit time period, often expressed as a percentage of the number of individuals in the population at the beginning of that period.

**Ratio(r) of land consumption rate to population growth rate**

\[ r = \sum_{i,j=1}^{n\text{ and } m} \frac{(Lc_{ij}+m - Lc_{ij})}{Lc_{ij}+m}/(P_{ij}+m - P_{ij})/(P_{ij}+m) \]

**Land use efficiency (r_e)**

\[ r_e = \sum_{i,j=1}^{n\text{ and } m} \frac{(Lc_{ij}+m - Lc_{ij})}{(GDP_{ij}+m - GDP_{ij})/(P_{ij}+m - P_{ij})/(P_{ij}+m)} \]

Three different types of efficiency:
- Intensive use type
- Abundant resource type
- Transition type

Indicator 11.3.1- Quantitative Formulation

**Ratio \( r \) of land consumption rate to population growth rate**

1. Ratio \( r \)

2. Land use efficiency \( r_e \)

3. Land population-carrying capacity \( r_p \)

\[
\begin{align*}
r_p &= \sum_{i=1}^{n} \sum_{j=1}^{m} \frac{(P_{ij} + m - P_{ij}^0)}{(Lc_{ij} + m - Lc_{ij}^0)} \frac{(GDP_{ij} + m - GDP_{ij}^0)}{(GDP_{ij} + m - GDP_{ij}^0)} \\
&= \frac{\sum_{i=1}^{n} \sum_{j=1}^{m} \frac{(P_{ij} + m - P_{ij}^0)}{(Lc_{ij} + m - Lc_{ij}^0)} \frac{(GDP_{ij} + m - GDP_{ij}^0)}{(GDP_{ij} + m - GDP_{ij}^0)}}{}
\end{align*}
\]

i, j: year; m: nation number; GDP: GDP

Three different types of efficiency
- Well coordinated development (in terms of land or population)
- Transition
- Extreme uncoordinated development (either land or population grows too fast)

**Data Used**

Land consumption, population and GDP are three primary data

Artificial surface data are used as a proxy measure of Land consumption data
Data Used

GlobeLand30-30 meter resolution, 2 years (2000 and 2010)

10 major classes: Open Water, Wetland, Artificial Cover, Cropland, Forest, Shrubland, Grassland, Bare Land, Tundra, Permanent snow & Glacier [Chen et al. Nature, 2015]

Data Used

GlobeLand30- Artificial surface

Urban and rural built up-areas
GlobeLand30 - Water Bodies

Water Bodies 2000/2010

GlobeLand30 - Wetland

Wetland 2000/2010
GlobeLand30 - Cultivated Land

Cultivated Land 2000/2010

GlobeLand30 - Permanent Snow and Ice

Glacier retreat
### Data Used
- Artificial surface and its change from 2000 to 2010

<table>
<thead>
<tr>
<th>Region</th>
<th>2000</th>
<th>2010</th>
<th>Change</th>
<th>Increase Proportion (%)</th>
</tr>
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<tbody>
<tr>
<td></td>
<td>Area 1,000 km² (%)</td>
<td>Area 1,000 km² %</td>
<td>Area 1,000 km² %</td>
<td></td>
</tr>
<tr>
<td>Global</td>
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<td>17.8 1.50</td>
<td>0.8 4.71</td>
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[Chen et al. Acta Geodaetica et Cartographica Sinica, 2015]
### Data Used
- Artificial surface and its change in Ten Countries,

<table>
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<th>Country/Region</th>
<th>Area in 2000 (10,000 km²)</th>
<th>Area in 2010 (10,000 km²)</th>
<th>Variation Rate (%)</th>
<th>Increase Proportion (%)</th>
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</table>

[Chen et al. Acta Geodaetica et Cartographica Sinica, 2015]

### Data Used
- Sources for Increased Artificial surface

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<th>Asia</th>
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<td>60.43</td>
<td>29.47</td>
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<td>27.91</td>
<td>20.86</td>
<td>50.26</td>
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<tbody>
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<td>Proportion (%)</td>
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<td>7.28</td>
<td>13.23</td>
<td>25.82</td>
<td>15.76</td>
<td>21.62</td>
<td>13.46</td>
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<table>
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<th>North America</th>
<th>South America</th>
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<th>Global</th>
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<tbody>
<tr>
<td>Area (km²)</td>
<td>3799.71</td>
<td>643.80</td>
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<td>Proportion (%)</td>
<td>15.03</td>
<td>11.25</td>
<td>40.59</td>
<td>20.69</td>
<td>31.61</td>
<td>40.07</td>
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<th>North America</th>
<th>South America</th>
<th>Oceania</th>
<th>Global</th>
</tr>
</thead>
<tbody>
<tr>
<td>Area (km²)</td>
<td>158.09</td>
<td>284.31</td>
<td>517.68</td>
<td>2563.72</td>
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<td>Proportion (%)</td>
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<td>12.83</td>
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<table>
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<th>Wet land</th>
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<th>North America</th>
<th>South America</th>
<th>Oceania</th>
<th>Global</th>
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</thead>
<tbody>
<tr>
<td>Area (km²)</td>
<td>33.68</td>
<td>127.33</td>
<td>27.54</td>
<td>743.92</td>
<td>17.91</td>
<td>20.46</td>
<td>970.87</td>
</tr>
<tr>
<td>Proportion (%)</td>
<td>0.13</td>
<td>2.23</td>
<td>0.32</td>
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<td>0.75</td>
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<table>
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<th>Waters</th>
<th>Asia</th>
<th>Europe</th>
<th>Africa</th>
<th>North America</th>
<th>South America</th>
<th>Oceania</th>
<th>Global</th>
</tr>
</thead>
<tbody>
<tr>
<td>Area (km²)</td>
<td>2.21</td>
<td>609.83</td>
<td>39.98</td>
<td>241.20</td>
<td>26.11</td>
<td>24.19</td>
<td>943.52</td>
</tr>
<tr>
<td>Proportion (%)</td>
<td>0.01</td>
<td>10.66</td>
<td>0.47</td>
<td>1.61</td>
<td>1.09</td>
<td>2.81</td>
<td>1.64</td>
</tr>
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</table>

<table>
<thead>
<tr>
<th>Bare land</th>
<th>Asia</th>
<th>Europe</th>
<th>Africa</th>
<th>North America</th>
<th>South America</th>
<th>Oceania</th>
<th>Global</th>
</tr>
</thead>
<tbody>
<tr>
<td>Area (km²)</td>
<td>1282.04</td>
<td>182.18</td>
<td>849.38</td>
<td>372.80</td>
<td>240.00</td>
<td>22.83</td>
<td>2949.24</td>
</tr>
<tr>
<td>Proportion (%)</td>
<td>5.14</td>
<td>3.18</td>
<td>9.91</td>
<td>2.49</td>
<td>10.04</td>
<td>2.66</td>
<td>5.13</td>
</tr>
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</table>

<table>
<thead>
<tr>
<th>Sub-total</th>
<th>Asia</th>
<th>Europe</th>
<th>Africa</th>
<th>North America</th>
<th>South America</th>
<th>Oceania</th>
<th>Global</th>
</tr>
</thead>
<tbody>
<tr>
<td>Area (km²)</td>
<td>24951.00</td>
<td>5720.80</td>
<td>8574.07</td>
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<td>2889.26</td>
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<td>57444.37</td>
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<td>Proportion (%)</td>
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<td>9.96</td>
<td>14.93</td>
<td>26.02</td>
<td>4.16</td>
<td>1.50</td>
<td>100.00</td>
</tr>
</tbody>
</table>

[Chen et al. Acta Geodaetica et Cartographica Sinica, 2015]
Data Used

Land consumption, population and GDP are three primary data

Land consumption
Population
GDP

Artificial surface data are used as a proxy measure of Land consumption data

Data Used

Per capita artificial surface and GDP are calculated

Artificial surface per capita
GDP per capita

GDP per capita (2010)

Million US$/km²
Land Use Efficiency Derived

Structural difference of resource allocation and utilization of land consumption can be observed

- Abundant resource (the USA, Canada, Russia.)
- Transition
- Intensive use type (Japan, Swiss, Korea, et al.)

Chen et al. Scientia Sinica Terrae, 2016

Changes of Land Use Efficiency

Structural difference of resource allocation and utilization of land consumption can also be observed from its changes

- Developed countries are relatively stable in land use efficiency.
- Developing countries have faster growth of per capita area and per GDP area.
- More fast growth of per capita area in less developed countries is obvious.

Chen et al. Scientia Sinica Terrae, 2016
Land use efficiency has improved from 2000 to 2010. An increase by 1% in artificial surface is associated with a 2.6% increase in population and about 20% increase in GDP.

**Evaluation index of growth efficiency**

\[ e_{\rho} = (-1) \ln \left( \frac{P_{j+i} - P_{j+i}}{L_i} \right) \]

\[ e_{g} = \ln \left( \frac{G_{DP_{j+i}}}{L_i} \right) \]

2000-2010:

- \( e_{\rho} \): Agglomeration degree of per capita area: 0.963
  - \( \exp(0.963) \approx 2.62\% \)
- \( e_{g} \): Agglomeration degree of per capita GDP: 2.954
  - \( \exp(2.954) \approx 19.18\% \)

Chen et al. *Scientia Sinica Terrae*, 2016

**Contents**

1. Background
2. An Example
3. Discussion
Three Ingredients to Success

- A better understanding and formulation of the indicators
- Well established approach or methodology
- Well prepared and reliable data.

Towards More Reliable LCC Data Sets

<table>
<thead>
<tr>
<th>Products</th>
<th>resolution</th>
<th>classification</th>
<th>Data year</th>
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</thead>
<tbody>
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<td>UMD_GeoCover</td>
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<td>1992</td>
</tr>
<tr>
<td>IGBP_DISCover</td>
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<td>17</td>
<td>1992</td>
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<td>BU_MODIS</td>
<td>1km</td>
<td>17</td>
<td>2000</td>
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<td>GLC2000</td>
<td>1km</td>
<td>22</td>
<td>2000</td>
</tr>
<tr>
<td>GlobCover2005</td>
<td>300m</td>
<td>17</td>
<td>2005</td>
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<tr>
<td>GlobCover2009</td>
<td>300m</td>
<td>17</td>
<td>2009</td>
</tr>
<tr>
<td>ESA Land Cover CCI</td>
<td>300m</td>
<td>22</td>
<td>Every 5 year; Annual from 2017 onwards</td>
</tr>
<tr>
<td>Globeland30</td>
<td>30m</td>
<td>10</td>
<td>2000, 2010</td>
</tr>
<tr>
<td>Forest map</td>
<td>30m</td>
<td>1</td>
<td></td>
</tr>
</tbody>
</table>
Globeland30- Updated Versions

Globeland30 was donated to UN in Sept. 2014, New York, by Chinese government

An updating is under preparation to produce new versions for 2015 and 2020 at 30m resolution globally, as well as 10 m at some hot areas.

A Dynamic Atlas for SDGs
A Special Issue in ISPRS Journal
Photogrammetry and Remote Sensing

Call for original papers on contributions of photogrammetry, remote sensing and spatial information sciences towards achieving the UN SDGs

- Receipt of 750 word abstracts: 1 January 2017
- Notification of acceptance of abstracts: 31 January 2017
- Deadline for submission of papers: 30 April 2017
- Completion of review process: 31 October 2017
- Publication of special issue: 31 December 2017

Thanks for your attention!
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