Informing SDG Indicators with Land Cover and Change (LCC)

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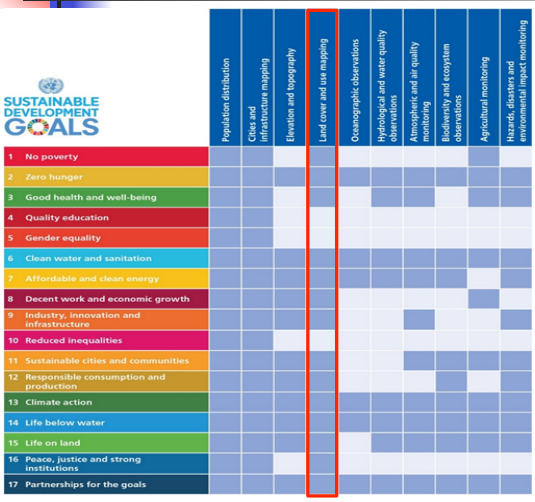
Contents

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

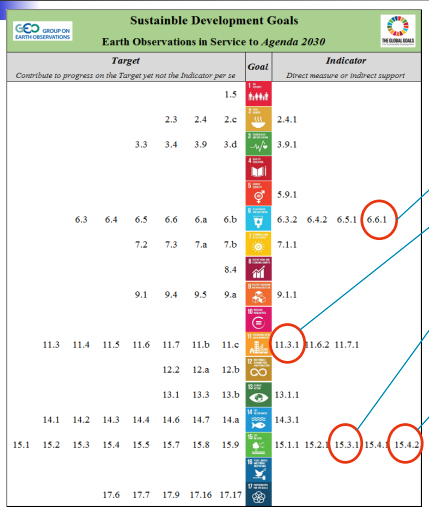
Land cover information Support to SDGs



- 13 of 17 SDGs are related to Land cover ad 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

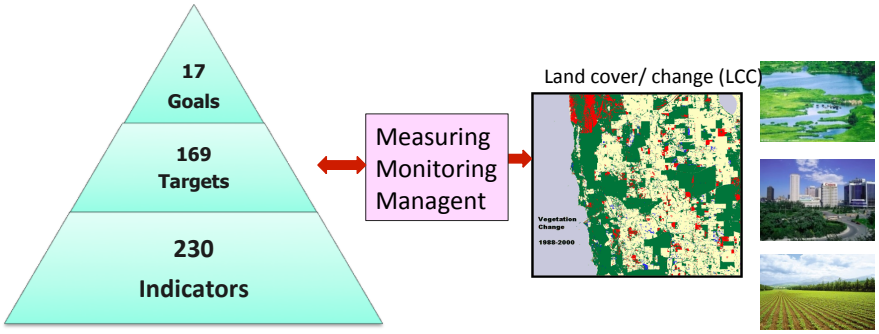
[André Obregón. 2016, 9]

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 dynamitic 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



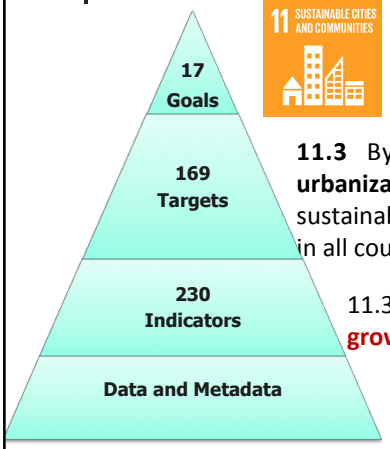
Understanding and formulation of indicators

Approach/ Methodology

Geospatial and statistical data

Contents

Indicator 11.3.1



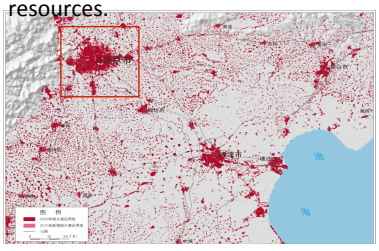
11.3 By 2030, **enhance inclusive and sustainable urbanization** and capacity for participatory, integrated and sustainable human settlement planning and management in all countries

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

•Land cover, population, and other statistical data

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 time 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**

Land consumption (Lc)	Conversion of open space or farmland to artificial surface (residential, commercial, office, or other developed land uses) (CMAP,2016).
Land consumption rate Lcr	The change in land consumption over a unit time period. (CMAP,2016).
Population growth(Pg)	The increase in the number of individuals in a population.
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.

CMAP: Chicago metropolitan Agency for Planning, http://www.cmap.illinois.gov/
Population Reference Bureau. "2013 World Population Factsheet" (PDF). www.pbr.org. Population Reference Bureau. Retrieved 5 December 2014.

Indicator 11.3.1- Quantitative Formulation

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

1. Ratio(*r*)

$$r=\sum i,j=1\ldots n\uparrow m=1\ldots n\square(Lc\downarrow j\uparrow i+m-Lc\downarrow j\uparrow i)/Lc\downarrow j\uparrow i+m/(P\downarrow j\uparrow i+m-P\downarrow j\uparrow i)/P\downarrow j\uparrow i+m$$

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

2. Land use efficiency (r_e)

$$r\downarrow e=\sum i,j=1\ldots n\uparrow m=1\ldots n\square(Lc\downarrow j\uparrow i+m-Lc\downarrow j\uparrow i)/(G\downarrow DP\downarrow j\uparrow i+m-G\downarrow DP\downarrow j\uparrow i)/(P\downarrow j\uparrow i+m-P\downarrow j\uparrow i)/P\downarrow j\uparrow i+m$$

i, j: year ; *m*: nation number; G_{DP}:GDP in nation

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*)**

土地人口承载力（城市人口承载力）：城市扩张与人口增加协调性；城市扩张快速型；人口高度集中型；

2. **Land use efficiency (r_e)**

3. **land population-carrying capacity(r_p)**

$$r_p = \sum_{i,j=1\ldots n} \sum_{m=1\ldots n} (P_{j+m} - P_j) / (Lc_{j+m} - Lc_j) \Big/ (GDP_{j+m} - GDP_j)$$

i, j: year; m: nation number; G_{DP}: GDP in nation

Three different types of efficiency

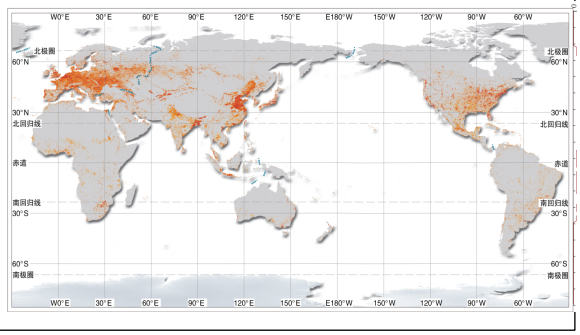
- Well coordinated development (in trems of land or population)
- Transition
- Extreme uncoordinated development (either land or population grows too fast)

Data Used

Land consumption, population and GDP are three primary data

Land consumption

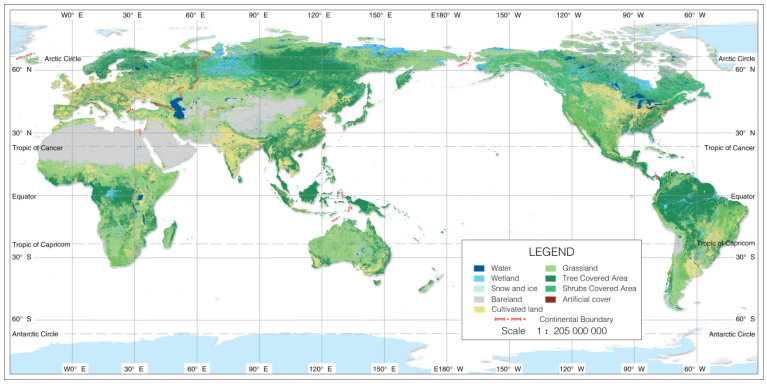
Globeland30 Artificial surfaces



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

Data Used

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

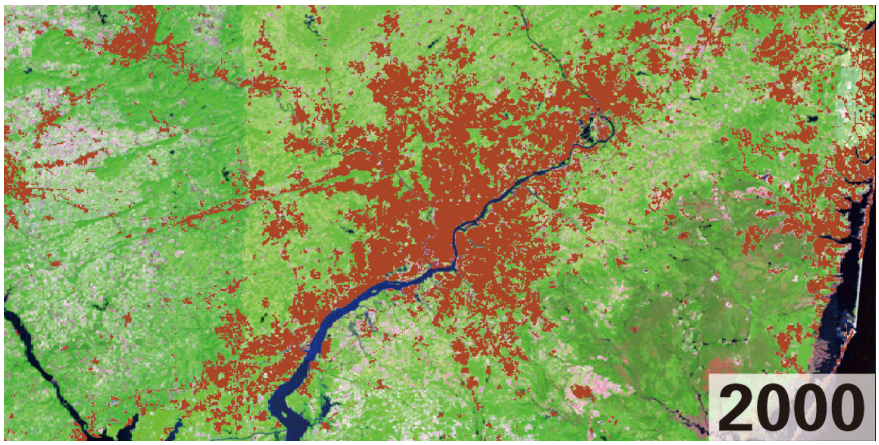


10 major classes: Open Water, Wetland, Artificial Cover, Cropland, Forest, Shrub land, Grassland, Bare Land, Tundra , Perm.snow & Glace

[Chen et al. Nature, 2015]

Data Used

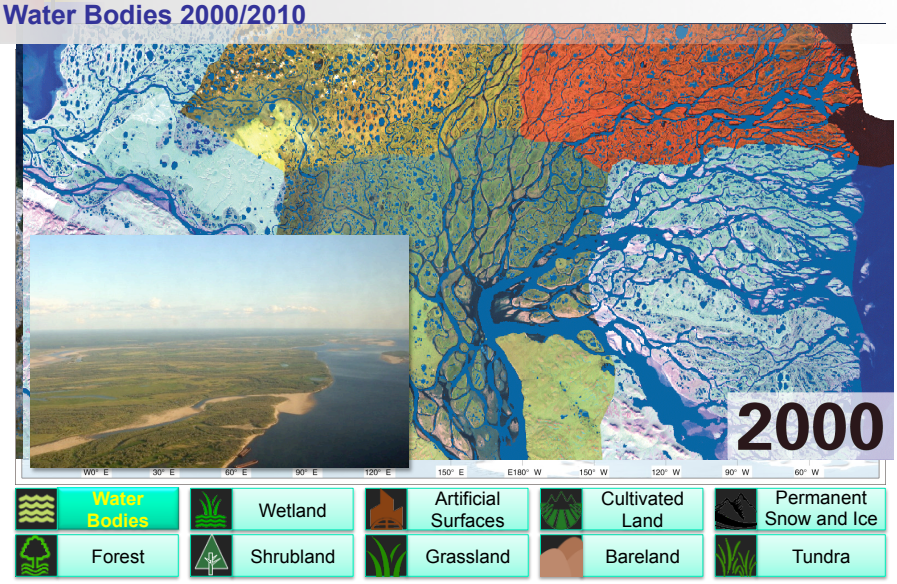
GlobeLand30- Artificial surface



Urban and rural built up-areas

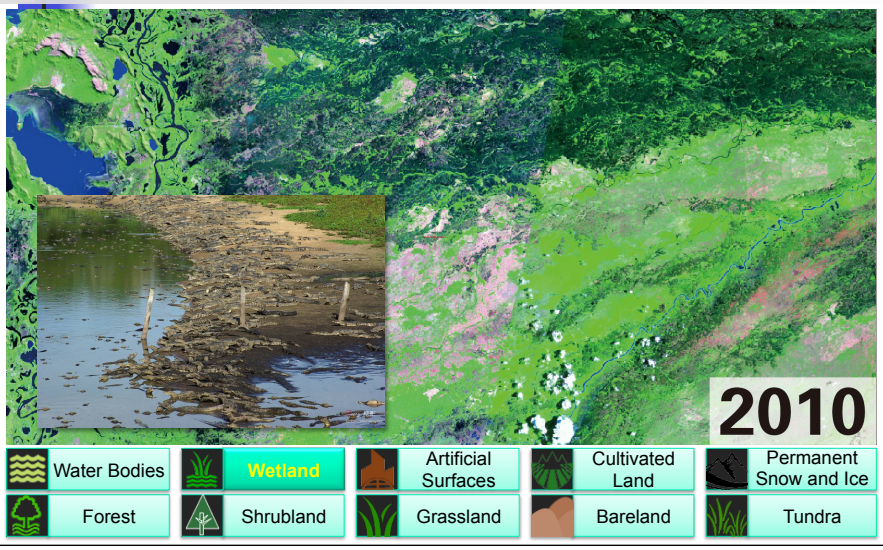
GlobeLand30 - Water Bodies

Water Bodies 2000/2010



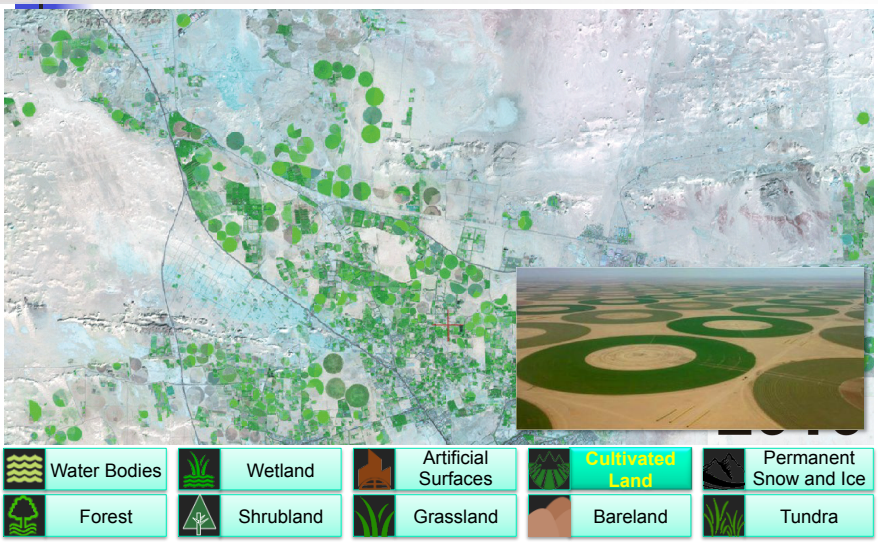
GlobeLand30 - Wetland

Wetland 2000/2010



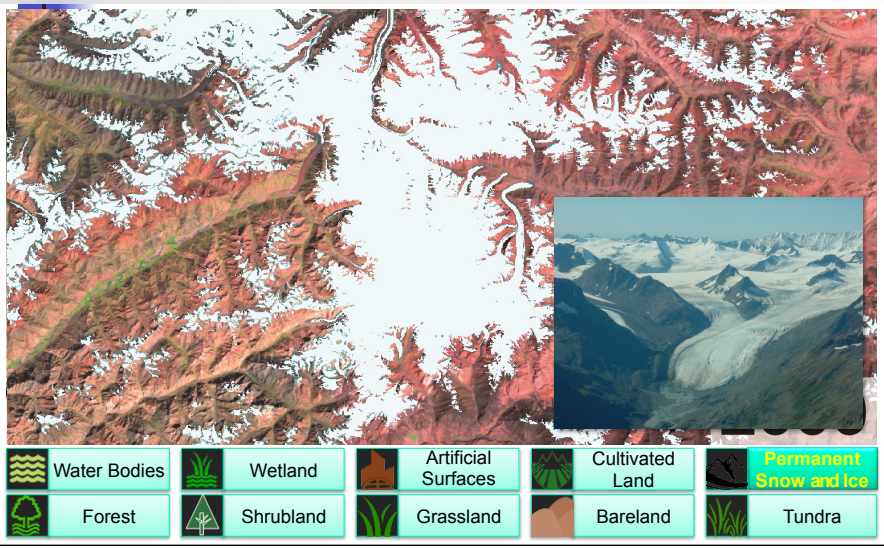
GlobeLand30 - Cultivated Land

Cultivated Land 2000/2010



GlobeLand30 - Permanent Snow and Ice

Glacier retreat



GlobeLand30 - Forest

Forest 2000/2010

Data Used

- Artificial surface and its change from 2000 to 2010

Region	2000		2010		Change		Increase Proportion (%)
	Area 1,000 km^2	(%)	Area 1,000 km^2	%	Area 1,000 km^2	%	
Global	1,130.1	100.0	1187.5	100.00	**57.4**	**5.08**	100.00
Asia	389.1	34.43	414.1	34.87	**25.0**	**6.43**	**43.55**
Europe	318.5	28.18	324.2	27.30	5.7	1.79	9.93
Africa	69.7	6.16	78.2	6.59	**8.5**	**12.20**	**14.81**
N. American	277.9	24.59	292.8	24.66	14.9	5.36	25.96
S. American	58.0	5.13	60.4	5.09	2.4	4.14	4.18
Oceania	17.0	1.50	17.8	1.50	0.8	4.71	1.39

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

Data Used

- Artificial surface and its change in Ten Countries,

Country/ Region	Area in 2000 (10,000 km2)	Area in 2010 (10,000 km2)	Variation Rate （%）	Increase Proportion （%）
China	14.49	**16.10**	**11.17**	**28.17**
U.S.A	22.38	**23.56**	**5.26**	**20.48**
Russia	9.50	9.83	3.46	5.73
Mexico	2.32	2.50	7.87	3.18
India	4.90	4.99	1.79	1.53
Brazil	3.18	3.24	1.83	1.01
Japan	2.50	2.54	1.55	0.67
France	2.86	2.90	1.29	0.64
Germany	3.02	3.02	0.03	0.01
Ukraine	4.09	4.09	<0.01	<0.01

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

Data Used

-Sources for Increased Artificial surface

		Asia	Europe	Africa	North America	South America	Oceania	Global
Arable land	Area(km²)	17968.43	3457.04	2525.80	4074.99	666.82	179.34	28872.41
	Proportion (%)	**72.01**	60.43	29.47	27.26	27.91	20.86	50.26
Forest land	Area(km²)	1756.84	416.31	1134.09	3859.18	376.62	185.92	7728.96
	Proportion (%)	7.04	7.28	13.23	25.82	15.76	21.62	13.46
Grassland	Area(km²)	3749.71	643.80	3479.60	3093.45	755.19	344.52	12066.26
	Proportion (%)	**15.03**	11.25	40.59	20.69	31.61	40.07	21.01
Shrub	Area(km²)	158.09	284.31	517.68	2563.72	306.59	82.71	3913.11
	Proportion (%)	0.63	4.97	6.04	17.15	12.83	9.62	6.81
Wet land	Area(km²)	33.68	127.33	27.54	743.92	17.93	20.46	970.87
	Proportion (%)	0.13	2.23	0.32	4.98	0.75	2.38	1.69
Waters	Area(km²)	2.21	609.83	39.98	241.20	26.11	24.19	943.52
	Proportion (%)	0.01	10.66	0.47	1.61	1.09	2.81	1.64
Bare land	Area(km²)	1282.04	182.18	849.38	372.80	240.00	22.83	2949.24
	Proportion (%)	5.14	3.18	9.91	2.49	10.04	2.66	5.13
Sub-total	Area(km²)	24951.00	5720.80	8574.07	14949.26	2389.26	859.97	57444.37
	Proportion (%)	43.44	9.96	14.93	26.02	4.16	1.50	100.00

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

Data Used

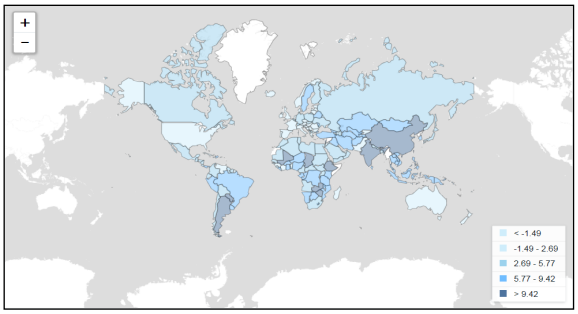
Land consumption, population and GDP are three primary data

Land consumption

Population

GDP

GDP Data (UNSD,2010)



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

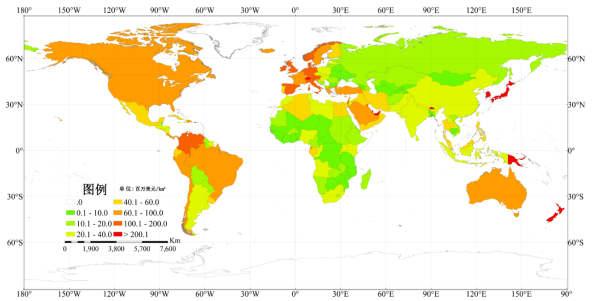
Data Used

Per capita artificial surface and GDP are calculated

Artificial surface per capita

GDP per capita

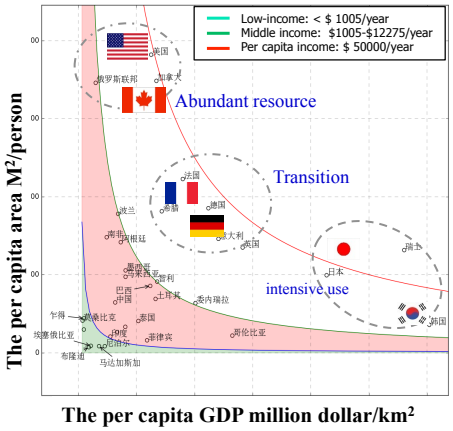
GDP per capita (2010)



Million US$/km^2

Land Use Efficiency Derived

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

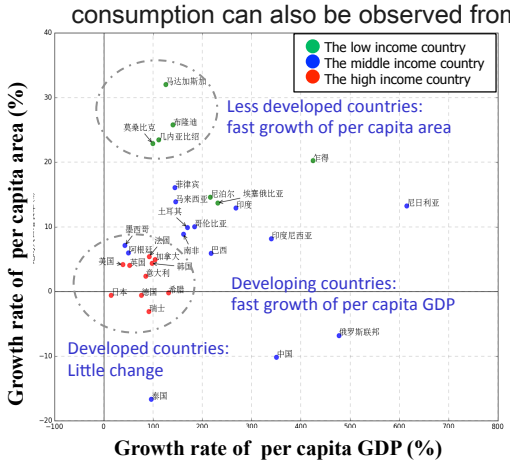


- Abundant resource (the USA, Canada, Russia.)
- Transition
- Intensive use type (Japan, Swiss, Korea, et al.)

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

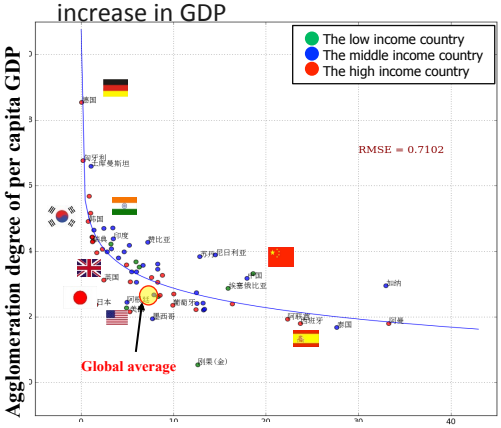


- Developed countries are relatively stable in land use efficiency.
- Developing countries have faster growth of per capita area and per GDP area.
- More fast growth of per capita area in less developed countries is obvious.

Chen et al. Scientia Sinica Terrae, 2016

Growth Efficiency

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

$$e_{\rho} = (-1)^{n} \ln|(P_{ji+m} - P_{ji}) / P_{ji} / (Lc_{ji+m} - Lc_{ji})| Lc_{ji}|$$

$$e_{g} = \ln(GDP_{ji+m} - GDP_{ji}$$

2000-2010:

e_p: Agglomeration degree of per capita area:0.963
~exp(0.963) =2.62%

e_g: Agglomeration degree of per capita GDP:2.954
~exp(2.954) = 19.18%

Chen et al. Scientia Sinica Terrae, 2016

Contents

Three Ingredients to Success

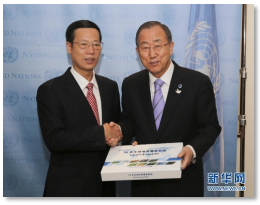
- A better understanding and formulation of the indicators
- Well established approach or methodology
- Well prepared and reliable data.

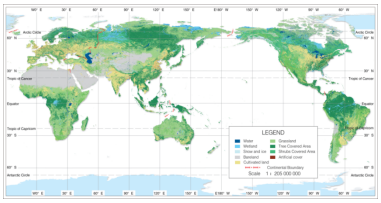
Towards More Reliable LCC Data Sets

Products	resolution	classification	Data year
UMD_GeoCover	1km	17	1992
IGBP_DISCover	1km	17	1992
BU_MODIS	1km	17	2000
GLC2000	1km	22	2000
GlobCover2005	300m	17	2005
GlobCover2009	300m	17	2009
ESA Land Cover CCI	300m	22	Every 5 year; Annual from 2017 onwards
Globeland30	30m	10	2000, 2010
Forest map	30m	1	

Globeland30- Updated Versions

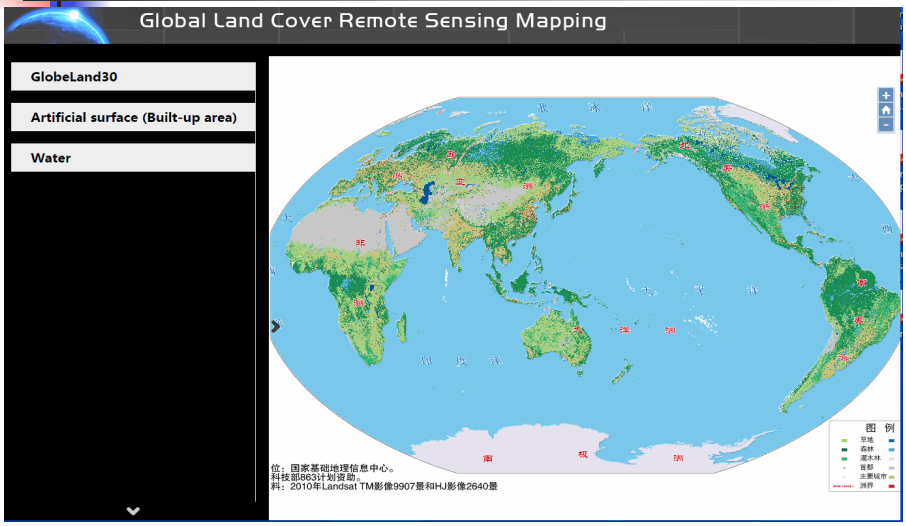
Globeland30 was donated to UN in Sept. 2014, New York, by Chinese government





An updating is under preparation to produce new versions for 2015 and 2020at 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