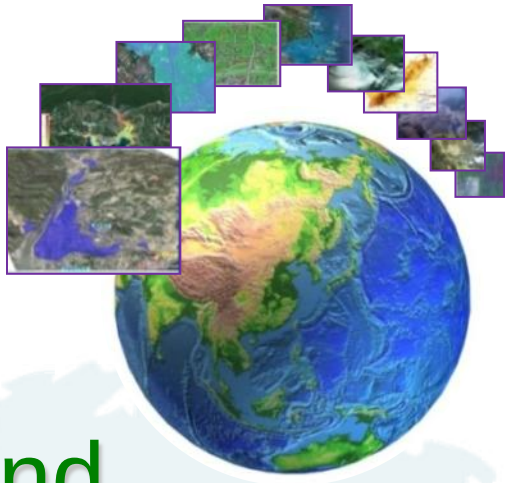


Global Ecosystems and Environment Observations: Annual Reports from China

Liao Xiaohan & Li Jiahong

National Remote Sensing Center of China, MOST

Institute of Geographic Sciences and Natural Resources Research, CAS

2016-8

Contents

Global Hot Issues

Global Ecosystems and Environment Changes

- Climate Change
- Water Shortage
- Pollution
- Decreasing Biodiversity
- Desertification

Global ecosystem and environment observations are becoming increasing urgent!

- 2030 agenda for sustainable development

Earth Observation Technology

An essential method for retrieving the ecological environmental parameters at global scale.

- Spaceborne Systems
- Airborne Systems

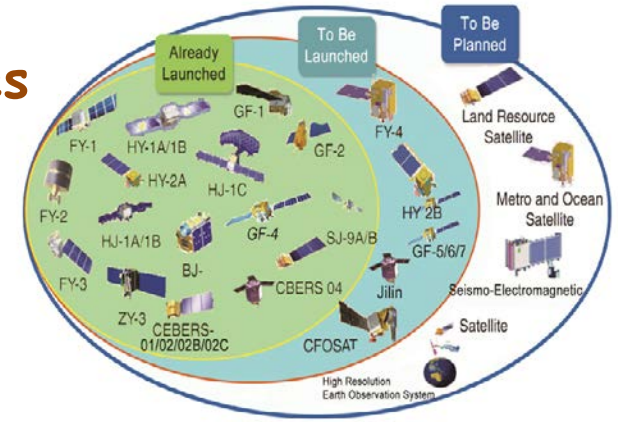
Advantages

- Large range
- High resolution
- Consecution
- Dynamic
- High efficiency

China's Earth Observation

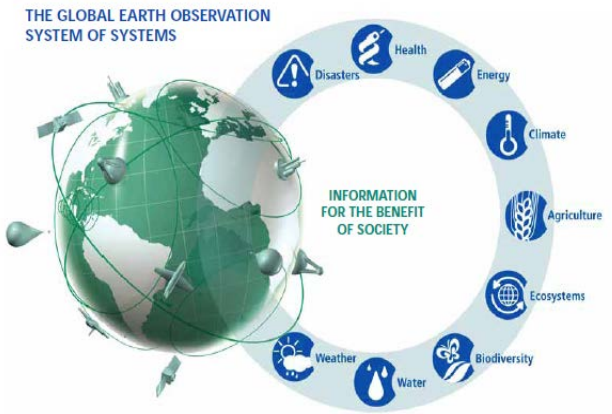
Developed series of earth observation satellites

- 8 satellites series
- 30 satellites in orbits



Established China GEOSS

- **GEOSS** —— *Global Earth Observation System of Systems*
- Link Earth observation resources world-wide across multiple Societal Benefit Areas.



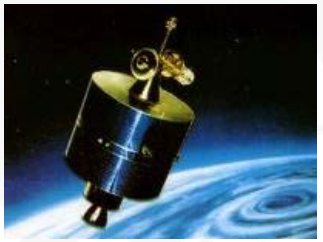
Support the Group on Earth Observations (GEO)

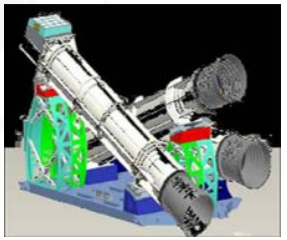
- **Founding country, Co-chair country**
- **Ministerial coordinating group**

Spaceborne Observation Capability

Satellite Series

- Meteorological Satellites (7, FY-2/3)
- Ocean Satellites (2, HY-1B/2A)
- Mapping Satellite-1 Constellation
- Tansat - Global CO2 Observing and Monitoring Mission
- Land Resource Satellites (7, ZY-3, HJ-1A/B, CBERS-04)
- Small Satellite (BJ-1)





High-Resolution Earth Observing System

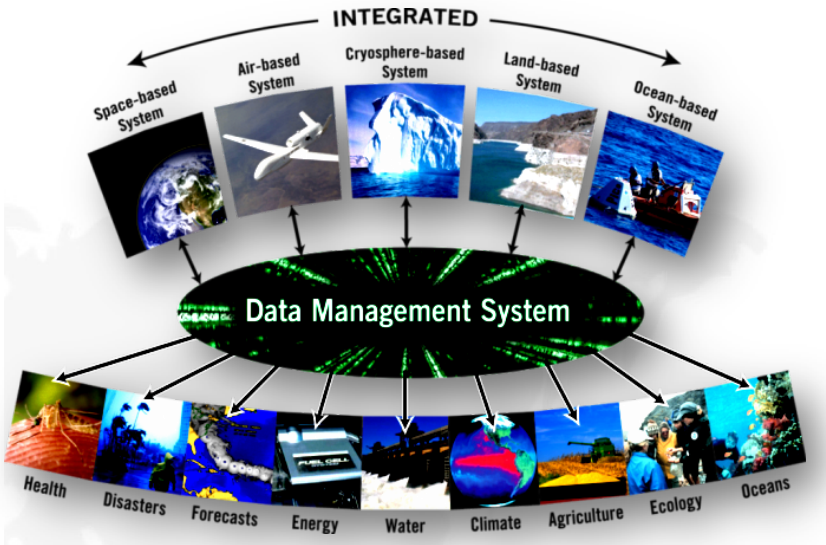
- CHEOS (3, GF-1/2/4)

Commercial Satellites

- Jilin-1 Constellation, TripleSat Constellation

Satellite image collected by Jilin-1

China GEOSS



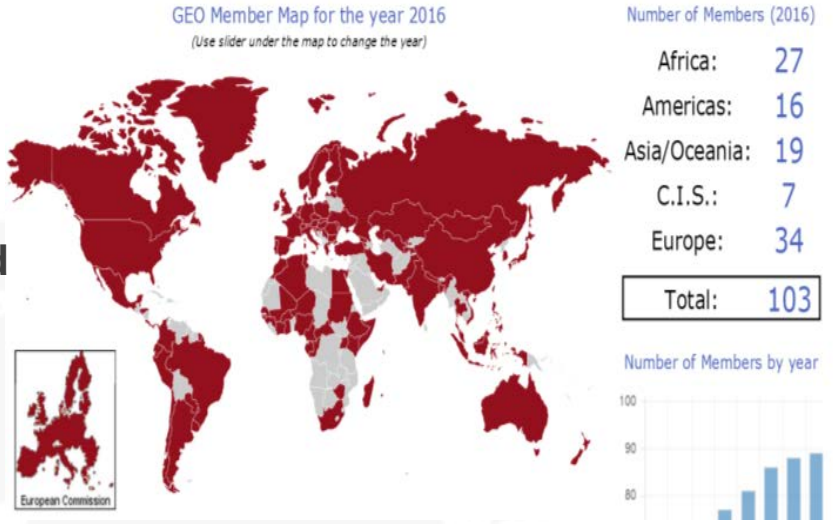
GEOSS —— *Global Earth Observation System of Systems*

- **Coordinates resources through virtual network**
- **Production capacity of time-space seamless global high-accuracy remote sensing common products.**
- **Make those resources available for better informed decision-making.**

Support GEO

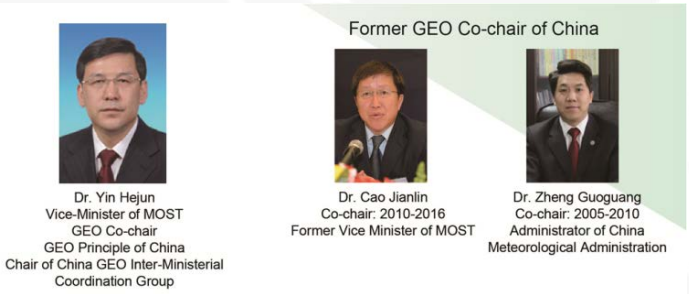
GEO

- Established in 2005.
- A voluntary partnership of governments and organizations.
- 103 Nations and European Commissions.
- 103 Participating Organizations.



China GEO

- Founding country
- Co-chair country
- ExCom member
- Ministerial coordinating group
- GEO China Secretariat



The origin of the GEOARC

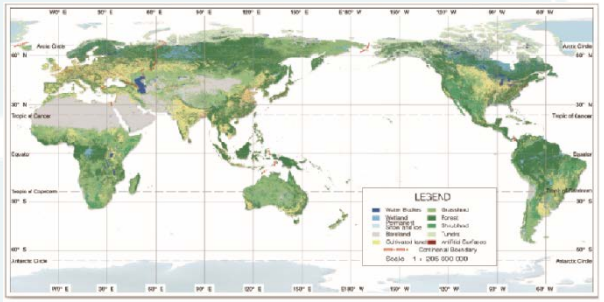
- Since 2012.
- Support global change studies and international cooperation via GEO.
- The National Remote Sensing Center of China (NRSCC), Ministry of Science and Technology (MOST) of the People's Republic of China supports the work.
- Integrated a series of products from the National Research and Development Program.

Contents

① Globe Land 30 (J. Chen, et al.)

Land Cover dataset has cross-cutting importance for many Societal Benefit Areas.

- Land Cover is one of GEO's top-priority Earth observation parameters
- The GEO Global Land Cover task is working to improve coordination of land cover activities around the globe.
- It seeks to develop an International Network where GEO Members can express their needs:
  - *Land cover products*
  - *Contribute mapping and monitoring efforts*
  - *Support related capacity development initiatives*



Map of Globe Land 30

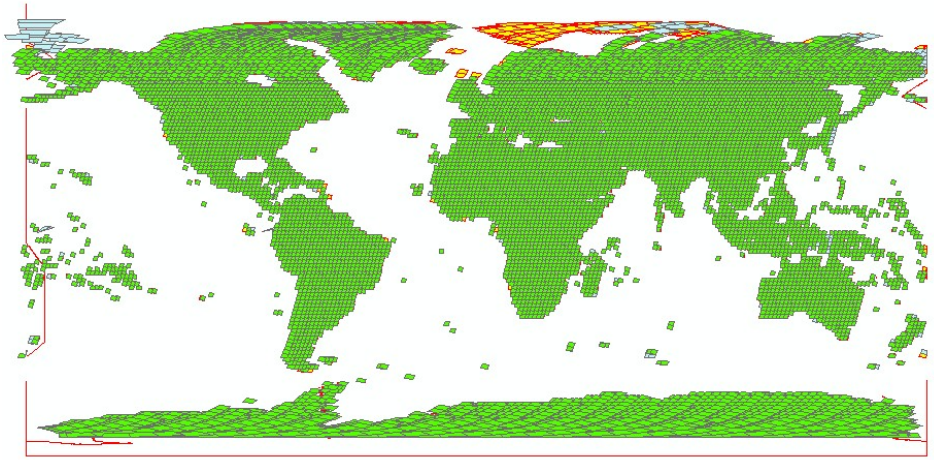
Globe Land 30

- The World's **first** 30m-resolution Global Land Cover Product.
- Be funded through National Research and Development Program.
- Generated by China Scientists, with the cooperation of U.S. and European Colleagues.

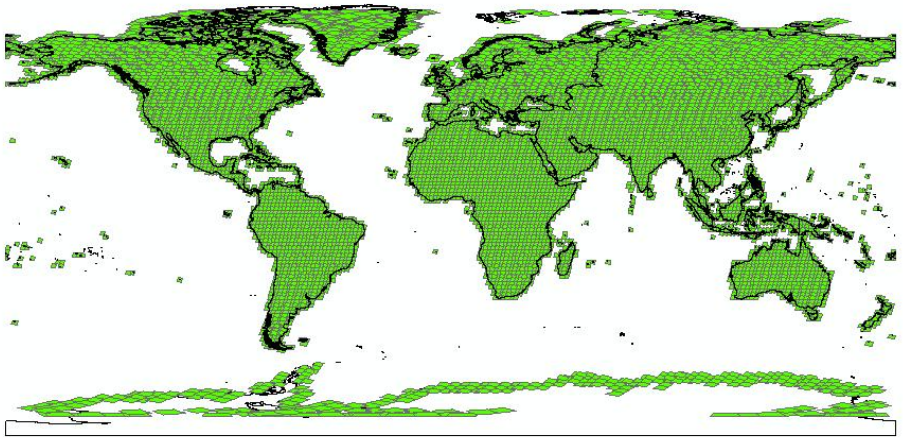
Data Tiles of Globe Land 30

① Globe Land 30 (J. Chen, et al.)

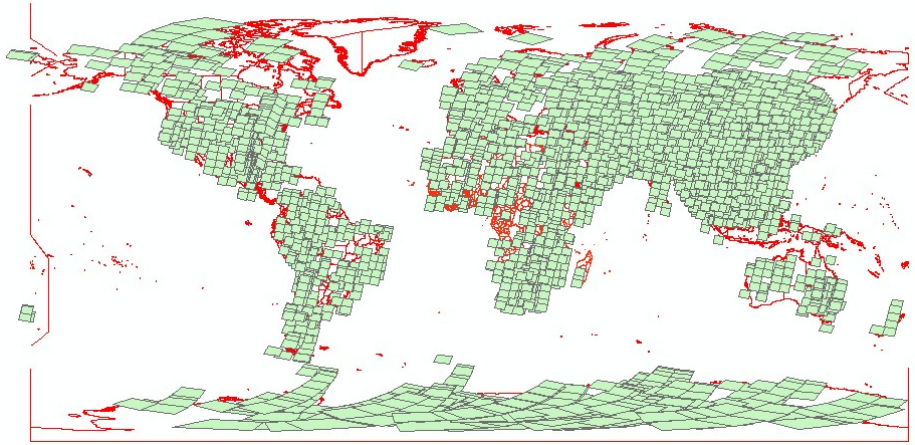
Generated by more than 20,000 Landsat images data.



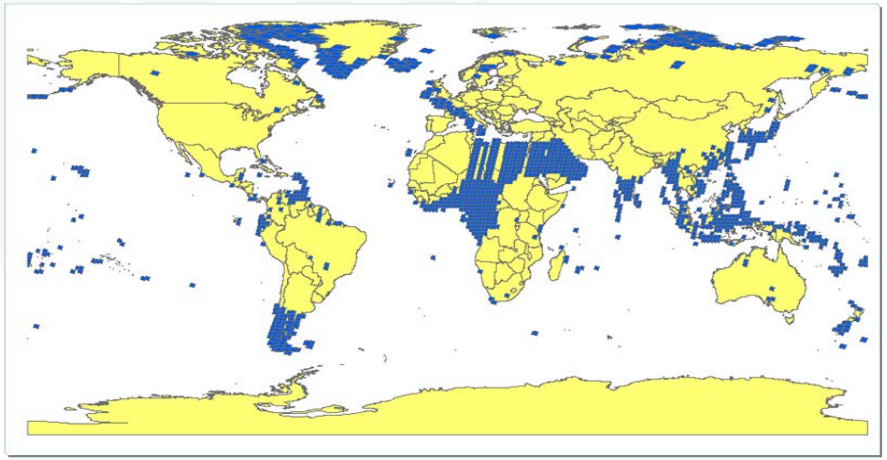
Year 2000 Landsat images - 10270
(Internet Download)



Year 2010 Landsat 5+Landsat7 images - 9907
(Internet Download)



Year 2010 HJ Programmed images - 2640

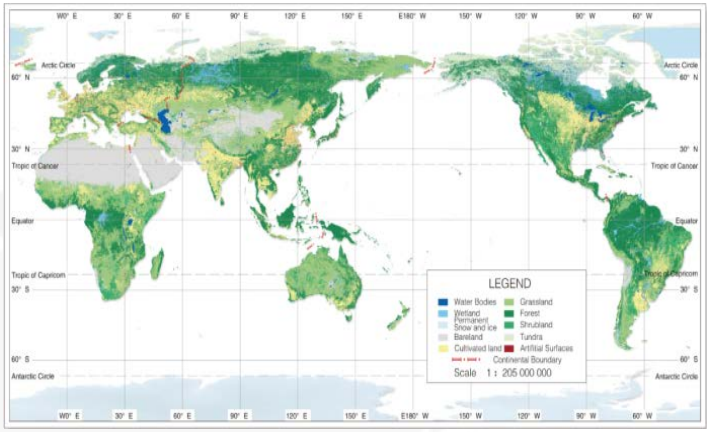


Year 2010 Landsat7 SLC-off images - 1360
(Internet Download)

① Globe Land 30 (J. Chen, et al.)

- **Ten Major Land Cover Class**

  - Cultivated land
  - Forest
  - Grassland
  - Shrubland
  - Wetland
  - Water bodies
  - Tundra
  - Artificial surfaces
  - Bareland
  - Permanent snow and ice

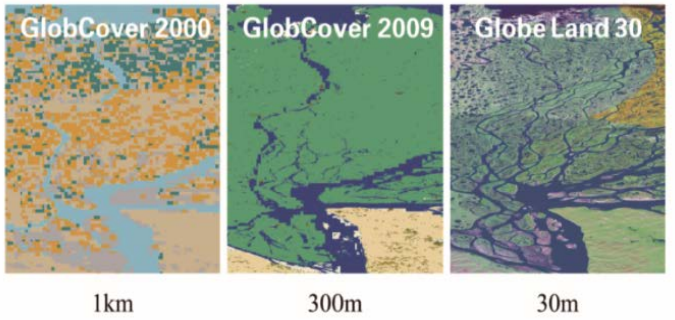


- **Advantages**

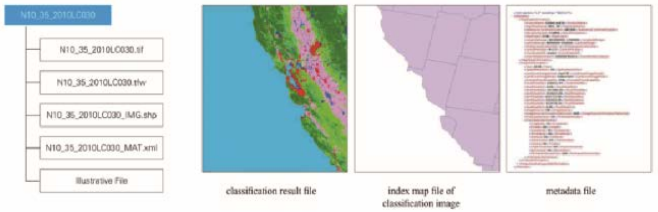
  - It can be used for deriving crucial information.

    (*Geographical Statistics*, *Landscape Pattern*……)

  - Be of great value for global climatic change studies and sustainable development planning and implementation.



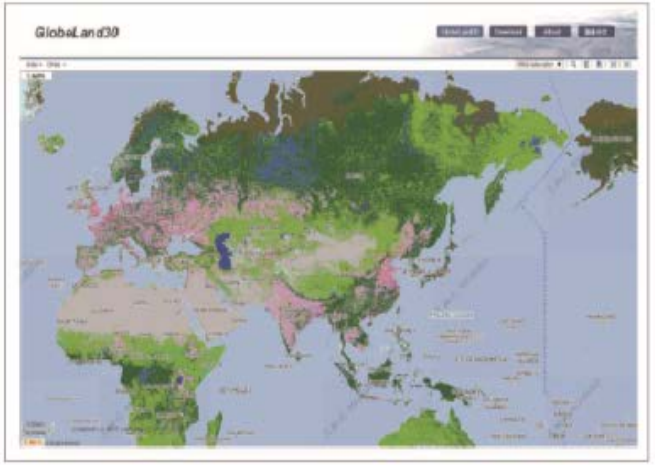
GLC Datasets at Different Resolutions



The Content of Globe Land 30 Dara Tile Zip File

① Globe Land 30 (J. Chen, et al.)

Data Sharing



- Developed a web-based information platform.
- On-line browsing and downloading
- The full dataset has been released for sharing and utilization.
- Chinese government donated the datasets to the U.N.

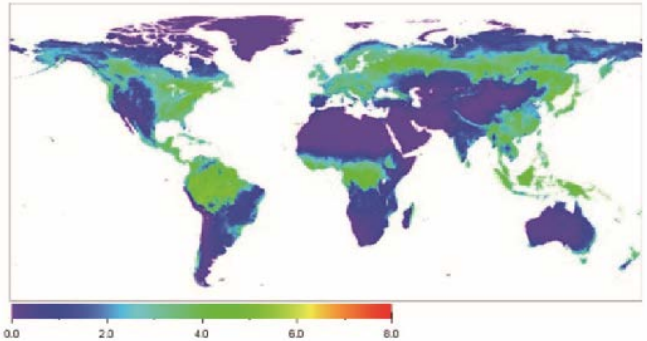
② GLASS (S.L. Liang, et al)

Global LAnd Surface Satellite (GLASS) Products

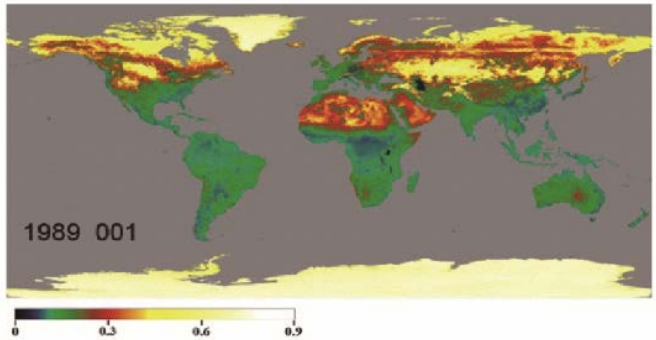
- Supported by the National Research and Development Program of China
- The key project ——'Generation and Applications of Global Products of Essential Land Variables'.
- Produced 5 kinds of GLASS Products:

Products	Spatial resolution	Temporal resolution	Temporal range
LAI	**1-5 km, 0.05°**	8 day	**1981-2013**
Shortwave albedo	**1-5 km, 0.05°**	8 day	**1981-2013**
Longwave emissivity	**1-5 km, 0.05°**	8 day	**1981-2013**
Shortwave radiation	5 km, 0.05°	**3 hour**	2008-2010
PAR	5 km, 0.05°	**3 hour**	2008-2010

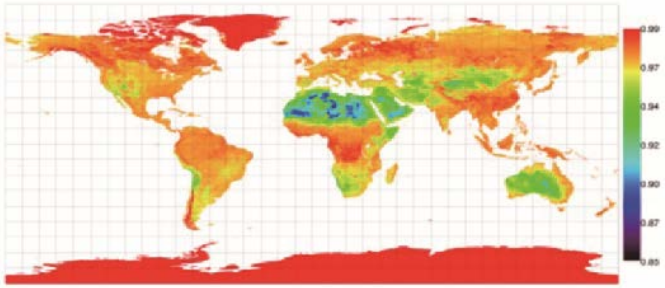
② GLASS (S.L. Liang, et al)



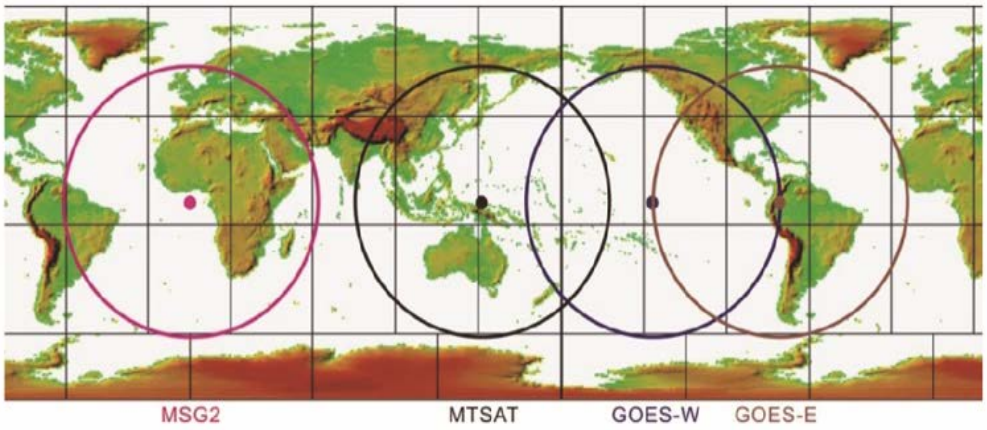
Global LAI Distribution from GLASS LAI Product



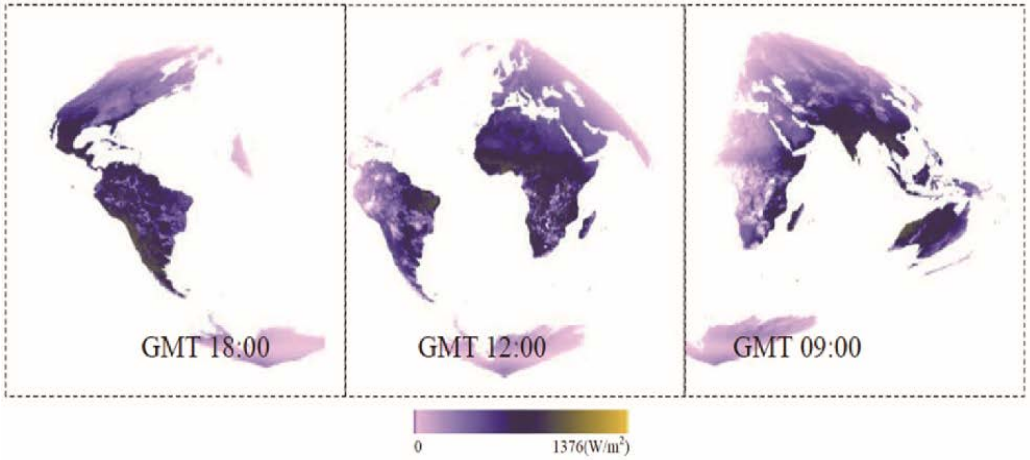
GLASS Black-sky Albedo Products



GLASS Longwave Emissivity



The Spatial Coverage of the Geostationary Satellite Data Used to Generate GLASS Shortwave Radiation and PAR Products

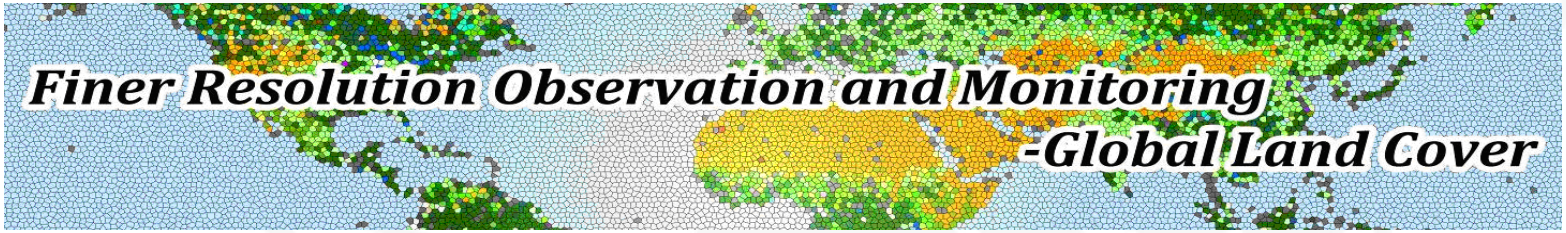


GLASS Shortwave Radiation Product Generated from Multiple Satellites

③ FROM-GLC (P. Gong, et al.)

Finer Resolution Observation and Monitoring of Global Land Cover

- 30m-resolution **global land cover maps**
- An important source of information for understanding the **complex interactions between human activities and global change**.



- Produced by using **Landsat TM and ETM+** data (30m), and integrate multi-resolution datasets, including **MODIS EVI time series (250 meter)**, **global DEM (1km)**, and so on.
- Generated land cover dataset with multi-resolution (i.e. **30 m, 250 m, 500 m, 1 km, 5 km, 10 km, 25 km, 50 km, 100 km**) to meet requirements for different resolutions from different applications.

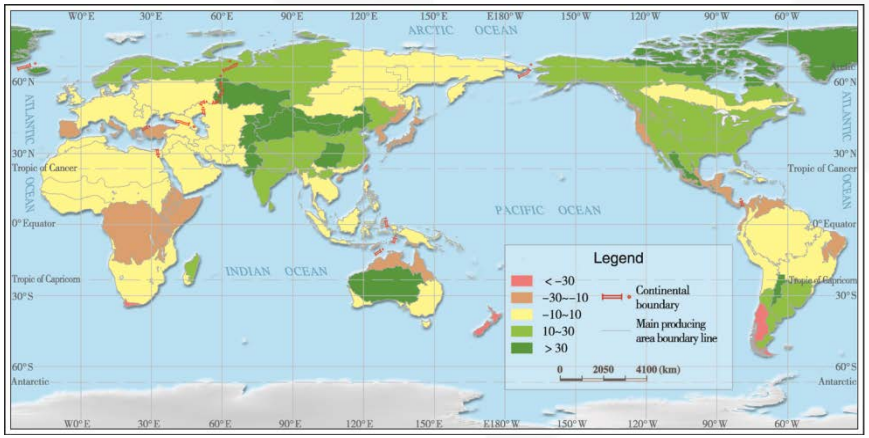
The datasets can be downloaded free from:

http://data.ess.tsinghua.edu.cn/

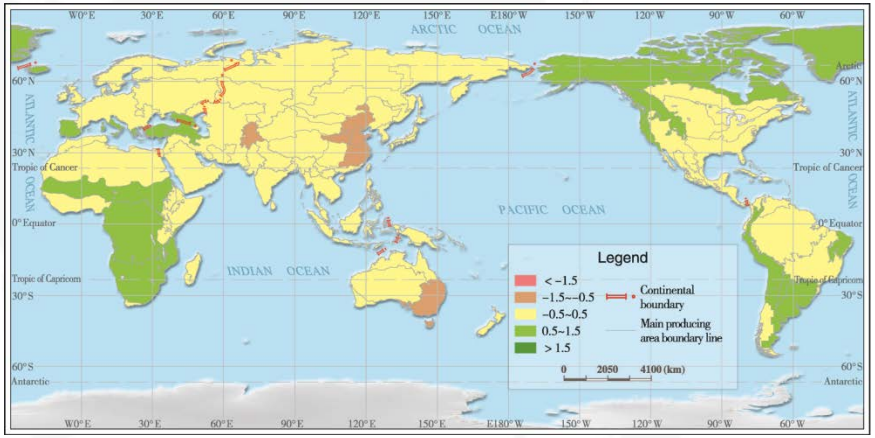
④ CropWatch (B.F. Wu, et al.)

An important component of GEO/GEOSS Global Agricultural Monitoring Initiative (GEOGLAM)

- **One of the three global crop monitoring systems.**
- **Monitoring global agro-climatic conditions by remote sensing:**
  - ***Rainfall, Photosynthetically Active Radiation (PAR), Potential Biomass***



(a) Global map of October 2014-June 2015 rainfall anomaly (as indicated by the RAIN indicator) by MRU, departure from 14YA (percentage)



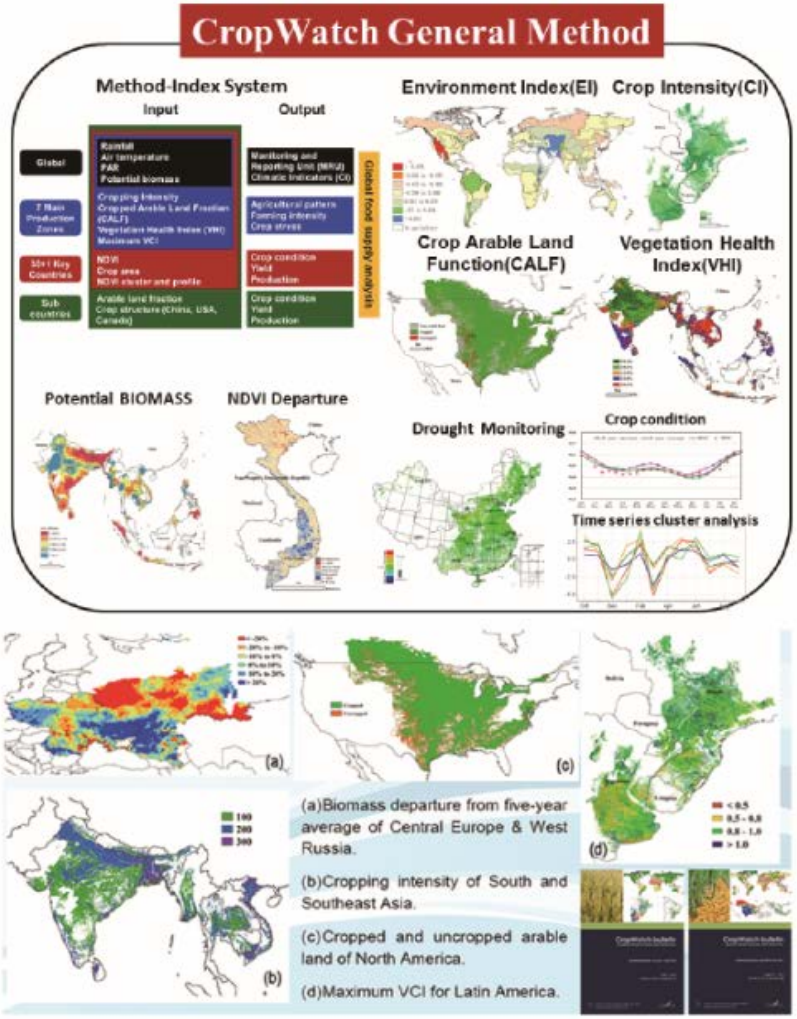
(b) Global map of April 2015-September 2015 temperature anomaly (as indicated by the TEMP indicator) by MRU, departure from 14YA (percentage)

④ CropWatch (B.F. Wu, et al.)

Determine key crop related indicators by using remote sensing data combined with selected field data.

- *Crop acreage,*
- *Yield and production,*
- *Crop condition,*
- *Cropping intensity,*
- *Crop-planting proportion,*
- *Total food availability,*
- *The status and severity of drought*

Release **monthly** and **quarterly bulletins**.



④ CropWatch (B.F. Wu, et al.)

Spatial Resolution

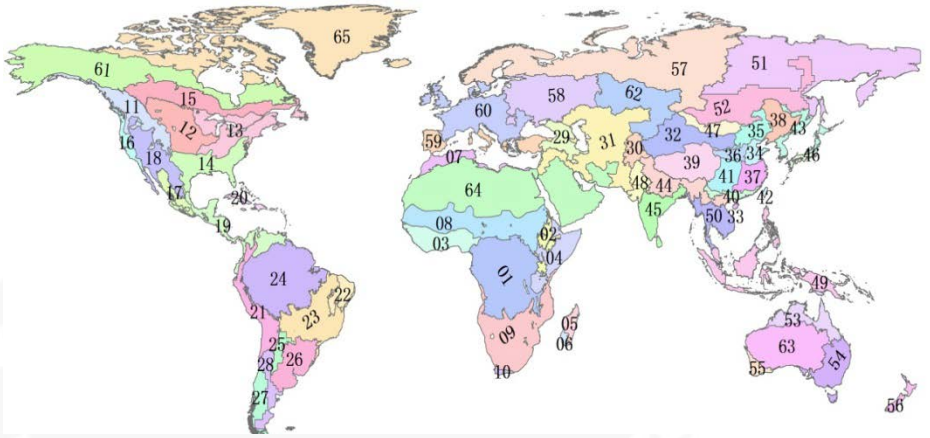
- **0.25° (**Global**)**
- **1km (4** Continent, Main Production Zones, Province / State Scale**)**
- **30m (**China**)**

Spatial Scale

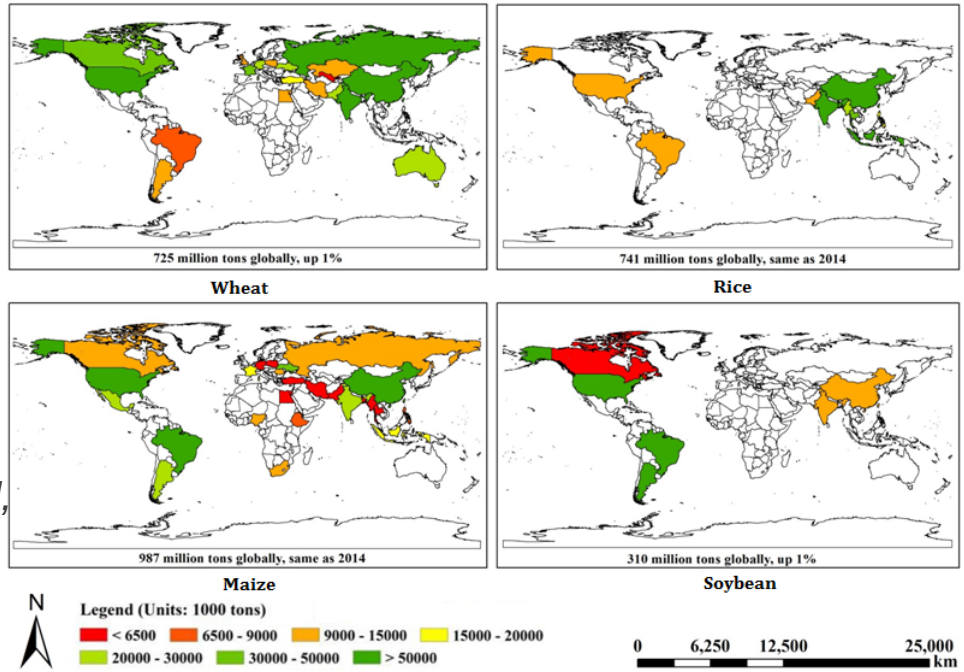
- **Globe, Continent, China, Province / State**

Temporal resolution

- **10 days:** *Environmental index*
- **15 days:** *NDVI, Crop condition*
- **Season:** *Farmland planting proportion, Maximum vegetation health index*
- **Growing Season:** *Area, Per unit area yield, total yield*
- **Annual:** *Cropping index*



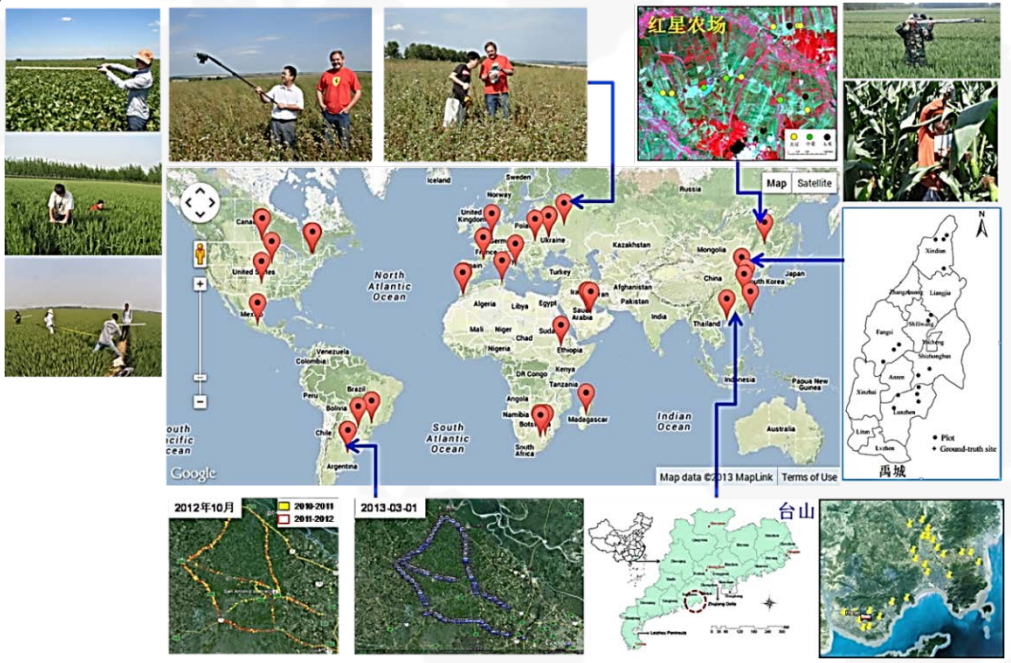
65 Crop Production System Zones (CPSZ) in the Globe



Production Outlook of Wheat, Rice, Maize and Soybean in 2015 for 31 Countries

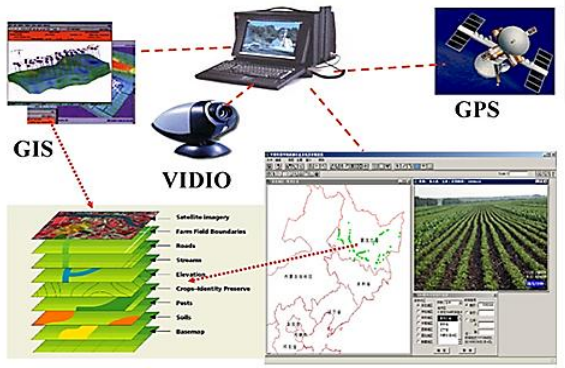
④ CropWatch (B.F. Wu, et al.)

Global Validation

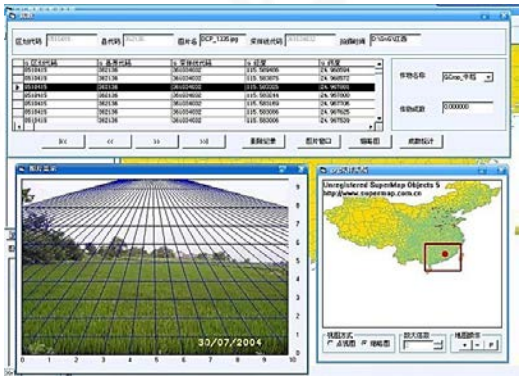


CropWatch Global Validation Sites

GVG Data Acquisition

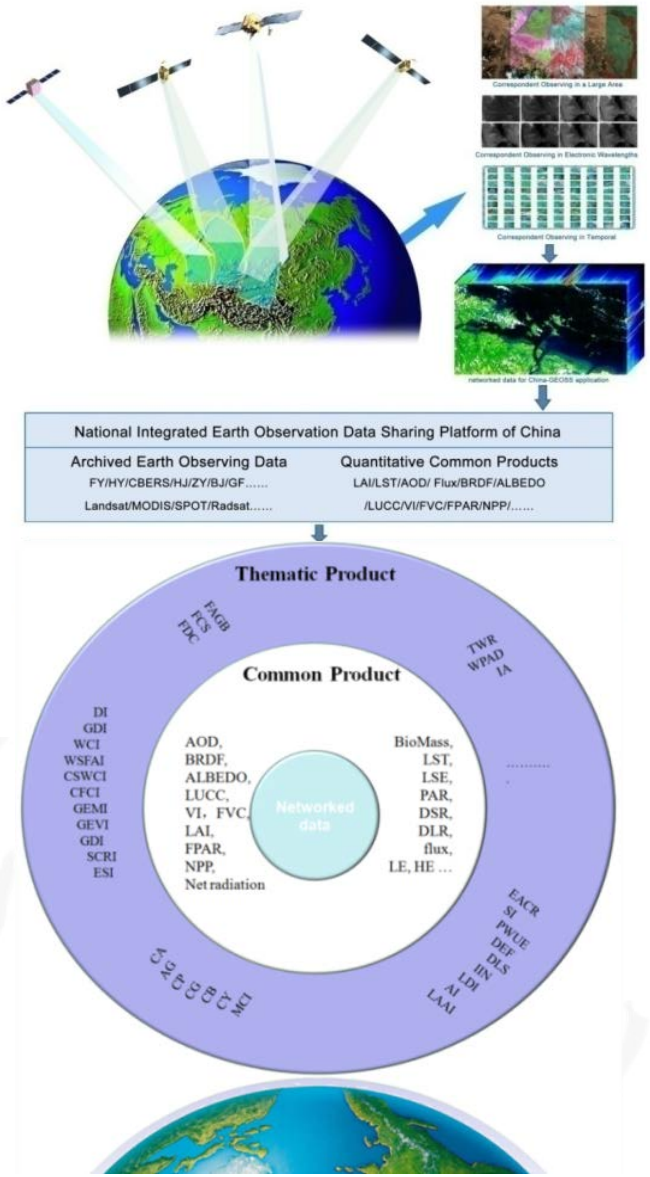


GVG GIS Platform



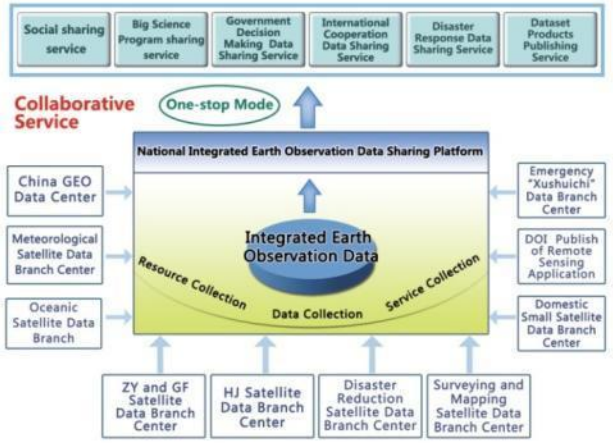
⑤ China GEOSS Framework

- **Being a Coordinated network**
  - Integrated earth observation satellite resources national and international
  - Provide the majority of users with efficient and quantitative remote sensing data, information products and services
- **Generates Global Products**
  - **40** common products
  - **20** quantitative remote sensing thematic products
  - **20** remote sensing monitoring and validation products



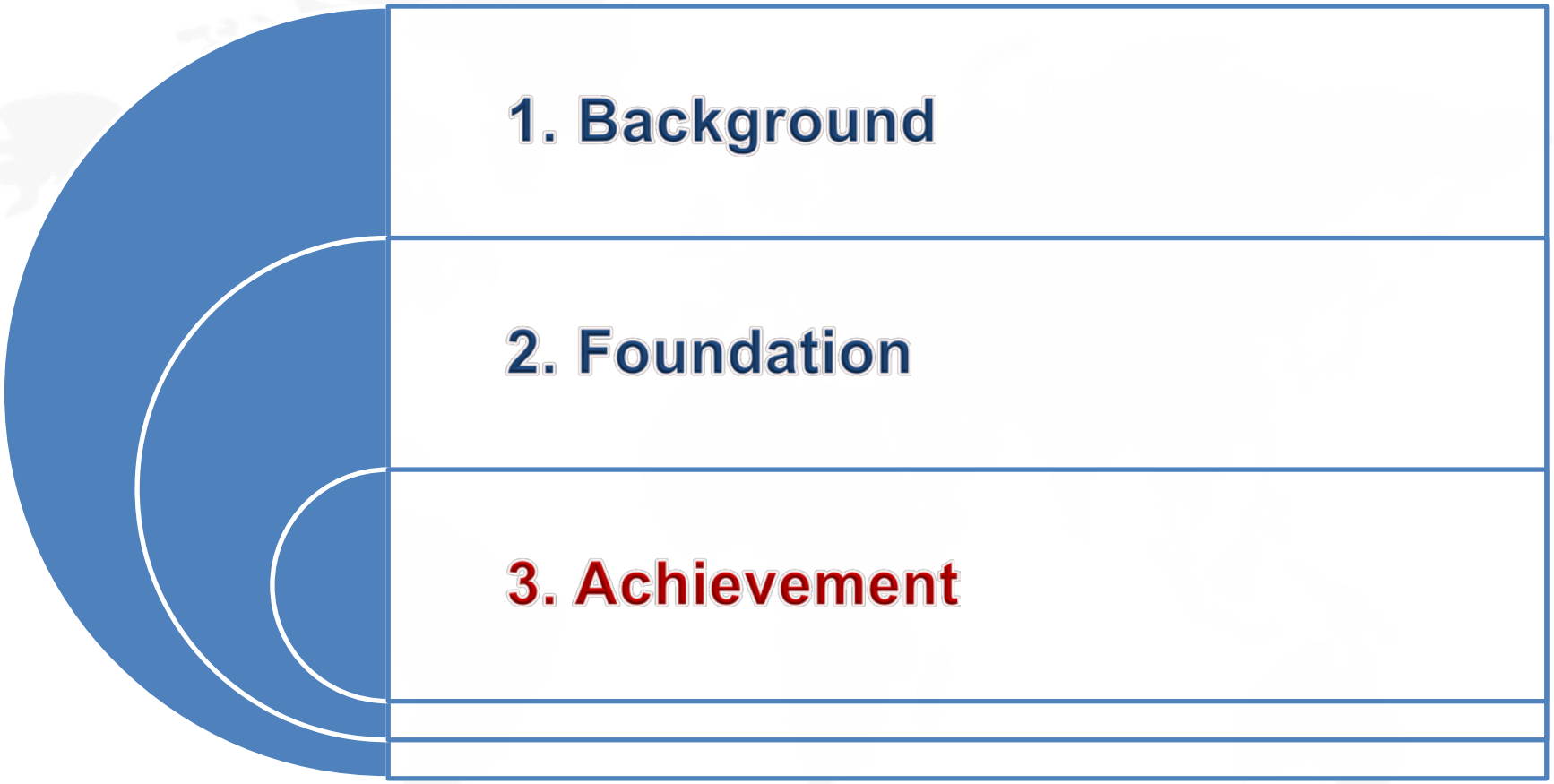
⑥ China GEOSS-DSNet

- National GEOSS data sharing Platform
  - Constructed by the whole Chinese earth observation communities
  - Integrated more than 10 national EO data centers
  - Data sharing to national and global users



China GEOSS DSNet Portal
http://www.chinageoss.org

Contents



GEOARC

Main Aims

- Cope with **global climate change**
  - The 2030 Agenda for Sustainable Development (U.N.)
- Develop and share **global datasets**
  - Monitor every country on a worldwide scale
  - Monitor every province and city in China on a national scale
- Analyze data and release **report**
  - Global Ecological Environment Factors
  - Focus on Hot Points and Hot Areas
- Provide **consultations** and help decision making

Focuses

- Global ecological environment factors
  - Terrestrial Vegetation (2012~)
  - Terrestrial Surface Water (2012~)
- Hot issues
  - Resident Land (2013)
  - Wetlands (2014)
  - Global Food Supply (2013~)
- Hot spots
  - Africa (2014)
  - China-ASEAN (2014)
  - 'The Belt and Road' Initiative (2015)
  - *Asia-Oceania (2016)*

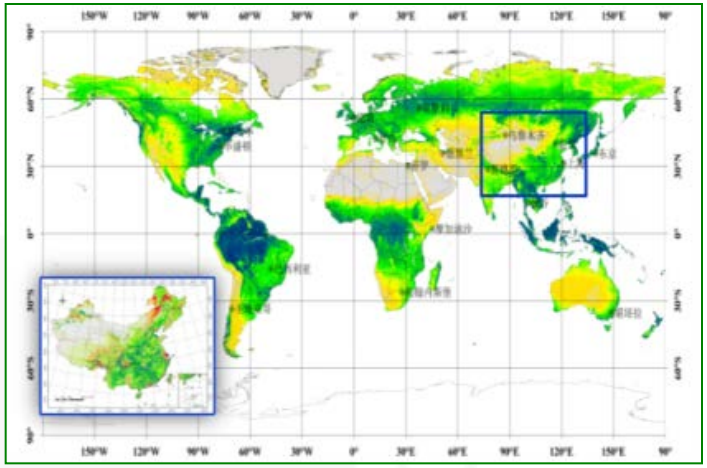
4 Years – 12 Reports

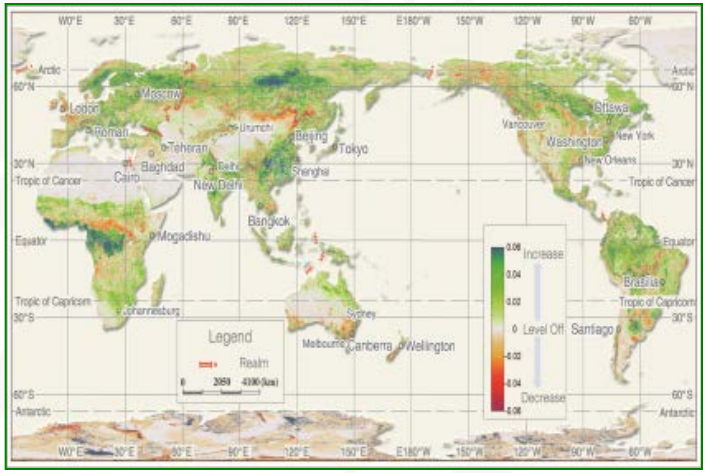
Year	Subject
2012	Changes of Vegetation Leaf Area Index (LAI) Dynamics
	Global Land Surface Water 2010 and Dynamic Changes of Sample Lakes
2013	Growth Conditions of Global Terrestrial Vegetation
	Large Terrestrial Surface Water Areas
	Supply Situation of Maize, Rice, Wheat and Soybean
	Urban and Rural Resident Land Cover Distribution
2014	Supply Situation of Maize, Rice, Wheat and Soybean
	Large Area Wetlands of International Importance
	Africa Land Cover
	China-ASEAN Ecological and Environmental Conditions
2015	“The Belt and Road Initiative” - Ecological and Environmental Conditions
	Supply Situation of Maize, Rice, Wheat and Soybean

① Global Terrestrial Vegetation

2012~2013

- **Annual Report Released**
  - 2012 — Changes of Vegetation Leaf Area Index (LAI) Dynamics
    - ✓ Based on *GLASS* products
    - ✓ Developed, analyzed and shared '*Global LAI Dataset 1982~2011*'
  - 2013 — Growth Conditions of Global Terrestrial Vegetation
    - ✓ Developed, analyzed and shared '*Global LAI Dataset 1982~2013*'
- **Subsequent Dataset Updated**
  - **2014, 2015** — 1km GLASS-LAI updated dataset



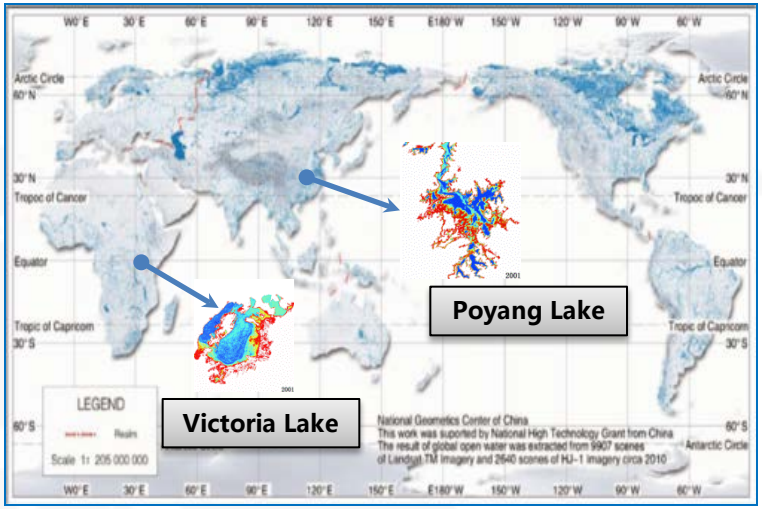


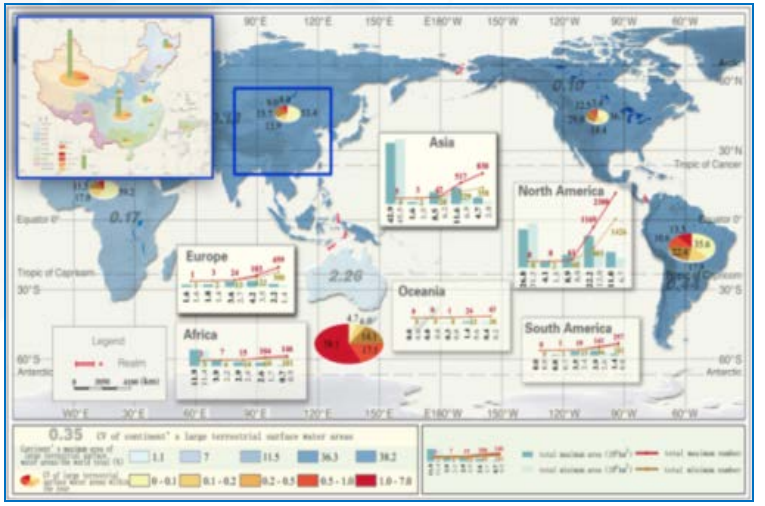
- The datasets can help research on issues such as global food security, forest and grassland management, and ecological evaluation, planning, construction and management of large and medium-sized cities all over the world.

② Terrestrial Surface Water

2012~2013

- **Annual Report Released**
  - 2012 — **Global Land Surface Water 2010 and Dynamic Changes of Sample Lakes**
    - ✓ Developed '**Global Land Surface Water 2010**' and '**Dynamic Changes of Sample Lakes in 2001~2011**' datasets
    - ✓ Analyzed "Seasonal Change of Sample Lakes in 2001-2011"
  - 2013 — **Large Terrestrial Surface Water Areas**
    - ✓ Developed '**Spatial-Temporal Distribution (2001~2012) Dataset of Large Terrestrial Surface Water Areas of the World**' dataset
    - ✓ Analyzed "Global Large Surface Water Area Variation in Typical Lakes Regions"
- **Subsequent Dataset Updated**
  - **2014, 2015** — Global dynamic changes updated dataset of Large Lakes

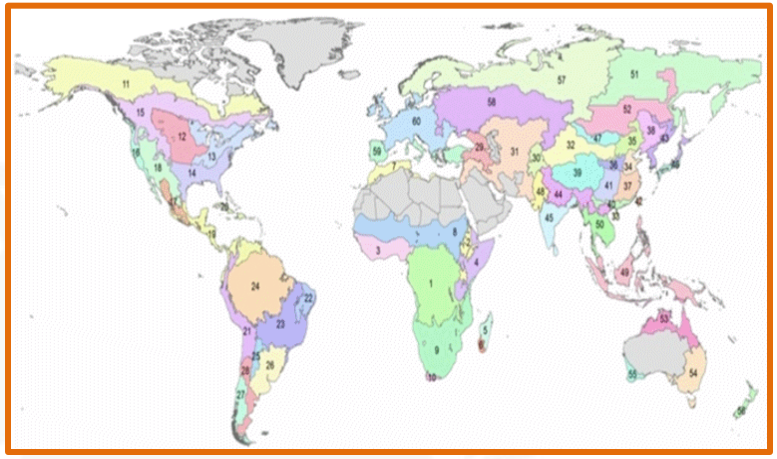




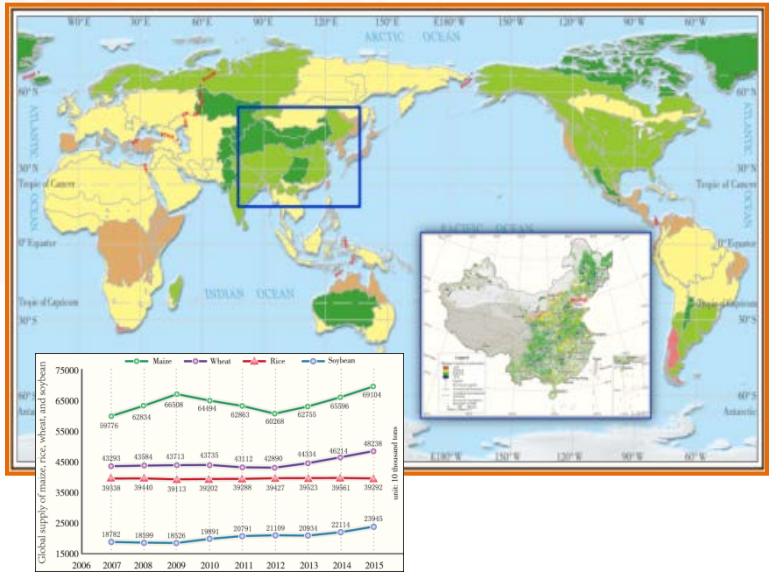
③ Global Food Supply

2013~2015

- **Annual Report Released**
  - **2013 — 2015 : Supply Situation of Maize, Rice, Wheat and Soybean**
    - ✓ **Based on the monthly and quarterly bulletins generated by 'CropWatch' system, a component in the GEO/GEOSS Global Agricultural Monitoring (GeoGLAM).**
  - **Main Focuses:**
    - ✓ **Global agro-climatic conditions**
    - ✓ **Cropping patterns and stress over major production zones**
    - ✓ **Agronomic conditions for China's major production regions**
    - ✓ **Crop production and food supply**



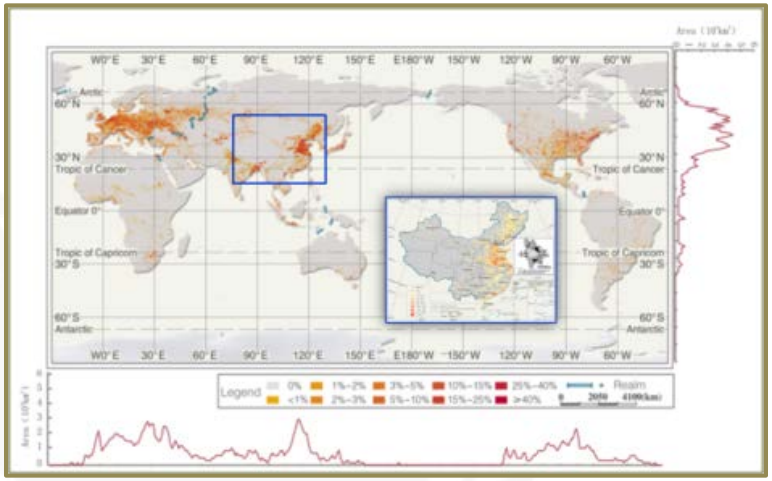
65 monitoring areas and 7 major Production Zones

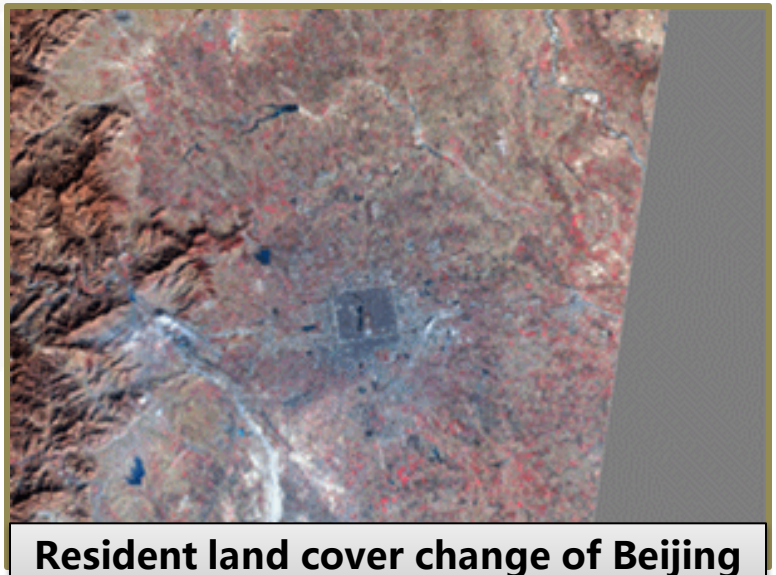


④ Resident Land

Urban and Rural Resident Land Cover

- 2013 — Urban and Rural Resident Land Cover Distribution
  - ✓ Based on 'Globe Land 30' dataset
  - ✓ Developed 'Global Urban and Rural Resident Land Cover Distribution between 2000~2010' datasets
  - ✓ Analyzed 'Urban and rural resident land cover changes in China'
  - ✓ Analyzed 'Urban and rural resident land cover changes in countries and major economic communities'

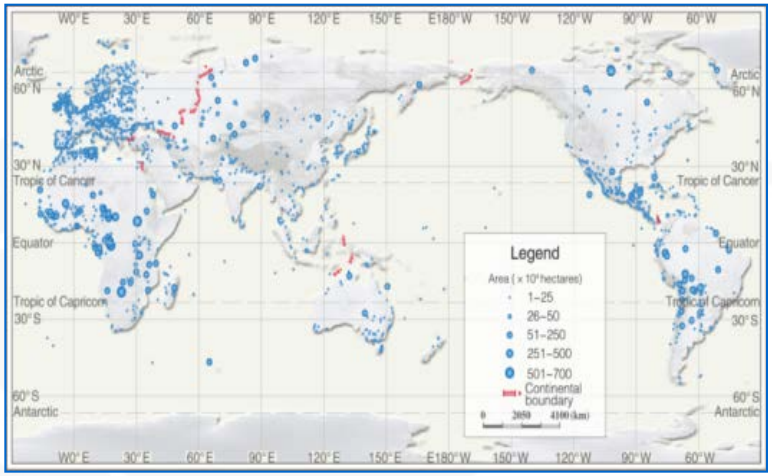




Resident land cover change of Beijing in the past 40 years.

⑤ Wetland

- 2014 — Large Area Wetlands of International Importance
  - ✓ There were **2193** sites are designated in the 'Ramsar List', covering **209 million hectares**.
  - ✓ Developed '**Remote Sensing Monitoring Dataset of Global Large Area Wetlands of International Importance**' datasets
  - ✓ Monitored **100 Ramsar sites** + **20 China sites**
  - ✓ Analyzed 'Changes of wetland area between 2001 and 2013'



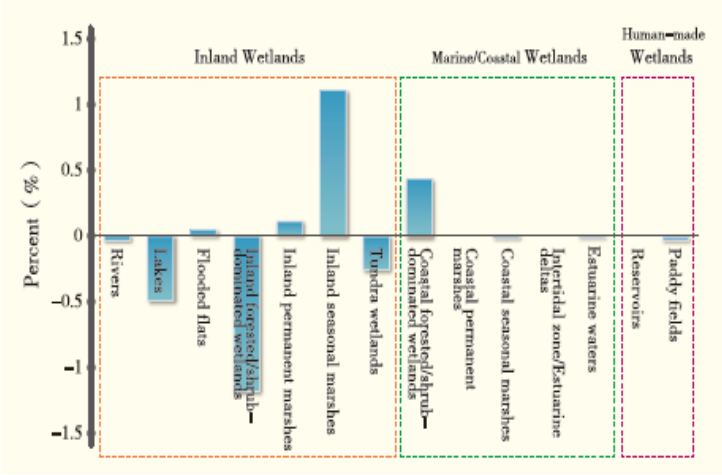


Figure 2–3 Change rate of wetland area in the large Ramsar sites between 2001 and 2013

⑥ Africa

Africa Land Cover

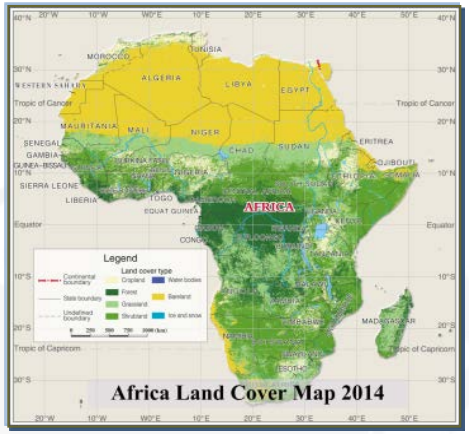
- 2014 — Africa Land Cover

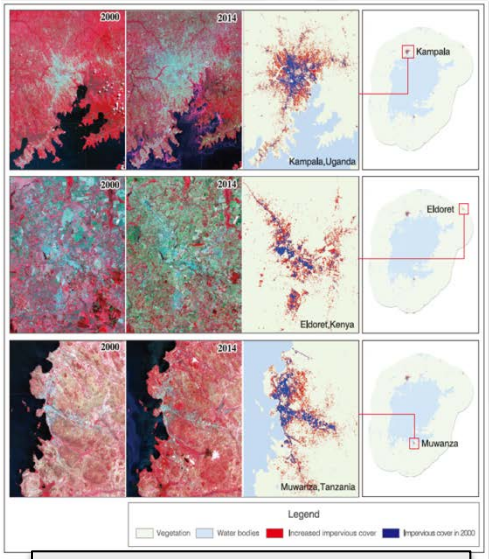
✓ Developed 'Africa Land Cover Dataset (2014)'

✓ Analyzed 'The Spatial Distribution of Different Land Cover Type'

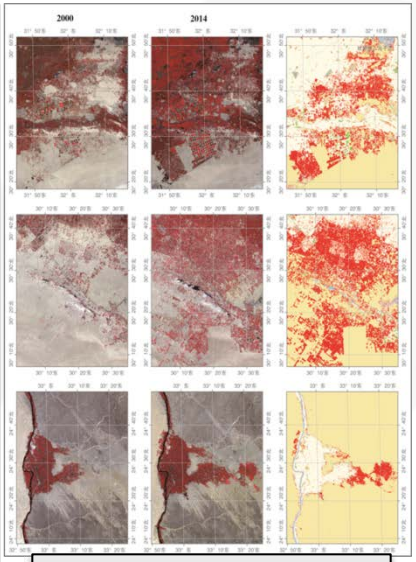
Cropland, Forest, Grassland, Shrubland, Water Surface, Barren, Ice and Snow, Artificial Surface.

✓ Analyzed 'Land Cover Changes for Selected Areas'

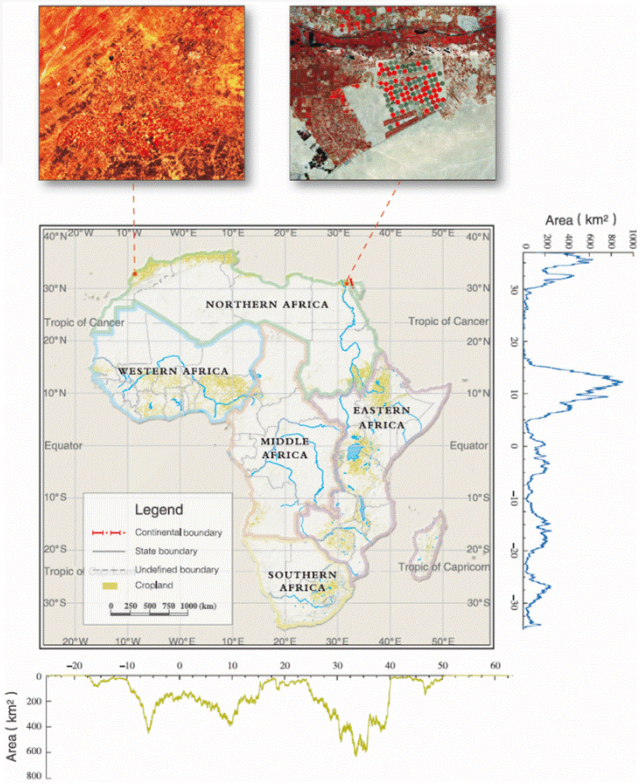




Water area changes around Lake Victoria 2000-2014



Crop land change in lower Nile 2000-2014



⑦ ASEAN

ASEAN (Association of Southeast Asian Nations)

- 2014 — China-ASEAN Ecological and Environmental Conditions

✓ Developed the datasets of 'China-ASEAN Ecological and Environmental Conditions'

✓ Analyzed 'Distribution Pattern of Natural Elements of Ecological Environment in China-ASEAN'

Photosynthetically Active Radiation (PAR),

Water Surplus,

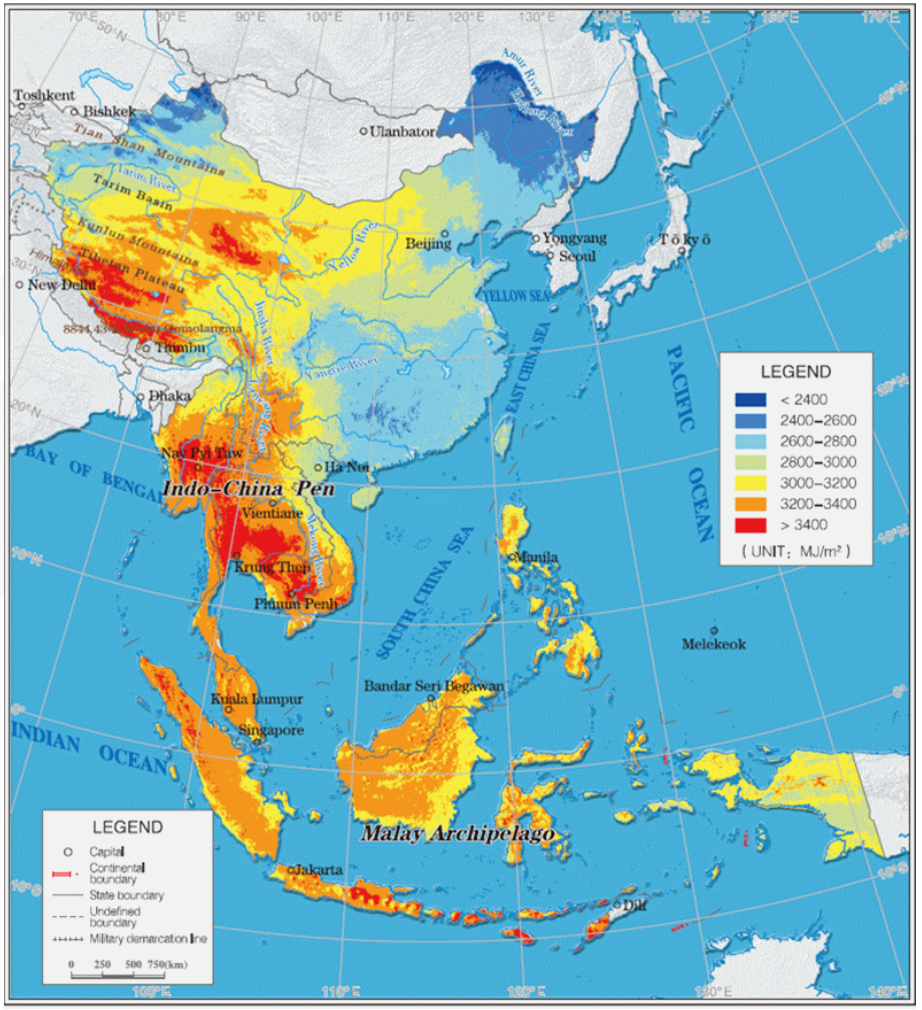
Net Primary Productivity (NPP),

Forest Biomass,

Multiple Cropping Indexes

✓ Monitored 'Water Resources of Lancang-Mekong River Basin'

✓ Analyzed 'The Ecological Resources of Each Country in China-ASEAN'



⑧ 'The Belt and Road' Initiative

2015

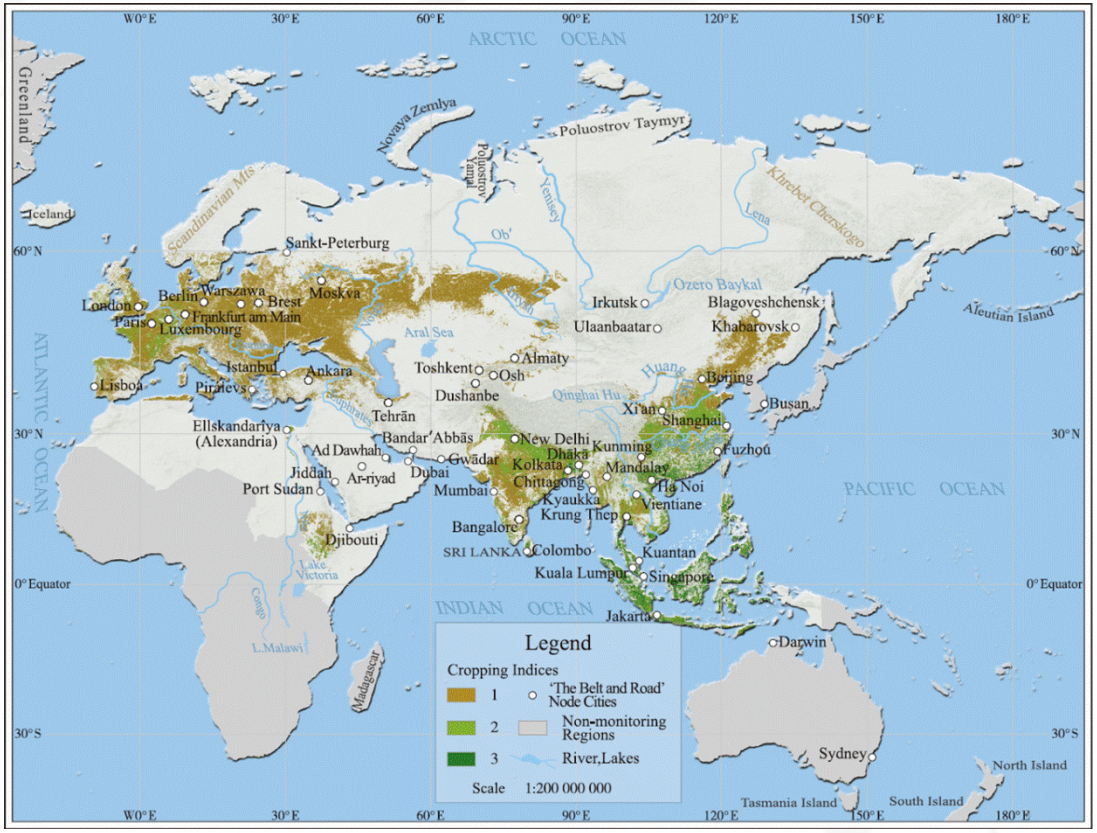
Monitoring Area

- **Terrestrial Areas**
  - Cover 56 ×10^6 km^2 (37.6% of Global Land Area)
  - 7 land regions
  - 6 economic corridors
  - 26 important inland node cities
- **Marine Areas**
  - Cover 22 ×10^6 km^2 (6.2% of Global Ocean Area)
  - 12 ocean regions
  - 25 important port cities and their coastlines

⑧ 'The Belt and Road' Initiative

Main Land Ecological Systems

- **Farmland**
  - 12 ×10^6 km^2
  - 53.3% of global farmland area
- **Forest**
  - 13 ×10^6 km^2
  - 35.1% of global forest area
  - Total biomass is 15×10^{10} t
- **Grassland**
  - 12 ×10^6 km^2
  - 34.9% of global grassland area
  - Total grassland NPP is 7.77×10^8 tC/a

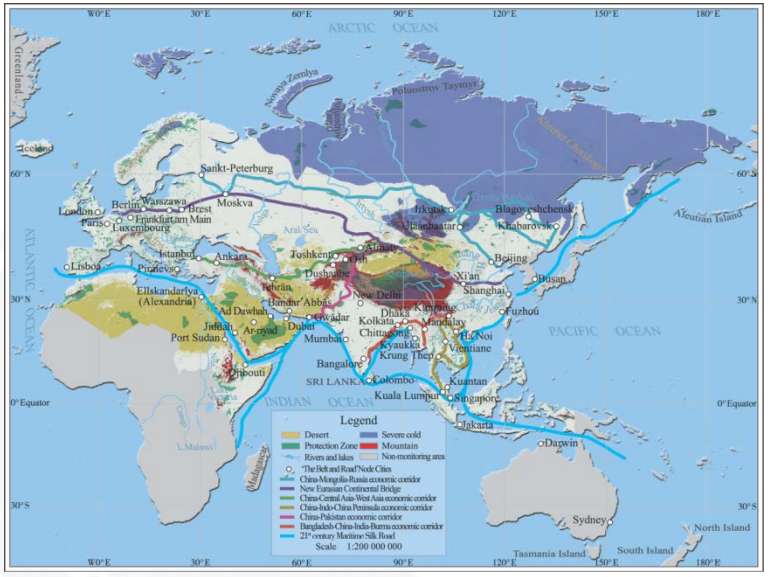


⑧ 'The Belt and Road' Initiative

Main Constraint Factors on Economic Corridor Construction

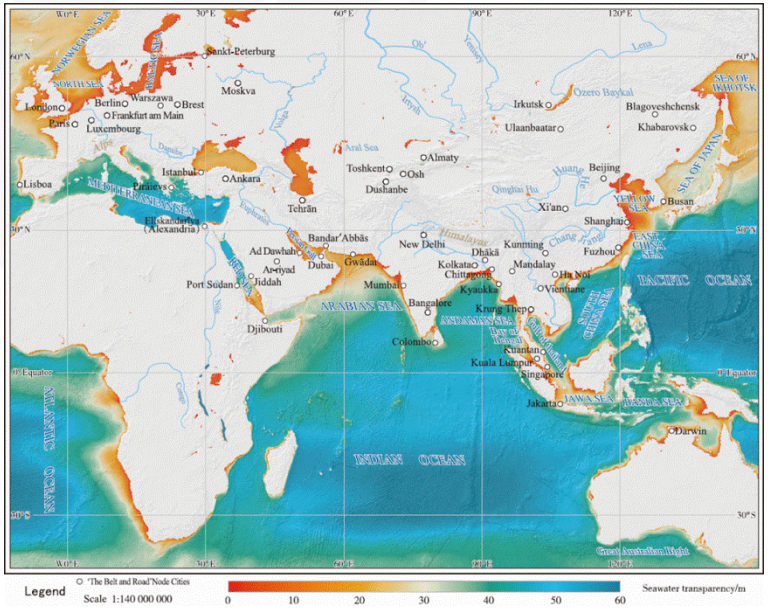
- Desert
- Severe Cold
- Protection Zone
- Mountain
- Extreme Weather

The ecological constraint factors are **different significantly** among each economic corridors and in ***different sections*** of every economic corridor!



Marine Ecological Environment

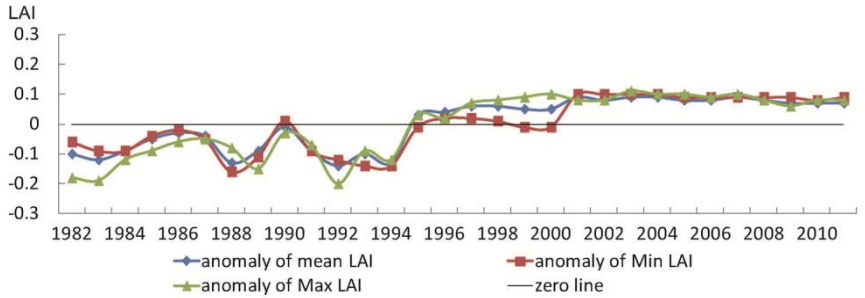
- *Sea Surface Temperature*
- *Photosynthetically Active Radiation (PAR)*
- *Ocean Transparency*
- *Chlorophyll Concentration*
- *Net Primary Productivity (NPP)*



Examples of Finding Highlights 1

Global LAI Dynamics from 1982 to 2011

- There is an **increase trend** of LAI from 1995 to 2001, and **remains stable** with little increase from 2001 to 2011, the anomaly values reach **0.06~0.10**.



- The **U.N. Conference on Environment and Development (1992)** and the following up **policies and actions** on environment in both international and national levels could contribute to the trends.

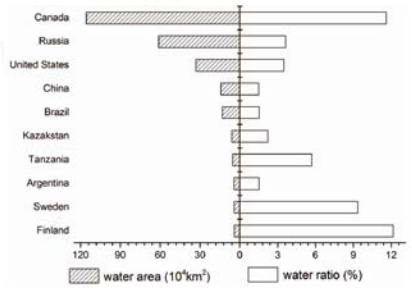
Spatial Distribution of Land Surface Water

- In 2010, the total area of global Land Surface Water is **3,676,700 km²**, which is **2.73%** of global land surface area.
- **North America** has the highest coverage, reaching **1,530,200 km²**.The highest country is **Canada**.

Table 1 Land Surface Water 2010 in the Continents

Continent	Area-LSW (km²)	WR-LSW(%)	Water Rate (%)
Asia	1,242,800	33.80	2.79
Europe	315,900	8.59	3.22
Africa	271,900	7.40	0.91
North American	1,530,200	41.62	6.28
South American	267,800	7.28	1.51
Oceania	48,200	1.31	0.57
Global	3,676,700	100.00	2.73

Note: The Antarctic is not included



Examples of Finding Highlights 2

Changes of Global Urban and Rural Resident Land Cover

- In 2000, the total area of the global urban and rural land is **1.1301 Million km^2**, increased **57,400 km^2** over the previous **10 years**, with the variation rate of **5.08%**.
- Among the increased global urban and rural land, what occupied most are **arable land**, accounting for **50.26%**.

Table 6 Statistics of Sources for Increased Urban and Rural Land in Each Continent

		Asia	Europe	Africa	North America	South America	Oceania	Global
Arable land	Area(km^2)	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(km^2)	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(km^2)	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(km^2)	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(km^2)	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(km^2)	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(km^2)	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(km^2)	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

Change of Large Wetlands of International Importance

- Between 2001 to 2013, the **total wetland area** decreased by less than **1%**.
- Among all continents, wetland area in **North American increased slightly**, while the value of the other continents showed different degrees of **decrease**.

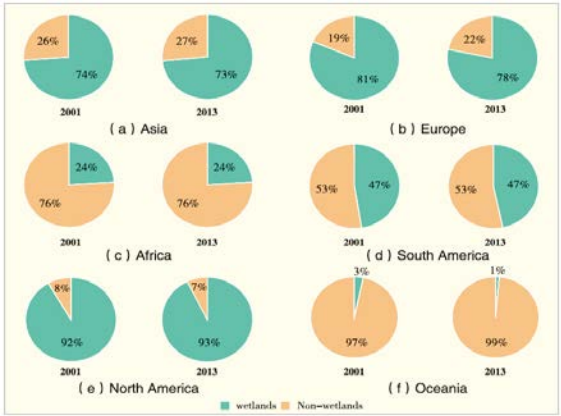
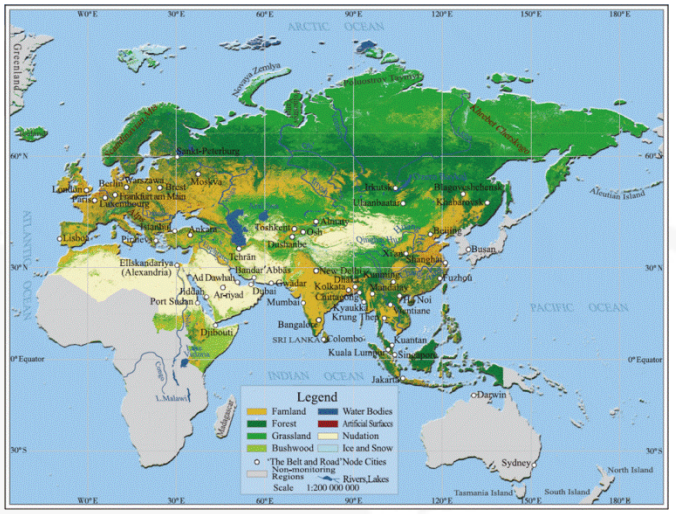


Figure 2-4 Wetland/Non-wetland ratio in the large Ramsar sites among different continents between 2001 and 2013

Examples of Finding Highlights 3

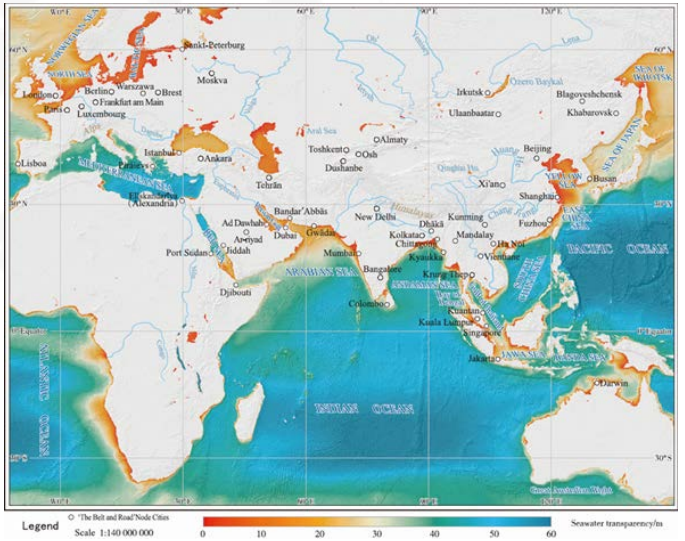
Land Use Situation of 'The Belt and Road'

- In monitoring area, the average land use degree index is **0.34** (*varies between 0 and 1*).
- The areas with **higher indices** accorded with the areas having **dense population** in general.



Marine Ecological Environment Conditions of 'The Belt and Road'

- From 2003 to 2014, the **transparency** of 12 oceanic regions has an increasing trend, indicating **an improvement of water quality overall**.
- The *Mediterranean Sea* has the highest mean transparency among above oceanic regions, reaching **35m**.



Released the Annual Report

Released the Annual Report and related datasets on **The World Environment Day**.

✓ 2013-05-28

✓ 2014-06-04

✓ 2015-06-04

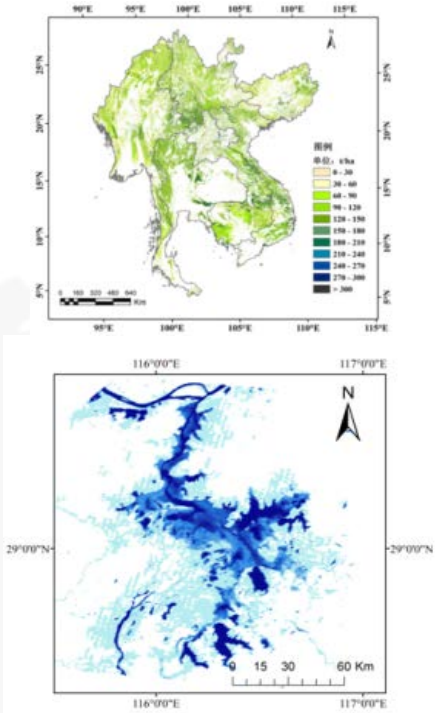
✓ 2016-06-06

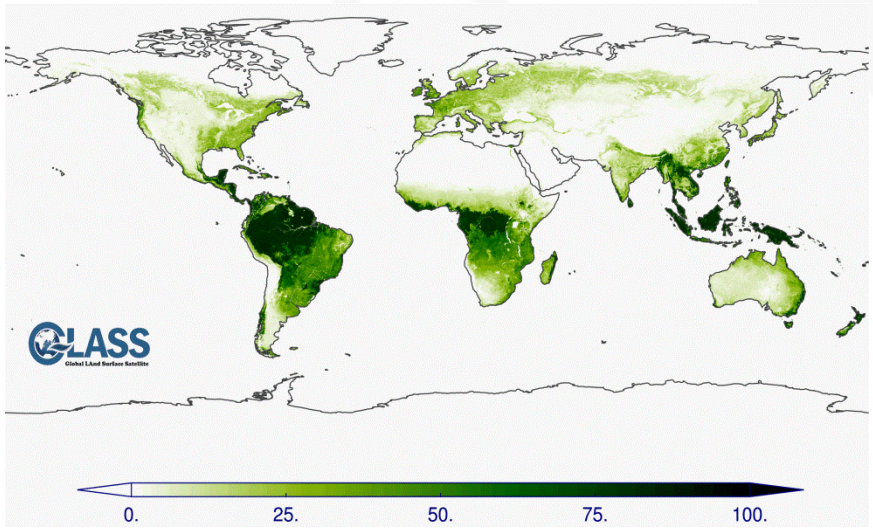
Hold the press conference before or after the world environment day every year.

Data Sharing

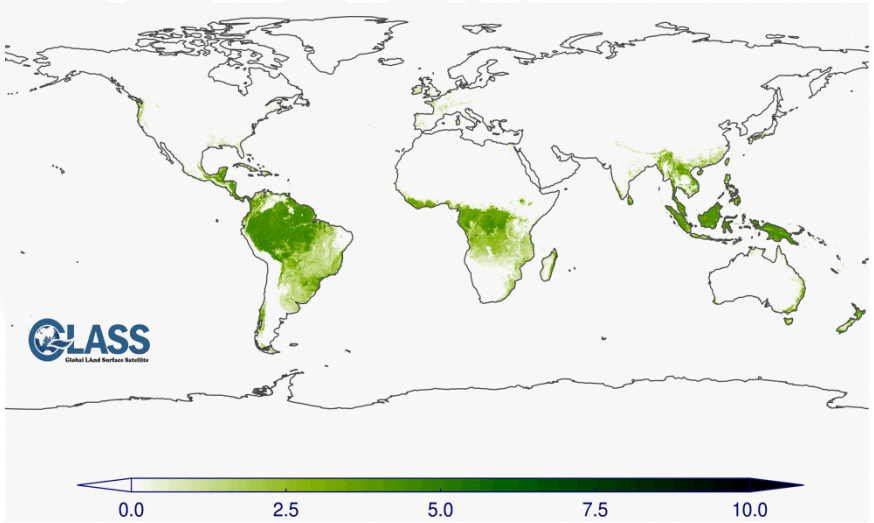
By GEOSS-DSNet

- Continuously updated Datasets of **Global Water Areas** and **Global Vegetation Distribution** since 2012
- ***http://www.chinageoss.org/geoarc/***
- Total downloads of datasets > **10TB**
- Total downloaded over **10,000 times**





2014 Global Annual FVC



2014 Global Annual LAI

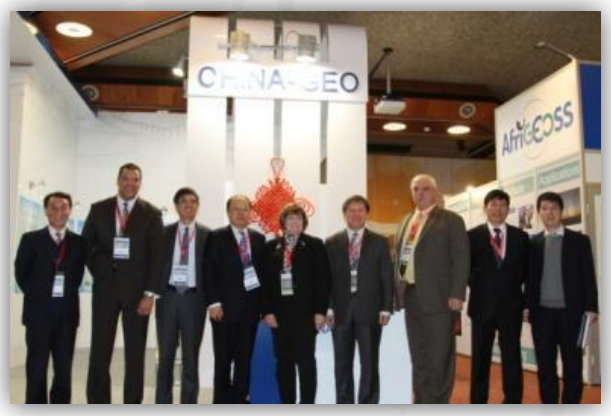
Data Sharing by China GEOSS DSNet Portal

Global Datasets	1	1km Global Dynamic Change Dataset of Vegetation Leaf Area Index (GLASS-LAI) between 1982 and 2014	2014
	2	1km Global Vegetation Net Primary Productivity (NPP) Dataset (Outside North America)	2015
	3	1km Global Forest Above-ground Biomass Dataset	2015
	4	1km Global Vegetation Coverage Dataset	2013, 2014, 2015
	5	5km Global Photosynthetically Active Radiation (PAR) Dataset	2015
	6	Global Distribution Dataset of Large Terrestrial Surface Water Areas	2013
	7	Global Dynamic Change Updated Dataset of Typical Lakes from 2002 to 2013	2014, 2015
	8	Global Classification and Dynamic Change Datasets of International Important Large Wetlands	2014
	9	10km Global Degree of Land Use Dataset	2015
	10	250m Global Land Cover Dataset	2015
Regional Datasets	11	Africa Land Cover Dataset	2014
	12	5km China-ASEAN Photosynthetically Active Radiation (PAR) Dataset	2014
	13	1km China-ASEAN Terrestrial Evapotranspiration Dataset	2014
	14	1km China-ASEAN Vegetation Growing-Season Length Dataset	2014
	15	1km China-ASEAN Annual Maximum Vegetation Coverage Dataset	2014
	16	1km China-ASEAN Annual Accumulative Vegetation Net Primary Productivity Dataset	2014
	17	30m Annual Maximum Vegetation Coverage Dataset of Greater Mekong Subregion	2014
	18	Forest Biomass Remote Sensing Inversion Dataset of Greater Mekong Subregion	2014
	19	Rainfall Runoff and Typical Lake Areas Distribution Dataset of Lancang- Mekong Drainage Basin	2014
	20	30m Urban Built-up Area Land Cover Dataset of 'The Belt and Road' Initiative Main Cities	2015
	21	Coastline Classification Dataset of 'The Belt and Road' Initiative Main Port Cities	2015
	22	Land Cover Classification Dataset of 'The Belt and Road' Initiative Main Port Cities	2015
	23	Marine Ecological Environment Remote Sensing Dataset of 'The Belt and Road' Initiative Area	2015

Contribution

Support to GEO

- GEOARC datasets cover many of the GEO Societal Benefit Areas
  - *Agriculture,*
  - *Biodiversity,*
  - *Land Cover*
  - *Water ……*
- Constitutes an important part of GEO's data and information assets



Evaluation

- **Experts and Scholars:**
  - GEOARC is a pioneering work in China.
  - This work reflected the active attitude of China to coping with global climate change.

- **Organizations Express Particular Concern:**
  - Food and Agriculture Organization (FAO)
  - United Nations Environment Programme (UNEP)
  - Economic and Social Commission for Asia an the Pacific (ESCAP) ……

- **Secretarial Director of GEO:**
  - The reports will become even more important as a coordinated and continuous national effort is put in place.
  - Has made great contribution to the GEO.
  - The reports and the original datasets will benefit users worldwide.

GEO GROUP ON EARTH OBSERVATIONS

Our Ref: 2015-ST/GEO/China

Mr Jianlin Cao
Vice-Minister of Science and Technology of the People's Republic of China
Ministry of Science and Technology
15B, Fuxing Road
Haidian District
100862 Beijing
China

Geneva, 16 July 2015

Dear Vice Minister Cao,

I am writing to express my sincere thanks to you for the great contributions China has made to the Group on Earth Observations (GEO) under your leadership. The recently released Annual Report on Remote Sensing Monitoring of Global Ecosystem and Environment (2014) is one of those contributions.

This series of reports cover many of the GEO Societal Benefit Areas including Agriculture, Biodiversity, Land Cover and Water, and therefore constitute an important part of GEO's data and information assets. The reports will become even more important as a coordinated and continuous national effort is put in place.

In this regard, if you agree, I would like to highlight the reports on our website in order to share them with the GEO community at large. With a full and open data sharing policy, the reports and the original datasets will benefit users worldwide.

Again, thank you for China's support of GEO.

Yours sincerely,

Barbara J. Ryan
Secretariat Director

Prospects

- Extend **report series**
- Keep focus on **global hot issues & hot spots**
- Cooperate with **international scientists** and **organizations**
  - Further research / application
  - Validation
  - Recommendations
- Further improve **China GEOSS**

Thank You !