



# 2012

## Report on Remote Sensing Monitoring of Global Ecosystem and Environment

Global Land Surface Water 2010 and  
Dynamic Changes of Sample Lakes 2001–2011

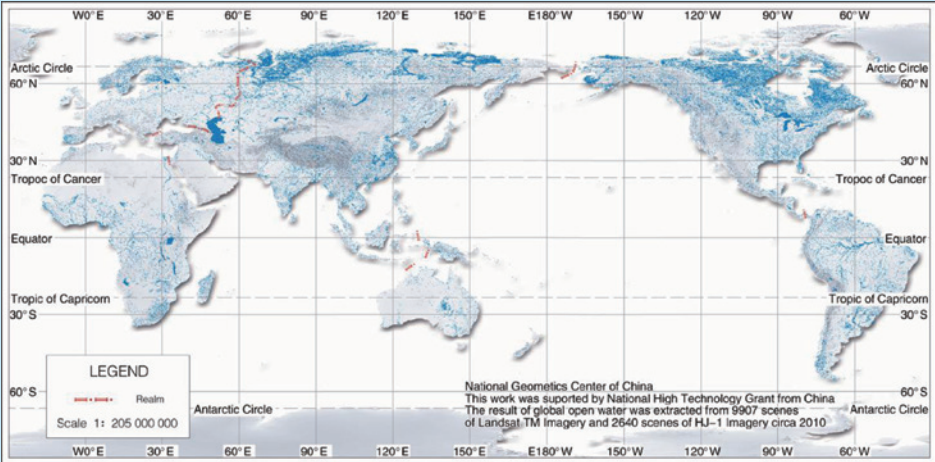


National Remote Sensing Center of China  
Ministry of Science and Technology of the People's Republic of China

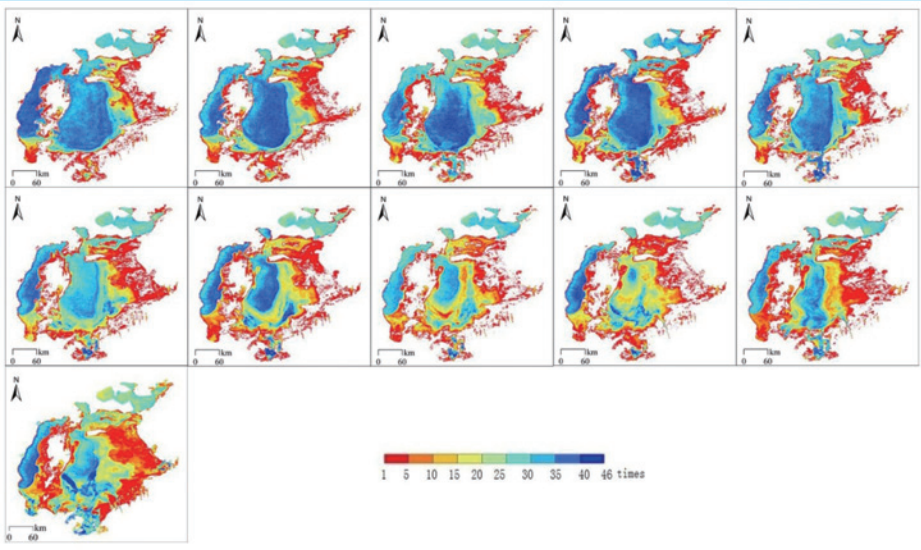


To support international cooperation on global change studies under the framework of the Group of Earth Observations and the Global Earth Observation System of Systems, the National Remote Sensing Center of China (NRSCC), Ministry of Science and Technology of the People's Republic of China launched the Program on Remote Sensing Monitoring of Global Ecosystem and Environment under the National High-tech R&D Program (863 Program). With common understanding of an integrated group of scientists, the aims of the program are: (1) making a series of global datasets on ecosystem and environment openly; (2) publishing a series of report and analysis based on these datasets; and (3) providing consultations and helping decision making for scientific research and the broader society.

**The Datasets and Analysis of Global Land Surface Water 2010 and Dynamic Changes of Sample Lakes 2001-2011** is part of the report series of the Program. The Dataset of Global Land Surface Water 2010 is a product of the **Global Land-30 Project**, which aims to create a series of datasets on global land indicators with pixel resolution of 30-meter. Under the organization and coordination of NRSCC, the datasets were developed by the National Geomatics Center of China (NGCC), Tsinghua University and Beijing Normal University. The datasets and report are published at the Website of the China Spatial Data and Information Network (<http://www.csi.gov.cn>).



Global Land Surface Water Map 2010



Area Changes of Aral Sea from 2001 to 2011

# 1 Datasets on Global Land Surface Water 2010 and Dynamic Changes of Sample Lakes in 2001-2011

Land Surface Water is a major component of global water circulation, and one of the most important parameters describing Earth ecosystem. Its fluctuation and dynamic changes indicate the influence of climate change, land-surface process and human activities on the water circulation, material migration and ecosystems. In this report, the words "Land Surface Water (LSW)" stands for all open water bodies on the land surface, such as rivers, lakes, reservoirs and so on.

The datasets are in two parts. The first dataset is Global Land Surface Water in 2010 with pixel resolution of 30-meter, including the area of Land Surface Water and the Rate of LSW area to the total area of the region under consideration. The second is on dynamic changes of open water inundated area of 7 sample lakes, with an interval of 8 days in the period of 2001-2011 with pixel resolution of 500-meter. The datasets are derived from integrated use of satellite data from Landsat-TM and ETM+, HJ-CCD, Terra/Aqua-MODIS and FY3-MERSI.

## 2 Analysis of Global Land Surface Water 2010

### 2.1 Spatial Distribution of Land Surface Water in the World

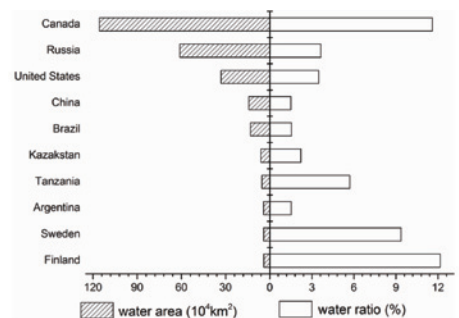
For analysis purpose, three indicators are used: the total Area of Land Surface Water (Area-LSW, km<sup>2</sup>), the Rate of LSW area of a region to that of the World (WR-LSW, %), and the Rate of LSW area of a region to the total area of the region (Water Rate, %).

Based on statistics from the Global Datasets of Land Surface Water 2010, the total area of global Land Surface Water is 3,676,700 km<sup>2</sup>, which is 2.73% of global land surface area. North America is the highest continent in LSW, with total LSW area of 1,530,200 km<sup>2</sup>, occupying 6.28% of its land surface area and 41.62% of global LSW area. Oceania is the lowest with a total LSW area of 48,200 km<sup>2</sup>, occupying 0.57% of its land surface area and 1.31% of global LSW area. The statistical result of each continent is listed at the Table 1.

Table 1 Land Surface Water 2010 in the Continents

Continent	Area-LSW (km <sup>2</sup> )	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

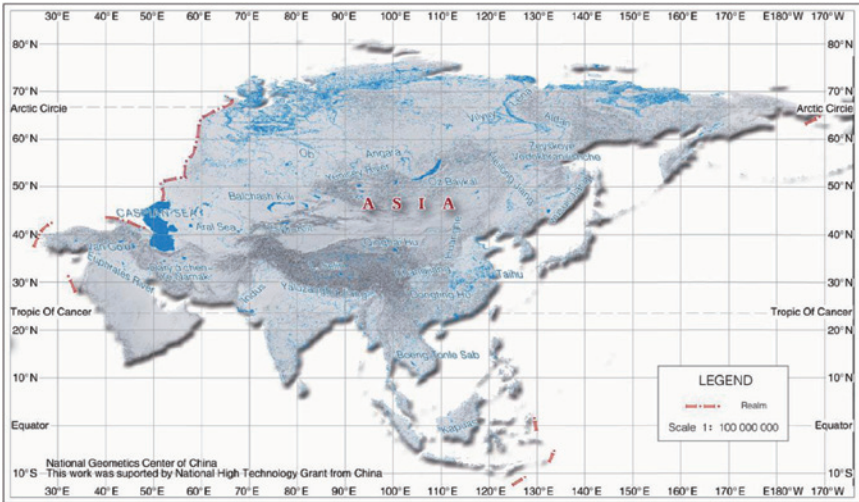


Areas of LSW of top 10 countries in the world and the Water Rate of these countries

The top ten countries rich in LSW are: Canada, Russia, United States, China, Brazil, Kazakhstan, Tanzania, Argentina, Sweden and Finland.

2.2 Areas of Land Surface Water in Each Continent

The total area of LSW of Asia is 1,242,800 km<sup>2</sup>, occupying 33.80% of world LSW area and only lower than that of North America. The top ten countries of LSW in Asia are: China, Kazakhstan, India, Turkmenistan, Indonesia, Iran, Uzbekistan, Mongolia, Turkey and Thailand<sup>1</sup>. The areas of Land Surface Water and Water Rate in North Asia, Southeast Asia, East Asia, South Asia, Middle Asia and Western Asia are listed in Table 2.



Land Surface Water Map of Asia 2010

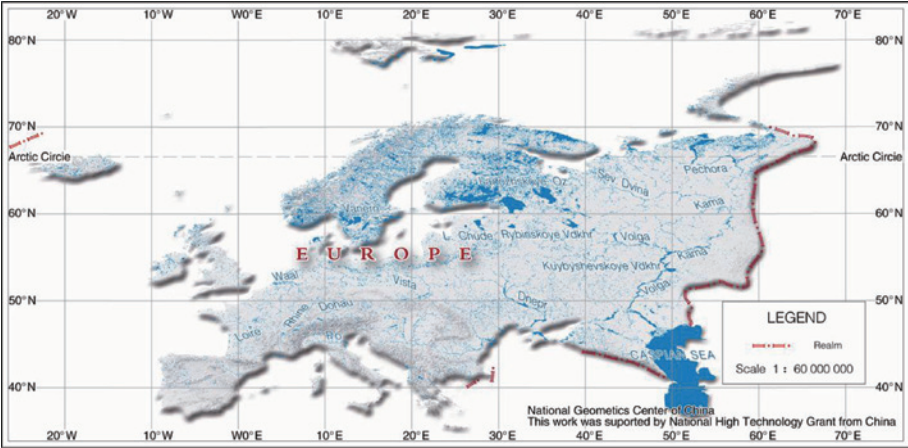
Table 2 Land Surface Water 2010 in Regions of Asia

Region	Area-LSW(km <sup>2</sup> )	Water Rate (%)
North Asia	463,200	3.59
Southeast Asia,	56,500	1.27
East Asia	162,800	1.40
South Asia	50,500	1.16
Middle Asia	110,600	2.76
Western Asia (including Caspian Sea)	399,200	5.58

<sup>1</sup>Note: Area of Caspian Sea (361,500 km<sup>2</sup>) is calculated into the LSW area of Asia, but not into its neighboring countries.



The total LSW area of Europe is 315,900 km<sup>2</sup>, which is 8.59% of the world. The Water Rate in Europe is 3.22%, which is above of the world average. The top ten LSW countries in Europe are: Russia (including its Asian part), Sweden, Finland, Norway, Ukraine, Poland, France, Germany, Spain and Romania. Finland is the top country in Water Rate, up to 12.16%. The LSW areas and Water Rates of Eastern Europe, Western Europe, Southern Europe, Northern Europe, and Middle Europe are listed in the Table 3.

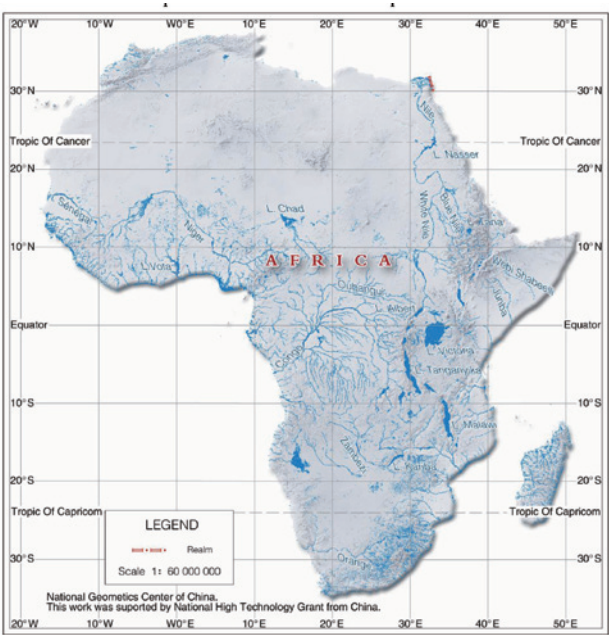


Land Surface Water Map of European 2010

Table 3 Land Surface Water 2010 in Regions of Europe

Region	Area-LSW (km <sup>2</sup> )	Water Rate (%)
Eastern E.	167,400	3.38
Western E.	9,700	1.04
Southern E.	15,900	0.96
Northern E.	108,300	8.20
Middle E.	14,600	1.44

The total LSW area of Africa is 271,900 km<sup>2</sup>, which is 7.40% of the world. Its Water Rate is 0.91%, lower than the average of the world. The top ten LSW countries in Africa are: Tanzania, the Democratic Republic of Congo, Uganda, Malawi, Zambia, Kenya, Mozambique, Nigeria, Ghana and Ethiopia. The LSW areas and Water Rates in Eastern Africa, Western Africa, Southern Africa, Northern Africa and Middle Africa are listed in Table 4.

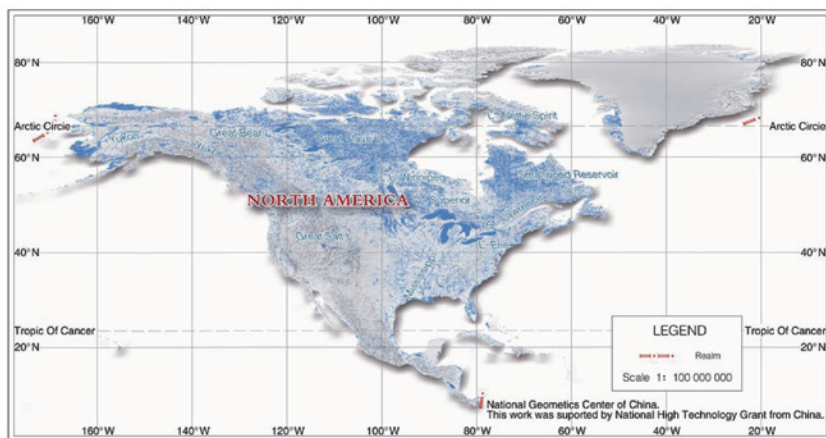


Land Surface Water Map of Africa 2010

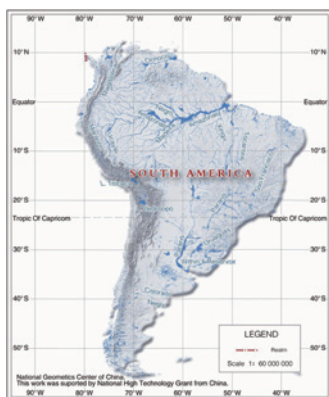
Table 4 Land Surface Water 2010 in Regions of Africa

Region	Area-LSW (km <sup>2</sup> )	Water Rate (%)
Northern A.	14.600	0.18
Eastern A.	111.900	3.01
Southern A.	64.900	0.99
Western A.	29.200	0.46
Middle A.	51.300	0.96

The area of LSW of North America is 1,530,200 km<sup>2</sup>, which is 41.62% of the total area of global LSW, and its Water Rate reaches to 6.28%, the highest in the world. The LSW area of South America is 267,800 km<sup>2</sup>, 7.28% of the total area of global LSW, and has a Water Rate of 1.51%, less than the average of the world. The LSW area of Oceania is 48,200 km<sup>2</sup>, with a Water Rate of 0.57%, which is the lowest in all of the continents.



Land Surface Water Map of North America 2010



Land Surface Water Map of South America 2010



Land Surface Water Map of Oceania 2010



### 2.3 Land Surface Water in Climate Zones

According to the Köppen-Geiger's Climate Classification System, LSW areas in 12 climate zones were calculated. The most rich LSW zone is the Marine West Coast Climate Zone, which covers 1,740,600 km<sup>2</sup> of Land Surface Water, occupying 47.36 % of global LSW.

The Area of Land Surface Water (Area-LSW), Rates of LSW area of a region to that of the World (WR-LSW, %), and the Water Rate (%) in each climate zone are listed in Table 5.

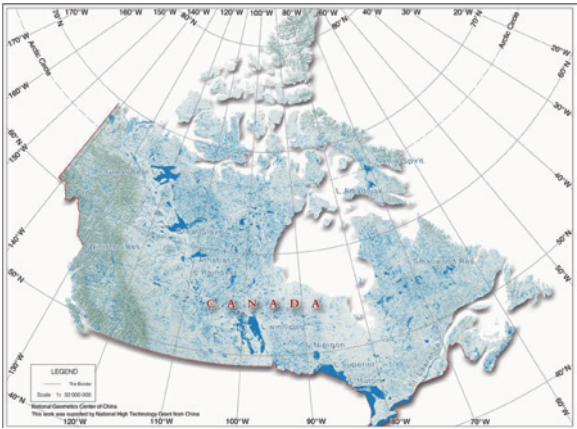
Table 5 Statistics of Land Surface Water in 12 Climate Zones

Climate Zone	Area-LSW (km <sup>2</sup> )	WR-LSW(%)	Water Rate (%)
Tropical Wet Climate	102.400	2.79	1.70
Tropical Monsoonal Climate	102.700	2.79	2.10
Tropical Savanna Climate	203.500	5.54	1.22
Subtropical Desert Climate	286.800	7.80	1.06
Subtropical Steppe Climate	286.300	7.79	1.66
Mediterranean Climate	88.300	2.40	3.19
Humid Subtropical Climate	178.200	4.85	1.91
Marine West Coast Climate	1,740.600	47.36	6.06
Humid Continental Climate	114.300	3.11	1.55
Subarctic Climate	180.600	4.91	6.35
Tundra Climate	391.300	10.65	7.96
Ice Cap Climate	500	0.01	0.03

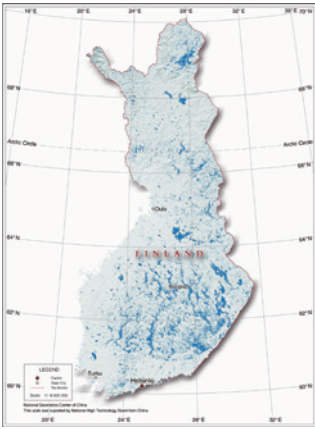
### 2.4 Sample Spatial Patterns of Land Surface Water

The patterns of Land Surface Water distributed on the Earth are diverse. Several samples are given in the report. Canada is the richest country of LSW in the world, having a LSW area of 1,160,000 km<sup>2</sup> and a Water Rate of 11.6%. Finland, the Country of Lakes, hosts more than 188,000 lakes, which is about 12.2% of the country's total area. The Great Rift Valley, filling in a string of more than 30 lakes, is a habitat of great biodiversity. The Amazon River, feeding the largest drainage basin in the world (about 7,050,000 km<sup>2</sup>), originates from the Andes in Peru and drains across Brazil to the Atlantic. It is also an area with highly biodiversity, from which, Brazil, Peru, Colombia, Bolivia, Venezuela and Ecuador are benefited.

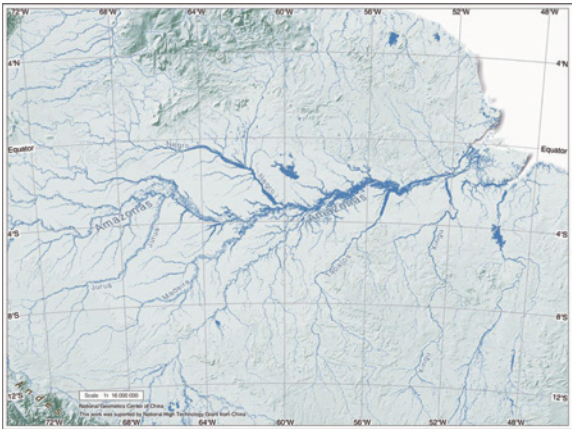
The Qinghai-Tibet Plateau, a system of lakes at the roof of the world, contains 608 billion m<sup>3</sup> of LSW, equivalent to more than 70% of that of China. The Lena delta is a braided river system, covering an area of 32,000 km<sup>2</sup>, with more than 1000 islands separated by more than 150 braided branches and ravine streams.



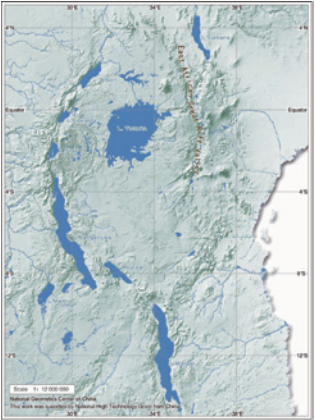
Canada - The richest country of Land Surface Water in the world



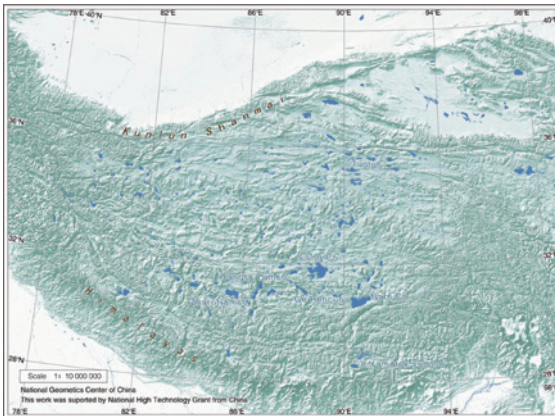
Finland - The Country of Lakes



Amazon River - Feeding the largest drainage basin in the world



Great Rift Valley - Filling in a string of lakes



Qinghai-Tibet Plateau - A system of lakes in the roof of the world



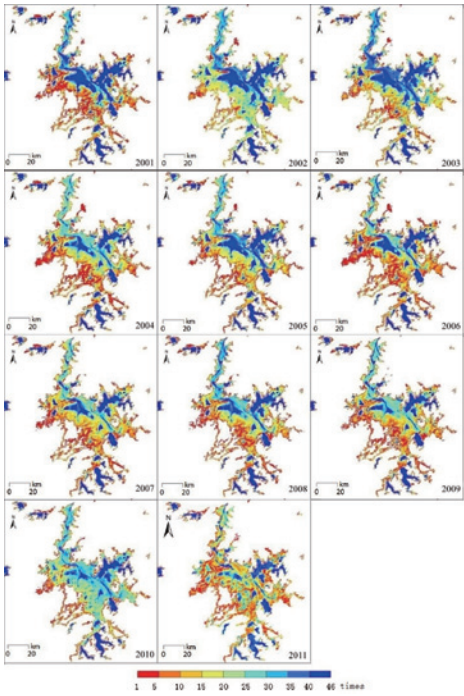
Lena delta - Braided river system

### 3 Seasonal Change of Sample Lakes in 2001-2011

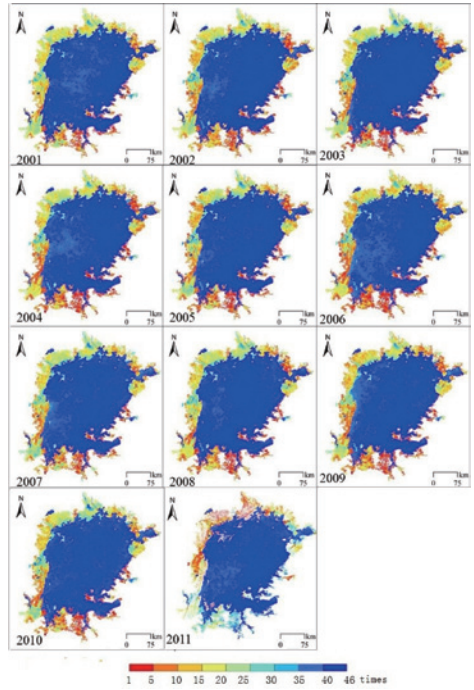
To analyze the changes of global lakes, 7 lakes were selected as examples, namely Poyang Lake (Asia), Aral Sea (Asia), Lake Victoria (Africa), Great Lakes (North America), Lake Vaner (Europe), Lake Titicaca (South America) and Lake Eyre (Oceania). Based on the dataset compositely derived from Terra/Aqua and FY-3 satellites with 8 days temporal interval (46 times each year), the dynamic changes of the lake areas were calculated from 2001 to 2011. The minimum 1 represents the areas that covered by water only for 1 x 8 days in a year, and the maximum 46 means that the areas were covered by water over the whole year.

Poyang Lake is the largest freshwater lake of China, connecting the Yangtze River, the largest river of the country. Affected by monsoon climate and intensive human activities, dynamic change in its area is remarkable both seasonally and annually. During the period from 2001 to 2011, its maximum area was 3,874 km<sup>2</sup> and the minimum was only 721 km<sup>2</sup>. The difference of water areas of the lake between rainy season (June-August) and dry season (November-February) was as high as about 2,700-3,200 km<sup>2</sup>.

Lake Victoria is the largest lake in Africa and one of the largest tropical lakes in the world. It has low seasonal variability in water area. During 2001-2011, its maximum area in wet season was 83,800 km<sup>2</sup>, and the minimum in dry season was 60,300 km<sup>2</sup>.



Poyang Lake's Water Area Changes from 2001 to 2011



Lake Victoria's Water Area Changes from 2001 to 2011