Project Progress

ID 5264

LOW LYING WATER BODIES AND WETLAND MONITORING EXPLOITING IN SITU DATA AND EARTH OBSERVATION IMAGERY, IN TERMS OF QUALITY, BIODIVERSITY DYNAMIC TRENDS AND RISK MANAGEMENT

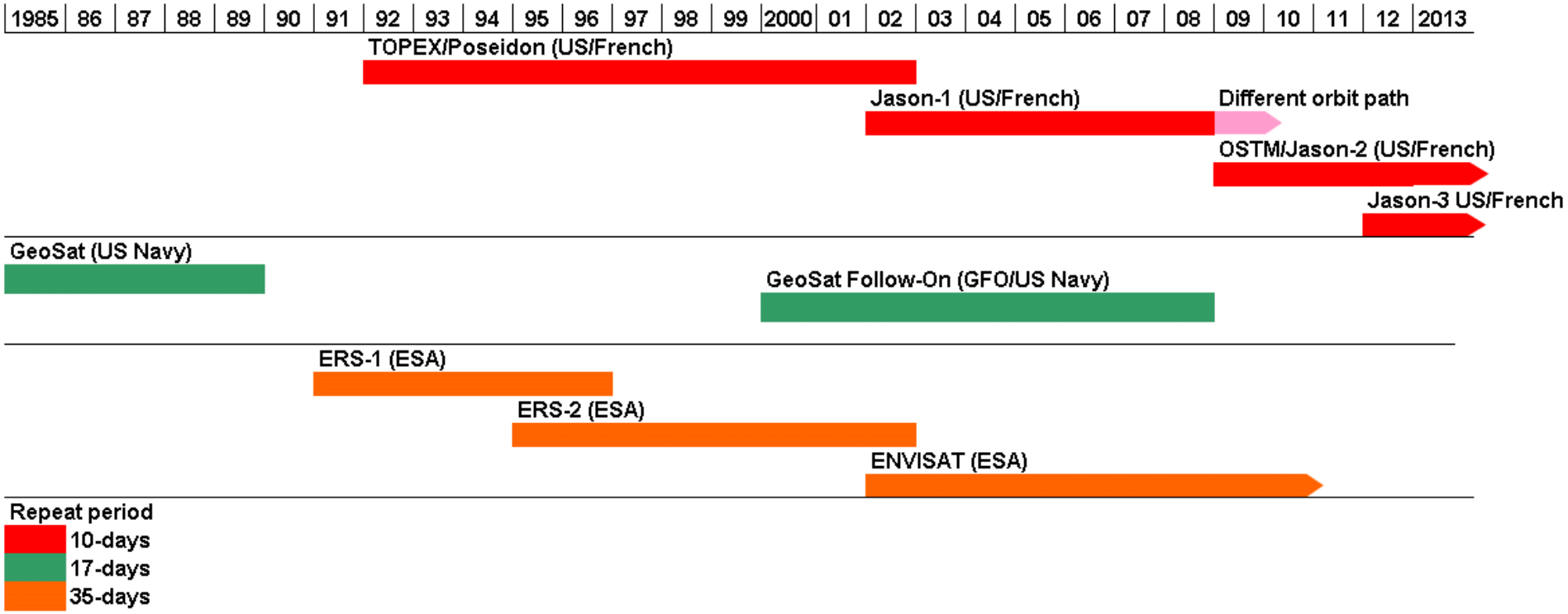
21 June 2011

Main Results

1) Water level fluctuation monitoring
2) Modified Otsu threshold method for water body extraction by ASAR
3) Inundation risk map
4) RS application in ecological and environmental assessment for the Yellow River Delta Wetland
5) Flood monitoring for whole country

1) Water level fluctuation monitoring

General Timeline for Satellite Radar Altimeters

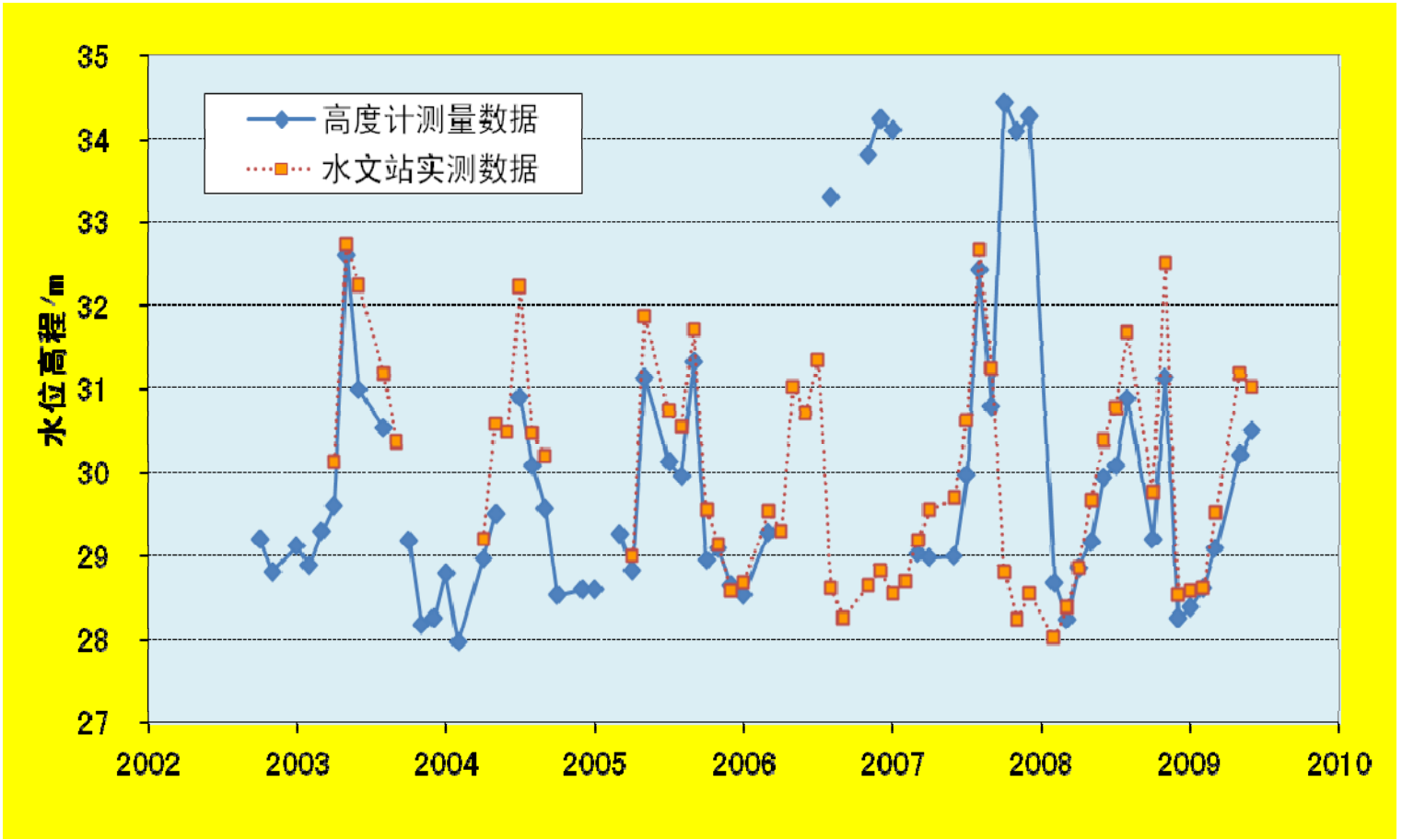


Application of ENVISAT/RA-2 (Radar Altimeter-2) data in the South Dongting Lake

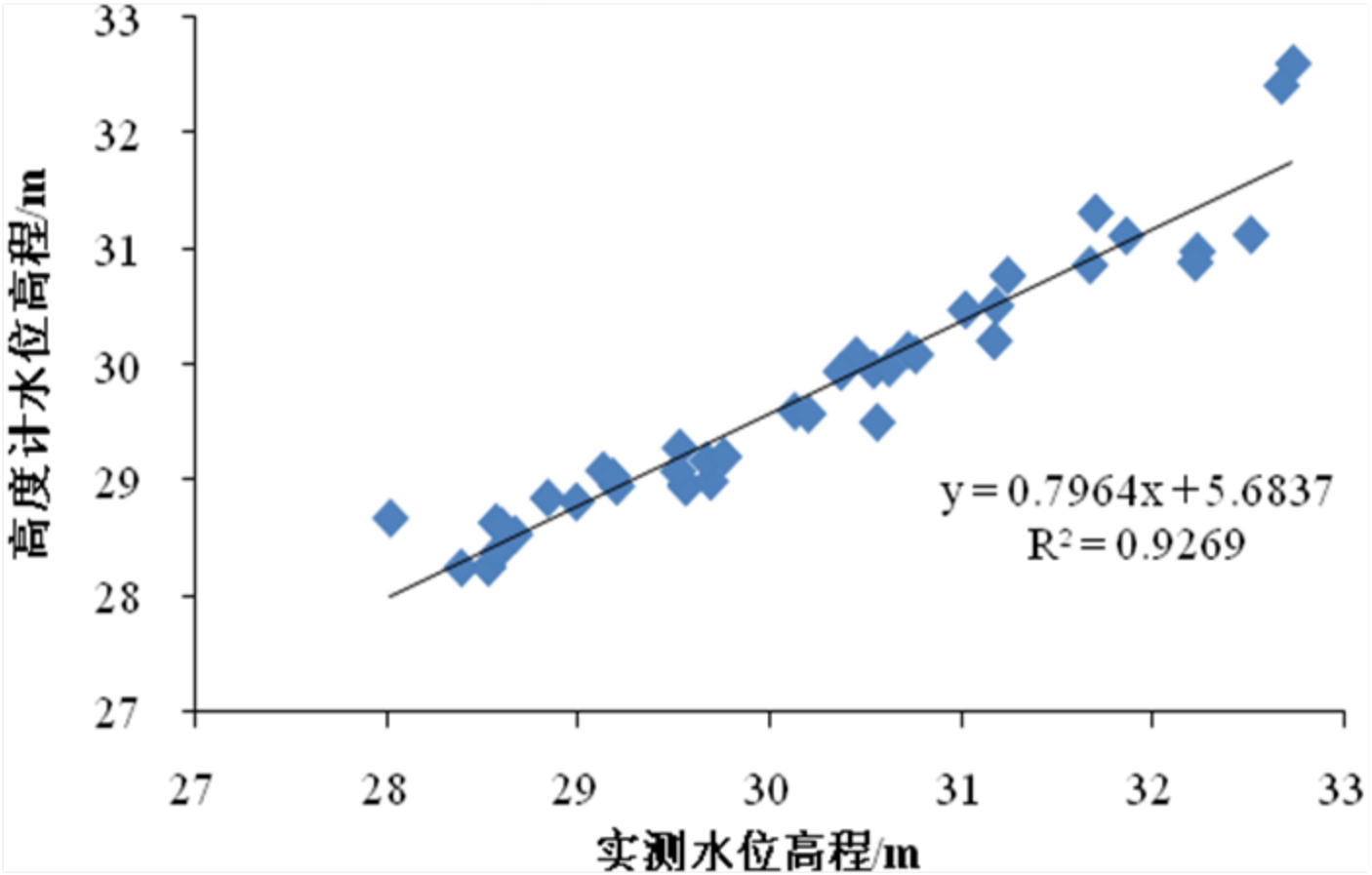
- Data was download after application from

  ESA website

- All Track347 GDR data from Sep. 30th 2002 to June 5th, 2009



Water level monitoring in the Dongting Lake by **ENVISAT/RA-2**



Correlation with observed ones

Application of Jason-2 altimetry data in the South Dongting

Data was download from Aviso website

All pass12 GDR data from 2008-07-12 to 2009-05-16（Cycle001 to Cycle032）

Jason-2 ground tracks

Ground tracks of Jason-2 satellite through the Dongting Lake

Data: Jason-2/ OSTM GDRs, from Aviso website;

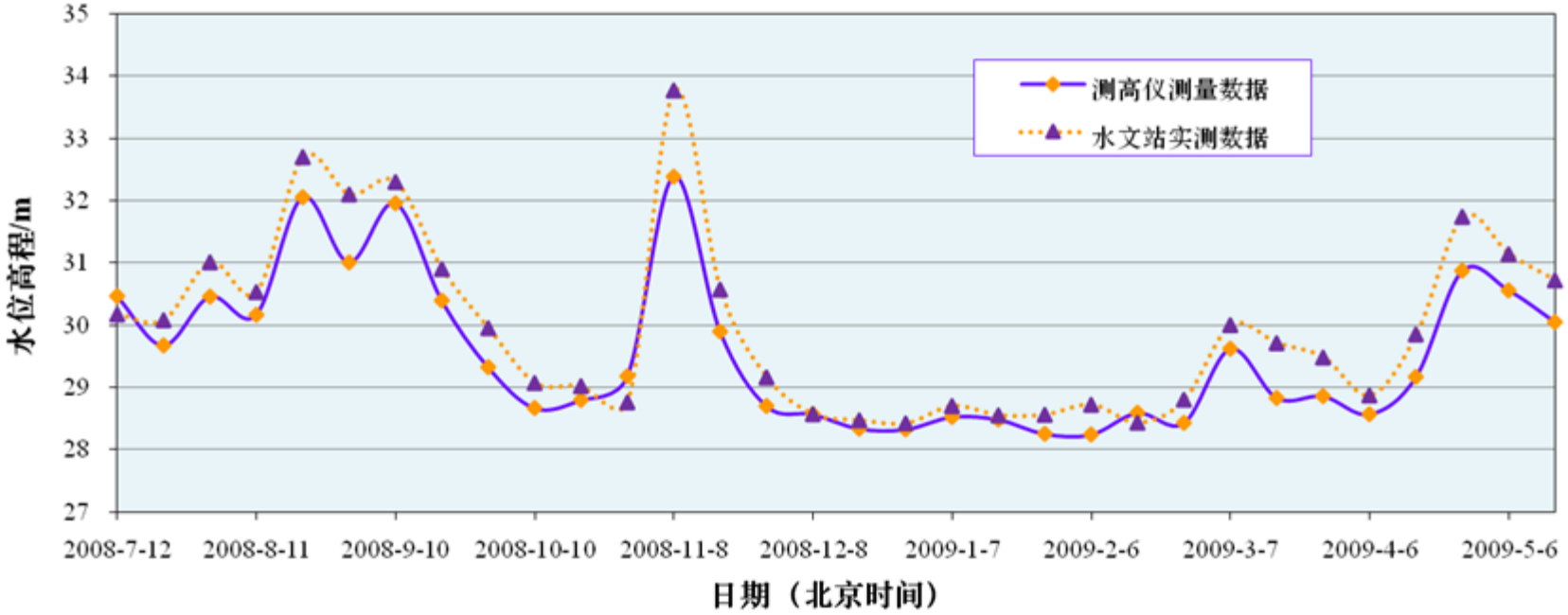
Pass number: 12;

Time: 2008-07-12~2009-05-16

（Cycle001~Cycle032）;

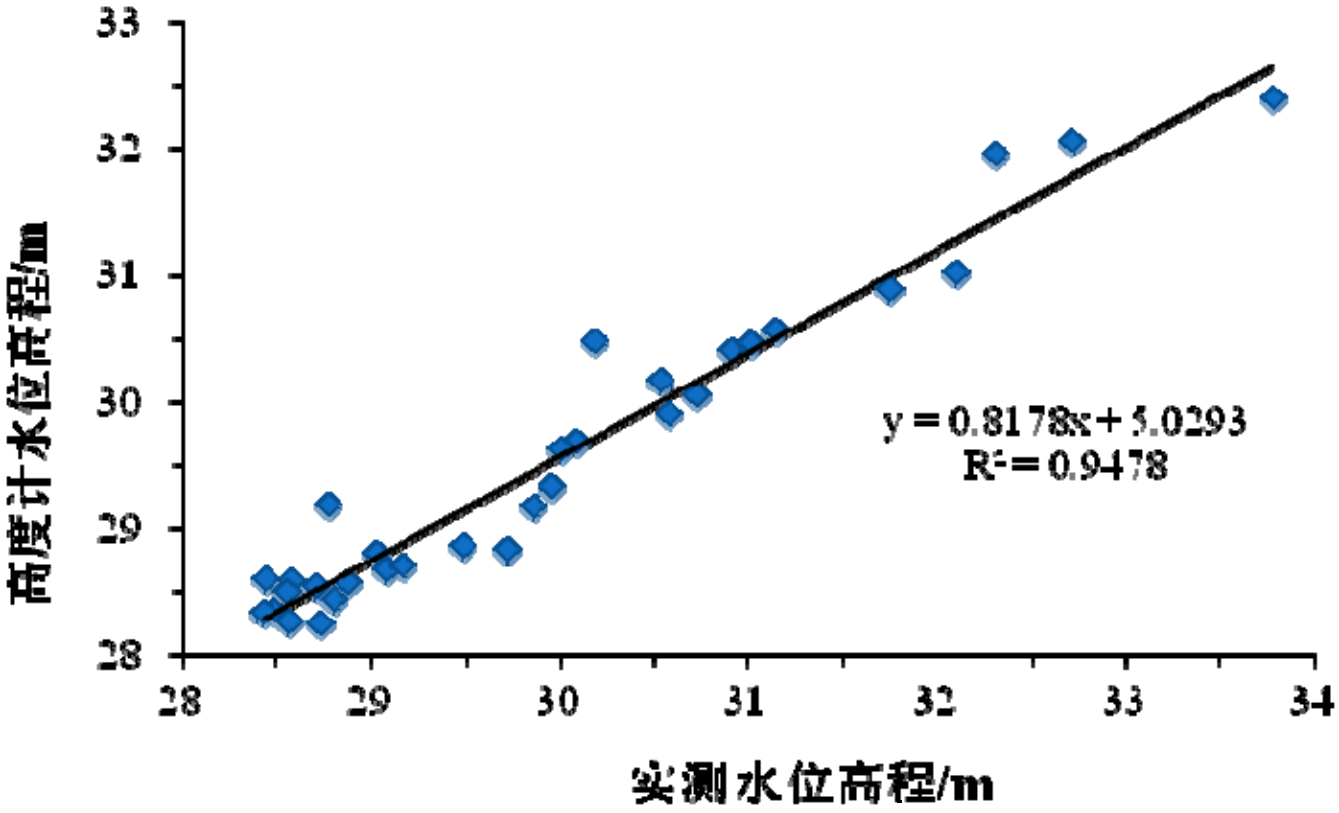
Repeat period: 10-days

Software: BRAT（Basic Radar Altimetry Toolbox）



Water level monitoring in the Dongting Lake by Jason-2 data

In November 2008, flood occurred in branches near the South Dongting Lake, and the water level in the South Dongting Lake became high, while the flood peak did not arrive the hydrological station. This is the reason for diviation.

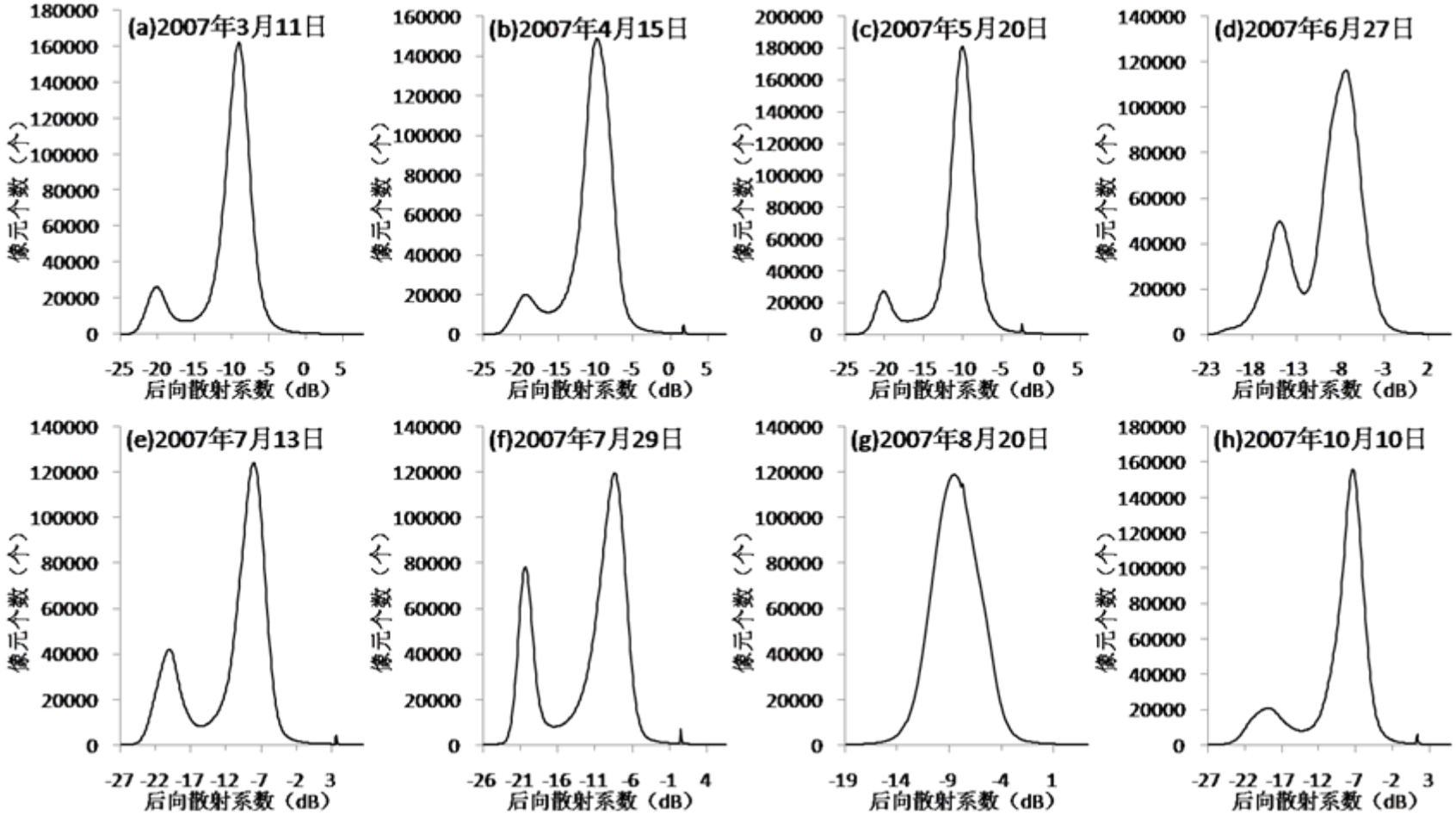


Correlation with the observed ones

2) Modified Otsu threshold method for water body extraction by ASAR

For water body extraction, the threshold index method from signal band of MODIS data can not effectively avoid the influence of mountain and cloud shadow, while the method based on band relation may reduce the spatial resolution, so a method which is combined with multi-information of band relation of typical ground objects was developed for water body extraction by MODIS data.

Optimal threshold searching

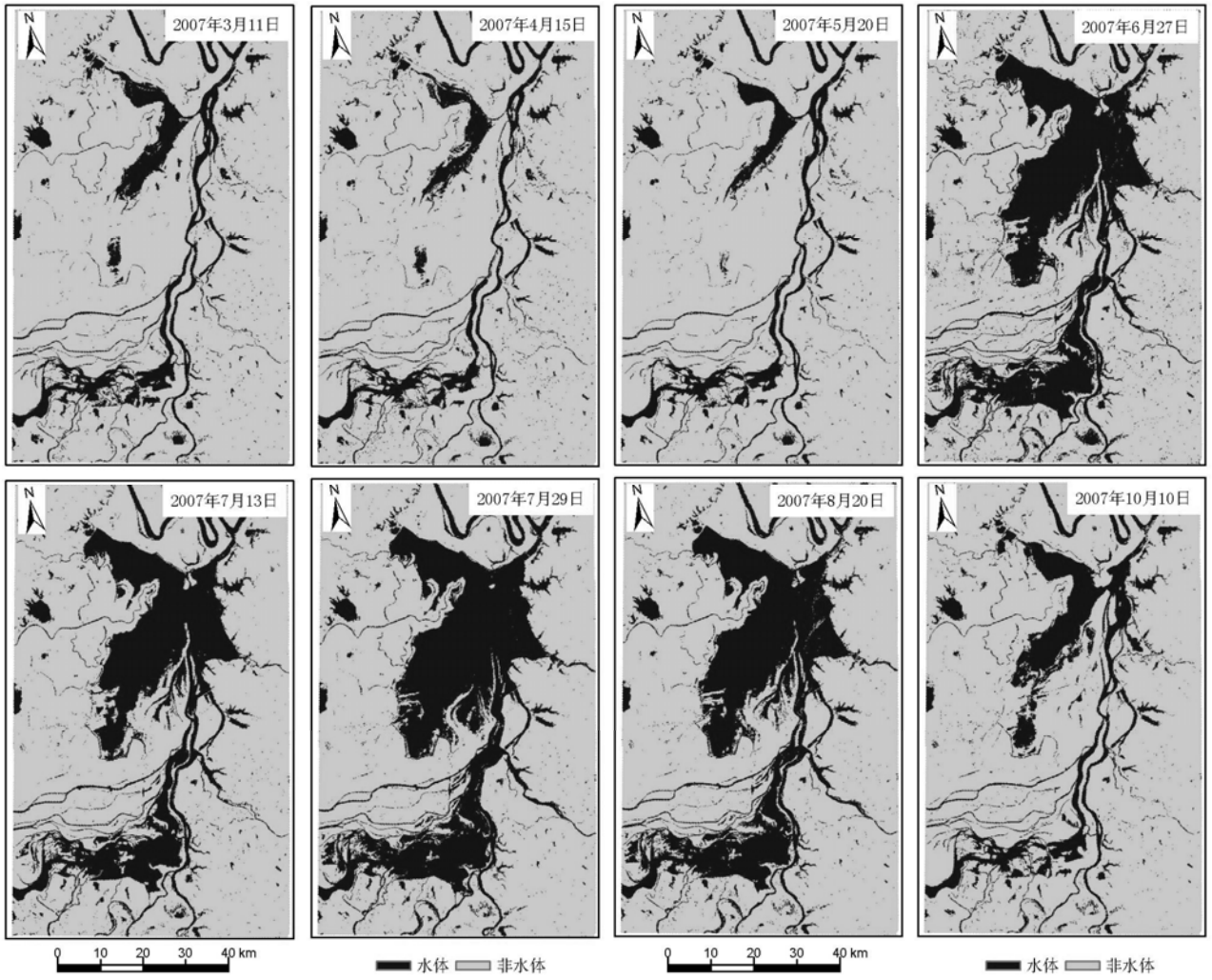


The histogram of the backscattering coefficient for the eight preprocessed ASAR images

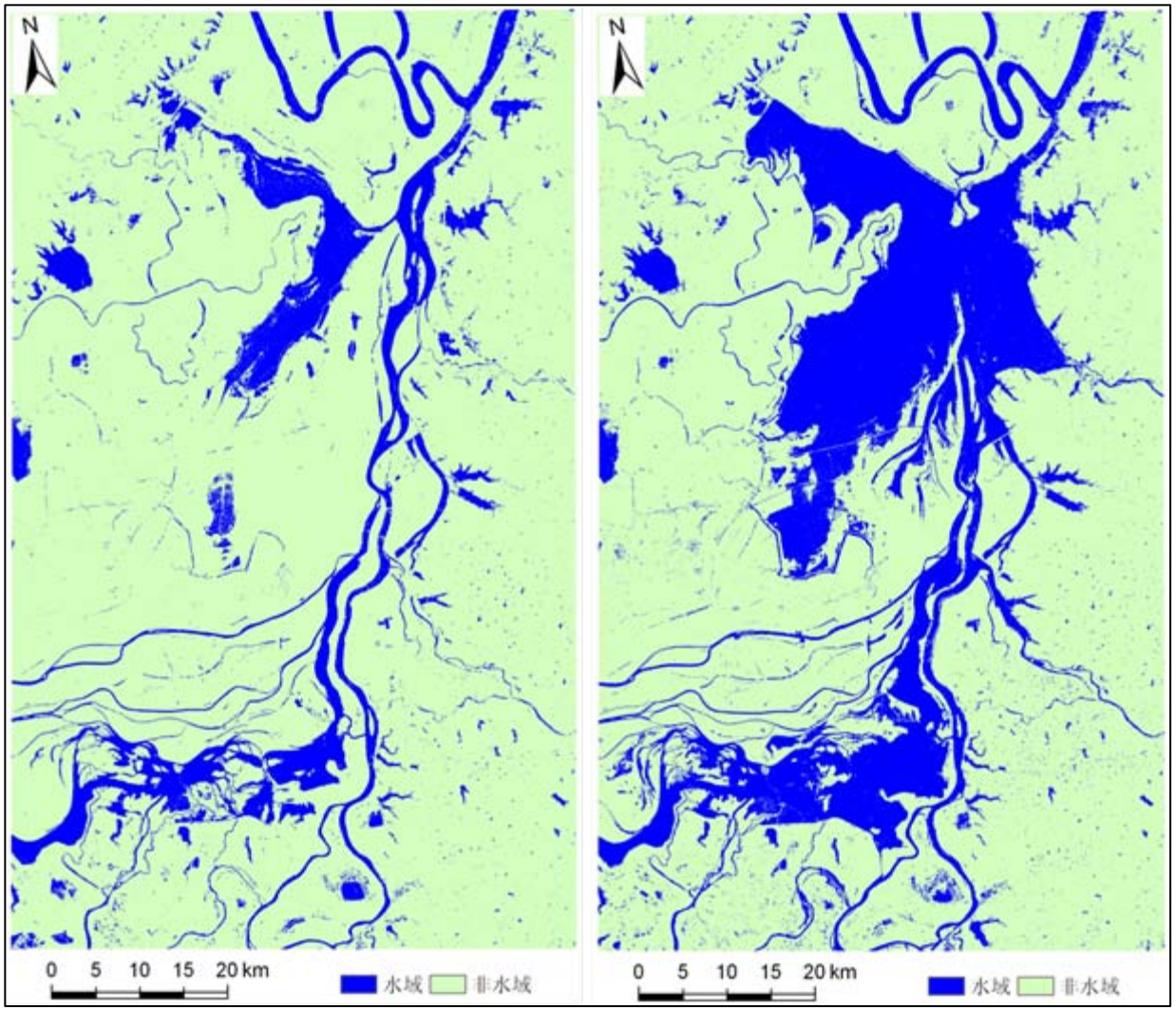
Optimal threshold searching results by the modified Otsu method

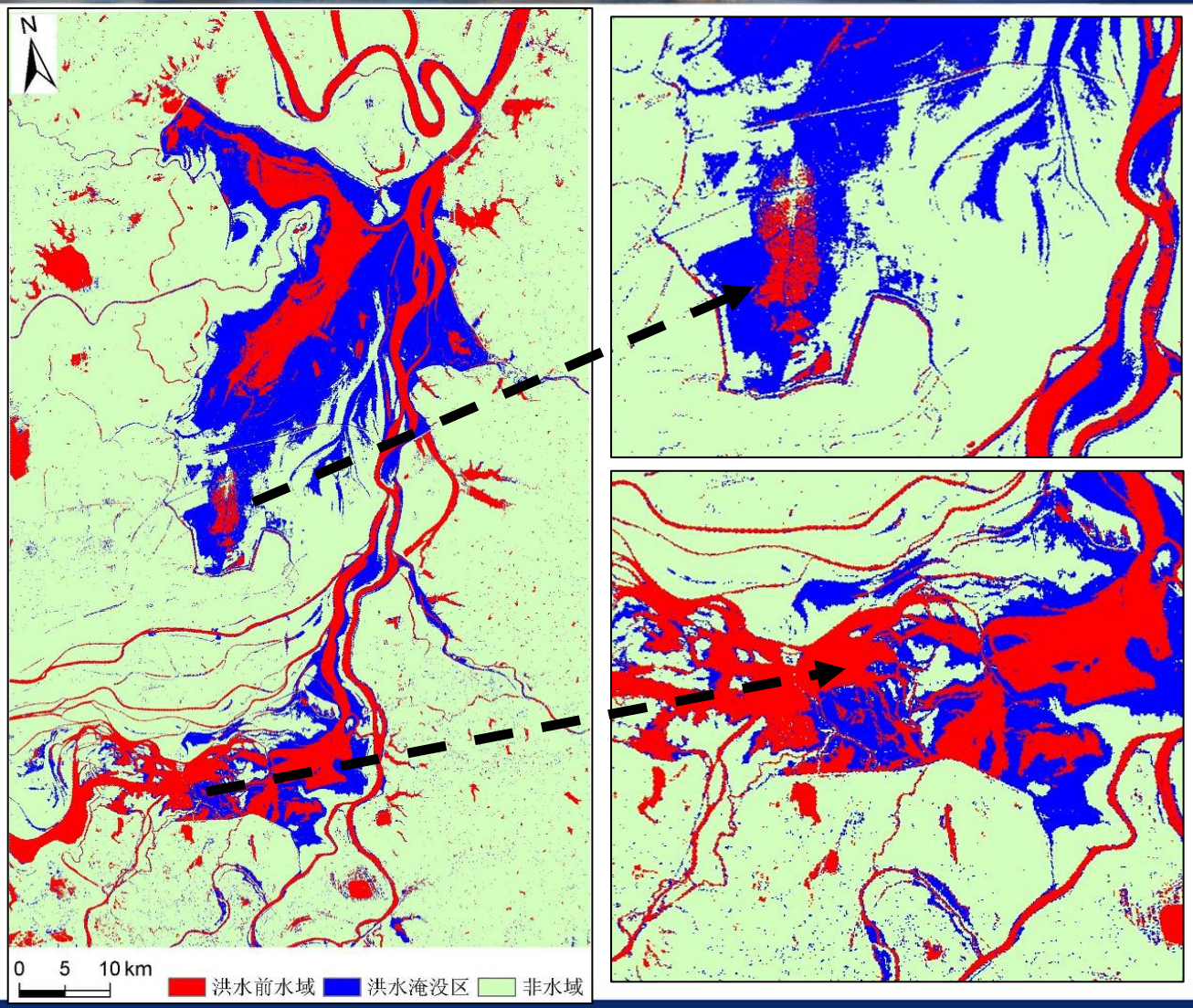
Time	Left-peak	Right-peak	Inter-peak valley	optimal threshold
2007-3-11	-20.0367	-9.03671	-16.5367	-15.8367
2007-4-15	-19.5498	-10.0498	-16.6498	-15.3499
2007-5-20	-20.0834	-9.98340	-17.0834	-16.4834
2007-6-27	-15.2501	-7.75012	-12.5501	-12.2501
2007-7-13	-19.8435	-7.74347	-15.6435	-15.2435
2007-7-29	-20.5582	-8.55821	-16.5582	-15.6582
2007-8-20	—	—	—	—
2007-10-10	-19.2492	-7.54919	-14.5492	-14.0492

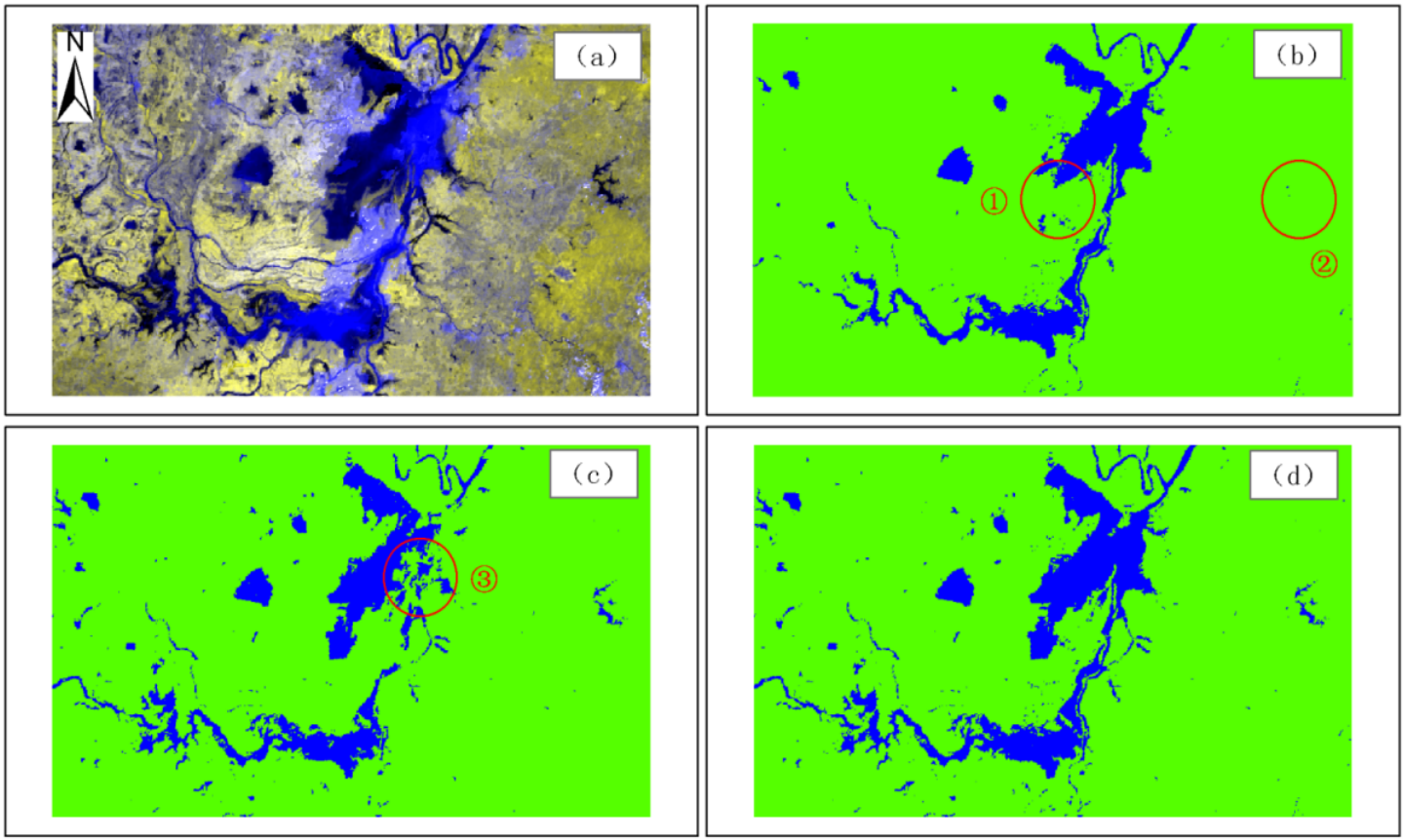
Note: The histogram of the backscattering coefficient for 2007-8-20 ASAR data has only one peak, so the modified Otsu method is not applicable.



The water extracted results based the optimal threshold from the modified Otsu method


N
0 5 10 15 20 km
水域
非水域
N
0 5 10 15 20 km
水域
非水域


N
0 5 10 km
洪水前水域
洪水淹没区
非水域

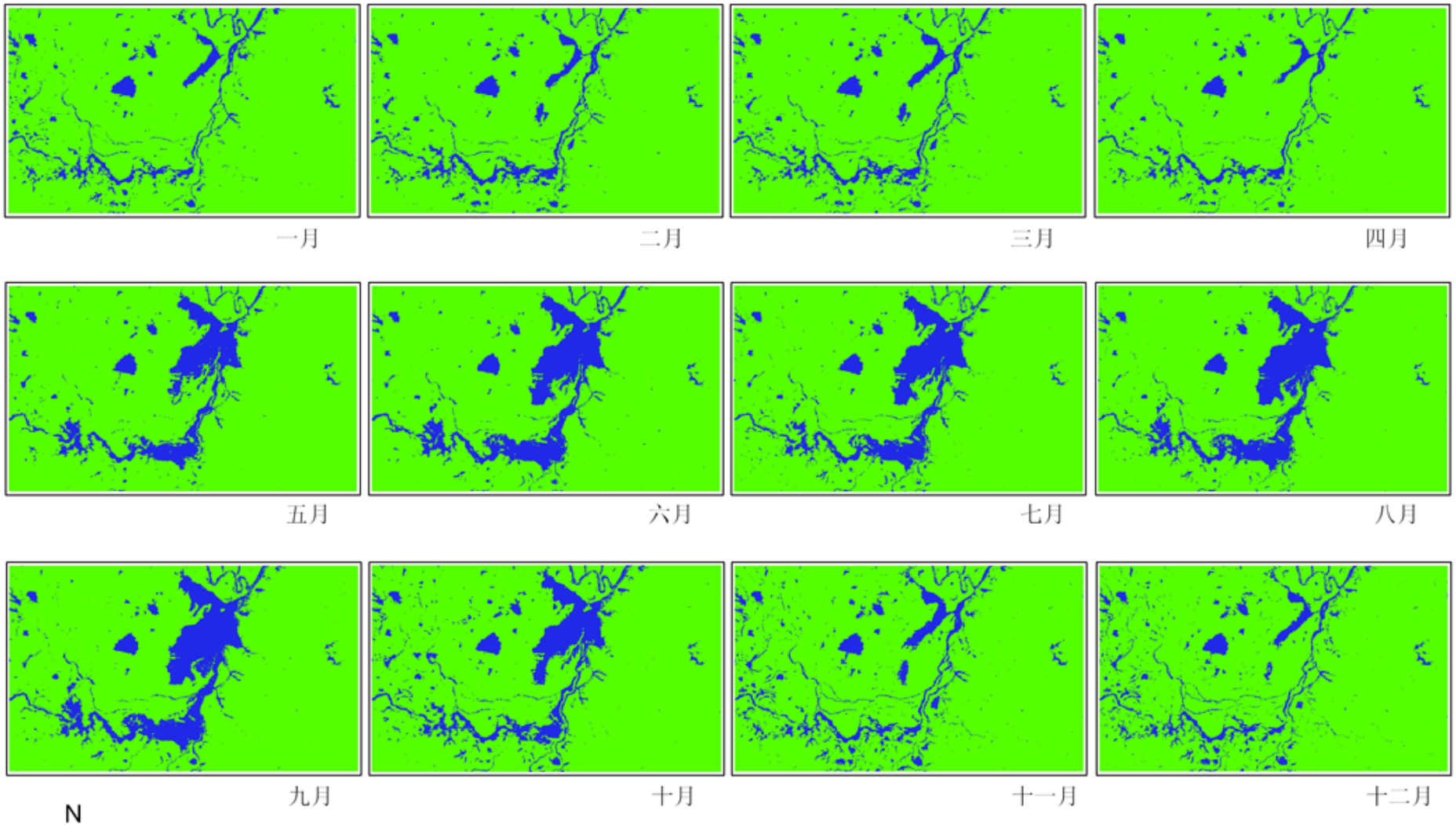


（a）：MODIS原始影像，2（红）、2（绿）、1（蓝）三波段假彩色合成；

（b）：利用规则1，基于NDVI指数的MODIS数据水域面积提取结果；

（c）：利用规则2，基于近红外波段的MODIS数据水域面积提取结果；

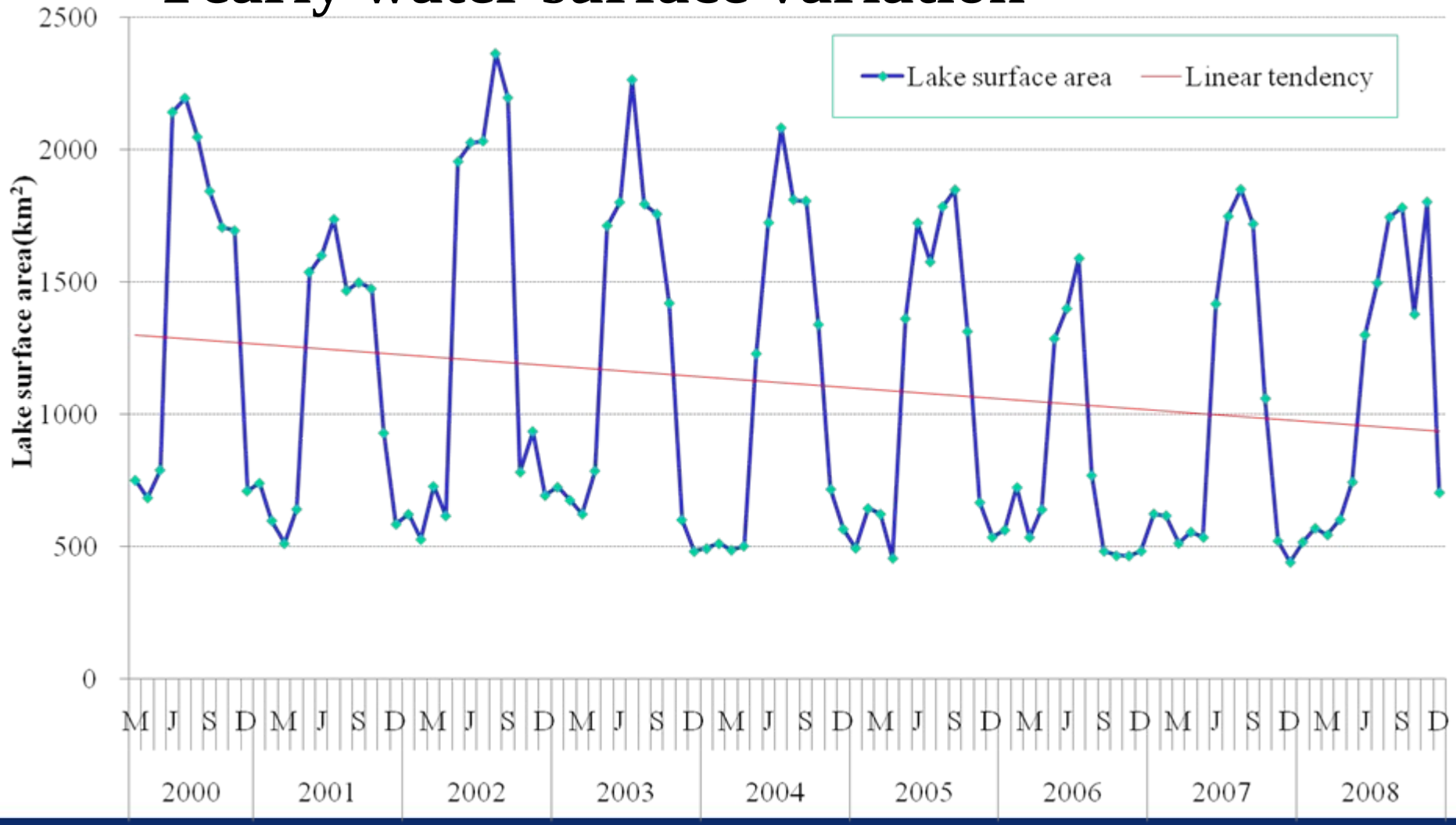
（d）：利用规则1和2，NDVI指数和近红外波段共同作用下的MODIS数据水域面积提取结果。


一月
二月
三月
四月
五月
六月
七月
八月
九月
十月
十一月
十二月
N
0
50
100 km
水域
非水域

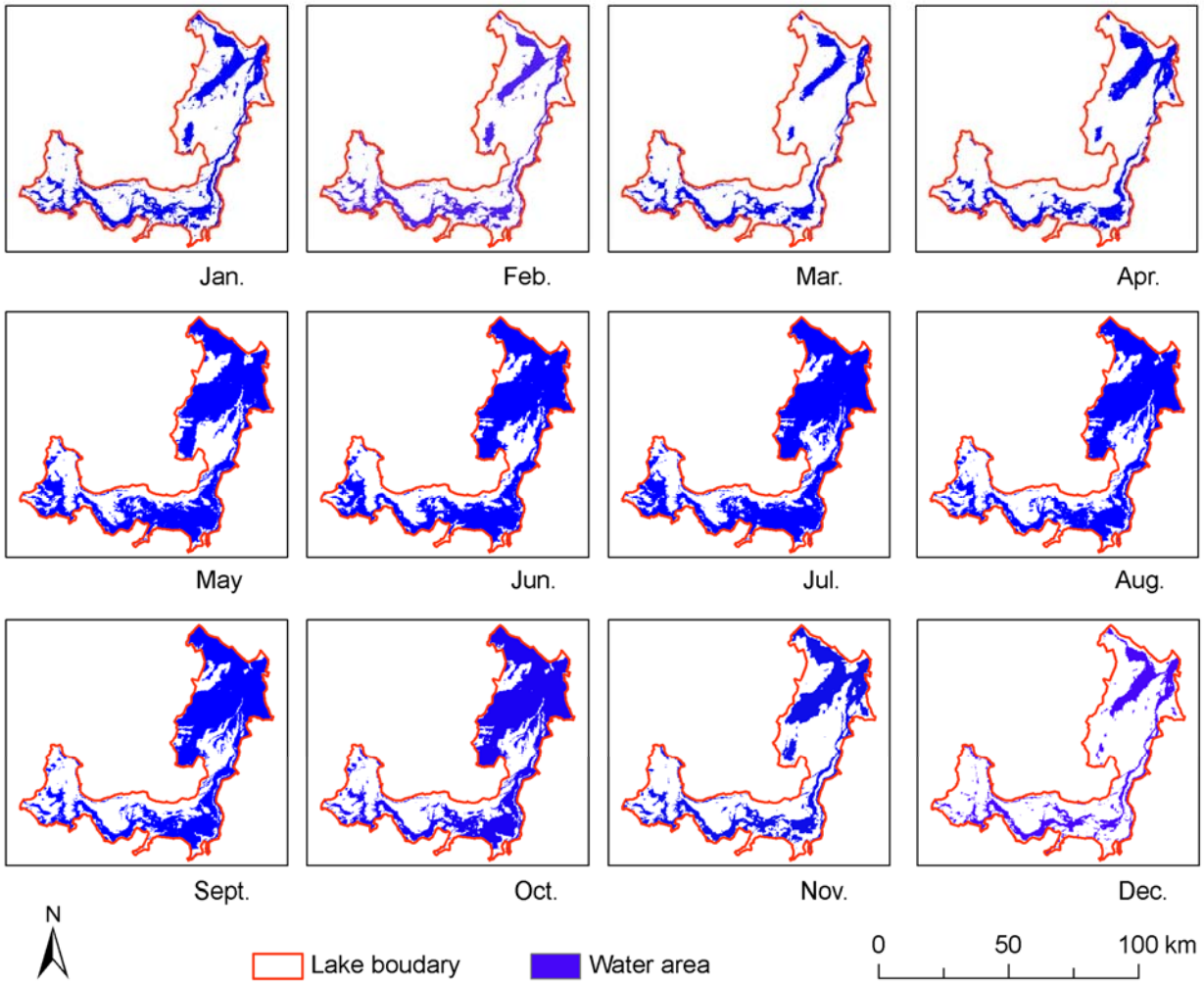
3) Inundation risk map

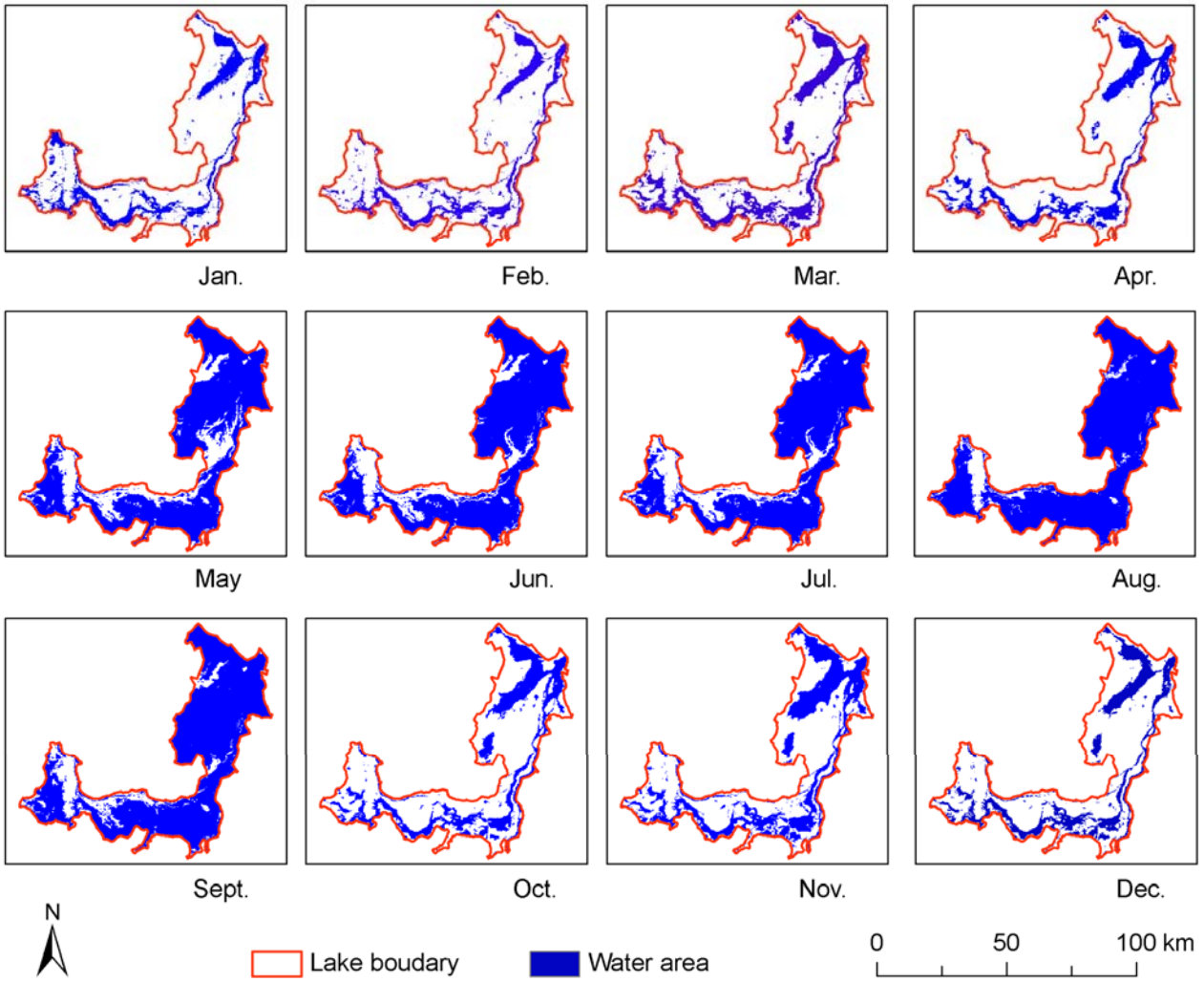
For the Dongting Lake, by means of long-term Terra/MODIS data, monitoring and analysis are made for characteristics of the water surface area variation, bottomland and wetland baring process, as well as primary productivity in recent 10 years.

Yearly water surface variation

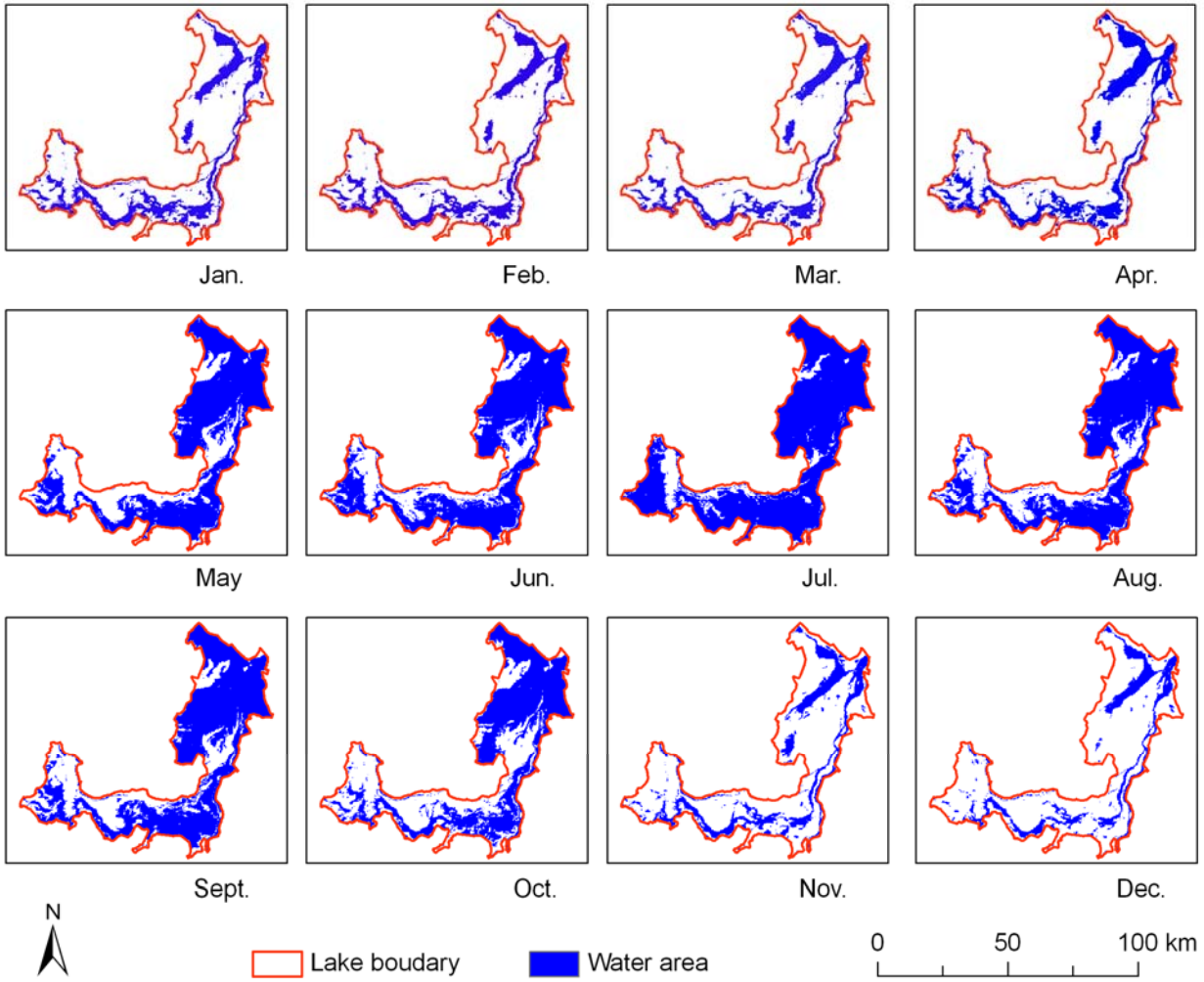


Dongting Lake variations observed by Terra/MODIS data between May 2000 and December 2008

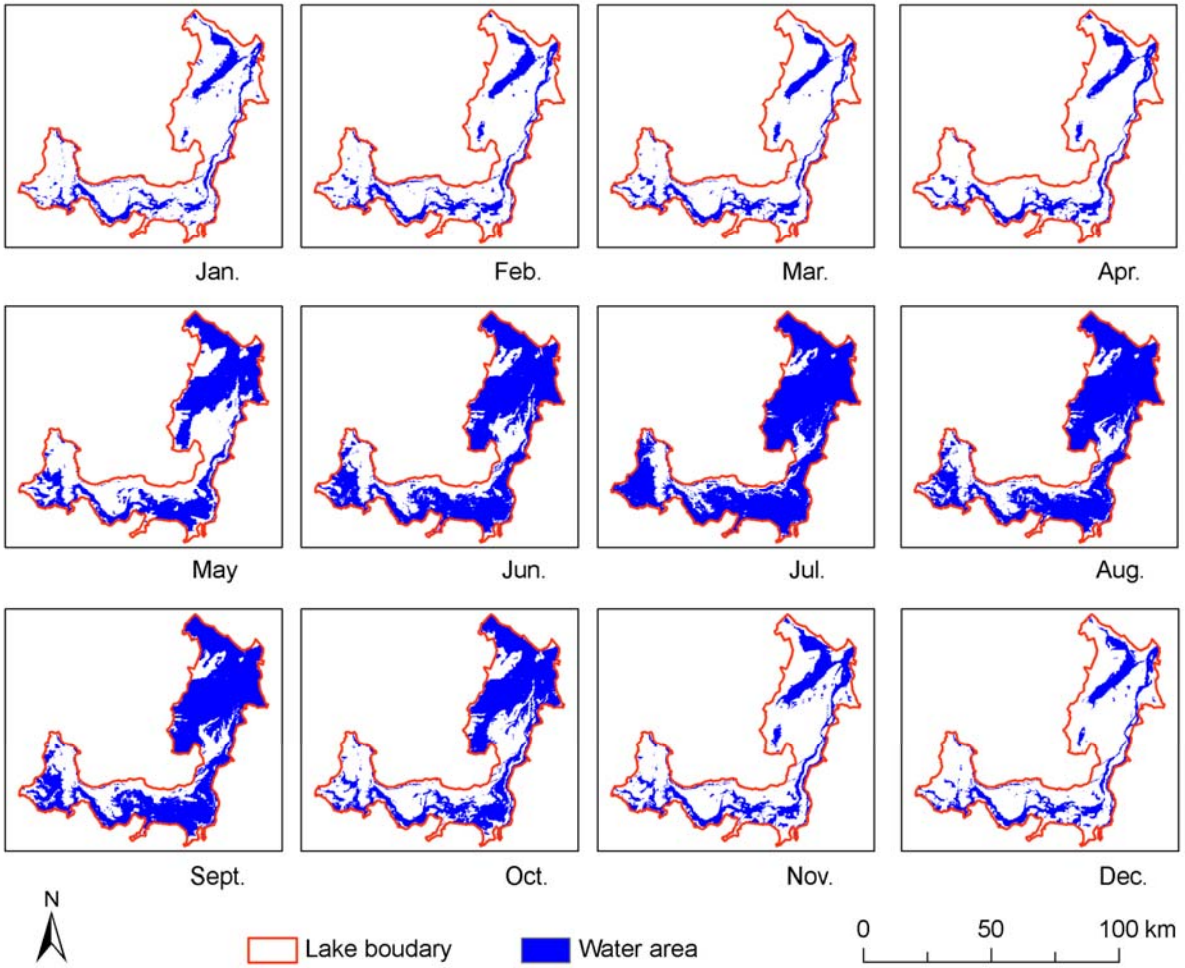

Jan.
Feb.
Mar.
Apr.
May
Jun.
Jul.
Aug.
Sept.
Oct.
Nov.
Dec.
N
Lake boudary
Water area
0
50
100 km


Jan.
Feb.
Mar.
Apr.
May
Jun.
Jul.
Aug.
Sept.
Oct.
Nov.
Dec.
N
Lake boudary
Water area
0
50
100 km

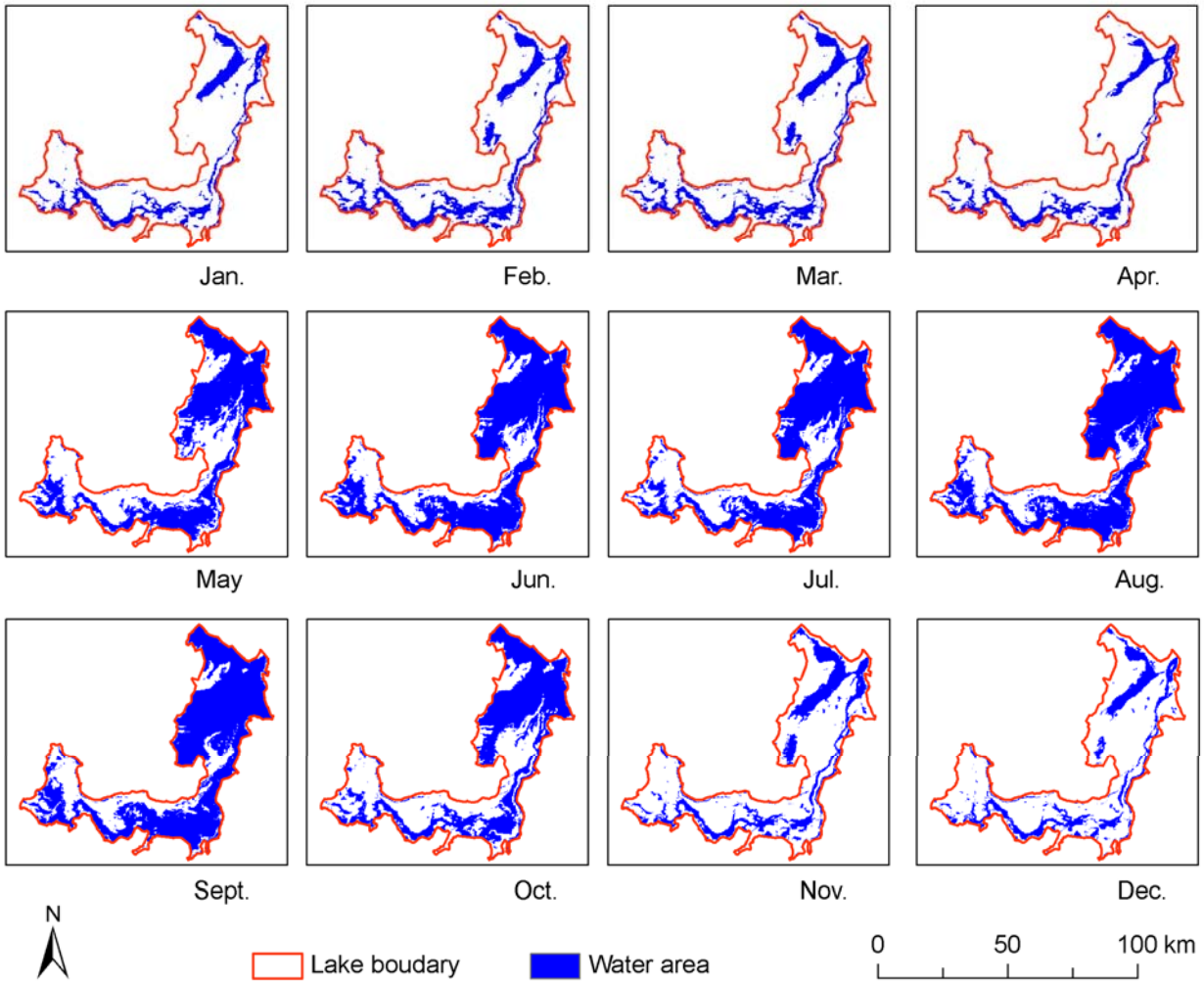
(2003)


Jan.
Feb.
Mar.
Apr.
May
Jun.
Jul.
Aug.
Sept.
Oct.
Nov.
Dec.
N
Lake boudary
Water area
0
50
100 km

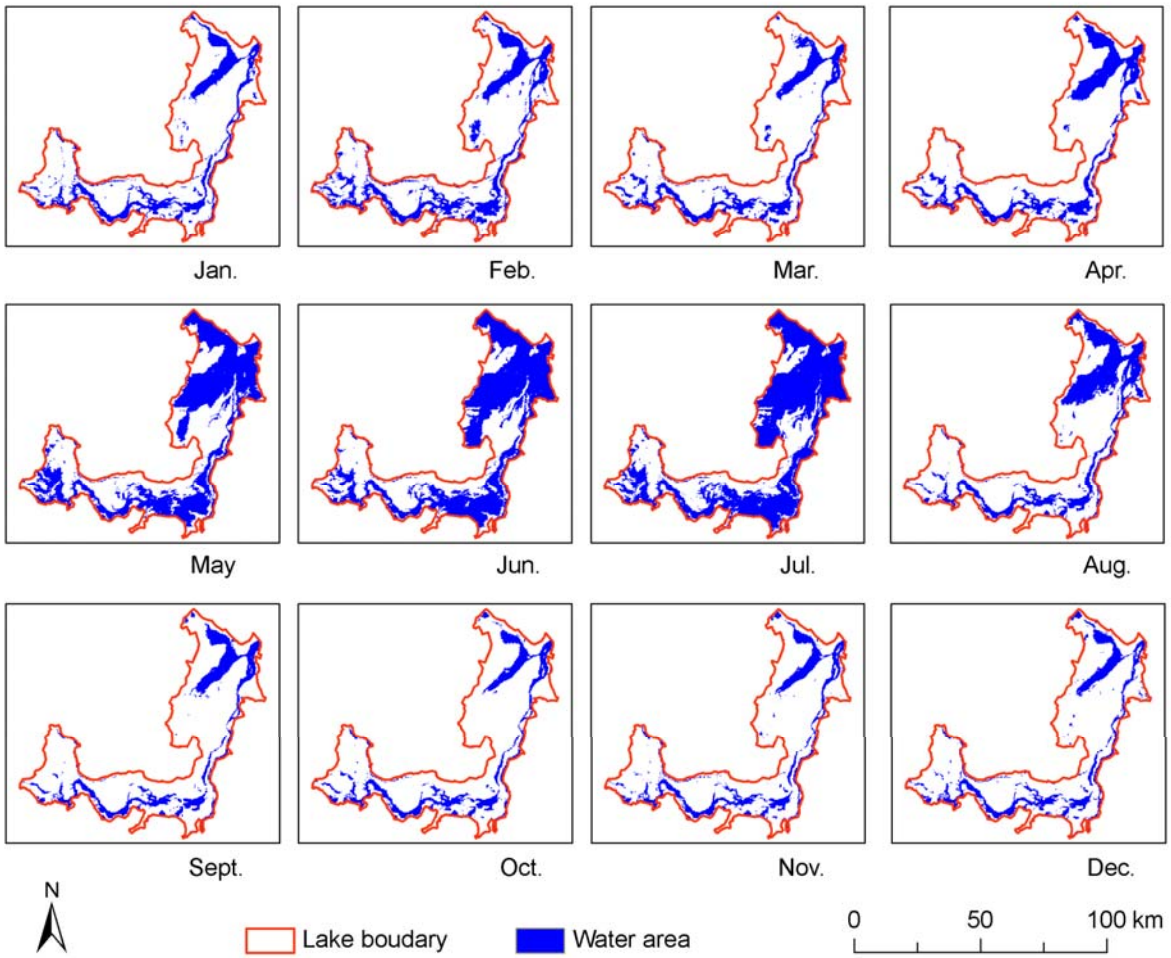
(2004)

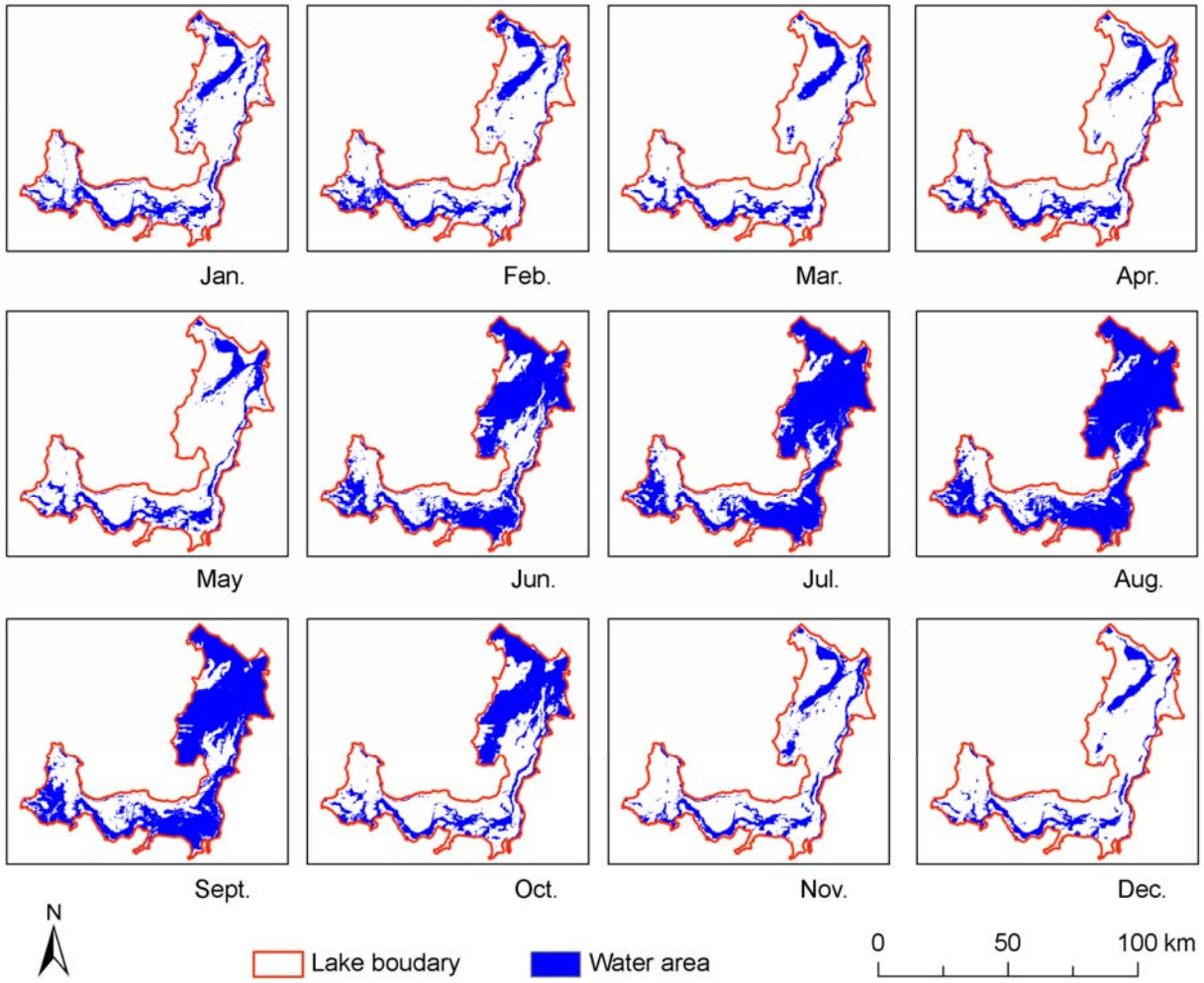

Jan.
Feb.
Mar.
Apr.
May
Jun.
Jul.
Aug.
Sept.
Oct.
Nov.
Dec.
N
Lake boudary
Water area
0
50
100 km

(2005)

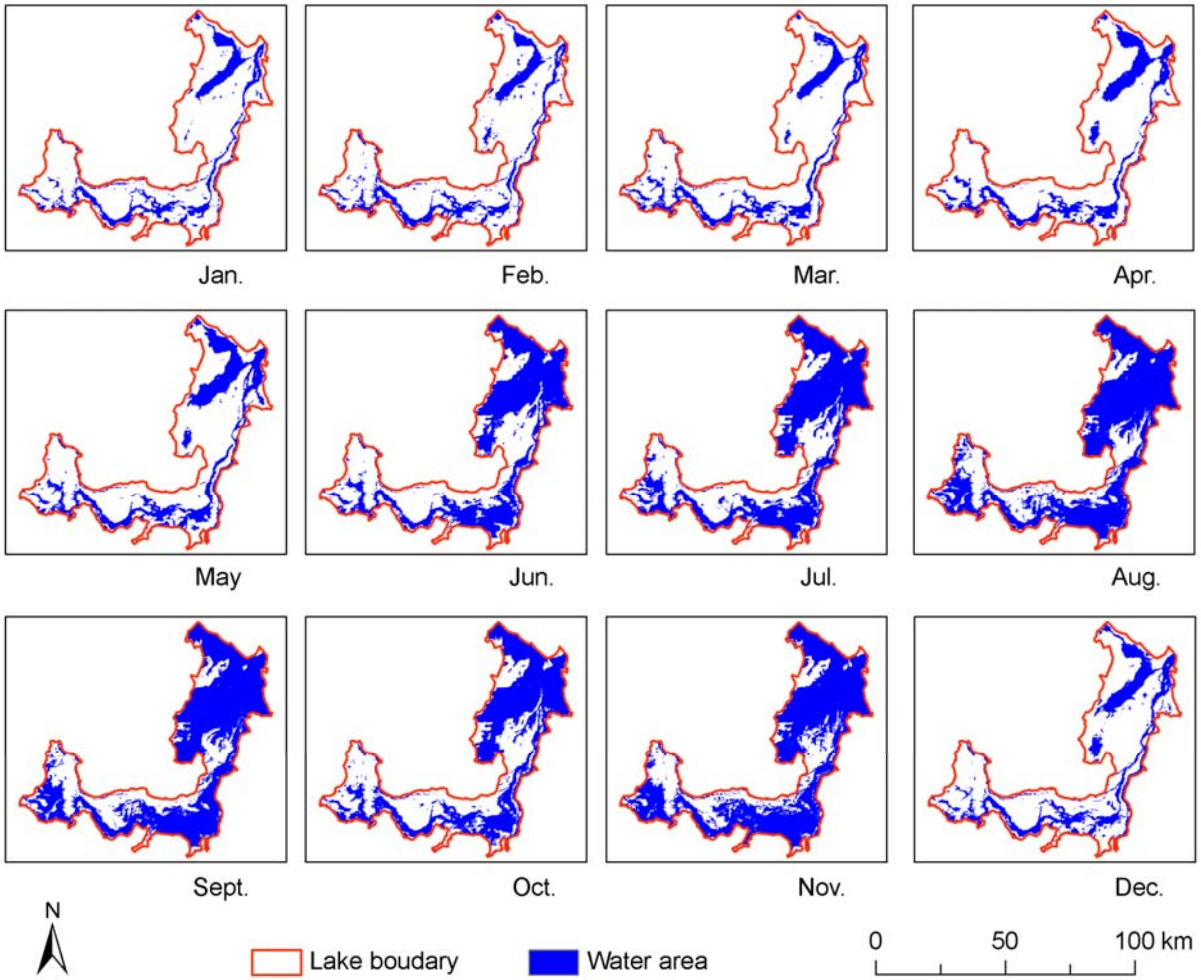

Jan.
Feb.
Mar.
Apr.
May
Jun.
Jul.
Aug.
Sept.
Oct.
Nov.
Dec.
N
Lake boudary
Water area
0
50
100 km

(2006)

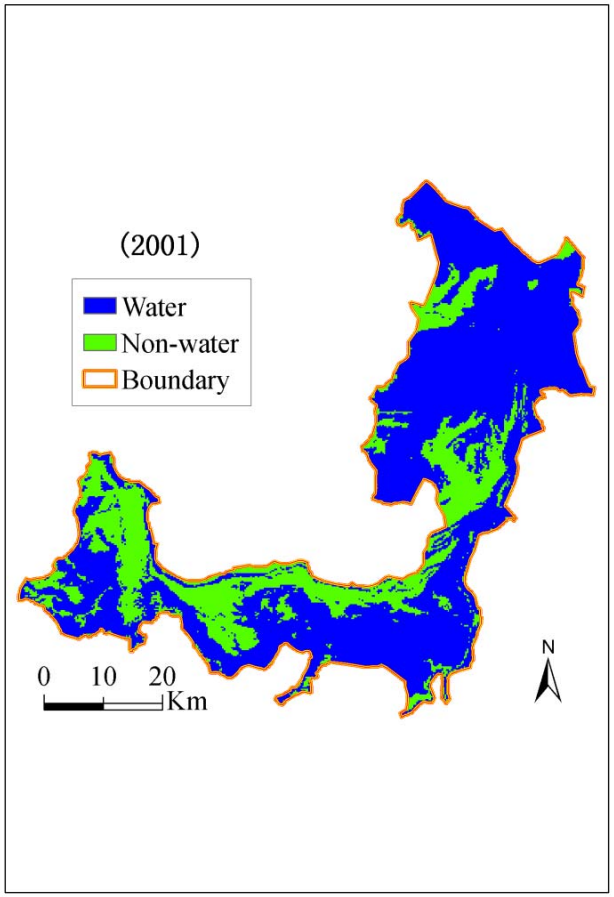

Jan.
Feb.
Mar.
Apr.
May
Jun.
Jul.
Aug.
Sept.
Oct.
Nov.
Dec.
N
Lake boudary
Water area
0
50
100 km


Jan.
Feb.
Mar.
Apr.
May
Jun.
Jul.
Aug.
Sept.
Oct.
Nov.
Dec.
N
Lake boudary
Water area
0
50
100 km

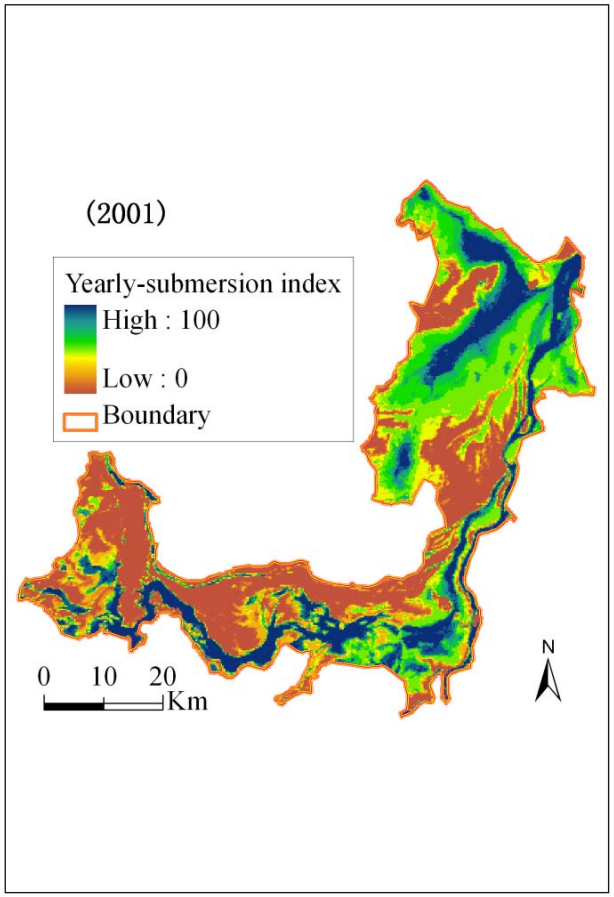
(2008)

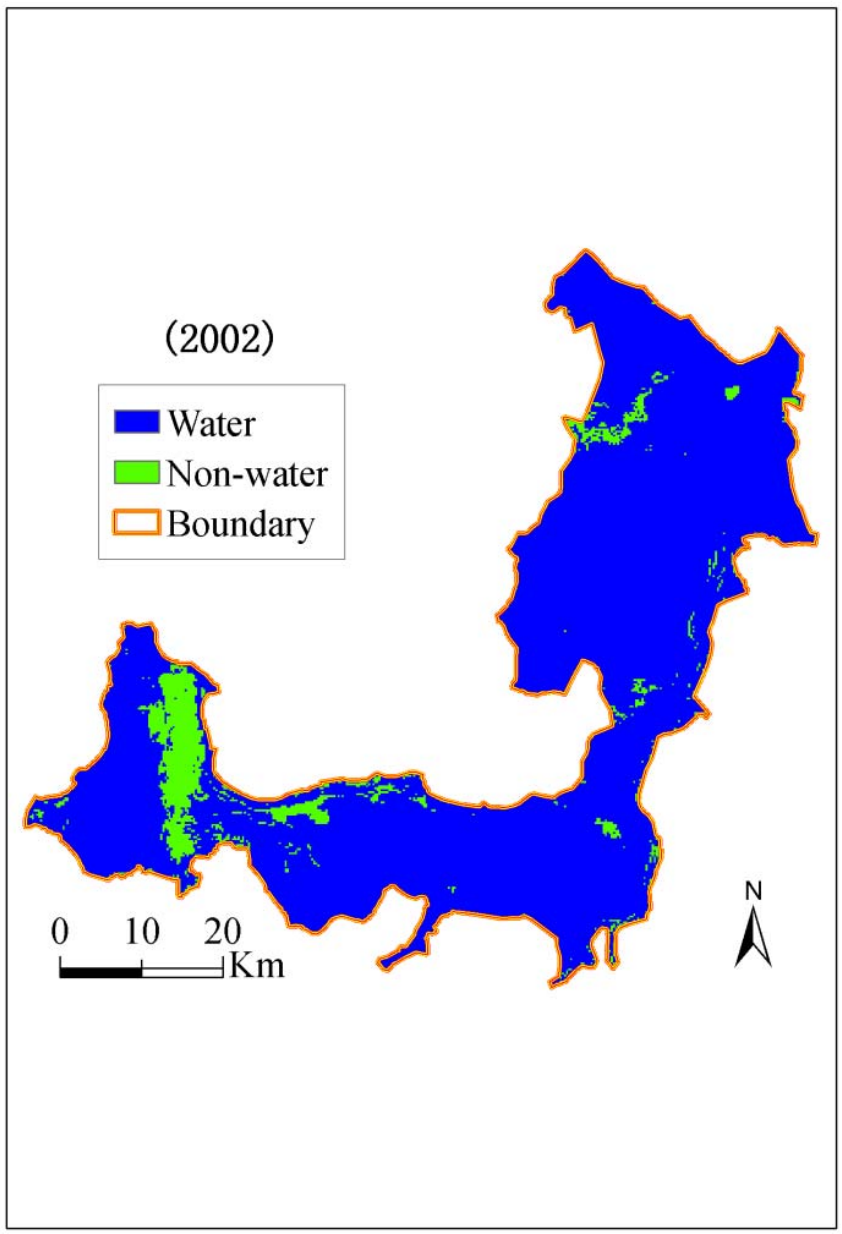

Jan.
Feb.
Mar.
Apr.
May
Jun.
Jul.
Aug.
Sept.
Oct.
Nov.
Dec.
N
Lake boudary
Water area
0
50
100 km

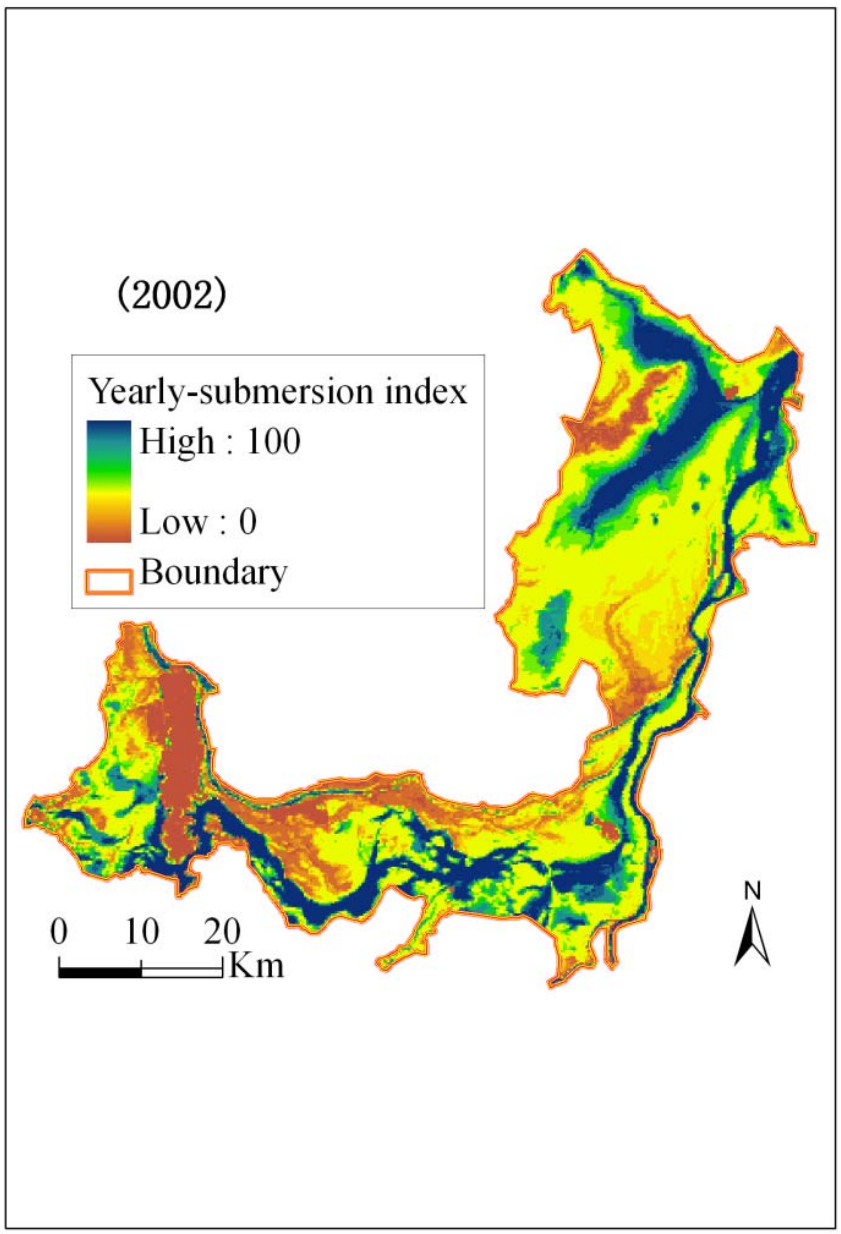
Water maximal extent (2001－2008)

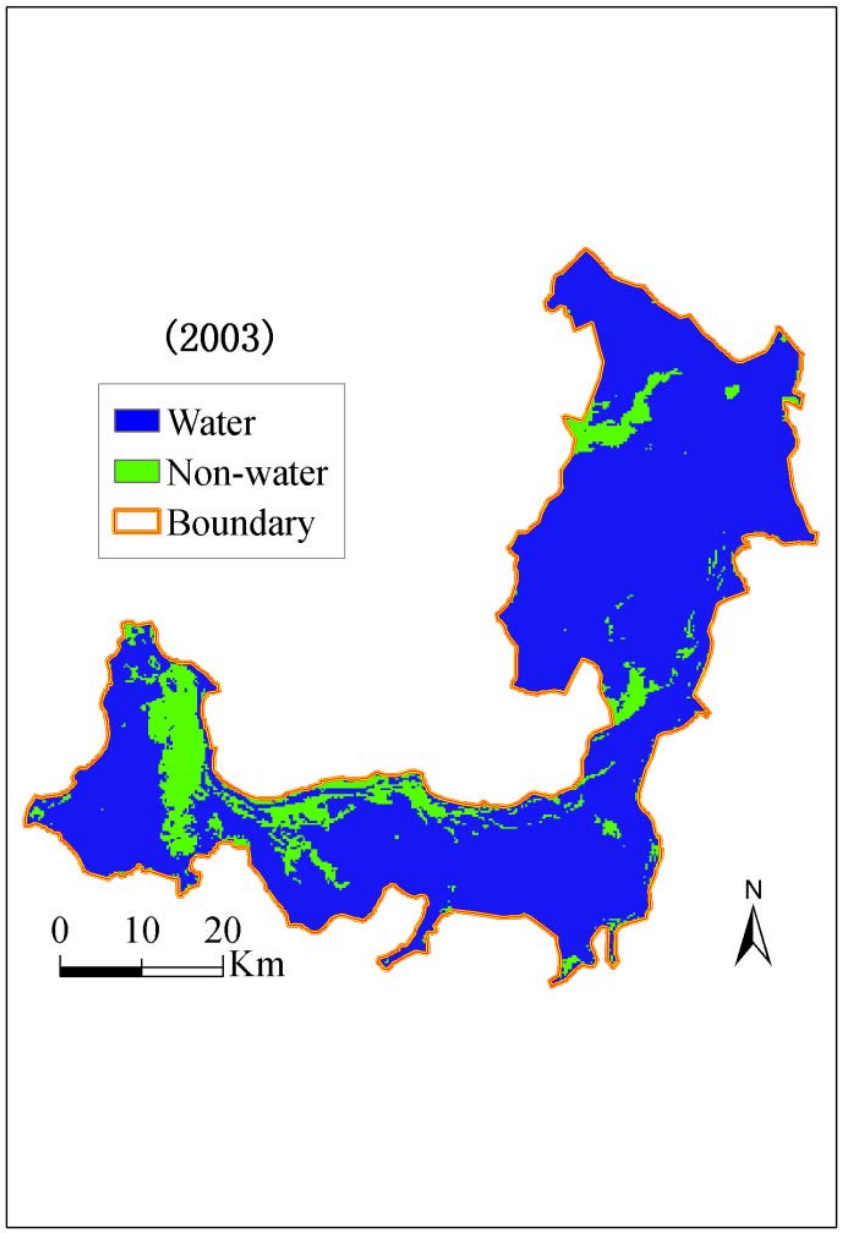


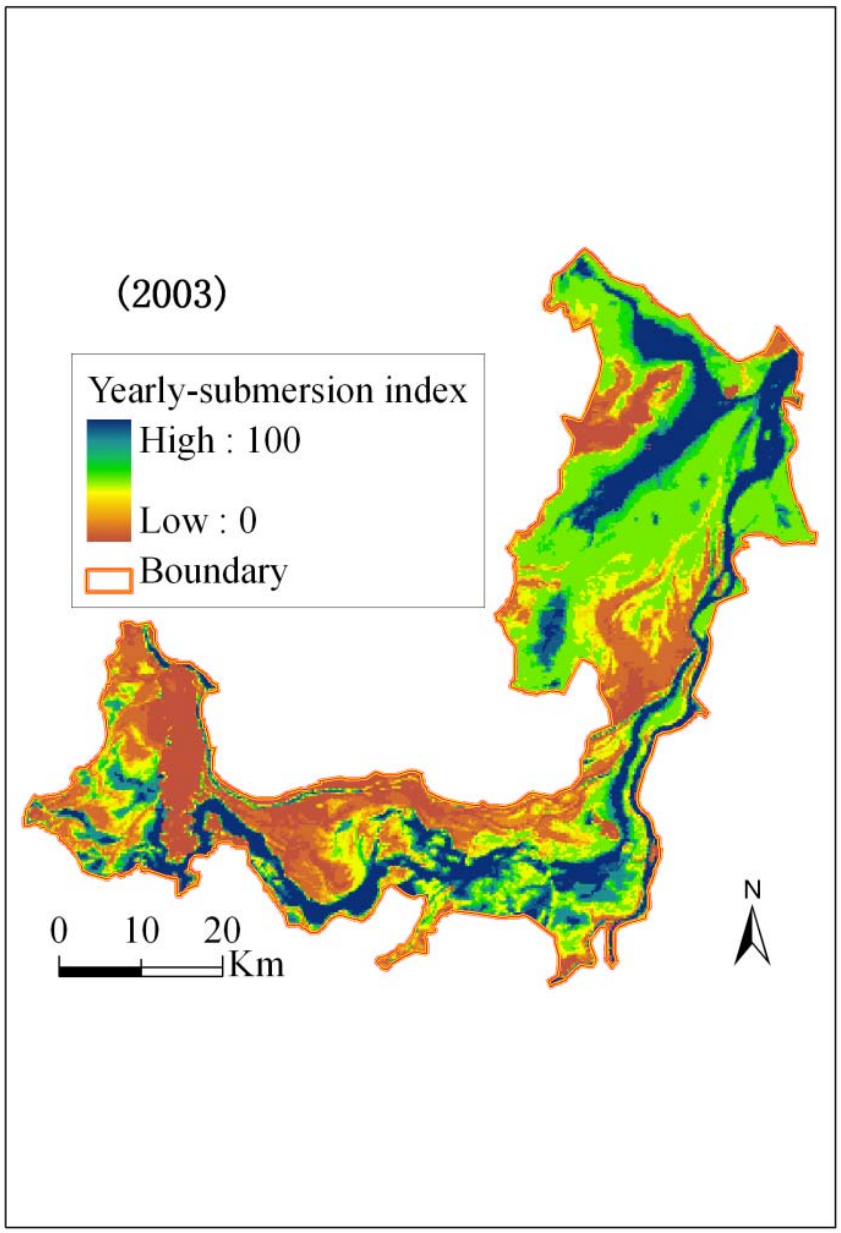
Water duration estimate (2001－2008)

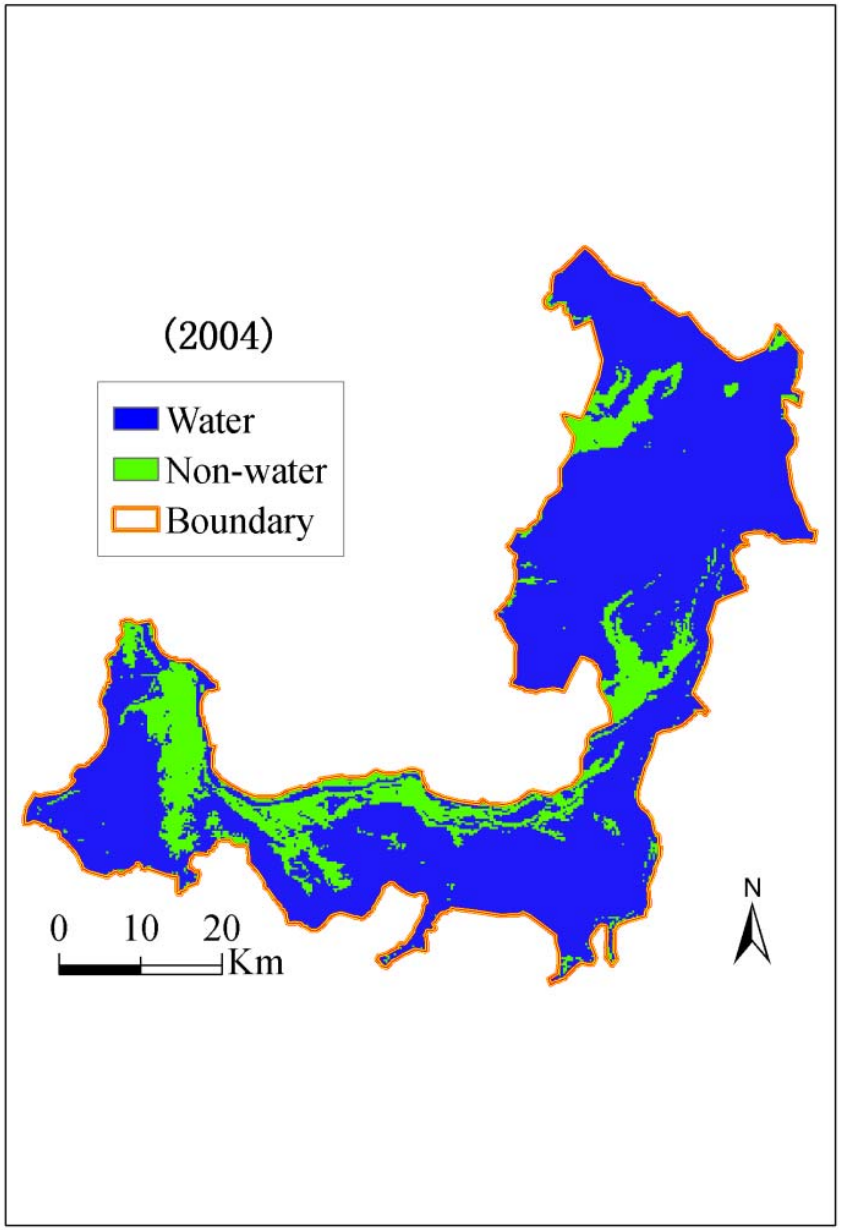


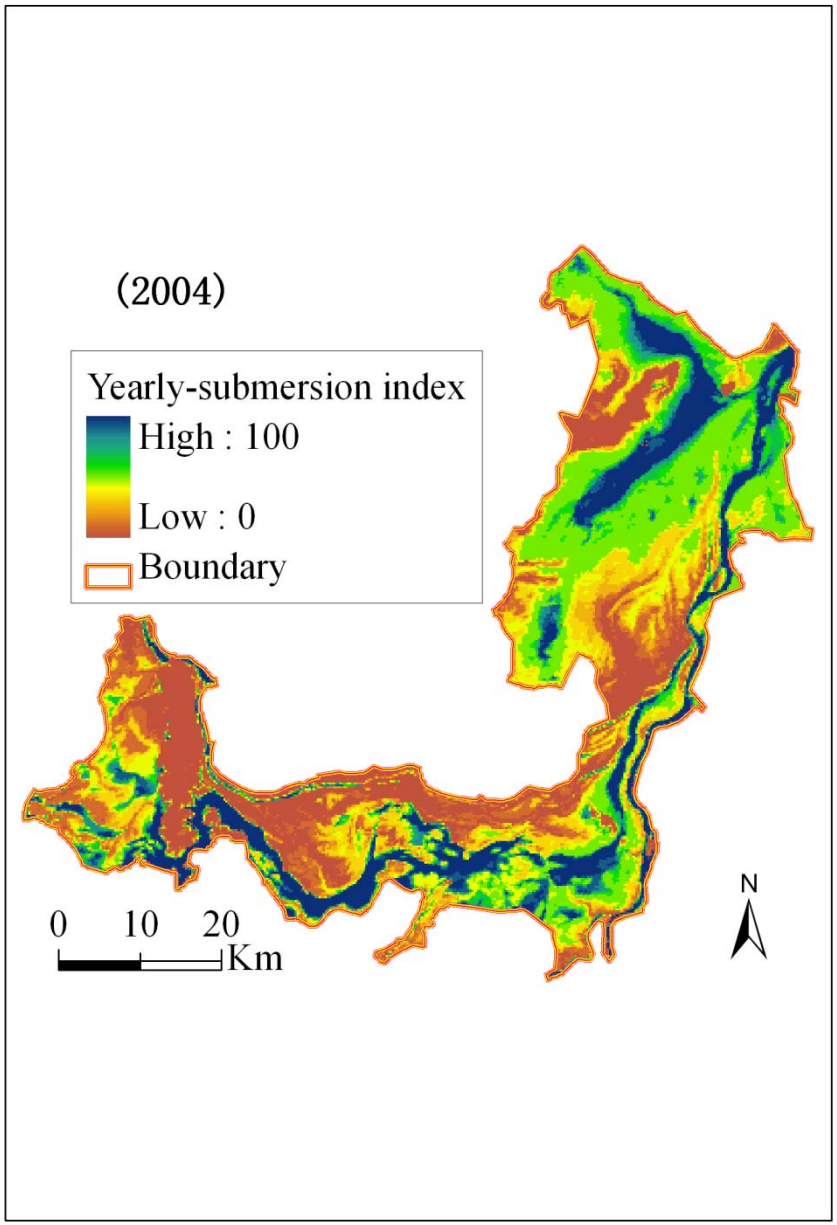

(2002)
Water
Non-water
Boundary
0 10 20
Km
N

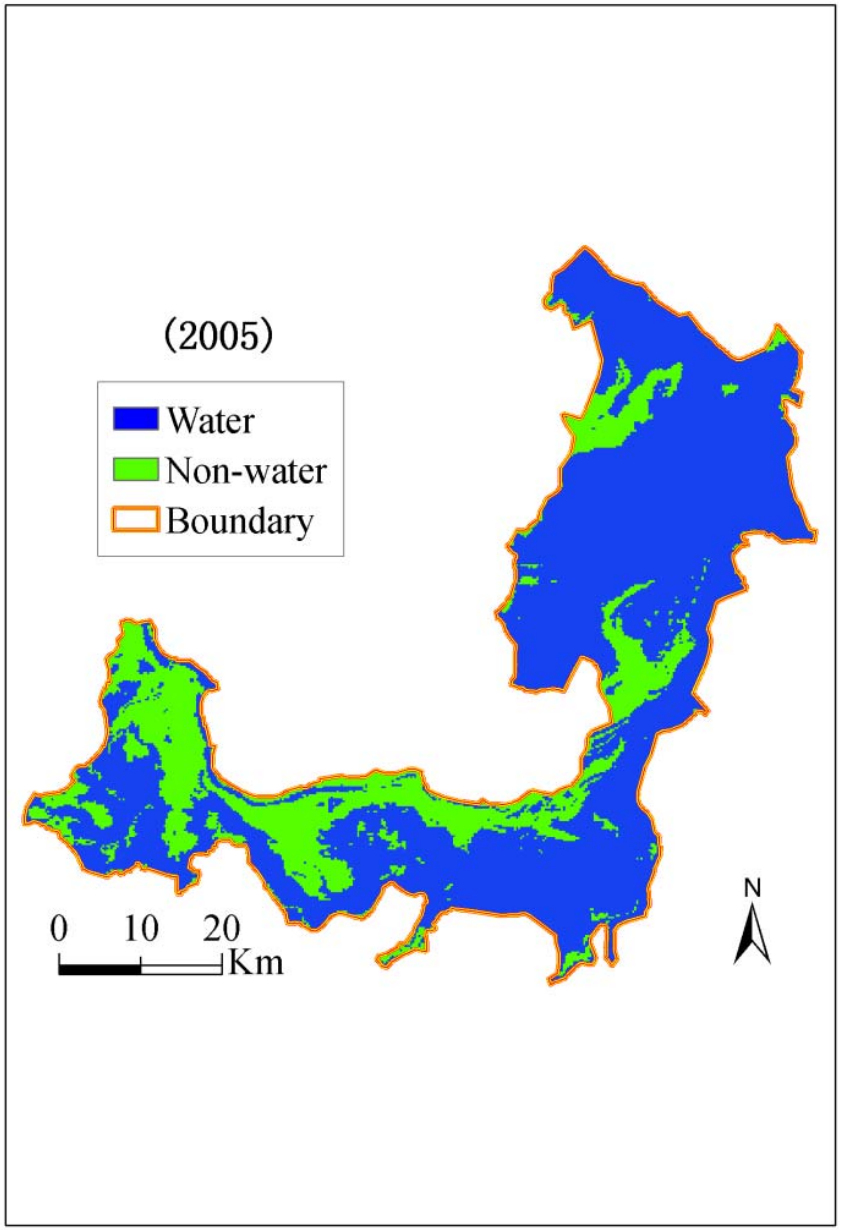

(2002)
Yearly-submersion index
High : 100
Low : 0
Boundary
0 10 20
Km
N

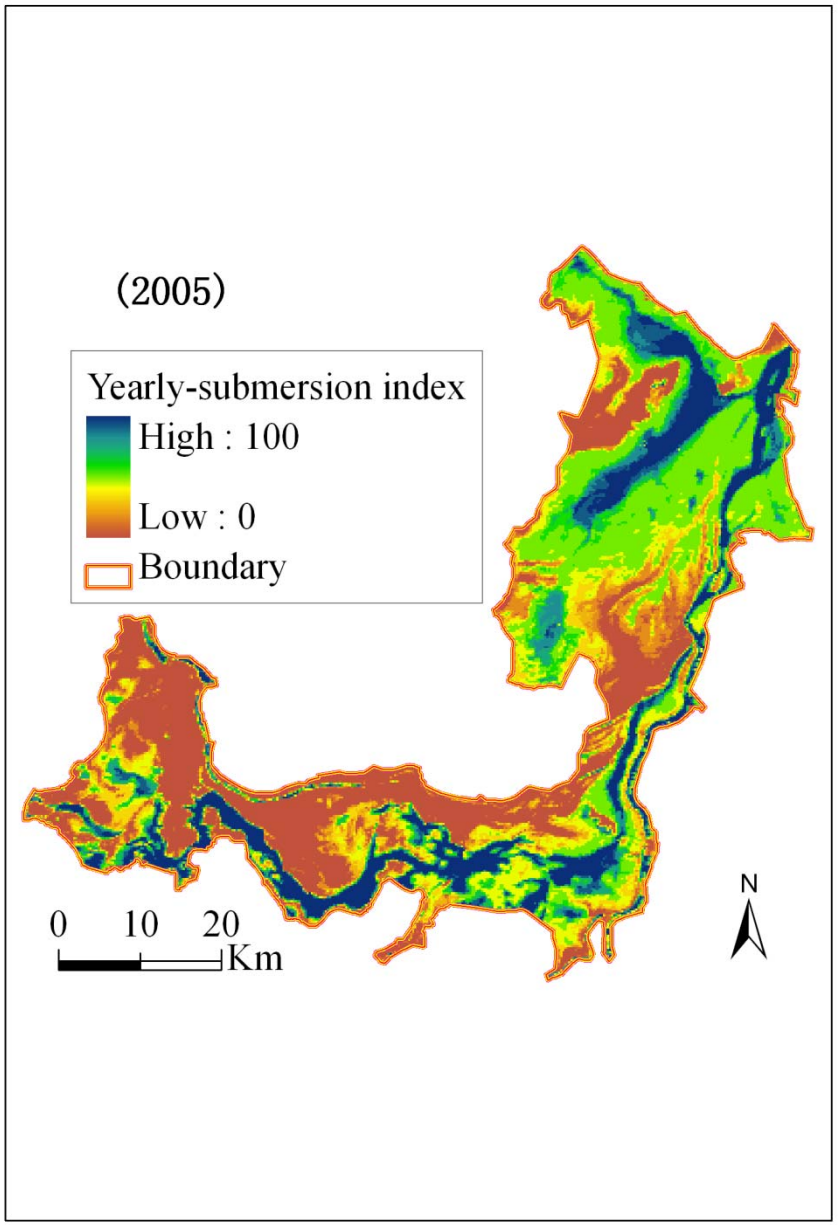

(2003)
Water
Non-water
Boundary
0 10 20
Km
N

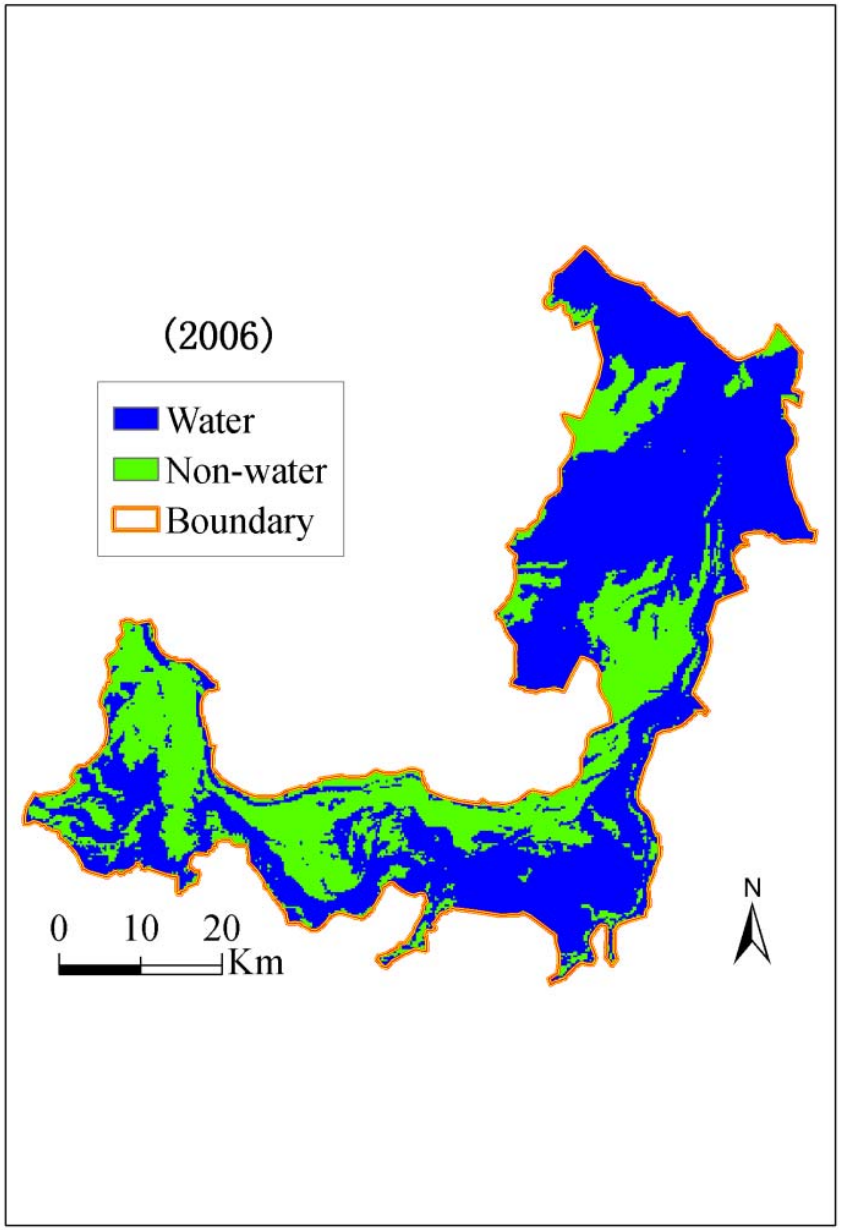

(2003)
Yearly-submersion index
High : 100
Low : 0
Boundary
0 10 20
Km
N

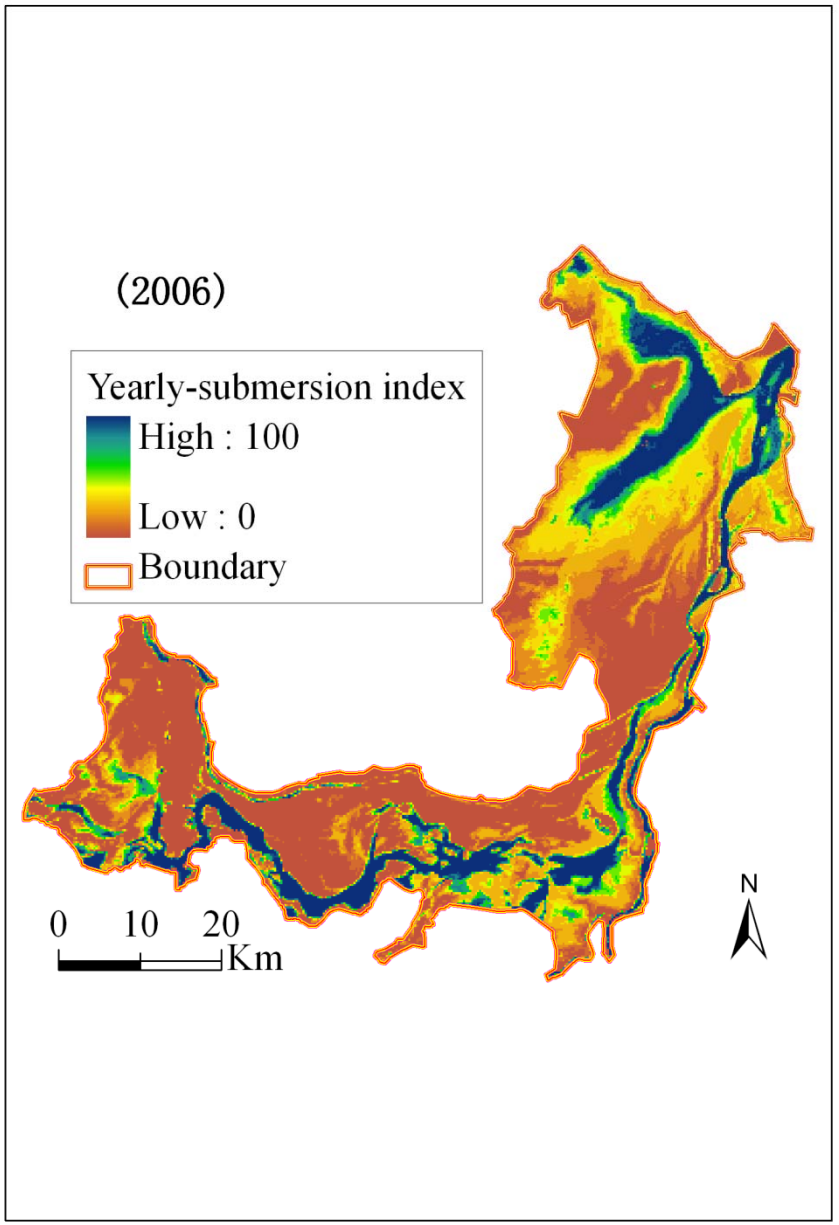

(2004)
Water
Non-water
Boundary
0 10 20
Km
N

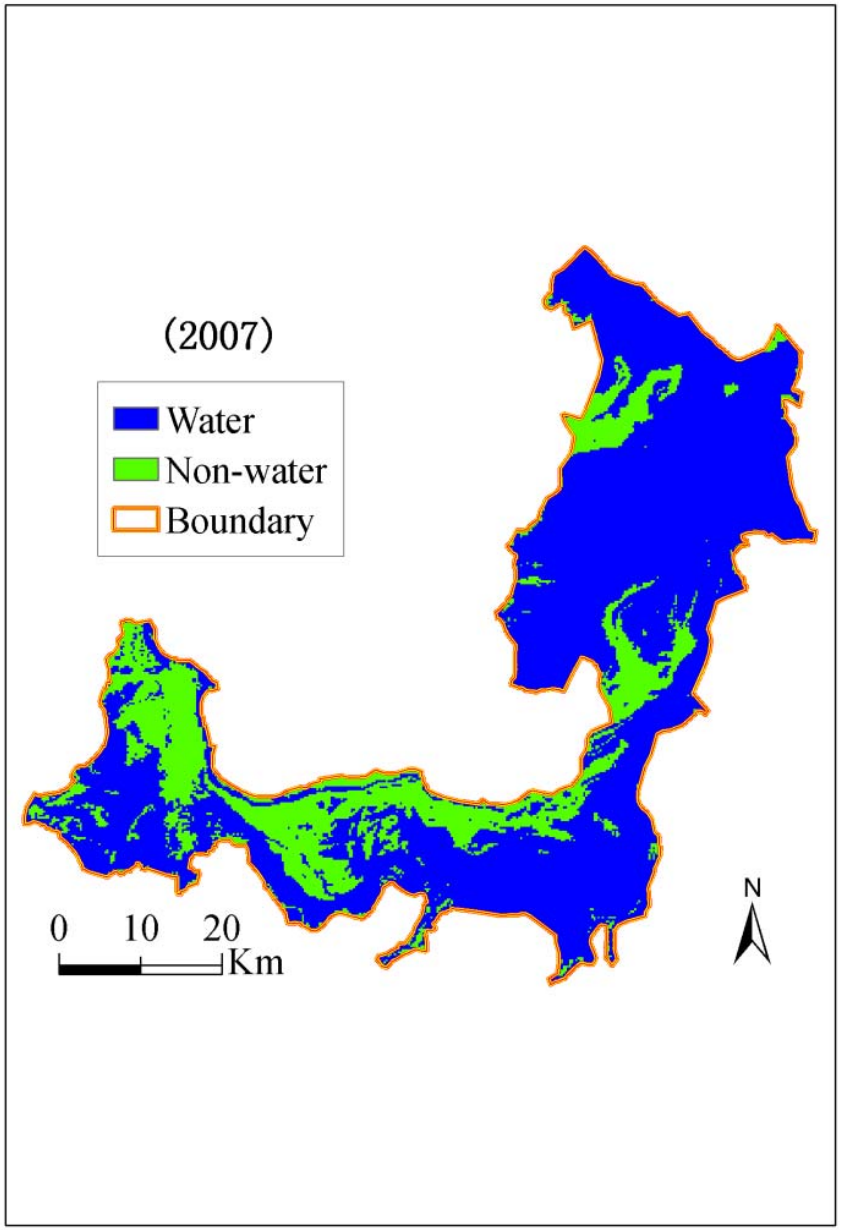

(2004)
Yearly-submersion index
High : 100
Low : 0
Boundary
0 10 20
Km
N

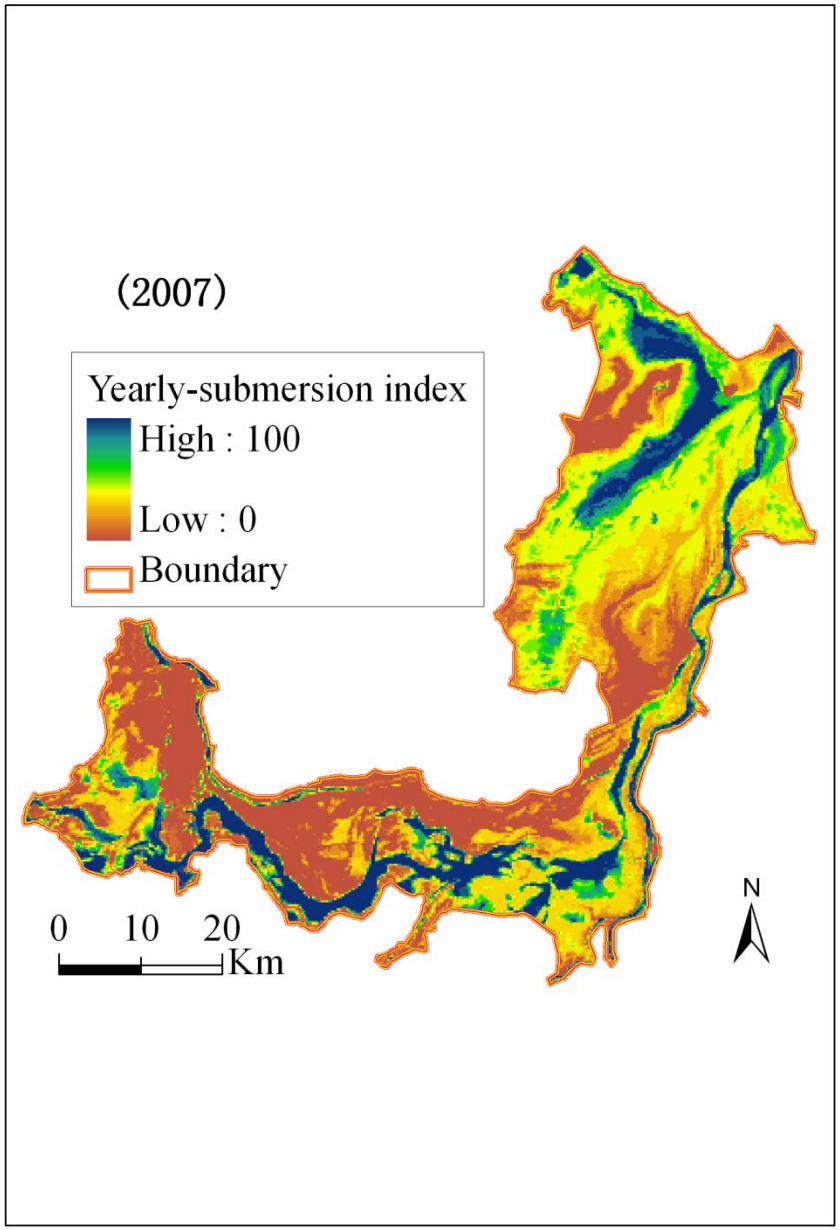

(2005)
Water
Non-water
Boundary
0 10 20
Km
N

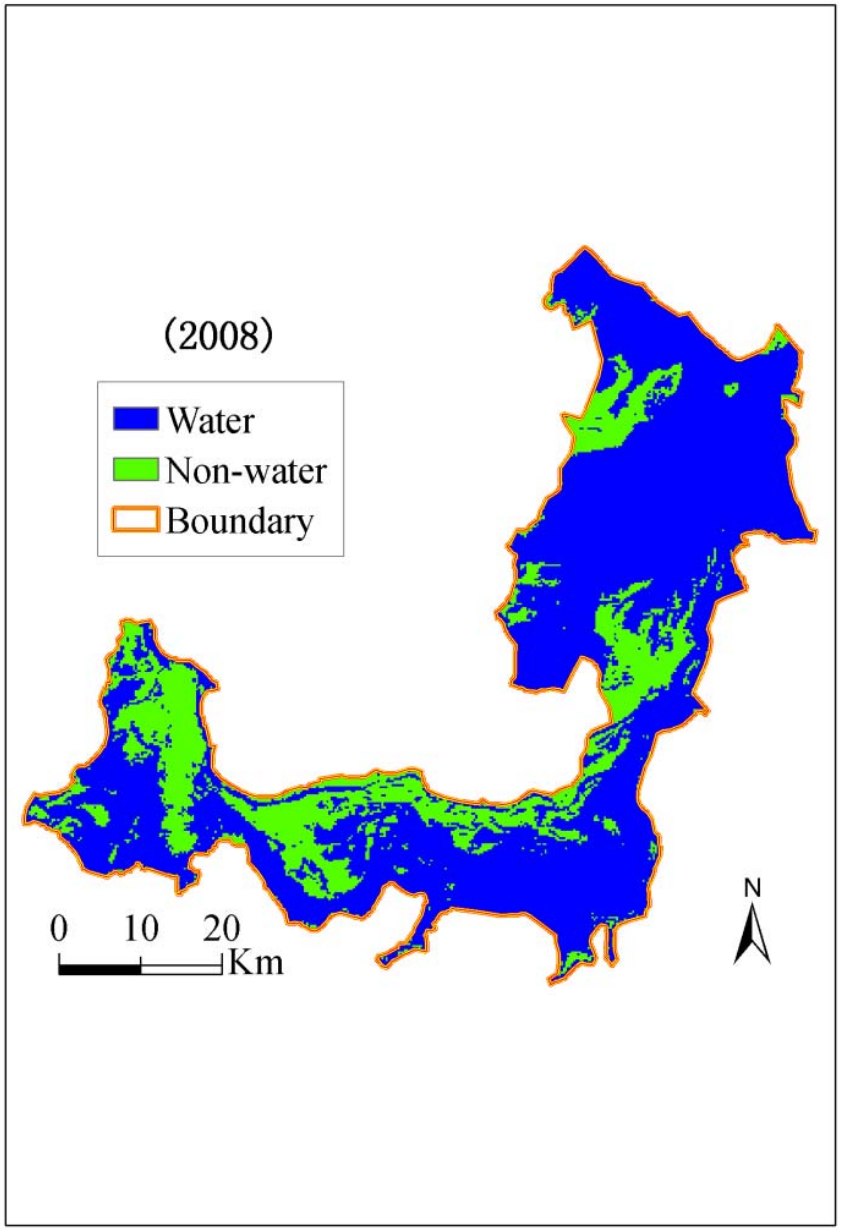

(2005)
Yearly-submersion index
High : 100
Low : 0
Boundary
0 10 20
Km
N

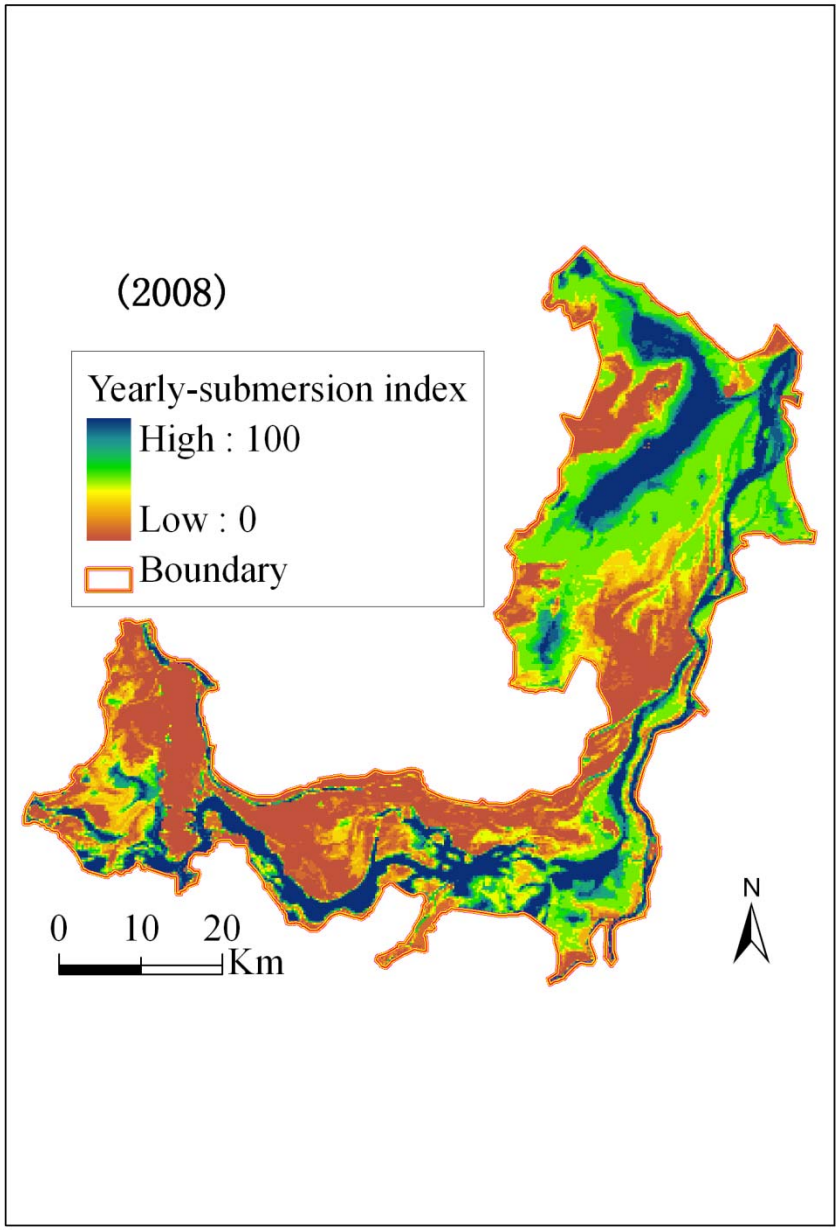

(2006)
Water
Non-water
Boundary
0 10 20
Km
N


(2006)
Yearly-submersion index
High : 100
Low : 0
Boundary
0 10 20
Km
N

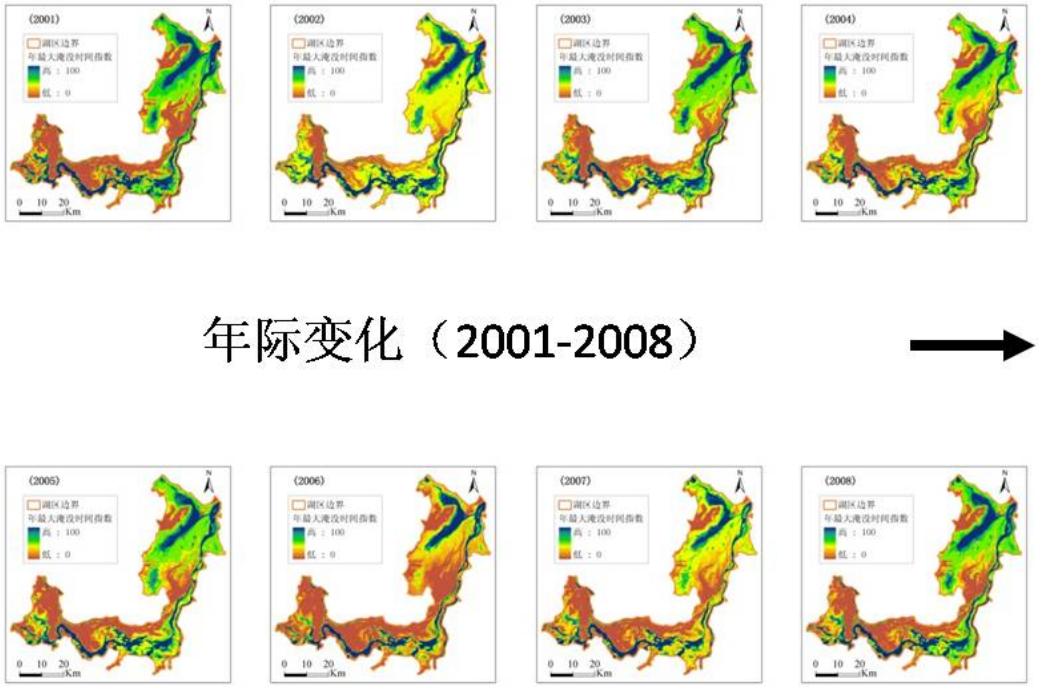

(2007)
Water
Non-water
Boundary
0 10 20
Km
N

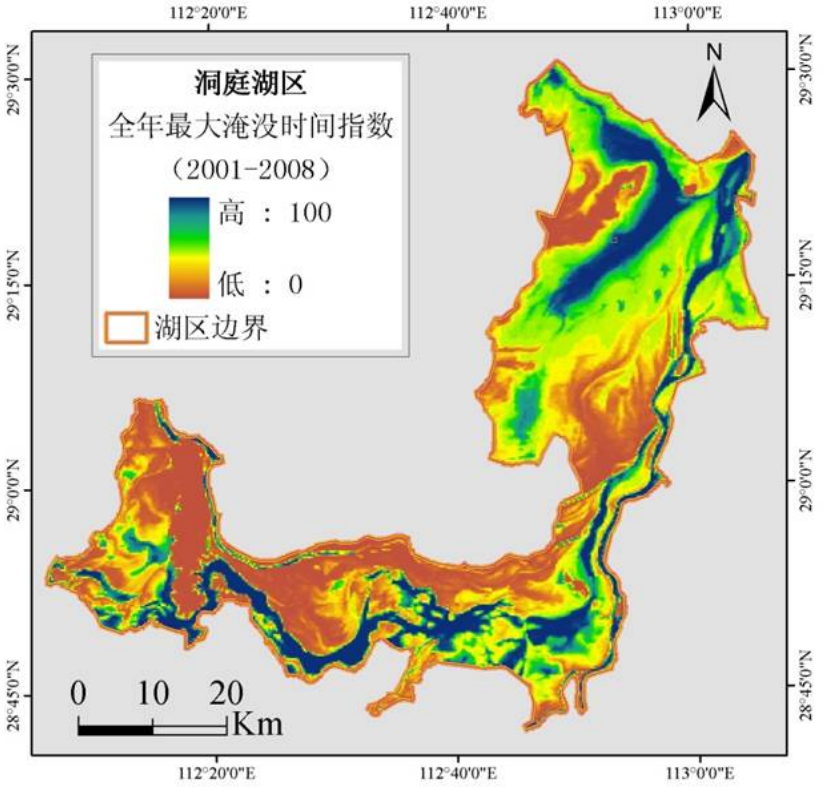

(2007)
Yearly-submersion index
High : 100
Low : 0
Boundary
0 10 20
Km
N


(2008)
Water
Non-water
Boundary
0 10 20
Km
N


(2008)
Yearly-submersion index
High : 100
Low : 0
Boundary
0 10 20
Km
N

Spatial distribution of annual max. inundation time index from 2001 to 2008





4) RS application in ecological and environmental assessment for the Yellow River Delta Wetland

RS application in Ecological and environmental assessment

- Land use
- Vegetation coverage
- Sediment concentration
- Land surface temperature
- Primary production

Assessment methodology

1.Ecological and environmental quality assessment

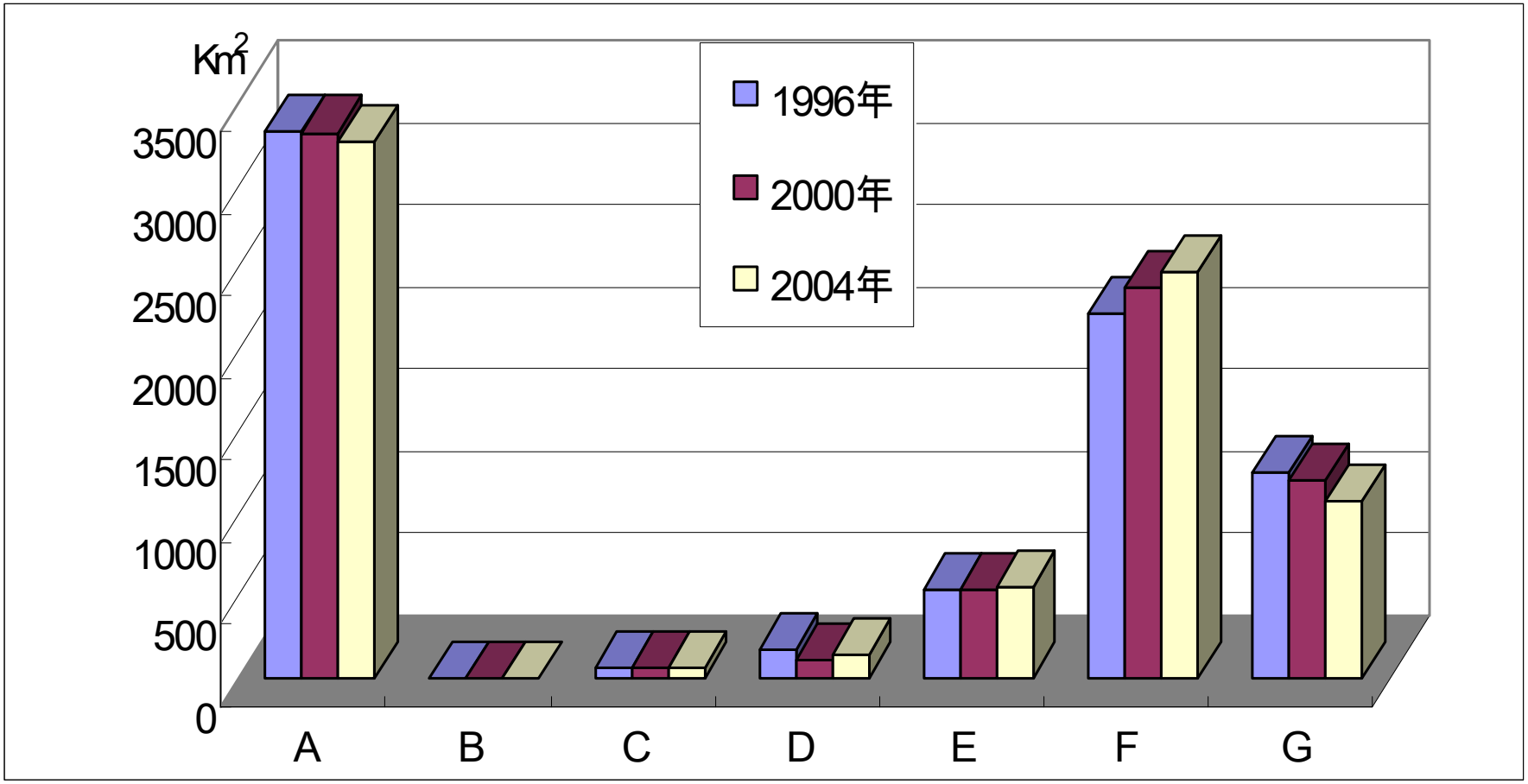
2.Landscape ecological assessment

3.Ecological footprint assessment

4.Ecosystem health assessment

Comprehensive assessment

◆Land use



A-cultivated land、B-garden land、C-forest land、D-grass land、
E-industrial and residential land、F-water、G-unused land

◆Land use

Land use transfer matrix of 1996-2004 (hm^2)

1996 \ 2004	Cultivated land	Garden land	Forest land	Grass land	Industry and residential land	water	Unused land
Cultivated land	316330	90	215	4446	2474	2911	6866
Garden land	15	678					
Forest land	91		6978			68	
Grass land	78			10068	34	7544	501
Industrial & residential land	199				53988	397	135
water	1023				53	210492	3291
Unused land	9067			348	200	19633	96837

◆Vegetation coverage

Coverage rate		2000年5月	2003年5月
Grade_1	<20%	504.34	100.89
Grade_2	20%-40%	223.45	313.88
Grade_3	40%-50%	403.84	450.73
Grade_4	50%-70%	651.48	589.65
Grade_5	>70%	490.72	52.13
Vegetation coverage area		2273.85	1507.29

<70%

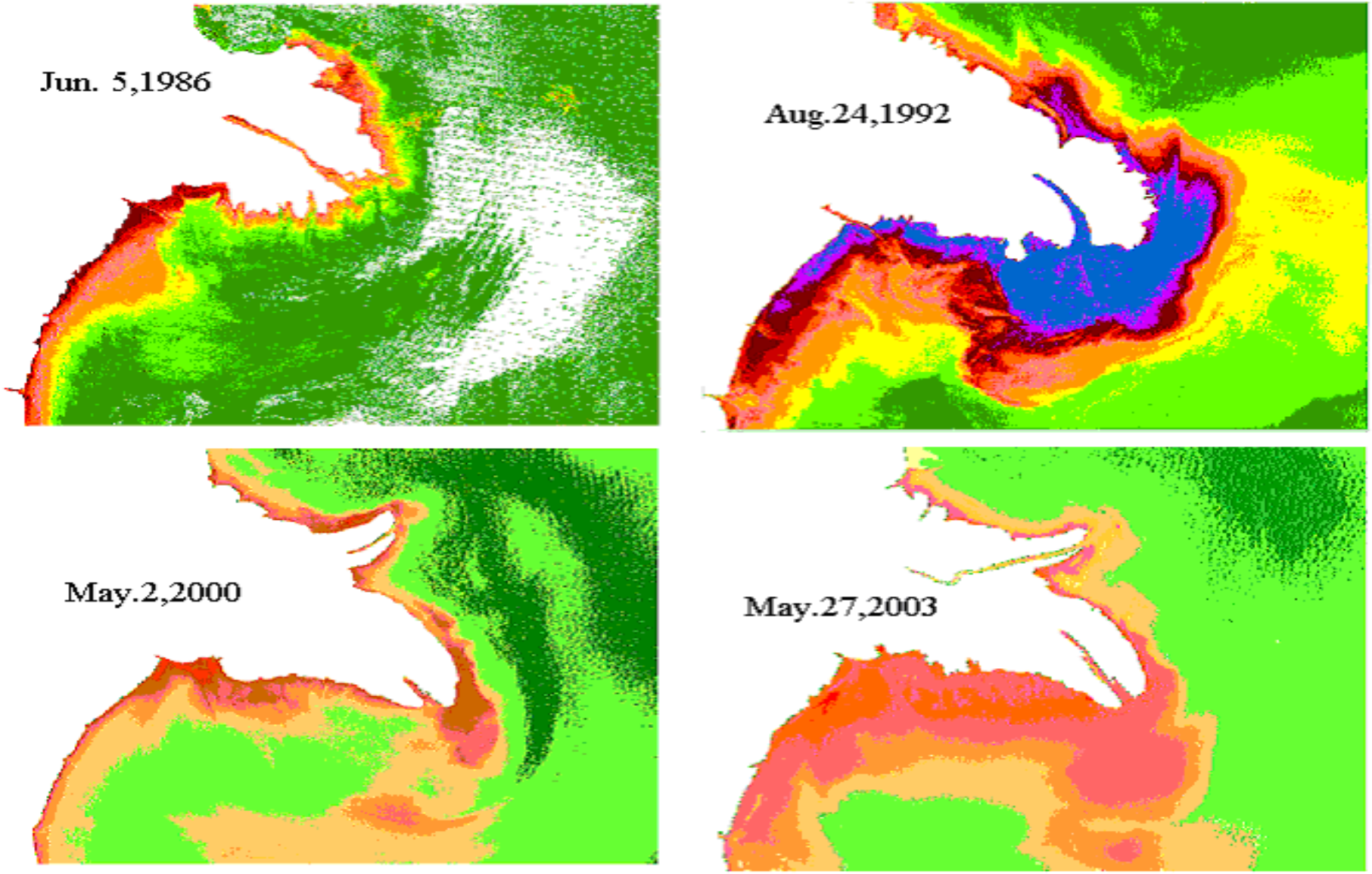
>70%

水域

2000 年 5 月

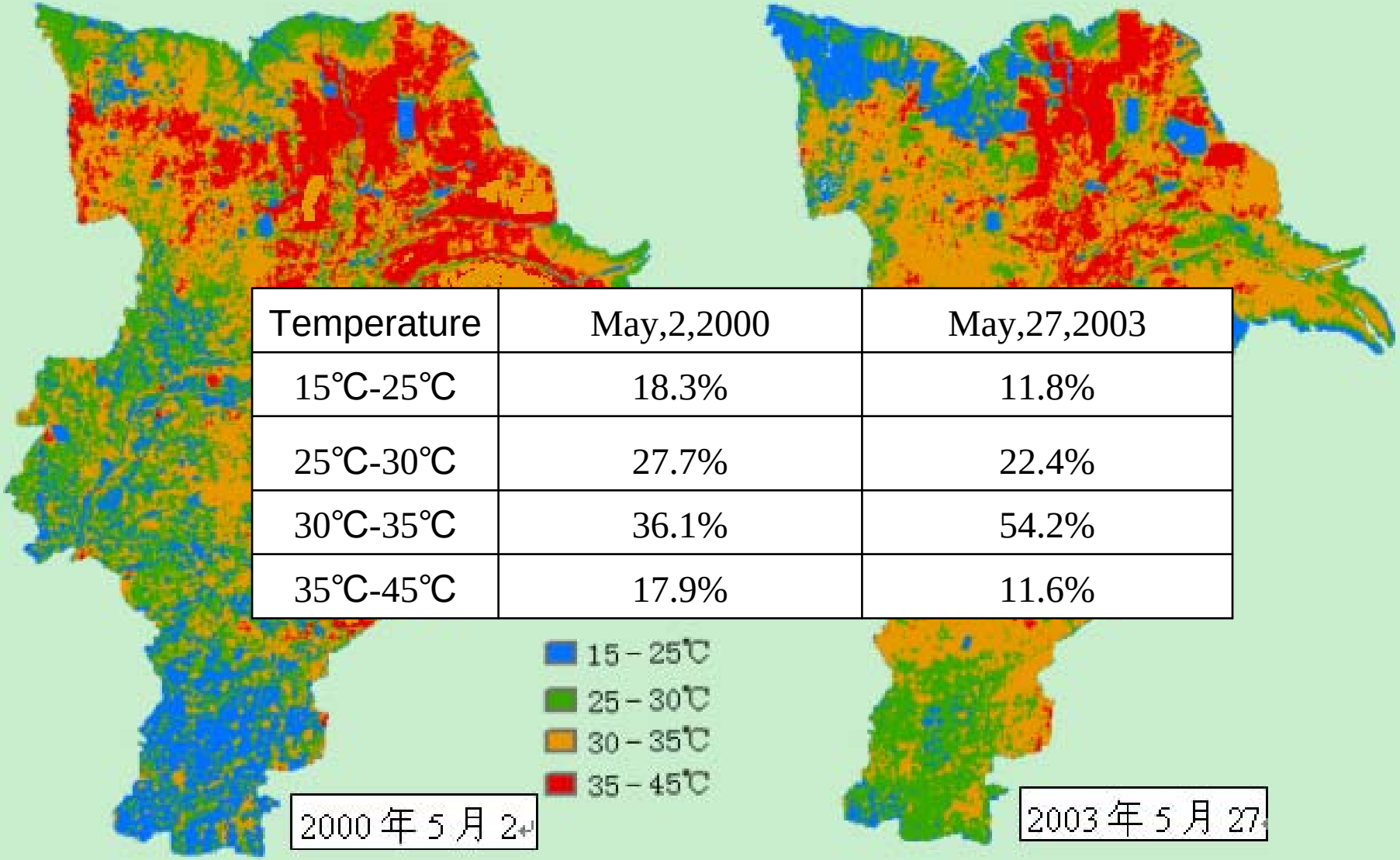
2003 年 5 月

◆Sediment concentration

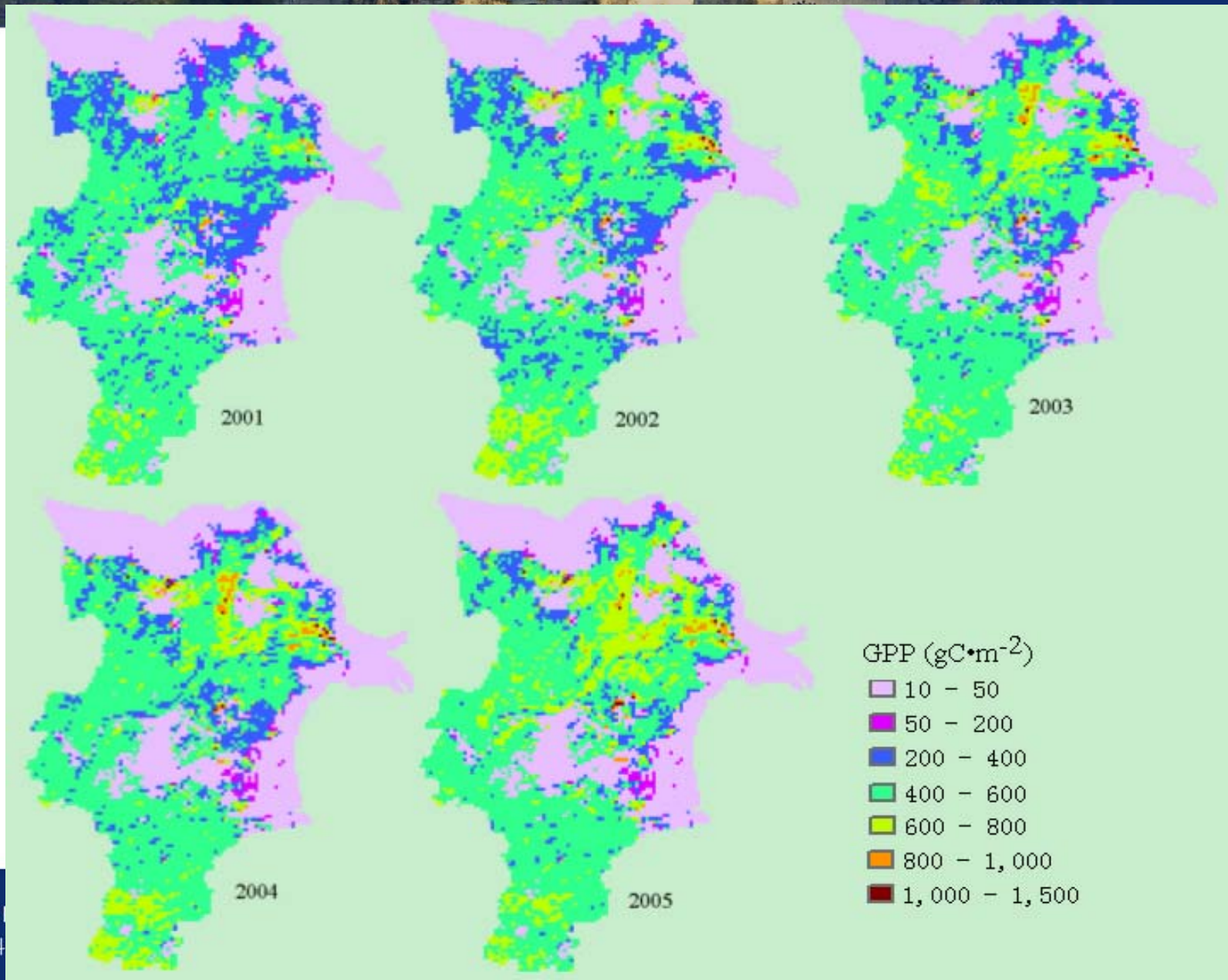


◆Land surface temperature

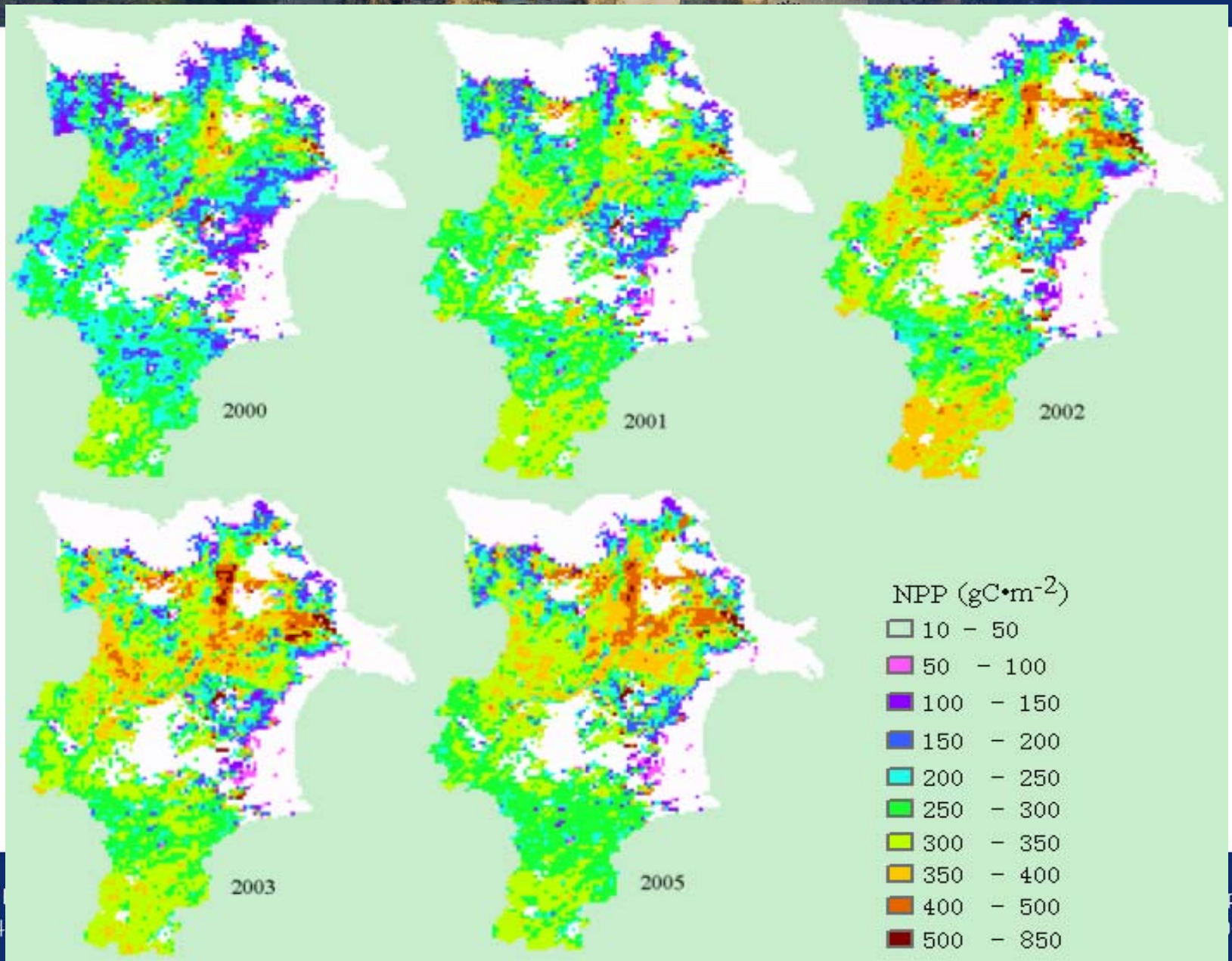
Temperature	May,2,2000	May,27,2003
15℃-25℃	18.3%	11.8%
25℃-30℃	27.7%	22.4%
30℃-35℃	36.1%	54.2%
35℃-45℃	17.9%	11.6%



◆Primary production-GPP



◆Primary production-NPP



Assessment methodology

◆Ecological and environmental quality assessment

assessment indices:

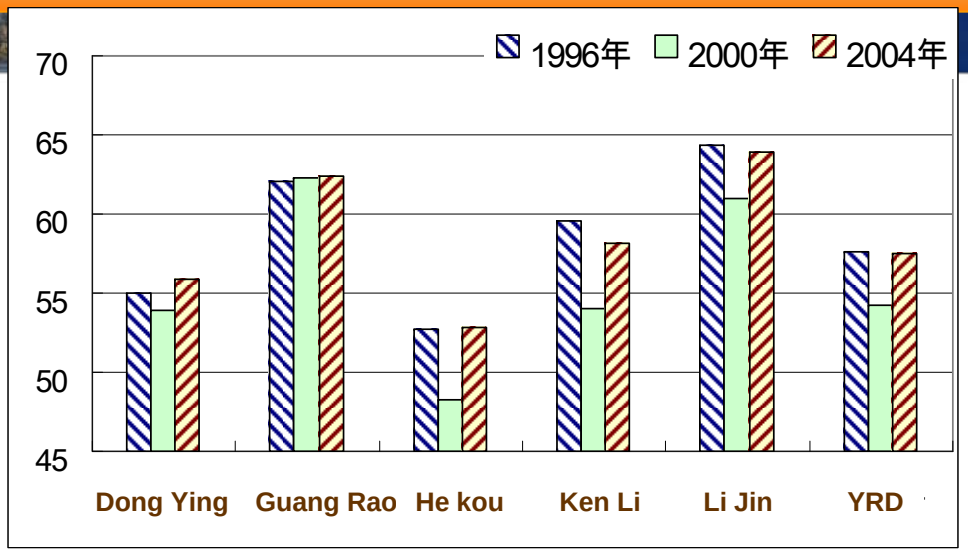
Analytic Hierarchy Process (AHP)

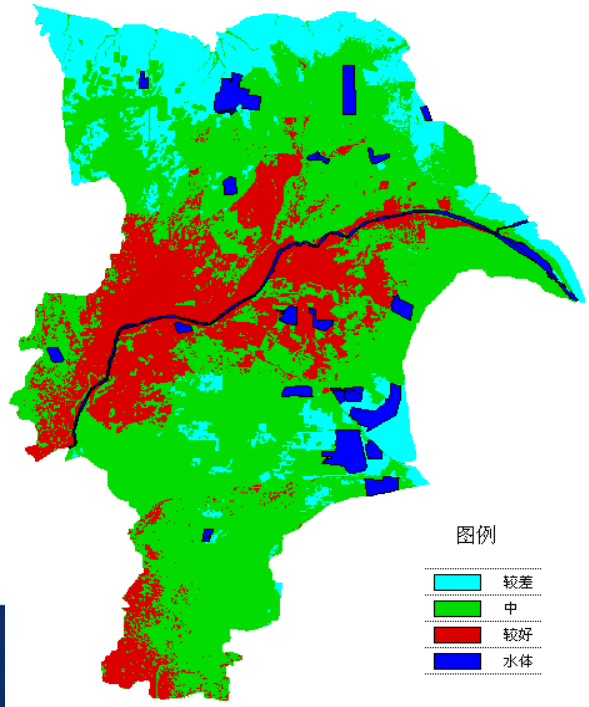
A Objective layer	O System layer	B Indices layer		O1	O2	O3	weight	order
				0.268	0.614	0.117		
	O1 Natural resource	B1 vegetation coverage rate	B1	0.634			0.170	2
		B2 cultivated land	B2	0.192			0.052	6
		B3 food	B3	0.174			0.047	7
	O2 Environment condition	B4 rainfall	B4		0.199		0.122	4
		B5 temperature	B5		0.167		0.103	5
		B6 ours of sunshine	B6		0.236		0.145	3
		B7 index of land use	B7		0.398		0.244	1
	O3 Social & economical condition	B8 natural population increase	B8			0.067	0.008	14
		B9 per-capita GDP	B9			0.240	0.028	8
		B10 growth rate of GDP3	B10			0.141	0.016	11
		B11 population density	B11			0.076	0.009	13
		B12 number of Medical personnel	B12			0.120	0.014	12
		B13 per-capita income of village	B13			0.209	0.024	9
		B14 non-agriculture population rate	B14			0.147	0.017	10

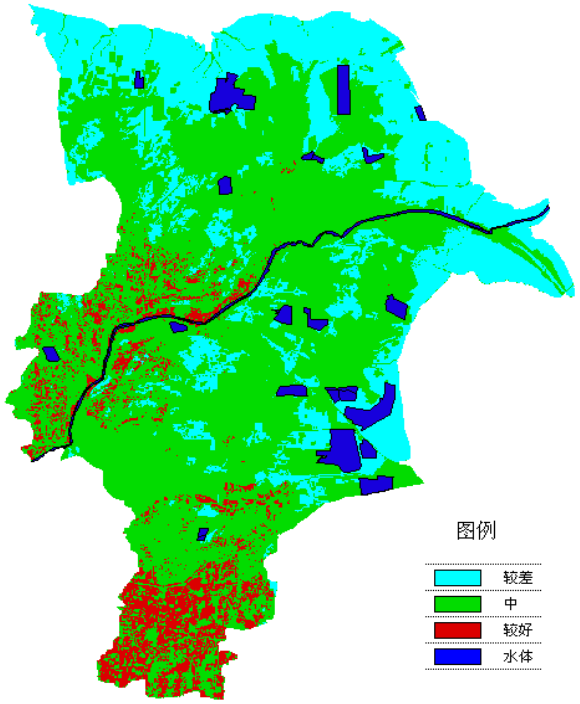
Assessment methodology

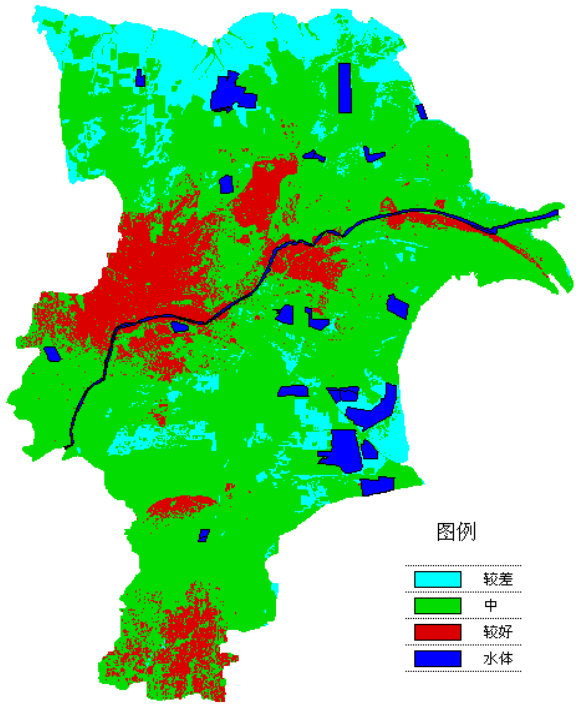
◆Ecological and environmental quality assessment

result:









Assessment methodology

◆Landscape ecological assessment

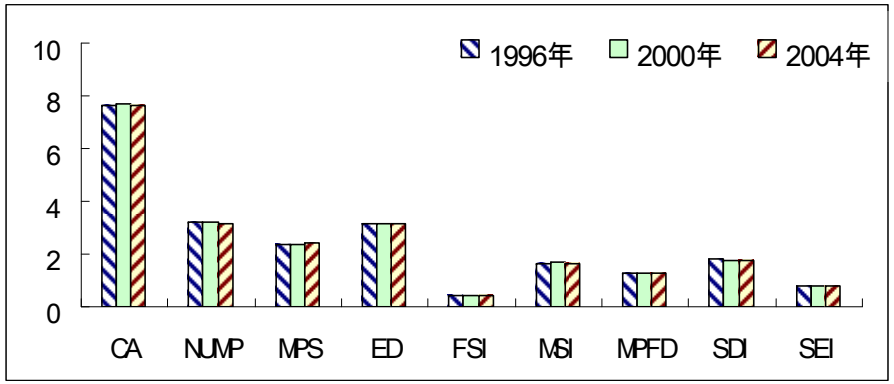
Landscape indices of each distract of YRD

distract	year	Patch area (CA) (km^2)	patch Number (NUMP)	Mean patch area (MPS) (km^2)	Edge density (ED) (m/km^2)	fraction Shape index (FSI)	Mean shape index (MSI)	Mean patch fraction dimension (MPFD)	Shannon Diversity index (SDI)	Shannon Evenness index (SEI)
Dong ying	1996	1114.68	603	1.849	3.494	0.206	1.594	1.260	1.521	0.731
	2000	1114.81	603	1.849	3.495	0.206	1.594	1.260	1.526	0.734
	2004	1109.71	600	1.850	3.481	0.206	1.592	1.260	1.527	0.734
Guang rao	1996	1155.55	522	2.214	3.224	0.211	1.645	1.268	1.278	0.615
	2000	1156.60	526	2.199	3.234	0.211	1.644	1.268	1.280	0.615
	2004	1155.52	523	2.209	3.325	0.210	1.639	1.266	1.317	0.633
He kou	1996	2653.72	742	3.576	2.658	0.209	1.751	1.265	1.892	0.861
	2000	2672.93	749	3.569	2.662	0.210	1.755	1.265	1.840	0.837
	2004	2634.86	712	3.701	2.548	0.207	1.714	1.261	1.837	0.836
Ken li	1996	1566.33	746	2.100	3.658	0.210	1.738	1.266	1.717	0.826
	2000	1578.32	747	2.113	3.629	0.210	1.741	1.266	1.718	0.826
	2004	1574.93	748	2.106	3.634	0.209	1.734	1.264	1.691	0.813
Li jin	1996	1144.35	590	1.940	3.300	0.209	1.560	1.264	1.574	0.757
	2000	1145.90	591	1.939	3.309	0.209	1.561	1.264	1.577	0.759
	2004	1144.38	591	1.936	3.259	0.208	1.547	1.263	1.536	0.699

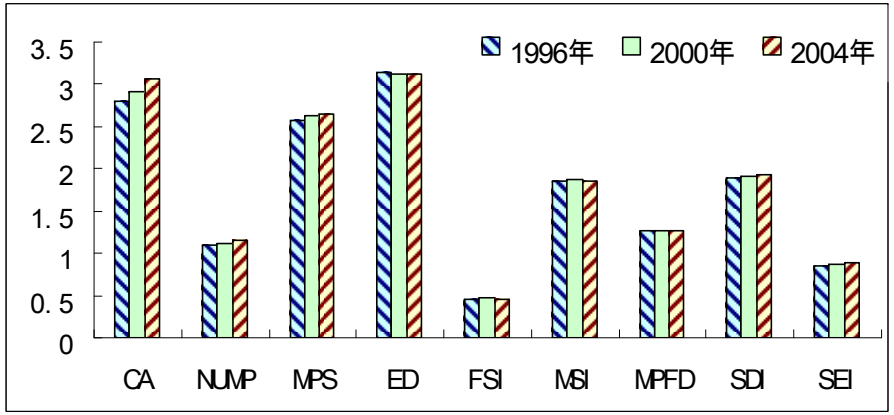
Assessment methodology

◆Landscape ecological assessment

indices:



Landscape indices of the whole YRD



Landscape indices of wetland in YRD

Steps:

Methods:

Fuzzy set pair analysis (FSPA)

$$u_{(A_1-B_1)} = \frac{s}{n} + \frac{f}{n} i + \frac{p}{n} j = a + bi + cj$$

$$a_{ts} = \frac{g_s p_s}{(g_s + p_s) x_{ts}}$$

$$a_{ts} = \frac{x_{ts}}{g_{ts} + p_{ts}}$$

$$a_t = \sum_{i=1}^{s} w_i a_{ti}$$

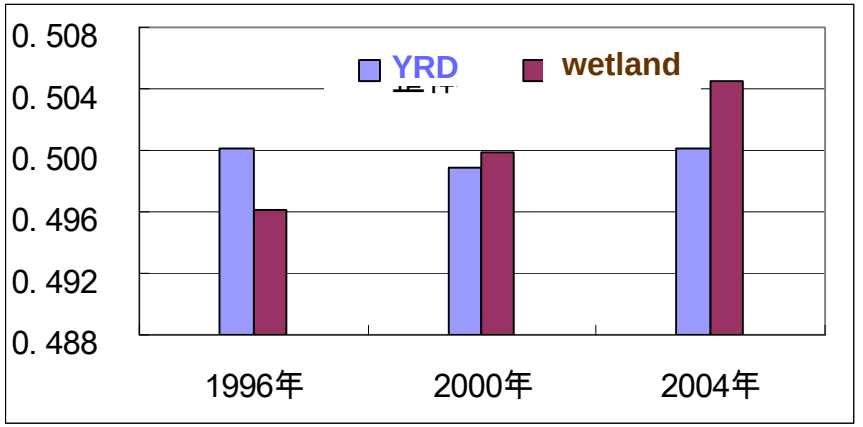
$$c_t = \sum_{i=1}^{s} w_i c_{ti}$$

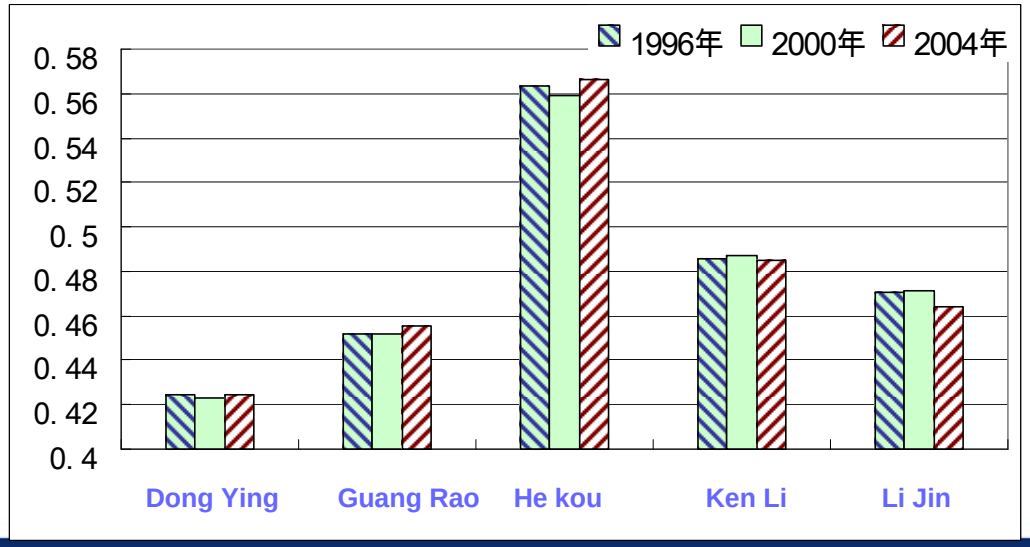
$$R_t = \frac{a_t}{a_t + c_t}$$

Assessment methodology

◆Landscape ecological assessment

result:

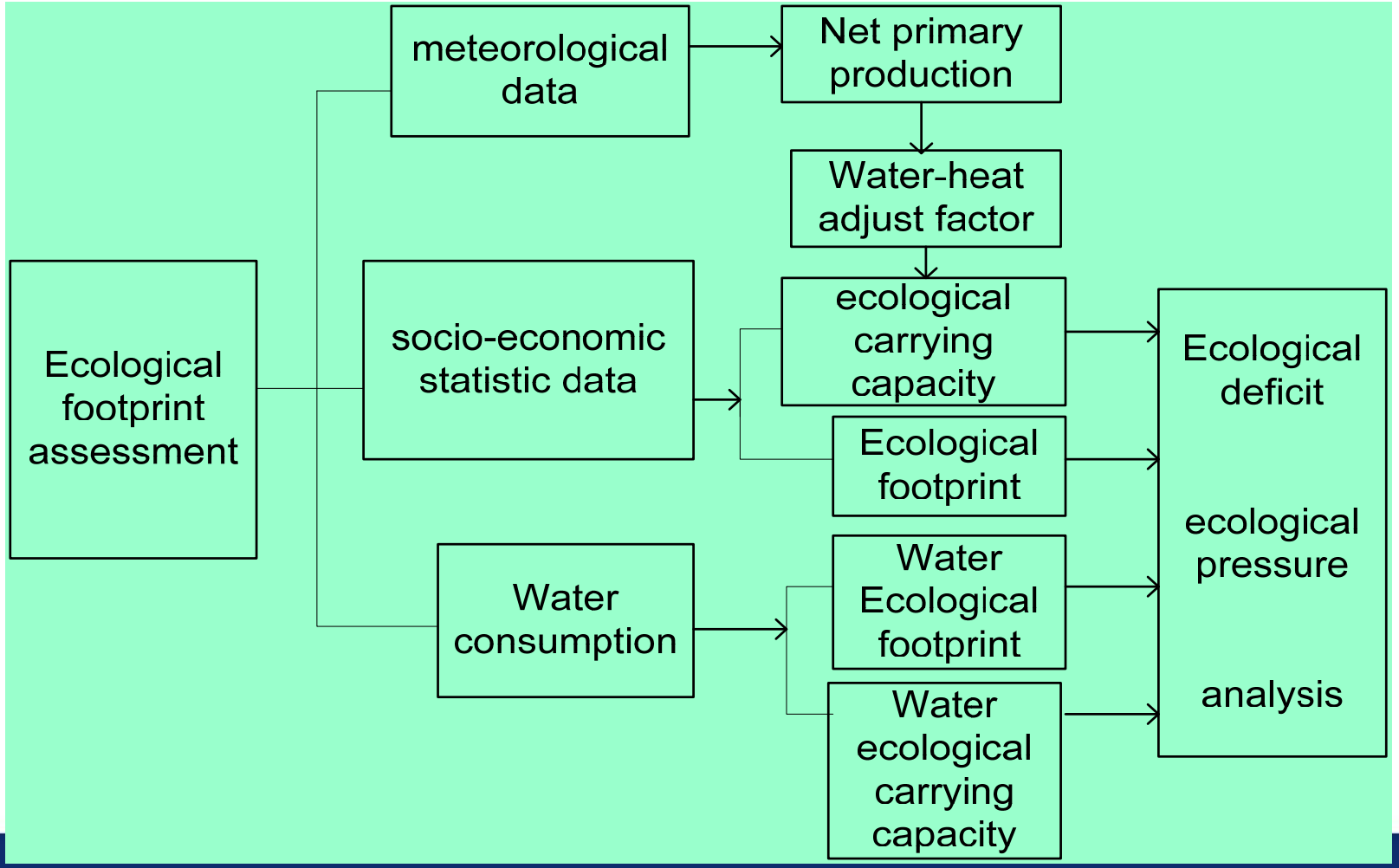




Assessment methodology

◆ecological footprint assessment

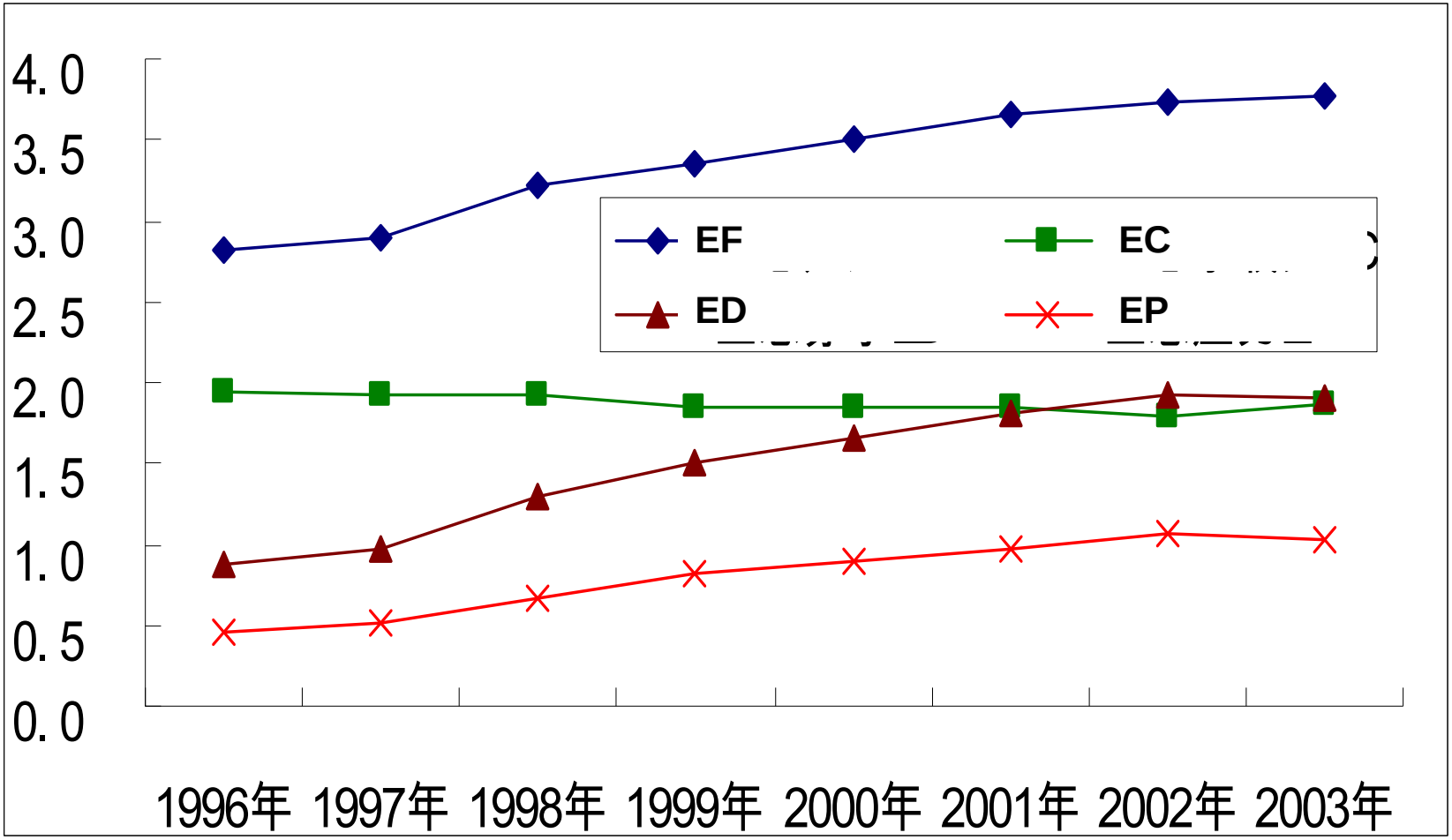
ecological footprint assessment process



Assessment methodology

◆ecological footprint assessment

result:



EF-ecological footprint EC-ecological carrying capacity
ED-ecological deficit EP-ecological pressure

Assessment methodology

◆Ecosystem health assessment

Indices and P-S-R frame

criterion	index	1996	2000	2004
pressure	Population pressure	1.702	1.775	1.731
	Farmland pressure	0.527	0.543	0.515
	Residential land index	3.301	3.053	3.173
	Economical development index	9.050	6.286	2.381
state	NPP （gC/m^2）	187.5	168.94	208.43
	Air pollution PM10（mg/m^3）	0.189	0.1386	0.148
	Coastline area（km^2）	260.95	288.42	272.68
	Sediment concentration（kg/m^3）	28.22	4.81	12.99
	Ecological water requirement（$10^9\ m^3$）	35.513	37.559	36.954
respond	inflow （$10^9\ m^3$）	155.2	49.0	198.6
	Per-capita wetland area（m^2）	16.934	16.289	17.098
	Per-capita green space（m^2）	1.572	1.115	1.276

Assessment methodology

◆Ecosystem health assessment

Methods: **Fuzzy matter element based on entropy weight**

Difference square composite fuzzy matter element

$$R_{\Delta} = \begin{pmatrix} & 1996年 & 2000年 & 2004年 \\ C1 & 0 & 0.0017 & 0.0003 \\ C2 & 0.0006 & 0.0027 & 0 \\ C3 & 0.0056 & 0 & 0.0014 \\ C4 & 0.5430 & 0.3859 & 0 \\ C5 & 0.0101 & 0.0359 & 0 \\ C6 & 0.0711 & 0 & 0.0040 \\ C7 & 0.0091 & 0 & 0.0030 \\ C8 & 0 & 0.7064 & 0.5356 \\ C9 & 0.0030 & 0 & 0.0003 \\ C10 & 0.0478 & 0.5672 & 0 \\ C11 & 0.0001 & 0.0022 & 0 \\ C12 & 0 & 0.0844 & 0.0354 \end{pmatrix}$$

weight
0.0511
0.0517
0.0531
0.1633
0.0606
0.0636
0.0545
0.2060
0.0516
0.1228
0.0511
0.0706

result:

item	1996	2000	2004
pressure	0.4719	0.5548	0.9832
state	0.8849	0.4182	0.4961
respond	0.8449	0.4435	0.8989
Ecosystem health	0.6827	0.4646	0.6633

Comprehensive Assessment

Methods:

$$CEI = \sum_{i=1}^{4} w_i EI_i$$

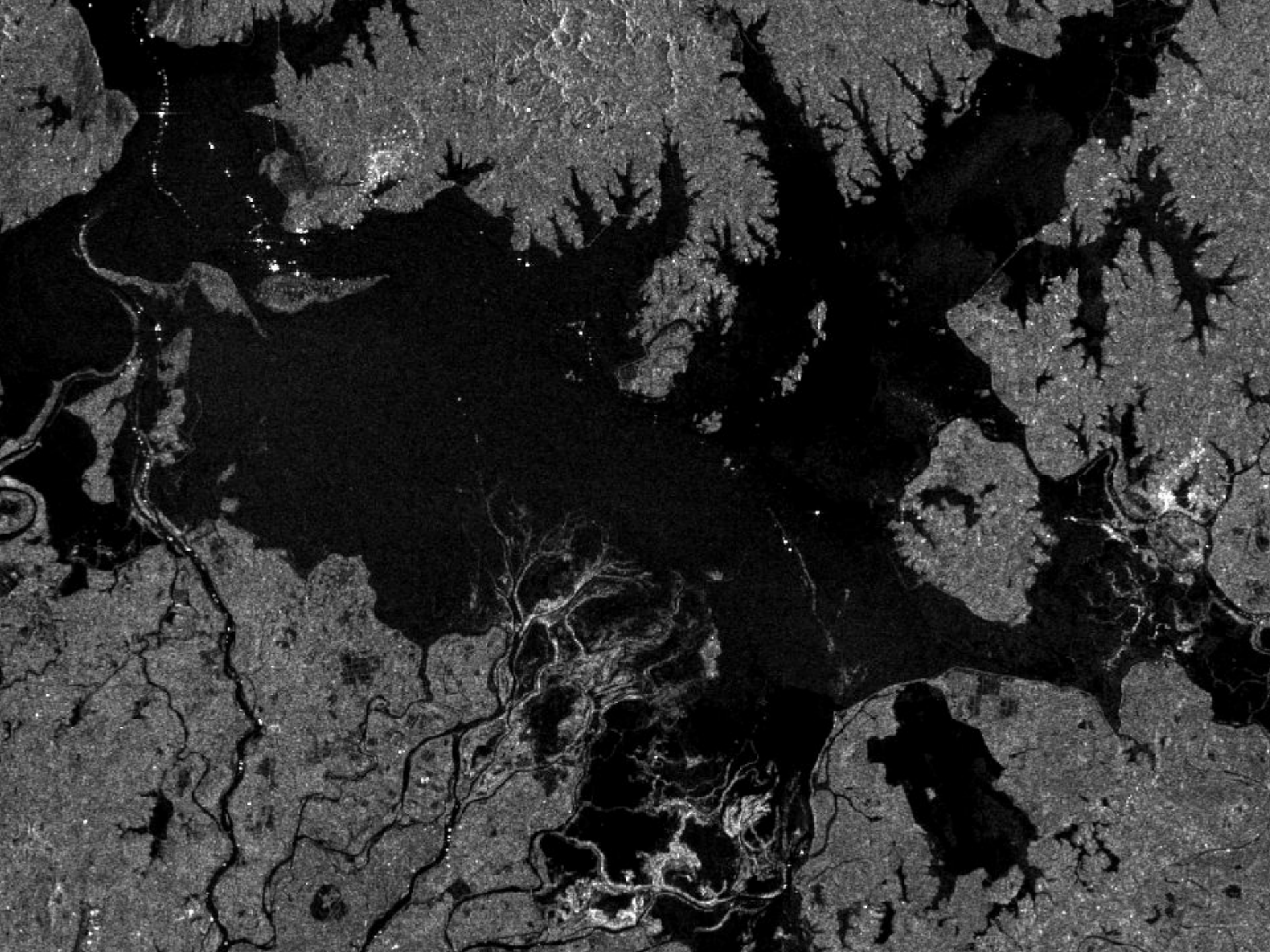
result:

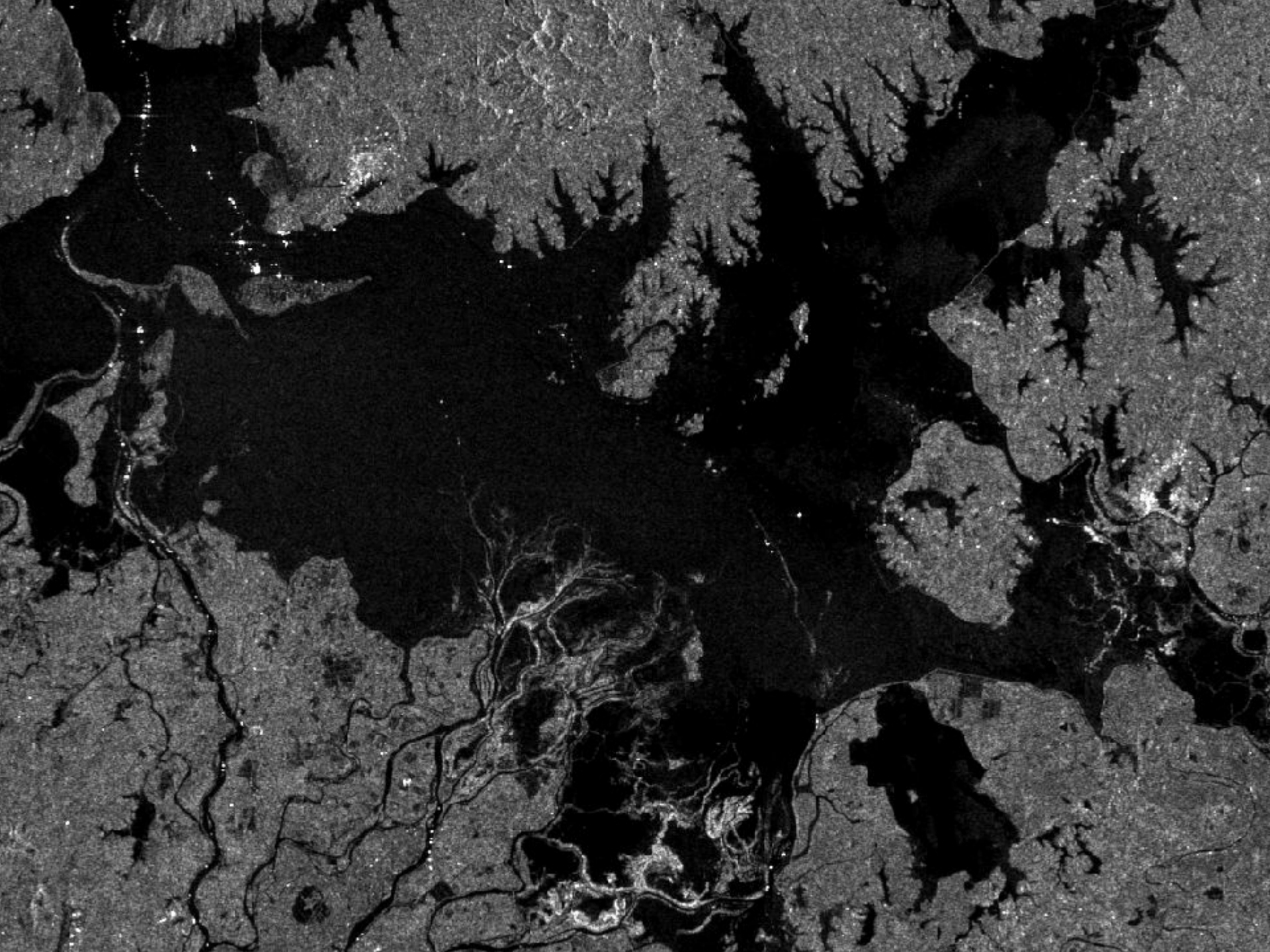
kind	weight	1996	2000	2004
A Ecological and environmental quality assessment	0.3	0.5761	0.5428	0.5749
B Landscape ecological assessment	0.2	0.5002	0.4989	0.5001
C Ecological footprint assessment	0.2	0.8572	0.6159	0.5361
D Ecosystem health assessment	0.3	0.6827	0.4646	0.6633
E Comprehensive Assessment		0.6491	0.5252	0.5787

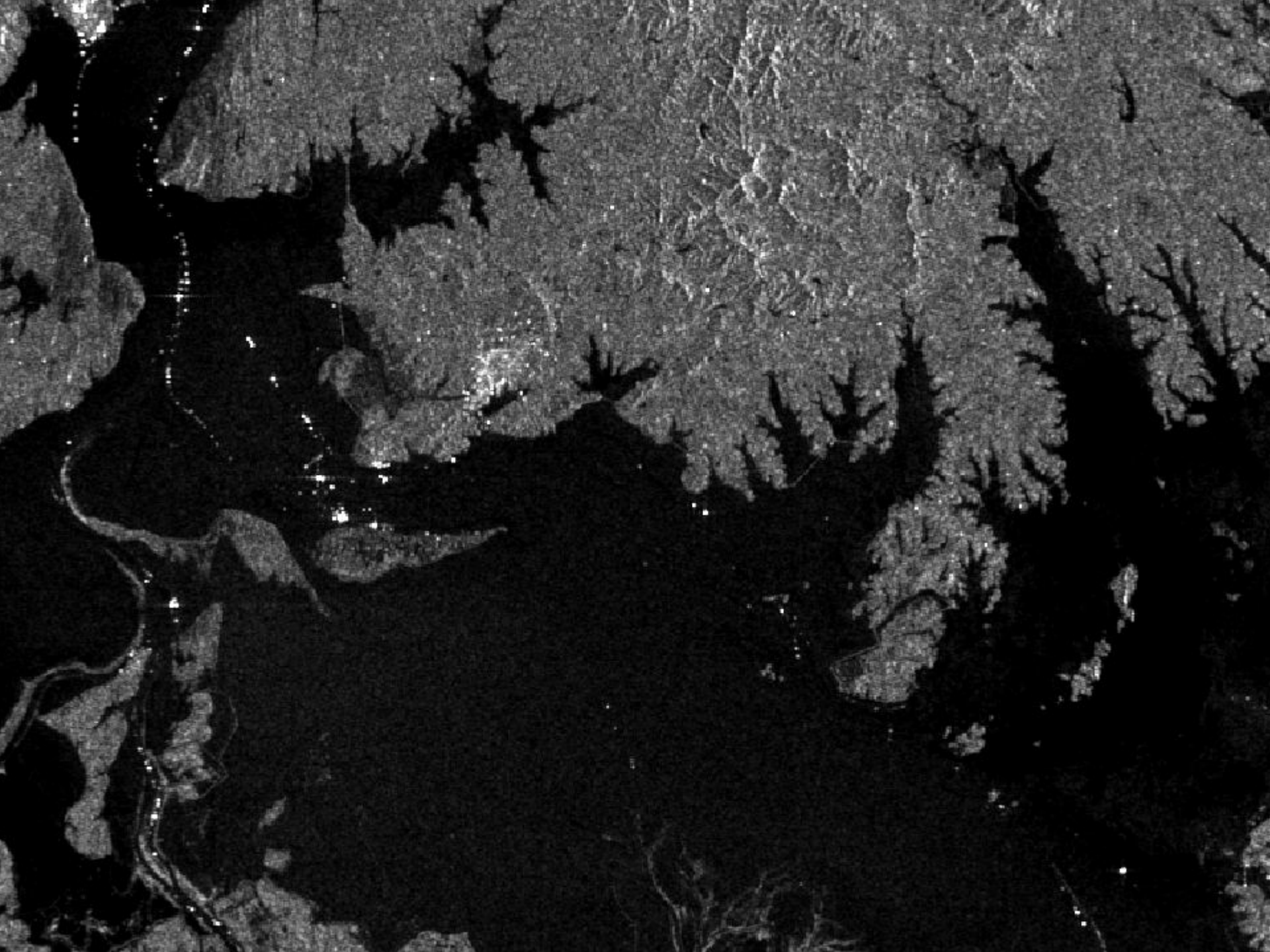
5) Flood monitoring for whole country

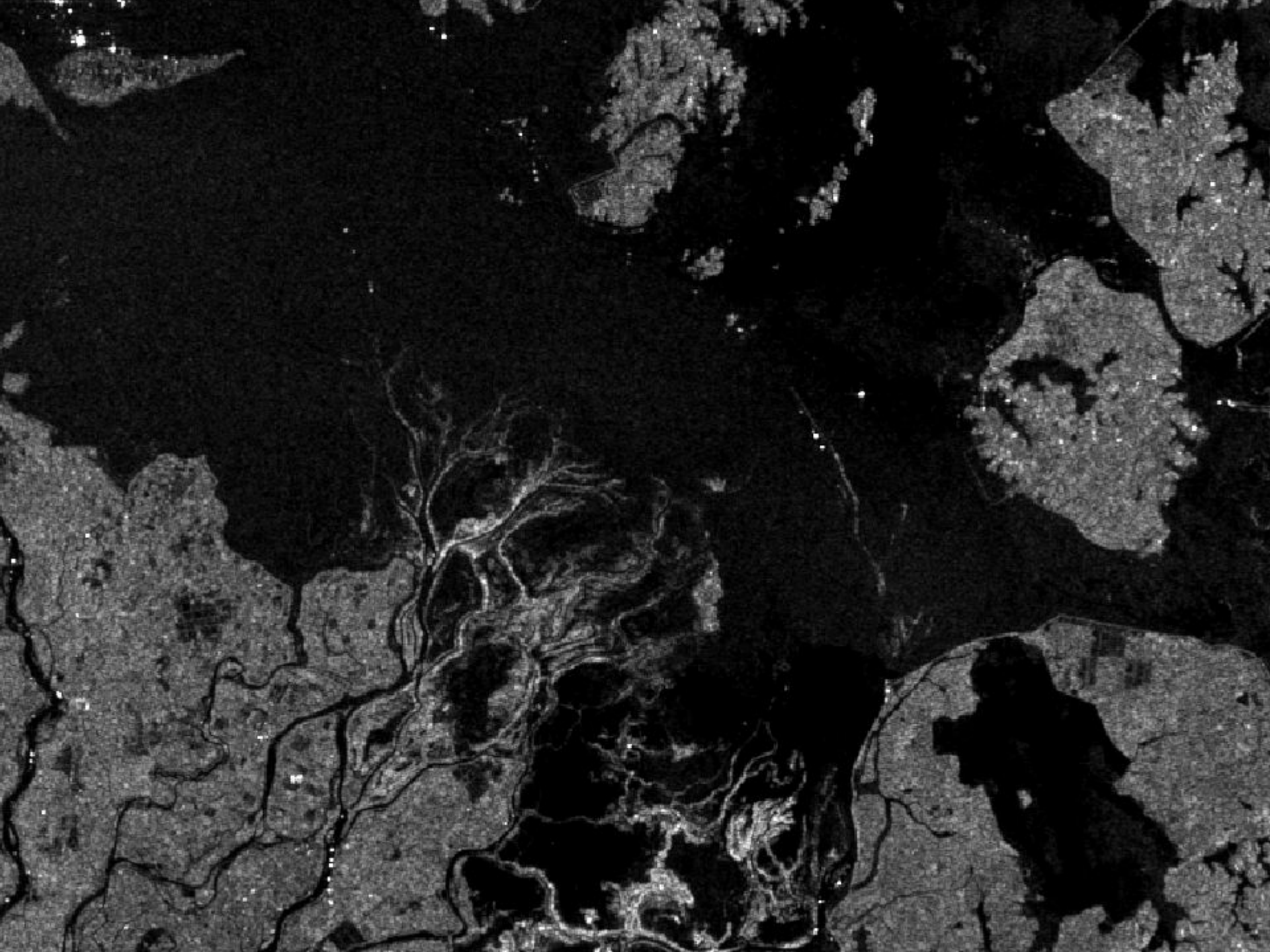
Flood monitoring in 2010

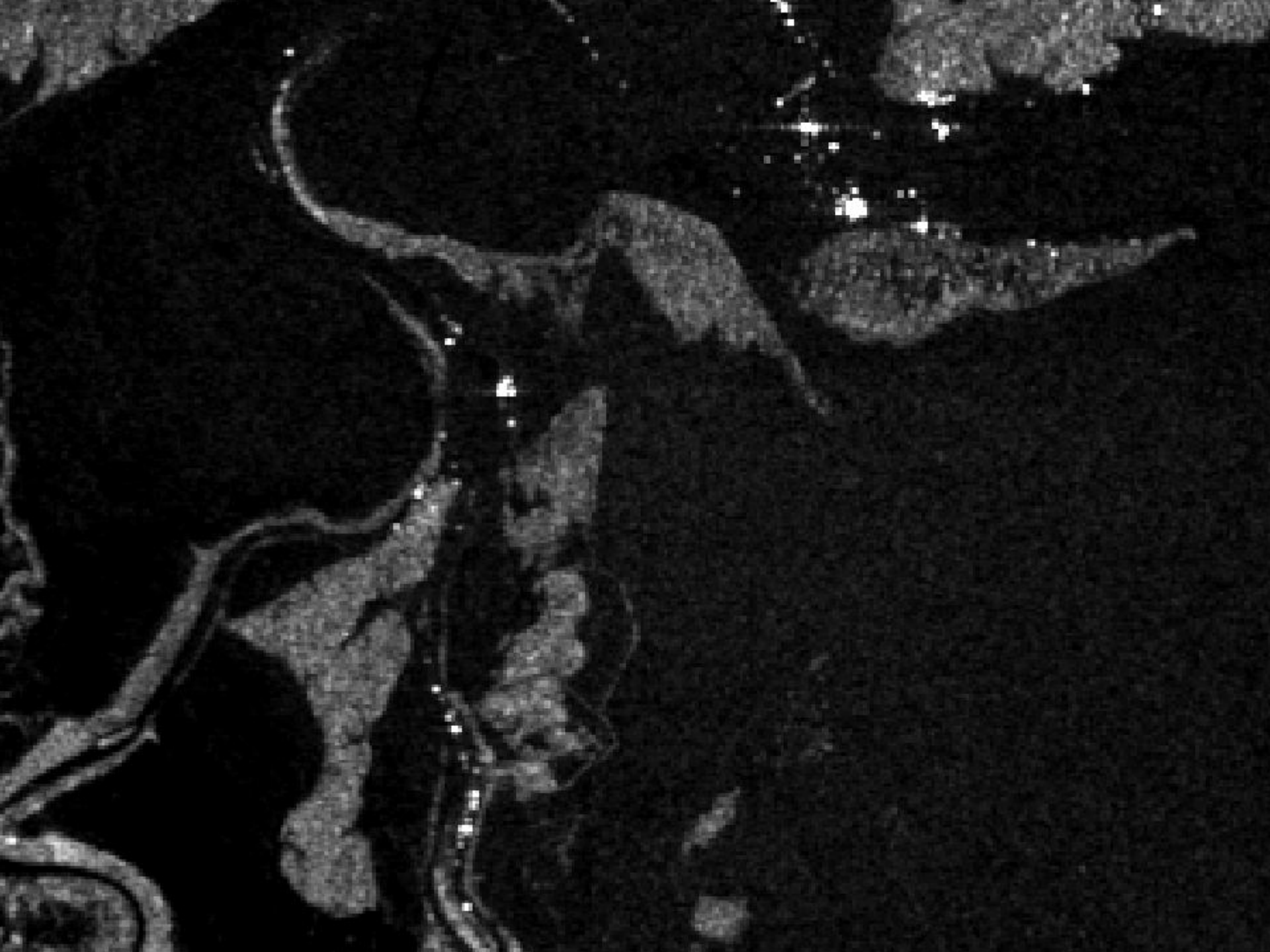
No	Location	Time	Type	Data
1	Dongting Lake	June 15	Flood	Envisat/ASAR
2	Dongting Lake	July 6	Flood	Envisat/ASAR
3	Dongting Lake	July 10	Flood	Envisat/ASAR
4	Poyang	July 8	Flood	Envisat/ASAR

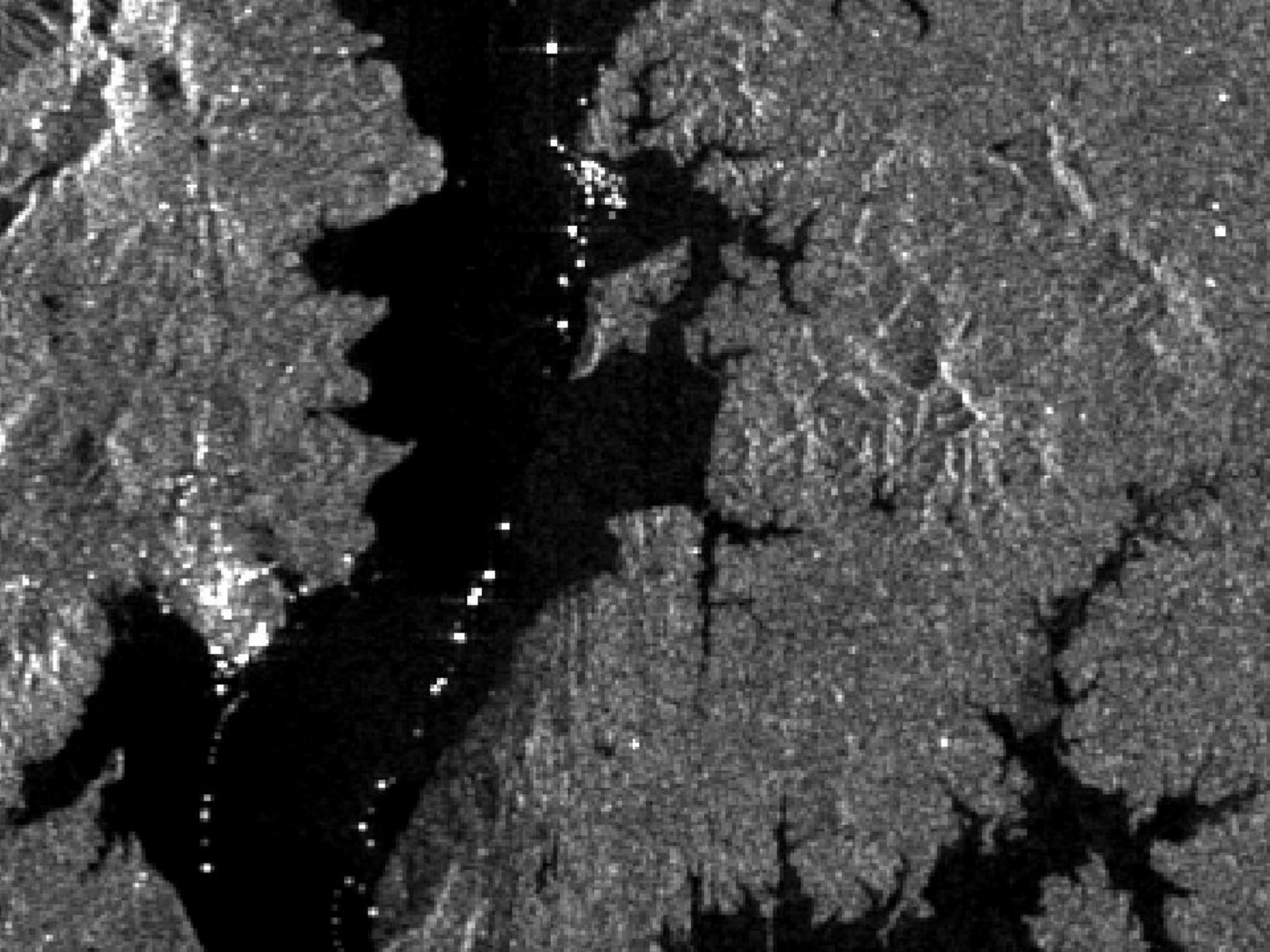












Thank you for your attention