Progress of Flood Monitoring & Assessment by Remote Sensing in China

China Institute of Water Resources &Hydropower Research(IWHR)

Li Jiren

2019.6

TOPICS

1. Flood monitoring
2. Disaster assessment
3. Monitoring on water project for flood control
4. Flood forecasting and risk map

China is suffered from flood disaster for a long history. So Chinese government pays more attention to flood control. Remote sensing technology has been used for flood monitoring since1980, then disaster assessment, water project monitoring, risk map making, and establishment1of professional system were made step by step.

1.Flood monitoring

Image Data Sources

1.Space satellite： Landsat 8,SPOT, Radarsat 2, Envisat、

Sentinel-1

GF-1, GF-2, GF-3, GF-4, GF-5, GF-6, ZY3-01, ZY3-02, ZY1-02C

ZY-04, BJ-2, JL-1

2.Air-born SAR   10,000~13,000m（all weather）

helicopter, unmanned plan

Real-time monitoring mainly depends on radar image

Background data from visible image

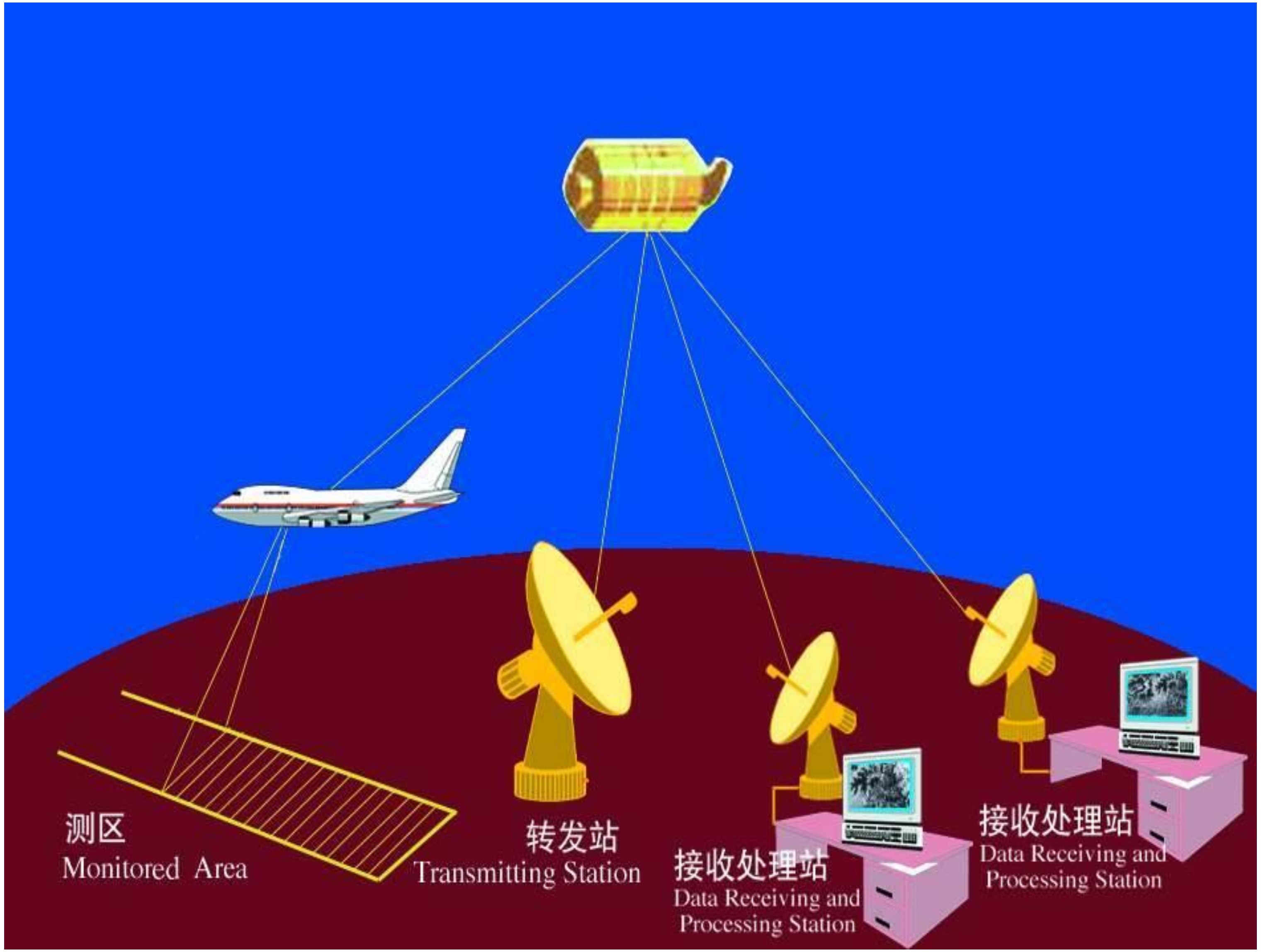
1.Flood monitoring

Appropriatness evaluation for remote sensing data usually used

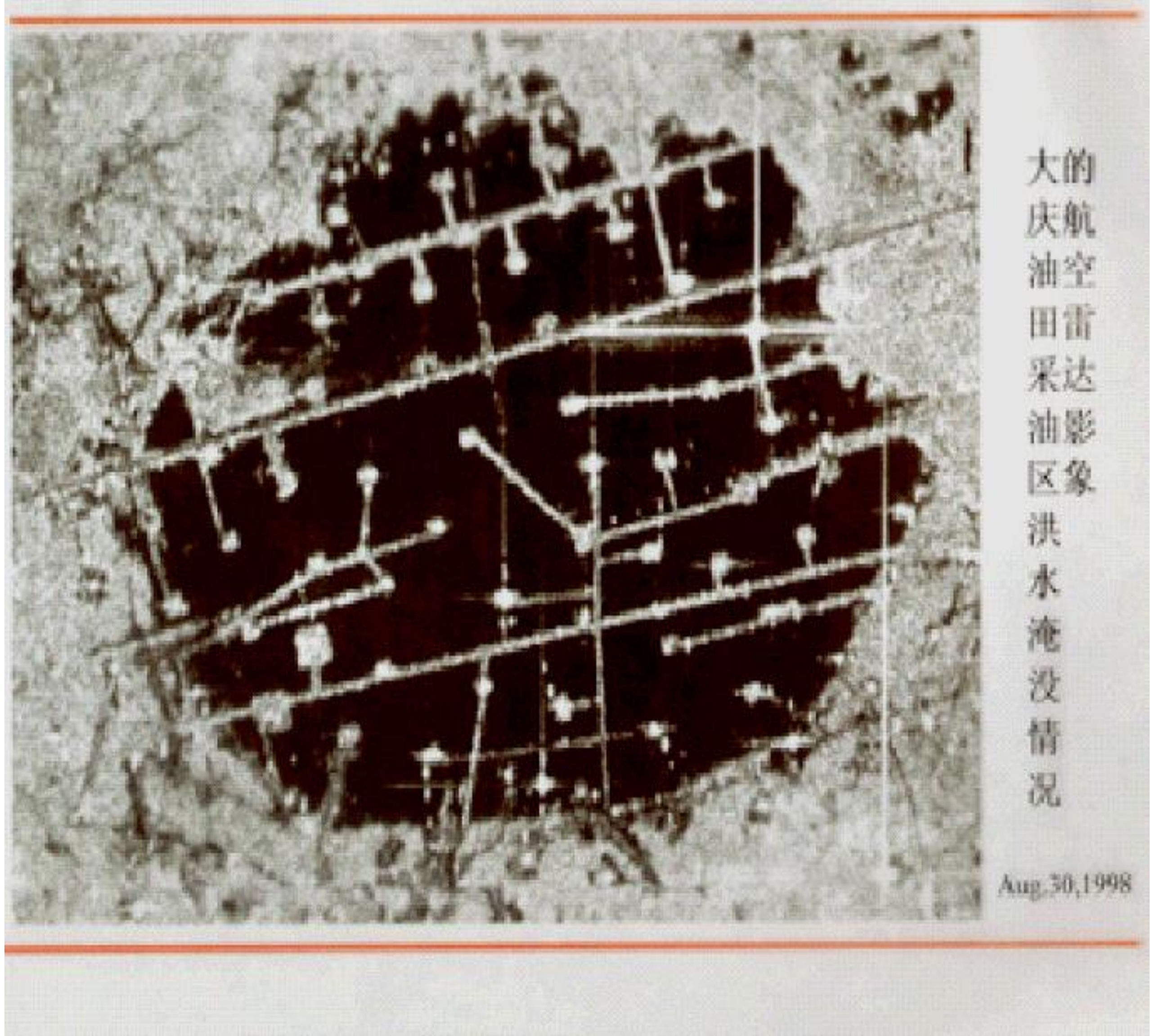
Data	Landsat 8	SPOT	NOAA/ AVHRR	GF-3 (domestic)	EOS/ MODIS	Sentinel-1	Air-born SAR	Unmanned plan
Revisit（d）	16	26	0.5	29	0.5	12	anytime	anytime
All weather	×	×	√	√√	×	√√	×	×
Data obtain	×	×	√	√	√√	√	√√	√√
Inundation extent	√√	√√	√√	√√	√√	√√	√√	√√
Water depth	√	√	×	√	×	√	√	√
Duration	×	×	√	—	√	—	—	√√
Background data	√√	√√	×	√	×	√	×	×
Water works monitoring	×	×	×	×	×	×	√√	√√
Disaster assessment	√	√	√	√	√	√	√	√

NOTE: √√very suitable √general suitable ×not suitable

Real-time transmission system of air-born SAR



Inundated oil-well at Daqing in 1998 by this system



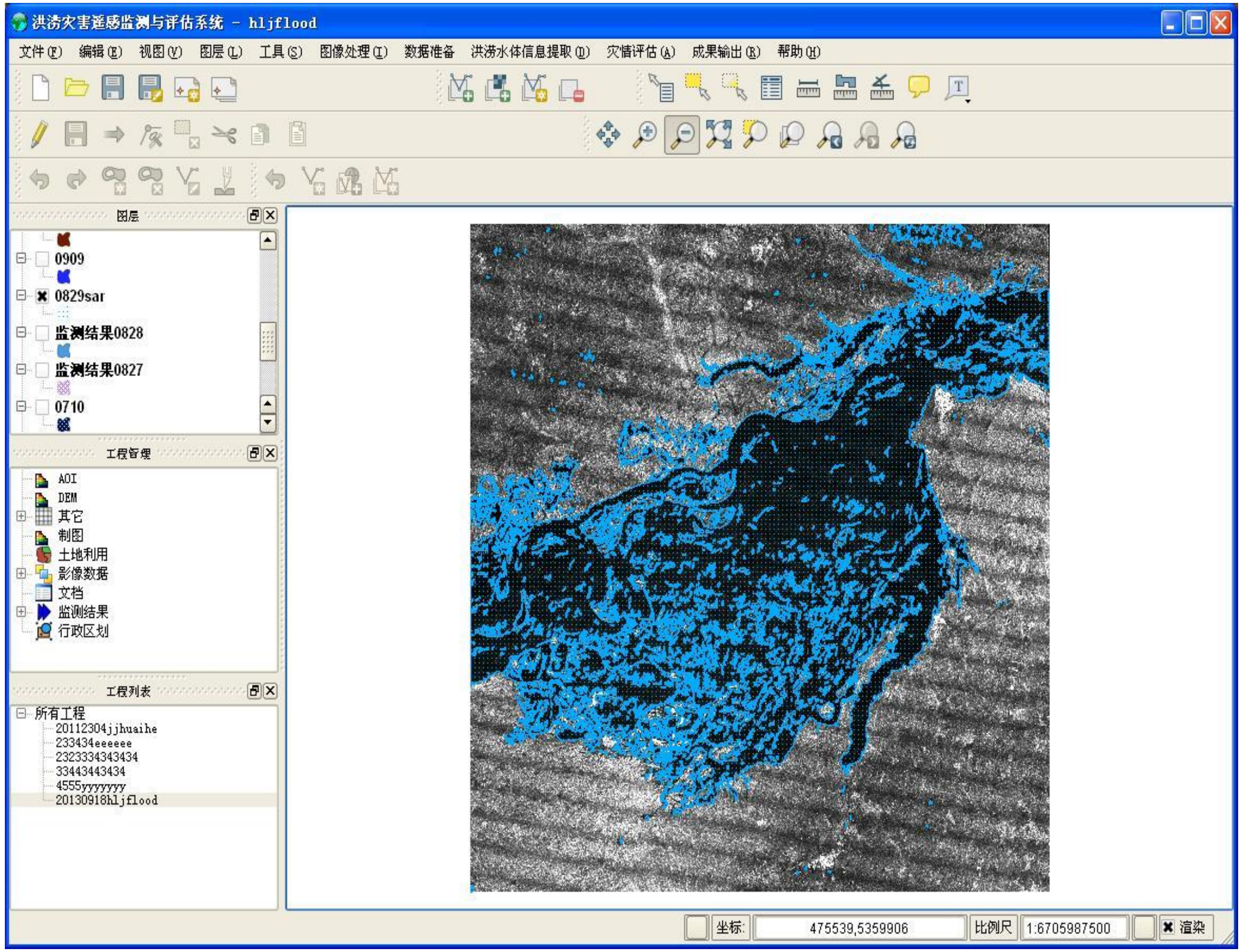
Factors for monitoring:

Extent of inundation

Duration of inundation(successive monitoring)

Water depth and its spacial distribution with the aid of DEM

Flood monitoring & assessment system (software)



中华人民共和国国家版权局

计算机软件著作权登记证书

证书号：软著登字第0381356号

软件名称：洪涝灾害遥感监测与评估系统 V1.0

著作权人：中国水利水电科学研究院

开发完成日期：2011年05月01日

首次发表日期：未发表

权利取得方式：原始取得

权利范围：全部权利

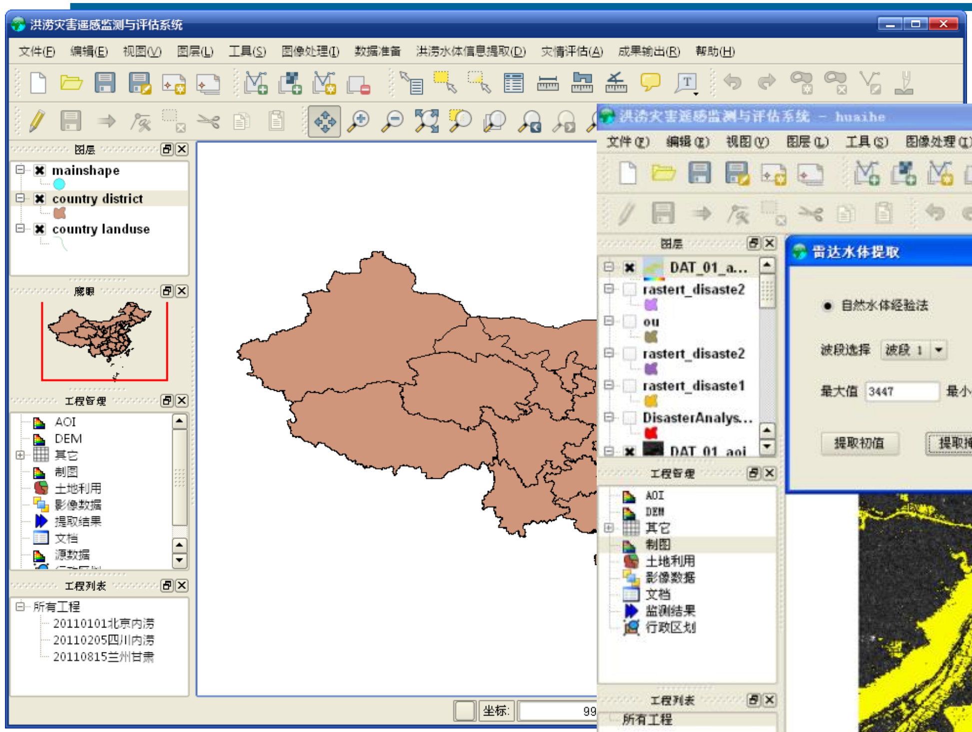
登记号：2012SR013320

根据《计算机软件保护条例》和《计算机软件著作权登记办法》的规定，经中国版权保护中心审核，对以上事项予以登记。

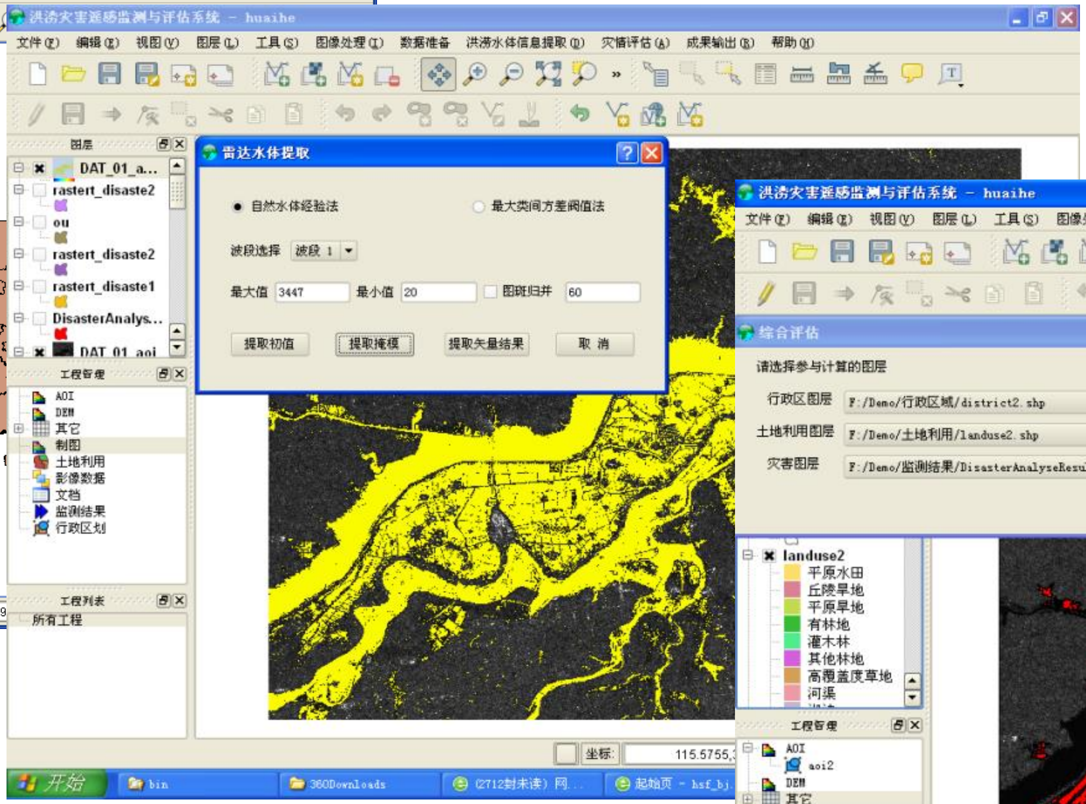
中华人民共和国国家版权局 计算机软件著作权登记专用章

No. 00091086

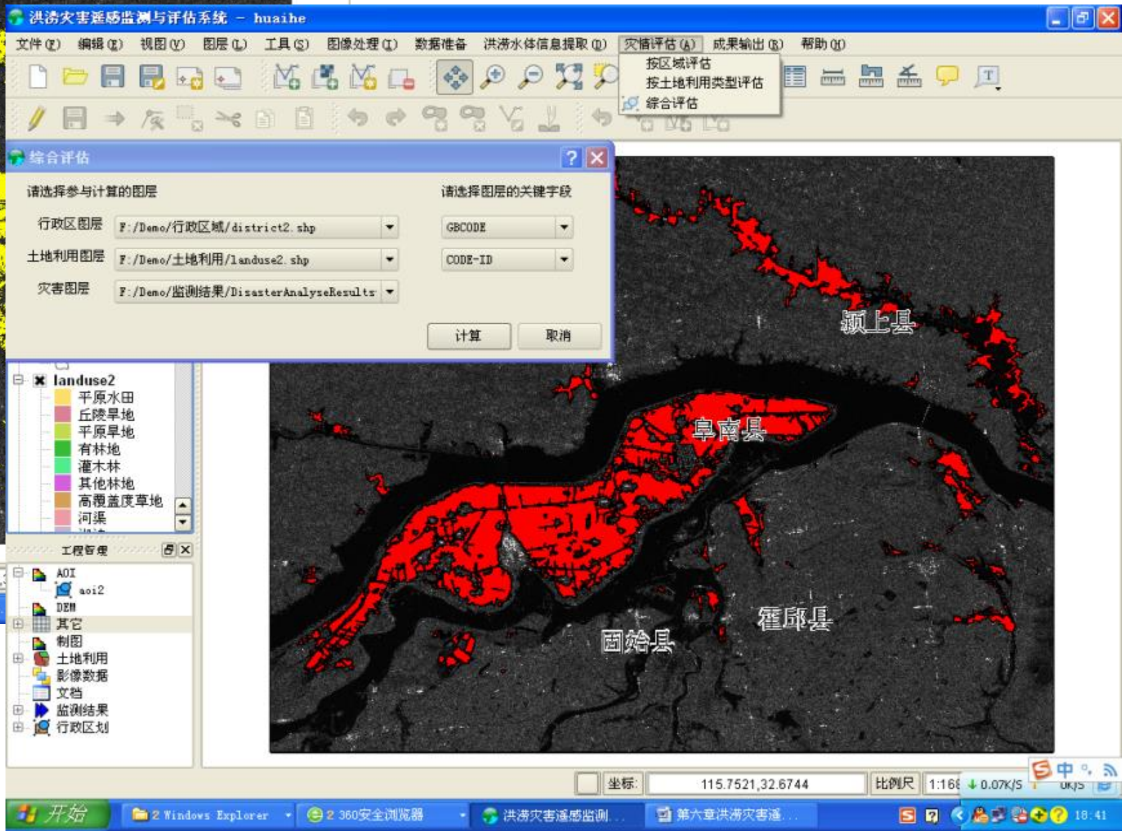
2012年02月24日



系统总界面

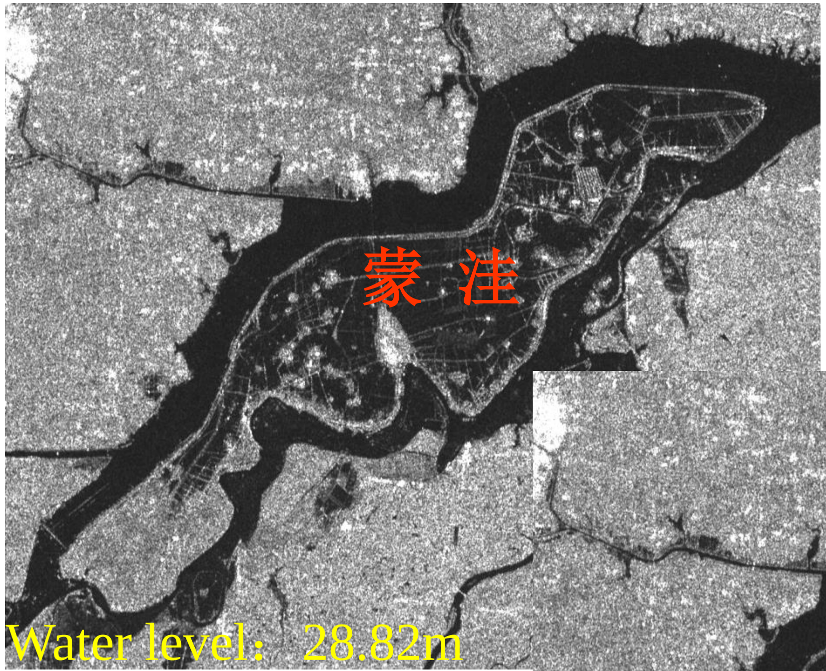


雷达影像水体自动提取界面

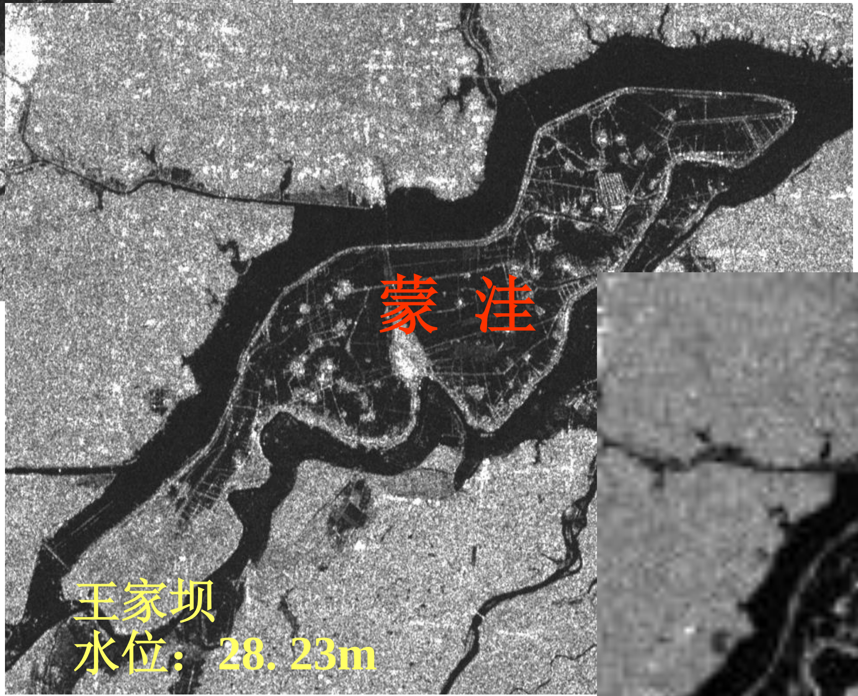


淹没范围提取界面

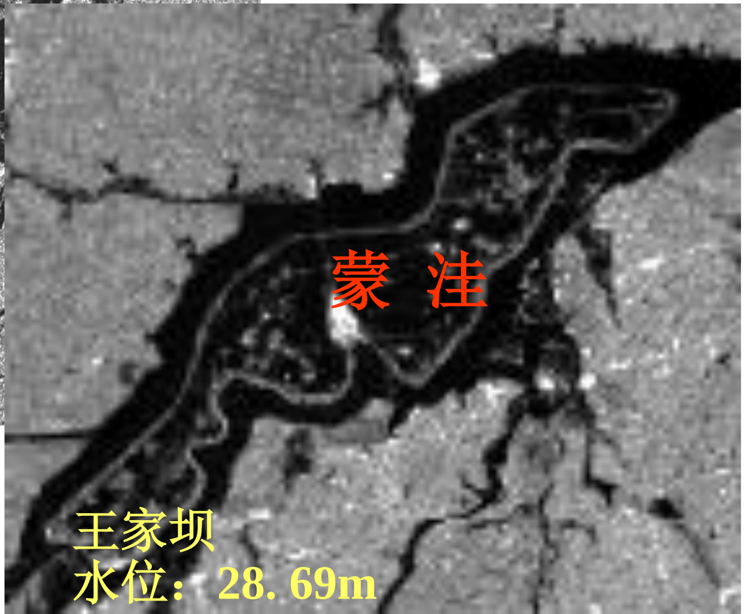
Dynamic Monitoring for Monwa Detention Basin



2003.7.5 17:22

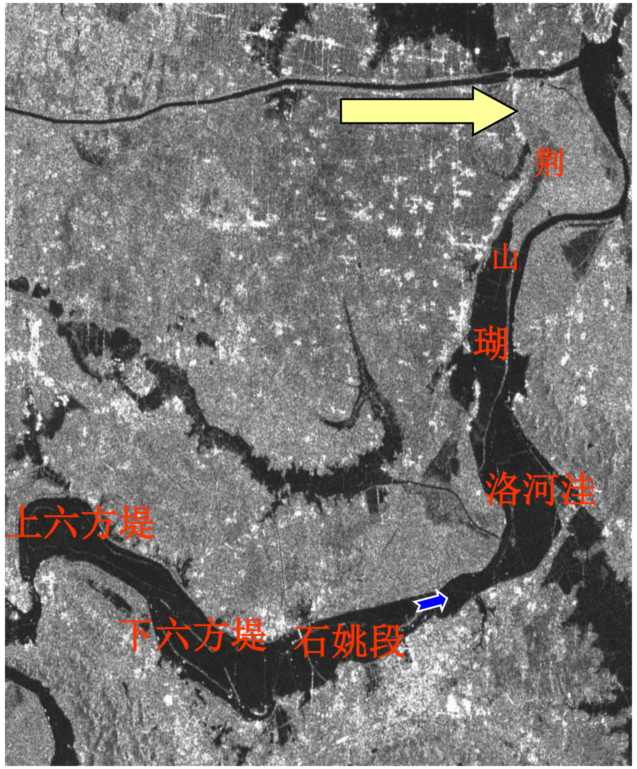


2003.7.7 6:11

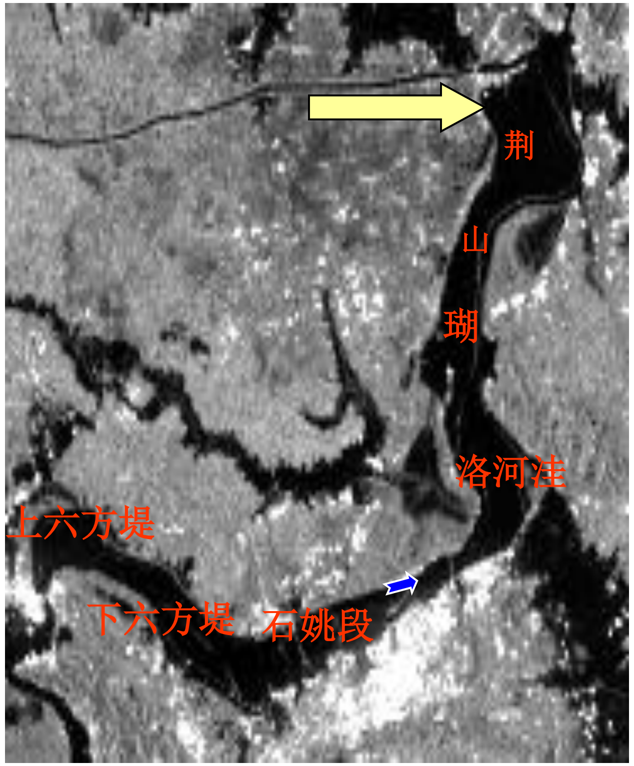


2003.7.12 18:18

Dynamic Monitoring for Jinshanhu Flooding Basin

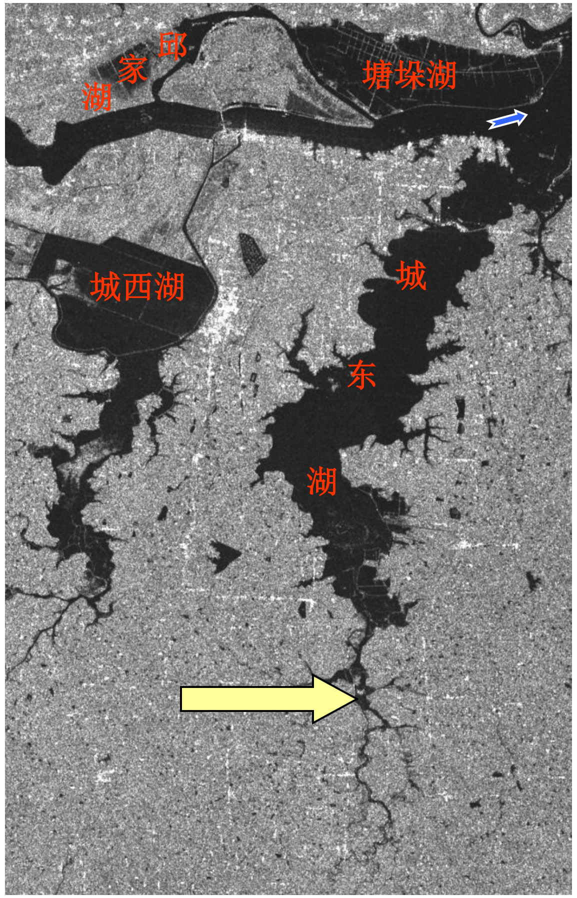


2003年7月7日6时11分

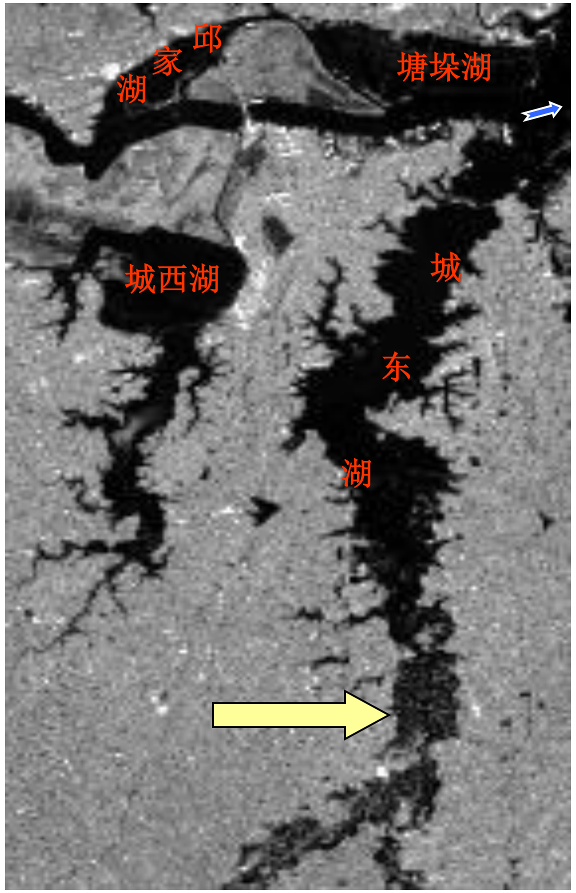


2003年7月12日18时18分

Dynamic Monitoring for the Chendonghu Detention Basin



2003年7月7日6时11分

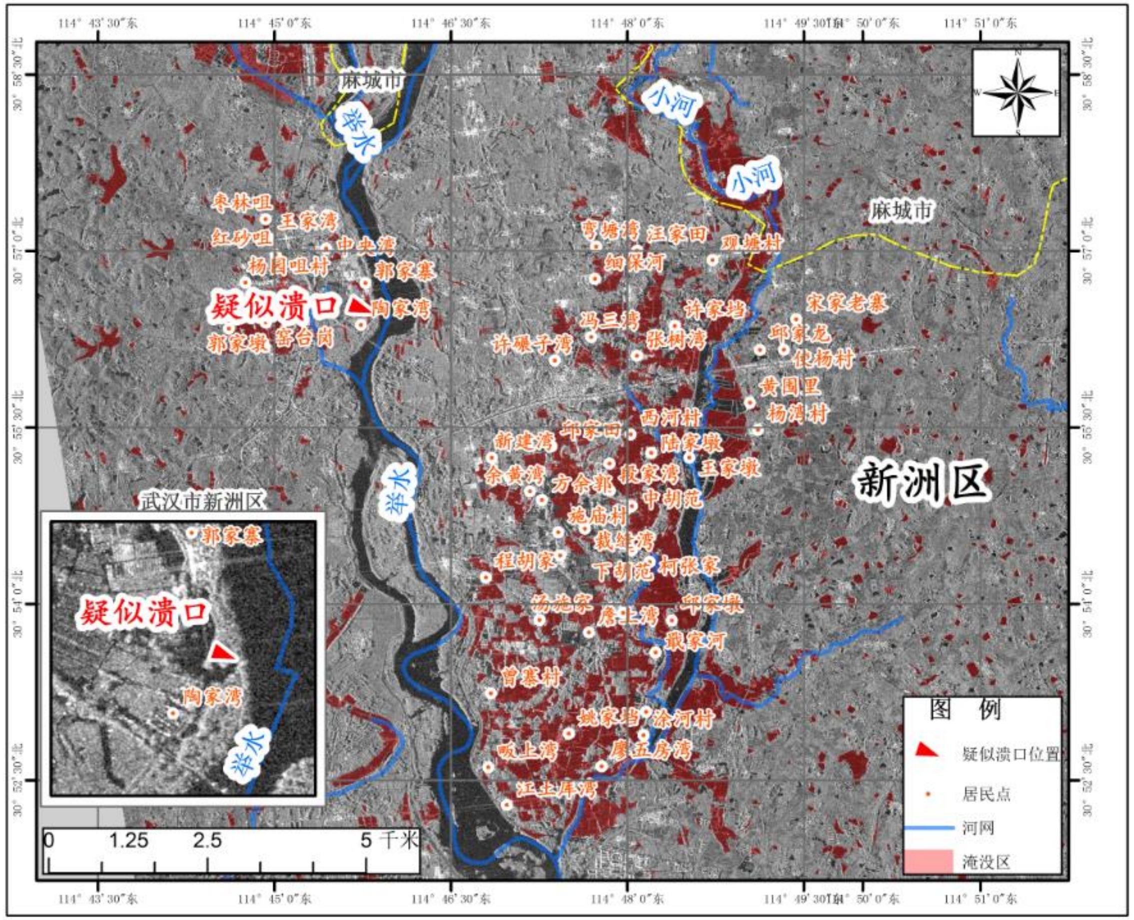


2003年7月12日18时18分

Heilong River in August,2013

Wuhan City in 2016

湖北省武汉市新洲区洪涝灾害遥感监测专题图

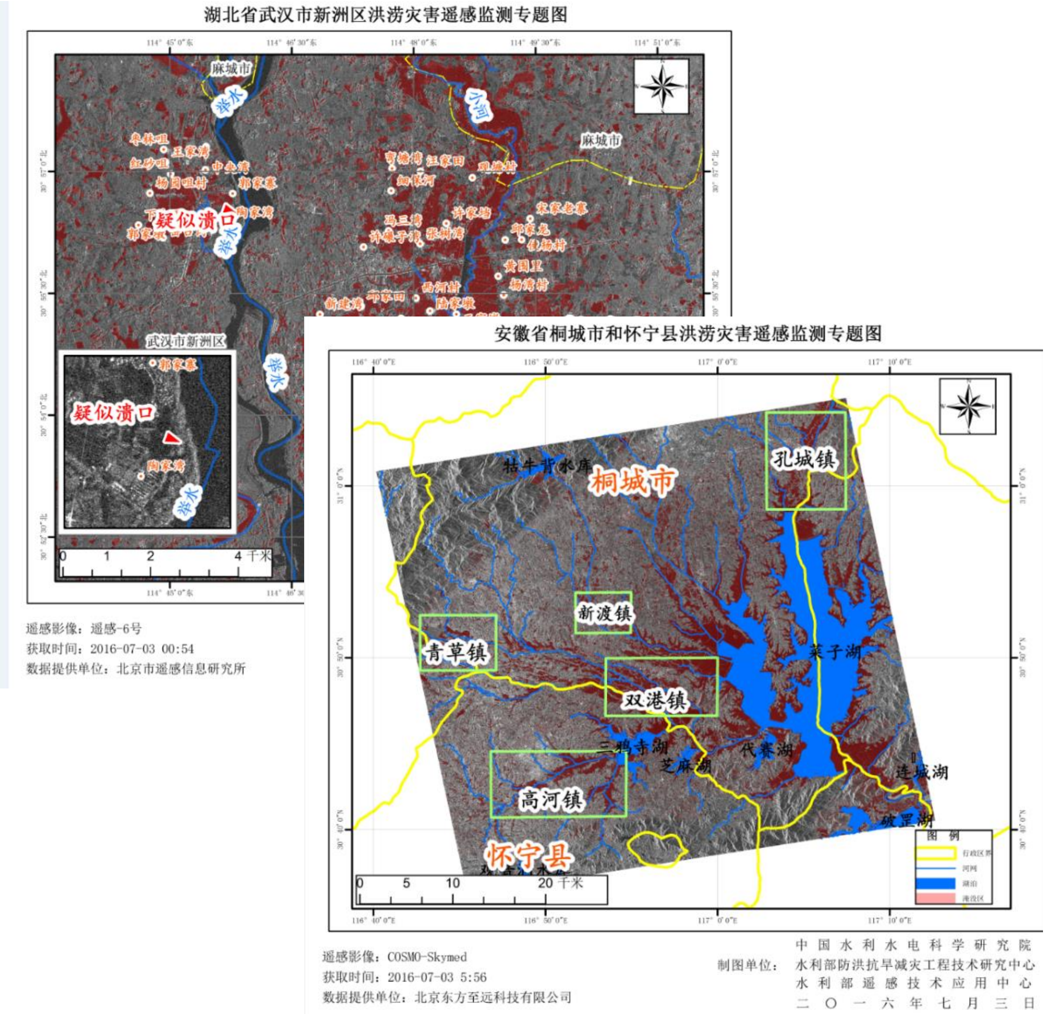


遥感影像：COSMO-Skymed
获取时间：2016-07-03 6:21
数据提供单位：北京东方至远科技有限公司

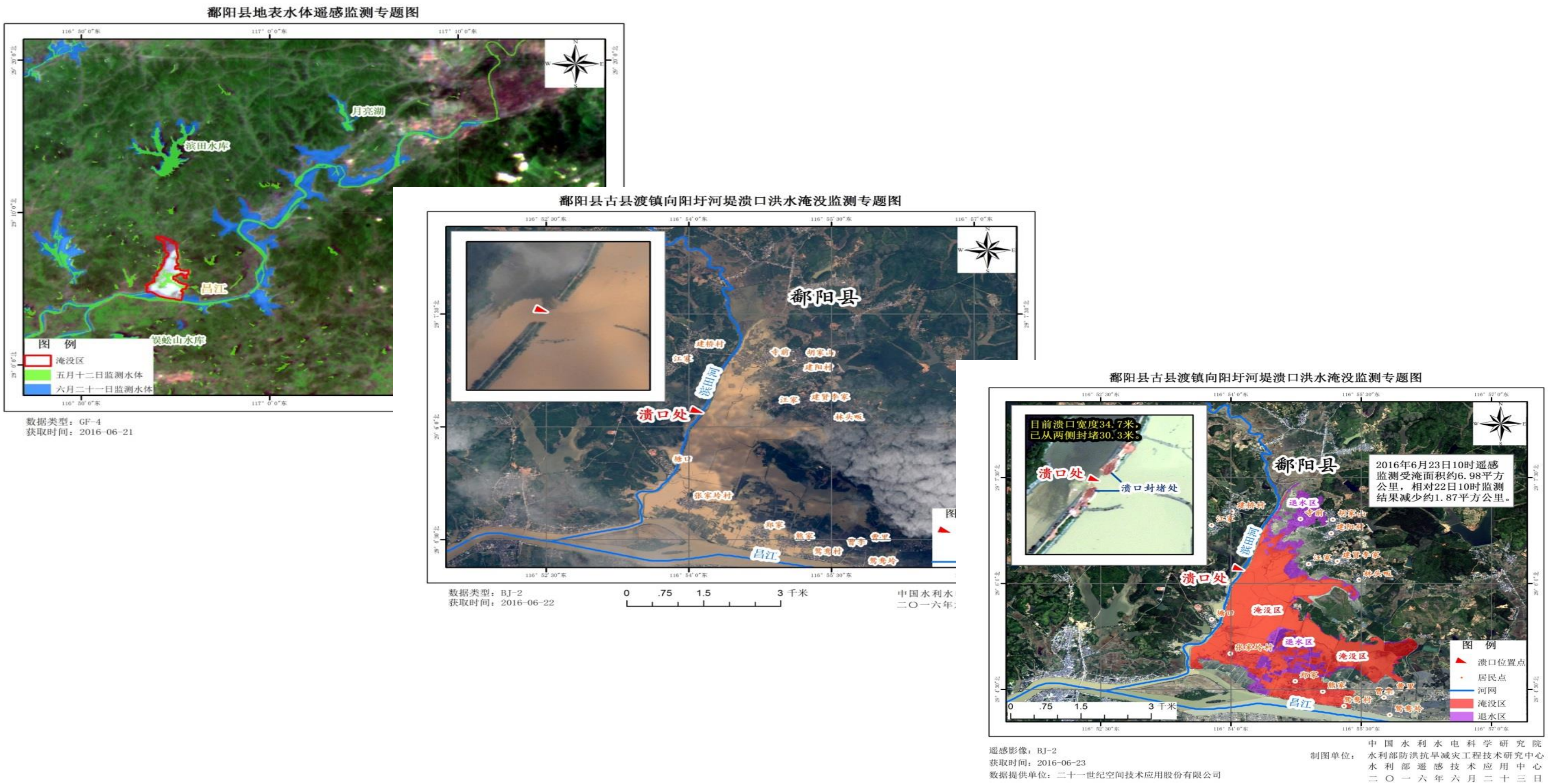
制图单位：中国水利水电科学研究院
水利部防洪抗旱减灾工程技术研究中心
水利部遥感技术应用中心
二〇一六年七月三日

Hubei and Anhui in 2016

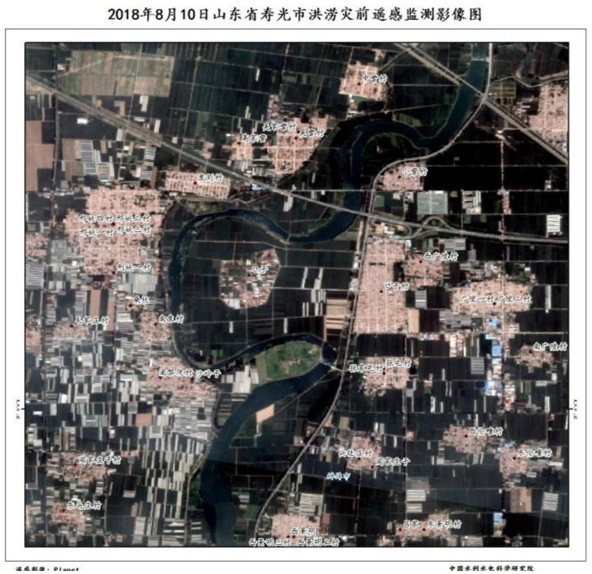
。

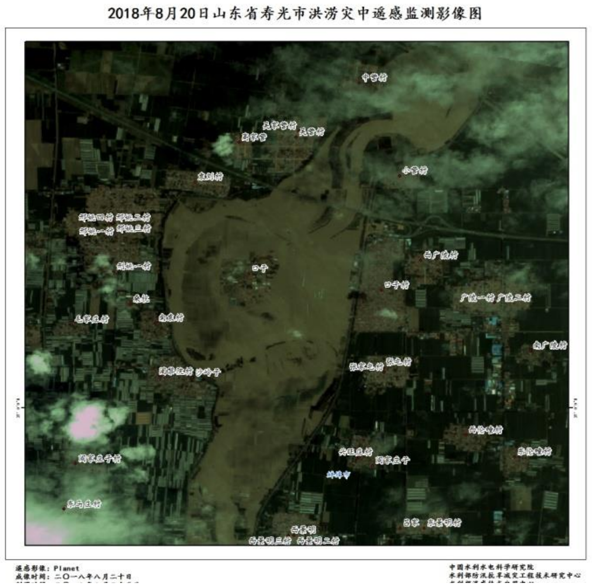


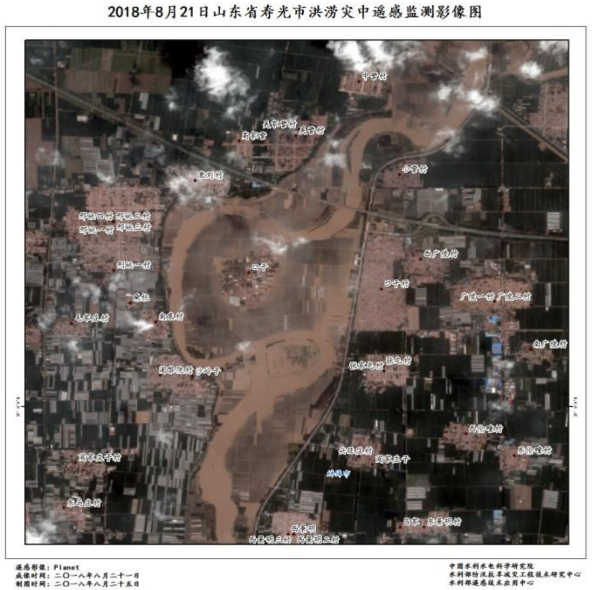
14 times monitoring for downstream of Yangtze River in 2016

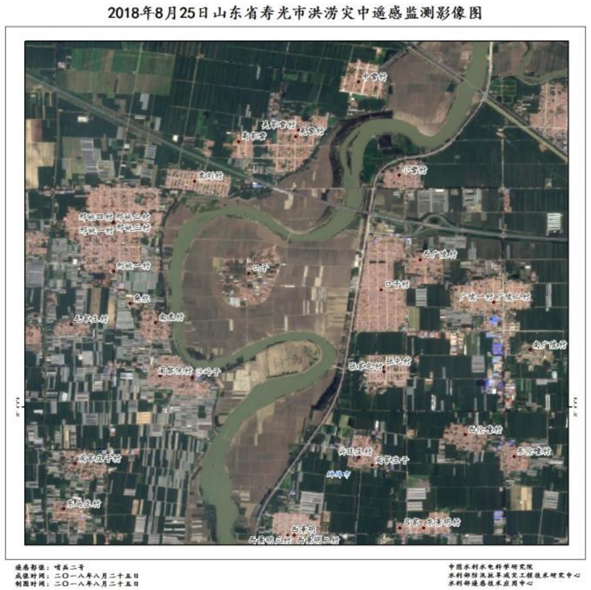


Shouguang, Shangdong in 2018

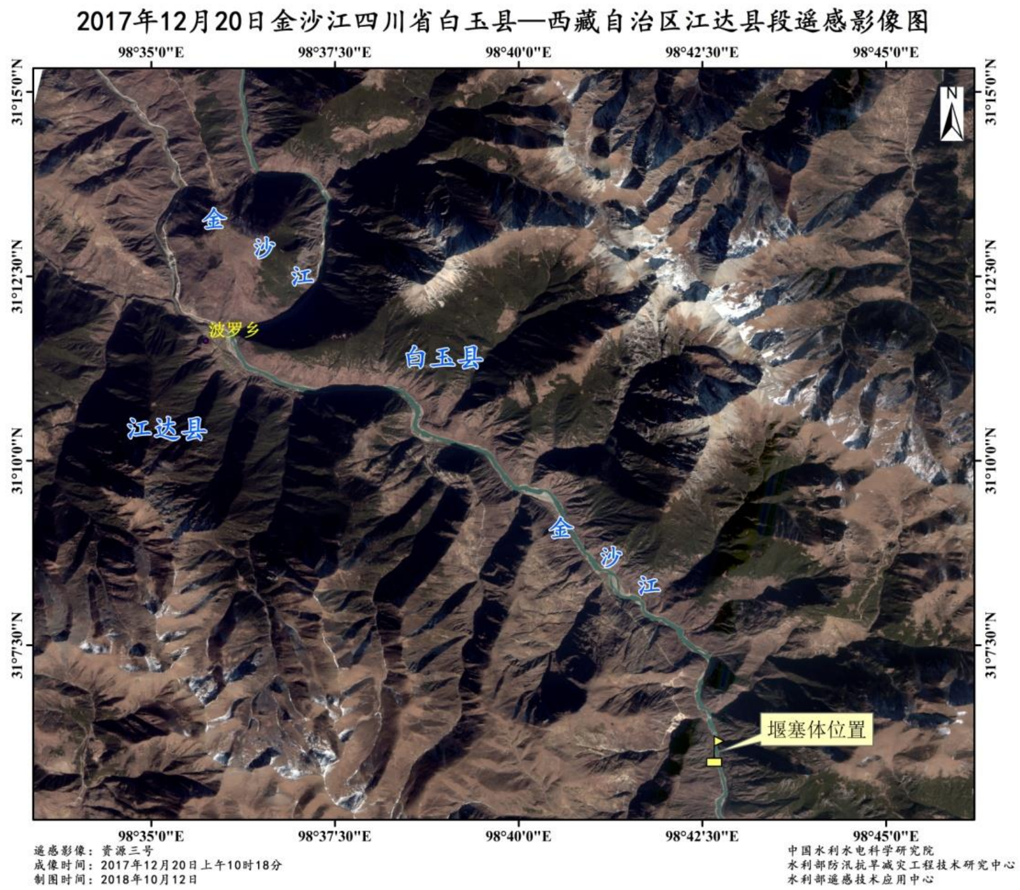


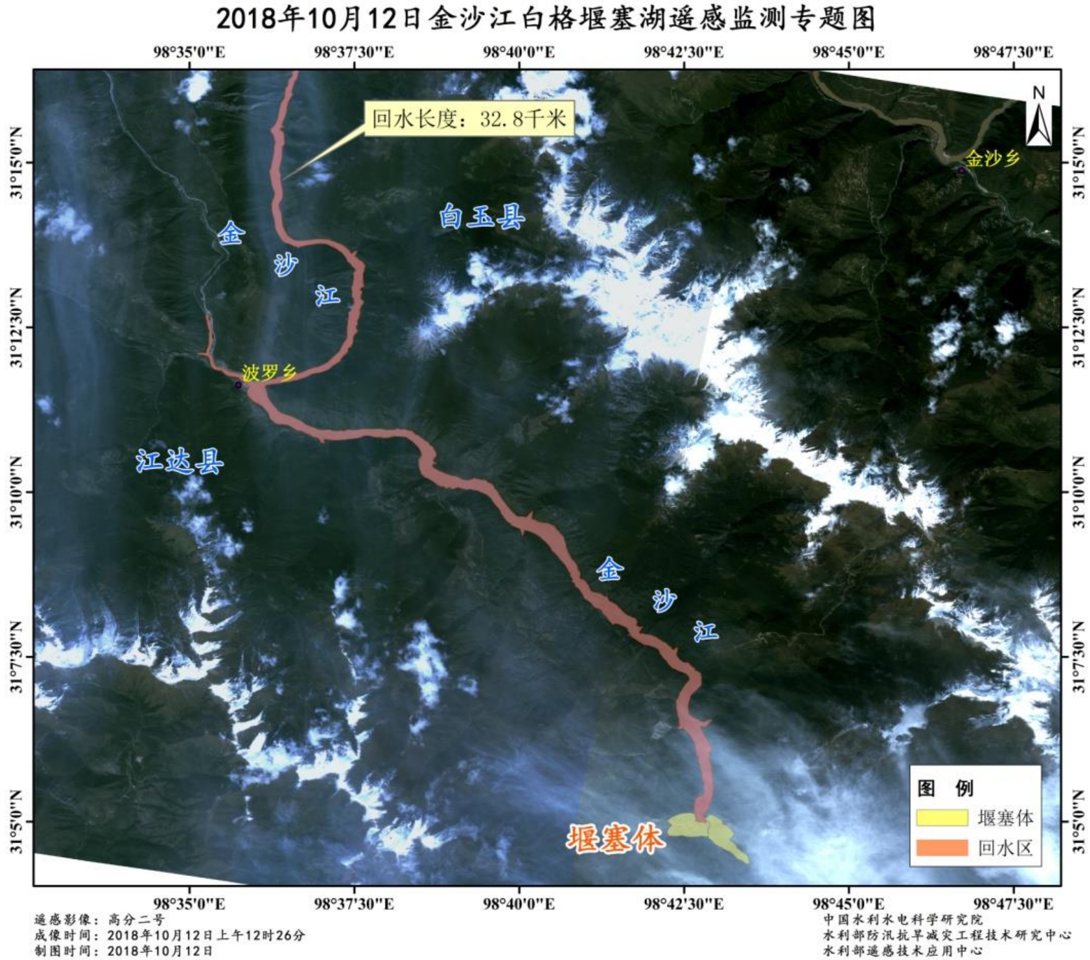






Dammed lake of the Jinsha River in 2017 & 2018





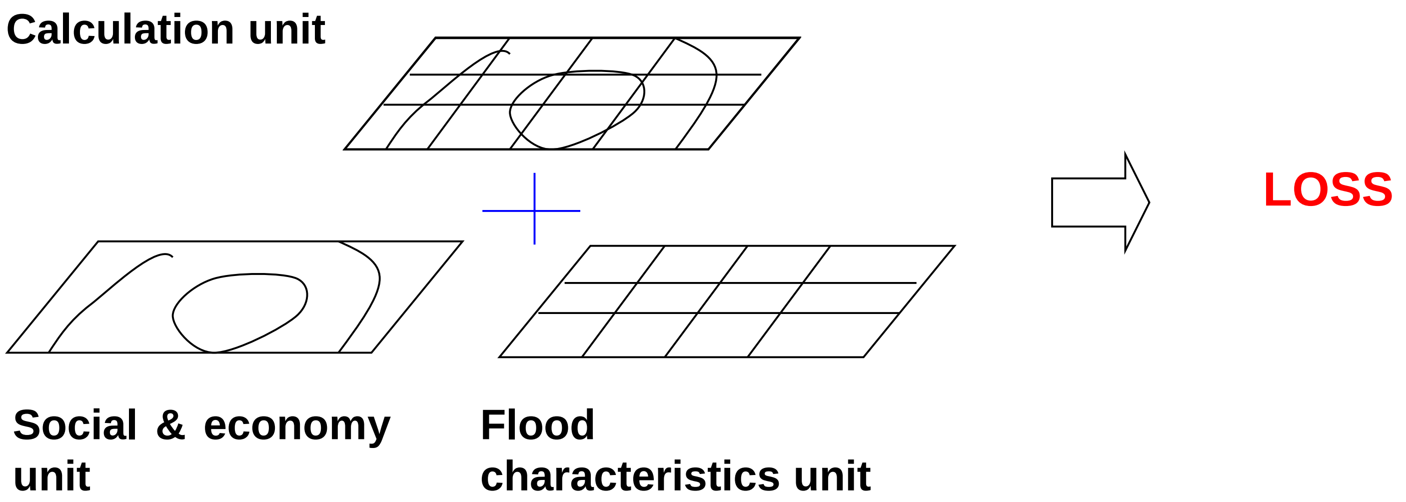
TOPICS

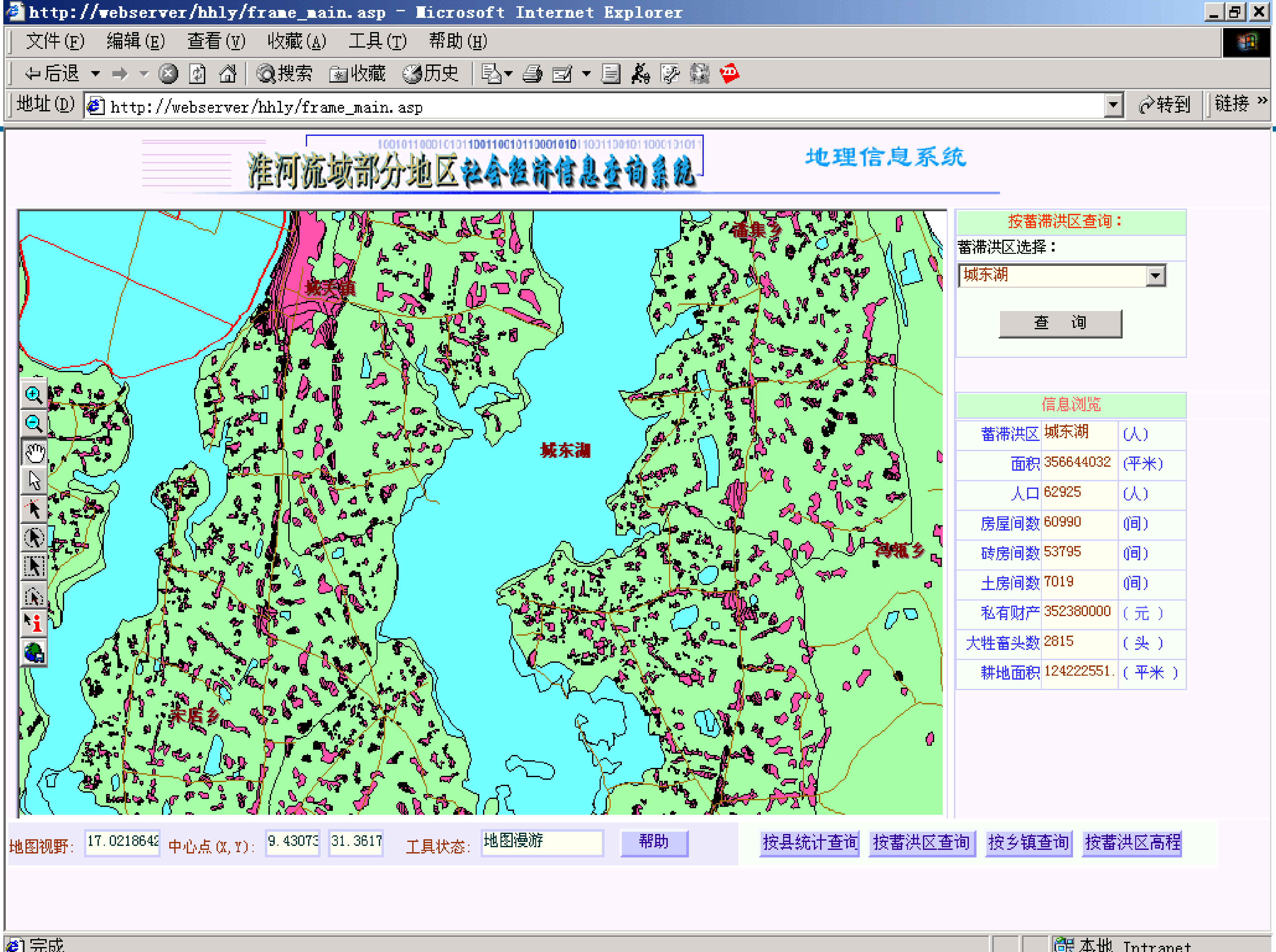
2

1. Flood monitoring
2. Disaster assessment
3. Security of Water Project for flood control
4. Flood forecasting and risk map

2. Disaster assessment

Depending on water depth, duration and inundated objects from social & economic data base, the most difficult factor is loss rate.




http://webserver/hhly/frame_main.asp - Microsoft Internet Explorer
文件(F) 编辑(E) 查看(V) 收藏(A) 工具(T) 帮助(H)
后退 搜索 收藏 历史
地址(D) http://webserver/hhly/frame_main.asp
转到 链接
淮河流域部分地区社会经济信息查询系统
地理信息系统
城东湖
宋店乡
按蓄滞洪区查询：
蓄滞洪区选择：
城东湖
查 询
信息浏览
蓄滞洪区 城东湖 (人)
面积 356644032 (平米)
人口 62925 (人)
房屋间数 60990 (间)
砖房间数 53795 (间)
土房间数 7019 (间)
私有财产 352380000 (元)
大牲畜头数 2815 (头)
耕地面积 124222551. (平米)
地图视野: 17.0218642
中心点(X,Y): 9.43073 31.3617
工具状态: 地图漫游
帮助
按县统计查询
按蓄滞洪区查询
按乡镇查询
按蓄滞洪区高程
完成
本地 Intranet

http://webserver/dth/frame_main.asp - Microsoft Internet Explorer

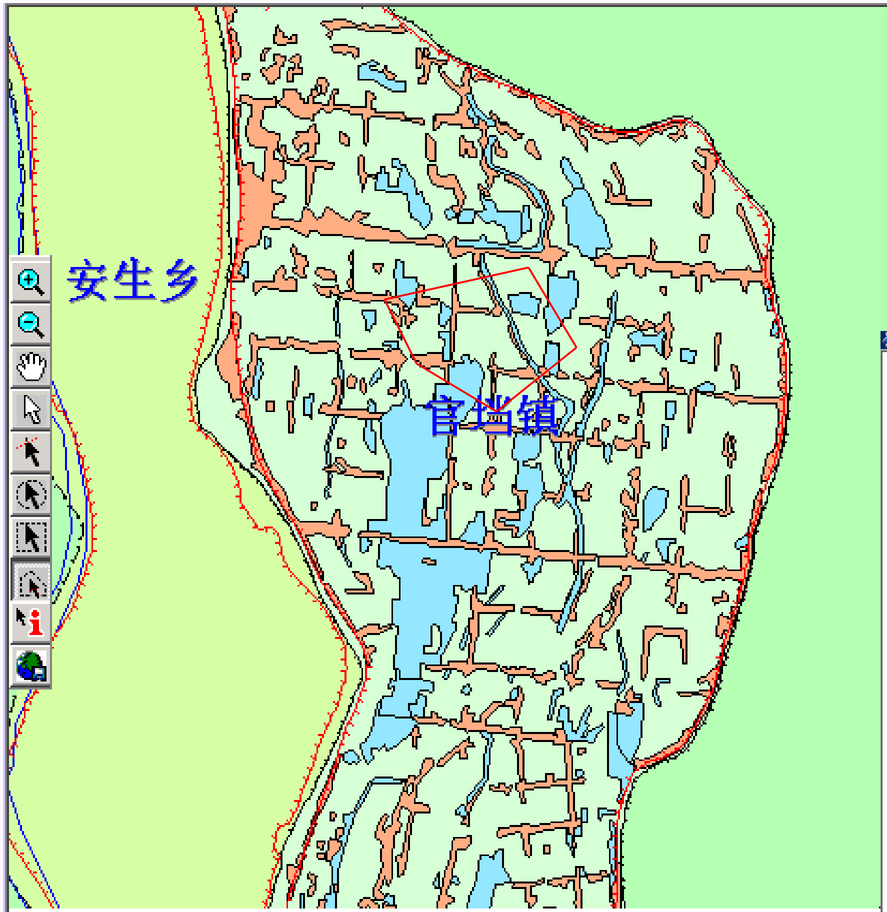
文件(F) 编辑(E) 查看(V) 收藏(A) 工具(T) 帮助(H)

后退 搜索 收藏 历史

地址(D) http://webserver/dth/frame_main.asp 转到 链接

湖南省洞庭湖地区 社会经济信息查询系统

地理信息系统



地图视野: 9.11652938 中心点(X,Y): 6.27502 28.3185 工具状态: 居民地信息范围线

按乡镇查询:

定 位

安化垸

官垱镇
三叉河镇

信息浏览

http://webserver/Dth/report1.asp?lyr=eleanhua - Microsoft Internet Explorer

居民地社会经济数据信息表

总共23条记录

区块代码	类型	面积(平方米)	高程范围	所属县市	所属乡镇	所属垸	人口(人)	房屋(间)	生猪(头)	耕牛(头)	耕地面积(亩)
1055	11	349688.75	31.5~32	安乡县	官垱镇	安化垸	0	0	0	0	524.51
1089	11	61833.16	32~32.5	安乡县	官垱镇	安化垸	0	0	0	0	92.75
1117	12	5612.04	31~31.5	安乡县	官垱镇	安化垸	0	0	0	0	0
1120	12	386.109	31.5~32	安乡县	官垱镇	安化垸	0	0	0	0	0
1123	22	6697.68	30.5~31	安乡县	官垱镇	安化垸	21	33	17	0	0
1124	22	10231	31.5~32	安乡县	官垱镇	安化垸	32	51	26	0	0
1126	22	2976.73	31~31.5	安乡县	官垱镇	安化垸	9	15	8	0	0
1133	22	12588.76	32~32.5	安乡县	官垱镇	安化垸	39	62	32	0	0
1135	22	2750.96	32~32.5	安乡县	官垱镇	安化垸	9	14	7	0	0
1137	22	11433.69	31.5~32	安乡县	官垱镇	安化垸	36	57	29	0	0
1138	22	14.3203	32~32.5	安乡县	官垱镇	安化垸	0	0	0	0	0
1140	12	1000.18	30.5~31	安乡县	官垱镇	安化垸	0	0	0	0	0
1141	12	1656.78	31~31.5	安乡县	官垱镇	安化垸	0	0	0	0	0
1142	12	1601.08	31.5~32	安乡县	官垱镇	安化垸	0	0	0	0	0
1144	11	353.617	31.5~32	安乡县	官垱镇	安化垸	0	0	0	0	0.53
1152	11	2184.91	30~30.5	安乡县	官垱镇	安化垸	0	0	0	0	3.28
1162	22	104.25	31.5~32	安乡县	官垱镇	安化垸	0	1	0	0	0
1163	11	31.3516	32~32.5	安乡县	官垱镇	安化垸	0	0	0	0	0.05
1170	11	1206.47	31~31.5	安乡县	官垱镇	安化垸	0	0	0	0	1.81

郑码

本地 Intranet

Disaster loss evaluation model

Economic loss estimation is performed on the basis of grid which is common for flood routing and social-economic database.

On the basis of water depth, inundation duration, inundation object and corresponding loss rate, the capital loss is calculated.

$$Rcapital = \sum_{i} \sum_{j} \sum_{k} \sum_{m} \sum_{n} A_{ij} \eta_{jkm} Y_{jn} (1 + e_j)^N$$

According to the inundation duration, the loss due to stoppage of business is calculated.

$$R_{busi} = \sum_{i} \sum_{j} L_j B_{ij} (1 + e_j)^N \times Days / 365$$

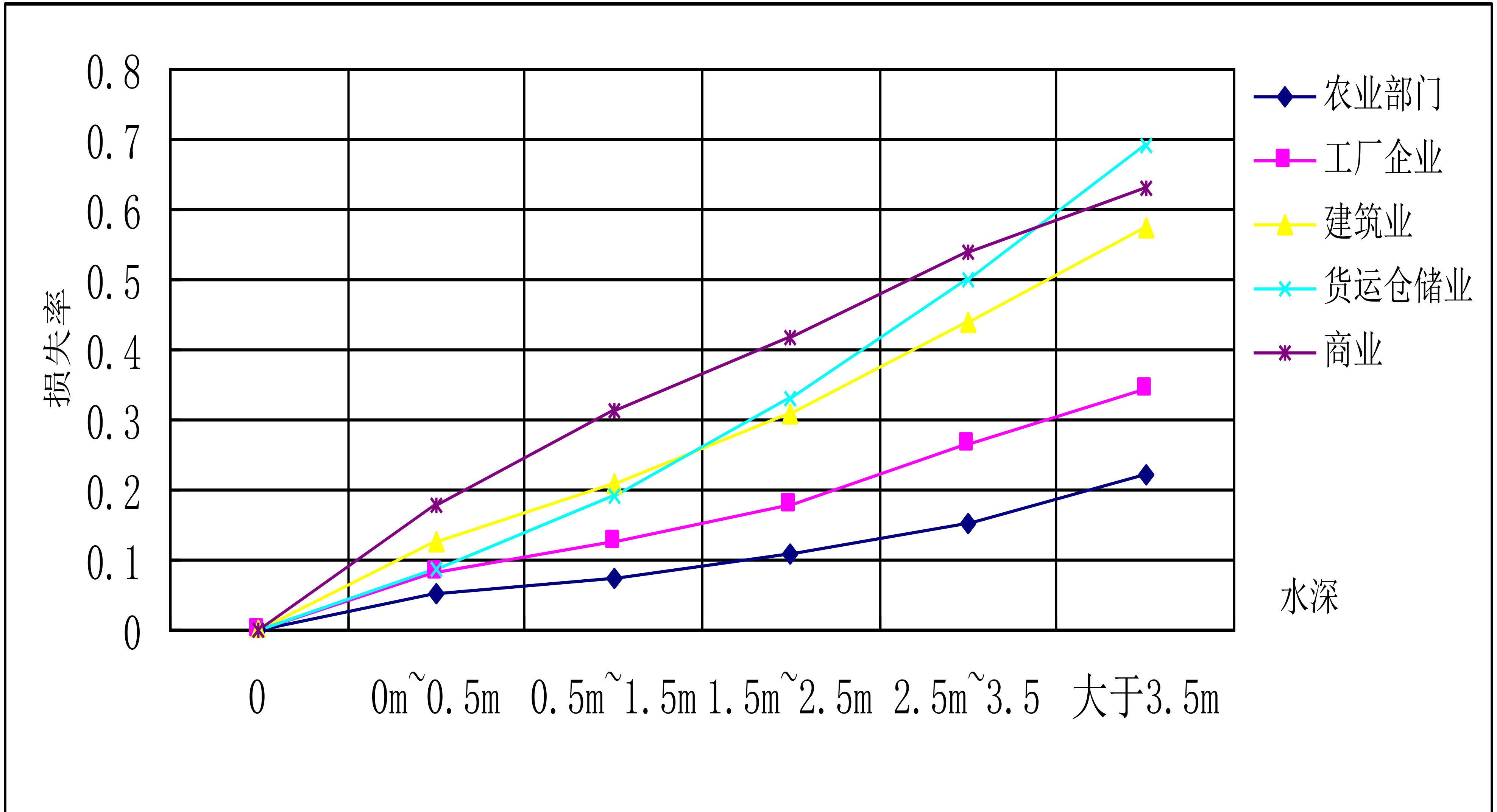
$$R_{indirect} = \sum_{i} \sum_{j} R_{ijdirect} \times K_j$$

$$R_{relief} = R_{historical}(1 + e_j)^N$$

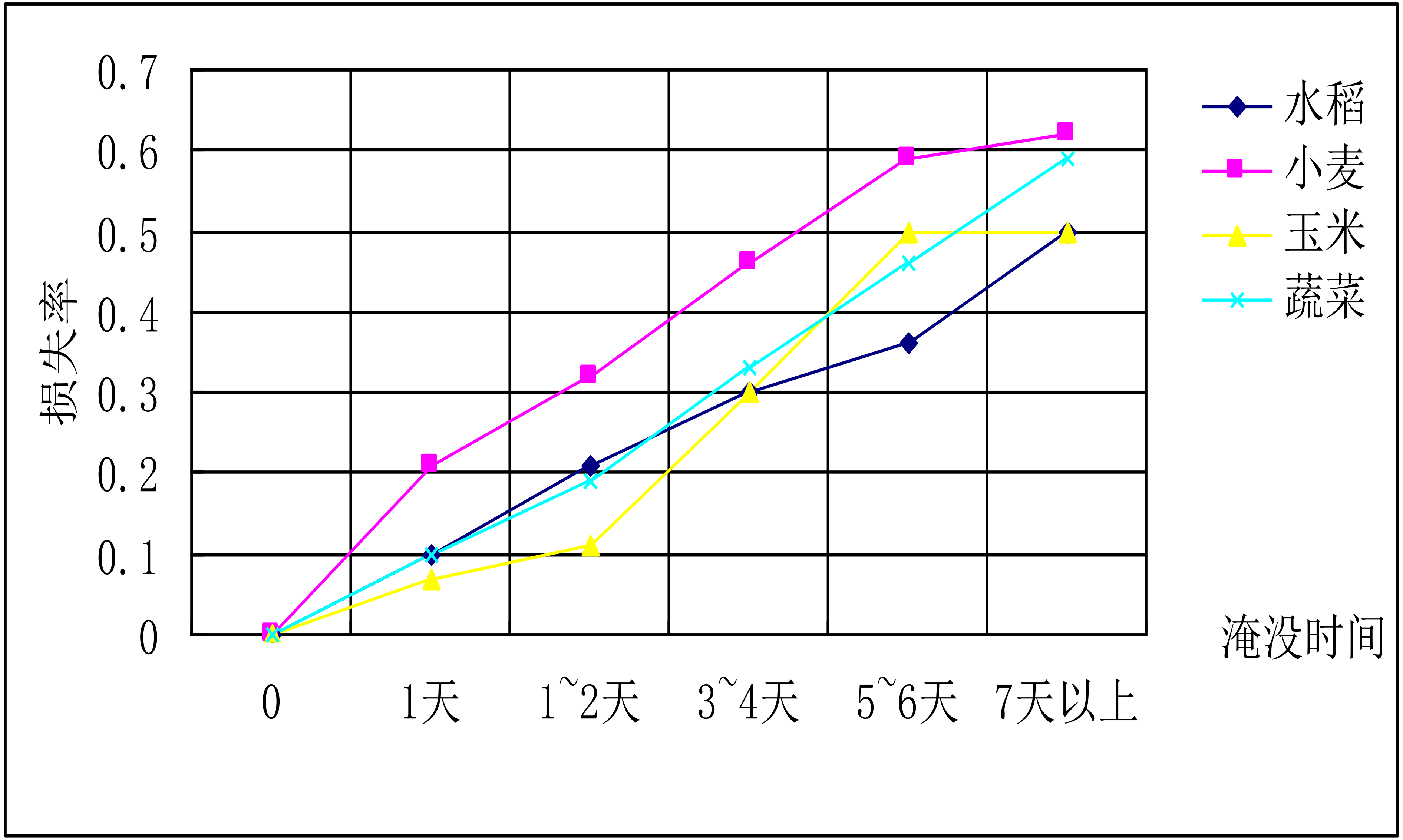
$$R_{benifit} = \sum_i U_i \times \int_0^T ae^{-bt} dt$$

$$W_{total} = R_{capital} + R_{busi} + R_{indirect} + R_{relief} - R_{benifit}$$

Relation curve between loss rate and water depth for different sector



Relation curve between loss rate and inundation duration for different crops



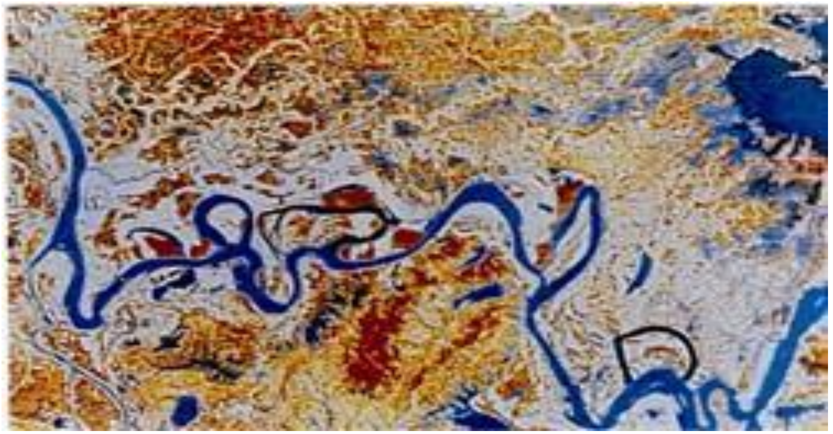
TOPICS

3

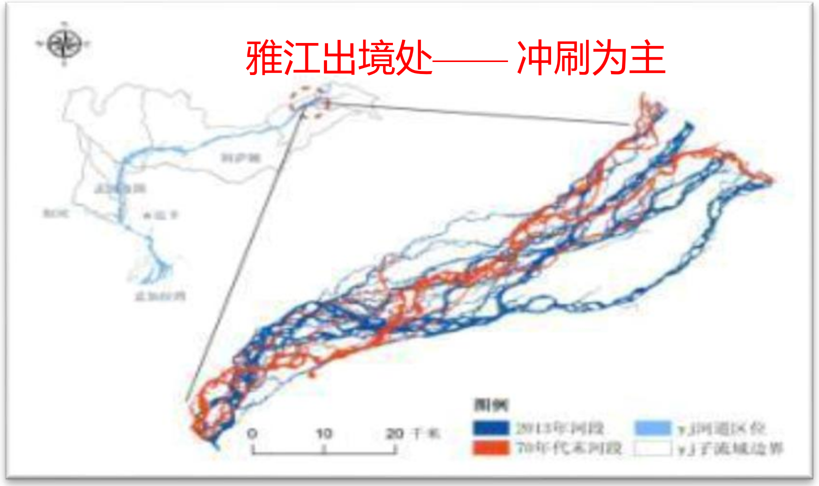
1. Flood monitoring
2. Disaster assessment
3. Monitoring on water project for flood control
4. Flood forecasting and risk map

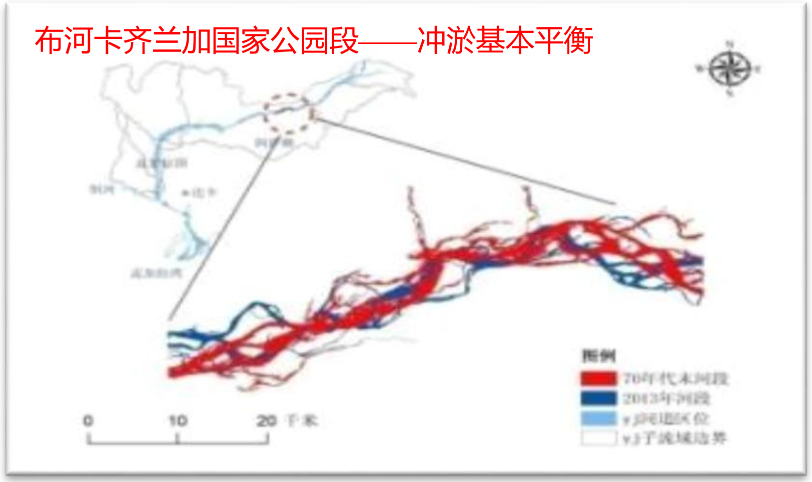
Variation of river regime

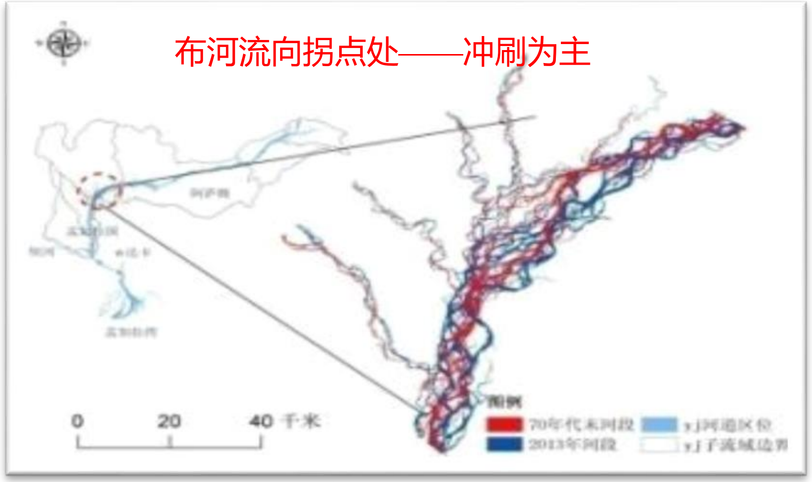
Variation of river regime due to scour and filling of sedimentation, also sand dredging may cause the change of flow direction, and threat the security of dyke.

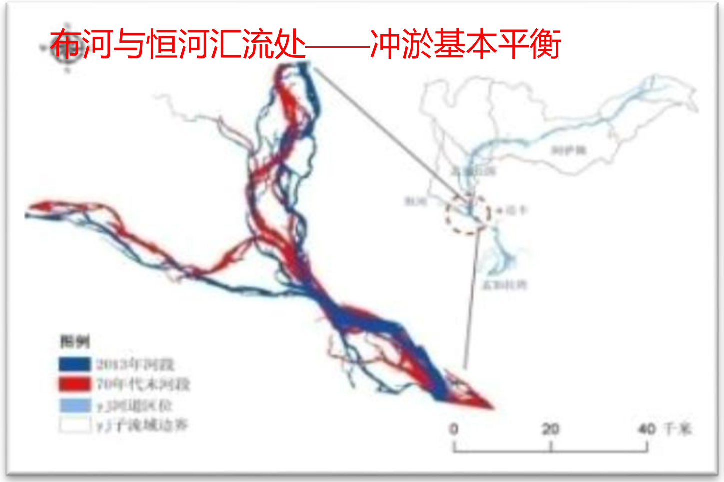

Variation of river course

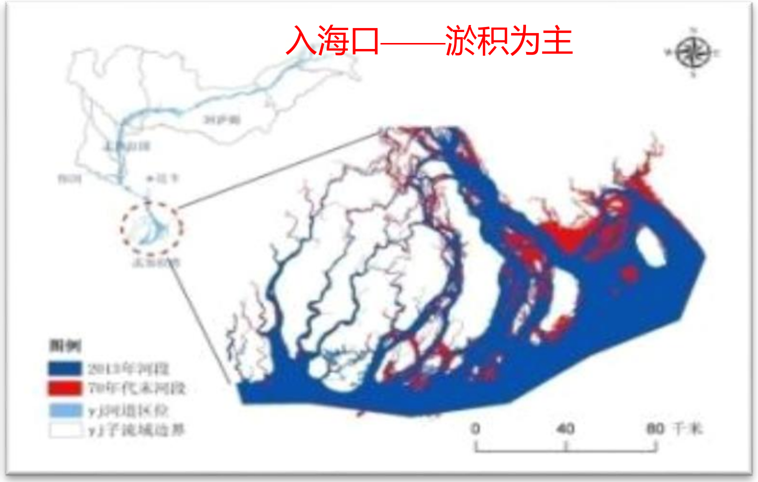






River course variation of the Yalouzhanbu River from 1980 to 2013





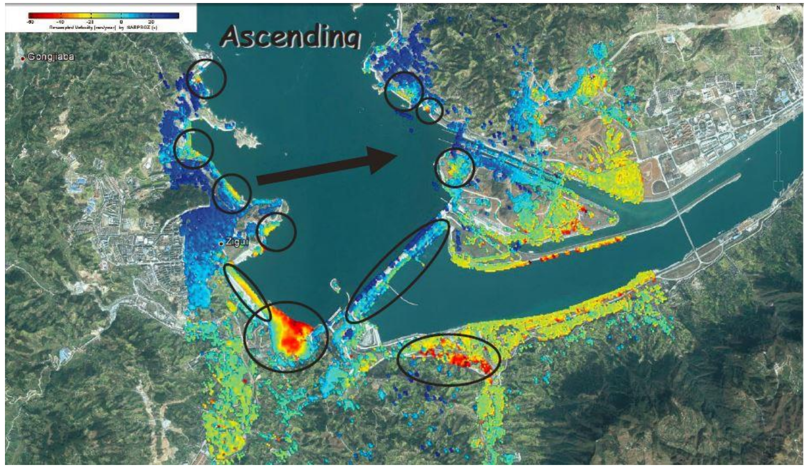
Monitoring of river regulation

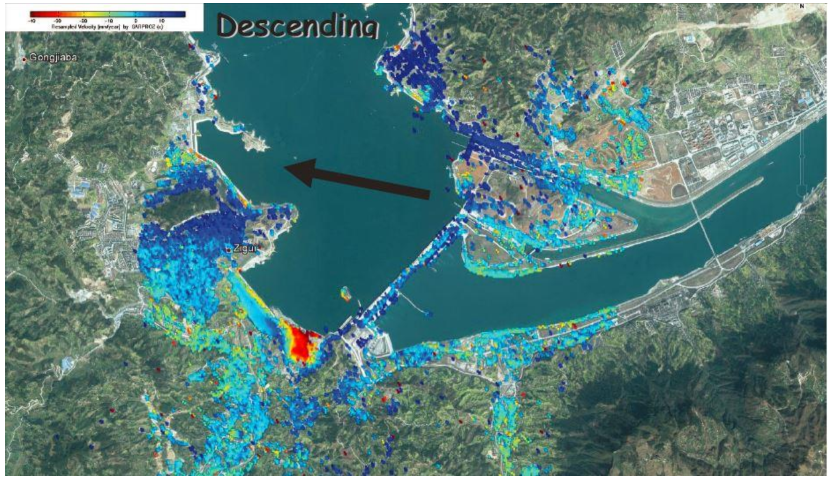
。

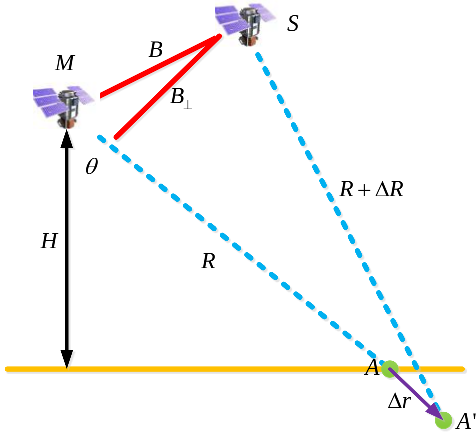
Monitoring of river regulation

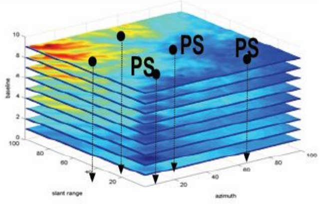
Monitoring on water project for flood control

Displacement and transformation of dam by INSAR





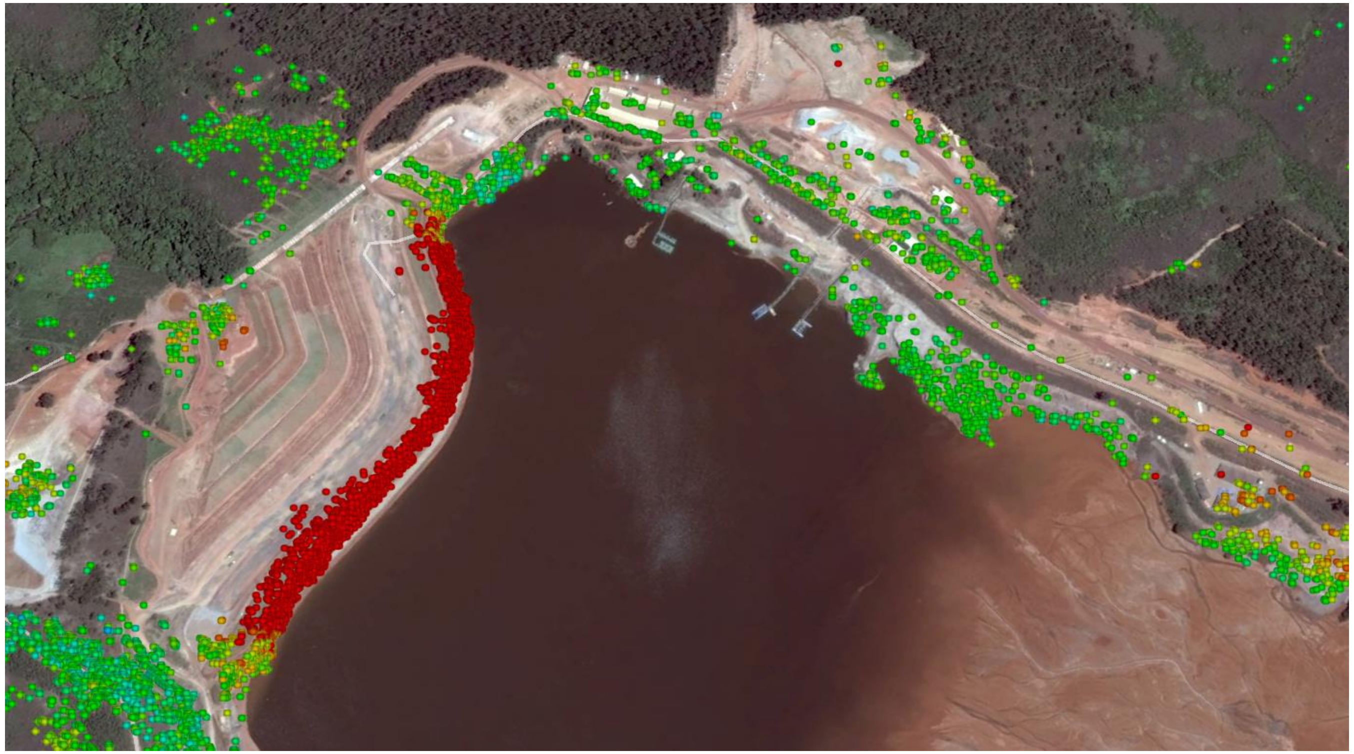


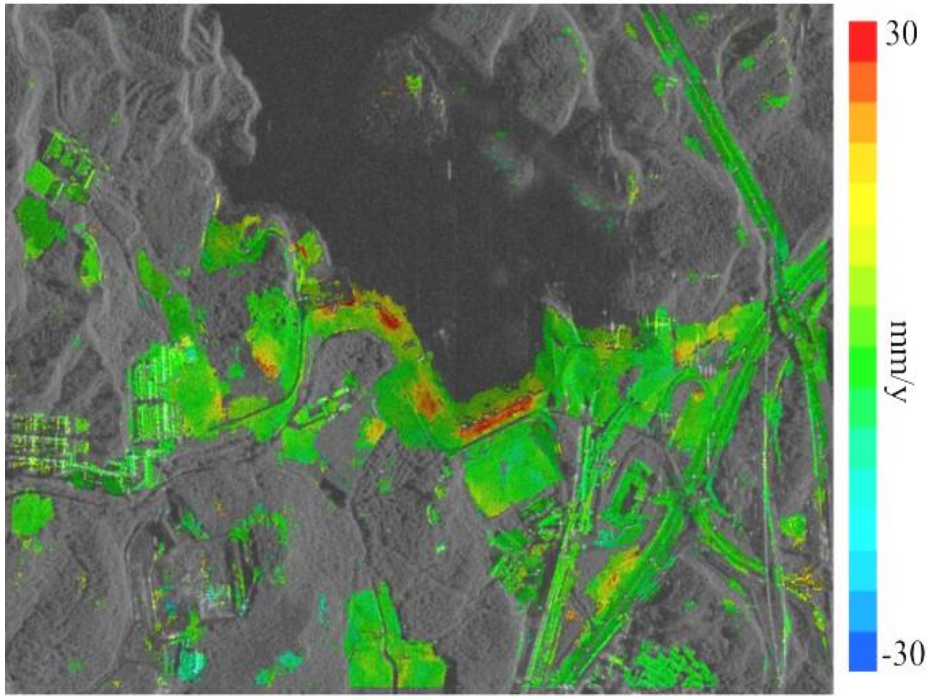


Three Gorge Dam

Monitoring on water project for flood control

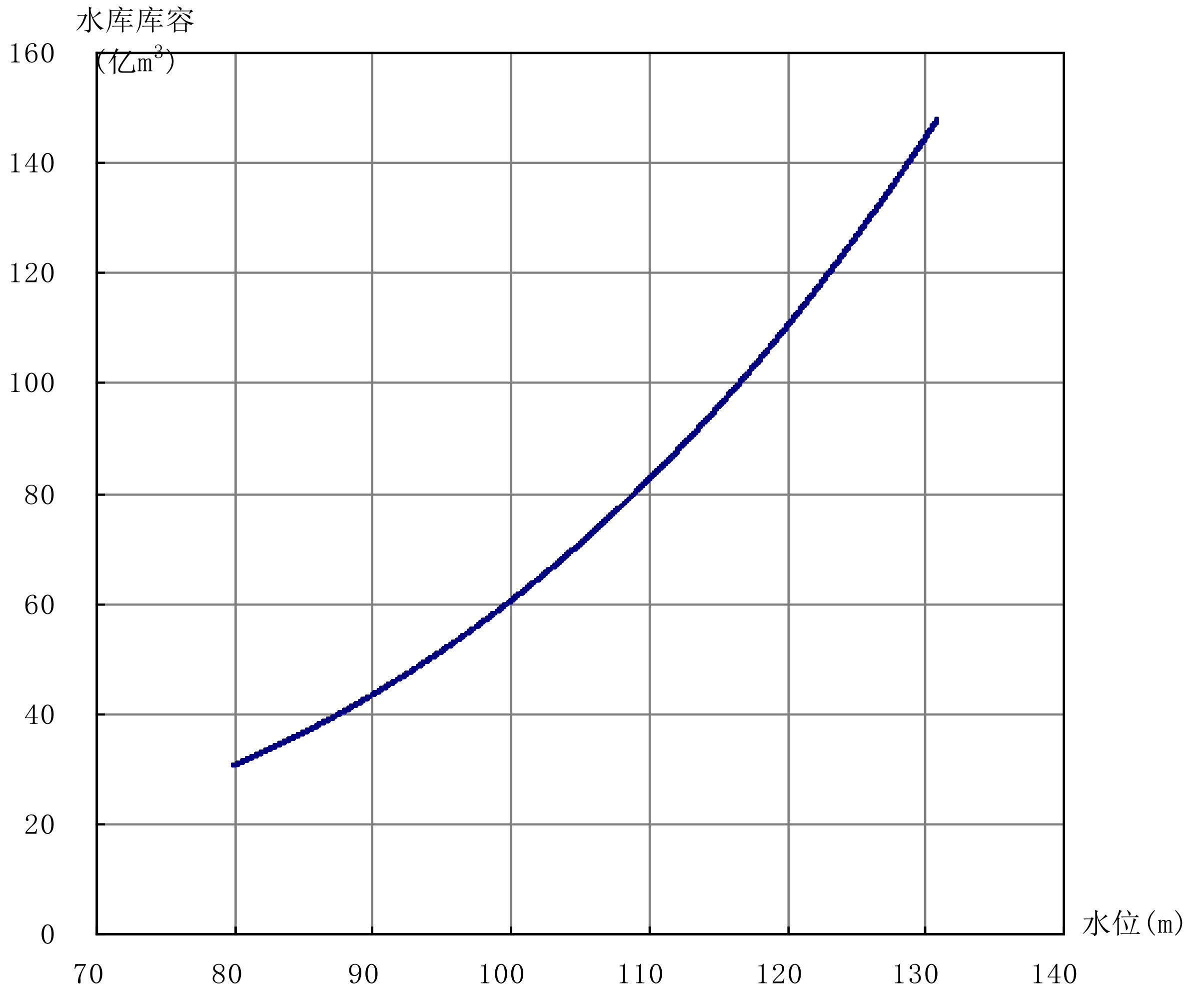
Stability of dam





Monitoring on water project for flood control

Revise of relation curve between Water level and Storage of reservoir by means of remote sensing images



Shuifeng Reservoir（80m～131m）

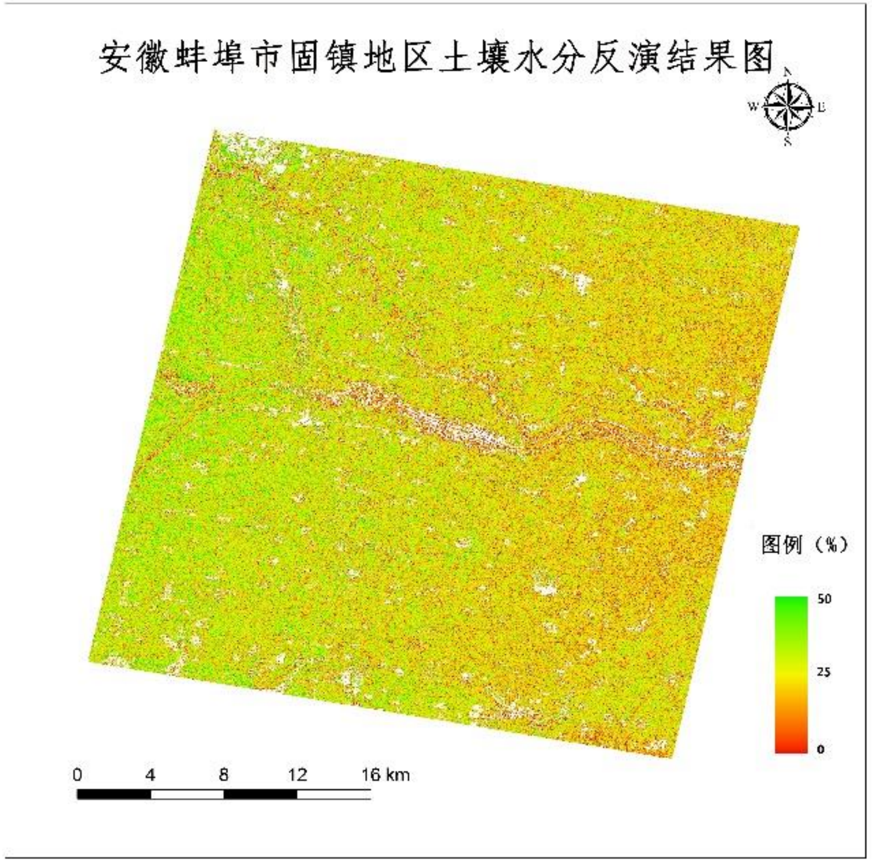
TOPICS

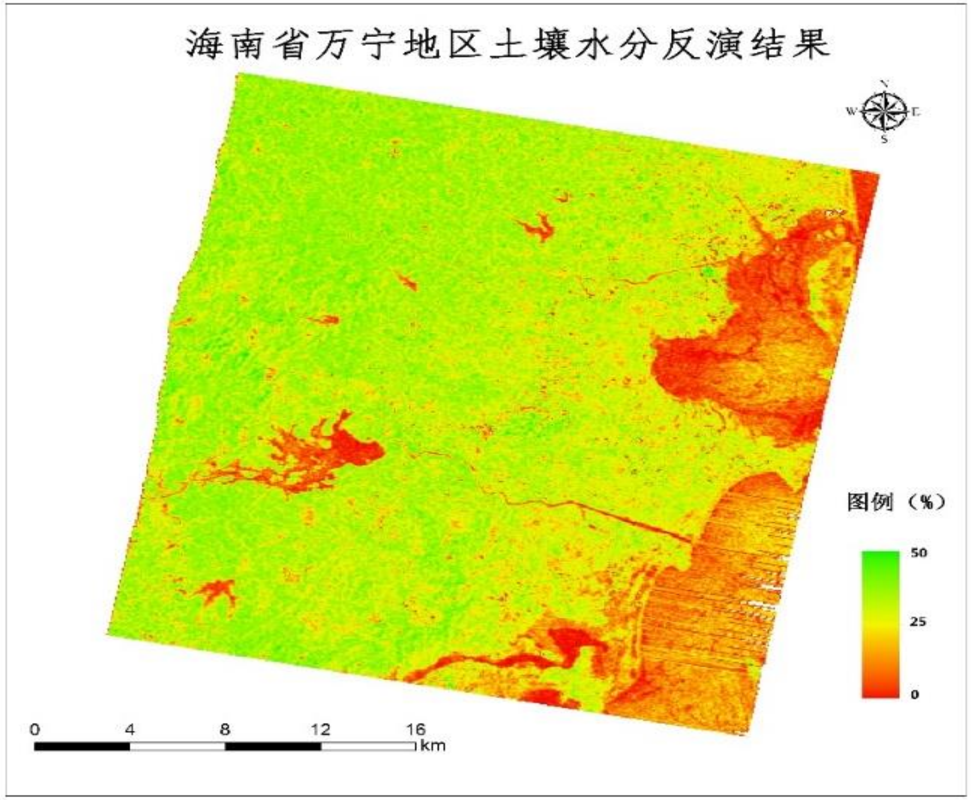
4

1. Flood monitoring
2. Disaster assessment
3. Monitoring on water project for flood control
4. Flood forecasting and risk map

Flood forecasting and risk map

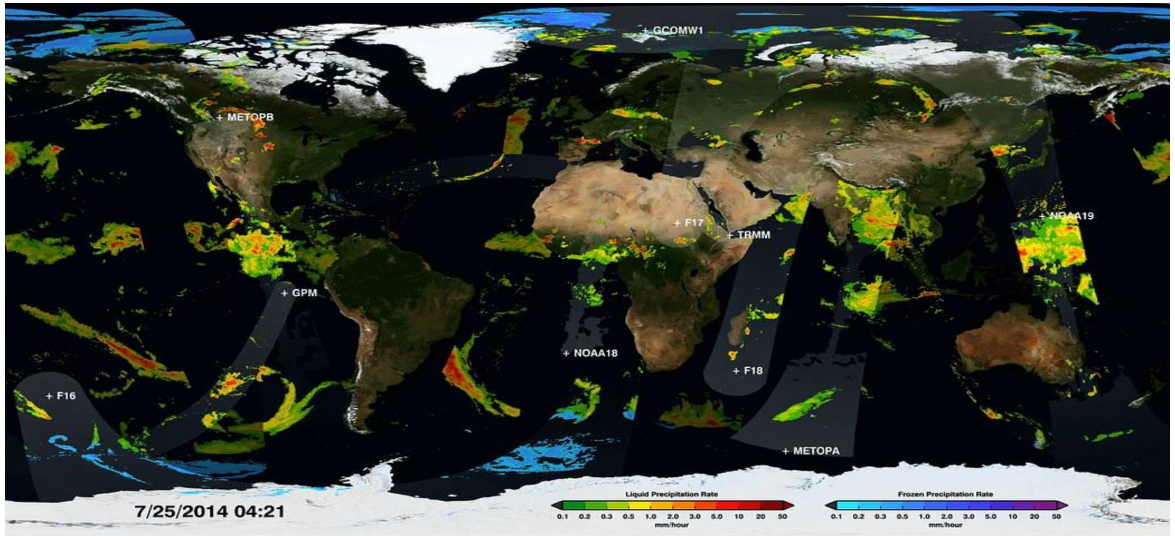
1) Input of flood forecasting system, including precipitation, initial soil moisture content.
Doppler radar, TRMM, GPM, GPS-RS





Flood forecasting and risk map

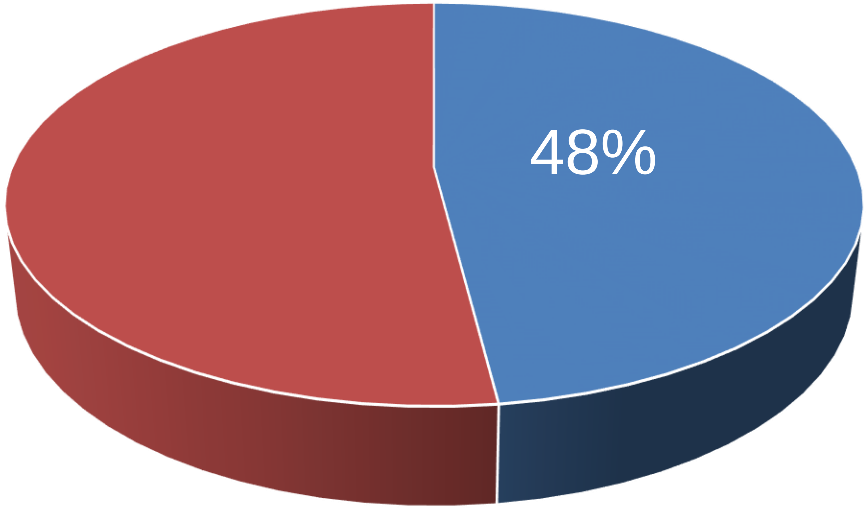
2)Parameter determination according to underlying conditions from remote sensing.
3)Watershed hydrological model on the basis of both water balance and energy balance, which is significant for ungagged basin.

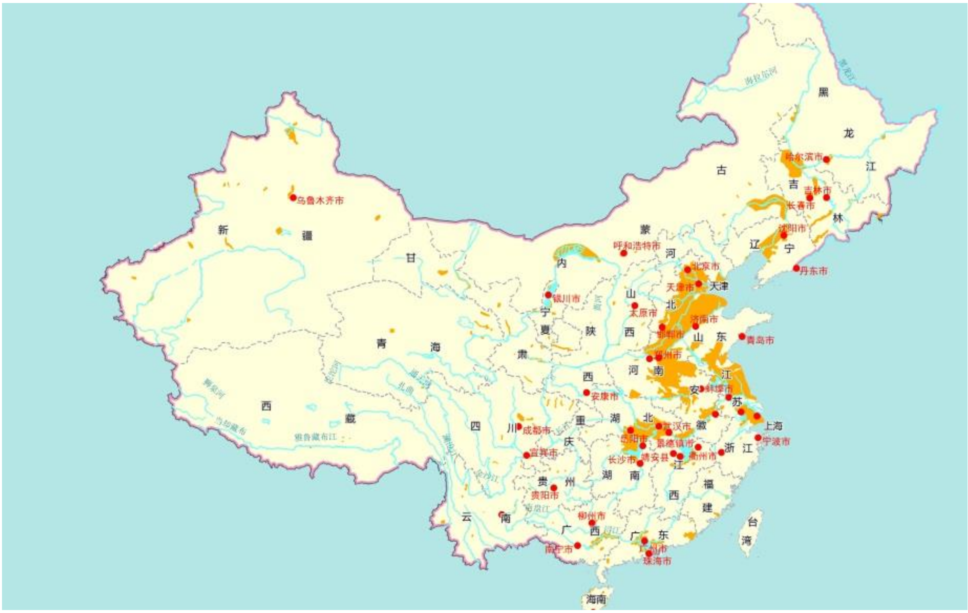


Risk maps reveal the flood risk degree and distribution characteristics under different flood scenarios in key flood control areas of China.

Risk map which has been made covers 496000 km^2, being occupied 48% of the risk region of whole country.

All basic data needed for making risk map are from remote sensing.





198 rivers with the total length of 2700 km、
45 important cities
78 Detention basins with the total area of 29000 km^2
26 flood plains with the total area of 8800 km^2
227 important area for flood detention with the total area of 408100 km^2

Thanks for Attention

lijiren@iwhr.com