



Center for Earth Observation and Digital Earth  
Chinese Academy of Sciences

# Earth Observation Technologies for Wenchuan and Yushu Earthquake Disaster Monitoring and Data Sharing

GUO Huadong  
[hdguo@ceode.ac.cn](mailto:hdguo@ceode.ac.cn)

22<sup>nd</sup> International CODATA Conference  
Oct. 25, 2010 Stellenbosch, Cape Town, South Africa

# May 12, 2008, Great Earthquake Occurred in Wenchuan

- **Time:** 14:28PM 12/05/2008
- **Magnitude:** Ms. 8.0
- **Location of Epicenter:** 103.4°E, 31 ° N
- **Geographic Location:** Wenchuan, Sichuan Province
- **Depth of Seismic Focus:** 14KM
- **Epicentral Intensity:** 11Degree
- **Casualty:** Dead 69,142, Missing 17,551



# April 14, 2010, Great Earthquake Occurred in Yushu



- **Time:** 7:49 AM 14/04/2010
- **Magnitude:** Ms.7.1
- **Location of Epicenter:** 96.6°E, 33.2 ° N
- **Geographic Location:** Yushu, Qinghai Province
- **Depth of Seismic Focus:** 14KM
- **Casualty:** Dead 2,698, Missing 270



# CEODE: Satellite Data Receiving Station System



Miyun ground station



Kashi ground station



Sanya ground station



Data coverage of the three ground receiving stations

# CEODE: Airborne Remote Sensing System



- **Two Cessna Citation S/II Aircrafts**
- **Two ARJ 21-700ER Aircrafts**
- **More than 12 sensors operating from visible-infrared to microwave bands**



# Outline



- I. Wenchuan and Yushu Earthquake Disaster Monitoring**
- II. Earth Observation Data Sharing**
- III. EO and Data-Sharing for Natural Disaster Mitigation**

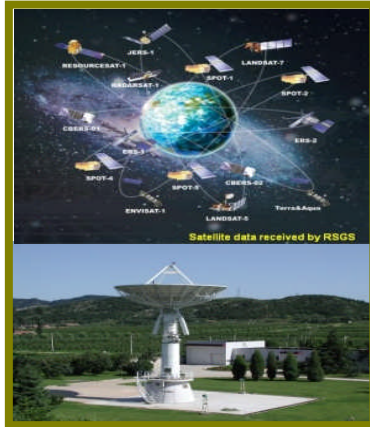


# I. Wenchuan and Yushu Earthquake Disaster Monitoring

# Earth Observation Data Acquisition



Data acquiring



Data Processing



## Satellite Data

### Pre-disaster Data Acquisition

From Satellites:

IRS-P6, LANDSAT-5, SPOT-5, RADARSAT-1, SPOT2/4, IKONOS, etc.

### Post-disaster Data Acquisition

From Satellites:

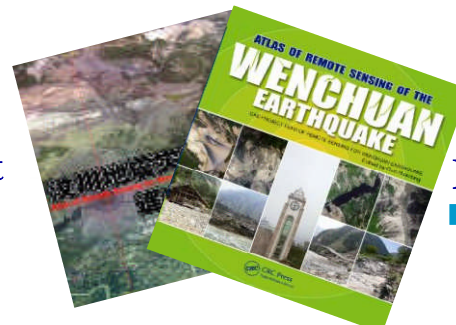
LANDSAT-5, SPOT-5, RADARSAT-1, RADARSAT-2, SPOT2/4, TERRASAR-X, EROS-B, QUICKBIRD, ALOS, etc.

### Overseas Satellite Data through CHARTER

Including:

ASTER, TM, ETM, IKONOS, WORLDVIEW, ALOS, TERRASAR-X, EROS-B, COSMOS, etc.

Disaster Assessment



Decision-making

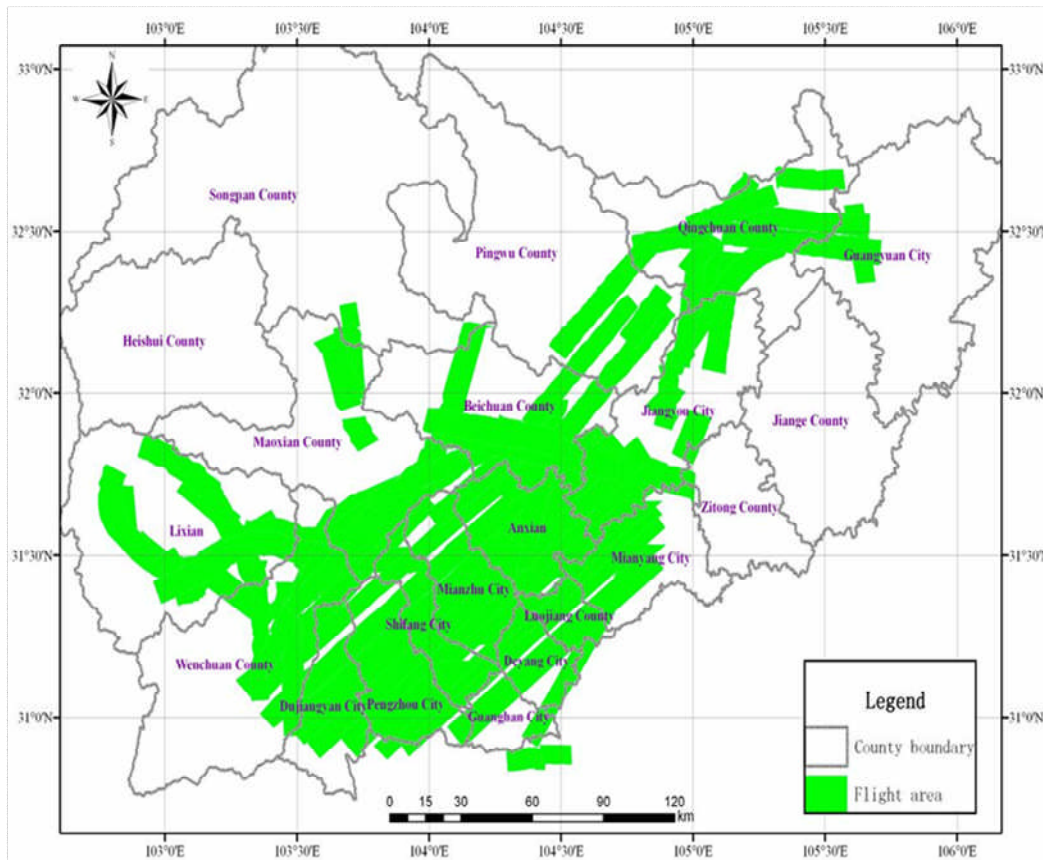




# Earth Observation Data Acquisition



**Airborne Remote Sensing data acquired Post-quake during from May 14 – Jun. 5**



**Airborne optical remote sensing covered above 20000 km<sup>2</sup> and data amounted 5.3 TB.**

**SAR remote sensing covered above 40000 km<sup>2</sup> and data amounted 18.5 TB.**

**CEODE sent two Remote Sensing aircrafts to the earthquake affected areas, one with optical sensor, and another with one SAR**



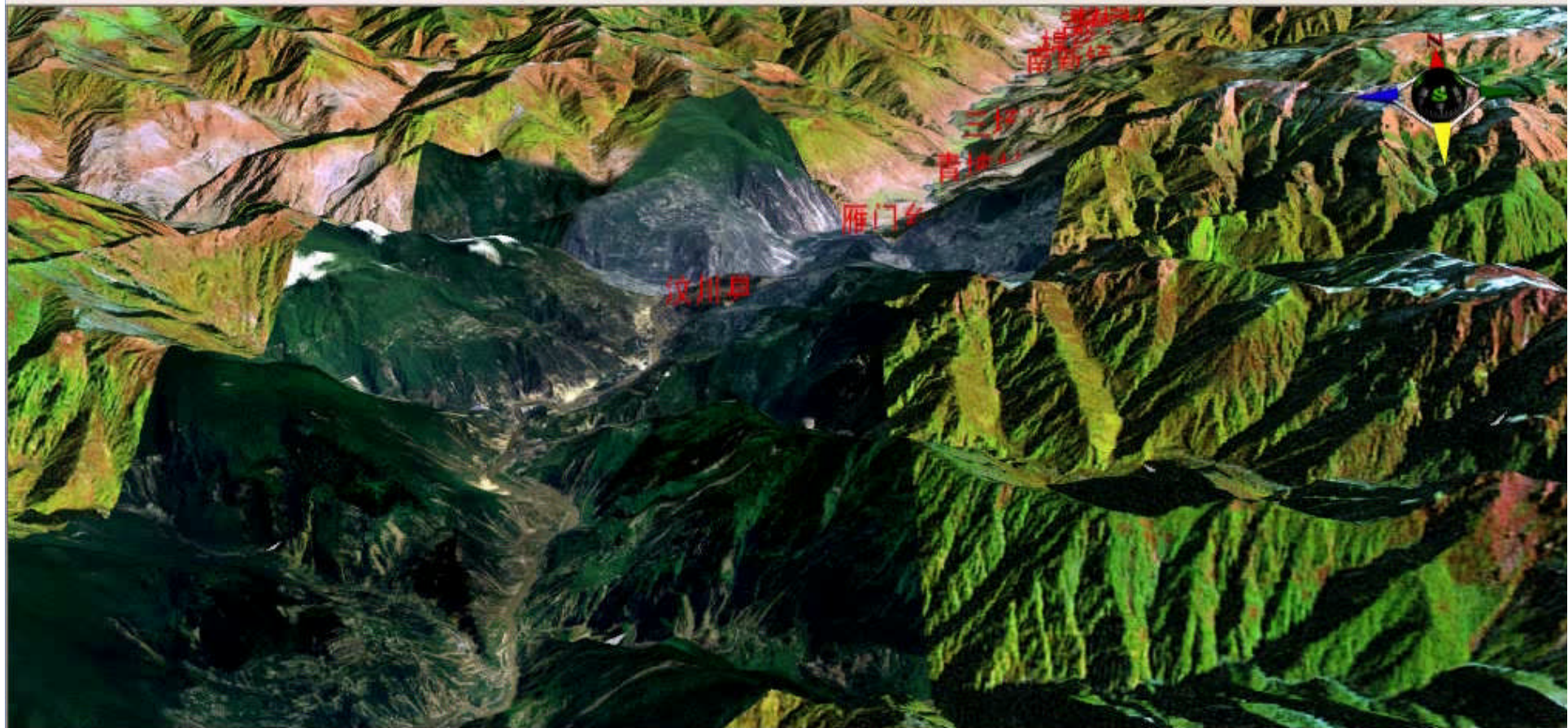
- Wenchuan Earthquake

地震灾害三维模拟与评估系统



文件(E) 编辑(E) 设置(S) 视图(V) 帮助(H)

1 2



就绪

步行 飞行 取消碰撞 鼠标转向 相机位置: 358039.9,3465557.3,8713.2 | 当前位置

# Collapsed Building Monitoring



**A. Beichuan Middle School**



**B. Agriculture Bank**



**C. Beichuan Hotel**

# Relocation of Town of Beichuan



Before Earthquake



After Earthquake



# Annual Monitoring of Wenchuan Earthquake Area



May, 2008

May, 2009

April, 2010



# Annual Monitoring of Wenchuan Earthquake Area



May, 2008

May, 2009

April, 2010



# Annual Monitoring of Wenchuan Earthquake Area



May, 2008

May, 2009

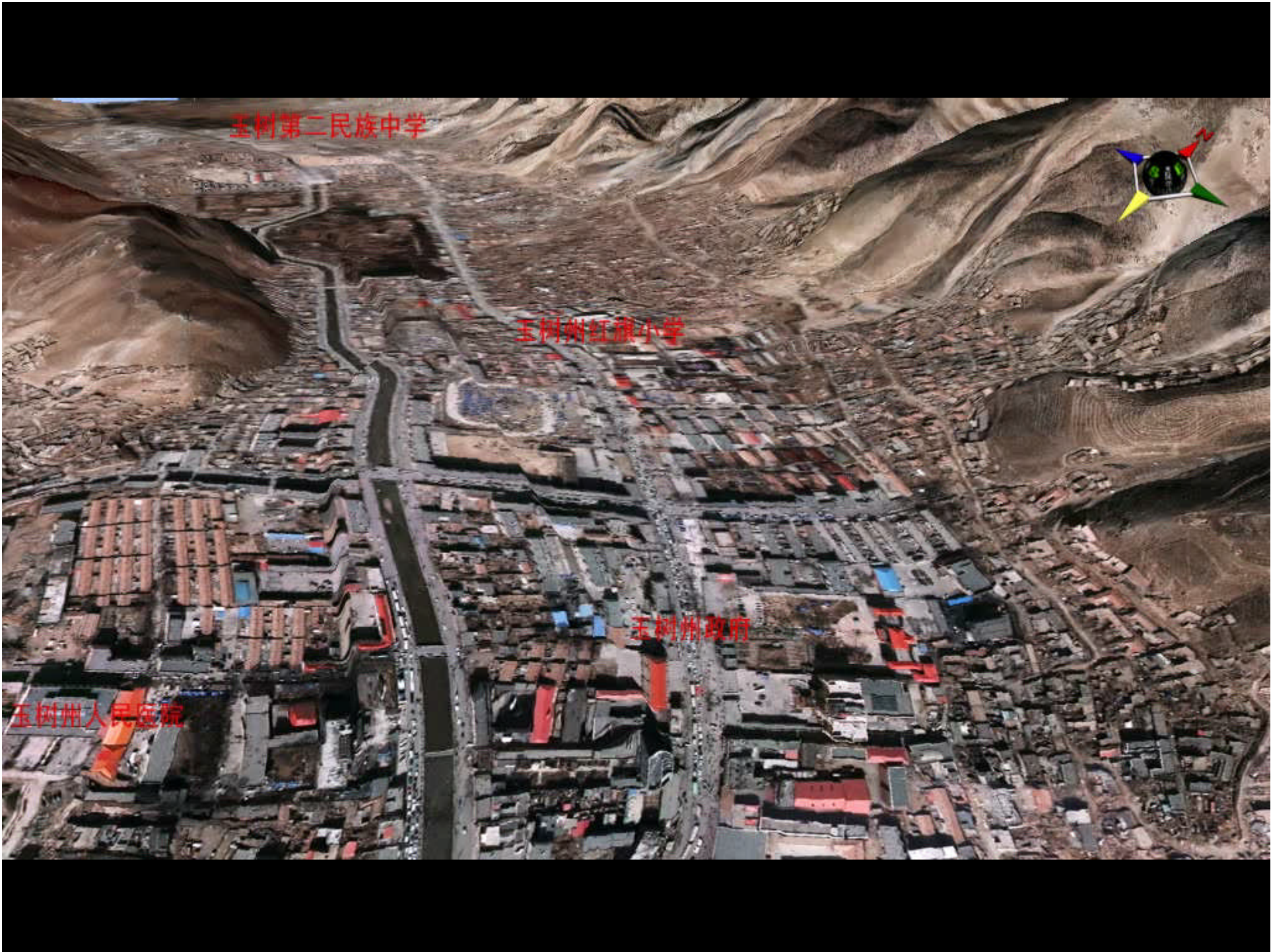
April, 2010







- Yushu Earthquake



玉树第二民族中学

玉树州红旗小学

玉树州政府

玉树州人民医院

# Collapsed House Rate Assessment



## *House-collapsing in spongy alluvial-fan foundation*



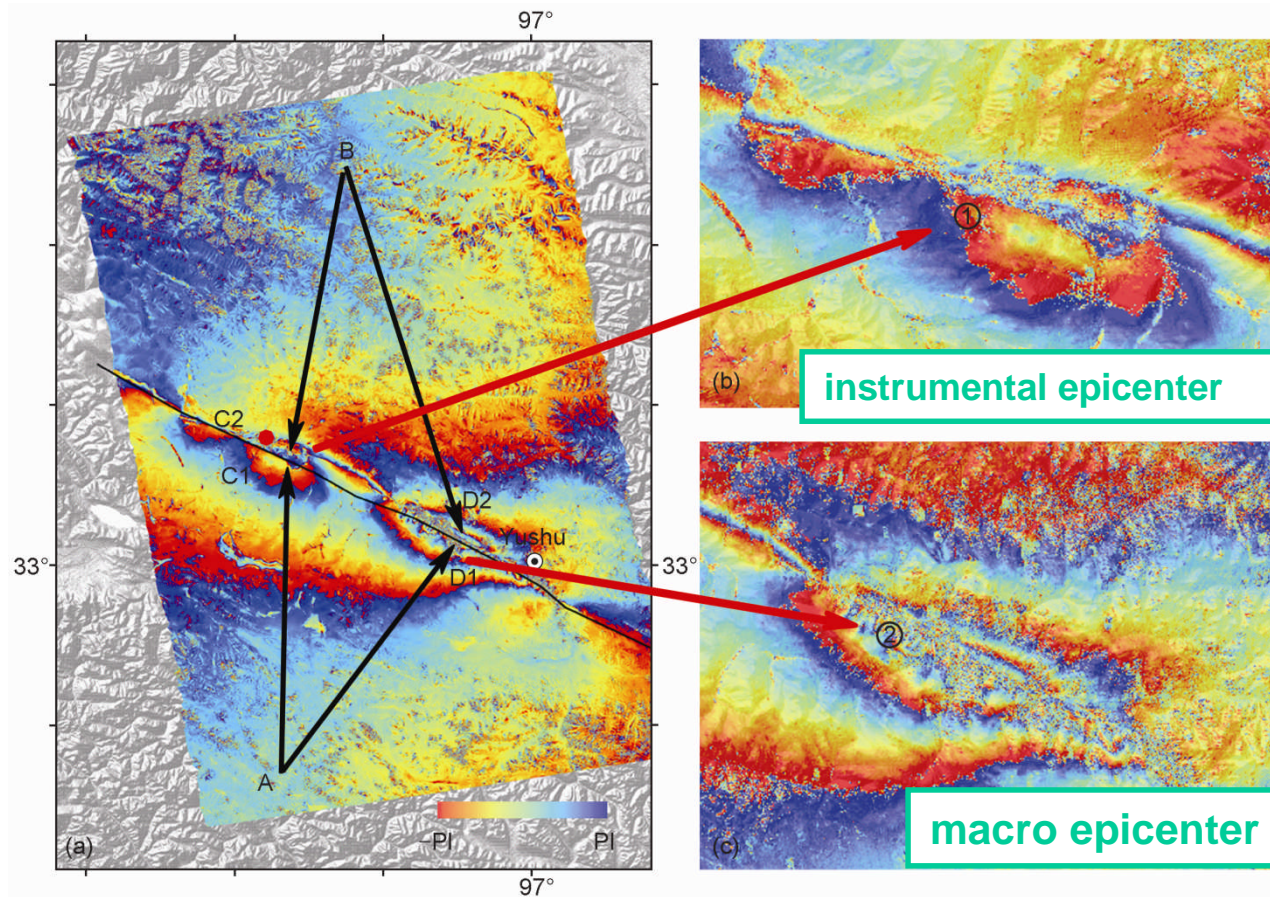
**Collapsed buildings on the Zhaxike alluvial fan.**

**(Red: Collapsed buildings;**

**Green: Standing buildings)**

**The house-collapse level on the Zhaxike alluvial fan was up to **85%**.**

# Deformation Field Analysis



**Data source:** PALSAR

**Beam mode:** Standard

**Acquired Date:** Apr. 17, 2010  
Jan. 15, 2010

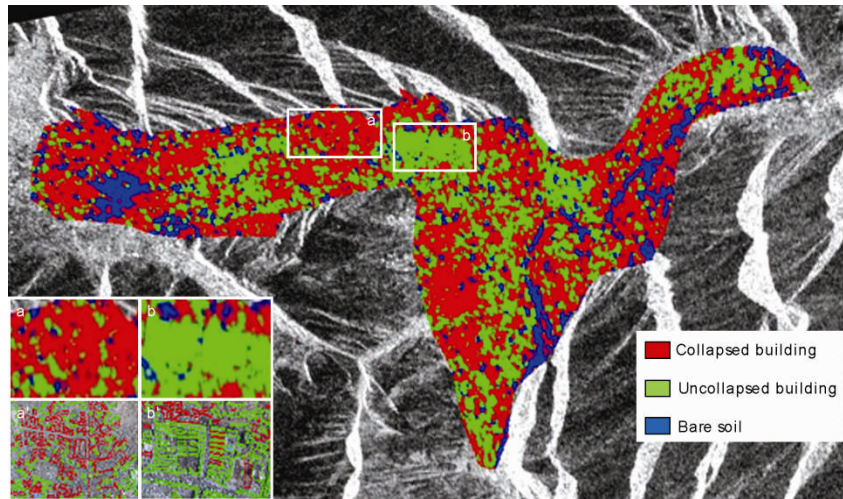
**Method:** SAR interferometer

**Objective:**

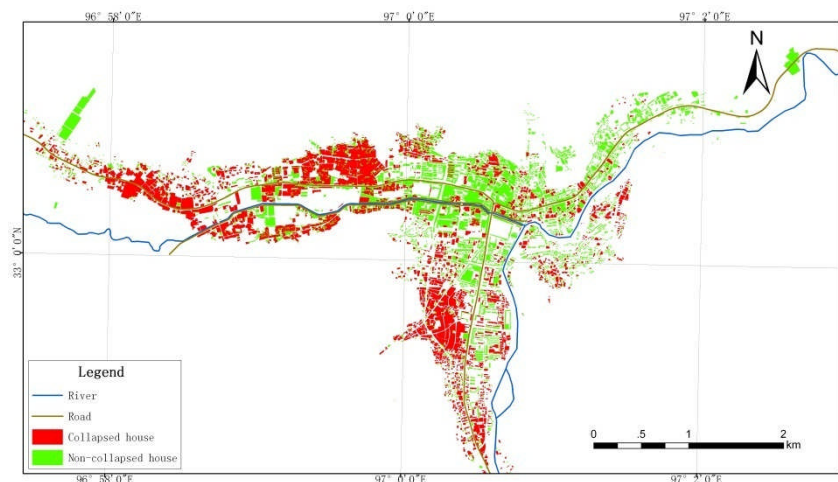
To assess the size and spatial distribution of the surface deformation field due to the Yushu earthquake.

- Two obvious slip zones were found, which coincided well with the instrumental epicenter and macroscopic epicenter.
- The line-of-sight displacement located at the main fault zone of the Yushu earthquake was not less than 94.4 cm.

# Extraction of Collapsed Buildings from PolSAR



Extraction of  $H-\alpha-\rho$  method from PolSAR image



Manual interpretation results from high resolution optical images

- From Radarsat-2 Polarimetric SAR data, the  $H-a-r$  method was used to extract the spatial distribution of building collapse caused by the earthquake in the Yushu urban area.
- The results are compared with the manual interpretation results from high-resolution optical images.

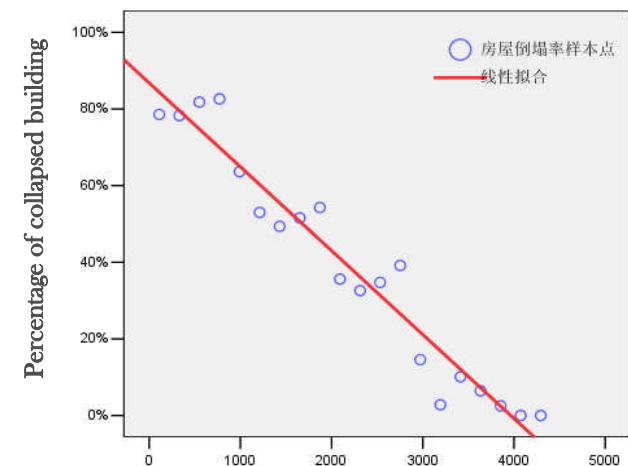
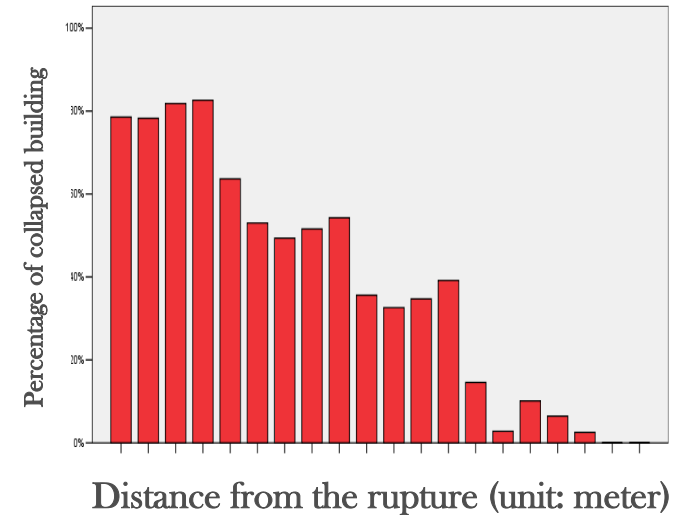
- PolSAR analysis showed that the percentage of collapsed buildings in the Yushu urban area that was devastated by the earthquake amounted to **58%**.
- The accuracy rates for the identification of collapsed and uncollapsed buildings using the  $H-a-r$  method are **88%** and **80%**, respectively.

# Assessment on Collapsed Buildings



## Due to the distance from the principal rupture

- House collapse ratio declines with increased distance from principal fracture (Ganzi-Yushu fault ).
- The collapse ratio was reduced to zero at 4 km distance from the principal fracture.
- The earthquake apparently released most of its energy along the principal fracture.
- The fitting precision between the distance to house and collapse level is high with  $R^2$  up to 0.94.



Linear fitting result of house collapse rate and its distance to principal rupture.

# CEODE: Set up the Emergency Response System



## Data acquiring



## Emergency



**CEODE**



## Emergency response system



Airborne optical remote sensing covered above 20000 km<sup>2</sup> and data amounted 5.3 TB

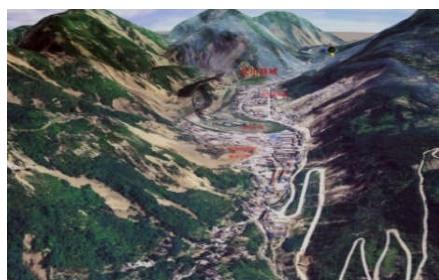


Collapsed Buildings



Barrier Lakes

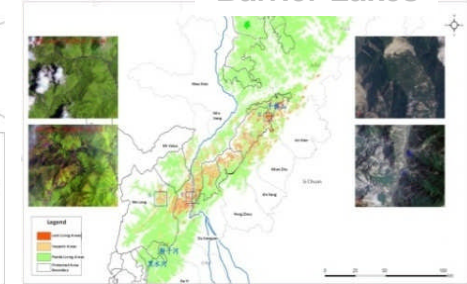
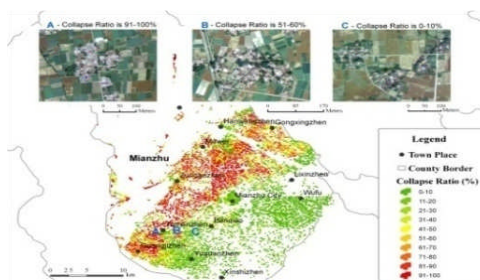
## National and international Cooperation Mechanism



Beichuan County Town After the Earthquake



Beichuan County Town Before the Earthquake





## **II. Earth Observation Data Sharing**





# Data Sharing Mechanism

- ① Freely Copy
- ② Freely Download
- ③ Data Exchange
- ④ Coordination
- ⑤ International Aid

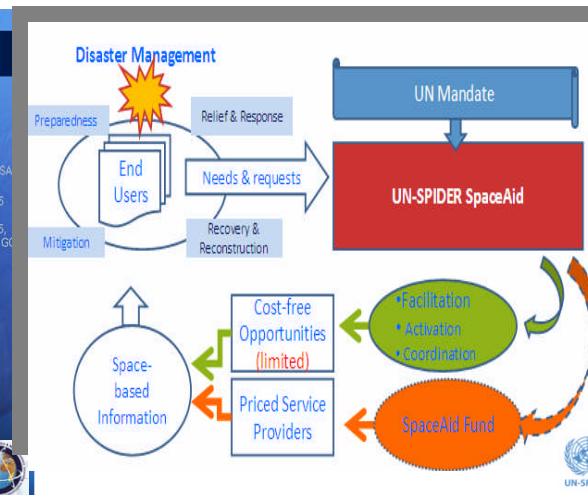
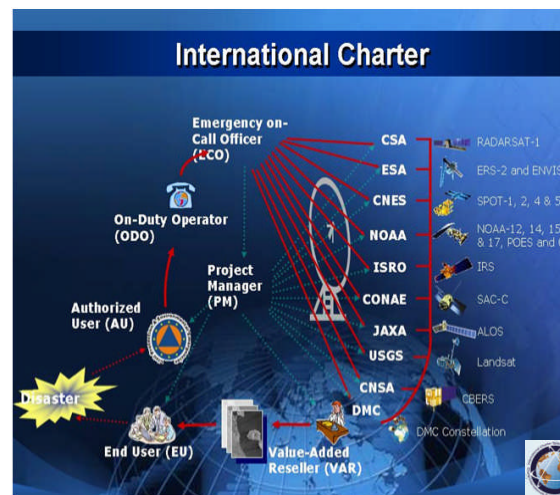


A data sharing mechanism for earthquake events was set up by the Ministry of Science and Technology (MOST) and Chinese Academy of Sciences, which were joined by 13 Ministries such as MLR, MWR, etc.

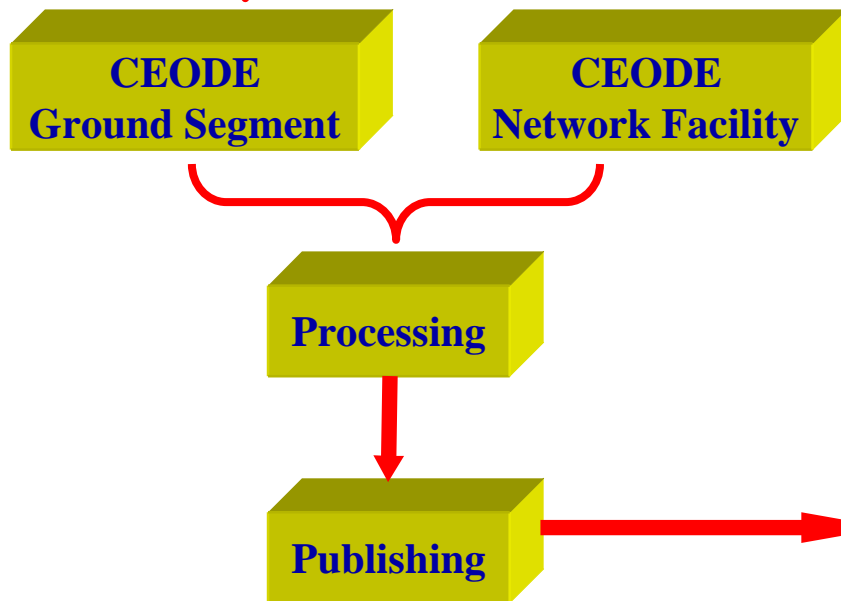
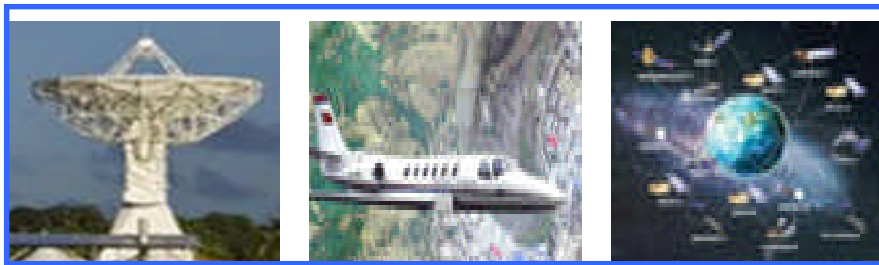
**CEODE is appointed to be the “pool” of earth observation data for the earthquake disaster response by the MOST**

## International Data Sharing

- International Charter on Space and Major Disasters
- United Nations Space-based Information for Disaster Management and Emergency Response (UN-SPIDER)

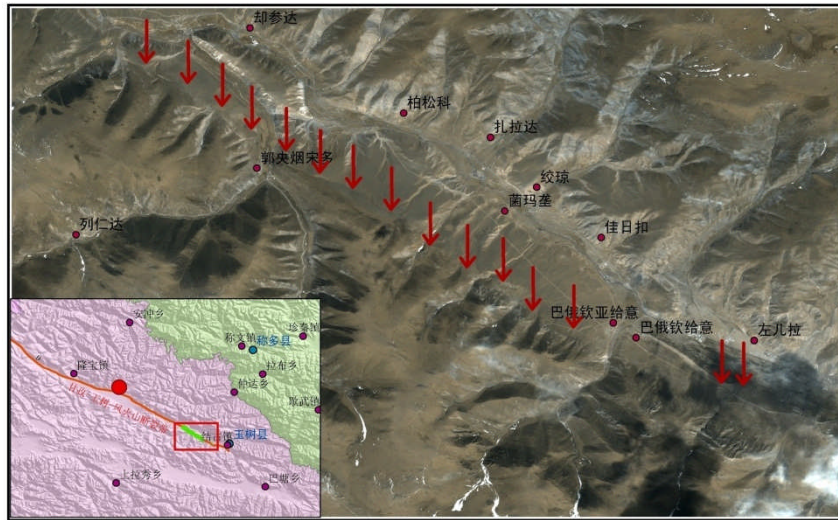


# Emergency Data Sharing Service Framework



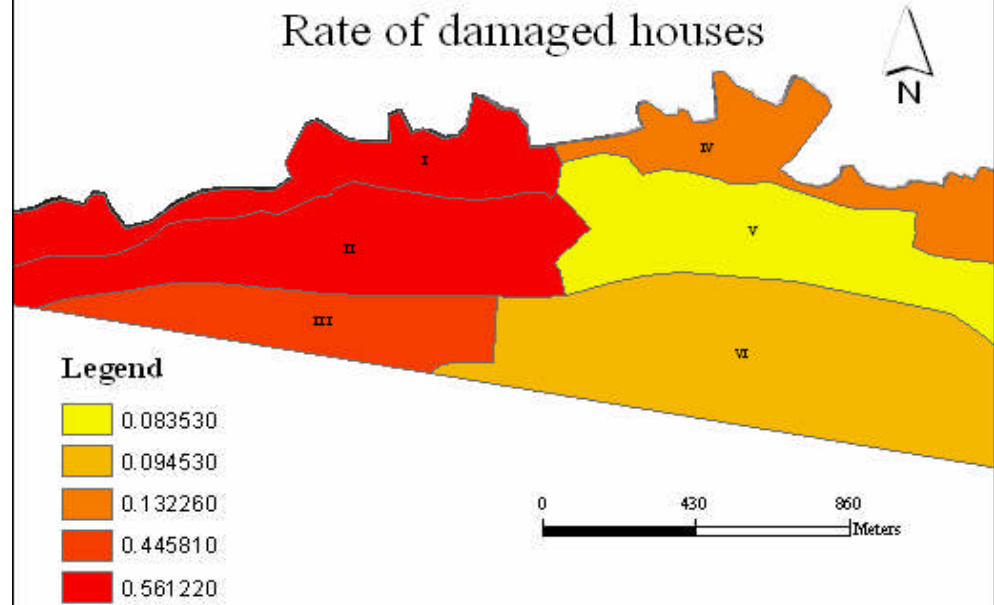
- Emergency Response Office of State Council
- State Bureau of Surveying and Mapping
- National Committee on Disaster Reduction
- China Earthquake Administration
- Ministry of Civil Affairs
- Ministry of Water Resources
- Ministry of Land and Resources
- General Headquarters of People's Armed Police
- Local Government
- Public

青海玉树Ms7.1级地震地表破裂带分布图



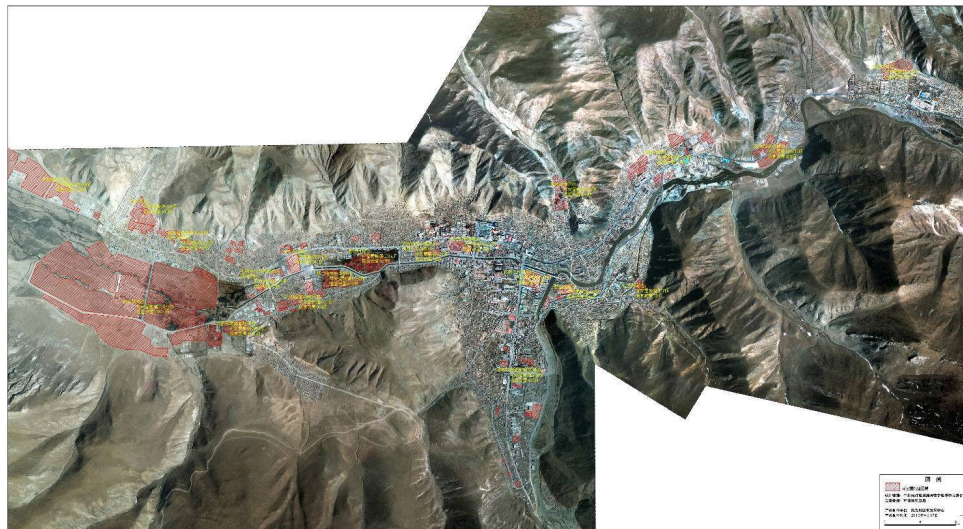
遥感数据由中国科学院对地观测与数字地球科学中心提供 2010年4月15日拍摄  
中国地震局地震应急遥感技术协调组 中国地震局地震预测研究所 中国地震灾害防御中心 2010年4月21日制作

Rate of damaged houses



## National Disaster Reduction Center of China

青海省玉树地震灾区结古镇周边地区帐篷安置分布评估



青海省玉树县结古镇城区4月19日灾民安置点监测图



# Data Sharing for the Public



sina 新闻中心

<http://news.sina.com.cn/photo/qhearthquakephoto/index.shtml>

玉树县结古镇



玉树县结古镇震后4月17日航空影像图

2010年04月18日 21:22



结古镇震后4月15号卫星影像地图

2010年04月18日 21:24



结古镇震前卫星影像地图

2010年04月18日 21:33



玉树地震建筑物震后4月17号航拍

2010年04月18日 21:37



玉树地震建筑物震后4月15号航拍



玉树地震建筑物震前航拍



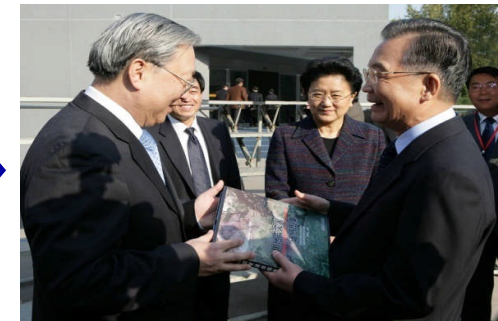
玉树地震建筑物2震后4月17号航拍



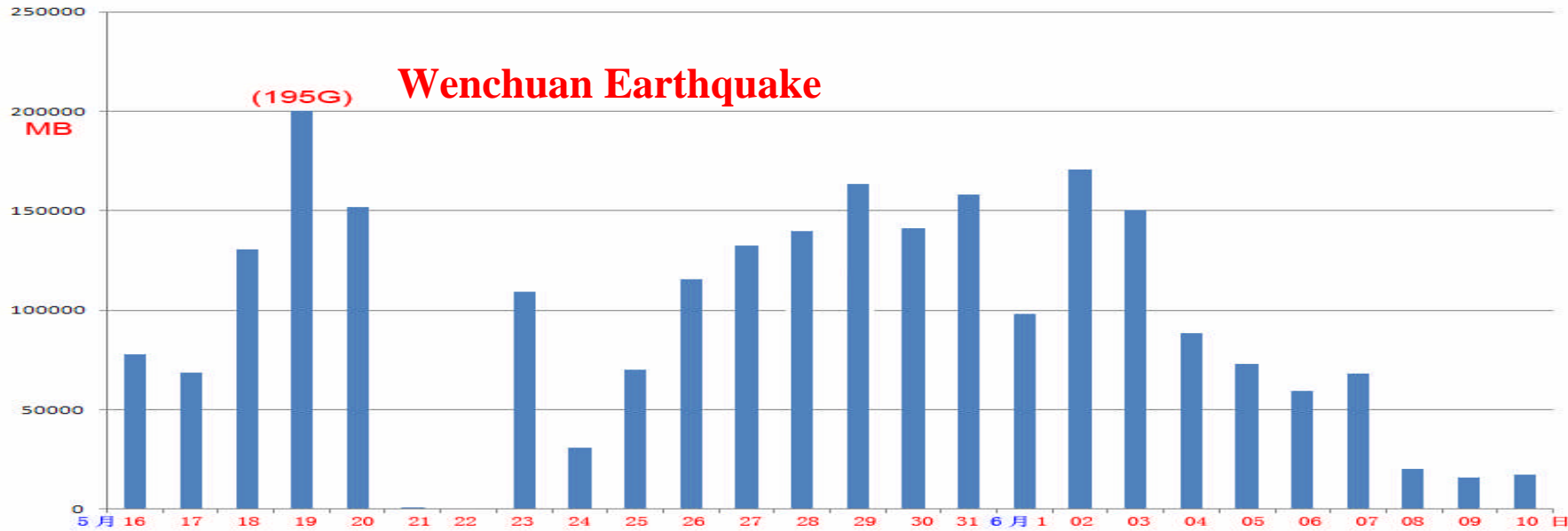
玉树地震建筑物2震后4月15号航拍

“Sina.com”, the biggest Chinese news website, published **31** remote sensing images provided by CEODE during Yushu earthquake. There were **15 million hits** in one week after the earthquake.

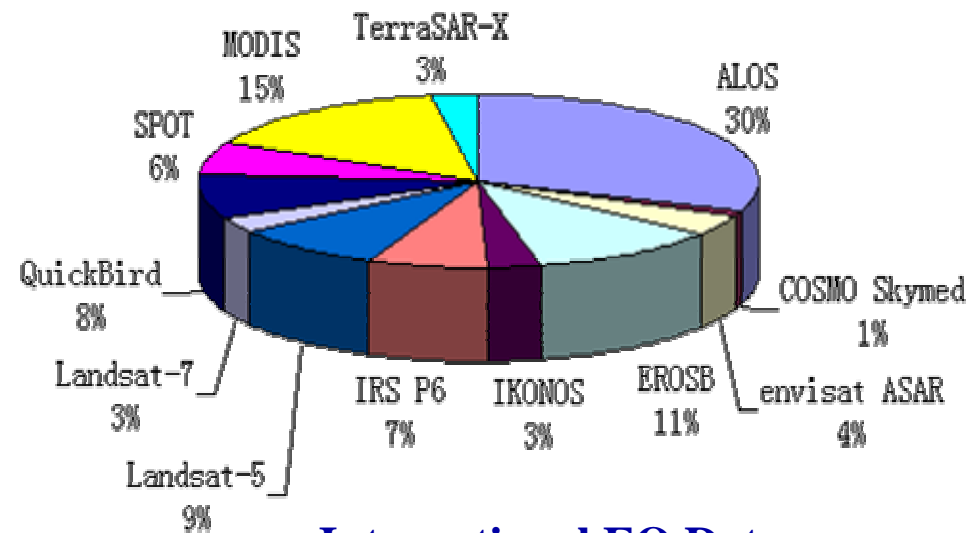
Result of Remote Sensing for Wenchuan Earthquake has served the high-level decision-makers.



# Data Shared Statistics



An amount of **5.89TB** of EO data had been freely accessed from CEODE during Wenchuan earthquake, **10%** of these were directly downloaded through the network.



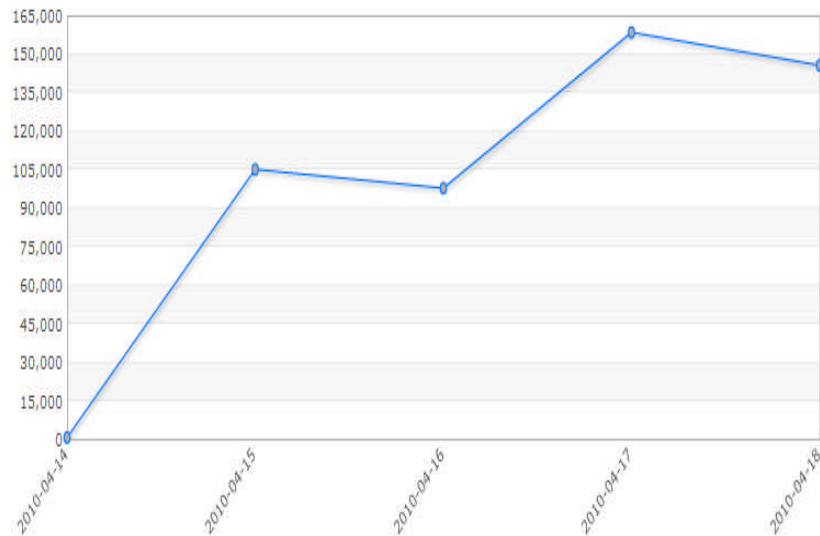
**International EO Data**

# Statistics of hits to CEODE website during Yushu Earthquake, with rush peak of *160,000 hits* per day.

## 访问次数统计

统计范围: 对地观测中心 中文版 2010年04月14日至2010年04月18日

总访问次数: 507,933



## Upgraded Capability of Data Sharing

April 14, 2010

- 7:49:38 Yushu Earthquake
- 22:03 The first several scenes of airborne data arrived in Beijing
- 22:10 Pre-earthquake Landsat-5、Spot-5 data free to the public
- 22:15 The first several scenes of airborne data over disaster region free to the public

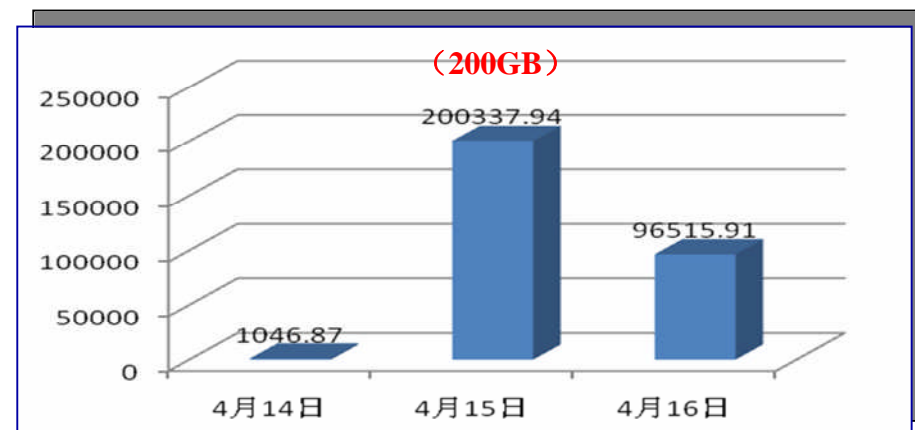
April 15

- 06:34 First large quantity of airborne data free to the public

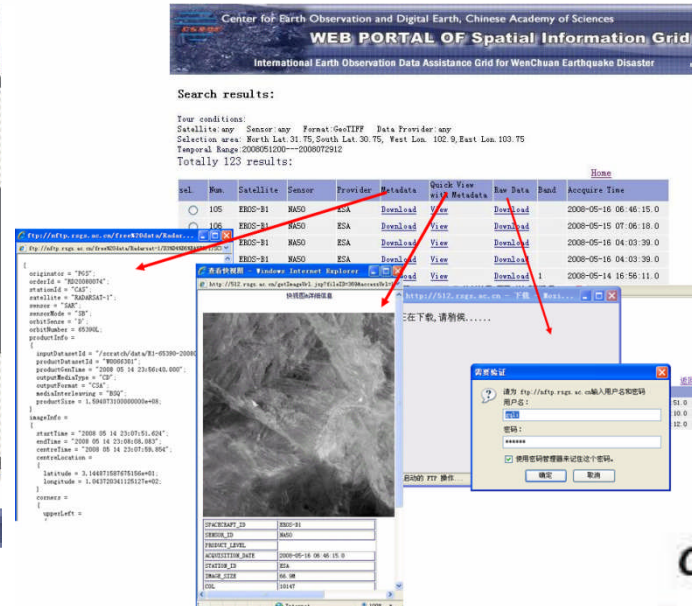
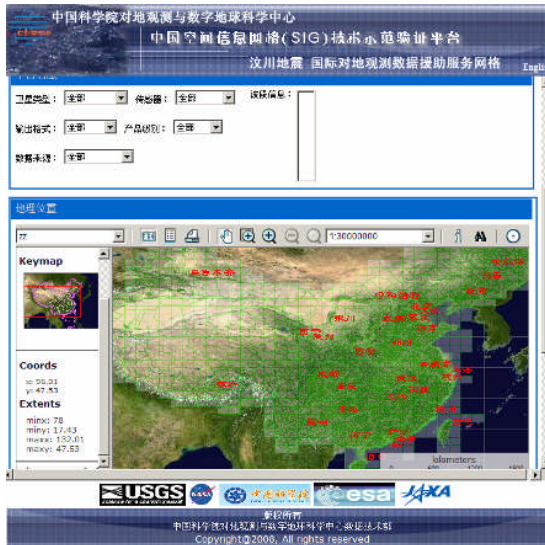
April 16

- 01:00 Second large quantity of airborne data free to the public
- 21:00 Third large quantity of airborne data free to the public
- .....

An amount of **4.85TB** of imagery had been freely accessed from CEODE during the Yushu Earthquake, **20%** of these were directly downloaded through the network.



# Cyber Tech Promoting EO Data Sharing

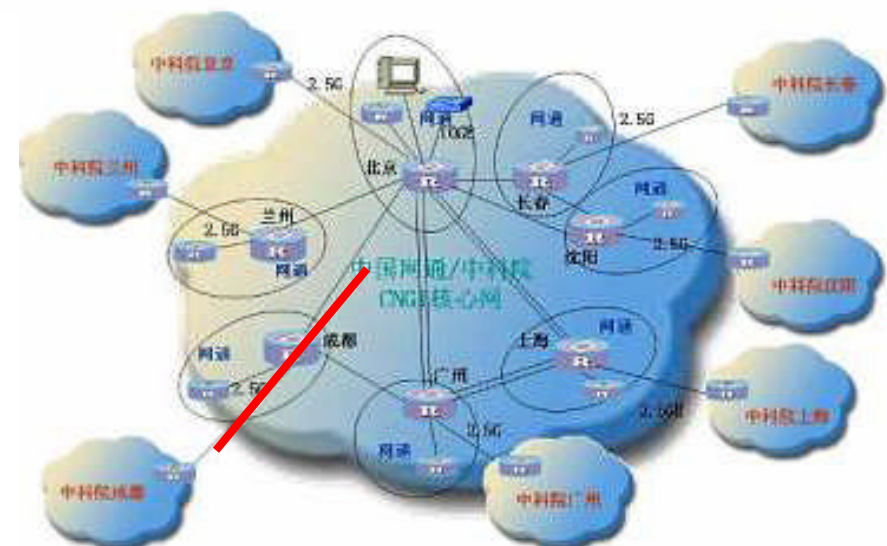


## Grid-based Distributed Earthquake Data Harvesting

**CNGI (IPv6) supported long distance disaster NRT transmission**

( It reduced the cost of large airborne data transmission **delay from 10 hours to 1 hour** )

### CNC/CAS CNGI Backbone

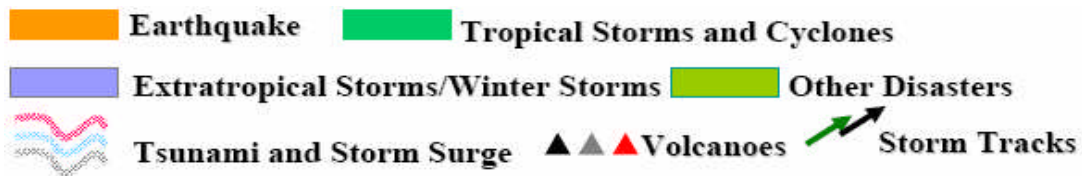
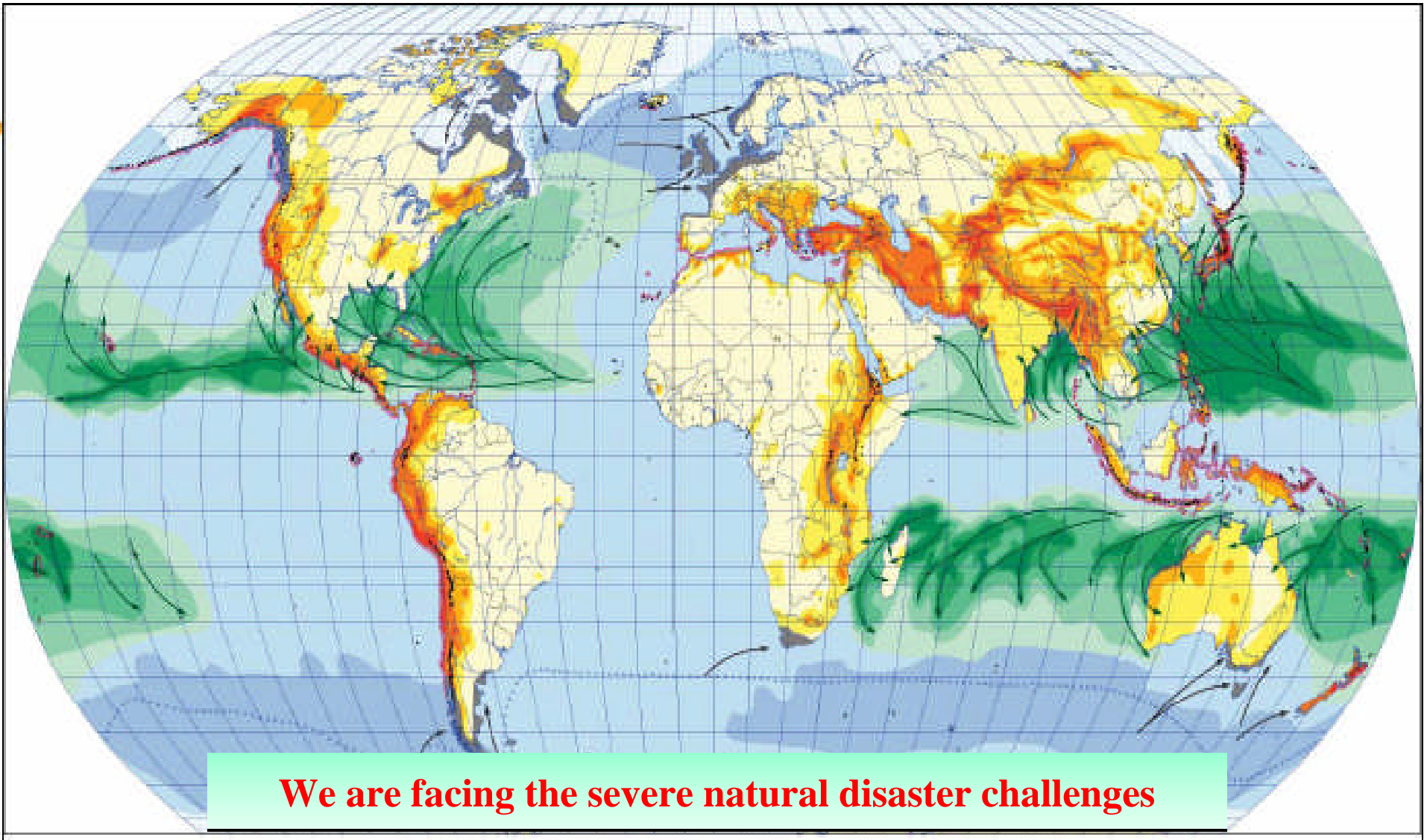


Fast network route used in Yushu Earthquake



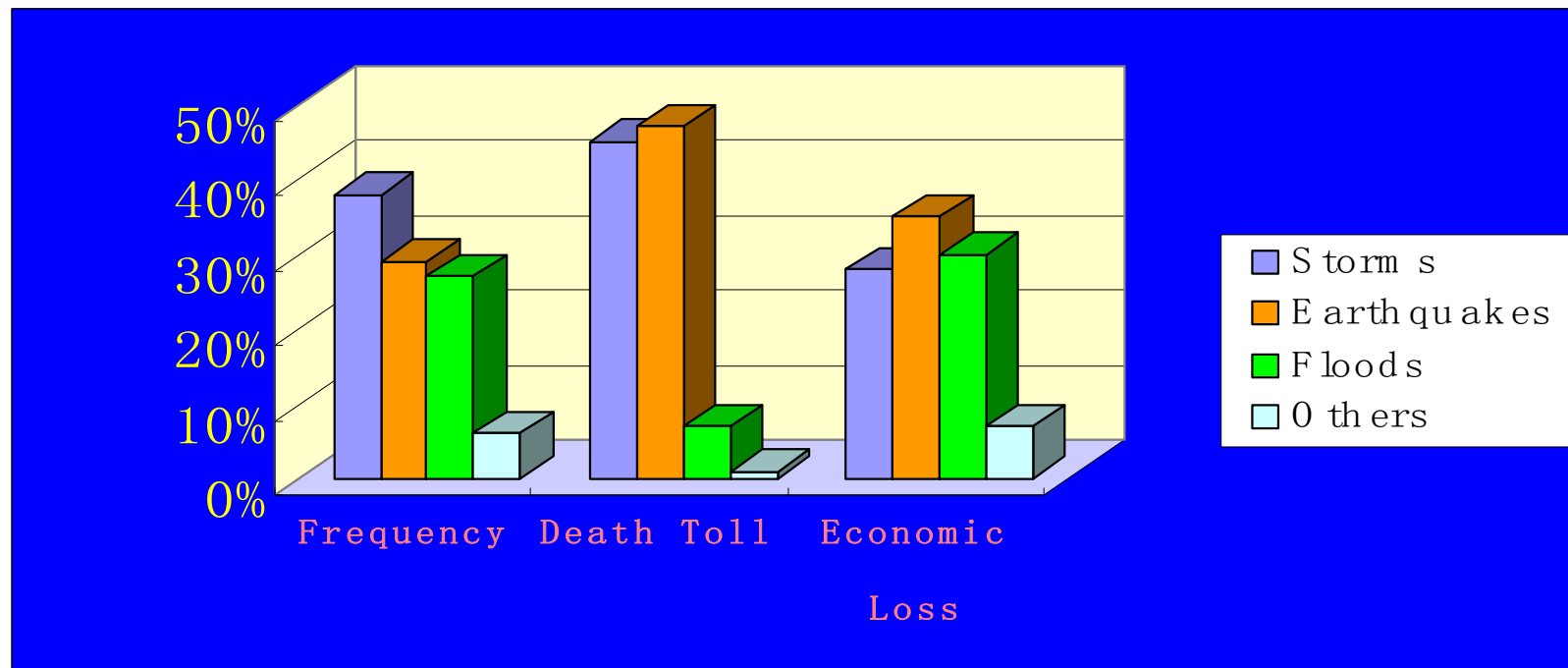
# III. EO and Data Sharing for Natural Disaster Mitigation





From 1950 to 2008 ,the great natural disasters have resulted in:

- A death toll of up to 2 million
- Economic losses up to US\$ 1950 billion

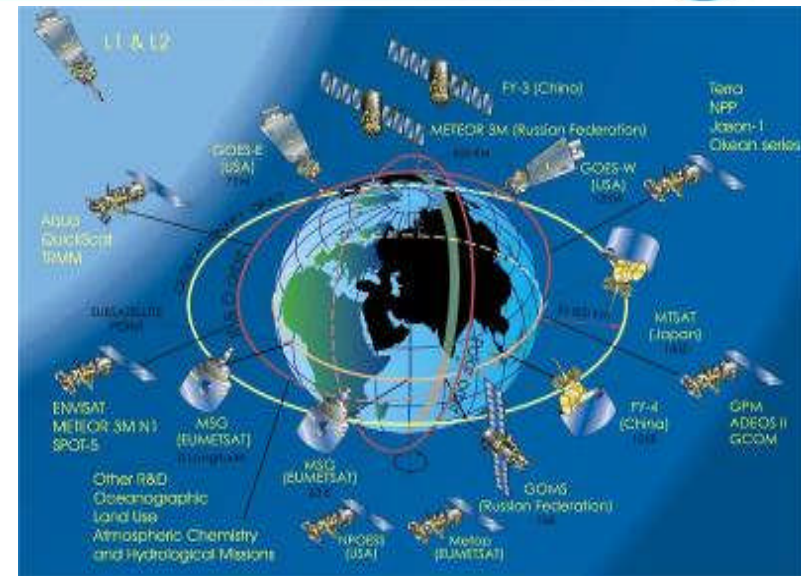


**Storm, Earthquake and Flood:** the major three natural disasters

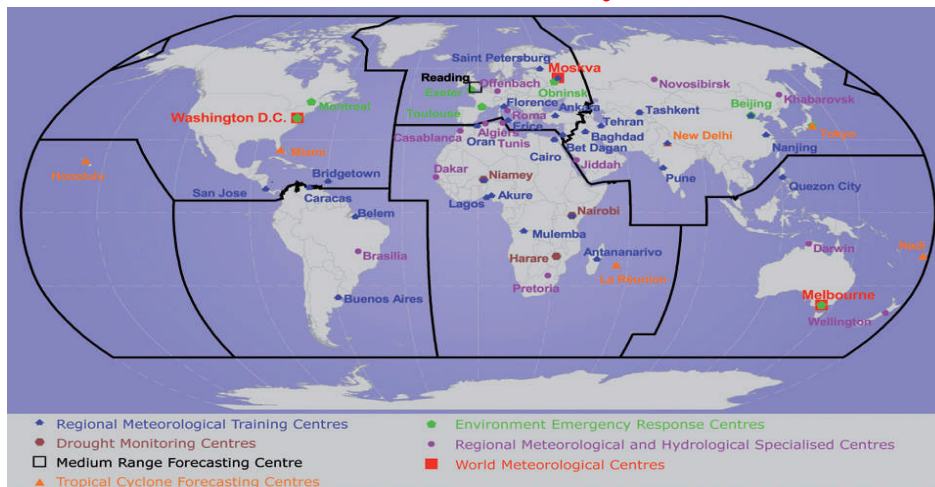
# EO & ICT for Natural Disaster Reduction



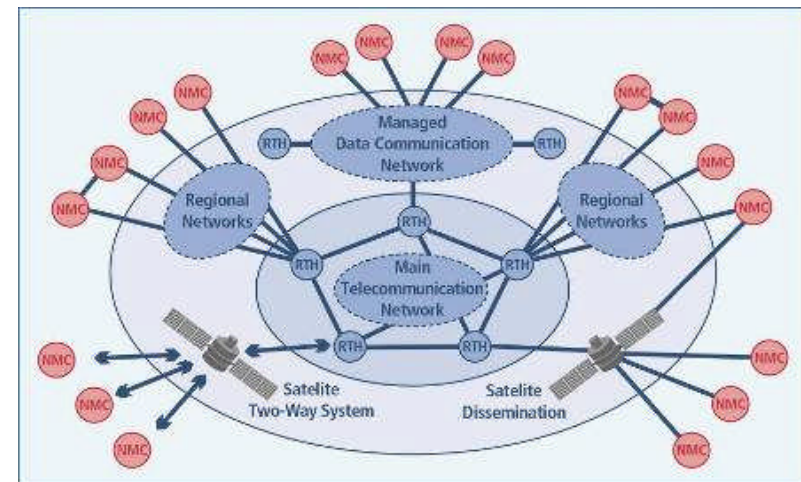
Global Observation System



Coordinated Satellite Activities



Global Data Processing and Forecasting



Global Telecommunication System



## PRESS RELEASE

Friday 13 November 2009. For immediate release.

## China to host new international disaster research programme

**Paris, France**—The International Council for Science (ICSU) today announced that China will host the office of the new international programme, Integrated Research on Disaster Risk (IRDR). The International Programme Office for IRDR will be established in Beijing at the Headquarters of the Center for Earth Observation and Digital Earth (CEODE)—the first time an international office of this type has been hosted in Asia.

The IRDR is a major new 10-year international research programme that aims to provide answers to the growing global problem of disasters and how countries can reduce the root causes of disaster risk. In a break from past approaches, it will combine diverse expertise and perspectives into one coordinated effort, drawing on the natural, socio-economic, health and engineering sciences.

ICSU, along with the other IRDR co-sponsors—the International Social Science Council (ISSC) and the United Nations International Strategy for Disaster Reduction (UN ISDR)—selected Beijing following an international call for offers. The office will be jointly funded by the China Association for Science and Technology (CAST) and the Chinese Academy of Sciences (CAS).



- **To provide answers to the growing global problem of disasters; and**
- **How countries can reduce the root causes of disaster risk.**

## Integrated Research on Disaster Risk ( IRDR )

- **EO technology plays an irreplaceable role in emergency monitoring and assessment for major natural disasters.**
- **Earth observation data sharing is key for end users and decision-makers.**

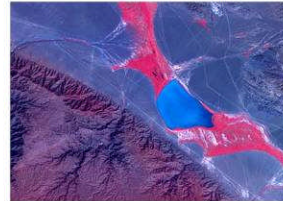
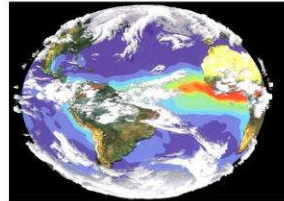


**“The success of GEOSS will depend on a commitment by all GEO partners to work together to ensure timely, global and open access to data and products.”**

**- GEOSS 10-Year Implementation Plan**

**For natural disaster mitigation **TIMELY** data sharing is most important.**

# Thanks



Center for Earth Observation and Digital Earth  
Chinese Academy of Sciences

Add: No.9 Beiyitiao Road, Zhongguancun, Beijing China 100190

Tel: 86-10-58887301 Fax: 86-10-58887302

E-mail: [office@ceode.ac.cn](mailto:office@ceode.ac.cn)

Web: [www.ceode.ac.cn](http://www.ceode.ac.cn)