



Institute of Remote Sensing and Digital Earth
Chinese Academy of Sciences

Protecting World Heritage from Natural Hazards through Earth Observation Technology

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Impact may disasters have on World Heritage



- Global climate change is also exposing World Heritage natural properties and the ecological systems that sustain life to increasing disaster risks.
- Disasters pose risks not only to the physical attributes that carry the heritage values of the property, but also to the **lives of visitors, staff and local communities** living on the site or in neighboring areas, and also to important collections and documents.

Impact may disasters have on World Heritage



Bam (Islamic Republic of Iran) due to earthquake in 2003



Before



After

Impact may disasters have on World Heritage



Bam (Islamic Republic of Iran) due to earthquake in 2003



Impact may disasters have on World Heritage



Bam (Islamic Republic of Iran) due to earthquake in 2003



Impact may disasters have on World Heritage



- **UNEVEN SETTLEMENT OF LAND AND LAND SLIDE IN HILLS**



WALL CRACKS



STRUCTURAL CRACKS – BADRINATH TEMPLE FACADE



After

Impact may disasters have on World Heritage



Edinburgh Old Town Fire - December 2002



Impact may disasters have on World Heritage



Temple of the Tooth Relic in Kandy (Sri Lanka) after terrorist attack in 1998



Why Protect Heritage?

- **Heritage drives sustainable development and local economies**
- **Disasters are driving losses to heritage**
- **Climate change and conflicts threaten heritage**
- **Heritage contributes to resilience**
- **Heritage is not being sufficiently protected**

Why Protect Heritage?



Heritage drives sustainable development and local economies

Cultural heritage is also a powerful asset for inclusive **economic development**, by **attracting investments and promoting green, locally based, stable and decent jobs** related to a wide range of sustainable activities in areas such as **tourism, conservation, construction, food production, traditional healing and, the production of crafts of all kinds and the arts** in general.

In Europe, for instance, heritage is vital to the competitiveness of tourism, which is valued **at 586 billion euros (€)** per annum and employs **9.7 million people**.



Rice Terraces of the Philippine Cordilleras

Why Protect Heritage?



Disasters are driving losses to heritage

- Heritage is exposed to a number of threats from urbanization, development pressures, socio-economic transformations, unsustainable tourism and lack of resources.
- The impact of disasters on heritage can also be severe. More cultural heritage is lost in disasters than is ever fully accounted.

Why Protect Heritage?



Disasters are driving losses to heritage



Damage to one of the turrets at the Castle of Ferrara during the earthquake in 2012, Italy.

Why Protect Heritage?



Disasters are driving losses to heritage



**Earthquake damage
to the Catholic
Basilica in
Christchurch, New
Zealand**

Why Protect Heritage?



Disasters are driving losses to heritage

**Damage to Cultural
Heritage in Leh,
India due to Cloud
Burst in 2010**

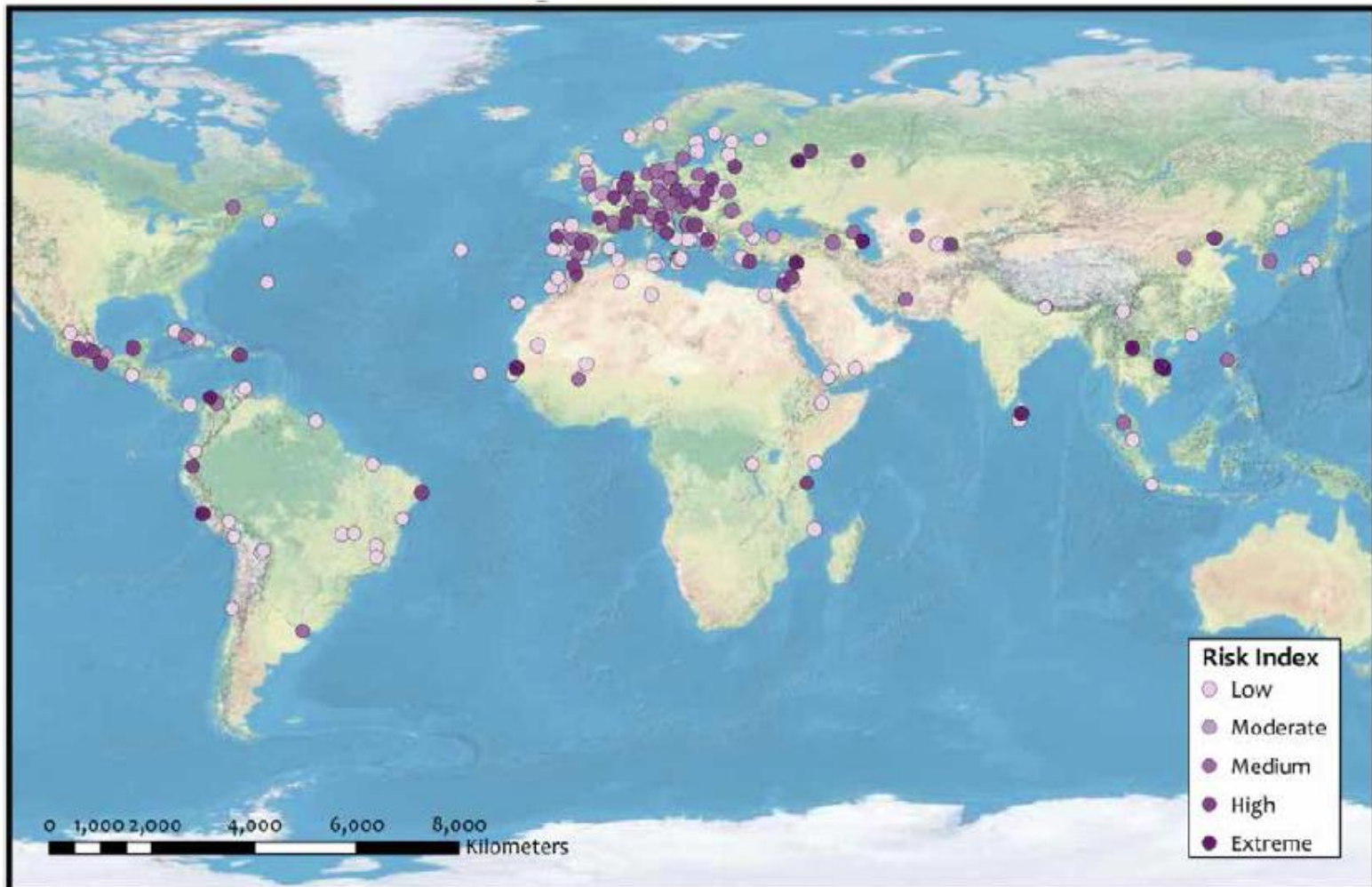


Why Protect Heritage?



Disasters are driving losses to heritage

Flood Risk to World Heritage Cities

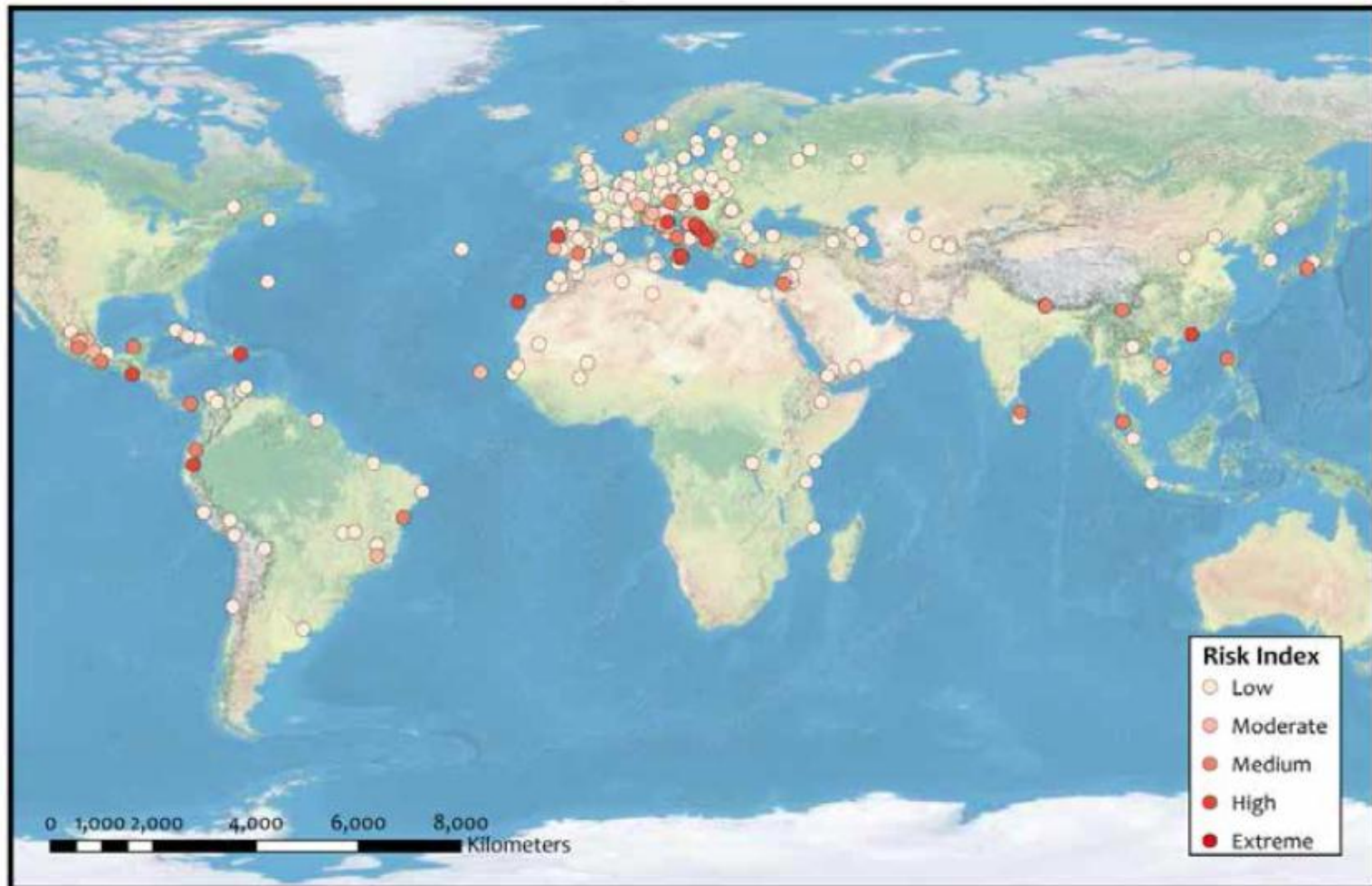


Why Protect Heritage?



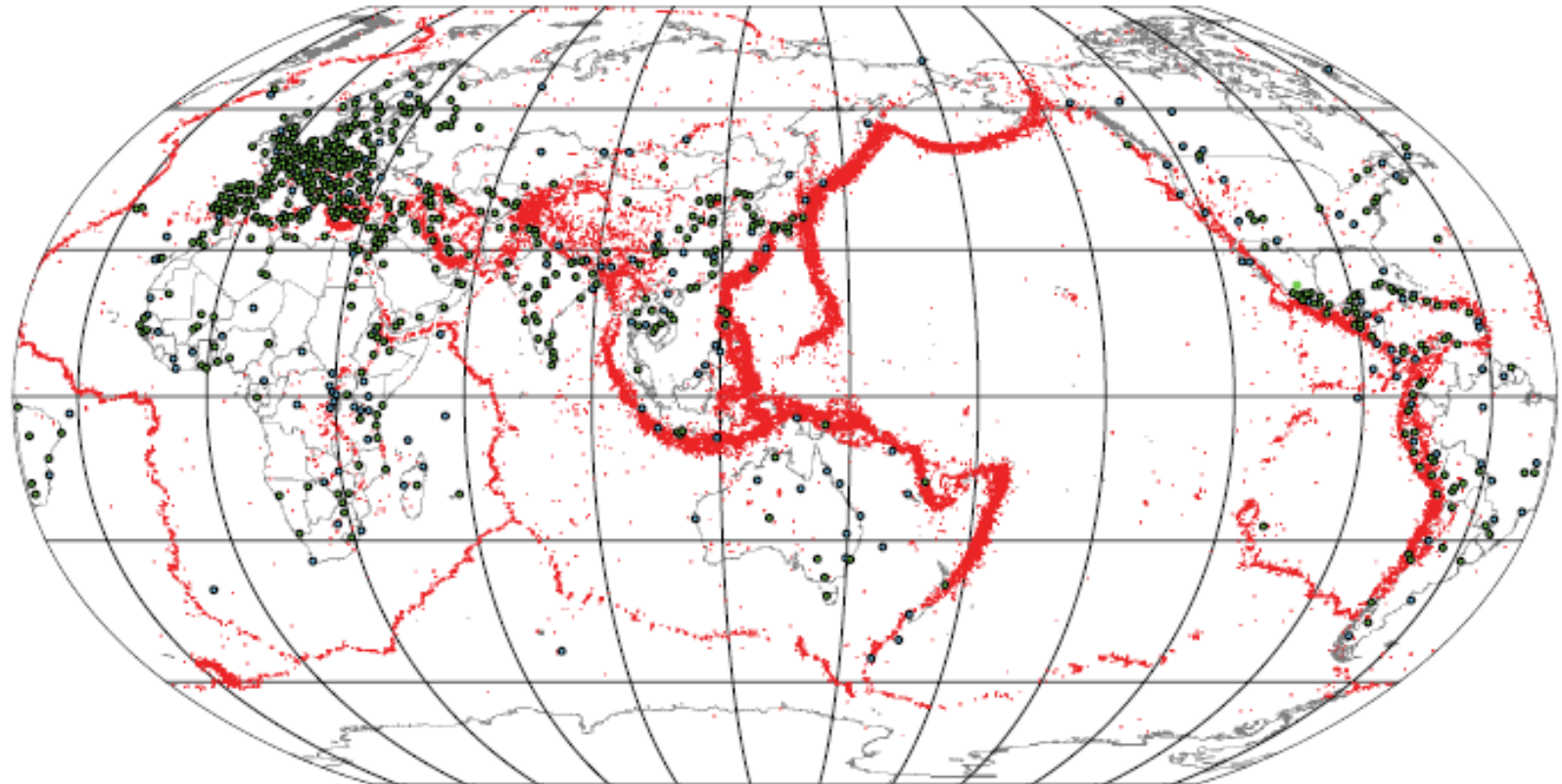
Disasters are driving losses to heritage

Landslide Risk to World Heritage Cities



Why Protect Heritage?

Disasters are driving losses to heritage



**WORLD HERITAGE SITES (JUNE 2008)
LOCATED IN THE EARTHQUAKE ZONES**

by Research Center for Disaster Mitigation of Urban Cultural Heritage,
Ritsumeikan University, Kyoto, Japan

- Earthquake
- Cultural and Mixed Heritage
- Natural Heritage

Why Protect Heritage?



Climate change and conflicts threaten heritage

A survey was launched by the World Heritage Centre among all States Parties to the World Heritage Convention to assess the extent and nature of the impacts of climate change on World Heritage properties.

A total of **125 World Heritage sites** were mentioned specifically as threatened by climate change.

Why Protect Heritage?



Climate change and conflicts threaten heritage

Conflicts and political tensions often have a disastrous impact on heritage sites.



The Citadel at Aleppo, Syria has suffered major damage due to ongoing conflict.

Why Protect Heritage?



Climate change and conflicts threaten heritage

Repair work at Timbuktu, Mali.

**The World Heritage site has
suffered significant damage
during civil unrest**



Why Protect Heritage?



Heritage contributes to resilience

- In the same way that biological diversity increases the resilience of natural systems, cultural diversity has the capacity to increase the resilience of social systems.
- Traditional construction technologies that have evolved through trial and error are often very resilient because of indigenous knowledge that has enabled these technologies to manage local hazards and use local materials.

Why Protect Heritage?



Heritage contributes to resilience

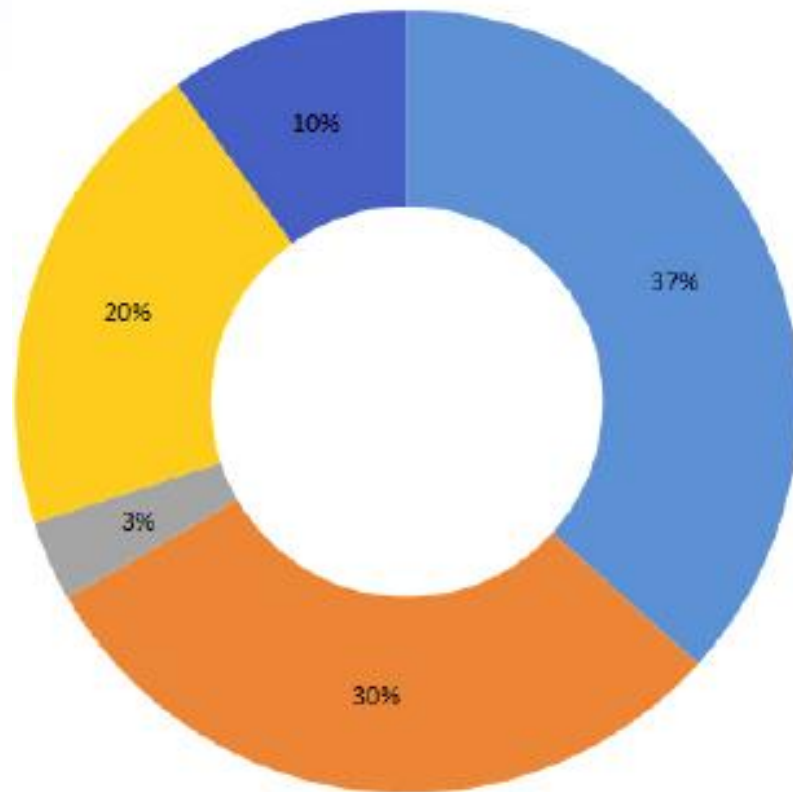
Traditional 'Bhunga' dwellings in Gujarat, India survived 2001 earthquake



Why Protect Heritage?



Heritage is not being sufficiently protected



- The cases where the risks were not identified within the management documents
- The cases where even though risks were identified, there was no concrete plan or any reference to mitigating these in the management systems established for the properties
- The cases where the risks were identified but mitigation included was considered mainly for visitor safety and not the properties themselves
- The cases where the risks were identified and plans to mitigate these were considered, but where the mitigation was not extensive enough or where there were concerns as to the effective implementation of such plans.
- The cases where both risks and mitigation of these were presented in an effective and extensive Risk Preparedness Plan.

Disaster Risk Management for heritage



- DRM aims **to prevent or reduce the negative impacts** of disaster on World Heritage properties.
- The values for which the property was inscribed on the World Heritage List should be the foundation on which all other plans and actions are based (**all other plans for Heritage**).
- DRM for heritage is concerned not only with protecting the property from major hazards but also with **reducing underlying vulnerability factors**.
- The risks to cultural and natural heritage that DRM must address may **originate inside the property or in the surrounding environment**.

Disaster Risk Management for heritage

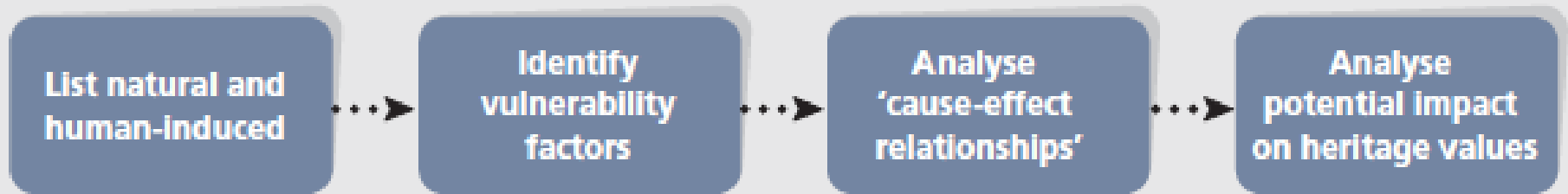


DRM plan linked to the site management plan of a heritage property



Lack of coordination between the **site management systems** for the particular heritage property and the organizational set-up, policies and procedures for **disaster management in the city** or region in which the property is located.

Analyze the factors that may cause disaster risks to your property



Step 1

Step 2

Step 3

Step 4

Analyze the factors that may cause disaster risks to your property



Step 1 - List natural and human-induced

Listing all the natural and human-induced hazards that expose the property to disaster risks. These would include primary hazards with potentially disastrous impact, such as earthquakes, as well as slow and progressive secondary hazards, or underlying risk factors, such as **changes in natural vegetation due to rising ground water or changes in ground water quality due to pollution.**

Analyze the factors that may cause disaster risks to your property



Step 2- Identify vulnerability factors

Identifying the processes that might, in combination with a primary hazard, cause disaster risk to the property.

- evaluating the **performance of existing management systems** and **disaster preparedness measures**
- analyzing the potential negative impacts of **existing damage and deterioration patterns or phenomena**
- analyzing the **underlying risk factors** relating to the **surrounding environment** that increase the property's vulnerability
- analyzing the potential negative effect of **poor restoration done in the past.**

Analyze the factors that may cause disaster risks to your property



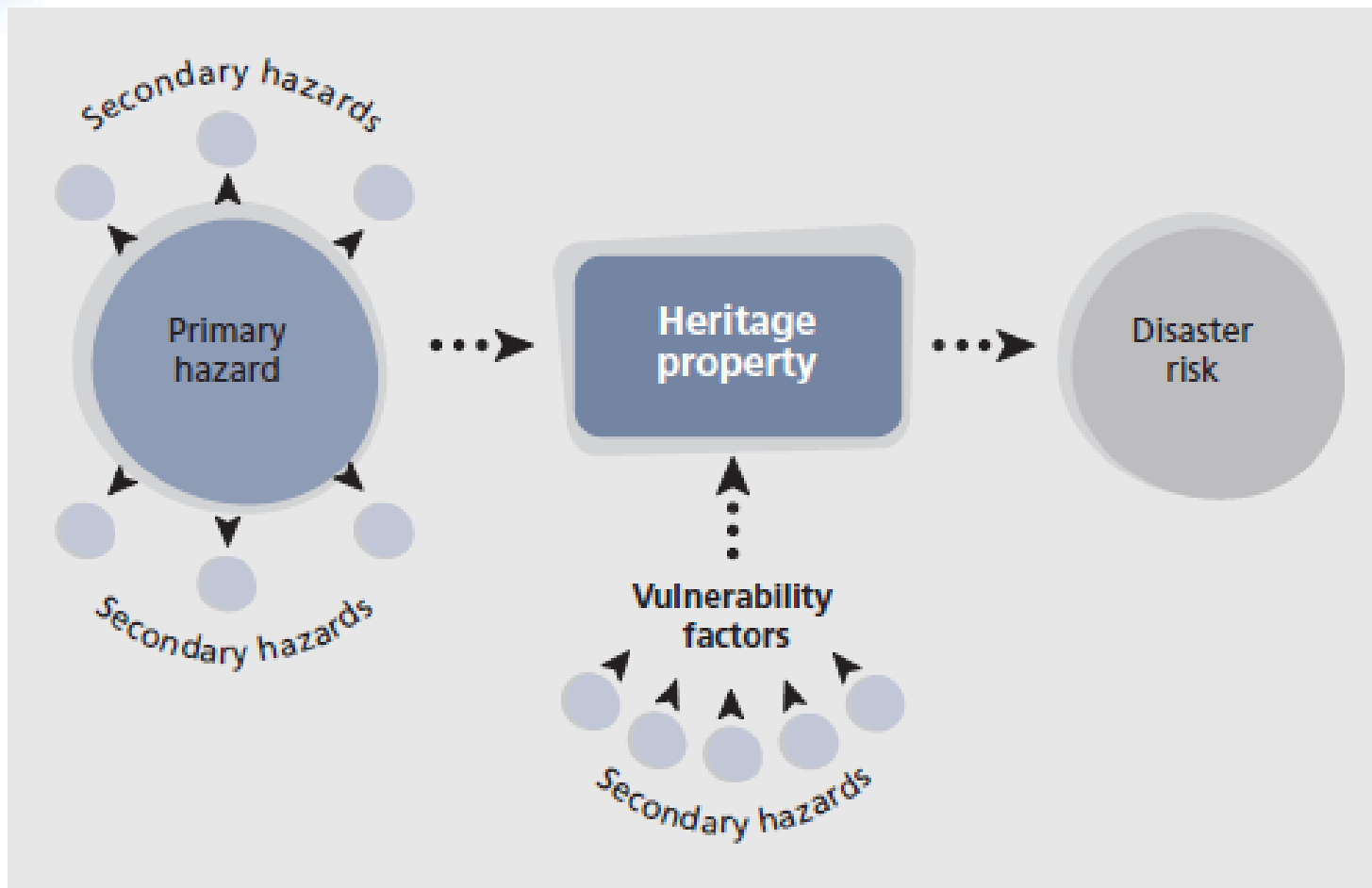
Step 3- Analyze 'cause-effect relationships'

the 'cause-effect' relationships between **various primary hazards** and **underlying risk factors** that increase the property's vulnerability and expose it to disaster risk.

Analyze the factors that may cause disaster risks to your property



Step 4- potential impact on heritage values



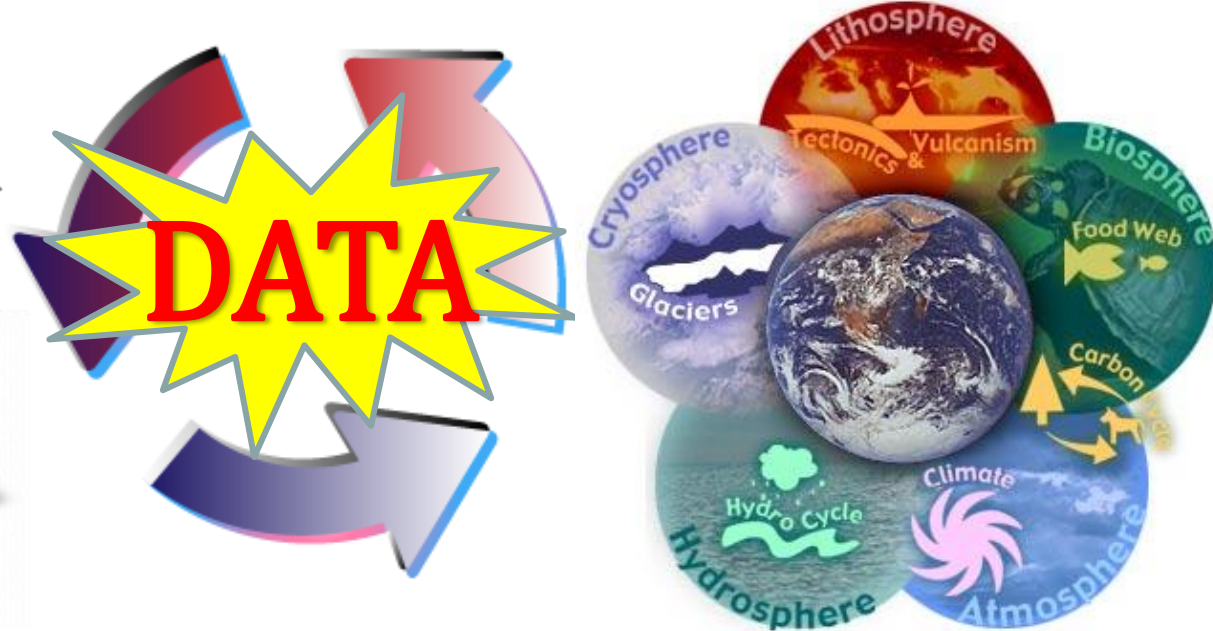
Earth Observation: A continues vision of our planet



Earth Observation



Earth System



Scientific Research & Human Society

EO for Disaster Mitigation

Space Station



Satellite



Air Ship



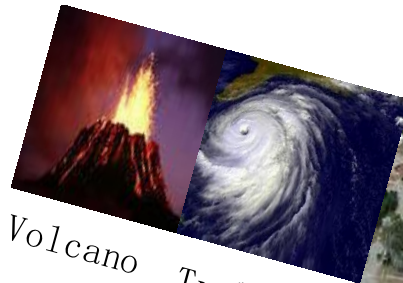
Airplane



Air Balloon



Earth Observation Systems



Volcano

Typhoon

Flood

Earthquake

Drought

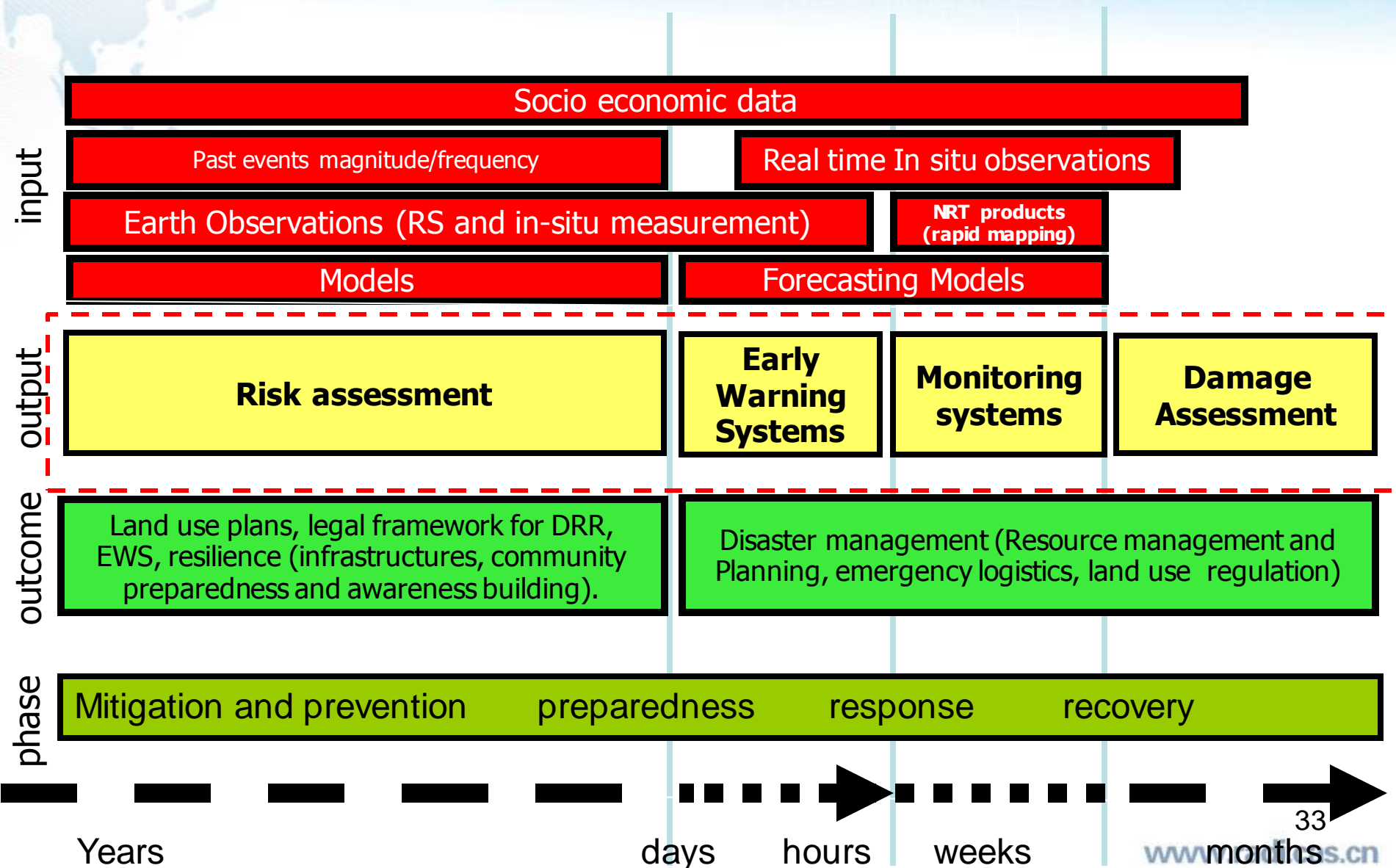
Tsunami

Wildfire

Dust storm

Snow storm

A (very simplified) logic model for disasters





CNSphoto

flood



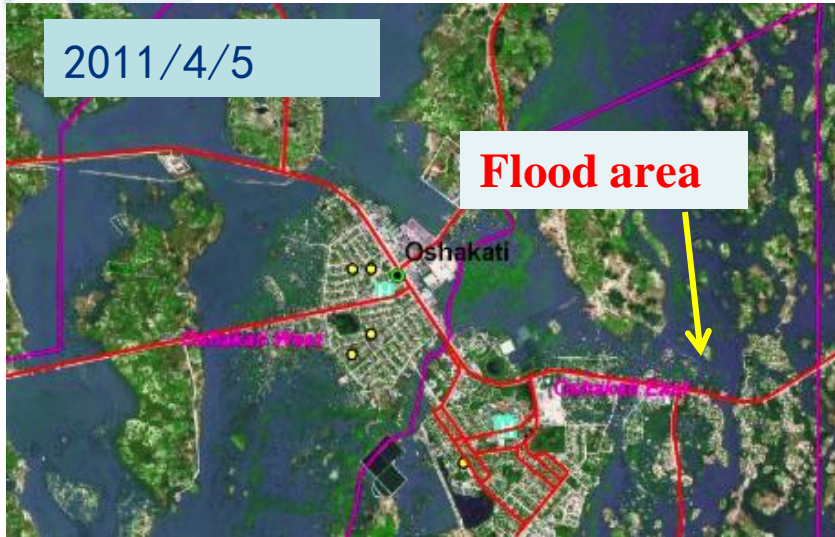
cnsphoto

EO for Flood Monitoring- Optical Sensor



Optical Sensor for Monitoring-SPOT-5

- SPOT 5 was launched on May 4, 2002. They offer a higher resolution of 2.5 to 5 meters in panchromatic mode and 10 meters in multispectral mode.

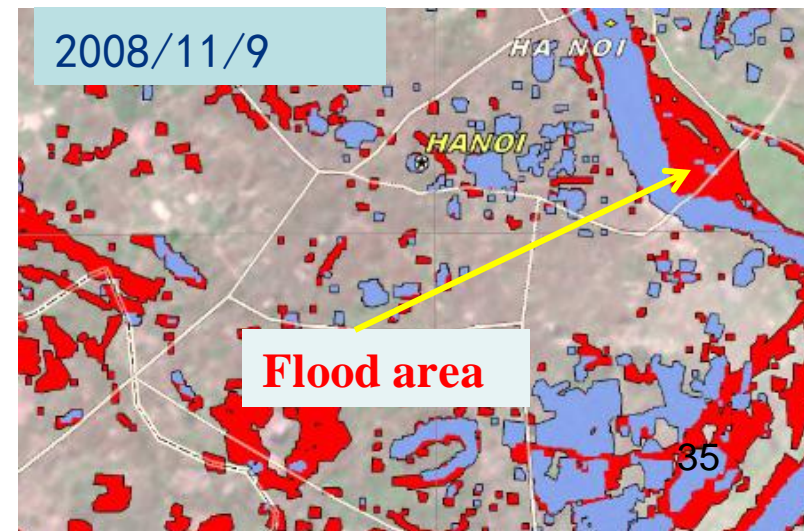


SPOT-5 for Africa floods (ICSMD)

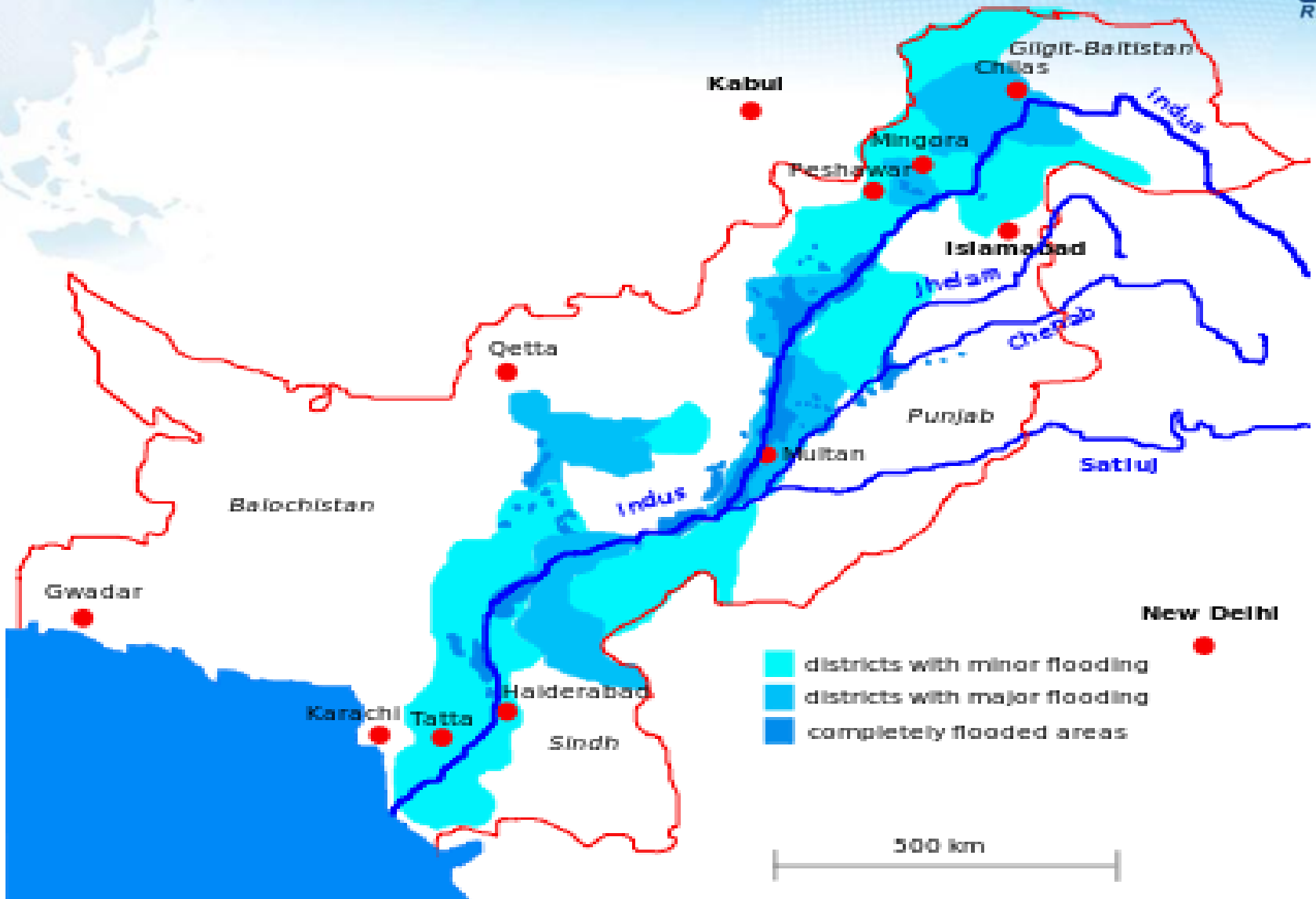
- The Disaster Monitoring Constellation (DMC) consists of a number of remote sensing satellites and operated for the Algerian, Nigerian, Turkish, British and Chinese governments.

Optical Sensor for Monitoring-DMC

DMC L1R for Vietnam floods (ICSMD)



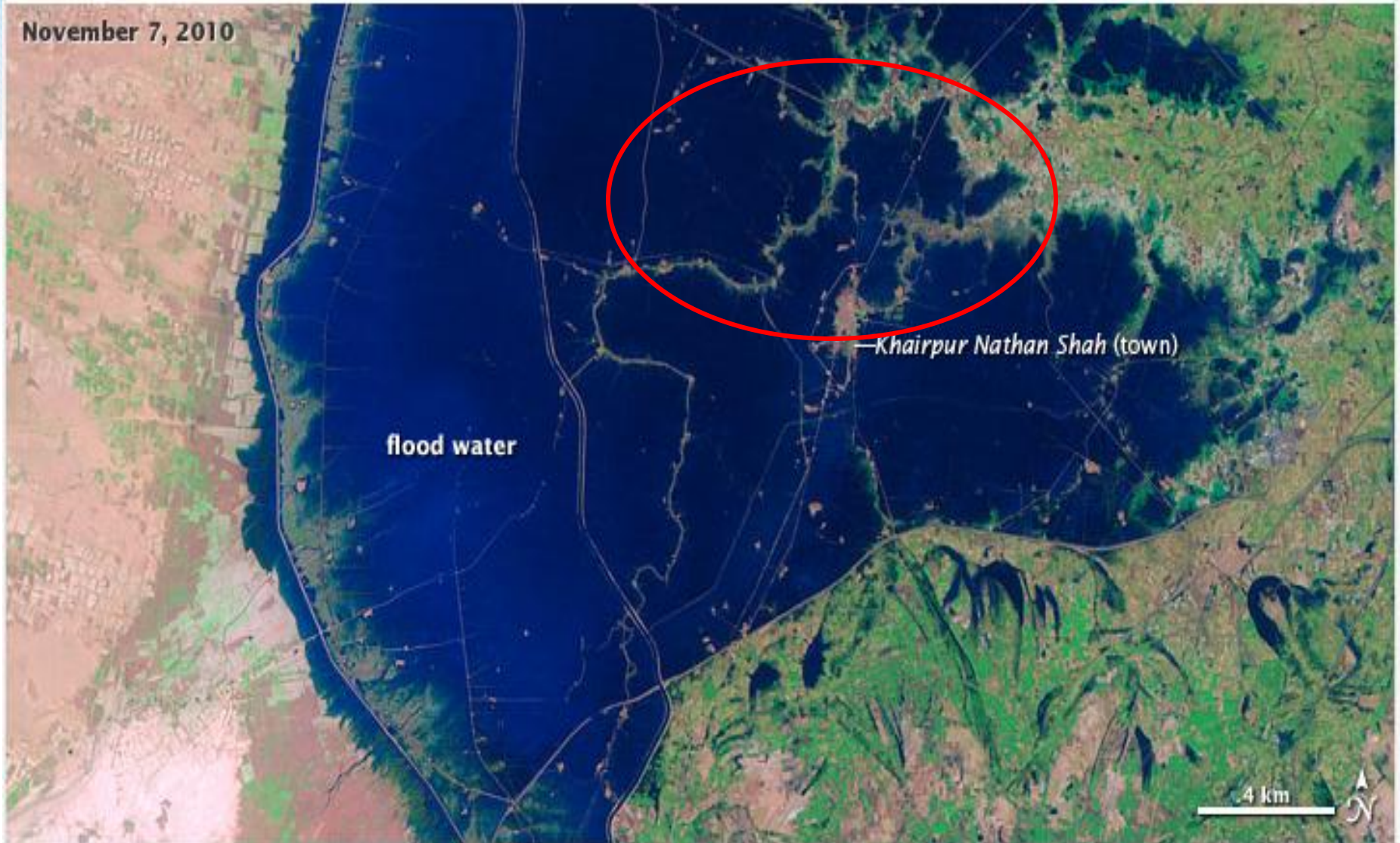
Flood in 2010 Pakistan



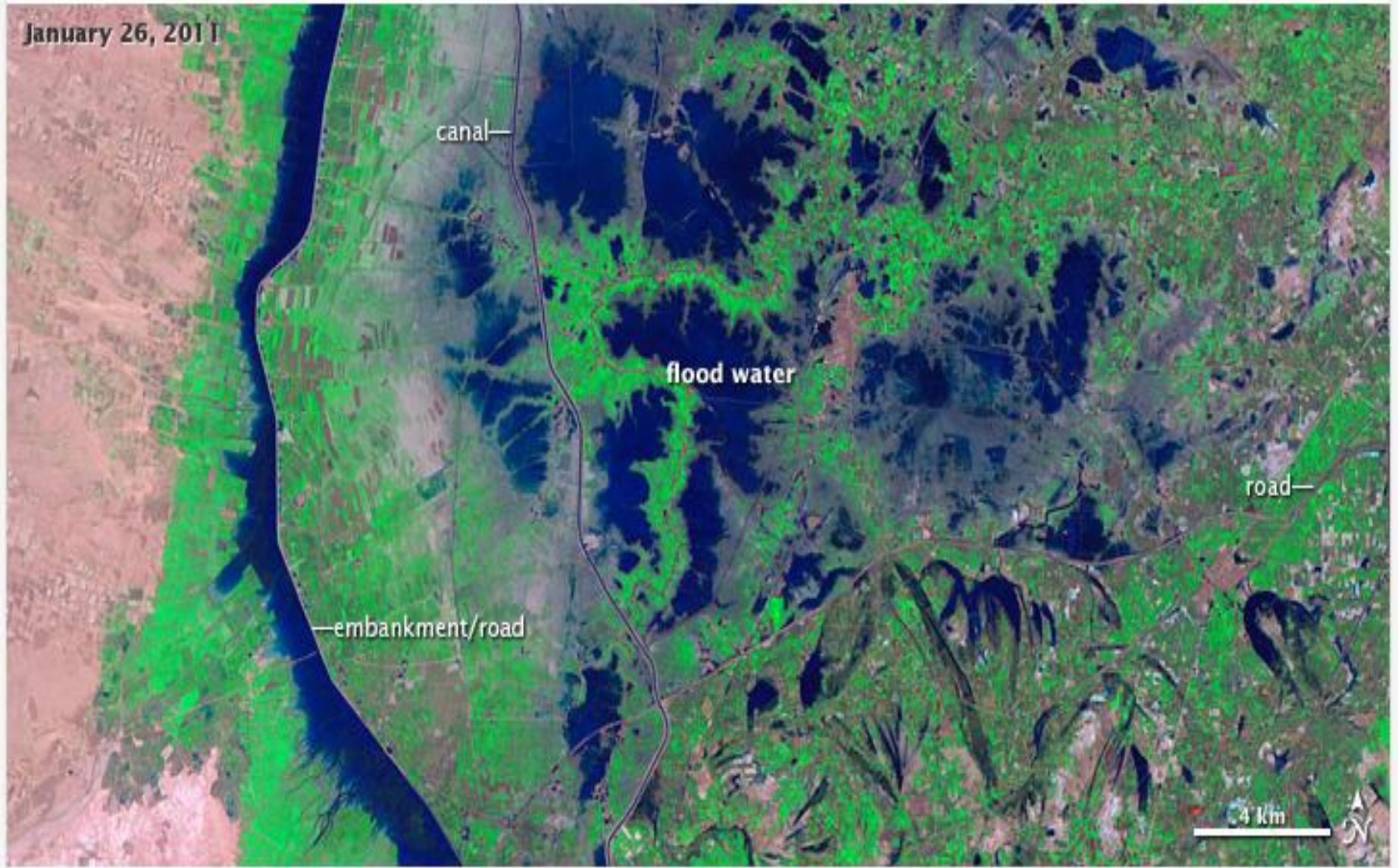
Flood in 2010 and Emergency response/Daily flood maps



November 7, 2010



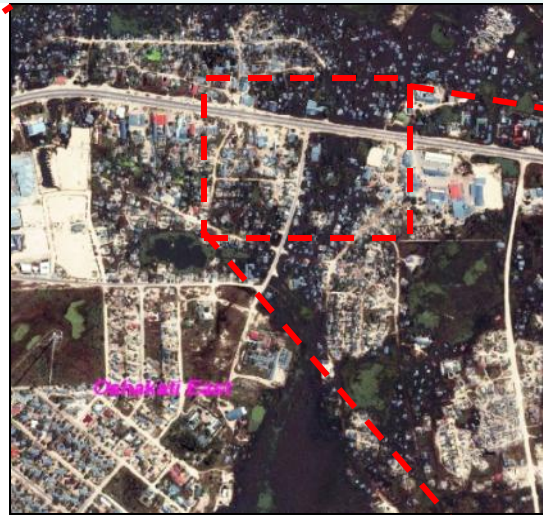
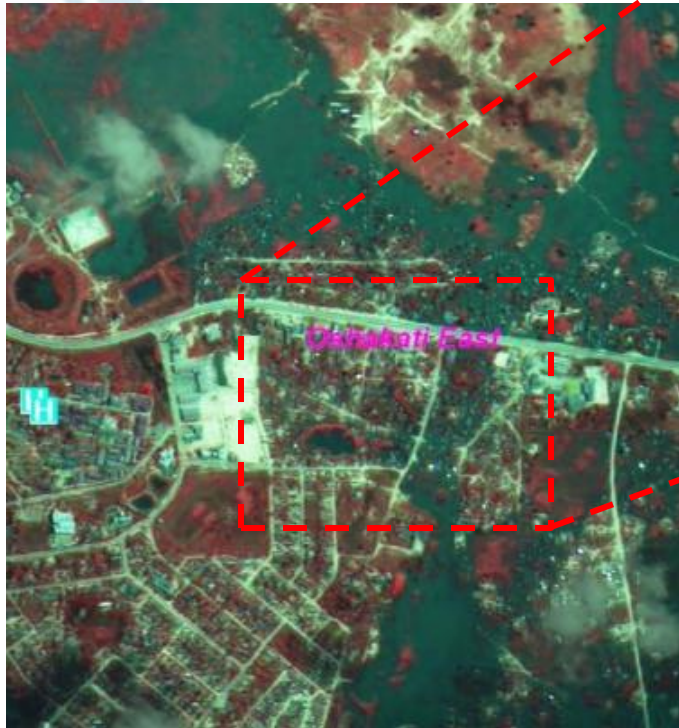
January 26, 2011



EO for Flood Monitoring



High resolution satellite for floods monitoring



Worldview -2 (USGS)

WorldView-2 satellite sensor, launched October 8, 2009, provides 0.46m Panchromatic (B&W) mono and stereo satellite image data.



Maze drought, 2009



Rice drought, 2007



drought

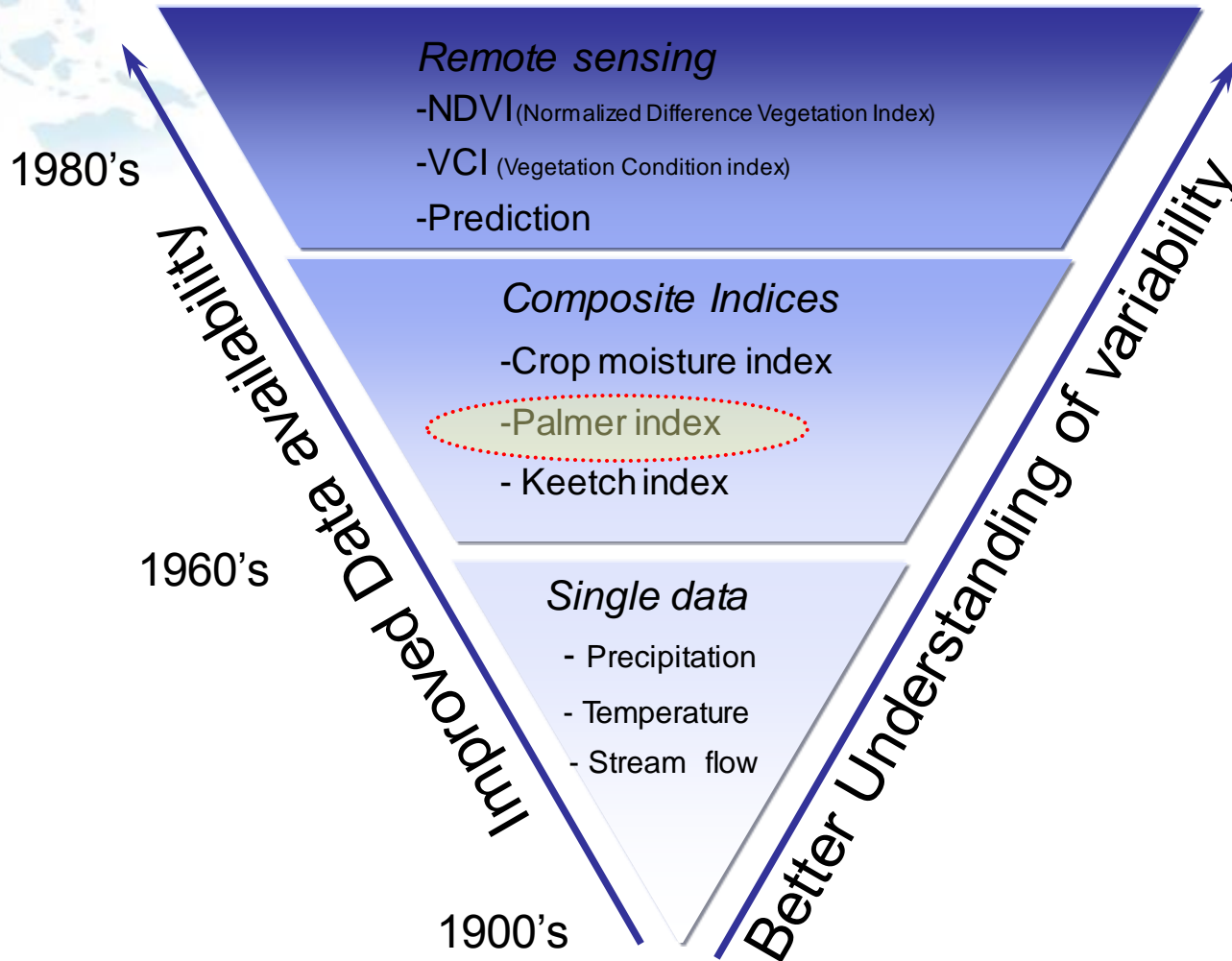
Wheat freezing and drought



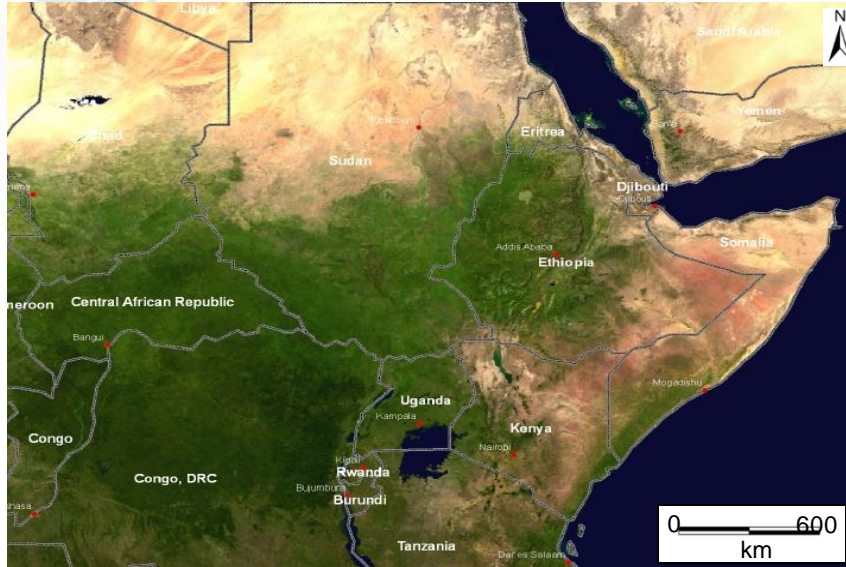
Lack of drink water



Measuring Drought



Monitoring drought

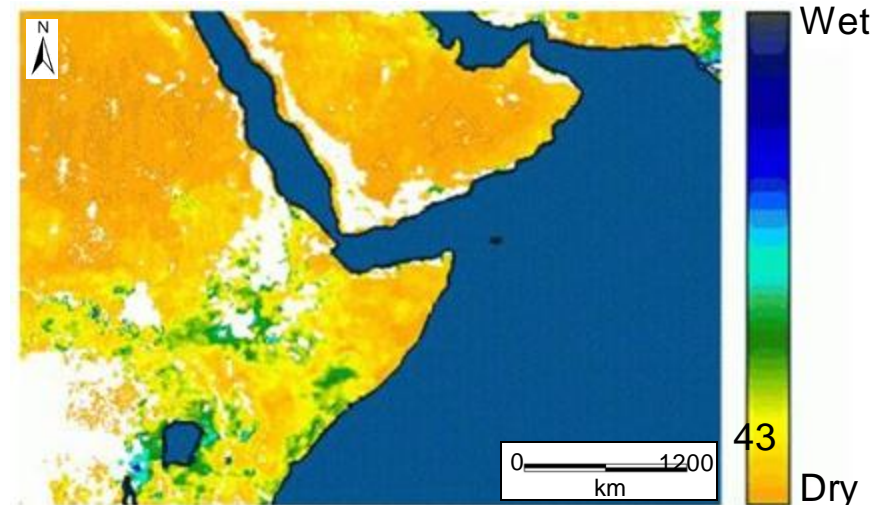


MODIS Vegetation Maps(UN-SPIDER)

MODIS can provide consistent, spatial and temporal comparisons of global vegetation conditions .

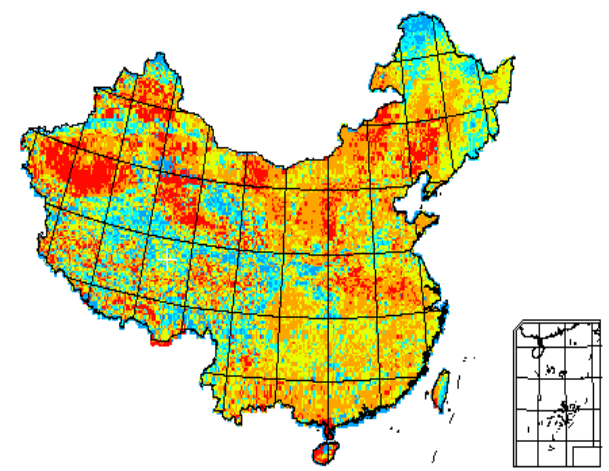
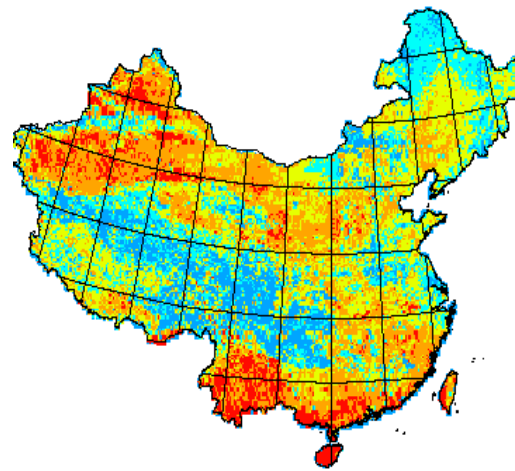
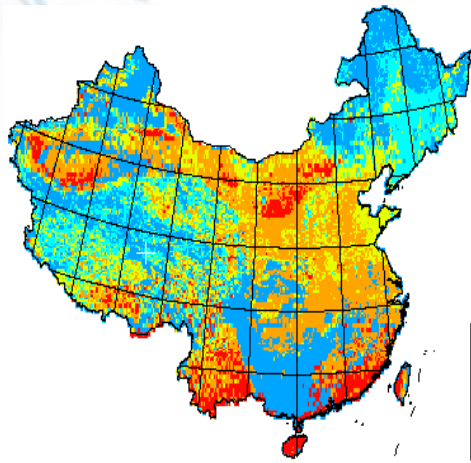
Between July 2011 and mid-2012, a severe drought affected the entire East Africa region. Said to be "**the worst in 60 years**", the drought caused a severe food crisis that threatened the livelihood of **9.5 million people**.

MODIS Drought Index Maps(UN-SPIDER)



Monitoring drought

TVDI



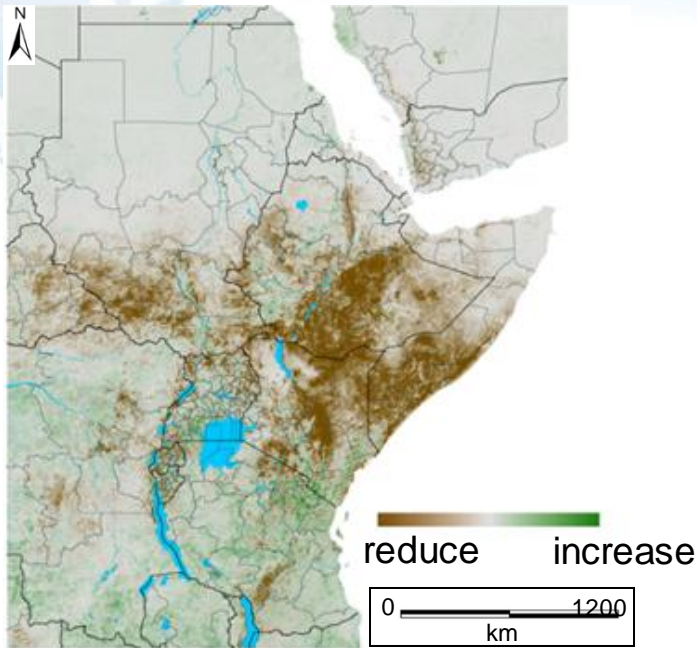
first ten days in March

first ten days in April

first ten days in May



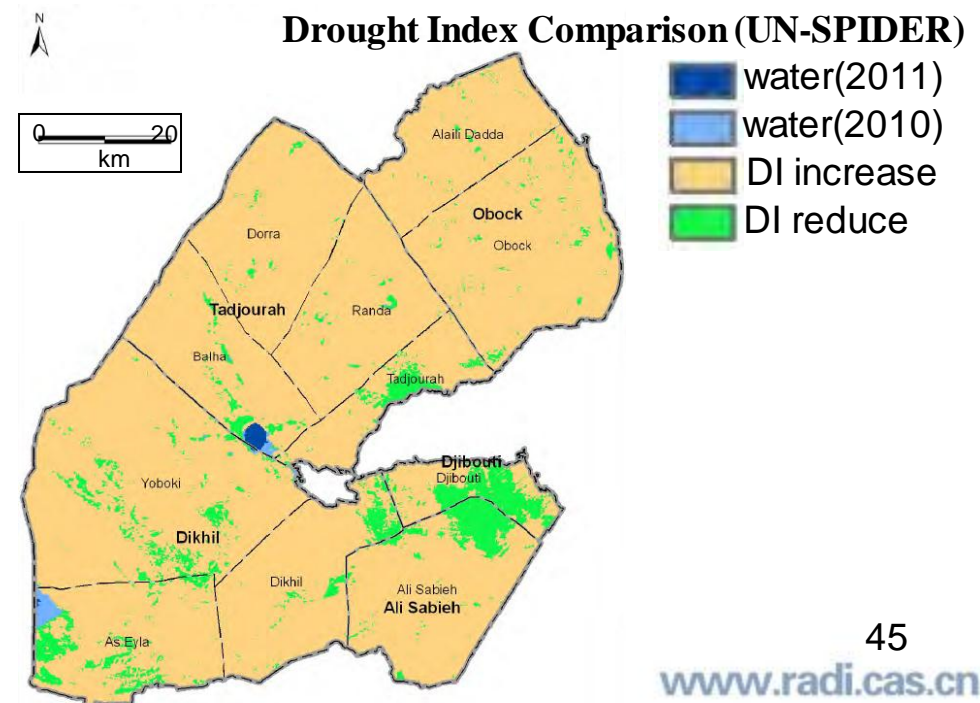
Monitoring drought



Vegetation Cover (2011) Vs. Average Vegetation Cover 2001- (USAID)



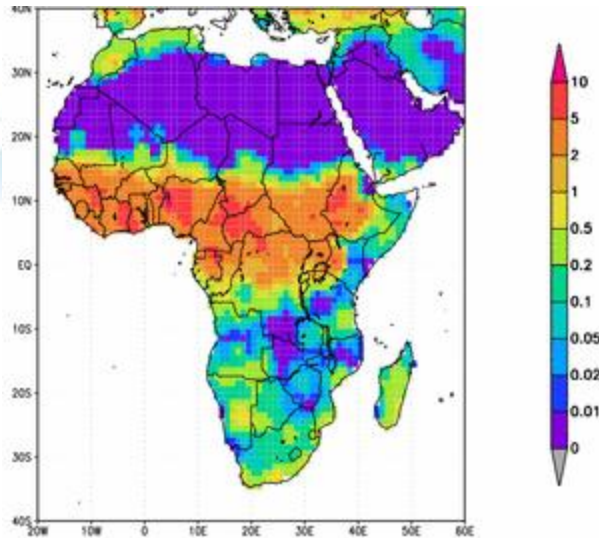
Temporal Comparison of Drought Impacts through Satellite Data



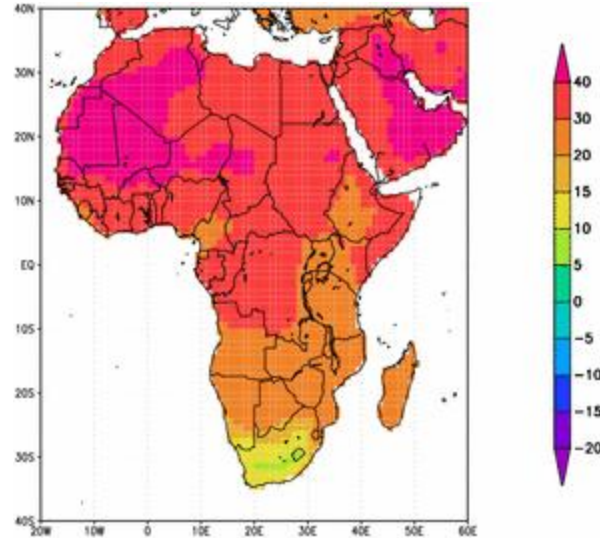
Drought modeling



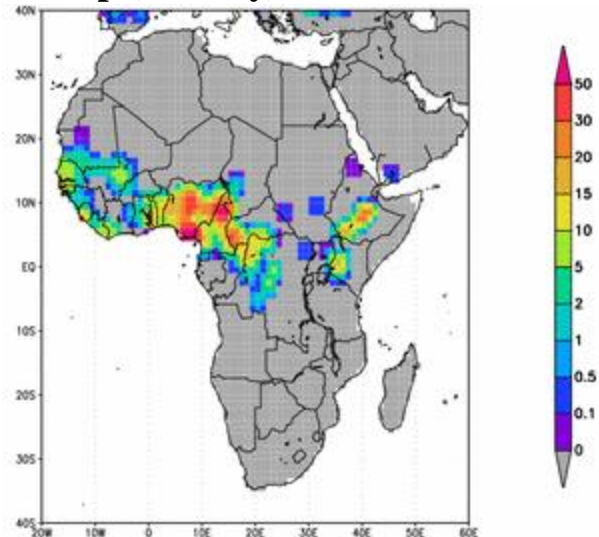
ET(mm/day) 2011/07/02



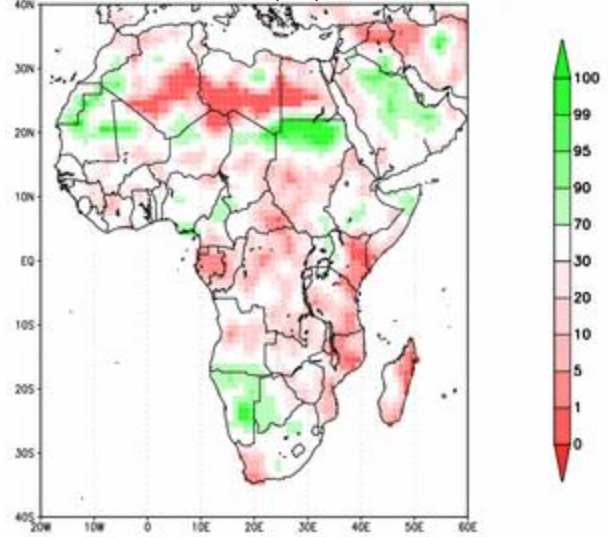
Air Temp. (°C) 2011/07/02



Precp.(mm/day) 2011/07/02



Rate of Soil Mois.(%) 2011/07/02



http://hydrology.princeton.edu/~justin/research/project_global_monitor/

Earthquake



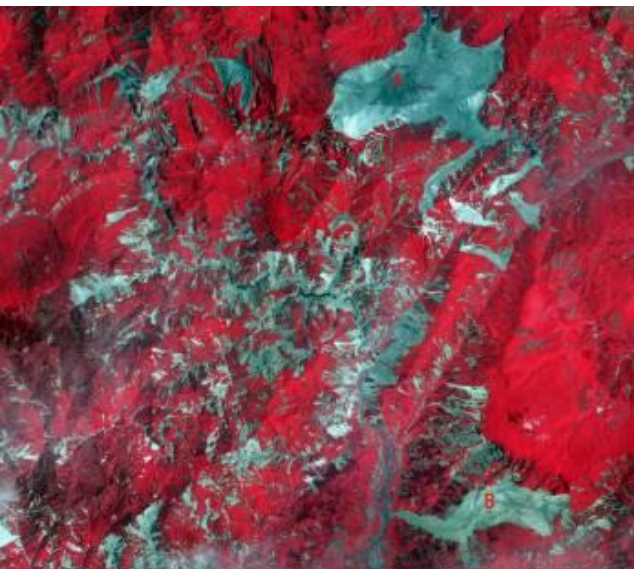
Wenchuan Earthquake

- Time: 12/05/2008 12:28PM;
- Magnitude: Ms.8.0;
- Location of epicenter: 103.4°E, 31 ° N;
- Geographic Location: Wenchuan,Beichuan,Sichuan province, China;
- Depth of Seismic focus: 14KM;
- Epicentral Intensity: 11Degree;
- Casualty: Death 69142, Missing 17551.



geology disaster after earthquake

image in Xiao Maoping Wenchuan County in 5.15



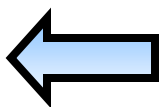
ALOS卫星影像显示灾后滑坡情况



汶川县小茅坪村机载光学遥感图像

0 50 100 200m

2008年5月15日获取。图像由四川省测绘地理信息局提供。在地震的恶劣条件下地形多基岩崩塌造成。灾民撤离自救和救援。



Geology disaster in Chenjiaba Beichuan
50% surface has been destroyed , such as
landslides and collapse form after-quake- lakes.



Road and facility monitoring



Jinhe phosphorite mine in Hongbai county



Road and facility monitoring



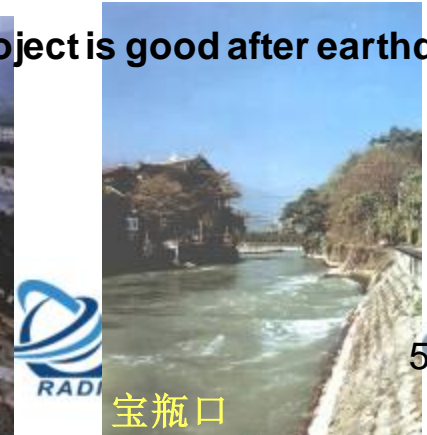
Ancient architecture damaged in Du Jiangyan



Du Jiangyan key water control project is good after earthquake



飞沙堰



宝瓶口

Zoology damage monitoring



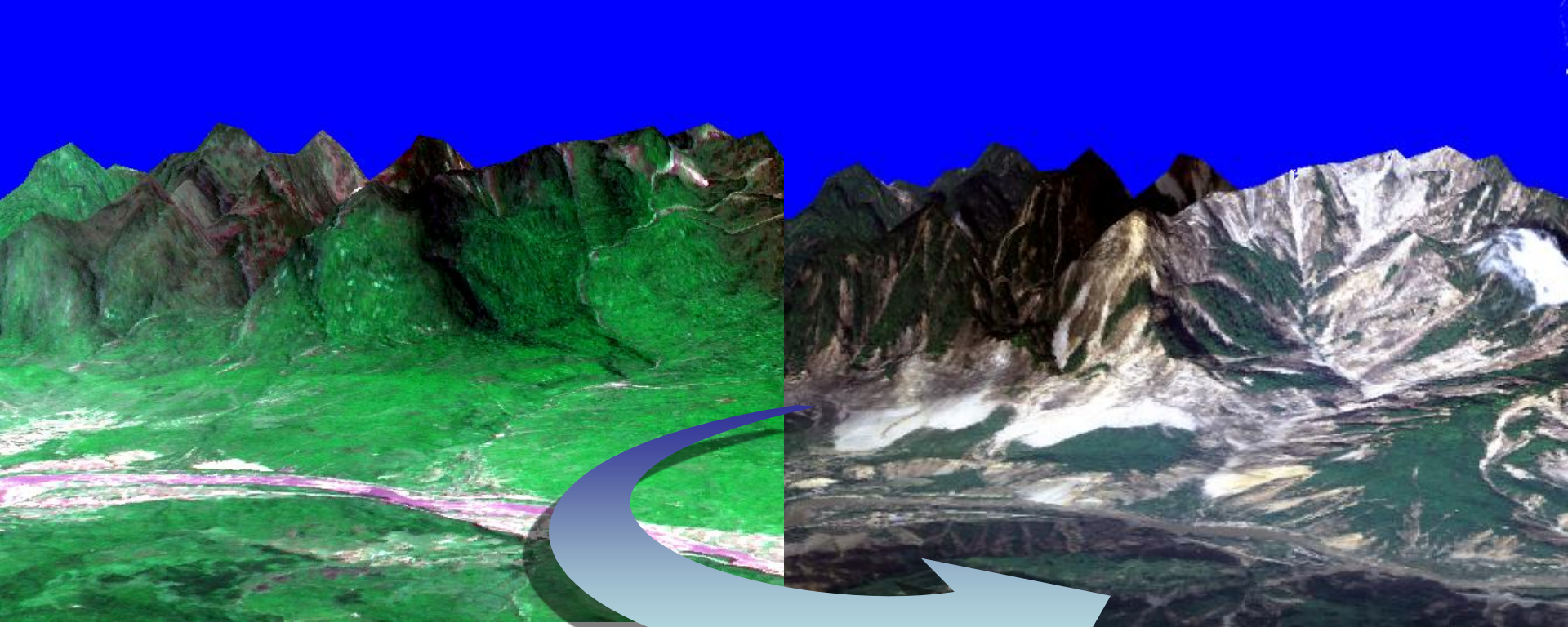
Long Chigang before earthquake



Long Chigang after earthquake



Zoology damage monitoring



**Landscape
before in Yinxing
2007-5-9**

**Landscape
after in Yinxing**

www.radi.cas.cn
2007-5-16

Thanks!



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