Ecological Monitoring and Assessment of Natural Disasters By Remote Sensing：A case work of Ludian earthquake

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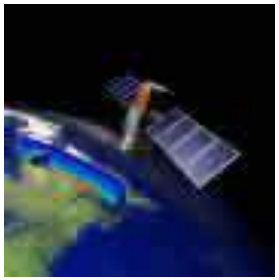
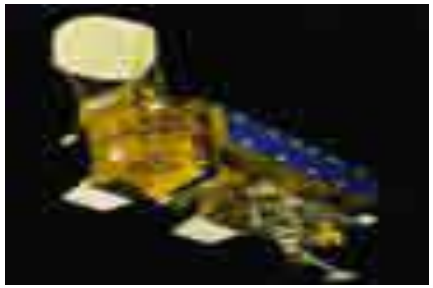
Background—Frequent natural disasters in China

- ✓ Natural disasters: Flood, Drought, Earthquake and Debris flows, etc.
- ✓ Severe ecological damages: Plants, River and native ecosystems.

Background—Rapid Development of RS technology

- ✓ More than 70 satellites can be used to monitor the ecological enviorment;
- ✓ High-resolution RS imagery is more easily to access;
- ✓ It is very important to understand the full distribution of disaster timely;
- ✓ Lack of ecological impact studies of the disaster.

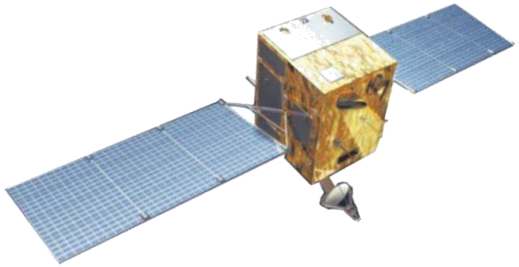
Background—Introduction of SEC

- Established in February, 2009
- A national agency sponsored and managed by MEP
- Primary Missions:
  - Providing valuable environmental information and necessary support to the public and the government based on remote sensing technique
  - Promoting the remote sensing applications in environmental monitoring and ecosystem protection

- Accomplished many work of Monitoring and Assessment of Natural Disasters By Remote Sensing

Outline

- Indicators
- **Methods**
- **Examples**



Indicators

There is different ecological impacts for different disaster type in different regions. Generally, the indicators mainly include:

- ✓ Indicators of Primary Disaster: the position, area, intensity of flood, drought, snow disaster, earthquake and other disasters are the basic information which can be reached by RS.
- ✓ Indicators of Secondary Disasters: the spatial information of Landslides, Barrier lake, mudslides is also important.
- ✓ Indicators of Ecological Impacts: includes the physical information, the ecosystem types, the sensitive targets in disaster region.

Indicators for Earthquake/Mudslides Disaster

- ✓ Basic information: the position of Earthquake/Mudslides;
- ✓ Secondary Disaster: The spatial distribution of Landslides, mudslides and Barrier lakes;
- ✓ Assessments:
  - Impactions on vegetation;
  - Impactions on Agro-ecosystem;
  - Impactions on River and Lakes;
  - Impactions on Sensitive Targets (Nature Reserves, Settlements, agro-ecosystem, vegetation etc.).

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- Methods
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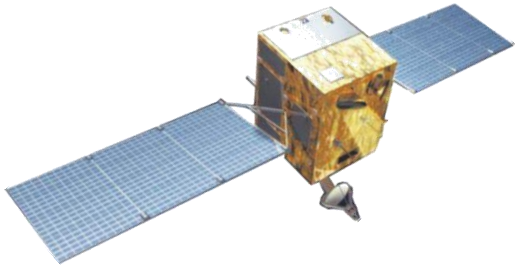


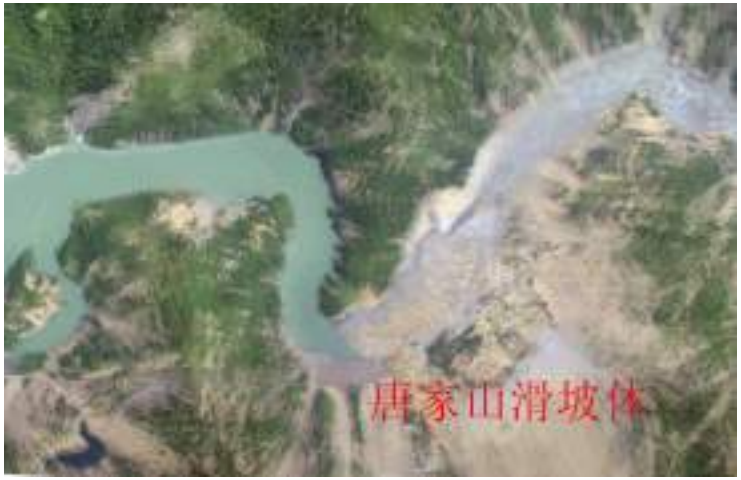
Remote Sensing Data

HJ Satellites:
HJ-1A : CCD/HIS; HJ-1B: CCD/IRS; HJ-1C: SAR;

Others:
Visible and Infrared Data: Landsat TM, SPOT; ZY 02C, ZY-3, GF-1, etc.;
SAR: Radarsat, TerraSAR, etc.

Target Recognition Based on Spectral Features

The snow-cover, landslides, barrier lakes and other secondary ecological damages can be recognized in RS image by colors, geometric shapes and other typical features, especially in the high-resolution RS images.



Landslides and Barrier lake in RS imagery

Comparisons among Multi-Date Images

We can get the spatial distribution of ecological damages and recovery through the Multi-Date RS images before/after the disaster in the same region. The following images:

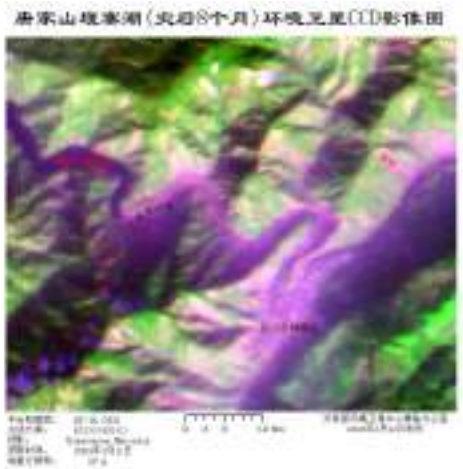
A: BJ-1 CCD data before the earthquake in Wenchuan;

B: FW-2 CCD data just after the Earthquake in Wenchuan;

C: HJ-1 CCD data 8 months after the Earthquake in Wenchuan.

A.

B.



C.

Quantitative Inversion Methods

To get the quantitative description of regional plant, the inversion models can be used to compute the NDVI, LAI, Fraction of Vegetation and other parameters.

Classification

Through the supervised classification or human-computer interaction interpretations, we can obtain the distribution of regional landuse, ecosystem, sensitive targets.

Overlay and Statistics

With the support of the GIS software, we can statistic the amount, area and other thematic by overlay method.

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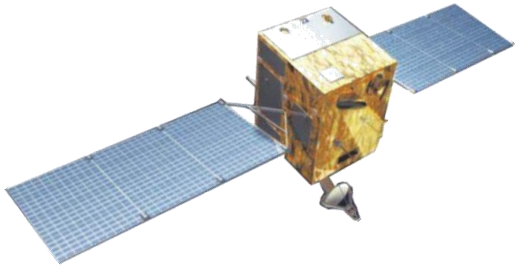


The following work have been accomplished by our TEAM：

- **Earthquake Disaster**

Wenchuan Earthquake in 2008, Yushu Earthquake in 2010, Yingjiang Earthquake in 2011, Yaan Earthquake in 2013, Ludian Earthquake in 2014, etc.

- **Meteorological Disaster**

Southern Freeze Disaster in 2008, North Drought in 2009, Yunnan Drought in 2013, etc.

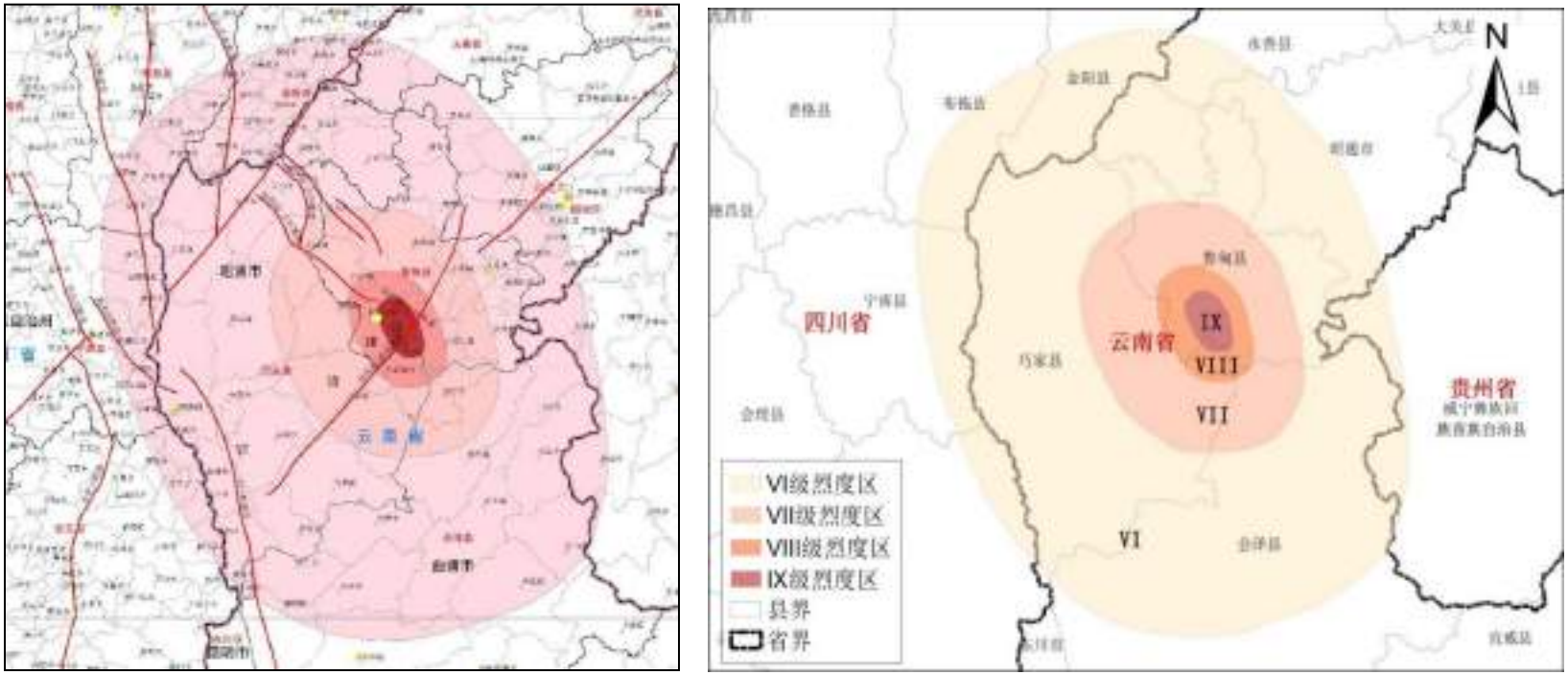
1. 2014 Ludian Earthquake

A 6.5-magnitude earthquake struck Yunnan Province, southwest part of China on 3 August 2014, with the epicenter in Longtoushan Township, 23 km southwest of Ludian County of Zhaotong City.



1. 2014 Ludian Earthquake

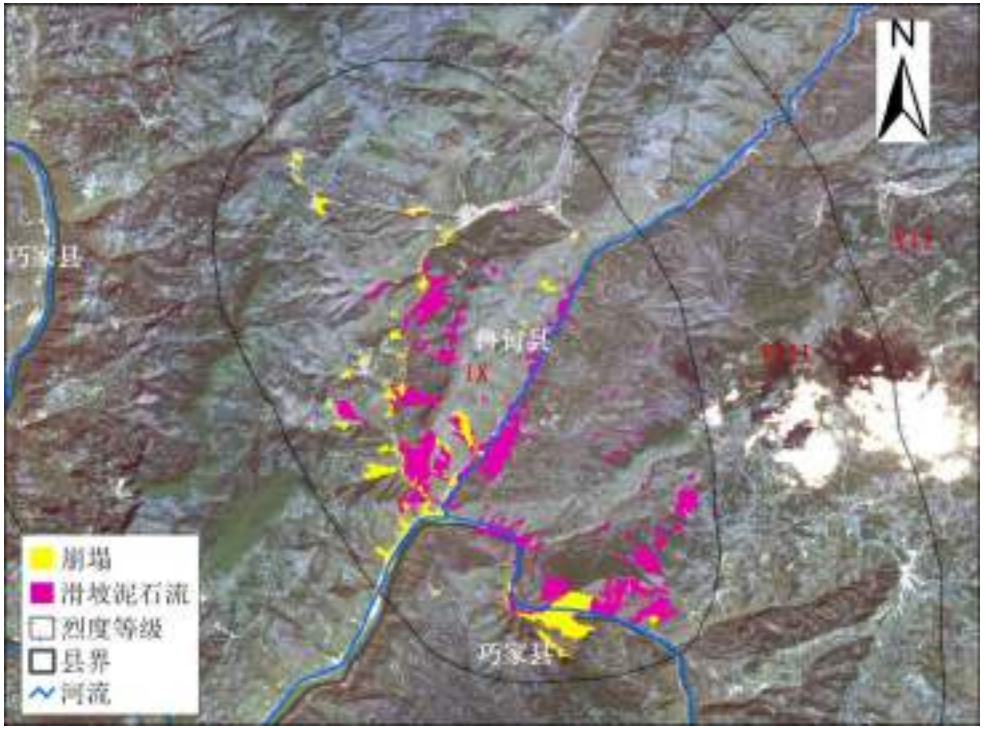
Below a "more detailed" shaking intensity map. The red lines are the known fault lines.
Violent shaking in the epicenter area, with all consequences involved.
Intensity IX was reached on the Liedu scale - 90 square kilometers
Intensity VIII - 290 square kilometers
Intensity VII - 1580 sq. km
Intensity VI - 8390 sq. km
Over 10000 square kilometers of damage. 100 x 100 sq. km.



The study area and the distribution of seismic intensity

1. 2014 Ludian Earthquake — Geological Disaster Distribution

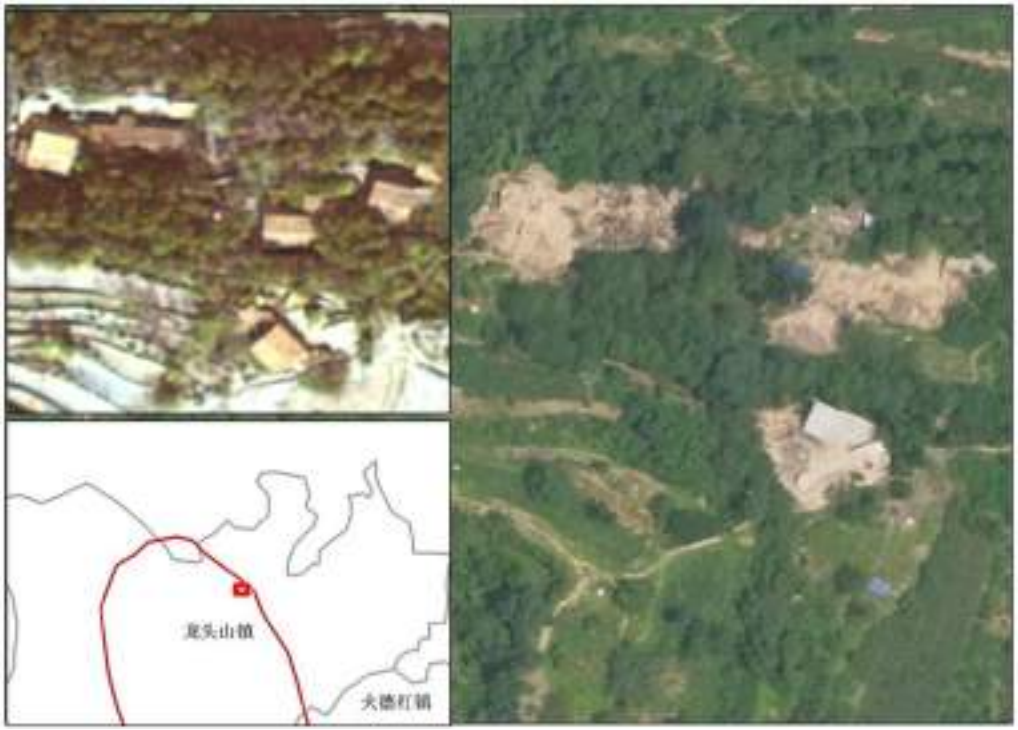
The total working area was 90km^2, which is 0.87% of the whole disaster region. There were 169 earthquake-induced secondary geological disasters which damaged 8.04 km^2 land，including 77 landslides which 2.27 km^2 and 92 debris flows which 5.77 km^2.



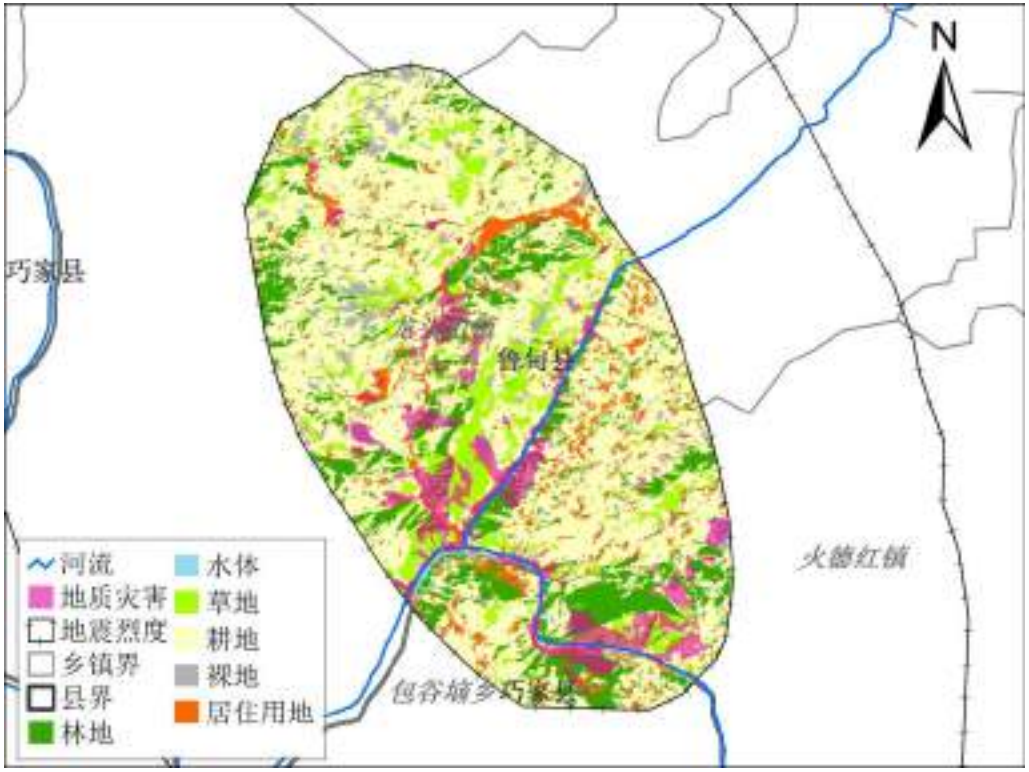
The distribution of earthquake-induced secondary geological disasters

1. 2014 Ludian Earthquake — building damage

There was 2.81km^2 living facilities damaged in Longtoushan township, which is 94% of living facilities area of the Longtoushan township. And 47% of the damaged area was caused by earthquake-induced secondary geological disasters.



1. 2014 Ludian Earthquake—Ecosystem Damage



Distribution of Damaged Ecosystem

In the imaging region, there was 53.1km^2 cropland. The area of damaged cropland is 2.88km^2 , 5% of the regional cropland.

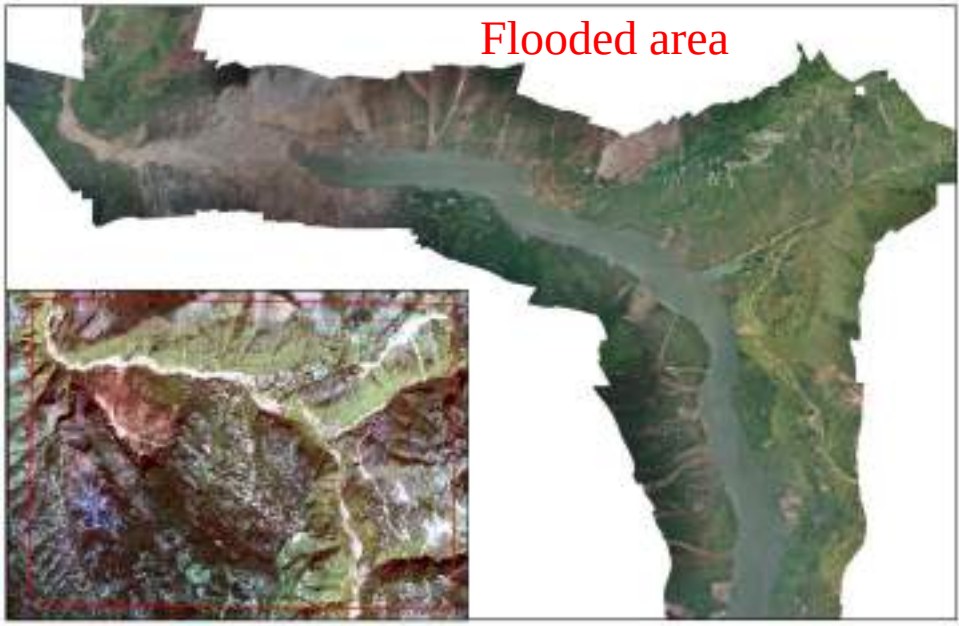
The forest area was 15.7km^2, the damaged area is 1.95km^2 , 12% of the regional forest.

The grassland area was 9.5km^2, the damaged area is 1.42km^2 , 15% of the regional grassland.

1. 2014 Ludian Earthquake—Impaction on River

Barrier lake

before

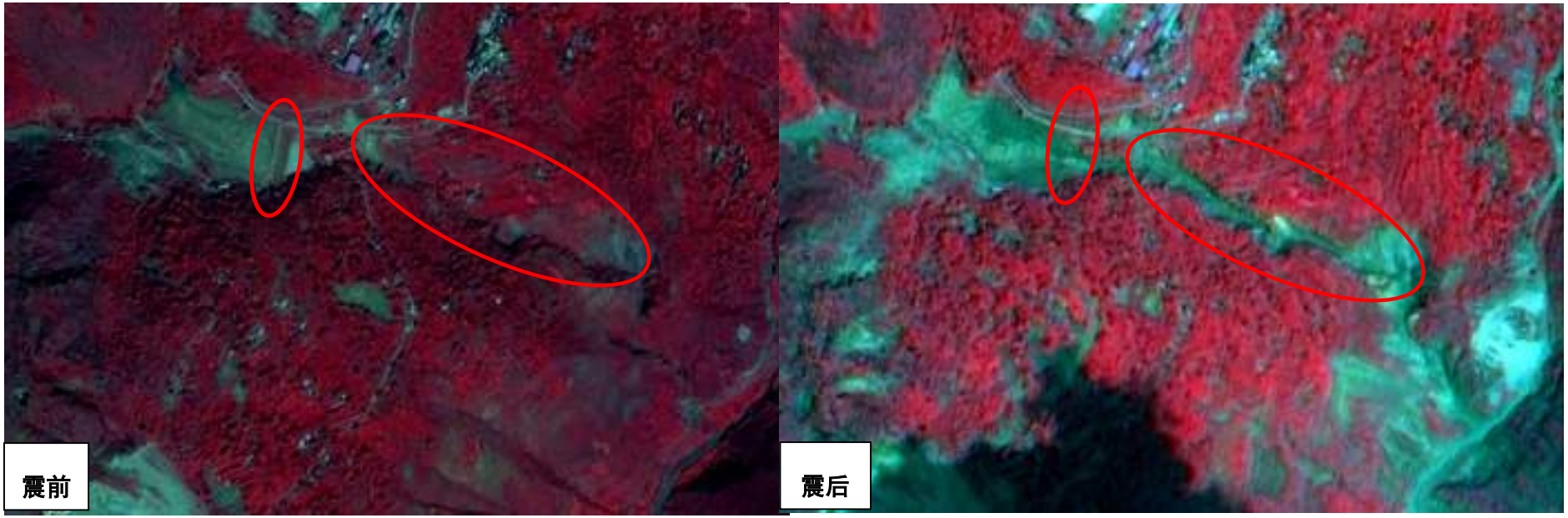


after

Barrier lake is often become more and more caused by the secondary disasters, and the water level may rise rapidly, which can bring flood disaster.

1. 2014 Ludian Earthquake—Impaction on Tailing Pond

Tailing Pond

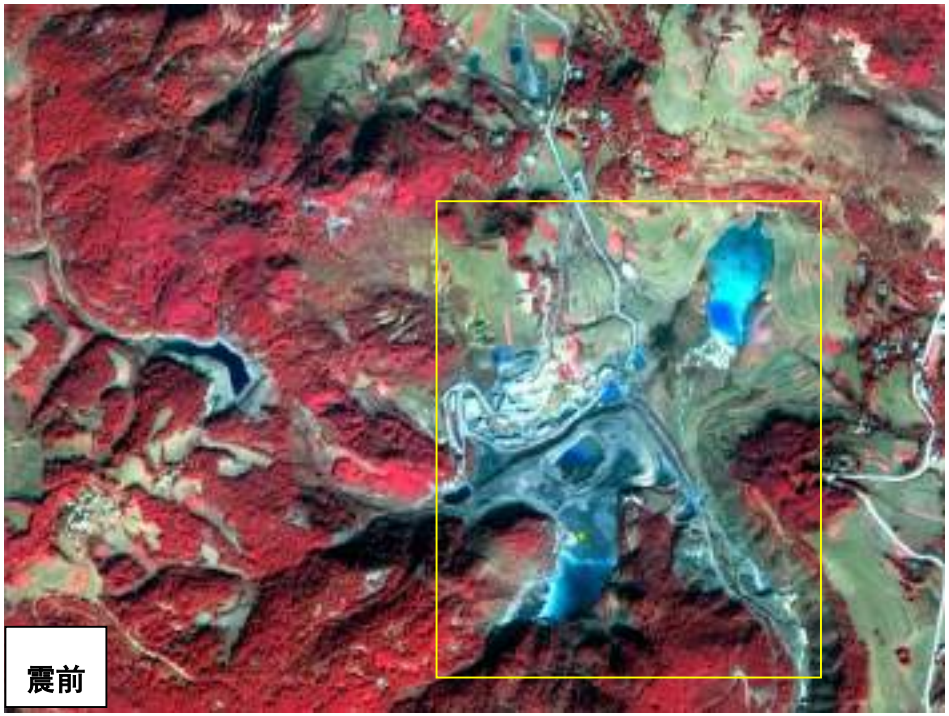


before

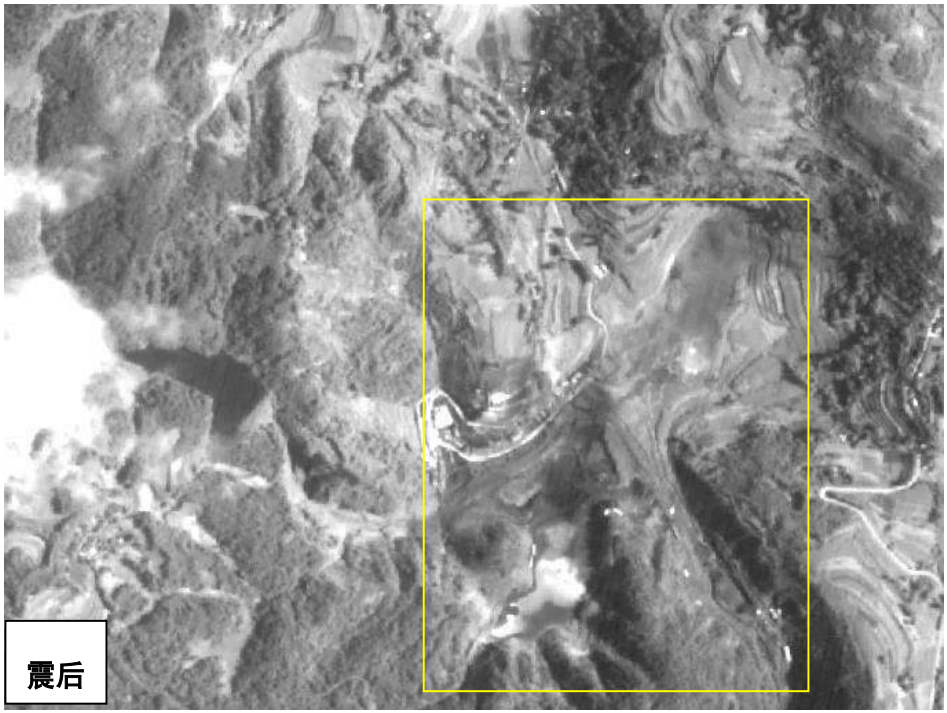
after

1. 2014 Ludian Earthquake—Impaction on Tailing Pond

Tailing Pond



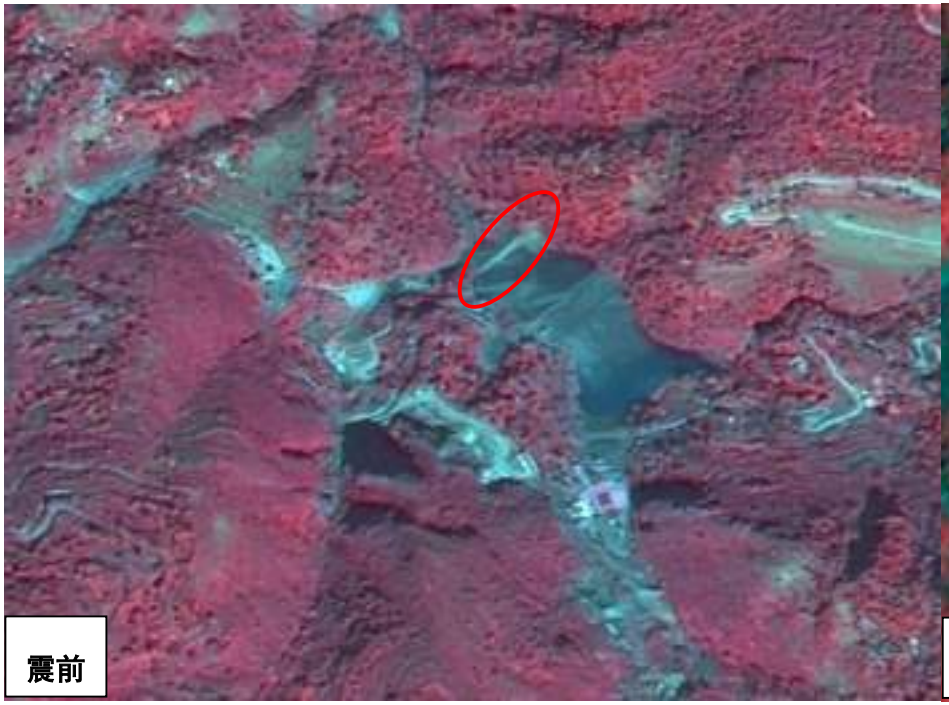
before



after

1. 2014 Ludian Earthquake—Impaction on Tailing Pond

Tailing Pond



before

after

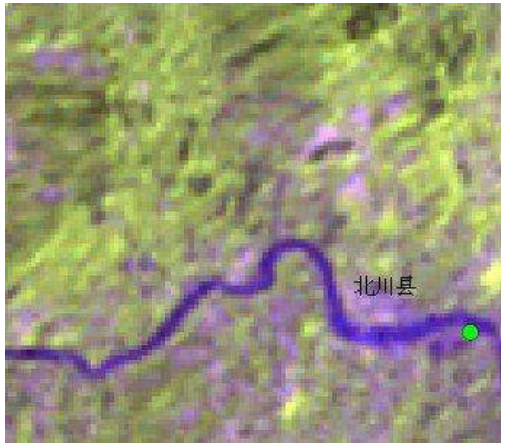
1. 2014 Ludian Earthquake—Impaction on Tailing Pond

Tailing Pond

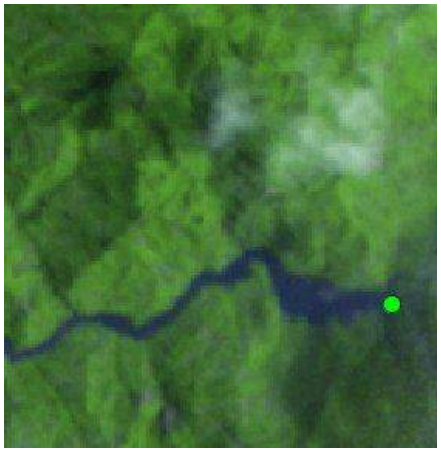
There were about 10 tailings in the earthquake affected areas，3 tailings were damaged by the earthquake, the dams of tailing pond were destroyed and endanger ecological environment.

The shortest distance between damaged tailing pond and the river was less than 50m .

2. 2008 Wenchuan Earthquake—Barrier Lakes

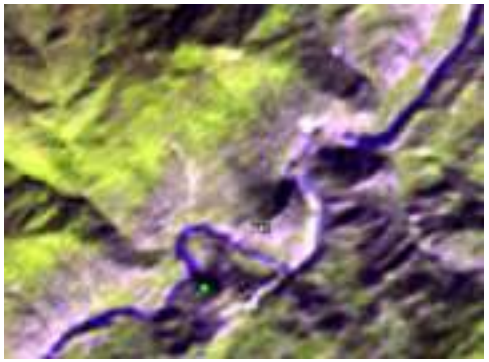


(a) Before the Earthquake



(b) After the Earthquake

Barrier Lake in Beichuan



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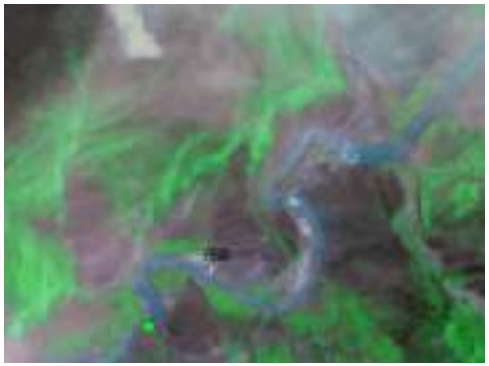


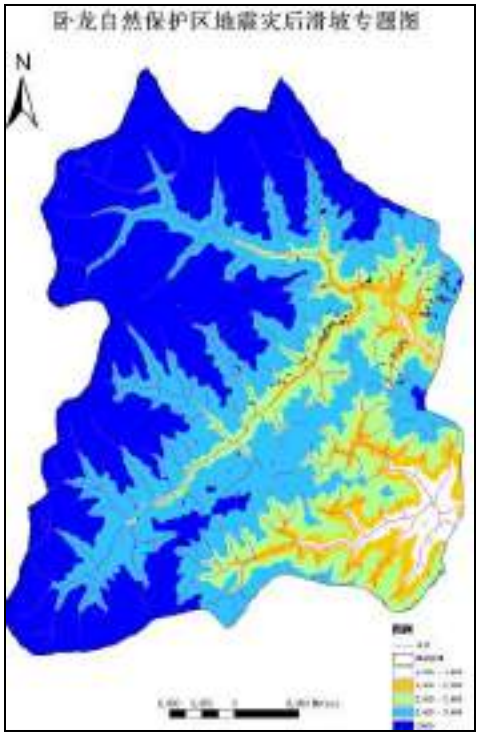
(b) After the Earthquake

Barrier Lake in Maoxian

Barrier lake

2. 2008 Wenchuan Earthquake—Sensitive Targets: Wolong Nature Reserve

Landuse thematic map of Wolong Nature Reserve



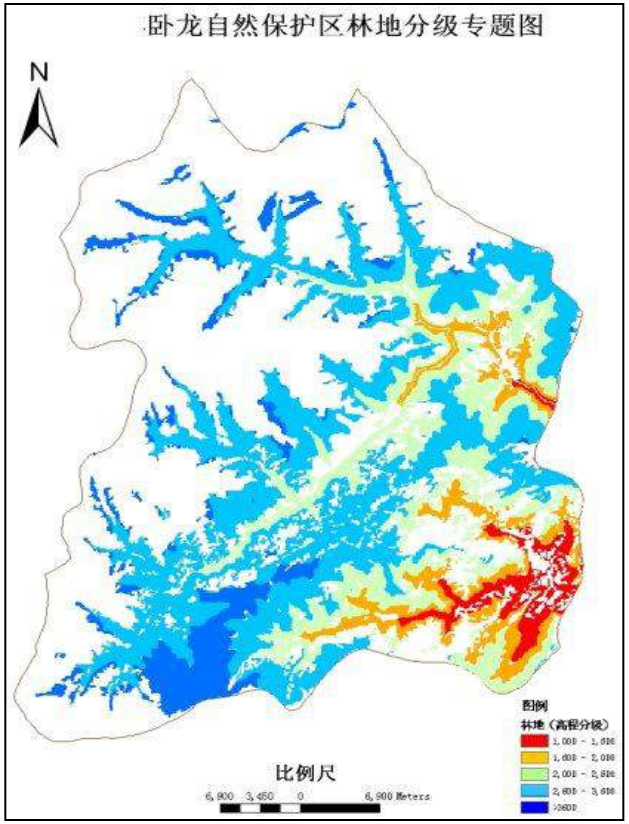
Distribution of Landsides of Wolong Nature Reserve

Landsides in Wolong Nature Reserve

Patch Number	Maximum Area (km^2)	Minimal Area (km^2)	Average Area (km^2)	Total Area (km^2)
126	0.4299	0.0008	0.0346	4.3580

There were 120 landsides or multisides with 4.35 km^2(0.21% of Wolong Nature Reserve), which inclued 3.66km^2 forest, 0.49km^2 grassland and 0.06km^2 cropland.

2. 2008 Wenchuan Earthquake—Sensitive Targets: Wolong Nature Reserve



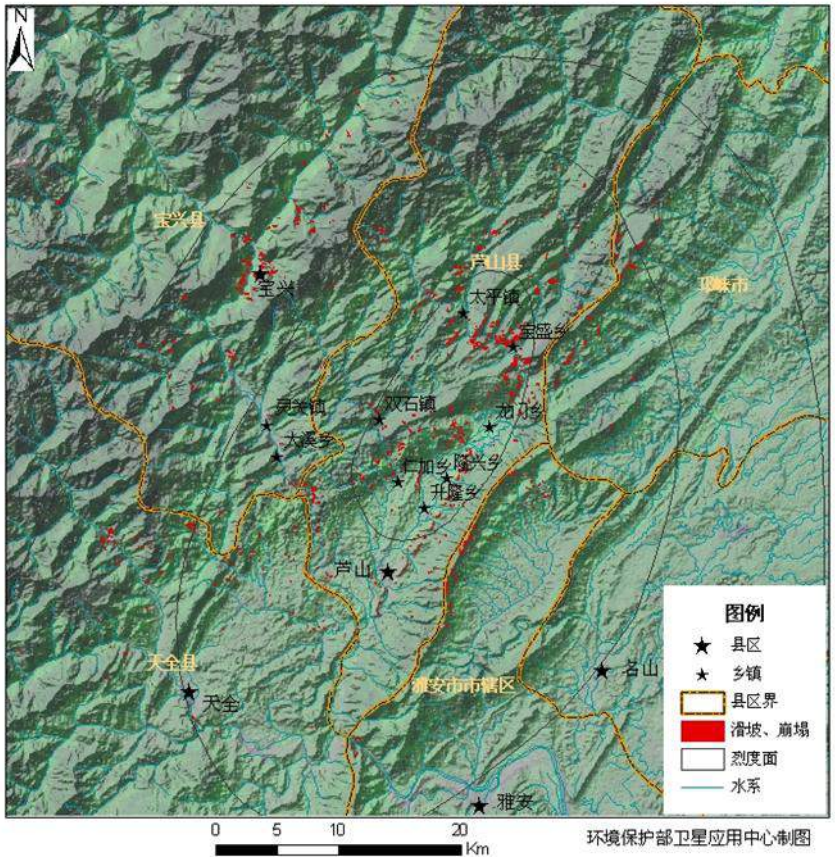
Forest in different elevati

Panda living area

Area of damaged forest in different elevations

Elevation (m)	Type of Forest	Area of Damaged forest (km^2)	Percentage of whole Damaged forest (%)	Percentage of forests in this elevations (%)
<1600	Evergreen broadleaf forest	0	0.00	0.00
1600～2000	Evergreen deciduous broadleaved mixed forest belt	0.68	18.58	0.71
2000～2600	pine|broadleaf mixed forest	1.37	37.43	0.58
2600～3600	subalpine coniferous forests, (Minjiang fir and Bamboo)	1.44	39.34	0.28
> 3600	Alpine and sub-alpine meadow and shrub	0.17	4.64	0.12

3. 2013 Lushan Earthquake

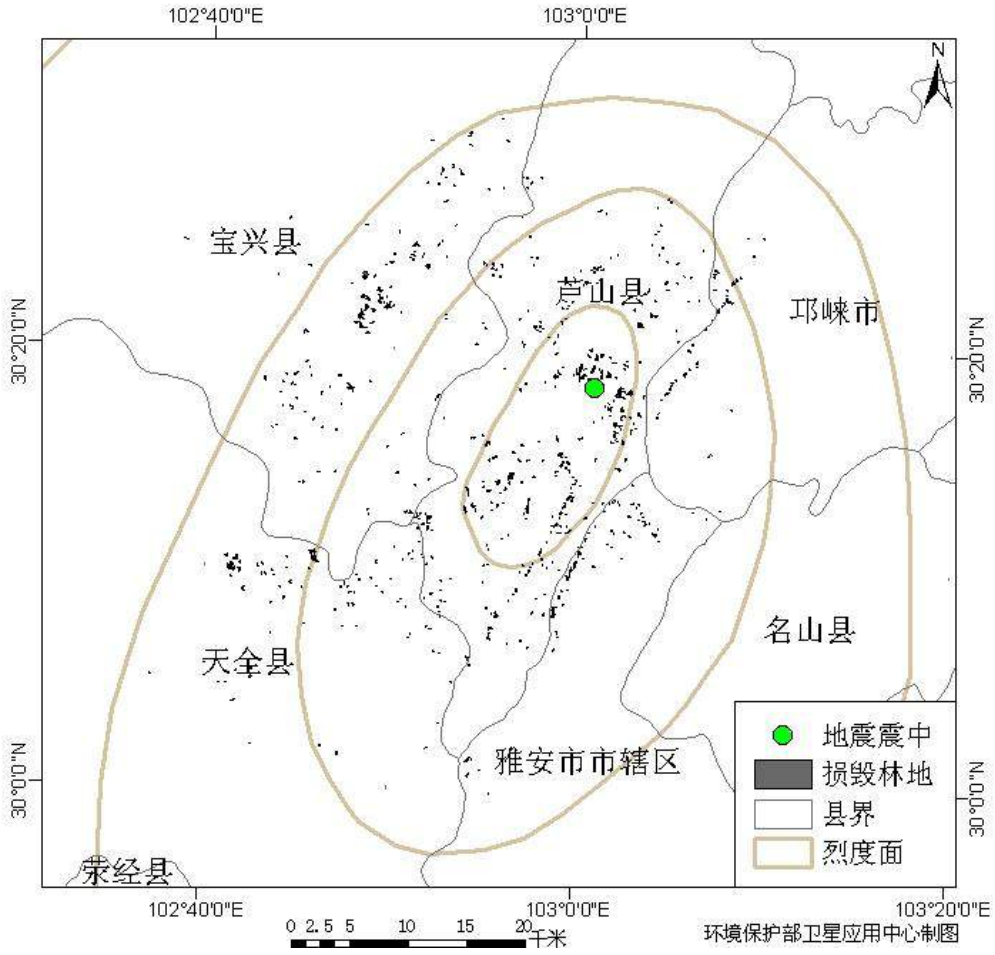


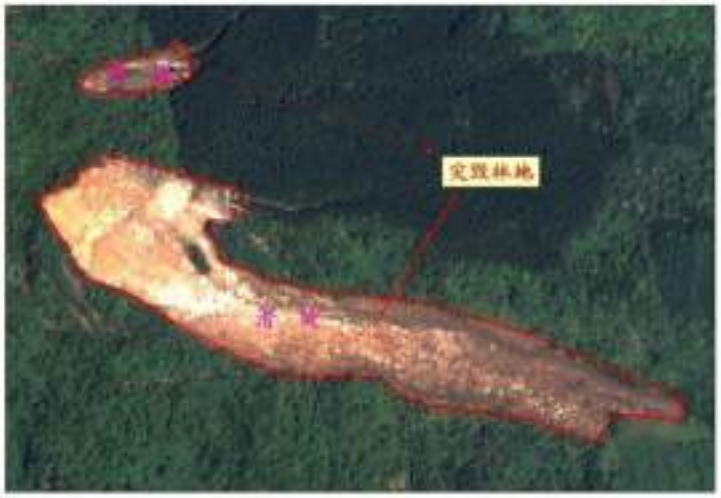
Distribution of Landslides and Collapses

Landslides and Collapses near Baosheng, Lushan

Landslides and Collapses near Baoxing

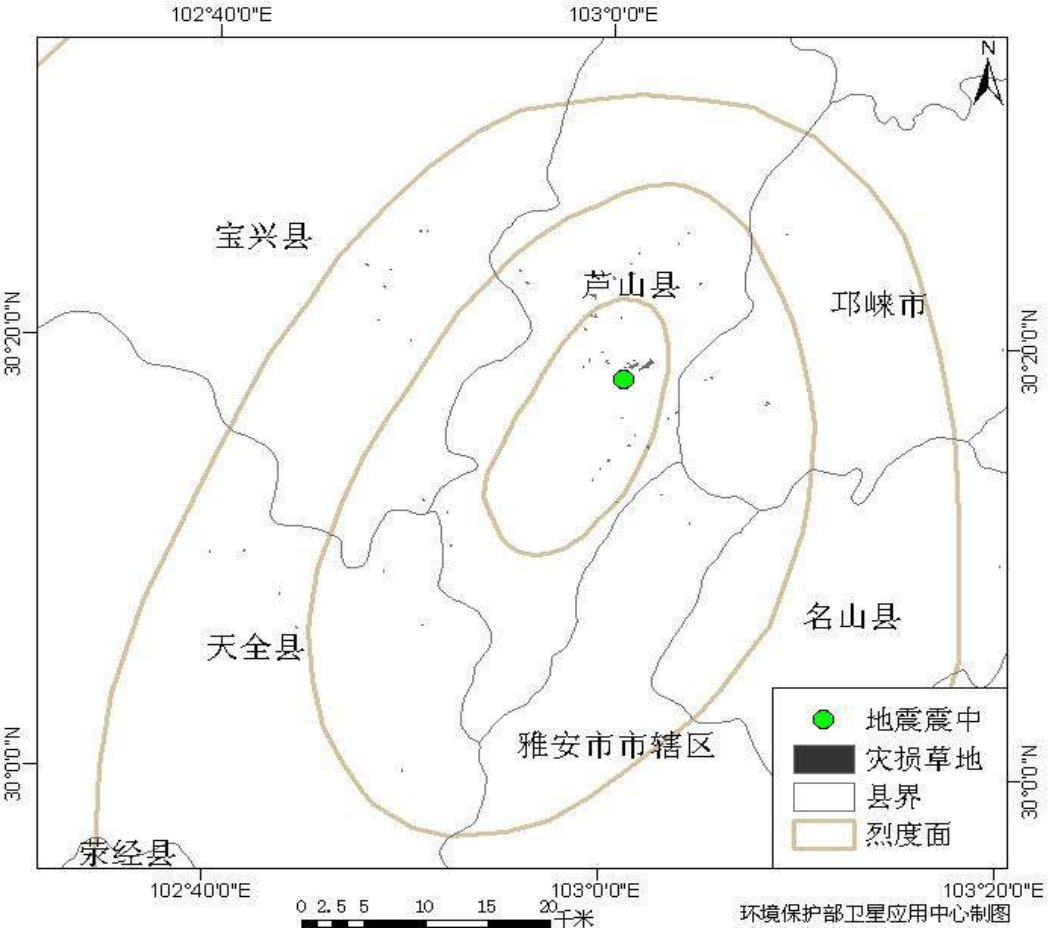
3. 2013 Lushan Earthquake

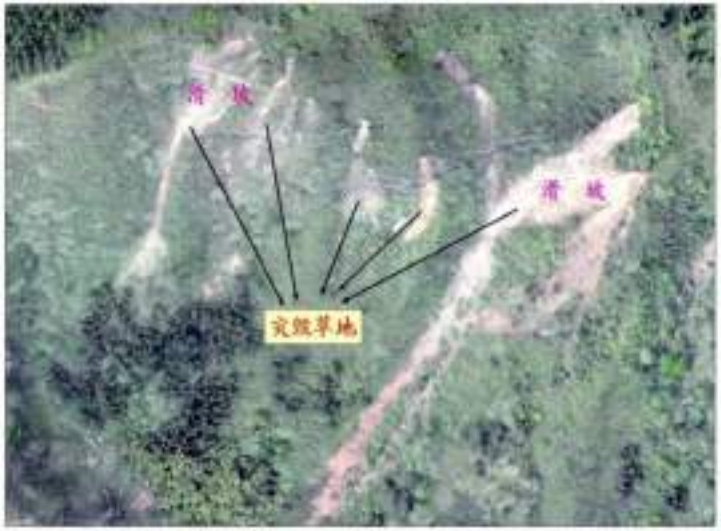


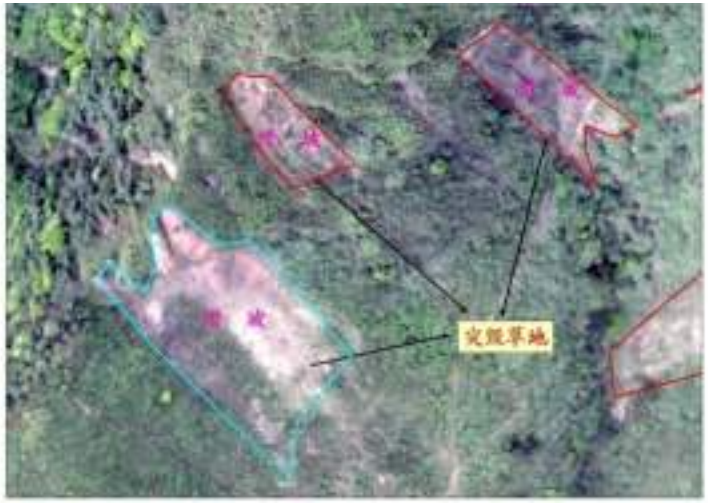


Distribution of damaged forest by the Lushan earthquake

3. 2013 Lushan Earthquake

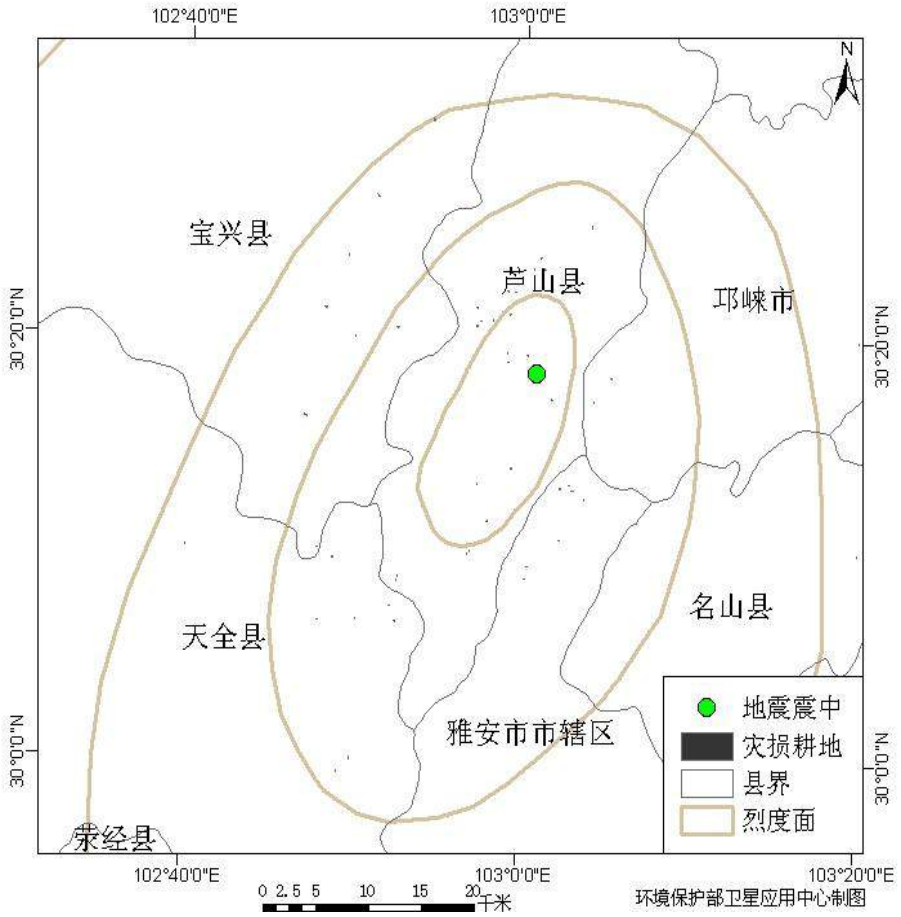






Distribution of damaged grassland by the Lushan earthquake

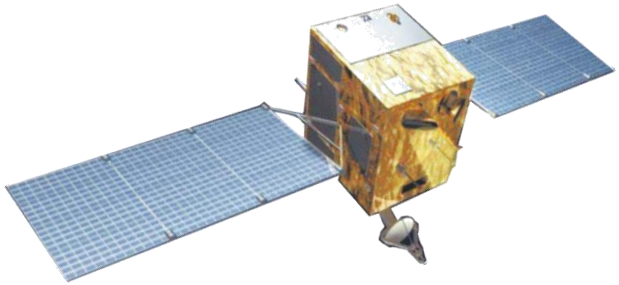
3. 2013 Lushan Earthquake



Distribution of damaged cropland by the Lushan earthquake

3. 2013 Lushan Earthquake

Blocking or occupied river by the Landslides and Collapses



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