

**3<sup>rd</sup> Joint Project Team Meeting for Sentinel Asia STEP3**

**Data Analysis Node Report**

**Li-Yu Chang**

**Associate Research Engineer**

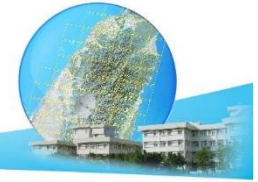
**Center for Space and Remote Sensing Research**

**National Central University, Taiwan**





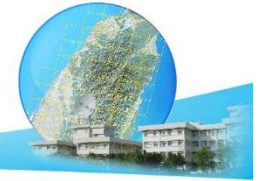
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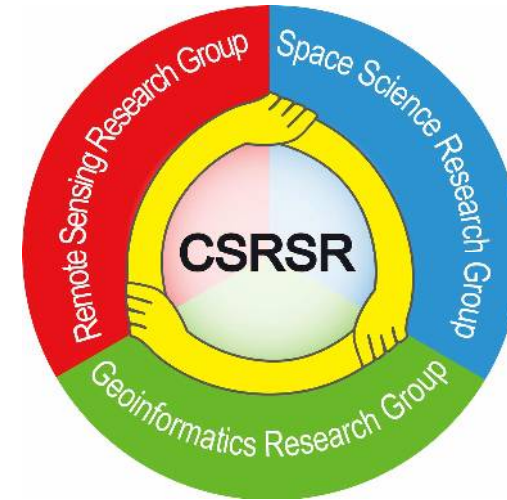
- Introduction of CSRSR
- Image product processing systems in CSRSR
- Disaster monitoring and data processing
  - Domestic cases
  - Foreign cases
  - Disaster information service platform



# Introduction of CSRSR



- CSRSR is a research center under NCU
  - Established in 1984
    - 20 faculty members (Professors)
    - 10 supporting staffs
    - 81 contract employees
  
- CSRSR is organized into two parts
  - 3 Research groups
    - Including 12 laboratories
  - Resource satellite receiving station



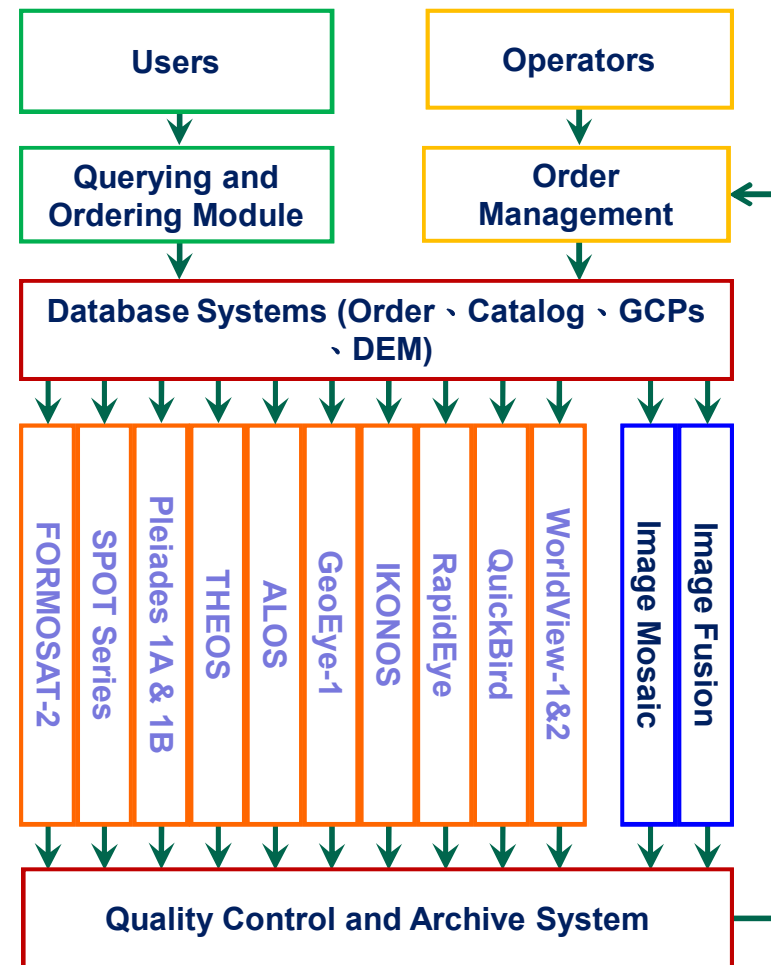
Research groups in CSRSR



Resource satellite receiving station

# Image product processing systems in CSRSR

- In CSRSR, satellite image products rectified with ground control and digital elevation model is a standard.
  - Level-3 or 4 rectified images are provided
- Multi-Sensor Geocoded Production System (MSGPS) was designed for image product processing



Framework of MSGPS



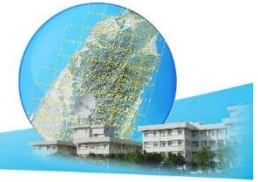
# Image product processing systems in CSRSR



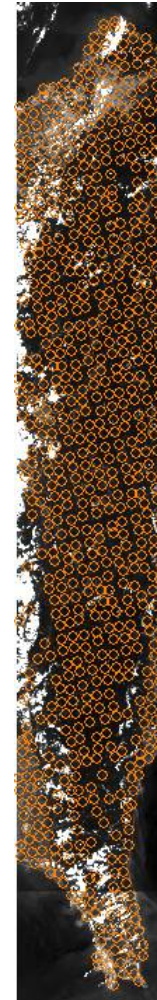
- Recently, image matching approach was accomplished for collecting ground control points automatically
  - Lower processing time
  - Higher geometric consistency



# Ground Control Point Matching



- Automatic GCP marking by image matching
- Reference Data
  - Orthoimage: Planimetric coordinates
  - Digital Elevation Model: Height value
- Image Matching
  - Normalized Cross-Correlation
    - Preliminarily Marking
  - Least Squares Matching
    - Subpixel Accuracy
  - Image Pyramid
    - Improve the Quality and Efficiency



SPOT 1A Image with GCP

# Image orthorectification by automatic GCPs generation

- Test area: Mount Bromo volcanic area, Indonesia
- Test data: FORMOSAT-2 images



Strip No.	Acquisition Date	Location of Image Center	Incident Angle (Degree)	
1	2015/6/19	N8.091698 / E112.923074	4.7	
2	2015/6/20	N8.097868 / E112.922359	4.7	
3	2015/6/21	N8.097184 / E112.92163	4.7	
4	2015/6/22	N8.093665 / E112.923954	4.7	
<b>Reference</b>	<b>5</b>	<b>2015/6/24</b>	<b>N8.043951 / E112.902621</b>	<b>4.7</b>
	6	2015/6/25	N8.093494 / E112.921885	4.7

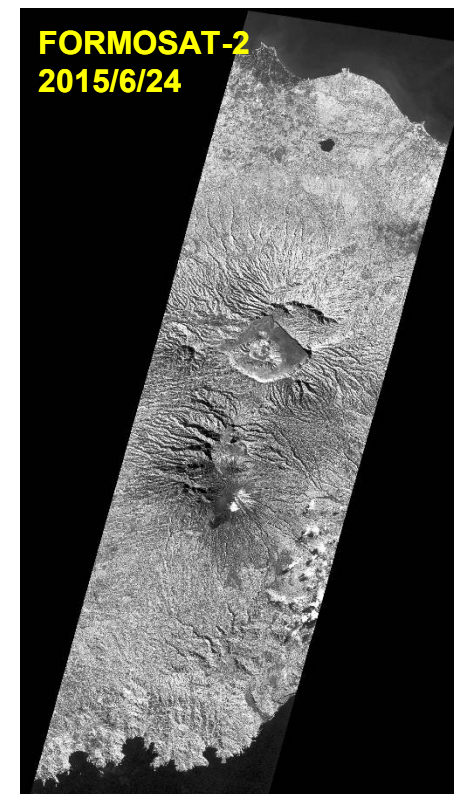
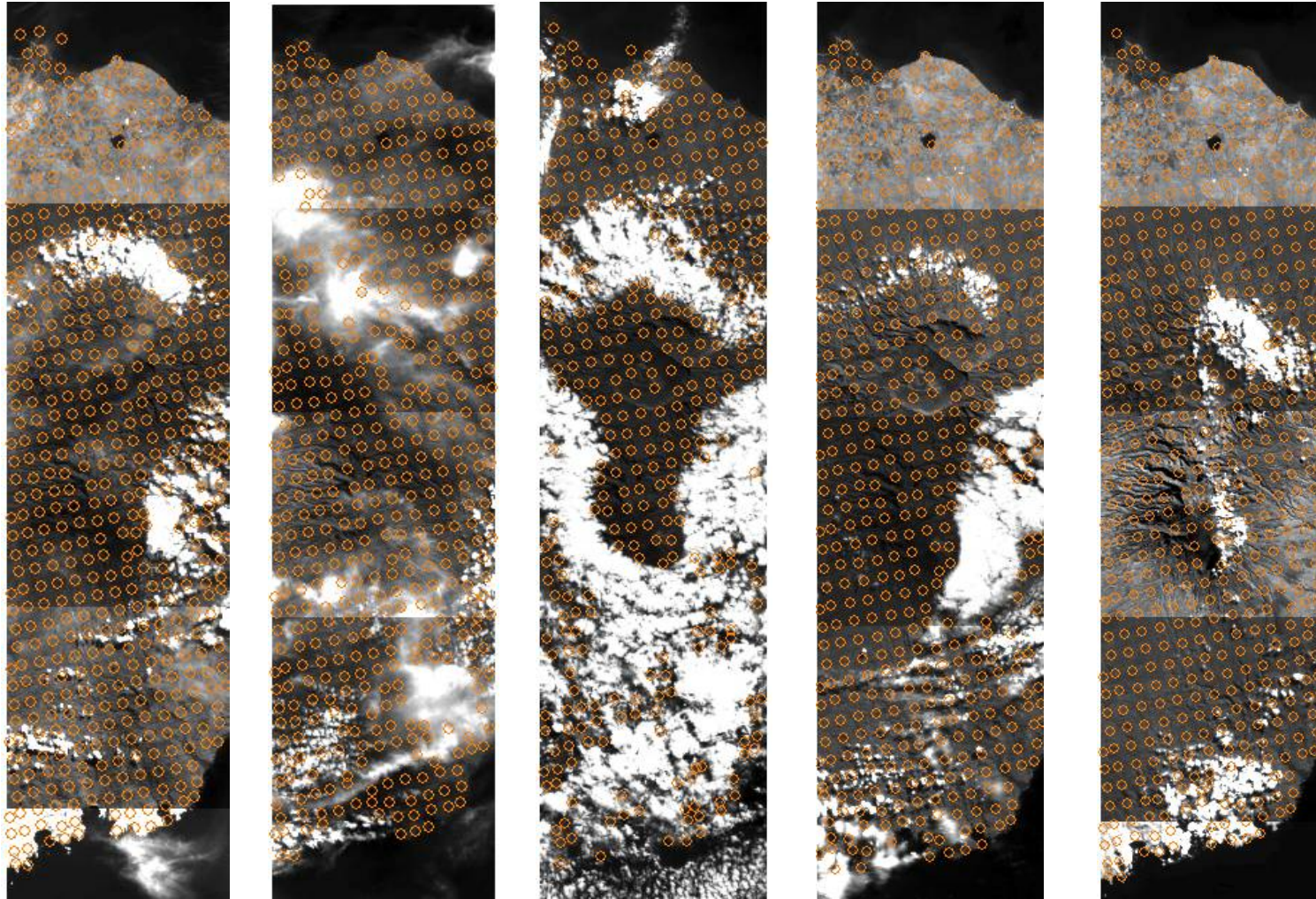


Image strip 5 is used as reference image.

# Automatically matched GCPs on L1A images



2015-06-19

2015-06-20

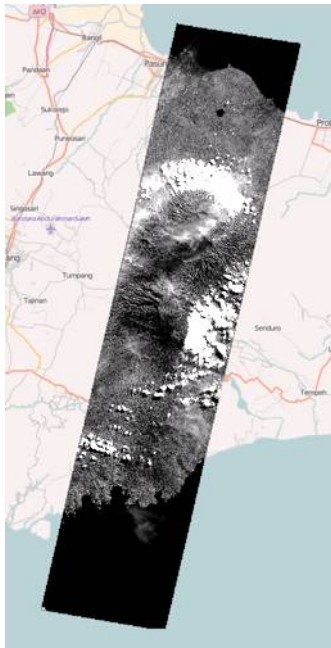
2015-06-21

2015-06-22

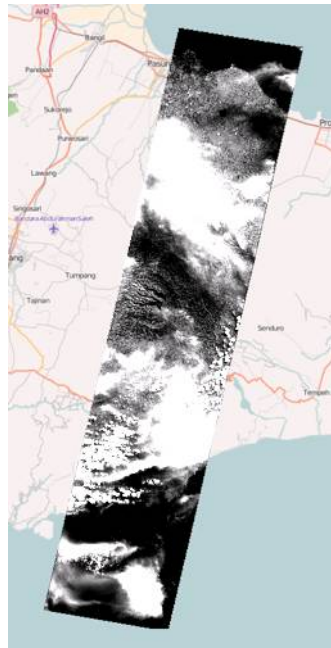
2015-06-25



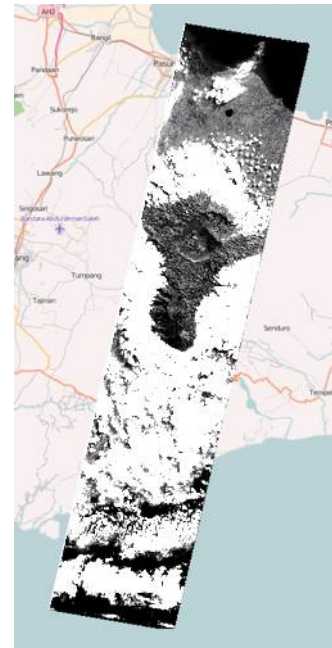
# Accuracy assessment of L4 corrected images



2015-06-19



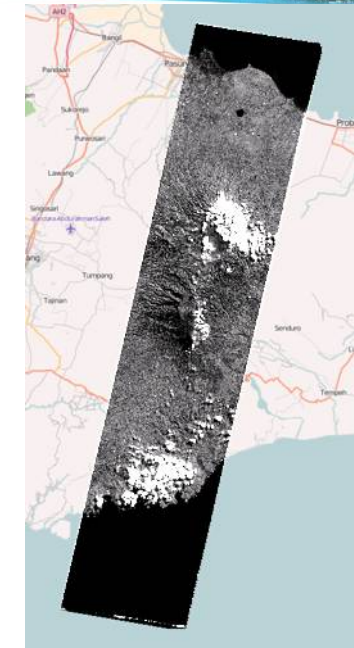
2015-06-20



2015-06-21



2015-06-22



2015-06-25

Acquisition Date	Number of GCPs	Matching Times (min)	Number of ICPs	RMSE_ICPs (E/N)	MEAN_ICPs (E/N)
2015-06-24	52		24	4.61/5.54	1.31/-0.55
2015-06-19	522	9.32	32	3.01/5.06	-1.02/0.12
2015-06-20	493	8.70	24	3.50/5.97	0.39/1.31
2015-06-21	357	9.00	18	1.69/3.62	-0.87/-0.21
2015-06-22	492	9.95	22	3.06/4.39	-0.71/1.73
2015-06-25	528	12.24	22	3.36/4.33	0.04/0.92

Reference:

High resolution satellite images in Google Maps

Unit: meter

# Disaster monitoring and data processing

## ➤ Domestic cases

### ➤ Typhoon Soudelor

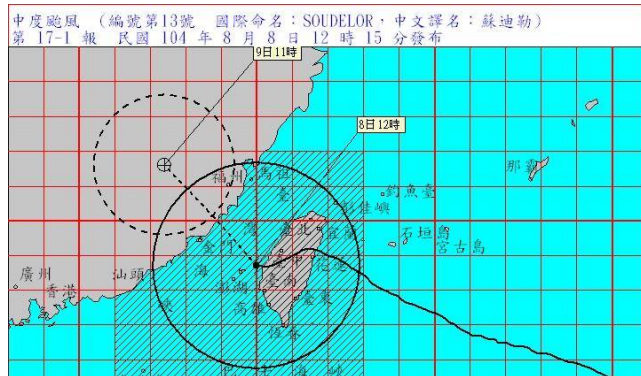
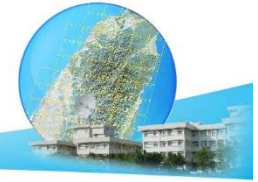
- Warning period: 2015/8/6~2015/8/9
- Super Typhoon Soudelor is taking aim at Taiwan and China, threatening damaging winds, destructive storm surge and flooding rains.

### ➤ Typhoon Dujuan

- Warning period: 2015/9/27~2015/9/29
- Super Typhoon, No EOR was sent.



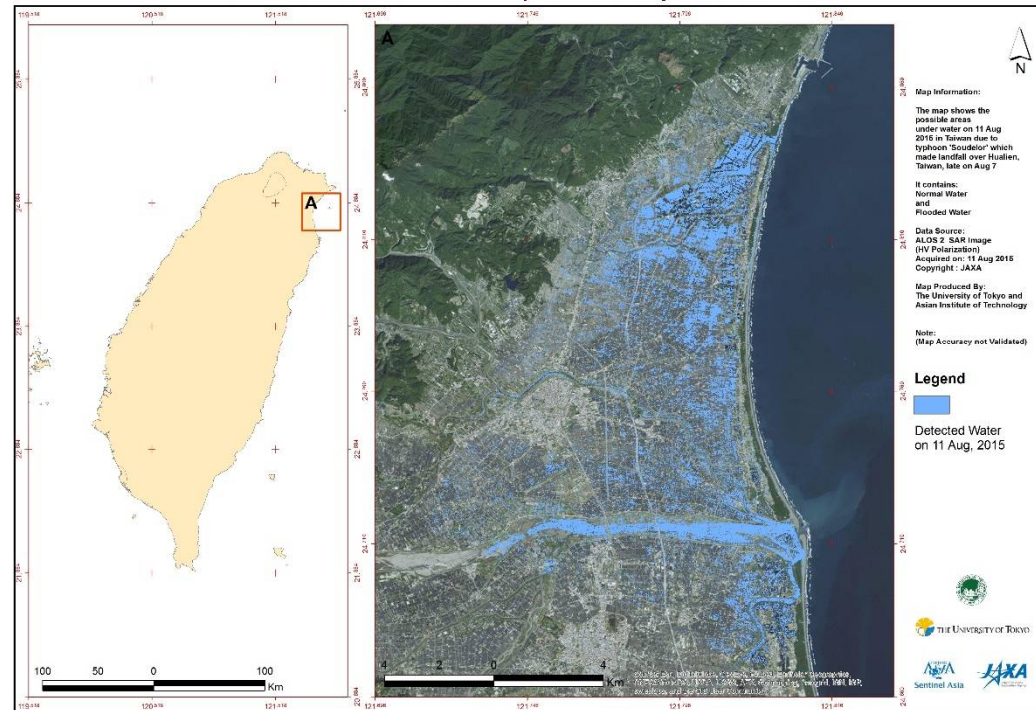
# Typhoon Soudelor



## ➤ Major flooded Area: I-Lan



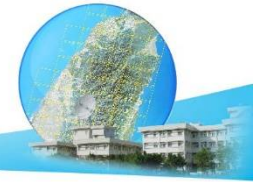
Area under Water, Detected by ALOS 2, Aug 11, 2015, Taiwan



Flooded area analyzed from ALOS-2 SAR images  
(Downloaded from Sentinel Asia Web Page)



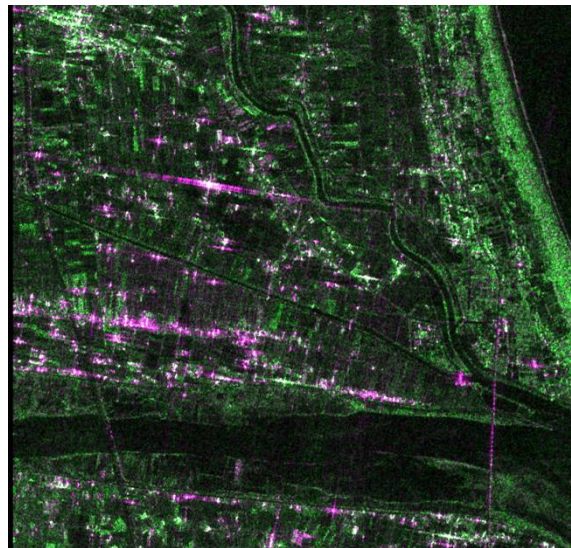
# Typhoon Soudelor



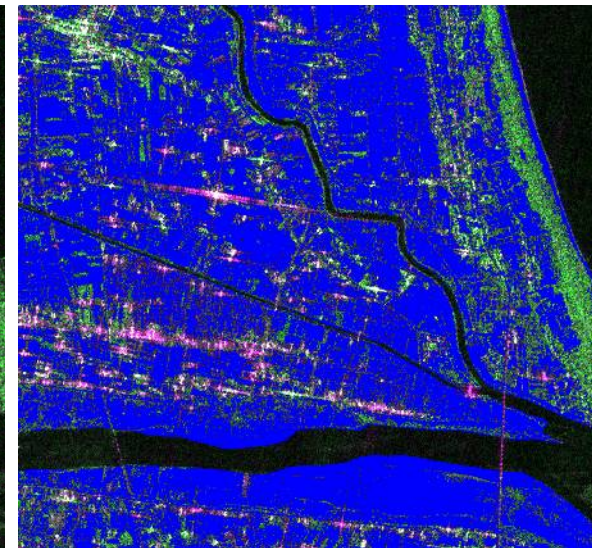
- Flood monitoring in CSRSR using ALOS-2 SAR image



SPOT6  
2015/05/29  
(Reference)



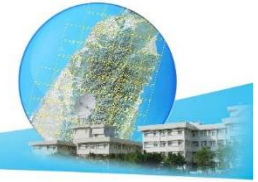
ALOS-2  
2015/08/11



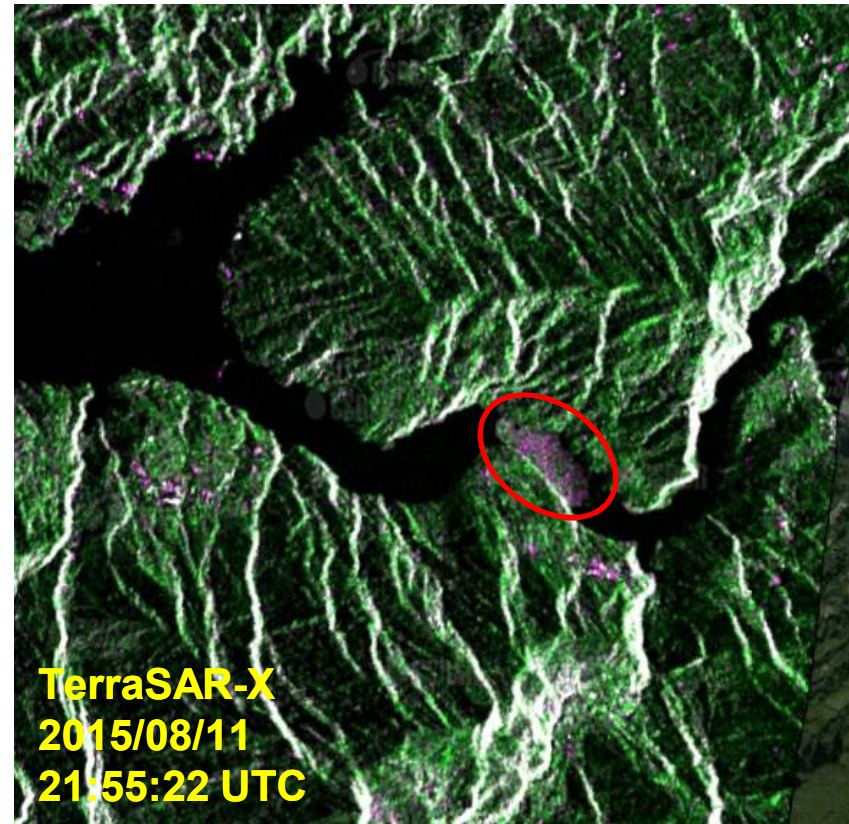
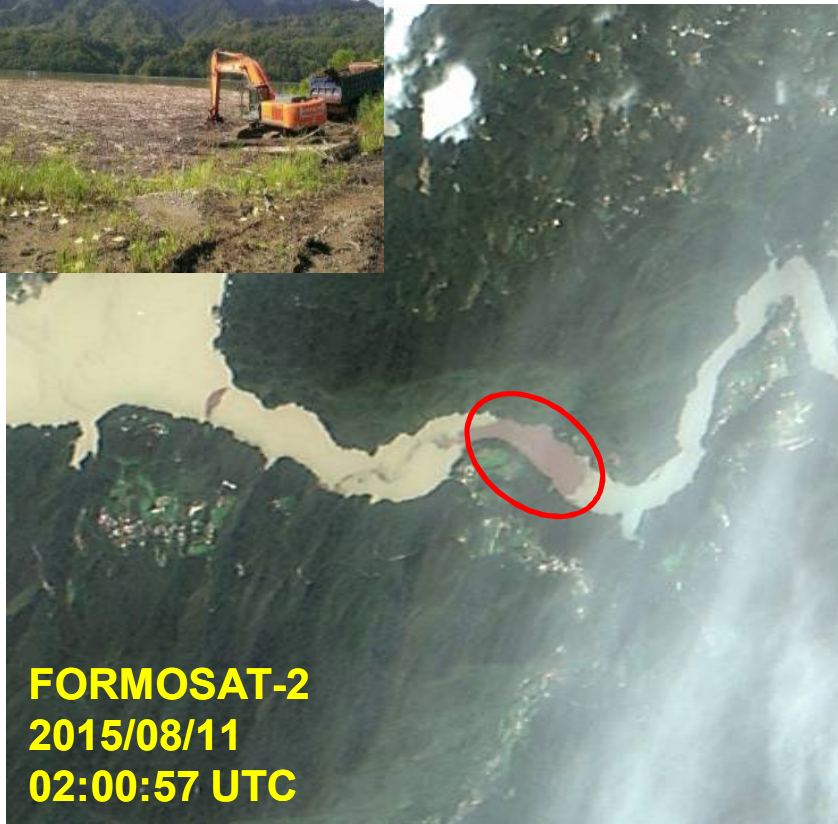
Flooded Area  
(Blue Area)



# Typhoon Soudelor

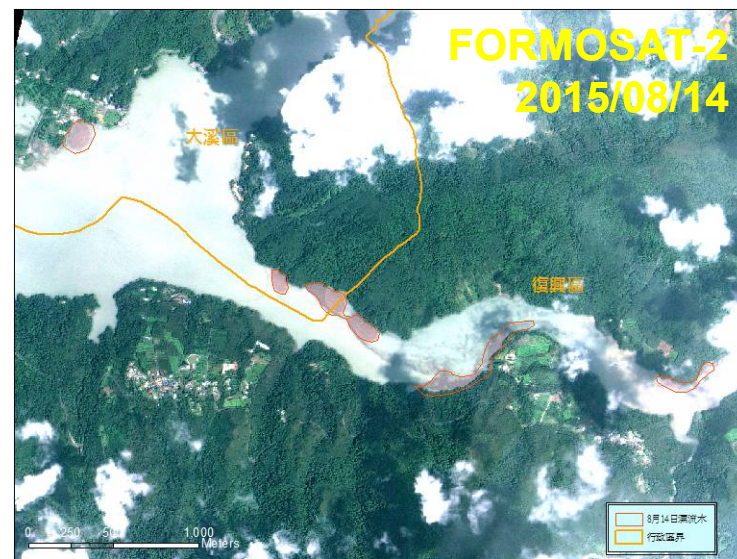
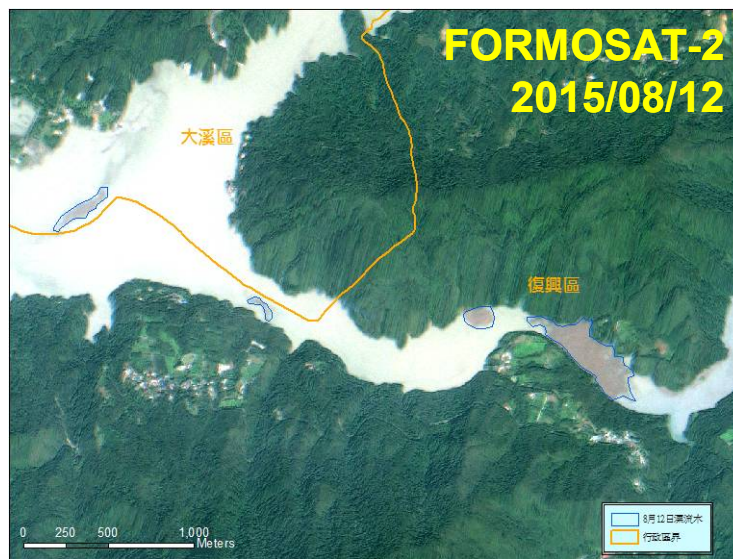
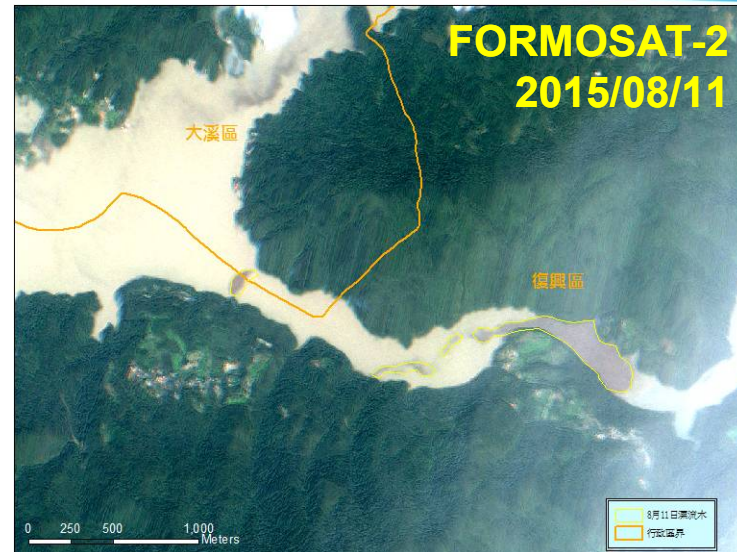
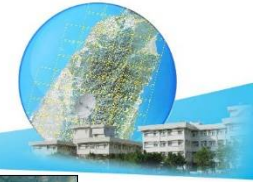


- Floating woods caused by Typhoon
- River flow blocked by floating woods



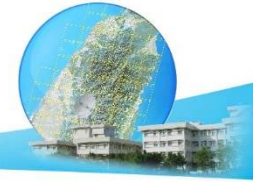


# Movement of floating woods





# Typhoon Soudelor



- Increasing river water turbidity due to landslide
- Pollution to water resources



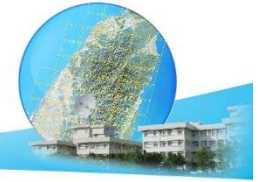
FORMOSAT-2  
2015/3/14  
2015/3/15



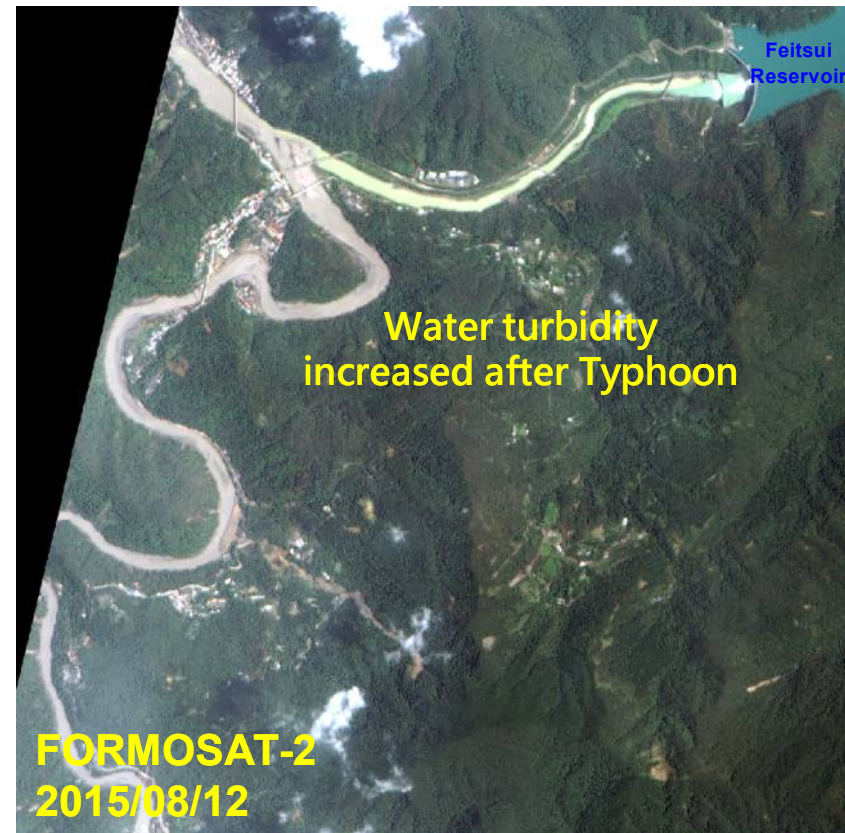
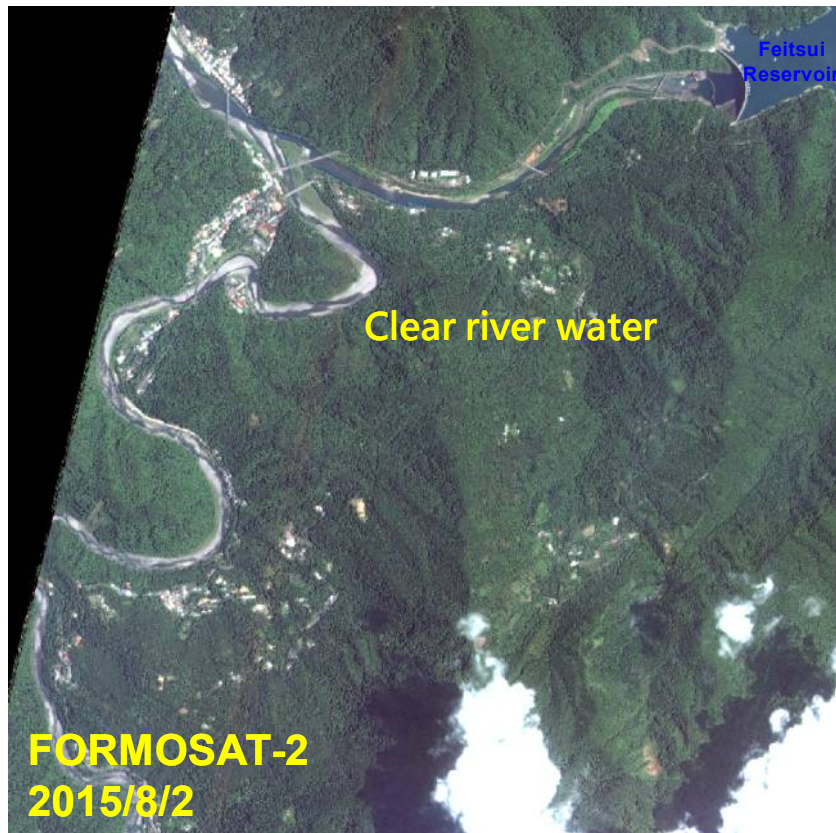
FORMOSAT-2  
2015/8/12



# Typhoon Soudelor



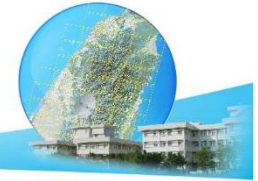
## ➤ Pollution to water resources



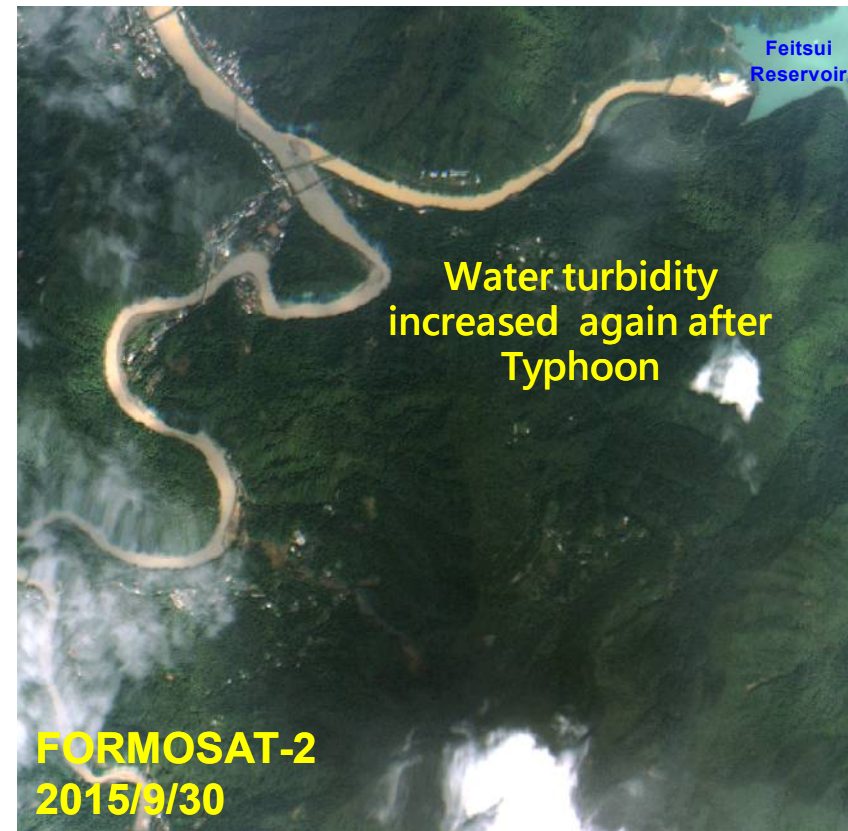
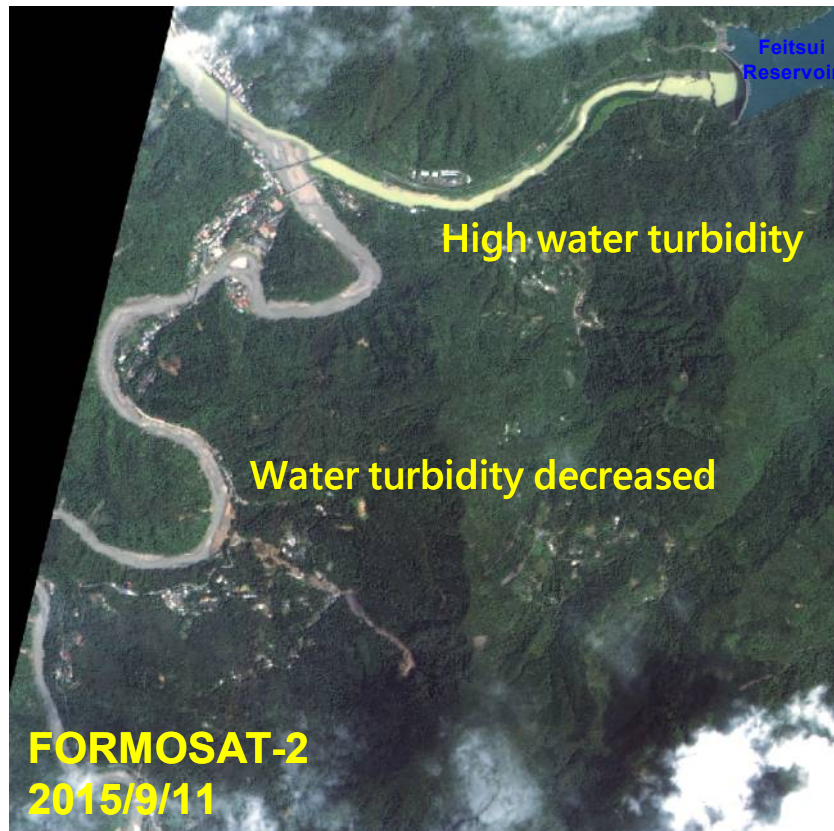




# Typhoon Dujuan



- Pollution to water resources: severer case



# Disaster monitoring and data processing

## ➤ Foreign cases

### ➤ Earthquake in Nepal

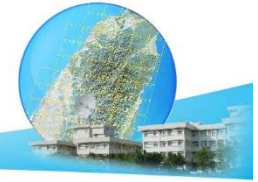
- Date: 2015/4/25
- A huge earthquake (M7.5) happened in Nepal, close to South Tibet of China to the north, and India to the south. The Capital of Nepal.

### ➤ Flood in Indonesia due to heavy rain

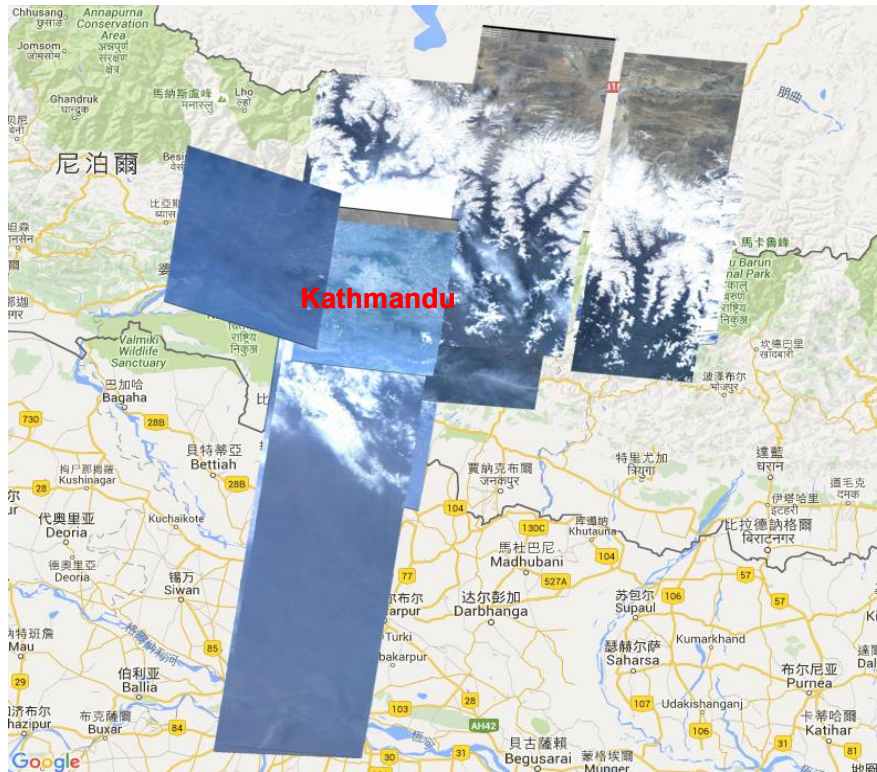
- Date: 2015/2/9
- Heavy rain has hit Indonesia's capital. Several areas of the city have been inundated with 20-40 cm. In some areas in West Jakarta, floods have reached 60 cm deep.



# Earthquake in Nepal



- Series Days of FORMOSAT-2 were processed and delivered for further analysis.
- 20 Level-4 image strips acquired in 17 days were provided



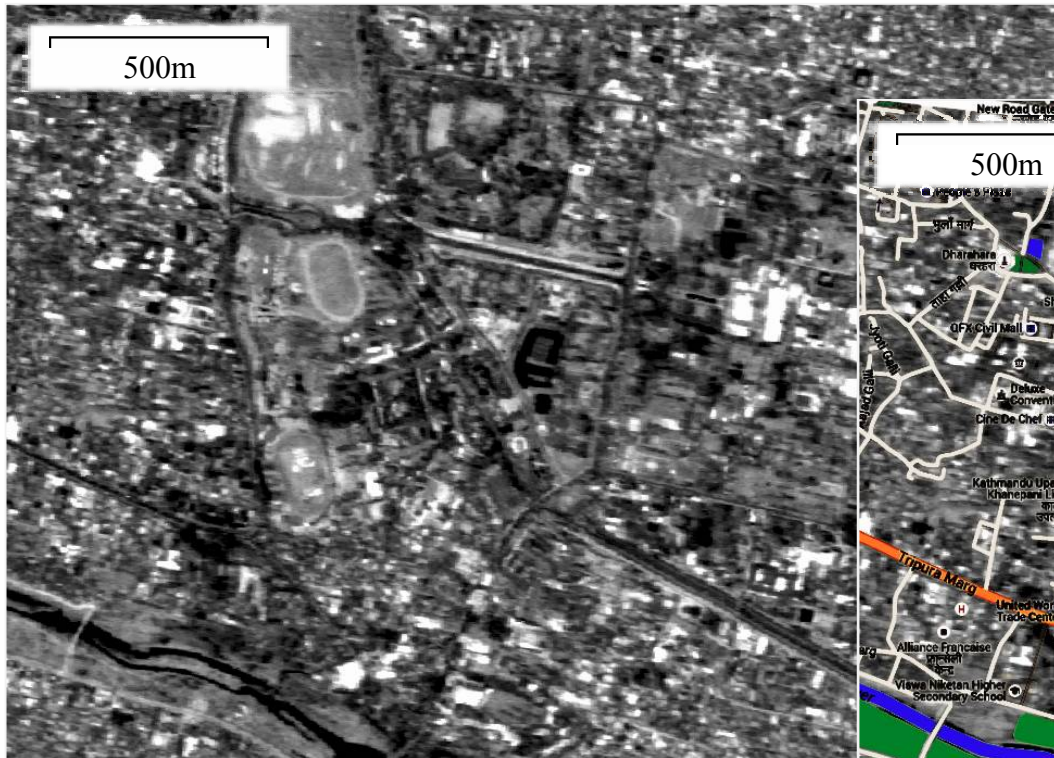
Strip No.	Acquisition Date	Image Center	Incident Angle (degree)	Delivery Date
1	2011/2/4	N27.618508 / E85.373435	54.7	2015/4/27
2	2011/2/6	N27.615238 / E85.350301	54.3	2015/4/28
3	2011/2/7	N27.605718 / E85.395914	55.0	2015/4/27
4	2011/2/9	N27.623906 / E85.353616	54.3	2015/4/27
5	2015/4/26	N27.638981 / E85.325176	56.9	2015/4/27
6	2015/4/27	N27.519476 / E85.395143	56.8	2015/4/28
7	2015/4/28	N27.137452 / E85.317764	62.8	2015/4/29
8	2015/4/28	N27.988955 / E86.771185	56.8	2015/4/29
9	2015/4/29	N27.565433 / E85.421618	65.8	2015/4/30
10	2015/4/30	N27.32727 / E85.374231	65.6	2015/5/1
11	2015/5/1	N27.75526 / E85.990326	55.0	2015/5/2
12	2015/5/2	N27.429327 / E85.410995	65.5	2015/5/3
13	2015/5/3	N27.661909 / E84.740605	67.5	2015/5/4
14	2015/5/3	N27.524673 / E85.312596	56.9	2015/5/4
15	2015/5/3	N27.538778 / E85.768938	67.5	2015/5/4
16	2015/5/4	N27.867906 / E86.754496	52.7	2015/5/5
17	2015/5/5	N27.864603 / E85.938895	55.5	2015/5/6
18	2015/5/6	N27.556131 / E85.276894	57.1	2015/5/7
19	2015/5/7	N27.997207 / E85.342364	57.4	2015/5/8
20	2015/5/13	N27.987085 / E86.102632	54.9	2015/5/24



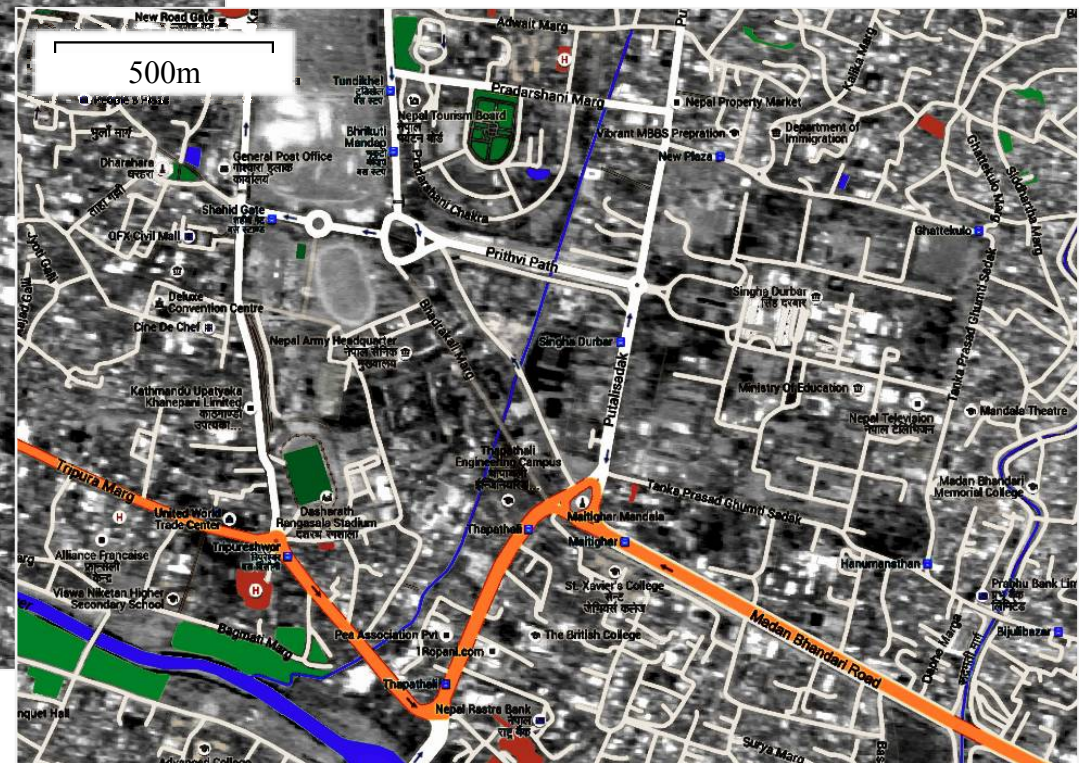
# Geometric accuracy assessment



- FORMOSAT-2 image acquired on 2015/5/3 over Kathmandu

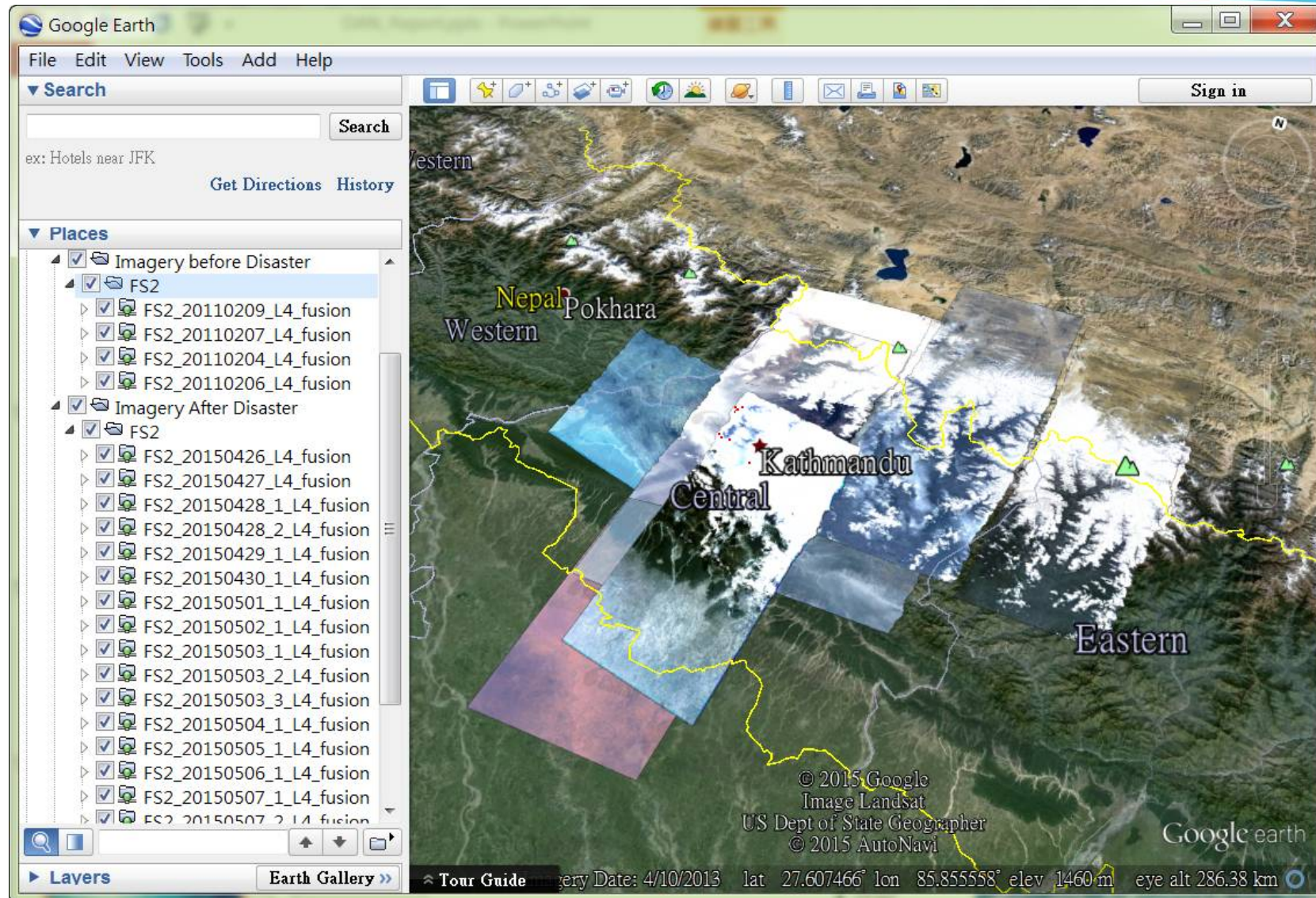


FORMOSAT-2 Level-4 Image



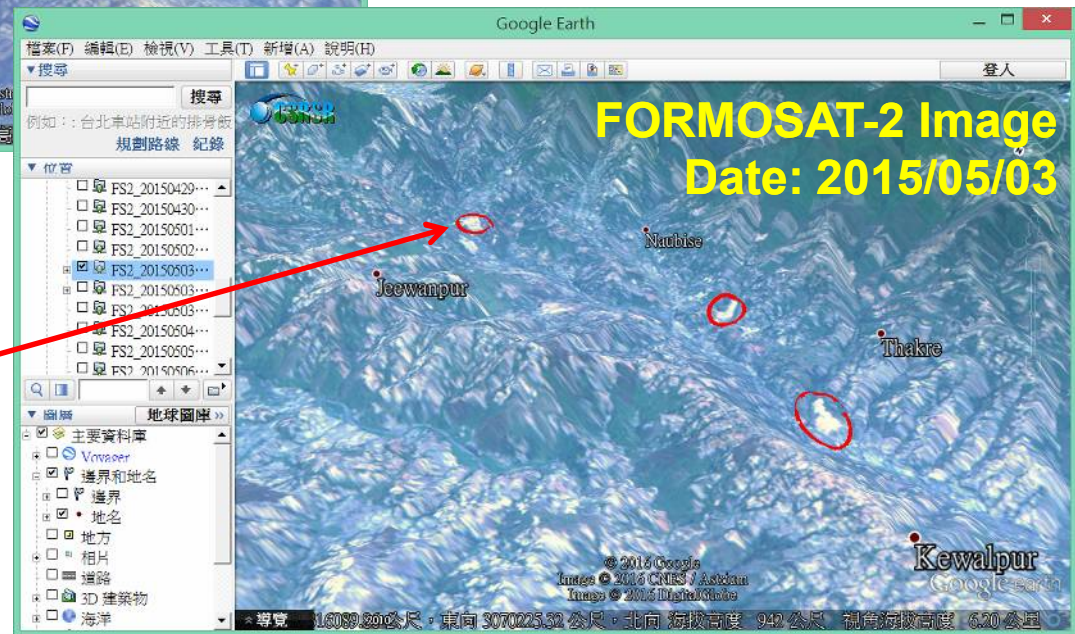
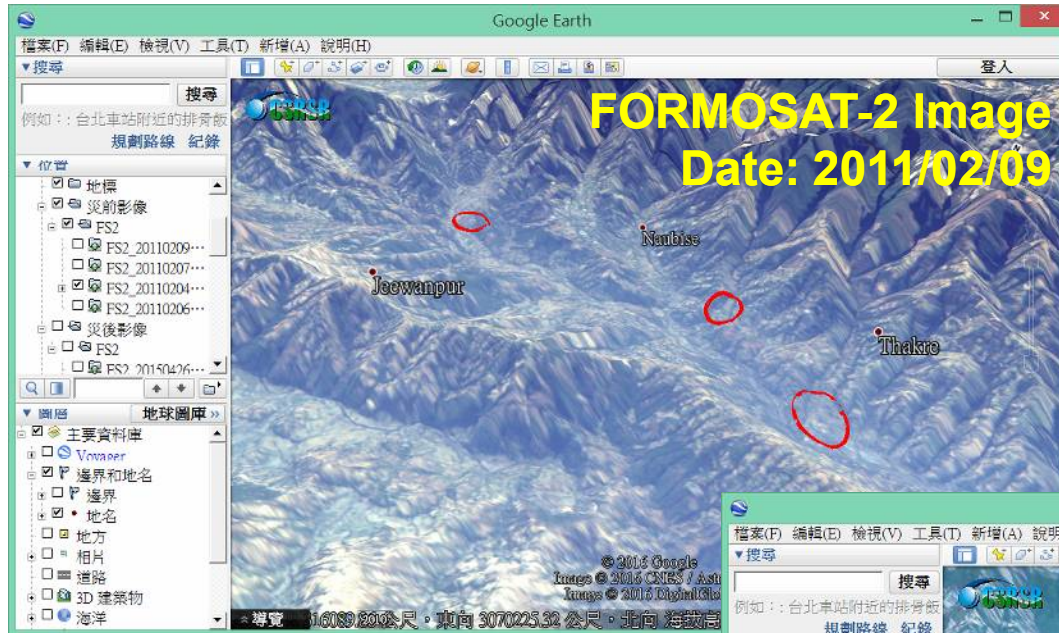
Level-4 Image overlaid with Roads from Google Map

# Ortho images were published and shown on Google Earth





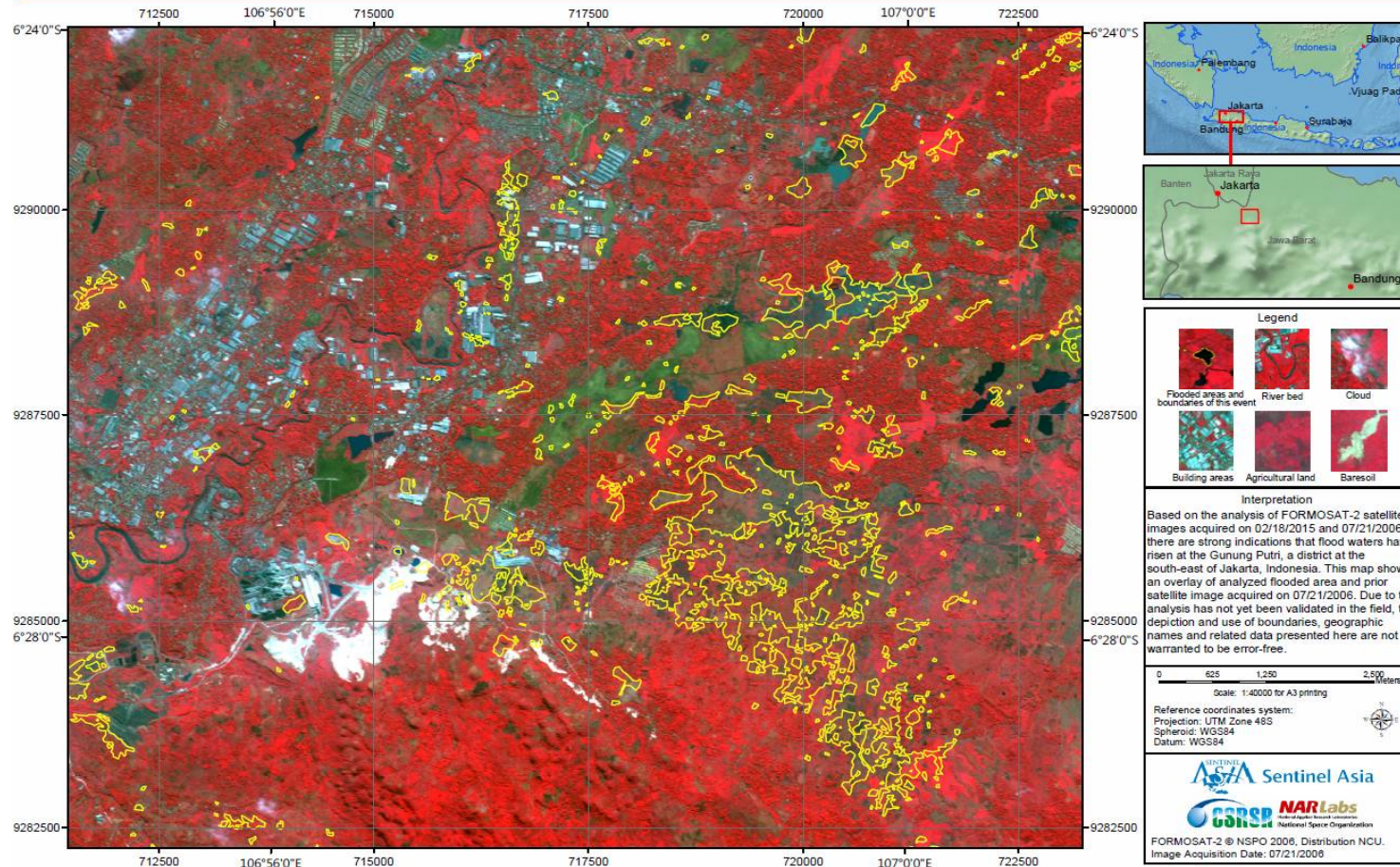
# Landslide observation



**Probable Landslide Area**

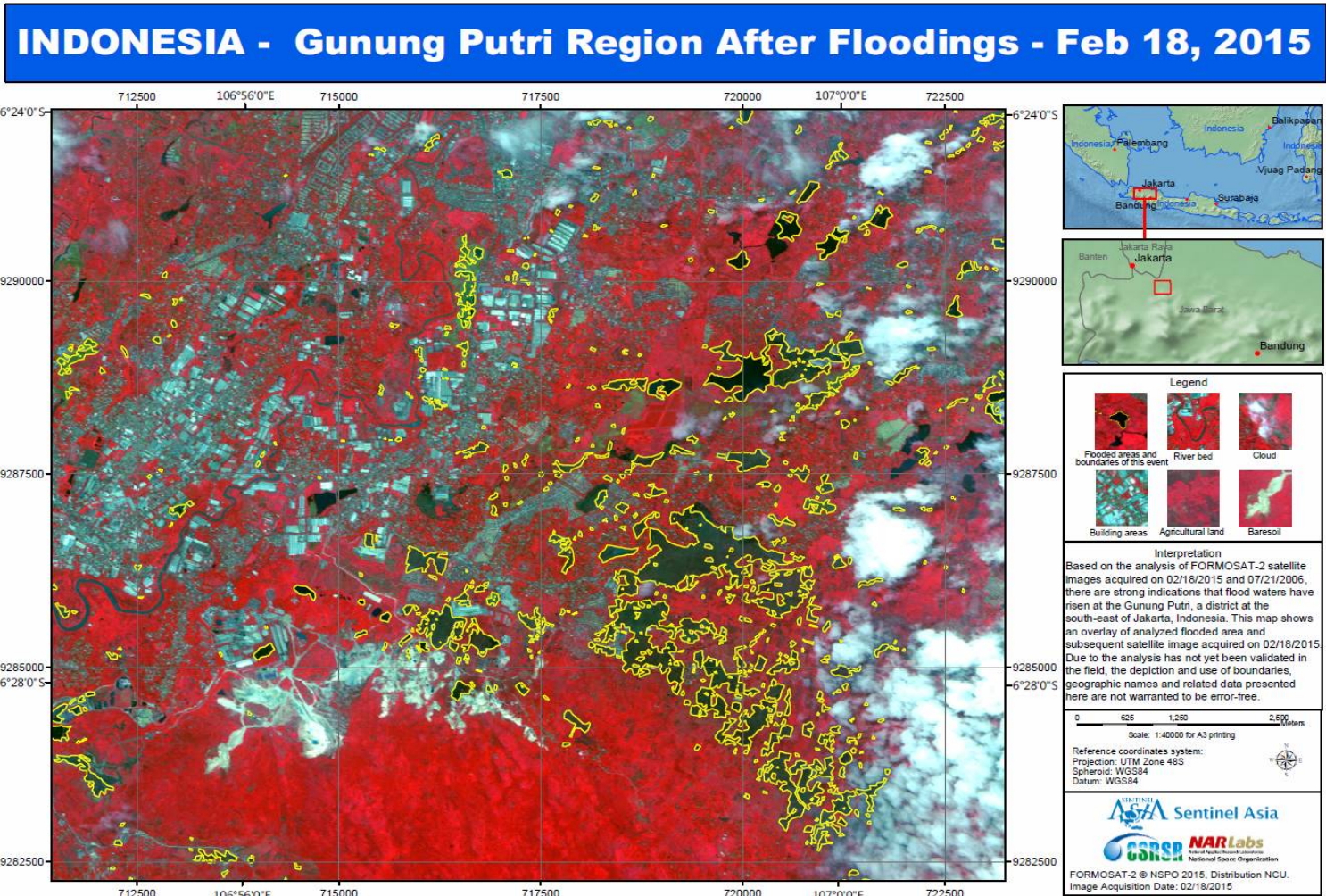
# Flood in Indonesia due to heavy rain

## INDONESIA - Gunung Putri Region Before Floodings - Jul 21, 2006



Prior Image and Analyzed Result

# Flood in Indonesia due to heavy rain



Later Image and Analyzed Result



# Disaster Information Service Platform

English Version

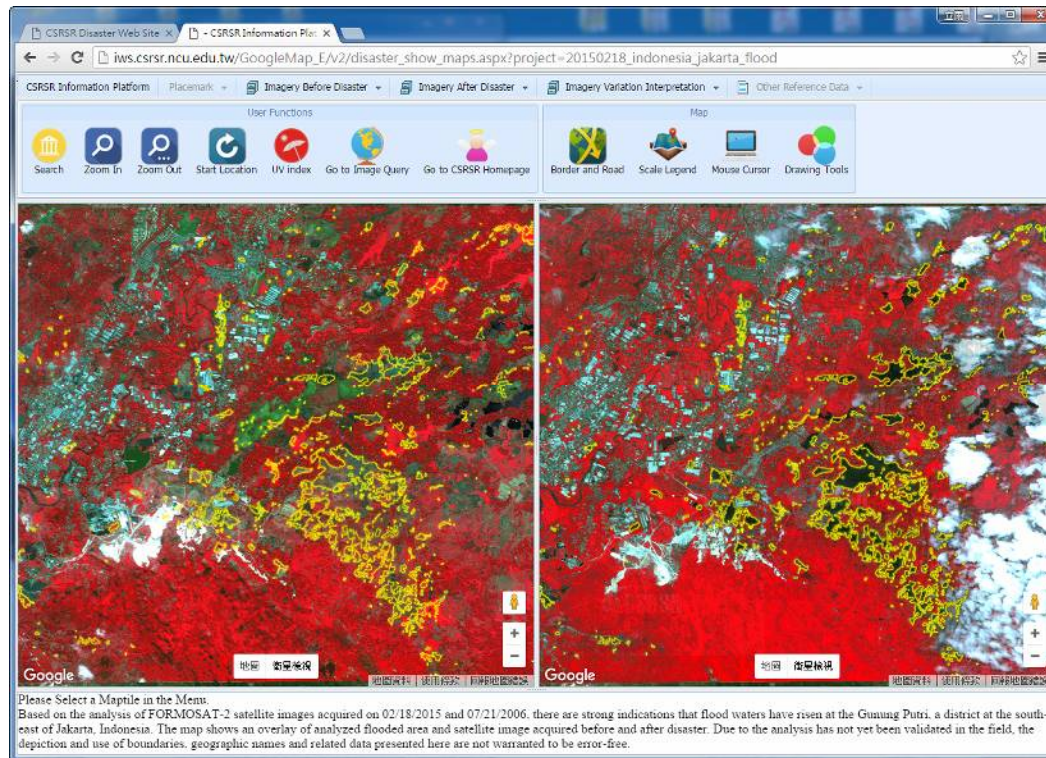
Date	List of Occurrences	Nation	Region
2015/04/25	Nepal Earthquake	Nepal	Kathmandu
2015/02/18	Indonesia Jakarta Floodings	Indonesia	Jakarta
2014/09/27	Mount Ontake volcanic eruption	Japan	Mount Ontake
2014/08/03	Yunnan earthquake	China	Ludian County Zhaotong
2011/10/23	Turkey earthquake	Turkey	Eastern Turkey
2011/10/15	Thailand flood	Thailand	
2011/03/11	Japan Sendai Earthquake	Japan	Sendai

Chinese Version

時間	事件名稱	國家	地點	災害類別	Skyline 平台	Google Earth 平台	Google Earth 平台使用人次
2015/04/25	尼泊爾地震	尼泊爾	加德滿都	地震	尚未提供	<a href="#">Go</a>	523
2015/04/14	104年第一次災害演練	台灣	台灣	其他	尚未提供	<a href="#">Go</a>	152
2015/02/18	印尼水災	印尼	印尼	水災	尚未提供	<a href="#">Go</a>	392
2014/09/27	御嶽山火山爆發	日本	長野縣御嶽山	火山	尚未提供	<a href="#">Go</a>	326
2014/08/03	雲南地震	中國	雲南省昭通市會同縣	地震	尚未提供	<a href="#">Go</a>	269
2014/07/22	麥德姆颶風	台灣	台灣	颶風	尚未提供	<a href="#">Go</a>	166
2014/03/15	第一季演練	台灣	台灣	颶風	尚未提供	<a href="#">Go</a>	420
2013/09/20	天兔颶風	台灣	台灣	颶風	尚未提供	<a href="#">Go</a>	565
2013/08/28	康芮颶風	台灣	台灣	颶風	尚未提供	<a href="#">Go</a>	560
2013/08/21	潭美颶風	台灣	台灣	颶風	尚未提供	<a href="#">Go</a>	232
2013/07/11	蘇力颶風	台灣	台灣	颶風	尚未提供	<a href="#">Go</a>	580
2013/06/02	南投地震	台灣	南投	地震	尚未提供	<a href="#">Go</a>	656
2013/03/27	南投地震	台灣	南投	地震	尚未提供	<a href="#">Go</a>	568
2012/08/22	天軒颶風	台灣	台灣	颶風	尚未提供	<a href="#">Go</a>	466
2012/07/31	蘇拉颶風	台灣	台灣	颶風	尚未提供	<a href="#">Go</a>	773
2012/06/18	泰利颶風	台灣	台灣	颶風	尚未提供	<a href="#">Go</a>	767
2012/06/11	台灣豪雨	台灣	台灣	豪雨	<a href="#">Go</a>	<a href="#">Go</a>	984
2011/10/23	土耳其地震	土耳其	土耳其東部	地震	<a href="#">Go</a>	<a href="#">Go</a>	628
2011/10/15	泰國水災	泰國	泰國	水災	<a href="#">Go</a>	<a href="#">Go</a>	779

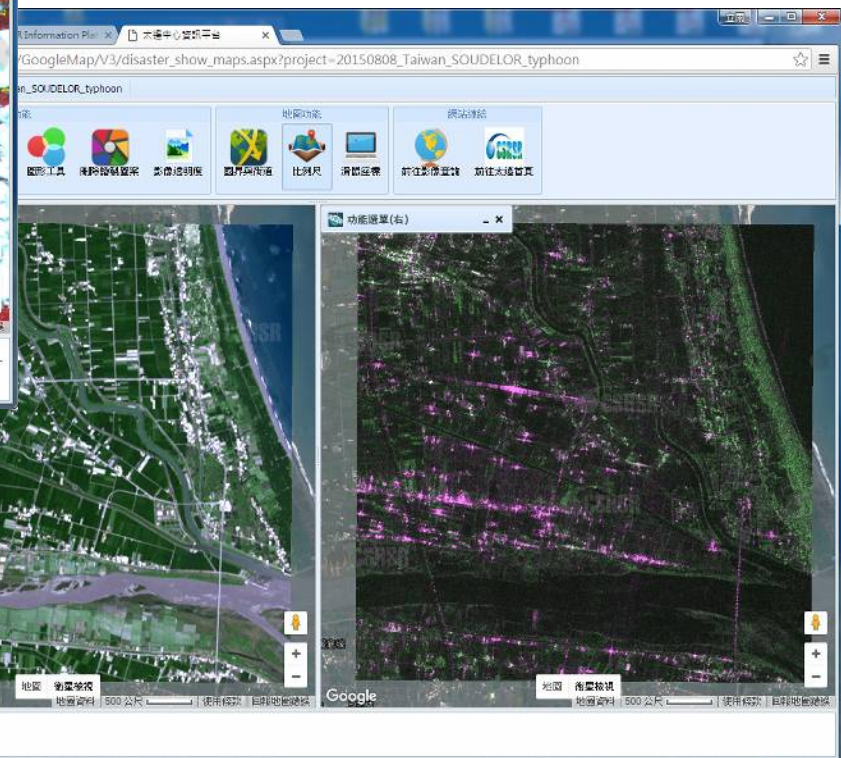


# Disaster Information Service Platform



Flooding event around Jakarta, Indonesia caused by heavy rain in 2015/2/9.

Flooding event in I-Lan, Taiwan caused by Typhoon Soudelor during 2015/8/6~2015/8/9.



***Thanks for your attention***

