YAMAGUCHI UNIVERSITY

Remote Sensing for Disaster

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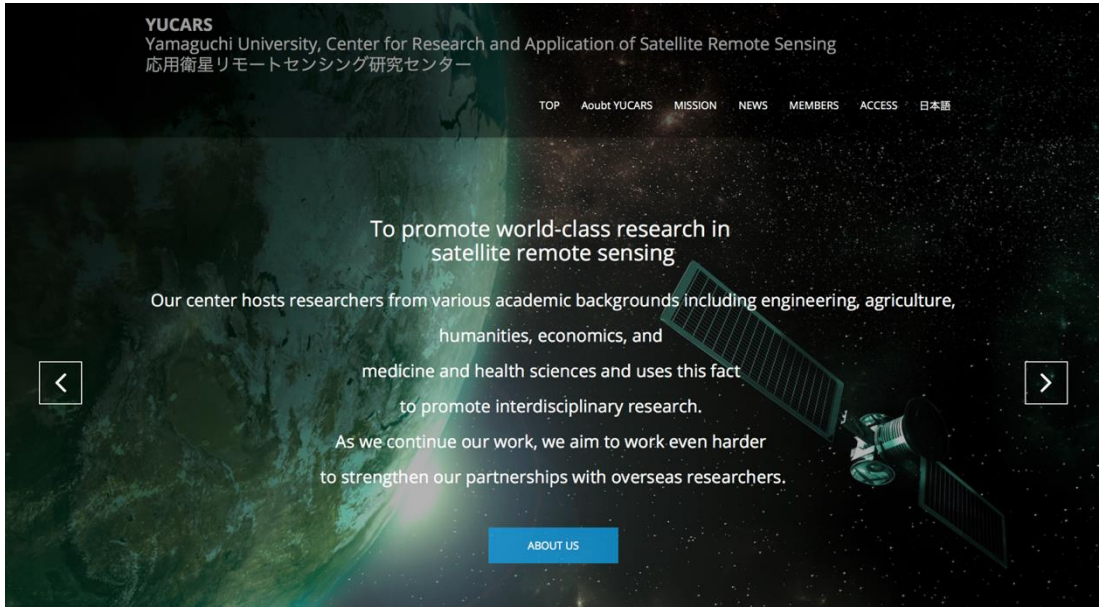
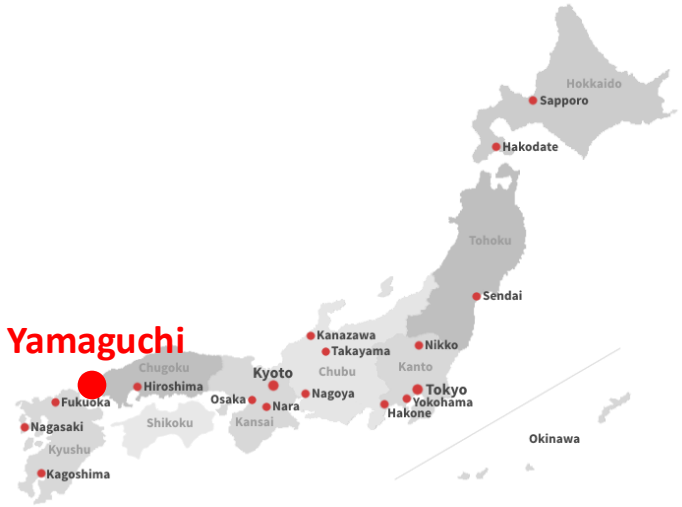
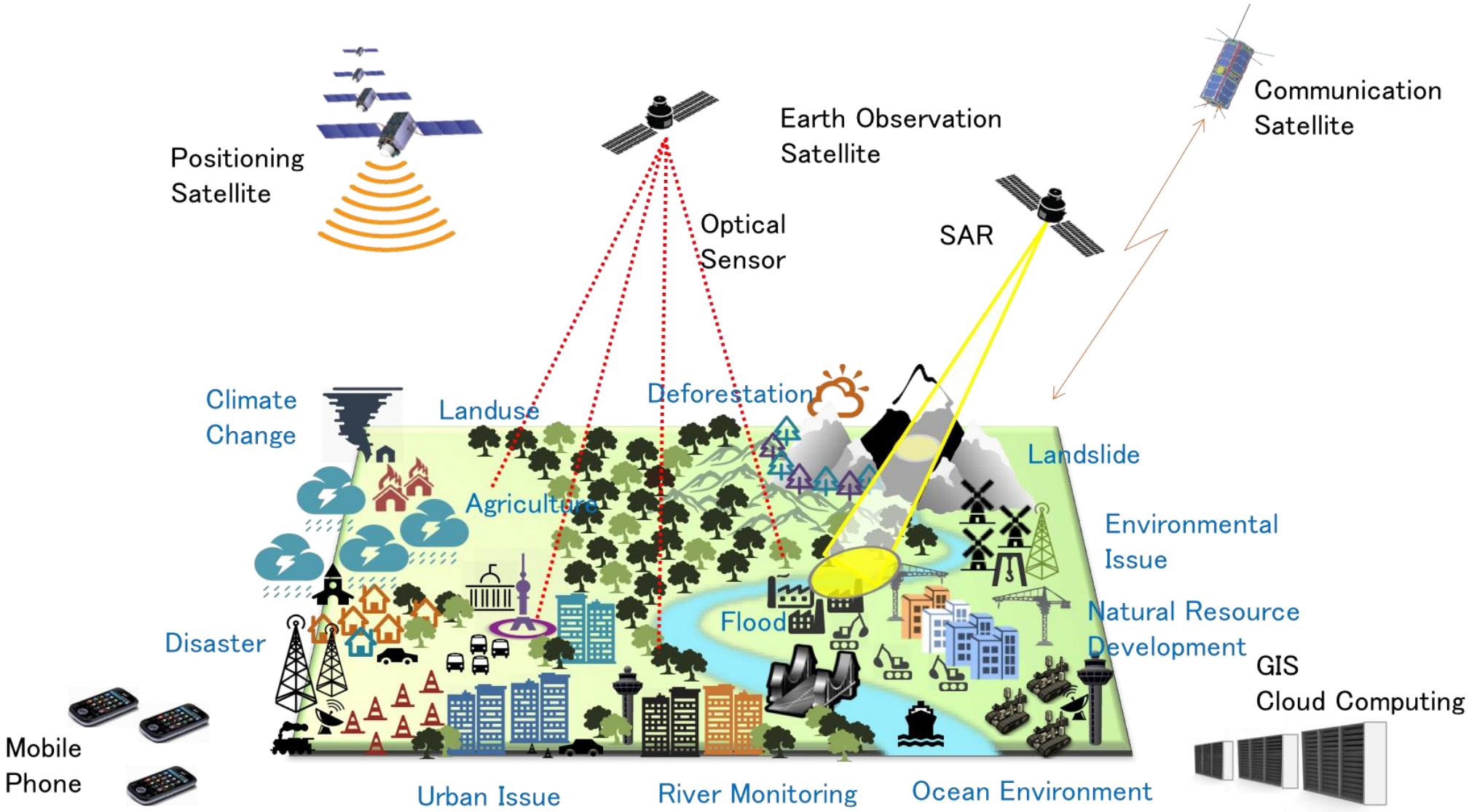


http://yucars.eng.yamaguchi-u.ac.jp/index_e.html

(YUCARS)



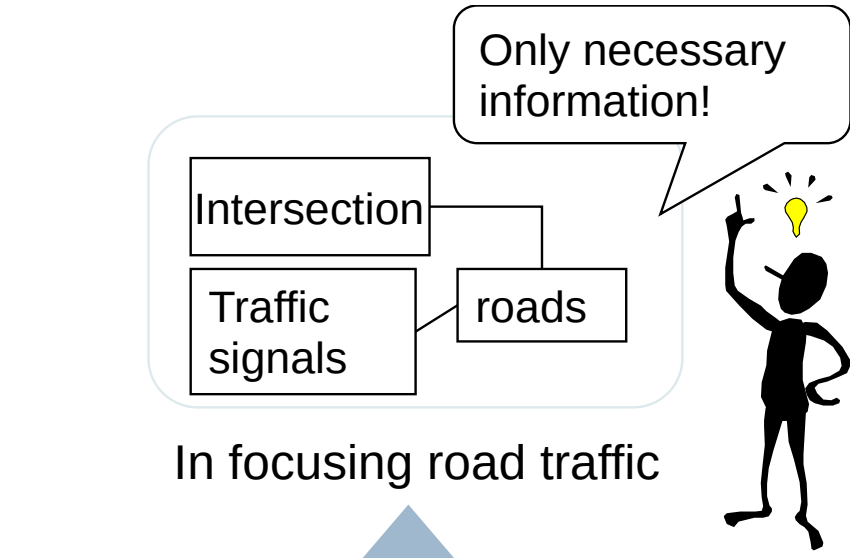
Integration of Space and Society



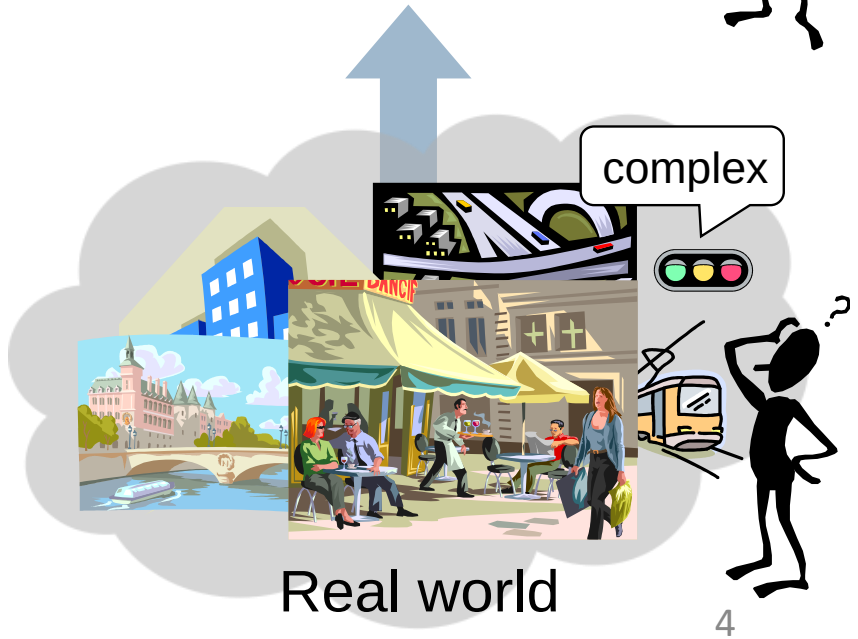
Digital Copy of “Real World

Real spatial world

Digital copy (GIS or spatial databases)



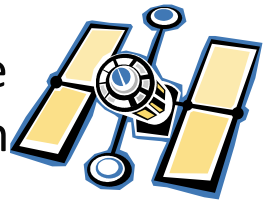
In focusing road traffic



What is Remote Sensing?

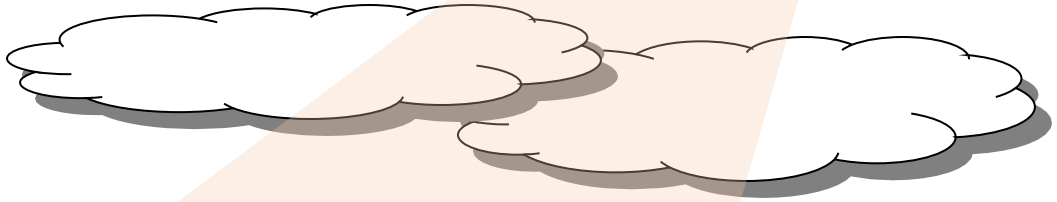
Tools for Data Acquisition

Earth Observation Satellite
500～600 km



Satellite Satellite Remote Senisng

Airplane, Helicopter
few 100m ～ 6000m



Drone
few 10 ～ 200 m

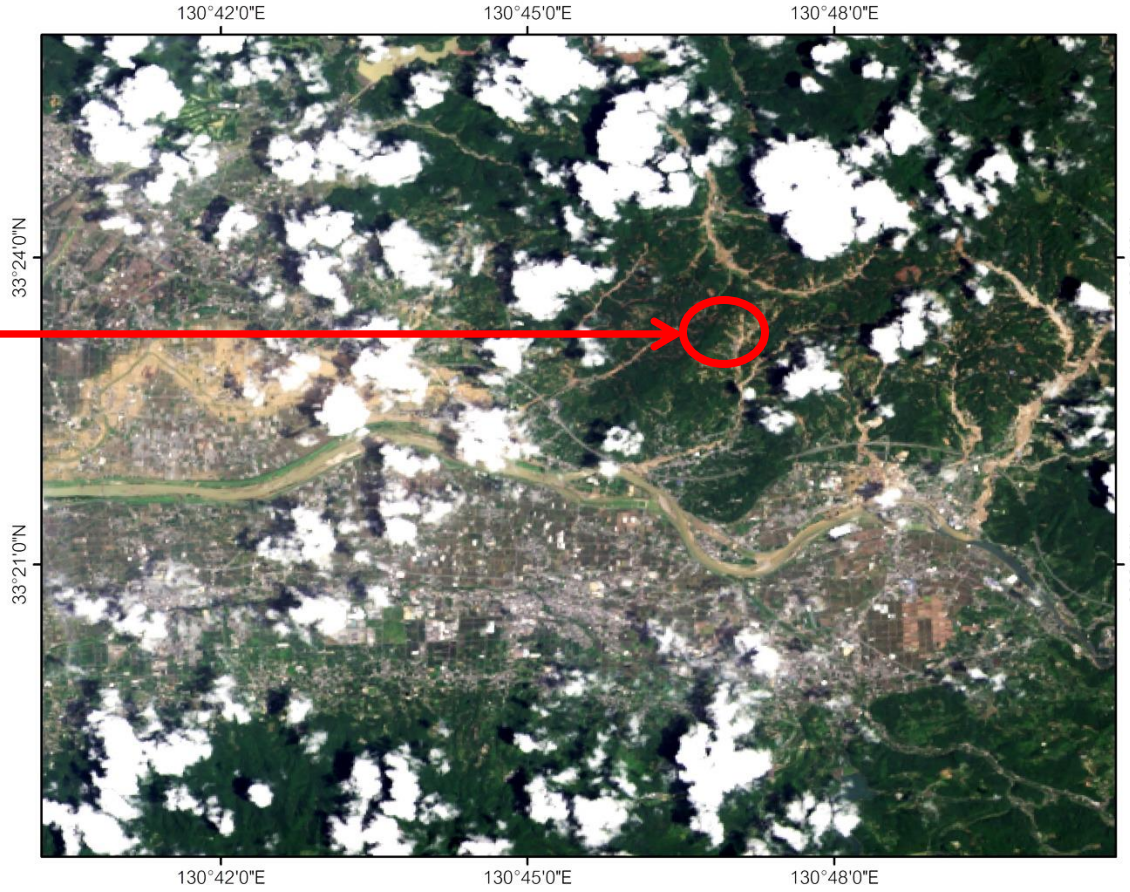
Ground
Observation
0 m

Tools for Data Acquisition

Drone

© Geospatial Information Authority of Japan

Ground Observation © Masahiko Nagai

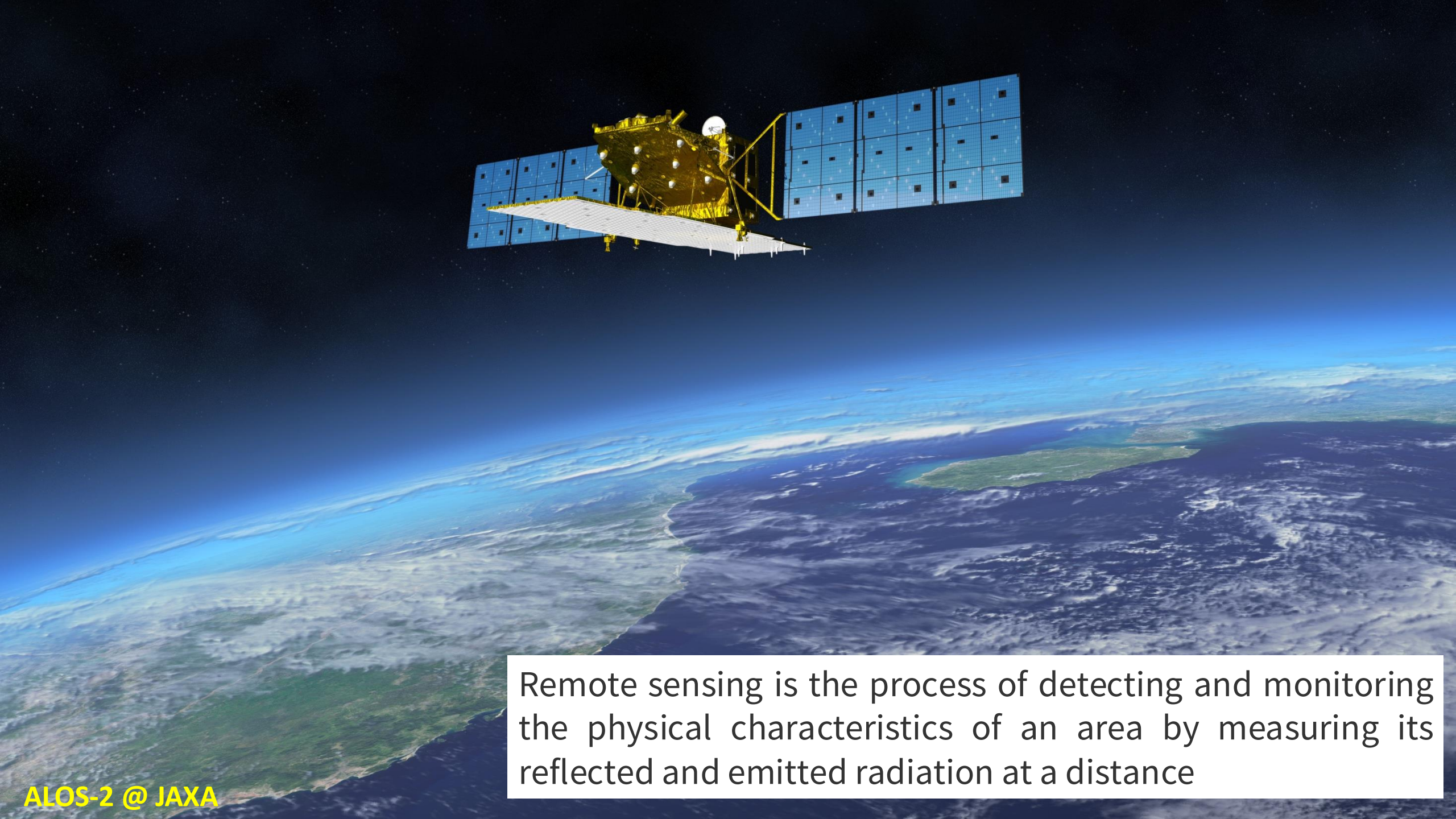


Earth Observation Satellite

© Masahiko Nagai

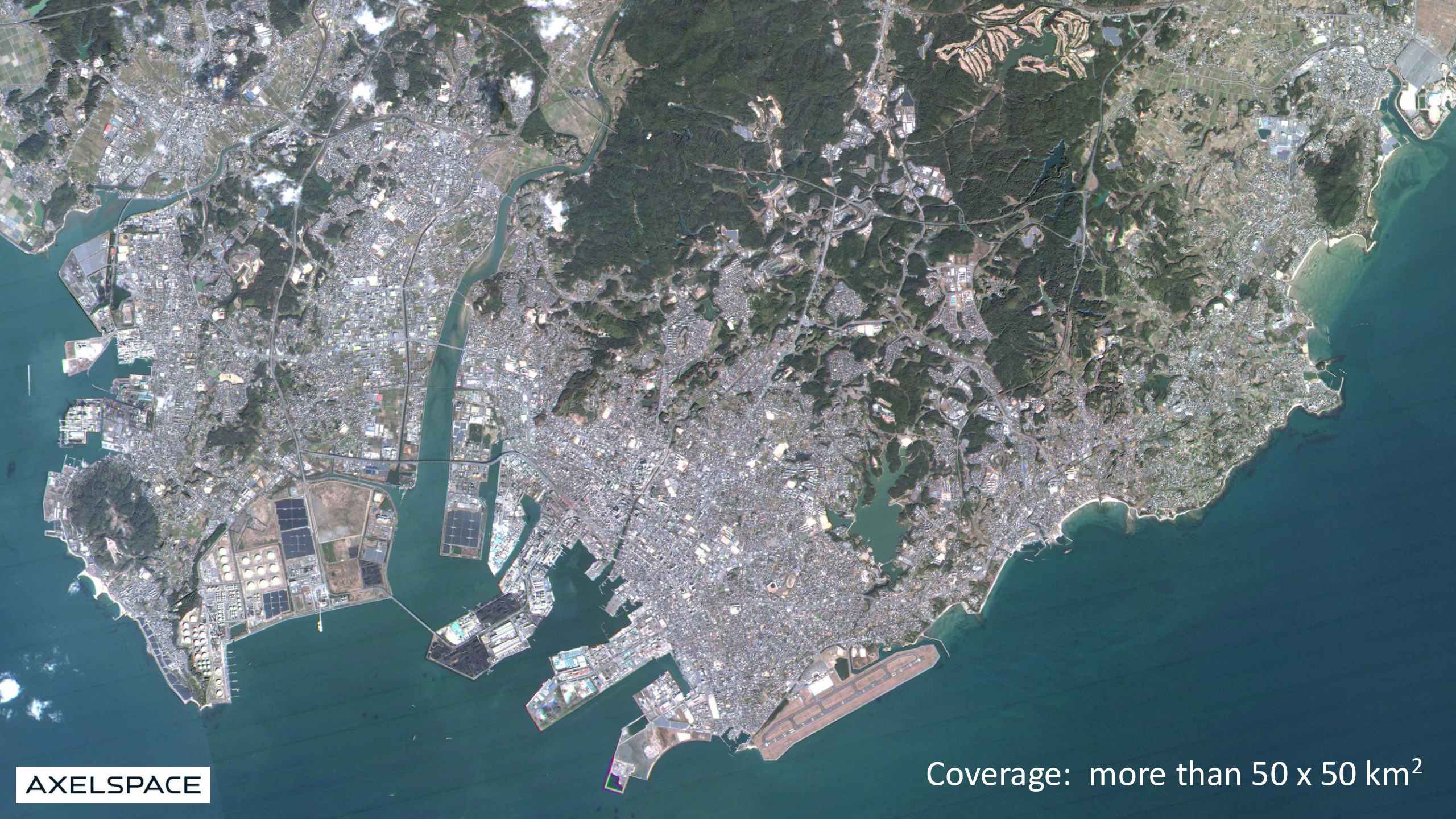
Tools for Data Acquisition

	Quickness	Observation Coverage	Details	Reliability	Easy to Understand	Weather	Applicability	Risk
Ground Observation	○	×	◎	◎	◎	×	◎	×
Drone	○	△	○	○	○	×	△	×
Airplane Helicopter	△	○	○	○	○	△	△	○
Satellite Remote Sensing	△	◎	△	△	△	◎	◎	◎



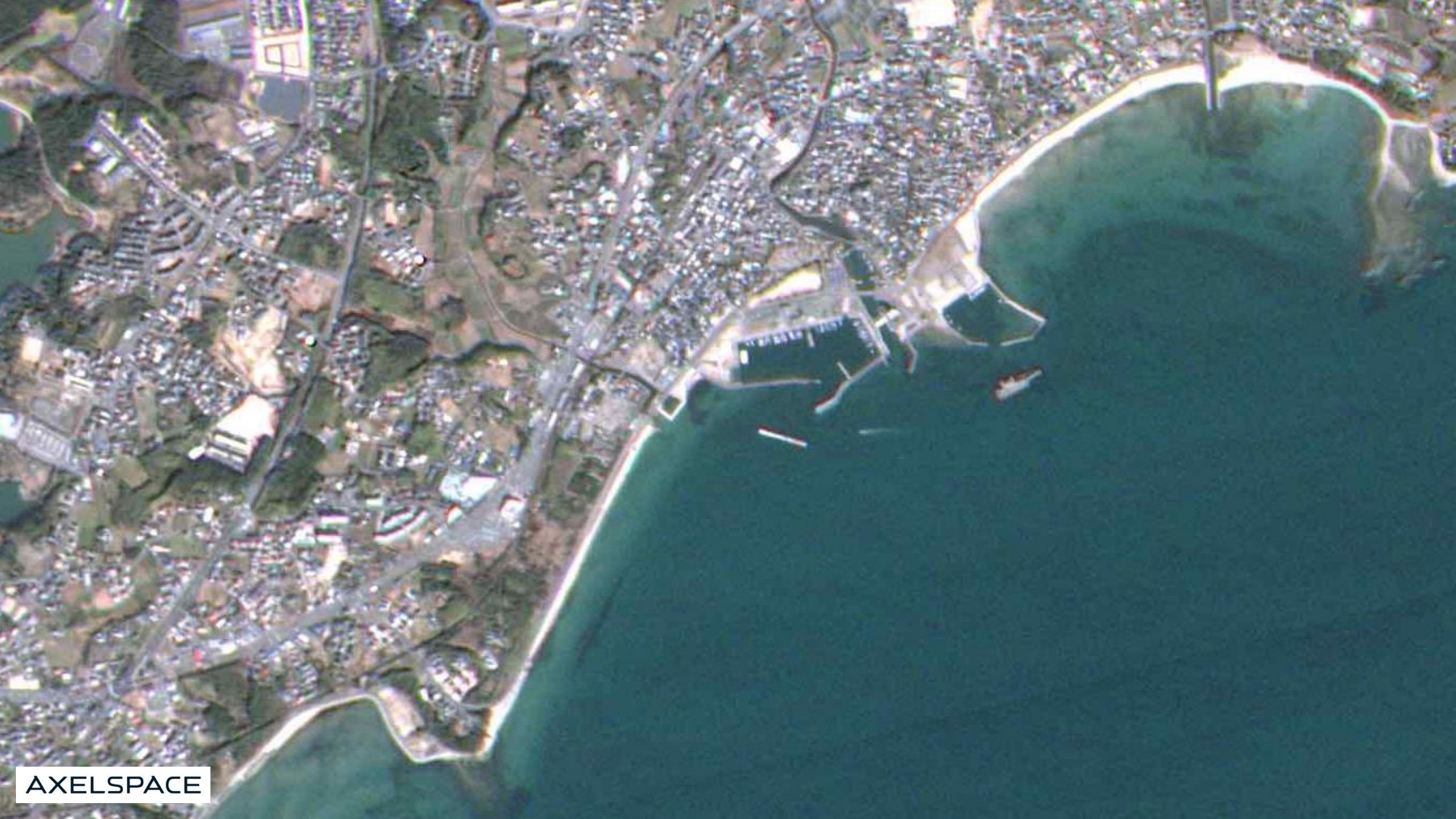
Remote sensing is the process of detecting and monitoring the physical characteristics of an area by measuring its reflected and emitted radiation at a distance

ALOS-2 @ JAXA

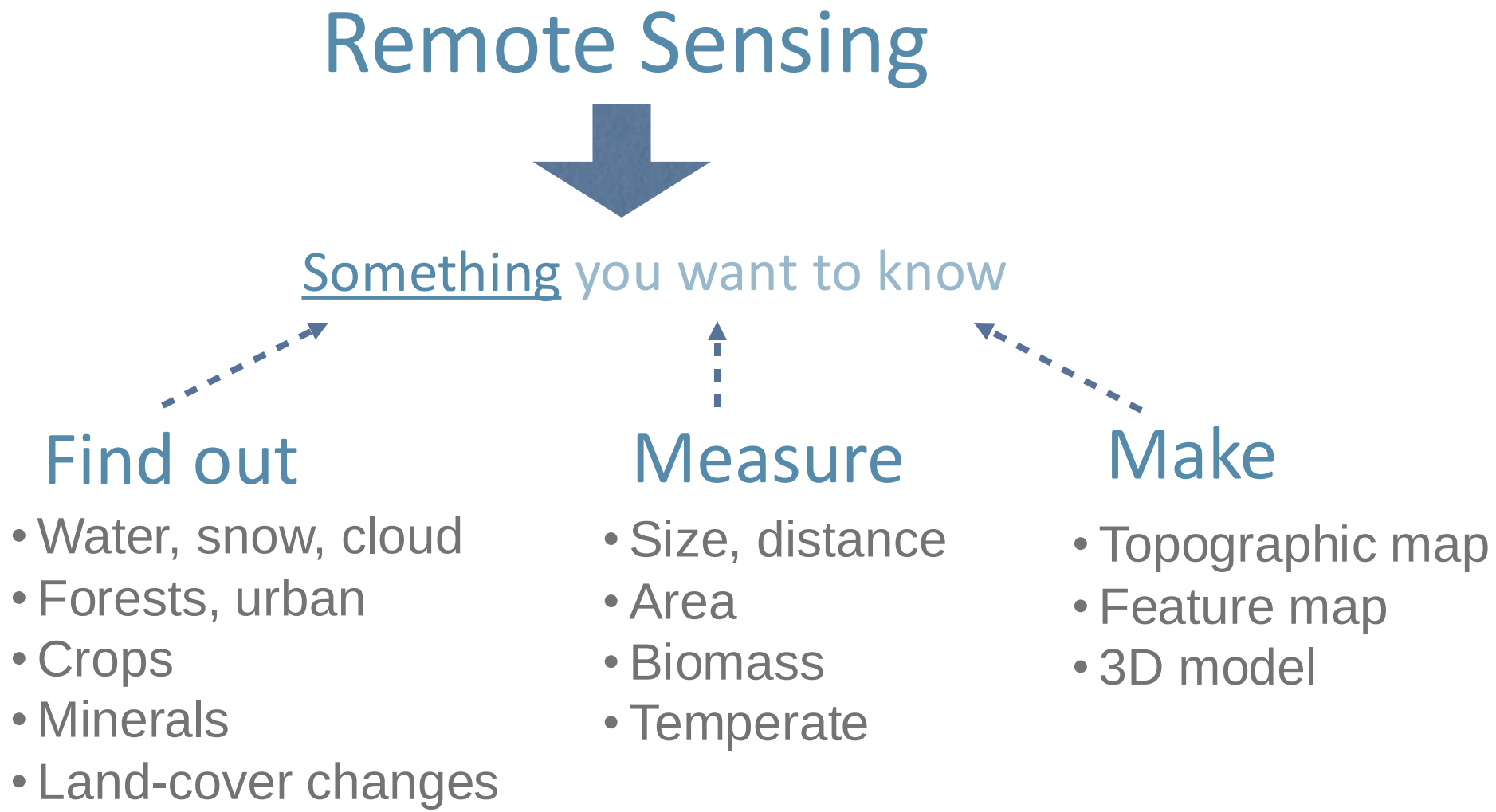

AXELSPACE
Coverage: more than 50 x 50 km²


AXELSPACE

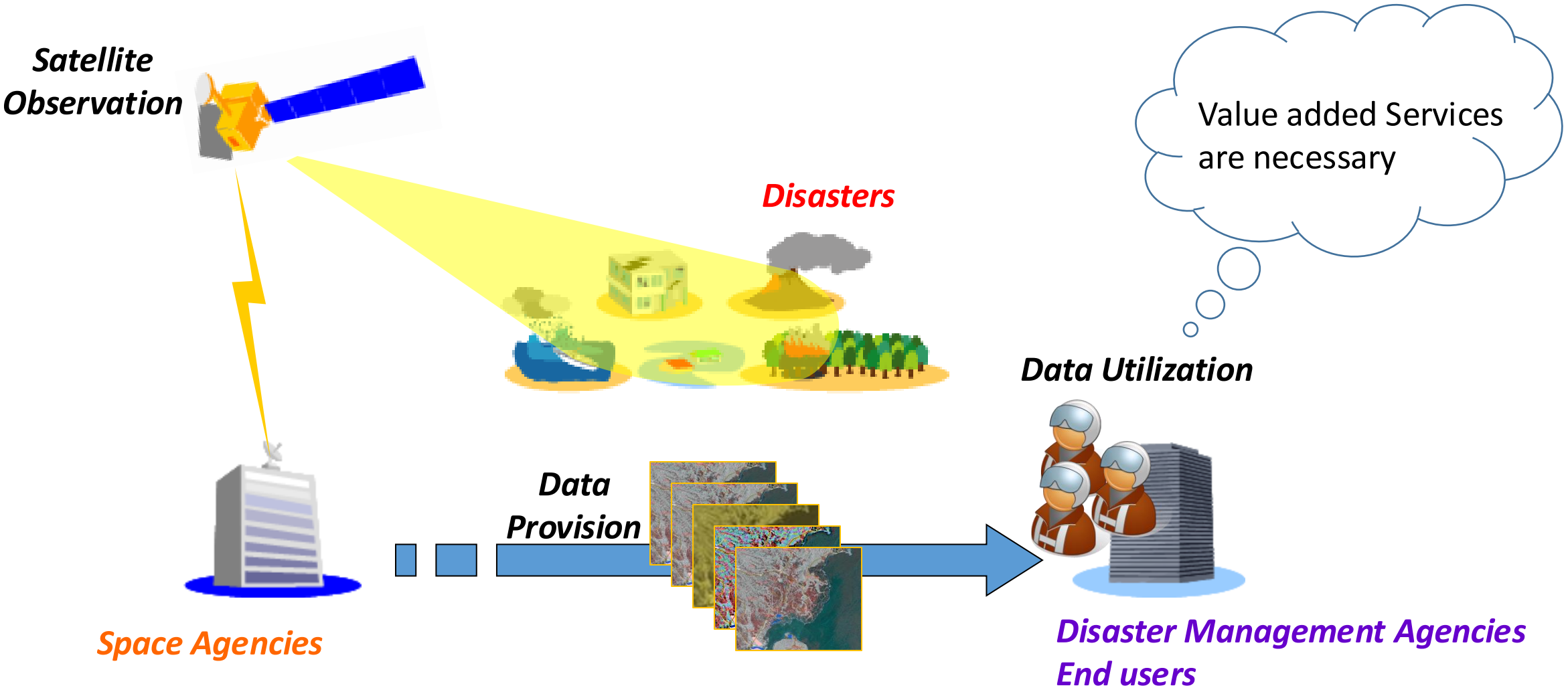

AXELSPACE


AXELSPACE

What is Remote Sensing?



Disaster Monitoring by Satellite Remote Sensing



Characteristics of Remote Sensing

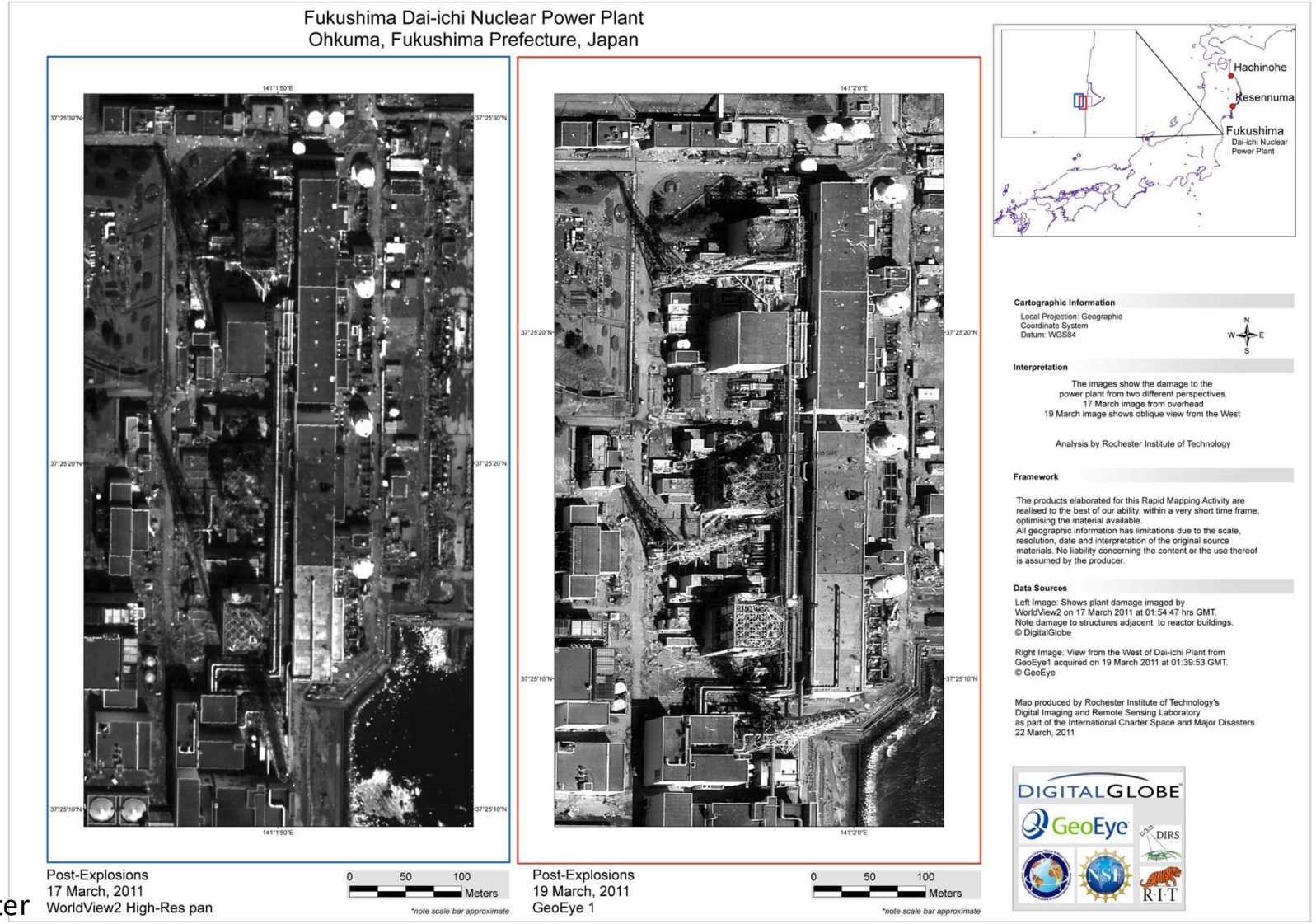
① Enables us to know the condition without visiting the area.

② Enables to observe broad area at a time.

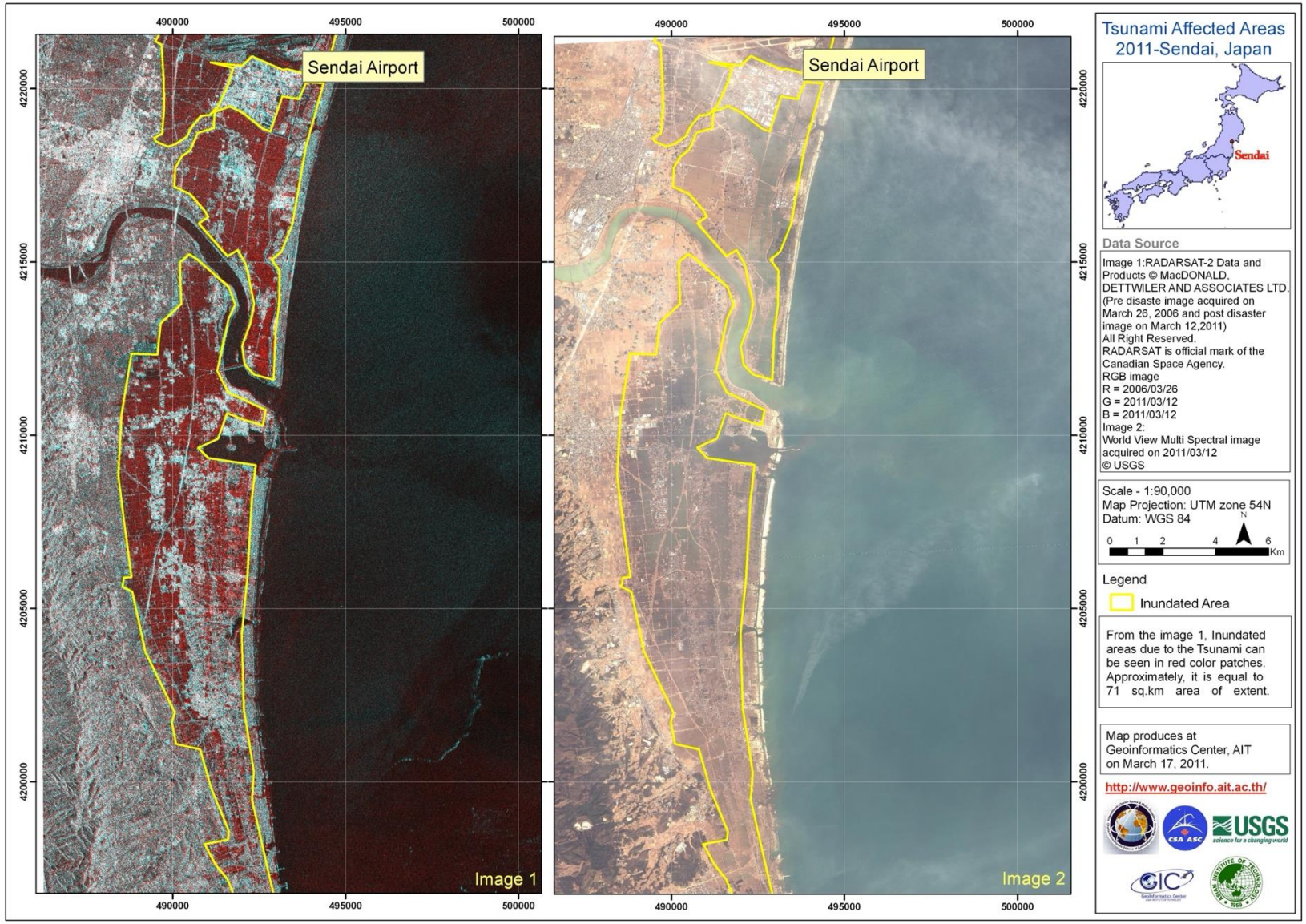
③ Enables us to know invisible information.

④ Enables to observe the area for a long period.

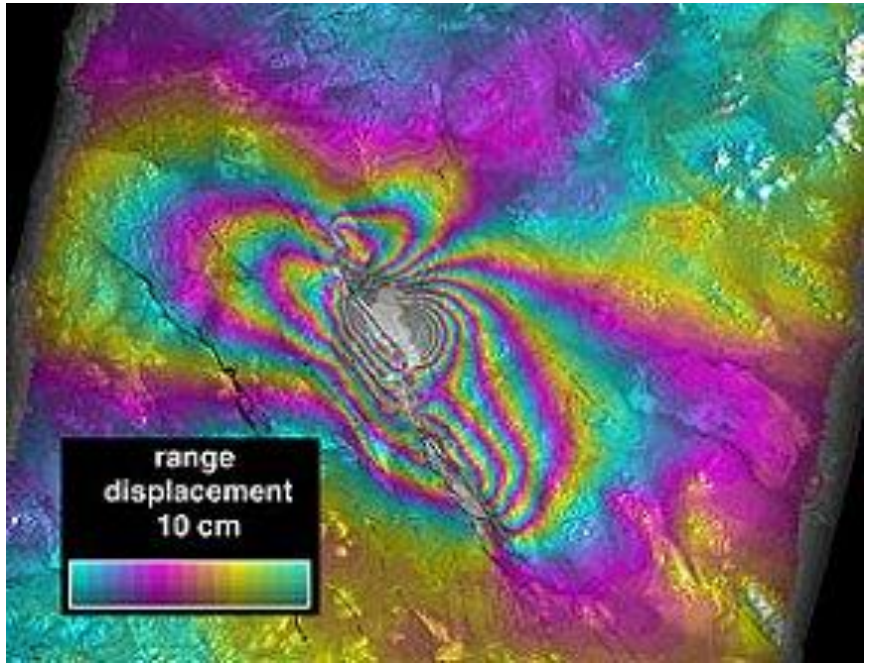
To know the condition without visiting the area



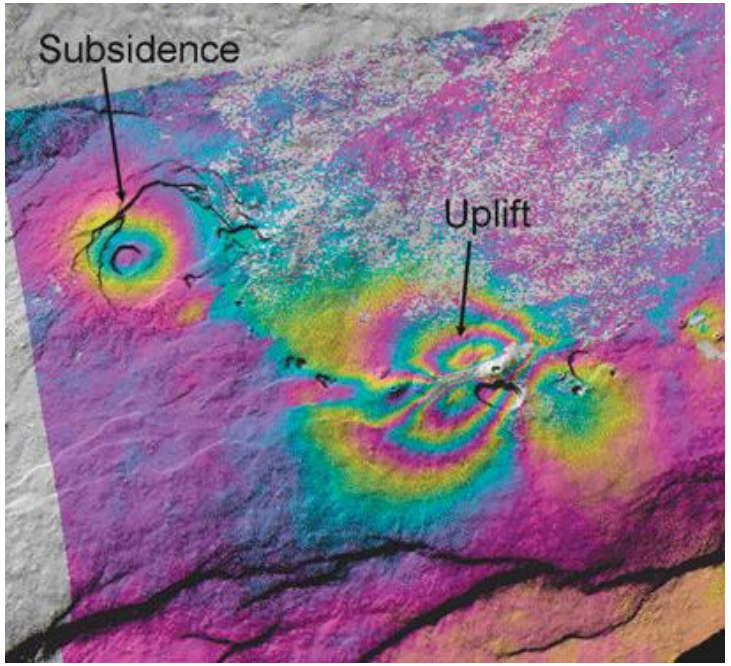
To observe broad area at a time



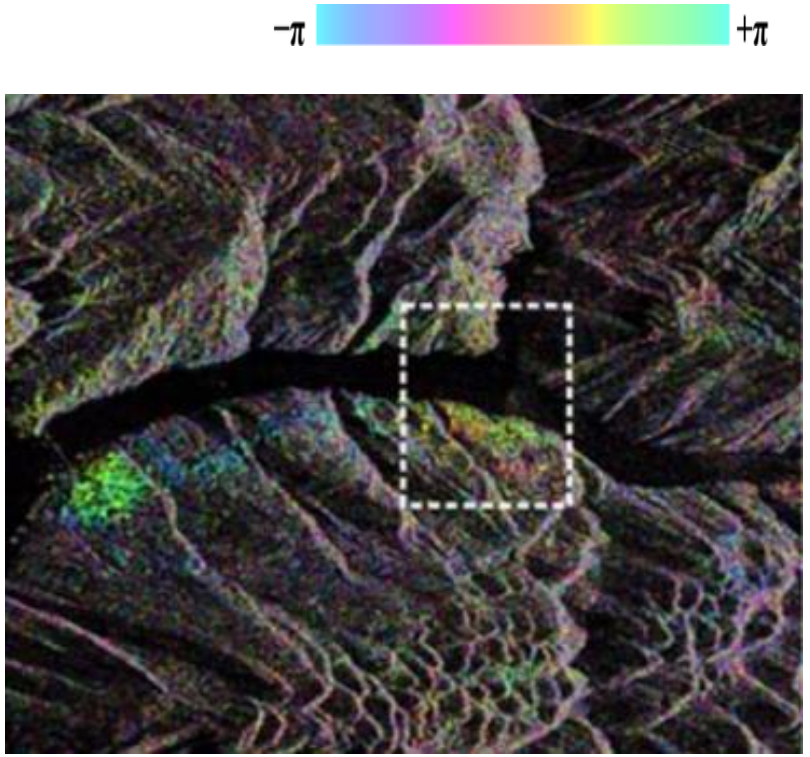
To know invisible information



InSAR monitor fault Hector Mine earthquake in 1999 (© NASA)



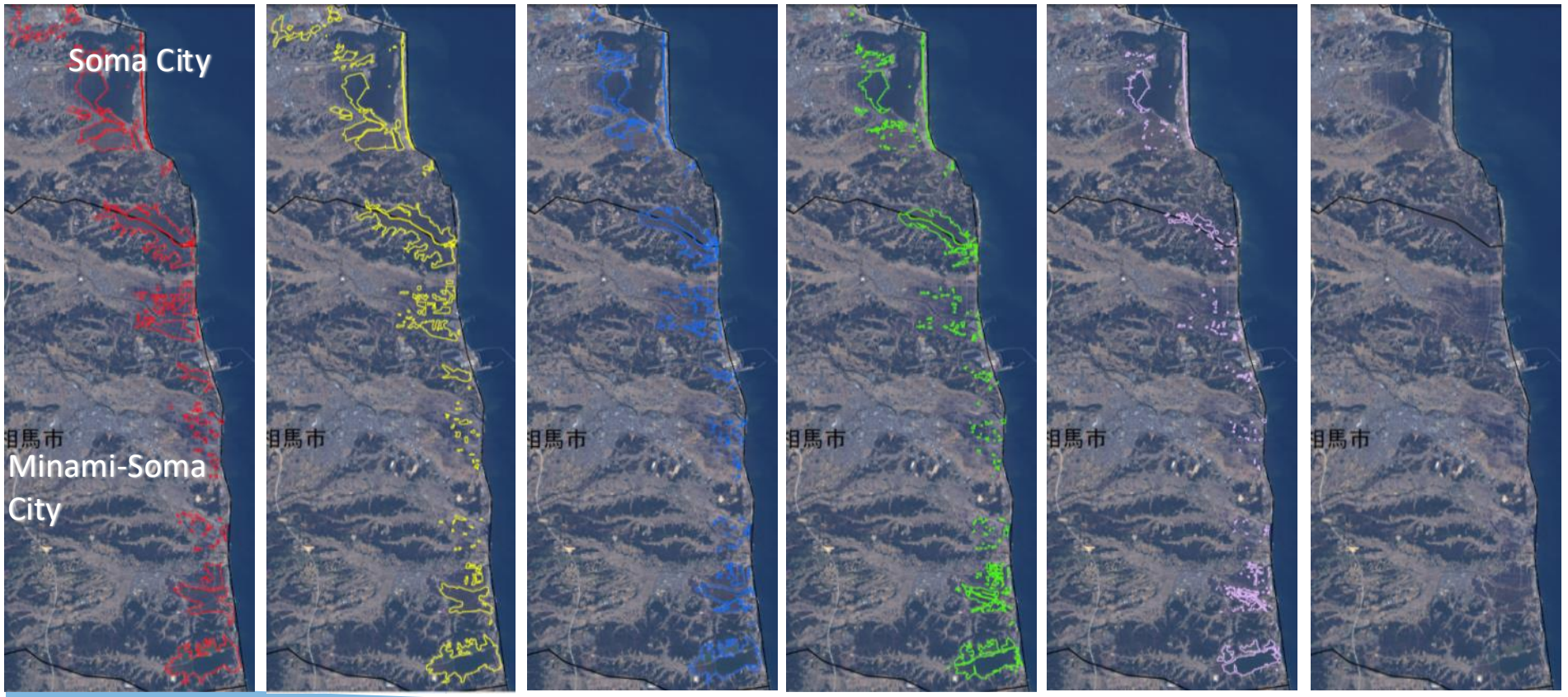
Uplift and subsidence associated with a June 2007 earthquake swarm on Kilauea Volcano (Zhong Lu, USGS., 2007)



Landslide Deformations in Three Gorges Area (Tantianuparp et al., 2013)

To observe the area for a long period

Baseline image: April 17, AVNIR-2



@ JAXA

Summary

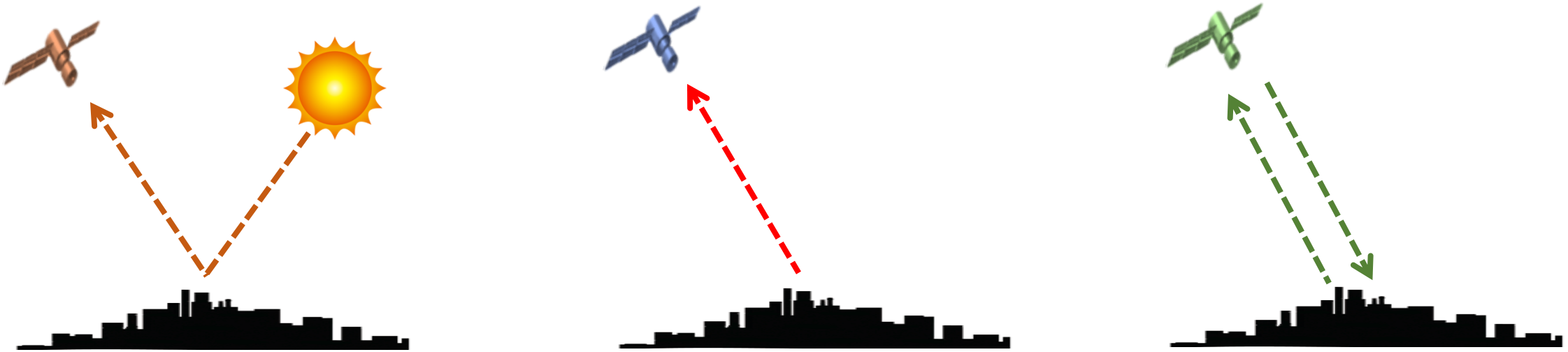
- It is necessary to use complementally / mutually, ground survey, Drone, airplane, and Satellite.
- It is very important to understand advantages of remote sensing.

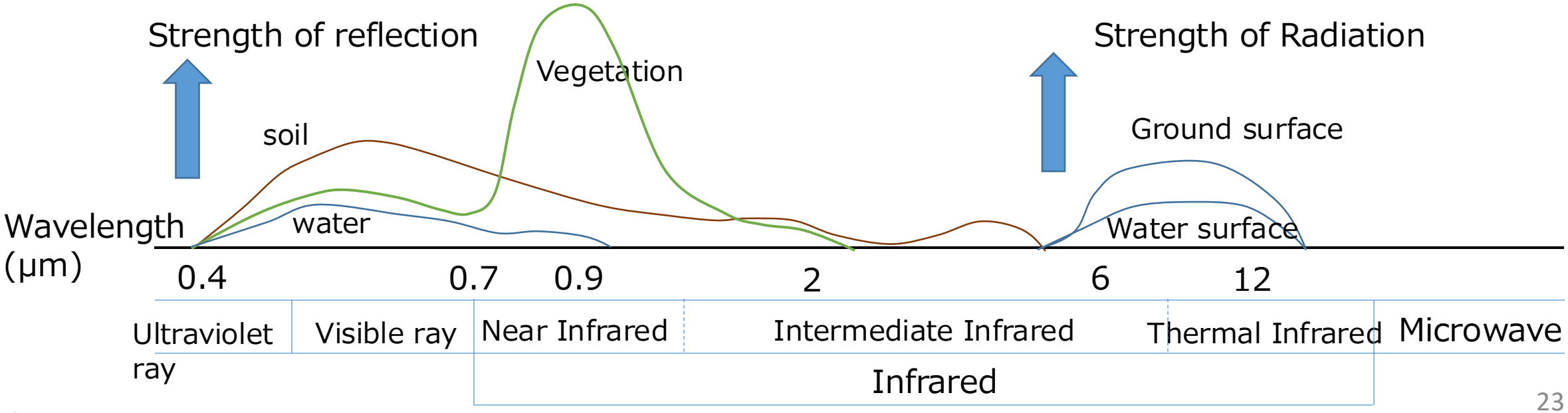
Type of Remote Sensing?

Optical Remote Sensing

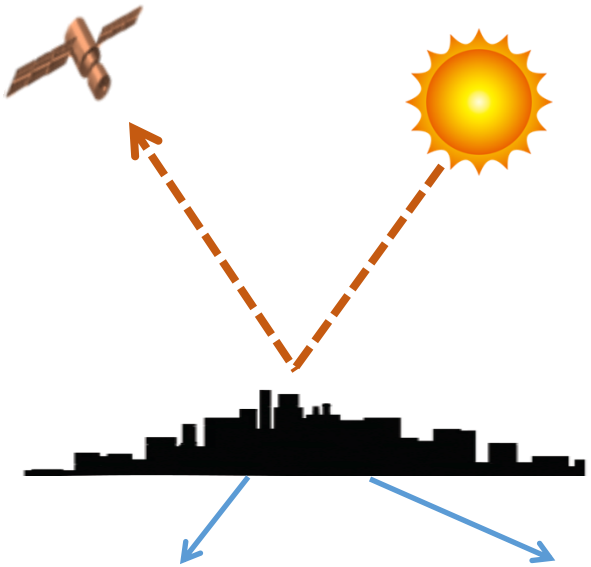
Thermal Remote Sensing

Microwave Remote Sensing





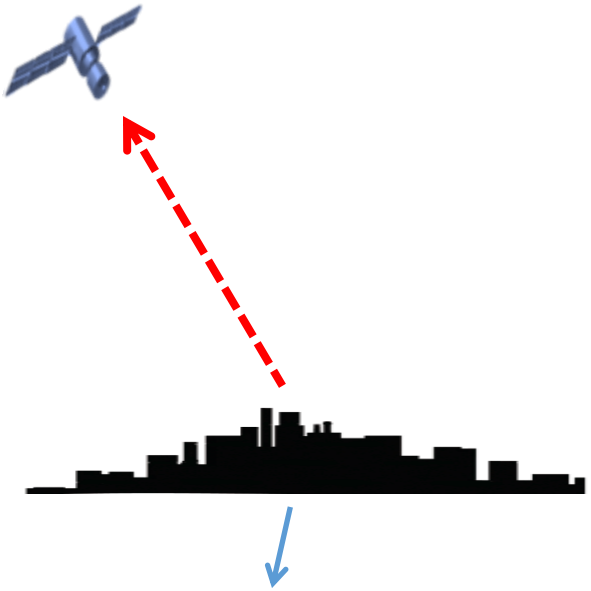
Optical Remote Sensing

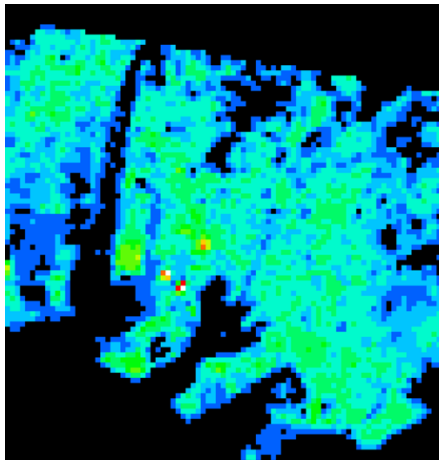


ALOS
(True Color Image)

Pleiades
(False Color Image)

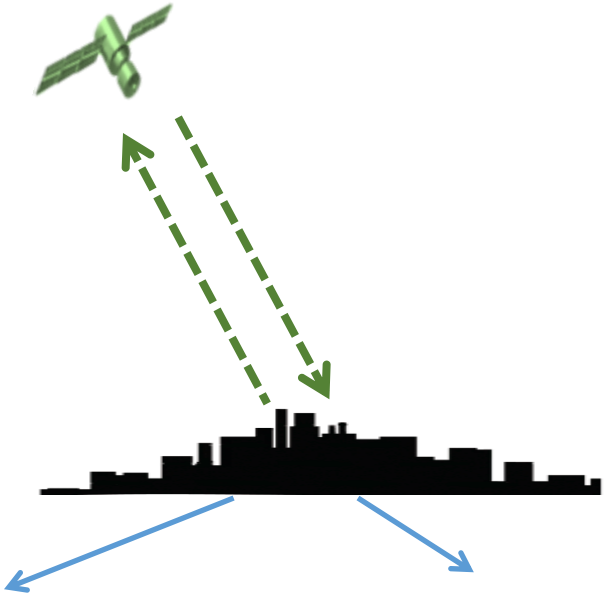
Thermal Remote Sensing

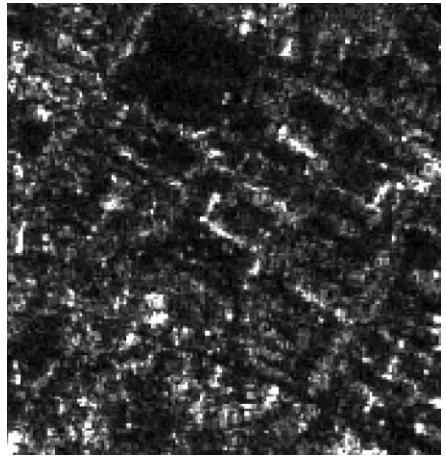




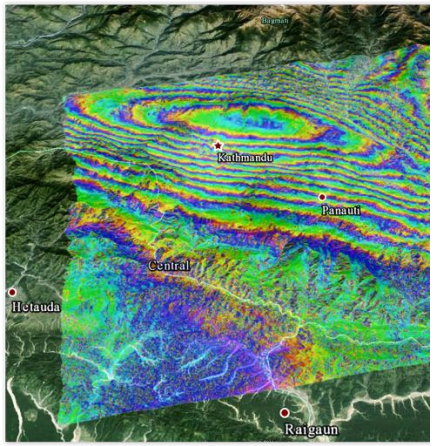
ASTER
(Thermal Image)

Microwave Remote Sensing





ALOS-2
(SAR Image(Amplitude))



ALOS-2
(SAR Image(Phase))

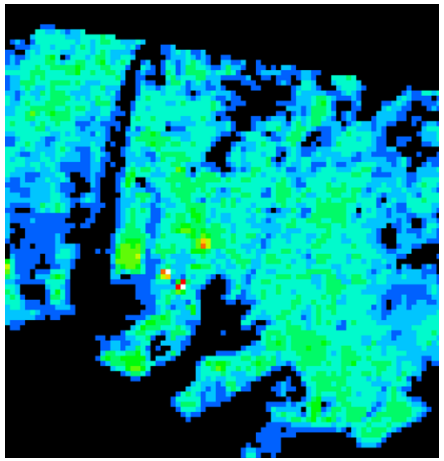
Optical Remote Sensing

Thermal Remote Sensing

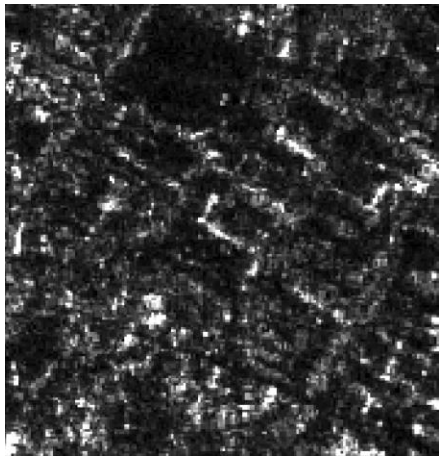
Microwave Remote Sensing

ALOS
(True Color Image)

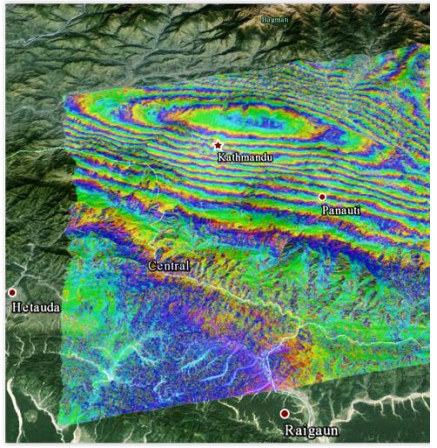
Pleiades
(False Color Image)



ASTER
(Thermal Image)



ALOS-2
(SAR Image(Amplitude))



ALOS-2
(SAR Image(Phase))

＜Applications＞
Landslide・Volcano
Flood・Tsunami
Building Damage

GRUS-1, PlanetScope
WorldView, Pleiades,
SPOT, Sentinel-2
ALOS-3

＜ Applications ＞
Landslide
Volcano・Lava flow
Flood・Tsunami

GRUS-1, PlanetScope
WorldView, Pleiades,
SPOT, Sentinel-2
ALOS-3

＜ Applications ＞
Volcano
Forest Fire
City Fire

ASTER, MODIS,

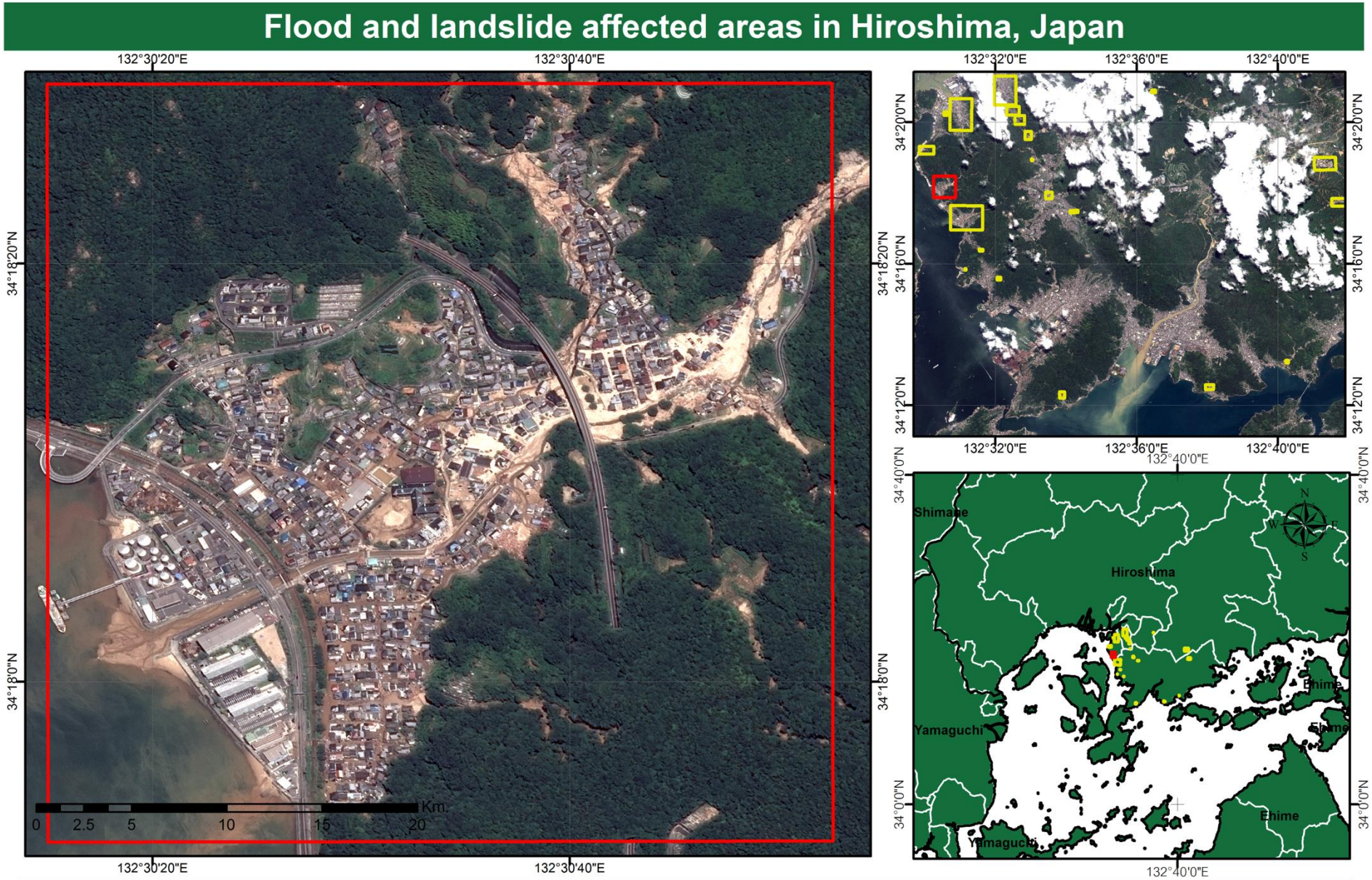
＜ Applications ＞
Flood・Tsunami
Landslide

ALOS-2, Sentinel-1
TerraSAR-X,
Rardarsat

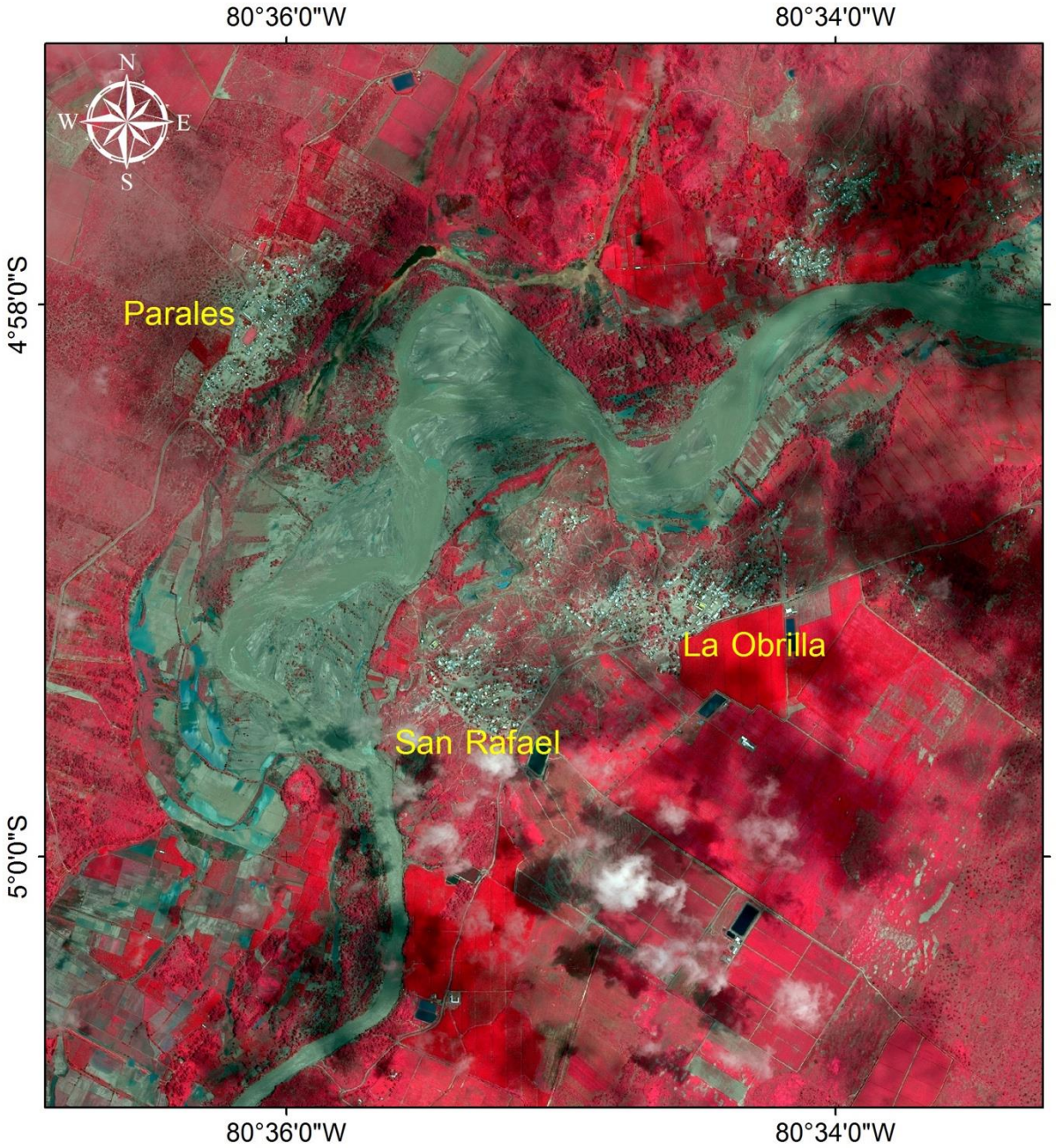
＜ Applications ＞
Land Deformation
Building Collapse
Liquefaction

ALOS-2, Sentinel-1
TerraSAR-X,
Rardarsat

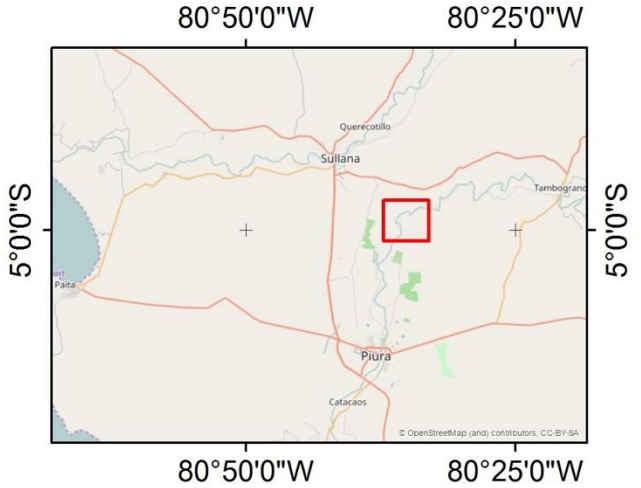
(True Color Image)



(False Color Image)



Flood in Piura, Peru



Information:

The map shows area under water around San Rafael, La Obrilla and Parales in Piura region, Peru.

The map is shown in false color composite.

Map accuracy is not validated.

Data Source:

SPOT-6 (c) CNES 2017, distribution Spot Image S. A., all rights reserved.

Date of acquisition: 4 April 2017

Produced by Yamaguchi University, Japan

(Thermal Image)

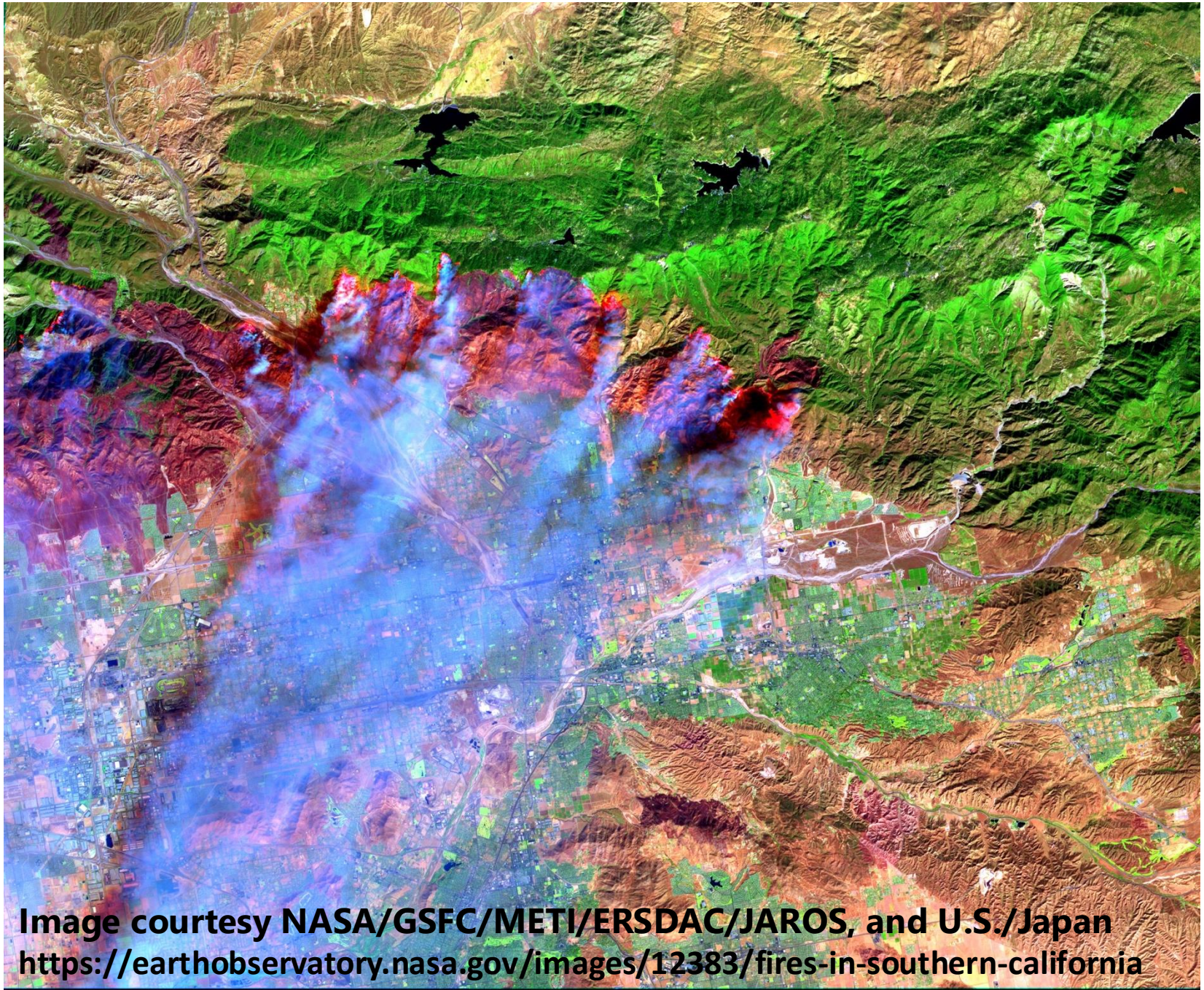
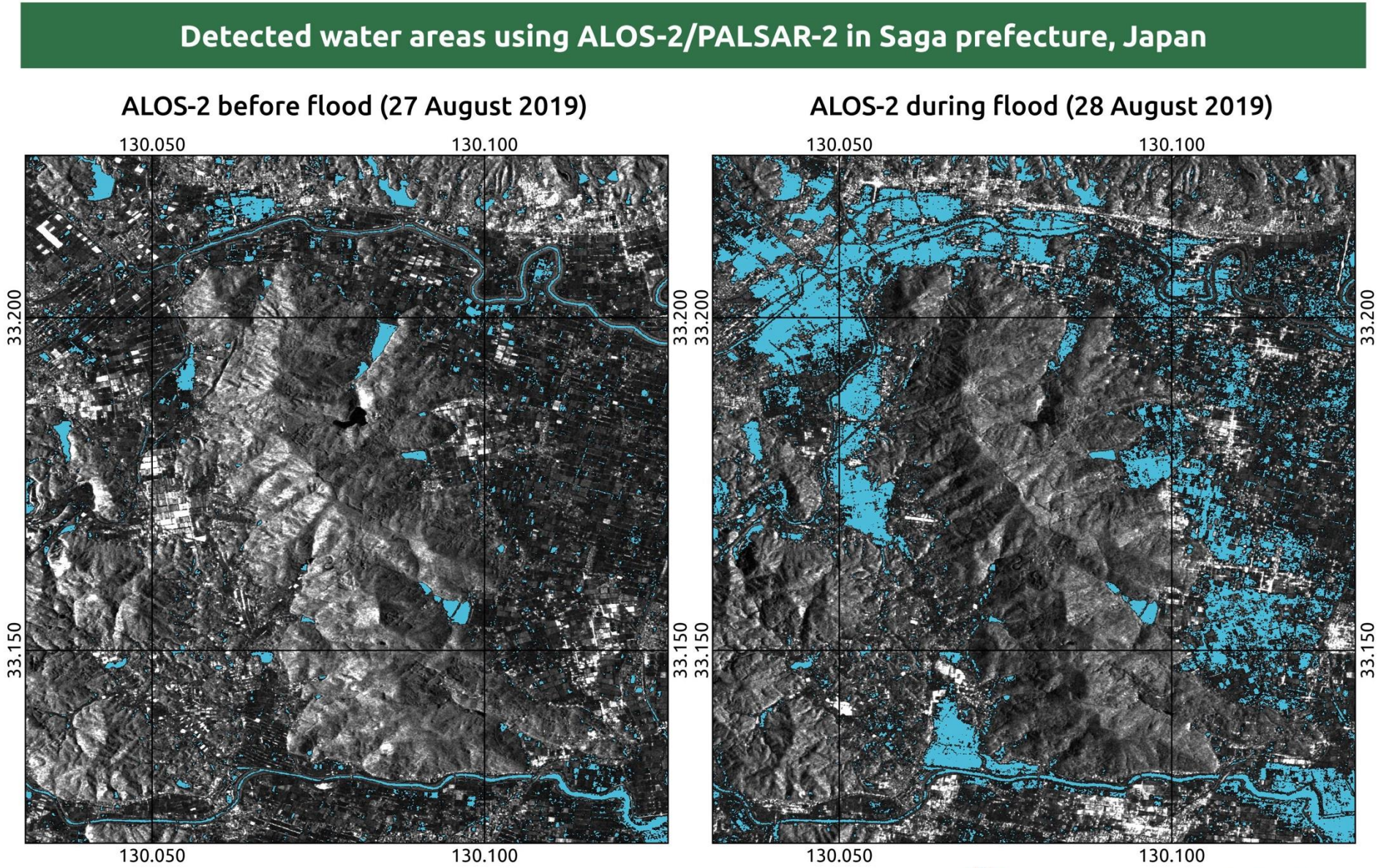
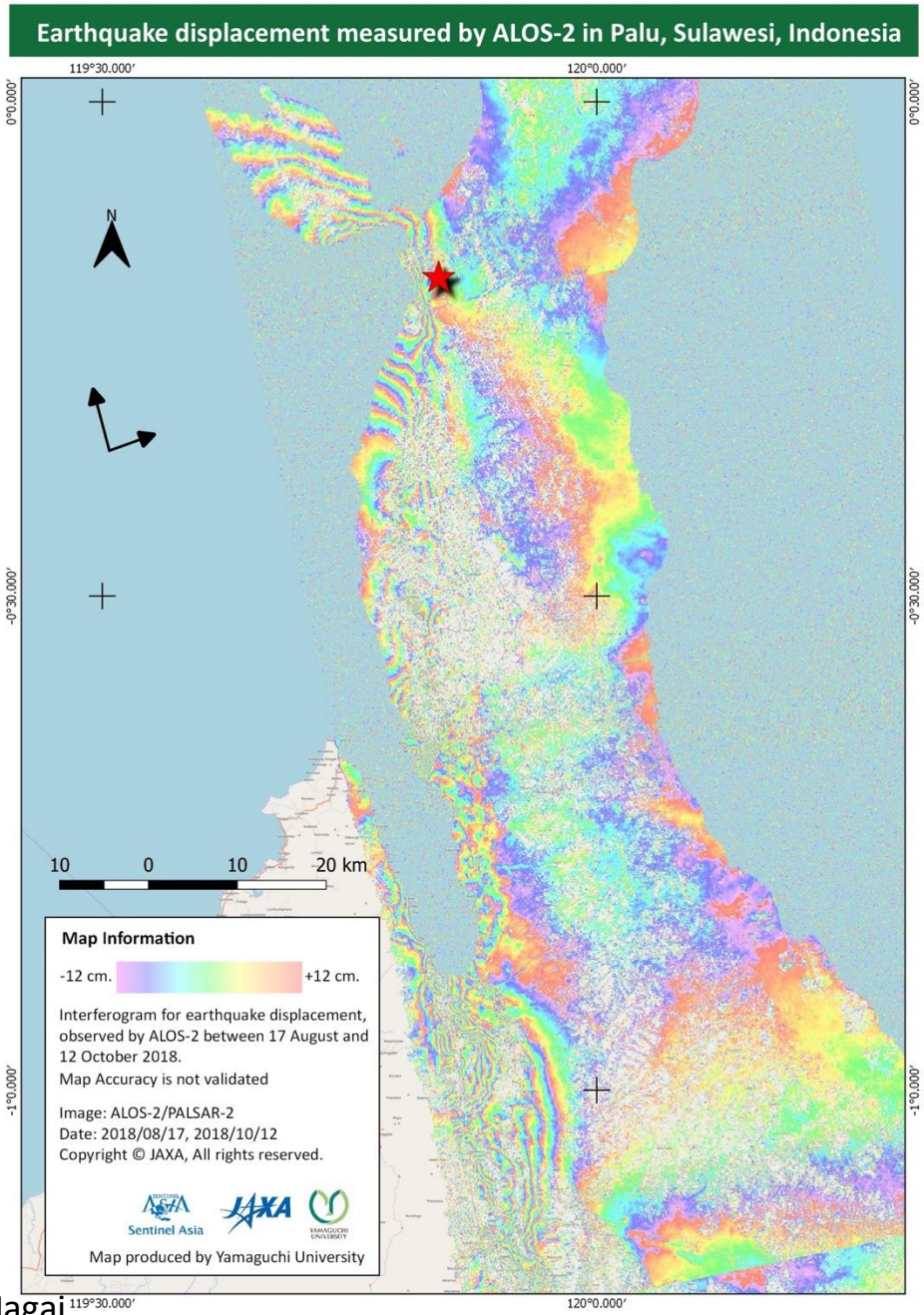


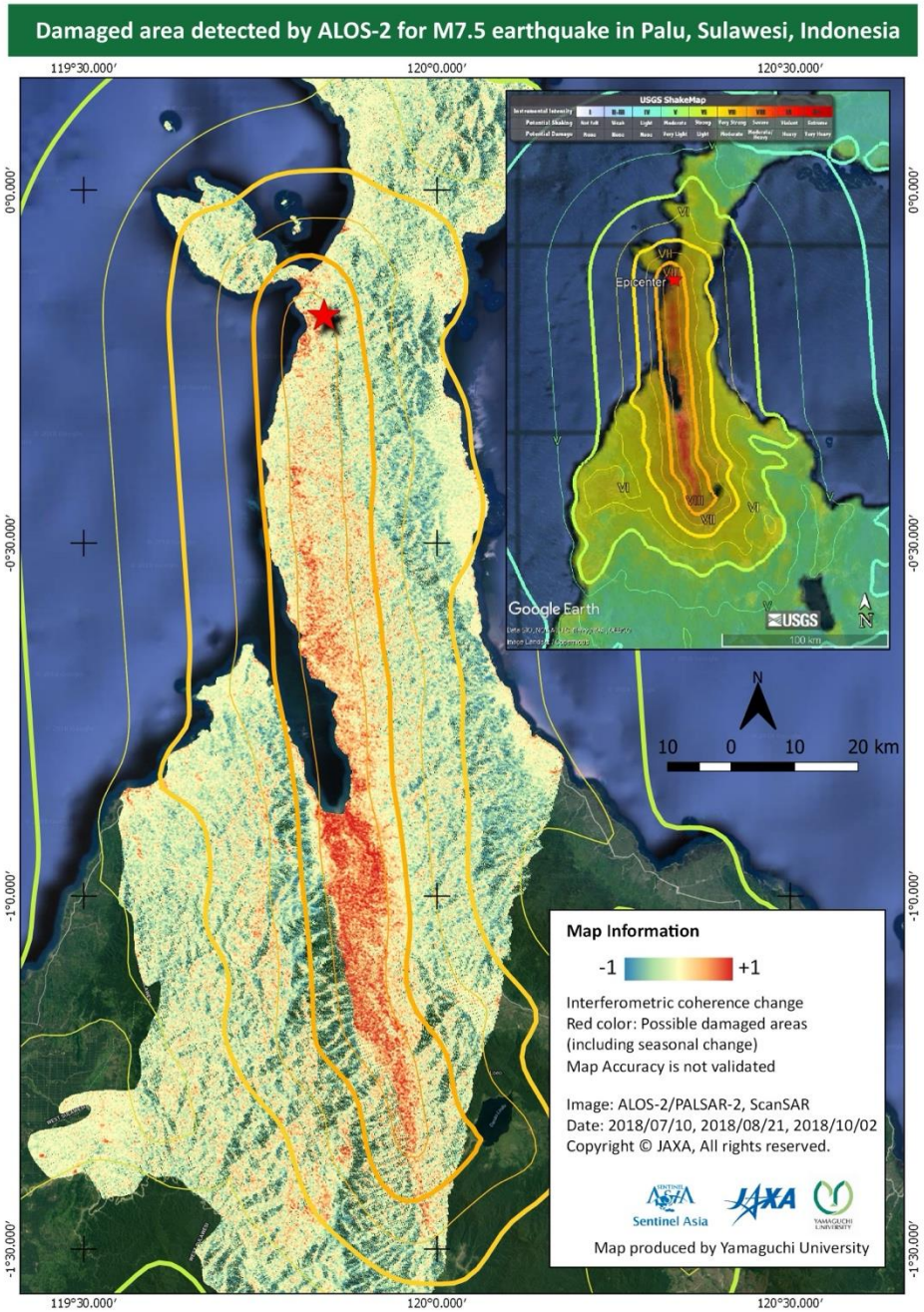
Image courtesy NASA/GSFC/METI/ERSDAC/JAROS, and U.S./Japan
https://earthobservatory.nasa.gov/images/12383/fires-in-southern-california

(SAR Image (Amplitude))



(SAR Image (Phase))





Summary

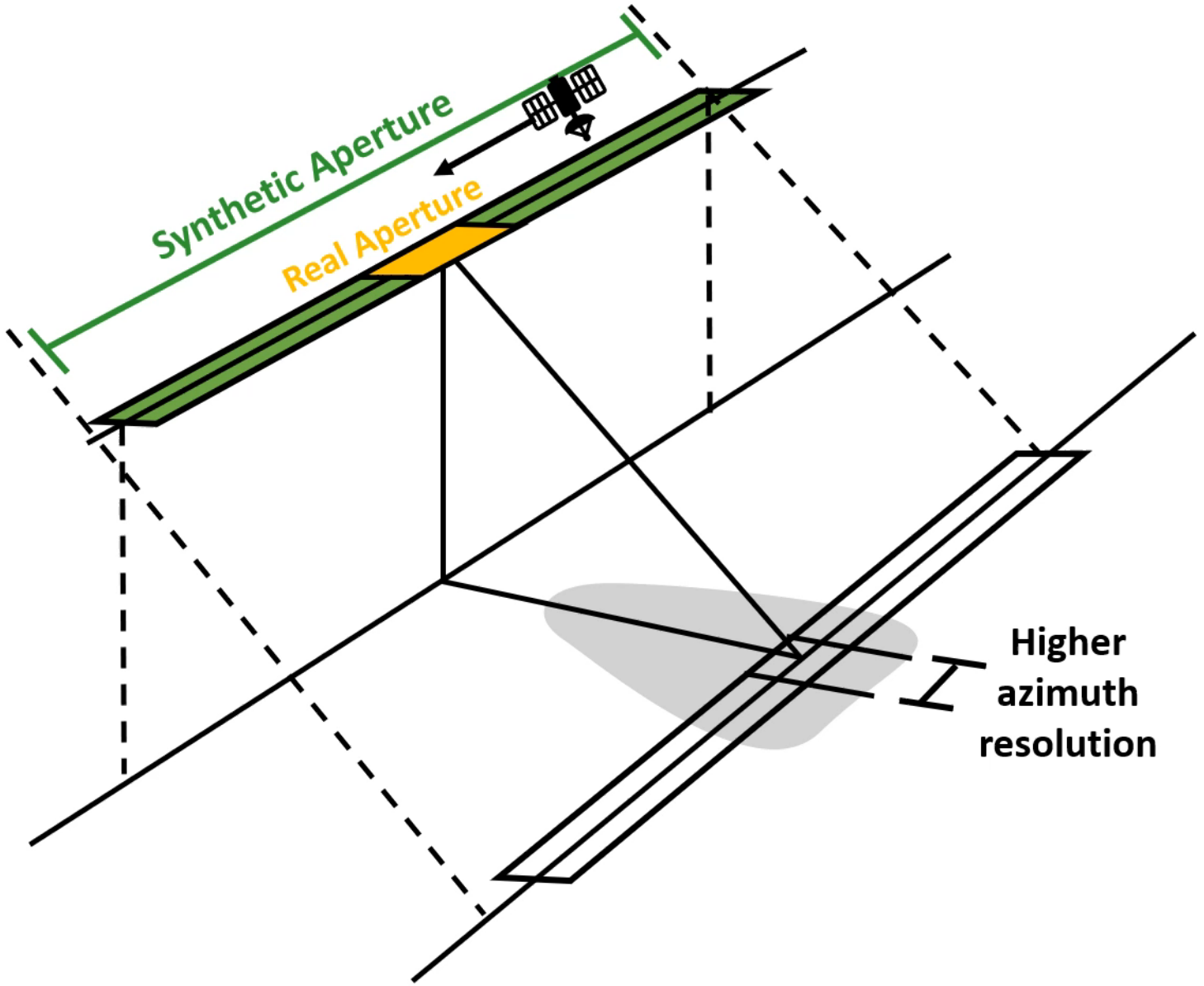
- There are several types of Remote sensing, Optical, Thermal, and Microwave remote sensing.
- It is necessary to select the most suitable satellite depending on type of disaster.

What is SAR?

What is SAR?

Synthetic Aperture Radar (SAR) is side looking radar which utilizes fight path to increase the antenna's size (aperture) and resolution in azimuth direction.

This system uses complicated data processing of multi-temporal signals and phase receiving from targets to generate high resolution image.



Advantages and Disadvantage of SAR

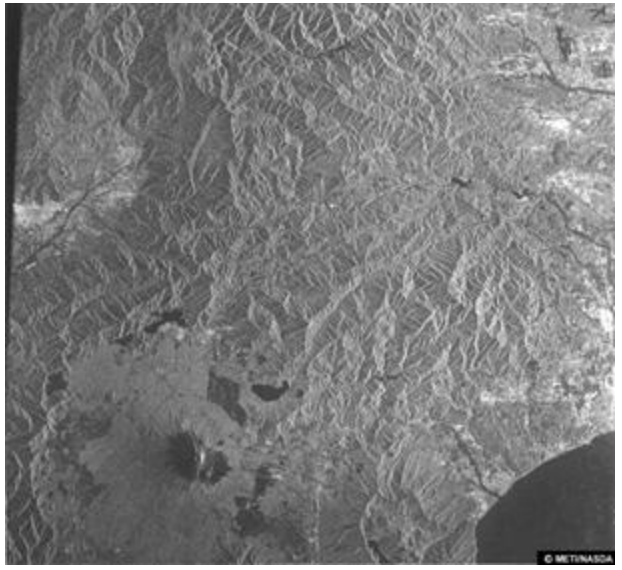
Advantages:

- Observe both day and night
- Small dependence on atmospheric conditions such as solar radiation, cloud cover
- Controllability of the emitted electromagnetic radiation such as power, frequency, polarization, radiation direction and etc.

Disadvantages:

- Black and white image
- Difficult to understand without understanding principle of SAR

http://www.eorc.jaxa.jp/en/hatoyama/etc/images/use/image/rn_12_2.jpg



http://www.eorc.jaxa.jp/en/hatoyama/etc/images/use/image/rn_12_1.jpg

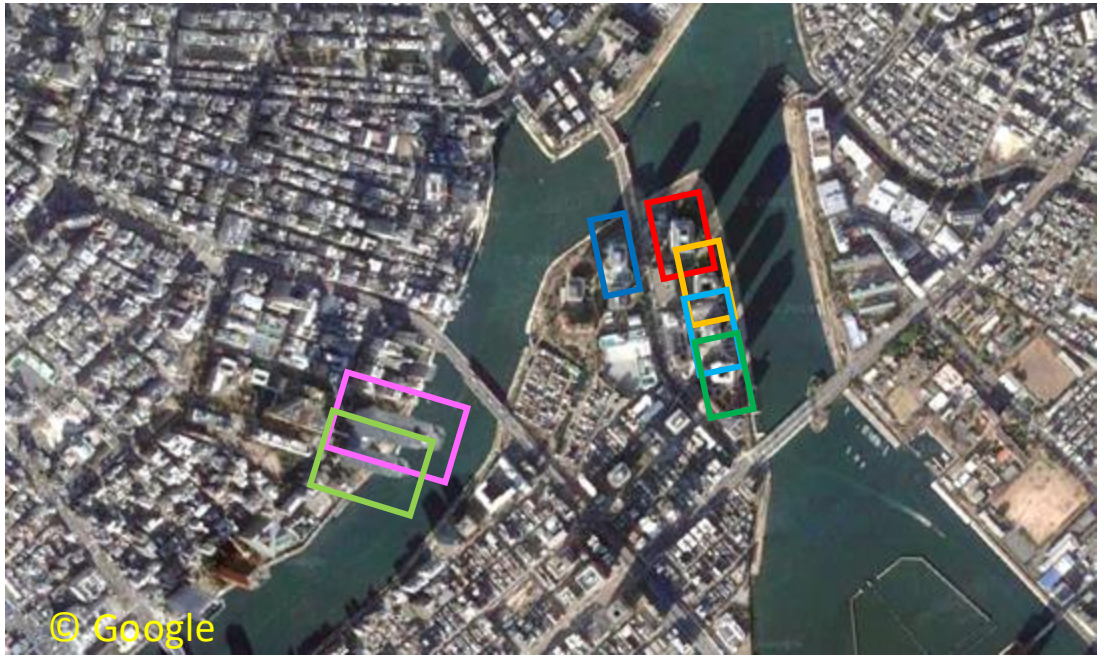
Differences between Optical Data and SAR

	Optical Sensor	SAR
Platform	Airborne/spaceborne	Airborne/spaceborne
Radiation	Reflected sunlight	Own radiation
Spectrum	Visible/infrared	Microwave
Frequency	Multi-frequency	Single/Multi-frequency
Polarimetry	N.A.	Polarimetric phase
Interferometry	N.A.	Polarimetric phase
Acquisition time	Day time	Day/night
Weather	Blocked by clouds	See through clouds


ALOS-2 © JAXA


ALOS-2 © JAXA


© Google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ALOS-2 © JAXA


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ALOS-2 © JAXA


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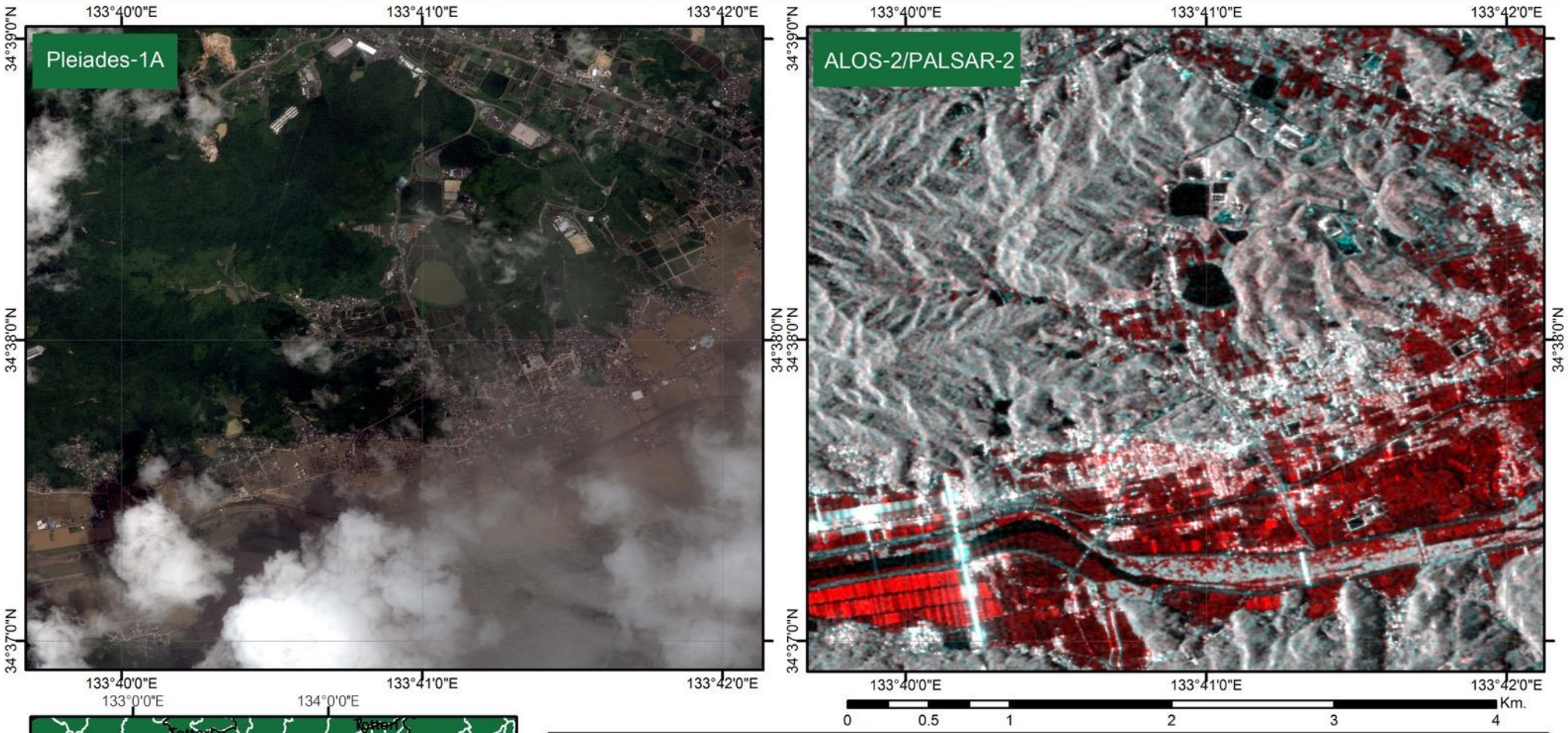
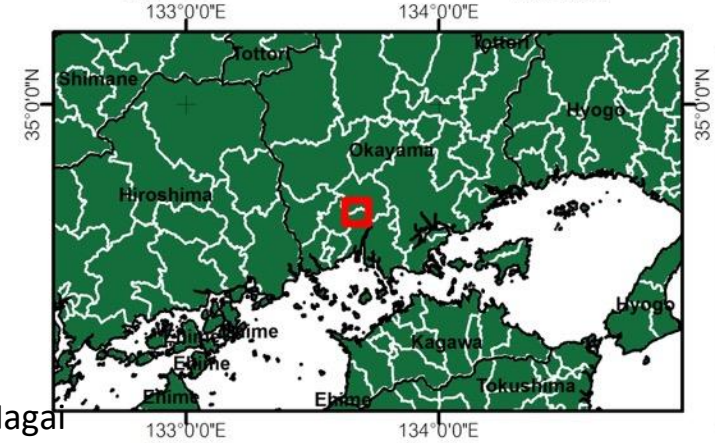
Flood Detection in Mabi, Kurashiki, Okayama, Japan





Information

Right image: Pleiades-1A
Date: 2018-07-09
Image Copyright: Pleiades © CNES (2018) -
Distribution: Airbus Defence and Space, all rights reserved.

Left image: ALOS-2/PALSAR-2 (SM1 mode)
Color Composite:
Red band: Before disaster: 2018-04-14 at 15:05 (UTC)
Green band: After disaster: 2018-07-07 at 15.05 (UTC)
Blue band: After disaster: 2018-07-07 at 15.05 (UTC)
Image Copyright © Japan Aerospace Exploration Agency, all rights reserved.

Legend of left image

Red color is possible to be flood area

Sentinel Asia

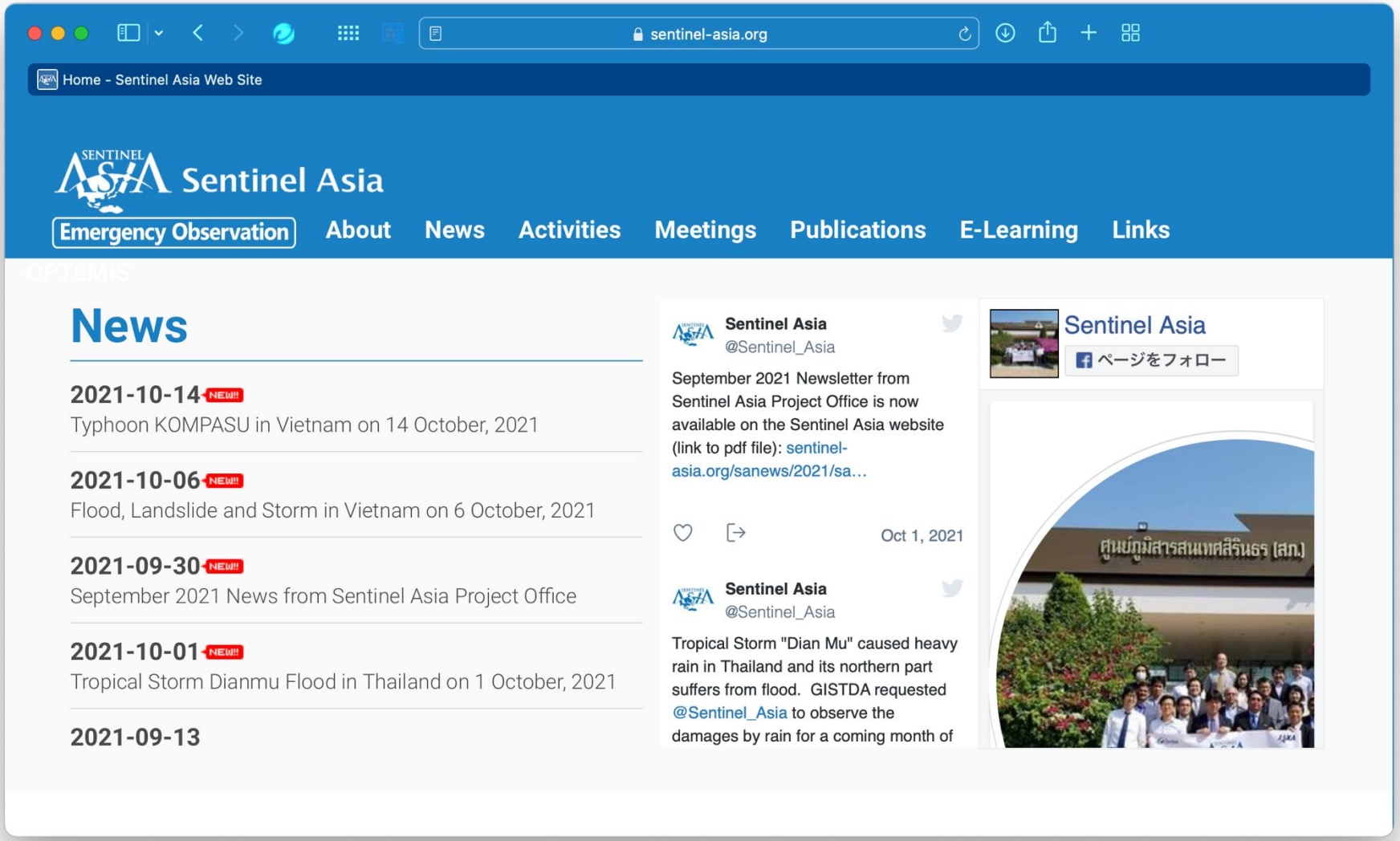
Map produced by Yamaguchi University

Summary

- SAR is very effective for disaster monitoring.
- SAR can penetrate clouds, collect during all- weather conditions, and capture data day and night.
- Some of SAR data is freely available such as Sentinel-1.

How to get Satellite Data?

Sentinel Asia



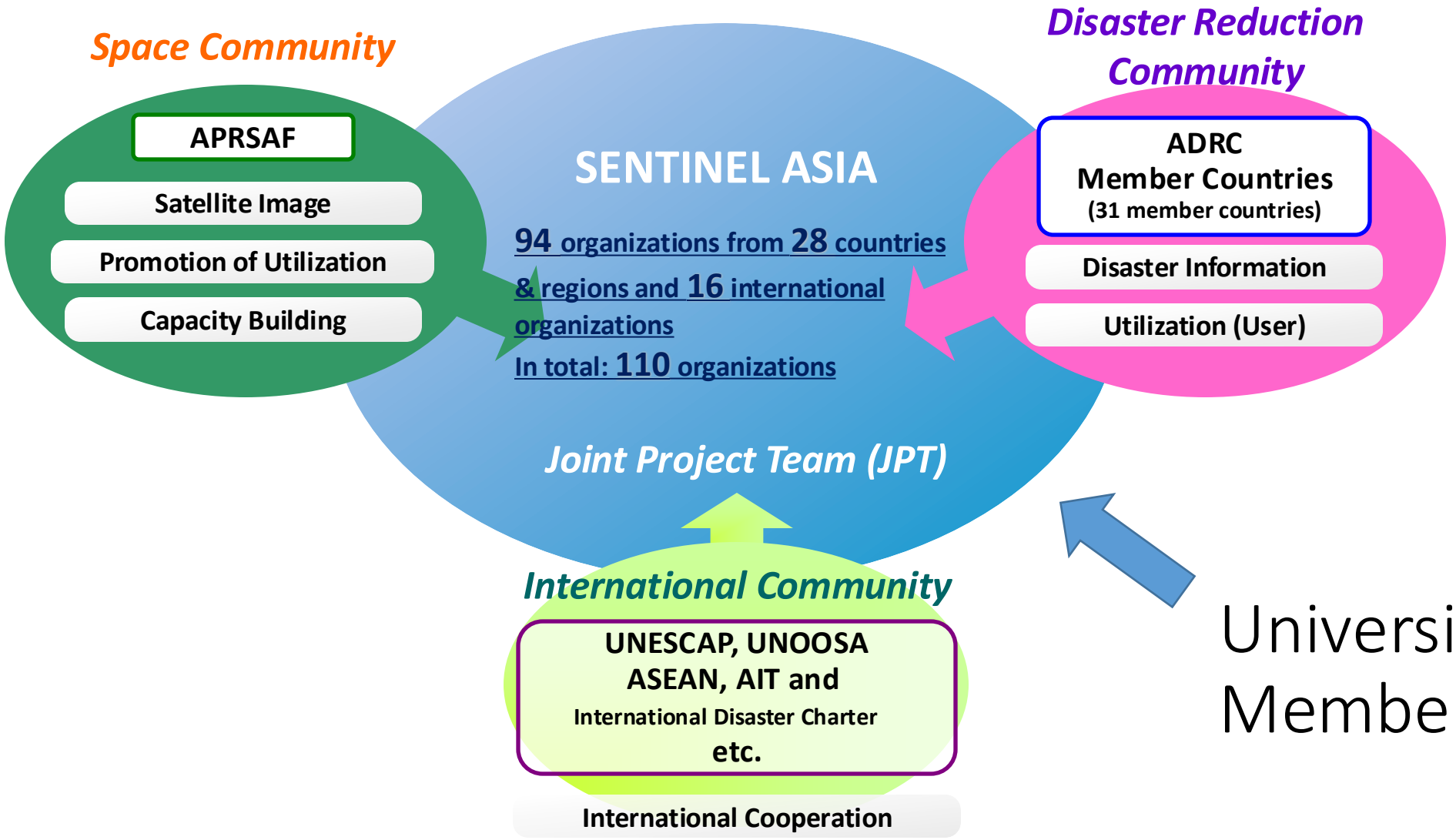
https://sentinel-asia.org

Sentinel Asia

- Sentinel Asia is a voluntary initiative between **space agencies** and **disaster management agencies** to apply **Remote Sensing** and **Web-GIS** technologies to assist disaster management in the Asia-Pacific region.

- Sentinel Asia aims to:
  - ✓ Improve safety in society by ICT and space technology
  - ✓ Improve speed and accuracy of disaster preparedness and early warning
  - ✓ Minimize the number of victims and social/economic losses.

Framework of Sentinel Asia



Member of Sentinel Asia

- *Sentinel Asia organizes Joint Project Team (JPT), and JPT consists of **111 organizations** including **94 agencies from 28 countries/region** and **17 international organizations**. (as of November 2019)*
- *JAXA is the secretariat of JPT.*
- *Also, Sentinel Asia cooperates with **ADRC** and **their members** closely, and they are also member of Sentinel Asia as well.*

JPT + members

Member of Sentinel Asia

Currently Sentinel Asia has 111 JPT members.

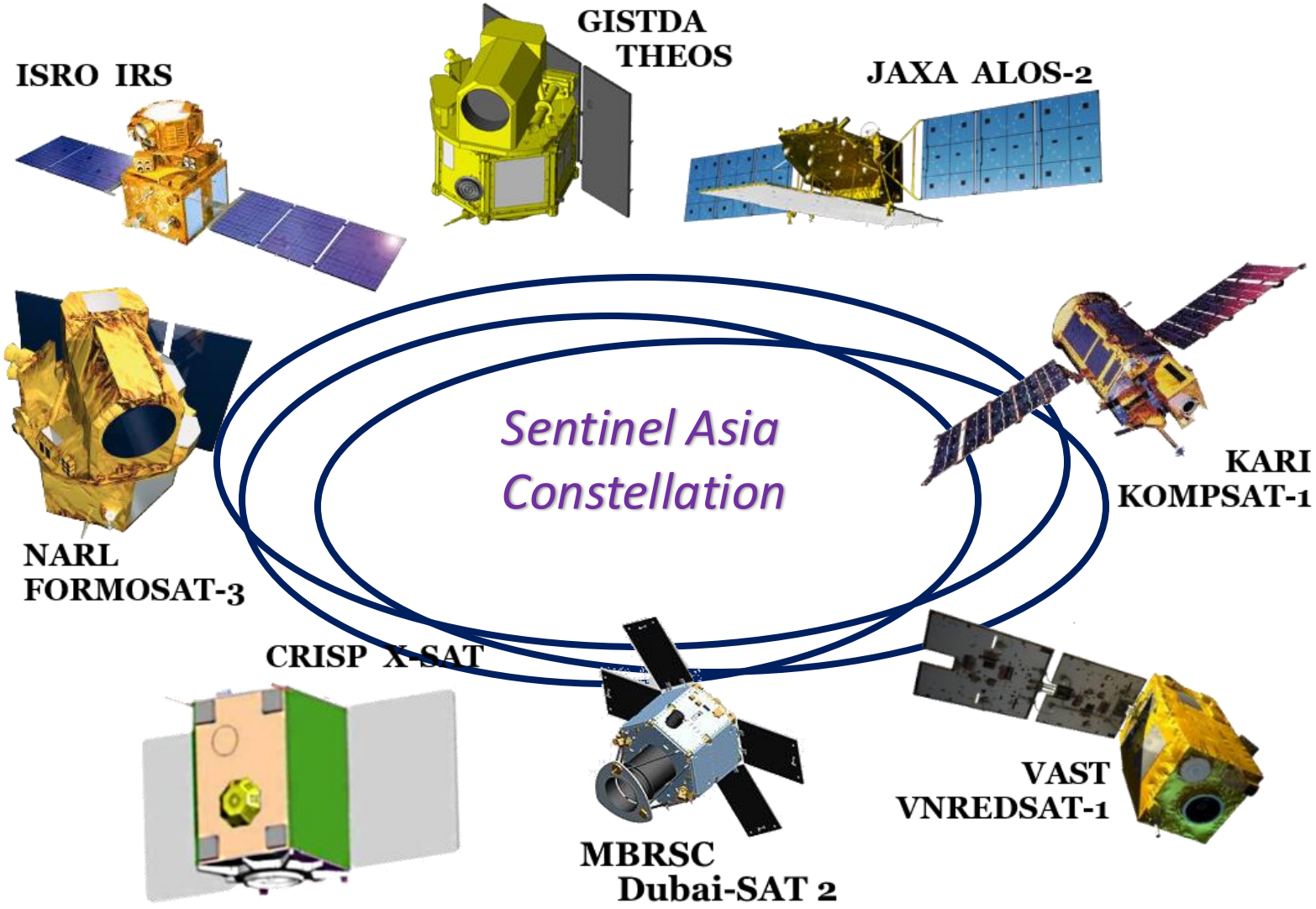
(94 organizations from 28 countries/regions and 17 international organizations)

No.	Country / Region	No.	Organization	Data Provider Node (DPN)	Data Analysis Node (DAN)
1	Armenia	1	Ministry of Emergency Situation (MES)		
2	Australia	2	CSIRO Office of Space Science and Applications (COSSA)		
		3	Geoscience Australia (GA)		
		4	Bureau of Meteorology (BOM)		
3	Bangladesh	5	Bangladesh Space Research and remote Sensing Organization (SPARRSO)		
4	Bhutan	6	Department of Disaster Management, Ministry of Home and Cultural Affairs		
		7	National Land Commission		
		8	Sherubtse College, Royal University of Bhutan		
		9	Department of Geology and Mines (DGM)		
		10	Ministry of Works and Human Settlement (MoWHS)		
5	Brunei	11	Survey Department (SD), Ministry of Development		
6	Cambodia	12	Ministry of Land Management, Urban Planning and Construction		
		13	National Committee for Disaster Management (NCDM)		

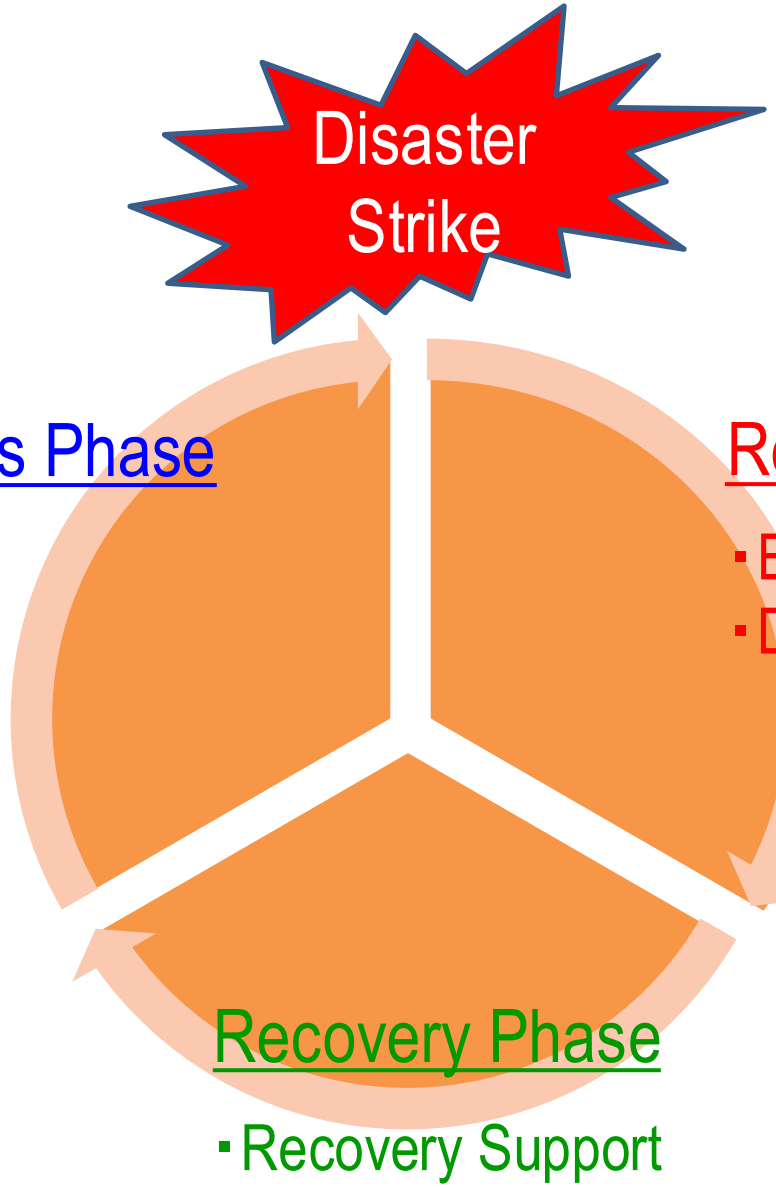
https://sentinel-asia.org/jptmember/JPTMember.html

DPN (Data Provider Node)

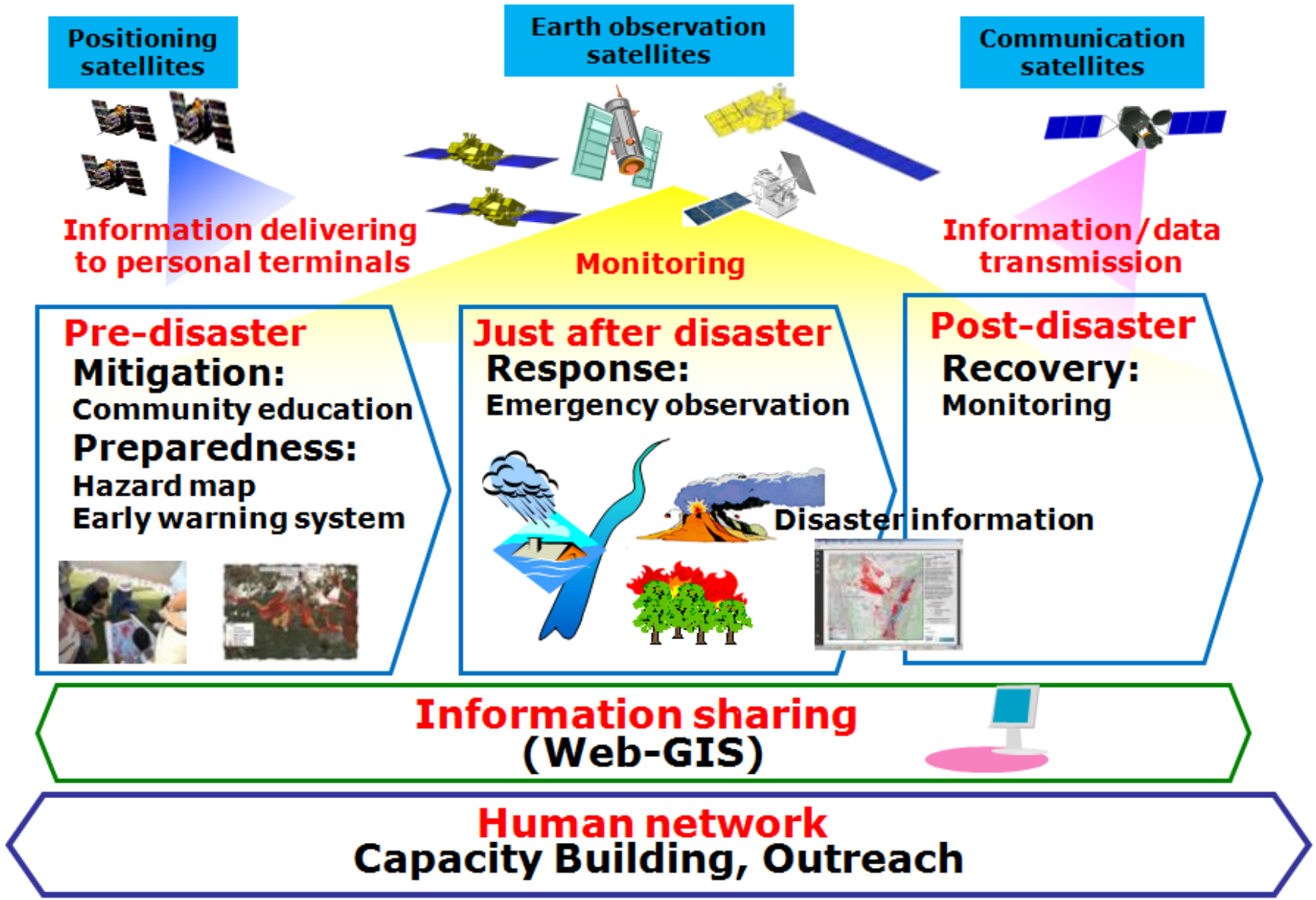
Sentinel Asia Constellation contributing to Emergency Observation



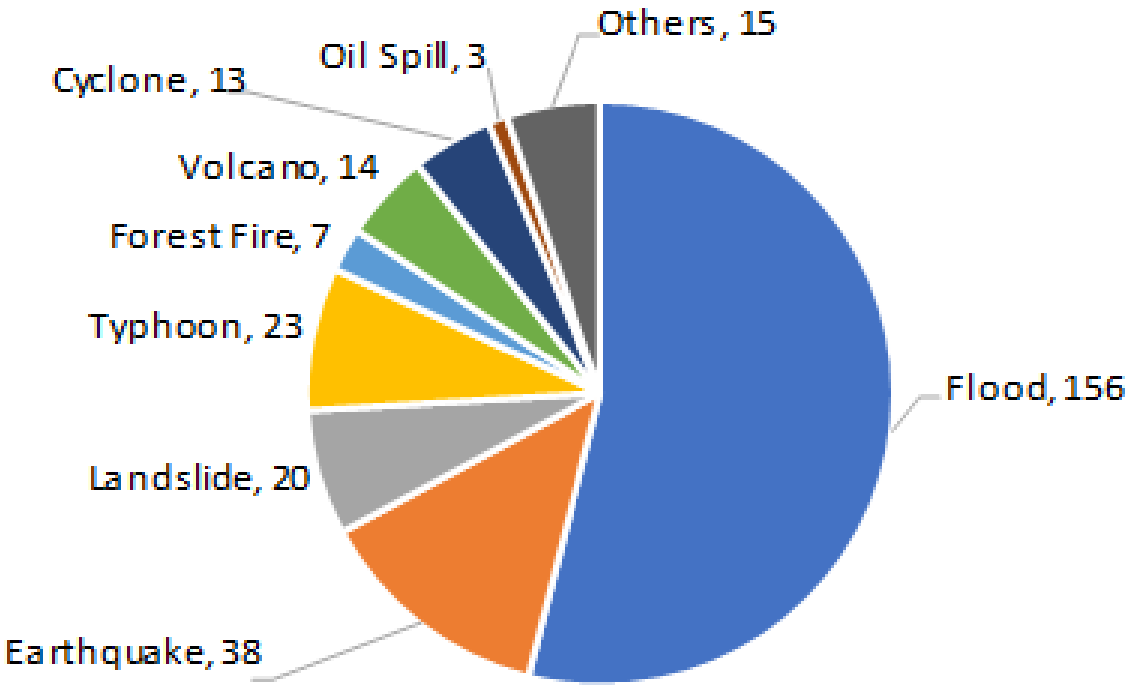
Disaster Cycle

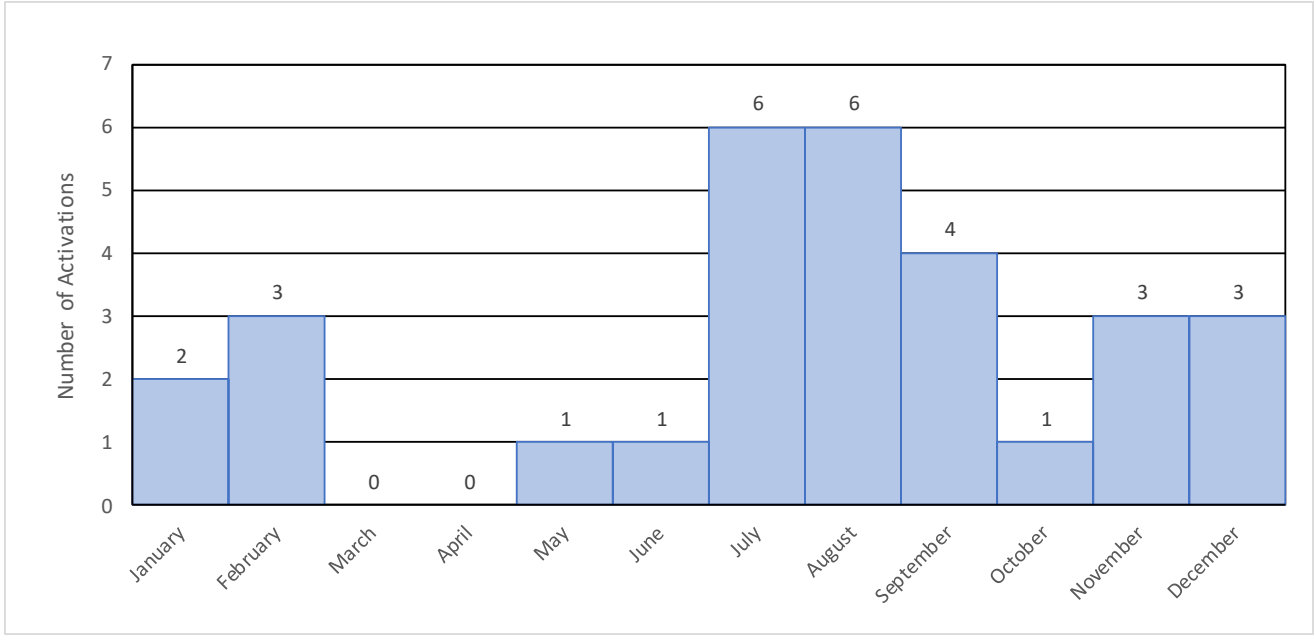


Concept of Sentinel Asia



Type of Disaster (2007 – 2018)





Number of Monthly Activation

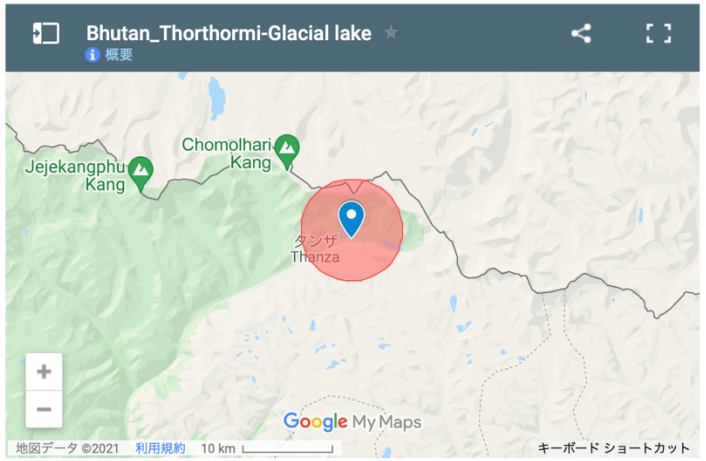
Bhutan Glacier Lake Breach Flood

Sentinel Asia

2019-06-20

Bhutan Glacier Lake Breach Flood

Emergency Obs. Request Information



Disaster Type: Flash flood

Country: Bhutan

Occurrence Date (UTC): 20 June, 2019

SA activation Date(UTC): 22 June, 2019

Requester: Ministry of Home and Cultural Affairs - Bhutan (MOHCA)

National Center for Hydrology and Meterology (NCHM)

Escalation to the International Charter: No

GLIDE Number:

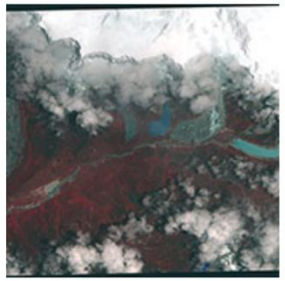
Disaster Situation

One (Thorthormi-Lake) of four potential dangerous lakes in the head waters of Phochu under the Punatsangchu is partially bridged 20th June night. We hope to observe because of detection of an advance warning of hazardous situation (Glacier Lake Outburst Flood).
[News: Kuensel Online] http://www.kuenselonline.com/experts-to-visit-thorthormi-today/

https://sentinel-asia.org/EO/2019/article20190620BT.html

Bhutan Glacier Lake Breach Flood

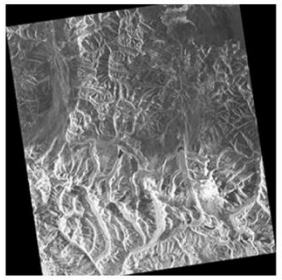
ISRO



2019-06-29
Resourcesat-2A LISS IV FMX data as observed on Jun 29, 2019

DOWNLOAD VIEW

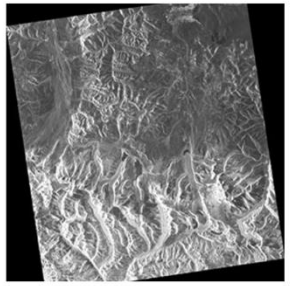
JAXA



2019-06-12
ALOS-2 PALSAR-2, P155F550, A, 39.3, 12 June, 2019

DOWNLOAD VIEW

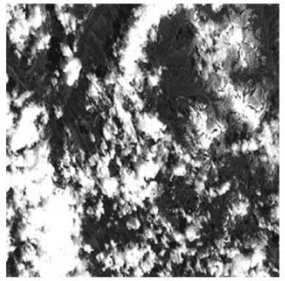
JAXA



2019-06-26
ALOS-2 PALSAR-2, P155F550, A, 39.3, 26 June, 2019

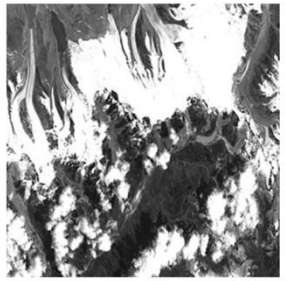
DOWNLOAD VIEW

GISTDA



2019-06-29
SCENE T1 L1A P 2019/06/29 04:45:14.8 0234-0294 0

DOWNLOAD VIEW



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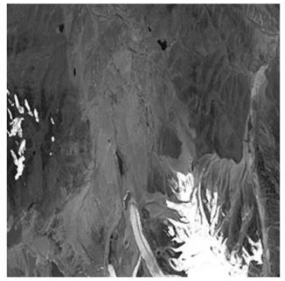
SCENE T1 L1A P 2019/06/29 04:45:11.4 0234-0294 0

DOWNLOAD VIEW



2019-06-29
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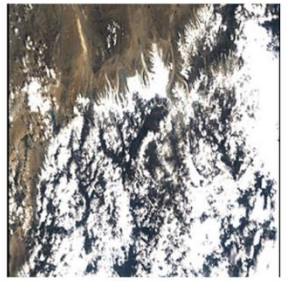
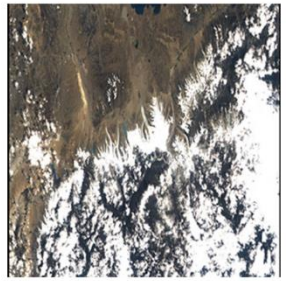
DOWNLOAD VIEW



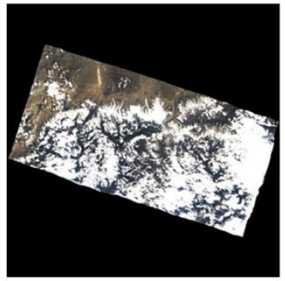
2019-06-29
SCENE T1 L1A M 2019/06/29 04:45:13.1 0234-0294 1179

DOWNLOAD VIEW



2019-06-29
SCENE T1 L1A M 2019/06/29 04:45:10.6 0234-0294 0

DOWNLOAD VIEW



2019-06-29
SCENE T1 L1A M 2019/06/29 04:45:13.1 0234-0294 1179

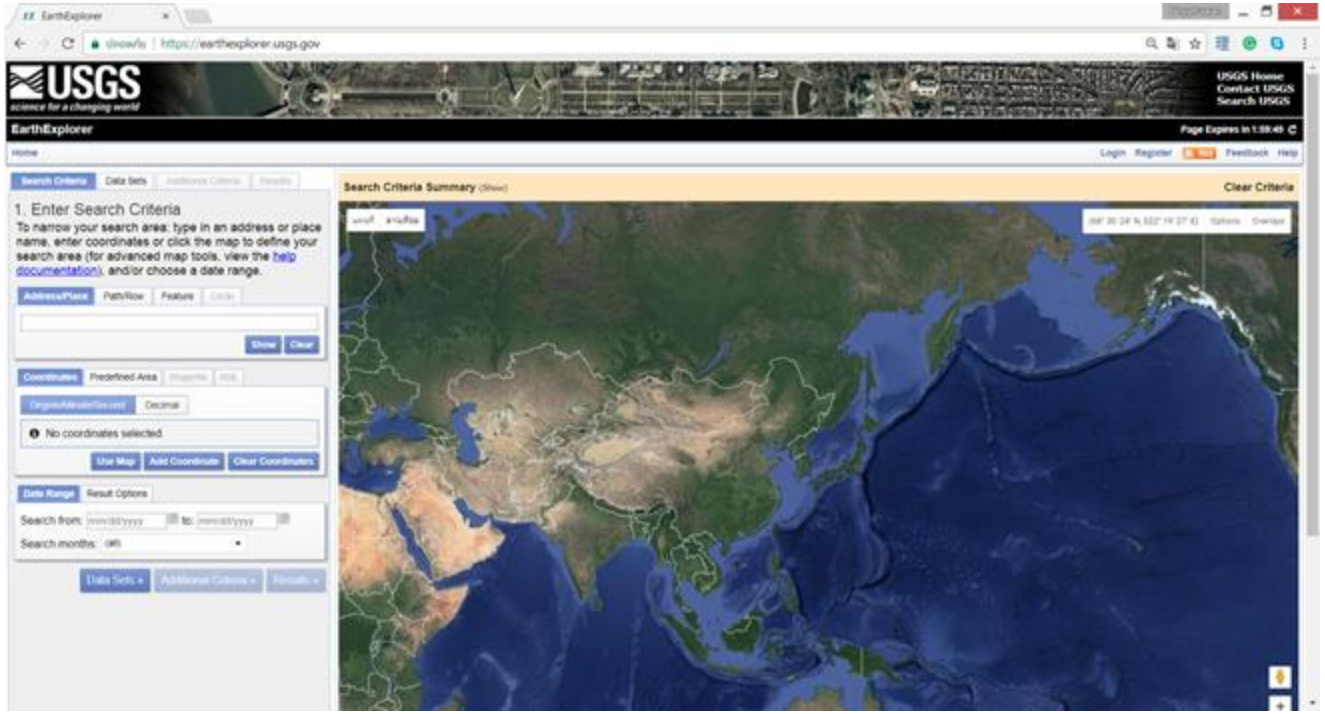
DOWNLOAD VIEW

https://sentinel-asia.org/EO/2019/article20190620BT.html

USGS Earth Explorer

Data: Aerial Imagery, AVHRR, CEOD Legacy, Commercial Satellites, Declassified Data, Digital Elevation, Digital Line Graphs, Digital Maps, EQ-1, Global Fiducials, HCMM, ISERV, Land Cover, Landsat, NASA LPDAAC collections, Radar, Sentinel, UAS, Vegetation Monitoring, ISRO resourcesat

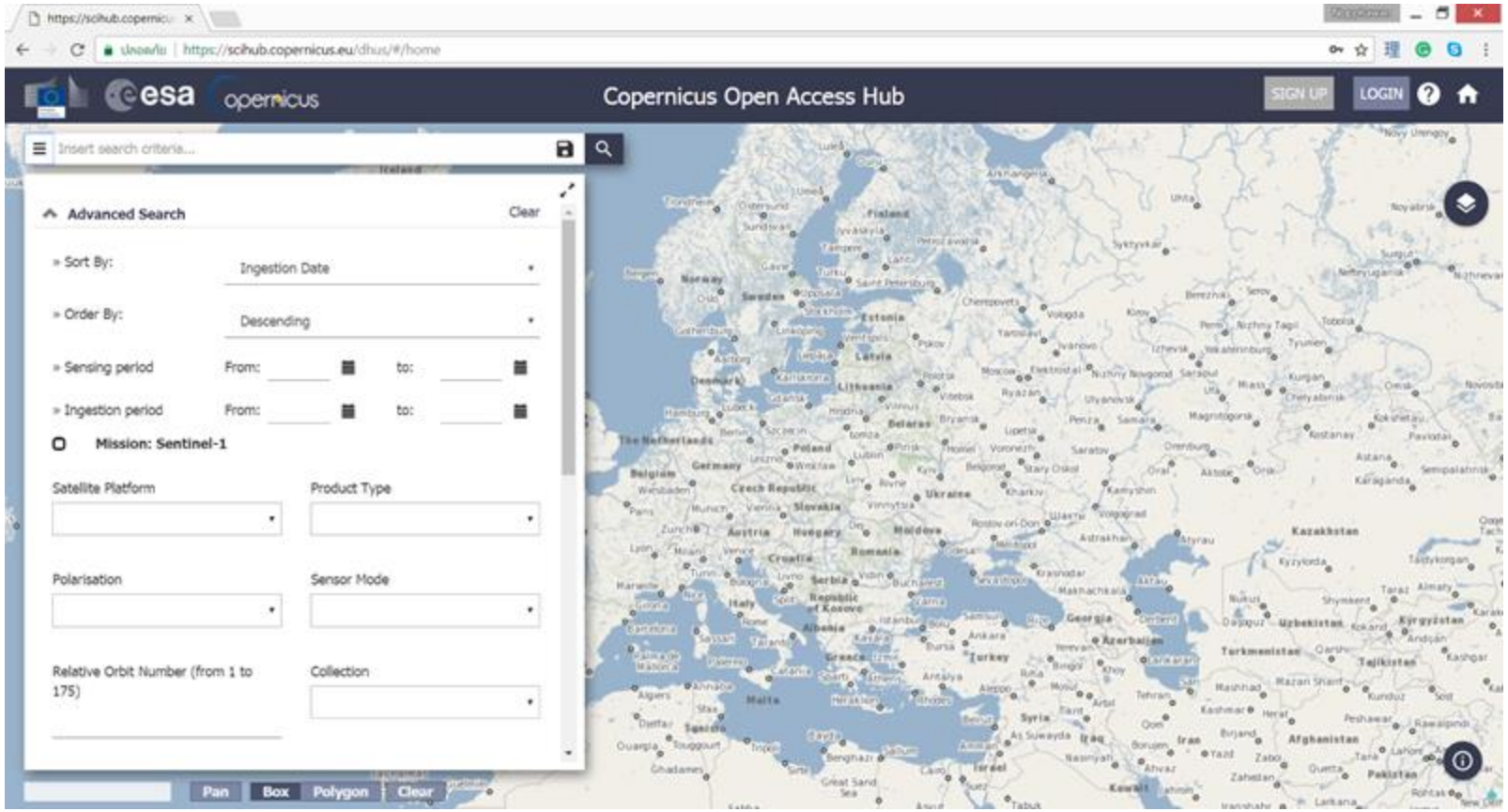
https://earthexplorer.usgs.gov/



Copernicus Open Access Hub

Data: Sentinel-1, Sentinel-2, Sentinel-3

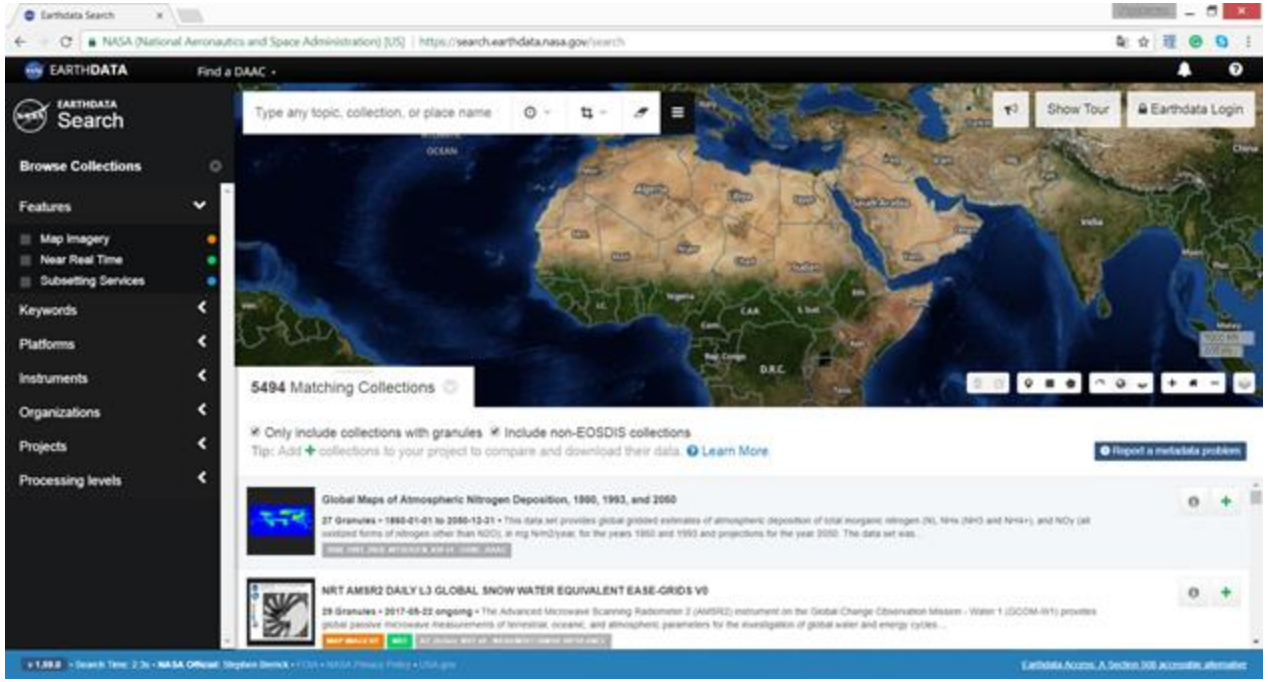
https://scihub.copernicus.eu/dhus/



NASA Earth Data

Platforms: AIRCRAFT, ALOS, Aqua, ERS-1, ERS-2, GEOS-8, JERS-1, Landsat-5, Landsat-7, Landsat-8, RADARSAT-1, Sentinel-1A, Sentinel-1B, Sentinel-2, Terra, GCOM-W1, NASA ER-2, NOAA(11-19), TRMM, etc.

Data related to agriculture, atmosphere, biological classification, biosphere, climate indicators, cryosphere, hydrosphere, land surface, oceans, terrestrial hydrosphere, etc.



https://search.earthdata.nasa.gov

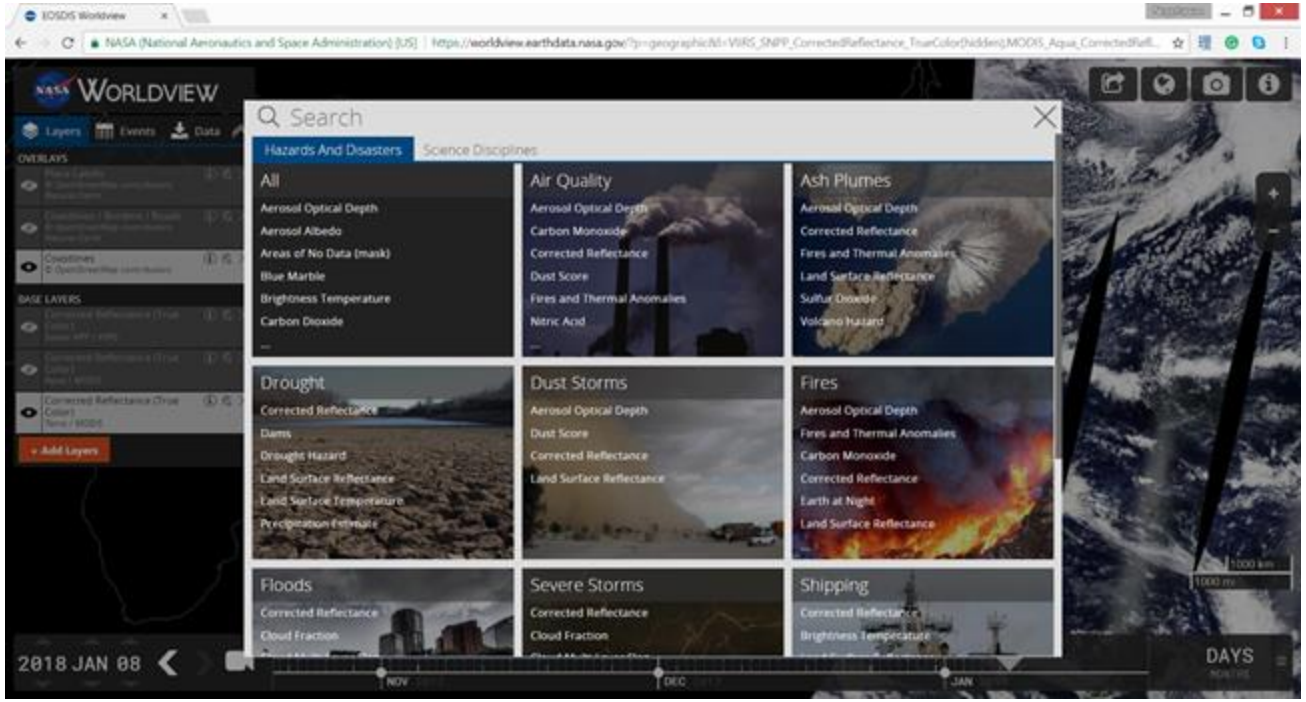
NASA WORLDVIEW

Platforms: MODIS/Terra, MODIS/Aqua, Landsat, GCOM-W1/AMSR2, SMAP, Sentinel-1, MERRA-2, etc.

Data related to

- Hazard and disaster including air quality, ash plumes, drought, storms, fires, floods, shipping, etc.
- Science Disciplines including atmosphere, biosphere, cryosphere, human dimension, land surface, oceans, spectral/engineering, terrestrial hydrosphere, etc.

https://worldview.earthdata.nasa.gov/



Summary

- Sentinel Asia is very effective activates to acquire satellite images by international cooperation.
- Satellite data is freely available. But, it is difficult to request newly observation.

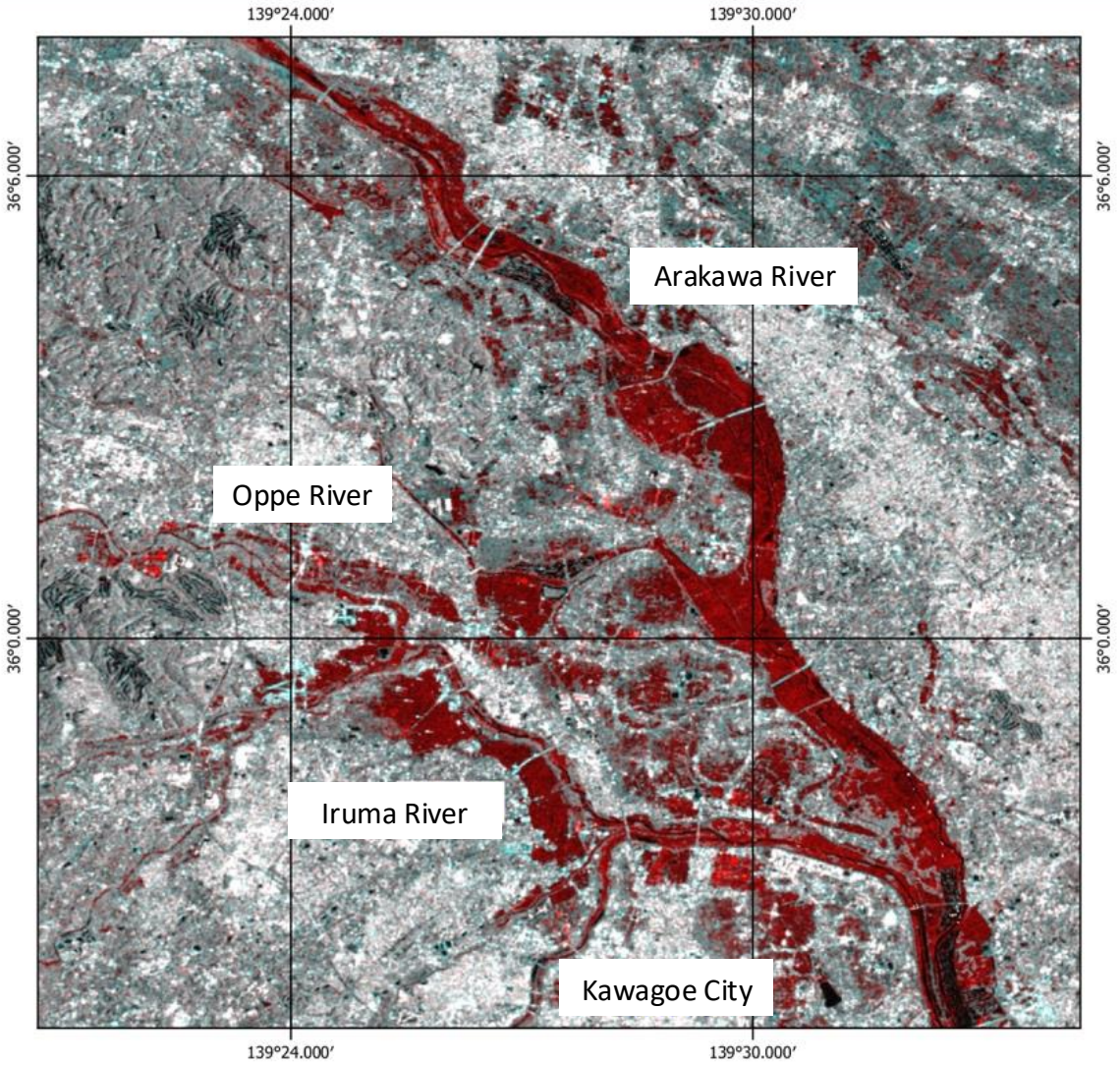
AI Technology

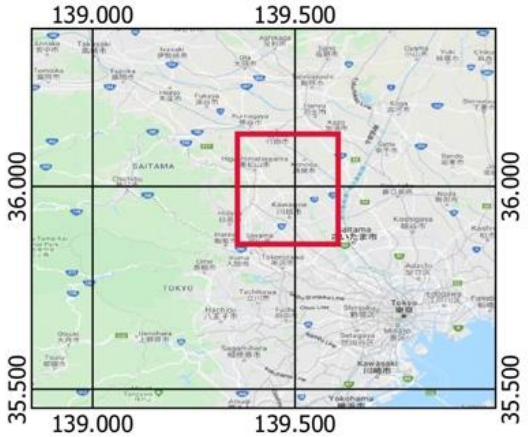
AI Technology for Remote Sensing Data

Over 10000 Polygons of the buildings has been utilized in the program as the training data to identify the classifiers for the buildings

Application for Disaster

Possible flooded areas using Sentinel 1 in Saitama prefecture, Japan





Map information

Possible flood areas

Data source

Image: Sentinel 1B
Image date: 2019-10-06 and 2019-10-12
Image copyright © European Space Agency - ESA

0 1 2 km

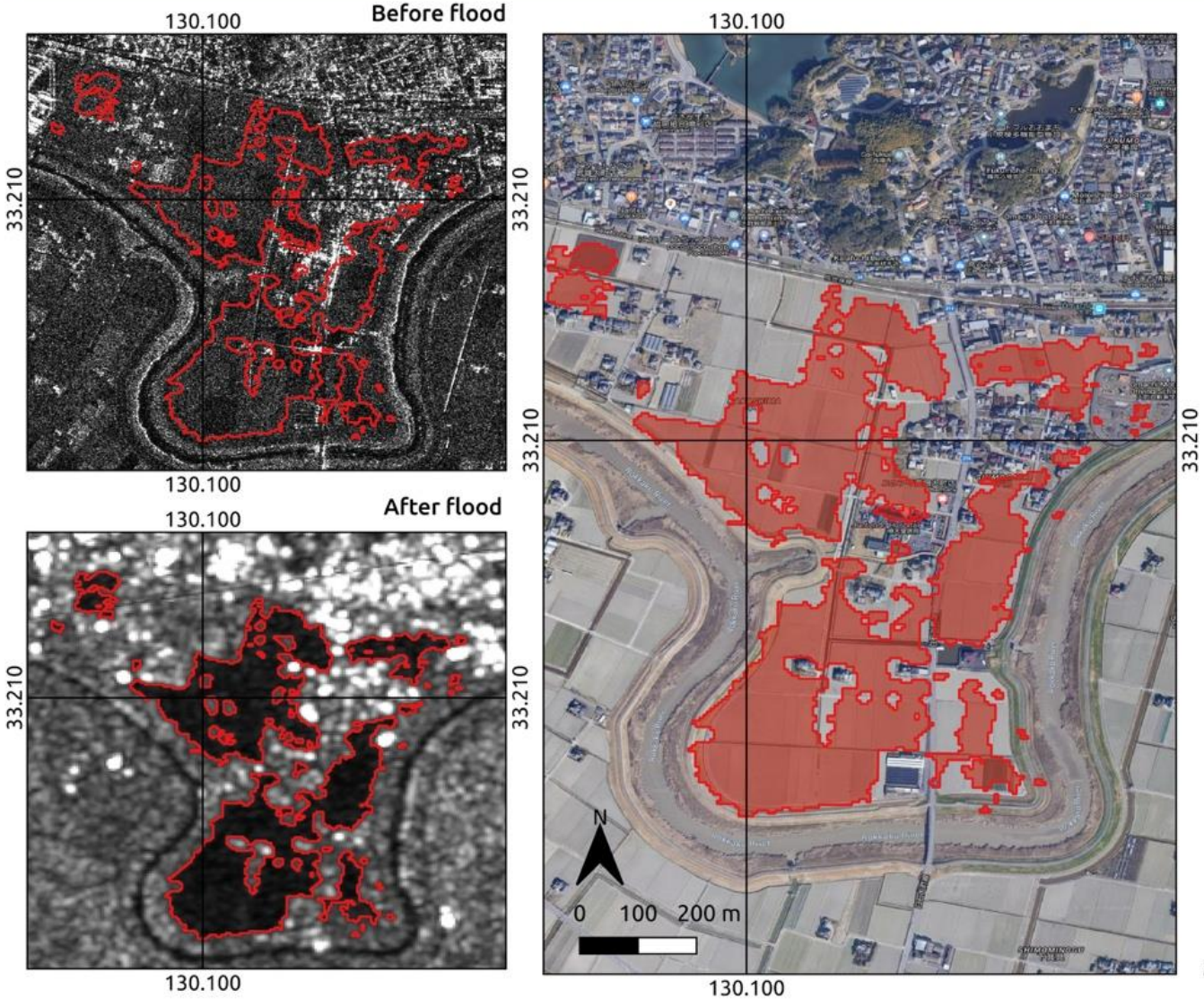
N

Accuracy is not validated
Map produced by Yamaguchi University

Sentinel Asia esa YAMAGUCHI UNIVERSITY SIP

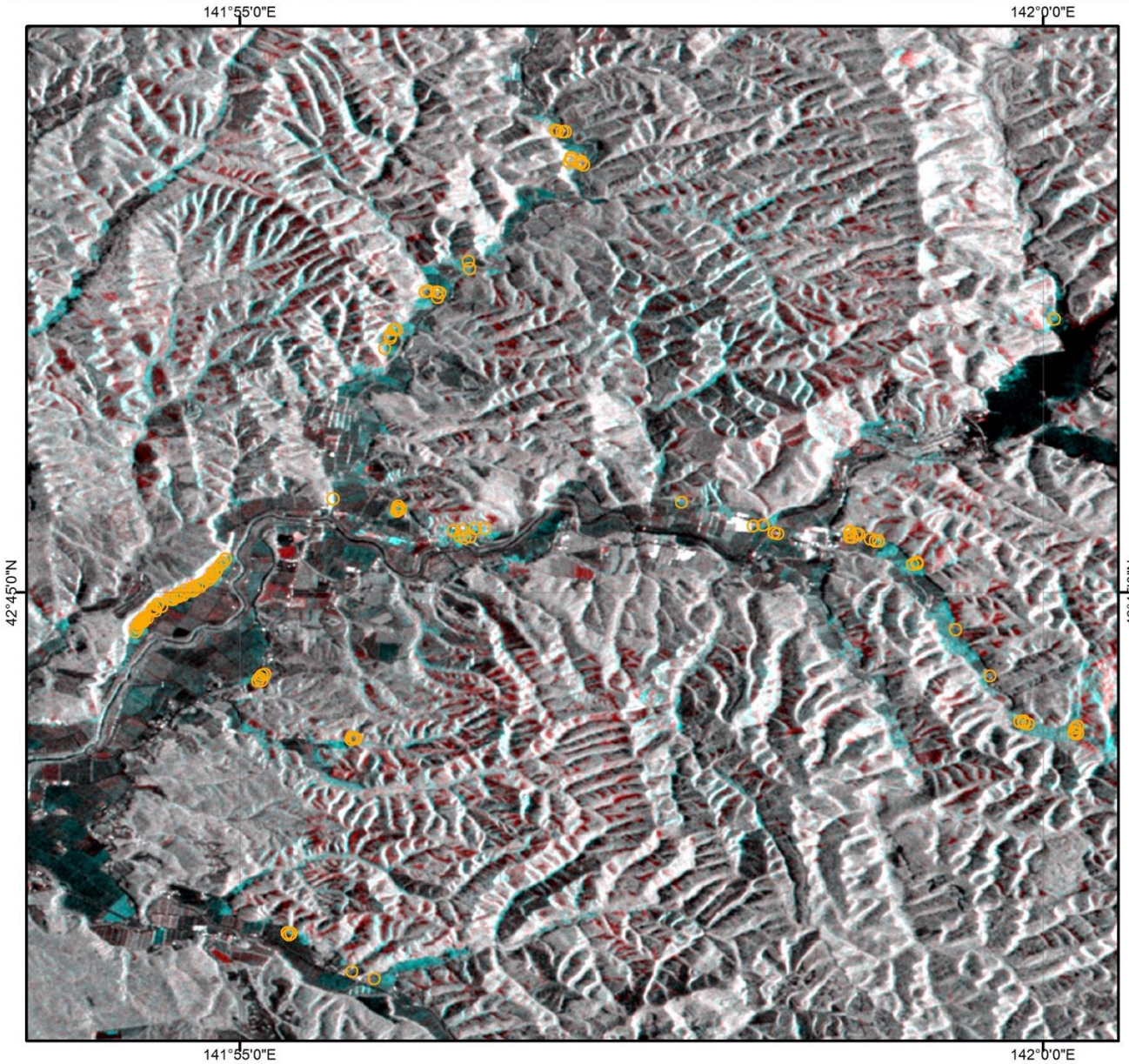
https://www.jiji.com/jc/p?id=20191013142904-0032859247

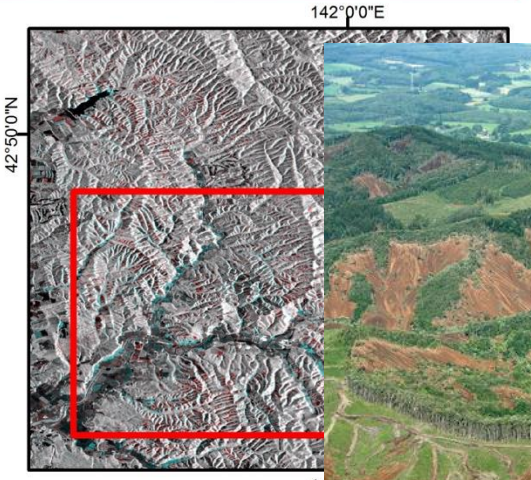
Oil leaking and flooding areas, observed by KOMPSAT-5, Saga prefecture, Japan



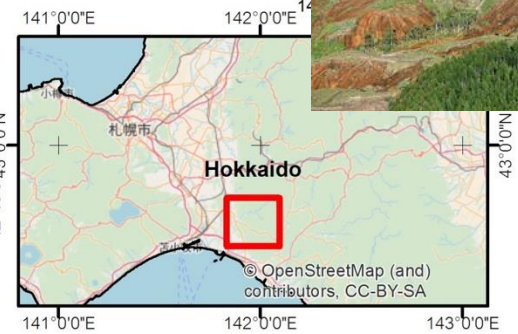
https://www.kobe-np.co.jp/news/zenkoku/compact/201908/p1_0012648276.shtml

Landslide areas induced by M6.7 earthquake in Hokkaido, Japan





© Asahi Shinbun



Information

Red and blue color present affected area
by color composite of before- and after-images.

○ Buildings in affected area

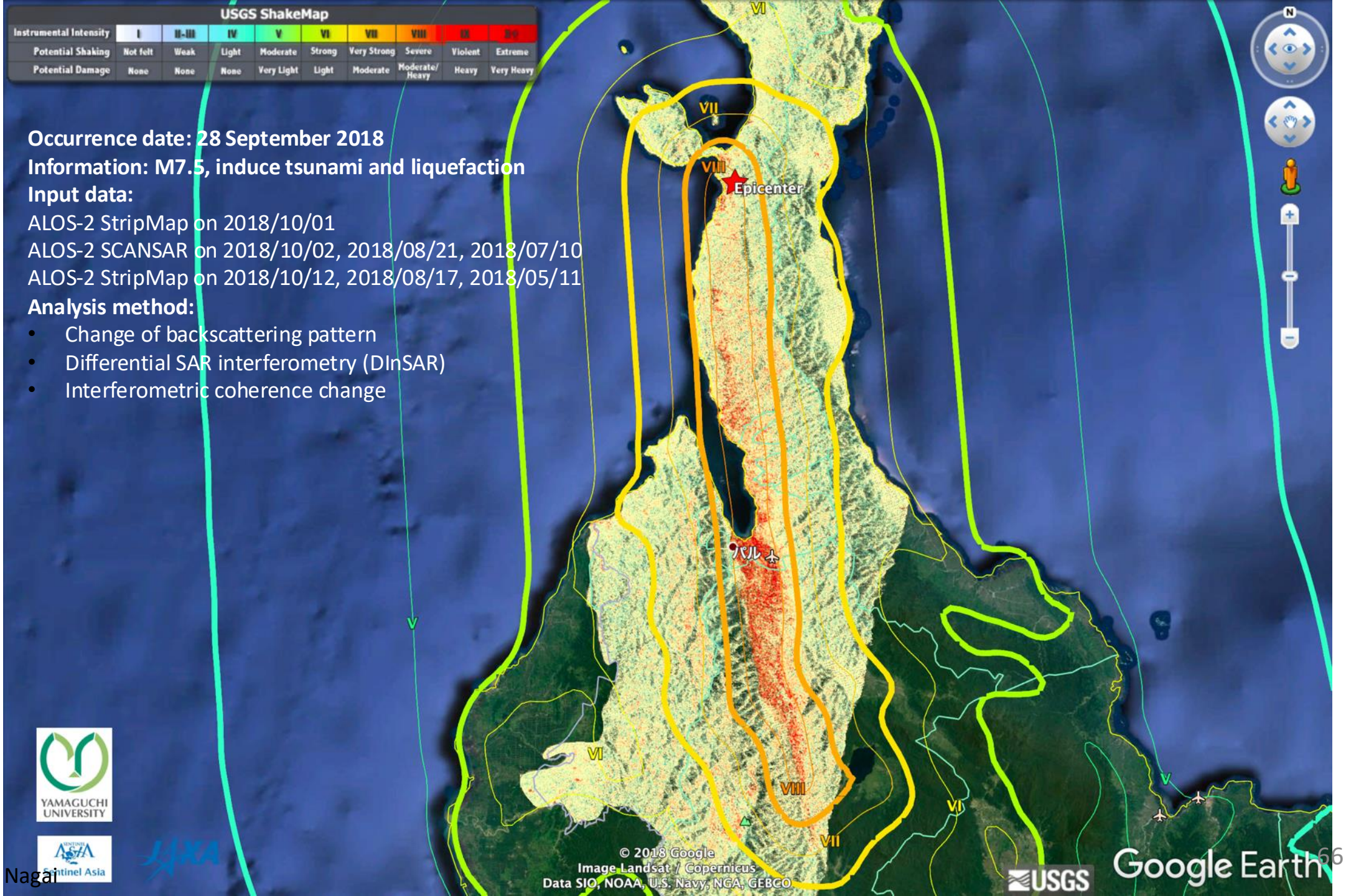
Map accuracy is not validated

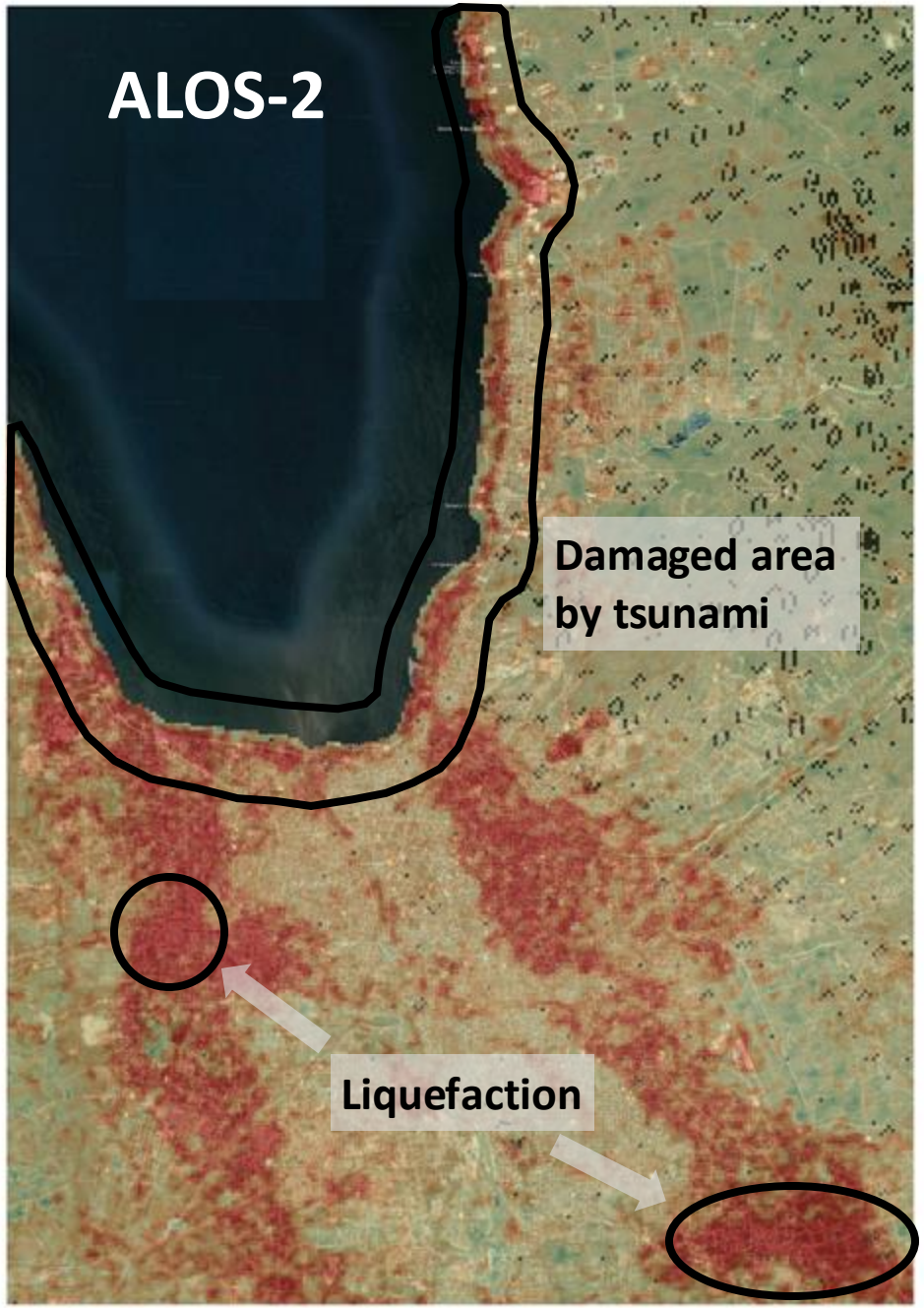
Image: ALOS-2/PALSAR-2
Before disaster: 2018-08-23
After disaster: 2018-09-06
Image Copyright ©JAXA, all rights reserved.

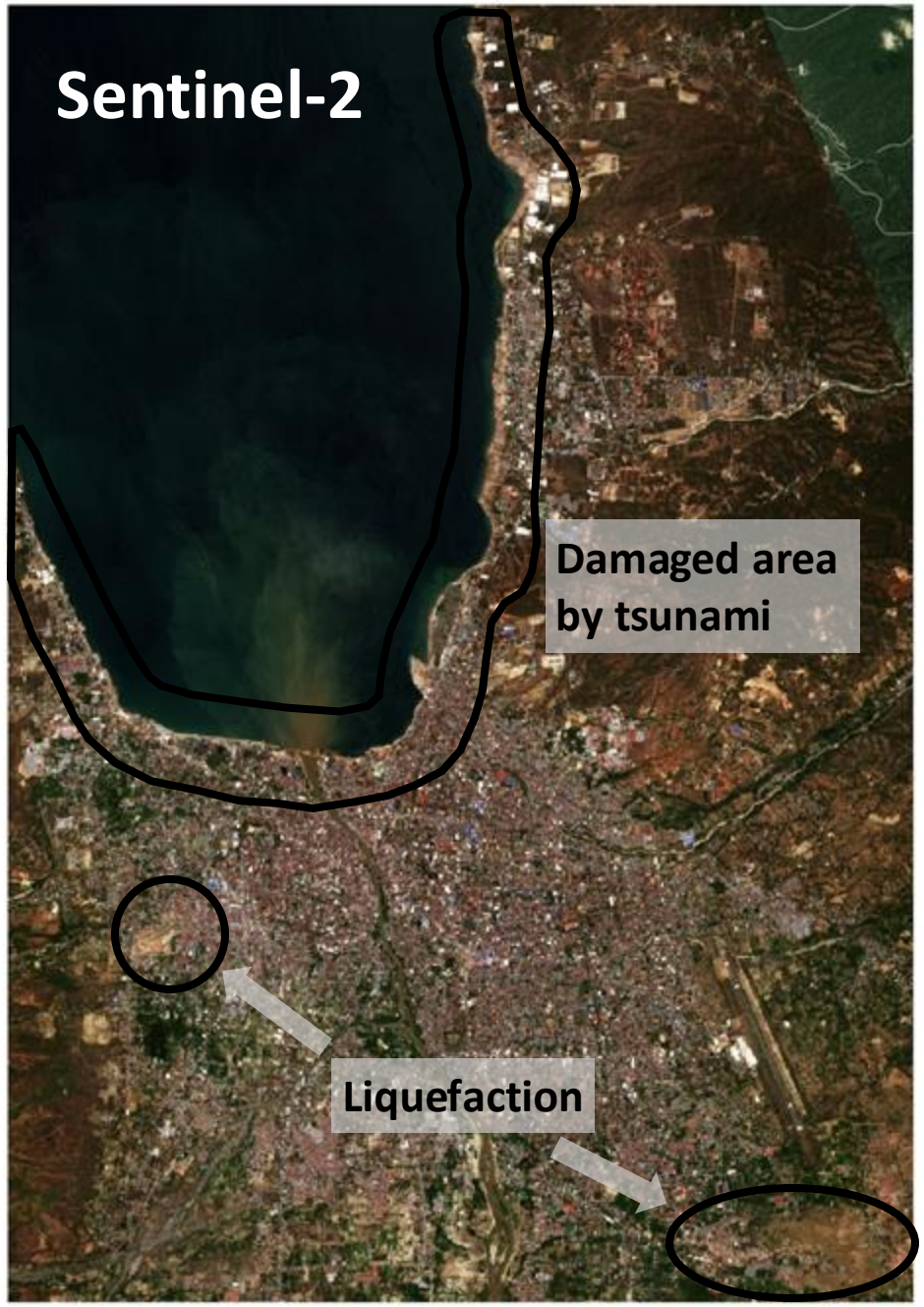
Sentinel Asia JAXA YAMAGUCHI UNIVERSITY

Map produced by Yamaguchi University

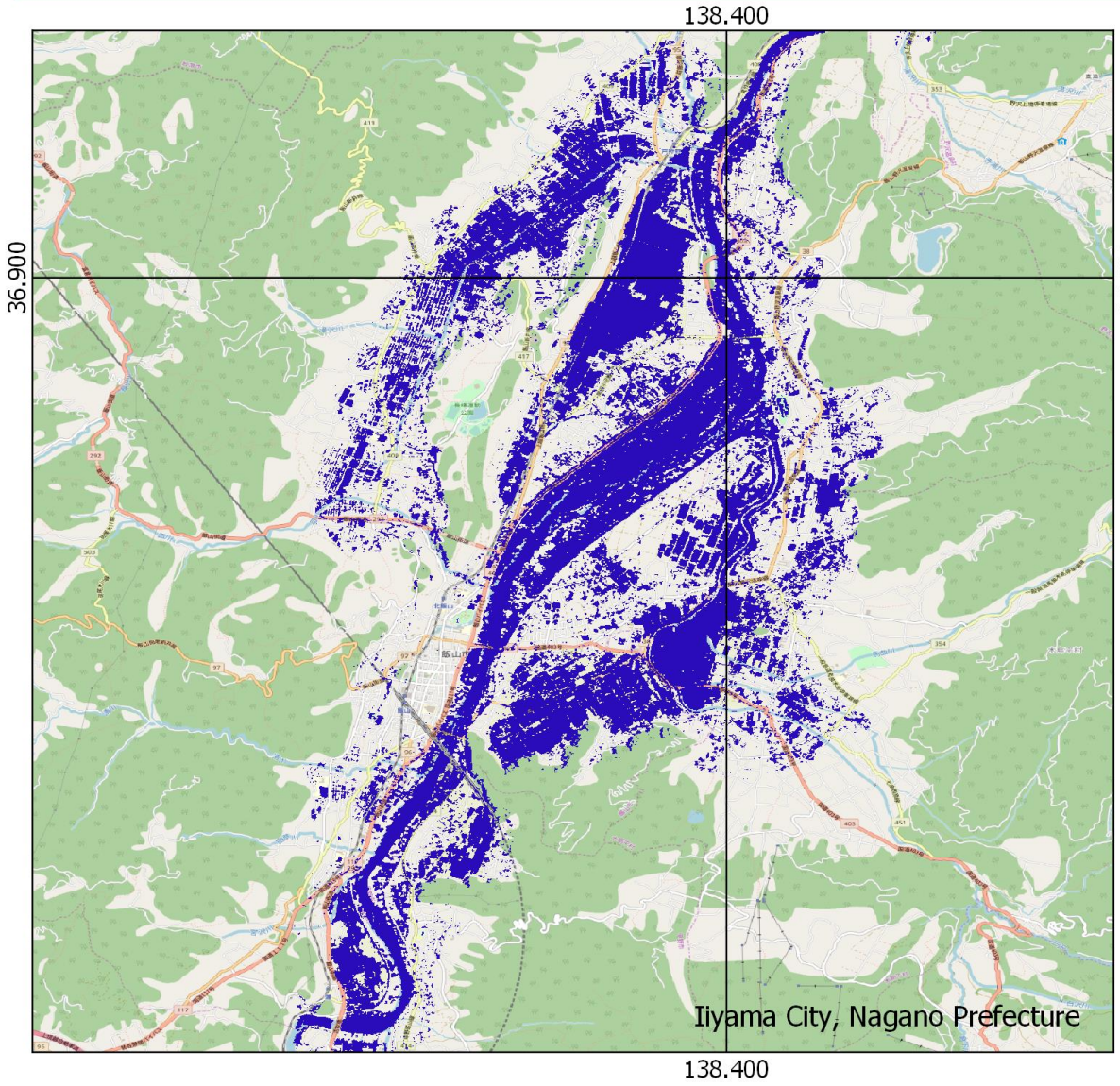
© Masahiko Nagai

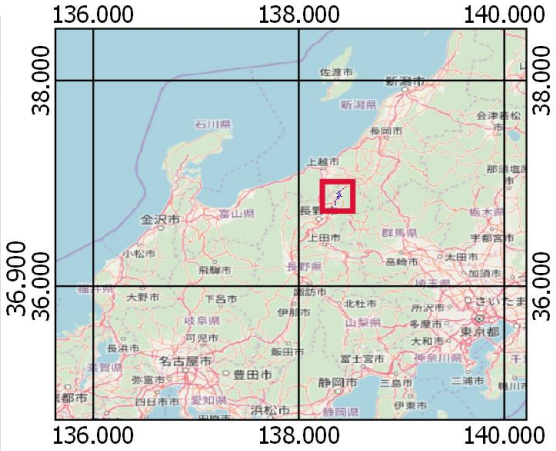






Detected water areas using ALOS-2/PALSAR-2 in Nagano prefecture, Japan





Map information

Possible water and flood areas

Data source

Image: ALOS-2/PALSAR-2
Image date: 2019-10-13
Image copyright © JAXA

0 750 1500 m

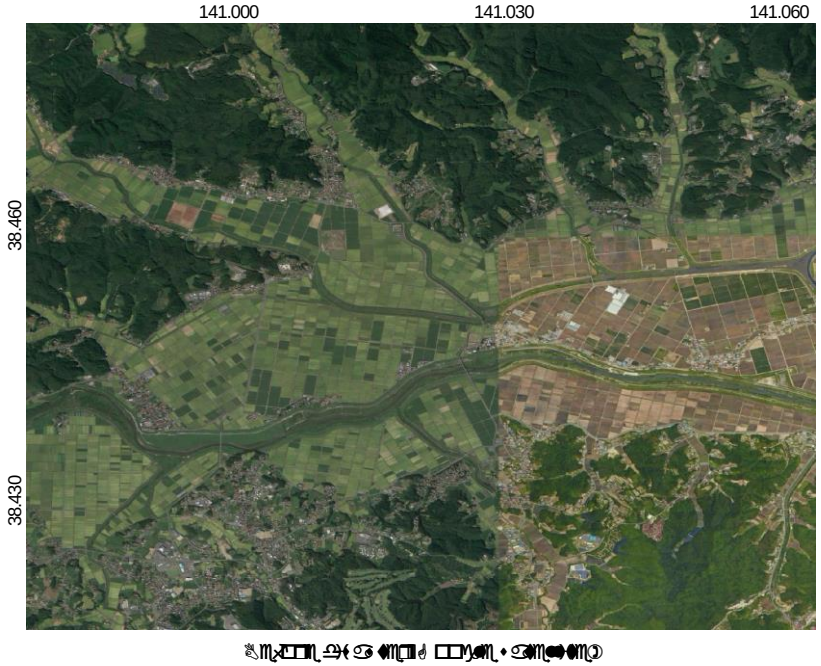
N

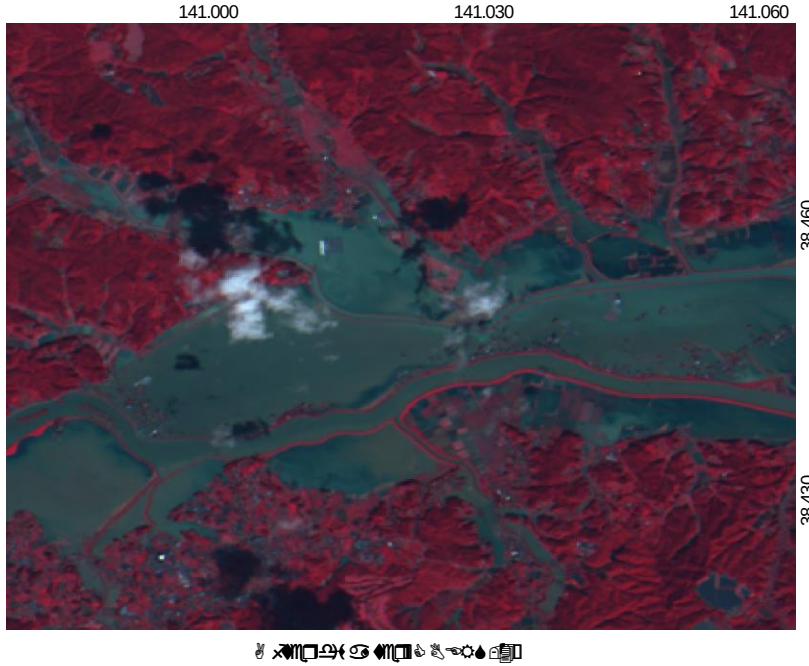
Accuracy is not validated
Map produced by Yamaguchi University

Chikuma River

https://www.sankei.com/region/news/191014/rgn1910140014-n1.html

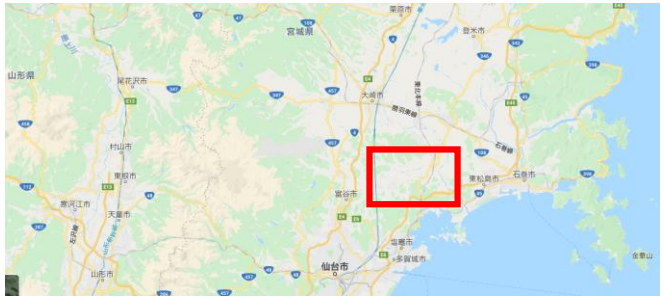
Possible flooded area using CBERS- 4 in Oosato- cho,Miyagi prefecture,Japan





Yoshida River

https://www3.nhk.or.jp/news/html/20191013/k10012128541000.html



Map information

Data source

0 1 2 3 km

Fire Vulnerability by Remote Sensing in Myanmar

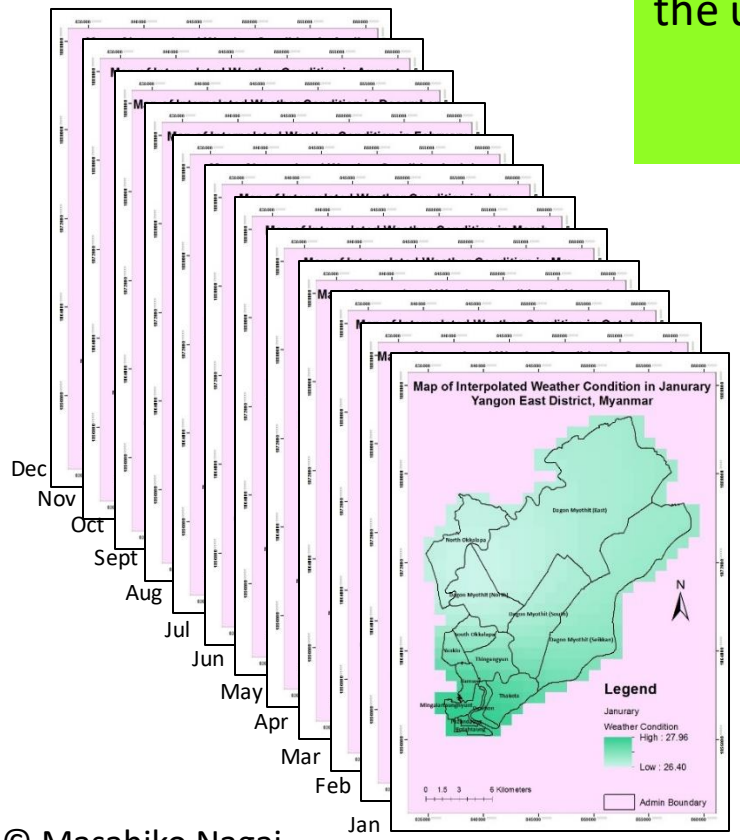
- Fire, the most frequent disaster of Myanmar as on average, approximately 900 cases are reported every year
- 71 % of annual damages and loss
- Amount of damage and loss due to fire is approximately
- 1 billion kyats (about 1,000,000 USD) (Hazard Profile, 2009).

Image Source : Myanmar Fire Service Department

Fire Vulnerability by Remote Sensing in Myanmar

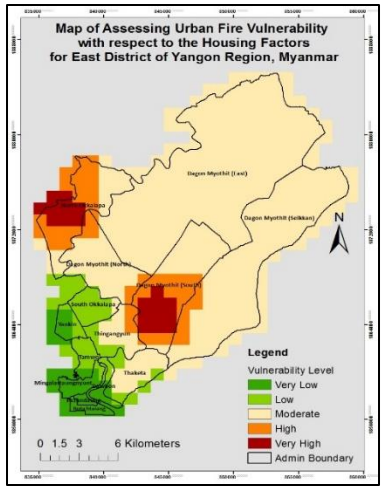
- based on the observation to the past fire incidences, the frequency of the incidences was varied all the time along with the changes of temperature and precipitation
- vulnerable area can be dynamically changed in the study area as of the monthly weather changes occurred
- the monthly and dynamic result maps for urban fire vulnerability can be generated for the study area

Weather

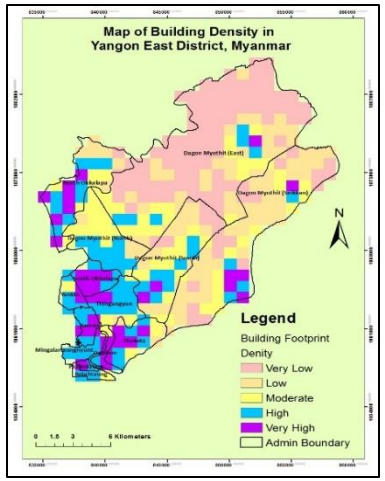


Map of assessing
the urban fire vulnerability = (0.14 x Weather) +
(0.33 x Housing Factors) +
(0.52 x Building Density)

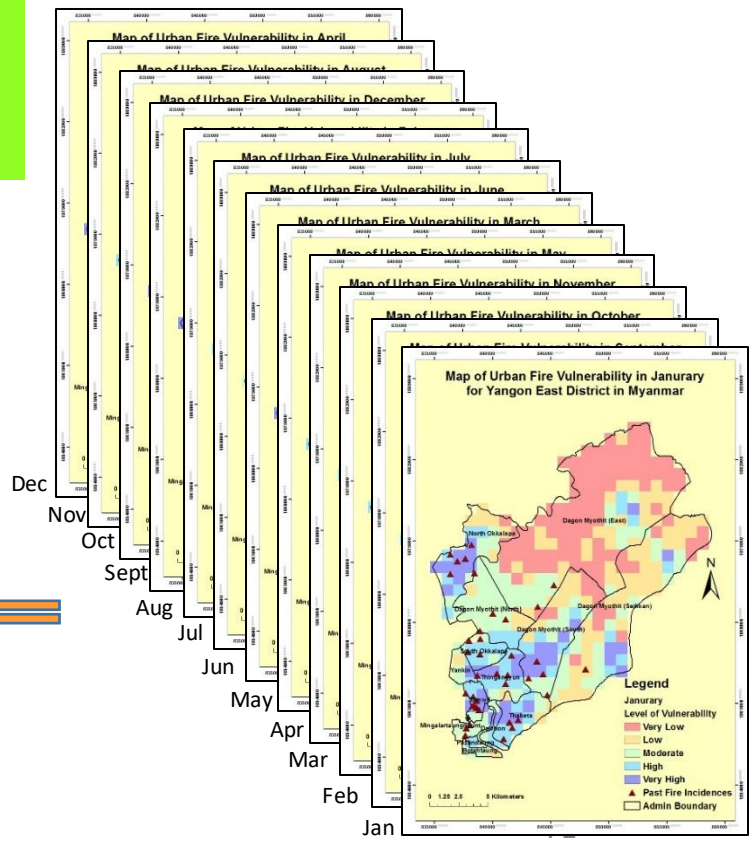
Housing Factors



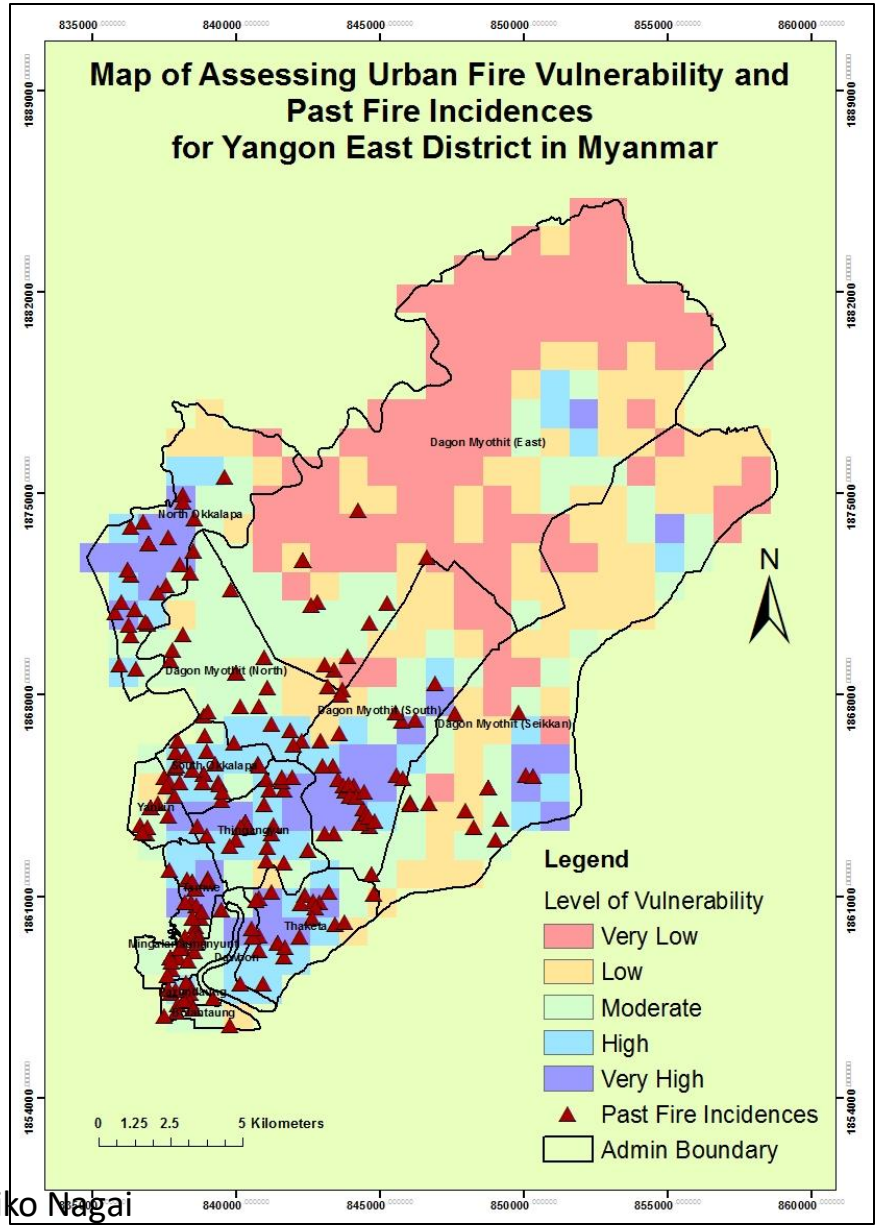
Building Density

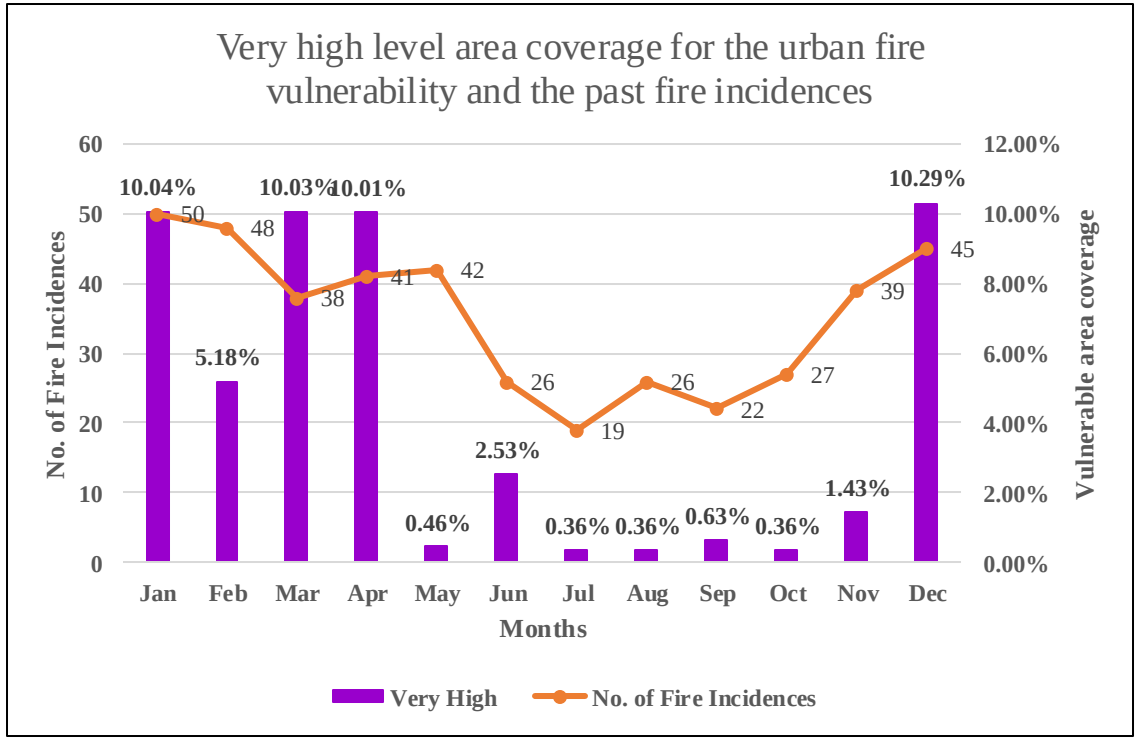


Seasonal Maps of Urban Fire Vulnerability

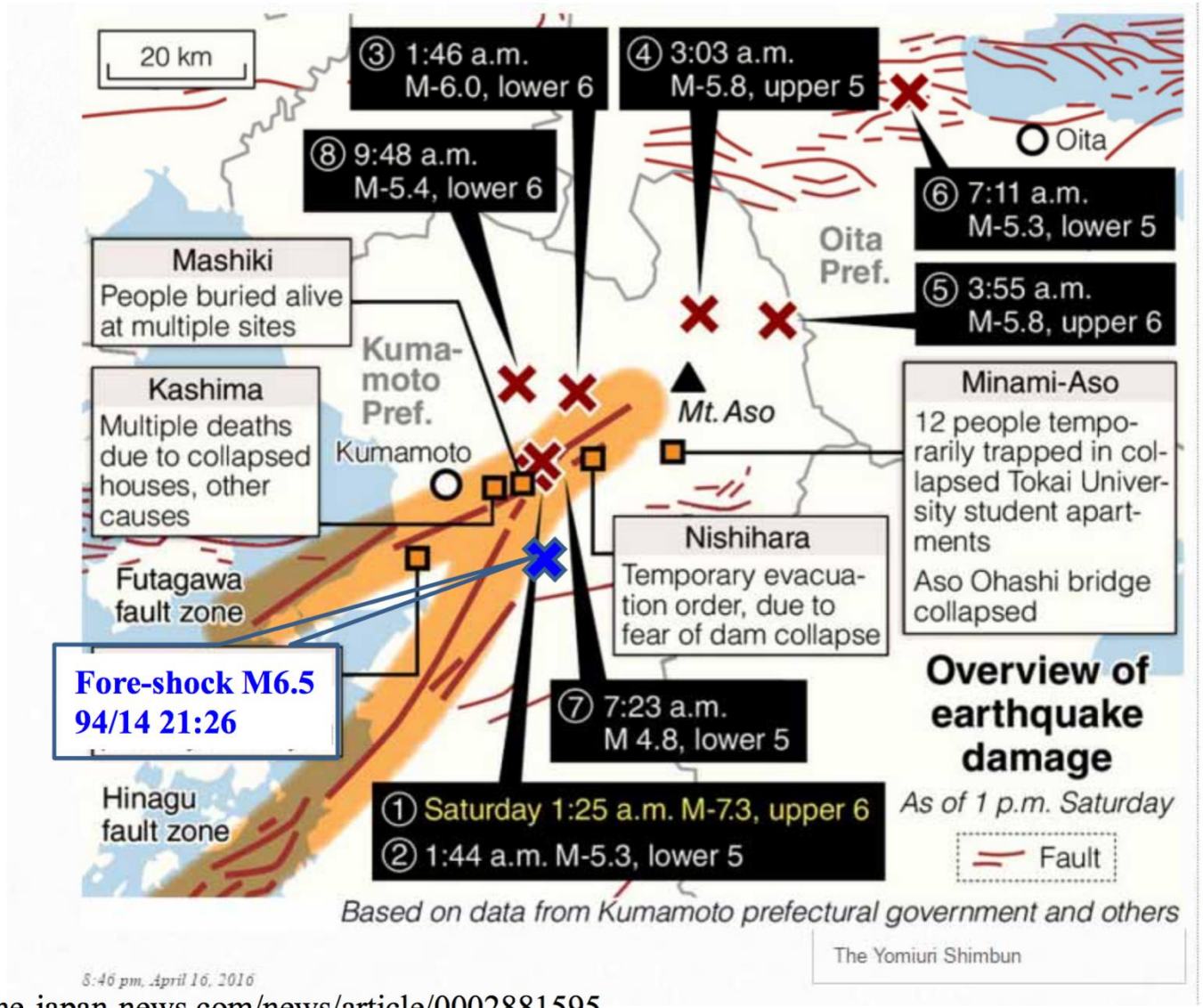


Fire Vulnerability by Remote Sensing in Myanmar





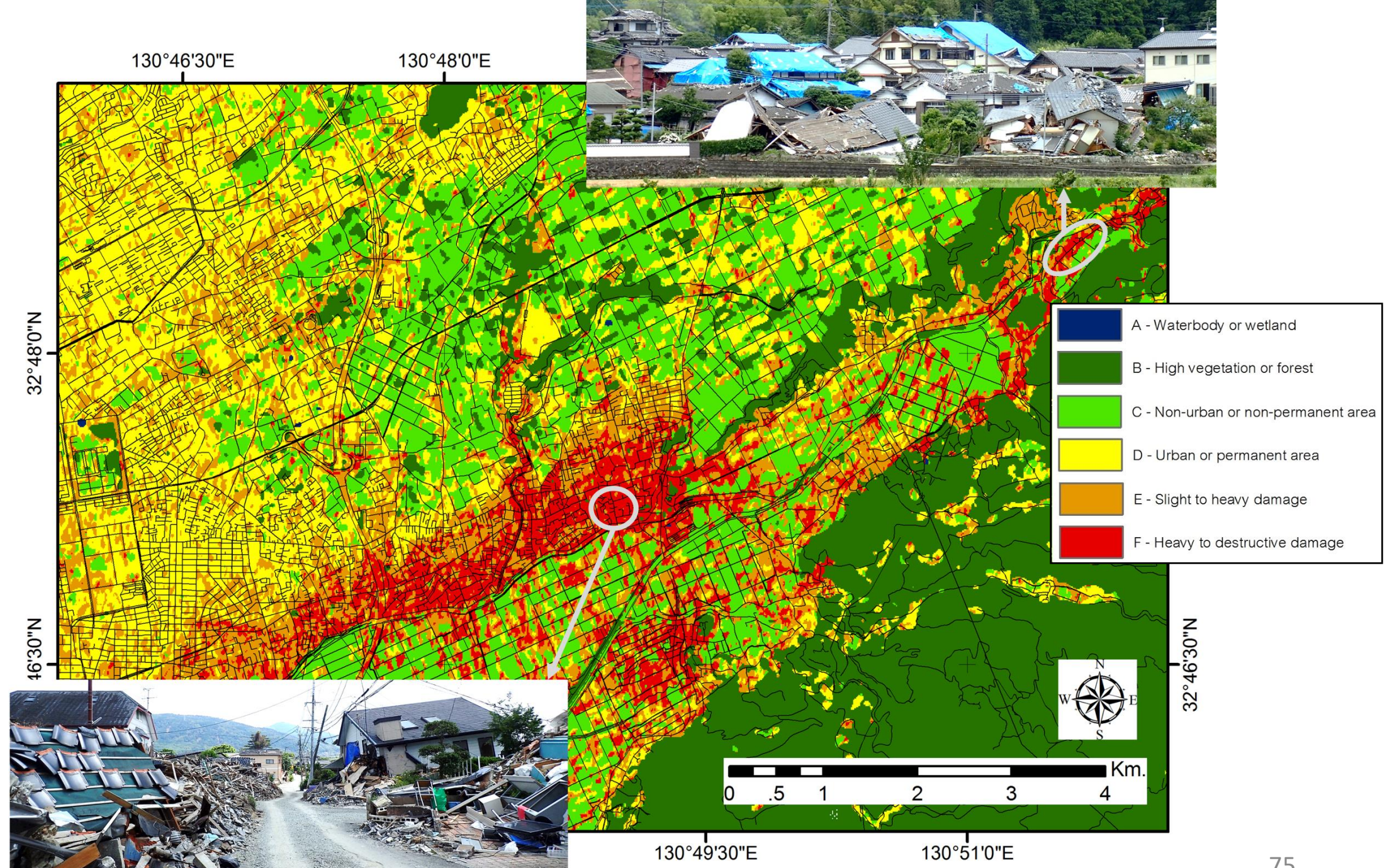
Earthquake in Kumamoto, Japan

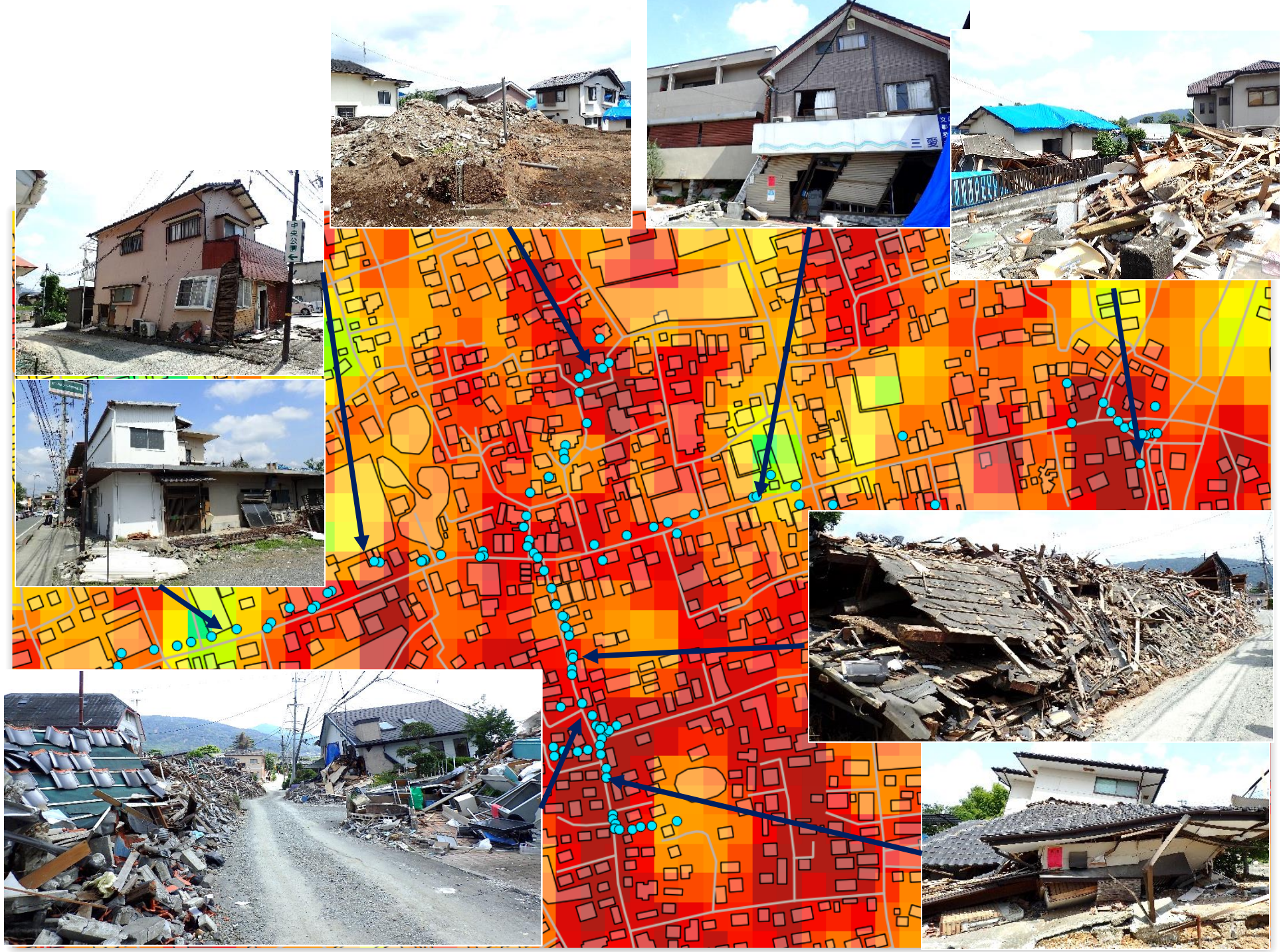


http://the-japan-news.com/news/article/0002881595

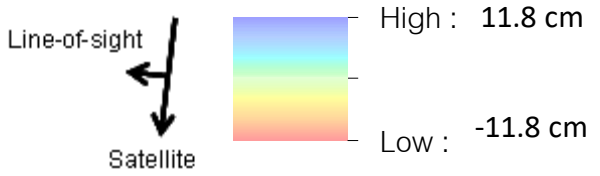
© Masahiko Nagai

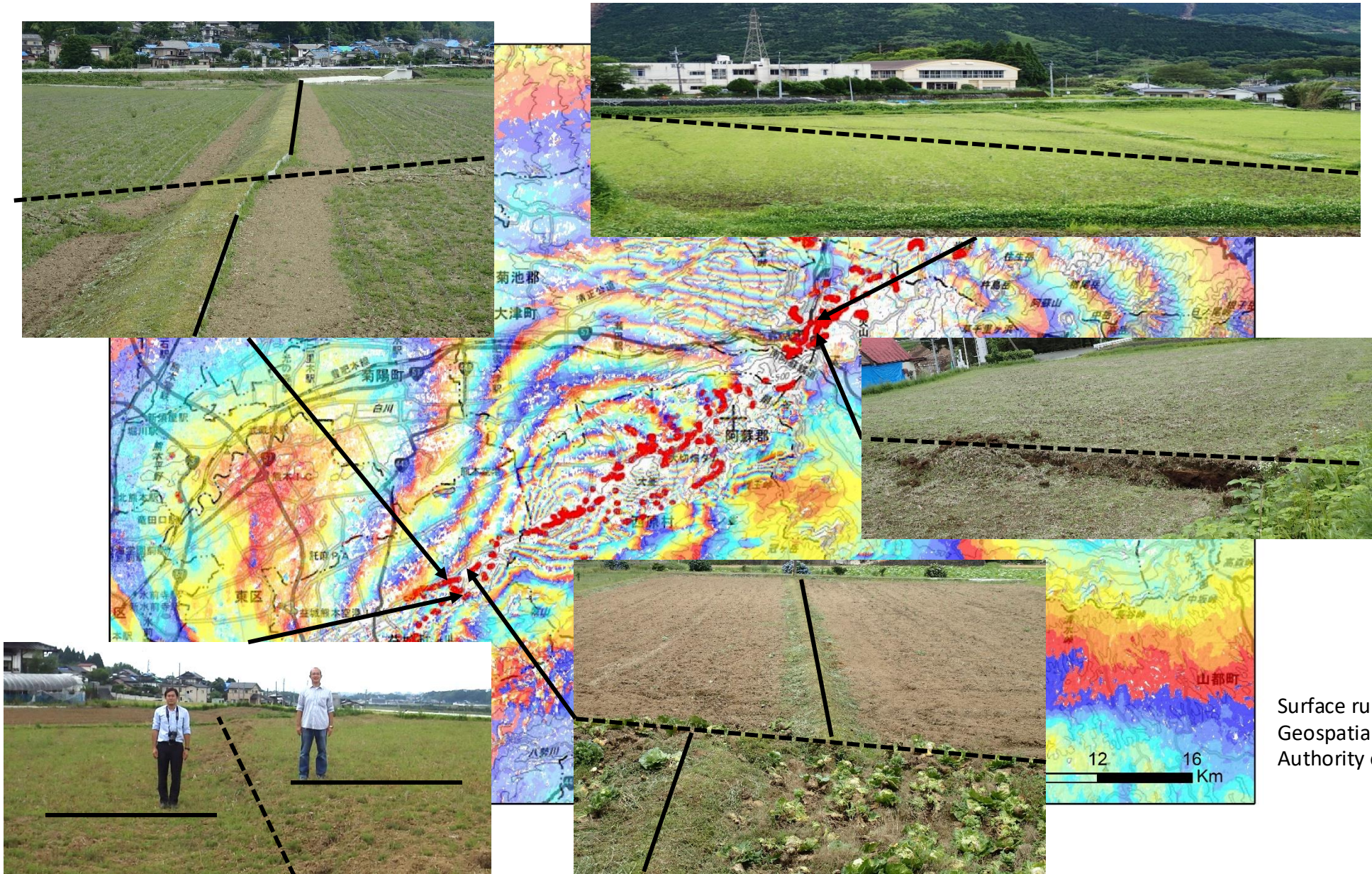

© Masahiko Nagai





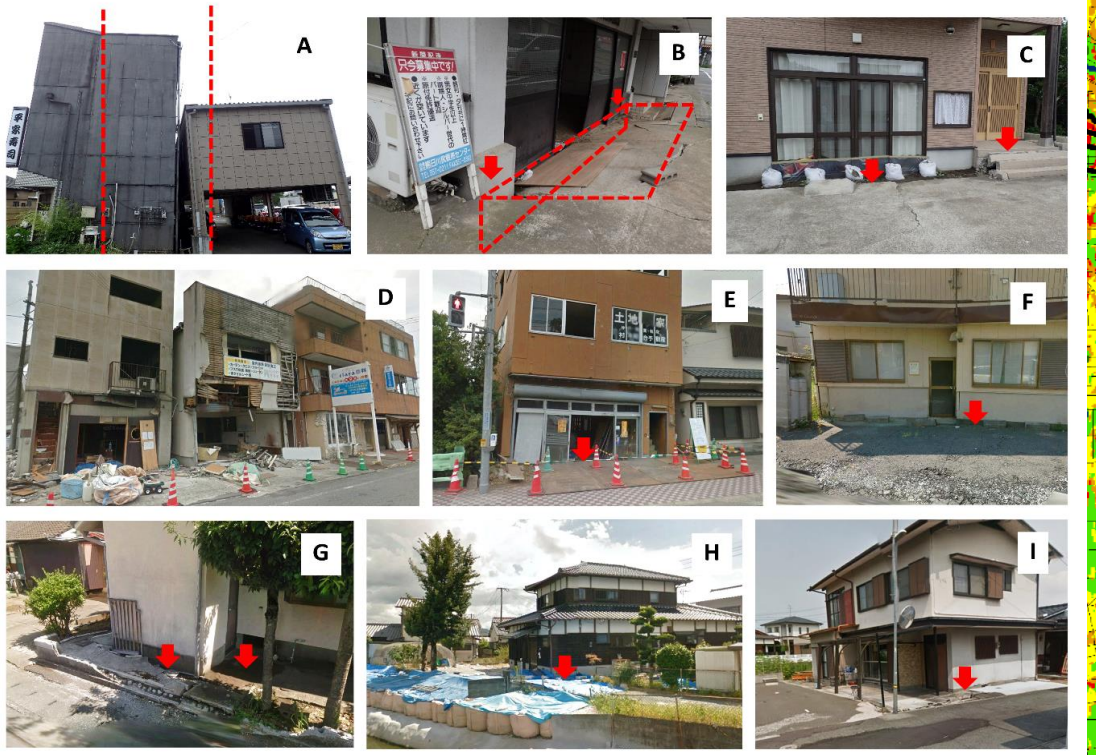
Detection of Surface Ruptures

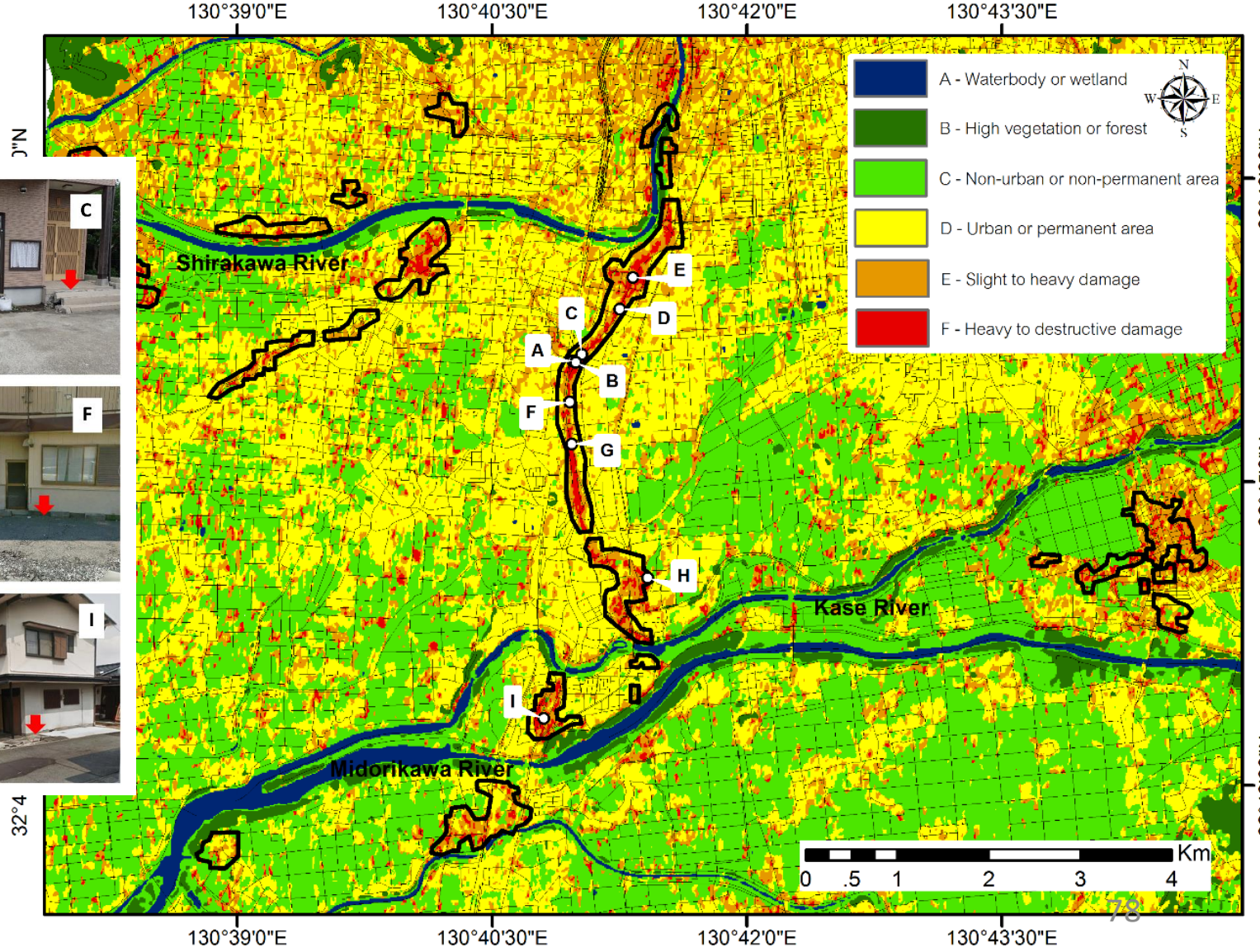




Surface ruptures source:
Geospatial Information Authority of Japan (GSI)

Detection of Liquefactions

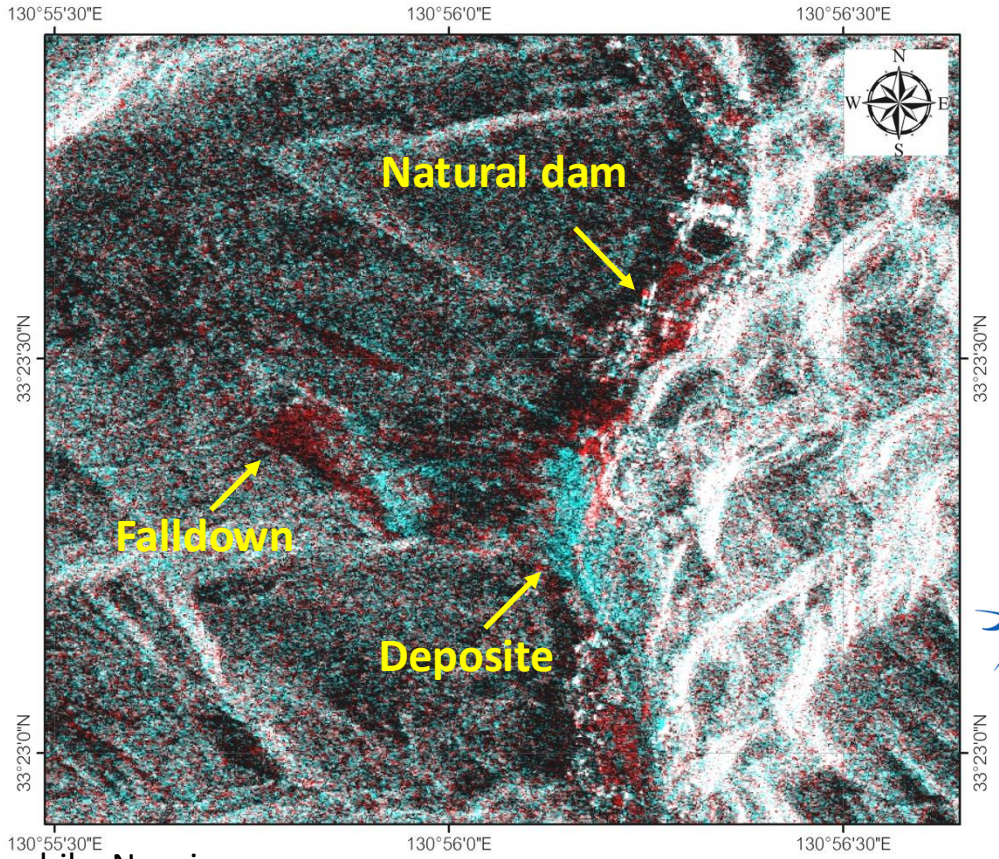




Landslide in Ohita, Japan

Landslide detection

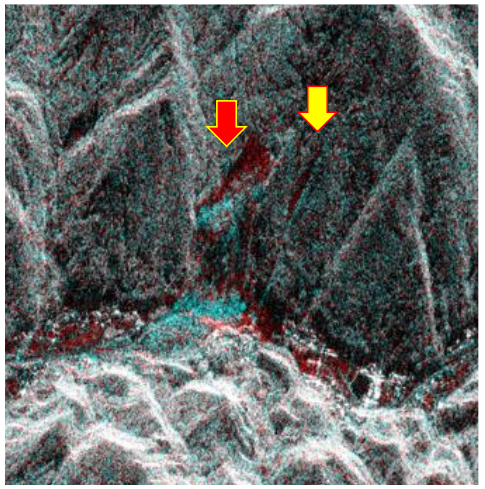
Input: ALOS-2 images, before and after events (level 1.5)
Analysis: color composite

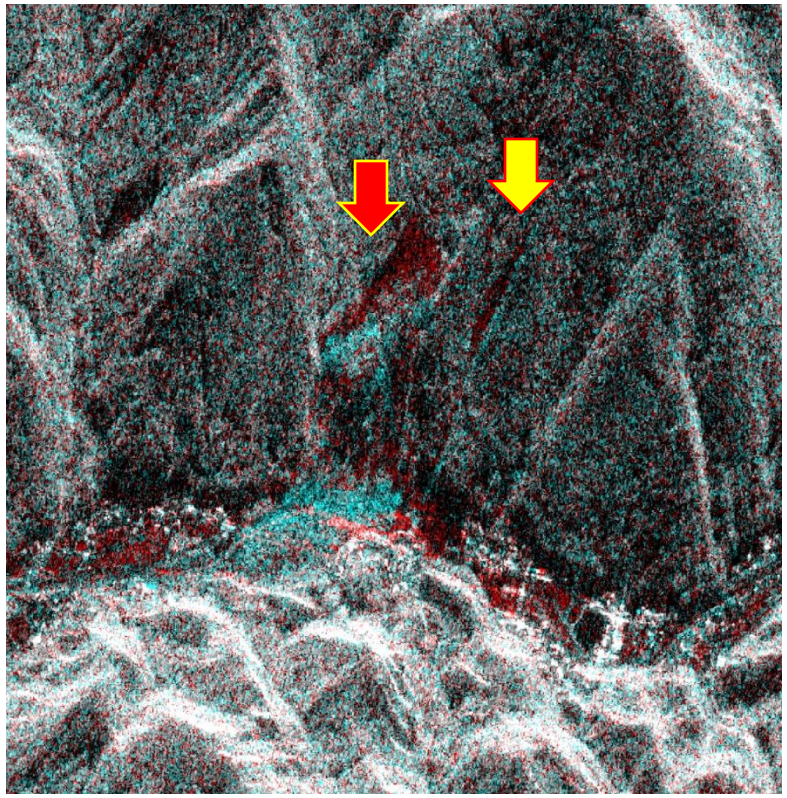


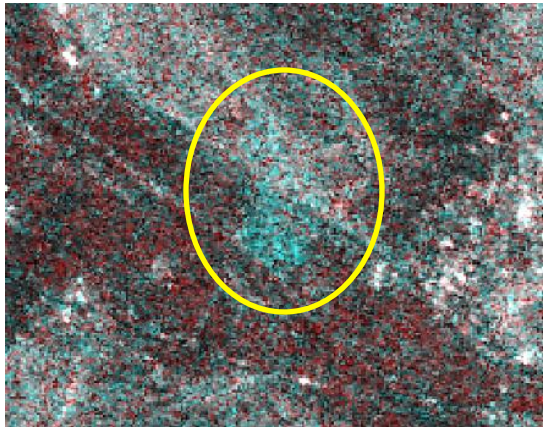
Data:
ALOS-2@JAXA

Before event
2016/04/29

After event
2017/07/07







Heavy Rain (5th to 6th July, 2017) in Kyushu, Activity in Yamaguchi University

University Network for New technology and Capacity Building

7th July 12:53 Observation by ALOS-2

↓ 2 Hours

7th July 14:50 Data Provision from JAXA

Automatic process

↓ 0.5 HOUR Data download in YU

7th July 17:00 Data Download Com
（6.4 GB x 6）

Automatic process

↓ 1.0 HOUR Single look complex (SLC) Level 1.1
→ multi-look image level 1.5
→ Ortho Rectify Level 2.1
→ Data Analysis, Color Composite Image

7th July 20:00 Data Analysis Completed

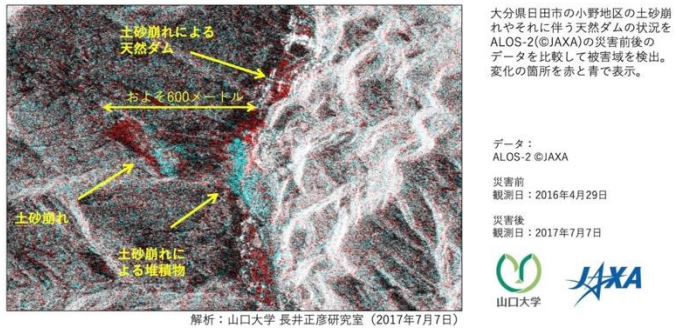
Close collaboration with Local Government

↓ 1.0 HOUR Data Validation,

7th July 23:00 Validation Completed, Provide to Local Government

2.5 HOUR

大分県日田市の小野地区の土砂崩れ



解析：山口大学 長井正彦研究室（2017年7月7日）

Summary

① Enables us to know the condition without visiting the area.

② Enables to observe broad area at a time.

③ Enables us to know invisible information.

④ Enables to observe the area for a long period.