Role of Geospatial Information for Disaster Risk Management

- Disaster Responses of Geospatial Information Authority of Japan as Exemplified in Recent Large Earthquakes in Japan -

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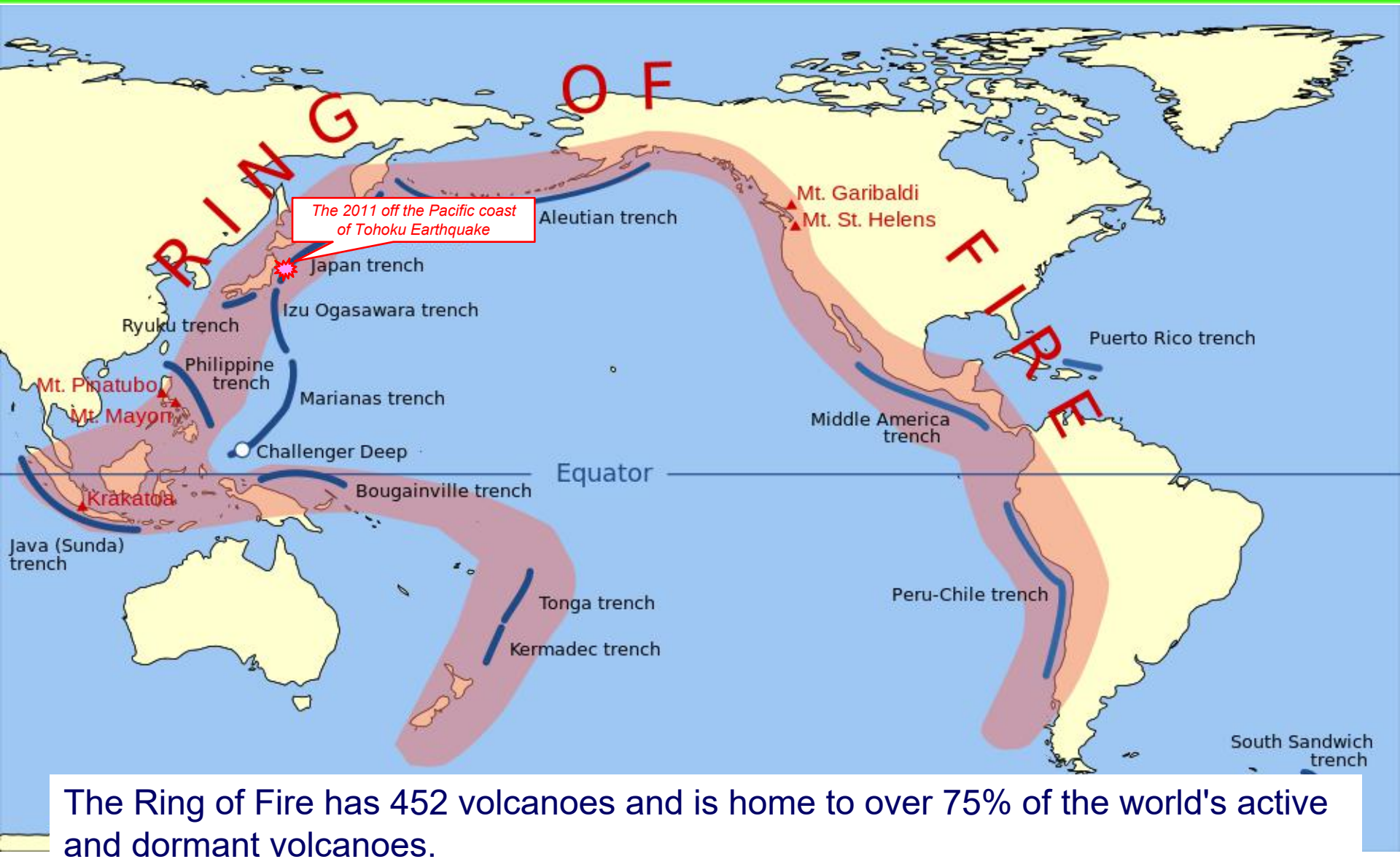
Geospatial Information Authority of Japan (GSI)

Ministry of Land, Infrastructure, Transport and Tourism

Government organization and responsible for surveying and mapping in Japan

Ring of Fire

Geospatial Information Authority of Japan

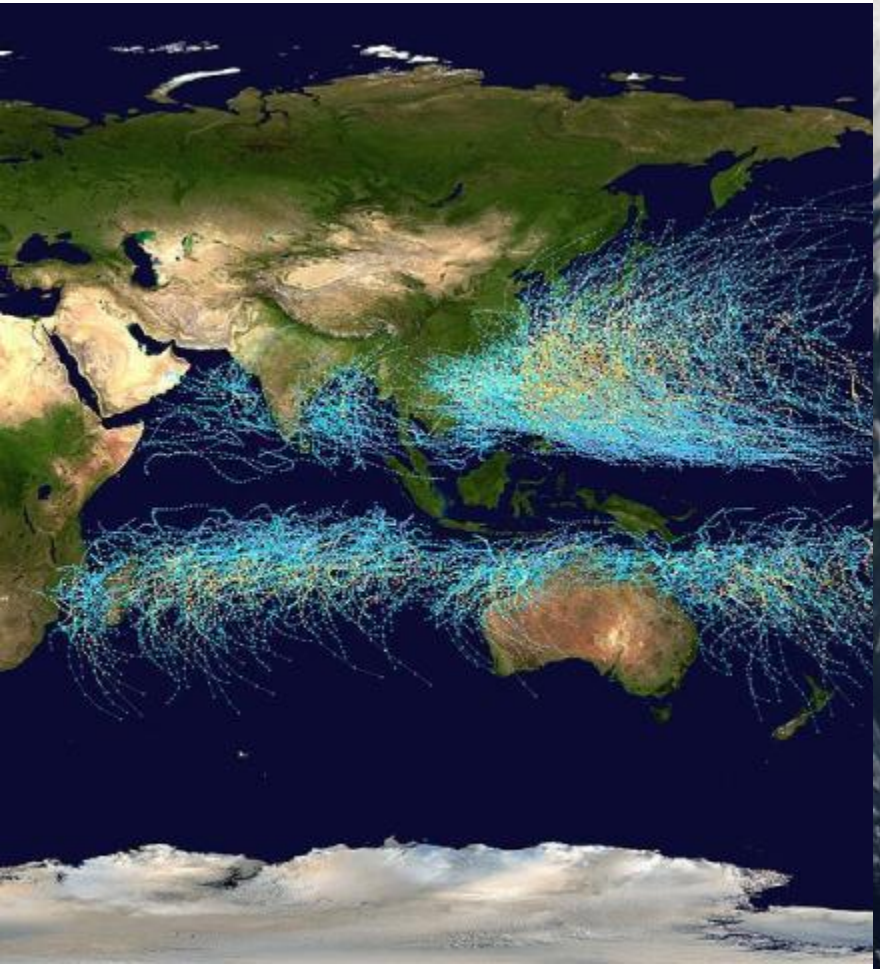


The Ring of Fire has 452 volcanoes and is home to over 75% of the world's active and dormant volcanoes.

About 90% of the world's earthquakes and 81% of the world's largest earthquakes occur along the Ring of Fire.

From Wikipedia

Typhoon paths



Global Tropical Cyclone

Blessings

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Hazards in Japan

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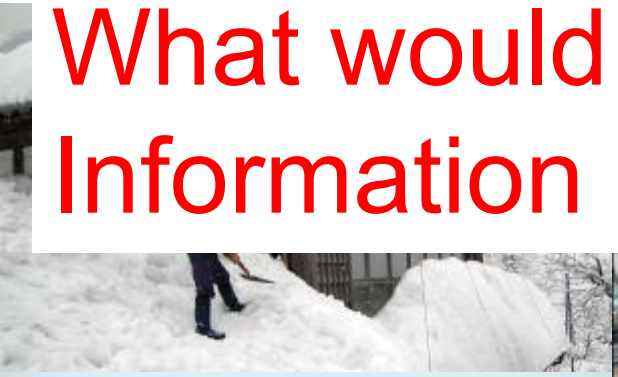
Photo: Cabinet Office web page

Photo: Asahi Shinbun

What would be the role of Geospatial Information in disasters?



GSI's Mandate for Disaster Reduction

- Basic Act for Disaster Countermeasures
  - Enacted more than 50 years ago
  - To protect land and property of the country/people from hazards by making necessary institutional arrangements and other measures including financial provisions
  - 24 designated organizations in the Government including GSI
    - Mandated to gather and share information on disasters,
      while **maximizing the use of geospatial information**.

Amended after 3.11 Earthquake

GSI's Response to the Tohoku Earthquake

平成23年5月18日撮影

国土地理院
Geospatial Information Authority of Japan

Disaster caused by the Great East Japan Earthquake on 11 March 2011

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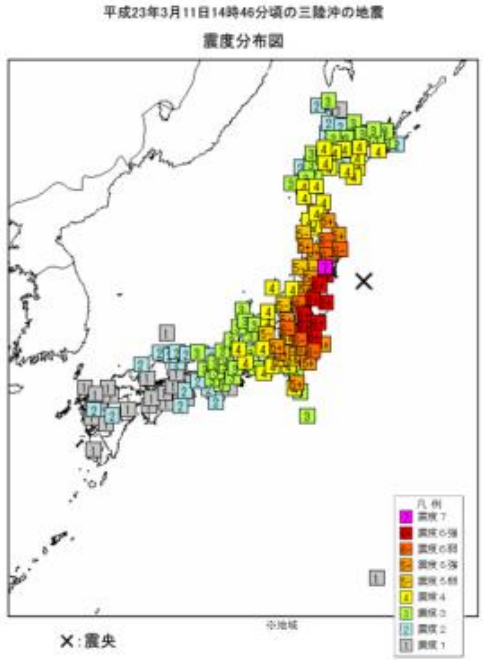
- Earthquake:

  Epicenter: Off coast of Sanriku area

  Depth: 24km Magnitude: 9.0

  Fault: Length 450km, Width 200km



- Tsunami:
  - Highest elevation reached: 43m
  - Inundated areas: 561 square km
  - Nuclear plant accident

The Great East Japan Earthquake

GSI staff in the field

Taken by GSI, March-April 2011

Geospatial Information Authority of Japan(GSI)
Ministry of Land, Infrastructure, Transport and Tourism

What GSI did in response

- Provision of maps of affected areas(paper maps, digital maps, printed images)
- Detection and analysis of ground surface movement with GNSS control point network
- Air survey (Aerial photos, Ortho images)
- Photo interpretation to map inundated areas
- LiDAR survey for detailed elevation data
- SAR interferometric analysis
- Resurvey of geodetic control points
- Reconstruction of destroyed GNSS station
- Recalculation of geodetic coordinate system
- Guidance for local governments' resurvey
- Modeling of fault slip using inversion method

GSI Response Summary

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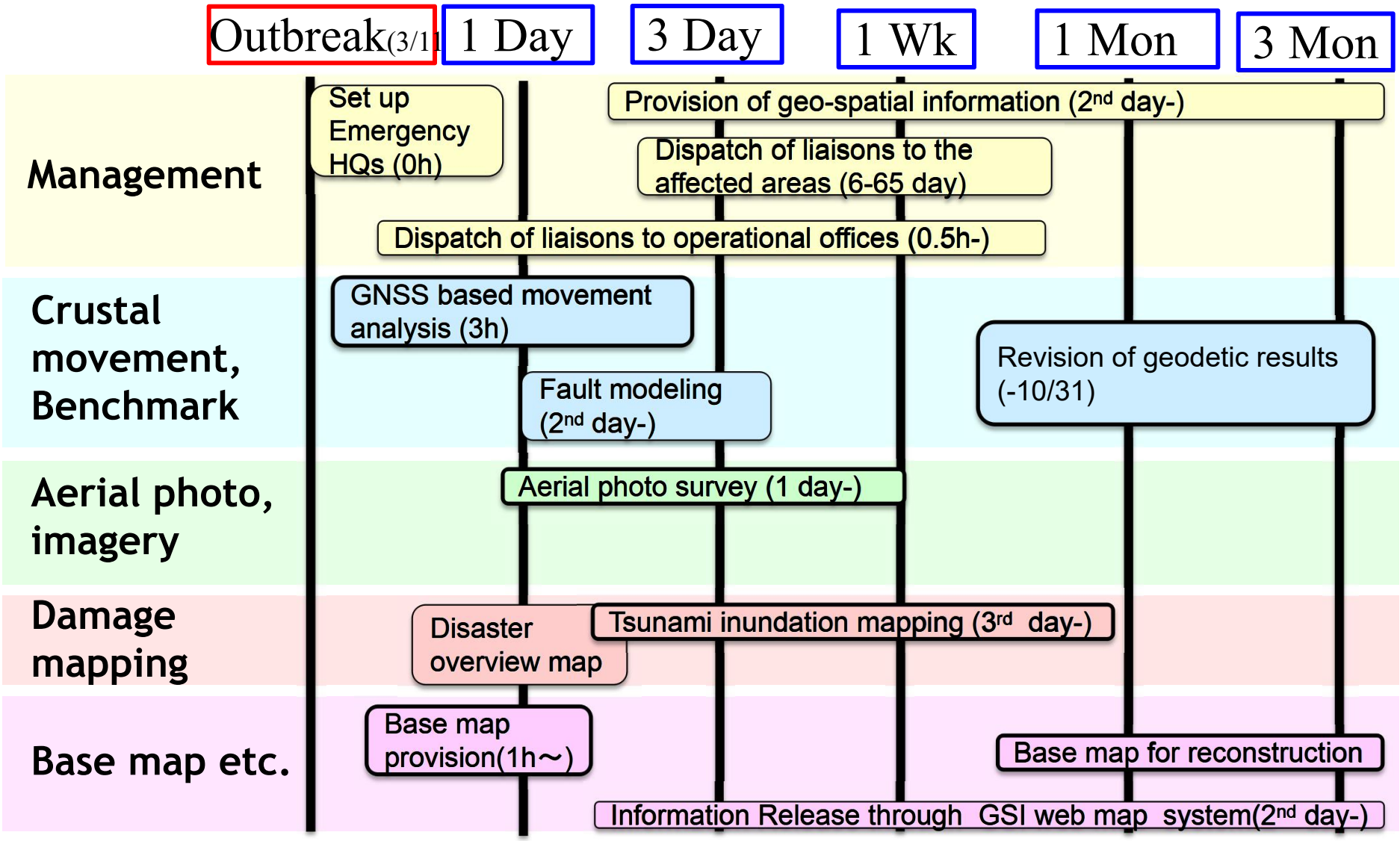

What GSI did
in emergency response phase

- Provision of maps of affected areas
  - Immediately (< 1h) to designated Government offices starting from small-scale maps (1:500k).
- Detection and analysis of ground surface movement with GNSS control point network
- Air survey (Aerial photos + Ortho images)
  - Photo interpretation and measurement of damaged areas.
- …

Provision of Maps (< 1 hour)

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Ground Surface Movement (+ 3 hours -)

Monitoring Crustal Deformation using GNSS-based control stations

- GNSS-continuous Obs.
- Real-time Obs.
- 1300 stations
- Stainless-steel pillar
  (height = 5m)

Ground Surface Movement (+ 3 hours -)

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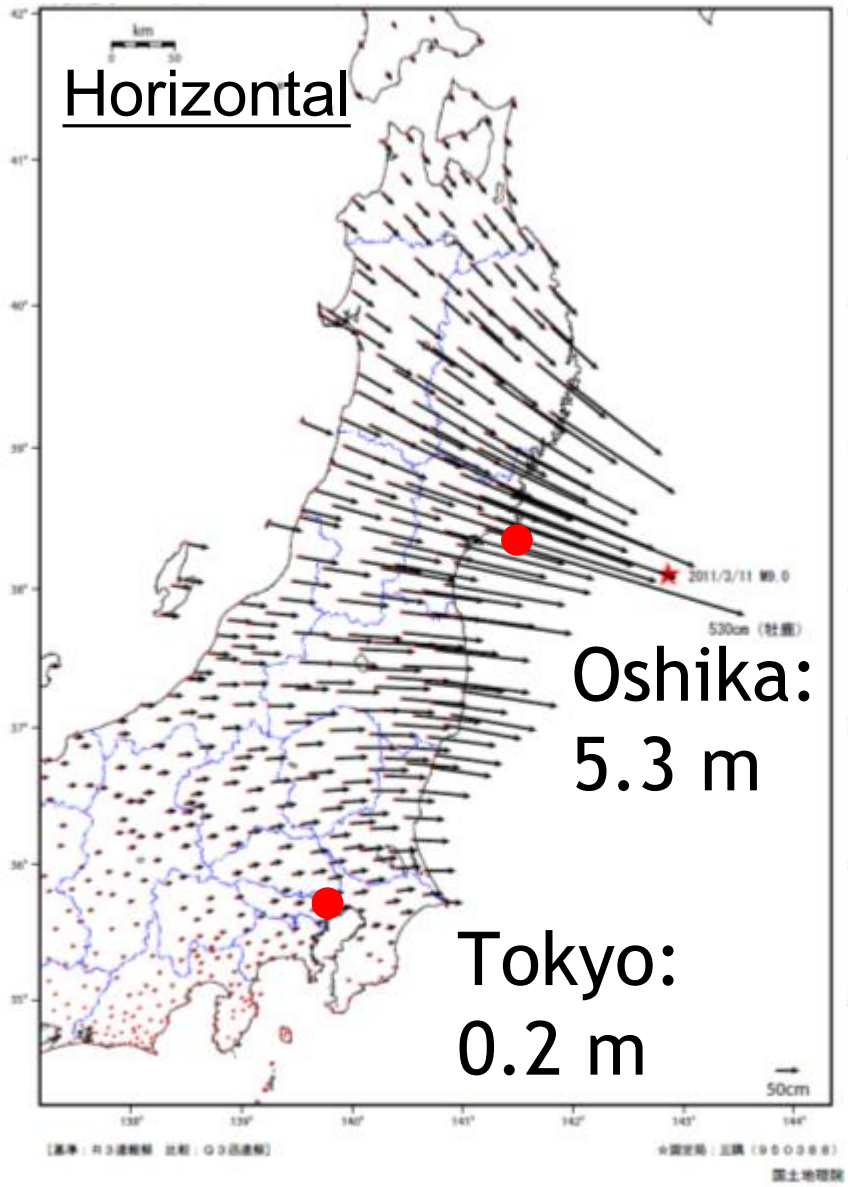
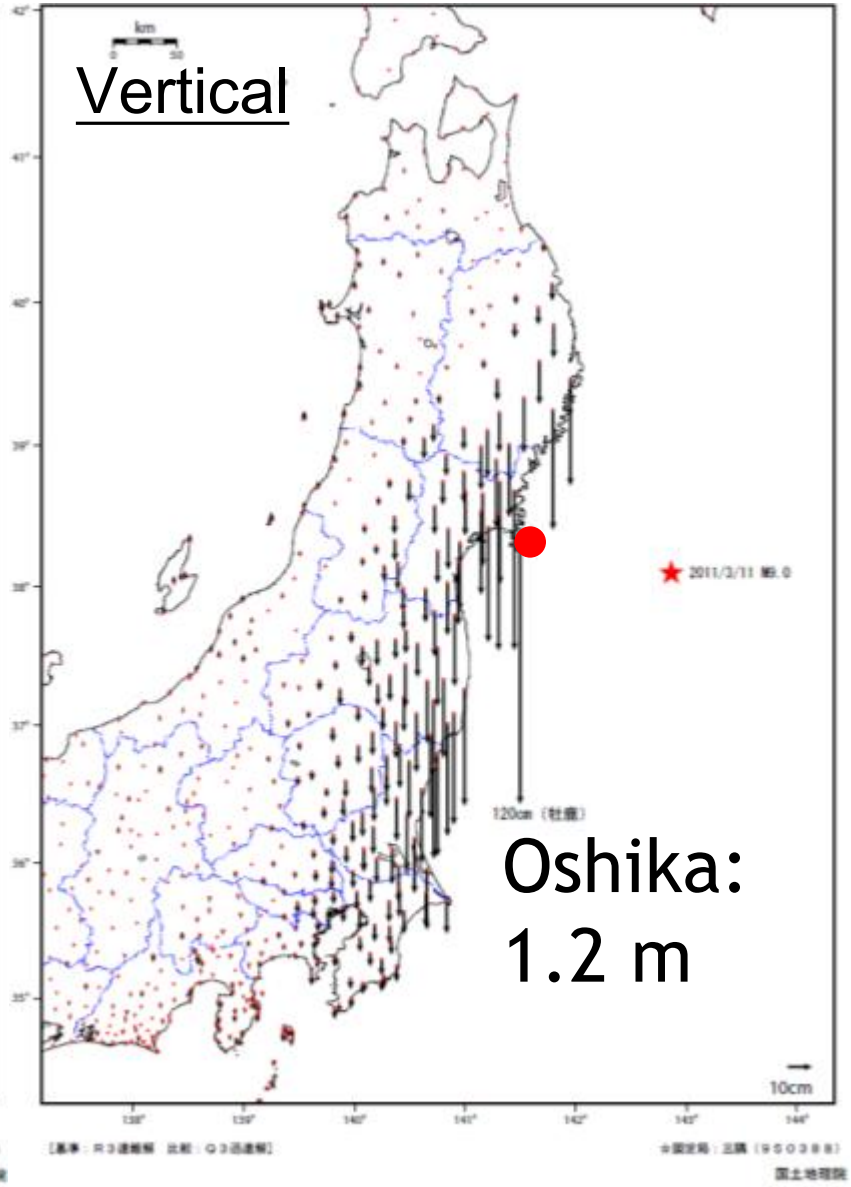
GNSS based control stations observed large crustal movement





Ground Surface Movement (+ 3 hours -)

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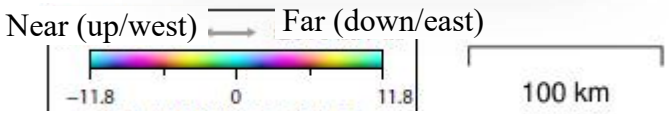
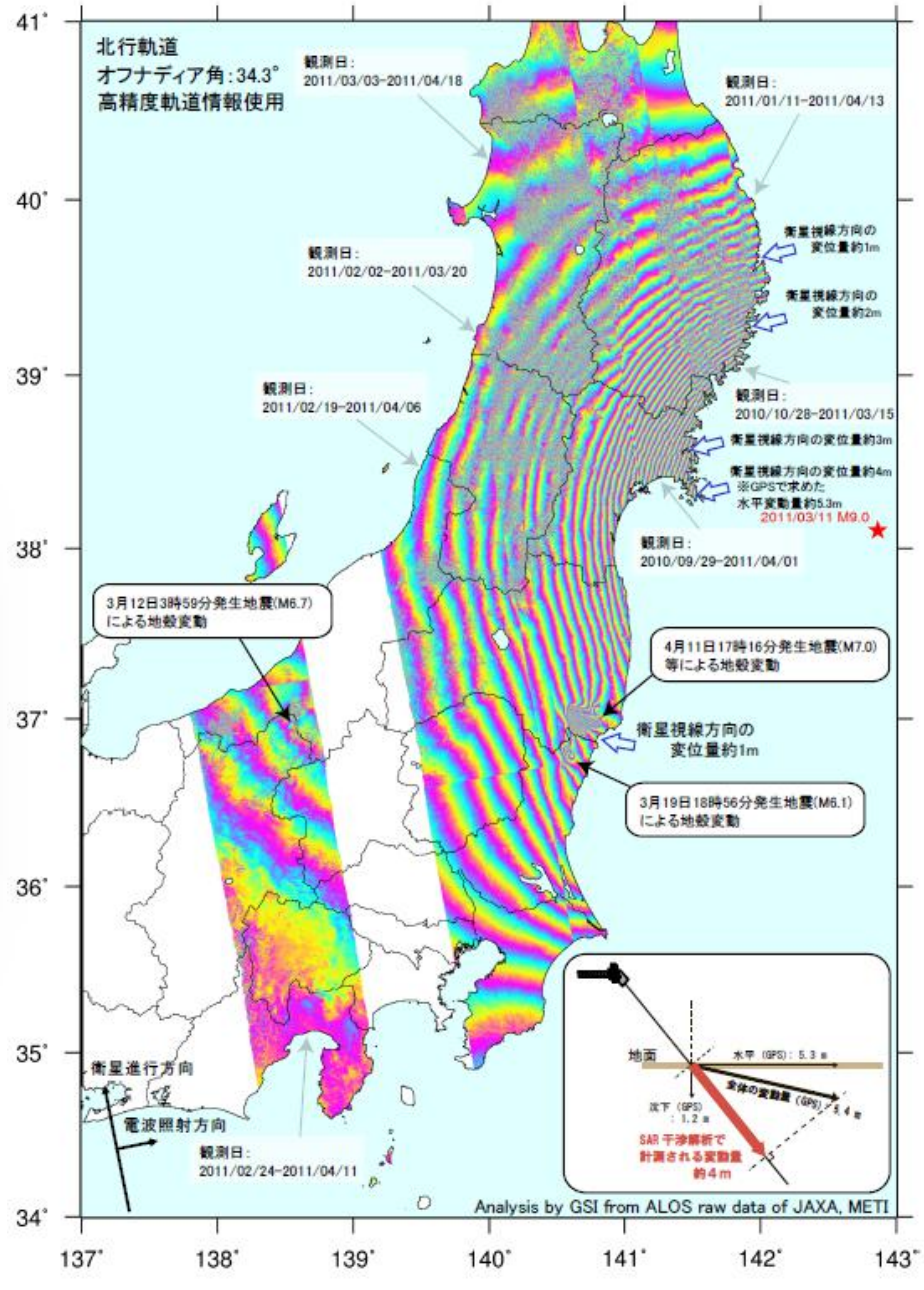
Detailed Surface Deformation from the Space:
Using Japanese SAR Satellite "ALOS"



Line of sight change (satellite – land surface) [cm]



Aerial Photograph (+1 day -)

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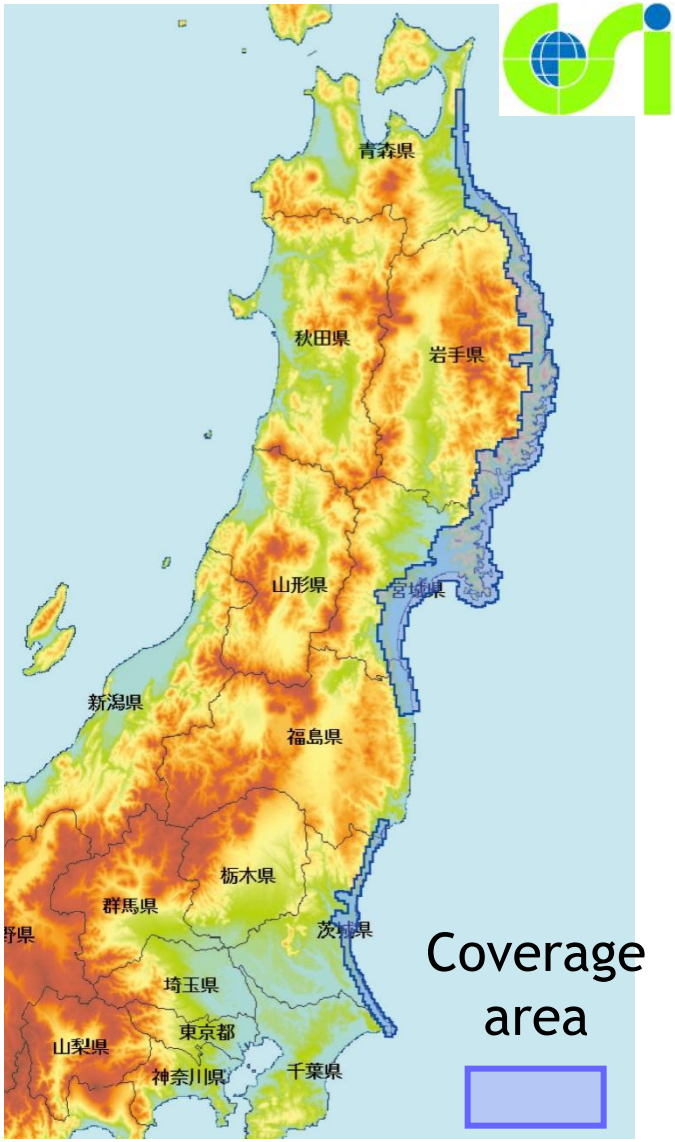
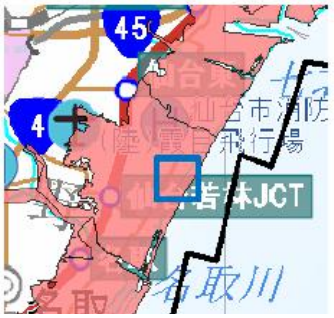
- Aerial photos were taken along Pacific Coast from 12 March to 5 April
  excluding areas around Fukushima No.1 nuclear power plant

- Collabortive works with private survey companies based on emergency aerial survey scheme



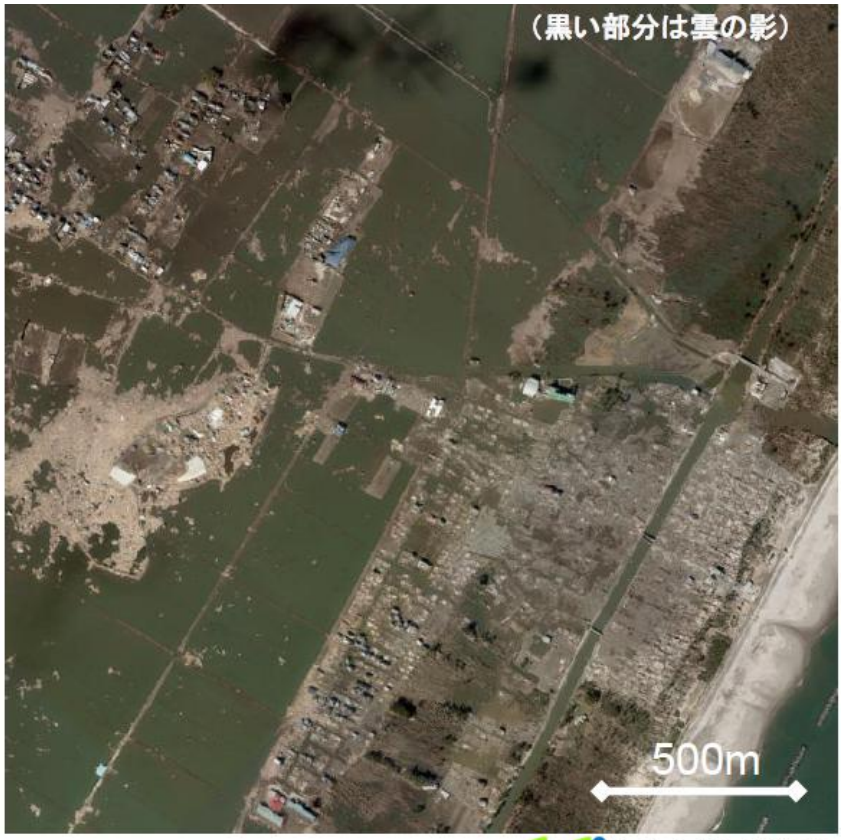
Photographed Area : about 6,900km^2

Damage Evaluation by Comparison with Archived Aerial Photo Taken before the Disaster



Before earthquake disaster, Oct. 2006

After earthquake disaster, 12 Mar. 2011



Air photos (+ one day -)

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Photo Interpretation (+ 3 days -)

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Inundation Areas

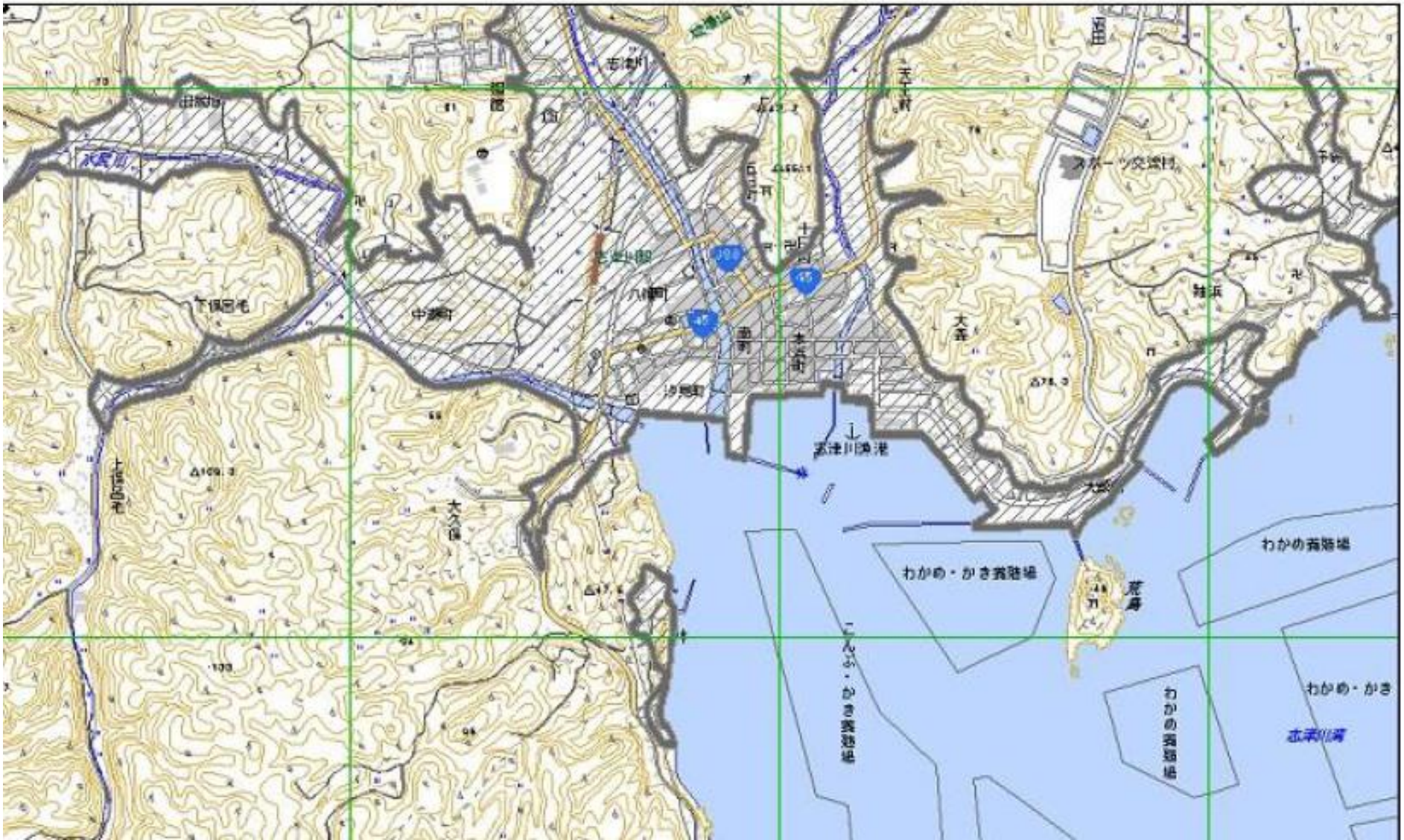
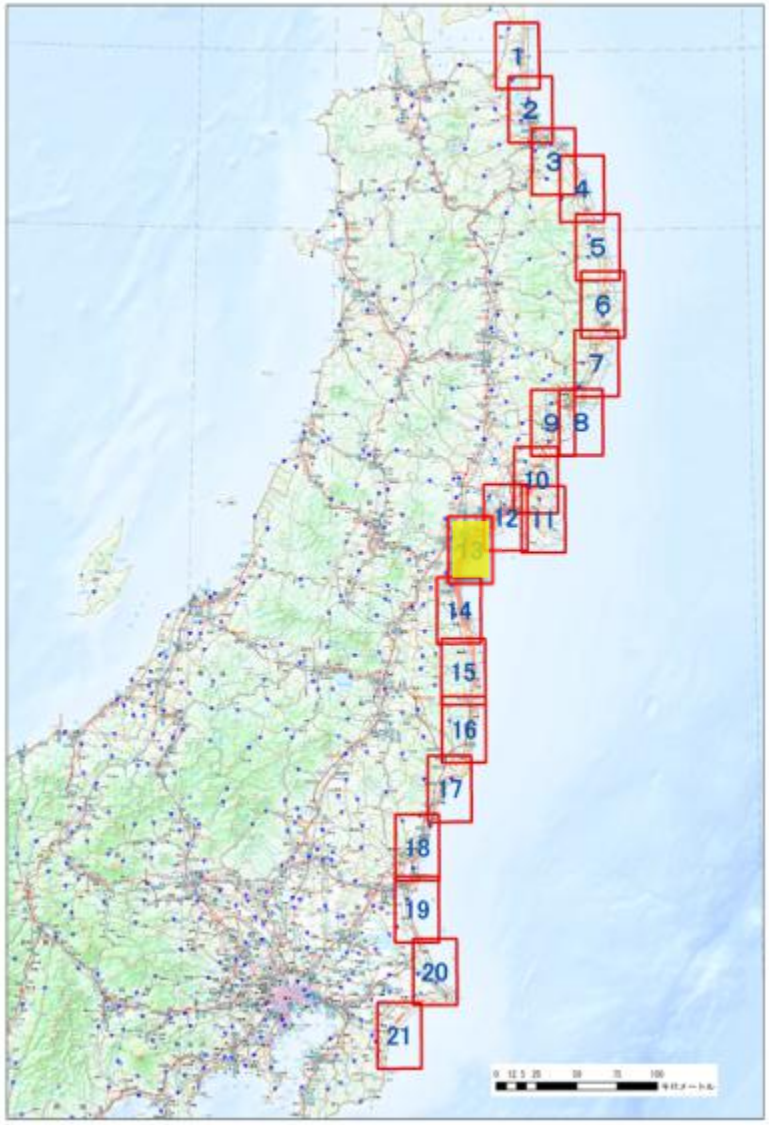


Photo Interpretation (+ 3 days -)

Geospatial Information Authority of Japan



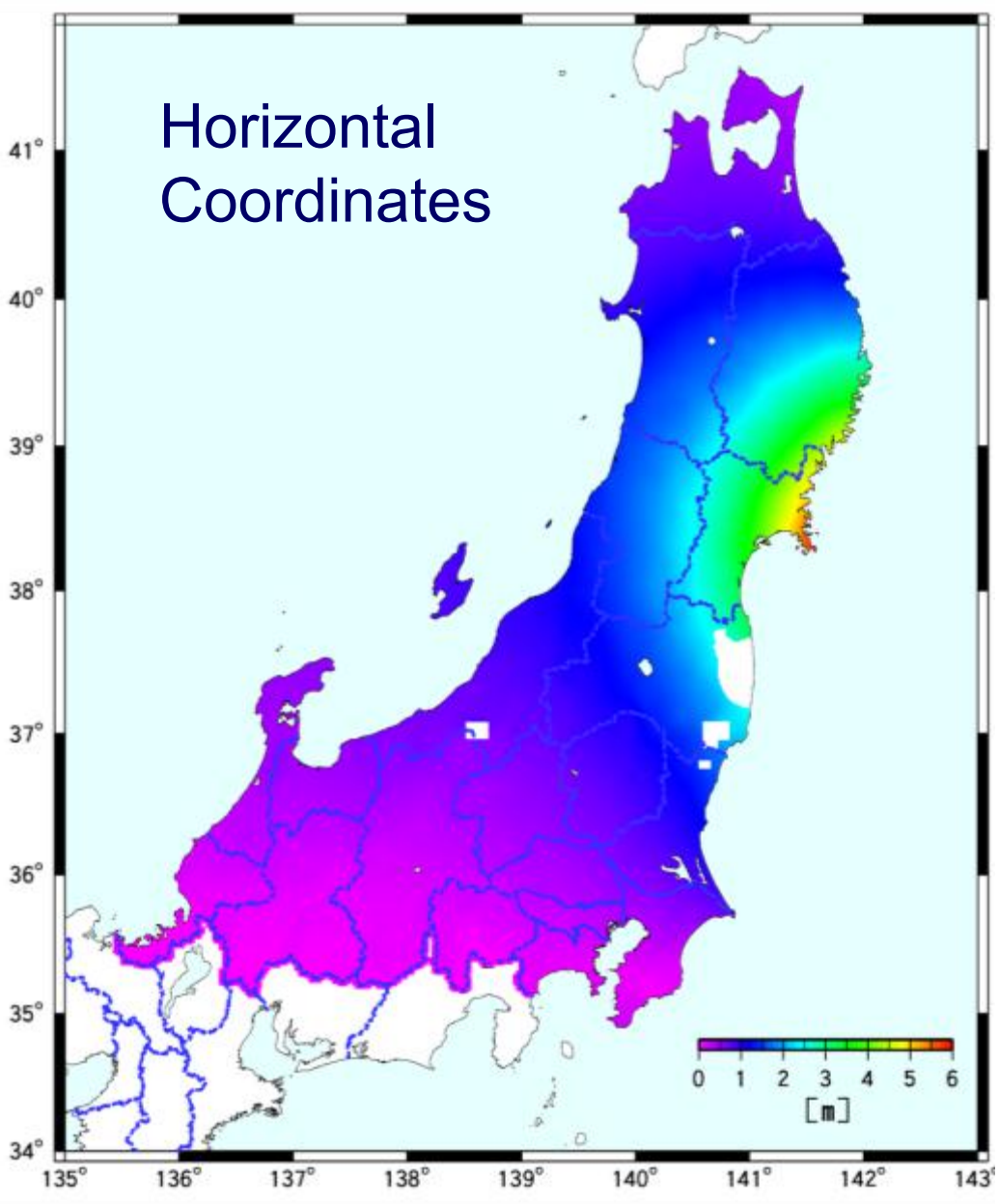
Total inundation areas: 561 square km

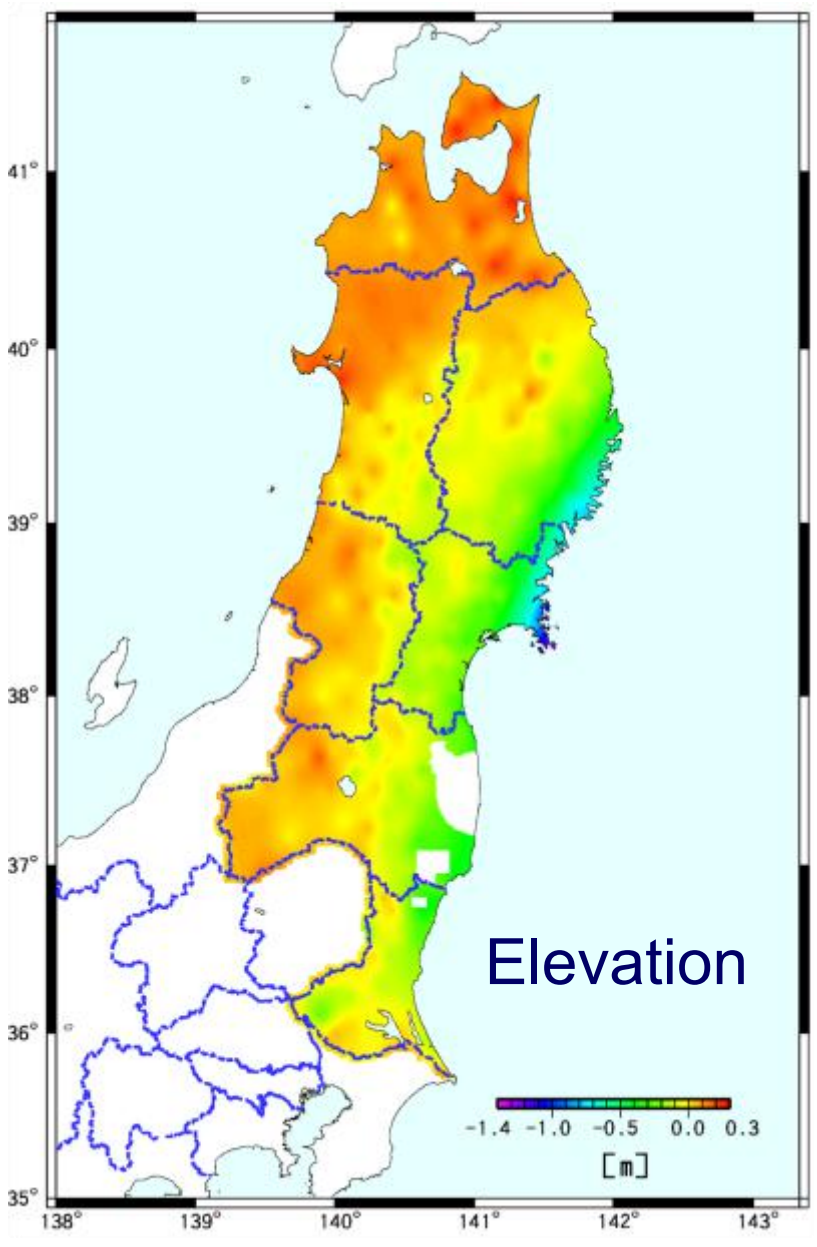
Recovery Phase (+ 1-2 months -)

- Resurvey for new coordinates of geodetic control points
  - Resurvey of selected control points
  - Calculation of transformation parameters
  - Revision of coordinates of control point network origins (horizontal & vertical)

- New mapping of damaged areas
  - 1:2,500 scale mapping for reconstruction planning

Correction parameters for triangulation points





Recovery Planning Map

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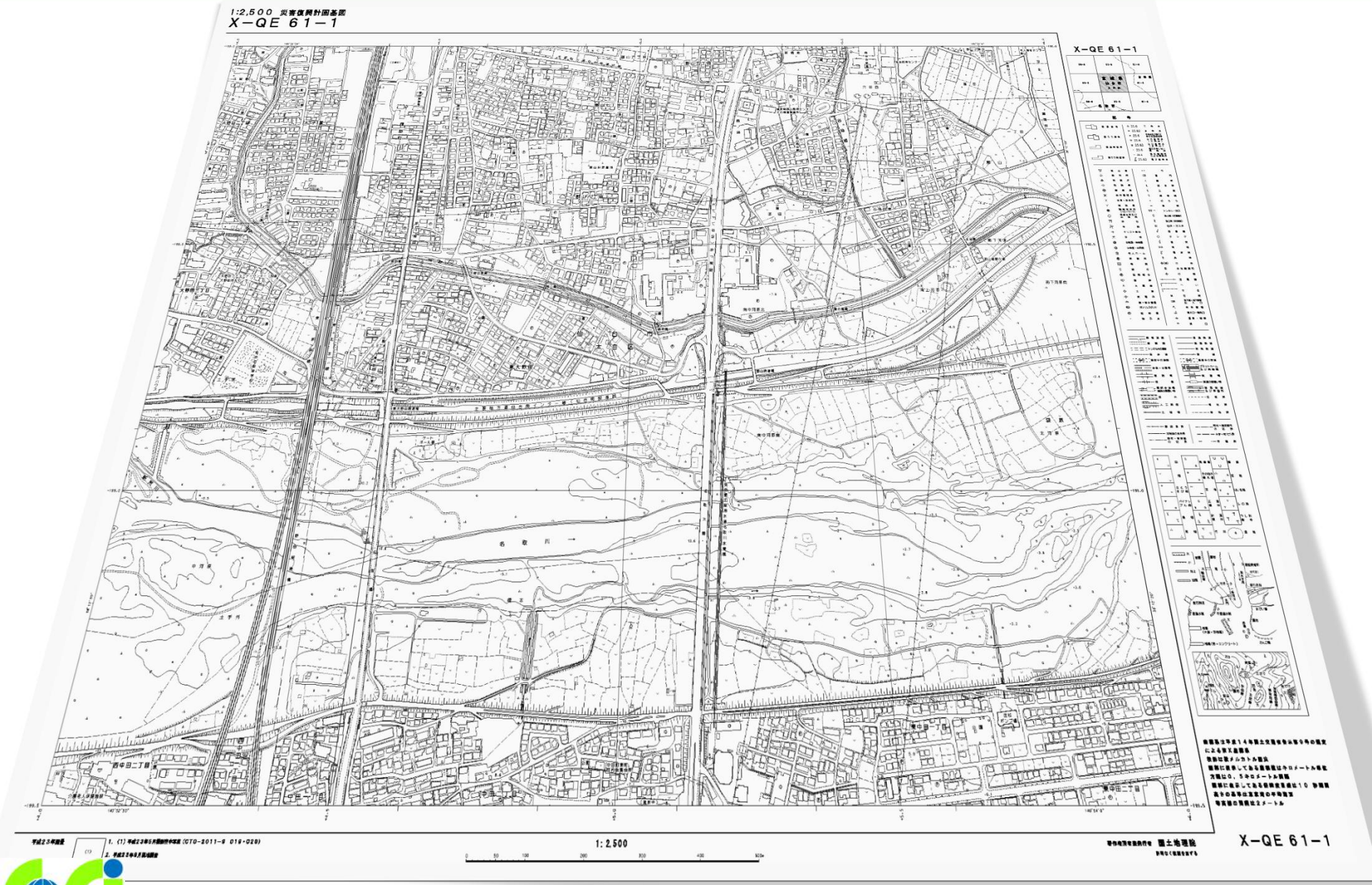
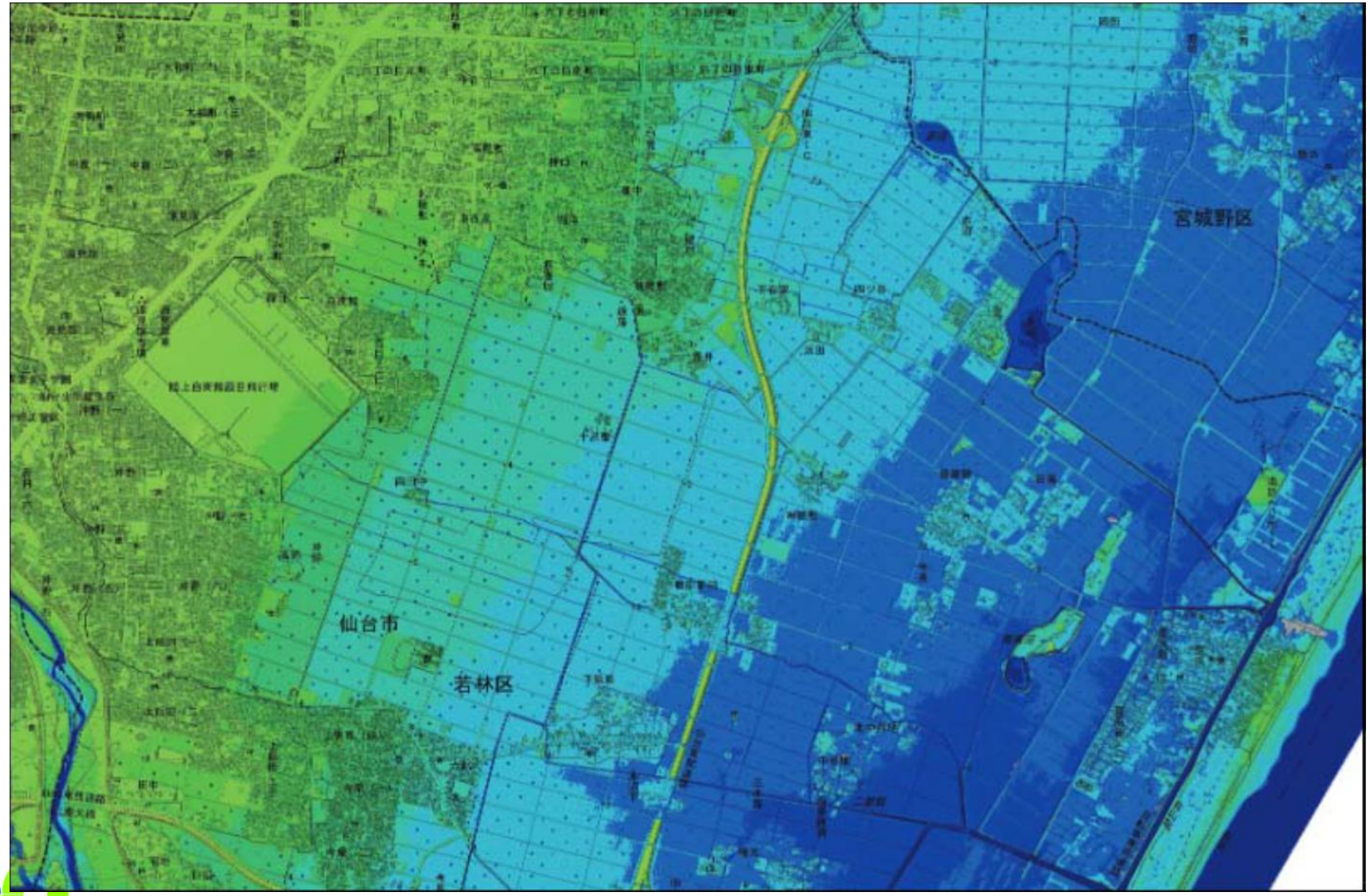


Detailed Elevation Data



GSI's Response to Kumamoto Earthquakes in 2016

Kumamoto Earthquakes

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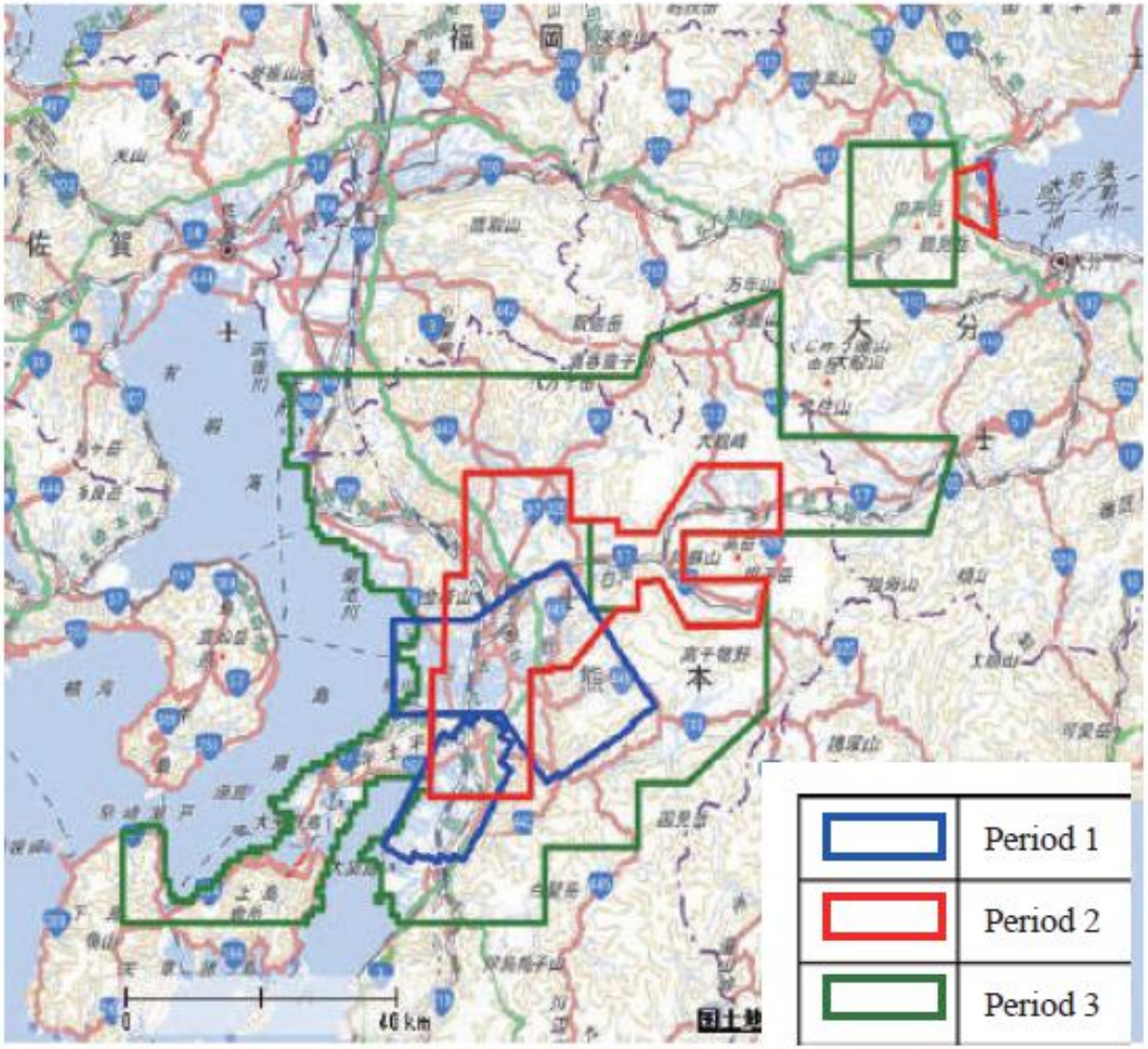
Aerial Photography



Aerial Photography

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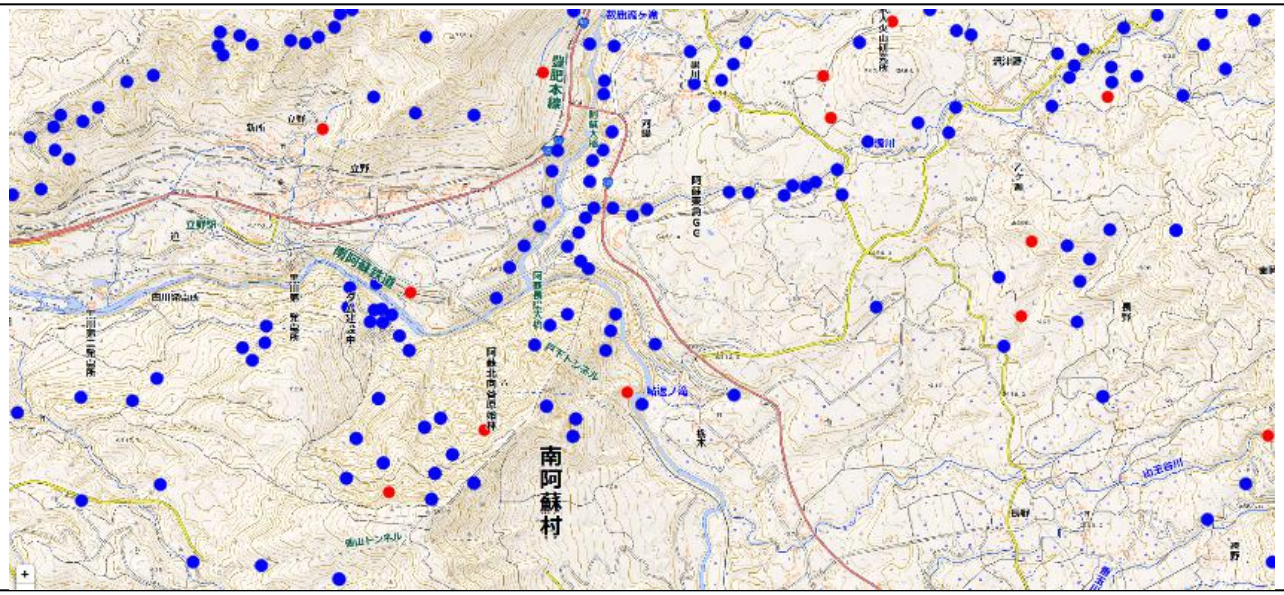
Collapsed buildings

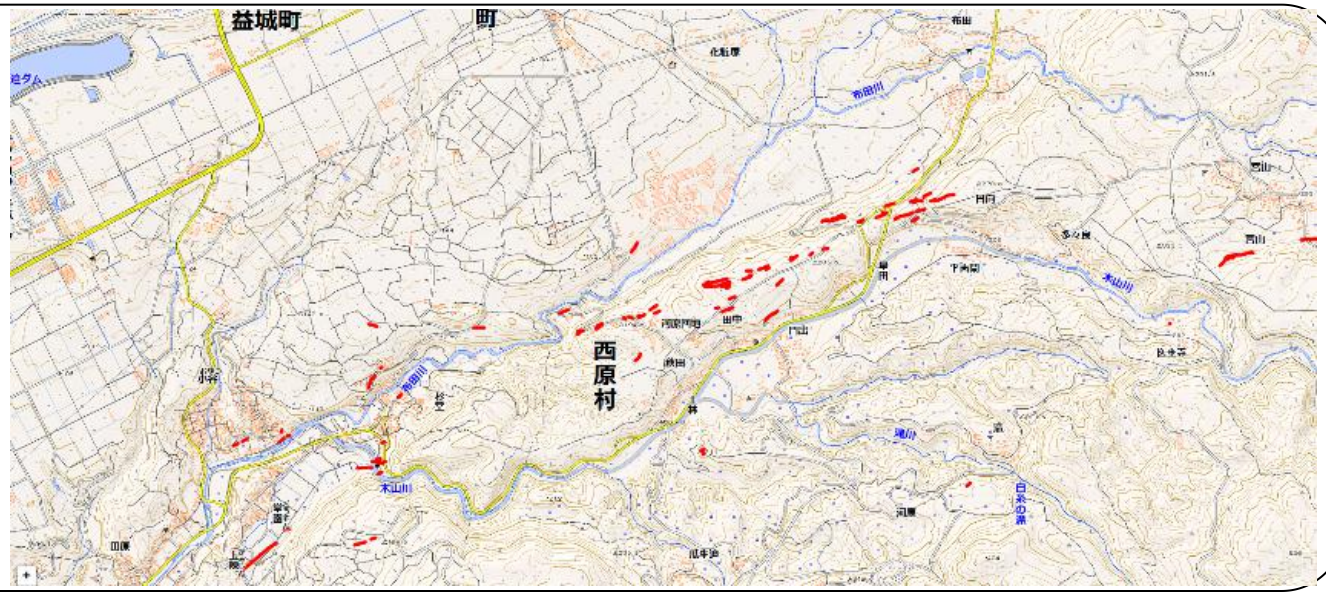
Cracks on the slope

Distribution of surface fissures and landslides

landslides



Surface fissures



Crustal Deformation Detected by GNSS

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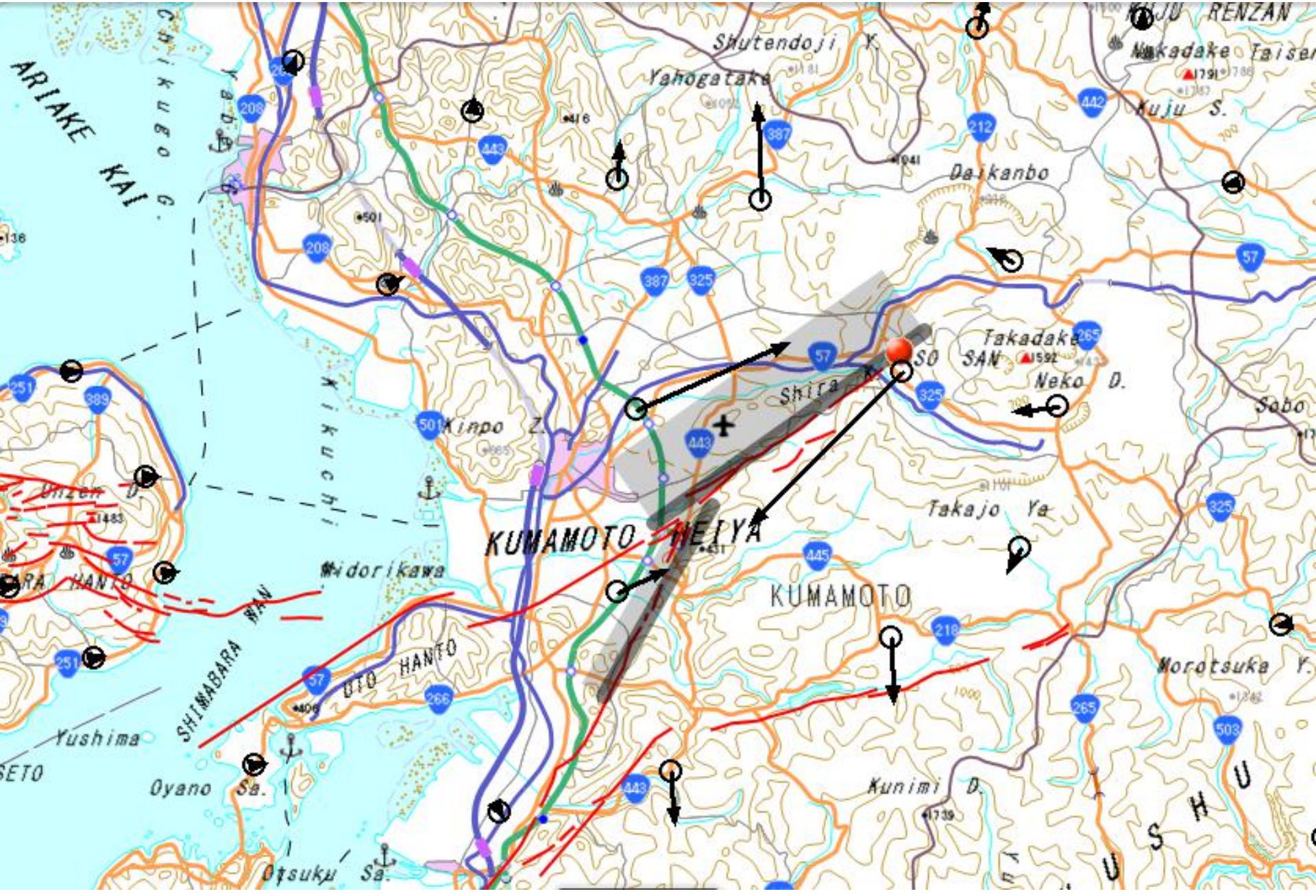
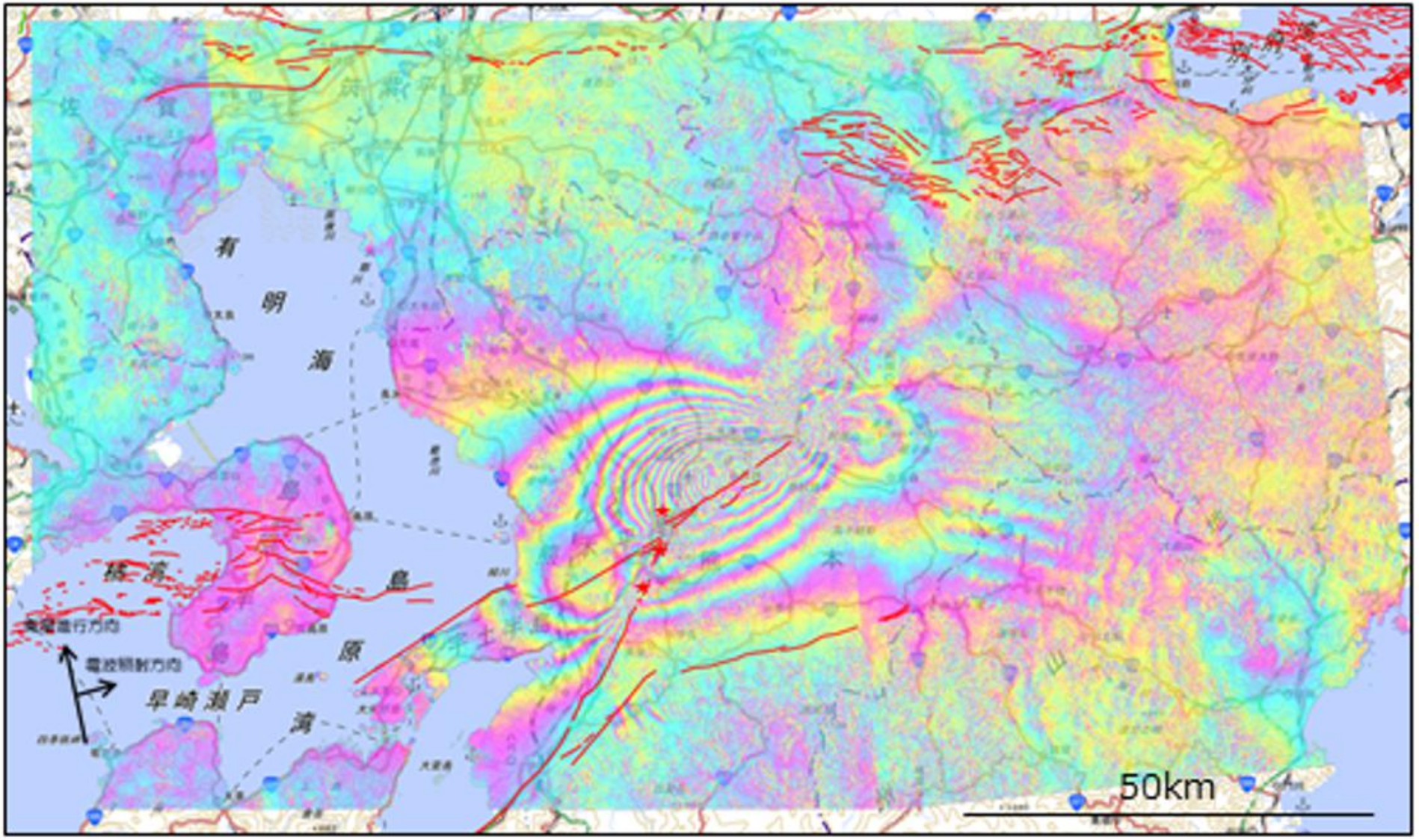
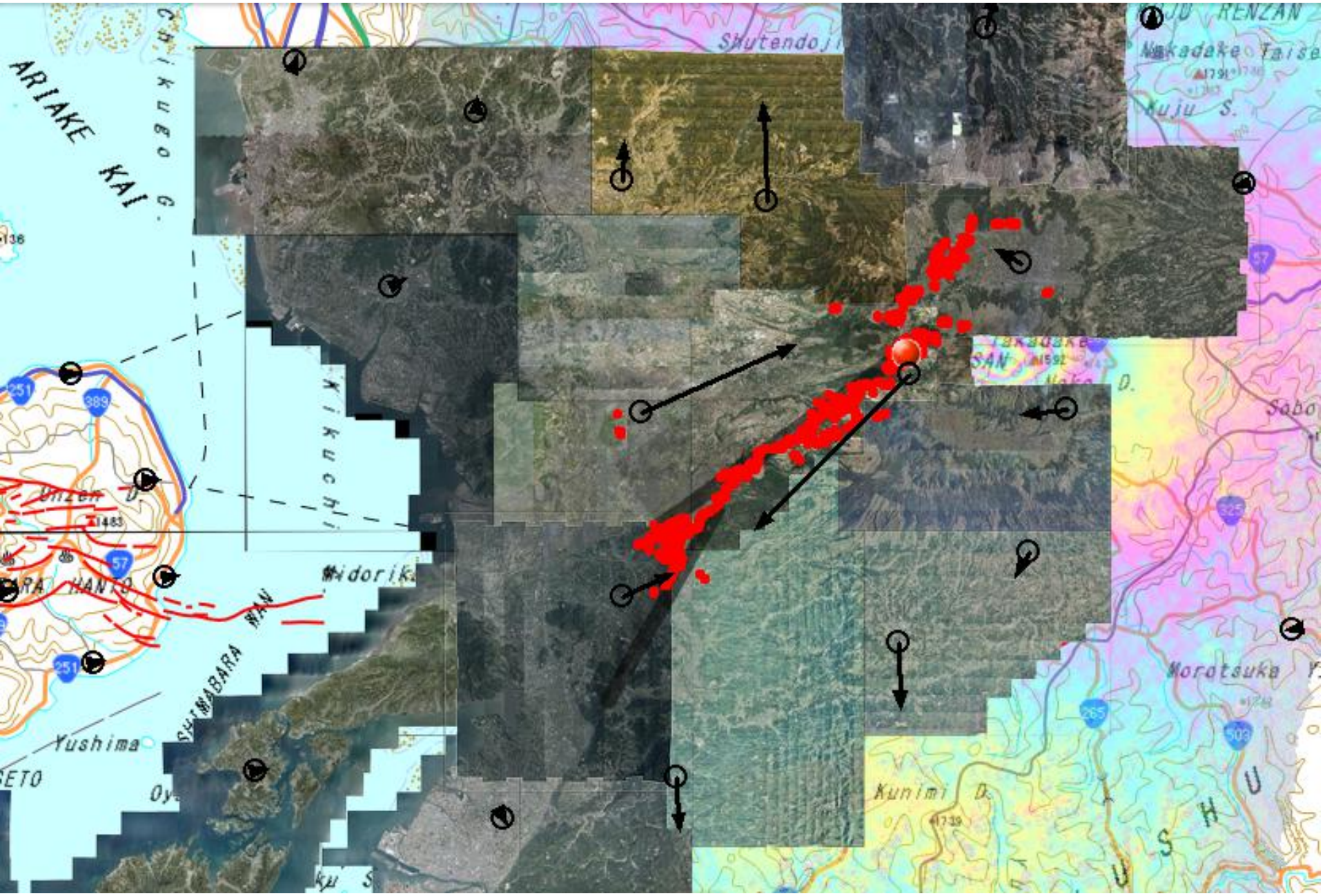


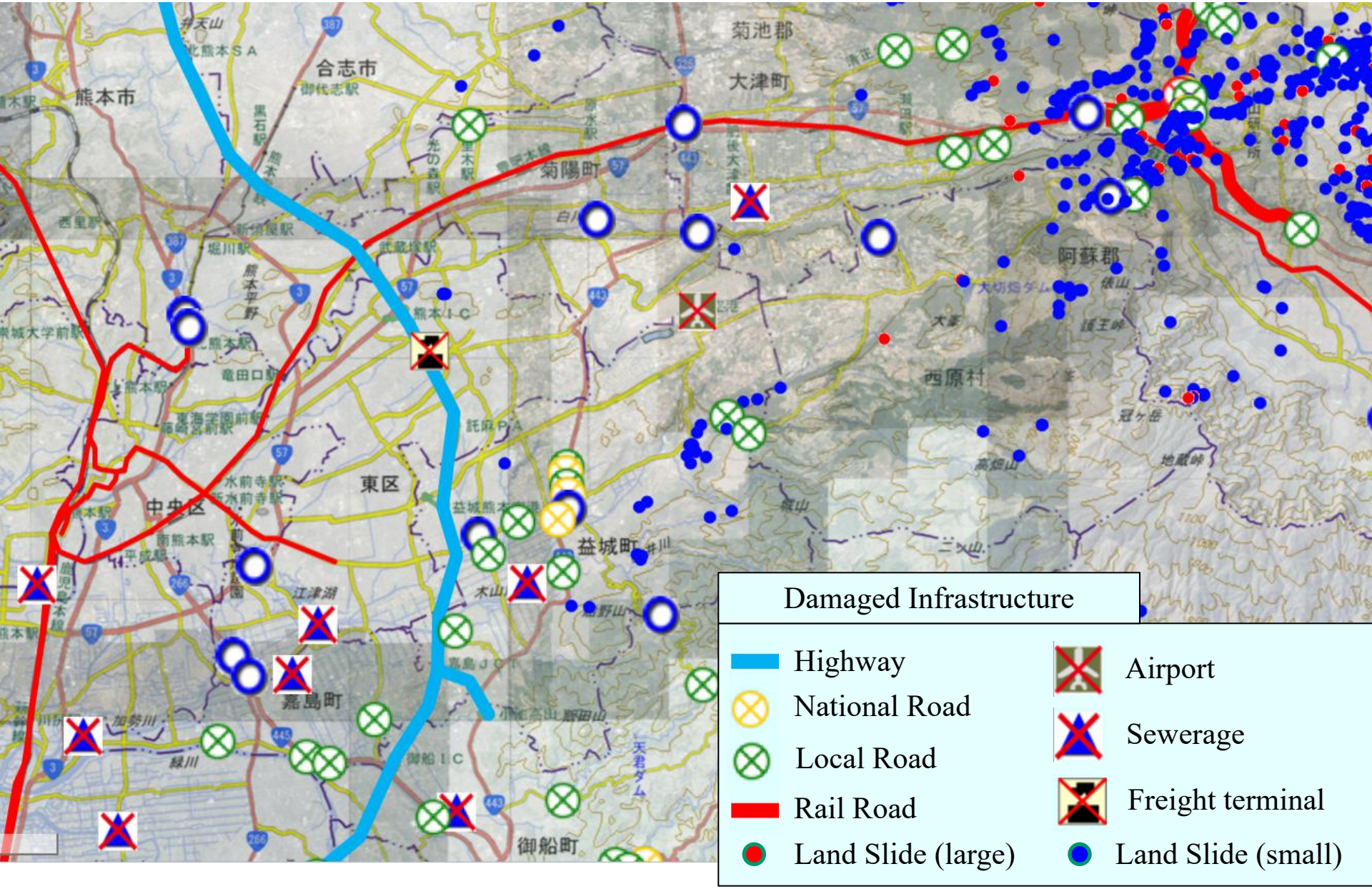
Satellite SAR Interferometry Analysis



Overlay on web-based “GSI map”



Integration of Damage Information Collected by Different Government Offices for Kumamoto



Refuge map

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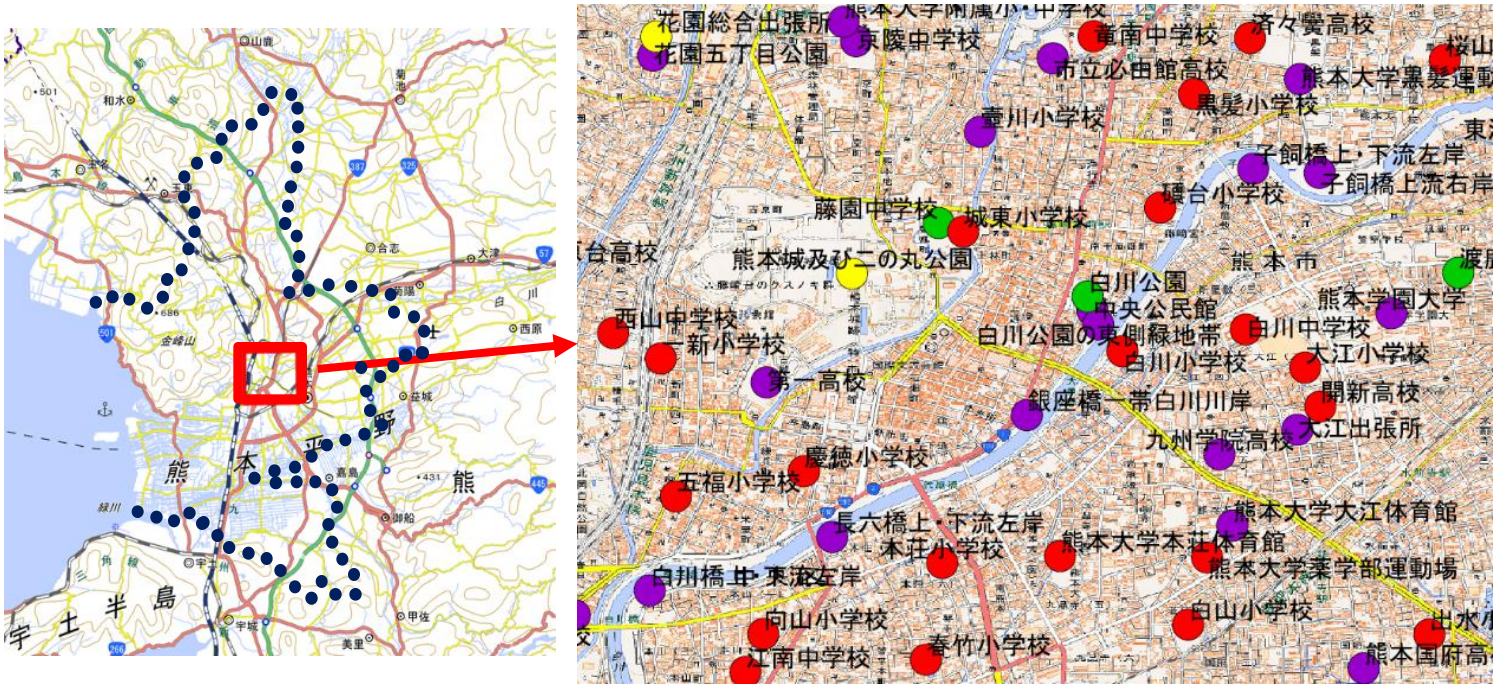

Damage status captured by UAVs

Large landslide

Surface rupture of earthquake fault

Surface rupture

Debris flow

Damage status captured by UAVs

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Large scale mapping for recovery planning

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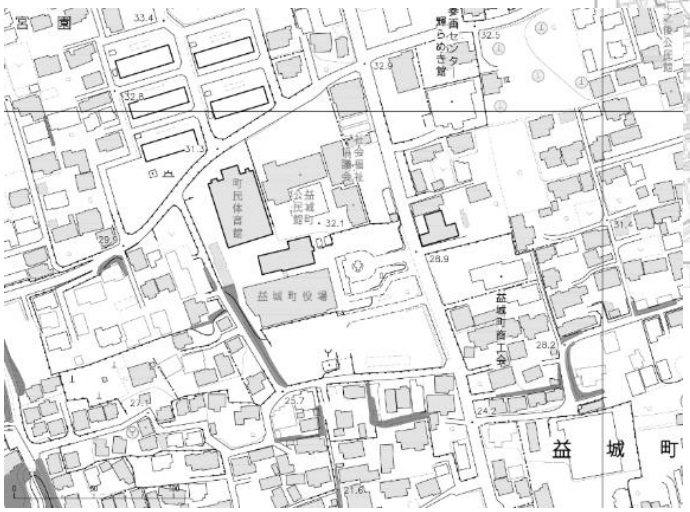

Source fault model presented over GSI map

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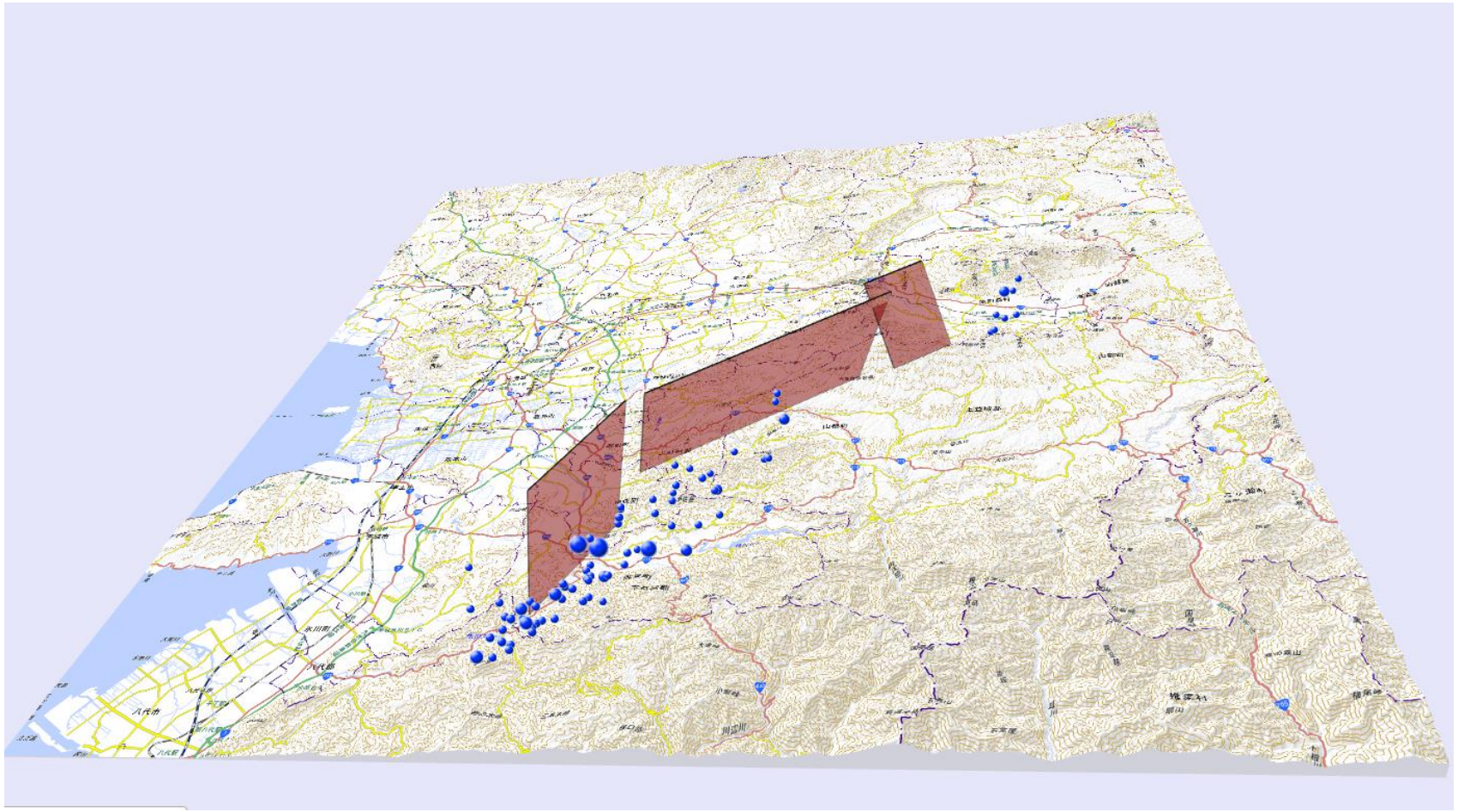
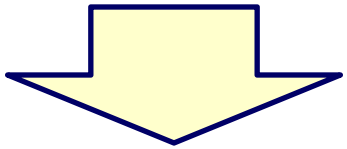
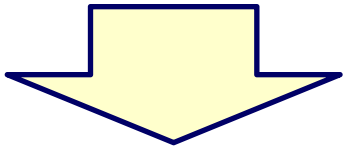


What should be done in preparation?

"What we can't do normally can't be done well in emergency response."



Good preparation makes us respond successfully to disasters.



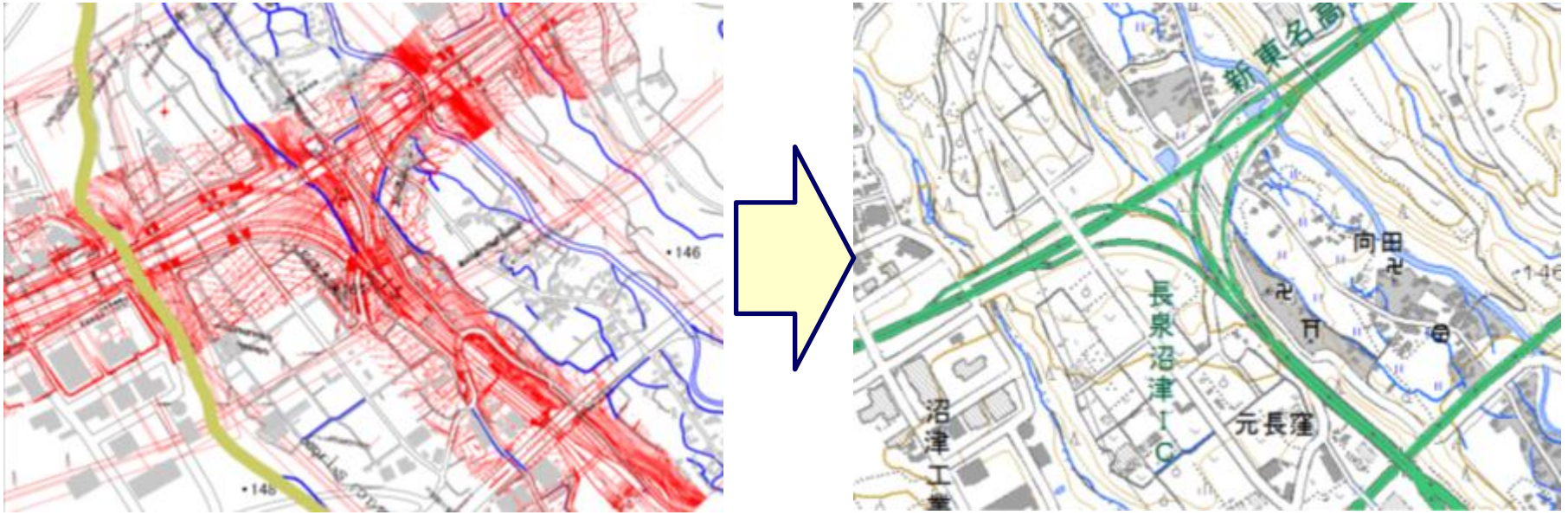
What makes us well prepared for disasters?

Archive

- Old air photos immediately tell us the impact of a disaster when compared to those taken after the disaster.
  - Archiving maps and air photos to make them readily available for disaster response is NGIA's important responsibility.

Map revision

- Rescue workers from remote areas rely on maps in the planning of their operations.
- If maps don't show latest features, their work might be significantly hampered.



Cooperation with relevant organizations

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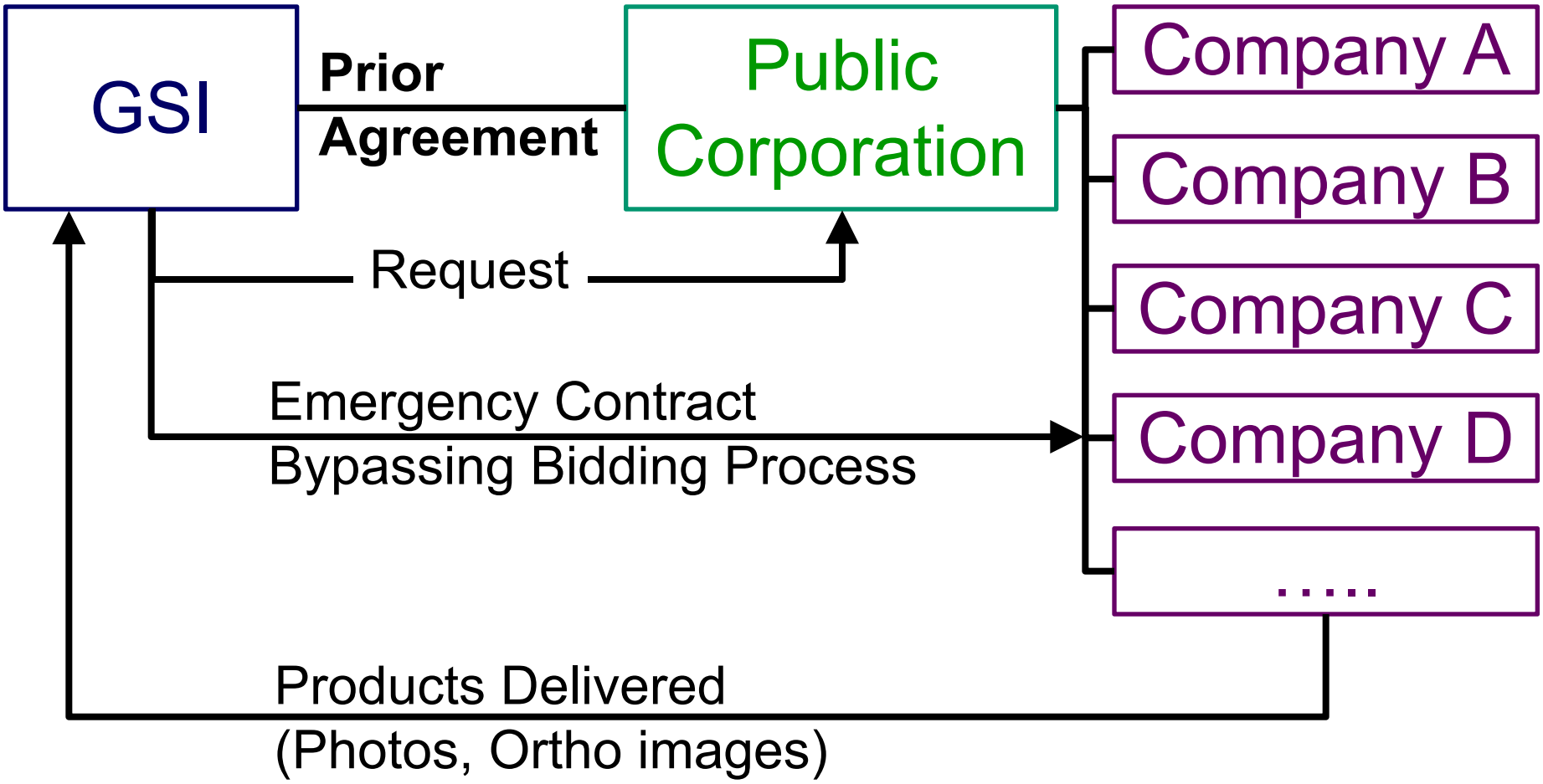
Arrangement for Emergency Air Survey



Drills

- Drills train us well prepared for disasters and also help us identify processes/equipment that need improvement/repair.
  - Communications
    - Response in 10 minutes to emergency messages to cell phone
    - Teleconference in 30 minutes
  - Air photos transfer to users (after plane landing)
    - < 4 hours for 11 prefectures around Tokyo
    - < 6 hours for the rest

New Technology

- Modern geospatial information technology supports easy application of geospatial information for DRR.
- Web Mapping technology enable us to browse various disaster-related geospatial information easily.
- 3D presentation provides us realistic image of lands.

→Increase the importance of preparation and sharing of reliable geospatial information

Sendai Framework for Disaster Risk Reduction 2015-2030

- 3rd UN WCDRR was held in March 2015 in Sendai, Tohoku, Japan.
- We worked to make the decision makers and disaster risk reduction community understand the importance of geospatial information and relevant technology in all the phases of disaster risk reduction and management.

Sendai Framework for Disaster Risk Reduction 2015-2030

Geospatial Information Authority of Japan

UN acknowledges;

the importance of application of geospatial information technology for disaster risk reduction.

UN World Conference on Disaster Risk Reduction
2015 Sendai Japan

Thank you for your attention!

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