Sixth Plenary Meeting of UN-GGIM-AP

Special Session on Geospatial Information for Disaster Response

-Case Study on 2016 Kumamoto Earthquake-

Part 4
Activities for Recovery and Reconstruction

10:45am-11:45am, 18th October 2017

Recovery of major infrastructure

Highways:
Recovery on 9 May 2016

Bullet Train (Kyushu Shinkansen):
Recovery on 27 April 2016

Electricity:
Recovery on 20 April 2016

Water:
90% Recovery on 21 April 2016
(recovery in process in mountain regions)

City Gas:
Recovery on 9 May 2016

Continued living in shelters

38,000 people still lived in shelters on 28 April 2016

Ref. Uto city hall
Private spaces created by a paper partition unit in a shelter.

For details on the paper partition unit, please refer to the website below.
http://www.shigerubanarchitects.com/

Numerous aftershocks

- Just for April (14-30 April): 120 earthquakes with SI larger than 4 occurred in Kumamoto.
- The record is the highest in Japanese Earthquake history
- People are still concerned with further damage

Period		Seismic Intensity									Total	Cumula-tive
		1	2	3	4	5 -	5 +	6-	6+	7		
2016	4	1,722	859	323	98	10	5	3	2	2	3,024	3,024
	5	344	134	43	8						529	3,553
	6	147	51	14	4	1					217	3,770
	7	85	19	8	1						113	3,883
	8	77	28	3	2	1					111	3,994
	9	49	16	7	2						74	4,068
	10	41	10	4							55	4,123
	11	24	16	1	1						42	4,165
	12	31	10	3							44	4,209

Ref. Japan Meteorological Agency

Phase change

Emergency Response

- Grasping situation
- Rescue & Search
- Shelter set-up
- Supply goods and foods
- Infrastructure Temporal Recovery
- (mainly in April)

Recover and Reconstruction

- Temporary house construction
- Infrastructure Permanent Recovery
- City planning for reconstruction
- Debris removal
- (mainly from May)

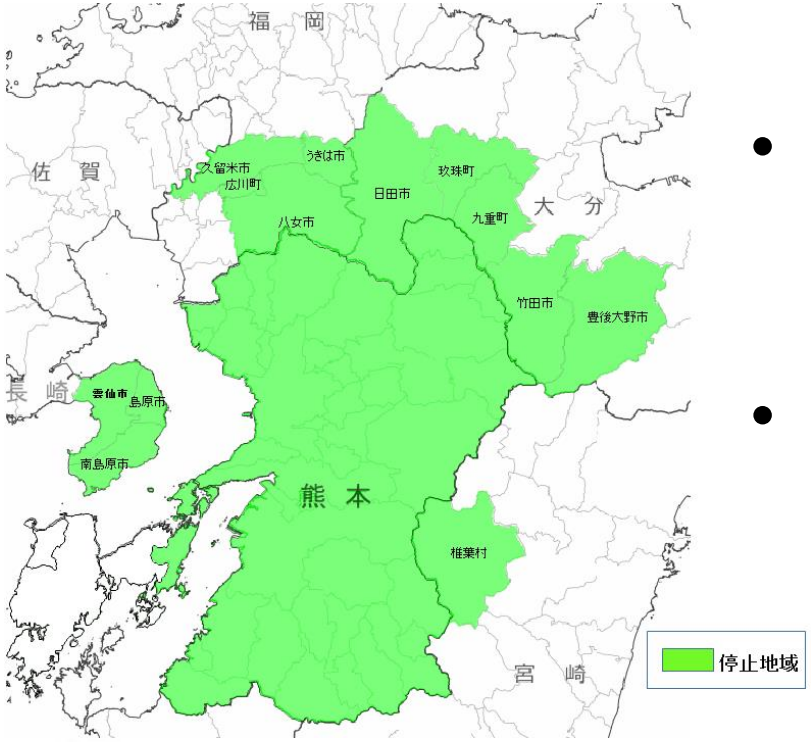
Different Policy Agenda -> Different Geospatial Needs

Topic for discussion #4

- **What kind of contribution can NGIAs make during the recovery and reconstruction phase for the disaster stricken areas?**

Control points resurvey: coordinates suspension

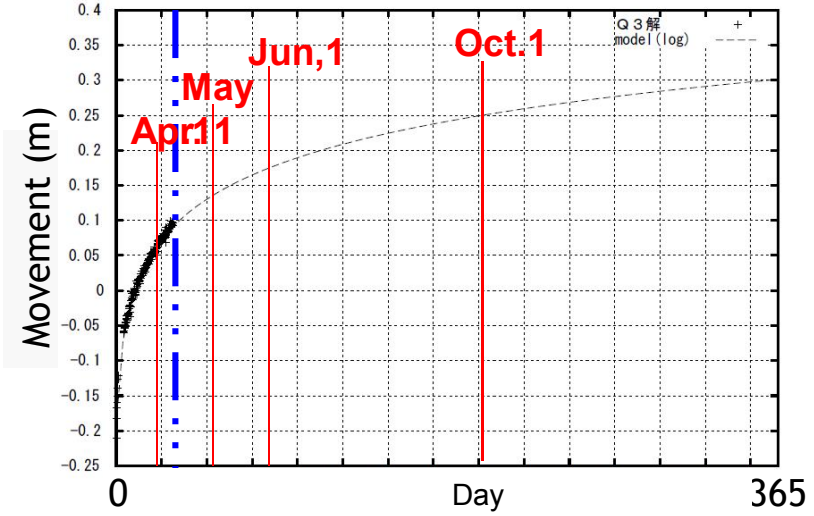
Coordinates suspended area



- Kumamoto Earthquake brought a large crustal movement
- Coordinates of control points for public survey was suspended on 16 April
- Suspended points were
  - 38 CORSs,
  - 4,169 Triangulation points,
  - 296 Benchmarks

Control points resurvey: after-slip

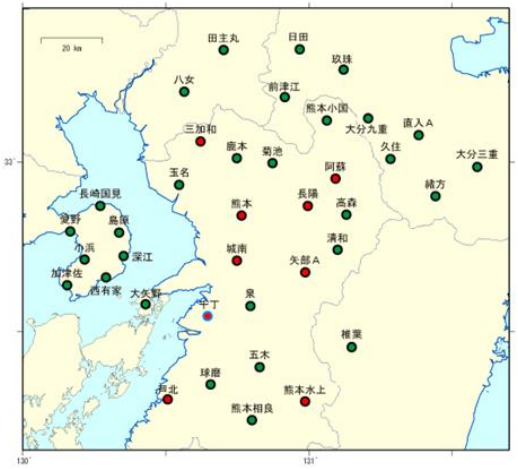
- Early coordinates revision was required for reconstruction work
- But post-seismic surface movement (after-slip) was observed in Kumamoto area
- A stalemate condition
  - If we resurvey too early, survey-error will be inevitable due to further after-slip
  - If we resurvey later, reconstruction work will be delayed

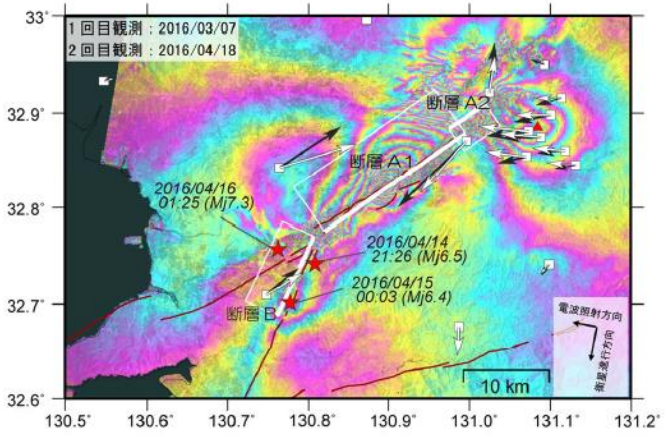


Example of after-slip, CORS "Yamada", in case of Great East Japan Earthquake in 2011

Control points resurvey: CORS

- By analyzing CORS data, GSI estimated the future trend of after-slip.
- If the trend becomes stable, coordinate revision is feasible.
- Further, earthquake fault modeling and SAR interferometric data were useful to specify the extent of coordinate revision

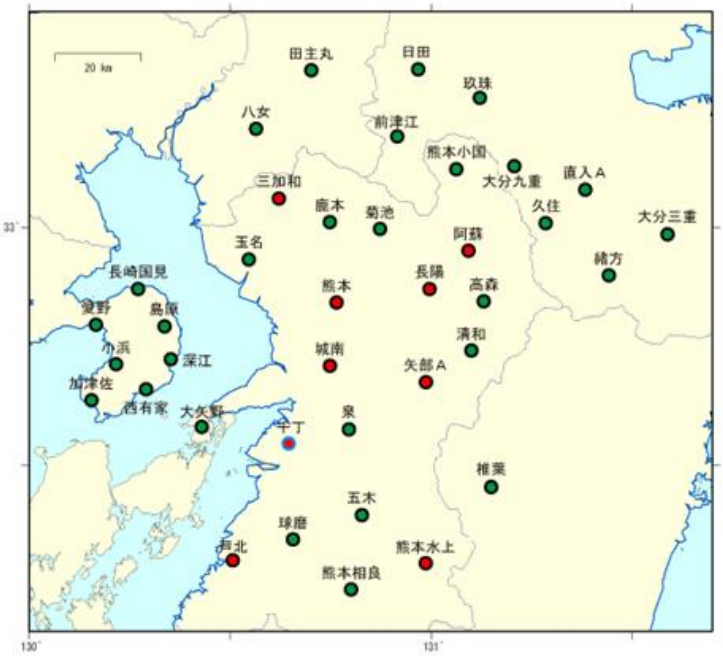




Control points resurvey: CORS

- Based on monitoring, GSI decided to **revise** 38 suspended **CORSs' data on 16 June 2016**
- Two months after the Mainshock
- GSI also identified monument control points to be resurveyed by using CORS data

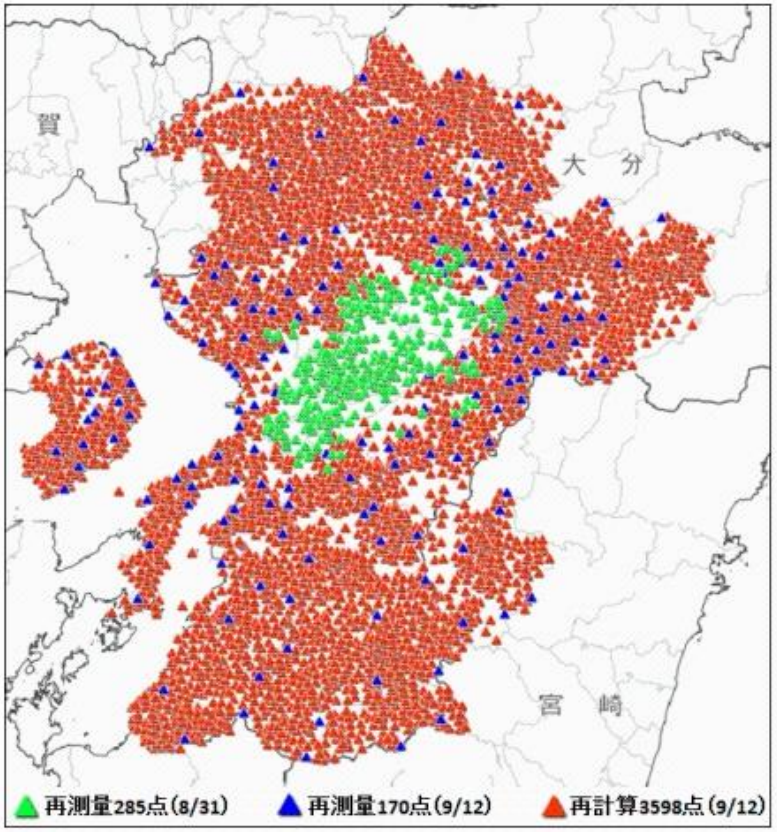
CORSs coordinates revised



Control points resurvey: triangulation points

- Subsequently, GSI outsourced resurvey of triangulation points.
- Green: Field Resurvey of the core area (285)
- Blue: Field Resurvey of the surroundings (170)
- Red: calculation using correction parameters from field resurvey (3,598)
- **Finally released on 12 Sept. 2016**

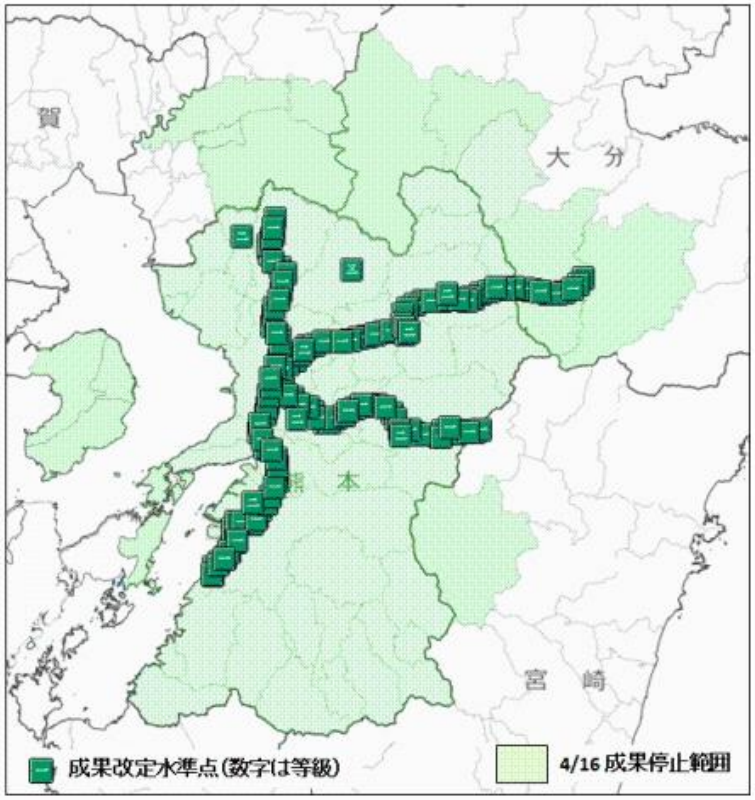
Triangulation points coordinates revised



Control points resurvey: benchmarks

- GSI also outsourced resurvey of benchmarks.
- 155 benchmarks are found to be resurveyed for height revision.
- **Finally coordinates results released on 12 Sept. 2016**

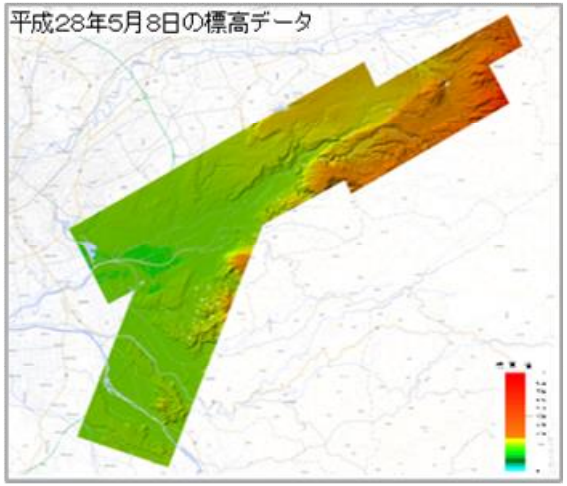
Benchmarks coordinates revised



Post-earthquake aerial laser survey (1)

- Concern with potential flooding during monsoon season in subsiding areas
- Local governments asked GSI to get precise post-earthquake elevation data (DEM)
- GSI decided to conduct aerial laser survey, implemented by a private company on 8 May 2016

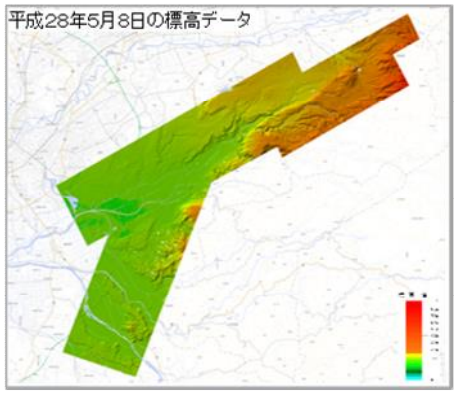
Post-earthquake DEM



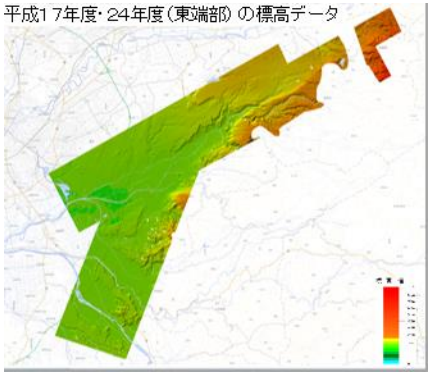
Post-earthquake aerial laser survey (2)

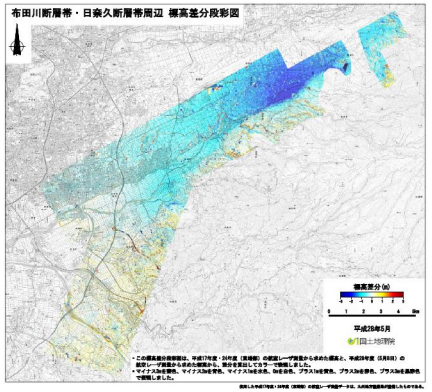
- Subsequently, DEM and height difference data were processed
- The results were presented to mayors of two municipalities at the end of May
- The results are also available on “GSI Maps”

Post-quake DEM

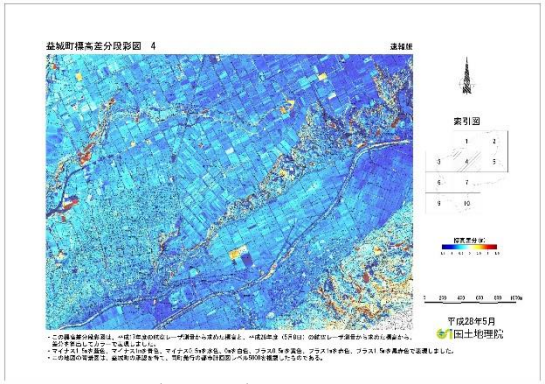


DEM 2005/2012





Height difference whole area

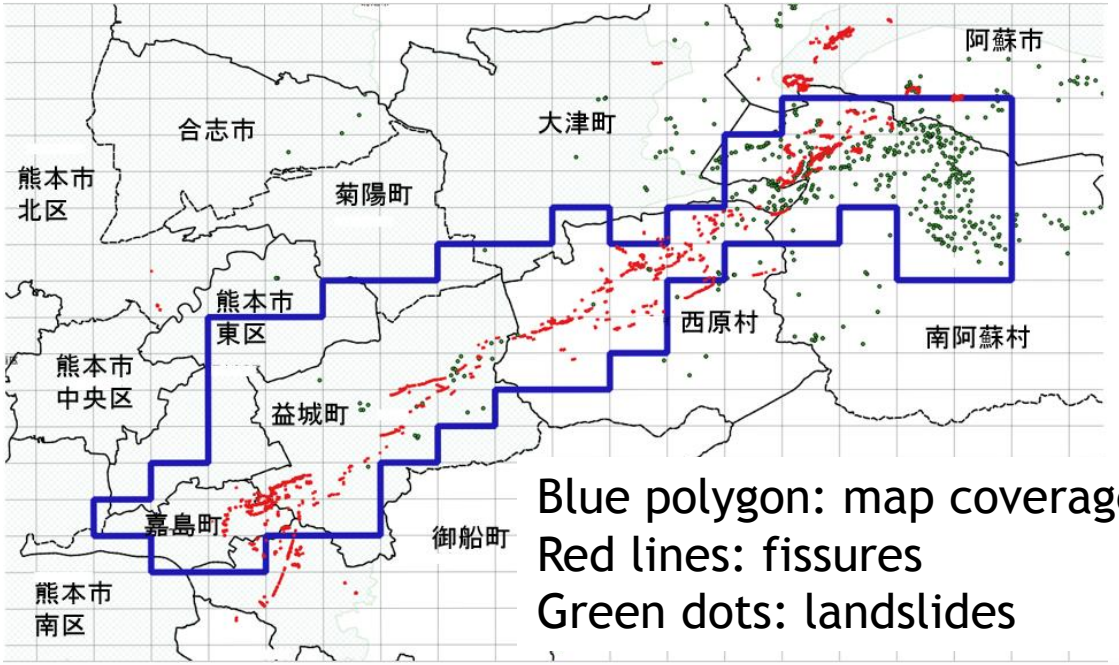


Height difference sheet map

Basic maps for recovery and reconstruction (1)

- Post-disaster basic maps: prerequisite for reconstruction planning and implementation
- GSI prepared 1:2,500 reconstruction maps for damaged areas

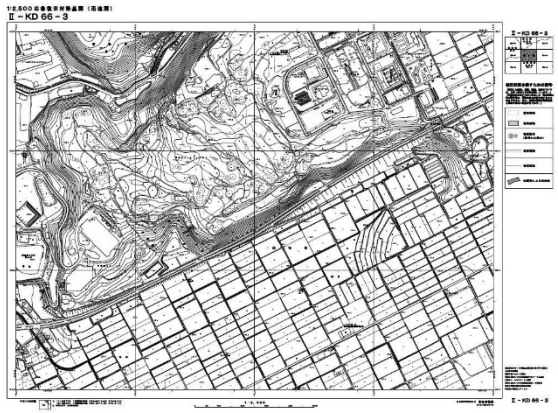
Basic Maps Coverage



Blue polygon: map coverage
Red lines: fissures
Green dots: landslides

Basic maps for recovery and reconstruction (2)

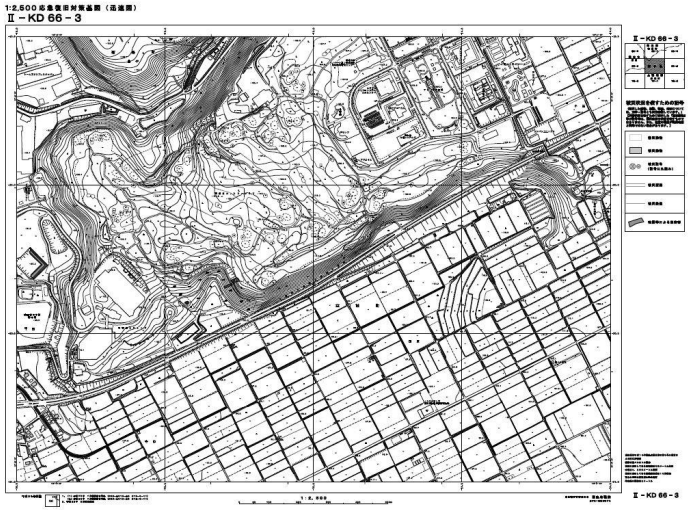
- Characteristics
  - 1:2,500 line maps and photo maps

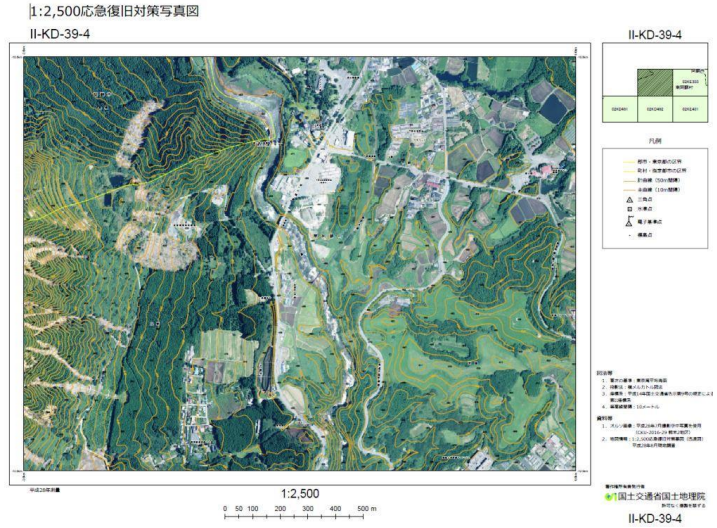


  - Include special post-disaster features
    - Temporary houses, damaged houses, landslides etc.
  - Preliminary provision and final provision
    - Be in time for local reconstruction planning

Basic maps for recovery and reconstruction (3)

- 30 & 31 May 2016: Air-photo taken.
- July 2016: Simplified preliminary version for municipalities and public organizations
- Sept. 2016: Ortho-photo maps final
- Dec. 2016: Line maps final
- Published maps are also available for the general public

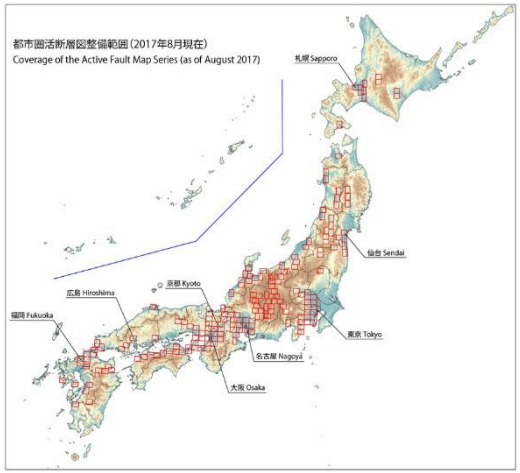




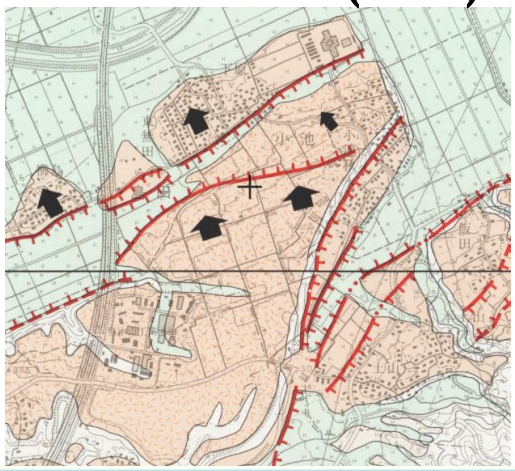
Revision of active fault maps (1)

- GSI has published “Active Fault Maps” to inform precise location of active faults since 1997, based on best available knowledge
- Kumamoto area was actually covered in 2001
- Earthquake faults that appeared in 2016 was nearly compatible with those described in the map

National coverage



Active fault map “Kumamoto” (Part)



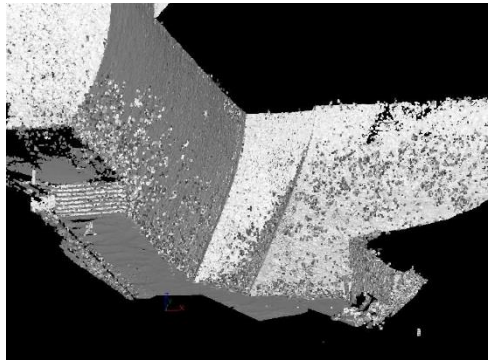
Revision of active fault maps (2)

- Some of the faults were unknown
- GSI decided to revise the active fault maps with an expanded coverage
- Working with researchers, GSI is revising the contents.

Earthquake fault appeared on the ground

3-D model for Kumamoto castle

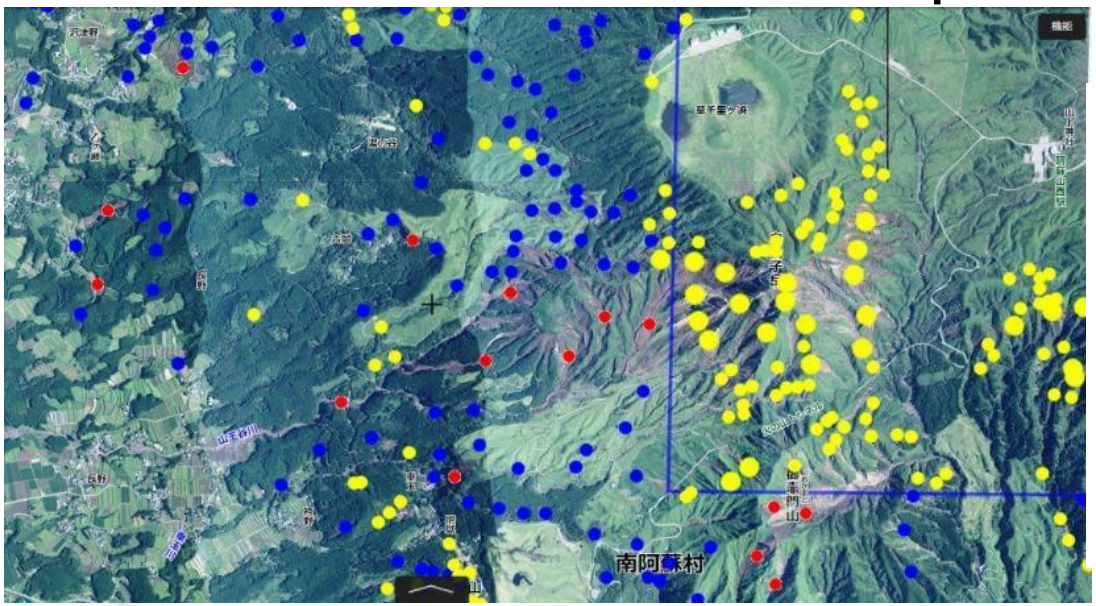
- In May 2016, Kumamoto city asked GSI to develop a 3-D model of collapsed stone walls and damaged parts of Kumamoto castle.
- GSI deployed a UAV team to capture the requested features.
- Also, terrestrial laser survey was conducted.



Response to secondary landslides

- Due to heavy rain (>500mm) in late June in Kumamoto, many landslides took place as secondary disasters
- GSI took aerial photographs in early July and revised landslide distribution map, released on 27 July 2016

Revised Landslide Distribution Map



*Large Yellow Circle: Large landslide caused in late June

*Small Yellow Circle: Small landslide caused in late June

*Blue and Red Circles: Landslide caused by the Mainshock

Almost all disaster response activities are completed.