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

- **City Gas:**
  Recovery on 9 May 2016

- **Electricity:**
  Recovery on 20 April 2016

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

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<th>Period</th>
<th>Seismic Intensity</th>
<th>Total</th>
<th>Cumulative</th>
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<td>2016</td>
<td>4</td>
<td>1,722</td>
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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?
Coordinates resurvey: coordinates suspension

- 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
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
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 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”.
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
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.
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.