Outline and Future Strategies of SABO Works in Japan

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The 10th Japan-Italy Conference on Sediment Disaster Prevention Technology
1. Sediment disaster situations in Japan

2. Summary of sediment disaster management

3. Future Perspectives and Strategies
Sediment-related disaster in 2014

76 casualties, August 2014
Hiroshima City, Hiroshima
Disaster Conditions around Aso Ohashi Bridge

**Outline of Earthquakes**

- **Foreshock**
  - Date and time of occurrence: April 14, 21:26
  - Epicenter: Kumamoto region, Kumamoto Prefecture
  - Scale: Magnitude: 6.5

- **Main quake**
  - Date and time of occurrence: April 16, 01:25
  - Epicenter: Kumamoto region, Kumamoto Prefecture
  - Scale: Magnitude: 7.3

**Outline of the Sediment Disasters**

- **Number of sediment disasters**: 190
  - Debris flows, etc.: 57
  - Landslides: 10
  - Cliff failures: 123

- **Human damage of sediment disasters**
  - 10 fatalities (plus 5 fatalities linked to the Kumamoto Earthquake)

- **Damage to houses caused by sediment disasters**
  - 22 houses totally destroyed, 5 houses semi-destroyed, 8 houses partially damaged
Features of Sediment Disasters caused by Kumamoto Earthquake – Occurrence of various sediment shift phenomena

1. Large-scale slope failure
   Example of large-scale slope failure (area around Aso Ohashi Bridge)

2. Slope failure and landslides on gentle slopes
   Example of gentle slope failure (Takanodai district)

3. The collapsed sediment moved downstream as debris flow
   Example of debris flow (Sanodanigawa district)

4. Multiple cliff failures
   Natural slope failure (Mashiki Town, Kumamoto Prefecture)
   Artificial slope failure (Mashiki Town, Kumamoto Prefecture)
Numerous Cracks Caused by Kumamoto Earthquake

Slope failures on the west side of Aso Ohashi Bridge: conditions of upper slope cracking

Cracks in Takanodai district, Minamiaso Village, Kumamoto Prefecture (installation of an extensometer for measuring the width of cracks)
Steps to Prevent Secondary Disasters Immediately Following Occurrence of Disasters

1. Lowering of the standard for issuing sediment disaster warnings
   - The standard was lowered in 45 municipalities in 6 prefectures in consideration of the fact that ground had been loosened by the earthquake.

2. Urgent notification to the Mayor of Minamiaso Village of the scope of evacuation
   - Direct explanation to the mayor on April 20, the day before heavy rain was forecast
   - [1] Sanodanigawa district
   - Explanation of reference information by the liaison staff to the mayor

3. TEC-FORCE has finished inspections of 1,155 high-risk areas
   - 131 spots requiring emergency countermeasures and vigilance were reported to Kumamoto Prefecture and 13 municipalities
   - Inspection of a steep slope at risk of falling
   - Inspection of a debris flow risk ravine

4. Establishment of an advisory team on sediment disaster countermeasures
   - Through locally offering advice in response to requests by municipalities and related agencies, the alert and evacuation setup was bolstered and efforts to secure safety in search activities were supported (April 22~)
   - Report to the Governor of Kumamoto Prefecture on April 28
   - Report to heads of municipalities, etc. on April 28 (Nishihara Village)
   - Meeting with disaster relief team
   - Field survey
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Laws related to disaster risk management

**Sabo Department**
- Sabo Law
- Landslide Prevention Law
- Steep Slope Failure Prevention Law
- Sediment Disaster Prevention Act

**MLIT**
- River Law
- Act on Specified Multipurpose Dams
- Coast Act
- Flood Control Act
- Building Standards Act
- City Planning Act
- Meteorological Service Act
  - etc.

**Other ministries**
- Disaster Countermeasures Basic Act
- Act on Special Measures concerning Countermeasures for Large-scale Earthquakes
- Act on Special Measures against Tokyo Inland Earthquake
- Act on Special Measures for Active Volcanoes
- Fire Service Act
- Disaster Relief Act
- Act on Special Financial Support to Deal with the Designated Disaster of Extreme Severity
  - etc.
Enactment and amendments of Sediment Disaster Prevention Act

*Hiroshima debris flow disaster in 29th Jun 1999*

May 2000
Enactment of Sediment Disaster Prevention Act
- Announcement of the design of sediment disaster warning area based on the basic investigation
- Establishment of warning and evacuation system in the sediment-related warning area
- Land use and house building regulation in the sediment disaster warning area

May 2005
Partial amendment
- Requirement of distribution of sediment-related disaster hazard map

Nov. 2010
Partial amendment
- Operation of emergency investigation when a large-scale sediment-related disaster is about to happen

Nov. 2014
Partial amendment
- Requirement of the publication of the basic investigation result
- Requirement of the announcement of sediment-related disaster alert for municipality and residents

May. 2017
Partial amendment is decided by the cabinet
- Requirement to operate evacuation drill and to prepare evacuation scheme at facilities used by people who needs assist (ex. Elders who need care, the physically challenged, students under 18)
Emergency investigation when large scale sediment-related disasters are about to happen

Debris flow and impoundment due to landslide dam
- Possibly submerged area
- Landslide dam (Height ≥ 20 m)
- Possibly inundated area

Debris flow following deposition of volcanic ash on steep slope
- Deposition of volcanic ash (≥ 1 cm)
- Watershed (Slope ≥ 10°)
- Deposited over 50%
- Possibly inundated area

Operation of emergency investigation
- In the case of landslide dam
  - Automatic observation of water level
  - Investigation by experts of NILIM etc.

Announcement of emergency information
- Possible areas and timing are announced
  - Landslide dam
  - Prediction of overtopping time
  - Possible areas suffered by debris flow

Evacuation advised / ordered by mayor of municipality
- Evacuation of residents

Simulation of overtopping and failure of landslide dam
Simulation of inundation
There are approximately 532,000 sediment disaster warning areas based on the Sediment Disaster Prevention Act, and survey has finished on approximately 400,000 special sediment disaster warning areas.

Estimated overall number of sediment disaster warning areas
666,414 areas

Movements in the Number of Areas where Basic Survey has Finished based on the Sediment Disaster Prevention Act (past 5 years)

<table>
<thead>
<tr>
<th>Sediment disaster warning area</th>
<th>Special sediment disaster warning area</th>
</tr>
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<tbody>
<tr>
<td>2013</td>
<td>347,884</td>
</tr>
<tr>
<td>2014</td>
<td>383,493</td>
</tr>
<tr>
<td>2015</td>
<td>423,021</td>
</tr>
<tr>
<td>2016</td>
<td>481,556</td>
</tr>
<tr>
<td>2017</td>
<td>395,038</td>
</tr>
<tr>
<td>2020</td>
<td>532,358</td>
</tr>
</tbody>
</table>

※ Estimated overall number of sediment disaster warning areas
Total number sediment disaster warning areas estimated by prefectural governments
Figures are current as of the end of March 2017 and may change in line with progress of basic surveys.
Damage Casued by Sediment Disaster in Hiroshima
Damage Caused by Sediment Disaster in Hiroshima

※Photographed by the Geographical Survey Institute

Sediment disaster warning area, etc. (showing debris flows)

- Warning area
- Special warning area
Obliogating of managers of facilities for people with special needs to compile evacuation plans, etc.

<table>
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<th>Evacuation plan</th>
<th>Facilities managers, etc.</th>
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**Collateral measures in plan preparation**

➢ Municipality heads can give the necessary directives to facilities managers, etc. that don’t prepare plans.
➢ If managers, etc. do not follow directives without good reason, the municipality heads can disclose that fact.

**Construction of a warning and evacuation setup for facilities for users with special needs**

- Confirmation of disaster prevention setup
- Evacuation plan preparation
- Evacuation plan preparation
- Announcement of start of evacuation
- Decision of whether to start evacuation
- Annoucement of completion of evacuation, and reporting
- Evacuation training

**Example of disaster affecting a facility for users with special needs**

Typhoon Lionrock, August 2016
Iwaizumi Town, Iwate Prefecture

9 people die in a group home for the elderly

**Goal**

Prepare evacuation plans and implement evacuation training in 100% of facilities for people with special needs by 2021.
To enhance the warning and evacuation system and disaster preparedness, evacuation drill is conducted in municipalities of all over Japan. Number of participants reaches a record high of about 975,000 in 2016.

**Main contents**
- Check facility owner’s ability to navigate people who need help in evacuation
- Explanation of evacuation to person who needs help
- Study of disaster prevention with evacuation drill
- Explanation of evacuation maps to local residents

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Increase in the number aging check dams

- The number of check dams has grown to about 42,000 in 2017.
- The number of check dam over 50 years old is about 12,000 in 2017.
- It is estimated that the number is going to be about 23,000 in 2030.

Cumulative number of check dam over 50 years old

Example

- The number of check dams has grown to about 42,000 in 2017.
- The number of check dam over 50 years old is about 12,000 in 2017.
- It is estimated that the number is going to be about 23,000 in 2030.

Erosion of the crown of check dam
Life Extension Plan for Sabo facilities

Life Extension Plan
Plan to prolong the function of SABO facilities thorough maintenance activities in an early stage of deficiencies

Contents of Life Extension Plan for Sabo facilities
○ Preparation of daily operation and maintenance plan
○ Soundness assessment based on inspection results
○ Preparation of priority ranking for maintenance activities (repair, reconstruction, etc.) and annual plan
○ Observation technique (survey, observation)
○ Detail of countermeasure (repair, reconstruction, etc.) etc.

Life extension plan for government-owned facilities has been developed until March 2017.

Life extension plan for municipality-owned facilities will be developed until March 2021.
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**Recent SABO construction technologies**

**Open check dam**
Encouraging the open check dam to effectively trap debris and driftwood

**Unmanned construction technologies**
- Used for dangerous sites
- Excavator, bulldozer, and dump truck were controlled from an operator’s room over 1 km away from construction site

**Construction using “Sabo soil cement”**
Encouraging the use of surplus soil to make concrete; Leads to reduction of soil emission and construction cost

**Surplus soil**

**Mixing surplus soil and cement**

**Placement and compaction**

**Completion of check dam**

Encouraging the use of surplus soil to make concrete; Leads to reduction of soil emission and construction cost
Progress of i-Construction

○Construction control using UAV and ICT (Information and communication technology)

construction equipment
1. 3D land surveying using UAV
2. 3D model of design
3. Construction with 3D data
4. Assessment of accuracy of construction using UAV

Elevation change due to the construction (used to confirm movement of slope and assess the accuracy of construction)

○Construction control using 3D data
3D data is created to design facilities (ex. Shafts of pile). By checking the ideal construction process through animation, mistakes in the process are prevented and the construction period is shortened. Moreover, the data are used for maintenance.

○Application of UAV to facility inspection
Using UAV, time and labor for inspection of Sabo facility are substantially saved.
Unmanned construction technologies

- Used for dangerous sites
- Excavator, bulldozer, and dump truck were controlled from an operator’s room over 1 km away from construction site

High speed wireless access system

- Radio station ①
- Radio station ②
- Radio station ③
- Radio station ④

Optic fiber cable (700m)

- Relay station ①
- Relay station ②
- Relay station ③
- Relay station ④

LAN cable

- Head camera
- Operating room
- Work area
- Operators room

Opposite bank camera
Recent topics for study

① Monitoring of sediment dynamics in mountainous watershed using hydrological and sediment transport observation

② Detection of possible slope failure using InSAR and Estimation of possible area suffered from high-volume sediment transport

③ Development of rainfall index for improvement of the accuracy of rainfall-induced sediment-related disaster prediction

④ Development of early warning system and identification of early-stage of sediment-related disaster using SNS (ex. Twitter)

⑤ Study on deep-seated landslide (1. Prediction of possible site, magnitude of, types of suffering, 2. Estimation of possible suffered area, 3. Establishment of countermeasure)

⑥ 1-dimensional calculation of bed deformation considering transition from debris flow to bed material load
4 Basic Goals

1) Protection of human life
2) Protecting important functions of the state and society without letting them suffer critical damage
3) Minimization of damage to citizens’ property and public facilities
4) Rapid rehabilitation and reconstruction

“Situations where large-scale volcanic eruptions or sediment disasters (deep-layer collapse), etc. cause multiple fatalities and heighten the vulnerability of national land in later years” are worst-case scenarios that must not be allowed to occur.

Important Achievement Indicators for National Land Toughening

- Implementation rate of sediment disaster countermeasures at points in important transportation networks

- Implementation rate of sediment disaster countermeasures for protecting facilities for people with special needs, disaster prevention centers, and human lives
4 Basic Goals

1) Protection of human life
2) State and social important functions are sustained without suffering critical damage
3) Minimization of damage to citizens’ property and public facilities
4) Rapid rehabilitation and reconstruction

"Situations where large-scale volcanic eruptions or sediment disasters (deep-layer collapse), etc. cause multiple fatalities and heighten the vulnerability of national land in later years" are worst-case scenarios that must not be allowed to occur.

Used at the promotion convention on November 15, 2015

Current Situation as of October 1, 2016

- Plans already compiled: 32 prefectures
- Still planning (including scheduled): 15 prefectures

All 47 prefectures have either already compiled or are compiling plans.
To obtain the safety against sediment-related disasters

Obtain safety against sediment-related disasters

MLIT

Universities

Japan Sabo Association

Sabo Technical Center

Sabo Frontier Foundation

Private companies

Residents

Sabo Volunteers

Prefectures

Municipalities

Relevant ministries and agencies

Collaboration

Sediment Disaster Prevention Act etc.

Disaster prevention by residents

Education Volunteer

Disaster prevention drill

Hazard map

Survey, Construction

Innovation

PR, Enlightenment

Research

Human resources

Sabo works

Obtain safety against sediment-related disasters

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