Outline and Future Strategies of SABO Works in Japan

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Technical Conference on Sediment Disaster Risk Management, Japan-Austria
1. Sediment disaster situations in Japan

2. Summary of sediment disaster management

3. Future Perspectives and Strategies
Natural conditions

Because of natural conditions, e.g.
1. 4 converging tectonic plates
2. Active volcanos
3. Earthquakes
4. Fragile geology
5. Mountainous topography

Japan is very susceptible to sediment disasters.

Ref.: White Paper on Disaster Management

Principal Volcanoes in the World

Number of active volcanoes (2014)

World 1,551

Japan 110 (7.1%)

World Geographical Distribution of Hypocenters and Plates

Number of earthquakes with magnitude of 6.0 or greater (2004-2013)

World 1,629

Japan 302 (18.5%)

Analysis of magnitude 5.0 and greater earthquake’s epicenters from 2004 to 2013

Typhoon Talas, 2011
Number of heavy rain and sediment-related disasters are increasing

Number of hourly rainfall (> 50 mm / hr)

Number of sediment-related disasters

Ref.: Sabo Department, MLIT
Sediment-related disaster in 2011

62 casualties, September 2011, Typhoon Talas
Kii peninsula, Nara and Wakayama

Tanabe City, Wakayama
Deep seated landslide and landslide dam

Totsukawa Village, Nara
Deep seated landslide and landslide dam

Nachikatsuura Town, Wakayama
Debris flows

Gojo City, Nara
Deep seated landslide and landslide dam
Sediment-related disaster in 2014

76 casualties, August 2014
Hiroshima City, Hiroshima
More people are killed inside a building in the case of sediment-related disasters

Disasters caused by heavy rain (Flooding, Plunge to a canal, etc. including sediment-related disasters)

- Inside: 43%
- Outside: 43%

Sediment-related disasters

- Inside: 82%
- Outside: 18%

Ushiyama and Yokomaku (2013): Location characteristics of victims caused by recent heavy rainfall disasters
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

Erosion of the crown of check dam
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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
OUSe used for dangerous sites
OE xcavator, 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
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.
### Sediment Disaster Prevention Act (2000)

#### Creation of Guidelines for Sediment Disaster Risk Management [MLIT]
- Basic principles of sediment disaster risk management
- Guidelines for basic investigation of risk assessment
- Guidelines for designation of Sediment Disaster Hazard Areas, etc.

#### Basic Investigation [Prefectures]
Investigation of the topography, geology, and land-use in sediment disaster prone areas

#### Designation of Sediment Disaster Hazard Areas [Prefectures]
**Yellow Zone**
(Areas at risk of sediment disaster)
- Development of information transmission and warning/evacuation systems [Municipalities]
- 480,000 is set as Yellow Zone by March 2017
  
  *(NOTE: Total number is estimated as 660,000)*

#### Designation of Sediment Disaster Special Hazard Areas [Prefectures]
**Red Zone**
(Areas where normal buildings would be completely destroyed by a sediment disaster)
- Land use regulations
  - Targets: Sales of building lots and houses, as well as development projects concerning facilities for special needs populations
- Building codes
- Recommendation of building relocation
- 330,000 is set as Red Zone by March 2017

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**NOTE:** Total number is estimated as 660,000.
## 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)
Purpose: To assist mayors in determining whether to issue evacuation recommendations/orders, and to provide residents with useful information for evacuation, during times of elevated danger due to rainfall.

Channels of Sediment Disaster Alerts
- Prefectures
- Municipalities
- Local Meteorological Observatories, etc.
- TV, Radio

Number of Alert in 2016
Total number of municipalities: about 1,800

Summary:
Because of heavy rainfall, sediment-related disaster risk is quite high in warning areas.

Recommendation:
Residents lived in an area prone to sediment-related disaster such as an area near a river or cliff should evacuate as soon as possible if necessary and be careful to heed information such as “evacuation advisement” announced by local government.
Evacuation table

1. Rainfall and soil water index reach warning level

2. Announcement of sediment disaster alert
   - [Prefecture/Meteorological office]

3. Evacuation recommendation/order
   - [Municipality]

4. Evacuation from yellow zones to public shelters

5. Cancellation of SDA and confirmation of safety
   - [Prefecture/Meteorological office]
   - [Municipality]

6. Cancellation of evacuation recommendation/order
   - [Municipality]

SDA: Sediment Disaster Alert
Emergency investigation when large scale sediment-related disasters are about to happen

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

**Debris flow following deposition of volcanic ash on steep slope**
- Deposition of volcanic ash (≥ 1 cm)
- Deposited over 50%
- Watershed (Slope ≥ 10°)
- 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
- Prediction of overtopping time
- Possible areas suffered by debris flow

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

**Possibly submerged area**

**Possibly inundated area**

**Landslide dam**

**Simulation of overtopping and failure of landslide dam**

**Simulation of inundation**

**Watershed**

**Deposition of volcanic ash**

**GIS**
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

Number of participants in evacuation drill

- 2006: 9,000
- 2007: 22,000
- 2008: 48,000
- 2009: 69,000
- 2010: 99,000
- 2011: 120,000
- 2012: 128,000
- 2013: 138,000
- 2014: 223,000
- 2015: 569,000
- 2016: 975,000
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Progress of Installation of Sabo facilities in dangerous locations for sediment-related disasters

Sabo facilities (check dams, landslide control facilities, slope failure prevention facilities) have been installed in about 50,000 dangerous locations for sediment-related disasters.

We have installed Sabo facilities about 4,000 in 2016.

We strongly install SABO facilities on the upstream of shelters, disaster prevention centers, facilities used by person who need help and important roads for evacuation.

<Installation of check dam to capture debris flow>  <Installation of facility to control landslide movement>  <Installation of retaining wall to prevent slope failure>
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.
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
Sabo volunteer, education of disaster prevention

Inspection of Sabo facility by Sabo volunteers

Education of disaster prevention for elementary students using experimental flume

Tree-planting event joined by residents

Example of text book for Sabo works

Tour event to Sabo facilities
To obtain the safety against sediment-related disasters