

Sabo Works in Wakayama Prefecture - Evolution Through Learning a Lesson from 2011 Disasters -

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Wakayama prefecture has high potential risk of sediment disasters due to geomorphological and geological factor and climate condition. The Wakayama prefectural government has been implementing various structural and non-structural measures in order to achieve zero death tolls by sediment disasters. However, many human losses were caused by typhoon TALAS in 2011 and large-scale sediment disasters occurred in the southern part of the prefecture. Taking this opportunity of the event, the central government began directly Sabo works and the Wakayama prefectural government established the Wakayama Sabo Research and Education Institute (IWSRE), as the base institution for researching sediment disasters and for succeeding disaster remembrance, in the Nachikatsu-ura town where was severely damaged by debris flow disaster events in 2011. The IWSRE implements various programs to mitigate sediment disaster impacts in cooperation with concerned organizations. This study introduces new programs that the prefectural government has been implementing after typhoon in 2011.

Key words: 2011 disasters, Sabo works by the central government, Wakayama Sabo Research and Education Institute

1. INTRODUCTION

Recently, severe sediment disasters such as the Hiroshima disaster in 2014 occur every year in Japan due to increase of intensive heavy rainfall that may be caused by global-scale climate change. The circumstances that local residents suffer from sediment disasters have been keeping because the specification of affected areas and the prediction of disaster events are very difficult.

About 80% of the Wakayama prefectural area is covered by mountains and hills which have steep and fragile slopes. And the mountainous area in the southern part of the prefecture is nationally renowned for having heavy rainfall and being vulnerable to typhoon threats. Therefore, the Wakayama prefecture has high potential risk of sediment disasters.

Aiming to achieve zero death tolls, the Wakayama prefectural government has been implementing various non-structural measures such as public notification of restricted area due to

sediment-related disaster and issue of sediment-related disaster warning information, i.e. in order to support warning and evacuation activities. However, many human losses were caused by the typhoon TALAS in 2011¹⁾.

This study shows 1) the outline of 2011 sediment disasters and lessons from typhoon TALAS, 2) Sabo works by the central government, 3) various new programs the prefectural government has been implementing after 2011 disaster event.

2. 2011 DISASTERS CAUSED BY TYPHOON TALAS

The typhoon TALAS has recorded a remarkable amount of rainfall that dreadfully focused on the mountainous areas of the Kii-peninsula. Widespread of continuous rainfall of more than 1,000mm through the period from 29th of August to 4th of September was observed and the Osugi rain gauging station eventually estimated a record-breaking rainfall figure of 1,998mm. This typhoon caused

flood and stimulated the occurrence of landslides and debris flows in the southern part of the prefecture²⁾. The damage of the disaster event brought total 61 casualties as well as 40 villages isolated by 180 cut off the road. The world heritages were also damaged by this event.

The rainfall contour map of the typhoon TALAS, the contour map of major sediment disasters and the statistics of the damages are respectively indicated in **Fig.1, Fig.2, Table 1**.

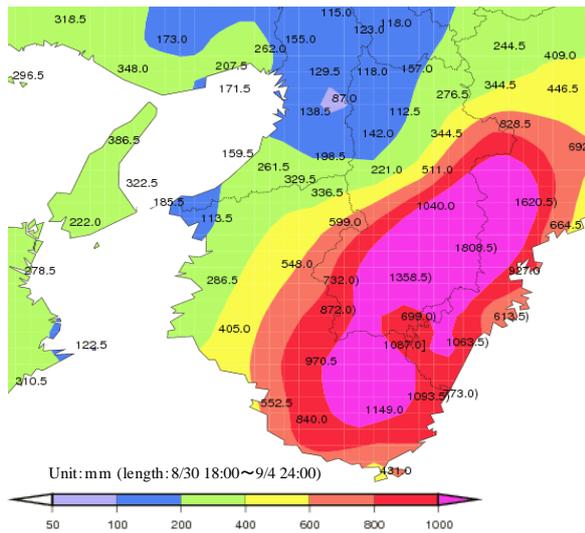


Fig. 1 Rainfall contour map of the typhoon TALAS

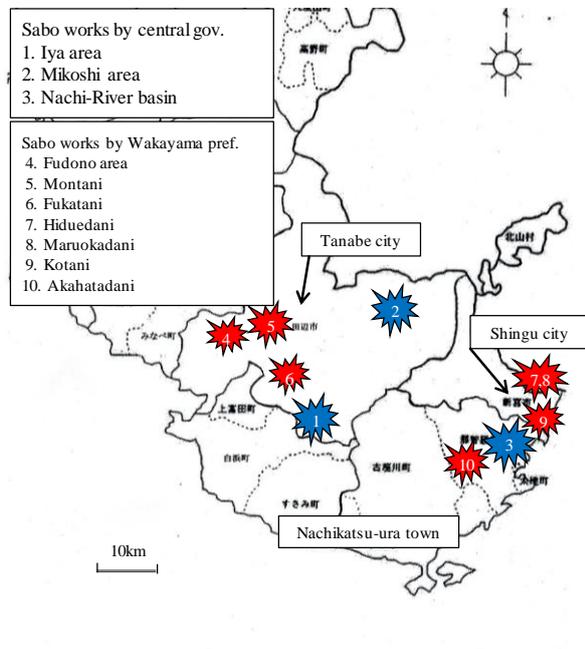


Fig. 2 Distribution map of major sediment disasters

Table 1 Damages by the typhoon TALAS

people			house destroyed	
dead	missing	injured	completely	partly
56	5	8	240	1,838

In particular, in the Iya area (Tanabe city), a landslide dam was formed by a large-scale deep-seated landslide. The potential damage that may be caused by the collapse of the landslide dam was under apprehensiveness and stimulated urgent circumstances. As for the Nachikatsu-ura town, debris flows occurred at many branch torrents in the Nachi-River basin and debris flow sediments deposited in its river area. As the result, the river area was affected by widespread flood damages. Emergency Sabo works were required in order to avoid the occurrence of secondary sediment disasters. The damage situation of the Iya area and the Nachikatsu-ura town is shown in **Fig. 3** and **Fig. 4**.



Fig. 3 Damage situation of the Iya area



Fig. 4 Damage situation of the Nachikatsu-ura town

This catastrophe revealed problems about preparedness for warning and evacuation and crisis management against large-scale sediment disaster etc. The prefectural government learned lessons as below.

- It is important to establish warning and evacuation system through confirmation of information on area affected by disasters, places and routes for evacuation, etc. in normal period.
- It is necessary to provide suitable information timely and to support municipalities in emergency period.
- It is necessary to establish crisis management system in order to take measures against large-scale sediment disasters.
- It is important to succeed disaster remembrance and to learn lessons from past disaster events.

3. SABO WORKS CONTRLED BY THE CENTRAL GOVERNMENT

High developed technology was required in order to implement Sabo works in the Iya area, the Mikoshi area and the Nachi-River basin among areas where the large-scale sediment disasters had occurred. The prefectural government requested the Ministry of Land, Infrastructure, Transportation and Tourism (MLIT) emergency Sabo works directly controlled by the central government and research about the mechanism of large-scale sediment disasters. The MLIT established the Kii Mountain Area Sabo Office in 2012 and the Sediment Disaster Prevention Technology Center (SDPTC) in 2014. The outline of the events and Sabo works by the central government are explained as below

3.1 Iya area

A landslide dam with a reservoir was formed due to the occurrence of a large-scale deep-seated landslide. The size of the landslide recorded approximately 450m in width and 650m in length. The volume of sediment caused by the landslide was estimated approximately 410,000m³.

Drainage works, backfilling of the reservoir and temporary channel works were carried out as emergency works. Sabo dam, stream preservation works and surface drainage works, etc. are carried out as restoration measures. Disaster prevention works are shown in **Fig. 5**.



Fig. 5 Disaster prevention works of the Iya area

3.2 Mikoshi area

A large-scale deep-seated landslide blocked the Mikoshi-River temporarily and a new river channel was formed in the center of a residential area located in left bank of the river.

Temporary revetment works and backfilling of reservoir were carried out as emergency works. Groundsels and revetment works are carried out as restoration measures. Disaster prevention works are shown in **Fig. 6**.



Fig. 6 Disaster prevention works of the Mikoshi area

3.3 Nachi-River basin

The Nachi-River area was affected by debris flows and drift woods, which were caused by surface failures at many branch torrents in the Nachi-River basin, and widespread flood damages that are accompanied by the debris flow sediments.

As the restoration works, Sabo dams are constructed at branch torrents where debris flow occurred and Sabo works are also constructed at main steam of the Nachi-River in order to entrap debris flows and drift woods. Disaster prevention works are shown in **Fig. 7**.



Fig. 7 Disaster prevention works of the Nachi-River basin

Sabo works, as mentioned above, raised the safety level of affected areas. However, sediment discharge has been keeping from devastated river basins. Therefore, the MLIT established a permanent Sabo office in the Kinki Regional Bureau and began new Sabo works by the central government on April 2017.

4. WAKAYAMA SABO RESEARCH AND EDUCATION INSTITUTE (IWSRE)

In order to mitigate sediment disaster impact like the 2011 disaster event, the Wakayama prefectural government established IWSRE in the Nachikatsu-ura town where severe sediment disasters had occurred. The duties of the IWSRE are to do research on the Sabo technology, to share information on the results of the research and to hand down disaster remembrance to posterity. The institute is shown in Fig. 8.



Fig. 8 Wakayama Sabo Research and Education Institute

In the IWSRE, the SDPTC implements research and development activities about advanced Sabo technology in cooperation with the Sediment Disaster Prevention Research Organization (SDPRO) that was organized by central and local

governments, universities, institutes in 2014. The organization chart is shown in Fig. 9.

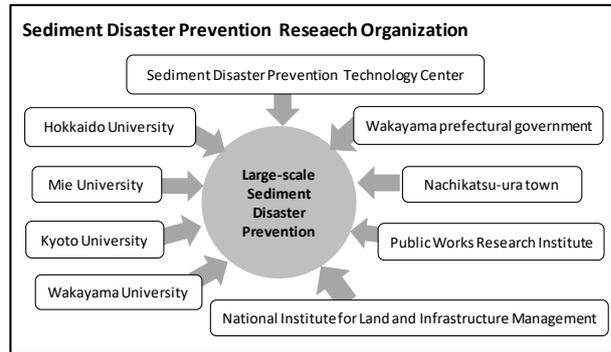


Fig. 9 Organization chart of SDPRO

In the respect that persons from academician to local government officer can participate in research and development activities, the SDPRO is a unique organization in Japan.

The IWSRE implements two activities as follows.

4.1 Research and development activities

The SDPTC, in cooperation with the SDPRO, does research on tasks as follows in the IWSRE³⁾.

- Extraction and evaluation of dangerous spots for large-scale sediment disasters
- Countermeasures for crisis management in mountain area
- Strengthening national land observation and national land management
- Development and introduction of next generation technology for disaster prevention

In addition to the tasks, the SDPRO has roles as follows.

- Support of promoting trainings for sediment disaster prevention
- Support of enriching and strengthening community-based disaster prevention
- Public information for disseminating knowledge on disaster prevention
- Sharing disaster prevention technology to foreign countries

Staffs of the IWSRE make an effort for improvement of their skill through assistance of research, which the SDPTC carries out, and give presentations at academic conferences. It is expected that the results of the research will be utilized on the site.

4.2 Awareness-raising activity

The erosion and sediment control division in the Wakayama prefectural government gives local residents trainings and lectures as awareness-raising activities. The IWSRE gave 123 groups such as

self-governing bodies, self-organizations for disaster prevention, fire fighters, etc. lectures till Mar 2017 after the IWSRE opened on Apr 2016. Many groups which live in other prefectures also visited the institute. A detail of groups which took lectures are indicated in Fig. 10.

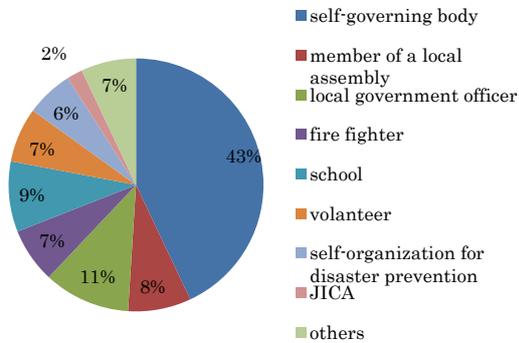


Fig. 10 A detail of groups

The IWSRE implements hearing about trainee's request at the time of reservation and makes materials that the trainee can understand easily. For example, information on sediment disaster at the trainee's home is utilized as the materials.

The IWSRE accepted Japan International Cooperation Agency (JICA) study tours from Latin America and Turkey. The IWSRE explained Sabo works in Wakayama prefecture and 2011 disaster to participants of the tours. Accepting the study tour from foreign countries is a significant way because information on the organization, facility and activities of the IWSRE can be widely given and information on disaster events and countermeasures in foreign countries can be exchanged. It is necessary to promote acceptance of the study tour in the future. Scenes of the study tour and discussion are shown in Fig. 11 and Fig. 12 respectively.



Fig. 11 Scenes of the study tour



Fig. 12 Scenes of discussion

Moreover, the IWSRE gave primary and secondary school students a lecture as a general study. Using a model channel, an experiment showing a debris flow runs and function of Sabo dam, etc. was carried out in the class. And a victim who had suffered from 2011 disaster talked her experience to the students using a picture story show. The students could understand a basic knowledge about sediment disaster. The lecture that uses a general study at primary and secondary schools are effective way that students can learn basic knowledge about sediment disasters and save their being by themselves. This way has another effect that their parents can have an interest on sediment disaster through conversation in their family. The Fig. 13 is the picture of the class.



Fig. 13 Class

Their awareness-raising activities are shown on HP as below.

<http://www.pref.wakayama.lg.jp/prefg/080604/top.html>

As above mentioned, the IWSRE implements various awareness-raising activities. However, there is a problem about sustainability because of their passive activities.

Therefore, the IWSRE plans to hold a roving

seminar for local residents. The IWSRE divides the prefecture into 7 blocks and holds a seminar at each block for 4 years. The seminar consists of a special lecture by a man of learning and experience, introduction of the SDPTC and the IWSRE and Sabo works in the local area. The first seminar was held in the Nachikatsu-ura town and about 150 residents participated in the seminar. The seminar is shown in **Fig. 14**.



Fig. 14 Roving Seminar

Besides, the IWSRE will send a message through making an English version HP in order to introduce its activities to the world. The IWSRE will plan various sustainable activities such as building

database on sediment disasters, systematizing disaster mitigation education, etc. in the future.

5. CONCLUSION

Taking the opportunity of 2011 catastrophe, establishment of the IWSRE and start of the Sabo works directly controlled by the central government are epoch making for the Sabo history of the Wakayama prefectural government.

The activity-base for research and enlightenment has been established through setting up the IWSRE. In order to mitigate sediment disaster impact, the prefectural government in cooperation with related organizations will make an effort in the future.

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REFERENCES

- 1) Keio CHITO, et al. (2014): Sabo works in Wakayama Prefecture –Historical disasters and Sabo-. INTERPRAEVENT 2014, proceedings, vol.1,pp. 703-708
- 2) Sediment Disaster Prevention Research Organization (2015): Annual report. (in Japanese total pages 67)
- 3) Wakayama prefectural government (2013): 2011 disaster record. (in Japanese total pages 304)