ESCAP/WMO
Typhoon Committee

REPORT OF THE PROJECT ON HAZARD MAPPING FOR SEDIMENT-RELATED DISASTERS

DECEMBER 2012

UNITED NATIONS ESCAP
Economic and Social Commission for Asia and the Pacific

WMO

TC/TD-No. 0006

ON THE COVER

Debris flow caused by torrential rain of the seasonal rain front in Aso city, Kumamoto Prefecture in July 2012
This torrential rain caused many sediment-related disasters resulting in 23 dead and missing in the western part of Japan, especially in the Aso region, Kumamoto Prefecture.

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Authors
Shin-ichiro Hayashi, Hideaki Mizuno, Atsushi Okamoto, (National Institute for Land and Infrastructure Management, NILIM)
Masaru Yamashita, Hideto Ochi, Hisashi Hoshino, (Ministry of Land, Infrastructure, Transport and Tourism, MLIT)
Satoshi Yamamoto, (Shizuoka City Office)
Masaki Hiruma, Reiji Kondo, (SABO and Landslide Technical Center, STC)

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ESCAP/WMO Typhoon Committee Secretariat
Avenida 5 de Outubro, Coloane
Macao, China
Tel.: (+853) 88010531 • Fax: (+853) 88010530
E-mail: info@typhooncommittee.org

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FOREWORD

Typhoon Committee (TC) area is the region with the most severe natural disasters in the world. Sediment-related disasters are one of the most severe types of natural disasters in terms of loss of life and serious socio-economic impacts in the TC Members, and the damage caused increase by climate change and unplanned land use in the future. The Asian Disaster Reduction Center (ADRC) has reported in 2010, in TC region, 13.2% of all natural disasters and 17.0% of mortality in all natural disasters were caused by sediment-related disasters.

On the one hand, the structural measures against sediment-related disasters will no doubt able to better protect residents. Moreover, structural measures require huge budgets and long construction periods. Thus, a proper combination of structural measures and non-structural measures is necessary. And if it is difficult to take structural measures, non-structural measures may be a more cost-effective measure to help residents avoid the potential damage.

Therefore the National Institute for Land and Infrastructure Management (NILIM), the SABO (Erosion and Sediment Control) Department of the Ministry of Land, Infrastructure, Transport and Tourism (MLIT) and the SABO and Landslide Technical Center (STC) implemented two TC projects regarding non-structural measures in TC Working Group on Hydrology (WGH). They conducted the project "Sediment-related Disaster Forecasting Warning System Project" from 2002 to 2008 and the "Project on Hazard Mapping for Sediment-related Disasters" from 2009 to 2012.

This publication is the final report on the latter project which is one of the most successful projects of WGH. Related TC Key Result Areas (KRA) of the project are as follows: 1) KRA 1, Reduced loss of life from typhoon-related disasters; 2) KRA 2, Minimized typhoon-related social and economic impacts; 3) KRA 4, Improved typhoon-related disaster risk management in various sectors; and 4) KRA 5, Strengthened resilience of communities to typhoon-related disasters.

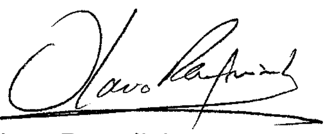
The aim of the Project on Hazard Mapping for Sediment-related Disasters is to share Japanese SABO technique and consequently to facilitate Members to make and use hazard maps for sediment-related disasters. Purposes of hazard maps are to restrict land use and to provide early warning information to residents who live in hazardous areas so they will evacuate.

During implementation of project in the past 4 years, Field training in Zhuhai, China in 2010 and SABO Workshop in Nha Trang, Viet Nam in 2011 were held for sharing Japanese SABO technique, and for demonstrating how to identify hazardous areas and how to establish the integrated system for residents' evacuation from sediment-related disasters. These activities were very helpful to encourage the awareness of sediment-related disaster prevention in TC members.

The report on their former project "Sediment-Related Disaster Forecasting Warning System" explains how to prepare early warning information. This report explains how to identify hazardous areas (Chapter3) and how to establish the integrated system for residents' evacuation from sediment-related disasters (Chapter2). These two reports are very useful to know Japanese SABO technique regarding all components of early warning against sediment-related disaster.

At 7th TC Integrated Workshop with the theme of "Effective Warning", which was held in Nanjing, China in November, 2012, WMO's keynote lecture indicated that clarifying roles against disasters in related organizations is very important to conduct effective warning. Chapter 2 of this report shows the roles of related agencies against sediment-related disasters to establish the integrated system for residents' evacuation from this type of disasters. This report can be one example of clarifying roles against sediment-related disaster, which is response to the above reference made in the keynote from WMO.

I am confident that the project has achieved the expected goals and its success will have a great impact in relation to sediment-related disaster prevention not only for the Typhoon Committee but also for the Members of the Panel on Tropical Cyclones, Hurricane Committee and the other regional bodies of the WMO Tropical Cyclone Programme. Also I believe that this final report does not mean the end of the cooperation in aspect of sediment disaster prevention in TC area. I would like to express thanks to all SABO experts of NILIM, MLIT and STC of Japan and all related TC WGH and WGDRR members for their kind cooperation and great contribution to this project during the past 4 years. We also appreciate that a new project named “Project on estimation for socio-economic impact of sediment-related disaster” will be launched in 2013.



Olavo Rasqũinho
Typhoon Committee Secretary
December 18, 2012

ACKNOWLEDGEMENTS

We would like to express our gratitude to the Typhoon Committee Secretariat, especially TCS Hydrologist Mr. Jinping Liu for all the support he gave to the conduct of this project.

And we also thank the WGDRR, SMG, CMA, Meteorological Department and The Office of Land and Resource of Zhuhai for their support with the conduct of the Field Training for the project “Hazard Mapping for Sediment-related Disasters” in Macao and Zhuhai, China, 2010, and the NHMS for its support for the conduct of the SABO Workshop in Nha Trang, Viet Nam, 2011.

We are also grateful to the Head of the Geotechnical Engineering Office and the Director of Civil Engineering and Development, the Government of the Hong Kong Special Administrative Region, for the permission to publish the figures and plate concerned in Chapter 5.

1. INTRODUCTION

1.1 Recent state of sediment-related disasters in Japan and TC member's regions

Throughout Japan, approximately 1,000 sediment-related disasters occur and 20 people die on the average each year (Fig. 1.1.1). Twenty victims equal half of the total number of people killed by natural disasters in Japan.

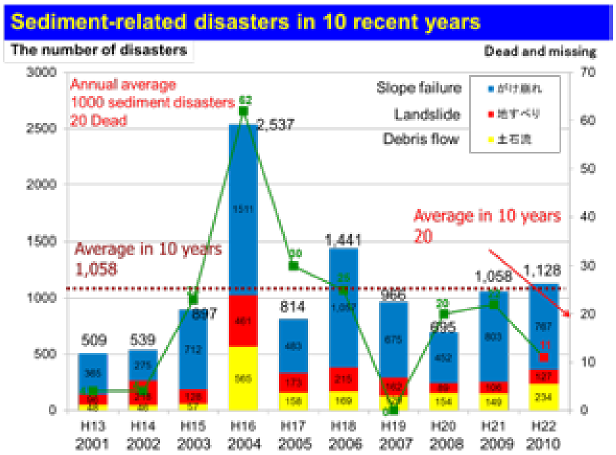


Fig. 1.1.1 Statistics regarding sediment-related disasters from 2001 to 2010 researched by MLIT

In particular, Typhoon Talas of September 2011 caused sediment-related disasters especially in Kii peninsula, resulting in serious damage and 79 dead and 19 missing in total (Photo. 1.1.1).

Debris flow, Nachi-katsuura town, Wakayama Pref.

Deep catastrophic landslide
Fudono, Tanabe city, Wakayama Pref.
Photo 1.1.1 Sediment-related disasters caused by Typhoon Talas.

In Asia, the ADRC[1)] has reported that according to CRED EM-DAT, in almost all TC members regions, 13.2% of all natural disasters were sediment-related (Mass Movement) events and 17.0% of those killed in all natural disasters were killed by sediment-related disasters (19 events and 2,567 killed). Sediment-related disasters are one of the most severe types of natural disasters in terms of loss of life and serious socio-economic impacts in the TC member's regions.

1.2 "SABO" Japanese countermeasures against sediment-related disasters

In order to reduce loss of life and socio-economic impacts, the general concept is to separate people from high risk areas. In Japan, we do this by taking countermeasures "SABO"[2)] to prevent sediment-related disasters. Fig. 1.2.1 shows three objectives of sediment-related disaster prevention.

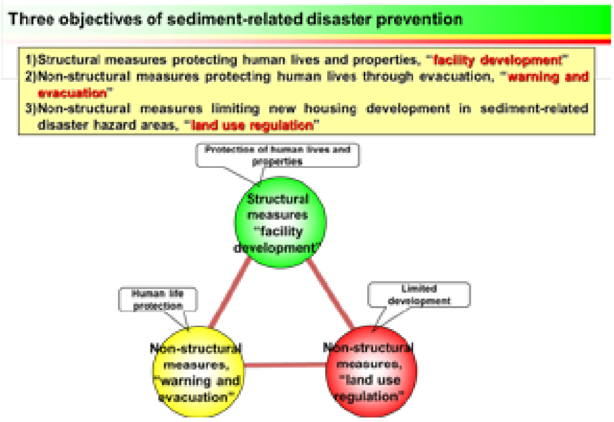


Fig. 1.2.1 Three objectives of sediment-related disaster prevention

The three objectives are as follows.

1) Structural measures “Facility Development”

To control sediment movement such as debris flow, slope failure and landslide

Ex.) Check dams (Photo 1.2.1), Channel works and so on

Photo 1.2.1 Check dam

2) Non-structural measures “Warning and Evacuation”

To evacuate people from dangerous areas

Ex.) Sediment disaster warning information (Fig.1.2.2) and so on

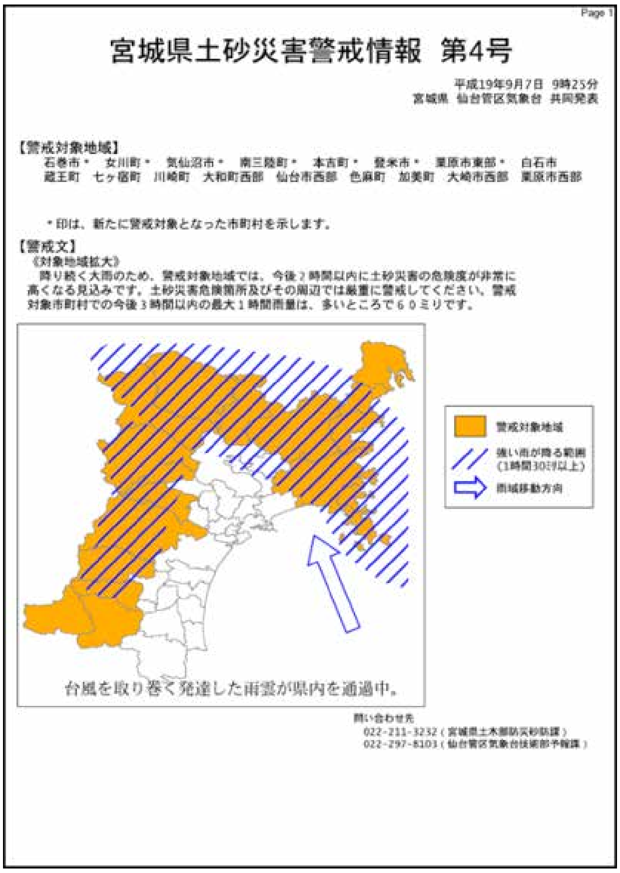


Fig. 1.2.2 Example of sediment disaster warning information (Orange hatched area is the area where warning was issued)

3) Non-structural measures “Land-use restriction”

To prevent human use of dangerous areas

Ex.) Designation of sediment-related disaster warning areas where land-use is restricted (Fig. 1.2.3) and so on

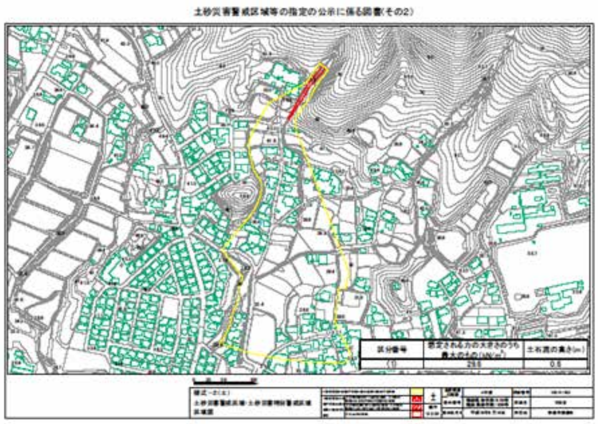


Fig. 1.2.3 Example of designation of a sediment-related disaster warning area (The area which is inside the yellow and red line)

1.3 Purpose of the Project on Hazard Mapping for Sediment-related Disasters

Structural measures reliably protect residents from sediment-related disasters. On the other hand, structural measures require huge budgets and long construction periods. Thus, a proper combination of structural measures and non-structural measures is necessary.

And if it is difficult to take structural measures, only non-structural measures may more effectively help residents avoid damage than doing nothing.

Therefore the National Institute for Land and Infrastructure Management ((NILIM, sabou@nilim.go.jp), the SABO (Erosion and Sediment Control) Department of the Ministry of Land, Infrastructure, Transport and Tourism (MLIT) and the SABO and Landslide Technical Center (STC) implemented two TC projects regarding non-structural measures in WGH. We conducted the project "Sediment-related Disaster Forecasting Warning System Project"[3)] from 2002 to 2008 and conducted the "Project on Hazard Mapping for Sediment-related Disasters" from 2009 to 2012. This report is the final report on the project "Project on Hazard Mapping for Sediment-related Disasters".

Related TC Key Result Areas (KRA) of "Project on Hazard Mapping for Sediment-related disasters" are KRA1, 2, 4, 5.

Reference

1) Asian Disaster Reduction Center: Natural Disaster Data Book 2010
http://www.adrc.asia/publications/databook/ORG/databook_2010/pdf/DataBook2010_e.pdf

2) Japan Sabo Association: SABO in JAPAN, 2001
http://www.mlit.go.jp/river/sabo/kondankai2/nihonnnosabo.pdf

3) Hideaki Mizuno: Sediment-Related Disaster Forecasting Warning System Project, WMO/TD-No.1520, 2010
http://www.typhooncommittee.org/docs/publications/book2_SEDIMENT.pdf

2. ESTABLISHMENT OF THE INTEGRATED SYSTEM FOR RESIDENTS' EVACUATION FROM SEDIMENT-RELATED DISASTERS

2.1 Flow of early warning information and four important players; the "Meteorological agency", "Agency for Disaster Prevention against Sediment-related Disasters", "Municipal offices" and "Residents"

Structural measures against sediment-related disasters can protect residents with a high degree of certainty. On the other hand, structural measures need huge budgets and long construction periods.

It is also important that residents evacuate before a disaster happens to protect their lives. Establishment of the integrated system for residents' evacuation from sediment-related disasters is a non-structural measure that helps support residents' evacuation.

Fig. 2.1.1 shows the "Early warning information" flow from creating the early warning information to evacuating residents. "Early warning information" should be provided to residents who live in hazardous areas to encourage them to evacuate.

Fig. 2.1.1 The flow of "Early warning information"

The report on our former project "Sediment-Related Disaster Forecasting Warning System Project"[1] (http://www.typhooncommittee.org/docs/publications/book2_SEDIMENT.pdf) explains how to prepare "Early warning information". And Chapter 3 of this report explains how to identify hazardous areas.

Fig. 2.1.2 shows the structure of the Japanese integrated system for residents' evacuation from sediment-related disasters. In each prefecture, the Local Meteorological Observatory (JMA's branch office) and Prefectural Sabo Department (section for sediment-related disaster prevention) prepare "Early warning information". The Local Meteorological Observatory provides early warning information to the Fire and Disaster Prevention Department of the prefectural government and TV and Radio stations disseminate the information to residents. The Prefectural Sabo Department gives the information to the municipal office that is in charge of protection of residents. The municipal office provides the information to residents to help them evacuate. In Japan, under the Disaster Countermeasures Basic Law, municipal offices are in charge of disaster control and protection of residents.

In this structure, four important players support residents' evacuation, the "Meteorological Agency", "Agency for Disaster Prevention against Sediment-related Disasters", "Municipal offices" and"Residents". Fig. 2.1.3 shows the roles of each agency against sediment-related disasters. The roles and how they should be filled will be explained based on Japanese examples in the following items in this chapter.

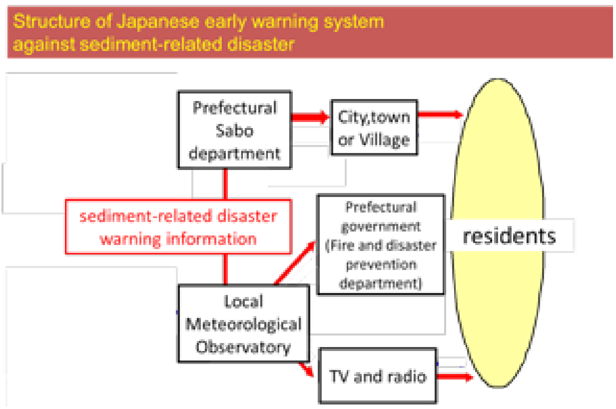
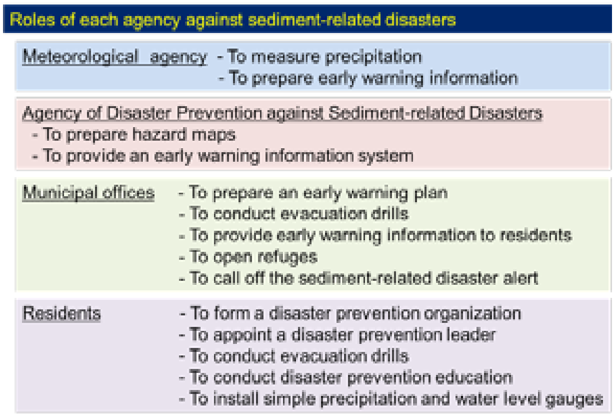


Fig. 2.1.2 The structure of Japan's integrated system for residents' evacuation



Roles of each agency against sediment-related disasters	
Meteorological agency	- To measure precipitation - To prepare early warning information
Agency of Disaster Prevention against Sediment-related Disasters	- To prepare hazard maps - To provide an early warning information system
Municipal offices	- To prepare an early warning plan - To conduct evacuation drills - To provide early warning information to residents - To open refuges - To call off the sediment-related disaster alert
Residents	- To form a disaster prevention organization - To appoint a disaster prevention leader - To conduct evacuation drills - To conduct disaster prevention education - To install simple precipitation and water level gauges

Fig. 2.1.3 Roles of each agency against sediment-related disasters

2.2 Roles of the "Meteorological Agency"

Since March 2008, Local Meteorological Observatories and Prefectural Sabo Departments have jointly issued "Sediment-related Disaster Warning Information" in all prefectures of Japan as "Early warning information".

Roles of the Meteorological agency are as follows.
1) To measure precipitation
2) To prepare early warning information

1) To measure precipitation
Measuring precipitation is essential to obtain data to input to prepare early warning information. JMA measures and calculates 2 kinds of precipitation information as follows.

a) Amount of precipitation analyzed by radar-AMeDAS
JMA has about 1,300 "AMeDAS" stations (Photo 2.2.1) and MLIT has C band radar (Fig. 2.2.1) to measure precipitation. JMA combines AmeDAS data and MLIT C band radar to prepare amount of precipitation analyzed by radar-AMeDAS (Fig. 2.2.2) as spatial precipitation data.

Photo 2.2.1 AMeDAS station

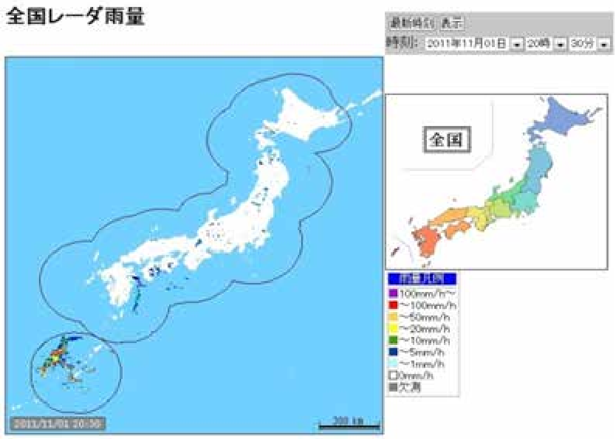


Fig. 2.2.1 MLIT C band radar (http://www.river.go.jp/)

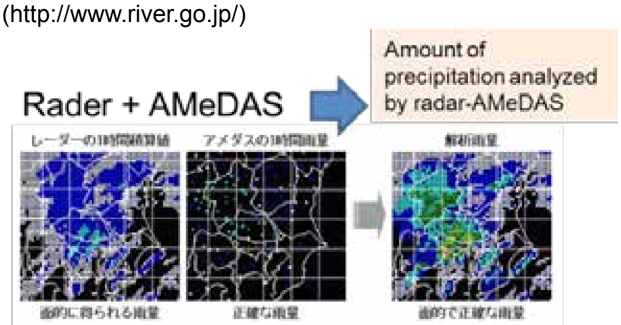


Fig 2.2.2 Amount of precipitation analyzed by radar-AMeDAS (http://www.jma.go.jp/jma/kishou/know/kurashi/kaiseki.

html, in Japanese)

b) Short-term precipitation forecast
JMA calculates short-term precipitation forecasts for the next 6 hours. Next 1 hour and 2 hour short-term precipitation forecasts are used to prepare sediment-related disaster warning information (Fig. 2.2.3).

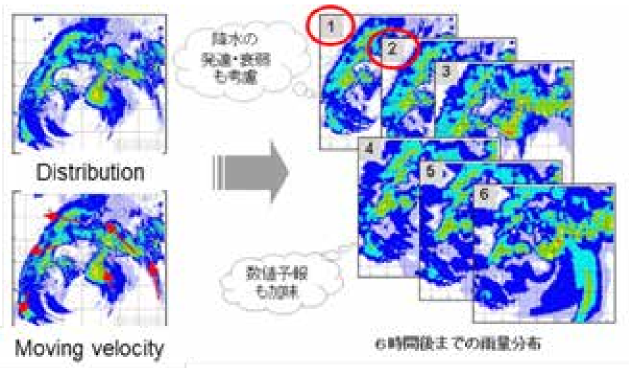


Fig. 2.2.3 Short-term precipitation forecasts (http://www.jma.go.jp/jma/kishou/know/kurashi/kotan_nowcast.html, in Japanese)

2) To prepare early warning information
The concept of preparing early warning information is shown in Fig. 2.2.4. By using input precipitation data, 2 indices are calculated every 30 minutes. One is the long-term rainfall index (X axis) and the other is the short-term rainfall index (Y axis). If the plotted calculation result is over the Critical Line (CL), early warning information is issued. The CL is set to divide the safe range and danger range based on historical precipitation data and disaster records.

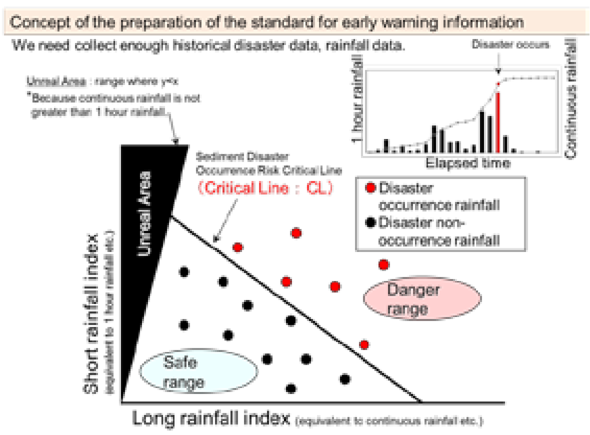


Fig. 2.2.4 Concept of preparing early warning information

"Sediment-related Disaster Warning Information"[2)] is prepared by the following three steps (Fig. 2.2.5). All Japan is divided into 5km×5km meshes. Every 5km×5km mesh has its original CL line.

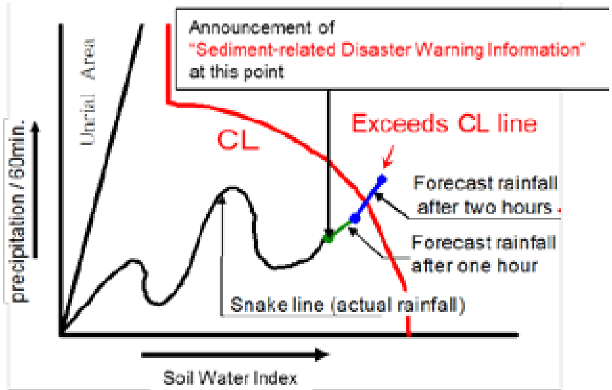


Fig. 2.2.5 Outline of steps to issue "Sediment-related Disaster Warning Information"

<u>1st Step</u>: Draw a snake line
X axis: Soil Water index
(Tank model made by JMA)
Y axis: 60 minutes rainfall

Both data come from Amount of precipitation analyzed by radar-AMeDAS.

<u>2nd Step</u>: Forecast a snake line after one hour and two hours
Points one and two hours later are estimated using the short-term precipitation forecast.

<u>3rd Step</u>: Judgment
If the point two hours later is located outside the critical line (CL), sediment disaster warning information is issued.

In Japan, everybody can know if "Sediment-related Disaster Warning Information" is announced or not. The JMA websites (Fig. 2.2.6) show municipalities where it is announced. The MLIT Sabo Dept. site and Prefectural Sabo Department websites (Fig. 2.2.7) show the risk level of each 5km×5km mesh. And TV and radio stations broadcast the information to the general public (Fig. 2.2.8).

Fig 2.2.6 JMA website (example of Shimane Prefecture, http://www.jma.go.jp/jp/dosha/, in Japanese)

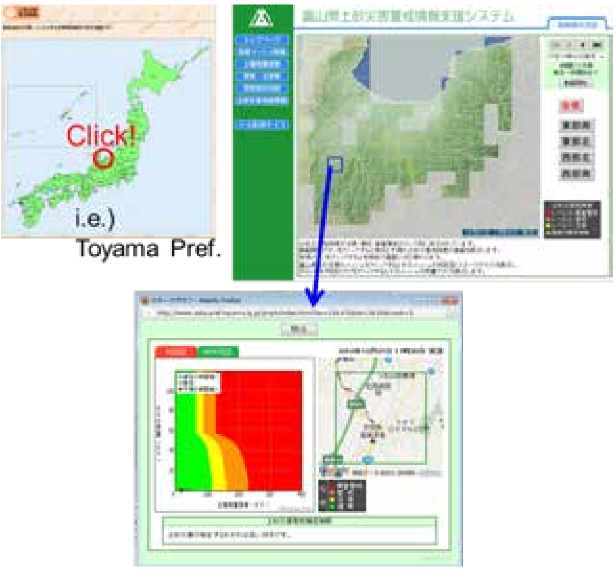
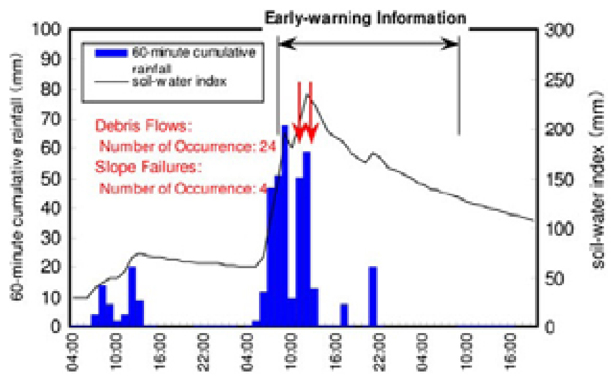


Fig. 2.2.7 MLIT Sabo Dept. Web site and Prefectural Sabo Department website (http://www.mlit.go.jp/river/sabo/sabo_ken_link/index.html, in Japanese)

Fig. 2.2.8 NHK TV news

On July 21st, 2009, 65 debris flows and 105 slope failures occurred in Hofu City, Yamaguchi Prefecture (Yamaguchi disaster). Fourteen people died as a result of these mass movements. The time series of 60-min rainfalls and soil water index, the timings of occurrence of debris flows and slope failures, and the period of early-warning information issue are shown in the top part of Fig. 2.2.9. The progress of the snake line and the timing of the disasters (red dots) are shown in the bottom part of Fig. 2.2.9. The disasters occurred when the snake line exceeded the CL and went into the danger range. CL adequately captured the timing of these disasters' occurrences.



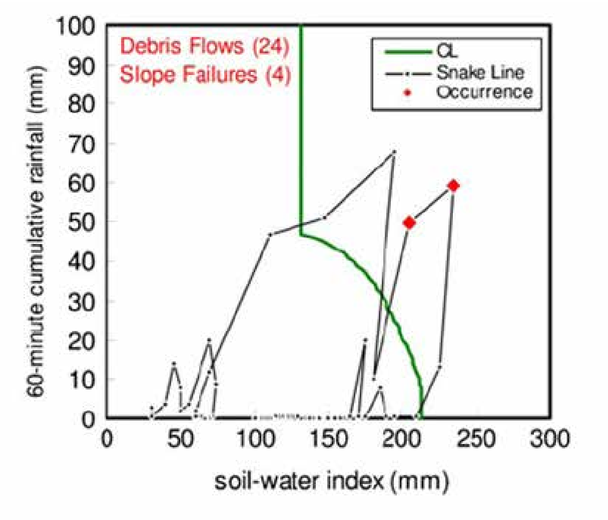


Fig. 2.2.9 CL and Snake line of the Yamaguchi disaster [2)]

At the QPE/QPF (Quantitative Precipitation Estimation and Quantitative Precipitation Forecasting) workshop conducted by WGM in conjunction with the TC 6th Integrated Workshop in Nha Trang, Viet Nam, in November 2011, the Sediment-related Disaster Warning Information was explained as an example of usage of the QPE/QPF.

2.3 Roles of the "Agency of Disaster Prevention against Sediment-related Disasters"

Roles of the "Agency of Disaster Prevention against Sediment-related Disasters" (Prefectural Sabo Department) are as follows.

1) To prepare hazard maps

2) To provide an early warning information system

1) To prepare hazard maps

Purposes of "Hazard Maps"[3)] are to restrict land use and to provide Early Warning Information to residents who live in hazardous areas so they will evacuate.

Japan had set about 230,000 hazardous area "Sediment-related disaster warning areas" up to September 2011. Fig. 2.3.1 shows the designation of a Sediment-related disaster warning area in Hofu city. The area inside the yellow line is a debris flow hazard area.

Fig. 2.3.1 Designation of Sediment-related disaster warning area in Hofu City

When the Yamaguchi disaster of 2009 occurred, debris flows occurred in several Sediment-related disaster warning areas in Fig. 2.3.1. One debris flow ran into a home for the aged, killing 7 old people. Another debris flow killed 2 people (Fig. 2.3.2). In hazardous areas, residents may die due to debris flow or slope failure. Therefore it is necessary to evacuate in advance of the disaster occurrence.

Fig. 2.3.2 Debris flows of the Yamaguchi disaster

In Japan, everybody can be informed if their house is or is not in a designated Sediment-related disaster warning area. Fig. 2.3.3 shows Shimane Prefecuture's Internet web GIS service. The inside of the blue line is a debris flow hazard area and the inside of the red line is a slope failure hazard area . In one slope failure hazard area, a slope failed, killing 2 residents in 2010.

Web site of MLIT SABO Dept.

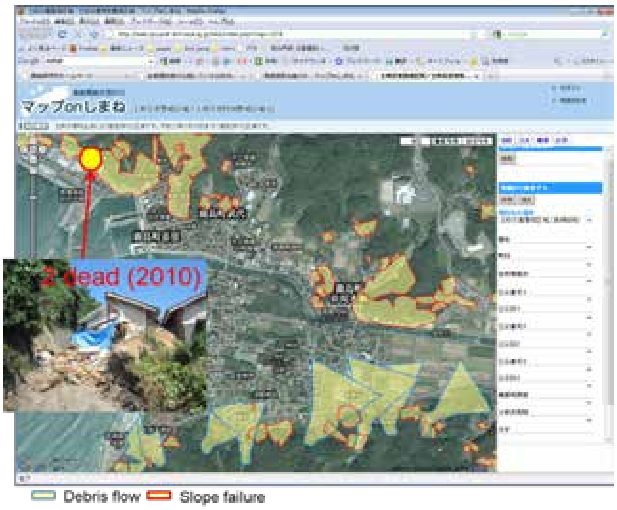


Fig. 2.3.3 Shimane Prefecture'sInternet web GIS service (http://www.mlit.go.jp/river/sabo/link_dosya_kiken.html, in Japanese)

And also, in Japan, municipal offices distribute sediment-related disaster hazard maps to their residents. Fig. 2.3.4 show one example of a sediment-related disaster hazard map in Hitachi-omiya City, Ibaraki Pref..

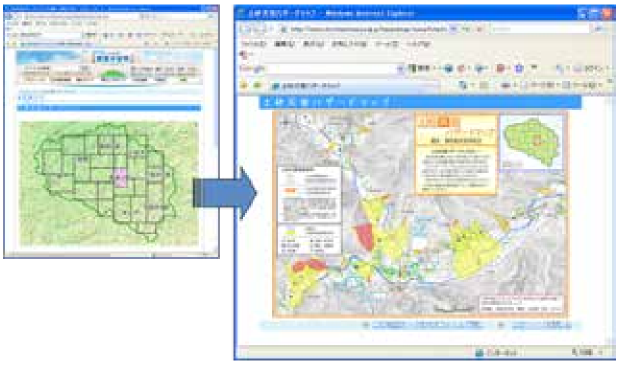


Fig. 2.3.4 Sediment-related disaster hazard map of Hitachi-omiya City, Ibaraki pref.

Methods of making and using sediment-related disaster hazard maps are explained in detail in chapter 3..

2) To provide an early warning information system

Another role of the Agency of Disaster Prevention against Sediment-related Disasters is providing early warning information systems. Fig. 2.3.5 shows an example of one which provides the level of danger of a sediment-related disaster to cellular phone users. In Japan, most prefectural governments establish systems to provide this information directly to municipal offices and residents. And web based provision systems are also established as shown in Fig. 2.2.6 and Fig. 2.2.7.

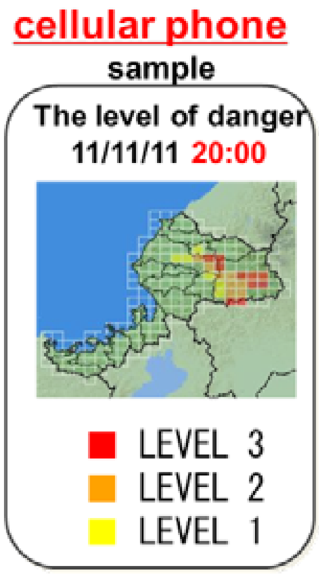


Fig. 2.3.5 Example of a system providing the danger level through cellular phones

2.4 Roles of "Municipal offices"

In Japan, municipal offices are in charge of disaster control and protection of residents under the Disaster Countermeasures Basic Law. Roles of Municipal offices are as follows.

1) To prepare an early warning plan
2) To conduct evacuation drills
3) To provide early warning information to residents
4) To open refuges
5) To call off the sediment-related disaster alert

1) To prepare an early warning plan
In Japan, every municipal office has enacted a "Regional Plan for Disaster Prevention" regarding disasters of all kinds. Each plan stipulates what offices and residents should do at normal times and in an emergency situation.

2) To conduct evacuation drills
It is very important to conduct evacuation drills at normal times to prepare for real disaster control and resident protection operations (Photo 2.4.1).

In Japan, June is designated as "Sediment Disaster Prevention Month" to raise citizen's awareness of sediment disaster prevention. On June 12th, 2011, the "All Japan sediment disaster prevention drills" were conducted. Evacuation drills were conducted by 74 municipal offices with 14,300 people participating. And 1,170 municipal offices joined the information transmission drill.

Photo 2.4.1 City office staff taking part in a sediment disaster drill

3) To provide early warning information to residents
A municipal office should have information transmission equipment to provide early warning information to local residents. Photo 2.4.2 shows the outdoor speaker of a municipal office's official disaster radio broadcast system and its control box. Photo 2.4.3 shows a community FM radio receiver installed in residents' houses. Local cable TV networks are also useful. These systems are used not only as emergency broadcast systems for all kinds of disasters but also as ordinary broadcast systems linking municipal offices to residents.

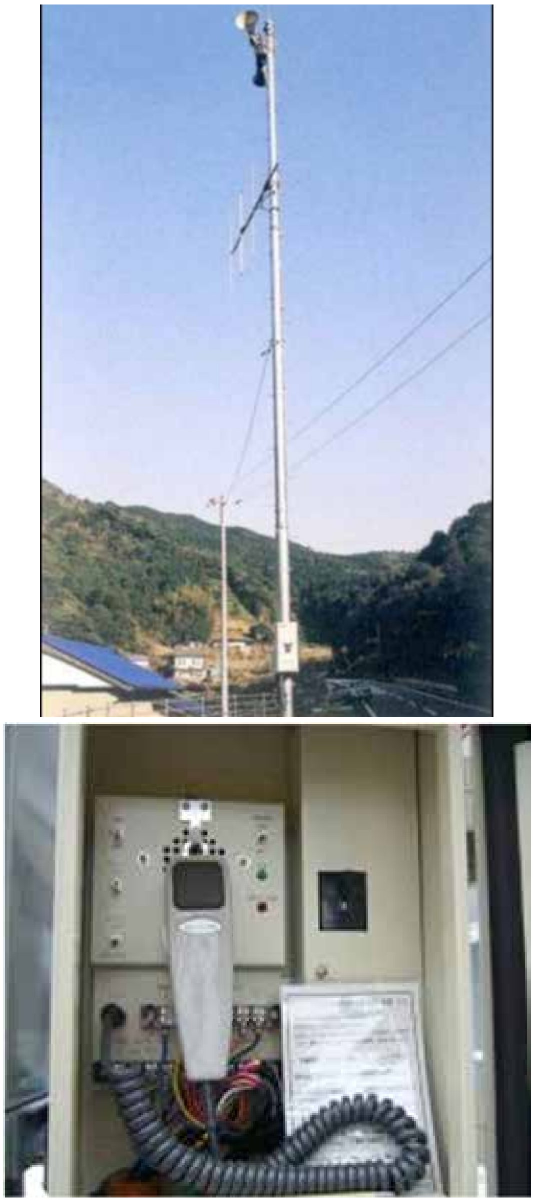


Photo 2.4.2 Information transmission Equipment for communication with local residents

Photo 2.4.3 Community FM radio receiver installed in homes

4) To open refuges
Every municipal office has to open a refuge for residents' evacuation when disaster risk is high. The refuge venue must be a place safe from sediment-related disasters. And the refuge has to have enough equipment to accommodate residents; for example, food, drink and bedding. Because municipal offices have to be used to open refuges in emergency situations, when performing evacuation drills, training in how to open refuges is preferable (Photo 2.4.4).

Photo 2.4.4 Drill practicing the distribution of foods and drink to evacuees

5) To call off the sediment-related disaster alert
The municipal office has to call off the sediment-related disaster alert to let residents go back home. Examples of call off criteria are as follows.
- Sediment-related Disaster Warning Information was called off by a Local Meteorological Observatory and Prefectural Sabo Department
-The municipal office can confirm no risk of a sediment-related disaster.

Although municipal offices have to play important roles to protect residents, usually a municipal office doesn't have enough organization, staff and knowledge about disasters. Therefore the MLIT provides the guideline "Sediment-related Disaster Warning and Evacuation Guidelines"[4) to support municipal offices.

2.5 Roles of "Residents"

The roles of residents are as follows.

1) To form a disaster prevention organization
2) To appoint a disaster prevention leader
3) To conduct evacuation drills
4) To conduct disaster prevention education
5) To install simple precipitation and water level gauges

1) To form a disaster prevention organization

2) To appoint a disaster prevention leader
In Japan, residents establish "voluntary organizations for disaster prevention" to prepare for all kinds of disasters in each local community in a municipality. Fig. 2.5.1 shows the structure of a "voluntary organization for disaster prevention". In the organization, some groups are given special roles in disaster prevention. For example, a rescue group, evacuation support group, information collection and provision group, meal and water supply group, and firefighting group. The leader has to manage these groups and maintain contact with the municipal office.

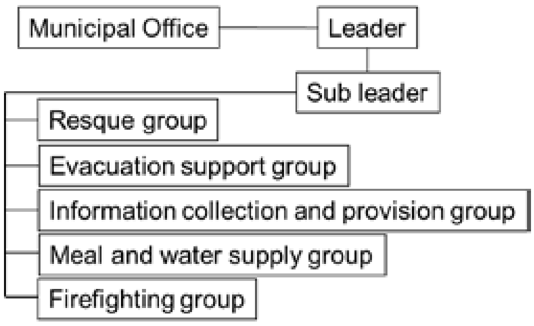


Fig. 2.5.1 the structure of a voluntary disaster prevention organization

3) To conduct evacuation drills
Residents should confirm the evacuation procedure, evacuation route and refuge by conducting evacuation drills at normal times (Photo 2.5.1). Throughout Japan, sediment disaster prevention drills, and resident evacuation drills are conducted. Because aged and handicapped people are especially hard to evacuate, great attention should be paid to such persons. It is best to make lists of such people and decide procedures to pick them up to evacuate.

Photo 2.5.1 Evacuation drill

4) To conduct disaster prevention education
At normal times, it is very important and effective to conduct disaster prevention education to raise residents' awareness. Photo 2.5.2 shows residents making a handmade hazard map while discussing their community's sediment-related disaster risk to share their knowledge.

Photo 2.5.2 Local residents making a handmade hazard map

Photo 2.5.3 shows a handmade hazard map made by elementary school students as result of classes regarding local disaster prevention. Disaster prevention education in elementary school is an important way to prepare future local disaster prevention leaders and effectively raise awareness among the student's families and local society. Photo 2.5.4 shows an example of teaching material used to teach the danger of debris flows and effects of structural measures against debris flows. Such teaching materials also help to give students a good understanding.

Fig. 2.5.3 Handmade hazard map made by elementary school students (Okitsu elementary school, Kochi Pref.)

Photo 2.5.4 Teaching material about debris flows

5) To install simple precipitation and water level gauges
It is very important that residents know when it is dangerous without outside information. Handmade precipitation and water level

gauges can effectively inform them when it is dangerous. Photo 2.5.5 shows a handmade precipitation and water level gauge[5] made from materials which are available in every country. Even just measuring precipitation using a glass or a plastic bottle to reveal unusual rainfall may be an effective way to become aware of imminent danger (Photo 2.5.6).

Precipitation gauge

Water level gauge

Photo 2.5.5 Handmade precipitation and water level gauges

Fig 2.5.6 Simple precipitation gauges made of a glass and a plastic bottle

2.6 JICA project "Integrated Disaster Mitigation Management Project for Banjir Bandang"

JICA (Japan International Cooperation Agency) and the public works ministry of Indonesia conducted the project "Integrated Disaster Mitigation Management Project for Banjir Bandang"[6] in Indonesia from 2008 to 2012. "Banjir Bandang" means flash flood or big debris flow in Indonesian. This project's purpose is to establish Banjir Bandang early warning and emergency measures at hazardous areas all over Indonesia. Japanese SABO experts participated in this project.

This project included many of the activities mentioned in this chapter conducted as follows, to establish an integrated system for residents' evacuation from sediment-related disasters and to raise local people's awareness of sediment-related disasters.

- Holding seminars for residents regarding disaster prevention (Photo 2.6.1)

- Distributing educational comic books (Fig. 2.6.1)

- Conducting drills with related organization and residents according to emergency scenarios (Photo 2.6.2, Table 2.6.1)

Photo 2.6.1 Seminar for residents

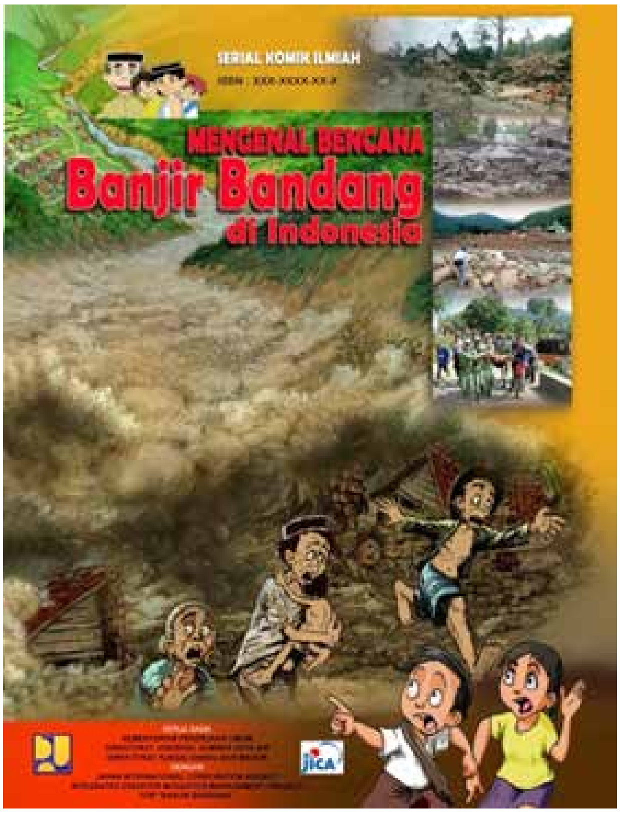


Fig. 2.6.1 Educational comic book

Photo 2.6.2 Drill

Jam	Data Curah Hujan	Data Curah hujan akumulasi	Level	Sensor curah hujan	Sensor Ketinggian Air	KONDISI LAPANGAN
13:45	23	28	0	Lv0	Lv0	Hujan Gerimis mulai deras
13:50	5	33	0	Lv1	Lv0	Hujan Gerimis mulai deras
14:00	15	48	0	Lv1	Lv0	Hujan Deras
14:05	30	78	1	Lv2	Lv1	Hujan Deras
14:10	22	100	1	Lv3	Lv1	Hujan Deras
14:15	9	109	2	Lv3	Lv2	Hujan Deras, pengukur keretakan tanah menunjukkan tanah mulai retak 2mm/hr
14:20	14	123	2	Lv4	Lv2	Hujan Deras, pengukur keretakan tanah menunjukkan tanah mulai retak 4mm/hr
14:25	20	143	3	Lv4	Lv3	Hujan Deras, pengukur keretakan tanah menunjukkan tanah mulai retak 8 mm/hr
14:30	82	225	4	Lv5	Lv4	Hujan Deras, terjadi tanah longsor (skala kecil)
14:35	52	277	5	Lv5	LV5	Hujan Deras, pasir, batu, kayu mengalir turun

Table 2.6.1 Drill Scenario

2.7 Warning signals of natural phenomena

Just before a sediment-related disaster occurs, some natural phenomena can warn of the disaster (Fig. 2.7.1). At normal times, it is helpful to distribute this knowledge among residents to help them protect themselves and avoid damage from disasters.

In Japan, the smell of mud, rumble of rocks and mountains are well known examples of such natural phenomena. Because such natural phenomena may be different in each region, after a disaster, it is necessary to gather information about such natural phenomena from the residents in the affected area.

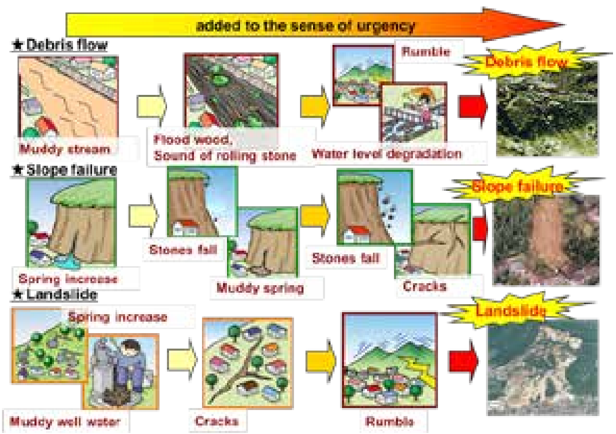


Fig. 2.7.1 Natural phenomena which warn of disasters

2.8 Evacuation to second floor

The best method is evacuation to a place of refuge in advance. However, at night and under bad weather conditions, evacuation may be more dangerous than staying home, because evacuees may suffer disaster damage or accidents on the way to their refuges. In such a situation, evacuation to a second floor room on the side opposite from the mountain slope may be the only way to protect one's life.

Fig. 2.8.1 shows a case where no damage affected a second floor room on the side of a house opposite the mountain slope during a debris flow disaster. This knowledge should be shared with for residents at normal times.

Fig. 2.8.1 No damage to a room on the second floor

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6) Integrated Disaster Mitigation Management Project for “Banjir Bandang” http://www.jica.go.jp/project/english/indonesia/0800040/index.html

3. HOW TO MAKE HAZARD MAPS FOR SEDIMENT-RELATED DISASTER

3.1 Difference between the phenomena "Debris flow", "Landslide", "Slope failure"

In Japan, sediment-related disasters are categorized as three types "debris flow" (Photo 3.1.1), "landslide" (Photo 3.1.2), "slope failure" (Photo 3.1.3) to make structural and non-structural countermeasures effective and efficient for each phenomena. Differences between landslides and slope failures are as follows.

- Landslides are mainly induced by groundwater-related disasters. Their slip surfaces are deep (about 10m and more) and their movement is very slow (several mm in a year).
- Landslides usually occur chronically.
- Landslides usually occur in special geology (ex. tertiary sediment rock)
- Slope failures move very quickly. Their slip surfaces are shallow (about 1m-2m).
- Slope failures occur at steep slopes with gradient more than 30 degree.

Aerial photograph

Photo 3.1.1 Debris flow (1999, Hiroshima City)

Photo 3.1.2 Landslide (1985, Jizukiyama, Nagano City)

Photo 3.1.3 Slope failure (2006, Hishikari town, Kagoshima pref.)

3.2 How to identify a “Debris flow” hazard area

The method of identifying a “debris flow” hazard area, which is similar to that for a Japanese sediment-related disaster warning area, is as follows (Fig.3.2.1).

1) Finding valley-type topography
2) Setting the direction of the debris flow and forming the longitudinal section
3) Measuring gradient of stream and identifying the point that it becomes:
10 degrees = flooding beginning point
2 degrees = the end of warning area
4) Drawing the warning area at level of 5m above riverbed at several points

1) Finding valley-type topography
- Make an enlarged copy of a topography map with scale of 1:10,000. (You can also use any map and any scale)
- Find valley-type topography (Fig. 3.2.2) where there are 5 houses on an alluvial fan and so on by reading contours on the map.

-The drainage area should be between 0.1km^2 and 5km^2.

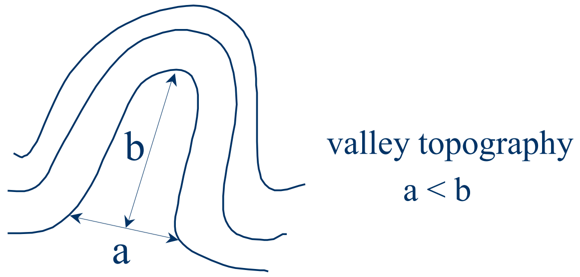


Fig. 3.2.2 Valley-type topography

2) Setting the direction of the debris flow and forming the longitudinal section
- Set the direction of the debris flow (you can set it as the present stream direction)
- Form a longitudinal section along the direction you set by reading contours on the map (Fig. 3.2.3).

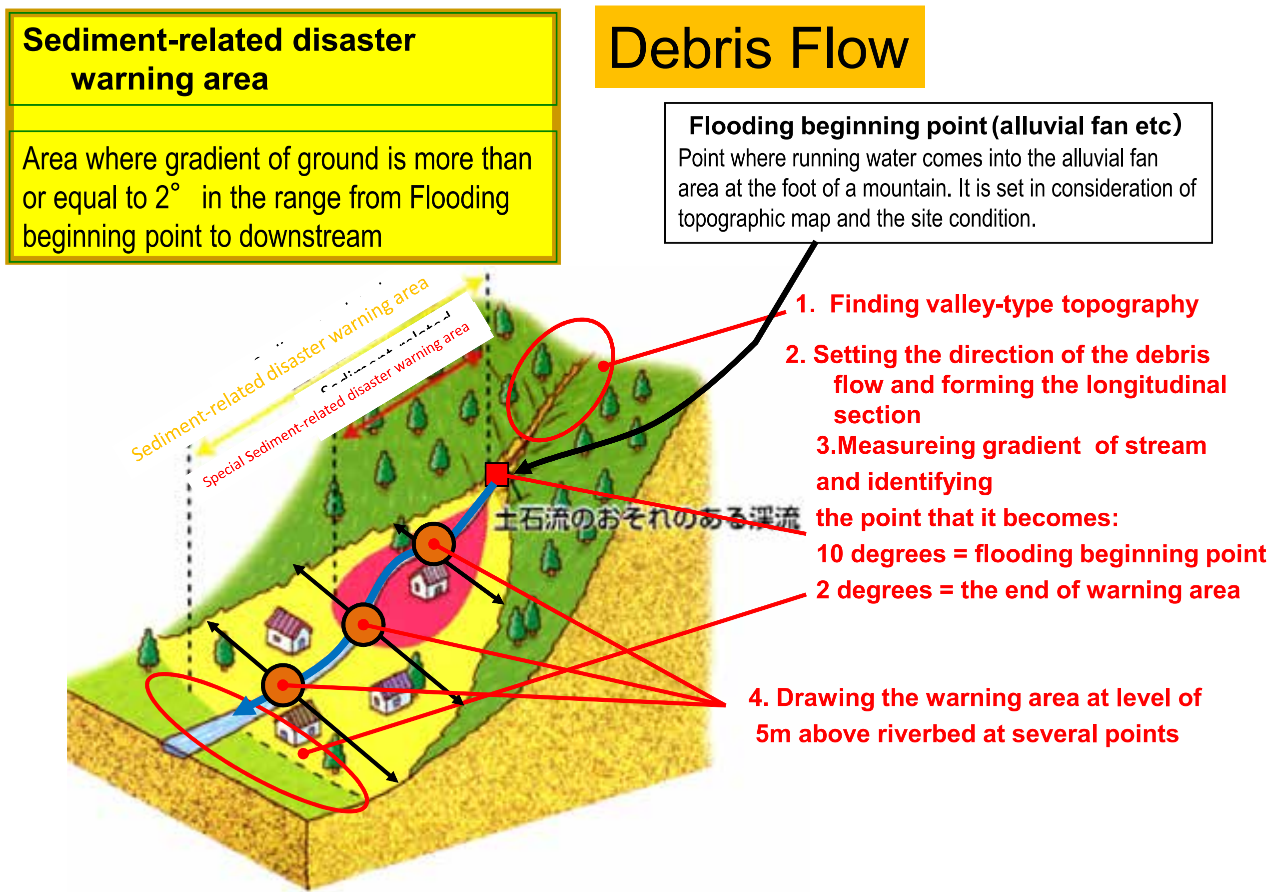


Fig.3.2.1 How to set a debris flow hazard area

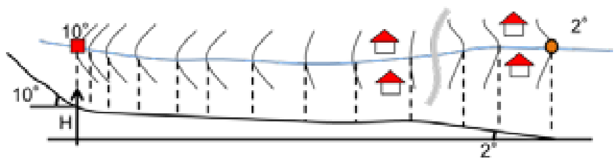


Fig. 3.2.3 Image of longitudinal section

3) Measure the gradient of the stream and identify the points that it becomes:
10 degrees = flooding beginning point
2 degrees = the end of warning area
- Measure the gradient of the stream at each point where the longitudinal section intersects the contour line.
- Find the points where it is 10 degrees and 2 degrees. (Fig. 3.2.3)

4) Draw the warning area at a level 5m above the riverbed at several points
-Draw the area 5m above the riverbed at several points on the longitudinal section between the 10 degrees and 2 degrees points (Fig. 3.2.4, Fig. 3.2.5).

In general, a debris flow cannot overflow 5m above a river bed. Thus the area, 5m above the river bed may be safe from a debris flow.

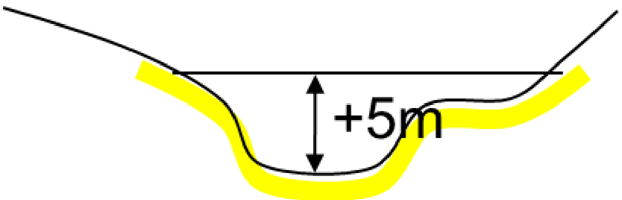


Fig. 3.2.4 Image of 5m above riverbed

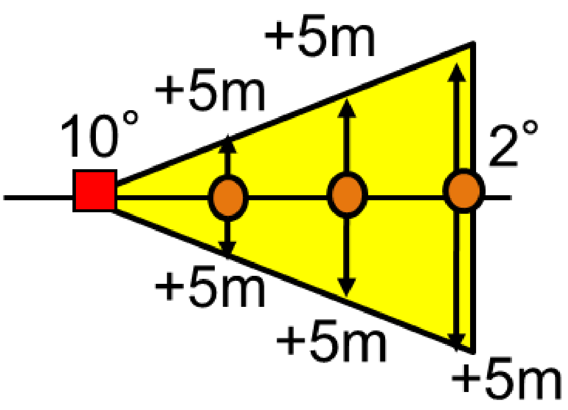


Fig. 3.2.5 Image of drawing warning area

As part of this project, Field Training for the project “Hazard Mapping for Sediment-related Disasters” was held in 2010 in Macao and Zhuhai, China. We held training at a model site regarding the above mentioned methodology for identifying debris flow hazard areas. The training procedure is as follows.

Fig. 3.2.6 shows
1) Finding valley-type topography
2) Setting the direction of the debris flow and forming the longitudinal section (blue arrow in Fig. 3.2.6).

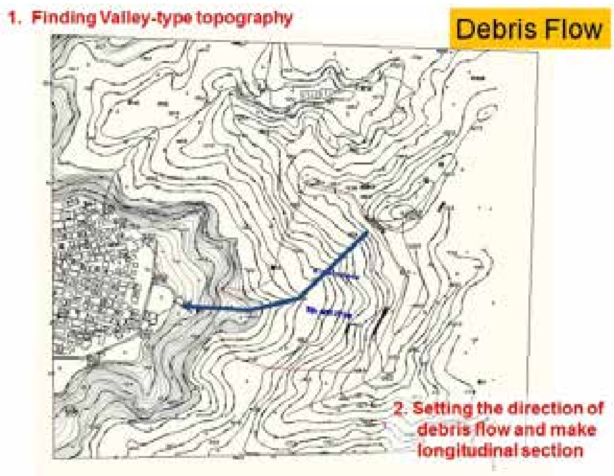


Fig. 3.2.6 procedure 1) and 2)

Fig. 3.2.7 shows
3) Measuring gradient of stream and identifying the point where it becomes:
10 degrees = flooding beginning point
2 degrees = the end of warning area.

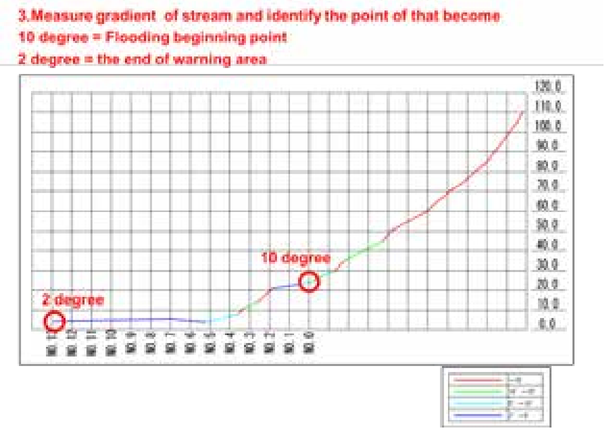


Fig. 3.2.7 procedure 3)

Fig. 3.2.8 shows
4) Drawing warning area up to level of 5m above

riverbed at several points.
Warning area is inside of yellow line in Fig. 3.2.8.

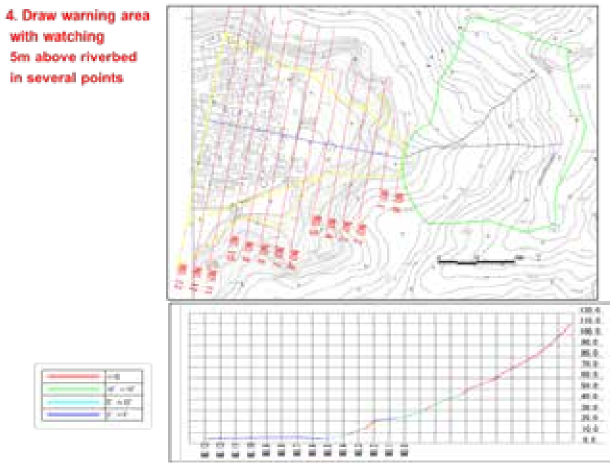


Fig. 3.2.8 procedure 4)

When using procedure 4), sometimes it is not possible to find the level of 5m above the riverbed at the outlet of the valley-type topography. The dispersion angle is set as in Fig 3.2.9 from 10 degrees to 60 degrees considering the topography.

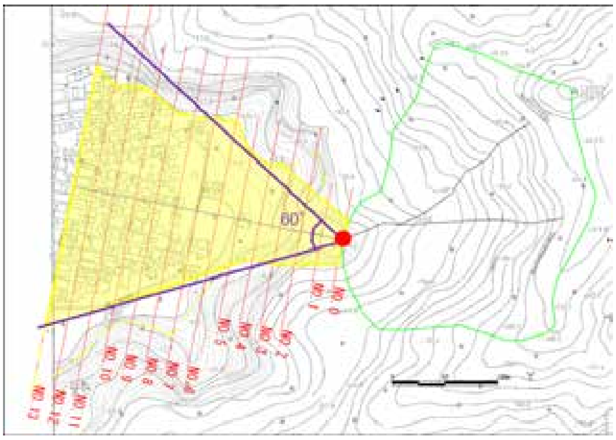


Fig. 3.2.9 Example of dispersion angle

Fig. 3.2.10 Debris flow hazard area at the model site

3.3 How to identify a "Landslide" hazard area

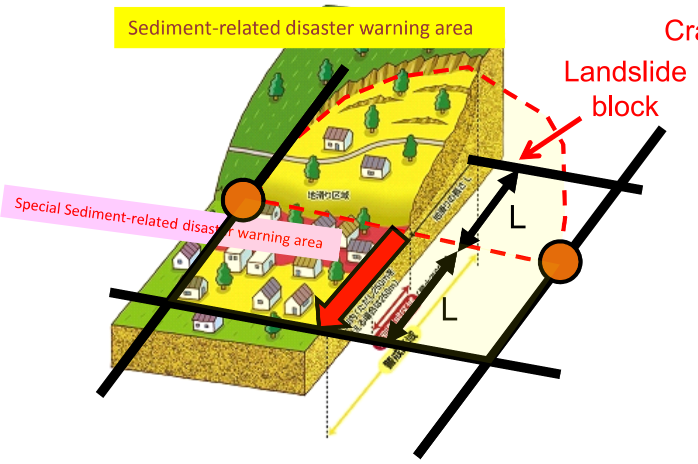
The method of identifying a "landslide" hazardous area, which is the same as a Japanese sediment-related disaster warning area, is as follows (Fig. 3.3.1).

1) Finding landslide-type topography using a map
Landslides have unique topography. Landslide-type topography tends to be semicircular in shape or like an overturned bowl. And it has a steep slope (scarp), many cracks on top of the landslide block, and ponds in the middle of the slope.

2) Decide
a) the direction of the landslide block
b) edge points of the landslide block (Orange dot in Fig. 3.3.1)
3) Draw parallel lines through the edge points
4) Measure the horizontal distance "L" of the landslide block as shown in Fig. 3.3.1
5) Set the line left from the bottom of the landslide block by "L"
6) Draw the warning area on the landslide block and the area surrounded by the bottom of the landslide and the lines which were made in 3) and 5)

Landslide

1) Finding landslide-type topography using a map
- Landslide-type topography tends to be semicircular in shape.
- There is a steep slope, many cracks and ponds on top of the landslide block.



2) Decide
a) direction of landslide block
b) edge points of landslide block

3) Draw parallel lines through the edge points

4) Measure horizontal distance "L" of landslide block.

5) Set the line left from the bottom of landslide block by "L".

6) Draw the warning area on the landslide block
and the area surrounded by the bottom of the landslide and the lines which were made in 3) and 5).

Fig. 3.3.1 How to set a landslide hazard area

3.4 How to identify a "Slope failure" hazard area

The method of identifying a "slope failure" hazard area, which is the same as a Japanese sediment-related disaster warning area, is as follows (Fig. 3.4.1).

1) Find a slope with ground gradient over 30° and height over 5m, and where there are more than 5 houses below the slope. (more than 1 house is also acceptable if it is necessary)
2) Set the lines on top and bottom of the slope
3) Set the lines
a) The line left from 10m above the top of the slope.
b) The line left from the bottom of the slope within double the slope height
4) Draw the warning area between lines a) and b)

3.5 Essential information concerning hazard maps and Japanese examples of hazard maps

Hazard maps have to safely guide residents' evacuation. We have to change hazard areas to hazard maps. The following are additional types of information need to make a hazard map.

- Hazard Area
- Evacuation route, refuge
- Explanation of risk

Fig. 3.6.1 and Fig. 3.6.2 are Japanese examples of hazard maps for sediment-related disasters. Both examples have these three essential types of information. Fig 3.6.1 is a "Photo version" with an aerial photograph as its background is so it is easier for residents to understand it. And Fig 3.6.2 is a "Map version" with a detailed map as its background.

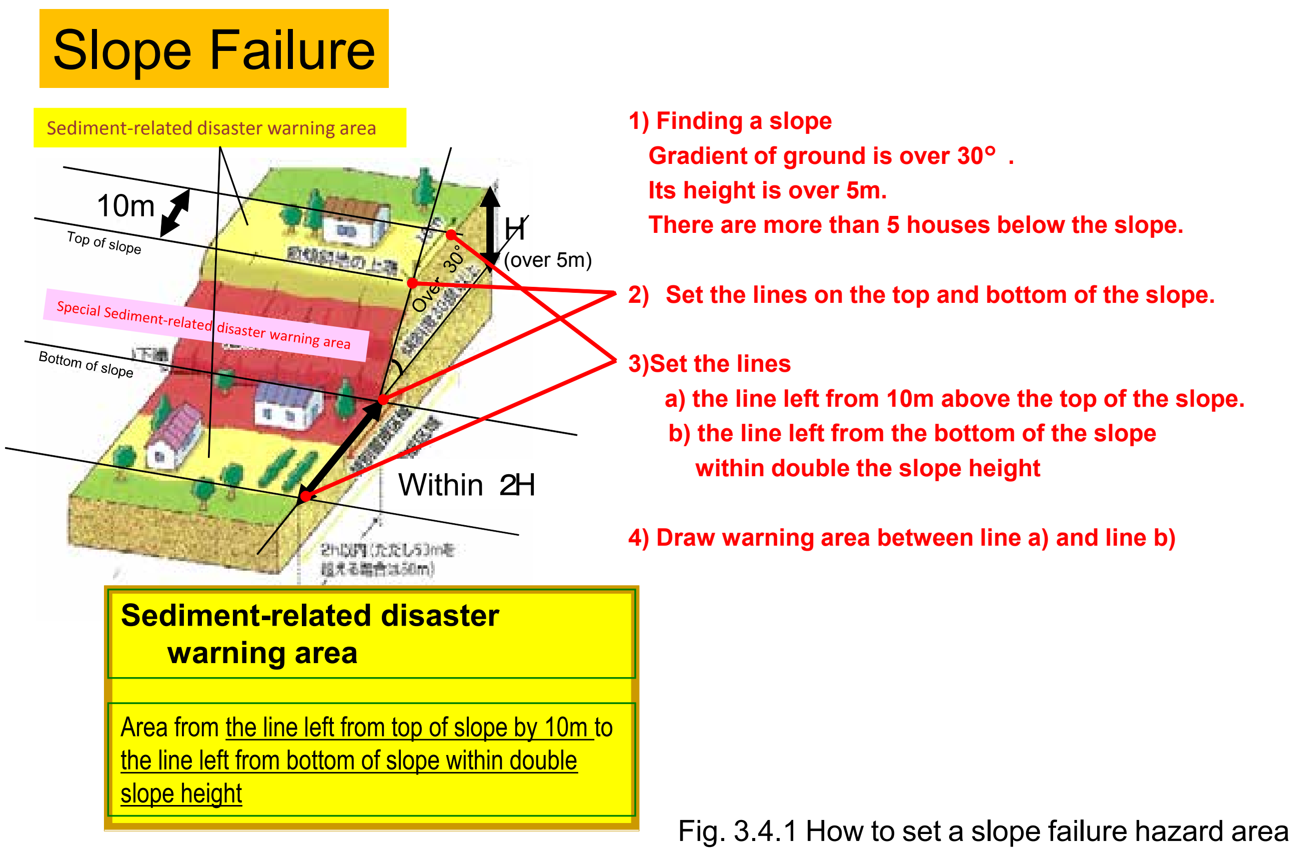


Fig. 3.4.1 How to set a slope failure hazard area

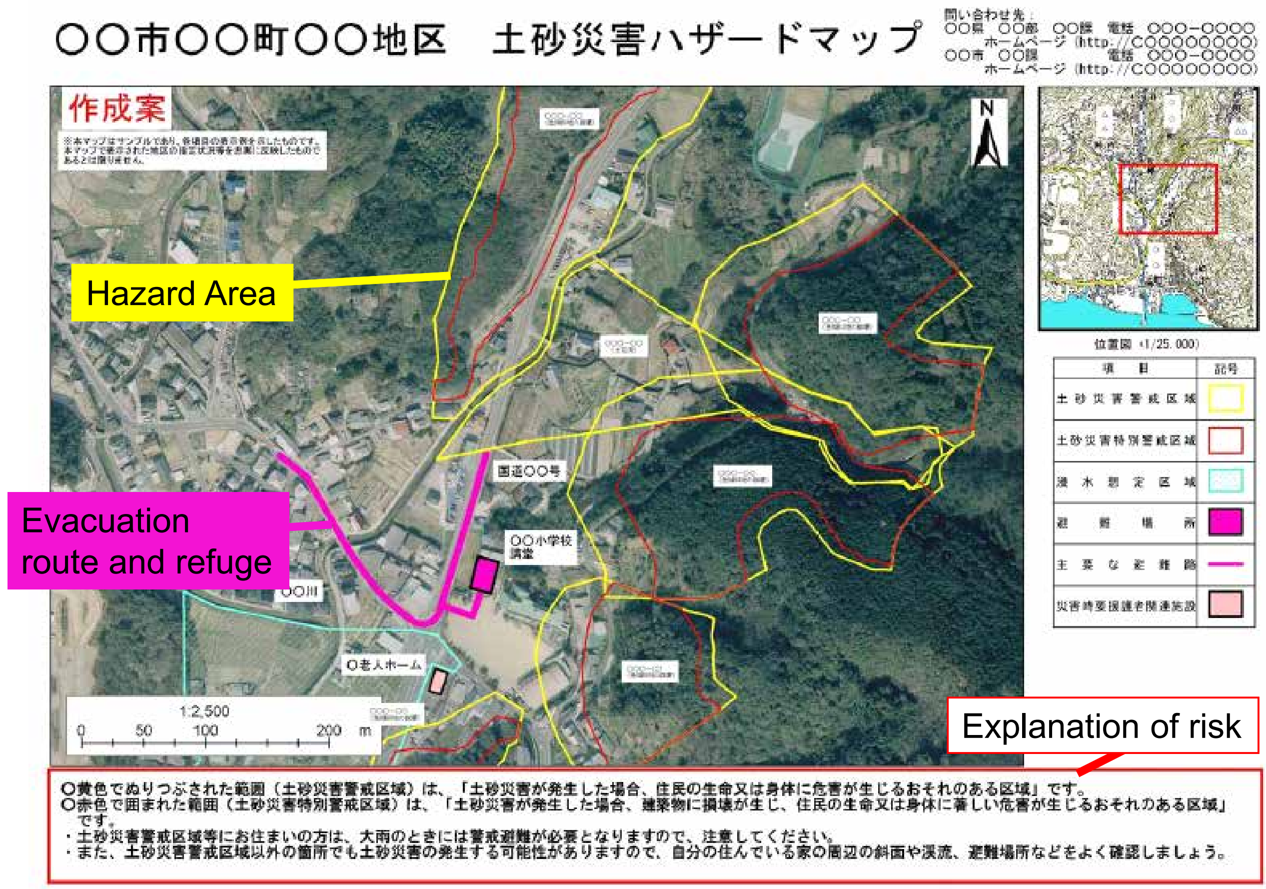


Fig 3.6.1 Japanese example of a hazard map (Photo version)

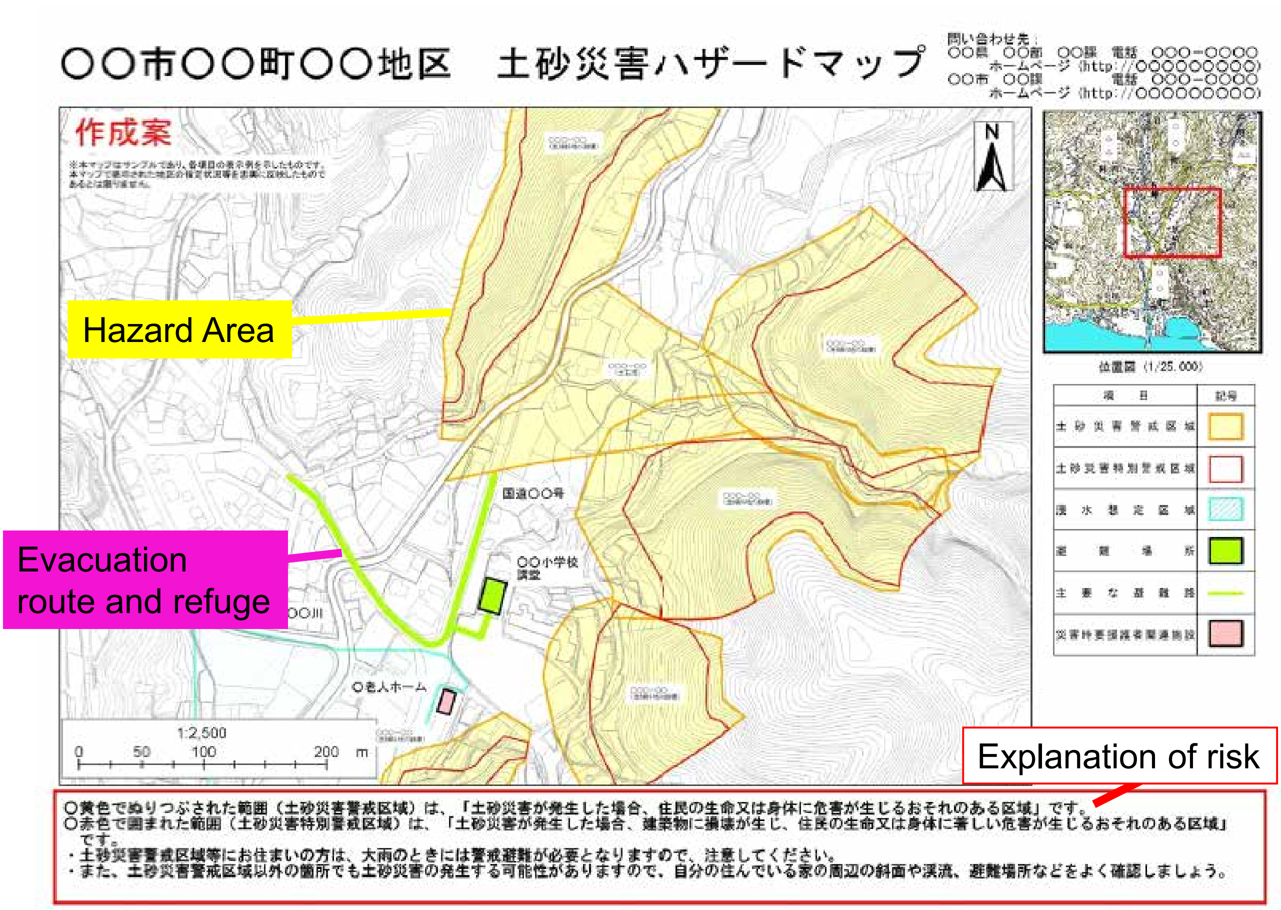


Fig 3.6.2 Japanese example of a hazard map (Map version)

4. ACTIVITIES CONCERNING "HAZARD MAPPING FOR SEDIMENT-RELATED DISASTERS"

4.1 Technical help desk of the International SABO network

The Typhoon Committee technical help desk has been opened on the International SABO Network website (http://www.sabo-int.org/). And related Japanese technical guidelines have been uploaded to that website (Fig. 4.1.1).

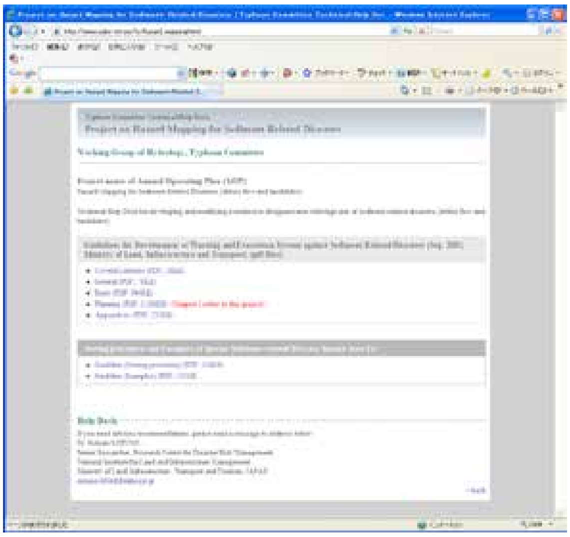


Fig. 4.1.1 Technical help desk on the International SABO network (http://www.sabo-int.org/tc/hazard_mapping.html)

4.2 Field training in Zhuhai, China

On Sept.4 and 5, 2010, a collaboration meeting between WGDRR and WGH and Field Training for the project "Hazard Mapping for Sediment-related Disasters", led by the SABO dept. of MLIT, NILIM and STC was held (Photo 4.2.1, Fig. 4.2.1).

On Sept.4, we held an indoor lecture on the Japanese techniques, "how to set hazards areas" and "how to make and use hazard maps", to enable residents to separate sediment-related disaster high risk areas by land use restriction and to evacuate residents at the Macao Science Center.

On Sept. 5, we held field training for TC members and local people (local engineers and residents) about how to set hazard areas and how to improve local people's awareness of risk of sediment-related disasters at a model site in Zhuhai city, China. Twenty people from 9 TC members (Cambodia, China, D.P.R.Korea, Hongkong China, Republic of Korea, Macao China, Thailand, Philippines and Japan) and 15 local people from Zhuhai City Office and residents participated in our meetings and field training.

Indoor Lecture in Macao, China, September 4, 2010

Field Training in Zhuhai, China September 5, 2010

Explanation for local residents in Zhuhai, China September 5, 2010

Photo 4.2.1 Photos of field training

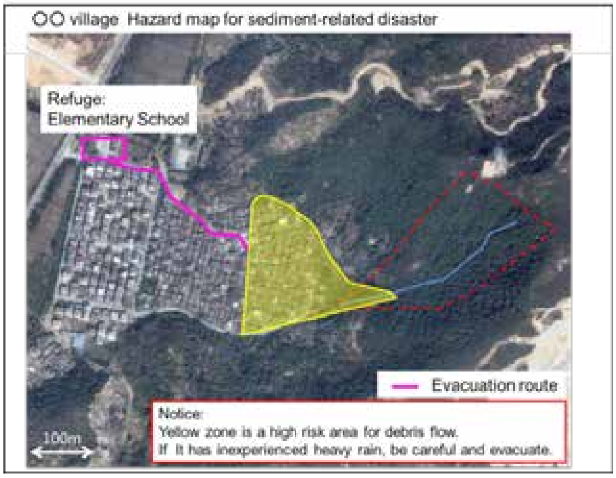


Fig. 4.2.1 Hazard map made by field training

4.3 SABO Workshop in Nha Trang, Viet Nam

Prior to the 6th TCIWS, on Nov. 6th, 2011, a SABO Workshop was held by the SABO Dept. of MLIT, NILIM and STC, Japan, in Nha Trang, Viet Nam (Photo 4.3.1, Fig. 4.3.1). At the SABO Workshop, an indoor lecture and an outdoor lecture, regarding how to establish a warning and evacuation system for sediment-related disasters, was held for 25 participants from 6 Typhoon committee members (Viet Nam, Thailand, Lhaos, Korea, China, Japan). Chapter 2 of this report is based on contents of the SABO workshop.

Indoor Lecture

Field Training

Participants

Photo 4.3.1 Photos of the SABO Workshop

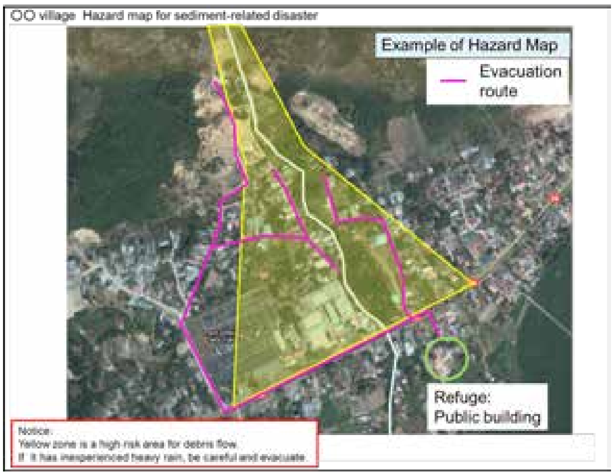


Fig 4.3.1 Hazard map made at the SABO Workshop

5. EXAMPLES FROM PARTICIPANTS OF THIS PROJECT

The project "Hazard Mapping for Sediment-related Disaster" has 5 participants from TC members, China, Hong Kong, China, The Philippines, Thailand, and United States. This chapter shows participants' examples of "Hazard Mapping for Sediment-related Disasters".

5.1 Hong Kong, China

Geotechnical Engineering Office (GEO) of Civil Engineering and Development Department (the then Civil Engineering Department) assessed the risk of slope failure to buildings, in terms of personal individual risk (PIR) and societal risk[1)]. At the hillside area below Sha Tin Heights Road (Fig.5.1.1), a "risk contour map" before mitigation was produced (Fig.5.1.2) based on a quantitative risk assessment that took into consideration the characteristics of the hillside (i.e. slope angle, depth of surface soil, and properties of soil material), past instabilities, and consequence of slope failures.

To reduce the risk of slope failure to the buildings, landslide risk mitigation options were formulated and Fig.5.1.3 shows one of the risk mitigation options. The "risk contour map" after mitigation is shown in Fig.5.1.4, which illustrates a reduction in PIR at the location of the buildings.

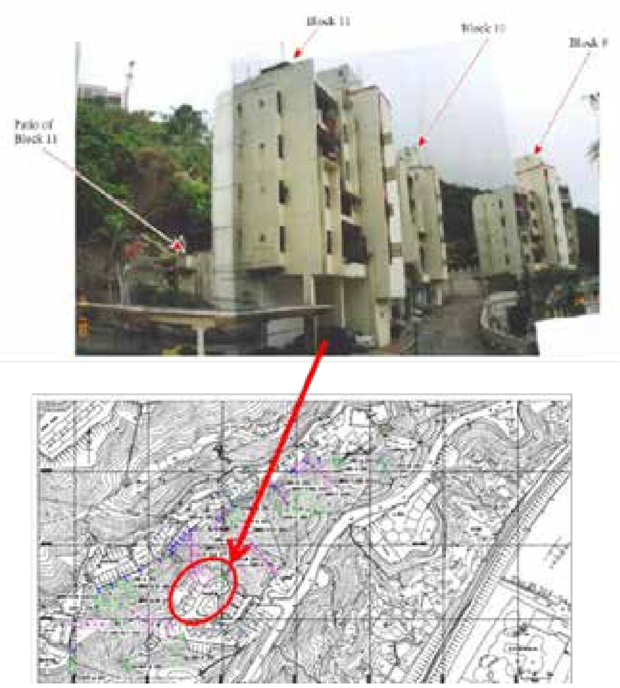


Fig.5.1.1 Photo and map of Sha Tin Heights Road

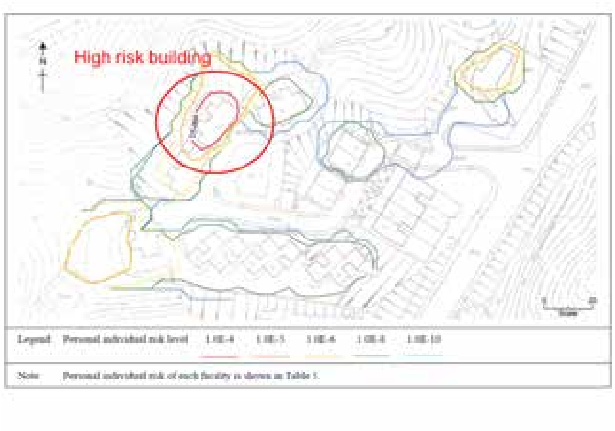


Fig.5.1.2 Risk contour map before mitigation

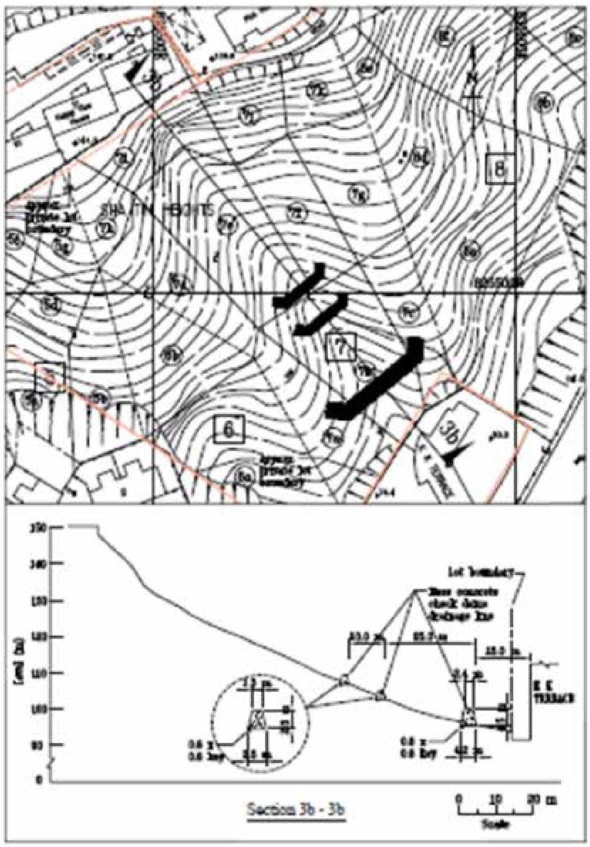


Fig. 5.1.3 Example of risk mitigation measures

Fig. 5.1.4 Risk contour map after mitigation

5.2 The Philippines

In October 2009, a debris flow caused by Typhoon Pepeng killed more than 80 persons at Barangay Puguis, La Trinidad, Benguet, the Philippines (Photo 5.2.1, Photo 5.2.2). The area was assessed by the Mines and Geo Science Bureau as highly susceptible to landslides in 2005 and 2007. Fig. 5.2.1, Landslide Susceptibility Map has been provided by the Mines and Geo Science Bureau. In Fig. 5.2.1, the purple hatched area means "Very high" susceptibility. The red hatched area means "High" susceptibility. The green hatched area means "Moderate" susceptibility. The yellow hatched area means "Low" susceptibility.

Photo 5.2.1 Aerial photos of damaged area in Barangay Puguis

Photo 5.2.2 Photo of damaged area in Barangay Puguis

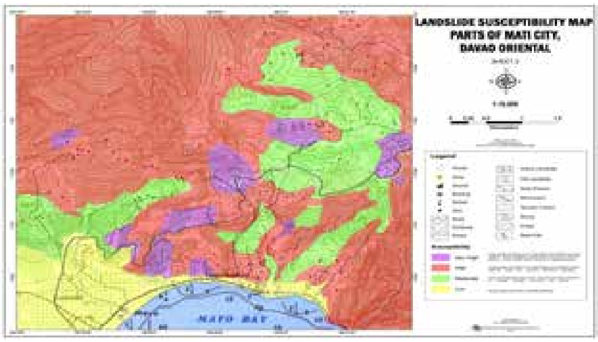


Fig.5.2.1 Example of Landslide Susceptibility Map (MATI CITY, http://mgbxi.org/maps/landslide-susceptibility-map/)

Reference

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Secretariat of ESCAP/WMO Typhoon Committee
Avenida 5 de Outubro, Coloane
Macao, China
Tel.: (+853) 88010531
Fax: (+853) 88010530
E-mail: info@typhooncommittee.org

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