Landslide Hazard Mitigation in Indonesia

Indonesia Ⅰ

Rain-induced landslides are one of the most common types of natural disasters, and they frequently occur in Indonesia as well as in the Asia-Pacific Region. During the period 1990 – 2007, 1,215 landslides occurred in Indonesia. Because of those landslides, 2,886 people lost their lives, 1,215 people were injured, and 14,849 people lost their homes. Normally, landslides occur during the rainy season, bringing a sudden flow of debris that leaves many victims in its wake. The majority of landslides during this period occurred in January (197 events).

Coordination of Landslide Mitigation Efforts

Basic disaster management concepts and basic knowledge of landslide phenomena were introduced in Indonesia to improve the understanding and awareness of its citizens, and to motivate and empower them to develop effective disaster management measures and public education programs. The development of a mitigation system is therefore a crucial step towards the marshaling of human resources to guarantee the sustainability of life and the environment in areas susceptible to landslides.

The Center for Volcanology and Geological Hazard Mitigation, the Geological Agency, and the Department of Energy and Mineral Resources have devised the following mitigation strategies for reducing the number of fatalities and the socio-economic impact caused by landslides.

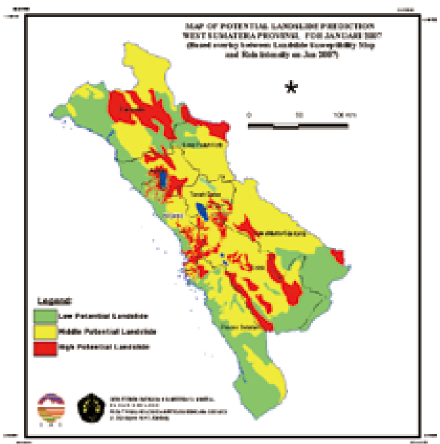
a. **Landslide Susceptibility Mapping**

Maps on a scale of 1:100000 show areas susceptible to landslides based on regional data. These maps were prepared using the Ilwiss 3.3 program and Map Info version 8. These maps identify areas that are highly susceptible to landslides and the factors controlling susceptibility.

b. **Early Warning System.**

The main function of the early warning system is to provide a potential landslide map prepared by overlaying landslide susceptibility maps and monthly rainfall forecasts. These maps are sent out monthly to local governments located in landslide hazard areas, and they can be uploaded at http://www.vsi.esdm.go.id every month.

Figure 1. (a) Landslide located in Padang, West Sumatra, killed 14 people and destroyed 5 houses (January 4, 2007). (b) Landslide prediction map for January 2007 showing that Padang landslide was located in area of high potential for landslide.



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c. Monitoring Landslides

Landslides are monitored in order to understand landslide behavior in terms of direction, intensity, and velocity of land movement. The landslide monitoring facility in the CVGHM office uses GPS, extensiometers, and piezometers.

d. Socialization

Basic disaster management concepts and basic knowledge of geohazard phenomena were introduced in Indonesia to improve the understanding and awareness of its citizens, and to motivate and empower them to develop effective geological hazard disaster management measures and public education programs. Socialization is therefore a crucial step towards the marshaling of human resources to guarantee the sustainability of life and the environment in areas susceptible to geohazards.

e. Quick Response Team

Quick response teams will visit hazardous areas and provide technical recommendations aimed at preventing landslides and reducing their impact.

Problems Facing Indonesia

Landslide hazard maps for geological disaster management have already been published and issued to the public, and mitigation efforts are underway. Unfortunately, disasters are still occurring in Indonesia and casualties remain high. This is because: (1) the number of settlements and public activity in medium –and high-susceptibility areas are still growing; (2) Landslide Susceptibility Maps and the Early Warning System are not being optimally used as a database for land use planning and regional development based on geohazard threats; and (3) geohazard management is not formally a part of the early education curriculum in schools.

- Background

Rain-induced landslides are one of the most common types of natural disasters, and they frequently occur in Indonesia. The majority of landslides during the period 1990-2007 occurred during the rainy season from November to March.

- Objective

To minimize the loss of human life and the socio-economic impact caused by landslides.

- Time Frame

This is an ongoing project, especially the Early Warning System for landslides. The Center for Volcanology sends Landslide Susceptibility Maps and Tables of Landslide Potential Areas to local governments every month.

- Activities undertaken

Collecting forecast data of monthly rainfall from geophysical and meteorological agencies; preparing landslide prediction maps by overlaying Landslide Susceptibility Maps and monthly rain forecasts; continuing to monitor landslides and map areas susceptible to landslides in Eastern Indonesia.

- Major achievements

Ninety percent of landslides have occurred in areas designated to have a medium or high potential of landslide occurrence. Unfortunately, local governments and communities in the landslide hazard areas have not been responsive and lack awareness of the Early Warning System, so the number of human victims and the socio-economic impact caused by landslides remain high.

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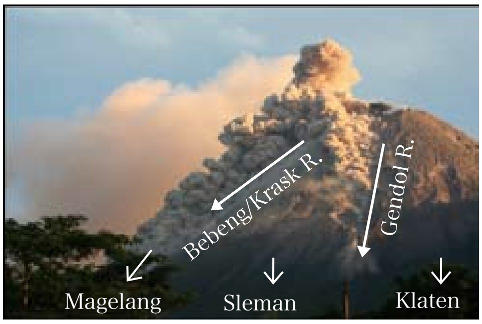
The Effectiveness of the Role of Communities in Hazard Mitigation Applied to Merapi Volcano

Indonesia II

Background

Mount Merapi (2968m) is a frequently erupting volcano whose last eruption occcured on June 14, 2006, after 5 years of repose. During the last eruption, there were 2 casualties who were trapped in a bunker that was covered by a pyroclastic flow. Even though mitigation measures have been put in place, improper procedure can lead to death. When the siren was sounded to signal people to evacuate, two volunteers preferred to stop and enter a bunker, which lead to their death. In the 2006 eruption, volcanic activity continued from April 2006 to November 2007. The peak of eruption occurred on 14 May 2006. During that day there were 3 pyroclastic flow events (at 8:14 am, 11:33 am and 3:15 pm) with PF distances of 5, 7 and 5 kilometers. The last eruption was different from previous eruptions, because it was characterised by rapid changes in morphology and a high magma extrusion rate. Between 1961 and 2001, Mount Merapi eruptions were predominantly directed to the southwest, except in 1994 and 1997. Fast morphological change at the summit due to intensive crack formations led to rapid growth of a lava dome. This rapid growth of lava dome also effected a change in pyroclastic flow direction. During the crisis, the pyroclastic flow direction changed from southwest to south-southeast. These changes affected not only the communities living around Merapi, but also their mitigation efforts. The communities living around Merapi can be grouped into those that have experienced eruptions and those that have not.

Pyroclastic flow events on 15 May 2006 were predominantly directed toward the Krasak River (Magelang,



Pyroclastic flow events on 15 May 2006 were predominantly directed toward the Krasak River (Magelang, southwest) and subsequently changed direction toward the Gendol River (Sleman and Klaten, south-southeast). Potentially threatened areas are shown by arrows.

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During the 2006 Merapi eruption, 3 regencies received the impact of the eruption, namely, Magelang (west-southwest flank), Sleman (south-southeast flank) and Klaten (southeast-east flank). Of these, Magelang is the most experienced community in relation to Merapi eruptions, and Klaten is the least experienced community. Sleman experienced the 1994 eruption, which caused 69 casualties, and it responded well to the 1997 eruption.

Concept and Planning

Recently, the Indonesian Government issued Government Regulation UU 24/2007 related to hazard mitigation. In the regulation it is mentioned that governments (central and local) are responsible for the management of hazard mitigation. Mount Merapi is an active volcano with a high frequency of eruptions, about once in 2-7 years. It is located in in a dense populated area, making it an even greater hazard. Besides knowledge and awareness, the participation of the community is nessescary in responding to a disaster. Community involvement starts with the formulation of community-based hazard mitigation measures. The main idea is that each member of the community living in a hazard zone should be capable of helping himself/herself and other people in facing the hazard. In a previous stage, information about volcano-related hazards was disseminated through members of the Hazard Mitigation Office (Slatlak/ Satkorlak). This effort was not as effective as expected due to insufficient involvement by the community. Therefore, the Volcano Technology Research Center (BPPTK), working under the Center for Volcanology and Geological Hazard Mitigation (PVG), proposed a program called Wajib Latih (Compulsory Training) regarding hazard mitigation to be applied in the communities around Mount Merapi as a study case.

The program is divided into 3 steps, namely, Concept and Planning, Implementation, and Evaluation. In the Implementation Stage, the program has been carried out by BPPTK-PVG, together with local governments, community organizations, local communities, and international organizations.

Implementation

Funding for the Implementation Stage was provided by the NZAID to the local goverment of Sleman. The Sleman Regency is part of Yogyakarta Province. The aim of the Compulsory Training Program is to build a community-based hazard mitigation program so that each individual in the community will be involved in hazard mitigation and account for hazard mitigation risk. As the competence of the community increases, the impact of disasters can be reduced. On the other hand, Compulsory Training will contribute to instrumental monitoring in the long term. With this training, it is assumed that the communities around Merapi already have knowledge and awareness of volcano-related hazards.

In the beginning Compulsory Training will be given to representative members of each community, who will then train others in their areas. This program has been carried out since the beginning of 2008 in the following areas: Sleman and Klaten Regencies (south and east flank) and Magelang and Boyolali Regencies (west and north flank). The program is scheduled to be completed in 2013.

Evaluation

By 2014, the people living around Mount Merapi should be ready to perform hazard mitigation actions. During its implementation, the program will be evaluated and improved. Continuous evaluation is necessary to achieve better and stronger community-based hazard mitigation efforts. At the moment, the Local Authority of Yogyakarta Province proposed to have the Center of Excellence for Disaster Management in its area. This means that the Authority should take the lead in implementing the hazard mitigation program. Good coordination of institutions, the public, non-governmental organizations and scientists will be neccessary. On the other hand, the building of efficient hazard mitigation facilities is essential. These facilities include modes of transportation, roads, lifelines, permanent evacuation centers and evacuation routes, which should be prepared in advance.

Well-trained and skilled volcanologists will also be needed to provide a good early warning system and accurate predictions.

- Background

A volcano with a high frequency of eruptions located in a densely populated area forced institutions involved in hazard mitigation to build a community-based hazard mitigation program.

- Objective

To build communities that can independently respond to hazard mitigation.

- Term/Time Frame

The concept and module were prepared in 2007. The program started in 2008 and is expected to be completed in 2013.

- Activities undertaken
Compulsory Training Program for people living in hazard areas.

- Major achievements
Program still in progress.

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The Role of the Quick Response Team During Volcanic Crises in Indonesia

Indonesia III

Indonesia is one of the largest volcanic areas in the world. There are 129 active volcanoes in Indonesia. Seventy-nine of them erupted in historical times (type A). Recently, there has been a significant increase in volcanic activity at almost the same time. From 2006 to 2007, 8 volcanoes were raised to activity Level 2, 4 volcanoes to Level 3, and 6 volcanoes to Level 4.

Volcanic crisis refers to the time from the beginning until the end of increasing volcanic activity. Indonesia applies four levels of activity, namely, Level 1 (Normal), Level 2 (Waspada/Alert), Level 3 (Siaga/Anticipation), and Level 4 (Awas/Warning). Increasing seismic activity and other parameters and the observation of changes around the crater are the criteria for raising volcanic activity from Level 1 to Level 2. Level 2 rises to Level 3 when seismic activity becomes intensive. This condition is supported by other monitored data and the observation of significant changes, possibly followed by eruptions. Level 3 changes to Level 4 when the main eruption occurs, with the initial eruption mostly composed of ash and vapor. This can be followed by a strombolian eruption (such as Krakatau).

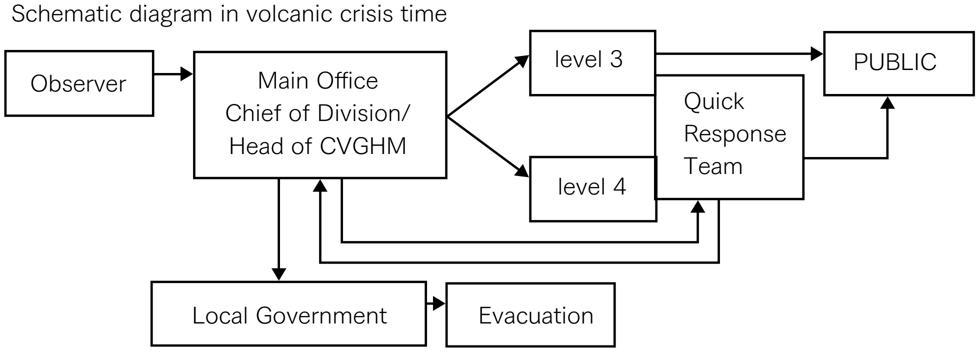
During Level 3 (Siaga/Anticipation) activity, the Head of the Center for Volcanology and Geological Hazard Mitigation (CVGHM) internally informs the Quick Response Team. The task of the team is to closely watch and thoroughly analyze volcanic activity. This team consists of multi-disciplined researchers who are responsible to the Head of the CVGHM. To coordinate with hazard mitigation officials and local governments, the leader of the team may represent for the Head of the CVGHM when there is an abrupt increase in activity levels. The team is also responsible for preparing routine evaluations and daily reports. It also gives recommendations to local governments and hazard mitigation officials. In addition to existing data analysis work, the team also confirms evacuation routes and locations with hazard mitigation officials.

Raising the activity level from Level 3 to Level 4 (Awas /Warning)) is decided by the Head of the CVGHM based on information and suggestions from the Quick Response Team. In an emergency situation, the team leader can inform the public about the change in the volcanic activity level and immediately report to the Head of the CVGHM. This information is very important for the main office in order to recommend to the local governments that they start evacuation procedures (Diagram 1).

Up to now the Quick Response Team has been performing a valuable task in supporting and implementing the hazard mitigation system.

Schematic diagram of Volcanic Activity
Level 1 (Normal) and level 2 (Alert)

Schematic diagram in volcanic crisis time



The following table shows events prior to volcanic eruptions handled by the Quick Response Team during the period 2006 – 2007.

No.	Name of Volcano	Precursor		Explanation
		Period (stage 3 and 4)	Indication	
1.	Karangetang, North Sulawesi	July 12, 2006 – February 12, 2007	Visual and seismic changes and deformation	Pyroclastic flow, 1,500 people evacuated
		August 11 – November 23, 2007	Visual and seismic changes and deformation	Big eruption, pyroclastic flow, 574 people evacuated
2.	Soputan, North Sulawesi	December 14, 2006 – November 23, 2007	Visual and seismic changes	On August 14, 2007, and October 25, 2007: ash eruption and pyroclastic flow
3.	Talang, West Sumatera	September 9, 2006 – January 27, 2007	Visual changes, temperature of fumarole, seismic changes, and deformation	Ash eruption
		March 17 - April 23, 2007		
		November 29 -Desember 14, 2007		
4.	Merapi, Central Java	April 26 – November 12, 2006	Visual and seismic changes and deformation	Big eruption, pyroclastic flow, 2 (two) victims
5.	Batutara, East Nusa Tenggara	March 22 – April 12, 2007	Visual changes	Ash eruption
6.	Gamkonora, North Maluku	July 8 – July 24, 2007	Visual and seismic changes and deformation	Big eruption on July 9, 10,000 people evacuated
7.	Kelud, East Java	September 29 – November 8, 2007	Visual changes, temperature of crater lake, seismic changes, and deformation	Effusive eruption and lava doming, 12,500 people evacuated
8.	Krakatau, Lampung	October 23 –up to now	Visual and seismic changes	Ash eruption
9.	Lokon, North Sumatera	Desember 9, 2007 – February 28, 2008	Visual and seismic changes and deformation	Ash eruption

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- Background

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- Objective

To provide accurate information about volcanic activity and to support decision-makers during a volcanic crisis.

- Term/Time Frame

Volcanic crisis period

- Activities undertaken

The Quick Response Team is responsible for preparing routine evaluations and daily reports, coordinating and giving recommendations to local governments and Satlak/Satkorlak PB (management hazard officials). In addition to existing data analysis work, the team also prepares evacuation routes and locations. When volcanic activity reaches Level 4, the team may inform the public about the change.

- Major achievements

Karangetang (July 12, 2006 – November 23, 2007), Soputan (December 14, 2006 – November 23, 2007) , Talang (September 9, 2006 – Desember 14, 2007), Merapi (April 26 – November 12, 2006), Batutara (March 22 – April 12, 2007), Gamkonora (July 8 – July 24, 2007), Kelud (September 29 – November 8, 2007), Krakatau (October 23 – to present), Lokon (Desember 9, 2007 – February 28, 2008).

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