

# Preparedness Assessment toward Volcano Eruption: Case of Primary Schools in Merapi Area, Indonesia

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## Abstract

The purpose of present study was to examine schools preparedness implementation in facing volcano eruption to clarify relationship between the risk level and the school preparedness of twenty-four selected primary schools in Merapi area, Yogyakarta, Indonesia. This study adopted a descriptive survey design based on the data of self-rated questionnaires distributed to participant headmasters. The major findings showed that, in general, the schools preparedness program was not effectively managed yet, mainly due to the shortage in soft components, such as lacking of special unit/persons responsible for emergency preparedness and response, lacking of evacuation plan, disorganized regular risk assessment, and inadequate teacher-training on disaster prevention education. In addition, after the check by Fisher's exact test (extended), it had been found out that frequency of subdivided risk level was associated with the school preparedness level.

**Key words:** school preparedness, primary schools, assessment, natural disaster, Merapi volcano

## 1. Introduction

It is noted that about 13 percent of the world's active volcanoes lie along Indonesian archipelago with potential to generate multiple hazards of different magnitudes and intensity (UNESCO, 2007). One of dangerous active volcanoes in Indonesia is Merapi which is part of Pacific Ring of Fire on the border of Central Java.

Merapi volcano, that has been active for 10,000 years, is located at 7°32'26"S and 110°26'48"E; the summit is 2,950m above sea level. Its position is about 25 kilometers north of Yogyakarta City and administratively situated in two provinces, Yogyakarta Special Region and Central Java.

International Association of Volcanology and Chemistry of Earth's Interior (IAVCEI) in 1994 (Putra, etal, 2011) had declared Merapi as one of the most dangerous volcanoes in the world due to its eruptions which were more than 80 times and killed thousands of people. This volcano frequently caused disasters with many deaths and loss of resources (Sutikno and Santoso, 2006). The latest Merapi eruptions occurred in 26<sup>th</sup> October 2010 and 5<sup>th</sup> November 2010.

Based on Indonesia Center for Data Information of National Agency for Disaster Management in 27<sup>th</sup> November 2010, Merapi volcano disaster in that year caused 242 deaths in Yogyakarta area, and killed 97 people in Central Java area (Paripurno, 2011). In addition, it affected the habitation, infrastructural, telecommunication, electrical and energy crisis, as well as sanitation. In habitation sector, the eruption buried many villages in Yogyakarta Special Region area and destroyed thousands of villagers'

houses both in Yogyakarta Special Region and in Central Java.

There are two aspects of natural disasters including volcano eruption, which are uniquely related to school buildings (Vickery, 2005). The first aspect is location. Schools are generally distributed with population and there is usually a school in every large village of rural areas. The school is, moreover, often the largest of village building. Thus, in places subject to recurring disaster, a school, which is designated to be disaster-resistant, may provide the focus for relief activities and even temporary housing for those injured and uninjured and whose accommodation was unable to withstand the force of phenomenon.

The second aspect is that, school buildings which are occupied during school day, have within them a concentration of human beings. Thus, a disaster to an occupied school can kill or injure the entire school students and teachers from a village and the area around it.

During Merapi volcano eruption in 2010 itself, it was reported that at least 217 schools were seriously damaged and 339 people were killed (Sardjunani et al, 2010).

Considering the cases above, having a well-organized school preparedness system toward volcano eruption including design and construction of disaster-resistant schools is very vital to minimize the disasters' impacts.

## 2. Objective of the study

This study aimed at describing the result of school preparedness assessment toward volcano eruption of 24 selected primary schools in Merapi area based on the headmasters' perceptions, and clarifying the relationship between the risk and the school preparedness levels in order to propose possible solution for improvement of the school preparedness.

## 3. Definition of terms

Referring to disaster preparedness definition by United Nations Office for Disaster Risk Reduction (UNISDR, 2007), the school preparedness in this perspective means activities and measures taken in advance by a school to ensure effective response to impacts of Merapi volcano eruption, including the issuance of timely and effective early warnings and the temporary removal of people and property from a threatened location.

In this study, a number of indicators showing components of the school preparedness are divided into two categories: soft and hard components. The first component refers to standard operating system (SOP) recommended by Indonesia government related to disaster prevention in general. It consists of six parts, namely special unit/person responsible for emergency preparedness and response, regular risk assessment for natural disasters, coordination with local fire department and medical center, supports from government, teachers-training, and evacuation plan. The second component refers to tools and or infrastructure such as emergency supply kits, emergency exits, and school building construction.

## 4. Research method

Questionnaire surveys, interview, and observation were conducted to get the data in this research.

Primary data collection was done by interviewing the headmasters and distributing them questionnaires. Those two activities were supported by secondary data collection through collecting reports, products and documentations from several sources.

The questionnaire itself consisted of ten items, in which the headmasters could respond them by choosing one of the 3-4 alternative options and writing their brief reasons for each answer in the column provided. The first item was related to risk-level of each school toward Merapi volcano eruption; while the other nine items were about indicators of the schools preparedness. The questionnaires were distributed to all respondent headmasters during the field survey in the 24 selected primary schools. All answered questionnaires were then returned to the researcher and statistically analyzed.

## 5. Study area

All the 24 primary schools participating in this study are located within a similar distance to the peak of Merapi volcano and belong to Sleman District of Yogyakarta Special Region. The schools (in Figure 1) are situated in Cangkringan (13), Pakem (6), and Turi (5) sub-districts that have been determined as high risk areas of having impacts from Merapi volcano eruption.

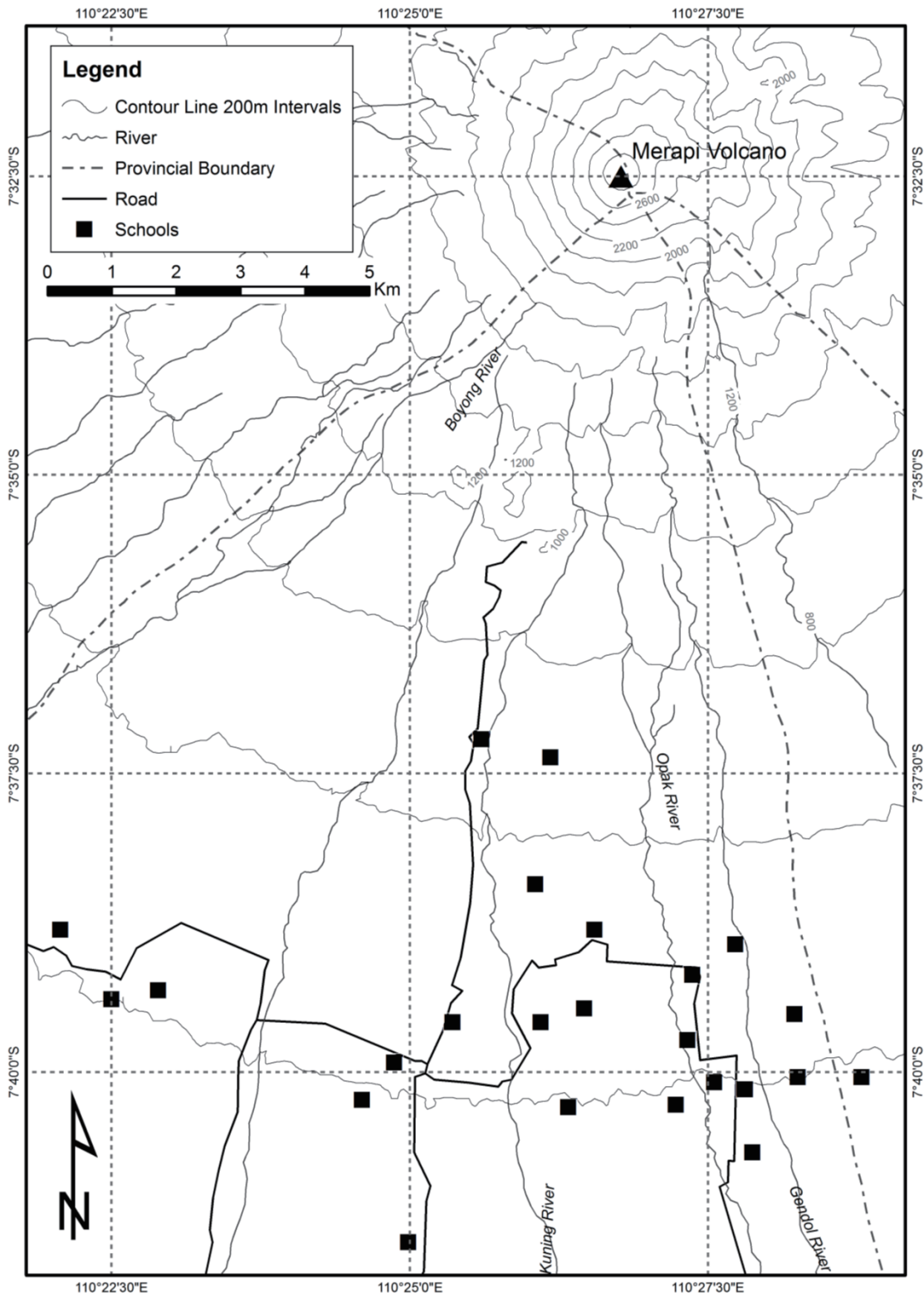


Figure 1. 24 researched schools location

## 6. Result

### 6.1 Schools risk to Merapi volcano eruption

Based on geological information and risk-level of a volcanic eruption, as stated in Indonesia Law No. 26 Year 2007 on Space Management; typology of areas prone to volcanic eruptions can be classified into three:

Type A: Area that is potentially flooded by lava and possibly affected by the expansion pyroclastic and lava flows. During the eruption enlarged, the area is potentially affected by falling material in the form of heavy ash and incandescent rocks hurl. The area has a low level of risk (quite far from the source of eruption, and in the event of the eruption, it is still possible for human beings to save themselves, so the risk of affected area can be avoided).

Type B: Area that is potentially knocked by pyroclastic, lava flows and lahars, burst or incandescent rock avalanches, heavy ash, hot mud, the flow of heat and toxic gases. The area has a moderate risk level (within fairly close to the source of eruption, the risk of human beings to save themselves at the time of the eruption is quite difficult; therefore, the possibility to be affected is very large).

Type C: The area is often knocked by pyroclastic flows, avalanches, dense ash, heavy hot mud, the flow of heat and toxic gases. This area has a high risk (very close to the source of eruption). At the time of magmatic activity, the region would be rapidly affected so that living things around the volcano are not possible to save themselves).

Schools in this study were mainly located in type C area in which the headmasters had sub-divided the school-risk levels into three categories as shown in table 1: lower, middle, and higher on the basis of each school location that was relatively estimated by geographic view-points which were mainly distance from both the peak of Merapi volcano and rivers due to high risk-hazard of pyroclastic flows, lava flows, and lahars.

**Table 1.** Reasons by headmasters for determination of school risk

<b>RISK LEVEL</b>	<b>NUMBER OF SCHOOLS (N=24)</b>	<b>REASONS BY HEADMASTERS</b>
Relatively lower	2 schools	Schools are physically strong and far (more than 15 km) from the peak of Merapi volcano and rivers
Relatively middle	17 schools	Schools are located (8-15 km) from the peak of Merapi volcano and they are also near rivers (e.g. Opak and Gendol rivers)
Relatively higher	5 schools	Schools are very near (less than 8 km) to the peak of Merapi volcano as well the rivers which are passed by lahars and lava during the eruptions

Information in table 1 showed that there was misunderstanding among the headmasters in determining the distance or the schools' geographic location toward the peak of Merapi volcano. For example, two headmasters thought that their schools' location was more than 15 km from the peak of Merapi volcano; in fact, based on the geographical map in figure 1, no school in this study was more than 15 km from the peak of Merapi volcano.

### 6.2 School preparedness

#### 6.2.1 Soft components

The findings related to soft components of school preparedness based on the headmasters' perceptions were shown in table 2.

**Table 2.** Schools preparedness related to soft components

NO	SOFT COMPONENTS	GOOD SCHOOLS (N=24)	CRITICAL SCHOOLS (N=24)
1	Special unit/persons responsible for emergency preparedness and response	11 schools	13 schools
2	Regular risk assessment toward disasters	8 schools	16 schools
3	Teacher-training	5 schools	19 schools
4	Evacuation plan	10 schools	14 schools
5	Coordination with local fire department and medical center	15 schools	9 schools
6	Supports from government	15 schools	9 schools

From the table 2, the schools' weak points in soft components of preparedness can be explained as follows: firstly, in relation to special unit/person responsible for emergency preparedness and response, 13 schools had no special unit for disaster prevention; while 11 schools were prepared in having such kind of unit. Some reasons for the unprepared schools, as stated by the headmasters, were due to the rare occurrence of natural disasters, no clear job description among teachers dealing with natural disasters, limited number of personnel at school, and no guidance from government in setting up the special unit.

Special unit for emergency preparedness and response is very important in dealing with and anticipating the impacts of natural disasters in school environment. Emergency preparedness means taking action to be ready for emergencies before they happen. The objective of emergency preparedness is to simplify decision-making during emergencies (USNRC, 2012).

Secondly, in relation to regular risk assessment, 16 schools did not conduct any regular risk assessment; 5 schools conducted risk assessment annually; 2 schools conducted risk assessment monthly; and only 1 school conducted it weekly. A headmaster stated that his school made a report on the result of regular risk assessment to the office of sub-district monthly, while at schools without having any regular risk assessment, the headmasters confessed to do risk-evaluation only when there was natural disaster.

In addition, in relation to teacher-training, teachers in 9 schools seldom (only 2-3 times in a year) got training related to disaster prevention; teachers in 8 schools almost never (0-1 time in a year) had the training, and teachers in 2 schools completely never got the training. Only 5 schools had their teachers' often-got training (4-5 times in a year). In fact, this professional program is very important, because without sufficient understanding and knowledge of teachers, disaster prevention education program at school cannot be implemented effectively.

Moreover, in relation to evacuation plan, only 10 schools had a well-prepared evacuation plan; while 8 schools had poor, and 6 schools had no evacuation plan at all. Headmasters of the schools with a well-prepared evacuation plan stated that their schools had at least six features of evacuation plan: detection of the problem area, decision, alarms, control reaction of people, movement of the crowd to safety and transportation. In addition, the schools had evacuation maps along with signs and symbols installed and, easily understood and identified by all school elements in the surrounding school area.

Headmasters of the schools with unprepared evacuation plan stated that their schools did not have any program and standard operational procedure (SOP) dealing with disasters; the schools just adapted to situation and condition whenever any disaster happened; and so far, the schools had not experienced serious natural disaster, except for 2010 Merapi volcano eruption when all people in the area were evacuated by the government. In this perspective, evacuation is necessary before, after or during a disaster (Ronaldo, 2011) and a well-established evacuation plans hasten the process of evacuation and thus can save more individuals.

In another side, the strong points of soft components in the school preparedness based on the table 2 can be described as follows: first, in relation to coordination with local fire department and medical center, 15 schools made good coordination with them. Seven schools had fair coordination, and 2 schools were evaluated to be having poor coordination. In this perspective, coordination, communication, and collaboration of schools with public health and medical partners during all four phases of emergency management (preparedness, response, recovery, and mitigation) are very important in anticipating disasters.

Secondly, in relation to support from government, 15 schools got sufficient support, while 9 schools got only some and few support respectively. As stated by the headmasters, the forms of government support to schools were things like posters and books on natural disasters for school libraries, communication equipment, and other tools related to evacuation process. The schools were also given financial assistance for class room building-renovation, disaster drills and training program.

### 6.2.2 Hard components

The findings related to hard components of school preparedness based on the headmasters' perception were shown in table 3.

**Table 3.** Schools preparedness related to hard components

NO	HARD COMPONENTS	GOOD SCHOOLS (N=24)	CRITICAL SCHOOLS (N=24)
1	Emergency supply kits	9 schools	15 schools
2	Emergency exits	2 schools	22 schools
3	Building construction	19 schools	5 schools

The weak points of hard components in the school preparedness based on the table 3 can be clearly explained as follows:

Firstly, based on the criteria by the government as stated by headmasters, a good school with at least 100 students in total should have at least three boxes of emergency supply kits. Each box is for two grades students (grade I and II, III and IV, V and VI). The boxes contain a number of medicine and other emergency equipments and they are stored either in the cupboard of the School Health Centre Room or in the Teachers' Room. It was found out that among the 24 primary schools, only 9 of them had sufficient emergency supply kits; 10 schools had some, and 5 schools had few emergency supply kits. For schools with sufficient amount of emergency supply kits, the headmasters mentioned that there was enough medicine supplies kept in the boxes of the school health centre room. They confirmed that the emergency supply kits were among others: betadine and revanol (liquid wound cleaner), vicks vabroub and paracetamols (kids fever medicine), eucalyptus oil (stomachache healer), cotton, gauze, and handsaplas (solid wound protection); while the headmasters of schools with few emergency supply kits stated that the very limited amount of supply kits stored in only one box, was not for anticipating natural disasters, but for small accident or illnesses among students, and the school had not yet got a health centre room either. The headmasters at schools with few emergency supply kits, in detail mentioned that although the number of the students reached to 100 in total, the schools only had a single small bottle of betadine and revanol, a pack of vicks vabroub and paracetamols, a small bottle of eucalyptus oil, cotton, gauze, and handsaplas which were kept in the box inside the cupboard of the teachers' room.

To enhance school preparedness, it is necessary to have emergency supply kits. This supply kits may be stored in a portable place and should contain a stockpile of essential emergency supplies. It can be in the form of backpacks or buckets kept in a secure and readily accessible location that can be easily taken and carried out of a school in case of an emergency (The Emergency Response and Crisis Management (ERCM) Technical Assistance Center, 2006)

Secondly, in relation to emergency exits, only two schools had many (more than 4) emergency exits; and ten schools had some (more than 2) emergency exits. Two schools had few (more than 1) emergency exits; eight schools had no emergency exits; and two schools did not give any response to this issue. Headmasters of the schools with no emergency exits stated that the schools only had common doors of the classrooms and one main school gate.

The strong point of hard component in the school preparedness was only in term of school building construction. Criteria used by headmasters to self-assess their school building quality were shown in table 4:

Standards for levels A to E are qualitative, and judgment standards are established for each item. For all items, level A denotes that facilities are in a good condition, and the degree and types of problems broaden as the scale goes down from level B to level E.

Among the 24 primary schools, it was found out that 19 schools had good quality in building construction and 5 schools had fair quality. Headmasters of the schools with good quality buildings, more detail stated that, recently their schools were newly-renovated by local government based on national standard in order to be disasters resistant. Furthermore, some schools had been already physically examined by local authorities to have the required national standard. Meanwhile, headmasters of the schools with fair building quality specifically confessed that, some classrooms in their schools were built without appropriate foundation so that they were risky of being collapsed anytime when big natural disaster hit the area.

**Table 4.** Criteria of school building construction

Classification	Physical Aspects	Maintenance Status for Facilities and Equipment
Good Schools	Condition of building site, facility structure, painting, flooring, windows, etc, school utilities (water, electricity, etc), ceilings and roofs, and school furniture was on level A	<ul style="list-style-type: none"> <li>• Facilities are kept very clean.</li> <li>• Materials are posted in classrooms and the teachers' room, and rooms are nicely decorated.</li> <li>• Broken furniture is immediately removed and replaced with new one.</li> <li>• Students, teachers and community members participate in repair and cleaning activities.</li> <li>• Local communities provide labor, equipment and funds for repair and maintenance.</li> </ul>
Fair Schools	Condition of building site, facility structure, painting, flooring, windows, etc, school utilities (water, electricity, etc), ceilings and roofs, and school furniture was on level B and C	<ul style="list-style-type: none"> <li>• Facilities are kept reasonably clean.</li> <li>• Some of the broken furniture is left as it is.</li> <li>• Part of the lavatory section is closed.</li> <li>• Funds for building additional facilities or remodeling facilities are used for maintenance.</li> </ul>
Bad Schools	Condition of building site, facility structure, painting, flooring, windows, etc, school utilities (water, electricity, etc), ceilings and roofs, and school furniture was on level D and E	<ul style="list-style-type: none"> <li>• Facilities are dirty and trash is found here and there.</li> <li>• Broken furniture and equipment is left as it is in the classroom and is never replaced.</li> <li>• Lavatories are broken.</li> <li>• Teachers are not willing to work with, and lack close ties with, local communities.</li> </ul>

Source: Ministry of National Education and special assistance for project sustainability (SAPS) reports, in 2002

## 7. Conclusion and Recommendation

### 7.1 Conclusion

There was still misunderstanding among the headmasters in determining the distance or geographical location of their each school toward the peak of Merapi volcano. This misunderstanding can lead to wrong decision in assessing the vulnerability (risk level) of their school toward Merapi volcano eruption disaster.

All the 24 primary schools were vulnerable to have impacts of Merapi volcano eruption, and as shown in table 5, after statistically checked (the cross table between subdivided risk level and preparedness level) by Fisher's exact test (extended), it had been found out that the frequency of subdivided risk level was associated with the school preparedness level (value=10.586, p=0.041). We can appreciate it. It meant that the higher the risk, the better school preparedness required.

**Table 5.** Relationship between risk-level and the school preparedness

		School preparedness				Total
		Good Sc & Hc	Critical Sc	Critical Hc	Critical Sc & Hc	
School risk level	Rl	0	1	0	1	2
	Rm	3	11	1	2	17
	Rh	3	0	0	2	5
	Total	6	12	1	5	24

Sc= Soft components  
Hc=Hard components

Rl=relatively lower  
Rm=relatively middle

Rh=relatively higher

The study found out that among the 24 primary schools, 13 schools still needed to improve the preparedness level due to either their critical soft or hard components. Eleven schools under relatively middle risk level had shortage in soft components of preparedness, and only one school under this risk level had shortage in hard components.

In addition, 5 schools were categorized in the worst condition with both critical soft and hard components. The schools under such condition had major characteristics of having no or poor evacuation plan and no regular risk assessment, few supply emergency kits, and few or no emergency exits, little support from government, and the teachers were almost never trained about disaster prevention education.

There were only 6 schools under well-preparedness level with both good soft and hard components. These schools had dominant characteristics, such as having a well-prepared special unit and evacuation plan, regular risk assessment, good coordination with local fire department and health centre, sufficient support from government, and the teachers often got training related to disaster prevention education.

## 7.2 Recommendation

This study showed that the preparedness level in facing volcano eruption among the 24 selected primary schools in Merapi area needed to be improved mainly due to the main shortage in soft components of preparedness.

For the improvement of school preparedness in hard components, it is recommended for the headmasters to report their schools' shortage to either the local or central government in order to get immediate appropriate assistance; while for the improvement of soft components, each school should set up educational activities on natural disaster prevention, such as dissemination of schools resilience program toward volcano eruption and teacher-training program for designing and implementing effective lessons on volcano eruption disaster prevention.

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