THESIS

IMPROVING EVACUATION PLANNING BASED ON PEOPLE'S BEHAVIOR IN RESPONSE TO VOLCANIC ERUPTION EVENTS

A Case Study of Magelang Regency, Indonesia

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By:

DIDIK KRISTIA SOFIAN

10/307101/PMU/06744

27376

Supervisor :

1. Prof. Dr. Junun Sartohadi, M.Sc. (UGM)

2. Drs. M.C.J. (Michiel) Damen (ITC)

GRADUATE SCHOOL
GADJAH MADA UNIVERSITY
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Prepared by
Didik Kristia Sofian
10/307101/PMU/06744
27376

was defended before the Board of Examiner
on the date 6th March 2012

Board of Examiners

Supervisor 1

Prof. Dr. Junun Sartohadi, M.Sc.

ITC Examiner

Dr. M. (Mark) van der Meijde

Supervisor 2

Drs. M.C.J. (Michiel) Damen

External Examiner

Prof. Dr. H.A. Sudibyakto, M.S.

This thesis was declared acceptable
to obtain the master degree
Date ... 13 MAR 2012

Program Director of Geo-Information for
Spatial Planning and Risk Management

Prof. Dr. H.A. Sudibyakto, M.S.
NIP. 19560805 198303 1 004

Approved by
Vice Director for Academic Affairs,
Development and Cooperation

Prof. Ir. Suryo Purwono, MA.Sc., Ph.D.
NIP. 19611119 198601 1 001

Disclaimer

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Yogyakarta, March 2012

Didik Kristia Sofian

Abstract

Magelang Regency is located at western slope of Merapi volcano. There are nineteen villages of Magelang regency situated in Merapi volcano hazard zone.

The last eruption of Merapi volcano occurred in 2010. There were a lot of difficulties to evacuate people in hazardous zones. A large numbers of people living at the slope of Merapi refused to evacuate, and did not respond to scientific-based warning. As many as 277 people from Yogyakarta province and 109 people from Central Java province were killed. Many were affected by pyroclastic flows. The aim of the research is to improve the existing evacuation planning by analyzing people's characteristics, people's behavior in response to Merapi eruption, and factors influencing the affected people in response to volcanic eruption.

The result of questionnaire survey reveals that evacuation response time of sixty-nine percent of respondent was less than 24 hours after evacuation order was received, and the others were more than 24 hours. Statistical analysis examines that the people who immediately evacuated less than 24 hours are:(1)People who perceive that Merapi eruptions are hazardous for their life;(2)People who receive evacuation order from Government staff, Non-Government staff, and their family;(3)People who know that government have evacuation standard operation procedure.

The research concludes that hazard perception, source of evacuation order, and acceptance of government evacuation procedure are factors that can be used to improve evacuation planning.

Key words**: Merapi eruption, people's behavior, evacuation.**

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ABBREVIATION

EMA	Emergency Management Australia
Badan Kesbangpol PB	Agency for Nation Unity, Politics, and Disaster Management
BAPPEDA	Local Agency for Planning and Development
BIG	Geospatial Information Agency
BNPB	National Disaster Management Agency
BPBD	Regional/Local Disaster Management Agency
BPS	Central Bureau of Statistics
BPPTK	Volcanology Observation and Technology Development Agency
Bupati	Regent
Desa	Village
DISKOMINFO	Local Agency for Communication and Information
DINKES	Local Agency for Health
DISHUB	Local Agency for Transportation
DISNAKERSOSTRANS	Local Agency for Manpower Social and Transmigration
DMC	Disaster Management Center
DPU	Local Agency for Public Work
Dusun	Hamlet/Sub Village
Kabupaten	Regency
KRB	Hazard Zone
POLRES	Local Police Department
PVMBG	Center for Volcanology and Geological Hazard Mitigation
RBI	Topographic Map of Indonesia
SPSS	Statistical Product and Service Solution
TPA	Permanent evacuation shelters
TPS	Temporary evacuation shelters

UNDRO	United Nations Disaster Relief Co-Ordinator
UNDP	United Nation Development Program
VEI	Volcanic Explosivity Index

1. GENERAL INTRODUCTION

1.1. Background of the study

The population density at the slope of Merapi Volcano is tremendously high, with an estimated 1.1 million people in 2000 (Thouret et al., 2000). As many as 440.000 people live in high-risk areas exposed to pyroclastic flow, and lahar surge (Thouret et al., 2000). The slope of Merapi volcano is densely populated due to fertile soil and abundant volcanic deposition. It invites people to stay, grow crops, and mine the sand from volcanic material.

Merapi volcano erupted in 1994. Pyroclastic flow travelled as far as 6.5 km along Boyong River. As many as 64 people were killed after Pyroclastic flow reached Turgo and Kaliurang villages and more than 6,000 people evacuated (Voight et al, 2000). The other eruptions prior to the 2010 occurred in 2006 in which pyroclastic flow reached 4 km from the crater. Two people killed in bunker located at Kaliadem village during eruption affected by pyroclastic flow, and more than 12,000 people evacuated from hazard zone (Wilson et al, 2007)

Volcanology Observation and Technology Development Agency (BPPTK) reported that the last eruption of this volcano occurred in 2010, and the first eruption occurred on 26 October 2010 at 17.02 p.m. It began with an increasingly violent series of eruptions at the end of October and continued in November 2010. Reported that over 350.000 people who lived in the slope of Merapi volcano were evacuated (JakartaGlobe, 2010a).

National Agency Disaster Management (BNPB) reported that until 12 December 2010 as many as 277 people from Yogyakarta province and 109 people from Central Java province were killed. Many are caused by pyroclastic flows. Most of the victims are the people who stayed at or returned to their home when Merapi volcano was explosively erupting from 26 October 2010 to 5 November 2010 (BNPB, 2010)

Figure 1.1. Merapi eruption on November 6th 2010
(Source: Reuters, 2010)

It becomes very clear that evacuation in volcanic eruption events have to be carefully prepared to minimize the victims. The existing evacuation plan has to be improved by analyzing people's characteristics, people's behavior in response to Merapi eruption, and factors influencing the affected people in response to volcanic eruption.

1.2. Research Problem

There were a lot of difficulties to evacuate people in hazardous zones, while the volcanic eruptions occurred. Although local governments had provided evacuation shelters and logistical needs, large numbers of villagers living at the slope of Merapi refused to evacuate, and did not respond to scientific-based warning. Some men were confident that they would be able to escape.

Other problems are that many evacuated people returned to their homes during the day after work in their agricultural lands and gave food to their cattle. The other fact is that the people who had evacuated came to their home when the status of Merapi volcano was in the level 4 (beware level), and that local governments did not pay attention about this fact (Kompas, 2010).

Earlier research (Donovan, 2009) described the many reasons why communities living in Merapi region refused to evacuate: firstly because at-risk communities worry about their properties, and secondly because they had to give food to their livestock.

Evacuation may well be prudent or even necessary to move people from hazardous zones to a place that is safe or at least safer in almost any natural disaster (UNDRO, 1984). Evacuation which is instituted before disaster impact can result in the preservation of life, reduction of personal injuries, and the protection of property (Perry, 1979). Blong (1984) explained that the success of an evacuation attempt will depend on the immediacy of threat, the cultural background of the potential evacuees, their perception of the risk, the inducements offered and a host of other factors.

The research problem of this study based on the problems mentioned above is how to examine factors influencing people behavior in response to volcanic eruption for improving evacuation planning.

1.3. Research Objective

1.3.1. The Main Research Objective

The main objective of this research is to improve evacuation planning based on people's behavior in response to volcanic eruption, case study of Merapi volcano.

1.3.2. The Specific Research Objective

To reach the main objective, the following specific objectives have to be achieved:

1) To identify characteristics of the people in the hazard zones.
2) To identify people's behavior in response to volcanic eruption events.
3) To examine factors influencing the evacuation response time.
4) To describe the disaster management of Magelang Regency related to evacuation.

1.4. Research Question

The following research question will be addressed in order to achieve the objectives which have been formulated and it is shown in Table 1.1.

Table 1.1. Research Objective and Research Question

No	Research Objectives	Research Questions
1.	To identify characteristics of the people in the hazard zones.	1. What are the characteristics of the people in the hazard zones?
2.	To identify people's behavior in response to volcanic eruption event.	1. Do the people pay attention to volcanic eruption event? 2. When do people receive impending eruption warning? 3. When do the people receive an evacuation order? 4. When do the people decide to evacuate? 5. How much time is needed in response to evacuation order? 6. What was the means of transportation to the evacuation place? 7. What evacuation place did the people go to?
3.	To examine the factors influencing the people's evacuation response time.	1. What are the factors influencing the people's evacuation response time?
4.	To describe the disaster management of Magelang Regency related to evacuation	1. How does the local government of Magelang Regency evacuate the people in the hazard zones? 2. What are the actual deficiencies and benefits of the local governments' evacuation efforts in response to volcanic eruption?

1.5. Research Limitation

This research deals with the identification of people's behavior in response to volcanic eruptions. The limitation encountered this study is related to the availability of time, especially when questionnaire survey conducted to respondents. Most of respondents are a farmer who works during the day. The questionnaire survey was conducted in the morning before the respondents worked at their farm, or in the evening when the respondents was staying at home.

The fieldwork was conducted only over short period, in practice only less than two months. Nine hamlets were selected as sampling unit area to represent all other hamlets situated in hazardous zones of Magelang Regency. The sampling areas were selected based on two official maps: Magelang Regency Administrative Map achieved from Local Agency for Planning and Development (Bappeda) and Merapi Volcano Hazard Zone Map produced by BPPTK.

1.6. Research Benefit

The result of this research may give benefits to stakeholders who have interest in volcanic disaster management at Magelang Regency as given below:

1. It represents characteristics of the people in the hazard zones of Merapi volcano.
2. It provides information related to people's behavior in response to Merapi eruption at Magelang Regency.
3. It provides information related to factors influencing the people's evacuation response time.
4. It represents disaster management of Magelang Regency related to evacuation effort in Merapi eruption.

1.7. Thesis Structure

This research focused on four main activities. There are identifying characteristics of the people in the hazard zone, identifying people's behavior in response to volcanic eruption event, examining the factors influencing the people's evacuation response time, and describing the disaster management of Magelang Regency related to evacuation. Each chapter describes specific subject described as follows:

1. Chapter 1-General Introduction. This chapter explains background of the study, research problem, research objective, research question, research limitation, and research benefit.
2. Chapter 2-Literature Review. This chapter describes literature review used in this research.
3. Chapter 3-Overview of study area. This chapter presents demographic of Magelang Regency and the hazard zone of Merapi volcano.
4. Chapter 4-Research Method. This chapter describes the step of research method divided into three steps: pre-fieldwork, fieldwork, post-fieldwork. This chapter also describes research instrument used in this research.
5. Chapter 5-Characteristics of the people in the hazard zone. This chapter explains socio-economic characteristics, experience of Merapi eruption, hazard knowledge, cultural beliefs, and hazard perception of the people on the study area.
6. Chapter 6-People's behavior in response to volcanic eruption. This chapter identifies when the people receive information of impending eruption, evacuation order, and evacuation decision time. This chapter also describes people activities during Merapi eruption.
7. Chapter 7-Factor influencing evacuation response time. This chapter examines the time needed in response to evacuation order and the factors influencing people's evacuation response time.

8. Chapter 8-Disaster management at Magelang Regency This chapter describes mitigation, preparedness, and response in 2010 Merapi eruption. This chapter also evaluate the disaster management of Magelang Regency.
9. Chapter 9-Conclusion and recommendation. This chapter provide conclusion and recommendation of this research.

2. LITERATURE REVIEW

2.1. Disaster Management

There are many different definition of disaster management. Regulation (2007) stated that disaster management is a series of efforts encompassing policies on development with disaster risk, disaster prevention, emergency response, and rehabilitation. DMC (1991) explained that disaster management is defined as "the range of activities designed to maintain control over disaster and emergency situations and to provide a framework for helping at-risk person to avoid or recover from the impact of the disaster, and disaster management copes with the situation before, during and after disaster occurrences".

Alexander (2002) cited in Coppola (2007) explained that the modern disaster management is based upon four distinct component: Mitigation, preparedness, response and recovery that the meaning of these terms is described as follows:

1. Mitigation is a method used to either make a hazard less likely to occur or reduce the negative impacts. On the other word, it can be defined as any sustained effort undertaken to reduce a hazard risk through the reduction of the likelihood and/or the consequence component of that hazard's risk;
2. Preparedness is the acts used to involve people who may be suffer of a disaster or who may be able to help those impacts with the acts to increase their chance of survival and to minimize losses;
3. Response is activity taken prior to, during, and immediately after a hazard event aimed at limiting injuries, loss of life, and damage to property and environment. the focus in response phase is on meeting the basic needs of the people until more permanent and sustainable solution can be found. Such as assisting evacuees with transportation, temporary shelters, and food;

4. Recovery is a part of disaster management used to repair, reconstruct, or regain what has been lost as result of a disaster. It can be used to reduce the risk of similar disaster in the future. The recovery phase generally begins after the immediate response has ended, and can persist for months or years thereafter.

Disaster Management is a cyclical process in which the end of one phase is beginning of another. Figure 2.1 shows the Disaster Management Cycle.

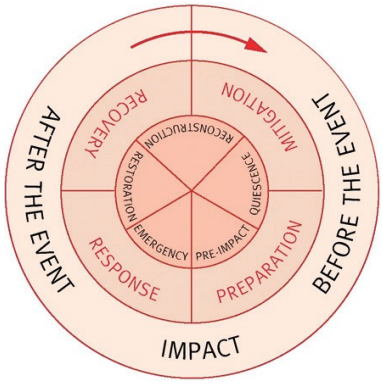


Figure 2.1. Disaster Management Cycle
(Source: Alexander, 2002 cited in Coppola, 2007)

Westen and Kingma,(2009) explained that Disaster risk management is "the systematic process of using administrative decisions, organization, operational skills and capacities to implement policies, strategies and coping capacities of the society and communities to lessen the impacts of natural and related environmental and technological disasters"

The disaster management is based upon four distinct components (Westen and Kingma, 2009): Prevention, preparedness, relief/response, recovery and reconstruction

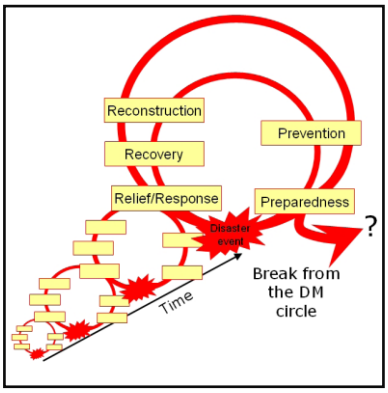


Figure 2.2. Traditional view of the disaster management
(Source: Westen and Kingma, 2009).

Figure 2.2 shows the traditional view of disaster management. It represents disaster management in the form of a circle that becomes larger because of improvements in the process. Small hazard event would not turn into disaster events, and relief/response would not be needed. It takes more time before a larger hazardous event still would become a disaster, and relief/response would be needed to break the cycle of disaster event (Westen and Kingma, 2009).

2.2. Definition of Evacuation

The term of evacuation can mean many things; flight, eviction, formal evacuation by authorities, or abandonment of an area and resettlement (Blong, 1984). Perry (1979) explained the meaning of evacuation as an important tool in the hands of authorities which is instituted before disaster that can cause in the preservation of life, reduction of personal injuries, and the protection of property. UNDRO (1984) stated that evacuation in almost any natural disaster is carefully done by moving people from hazardous areas to safe or least safer areas.

There are two types of evacuation: the first type is immediate evacuation that an evacuation resulting from a hazard impact and forces immediate action. The second type of evacuation is pre-warned evacuation that an evacuation resulting from an event that provides adequate warning and does not unduly limit preparation time (EMA, 2005).

2.3. The Role of Evacuation in Disaster Management

Based on Law Regulation number 24 of 2007, evacuation of affected people is an activity that has to be conducted during the emergency response (Regulation, 2007).

DMC (1991) explained that evacuation is a part of response activity in natural disaster management. Figure 2.3 shows the evacuation role in major aspects of natural disaster management.

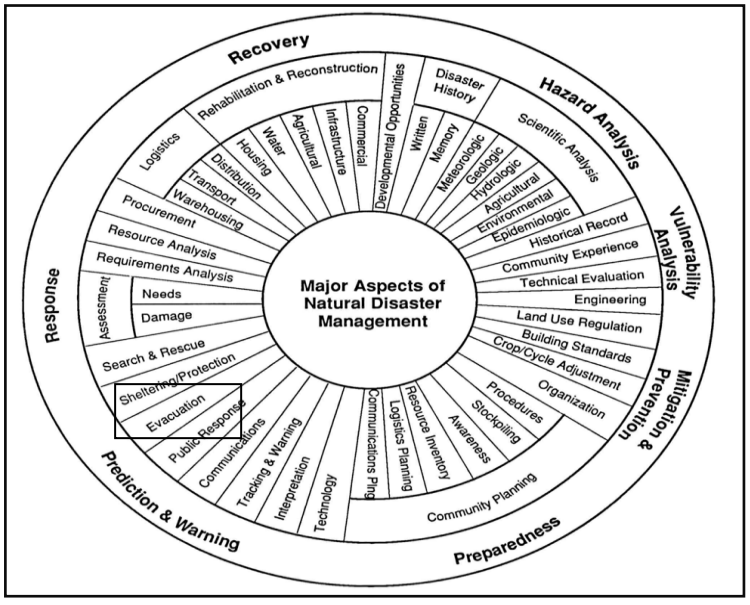


Figure 2.3. Major Aspect of Natural Disaster Management
(Source: DMC, 1991)

2.4. Evacuation Time

Evacuation time is one of valuable factors discussed in evacuation behavior. UNDRO(1984) explained that evacuation time is defined as the interval between detection of an event which eventually requires evacuation to the end of evacuation itself that are divided into four components of evacuation time: decision time (the time elapsed from detection of a disaster until a decision is made by competent authority to order an evacuation), notification time (the time

required to get the evacuation notification to everyone in the specified area), preparation time (the time required for people to prepare to evacuate the specified area), and response time (the time required for people actually to move out to safer area).

An evacuation is a complex process consisting of several phases (Stepanov and Smith, 2009). The first phase is detection of disaster. In the second phase, decision makers have to evaluate the risk and potential threat for specific areas which constitute origins of evacuation. In the third phase, the alert has to be communicated to the affected people. In the fourth phase, the affected people make a decision to evacuate or not to evacuate depending on their risk perception. This phase also implies preparation for leaving. In the fifth phase, implies movement of affected people to evacuation place or designed safe area. This step involves clearing of people from affected areas. In sixth phase, affected people arrive to safe area. Finally, in the seventh phase, a verification that all evacuees have made it safely must be carried out.

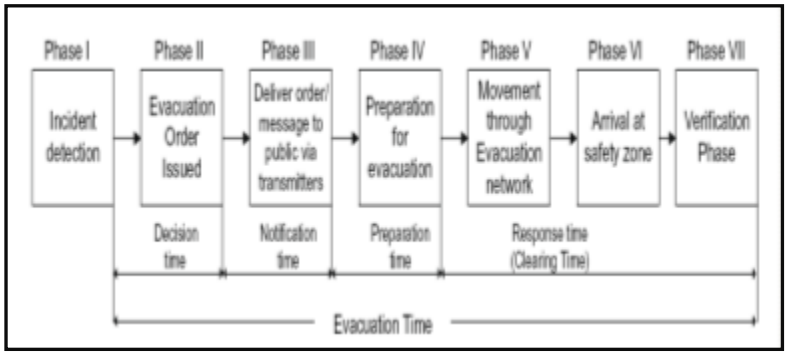


Figure 2.4. Evacuation Phase (Source: Stepanov and Smith, 2009)

Stepanov and Smith (2009) explained that the time intervals for the third phase and the fifth phase represent the people's evacuation response time (ERT). During the third phase, evacuation order is carried out by people who have responsibility for issuing evacuation order to affected people. This phase constitute the receiving time of evacuation order (RT). In the fifth phase, the

affected people make a decision to evacuate. This phase also implies as people evacuation decision time (EDT). The calculation of people response time is showed in the following formula:

$$ERT = EDT - RT \quad (1)$$

Where

ERT = Evacuation response time (Hours)

RT = Receiving time of evacuation order (Date and hour)

EDT = Evacuation decision time (Date and hour)

2.5. Evacuation Planning

The evacuation can be mandatory, recommended, or voluntary and should be conducted according to an evacuation plan (Stepanov and Smith, 2009). EMA (2005) divided the evacuation planning consideration into five stages of the evacuation process (see Figure 2.5):

1. Decision to evacuate

   The decision as to whether to evacuate or not will be assisted by the availability of timely and relevant information. If the decision is made to early and the hazard recedes, the evacuated people will be exposed to unnecessary risk, inconvenience and cost. If the decision is made too late, the affected people will be forced to evacuate under high risk conditions.

2. Warning

   An evacuation warning is structured to provide timely and effective information. The factors influencing the effectiveness of the warning include time, distance, visual evidence, threat characteristics and sense of urgency demonstrated by emergency services.

3. Withdrawal

   An evacuation process involves the removal of people from hazardous area to a safer area. The agency that has the authority to order an evacuation has to concern to the degree or urgency and to the time in this stage.

4. Shelter i

   The evacuation process and involves provision of the basic needs for the affected people away from the immediate or potential effects of hazard. Shelter provides for the temporary respite of evacuated people.

5. Return

   It will be necessary to assess the hazardous area to determine if return is possible and identify any conditions which may need to be imposed.

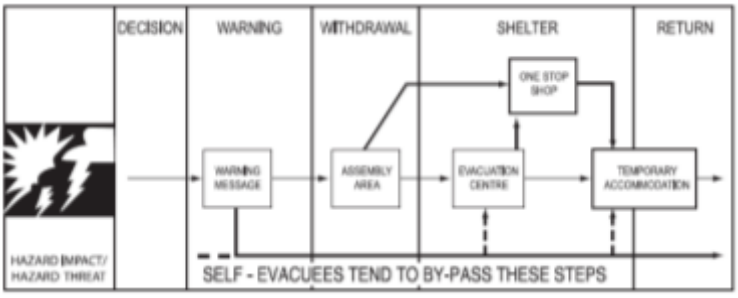


Figure 2.5. Five stages of Evacuation Process
(Source: EMA, 2005)

Blong, (1984) explained that the list suggests points which need to be considered in the design of an evacuation plans are: (1) Enforced evacuation is relatively inefficient, (2) Voluntary evacuation often requires incentives, (3) Evacuation plans must be formulated and communicated to potential evacuees long before the hazard impact occur,(4) Evacuation is dependent on effective communication and transportation,(5) Evacuation routes must be specified in warning message and must remain clear until evacuation is complete,(6) Most potential evacuees seek confirmation of an evacuation order from neighbors, relatives or officials,(7) Separation of family unit during evacuation create anxiety

and attempts to return to the evacuated area,(8) A large proportion of evacuees do not use public shelter facilities, but stay with friends and relatives,(9) Evacuees worry about the security of their properties.

Evacuation plan for future volcanic eruption impacts requires specific data about past eruption such as information about agents of death, the number of people at risk, whether evacuation was ordered before the eruption began, the proportion of bodies recovered, the proportion of those who died during the eruption versus those who died later, clinical cause of death or injury, and the extent and the nature of injury sustained (Blong, 1984).

2.6. Factors Influencing Evacuation Decision

Evacuation in the face of volcanic hazards has one major difference when compared with evacuation from other natural hazard impacts (Perry, 1979). The duration is much less certain. Evacuation from a hurricane or a flood impacts is unlikely to be for more than one week, but receiving time of evacuation order in volcanic eruption are unpredictable. Various factors influence the evacuation in volcanic eruption events. According to Perry (1979) the major factors influencing the evacuation are (1) the presence of the adaptive plan; (2) the individual's definition of threat as real (i.e. the development of a warning belief (3) the level of perceived risk. The other factors supporting the major factors are (1) the family context in which the warning is received, (2) kin relationships in which the family is enmeshed, (3) level of community involvement. In common opinion the main factors of evacuation decision making are influenced by hazard knowledge, risk perception, people's behavior, and conditional on volcanic (UNDRO, 1984).

Lindell and Perry (1992) developed and analyzed a model of protective response that could be represented by a decision tree consisting of three questions. Kathleen, et al (2001) explained that the model developed by Lindell and Perry (1992) were similar frameworks for conceptualizing the evacuation process. An

evacuation decision is mainly affected by observable cues in the environment, the psychological, socio-demographic, and socio-cultural characteristics and past experience. This model is shown in the following figure.

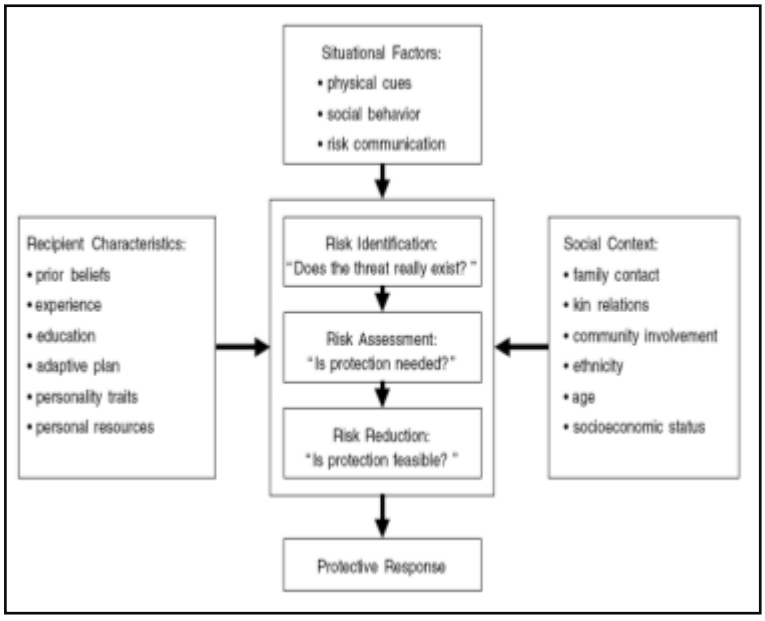


Figure 2.6. Decision Tree Model developed by Lindell and Perry (1992) cited in Kathlen et al (2001)

2.7. Volcanic Hazard

Smith and Petley (2009) explained that volcanic hazard can be classified into primary and secondary hazards. Pyroclastic flows, lava flows and volcanic gasses are the primary hazard that is related to the material produced directly by volcanic eruption events. Lahar is the secondary hazard generated by the material flows from eruption and combining with other factors such as rainfall and over-steepening slopes.

Ball (2010) clarified some volcanic hazards that are related to Merapi eruption are stated as:

1) Pyroclastic flows

   Many of the Merapi eruptions in history have involved pyroclastic flow. The pyroclastic flows are known locally as "wedhus gembel" (Javanese for

"shaggy goat"). Pyroclactic flows contain mixtures of hot lava blocks, ash, pumice and volcanic gas, descending slopes at very high speeds. Figure 2.7 shows the historical distribution of pyroclastic flows on Merapi volcano. The western flank is swept by pyroclastic flows every 8-15 years (Thouret et al, 2000).

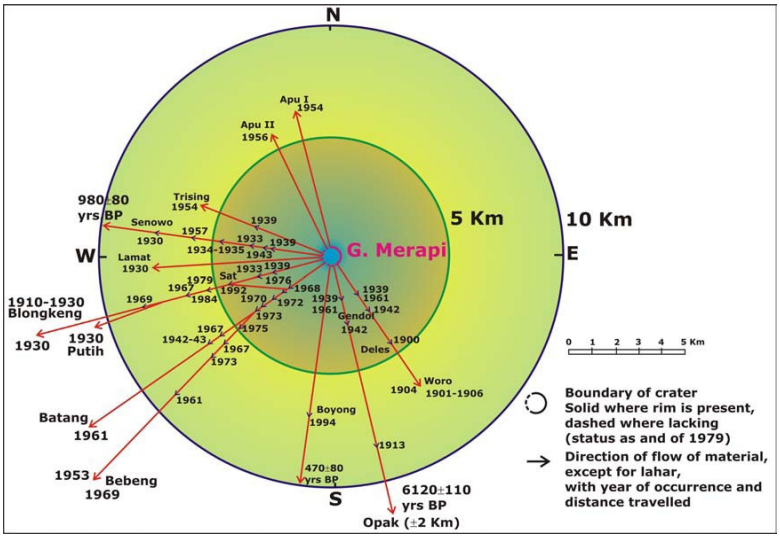


Figure 2.7. Azimuths and travel distances for pyroclastic flows
(Source: Thouret et al., 2000)

2) Lava flow

Lava flow is molten rocks that flow out of a volcano. Most lava flows can be easily avoided by a person on foot, since lava flow do not move much faster than walking speed. Lava flow usually cannot be stopped or diverted because they are extremely hot . The temperature of lava flow is from 1,000 ^{o} C – 2,000^{o} C . The upper cone 1 km^2 in area is covered frequently by present and historical stubby lava flows. However, an additional area 3 km^2 can be buried by lava flow-forming eruptions like in 1930-1931 and 1975-1976 (Thouret et al, 2000).

3) Volcanic ash

Volcanic ash is low-density rock material ejected from a volcanic vent into the air. The weight of ash deposited can bring down roofs and cause serious damage as well as injury to people.

4) Gases

Volcanic gases are probably the least showy part of a volcanic eruption, but they can be one of an eruption 's most deadly effects. Most of the gas released in an eruption is water vapor (H^2O), and relatively harmless , but volcanoes also produce carbon dioxide (CO2), sulfur dioxide (SO^2), hydrogen sulfide (H^2S), fluorine gas (F^2), hydrogen fluoride (HF), and other gases.

5) Lahar

Lahar is an Indonesian term that describes a flowing mixture of rock debris and water from a volcano, which encompasses a continuum from debris flows (sediment concentration > 60% per volume) to hyper concentrated flows (sediment concentration from 20% to 60% per volume). Lahars are more deadly and devastating than pyroclastic flows for several reasons. They flow farther down slopes to the more heavily populated plains. The rock fragments carried by lahars make them especially destructive, while abundant liquid allows them to flow over gentle gradients and inundate areas far distant from their source. Requiring only the sudden mixture of large amounts of water with abundant, loose and easily eroded debris on a volcano slope, they can be formed in a variety of ways. They occur more frequently and over longer periods of time than pyroclastic flows. Since 1822-1990, at least 12 of 33 eruptions at Merapi volcano triggered lahar, that caused death and created damage in 1849,1871-1873, and 1930-1931 (Thouret et al, 2000).

2.8. Volcanic Explosivity Index (VEI)

The way to describe the relative size or magnitude of explosive volcanic eruptions is mentioned by Volcanic Explosivity Index (VEI). Newhall and Self's (1982) stated that VEI provides a simple descriptive measure appropriate to a discussion of volcanic hazard. VEI is a general indicator of the explosive character of an eruption. It is a composite estimate of Walker's magnitude and/or intensity and/or destructiveness and/or (less frequently) dispersive power, violence, and energy release rate, depending on which data were available.

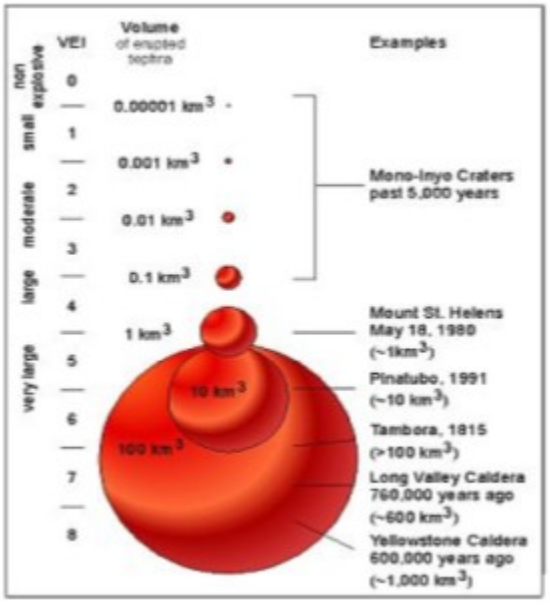
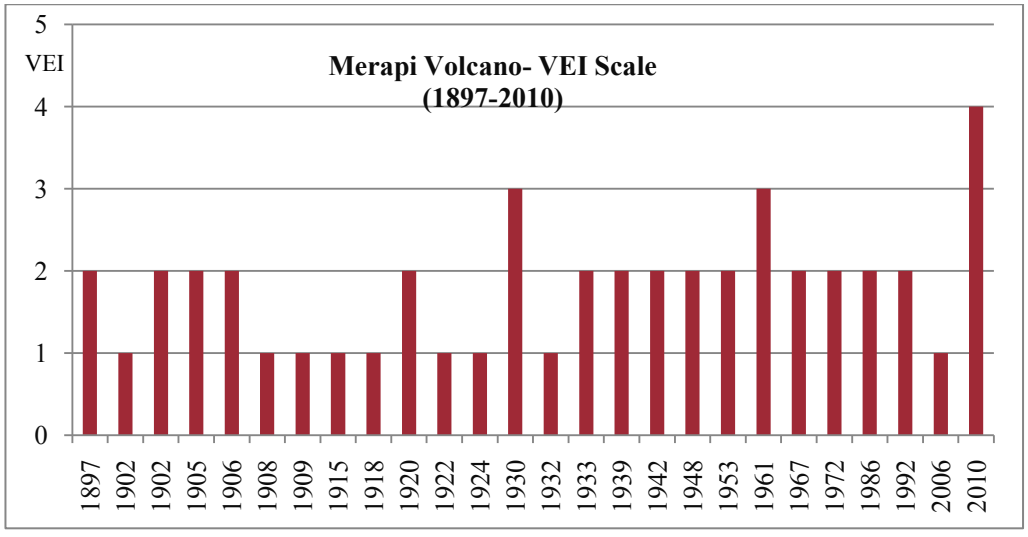


Figure 2.8. Volcanic Explosivity Index (VEI)
(Newhall and Self's,1982)

This index combines the total volume of eruptive products (for example, ashfall, pyroclastic flows, and other ajecta) , the height of the eruption cloud, duration of the main eruptive phase and the several descriptive terms into a simple 0-8 scale of increasing explosivity.

VEI is a useful tool for comparing the relative explosivity of historic eruptions and to illustrate applications of the VEI to studies utilizing the historical record of volcanism.

No volcano in Indonesia has been better monitored than Merapi volcano (Voight et al, 2000). Information on Merapi eruptive activity is scattered and much is remotely located. A concise and well-documented summary of this activity has been long needed to assist researchers and hazard-mitigation efforts. Graph 2.1 shows the eruptive history of Merapi volcano from 1897 to 2010 that is derived from Global Volcanism Program (2012).



Graph 2.1 The eruptive history of Merapi Volcano (VEI/Year)
(Source: Global Volcanism Program, 2012)

2.9. Merapi Hazard Zones

Volcanoes hazard zones are region around the volcano that are liable to be affected by one or more destructive materials during eruption. The effect of hazardous eruptive event can be ranked according to distance from the volcano vent, and the effects can be either immediate or delayed and may last long after eruption (Thouret, 2004).

Based on the Merapi Volcano Hazard Zone map published by BPPTK on 11 June 2008 and referred by Local Government of Magelang Regency on Mitigation of Merapi volcano eruption in 2010, the hazard zones of Merapi Volcano are divided on three hazard zones:

1). The Third Hazard Zone (KRB 3)

The third hazard zone is the nearest to the hazard sources affected frequently by Pyroclastic flows, lava flows, rock falls, and ejected rock fragments. Permanent settlement in the third hazard zones is not allowed because of the high vulnerability. The boundary of the third hazard zone is based on the history of Merapi eruption within the last one hundred years with VEI scale 1-3.

2). The Second Hazard Zone (KRB 2)

The second hazard zone is divided into two parts. The first part is affected for the mass flow like pyroclastic flows, lava flows and lahar. The second part is affected by the ejectal material such as the thick dry volcanic ash fall, and volcanic rock. The boundary of the third hazard zone is based on the history of Merapi eruption more than one hundred years with VEI scale 3-4.

3). The First Hazard Zone (KRB1)

The first hazard zone is the farthest hazardous zone where the lahar overflowing. During the increasing of eruption, these zones are potentially affected by volcanic ash and ejected rock fragments.

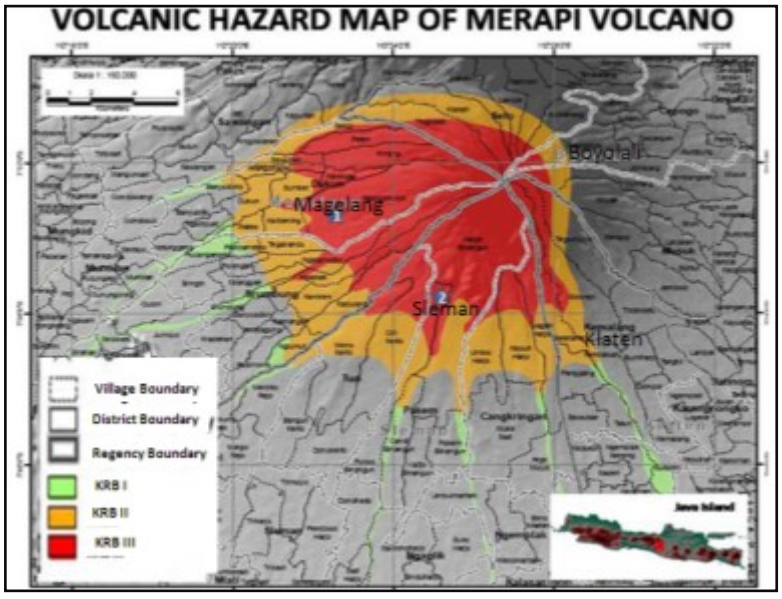


Figure 2.9. Merapi Volcano Hazard Zones
(Source: Badan Kesbangpol PB,2010a)

On 25 October 2010, PVMBG, based on official letter number 2047/45/BGL.V/2010, recommended that the evacuation order was given based on concentric hazard zone (see Figure 2.10).

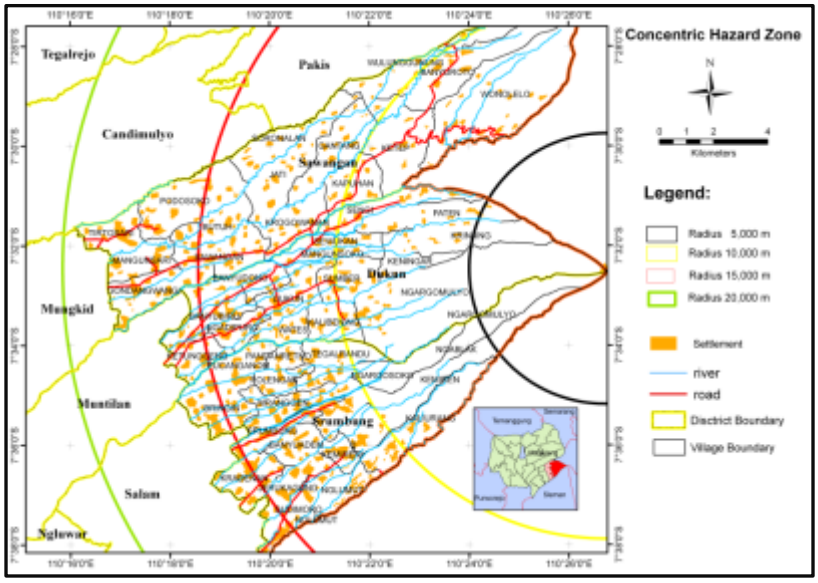


Figure 2.10. Concentric Hazard Zone

2.10. Disaster Management in Indonesia

The national parliament of Indonesia approved Law of the Republic of Indonesia number 24 of 2007 concerning disaster management. Taking note with the article 5 in the law of disaster management, government established BNPB as non-departmental government institution on a level equal to ministries who bear responsibility for disaster management in Indonesia. BNPB has the tasks to provide guidelines and directions on disaster management which include disaster prevention, emergency response, rehabilitation, and reconstruction. BNPB is assisted by regional/local disaster management to formulate and stipulate disaster management policy, and handling evacuation through immediate, appropriate, effective, and efficient actions. Regional/Local governments shall establish Regional/Local Disaster Management Agency (BPBD) presided over by an official whose position rank second to regent/mayor or equivalent to echelon IIa (Regulation, 2007).

The Center for Volcanology and Geological Hazard Mitigation (PVMBG), one of institutions in Geological Agency, has responsibility for assessing and monitoring volcanic hazard. This institution provides hazard zone map intended to support disaster management agency in estimating the area that can be affected by various volcanic hazard (Mei and Lavigne, 2012)

2.11. Cultural Beliefs Influencing Evacuation Behavior

People living on the slope of Merapi volcano still have animist convictions and worship spiritual gods (Lavigne et al, 2008). Most of them said that there is another world within the crater of Merapi volcano (Dove, 2008). There are *"Makhluk Halus"*/Unseen creatures living in Merapi volcano (Donovan, 2009).

Traditional ceremony is routinely conducted on the slope of Merapi volcano to placate the creatures who can control the Merapi eruption by giving food, clothes and money (Donovan, 2009). "*Labuhan"* is traditional ceremony

that is held in Kinahrejo village. Many people attend the ceremony, and they wish to get a blessing from the Creator of the World (Lavigne et al, 2008).

An important person in cultural beliefs on the slope of Merapi volcano is Mbah Marijan. He was one of cultural leader in the traditional Javanese religion (Kejawen), and he was the gatekeeper of Merapi volcano. The Javanese people believe that Mbah Marijan could communicate with spirits who look after of Merapi volcanic (Lavigne et al, 2008).In the 2006 Merapi eruption, Mbah Marijan did not have any sign from spiritual creatures, and he believed that the 2006 Merapi eruption would not trigger a disaster. Therefore, some of villagers refused to evacuate (Wilson et al, 2007; Mei and Lavigne, 2012). On 26 October 2010, Mbah Marijan and 16 people were found died in Kinahrejo village affected by pyroclastic flow (Mei and Lavigne, 2012).

2.12. Sampling Method

Yunus (2010) described in his book that sample survey method is a research that obtains data from a subset of a population in order to estimate characteristics of the whole population. There are two main sampling methods to select the sample: probability and non-probability sampling method. A probability sampling is any sampling method in which every individual in population has a chance of being selected in the sample. Otherwise, a non-probability sampling is any sampling method in which some individual of the population have no chance of being selected in the sample, and it involves the sample selection based on assumption regarding the population of interest.

Stratified random sampling is one of probability sampling methods in which the population is divided into a number of distinct categories (strata). Each stratum is sampled as an independent sub-population. Individual elements can be randomly selected in each stratum. This sampling can maximize the degree of population representation (Yunus,2010).

To achieve that the conclusions of statistical analysis are valid, the sample size must be determined and can represent a population. Yunus (2010) explained that the sample size (N) is very nearly normal for N>30 samples.

2.13. Statistical Analysis

Statistics is concerned with scientific methods for collecting, organizing, summarizing, presenting and analyzing data, as well as drawing valid conclusions and making reasonable decisions on the basis of such analysis (Spiegel, 1961).The statistical tool used to determine whether there is an association or relationship between two categorical variables is χ^2 (read chi-square) test for independence (Spiegel, 1961).

Cross-tabulation Analysis is statistical tool that presents and analyses data arranged in rows and columns, and it displays a relationship between two or more categorical variables. Nominal and ordinal data are the type of data used in cross-tabulation analysis (Ghozali, 2006).

To apply the chi-square (χ^2) test for independence to sample data, the degree of freedom (df) and chi-square (χ^2) are computed to determine whether there is a significant relationship between two categorical variables. The decision to accept or reject the null hypothesis could be calculated based on either comparison between the computed value of χ^2 or some critical value of χ^2 or consideration of probability (p-value) (Ghozali, 2006)

Spiegel(1961) provided a simple formula for computing degree of freedom and chi-square (χ^2). The following table describes the formula for h x k contingency tables:

Table 2.1. All type of Contingency Tables

Event	E_1	E_2	E_3	……..	E_k
Observed Frequency	o_1	o_2	o_3	…….	o_k
Total	e_1	e_2	e_3	……..	e_k

Source: Spiegel (1961)

A formula of χ^2 analysis for h x k tables:

$$\chi^2 = \frac{(o1 - e1)^2}{e1} + \frac{(o2 - e2)^2}{e2} + \cdots + \frac{(ok - ek)^2}{ek} = \sum_{j=1}^{k} \frac{(oj - ej)^2}{ej} \quad (2)$$

The number of degrees of freedom (df) of this chi-square distribution is given for h>1 and k>1 by:

$$df = (h - 1)(k - 1) \quad (3)$$

Where h=number of rows and k=number of columns

3. OVERVIEW OF STUDY AREA

3.1. General Information of Magelang Regency

This study was conducted on the western slope of Merapi volcano which administratively situated at Magelang Regency. This regency is also surrounded by two other volcanoes: Merbabu volcano in the east side, and Sumbing volcano in the north side.

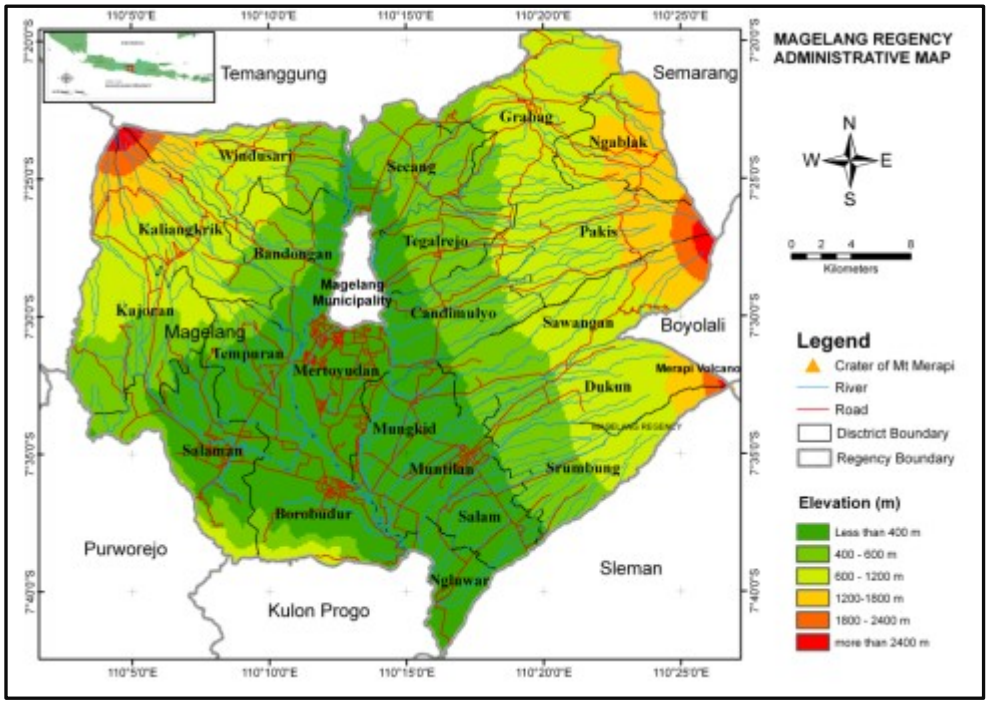


Figure 3.1. Magelang Regency

Magelang regency area is spread out from 110°01’51’’ until 110°26’58’’ eastern longitude and from 7°19’13’’ until 7°42’16’’ southern latitude. Total area of Magelang Regency is 108,573 hectares divided into 21 districts (kecamatan), with 372 villages (desa), and 2,379 hamlets (dusun).

Most areas of Magelang Regency are an undulating area in which the flat area is 1,628 hectares, the undulating area is 59,175 hectares, the steep area is

27,686 hectares and the very steep area is 19,542 hectares with an altitude between 152-3,065 m above sea level with administrative boundaries as follows:

Situated at the centre : Magelang Municipality

North boundary : Temanggung Regency and Semarang Regency

East boundary : Semarang Regency and Boyolali Regency

South boundary : Sleman Regency and Kulon Progo Regency

West boundary : Purworejo Regency, and Wonosobo Regency

Based on BPS (2010) the number of population of Magelang Regency reached 1,217,672 people consisting of 608,962 females and 608,710 males in 2009.

3.2. Merapi Volcano Hazard Zone of Magelang Regency

Merapi volcano hazard zone situated at Magelang Regency is comprised of three districts: Sawangan, Dukun, and Srumbung.

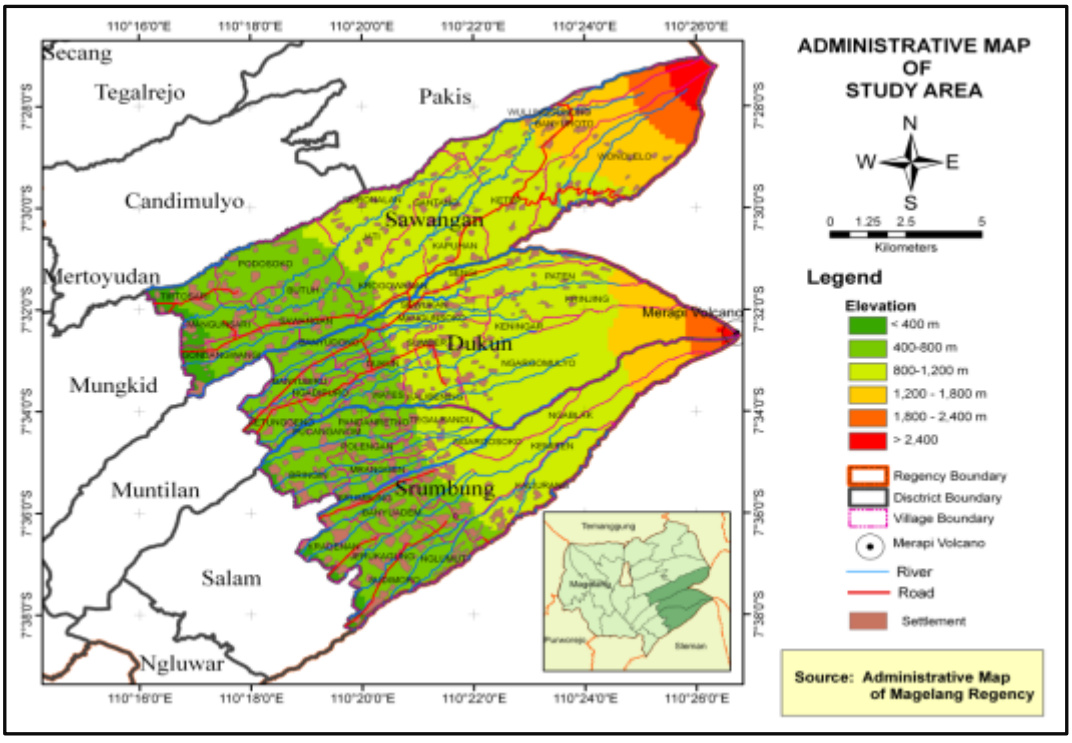


Figure 3.2. Administrative Map of Study Area

Total area of these districts was 17,894 hectares or about 16.48 percent of Magelang Regency in which the overall number of population was 146,645 people with 40,231 households in 2009. Administratively, this study area is divided into 47 villages, and 394 hamlets (BPS, 2010).

Table 3.1. The characteristics of study area

Distirct	Area (Km2)	Village	Hamlet	Household	Population
Sawangan	72.37	15	124	15,332	57,245
Dukun	53.40	15	143	12,891	44,056
Srumbung	53.17	17	127	12,008	45,344
	178.94	47	394	40,231	146,645

Source: BPS, 2010.

Figure 3.3 shows Merapi volcano hazard zone situated at Magelang Regency. It is resulted from overlay technique between Merapi volcano hazard zone map and administrative map of Magelang Regency.

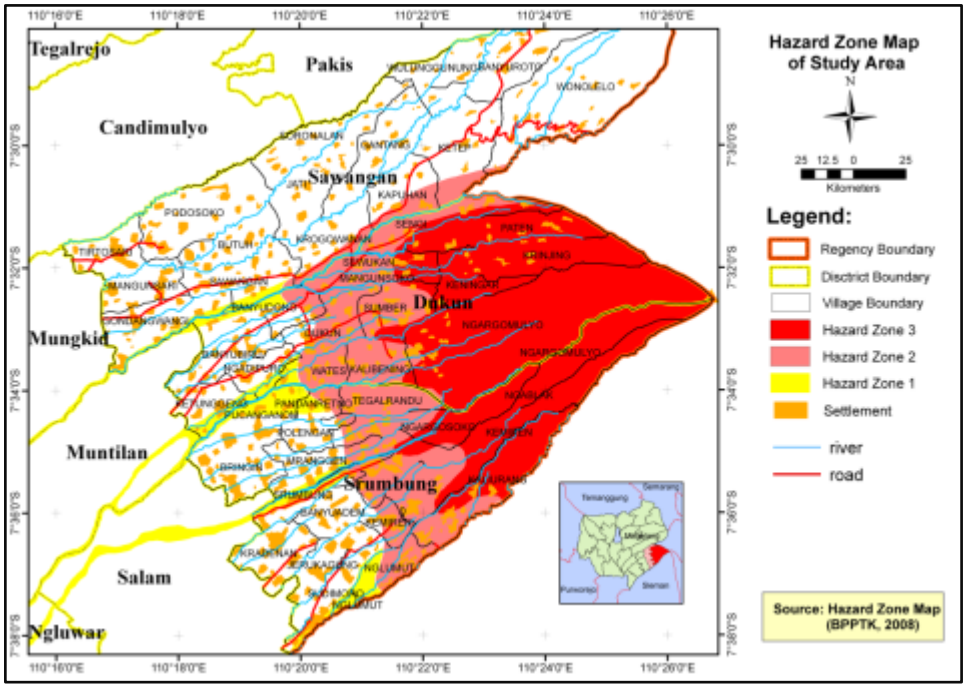


Figure 3.3. Hazard Zone Map of Study Area

3.3. Mitigation of Volcanic Eruption

Local Government of Magelang Regency appointed the Agency for Nation Unity, Politics, and Disaster Management (Badan Kesbangpol PB) according to the Bupati Act of Magelang Regency No.10/2009 about Detailed Task of Structural Function in Agency for Nation Unity, Politics, and Disaster Management to hold responsibility to arrange the standard operating procedure for managing the disaster.

Badan Kesbangpol PB produced a standard operation procedure of disaster management for Merapi eruption at Magelang Regency as a guideline for the related institution activities that should be established before, during and after the Merapi eruptions. This institution produced evacuation plan that was named Contingency plan to response Merapi eruption/*Rencana Kontijensi Penanganan Bencana Merapi*.

3.3.1. Hazard Assessment of Merapi eruption

Emergency and response planning is one of category in government preparedness action (Coppola, 2007). Local government of Magelang Regency has identified the hazardous areas on the western slope of Merapi volcano based on the hazard map conducted by BPPTK in 2006. The map indicates that there are three districts located at hazard zones of Merapi volcano. The following table shows the people living in hazard zones of Merapi volcano before the 2010 Merapi eruption.

Table 3.2. Districts and People in the hazard Zones

Districts	Number of Villages	Number of Hamlets	Number of Households	Number of Inhabitants
Srumbung	8	36	3,620	13,110
Dukun	8	64	5,937	19,885
Sawangan	3	5	373	1,211
	19	105	9,930	37,507

3.3.2. Evacuation Planning

Evacuation planning is the activity to organize the process of moving people from hazardous areas to safe or at least safer areas. Local Government of Magelang Regency planed to evacuate their people after they received recommendation from BPPTK. Evacuation order would be given when the alert level of Merapi volcano activity reached the level 4 (beware). Badan Kesbangpol PB gives orders to evacuate all inhabitants in hazard zone. An evacuation process was done in a hurry. On this time, the major eruption is predicted that will possibly occur within 24 hours.

There were three types of evacuation shelter prepared by local government. The differences of those shelters were based on the functions, capacity and capability of shelters to accommodate the evacuated people.

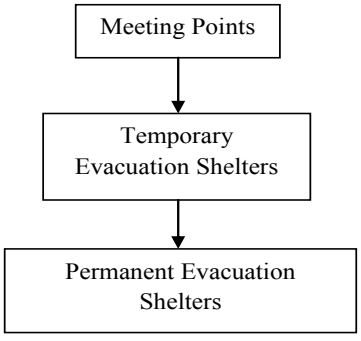


Figure 3.4. Evacuation Shelter Types

The existence of meeting point (*Titik Kumpul*) was aimed for evacuating people in the fastest period and on the shortest distance after evacuation warnings were given to people at hazardous zones, Firstly the evacuated people were accommodated in meeting points located at every village. The capacity and capability of assembly points to accommodate the evacuated people were only less than 24 hours.

Temporary evacuation shelters *(Tempat Pengungsian Sementara)* had capacities and capabilities to accommodate the evacuated people on a limited time. The open space areas and public buildings were used as temporary evacuation shelters which did not have satisfying facilities although they were located at safer areas, and the nearest to evacuated people's homes.

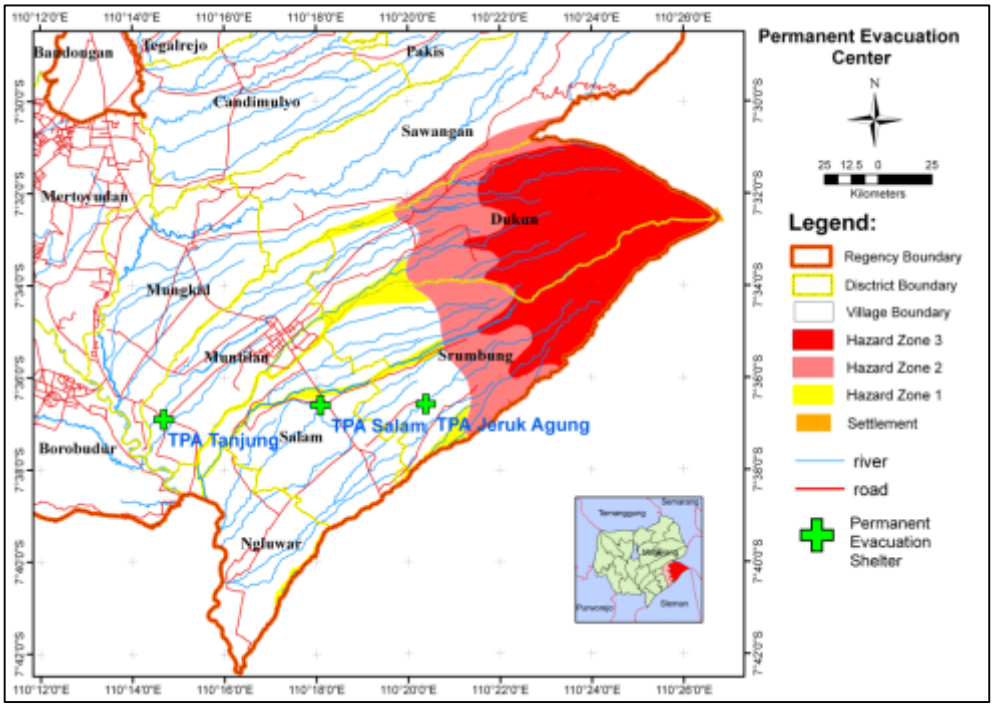


Figure 3.5. Permanent Evacuation Shelter Sites

Permanent evacuation shelters *(Tempat Pengungsian Akhir)* were prepared to evacuate people in long time periods. The Local government intentionally prepared buildings that were especially used for accommodating the evacuated people. There were three permanent evacuation shelters located at Magelang Regency (TPA Tanjung, TPA Jerukagung, and TPA Salam).

The facilities and infrastructures of evacuation shelters were prepared by Local Government to accommodate the affected people. The scenario of evacuation process was prepared by establishing the location and the capacity of evacuees accommodated each evacuation shelter (Badan Kesbangpol PB, 2010a).

3.3.3. Institutional Responsibility Arrangement

Local government of Magelang Regency had an evacuation plan that discussed about nine prepared sectors in facing Merapi eruption. The following table describes the responsibility of related institutions in Merapi Volcano Risk Management.

Table 3.3. Important Sectors and Related Institutions in Merapi Volcano Disaster Management

No	Sector	Institution	Role
1	Management and Coordination	Badan Kesbangpol PB	• Prepare central coordination office located at every hazardous village • Coordinate the risk management activities. • Organize the risk management activity report.
2	Health	DINKES	• Provide the health center including medicines and ambulance at every evacuation shelter. • Prepare the health staff, doctors, and nurses.
3	Evacuation activity and Transportation	DISHUB	• Provide transportation facilities, evacuation routes, and signs of evacuation.
4	Logistics	DISNAKERTRANS	• Receive and distribute logistics
5	Evacuation Shelter	DPU	• Prepare evacuation shelters including facilities of electric, clean water, sanitation.
6	Public Kitchen	DISNAKERTRANS	• Provide food and beverage for evacuated people and evacuation personnel. •
7	Communication and Documentation	DISKOMINFO	• Provide telecommunication means at given sites.

No	Sector	Institution	Role
8	Security	POLRES	• Provide personnel to secure the areas which were left by evacuated people
9	Education	DISDIK	• Provide temporary schools at evacuation shelters, including teacher and the studying facilities.

Badan Kesbangpol PB of Magelang Regency was institution pointed as coordinator of all related institutions for managing the Merapi volcano risk management activities. The responsibility of each sector was given to institutions that were appropriate to their main work functions (Badan Kesbangpol PB, 2010a).

Local government was assisted by Non Government Organizations, Military, and Red Cross to facilitate evacuation activities of affected people by:

1. Providing the means of evacuation transportation
2. Using Public buildings at safe areas were as temporary evacuation shelters.
3. Twice a day, the coordinator of evacuation shelter sent the logistical report to coordination centre office in Bupati Office to gain the logistics needs.
4. Public kitchens were established in every evacuation shelter preparing the food for evacuated people, and food was distributed by using buffet model in order to simplify in distribution.
5. Temporary toilets were built in evacuation shelters based on the number of accommodated people in a evacuation shelter in which every toilet was used ideally for only 50 persons.
6. Providing clean water that could be used to supply either drinking water or water for other uses by both sending water in tanker trucks and pumping water from nearby source into evacuation shelters.

3.4. Chronology of the 2010 Merapi Eruption

The important event of 2010 Merapi eruption based on daily report of Merapi eruption reported by BPPTK is described in the following Table 3.4:

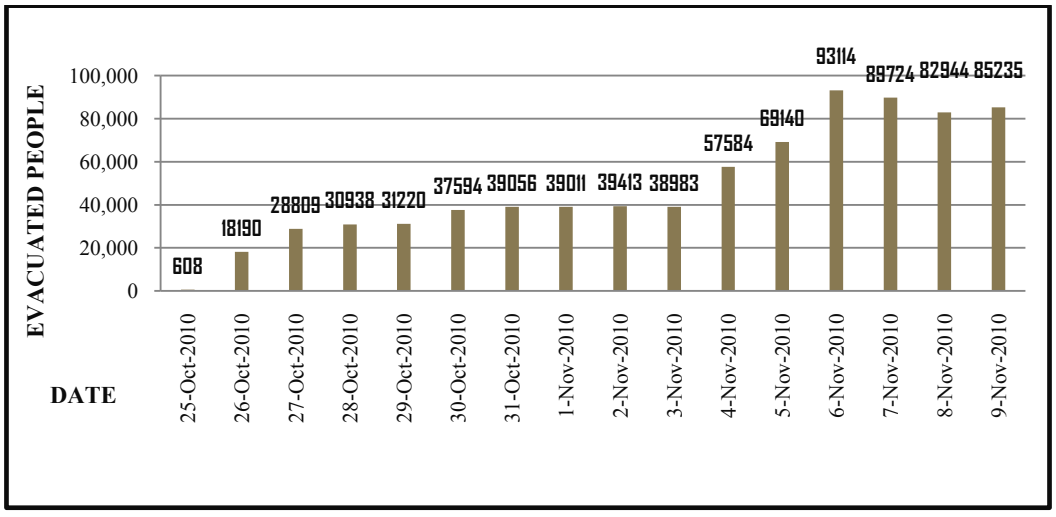
Table 3.4. Important Events of the 2010 Merapi Eruption

Date	Time	Event
20 September 2010		Alert level increased from Level 1(normal activity) to Level 2 (caution).
21 October 2010		Alert level increased from Level 2 (caution) to Level 3 (alert).
25 October 2010	06.00	Alert level increased in the highest level from level 3(alert) to level 4 (beware). BPPTK recommended communities within 10 km of the crater evacuated.
26 October 2010	17.02	The first eruption occurred with pyroclastic flow reaching 7.5 km from the crater.
3 November 2010	11.11-15.00	The activity of eruption still increased. Pyroclastic flow reached 9 km from the crater.
3 November 2010	15.05	The eruption activity increased. BPPTK recommended the safe area is more than 15 km from the crater.
4 November 2010	00.00-24.00	A Series of eruption occurred with pyroclastic flow reaching 14 km from the crater flowed all rivers in Mt.Merapi.
5 November 2010	01.00	BPPTK announced that the safe area decided more than 20 km from crater.
14 November 2010		At Magelang regency, the dangerous area lowered within 15 km from the crater .
19 November 2010		At Magelang regency the dangerous area lowered within 10 km from the crater.
3 December 2010		Alert level lowered from level 4(beware) to level 3 (alert).

(Source: BPPTK, 2010)

3.5. Evacuation Effort of Local Government of Magelang Regency

Based on Disaster Management Report at Magelang Regency in 2010 which was reported by Badan Kesbangpol PB, Local Government of Magelang regency began to evacuate people living in hazard zone on 25 October 2010. After the first at least 28,000 people was evacuated from the third hazardous zone. The number of evacuees increased following the enlarging activity of Merapi eruption.



Graph 3.1 The number of evacuated people in Magelang Regency
(Source: Bappeda, 2010)

Local Government of Magelang evacuated a number of evacuees around 93,000 people on 6 November 2010 after BPPTK announced the hazardous areas reached 20 km from the crater on 5 November 2010 (Bappeda, 2010). In this circumstance, public buildings and open space areas at Magelang Regency were used to evacuate temporarily for protecting the evacuees that were never assumed in the existing evacuation plan. Reported by Badan Kesbangpol PB, 51 people died at Magelang Regency during Merapi eruption in 2010 (Badan Kesbangpol PB, 2010b)

4. RESEARCH METHOD

The method used in this research was survey method. There were two kinds of data obtained from survey method: primary and secondary data. Primary data were collected through both questionnaire survey and interview, while secondary data were obtained from government institutions related to disaster management.

Sampling method used to select respondents was stratified random sampling. The differences of Merapi volcano hazard zones were used to apply this method. Two kinds of map used to determine the selected study area: Merapi hazard zone map and Administrative map. The number of respondents was 120 household in which every hazard zone was represented by three hamlets with forty respondents. Respondents were selected by simple random sampling based on the list of households given by the head of hamlets.

The data of questionnaire survey were analyzed by using both frequency analysis and chi-square (χ^2) test for independence analysis by using SPSS 17 statistical software. The results of statistical analysis were supported by both in depth interview and the secondary data collection for further analysis.

The detailed steps of this research are described in the following sub chapters.

4.1. Pre-fieldwork

Literature reviews related to information about disaster management, evacuation, volcanic hazard and research methods from previous study, books, journals and report were collected by researcher. The other activities in pre-fieldwork; the author formulated questionnaires based on the literature and preliminary observation, determined the research area, determined the respondents, and obtained institution permission letter. The detailed activities in pre-fieldwork are explained as follows:

4.1.1. Questionnaire Formulation

The questionnaires were used to interview the respondents in study area formulated to achieve the research objectives (see Appendix 1). The questionnaire was developed by the author in this research adopted from Rianto (2009) and Tayag et al (1992).

The structure of the questionnaire is devised in such a manner in order to be easily followed by respondents. There are sixty-two questions divided into nine sections. First section is socio-economic characteristics of respondents (age, sex, family members, education, income, etc). Second section is concerned with disaster experience (number of disaster experience, number of evacuated experience, etc). Third section is concerned with hazard knowledge (number of attending the training, hazard zone knowledge, distance of the crater knowledge, etc). Fourth section is concerned with cultural beliefs (belief in the existence of unseen creature, belief in spiritual leader, etc). Fifth section is concerned with risk perception (the perception in Merapi eruption, the benefit of Merapi volcano, etc), Sixth section is focused on governments' evacuation plan knowledge (knowledge of standard operating procedure, knowledge of evacuation shelter sites, etc).

The other sections are related to 2010 Merapi eruption. Seventh section is concerned with people's evacuation behavior facing the 2010 Merapi eruption (the time when the people realize that Merapi eruption will occur, source of information, the receiving time of evacuation order, the source of evacuation order, etc). Eighth section is focused on evacuation shelters quality (feasibility, facility, etc), and ninth section is focused on the route condition(evacuation route preparation, capacity of evacuation route, etc).

4.1.2. Determination of Sampling Area

This research applied stratified random sampling based on Merapi volcano hazard zones. This sampling method has been applied in research conducted in Merapi volcano hazard zones (Rianto, 2009).

The first step in this sampling method is overlying the Merapi volcano hazard zone and administrative map of Magelang Regency for producing Merapi volcano hazard zone of Magelang Regency map. Three districts of Magelang Regency were situated in the hazard zone.

The second step is selecting sampling areas. Based on preliminary observation was done to collect data about the hamlets including its population, and its distance from hazard sources supported by Merapi volcano hazard zone of Magelang Regency map, the sampling areas were not selected based on the district areas. It was caused that one of three districts, Sawangan district, did not have area situated within the third hazard zone. The sampling areas were determined based on the three parts of hazard zones: northern part, middle part, and southern part (see Figure 4.1).

A hamlet, namely “Dusun” in Indonesian, is a part of village in which the local government of Magelang Regency uses as the smallest administrative unit area. In the third hazard zone, the hamlets were selected as sampling area situated nearest from the crater of Merapi volcano: Sumberejo, Banaran, and Babadan Atas. In the second hazard zone, three selected hamlets are Wonogiri Kidul, Duren, and Nglumut 2. In the first hazard zone, the sampling areas are Ngentak, Sabrang, and Argopeni.

These sampling areas could be determined by the part of hazard zone. Three sampling areas were situated at northern part of hazard zone: Babadan Atas, Wonogiri, Ngentak. The sampling areas in southern part of hazard zone were Sumberejo, Nglumut 2 and Argopeni. In the middle part, the sampling areas were Banaran, Duren, and Sabrang (see Figure 4.1 and Table 4.1).

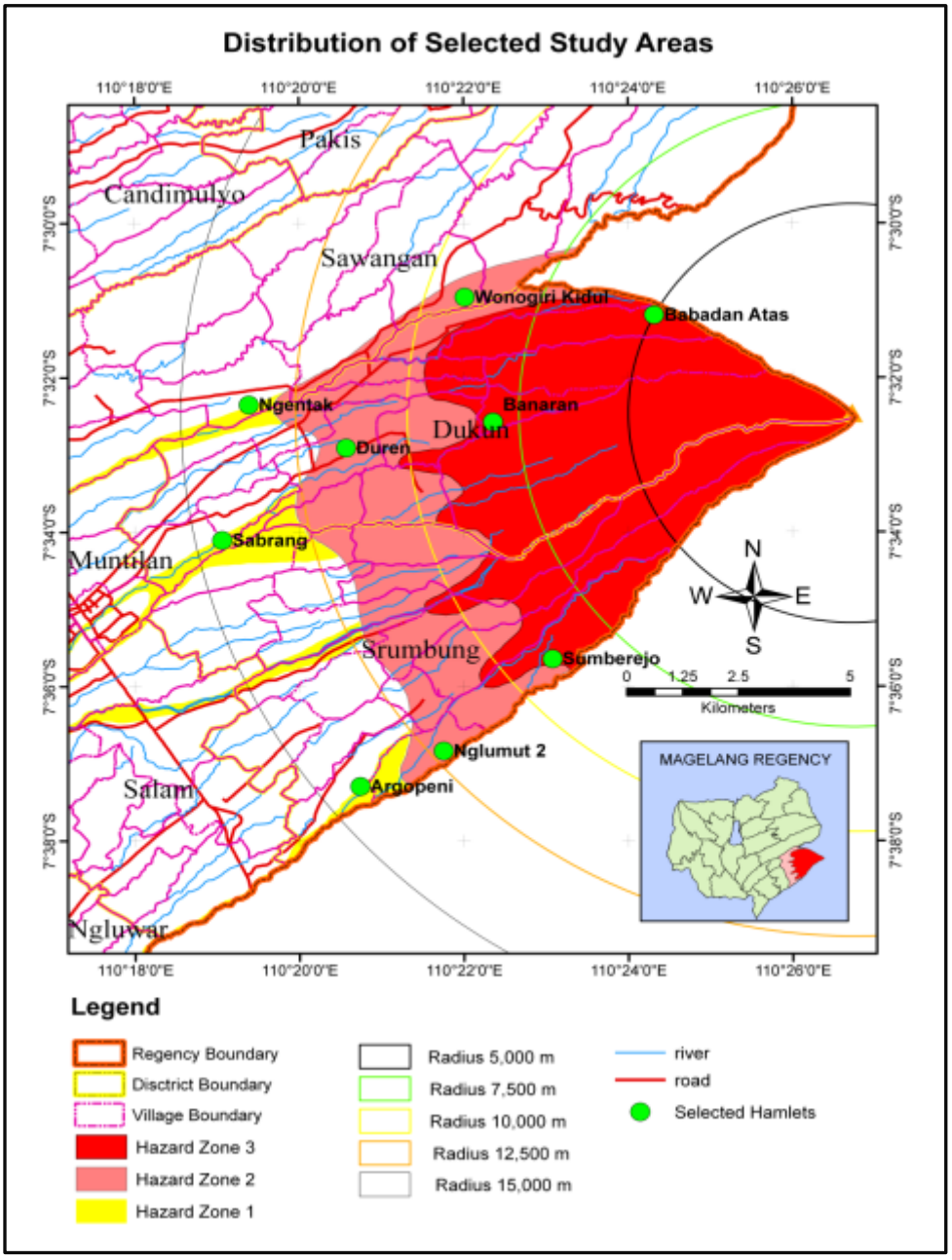


Figure 4.1. Selected Hamlets Distribution Map

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Table 4.1. Sampling Area

No	Hamlet	Hazard Zone	Average distance of Hamlet to		Number Of Household
			Crater (km)	River (m)	
1	Ngentak	1	13.5	150	97
2	Sabrang	1	14.5	100	70
3	Argopeni	1	14.2	100	114
4	Wonogiri Kidul	2	9.1	100	108
5	Duren	2	11.3	550	91
6	Nglumut 2	2	12.1	100	117
7	Babadan Atas	3	5.0	250	106
8	Banaran	3	8.1	500	160
9	Sumberejo	3	8.8	400	107

4.1.3. Determination of Sampling Unit

The number of sampling unit was determined based on the number of household in sampling areas. To apply stratified random sampling, the number of respondents was 120 households, selected randomly from nine hamlets at three different levels of hazard zone. It means that every hazard zone had 40 respondents divided into three hamlets. The respondents were sampled for every hamlets decided based on consideration of household population to obtain stratified random sampling. Table 4.2 explains how the number of respondents from each hamlet was decided.

Table 4.2. Sampling Unit Determination

No	Zone	Hamlets	Number Of Household	Number of Sampling Unit
1	1	Ngentak	97	(97/281)*40*100%=14
2	1	Sabrang	70	(70/281)*40*100%=10
3	1	Argopeni	114	(114/281)*40*100%=16
			281	40
4	2	Wonogiri Kidul	108	(108/316)*40*100%=14
5	2	Duren	91	(91/316)*40*100%=11
6	2	Nglumut 2	117	(261/316)*40*100%=15
			460	40
7	3	Sumberejo	107	(107/373)*40*100%=12
8	3	Banaran	160	(160/373)*40*100%=17
9	3	Babadan Atas	106	(106/373)*40*100%=11
			373	40

4.1.4. Respondent Selection

The next step of stratified random sampling is selection of respondents. The respondents were households that were chosen by using simple random sampling in each sampling areas.

Figure 4.2. Book of Household List

Furthermore, for obtaining a random sample of respondent, after the author had the list of households given by the head of hamlets, there were followed techniques in order to obtain randomly selected respondents, such as to assign a number to each member of head of households, write these numbers on

small pieces of paper, place them in an empty box, mix thoroughly before each drawing, and then draw the small papers from the box repeatedly until the numbers of drawn samples equal to the number of samples.

4.2. Fieldwork

The main data of this study originated from fieldwork activities that were carried out from August-November 2010. The aim of fieldwork activities is to achieve the objectives of this study.

The needed data and the data source collected in this research is shown in the table below.

Table 4.3. Required Data and Data Sources

No	Data Requirement	Data Source	Method
1.	People's evacuation behavior in Volcanic Eruption	Respondents	• Questionnaire Survey • Interview
2.	Related Factor influencing people's response to evacuation warnings	Respondents	• Questionnaire Survey • Interview
3.	Evacuation plan at Magelang Regency	Badan Kesbangpol dan PB	• Interview
4.	Population	BPS	• Secondary Data Collection
5.	Volcanic Hazard Map of Merapi Volcano.	PVMBG	• Secondary Data Collection
6.	Chronology of the 2010 Merapi eruption	BPPTK	• Secondary Data Collection
7.	Topographic Map/ RBI	BIG	• Secondary Data Collection
8.	Administrative Map	Bappeda	• Secondary Data Collection

4.2.1. Questionnaire Survey

After having a list of respondents obtained by random sampling, the author conducted the questionnaire survey to acquire the primary data by giving the questionnaire to 120 respondents at nine selected hamlets. The author guided how to fill-up the questions and helped the respondents to recall their activities in 2010 Merapi eruption that happened almost one year before by giving information on the important events, for example, the day the first time Merapi eruption occurred, in order to make sure that the answers given by respondents were the correct ones. During questionnaire survey, the author was helped by local people guided the author to the respondents' home.

Figure 4.3. Respondents

4.2.2. In depth Interview

In depth interview are intended to collect detailed information from both resident living at the Merapi volcano hazard zone and related institutions at Magelang Regency. To provide deeper information that added the findings from questionnaire survey, the author visited the house of respondents to carry out in depth interviews. Interviews were conducted face to face and in Javanese language.

The aim of in depth interview are to collect detailed information of their experience in 2010 Merapi eruption, risk perception before and after eruption, their opinion about cultural beliefs, and their opinion about government effort in facing Merapi eruption. The author successfully interviewed fifteen respondents, most of whom were hospitable. As for result, much information was collected in depth interview.

The other interview was arranged to key player of disaster management at Magelang Regency. The author met Head of Disaster Management Division in Badan Kesbangpol PB, Moch. Damil Ahmad Yani. Questions regarding disaster management at Local Government of Magelang Regency and evacuation effort in response to Merapi eruption were clearly explained by him. Some related documents such as Contingency plan to response Merapi eruption, and Disaster Management Report at Magelang Regency in 2010 were also given by him.

The other official informant in this research was M.Cholik, staf of Merapi section at Volcanology Observation and Technology Development Agency (BPPTK). Not only questions regarding chronology of 2010 Merapi eruption was explained but also the official documents such as the announcement letter concerning the boundary of the hazard zone, and activity status of Merapi volcano were obtained from his office.

4.2.3. Secondary Data Collection

The author collected secondary data from three institutions having responsibility related to Merapi volcano mitigation: BPPTK, Bappeda, and Kantor Kesbangpol PB.

Data about chronology of the 2010 Merapi eruption was obtained from BPPTK, and Administrative map was achieved from Bappeda. Data concerning the existing government's evacuation plan that implemented in the 2010 Merapi eruption was achieved from Badan Kesbangpol PB.

4.3. Post-Fieldwork

4.3.1. Data Processing

Data processing is organizing data in order to from the desired information. There were two types of data collected from fieldwork phase. The first data obtained from questionnaire survey were collected and inputted to statistical software. In this study we used SPSS 17.0 version to carry out the statistical analyses. To represent the result from SPSS analyses, we used Microsoft Office 2007. Statistical analysis of questionnaire response is proved to be highly effective in measuring the "cause and effect" of individual variables and have been successfully used in the volcanic risk perception domain (Mei and Lavigne, 2012) The second obtained data from in depth interview. The importance statement was written and recorded. Almost all respondents spoke with Javanese language, therefore the author have to translate in Bahasa and English.

4.3.2. Data Analysis

This study had two parts of statistical analysis. The first analysis, frequency analysis, was used to figure socio-economic characteristics, disaster experience, hazard knowledge, cultural beliefs, hazard perception, acceptance of government's evacuation plan, and people's evacuation behavior.

The second was the relationship analysis between related factors and evacuation response time. In this analysis, the data was examined by using cross-tabulation and chi-square (χ^2) test for independence analysis based on method of cross-tabulation and chi-square analyses given in the Application of Multivariate Analysis by Using SPSS (Ghozali,2006).

The decision is made based on consideration of p-value. There is a relationship based on the p-value at 0.05 significant levels. If the probability is p-value > 0.05, then H_0 is accepted. It means that the null hypothesis (H_0) is accepted, the alternative hypothesis (H_a) is rejected. Otherwise, if p-value < 0.05

then H_0 is rejected, and the alternative hypothesis (H_a) is accepted. The following subsections discuses whether the response time is significant or not significant to related factors.

4.4. Research Instrument and Software

Table 4.4 explains the research instruments used in this research supporting to achieve the aim of this research.

Table 4.4. Research Instrument

Material	Function
Questionnaire	Providing information from structured questions.
Interview guide	Guidance to obtain detailed information
Stationery	Making notes
Topographic Map and Hazard Zone Map	Mapping the selected study areas
Digital Sound Recorder	Recording the voice of respondents during interview

Three types of software were used for analyzing and presenting data in this research as follows:

Table 4.5. Software

Software	**Function**
SPSS 17	Statistical analysis
ArcGis 9.2	Spatial data analysis
Microsoft Office 2007	Visualizing and presenting data

4.5. Research Flowchart

The research methods are represented in a conceptual framework as shown in following figure:

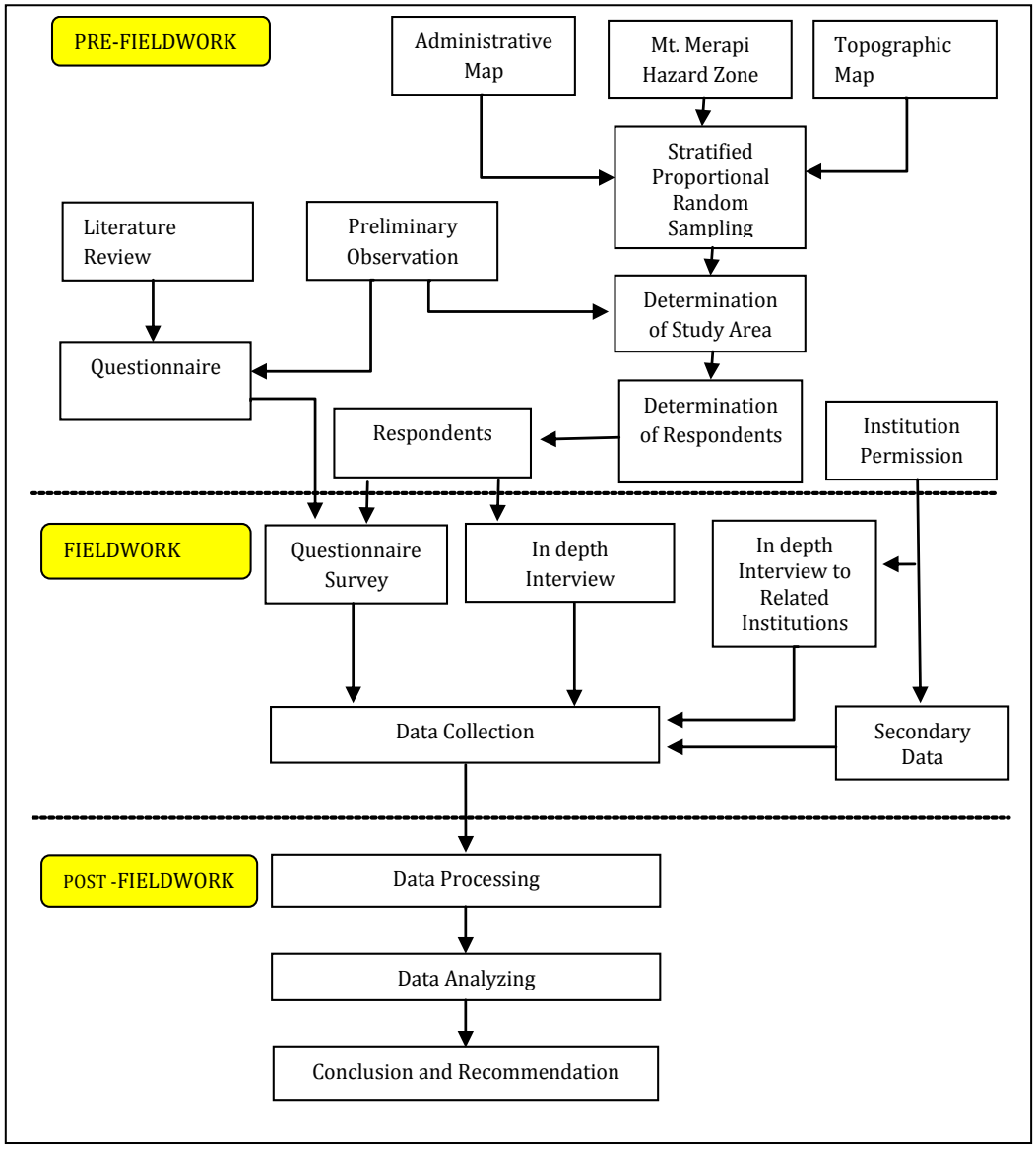


Figure 4.4. Research Conceptual Framework

5. CHARACTERISTICS OF THE PEOPLE IN THE HAZARD ZONE

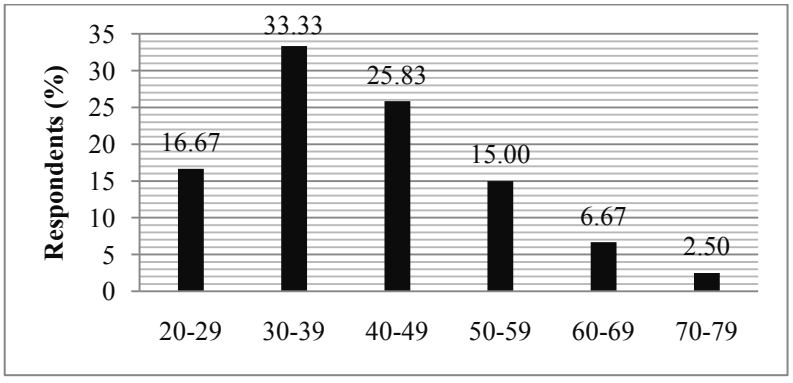
5.1. Socio Economic Characteristics

Lavigne et al (2008) described that Merapi volcano influences socio-economic characteristics of the local people living on its slope. They believe that Merapi volcano is the source of live, providing fertile soil for agriculture, and is the home of forests, and fresh water. People living on Merapi volcano have developed a system for living on its slopes and conceptualizing its hazard based on naturalizing, familiarizing, and 'domesticating' the treat from the volcano (Dove, 2008).

This research uses socio economic characteristic as variables assumed to have relationship to people's evacuation response time. Socio-economic characteristics focus on the following variables: age, household size, education, occupations, income, house ownership, agriculture land ownership, livestock ownership, vehicle ownership, and reason for living in the hazard zone.

5.1.1. Age of Household Head

The age of household head distribution was between 22-71 years old. Most of them were aged between 30-39 years totaling at the number of 33 % of 120 respondents. While the youngest the head of the households, between 20-29 years, is about 16 % of respondents.



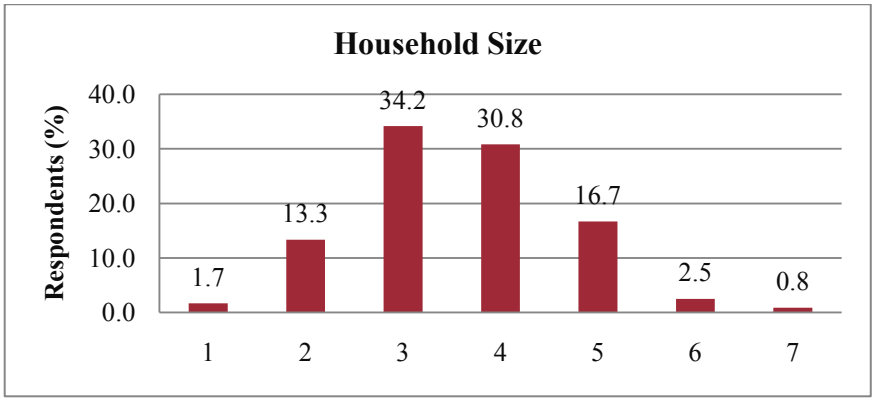
Graph 5.1. Age of Household Head

5.1.2. Religion Distribution

The majority of the respondents are Muslim who believe on Islam religion. The other respondents were Christians about 4.2% of respondents with about 1.7% of them are Protestants, and 2.5% of them were Catholics.

5.1.3. Household Size

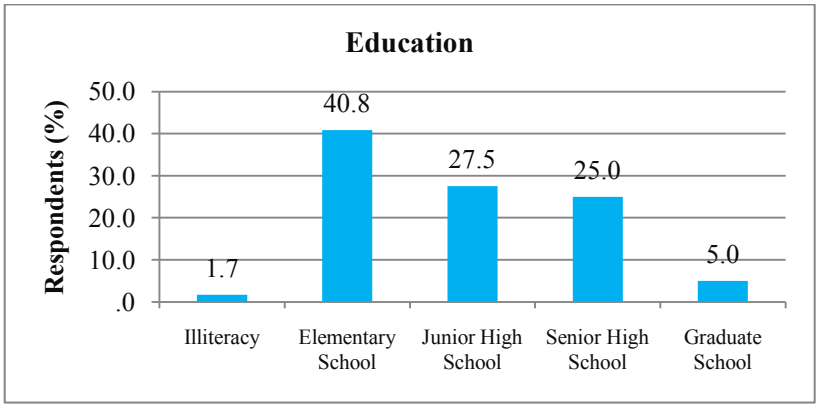
Having three or four family members in a household is common household at study area. Meanwhile the minority household size of respondents is family with seven family members.



Graph 5.2 Household Size

5.1.4. Education Level

Education level is being variables in this research with assumption that level of education can lead the people evacuation response time. Leone and Lesales (2009) said that one of key factor in improving the perception of volcanic threats is education.



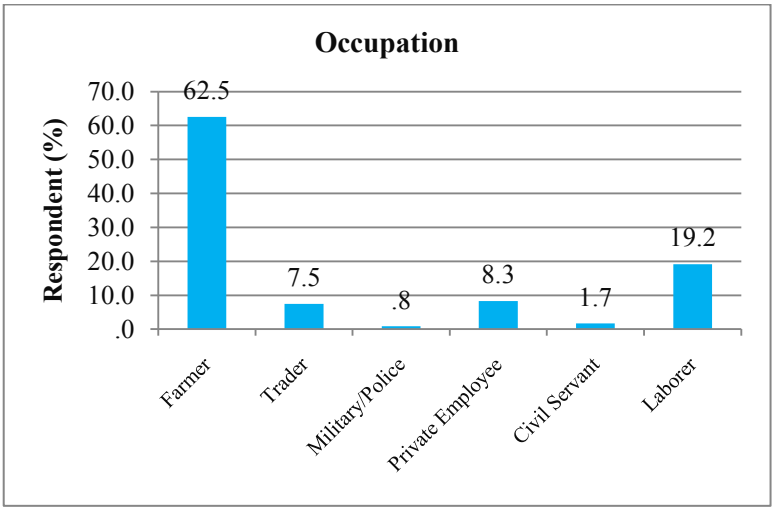
Graph 5.3 Education Level Distribution

The majority of respondents are elementary school graduated with more than 40%., and those who have bachelor degree are only 5% of respondents. Some respondents said that they are more likely work for fulfilling the basic needs rather than education need. They work on non formal sectors which do not need high education level.

5.1.5. Occupation

In term of occupation, the majority of respondents is farmer (62%). It is common that farmer also have the other economic activity, such as stock farmer, and sand miner. The fertility of agriculture land on slope of Merapi volcano and the abandon of sand and rock are the reasons the other economic activities of the farmer living on the slope of Merapi volcano.

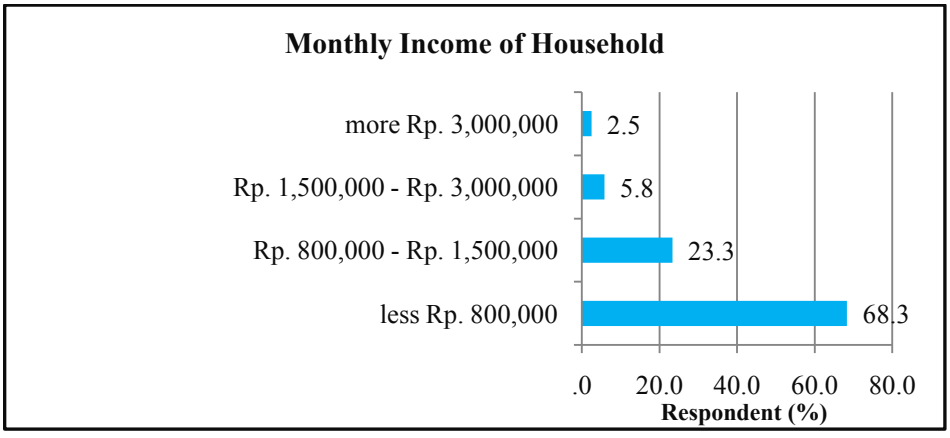
Graph 5.4 shows the distribution of occupation of household heads living on slope of Merapi volcano.



Graph 5.4 Occupation

5.1.6. Monthly Income of Household

Most of households (68%) had only less than Rp. 800.000,- income per month. Local government of Magelang Regency decided that standard minimum income in 2010 at Magelang Regency was Rp. 752.000,- (Suara Merdeka, 2010). It means that the majority of households had relatively low income.



Graph 5.5 Monthly Income of Households

5.1.7. Ownership

The ownership characteristics of respondents can be seen from Table 5.2. In the term of house ownership, almost all of the respondents had their own house, and majority house on the slope of Merapi volcano were constructed with cement.

Table 5.1. Ownership Characteristics of Respondents

Characteristics	Variables	Percent		Characteristics	Variables	Percent
House Ownership	Rent	6		Livestock Ownership	None	24
	Owner	94			Poultry	26
					Goat	17
					Cow	33
House Structure	Wood	14				
	Cement	86		Vehicle Ownership	None	20
					Motorcycle	72
Agricultural Land Ownership	None	17			Car	5
	< 1 Ha	71			Truck/Bus	3
	1-2 Ha	11				
	>2 Ha	0.8				

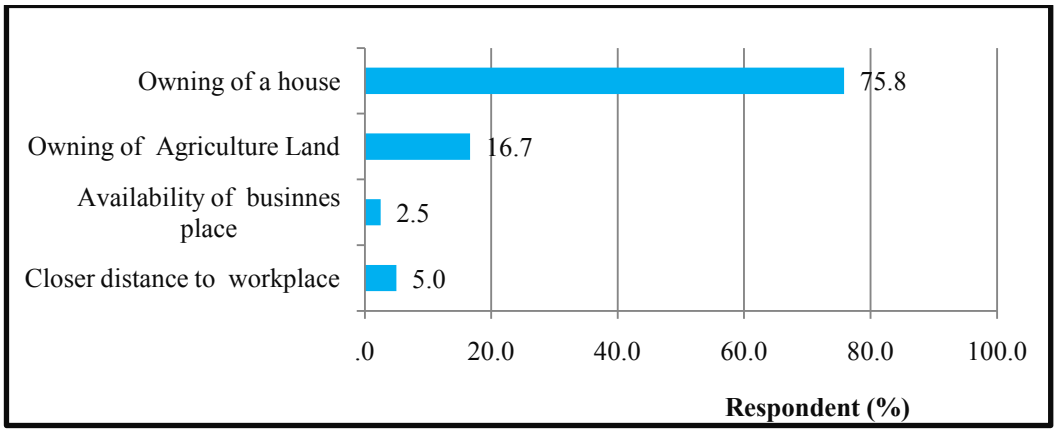
Most of respondent had less than 1 hectare agriculture land. In term of livestock ownership, most of respondents had cows as their livestock, despite it is possible that respondents had more than one livestock.

In term of vehicle ownership there were 20% of respondents who had no vehicle in their household. When Merapi eruption occurred, they became passengers of their neighbor's, communities', or government's vehicles. They depended on the existence of evacuation vehicles that brought them to safer areas. It can impede evacuation process if there are no vehicles on one household.

Motorcycle was effectively used to evacuate the family who has only less than three family members. The majority of respondents as numerous as 72% have motorcycles as their means of transportation. The big vehicles such as trucks or buses which have 6 wheels are owned by 3% of respondents, and the families

that had cars were only 5% of respondents in which they could evacuate all family members using their own car.

In term of reasons for living in the hazard zones, most of respondents (75%) had a house in the hazard zone as the reason why they live there. Some respondents had been living in their home since they was born.



Graph 5.6 Reason for living in the hazard zone

5.2. Experience of Merapi eruption

5.2.1. Status of Residents

This research used the status of residents as a question with assumption that the number of experiences of Merapi eruption depends on the age and the length of stay of respondents, so the origin inhabitants living at slope of Merapi volcano has experience in Merapi eruption.

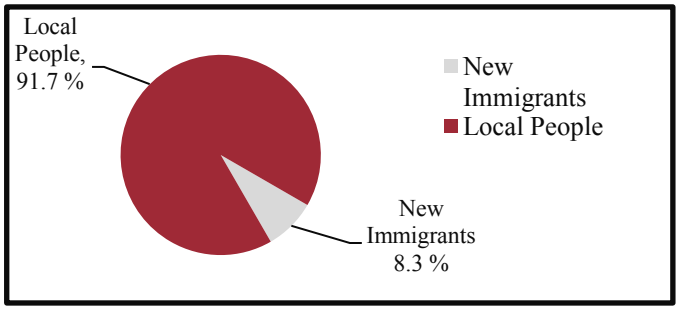
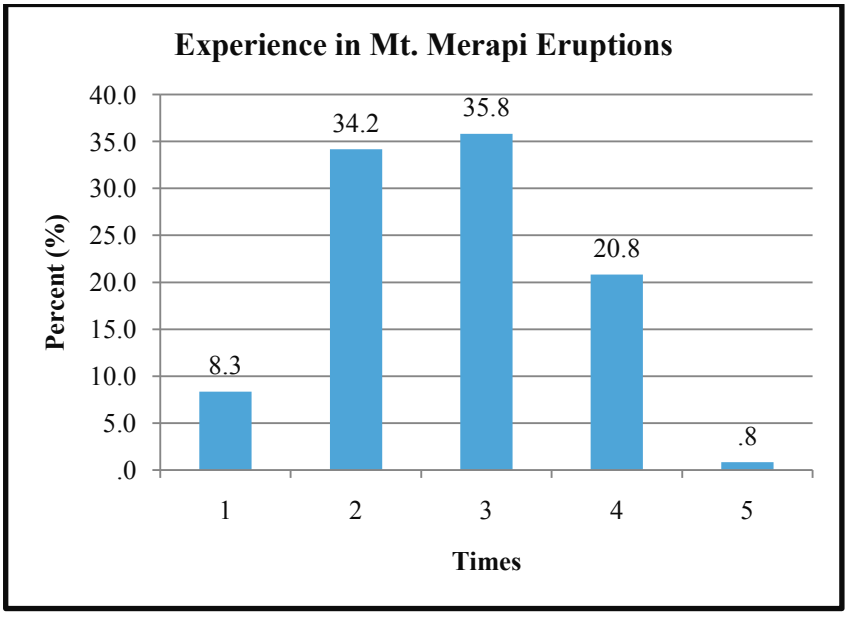


Figure 5.1. Status of Resident

More than 91% of respondents were the local people who lived at the same village at slope of Merapi volcano from the time they were born until they became the head of the households with the average 30s years old. The other respondents, more than 8 %, were new immigrants.

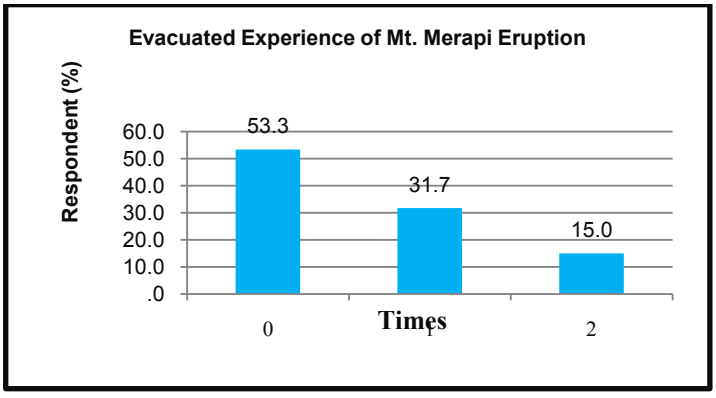
5.2.2. Merapi eruption Experience

The majority of respondents had experienced the Merapi eruption two and three times. Some respondents recalled that before 2010 eruptions, Merapi volcano erupted in 1960s, 1980s, 1994, and 2006 although Merapi volcano has erupted more than five times since 1950 (Thouret et al., 2000).



Graph 5.7 Experience in. Merapi eruption

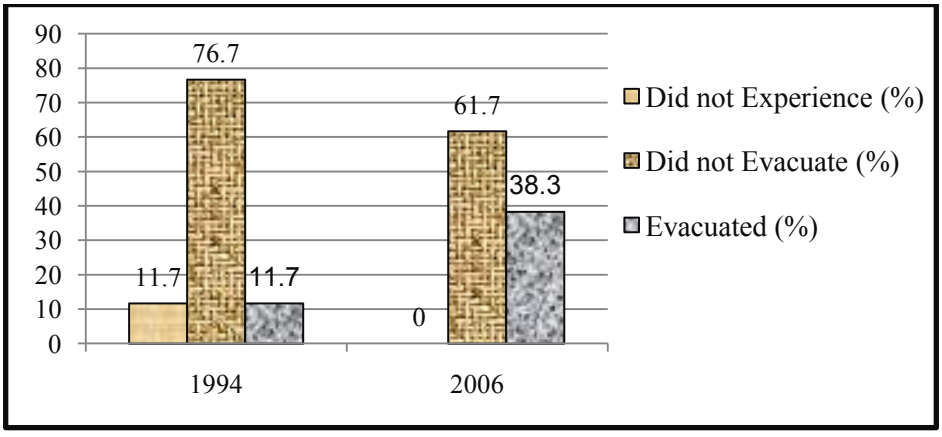
5.2.3. Evacuated Experience



Graph 5.8 Evacuated Experience in Merapi eruption

The majority of respondents have never evacuated before 2010 Merapi eruptions. The Merapi eruption in both 1994 and 2006 did not influence their daily live activity. There are only 15% of respondents who evacuated two times and almost 32% of respondents evacuated once in their life.

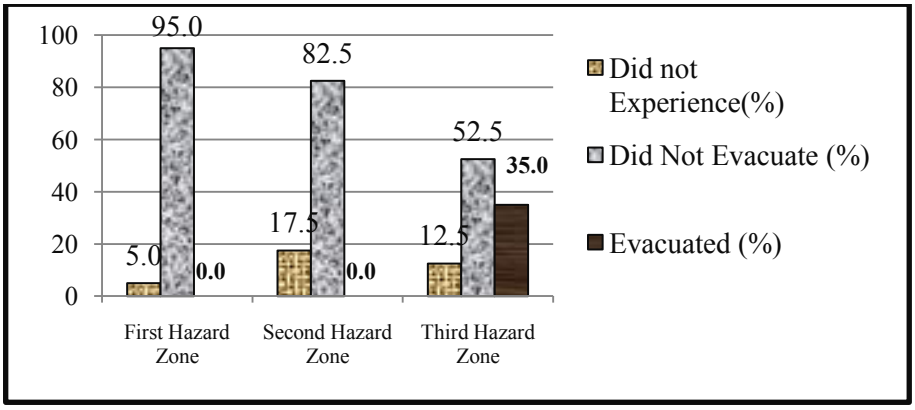
5.2.4. Experience in the 1994 and 2006 Merapi eruption



Graph 5.9 Experience in 1994 and 2006 Merapi eruption

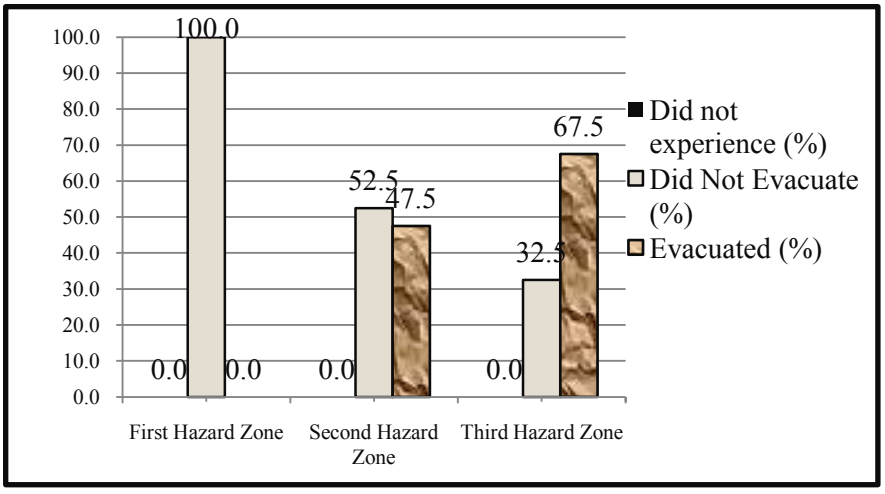
The number of evacuated people increase from 11% of the 120 respondents did evacuate in 1994 to 38% respondents did evacuate in 2006.

Graph 5.10 shows the number of respondents who experience in the 1994 Merapi eruption based on the hazard zones. There are 35% of respondents on the third hazard zone evacuated when Merapi Volcano erupted in 1994



Graph 5.10 Experience of the 1994 Merapi eruption at Different Hazard Zone

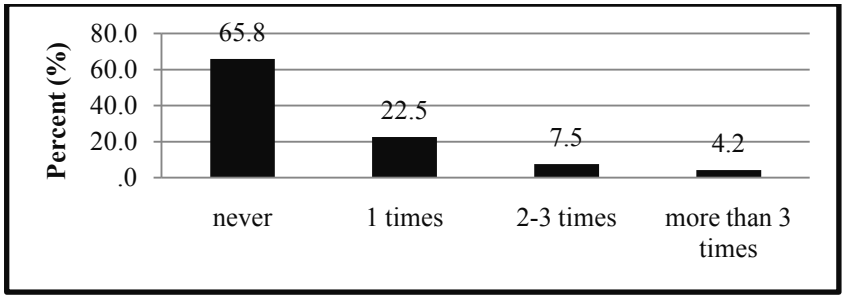
In the 2006 Merapi eruption, all of respondents experienced that eruption. The respondents who evacuated were around 47% and 67% of respondents living in the second and third hazard zones respectively.



Graph 5.11 Experience of the 2006 Merapi eruption at Different Hazard Zone

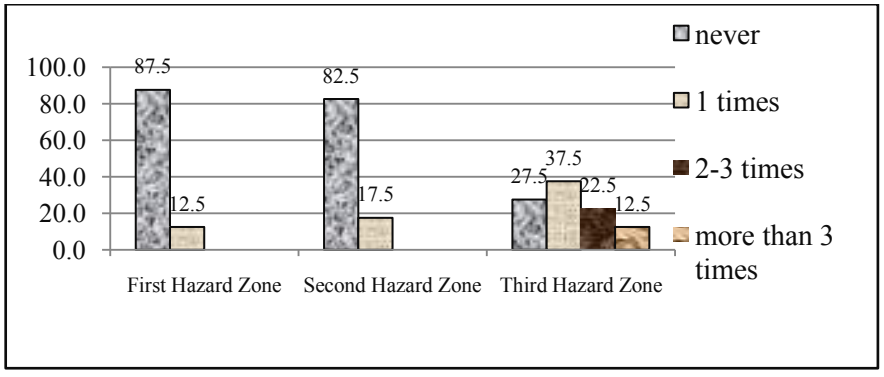
5.3. Hazard Knowledge

Carlino et al (2008) said that lack of knowledge about volcanic hazard can lead to low volcanic risk perception. The people living in hazard zones attended the disaster trainings to reduce the impact of Merapi eruption. Most of respondents did not attend the disaster trainings. The number of respondents who attended the training is only 34%. Of those who had attended the training, around 22% had attended once, 7% 2-3 times, and 4% more than 3 times (see Graph 5.12).



Graph 5.12 Disaster Training Attended By Affected People

The disaster trainings were mostly conducted at the third hazard zone. Almost all respondents at this zone attended the disaster training. Meanwhile at the other hazard zones, majority of respondents never attended the training.



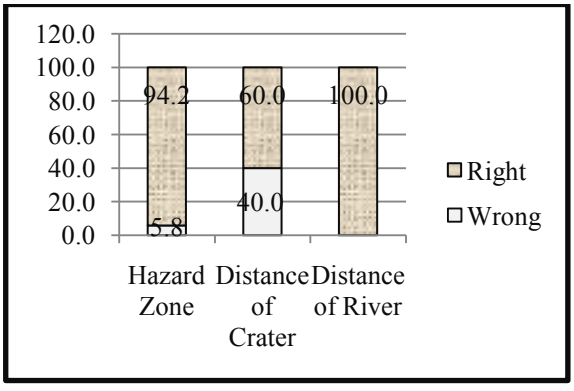
Graph 5.13 The number of attended disaster training at different hazard zone

The authorized institutions, such as BPPTK and Badan Kesbangpol PB, hold disaster trainings for improving the hazard knowledge of the affected people. Staff of Badan Kesbangpol PB clarified that the hazard knowledge is important to be known by affected people for understanding the warning when Merapi eruption occurs, so the Badan Kesbangpol PB routinely conducts disaster management training for head of households living in the hazard zones. BPPTK gave training focused on the people in the third hazard zones.

M.Cholik, staff of BPPTK, explained that BPPTK routinely conducts disaster training to improve capacity of communities in hazard zones in response to Merapi eruptions. The trainings were given by using classical method. Because of the budget and resources limitations, the training was followed by selected people living in the hazard zones.

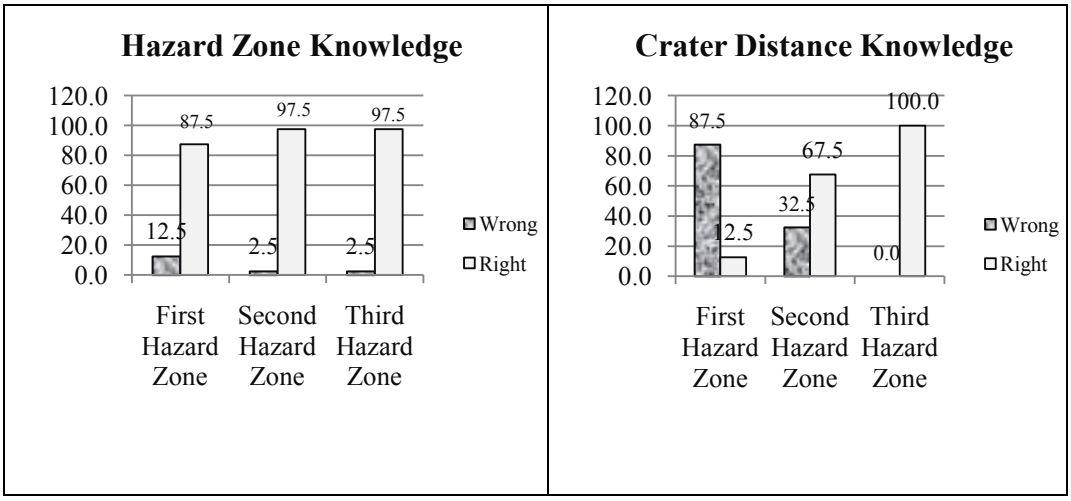
The hazard knowledge was measured by analyzing their answers of questions no. 24, 25, and 26 (see Appendix 1). To distinguish whether the answers are either right or wrong, the author compared the respondents' answer in the questionnaire with both the distance of hazard sources and the hazard zones on the study area map.

Although the government has announced the hazard zone map, more than 5% of respondents failed to answer in which hazard zone they live. The respondents commonly wrong answered with exchanged answer between zones.



Graph 5.14 Hazard Knowledge Measurements

In this research found that 40% of respondents had wrong answered about the distance of the crater from their home while the government announced the level of hazard zone based on concentric hazard zone when Merapi eruption occurred in 2010.



Graph 5.15 The hazard knowledge measurements at different hazard zone

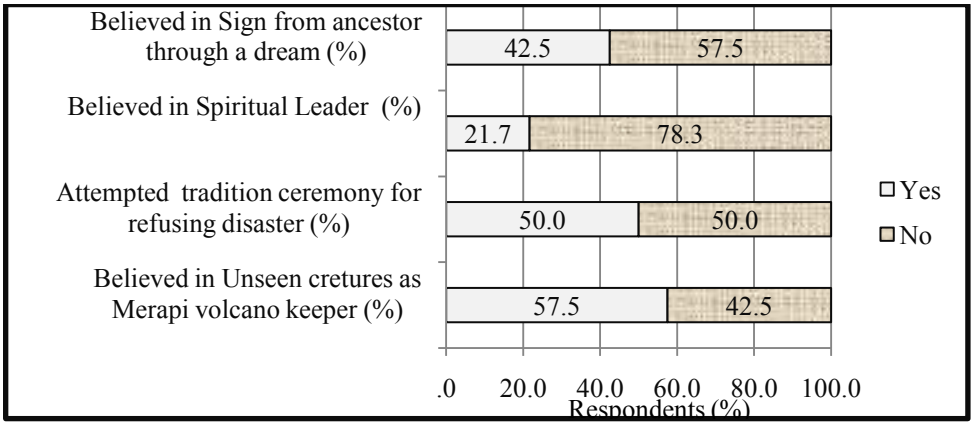
The wrong answers about both hazard zones and crater distance knowledge were dominated by people who had been living in the first hazard zone. As numerous as 12.5 % of respondents in the first hazard zone had a wrong answer about in which zone their homes were in which their answer is they live in the third hazard zone, and more than 80% had a wrong answer about the distance of their homes from the crater. They answer with the farther distance. More than 90% of respondents in the third hazard zone had right answers about both the hazard zone and the distance of their homes from the crater. It seen that who have attended a disaster training can answer the hazard zone correctly.

Moreover, the fact that there was no a sign or guidance set up at slope of Merapi volcano informing about the distance of the crater. Figure 5.2 was a proof that the sign was set up by governments showed no information about the distance of crater.

Figure 5.2. Hazard Zone Sign

5.4. Cultural Beliefs

People living on the slope of Merapi volcano believe that Merapi volcano is different to other volcanoes. Graph 5.16 indicates the existence of cultural beliefs of the people living in hazard zone of Merapi volcano. To identify cultural beliefs rely on the Merapi eruptions, the author uses four questions to figure people's cultural beliefs on Merapi volcano.



Graph 5.16 Related Questions in Cultural Beliefs

Of the respondents, more than half believe in unseen creatures as the Merapi volcano keeper. Related to traditional ceremony to placate Merapi volcano activity, some 50% of the people hold the ceremony, as well as 50% of the other do not. In term of belief in spiritual leaders, majority of the respondents (78%)

said that they do not believe. Talking about signs from the ancestor through a dream, there were around 42% of respondents said that they believe, while the other did not.

Obtained from in depth interview, there were two contrary opinions about the existence of unseen creatures as the Merapi volcano keeper. Their opinions are written as follows.

Sumedi Seto, male, 72 years old, one of residents living in the third hazard zone, said his opinion:

> *"I believe in the existence of an unseen creature who protect my village from Merapi eruption. His name is Mbah Petruk, so Merapi volcano will not destroy my village as far as Mbah Petruk stays at Merapi volcano "*

It is supported by one of residents living in the first hazard zone. Subardi Wiyono, male, 52 years old, has an opinion:

> "*I believe Mbah Marijan(key holder of Merapi volcano) is a person who can talk to Mbah Petruk (the unseen creature).Every time Merapi eruption occurs, Mbah Marijan receives the message from Mbah Petruk about when and how the eruption will occur."*

Otherwise, H.Samsudin, male, 63 years old, living in the second hazard zone said:

> *"Talking about unseen creature as the keeper of Merapi volcano is fiddlesticks. I don't believe that. The story about unseen creature is only for farmers' talk on their free time, and until now there is no evidence to explain the existence of the unseen creature as the Merapi volcano keeper"*

The result of in dept interview describes the different opinions related to traditional ceremony.

An opinion was said by Mbah Parto Giman, male, 72 years old, living in the third hazard zone:

> *Residents in my village hold "wayangan" (performances of shadow puppet theatre are accompanied by gamelan) every "Sapar" (a month in Javanesse calendar). The aim of this ceremony is for improving the unity between residents.*
>
> *We conduct "Mujadahan" to pray together every Thursday night. By this effort, we request to Allah, so we can be kept away from disaster.*

Figure 5.3. Traditional Ceremonies of "Labuhan"
(Source: Sangga Sarana Persada, 1998)

Sangga Sarana Persada (1998) explained that there are traditional ceremonies which are always held every year on the southern slope of Merapi volcano as follows:

> *"A traditional ceremony is always held in the southern slope of Merapi volcano named "Labuhan". This word is from the word "Labuh", means to throw away into. The rituals are conducted in accordance with the long years of inherited tradition. Usually, the ceremony is also attended by a lot of people wishing to get a blessing from the Creator of the world".*

> *"On the eastern slope of Merapi volcano, at the Selo village, the local residents routinely make traditional ceremony offering to Merapi volcano, called "Sedekah Gunung" (Mountain offering). They hope to live in safety and good welfare with enough crops from their land. The process of offering starts at the village house and then the burial of a Buffalo head shall take place on the peak of Merapi volcano, or if the condition is dangerous then it shall be buried in Pasar Bubrah."*
>
> Cited in Sangga sarana persada (1998).

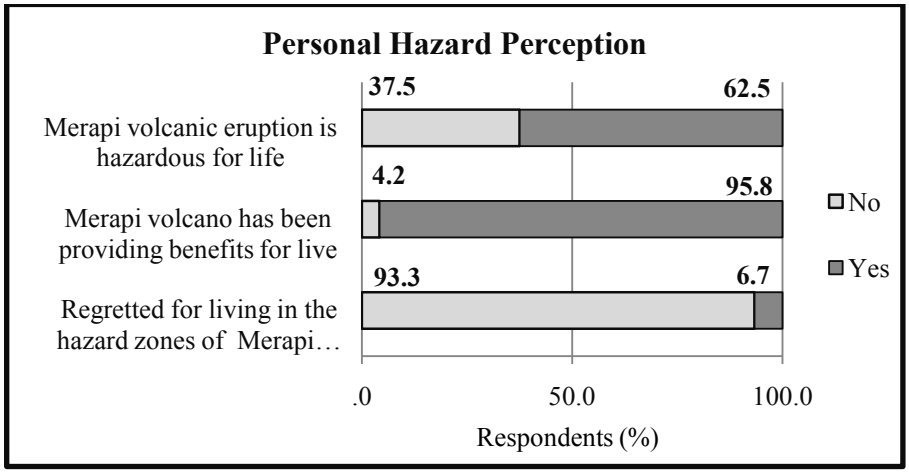
Obtained from in depth interview, there are respondents who said that they did not believe in spiritual leader for guidance in evacuation decision making. For example, Harwoko, male, 30 years old, living in the second hazard zone said:

> *"We did not believe in the paranormal statements. We always choose follow the orders from expert volcanologists as Mbah Surono (the head of PVMBG)"*

Although 51 of 120 respondents said beliefs in a sign from ancestors through dreams, the author did not meet anyone who has experience in receiving a dream related to a sign from the ancestors.

5.5. Hazard Perception

Blong (1984) said that individual and community perception of the hazard is the factors which influence the social effects of an eruption. One study of volcanic hazard perception in the Puna district of Hawai explained that most of interviewees did not perceive volcano eruptions as hazardous (Blong, 1984). In this study hazard perception were known by asking the people about their view of Merapi volcano as the hazard source.



Graph 5.17 Related Questions in Hazard Perception

More than half of respondents (62%) said that Merapi eruption is hazardous for life. The second fact, almost all respondents said that Merapi volcano provides benefits for life. Another fact, more than 93 % of respondents said that they did not regret for living in the hazard zones.

To describe deeply concerning to personal hazard perception to Merapi volcano, the author collected information from affected people in the hazard zones. One of informants is Ibu Narto Wiyono, female, 48 years old, living in the second hazard zone said:

> *On 26 October 2010, I knew that the government officers had ordered to evacuate started at 3.00 p.m. At 5.00 pm, I heard eruption roar and thunderous claps. I was very scared, and I continuously whined to my husband to evacuate immediately. My husband asked me to evacuate at 5.00 pm.*
>
> *After three days lived in evacuation shelters, I returned home. my village were very horrible, and the condition for living on this village were very hard. There were no food, and no electricity.*

The Merapi eruption in 2010 was the most frightened eruption in my life. I had to back to evacuation shelters to safe my life.

The other informant is Ibu Muhtadi, female, 52 years old. She recalled her experience in 2010 Merapi eruptions as follows:

Every time Merapi eruptions, My family always follow what is instructed by Government staff. Because not only my hamlet is located in the hazard zones, but also we have terrifying experiences in both 1961 and 1969 eruptions in which hot lava flowed in the river near my hamlet.

Merapi eruption in 2010 is the most terrifying experience as long as I live on the slope of Merapi volcano.

5.6. Concluding Remarks

Based on frequency analysis of data obtained from questionnaire survey, the characteristics of people in the hazard zone can be conclude that most of them work as farmer with less than 1 hectare agriculture land, and majority of them have low income. This observation is similar with Rianto (2009) in which the occupation as farmer dominated the people on southern slope of Merapi volcano.

The people who were average 30s years old had experienced the Merapi volcanic eruption two and three times, and only the people living in the third hazard zone had evacuated experience in the 1994 and 2006 Merapi eruption, and they have attended disaster training.

Beliefs in both sign from ancestor trough dream and spiritual leader are followed by more than half people in the hazard zone, and less than half of them believe in unseen creatures as the Merapi volcano keeper. During in depth interview survey, the author met respondents to ask about traditional ceremonies intended to reject negative impacts of Merapi eruption in order to make them live

safely. Interestingly, the research referring to a traditional ceremony conducted on western slope of Merapi volcano especially related to communities living at Magelang Regency were not found. Meanwhile, some literatures discuss about traditional ceremonies conducted on southern slope of Merapi volcano (Lavigne et al, 2008; Dove, 2008; Donovan, 2009).

Most of the people perceive Merapi eruption as hazardous, but majority of them also said that Merapi volcano has been providing benefits for their life. The other fact was found that they did not regret as people living in the hazard zone.

6. PEOPLE'S BEHAVIOR IN RESPONSE TO VOLCANIC ERUPTION

6.1. Impending Eruption Information

Based on the official letter number 1846/45/BGL.V/2010 on 22 September 2010, BPPTK reported the volcanic earthquake increased from normal level (5 times per dayto 10 times per day). The activity of Merapi volcano for the first time raised to the level 2 (Danger). As the Merapi volcano activity increased, the status of Merapi volcano was continuously changed from the level 2 (Danger) to the level 3 (Alert) on 21 October 2010. BPPTK announced that the volcanic earthquakes intensity increased to 38 times per day and the local government around Merapi volcano was suggested to prepare evacuation efforts.

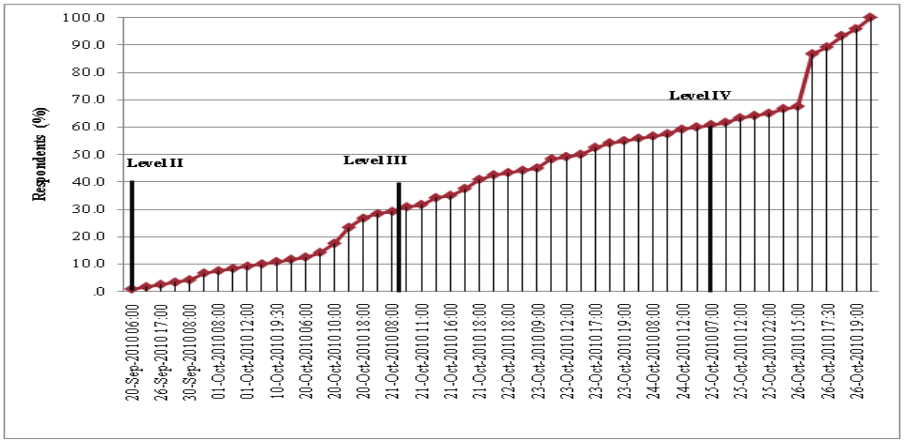
On 25 October 2010, PVMBG announced that the activity of Merapi volcano raised to the level 4 (beware). People living within 10 kilometers radius were told to evacuate on 25 October 2010 based on concentric hazard zone. This hazard zone changed progressively four times: from radius10 kilometers to 15 kilometers on 3 November 2010, from15 to 20 kilometers on 5 November 2010, back to radius 15 kilometers on 14 November 2010, and back to 10 kilometers on 19 November 2010.

Most of respondents did not pay attention the impending eruption when the government announced the status of Merapi volcano was reaching level 2 (caution) on 21 October 2010. Although the information of the impending eruption was announced by governments through their staff and media coverage, some 30% of respondents realized the impending eruption after it erupted.

6.1.1. Receiving Time of Impending Eruption Information

Information dissemination to the society at risk is the key factors in correcting and improving the perception of volcanic threats (Leone and Lesales, 2009). Graph 6.1 presents the time and the number of people who accepted the information of impending eruptions for the first time.

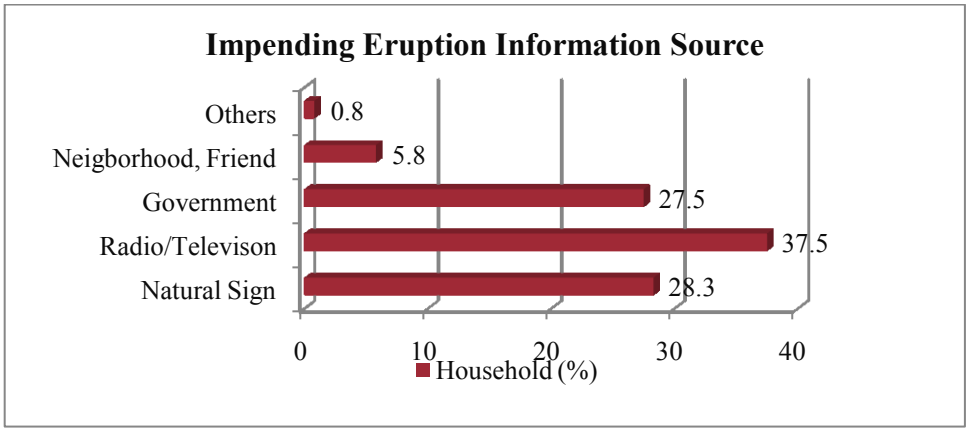
It can be figured that, the number of people increased slightly between 20 September 2010 and 25 October 2010 in realizing of the impending eruption. Furthermore, the number of aware people dramatically rose after the first eruption occurred on 26 October 2010.



Graph 6.1 Receiving Time of Impending Eruption Warning

6.1.2. Impending Eruption Information Sources

Graph 6.2 shows the source of impending eruption information. There are four main sources, such as from natural signs, radio/television media, government's staff, and their own neighbor. The majority respondents knew the impending eruption from radio and/or television media,



Graph 6.2 Impending Eruption Information Source

6.2. Evacuation Order

6.2.1. Receiving Time of Evacuation Order

Evacuation order was given according to concentric hazard zone. Based on the sampling area distribution (see Figure 6.1), there are four hamlets situated at less than 10 km radius (Babadan atas, Wonogiri Kidul, Banaran, and Sumberejo). 54 of 120 respondents live on this area. The other respondents live on 10 to 15 kilometers radius.

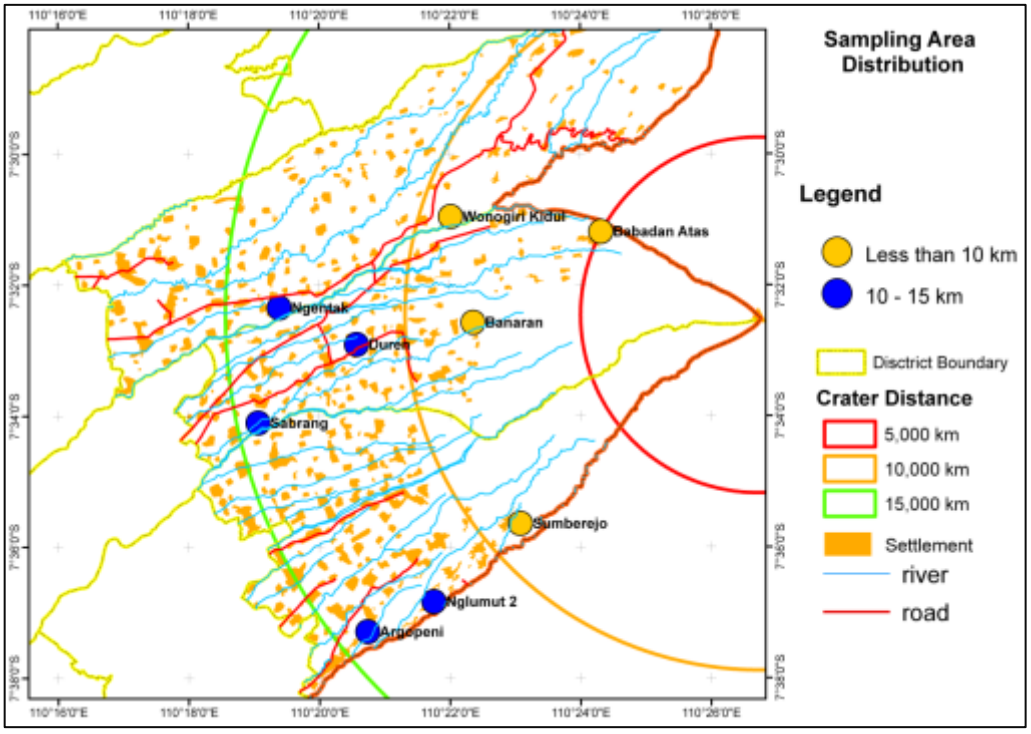
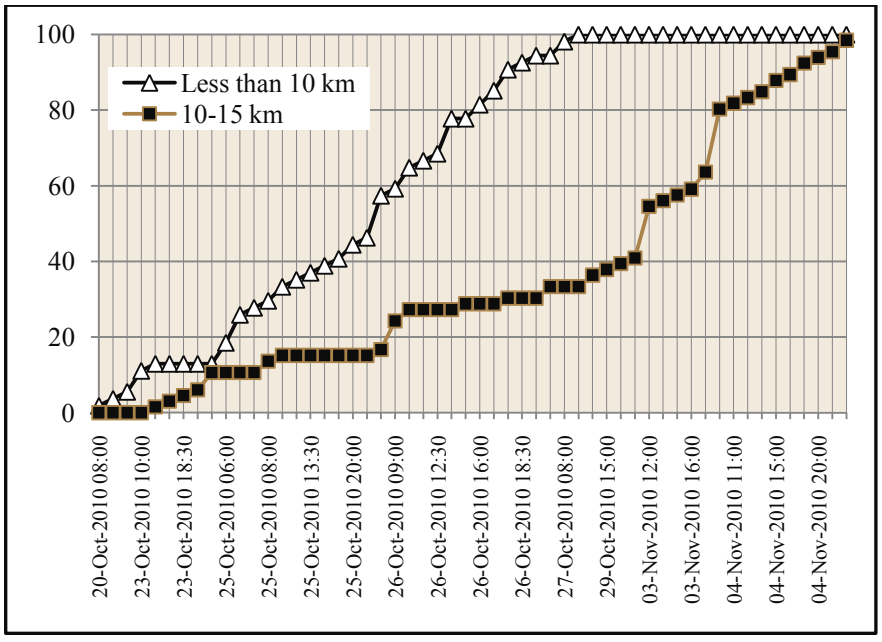


Figure 6.1. Sampling Area Distribution

Evacuation order was given by BPPTK to the people in the radius 10 km from the crater on 25 October 2010 at 06.00 a.m., as many as 13.0% of 54 respondents had learned an evacuation warning before it's time. When the first eruption occurred on 26 October 2010 at 17.02 p.m., as numerous as 85.2% of respondent living at radius 10 km of the crater had received the evacuation order, meanwhile the other respondents had not received an evacuation order yet.

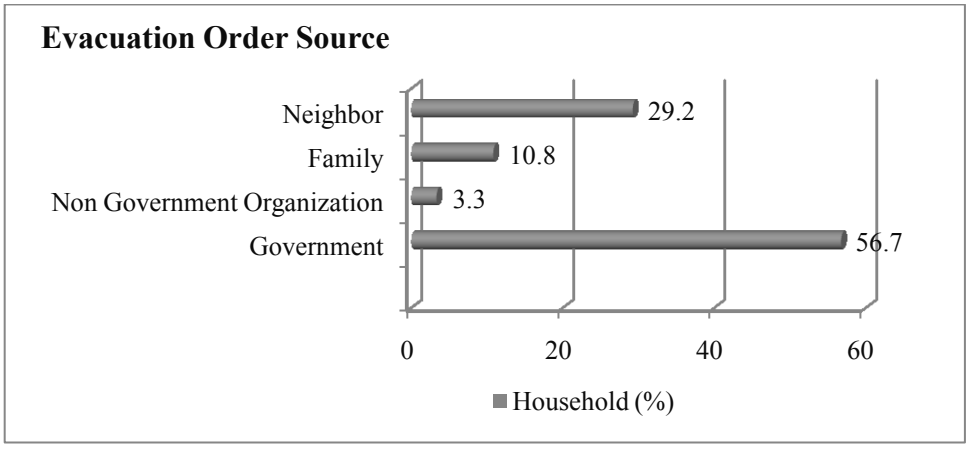
On the other hand, when the second evacuation order was given to the people living at less than 15 km on 3 November 2010 at 15.05, as many as 59.1% of people had received the evacuation orders, and the other respondents did not. Graph 6.3 depicts the time when the respondents received the evacuation order.



Graph 6.3 Receiving Time of Evacuation Order

6.2.2. Sources of Evacuation Order

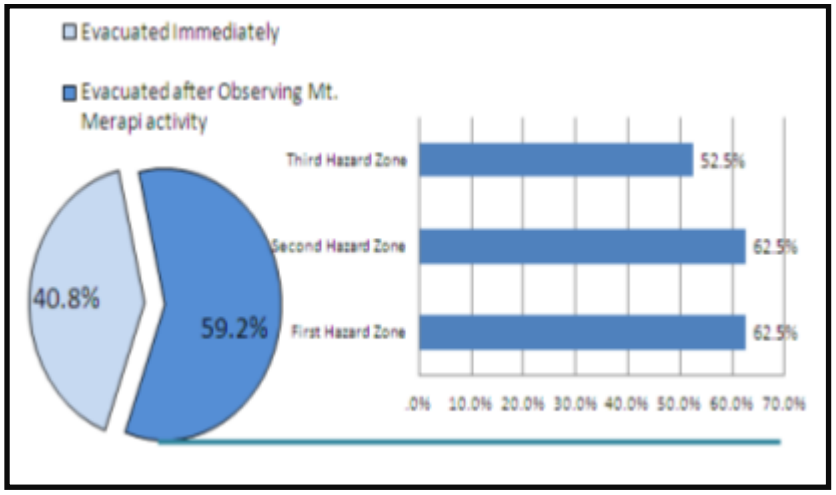
Evacuation order was given by door to door methods coupled with radio announcements. The majority of respondents received evacuation order from government staff, and a few number of respondents received this order from non government organization.



Graph 6.4 Evacuation Order Source

6.3. People's Attitude toward Evacuation Order

There were two kinds of their attitude in response the evacuation order: evacuate immediately, and evacuate after observing of Merapi volcano activities carefully. Graph 6.3 indicates that more than 59% of respondent said that they would evacuate after observing the Merapi volcano activity first. It means if the circumstances of Merapi volcano activity increased more hazardous, they would evacuate, but if the Merapi volcano activity decreased, they would stay at home.

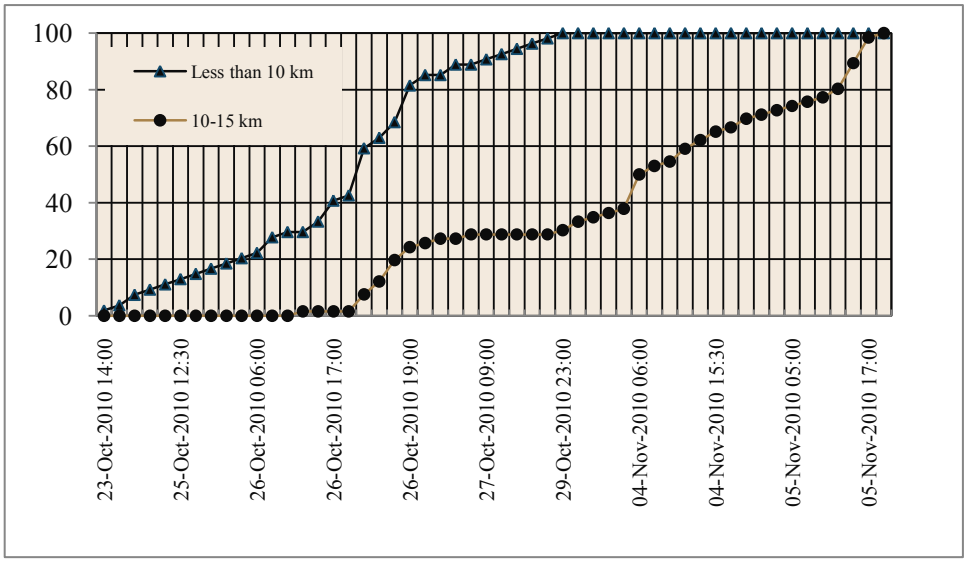


Graph 6.5 Attitudes toward evacuation order

Reviewed based on the hazard zones, this attitude was followed by around 52% respondents living in the first hazard zone, 62% respondents living in the second hazard zone, and 62% respondents living in the third hazard zone. On the other hand, a sizeable number of respondents stated that they would evacuate immediately after received an evacuation order (40.8 %).

6.4. Evacuation Decision Time

The following graph shows the time when people move out from the hazard zone.



Graph 6.6 Evacuation Decision Time

The number of evacuated people increased slightly between 23 October 2010 and 05 November 2010.

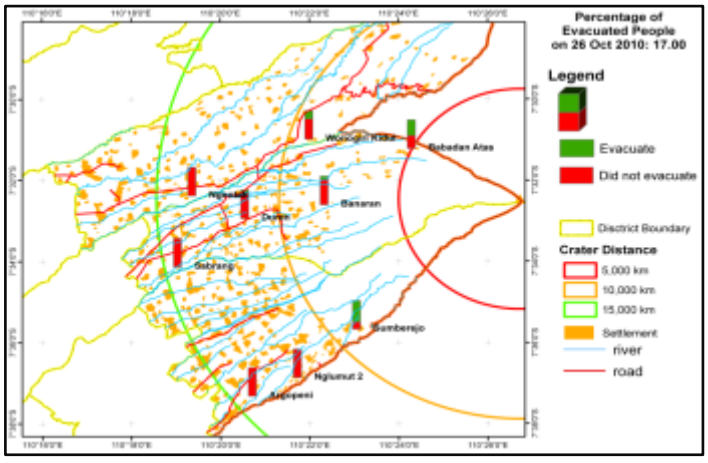


Figure 6.2. Percentage of Evacuated People on 26 October 2010:17.00

Only eighteen percent of the respondents had evacuated before Merapi volcano erupted on 26 October 2010, this percentage was much higher in 10 km radius hazard zone than in the 10-15 km hazard zone. The evacuated people living at less than 10 km from the crater rose rapidly from 0% to 40.7% respondents at beginning of period, from 23 October 2010 until 26 October2010 at 17.00 p.m., and people living between 10 km and 15 km from the crater on the first time they evacuated on 26 October 2010 at 13.00 p.m., and after ten hours later evacuated people rapidly increased to 28.79%.

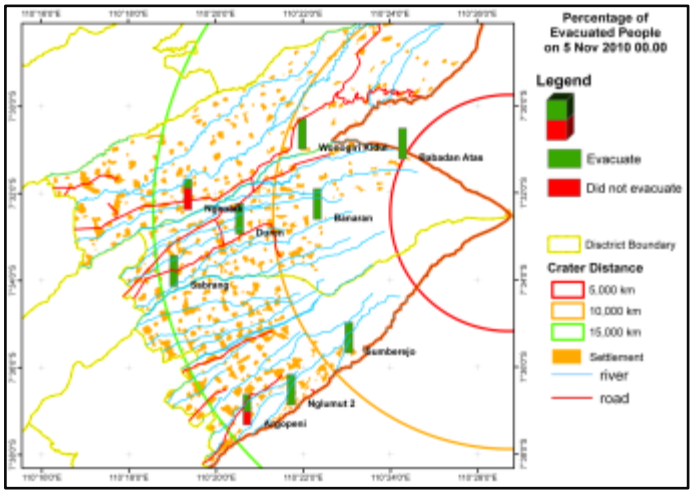


Figure 6.3. Percentage of Evacuated People on 05 November 2010: 00.00

6.5. Evacuation Response Time

An evacuation response time is resulted by subtracting evacuation decision time from receiving time of evacuation order. Using frequency analysis (see Appendix 2), the result obtained is that the minimum response time is 0.5 hours and the maximum response time is 189.5 hours.

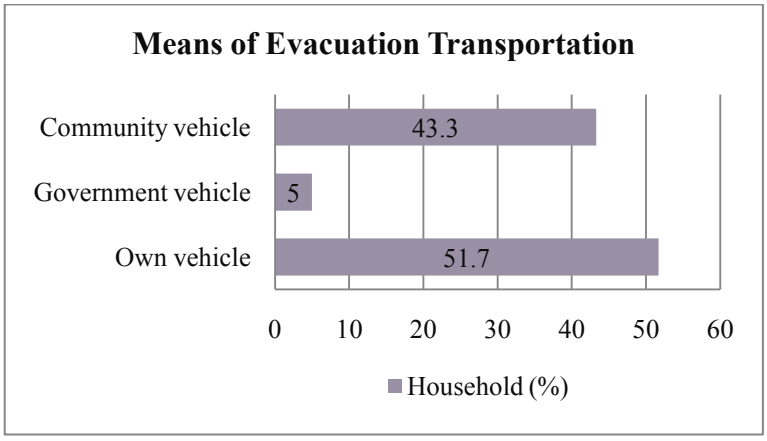
The available time between the time when government raised the alert to level 4 (beware) and the time of possible volcanic eruption will occur is less than 24 hours (Badan Kesbangpol PB, 2010a). Based on this circumstance, the evacuation response time is classified into two categories: immediate and late evacuation response time.

Table 6.1. Response Time Categories

Category	Response time	Number of Respondents	Percent
Immediate	< 24 hours	83	69.2
Late	> 24 hours	37	30.8
		120	100.0

6.6. Evacuation Transportation

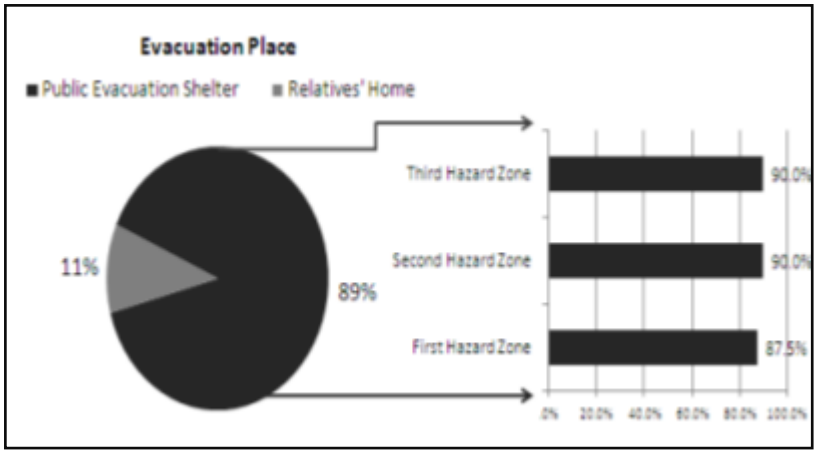
There were various means of evacuation transportation used in evacuation. Most of the respondents (51%) used their own vehicles for the means of evacuation transportation. The other means of evacuation transportation used by the respondents were community vehicle (43%) and governments' vehicles were used by 5% of respondents.



Graph 6.7 Means of Evacuation Transportation

6.7. Evacuation Shelter Choices

Two types of evacuation shelters were selected as evacuation places: public evacuation shelters and relative's homes.



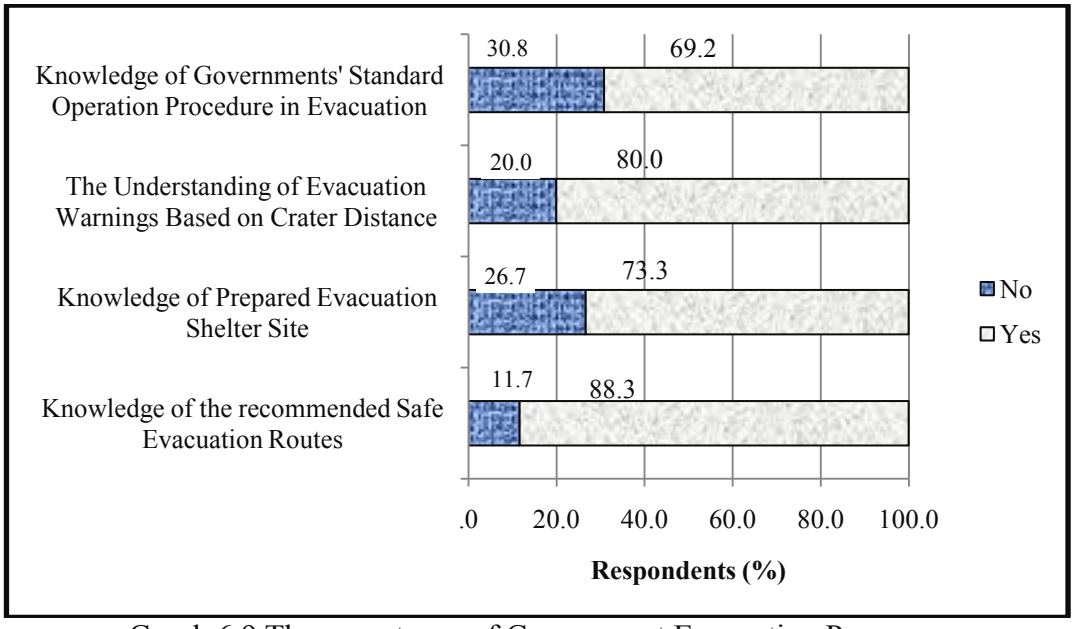
Graph 6.8 People's evacuation shelter choices

The use of public evacuation shelters prepared by Government was the most preferred choice in which they could live during the volcanic eruption. Majority of respondents used the public evacuation shelters separated on safe area at Magelang Regency. Only 11% of respondents used their relative's home.

Figure 6.4. Temporary Evacuation Shelters

6.8. Acceptance of Government Evacuation Program

The people's acceptation of government evacuation program was identified by analyzing the response of people to the question related to the acceptance of government evacuation program. Graph 6.9 shows the analyzing of the respondents' answer.



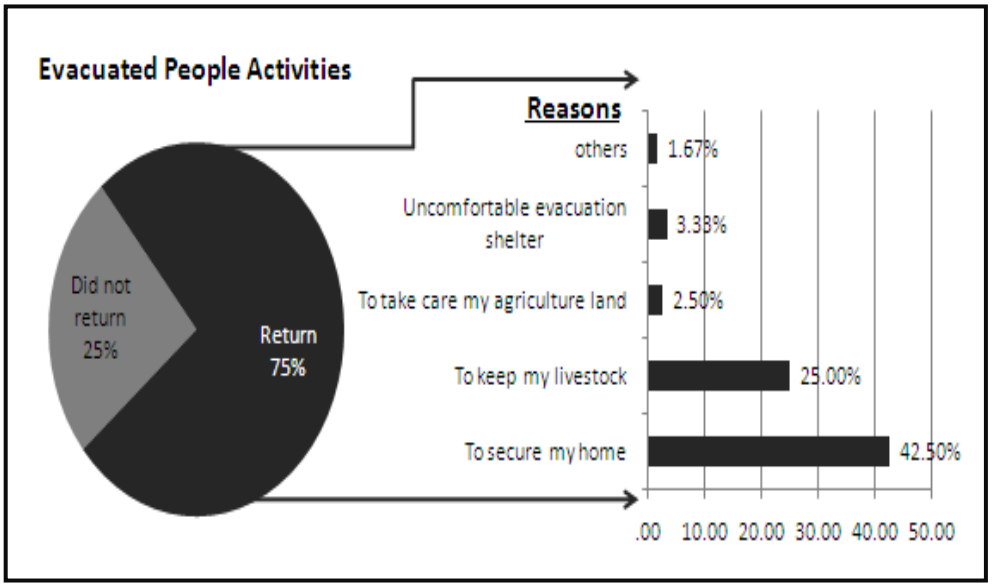
Graph 6.9 The acceptance of Government Evacuation Program

The majority of respondents have known the government had the standard operation procedures in evacuation. From 120 respondents, majority of

respondents had known those procedures, the evacuation warnings based on the crater distance, the evacuation shelter sites, and the safe evacuation route.

6.9. Evacuated People Activities during Merapi eruption

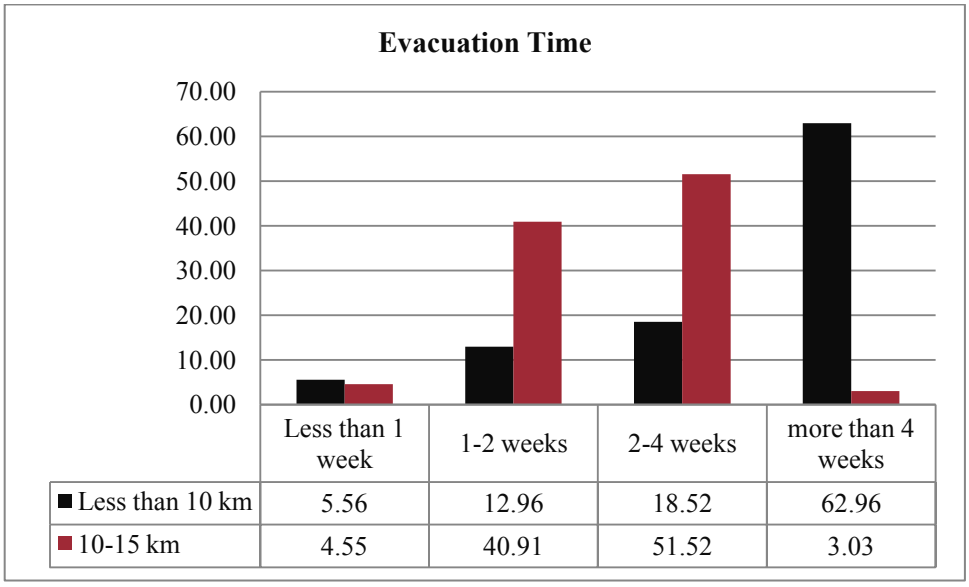
Most of evacuated people returned daily to their homes when the alert level of Merapi eruption was in the highest level.



Graph 6.10 Reasons why people daily returned to their homes during eruption

There are various reasons for those. The main reason why people returned to their home was because they wanted to secure their homes. The other reasons were to keep their livestock, to take care of their agricultural land, and only a few of people returned to their home were because the evacuation shelter condition was uncomfortable

The Merapi eruption caused the people leaved their homes. The majority respondents left their homes as long as 2-4 weeks. 30% of respondents left their homes until more than 4 weeks. Meanwhile, the other left their homes for 1-2 weeks and only 5% respondents left their homes less than 1 week.



Graph 6.11 Evacuation Time

Most of people living within 10 kilometers hazard zone more than 4 weeks. The people who evacuated earlier returned later.

6.10. Concluding Remarks

People's evacuation behavior following the 2010 Merapi eruption event was analyzed by using statistical analysis. This research found that majority of the respondents did not pay attention to the impending eruption of Merapi volcano. Radio and television media were the primary source of impending eruption information.

Thirteen percent of people living within 10 kilometers hazard zone had received evacuation order when government issued the alert to level 4 (beware), and evacuation order was given to the people within 10 kilometers hazard zone on 26 October 2010. More than half of people living within 10-15 kilometers hazard zone had received evacuation order when government issued evacuation order on this zone on 3 November 2010. This observation is similar with the finding of Tayag et al (1992). They said that in the 1991 Pinatubo eruption about 25% of the

people living in the hazard zone were reached by warnings before explosive eruption began. Less than half of the respondents living within 10 kilometer hazard zone had evacuated when the first eruption occurred, and all people on its hazard zone had evacuated four days after evacuation order was received, and all people living within 10-15 kilometers hazard zone had evacuated two days after the evacuation order was received.

All respondent evacuated in response to 2010 Merapi eruption, and majority of them evacuated in less than 24 hours after they received an evacuation order.

7. FACTORS INFLUENCING EVACUATION RESPONSE TIME

Statistical analysis of relationship between factors influencing evacuation response time is discussed in the following subsection.

7.1. Socio Economic Characteristics Analysis

The relationship between response time and socio-economic factors is presented in the following table based on chi-square analyses (see Appendix 3.1-3.10). There are no relationships found between evacuation response time and socio-economic factors. Evacuation response time did not differ significantly by age, religion, education level, occupation, income, house ownership, livestock ownership or vehicle ownership.

Table 7.1. Socio-Economic Factor Analysis

No	Related Factors	χ^2	P	Result
1	Age	1.05	0.95	No relationship
2	Religion	0.91	0.63	No relationship
3	Education	0.57	0.96	No relationship
4	Occupation	4.13	0.53	No relationship
5	Income	1.22	0.74	No relationship
6	House Ownership	0.50	0.47	No relationship
7	House Material	0.99	0.31	No relationship
8	Agricultural Ownership	4.12	0.24	No relationship
9	Livestock Ownership	4.59	0.20	No relationship
10	Vehicle Ownership	3.96	0.26	No relationship

7.2. Disaster Experience Analysis

The number of Merapi volcano eruption experiences was different between respondent, and this difference had no relationship with response time. The number of evacuation experiences was different between respondents, but it also did not influence to evacuation response time (see Appendix 3.11-3.12).

Table 7.2. Disaster Experience Analysis

No	Related Factors	χ^2	p	Result
1	The number of Merapi eruption experience	0.816	0.936	No relationship
2	The number of evacuation experience	0.260	0.878	No relationship

Our finding indicates that people who have more experience in volcanic eruption and have more evacuation experience did not increase their response to evacuation orders. The other finding, the evacuation response time of people who have more evacuation experience is not different with the evacuation response time of people who have no evacuation experience.

In this context, it can be concluded that there is no guaranty that people who had experience in Merapi eruption, would evacuate in immediate evacuation response time.

Furthermore, if it is reviewed from the previous experience, it is shown that respondents who evacuated in 1994 eruption evacuated in 2006 eruption. Of 92 respondents did not evacuate in 1994 eruption, there are 68 respondents who did not evacuate in 2006 eruption, and of 14 respondents evacuated in 1994 eruption, all of them evacuated in 2006 eruption. Meanwhile 14 respondents who did not experience in 1994 eruption, 6 people of them did not evacuated and the rest evacuated in 2006 eruption.

Table 7.3. Relationship between 1994 and 2006 Experience Analysis

		1994			Total
		Did not Experience	Did Not Evacuate	Evacuated	
2006	Did Not Evacuate	6	68	0	74
	Evacuated	8	24	14	46
Total		14	92	14	120

The result of chi-square analysis shows that experience in 1994 eruption influences evacuation decision in 2006 eruption. The relationship between two previous eruptions is in line with the finding of Donovan (2009) that the villagers' perception of hazard and their reaction to an eruption are greatly influenced by their previous experience.

7.3. Hazard Knowledge Analysis

The author analyses the level of people's hazard knowledge by counting the number of training attended by respondents. The number of people who had never attended the training accounts for 79 people, and 54 people of whom have immediate evacuation response time while the rest of them had late response time. On the other hand, the number of people who had attended the training was 41 people, and 29 of them have immediate response time while the rest of them had late response time (see Appendix 3.14).

Table 7.4. The Number of People Attending Trainings Analysis

No	Related Factor	χ^2	p	Result
1	The number of people attending training	3.054	0.383	No relationship

Furthermore, our findings indicate that there is no significant level of relationship between evacuation response time and the number of people attending training

7.4. Cultural Belief Analysis

A number of the survey questions addressed cultural beliefs those who believe in unseen creatures, hold a ceremony to placate Merapi volcano activity, believe in spiritual leader, and believe in sign from ancestors. Moreover, the relationships between those all and evacuation response time is discussed in following table:

Table 7.5. Cultural Beliefs Analysis

No	Related Factor	χ^2	p	Result
1	Beliefs in the existence of unseen creatures as the keeper of the Merapi Volcano?	0.260	0.610	No relationship
2	Beliefs in attempted traditional ceremonies for refusing disaster.	0.039	0.843	No relationship
3	Beliefs in spiritual leaders for guidance in evacuation?	0.223	0.636	No relationship
4	Beliefs in a sign from the ancestors through dreams?	0.120	0.912	No relationship

The table above indicates that there are no relationships between all related variables in cultural beliefs and evacuation response related to survey question "Did you believe in the existence of unseen creature as the keeper of the Merapi volcano" indicates no clear distinction between variables. On the second row, it is found that there is no relationship between the beliefs in attempted traditional ceremonies for refusing disaster and evacuation response time Furthermore, the relationship between the beliefs in spiritual leader for guidance in evacuation and evacuation response time is shown in the above table. It means that there is no relationship between them.

Moreover, the last survey question related to cultural beliefs is "Did you believe in a sign from the ancestor trough dreams". The cross-tabulation analysis results (see Appendix 3.18) indicate that there is no relationship between response time and the beliefs in sign from the ancestor trough dream.

7.5. Hazard Perception Analysis

There were three questions related to hazard perception addressed to identify the hazard perception of people living at the study area (see Appendix 3.19-3.21).

Table 7.6. Hazard Perception Analysis

No	Related Factor	χ^2	P	Result
1	Are the Merapi eruptions hazardous for your life?	28.72	0.000	Related
2	Has Merapi volcano been providing benefits for life?	2.081	1.149	No Relationship
3	Did you regret for people who live in hazard zones of Merapi volcano	0.223	0.636	No Relationship

The results of chi-square analyses are presented in Table 7.6. Of the hazard perception analysis, the evacuation response time have significant relation in the answer of question "Are Merapi eruptions hazardous for their life?". It means that people who perceived that Merapi eruptions were hazardous for their life are dominant to evacuate in immediate evacuation response time

Table 7.7. Response to the questions: Are the Merapi eruption the hazardous for life

		Response Time		Total
		Immediate	Late	
Are the Merapi eruption the hazardous for life?	No	18	27	45
	Yes	65	10	75
	Total	83	37	120

7.6. The Source of Evacuation Order Analysis

There is relationship between evacuation response time and the source of evacuation order. The majority of respondents who received evacuation orders from government staff, non government organization, their family evacuated in immediate time.

Table 7.8. The Source of Evacuation Order

	Response Time		
	Immediate	Late	Total
Government	52	16	68
Non Government Organization	4	0	4
Family	11	2	13
Neighbor	16	19	35
	83	37	120

Meanwhile respondent receiving evacuation order from their neighbor evacuated in late time.

7.7. The Acceptance of Government Evacuation Program Analysis

The result of chi-square analyses (see Appendix 3.22-3.25), the relationship between the acceptance of government evacuation program and evacuation response time are shown in Table 7.8. The evacuation response time was influenced by the acceptance of the government's evacuation standard operation procedure.

Table 7.9. The Acceptance of Government Program Analysis

No	Related Factor	χ^2	p	Result
1	Did you know that government has already had a standard operation procedure to evacuate the people in hazardous areas?	29.05	0.000	Related
2	Are the volcanic eruption warnings from government based on the distance of both the river and the crater easy to understand?	0.039	0.843	No Relationship
3	Did you know the locations of evacuation shelters which had been prepared by government before Merapi eruption occurred?	0.004	0.952	No Relationship
4	Did you know the safe evacuation routes prepared by government before Merapi eruption occurred?	0.657	0.418	No Relationship

Relationship between evacuation response time and the number of people who believe in that government has already had a standard operation procedure to evacuate the people in hazardous areas is significant.

Table 7.10. Response to Questions: Did you know that Government has already had a procedure to evacuate

Answer	Response Time		Total
	Immediate	Late	
No	13	24	37
Yes	70	13	83
Total	83	37	120

The people who believe in government that has already had a standard operation procedure were dominant to evacuate in immediate evacuation response time.

7.8. Concluding Remarks

Although the reason why people returned to their home was because they wanted to secure their homes and to keep their livestock, this research found that socio-economic characteristics did not influence the evacuation response time. This finding is contrary to previous research. Lavigne et al (2008) wrote that social economic constraints are important factors of people's behavior facing the volcanic eruption.

Previous researches explain that residents on the slope of Merapi volcano hold a traditional ceremony to refuse the negative impacts of Merapi eruption (Donovan, 2009; and Sangga Sarana Persada, 1998). This research found that there is no relationship between traditional ceremony and evacuation response time.

Based on statistical analysis, this research found that there are three factors influencing evacuation response time: hazard perception, source of evacuation order, and the acceptance of government evacuation procedure.

8. DISASTER MANAGEMENT OF MAGELANG REGENCY

8.1. Institution Response in 2010 Merapi eruption

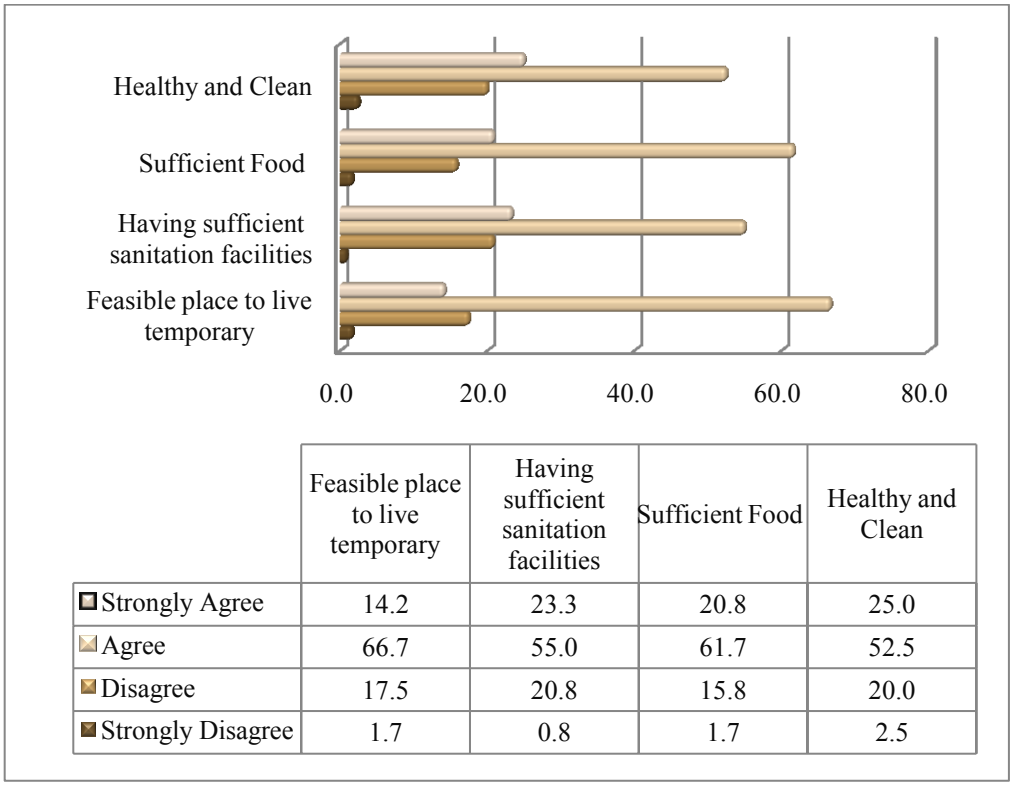
Structural and nonstructural mitigation have been conducted in response to Merapi eruption. Some nonstructural mitigation, such as hazard mapping, evacuation planning, institutional responsibility arrangement had been conducted in work together with other government agencies. Hazard zone map conducted by BPPTK in 2008 was generated based on the previous eruption in 2006. Structural mitigation, such as evacuation shelter, and evacuation route, had prepared only for accommodating the people living in the hazard zone.

Merapi eruption in 2010 was extremely dissimilar with the closest previous eruption in 2006. The Head of PVMBG, Dr. Surono, reported trough television media that Merapi eruptions on Tuesday, 26 October 2010 started at 17.02, were classified as explosive events that a column of smoke rose from the top to a vertical distance of 1.5 kilometers from the crater of Merapi volcano. He also reported that Merapi eruption of Friday 5 November 2010 was to be the biggest since the 1870s and the explosive eruption reaching VEI-4. Moreover, the hazard zone had been expanded in the largest area ever reported that reached to radius 20 kilometers from the crater. This circumstance is the main reason why the existing evacuation plan did not work in response to 2010 Merapi eruption.

Based on the contingency plan the Local Government was planned to evacuate 37,507 persons included provision of the basic need, such as food, clothing, sleeping facilities, and water, in fact the number of evacuated people reached in peak on 6 November 2010 amounting to 93,114 people who were accommodated at 207 TPS (Badan Kesbangpol PB, 2010b).

8.2. Public Evacuation Shelter Condition

To evaluate the public evacuation shelter prepared by local government of Magelang Regency, four questions were given to all respondents. Meanwhile some of them did not evacuate in public evacuation shelters.



	Feasible place to live temporary	Having sufficient sanitation facilities	Sufficient Food	Healthy and Clean
Strongly Agree	14.2	23.3	20.8	25.0
Agree	66.7	55.0	61.7	52.5
Disagree	17.5	20.8	15.8	20.0
Strongly Disagree	1.7	0.8	1.7	2.5

Graph 8.1 Public Evacuation Shelter Condition

It shown that about 66% of respondents said that evacuation shelter are feasible place to live temporarily, around 17.5% said disagree with the given statement.

When statement "Evacuation shelters have sufficient sanitation facilities" was asked, As many as 55% of respondents said agree, about 23% of respondent said strongly agree to the given statement, and 20% of respondents said disagree and strongly disagree.

Moreover, the response to statement "There is sufficient food at the evacuation shelter", were 1.7% of respondents said strongly disagree, 15.8% of respondents said disagree. Otherwise, 61.7% of respondents said agree, and 20.8% of respondents said strongly disagree.

Furthermore, when statements “Evacuation shelters are quite healthy and clean” were asked, the responses were that 2.5% of respondents said strongly disagree, 20.0% of respondents said disagree. Otherwise, 52.5% of respondents said agree, and 25.0% of respondents said strongly disagree.

To identify how local government accommodate the daily basic needs, such as food, drinking water, sleeping facilities, clothes, women supplies, hygiene kit, and baby diapers. In depth interviews we carried out to a number of respondents. The results can be presented as follows:

Harwoko who lives about 12.1 kilometers from the crater said:

> *When My family and I evacuated at Village building of Sucen, we were very grateful that the place where we were living was suitable for temporary life, and in this place, My family’s basic need were fulfilled by local government including my baby’ need, such as milk and diapers.*

Subardi who lives about 14.2 kilometers from the crater recalled :

> *In the place where my neighbors and my family were living during eruption time, the local government did not send any daily basic need. I realized that place was not known by local government as evacuation shelter because we prepared by ourselves. My family could not eat regularly. Sometimes, we only ate once a day. I was ashamed to ask food from the others.*

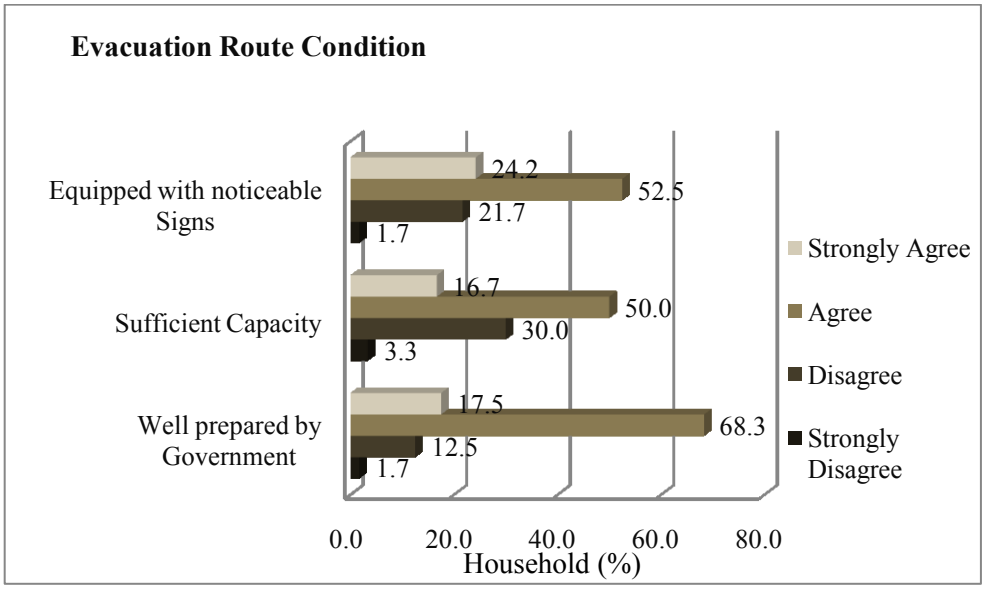
Similar opinions were said by Sudarno who lives about 4.9 kilometers from the crater of Merapi volcano, and Ismi, whose house is about 11.3 kilometers from the crater.

Wartimah, evacuating people in TPA Tanjung reported in local newspaper that the daily basic needs especially baby formula/milk were not

available enough in evacuation shelters and also toilets were not well prepared by Local government of Magelang Regency (Kedaulatan Rakyat, 2010)

8.3. Evacuation Routes Condition

This research is conducted to know the people's assessment toward the evacuation routes condition. Three statements related with evacuation routes condition assessment were asked to respondents.



Graph 8.2 Assessment of Evacuation Route

The results of respondents' statement when they was asked "The evacuation routes are well prepared by the Local Government" was found that 1.7% of respondents said strongly disagree, 12.5% of respondents said disagree. Otherwise, 68.3% of respondents said agree, and 17.5% of respondents said strongly disagree.

The response of respondent to statement "The roads used for evacuation route have sufficient capacity based on the number of vehicles passing" 3.3% of respondents said strongly disagrees, and 30% said disagree. While 50% of respondents said agree and 16.7% of respondents said strongly agree.

Figure 8.1. Evacuation Routes Condition during Merapi eruption occurred
(source: Badan Kesbangpol PB,2010b)

Moreover, when question statement "Evacuation routes have been equipped with the noticeable signs" were asked, there were 1.7% of respondents said strongly disagree, 21.7% of respondents said disagree. Otherwise, 52.5% of respondents said agree, and 24.2% of respondents said strongly agree.

The statements above present the evacuation routes conditions when the first phase of eruption occurred. It changed after the volcanic ash brought down causing trees uprooted and the roads were damage. The evacuation routes were seriously inaccessible at that time.

8.4. Concluding Remarks

Merapi eruption in 2010 reached VEI 4 that forced the Local Government of Magelang Regency to move all evacuation shelters within 20 kilometer radius hazard zone away from the summit. The government had never prepared to evacuate the people living within 20 kilometers radius hazard zone. The conditions of evacuation shelters were not suitable for temporary life on this circumstance.

Contingency plan to response Merapi eruption in 2010 was established by Badan Kesbangpol PB referring to both experiences on the previous eruption in 2006 and the hazard map conducted by BPPTK in 2006 in which the affected

people understood the hazard zones in Merapi volcano divided into three different levels of hazard zones.

The inconsistent methods in hazard assessment cannot easily be understood by people living on the slope of Merapi volcano. For example, in term of hazard knowledge, the misunderstanding of where their homes are located influences a fault when the people make evacuation decision.

Local Government of Magelang Regency could accommodate to evacuate their people in unpredictable volcanic eruption activities. It is one of beneficial effort of Local Government of Magelang Regency in response to Merapi eruption. On the other hand, there are complaints from evacuated people that the Local Government has to improve the basic needs in evacuation shelters.

9. CONCLUSION AND RECOMMENDATION

9.1. Conclusions

The main objective of this study is to improve evacuation planning based on people's behavior in response to volcanic eruption. Based on the previous discussion, the research found that majority of people living in hazard zone work as farmer and most of them are elementary school graduated. People living on the slope of Merapi volcano have been frequently exposed to the volcano hazards. Majority of people perceive Merapi eruption as hazardous although they said that Merapi volcano has been providing benefits for their life, and they did not regret as people living in the hazard zone. All respondents evacuated in response to 2010 Merapi eruption. Majority of them evacuated in less than 24 hours after received evacuation order.

The research concludes that hazard perception, sources of evacuation order, and acceptance of government evacuation procedure are factors that can be used to improve evacuation planning. People who perceive that Merapi eruptions are hazardous for their life are dominant to evacuate in immediate time. The source of evacuation order from government staff, non government staff, and their family are the sources of evacuation orders causing immediate evacuation response time, and the late evacuation response time is resulted from evacuation order given by their neighbors. The acceptance of government evacuation standard operation procedure influences the evacuation response time. The people who know that government has already had an evacuation procedure are dominant to evacuate in immediate evacuation response time.

The following table addresses the research questions of this research.

Table 9.1. Reference of research question achievement

No	Research Question	Reference
1.	**Research Objective:** To identify characteristics of the people in the hazard zones.	
1.1.	What are the characteristics of the people in the hazard zones?	Chapter 5
2.	**Research Objective:** To identify people's behavior in response to volcanic eruption event.	
2.1.	Do the people pay attention to volcanic eruption event?	Sub-chapter 6.1.
2.2.	When do people receive impending eruption warning?	Section 6.1.1.
2.3.	When do the people receive an evacuation order?	Section 6.2.1.
2.4.	When do the people decide to evacuate?	Sub-chapter 6.4.
2.5.	How much time is needed in response to evacuation order?	Sub-chapter 6.5.
2.6.	What was the means of transportation to the evacuation place?	Sub-chapter 6.6.
2.7.	What evacuation place did the people go to?	Sub-chapter 6.7.
3.	**Research Objective:** To examine the factors influencing the people's evacuation response time.	
3.1.	What are the factors influencing the people's evacuation response time?	Chapter 7
4.	**Research Objective:** To describe the disaster management of Magelang Regency related to evacuation	
4.1.	How does the local government of Magelang Regency evacuate the people in the hazard zones?	Sub-chapter 3.4, 3.6, and 8.1.
4.2.	What are the actual deficiencies and benefits of the local governments' evacuation efforts in response to volcanic eruption?	Sub-chapter 6.7, 8.2, and 8.3.

9.2. Recommendation for Local Governments

The developed methodology in this research can be adopted by local governments as a method to improve evacuation planning. This research developed a feasible method using statistical analysis of data obtained from questionnaire survey. This method is known to be highly effective in measuring the 'cause and effect' of individual variables.

A variety of strategies have to improve to increase the speed of evacuation in the hazard zone of Merapi volcano. Based on the findings in this research, evacuation planning in response to Merapi eruption can be improved by conducting program as follows:

1. Local government have to conduct the disaster training programs in order to ensure that the affected people will react intelligently and comply with instructions issued by the authorities. The evacuation standard operation procedure prepared by local government can be explained during the trainings.
2. The hazard signs or evacuation guidance have to be set up in the hazard zone including information about the distance of the crater and on which hazard zone a village situated. This research found that some of affected people did not know where their villages are situated. The existing hazard signs did not inform about which hazard zones and how far from the crater of Merapi volcano.
3. Regulation law number 24 of 2007 organizes the establishment of disaster management institution in national, regional, and local government level. Based on this regulation law, Local government of Magelang Regency needs an agency of disaster management having authority to undertake disaster management that can be able in arrangement of organizations in response to Merapi volcano.

9.3. Recommendation for further research

Identifying the social resilience is an important issue that will help the community and local government to make an evacuation planning. The research questions related to social resilience are: (1) how does the social resilience of a community work? and (2) what are the people behavior to prepare in response to volcanic hazard?.

Related to structural mitigation, local governments had difficulties to prepare evacuation shelter when the volcanic eruption occurred. The capacity of evacuation shelter and boundary of dangerous areas were found as a problem in evacuation effort. It is important to improve evacuation planning by identifying the potential evacuation shelters and the safe evacuation route. The research questions that can be formulated are: (1) Which criteria of building are used for evacuation shelter? (2) How is the evacuation shelters distributed spatially? (3) Which roads can be used as evacuation route? (4) How many evacuation shelters are needed to accommodate the affected people?

Related to this research, the factors influencing the people's behavior in response to volcanic eruption has been answered in this research. It is important to identify the factors influencing the people's behavior in response to volcanic eruptions on the other slopes of Merapi volcano or the other volcanoes. This is also an interesting topic for further research.

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APPENDIX

APPENDIX 1: QUESTIONNAIRE

QUESTIONNAIRE

RESEARCHER : Didik K. Sofian
TITLE : Improving Evacuation Planning Based on People's Behavior in response to Volcanic Eruption Events

This information is only used for research importance

Interview No : ……..
Date : ……..
GPS : Lat ……Long……..

Note : All questions is answered based on the condition at the time of 2010 Merapi eruption.
Respondent:

1. Name of respondent	
2. Address	*Hamlet : _____* *RT :_____* *Village :_____* *District :_____*
3. Age	*_____years*
4. Sex	□ *male* □ *female*
5. Religion	□ *Muslim* □ *Protestant* □ *Catholik* □ *Hindu* □ *Budha* □ *Konghucu* □ *Others*

Socio-Economic Characteristics

6. Family members	*Total : _____ persons* *Content of :* *Male :_____ persons* *Female:_____ persons* *Age:* *0 - 5 th : _____ persons.* *6 – 20 th : _____ persons* *21- 60 th : _____ persons.* *More than 60 th :_____ persons*

7. Education	□ *illiteracy* □ *Elementary School* □ *Junior High School* □ *Senior High School* □ *Graduate School*
8. Occupation	□*farmer* □*Trader* □ *Military* □ *Private employee* □*Civil Servant* □ *Laborer* □ *Others*
9. Income per month	□ *< Rp. 800.000* □ *Rp. 800.000 - Rp. 1.500.000* □ *Rp. 1.500.000 - Rp. 3.000.000* □ *> Rp. 3.000.000*
10. Homeownership	□ *Rent* □ *Owner*
11. Types of building	□ *Wood* □ *Cement*
12. Agricultural land ownership	□ *none* □ *< 1 Ha* □ *1 - 2 Ha* □ *> 2 Ha*
13. Livestock ownership	□ *none* □ *Poultry* □ *Goat* □ *Cow* □ *Others*_____
14. Vehicle ownership	□ *None* □ *Motorcycle* □ *Car* □ *Truck/Bus* □ *Others* _____
15. The main reason to stay in the village	□ *Closer distance to workplaces* □ *Availability of business places* □ *Owning of agriculture land* □ *Owning of a house* □ *Others* _____

Disaster Experience:

16. Was you born in this village? □ Yes □ No
17. How many times did you experience in Merapi eruption?_____ times
18. How many times did you evacuate?_____ times
19. Did you experience in the 2006 Merapi eruption? □ Yes □ No
20. Did you experience in the 1994 Merapi eruption? □ Yes □ No
21. Did you evacuate in the 2006 Merapi eruption? *□ Did not Experience □ Did not evacuate □ Evacuate*
22. Did you evacuate in the 1994 Merapi eruption? *□ Did not Experience □ Did not evacuate □ Evacuate*

Disaster Knowledge:

23. Number of attending the training to deal with volcanic eruption *□ never □ once □ 2 – 3 times □ more than 3 times*
24. Did you know which hazard zone is your hamlet? *□ The Third Hazard Zone* *□ The Second Hazard Zone* *□ The first Hazard Zone*
25. Did you know which the distance of your home to the crater *□ < 10 km* *□ 10-15 km* *□ > 15 km*
26. The distance of your home to the river *□ < 150 m* *□ 150 -300 m* *□ > 300 m*

Cultural Beliefs

27. Did you believe in the existence of unseen creatures as the keeper of the Merapi Volcano? □ Yes □ No
28. Did you attempt the traditional ceremonies to refuse disaster? □ Yes □ No.
29. Did you believe in spiritual leaders for guidance in evacuation? □ Yes □ No
30. Did you believe in a sign from the ancestors through dreams? □ Yes □ No

Risk Perception

31. *Are the Merapi eruptions hazardous for your life? □ Yes □ No*
32. *Does Merapi volcano provide benefits for your life? □ Yes □ No*
33. Do you regret for people who live in hazard zones of Merapi volcano? *□ Yes □ No*

Governments' Evacuation Plan Knowledge

34. *Did you know that government has already had a standard operation procedure to evacuate the people in hazardous areas?* □ *Yes* □ *No*
35. *Are the volcanic eruption warnings from government based on the distance of the river and the crater easy to understand?* □ *Yes* □ *No*
36. *Did you know the locations of evacuation shelters which had been prepared by government before Merapi eruption occurred?* □ *Yes* □ *No*
37. Did you know the safe evacuation routes prepared by government before Merapi eruption occurred? □ *Yes* □ *No*

The People's Behavior in response to Merapi eruption

Note: *Activity status of Merapi Volcano was increased from Level 1 (Normal Activity) to Level 2 (Caution) on September 20, 2010. It was increased to Level 3 (Alert) on October 21, 2010 and then was increased to the highest level, Level 4 (beware), on October 25, 2010 at 06:00 pm.* *The first eruption occurred on October 26, 2010 at 17:02 pm. It was followed to a series of other eruptions. The largest eruption occurred on November 5, 2010..*

38. When did you first learn that the Merapi would erupt? *Date :_____ Time :_____*
39. How did you know about the Merapi impending volcanic eruption? □*Seeing the sign of nature by yourself* □ *Information from Radio / TV* □ *Information from the Government Staff* □ *Information from neighbors / Relatives / Friends* □ *others*
40. Did you receive an evacuation order? □ *Yes* □ *No* *41. If you received evacuation order, when did you receive the evacuation order?* *Date :_____ Time :_____*
42. Who gave you the order to evacuate? □*Government Staff* □ *Non Government Staff* □ *Family* □ *Neighbor* □ *others* _____
43. After you received evacuation order, what was your attitude? □ *evacuated immediately* □ *evacuated after observing of Merapi activities carefully* □ *did not evacuate*

These questions are for those who evacuated

44. *When did you evacuate?*
    Date :_____ Time :_____

45. *What was the vehicle used to evacuate?*
    □ *my own vehicle* □ *government evacuation vehicle* □ *community evacuation vehicle*
    □ *Others _____*

46. *Where did you take refuge?*
    □ *Public evacuation shelter* □ *Family* □ *Friends* □ *Hotel*
    □ *Others_____*

47. *During volcanic eruption, did you return daily to your home?*
    □ *Yes* □ *No*
    (If the answer is "yes" answer the question no. 48 , if the answer is "no" go directly to question no.49)

48. *What was the main reason why you returned daily to your home?*
    □*To secure their home* □ *To keep livestock* □ *To take care agriculture land*
    □ *uncomfortable evacuation shelter* □ *others……..*

49. *How long did you evacuate?*
    □ *< 1 week* □*1-2 weeks* □ *2-4 weeks* □ *> 4 weeks*

50. *How many times did you have to move to other evacuation shelter?*
    □ *once* □ *2 times* □ *3 times* □ *> 4 times*

51. *Using the following table describe the time and the places you evacuated?*

Date	*Address*	*selected evacuation shelter distance (km)*

52. *Did you leave the evacuation shelter in accordance at the time where you could be safe to return to your home?*
    □ *yes* □ *no*

53. *Did you receive advice on whether or not and it would be safe to return?*
    □ *yes* □ *no*

These questions are for those who did not evacuate

54. What was the main reason why you did not evacuate? □ *Maintaining Security* □ *Keeping livestock* □ *Maintaining agriculture* □ *Feeling safe at home* □ *not accepting orders to evacuate* □ *not believing in the order given.* □ *Others*_____
55. If the Merapi eruption will occur in the future, what will you do? □ *evacuate immediately* □ *observe the activity of Merapi first* □ *do not evacuate*

To measure the quality of evacuation shelter

56. Evacuation shelters are feasible place to live temporarily	□ *Strongly disagree* □ *Not Agree* □ *Agree* □ *Strongly Agree*
57. Evacuation shelters have sufficient sanitation facilities (toilets & bathrooms)	□ *Strongly disagree* □ *Not Agree* □ *Agree* □ *Strongly Agree*
58. There is sufficient food at evacuation shelters.	□ *Strongly disagree* □ *Not Agree* □ *Agree* □ *Strongly Agree*
59. Evacuation shelters are quite healthy and clean	□ *Strongly disagree* □ *Not Agree* □ *Agree* □ *Strongly Agree*

To measure the evacuation route condition

60. The evacuation routes are well prepared by the Government.	□ *Strongly disagree* □ *Not Agree* □ *Agree* □ *Strongly Agree*
61. Roads used for evacuation route have sufficient capacity based on the number of vehicles passing	□ *Strongly disagree* □ *Not Agree* □ *Agree* □ *Strongly Agree*

62. Evacuation routes have been equipped with the noticeable signs.	□ *Strongly disagree* □ *Not Agree* □ *Agree* □ *Strongly Agree*

MESSAGES:

***** thank you for your information *****

APPENDIX 2: RESPONSE TIME FREQUENCY ANALYSIS

		Response Time (Hour)
N	Valid	120
	Missing	0
Mean		26.0063
Mode		3.00
Std. Deviation		36.62759
Minimum		.50
Maximum		189.50

		Frequency	Percent
Valid	Immediate	83	69.2
	Late	37	30.8
	Total	120	100.0

APPENDIX 3: CHI-SQUARE ANALYSIS

Appendix 3.1. Cross-tabulation between response time and age.
(χ^2=1.059, df=5, p=0.958)

		Response Time		
		Immediate	Late	Total
Age classes of Respondent	20-29	13	7	20
	30-39	30	10	40
	40-49	21	10	31
	50-59	12	6	18
	60-69	5	3	8
	70-79	2	1	3
Total		83	37	120

Appendix 3.2. Cross-tabulation between response time and Religion
(χ^2=0.912, df=2, p=0.634)

		Response Time		
		Immediate	Late	Total
Religion	Muslim	79	36	115
	Protestant	2	0	2
	Catholic	2	1	3
Total		83	37	120

Appendix 3.3. Cross-tabulation between response time and Education.
(χ^2=0.572, df=4, p=0.966)

		Response Time		Total
		Immediate	Late	
Formal Education Level	Illiteracy	1	1	2
	Elementary School	35	14	49
	Junior High School	23	10	33
	Senior High School	20	10	30
	Graduate School	4	2	6
Total		83	37	120

Appendix 3.4. Cross-tabulation between response time and Occupation
(χ^2= 4.133, df=5, p= 0.530)

		Response Time		Total
		Immediate	Late	
Occupation	Farmer	51	24	75
	Trader	7	2	9
	Military/Police	0	1	1
	Private Employee	6	4	10
	Civil Servant	2	0	2
	Laborer	17	6	23
Total		83	37	120

Appendix 3.5. Cross-tabulation between response time and Monthly Income of Household Head
(χ^2= 1.225, df= 3, p= 0.747)

		Response Time		Total
		Immediate	Late	
Income	less Rp.800.000	57	25	82
	Rp.800.000 – Rp. 1.500.000	18	10	28
	Rp. 1.500.000 - Rp. 3.000.000	6	1	7
	more Rp.3.000.000	2	1	3
Total		83	37	120

Appendix 3.6. Cross-tabulation between response time and House Ownership (χ^2= 0.504, df= 1, p= 0.478)

		Response Time		
		Immediate	Late	Total
House Ownership	Rent	4	3	7
	Owner	79	34	113
Total		83	37	120

Appendix 3.7. Cross-tabulation between response time and House Material (χ^2= 0.994, df= 1, p= 0.319)

		Response Time		
		Immediate	Late	Total
Wall material	Wood	10	7	17
	Cement	73	30	103
Total		83	37	120

Appendix 3.8. Cross-tabulation between response time and Agriculture Ownership (χ^2= 4.128, df=3, p=0.248)

		Response Time		
		Immediate	Late	Total
Agriculture Ownership	none	11	9	20
	< 1 Ha	59	26	85
	1 -2 Ha	12	2	14
	>2 Ha	1	0	1
Total		83	37	120

Appendix 3.9. Cross-tabulation between response time and Livestock Ownership (χ^2=4.592, df=3, p=0.204)

		Response Time		
		Immediate	Late	Total
Livestock Ownership	none	21	8	29
	Poultry	24	7	31
	Goat	10	10	20
	Cow	28	12	40
Total		83	37	120

Appendix 3.10. Cross-tabulation between response time and Vehicle Ownership (χ^2= 3.967, df= 3, p= 0.265)

		Response Time		
		Immediate	Late	Total
Vehicle	None	19	5	24

Ownership	Motorcycle	56	31	87
	Car	5	1	6
	Truck/Bus	3	0	3
Total		83	37	120

Appendix 3.11. Cross-Tabulation between Response Time and Number of Merapi eruption Experience (Q17)
(χ^2= 0.816, df=4, p=0.936)

		Response Time		
		Immediate	Late	Total
How many times did you experience in Merapi eruption	1	7	3	10
	2	29	12	41
	3	30	13	43
	4	16	9	25
	5	1	0	1
Total		83	37	120

Appendix 3.12. Cross-tabulation between Response Time and The Number of Evacuation Experiences (Q18)
(χ^2= 0.260, df= 2, p= 0.878)

		Response Time		
		Immediate	Late	Total
How many times did you evacuate	0	43	21	64
	1	27	11	38
	2	13	5	18
Total		83	37	120

Appendix 3.13. Cross-tabulation between Experience in 2006 Eruption (Q21) and Experience in 1994 Eruption (Q22)
(χ^2=30.454, df=2, p=0.000).

		1994			Total
		Did not Experience	Did Not Evacuate	Evacuated	
2006	Did Not Evacuate	6	68	0	74
	Evacuated	8	24	14	46
Total		14	92	14	120

Contingency Coefficient=0.450

Appendix 3.14. Cross-tabulation between Response Time and Attended Trainings (Q23) (χ^2=3.054, df=3, p=0.383).

		Response Time		
		Immediate	Late	Total
Attended Trainings	never	54	25	79
	1 times	17	10	27
	2-3 times	7	2	9
	> 3 times	5	0	5
Total		83	37	120

Appendix 3.15. Cross-Tabulation between Response Time and Culture (Q27) (χ^2=0.260, df=1, p=0.610).

		Response Time		
		Immediate	Late	Total
Did you believe in the existence of unseen creatures as the keeper of the Merapi Volcano?	No	34	17	51
	Yes	49	20	69
Total		83	37	120

Appendix 3.16. Cross-tabulation between Response Time and Culture (Q28) (χ^2=0.039, df=1, p=0.843).

		Response Time		
		Immediate	Late	Total
Did you attempt the traditional ceremonies to refuse disaster?	No	41	19	60
	Yes	42	18	60
Total		83	37	120

Appendix 3.17. Cross-tabulation between Response Time and Culture(Q29) (χ^2=0.223, df=1, p=0.637).

		Response Time		
		Immediate	Late	Total
Did you believe in spiritual leaders for guidance in evacuation?	No	66	28	94
	Yes	17	9	26
Total		83	37	120

Appendix 3.18. Cross-Tabulation between Response Time and Culture (Q30) (χ^2=0.12, df=1, p=0.912).

		Response Time		
		Immediate	Late	Total
Did you believe in a sign from the ancestors through dreams?	No	48	21	69
	Yes	35	16	51
Total		83	37	120

Appendix 3.19. Cross-tabulation between Response Time and Perception(Q31) (χ^2= 28.72, df= 1, p= 0.000).

		Response Time		
		Immediate	Late	Total
Are the Merapi eruption the hazardous for life activities?	No	18	27	45
	Yes	65	10	75
Total		83	37	120

Contingency Coefficient=0.439

Appendix 3.20. Cross-tabulation between Response Time and Perception (Q32) (χ^2= 2.081, df= 1, p= 0.149).

		Response Time		
		Immediate	Late	Total
Has Merapi Volcano been providing benefits for life?	No	2	3	5
	Yes	81	34	115
Total		83	37	120

Appendix 3.21. Cross-tabulation between Response Time and Perception (Q33) (χ^2= 0.137, df= 1, p= 0.712).

		Response Time		
		Immediate	Late	Total
Did you regret for people who live in hazard zones of Merapi volcano?	No	77	35	112
	Yes	6	2	8
Total		83	37	120

Appendix 3.22. Cross-tabulation between Response Time and Governments' Evacuation Plan Knowledge (Q34)
(χ^2= 29.050, df= 1, p= 0.000).

		Response Time		
		Immediate	Late	Total
Did you know that government has already had a standard operation procedure to evacuate people in the hazardous areas?	No	13	24	37
	Yes	70	13	83
Total		83	37	120

Appendix 3.23. Cross-tabulation between Response Time and Governments' Evacuation Plan Knowledge (Q35)
(χ^2= 0.039, df=1, p=0.843).

		Response Time		
		Immediate	Late	Total
Are the volcanic eruption warnings from government based on the distance of the river and the crater easy to understand?	No	17	7	24
	Yes	66	30	96
Total		83	37	120

Appendix 3.24. Cross-tabulation between Response Time and Governments' Evacuation Plan Knowledge (Q36)
(χ^2=0.004, df=1, p=0.952).

		Response Time		
		Immediate	Late	Total
Did you know the locations of evacuation shelters which had been prepared by government before Merapi eruption occurred?	No	22	10	32
	Yes	61	27	88
Total		83	37	120

Appendix 3.25. Cross-tabulation between Response Time and Governments' Evacuation Plan Knowledge (Q37)
(χ^2= 0.657, df=1, p=0.418).

		Response Time		
		Immediate	Late	Total
Did you know the safe evacuation routes prepared by Government	No	11	3	14
	Yes	72	34	106
Total		83	37	120

Appendix 3.26. Cross-tabulation between Response Time and Evacuation Warning Sources (Q42)
(χ^2=13.966, df=3, p=0.003).

		Response Time		
		Immediate	Late	Total
Who gave you the order to evacuate?	Government	52	16	68
	Non Government Organization	4	0	4
	Family	11	2	13
	Neighbor	16	19	35
Total		83	37	120

Appendix 3.27. Cross-tabulation between Response Time and Means of Evacuation Transportation(Q45)
(χ^2= 0.650, df= 2, p=0.723).

		Response Time		
		Immediate	Late	Total
What was the vehicle used to evacuate?	My own vehicle	43	19	62
	Government vehicle	5	1	6
	Community vehicle	35	17	52
Total		83	37	120