THESIS

DEVELOPING A PROTOTYPE LANDSLIDE INFORMATION AND WARNING SYSTEM USING MOBILE TELEPHONES BASED ON LOCAL COMMUNITY PARTICIPATION; A Case Study In Kulonprogo District, Indonesia

Thesis submitted to the Double Degree M.Sc. Programme, Gadjah Mada University and Faculty of Geo-Information Science and Earth Observation, University of Twente in partial fulfillment of the requirement for the degree of Master of Science in Geo-Information for Spatial Planning and Risk Management

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GRADUATE SCHOOL
GADJAH MADA UNIVERSITY
FACULTY OF GEO-INFORMATION AND EARTH OBSERVATION
UNIVERSITY OF TWENTE
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DEVELOPING A PROTOTYPE LANDSLIDE INFORMATION AND WARNING SYSTEM USING MOBILE TELEPHONES BASED ON LOCAL COMMUNITY PARTICIPATION;
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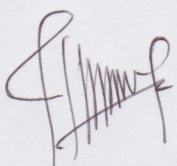
DISCLAIMER

This document describes work undertaken as part of a program of study at the Double Degree International Program of Geo-Information for Spatial Planning and Disaster Risk Management, a Joint Education Program of ITC Faculty of University of Twente, the Netherland and UGM, Indonesia. All views and opinions expressed there in remain the sole responsibility of the author, and do not necessarily represent those of the institute.



Aris Djati Dwi I

Abstract

Samigaluh is one subdistrict of Kulon Progo regency which located in a landslide prone area. Most areas of Samigaluh subdistrict are susceptible to landslide hazards. Based on the susceptibility map that was built by PSBA (2010), there are three level of susceptibility that located in this area, namely high, moderate and low.

The main objectives of this research are to assess community preparedness related to landslide hazard, to identify the local early warning system, and to develop landslide information and warning system using mobile phones based on the community participation.

The field study was carried out in two village that included in Samigaluh subdistrict, namely Ngargosari and Gerbosari village. Primary data was collected by interviewed to 140 respondents that located in these villages. The respondents were chosen with purposive sampling based on historical data and information from the key person in the study area to represents the people that affected to landslide hazards.

In general, the local people in the study area have knowledge related to landslide hazards. It can be shown by their perception related to the definition of landslide, the location, the causes, the occurrence and the signs of landslides. In addition, there is also have emergency planning and local early warning, but it is need to be improvement. And there are several planning that have been done by local government, such as the establishment of PUSDALOPS, TAGANA, logistic supply, desa tangguh bencana (disaster resilient village), and kampung siaga bencana (disaster alert village).

Utilization of technology in disaster risk reduction program is needed to minimize the impact of disaster. The study area is the appropriate areas that can be developed landslide information and warning system using mobile phone based on local community participation because mostly respondent has mobile telephones, the local people have high motivation and interested to participate in developing this system, and this system is accepted by the communities (easy to use, low cost and useful).

Key words: community preparedness, disaster risk reduction, landslide information and warning system, participation of local communities.

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Yogyakarta, March 2013

Aris Djati Dwi Iswanto

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List of Abbreviations

BPBD	: Regional Disaster Management
BAKOSURTANAL	: National Mapping and Survey Coordinating Board
BPS	: The Central Bureau of Statistics
RT	: Rukun Tetangga (sub area of RW)
RW	: Rukun Warga (sub area of village)
BAPPEDA	: Local Agency for Planning and Development
PSBA	: Centre Study of Natural Disaster
KESBANGLINMAS	: Agency for National Unity and Community Protection
PUSDALOPS	: Operation Control Center
KSB	: Kampung Siaga Bencana (Disaster Alert Village)
BTS	: Base Transceiver Station

CHAPTER 1. INTRODUCTION

This chapter presents a general overview of this research, which consists of the background of the research, research problem, research objectives, research questions, benefit of the research, scope and limitation, and conceptual framework.

1.1. Background

Indonesia is a country which has several prone areas to natural disasters. Indonesia is located on the edge of the Pacific, Eurasian and Indo- Australian tectonic plates which have many volcanoes and a high frequency of earthquakes. There are various types of natural disasters which occur in the last ten years such as flood, landslides, volcanic eruption, tsunami, earthquake, typhoon, flood, and landslide due to flood, tidal wave/abrasion, forest fire, and drought.

One type of disaster which is potential to occur in Indonesia is landslides, especially in the hilly and mountainous area. For example, several areas of Kulon Progo Regency, Yogyakarta Province are prone areas to landslide. According to Hadmoko *et al.*, (2010), there are several factors causing areas of Menoreh mountains to have high susceptibility to landslide such as; steep slopes, humid climate (heavy rainfall), earthquakes and human activities, for example mining, heavy development and agriculture.

Heavy rainfall that occurred on 1 January 2012 caused several landslide events in Kulon Progo regency which happened for few days. Those events occur in four sub districts namely, Samigaluh, Kalibawang, Girimulyo and Kokap (Tribunnews.com). Moreover, Regional Disaster Management Agencies (BPBD) Kulon Progo, asserts that in early 2012, there were 13 landslides which are mostly located in the mountainous region of Menoreh Kulon Progo. There are five sub districts in this region which are prone to landslide, such as Girimulyo, Samigaluh, Kalibawang, Nanggulan and Kokap (http//:kulon-progonews.wordpress.com).

The map of the threat of landslides in Kulon Progo, which is made by UNDP-ERA BAPPENAS and local government of Kulon Progo, shows that

Samigaluh subdistrict includes areas which have a high level of landslide hazard. Only a small area is included in the category of moderate threat. This condition can be seen on the Figure 1.1.

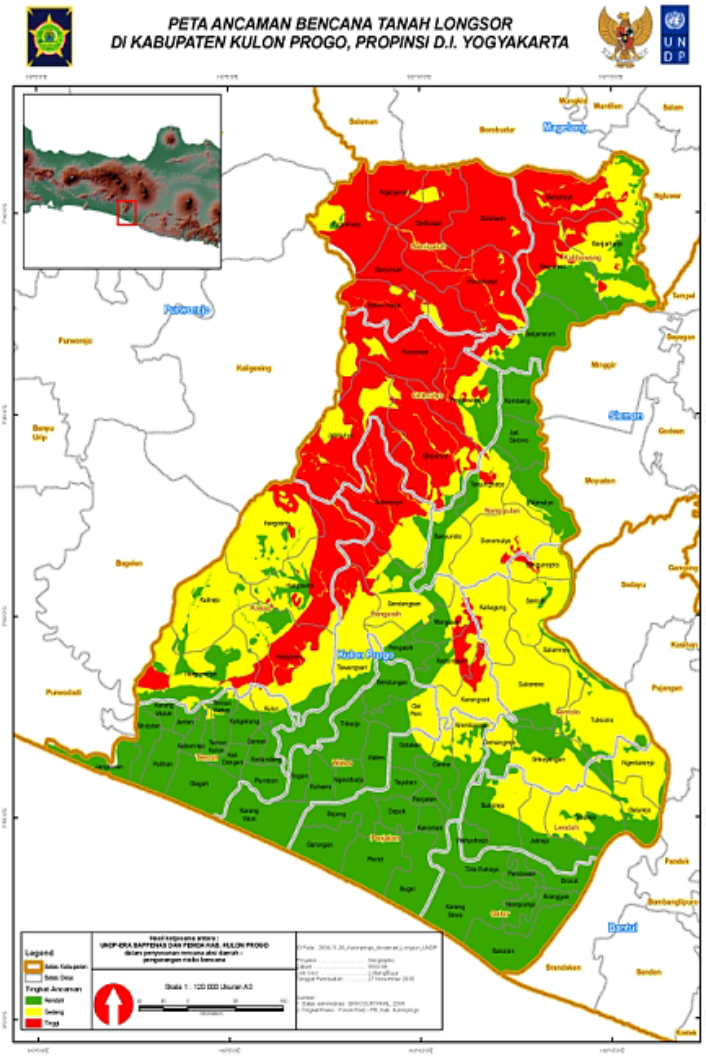


Figure 1.1. Map of the threat of landslides in Kulon Progo (Source; BPBD Kab. Kulon Progo)

Related to the many landslide events which occurred in Kulon Progo region, improving disaster risk reduction strategies are needed. One key to success in integrated disaster risk management is a community-based approach (Ikeda *et al*., 2006). Participation of local people in the design and planning processes in risk management is important to improve individual's disaster preparedness and risk communication among residents, regional communities

and local authorities. Risk communication is an important issue in disaster risk reduction which depends on the socio-cultural context of the society and the scale of the community; rural, small city or megacities (Sagala, 2007). Effective communication should begin long before the event and should continue long after the immediate threat has subsided (Laituri and Kodrich, 2008).

One example representing the involvement of local people in disaster risk management is Community-based early warning systems (CBEWS). It means that people are central in the system and it empowers individuals and communities to take measures against the hazard impact by reducing the possibility of injuries, loss of life, property damage, environment, and economic losses. Moreover, the Faculty of Engineering of UGM also develops a website that includes community contribution for giving signs and symptoms landslide hazard information in their area using mobile phones (www.landslide-ugm.com).

There are several ways and equipment that can be used to communicate information related to disaster. Mobile telephone is one technology which is suitable to build a local early warning system. People who live in an area which is prone to disaster can give many information about condition and signs related to disaster in their area, such as the occurrence of rain, the appearance of cracks in the soil and other information related to the sign and symptom of landslide using their mobile phones (Ming, *et. al.*, 2011; Car, N. J., E. W. Christen, *et al*., 2012).

1.2. Research Problem

Indonesia is often impacted by hydro-meteorological and geological hazards, due to its active geo-environment and high population density. Many of these caused negative effects related to social, economic, environmental and infrastructure damage. For example in 2011, 179 landslide events occurred in Central Java and 141 in 2010 (http://jateng.antaranews.com).

Samigaluh is one subdistrict in Kulon Progo which has a high vulnerability from landslide hazard. Almost every year, there are several landslide

events in this area which caused several damages. The first element that gets direct impact from disaster is local people who are living in the prone area. They have high risk from the occurrence of disaster. Many occurrences of landslide still caused casualties, injuries, property damage and other negative impacts. This illustrates that the awareness and community preparedness need to be improved.

Community preparedness is one important factor in disaster risk management. With proper preparedness, reduction efforts are expected to be more quickly and accurately, to minimize the number of casualties and damage. Preparedness is part of disaster management cycle which consists of four phases, namely mitigation / prevention, preparedness, response, and reh abilitation / reconstruction.

One of the major elements in disaster risk reduction is an early warning system. To increase the effectiveness of early warning system, it needs the involvement of local communities to inform the signs or symptoms related to landslide hazard based on their knowledge and experience. Local knowledge and community participation are necessary to improve the integration of landslide risk management. The accurate information and good communication are part of the successful of early warning system.

There are some communication tools that can be used to inform and to communicate the sign of landslide hazard, such as kentongan, sound system, handy talky, and mobile phone. Mobile phone is one tool that is common and easy to use. The use of mobile phone in Indonesia is also growing. According to the survey from Nielsen, compared to countries in Southeast Asia, in the last four years the percentage of mobile phone users in Indonesia increased from 23% to 53% (www.Tribunnews.com/13/8/2012). This means that the mobile phone can be used as an effective tool to provide landslide information and warning system, through direct call or through short message service (SMS). The research problem is how to develop landslide information and warning system using mobile phones based on local community participation.

1.3. Research Objectives

The main objective of this research is to develop a landslide information and warning system based on community participation. The specific objectives are:

1. To assess community preparedness related to landslide hazard
2. To identify the local early warning system related to landslide
3. To develop landslide information and warning system using mobile phones based on community participation

1.4. Research Question

Table 1.1. Research Objectives and Research Question

No	Research Objectives	Research Question
1	To assess community preparedness related to landslide hazard	a. What is the people perception about landslide hazard? b. What is the preparedness planning of local community? c. What is the preparedness planning of the local governments?
2	To identify the local early warning system related to landslide	a. What kind of local early warning system is available in the area? b. What local organizations are involved in local early warning system? c. What is the role of local community in the early warning system?
3	To develop landslide information and warning system using mobile phones based on community participation	a. Who are the users of the system? b. What is the role of each user in the system? c. What is the mechanism of the system? d. What kind of input data is needed for the system? e. What information will be produced from the input data? f. How is the training for the users to use the organized system?

1.5. Benefit of the research

This study provides information to local government regarding the signs and early symptoms that occur in disaster prone areas based on community participation. This information can be used as consideration to adopt policies and preventive measure in order to reduce the impact of disaster risks.

1.6. Conceptual Framework

The conceptual framework for this research is described in Figure 1.2. In general, this research is developing landslide information and warning system based on local community participation. It consists of three main parts: community preparedness, local early warning system and developing landslide information and warning system. First, community preparedness is important to reduce the impact of disaster. Especially for people who live in disaster prone area. They should have good preparedness in dealing with landslides. Their knowledge and planning are necessary to support a better preparedness. Second, this study would like to know the local early warning system that is available in their location and what organizations are involved in this system and what are the roles of the community. Finally, this research develops landslide information and warning system using mobile phone based on local community participation.

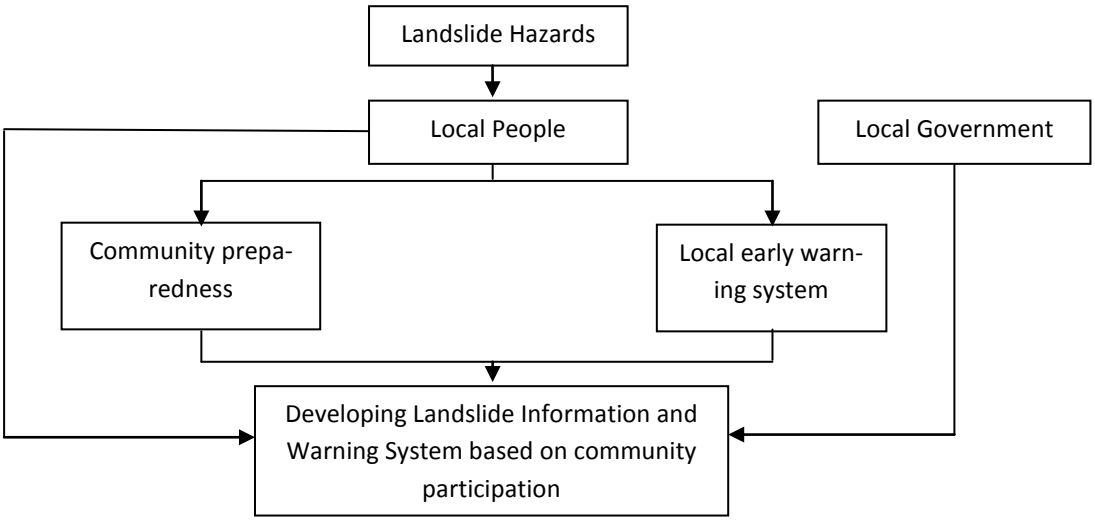


Figure 1.2. Conceptual Framework

CHAPTER 2. LITERATURE REVIEW

This chapter provides an overview of the related literatures used to support the discussion in this research. It will also discuss about the definition of hazard, disaster, community participation, preparedness, landslides, and early warning system.

2.1. Hazard

There are two types of hazards; natural hazard (such as earthquake and landslide) and hazards induced- by- human –processes (industrial accident). Hazard is a potential threat to humans and their welfare (Twigg, 2004).

UNISDR (2009), mentioned that hazard is dangerous phenomenon, substance, human activity or condition that may cause loss of life, injury or other health impacts, property damage, loss of livelihoods and services, social and economic disruption, or environmental damage. It means that hazard is a condition that dangerous for people, either natural or manmade, and can cause loss of human lives, property damage, social economic disruption and environmental damage.

According to Smith (1991) in Westen (2009), there are three classes of hazard categorized, that can be seen on the Table 2.1.

Table 2.1. Classification of hazard

Natural Hazards (extreme geophysical and biological events)		
	Geologic	Earthquakes, volcanic eruptions, landslides, avalanches
	Atmospheric	Cyclones, tornadoes, hail, ice and snow
	Hydrologic	River floods, coastal floods, drought
	Biologic	Epidemic diseases, wildfires
Technological Hazards (major accidents)		
	Transport accidents	Air crashes, train crashes, ship wrecks
	Industrial failures	Explosions and fires, release of toxic or radioactive materials
	Unsafe public buildings and facilities	Structural collapse, fire
	Hazardous materials	Storage, transport, miss-use
Context hazards (global change)		
	Climate change	Sea-level rise, frequency change of extreme events
	Environmental degradation	Deforestation, desertification, loss of natural resources
	Land pressure	Intensive urbanization, concentration of essential facilities
	Super hazards	Catastrophic Earth changes, impact of near-Earth objects

Source: Smith (1991) in Westen (2009).

2.2. Disaster

Based on UNISDR (2009), *"Disaster is a serious disruption of the functioning of a community or a society involving widespread human, material, economic or environmental losses and impacts, which exceeds the ability of the affected community or society to cope using its own resources."*

According to the Act of Republic Indonesia number 24, 2007, a disaster is an event or series of events that threaten and disrupt the lives and society livelihoods which is caused by natural factors and/or human factors that result in human casualties, damage of the environment, loss of property, and psychological impact.

A disaster is a serious event which causes injuries, casualties, property damage, economic and environmental losses and disrupts the normal living community. Disasters can be caused by natural factors (earthquake, tsunami, landslide, volcano eruption), and human factors (failure of technology, social conflict, terrorism).

Disaster risk management is implementing strategies, policies and improving capacities to reduce the damage impacts of hazards and possibility of disaster with systematic process (UNISDR, 2009).

The purpose of disaster risk management is to avoid and minimize the adverse effects of hazards with prevention, mitigation, and preparedness. According to FIG, (2006) there are several key elements of disaster risk management. The first is risk identification/assessment. This consists of three things: hazard analysis and monitoring, vulnerability analysis and determination of risk. The second element is prevention and mitigation which contain land use planning, land management and structural or non structural measures. The third is preparedness. It consists of three things; early warning, evacuation and emergency planning. Finally, the last element included in disaster risk management is recovery, which contains rehabilitation, reconstruction and rescue services. The schematic of disaster risk management's key elements can be seen in Figure 2.1.

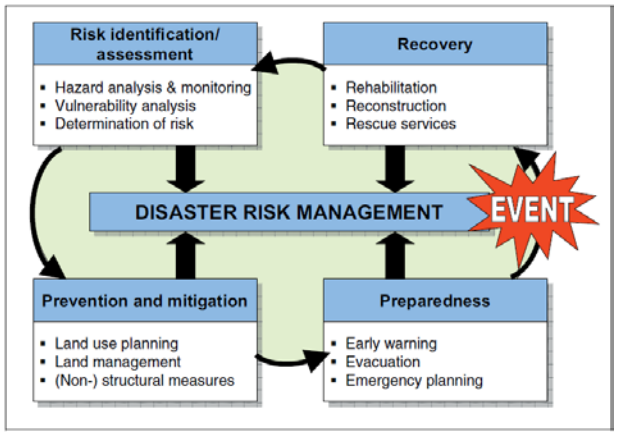


Figure 2.1. Key elements of disaster risk management (FIG, 2006)

2.3. Community Participation

Community participation can be defined as the active involvement of people in making decisions about the implementation of processes, programmes and projects which affect them (Twigg, 2004). Involving community in the planning, design, financing, construction and maintenance is important for sustainable progress (Nare, *et al*., 2011). Communities are not passive actors, but they are active agents in their context and can influence their environments and change them (Garcia, 2012). There are two groups' of approaches to participation, namely guided participation and people-centered participation.

- Guided participation: include people in improvement projects, but this project still initiated, funded and ultimately controlled by professional planners from outside the communities.
- People-centered participation; addresses issues of power and control. It is involving communities to define their problems, to decide solution, and to implement activities and evaluate the result.

2.4. Preparedness

Preparedness is knowledge and capacities which are developed by government, professional response and recovery, communities and individual to effectively anticipate, respond to and recover from the impact of hazard events

(UNISDR, 2009). Preparedness is based on a sound analysis of disaster risks and good linkage with early warning system. ADPC (2003), define preparedness as activities and measures taken in advance to ensure effective response to the impact of disaster. It includes the issuance of timely and accurate forecast along with effective early warnings and temporary removal of people and property from threatened area.

2.5. Landslide

Acccording to Highland and Bobrowsky (2008), *landslide is "a down slope movement of rock or soil, or both, occurring on the surface of rupture—either curved (rotational slide) or planar (translational slide) rupture—in which much of the material often moves as a coherent or semi coherent mass with little internal deformation"*. Type of landslide also can be categorized into five main groups (Highland and Bobrowsky, 2008), that consist of:

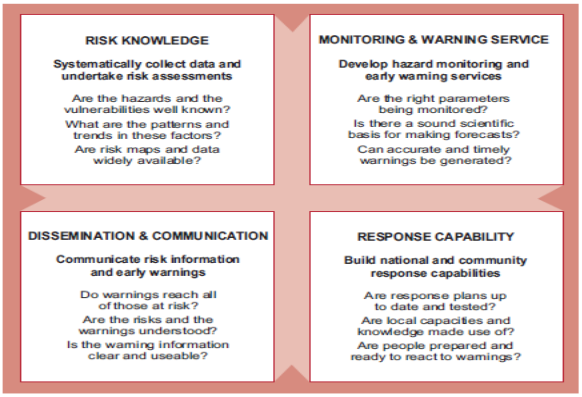
- Fall is a movement of soil or rock, or both that occurred in a steep slope because of the steepness of the slope. It particularly happen by falling, bouncing, and rolling.
- Topple is the forward rotation out of slope of mass of soil or rock around a point or axis below the center of gravity of the displaced mass.
- Slide is the movement of soil, debris or rock along a distinct surface or rupture that separates the slide material from the more stable underlying material.
- Spread landslide is an extension of a cohesive soil or rock mass which is combined with the general subsidence of the fractured mass of cohesive material into softer underlying material.
- Flow is the type of mass movement with a fluid motion. The speeds of the movements vary from slow to rapid. The ranges of material are differently graduated from massive boulders to sand, clay, snow and ice.

2.6. Early Warning System

According to the Act of Republic Indonesia number 24, 2007 about Disaster Management, "*Early warning is a series of events which is given as soon as possible to the public about possibility of disaster in a place by authorized agency*". There are several ways that can be done as an early warning, such as observation of the symptoms of disaster, analysis of observations of the symptoms of a disaster, decision making by the authorities, disseminating information on disaster warning and taking action by community.

"*Early warning system is the set of capacities needed to generate and disseminate timely and meaningful warning information to enable individuals, communities and organizations threatened by a hazard to prepare and to act appropriately and in sufficient time to reduce the possibility of harm or loss*", (UNISDR, 2009).

Effective early warning system can be reached by empowering individuals, communities, and businesses to respond timely and appropriately to hazards in order to reduce the risk of disaster. Based on UNISDR 2006, there are four elements of people-centered early warning system that are important to achieve the completeness and effectiveness of early warning system. Figure 2.2 shows the four elements of people-centered early warning system which consist of risk knowledge, monitoring and warning services, dissemination and communication, and response capability.



Source: UN/ISDR, Platform for the Promotion of Early Warning (PPEW).

Figure 2.2. Four elements of people-centered early warning system

2.7. Landslide Information and Warning System

Landslide is a serious disaster that threats the people who live in prone area. It causes the damage of infrastructure, environment, and livelihood. In order to minimize the impact of landslide disaster, mitigation measures and increasing of the community preparedness is necessary to develop in prone area.

One way that can be used to enhance the preparedness of community is the utilization of information communication and technology (ICT). The rapid growth of technology is useful in supporting disaster risk reduction and other aspects of development. One of tool that familiar and majority people are owned is mobile phones. Mobile phones are not only used for phones call and messaging (SMS), however also used to capture and distributed images and videos, access the radio and television, music and download news from the internet. In addition, the use of mobile phone for the development of landslide information and warning system is an appropriate technology and low-cost. Community can provide information related to the signs of landslide through sms to the landslide information center.

The landslide participatory monitoring and early warning system was developed by faculty of engineering of UGM, which namely Smart Grid for Landslide Monitoring and Early Warning System.

Smart grid is a participatory cyber-based communication and information system, developed as a system of handling networks of information nodes consisting of local experts, local surveyors, or selected members of local task force and the contact person in the local communities (Karnawati, *et. al*, 2012).

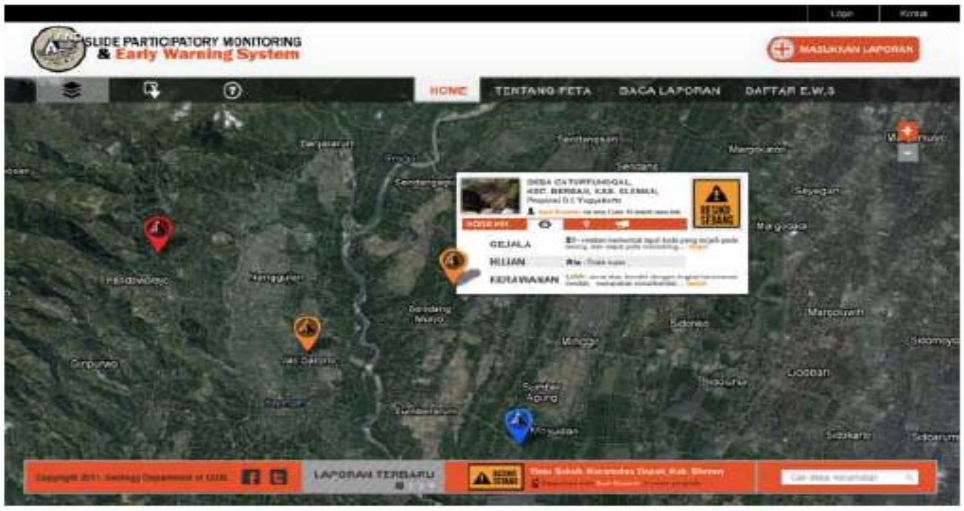


Figure 2.3. Web performance of "Smart grid for landslide monitoring and early warning system" (Source: Karnawati, *et.al.*, 2012)

Smart Grid is design as a system of handling networks of information nodes through the online web or cyber system to facilitate the participatory data reporting via the online web, mobile phone, or other various social media. Figure 2.3 shows the geographical position of the reporting nodes. By utilizing this system, any people who live in the landslide prone area can have direct access to the hazard communication, monitoring and early warning system, via online, mobile phones and another social media.

2.8. SMS (Short Message Service)

Short message service (SMS) is a mechanism of delivery and receive messages in the form of text (words, numbers or alphanumeric combination) between mobile phone device and other devices equipment. Beside phone call, SMS (Short Message Service) is an important part of basic mobile communication. If using Latin alphabet, each message consists of 160 characters, while use another alphabet, such as Arabic or Chinese character it contain 70 characters (http://www.wirelessdevnet.com). SMS is an application that most of enthusiasts users that can be evidenced by the emergence of various types of applications that take advantage of SMS facility. There are several advantages of SMS application, such as low cost, and "Delivered Oriented Services", that meaning the message will always endeavored to be delivered to the

destination.The organization of delivering SMS can be seen in Figure 2.4.

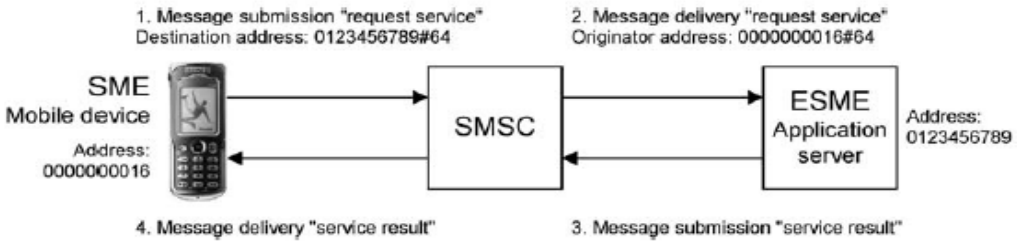


Figure 2.4. The process of SMS delivery (source: Bodic, 2003)

Figure 2.4 shows the organization of SMS. The mechanism of SMS system is send message from the sender to the recipient through Short Message Service Center (SMSC). This is a device which has function to store and to forward message that traffic its.

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2.9. SMS Gateway

SMS gateway is an application that connecting one system with a different system, so that there is a data exchange between the systems. Moreover, SMS gateway can be interpreted as a hub for traffic data messages, both sent and received. SMS gateway can be used to forward the simple e-mail to mobile receiver. It can also be useful in developing web applications that can interact via SMS.

Every company develops SMSC that different with the others. They use their own communication protocol and most of these are proprietary. Between two SMSC cannot connect if they do not have SMSC protocol. So it needs bridge/gateway that can connect between them. SMS gateway is an application that can connect the different SMSC. The illustration of this system can be seen in Figure 2.5.

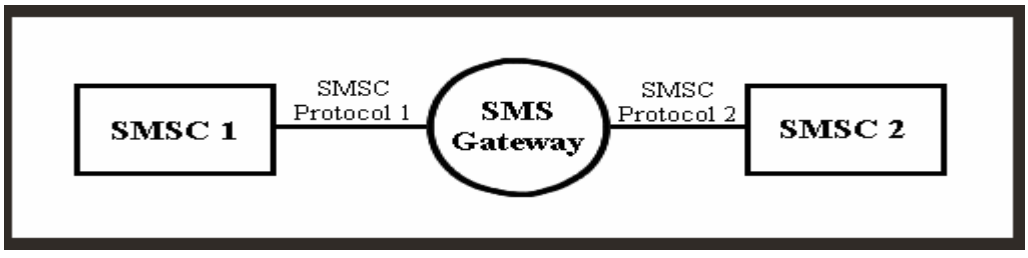


Figure 2.5. SMS gateway between two SMS centers
(Souce:http://www.developershome.com/sms/sms_tutorial)

CHAPTER 3. STUDY AREA AND RESEARCH METHODOLOGY

This chapter presents a general overview of the study area including geographic information and administration. The discussion section is about the method of this study, data collection, and analyses.

3.1. General Information of Samigaluh Sub district

Samigaluh is a sub district in Kulon Progo regency, Yogyakarta province. Samigaluh is located in the north in the regency of Kulon Progo. Samigaluh areas is dominated by the hills (part of the hills Menoreh) located on the border between the province of Yogyakarta and Central Java Province (Purworejo and Magelang regency). Figure 3.1 presents the study area which lies between 110° 7' 00" - 110° 13' 00" E and 7° 38' 40" - 7° 43' 15" S. Samigaluh sub district has boundaries, namely:

- Northern : Salaman and Borobudur sub district, Central Java
- Southern : Girimulyo and Kalibawang subdistrict, Kulon Progo
- Eastern : Kalibawang subdistrict, Kulon Progo
- Western : Bener, Kaligesing and Loano subdistrict, Purworejo, Central Java

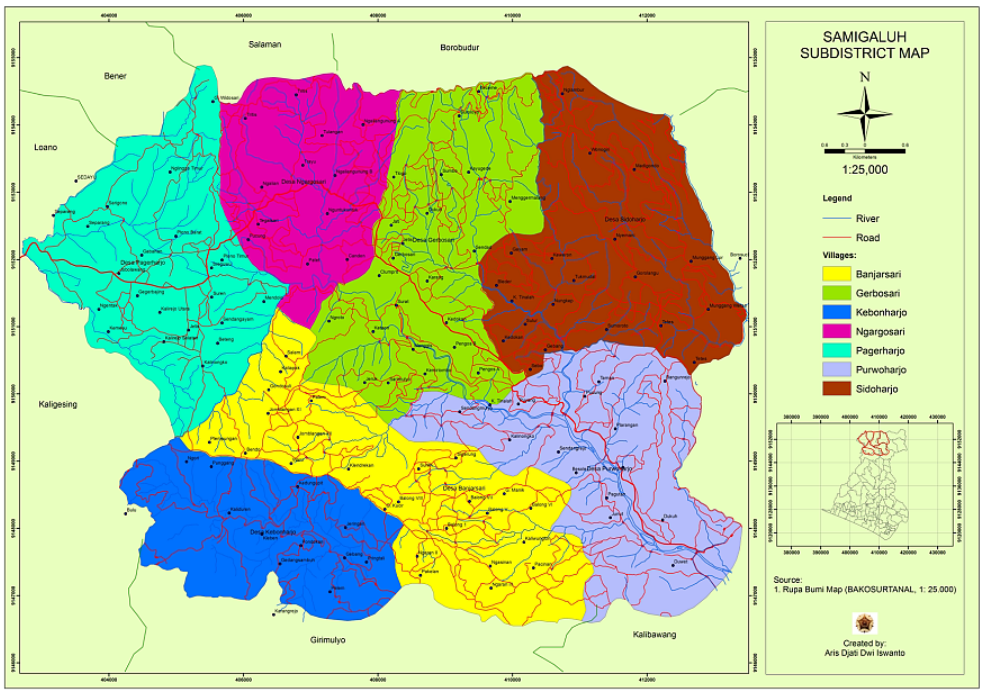


Figure 3.1. Samigaluh Subdistrict, Kulonprogo (Source: BAKOSURTANAL)

Samigaluh sub district has 6.929, 31 hectares and consists of 7 (seven) villages namely Ngargosari, Gerbosari, Pagerharjo, Sidoharjo, Banjarsari, Kebonharjo and Purwoharjo. The area of each village can be seen in Table 3.1.

Table 3.1. Area of Samigaluh sub district

No	Village	Villages Area (Ha)	Percentage of Villages Area from Subdistrict (%)
1	Kebonharjo	748,63	10,80
2	Banjarsari	855,44	12,35
3	Purwoharjo	1.009,26	14,57
4	Sidoharjo	1.374,46	19,84
5	Gerbosari	1.076,61	15,54
6	Ngargosari	724,39	10,45
7	Pagerharjo	1.140,52	16,46
Total		**6.929,31**	**100,00**

Source: BPS (2011)

Population of Samigaluh subdistrict in 2010 is 31.323 persons which consist of 15.548 males and 15.775 females. The distribution of population in Samigaluh sub-district can be seen on Table 3.2.

Table 3.2. Distribution of Population in Samigaluh Subdistrict

No	Village	Population		Total
		Male	Female	
1	Kebonharjo	1390	1475	**2865**
2	Banjarsari	1889	1895	**3784**
3	Purwoharjo	1895	2016	**3911**
4	Sidoharjo	2821	2817	**5638**
5	Gerbosari	2647	2653	**5300**
6	Ngargosari	2209	2265	**4474**
7	Pagerharjo	2697	2654	**5351**
Total		**15.548**	**15.775**	**313.23**

Source: BPS (2011)

3.1.1. Ngargosari Village

Ngargosari is one village that is included in Samigaluh sub district. This is the smallest village in Samigaluh subdistrict and has 724,39 ha. The administrative boundaries of Ngargosari village are Giri Purno village (Borobudur subdistrict) in the north, Banjarsari village in the south, Gerbosari village in the east and Pagerharjo village in the west. Ngargosari consists of 11 dusun (hamlet). The entire of hamlet is then devided into 22 RW (sub area of village) and 55 RT (sub area of RW).

Based on the statistic data from Village profile of Ngargosari, there are several types of land use that are located in this area. The detail information of land use is shown on the Table 3.3.

Tabel 3.3. Land use type in Ngargosari village

No	Land Use Type	Area (Ha)	Percentage of land use type (%)
1	Settlement	127,40	17,59
2	Rice Field	26	3,59
3	Plantation	173,50	23,95
4	Cemetary	2,60	0,36
5	Yard	156,70	21,63
6	Building office	1,20	0,17
7	Other Infrastructures	3,70	0,51
8	Dry Land Agriculture	233,30	32,21

Source: Ngargosari village profile (2012)

3.1.2. Gerbosari Village

Gerbosari is a village which is the center of Samigaluh subdistrict. Almost all of the government buildings are situated in this village. Total area of Gerbosari is 1.076,61 hectares with 5300 persons of population which consist of 2647 males and 2653 females. There are four administrative village boundaries: Borobudur subdistrict in the north, Banjarsari village in the south, Ngargosari village in the west and Sidoharjo village in the east. Gerbosari consists of 19 dusun (hamlets). Administratively, this village is divided into 38 RW (sub area of village) and 75 RT (sub area of RW).

According to the Gerbosari village profile (2011), there are several types of land use in this area which can be seen in Table 3.4.

Tabel 3.4. Land use type in Gerbosari village

No	Land Use Type	Area (Ha)	Percentage of land use type (%)
1	Settlement	522.26	46,85
2	Rice Field	217,58	19,52
3	Plantation	127	11,39
4	Cemetary	7,35	0,66
5	Building	9,28	0,83
6	Other Infrastructures	11,13	1,00
7	Dry Land Agriculture	199,16	17,87
8	Critical Land	20,92	1,88

Source: Gerbosari village profile (2011)

3.2. Landslide Occurrence in Samigaluh

Samigaluh is located in the eastern flank of Menoreh Mountains. Most areas of Samigaluh subdistrict are vulnerable to landslides. Historical landslide data from BPBD indicates that there are many occurrences of landslides located in this area. Detailed information about landslide events which occurred in Samigaluh sub district is shown in the Figure 3.2.

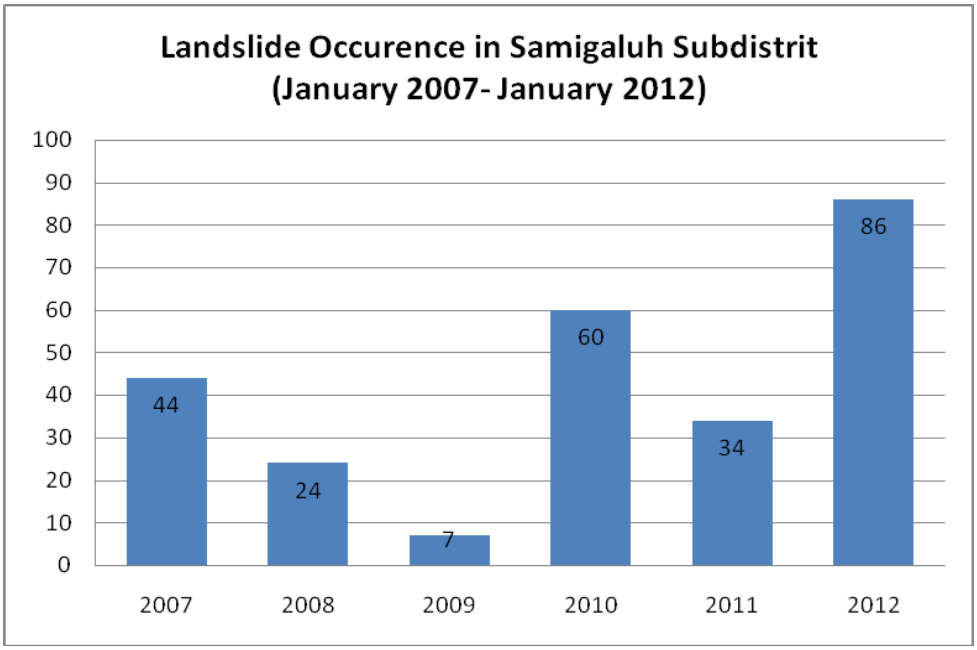


Figure 3.2. Landslide occurrence in Samigaluh Subdistrict (2007-2012)
Source: BPBD Kulon Progo, 2012.

According to the graph, the landslide occurrence in Samigaluh sub district from 2007 until January 2012 is fluctuating. In the earlier of 2012, there are some events of landslide that occur in these area. The location of landslide occurrences is shown in the Figure 3.3.

Figure 3.3. Landslide events in Ngargosari and Gerbosari village
(source: fieldwork, 2012)

Figure 3.3 describe the location of landslide events which situated in Ngargosari and Gerbosari village. It also shows the impact of landslide occurrence that damaged the properties, live stock, agriculture land, road and school building. Picture a and b represent the sample of household that affected by landslide occurrence in Ngargosari village. They are located in Tritis and Tegalsari sub village. The next pictures are taken in Manggis and Kecemen sub village that included in Gerbosari village area.

3.3. Research Methodology

This research focused on analyzing the local community preparedness and developing landslide information and warning system in part of Kulon Progo regency that are prone to landslide. Figure 3.4 shows the level of landslide susceptibility map in Samigaluh sub district.

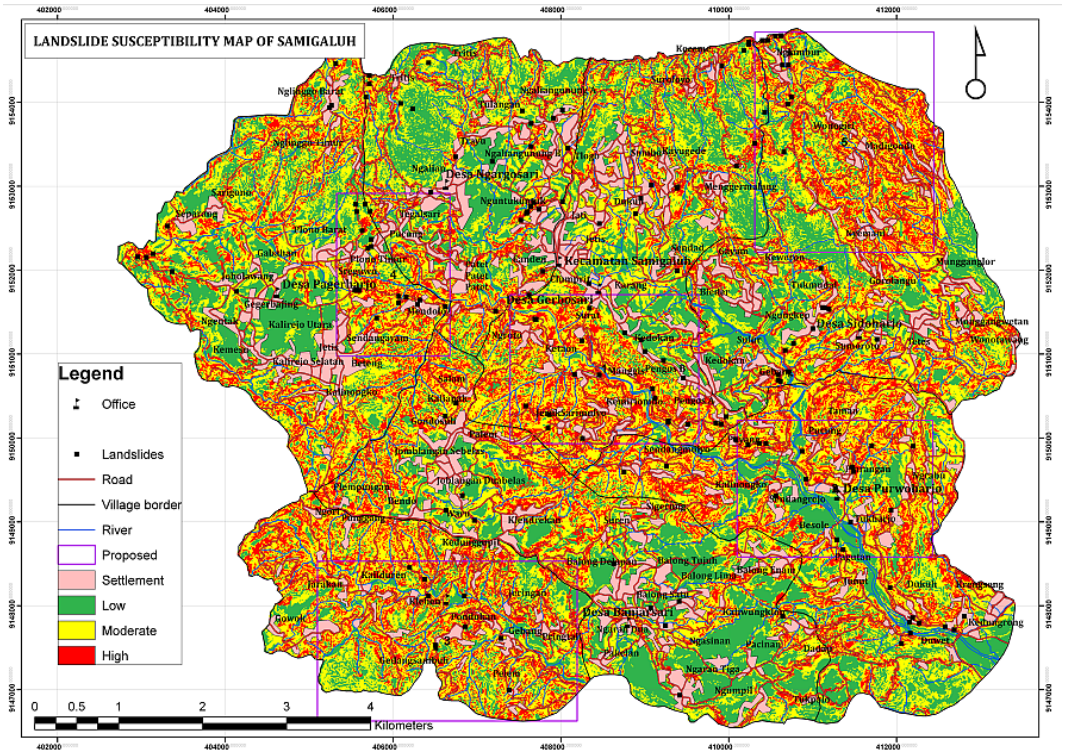


Figure 3.4. Landslide susceptibility map of Samigaluh subdistrict

Source: PSBA, 2010

Landslide susceptibility map is made by PSBA in 2010. The map shows that Samigaluh subdistrict has three levels of landslide susceptibility; high, moderate and low. There are 7 villages in this area. However, two villages were chosen to be the study area i.e. Ngargosari and Gerbosari. These villages are located in the center of Samigaluh sub district. Based on the data from BPBD, until January 2012, these villages have high frequency of landslide events. There are many locations location of landslide events which situated in these villages. Then a sample of respondents was selected by purposive sampling in every village using historical data from BPBD and information from key respondent in the field. Finally, 140 household were selected to be

interviewed in these areas. The spatial distribution of respondents was made by transferring point stored from GPS into ArcGis software.

The spatial distribution of respondent can be seen in Figure 3.5. It shows the distribution of respondent in Ngargosari and Gerbosari village.

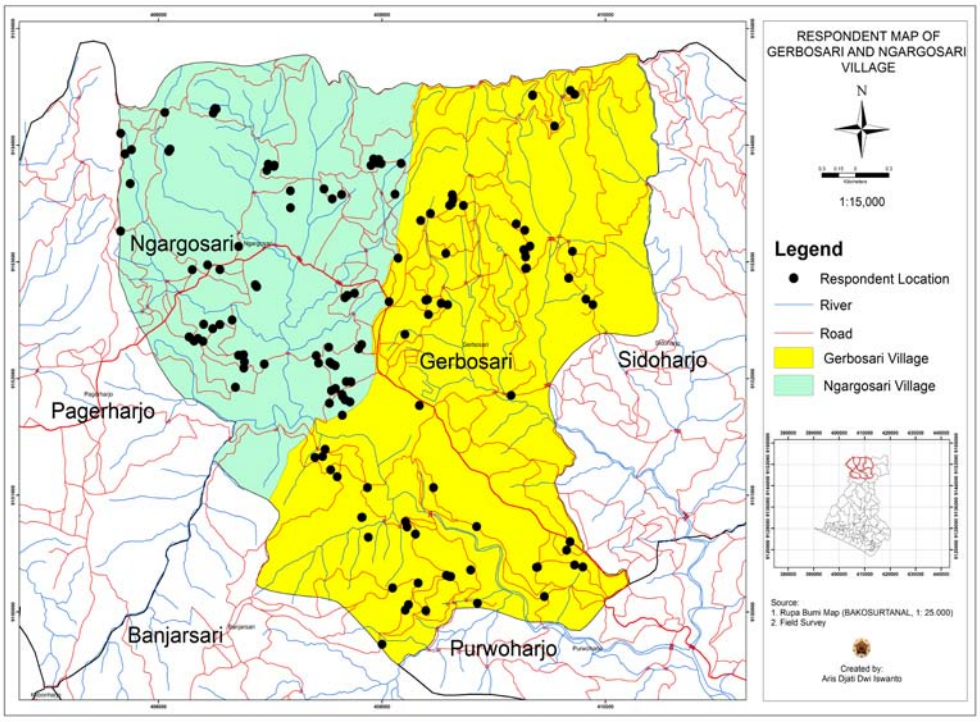


Figure 3.5. Spatial distribution of respondent in the study area

There are 62 respondents that spread over in Ngargosari village, while in Gerbosari village has 78 respondents located in this village. The respondents were chosen based on the list data that available on the BPBD and information from the key person in this area. There are many landslide events in that occurred in the early of 2012. Based on the historical data from BPBD, the highest number of landslide occurrence in Samigaluh sub distrit is occurred in Ngargosari and Gerbosari village.

3.4. Flowchart

The research activities are divided into three phase; pre-fieldwork activities, fieldwork activities, and post fieldwork activities. All of this process can be seen in Figure 3.6.

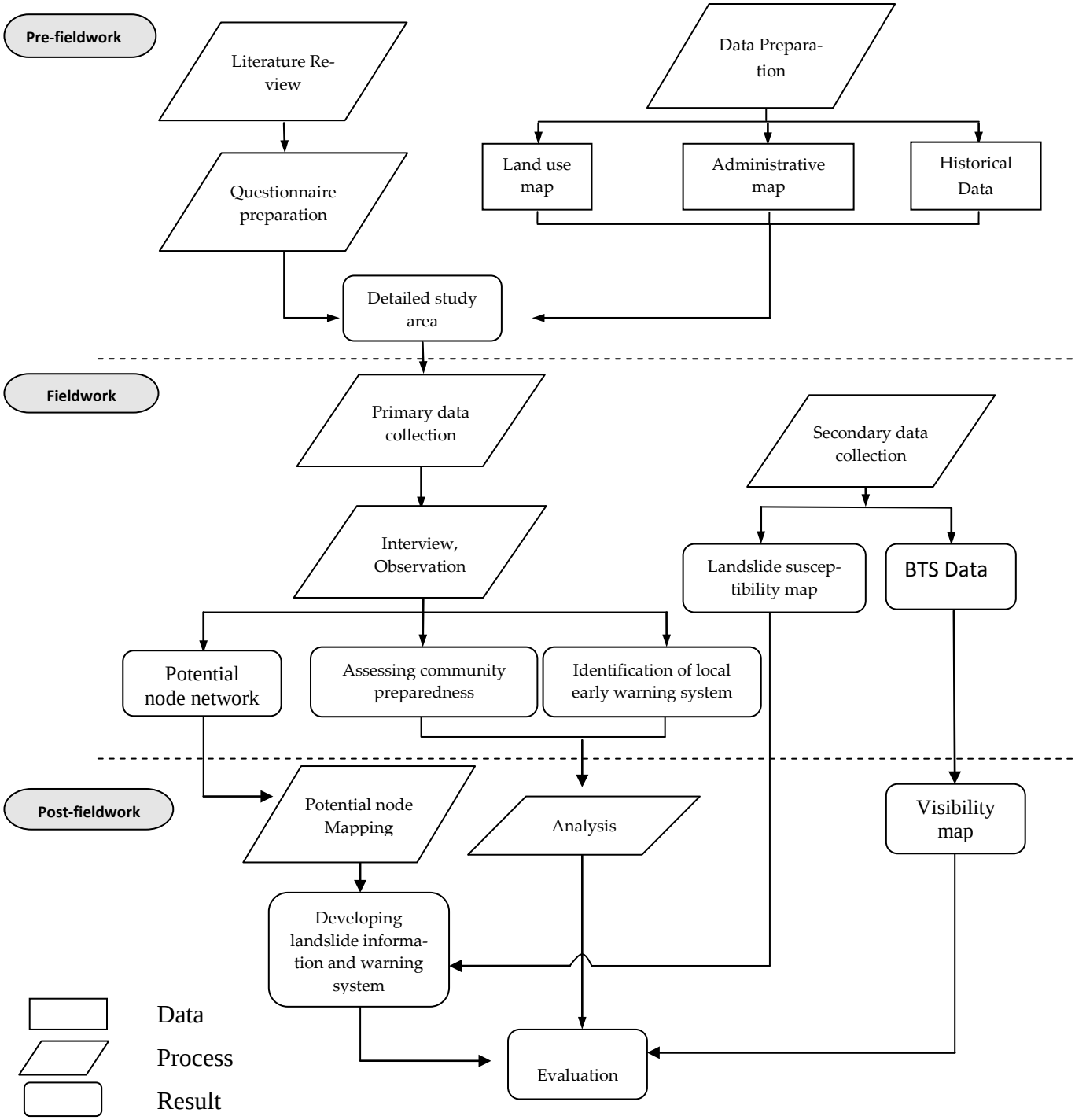


Figure 3.6. Research Flowchart

3.4.1. Pre-Fieldwork

Pre-fieldwork is a phase which consists of collecting literature reviews and data preparation. In this phase, arranging questionnaire and collecting data related with the research, such as land use map, administrative map, susceptibility map, and historical landslide data. There are done several activities in pre-fieldwork i.e.:

a. Intensive literature review related to this topic to strengthen the concept of this research.
b. Preparing the materials, tools, and administrations that will be used in this research.
c. Site observation to get the real condition of the study area.

3.4.2. Fieldwork

This stage was conducted in September-December 2012. A fieldwork stage is composed by collecting primary and secondary data.

3.4.2.1. Secondary Data

Secondary data were collected from related organizations, such as local government/BPS/BPBD and another institutions that are concern with disaster management. Several data sets that are collected are village profile, demographical data, and historical landslide data which occurred in this area.

3.4.2.2. Primary Data

Primary data collection was conducted by interviewing sampled households, community leaders, key informants, and governmental agencies, such as BPBD, Social Agency, and other related institutions. These data related to the people perception and their preparedness related to landslide hazard, and identify of local early warning system. In this phase the people who have willingness to be a network node in developing landslide information and warning system are also identified. There are some data that are needed as a network node, such as name, location, phone number and coordinate position.

3.4.2.3. Households Interview

Primary data were collected by interviewing respondents about the landslide perception and their preparedness. Information about local early warning system that is available in this area and people who have willingness to joint as a node in developing landslide information and warning system are also collected.

3.4.2.4. Officer Interviews

In order to get information about preparedness planning of community and local government, there were discussions and consultation with local authorities and organization which have concerns for disaster management such as village institutions, Social Agency, BPBD, and Kesbanglinmas. Figure 3.7 shows the condition of the primary data collection in the study area which consists of household interview and office interview.

Figure 3.7. Primary data collections in the study area
(a, b) household interviews; (c, d) Office interview (source: fieldwork, 2012)

3.4.3. Post-Fieldwork

Finally, post fieldwork is the last phase in this research which consists of analysis and evaluation. Data was analyzed according to the objective of the research. Based on the data analysis and evaluation, the result and conclusion from this research can be obtained.

3.5. Data Needed

There are several data that will be required in this research to achieve the objectives. Some data that are needed can be seen in Table 3.5.

Table 3.5. Data needed

No	Data	Source
1	Demographical and statistical data	Local Government/BPS
2	Administrative boundary map	Bakosurtanal
3	Landslide susceptibility map	PSBA
4	Land use map	BAPPEDA/BAKOSURTANAL
5	Mobile phone ownership	Interview, Field observation
6	BTS Location	Telkomsel/XL/Indosat

3.6. Instrument and Software

Several instruments that will be used in this research are:

1. GPS Garmin
2. Documentation tool
3. Microsoft office 2007
4. Arc GIS 9.3
5. Gammu, PHP, MySql, Apache

CHAPTER 4. CHARACTERIZATION OF THE SURVEYED COMMUNITIES, PEOPLE PERCEPTION OF LANDSLIDE, AND PREPAREDNESS PLANNING OF LOCAL COMMUNITY AND LOCAL GOVERNMENT

This chapter discusses about social characteristics of the local people represented by respondent. It also discusses about landslide perception and preparedness planning of local community and local government in the susceptible areas. People knowledge and their experience in landslide hazard influenced their perception and preparedness.

4.1. Characterization of the Surveyed Communities

4.1.1. Surveyed Villages

This study carried out in two villages located in Samigaluh subdistrict. They are included as areas which are susceptible to landslide hazard: Ngargosari and Gerbosari villages. The study area of this research can be seen in Figure 4.1.

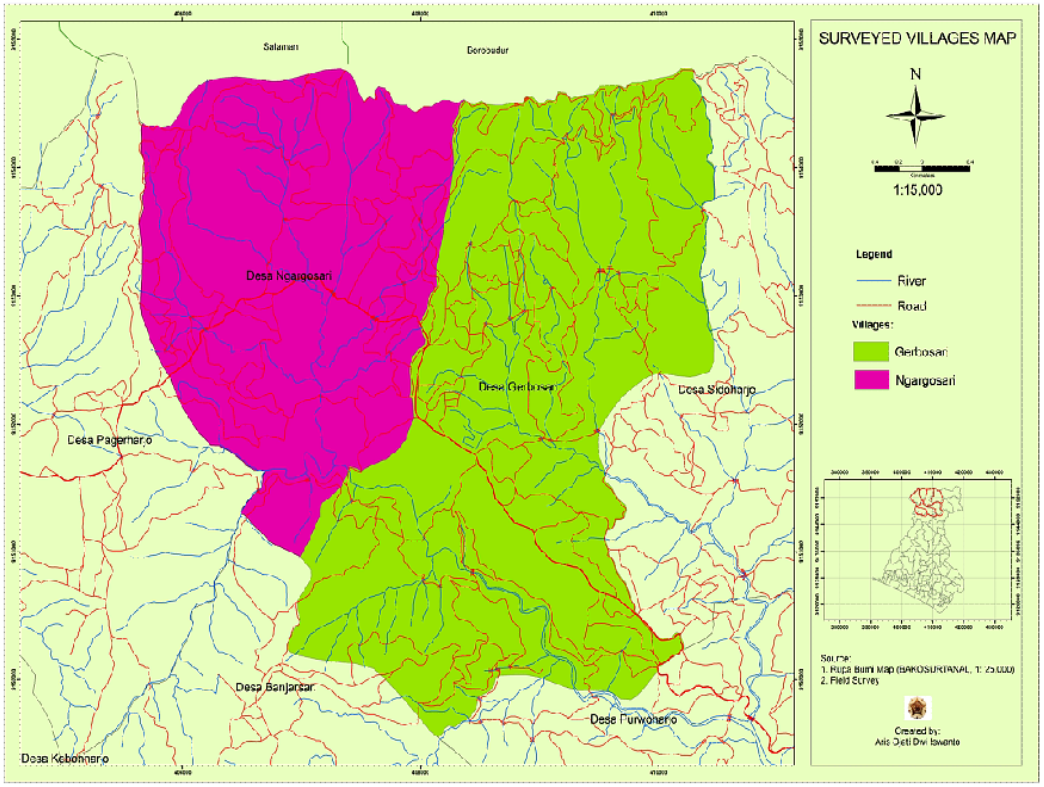


Figure 4.1. The surveyed villages map

4.1.2. Age Distribution

The distribution of age respondent between Ngargosari and Gerbosari villages are described in Table 4.1. The ranges of respondents' age varied from 20 until more than 70 years old.

Table 4.1. Distribution of respondents based on age

No	Age (years old)	Ngargosari		Gerbosari	
		Frequency	Percent (%)	Frequency	Percent (%)
1	20-30	4	6.45	6	7.69
2	31-40	11	17.74	15	19.23
3	41-50	22	35.48	30	38.46
4	51-60	13	20.97	17	21.79
5	61-70	9	14.52	7	8.97
6	>70	3	4.84	3	3.85
Total		**62**	**100.00**	**78**	**100.00**

The table described the distribution of respondents based on age, between Ngargosari and Gerbosari villages which shows the same trend, i.e. the domination of range of age 41-50 with 35.48% in Ngargosari and 38.46% in Gerbosari village. The lowest frequency of respondents included in range of more than 70 years old with 4.84% and 3.85% for Ngargosari and Gerbosari village.

4.1.3. Gender

Distribution of respondent based on gender showed that the percentage of male is higher than female both in Ngargosari and Gerbosari villages (Table 4.2). Ngargosari village has 77.42 % of male respondent and approximately 22.58 % female respondent, whereas Gerbosari village has 82.05 % male respondent and 17.95 % female respondent.

Table 4.2. Distribution of respondent based on gender

No	Gender	NGARGOSARI		GERBOSARI	
		Frequency	Percent (%)	Frequency	Percent (%)
1	Male	48	77.42	64	82.05
2	Female	14	22.58	14	17.95
TOTAL		**62**	**100.00**	**78**	**100.00**

4.1.4. Education Level

Table 4.3. Illustrates the level of respondent based on education level in Ngargosari and Gerbosari village. There are four levels of education, i.e. elementary school, junior high school, senior high school and college. Based on the level of education of respondents, Ngargosari village was dominated by elementary school with 46.77%, while Gerbosari village was dominated by senior high school with 35.90%.

Table 4.3. Distribution of respondent based on education level

NO	EDUCATION	NGARGOSARI		GERBOSARI	
		Frequency	Percent (%)	Frequency	Percent (%)
1	Elementary School	29	46.77	22	28.21
2	Junior High School	8	12.90	25	32.05
3	Senior High School	19	30.65	28	35.90
4	College	6	9.68	3	3.85
	TOTAL	**62**	**100.00**	**78**	**100.00**

4.1.5. Occupation Type

There are nine types of occupation from the respondents that are found in the study area. Table 4.4 showed that between Ngargosari and Gerbosari village, the occupation based on the distribution of respondent was dominated by farmer with 64.52% for Ngargosari and 64.10% for Gerbosari village.

Table 4.4. Distribution of respondent based on occupation

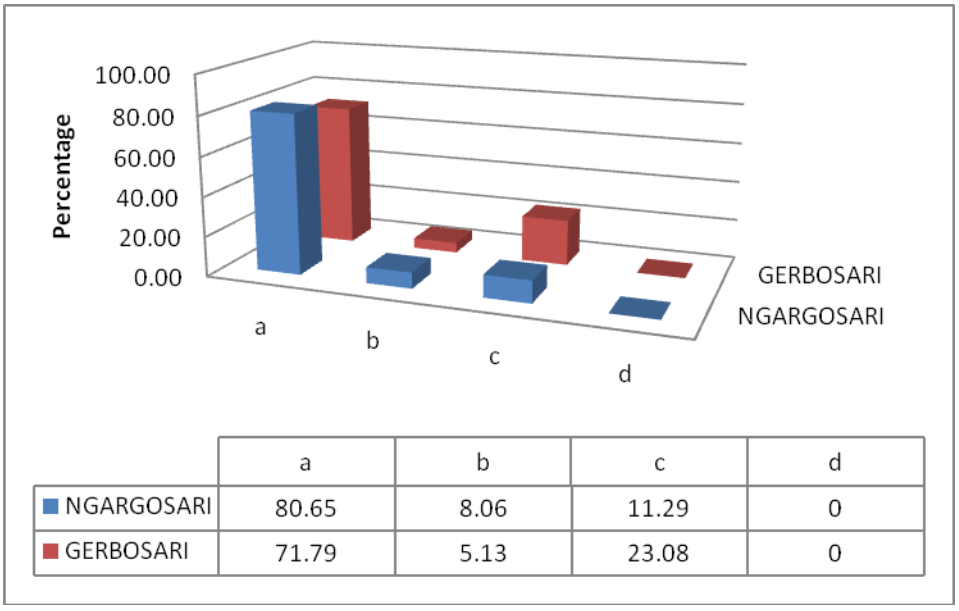
No	Occupation	Ngargosari		Gerbosari	
		Frequency	Percent (%)	Frequency	Percent (%)
1	Farmer	40	64.52	50	64.10
2	Retired	4	6.45	2	2.56
3	Civil Servant	5	8.06	2	2.56
4	Government Officer	3	4.84	13	16.67
5	Private Employee	3	4.84	4	5.13
6	Businessman	2	3.23	3	3.85
7	Housewife	3	4.84	4	5.13
8	Driver	1	1.61	0	0.00
9	Carpenter	1	1.61	0	0.00
Total		**62**	**100.00**	**78**	**100.00**

4.2. People Perception of Landslide

People's knowledge about perception of landslide is identified using the questionnaire during the interview with the households. There are 5 questions about people perception related to landslide hazards.

4.2.1. People's Perception of Landslide Definition

There are four answers related to the definition of landslide: a. land mass that moves down on the steep slope, b. subsidence of land mass, c. rock and soil fall out, d. other. Based on the responses from the respondents, there are three categories of landslide definition. Figure 4.2 shows the percentage of landslide definition based on perception of respondent in study area.



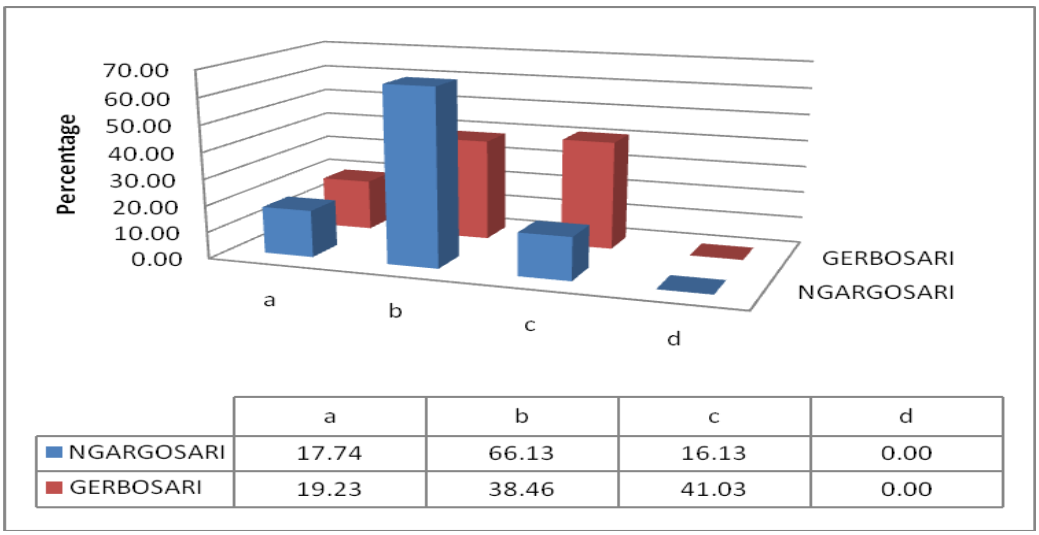
	a	b	c	d
NGARGOSARI	80.65	8.06	11.29	0
GERBOSARI	71.79	5.13	23.08	0

Figure 4.2. Landslide definition based on perception of respondents

The graph above showed that majority of respondent in Ngargosari and Gerbosari villages choose the definition of landslide as land mass that moves down on the steep slope, by 80.65% (Ngargosari) and 71.79% (Gerbosari). The second response is rock and soil fall out, by 11.29% in Ngargosari and 23.08% in Gerbosari village. There are 8.06% (Ngargosari) and 5.13% (Gerbosari) respondents who select down slope movement of soil from a steep slope.

4.2.2. People's Perception of Location of Landslides

Based on the location of landslide occurrences, there are four answers that are used in the questionnaire, i.e. a. the cliff on the river, b. steep slopes, c. hilly and high mountain, and d. other. Figure 4.3 explains about the percentage of landslide's location based on perception of respondent.



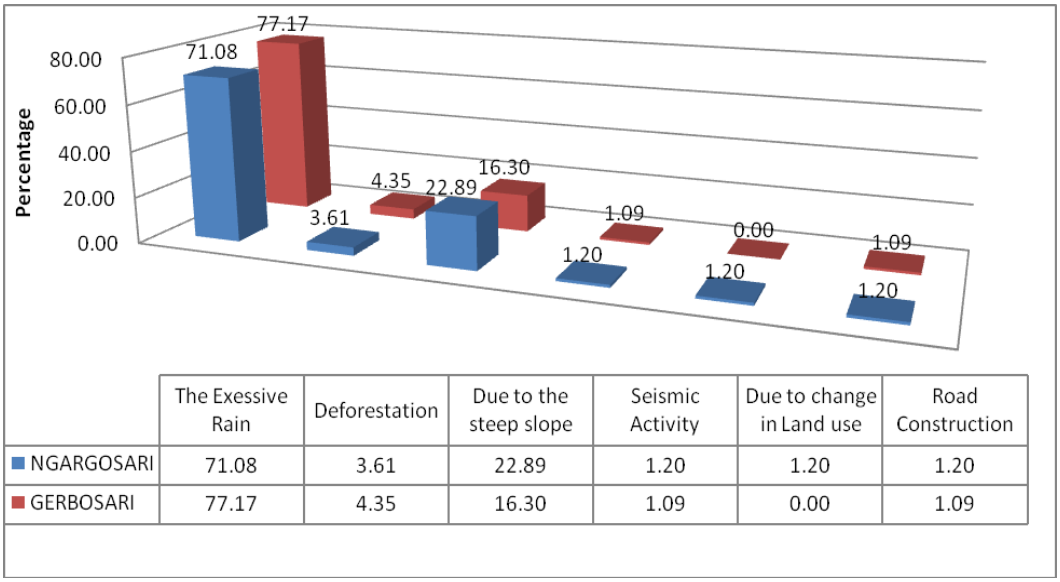
	a	b	c	d
NGARGOSARI	17.74	66.13	16.13	0.00
GERBOSARI	19.23	38.46	41.03	0.00

Figure 4.3. Location of landslide based on perception of respondent

The majority respondents in Ngargosari village have response that the location of landslide is in steep slopes by 66.13%. The second is in the cliff on the river (17.74%) and the lowest response is in the hilly and high mountain by 16.13%. The highest percentage of respondents in Gerbosari is hilly and high mountain (41.03%). The second highest is in the steep slopes by 38.46% and the lowest is in the cliff on the river with 19.23%

4.2.3. People's Perception of Cause of Landslide

Figure 4.4 gives explanation about the cause of landslide based on perception of respondent. There are several answer in the questionnaire related to the causes of landslide hazard. Based on the responses of respondent, the factors that cause landslide in Ngargosari village are the excessive rain (71.08%), the steep slope (22.89%), deforestation (3.61%) and seismic activity and change in land use by 1,20 respectively. The causes of landslide in Gerbosari village are dominated by excessive rain (77.17%), steep slope (16.30%), deforestation (4.35%), seismic activity and road construction with 1.09%.



	The Exessive Rain	Deforestation	Due to the steep slope	Seismic Activity	Due to change in Land use	Road Construction
NGARGOSARI	71.08	3.61	22.89	1.20	1.20	1.20
GERBOSARI	77.17	4.35	16.30	1.09	0.00	1.09

Figure 4.4. Cause of landslide based on perception of respondents

4.2.4. People's Perception of Occurrence of landslide

Based on the landslide occurrences in this area, there are three groups of responses from the respondents during interview with the households, i.e. frequently (more than 5 events during 10 years), moderate (2-4 events during 10 years) and rare (1 event during 10 years). The percentage of occurrence of landslide in study area can be seen in Figure 4.5.

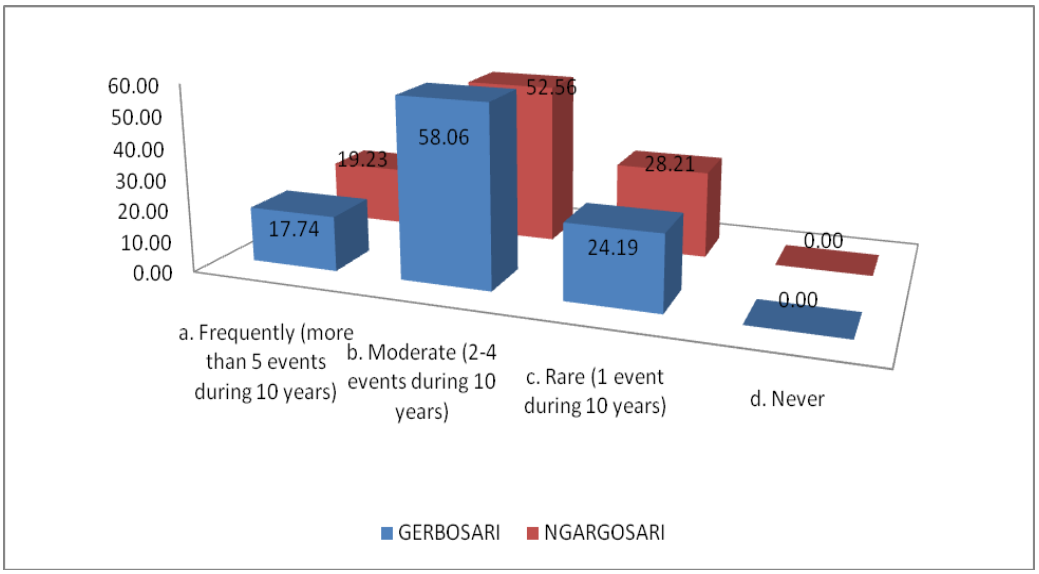


Figure 4.5. Occurrence of landslide based on perception of respondents

Figure 4.5 described that the majority respondent in Ngargosari and Gerbosari selecting the landslide occurrences in their area are included in moderate (2-4 events during 10 years) categories by 58.06% in Ngargosari and 52.56% in Gerbosari village. The second is rare (1 events during 10 years) with 24.19% and 28.21 %. There are 17.74% and 19.23% respondents choosing frequently (more than 5 events during 10 years).

4.2.5. People's Perception of the signs/symptom of landslide

There are various signs or symptoms before the occurrence of landslide that can be determined by visual interpretation. However, not all people realize that these symptoms are a sign of the start before the occurrence of landslides. The percentage of the sign before a landslide occurrence based on the perception of respondent in the study area can be seen in Figure 4.6.

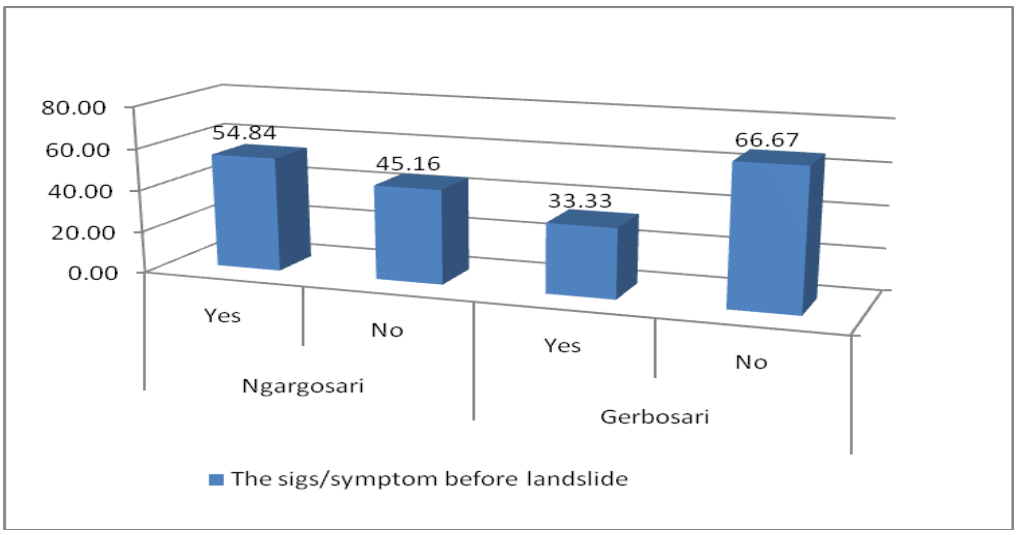


Figure 4.6. The signs/symptom before a landslide based on perception of respondents

According to the response of the respondents related to the signs or symptom before the landslide, 54.84% respondents in Ngargosari say that they know about this signs/symptom. While the responses of respondents in Gerbosari village shows 33.33% of respondents know about these symptom. The respondent said that before landslide occurred, there are several signs that appear around their area. The signs

that can be interpreted by them are cracks of soil, position trees that sloping down to the hill, and heavy rain with long period.

4.3. Preparedness Planning of Local Community

This study uses two indicators to assess the preparedness planning of the local community in the study area, i.e. emergency planning and early warning system.

4.3.1. Emergency Planning

There are six variables of emergency planning of local community that are used in this study, i.e. the availability of medicines, evacuation skills training, the availability of basic needs, the availability of communication tools, the availability of disaster preparedness supplies, and the availability of addresses/phone numbers of hospital, electricity agencies, local disaster management, etc. Based on the response of respondents, the percentage of preparedness planning of the local community in Ngargosari and Gerbosari village can be seen in Table 4.5.

Table 4.5. Emergency planning of local community

No	Emergency planning	NGARGOSARI				GERBOSARI			
		Freq		(%)		Freq		(%)	
		Yes	No	Yes	No	Yes	No	Yes	No
1	Availability of medicines	25	37	40.32	59.68	37	41	47.44	52.56
2	Evacuation skills training	13	49	20.97	79.03	20	58	25.64	74.36
3	Availability of basic needs	53	9	85.48	14.52	56	22	71.79	28.21
4	Availability of communication tools	53	9	85.48	14.52	63	15	80.77	19.23
5	Availability of disaster preparedness supplies	13	49	20.97	79.03	13	65	16.67	83.33
6	Availability of addresses/phone number of hospital, electricity agencies, local disaster management, etc	14	48	22.58	77.42	10	68	12.82	87.18

Table 4.5 described the preparedness planning of local community in the study area which consists of six variables. First, the response of respondents related to availability of medicines shows that the majority of respondents in Ngargosari and Gerbosari village do not have the availability of medicines by 59.68% and 52.56%. The second is evacuation skills training which represents 79.03% and 74.36% respon-

dent in Ngargosari and Gerbosari village that do not have evacuation skills training. The third is the availability of basic needs. The majority respondents in these areas say that, they have high preparedness by 85.48% and 71.79%. The fourth variable is availability of communication tools. Most of all respondents have communication tools especially mobile phones. 85.48% and 80.77% respondents in Ngargosari and Gerbosari have communication tool. The next variable is the availability of disaster preparedness supplies which reflects that 20.97% respondents in Ngargosari and 83.33% respondents in Gerbosari do not have disaster preparedness supplies. Finally, the availability of addresses/phone numbers of hospital, electricity agencies, and local disaster management is very minimizes. There are 22.58% and 12.82% respondents who have this availability.

4.3.2. Early Warning System

Based on the response of respondents in the study area, there are varied opinions related to early warning. It can be seen in Table 4.6.

Table 4.6. The early warning system of local community

Early warning	Ngargosari (%)		Gerbosari (%)	
	Yes	No	Yes	No
Is there any information about hereditary characteristics of the occurrence of landslide?	9.68	90.32	17.95	82.05
Are there any notices of government agencies on disaster warning?	64.52	35.48	73.08	26.92
Have there been any exercises or simulations that address these issues?	17.74	82.26	44.87	55.13

Mostly respondents in the study area have response that they do not have any information about hereditary characteristics of the occurrence of landslide. There is only 9.68% and 17.95% of respondents in Ngargosari and Gerbosari village who have this information. Most of them say that there is no message or specific information from their parents or figures that tell about the symptoms that appear before the landslide. 64.52% and 73.08% respondents in this area give response that there are notice from the government agencies on disaster warning. They said that this notice was given by the head of village or the head of sub village when they held a formal meeting in their area or in the religious events meeting, especially when the rainy season starts.

The next is related to the exercise or simulation in this study area. According to the response of respondents, more than half of respondents do not have experience with exercise or simulation which is relevant to landslide hazards. Only a few respondent, who have had training and simulation. The participants of the training are community leaders and community protection officer. So, it means that the study area needs more socialization and evacuation training for all people who located in prone area to improve their awareness and preparedness to deal with landslide hazards.

4.4. Preparedness Planning of Local Government

Local government is one institution/stakeholder that has a main role in implementing a disaster risk reduction. According to UNISDR (2010), there are four major roles of local governments related to an implementation of disaster risk reduction, i.e.:

1. Playing a central role in coordinating and sustaining a multi-level, a multi-stakeholder platform to promote disaster risk reduction in the region or to a specific hazard.
2. To effectively engage local communities and citizens with disaster risk reduction activities and link their concerns with government priorities
3. Strengthening their own institutional capacities and implementing practical disaster risk reduction actions by themselves
4. To implement innovative tools and techniques for disaster risk reduction, this can be replicated elsewhere or scaled up nationwide.

Based on the discussion with several government agencies that have responsibilities related to disaster, it can be seen that these organizations have preparedness planning and actions to reduce disaster risk. There are several planning and actions which have already done by the local government in this area.

4.4.1. Establishment of PUSDALOPS (Operation Control Center)

One of way that has been done is the establishment of PUSDALOPS (Operation Control Center), where the coordinator is BPBD Kulon Progo district. This organization was built in the end of 2012. With the establishment of this organization are expected to enhance the preparedness of communities and local government in the face of disaster threats that arise any time. In addition, this organization has aim to integrate disaster management in this region.

PUSDALOPS is a functional organization unit of BPBD which support infrastructure/facilities with its main function, i.e. are to receive data/information, record, process/analyze and distribute as verified in accordance with procedure established. Furthermore, the data/information that has been processed is used to a decision-making support more responsible for disaster management. In general, there are several functions of PUSDALOPS related to disaster management, i.e.:

1. Monitoring and early detecting of all symptoms, threats and disaster in their area and making notes and daily reports
2. Collecting, processing, and presenting the data/information and the development of threats and disaster situation
3. Delivering widely the disaster early warning with authorization from the head of BPBD to the related institutions, stakeholder and community in prone area
4. Implementing support and commanding coordination among agencies/institutions involved in the implementation of the pre disaster, when a disaster, emergency response and post-disaster
5. The implementation of communications system data/information in support of operation disaster

PUSDALOPS is combination of several elements of SKPD and volunteers in the region, such as social agencies, public works, public health, kesbanglinmas, BAPPEDA, construction administration. In addition, some of the organizations and volunteers who join in PUSDALOPS are PMI, ORARI, RAPI, TAGANA, KOKAM, and BANSER. Moreover, they also have quick response team which consists of

several elements that joined in this organization. The list of elements and personnel of rapid response team can be seen in Table 4.7.

Table 4.7. List of elements and rapid response team personel

No	INSTITUTION	PERSON
1	BPBD (Regional Disaster Management)	3
2	ADMINISTRASI PEMBANGUNAN	1
3	BAPPEDA	1
4	DINKES (Health Agency)	2
5	DPU (Public Work Agency)	1
6	DINSOS (Social agency)	1
7	KESBANGLINMAS	1
8	PMI (Red Cross Indonesia)	2
9	TAGANA	3
10	SARLINMAS	3
11	ORARI	1
12	RAPI	1
13	BANSER	1
14	KOKAM	1

Source: BPBD Kab. Kulon Progo, 2012

Every institution has a different role and function. The role and function of each institution is adjusted to the duties and functions of the respective institutions. However, the coordinator of this organization is BPBD. For example, public work (DPU) has role and function to handle the damage of the infrastructure that is impacted by landslide hazards. Organizations that have role in supporting healthy are Red Cross Indonesia (PMI) and health agency (Dinkes). Related to the availability of logistic, stakeholder that has responsibility is social agency (Dinsos), PMI and BPBD.

4.4.2. Logistic Supply

Relating to the supply logistics in disaster, BPBD Kulon Progo already have stock inventory. If disaster strikes, the supplies can be used and distributed according to the need. The main sources of funding or logistics supply and equipment came from BNPB and BPBD Yogyakarta province. In addition, BPBD Kulon Progo district also has a special budget allocation for logistic supply each year. The head of reha-

bilitation and reconstruction section, Mr. Eko Susanto said that BPBD Kulon Progo also had cooperative agreement with POS DAYA related to the provision of logistics. So, when disaster strikes and logistics stock shortages, BPBD could take necessary of logistics supply from this cooperative. Other agency that has a supply of logistics in disaster management is the social agency. One of the main tasks of social agency in the field of disaster is related to the supply and distribution logistics. The logistical resource from the social agency of Yogyakarta province has been distributed to the all of subdistrict in Kulon Progo regency.

4.4.3. Establishment of Desa Tangguh Bencana (Disaster Resilient Village)

A preparedness planning program that has been undertaken by governments in the face of disaster in Kulon Progo is to form a resilient village. According to the rule of disaster agency head number 1/2012, disaster resilient village is a rural/village with independent ability to adapt and deal with the potential threat of disaster, and recover quickly from the effect of catastrophic adverse. Disaster resilient village was formed by National Disaster Management (BNPB).

Thus a village tough disaster is a village that has ability to identify threats in the region and able to organize resources communities to reduce vulnerability and increases capacities to reduce disaster risk. This capability is realized in the development planning efforts containing prevention, preparedness, disaster risk reduction and the increased capacity for recovery after an emergency. Village development disaster resilient is one based disaster risk reduction community. In the village disaster resilient, it engages community to be active in reviewing, analyzing, and handling, monitoring, evaluating, and reducing disaster risks that exist in the area, mainly by utilizing local resources to ensure sustainability.

Currently, only one village has been a catastrophic tough village in Kulon Progo regency that is Sidoharjo village which is included in Samigaluh subdistrict. Sidoharjo village is one village that has a high risk of landslides and has economic potential still to be developed, namely empon-empon (medicinal spices). From thus, the community is expected to be able to develop the already existing potential trough the optimalization of the utility of the existing land with due regard to the

environmental sustainability and land conservation. This is necessary because disasters are economic losses due to delays in economic activities, such as lost livelihoods. Community must be strengthened to be resilient in economic terms, despite living with disasters.

One of the activities carried out in order to reach the tough village is to provide guidance to community groups in the village Sidoharjo, so that they can develop the business and interest in accordance with their respective fields. For assistance in this case, it was solved by providing training to the 107 participants of farmer group's cultivation, such as Sidodadi, Sido Rukun, Subur Menoreh, Margo Mulyo, and Agro Menoreh Lestari, followed by giving 170 seed packets (jogja.antaranews.com). On the other hand, a group of post-harvest has been formed, namely Agro Cahaya Menoreh, providing business development training, and delivering the dryer and the chopper, in order to develop them into a professional farmers. The situation of socialization and establishment of village disaster resilient can be seen in Figure 4.7.

Figure 4.7. Socialization and establishment of village disaster resilient.
Source: BPBD Kab. Kulon Progo, 2012.

4.4.4. Establishment of Kampung Siaga Bencana/KSB (Disaster Alert Village)

In order to improve community preparedness for disasters, one of the programs that have been conducted by the local government of Kulon Progo is the establishment of disaster alert village (Kampung Siaga Bencana/KSB). It was formed by Social Agency. KSB is a formal medium in community-based disaster management framework that aims to enhance the capacity of communities to use the potential and resources of the community in the face of the threat of disaster. Community-based disaster management is an organized effort on the community in disaster management activities starting from before, during and after a disaster by way of prioritizing the utilization of local resources, either in the form of trained human resources (skilled), or the nature and infrastructure that exist in the community aimed at reducing the risks/impacts that may result from catastrophic events. The main principle of the implementation of the village disaster preparedness is prioritizing community independence. However, the support of other parties interested in the response as the government and the private sector will be needed. It is intended to motivate and strengthen disaster management institutions at the community level.

There are two types of KSB activities, namely physical and non-physical. Several activities included in physical categories are building dikes, making culverts, making evacuation routes, reforestation of deforested areas, and improving the drainage system, while the non-physical activity can be exemplified as training and simulation/rehearsal meetings or providing input to the government in formulating disaster management policy.

In general, the local government of Kulon Progo has established two disaster alert village (KSB) namely Gerbosari and Banjaroyo which are located in Samigaluh and Kalibawang subdistrict. Training and simulation were done in September of 2012 with the involvement of all elements of society in the village. This training was followed by the head of the hamlet, community leaders, youth organizations (Karang Taruna), PKK, and health cadres. The number of participants involved in the training is approximately 100 people. At the time of disaster simulation practice activities, it involved communities who were living around the venue. Training and simu-

lation activities are expected to increase the capacity and independence in the face of disasters that threaten their region. So, they can take appropriate and accurate action, either through physical or non-physical in a bid to reduce the risk of disaster. Moreover, KSB also has support facilities, i.e. social barns (lumbung social) and social substation (gardu social). Social barn serves to accommodate and store logistical preparedness for disaster. While social substation serves as communication link between citizens, related to disaster preparedness. Both facilities are managed by community; the government only gives facility. Figure 4.8 illustrates the situation and condition at the time of training and disaster simulations as part of the process of the formation of disaster alert village (KSB).

Figure 4.8. Training and simulation of village disaster preparedness (KSB)
Source: Gerbosari village office, 2012

4.5. Local Early Warning System

Early warning system is a major factor in disaster risk reduction. Early warnings prevent loss of life and reduce the impact in the economic and material sides from a disaster. Effective early warning can be done by involving community, facilitating education and awareness risks, spreading warnings effectively, and ensuring preparedness to be always maintained.

4.5.1. Early warning system in study area

Based on the result of interviews with respondents and field observation, in the study area has not developed formal systems to provide warning information. However, to distribute information and warning in dealing landslide hazards, the communities use traditional tool and several tools that they have to communicate with other people. There are several tools that they used to give information and warning to other people related to disasters, such as kentongan, loudspeaker, mobile phones, and handy talky. Kentongan is traditional tool which has many functions and it is useful for people who live in this area. Besides that, it is used to provide information and warning related to disaster, this tool also can be used as a sign or invite people to come together when there is an event in this region. By using this tool, the community will know what information is delivered, because information that comes from this tool has different sign. They already understand about the typical of kentongan sound that indicates the dangerous condition from the landslide by the continually sound. This tool is useful for community to be cautious in case of landslide hazard.

In addition, they also use loudspeaker from mosque and mobile phone. This tool is useful to give information and warning to people who live in area that is in threat from disaster, because it can cover wide area.

On the other hand, there is also handy talky that is owned by some people in this area. It can be used to communicate in wide cover area and useful in the area that so is far from other people. However, this tool is rather expensive than other tools and only few people have this tool. But this tool is very useful for the community in delivering information and communication with stakeholders that has concern for disaster.

4.5.2. Organization involved

The application of early warning systems required roles of various parties who have concern for disaster events. With a good warning and information, it expected to reduce the impact of disaster events. From the interviews and discussions with respondents and local governments, it is known that there are several organizations involved in early warning system in this region. Organization and volunteer that are involved in information and warning system are BPBD, TAGANA, PSBA (Center of Disaster Studies/UGM), RAPI, and ORARI. They have big role in giving information and warning to the people who live in prone area. PSBA is one institution which has active role in developing early warning system in this region. They also conducted socialization of early warning system for landslide disaster. In addition, they will train the community about operational procedures, functions, maintenance, and mechanism of action of early warning system.

4.6. Concluding Remarks

The landslide perception of the local community consists of some characteristics of landslide perceived by respondents. It can be identified based on the interview, i.e. the definition of landslide, the location of landslide, the time/occurrences of landslide, the causes of landslide, the frequent of landslide, and the signs/symptom before landslide. The result shows that the local community has knowledge related to landslide. Their knowledge and wisdom may influence their perception on the necessary of the disaster risk reduction program that will be developed in their area. Related to the preparedness planning of local community, the result of interview described that there were varied response from the respondents. The characteristic of preparedness planning of respondents can be identified from the availability of the medicines, the evacuation skills training, the availability of basic needs, the availability of communication tools, the availability of disaster preparedness supplies and the availability of addresses or phone number of hospital, electricity agencies, local disaster management and etc. More than half of respondents in the study area do not have the availability of medicines. 40.32% respondents in Ngargosari village have the availability of medicine. While in Gerbosari village, respondents who have the availability of medicine reach to 47.44%. Most of all respondents do not have the availability of evacuation skills training. Only 20.97% respondent in

Ngragosari and 25.64% respondent in Gerbosari have the availability of evacuation skills training. Moreover, 85.48% and 71.79% respondent in Ngargosari and Gerbosari have the availability of basic needs. Mostly the respondents in the study area have alternative communication tools. 85.48% and 80.77% of respondents in Ngargosari and Gerbosari have the availability of communication tools (mobile phones).

Only a minority of respondents have the availability of disaster preparedness supply. 79.93% and 83.33% of respondents in the study area do not have disaster preparedness supply. Finally, the characteristic of the respondents' preparedness planning is the availability of address or phone number hospital, electricity agenciy and local management disaster. There are 22.58% and 12.82% respondents in the study area who have this availability.

Moreover, there are several planning programs that have been done by the local government of Kulon Progo such as the establishment of PUSDALOPS (Operation Control Center), quick response team (Tim Reaksi Cepat/TRC), village disaster resilient (desa tangguh bencana), disaster alert village (kampung siaga bencana/KSB), the installation tool of landslide early warning system, socialization and simulation. These events involve several institutions and volunteers which located in this region, such as BPBD, social agency, public work, public health, PMI, Orari, Rapi, Banser, and Kokam.

Related to the local early warning system that is available in this area, it can be concluded that there are several tools that are used in the early warning system, i.e. kentongan, loudspeaker, mobile phones, and handy talky.

There are also several organizations/volunteers which are involved in the early warning system such as BPBD, TAGANA, PSBA, RAPI and ORARI. Although there are several tools and organizations which are involved in the local early warning system, but the role of community in this area also important in supporting early warning system. Their knowledge and information are necessary in the detection of the landslide symptoms that can be used to enhance their preparedness related to the landslide hazards.

CHAPTER 5. DEVELOPING A LANDSLIDE INFORMATION AND WARNING SYSTEM USING MOBILE PHONES BASED ON COMMUNITY PARTICIPATION

This chapter presents the design of a landslide information and warning system using mobile phones,with description of the users in this system, the role of user, and mechanism of system, data needed, information produce and the organizing of the user.

Developing and implementing the effective early warning system requires contributions and coordination of the various institutions or stakeholders that has concern for disaster management. The goal of the development of landslide information and warning system based on community participation is to empower individuals and communities which are threatened by the hazards. They can act in time fairly and in a manner appropriate to reduce the possibility of personal injury, loss of life and the destruction of property and the environment.

5.1. Developing Landslide Information and Warning System

Developing landslide information and warning system is one way that can be used to facilitate the community participation in reporting and recording data using mobile phones. This system uses mobile phone because it is easy to use and low in cost. In addition, most of the people have mobile phone and it is also familiar for them.

The important factor in developing the disaster information system is the active role and participation of community, and the speed of information delivery. The involvement of local communities and social elements that are organized widely can be an important key in disaster prevention. They have role as contributor in providing information about symptoms that can trigger landslide and information about rain occurred in their area or actual landslide occurrence around them. This information is a key factor in developing this system, because the local disaster management can provide warning and action to the public by considering and analysing the information. It is expected that the system will serve as decision support for stakeholders in order to improve the preparedness of the danger of landslides. The systematic view of developing landslide information and warning system can be seen in Figure 5.1.

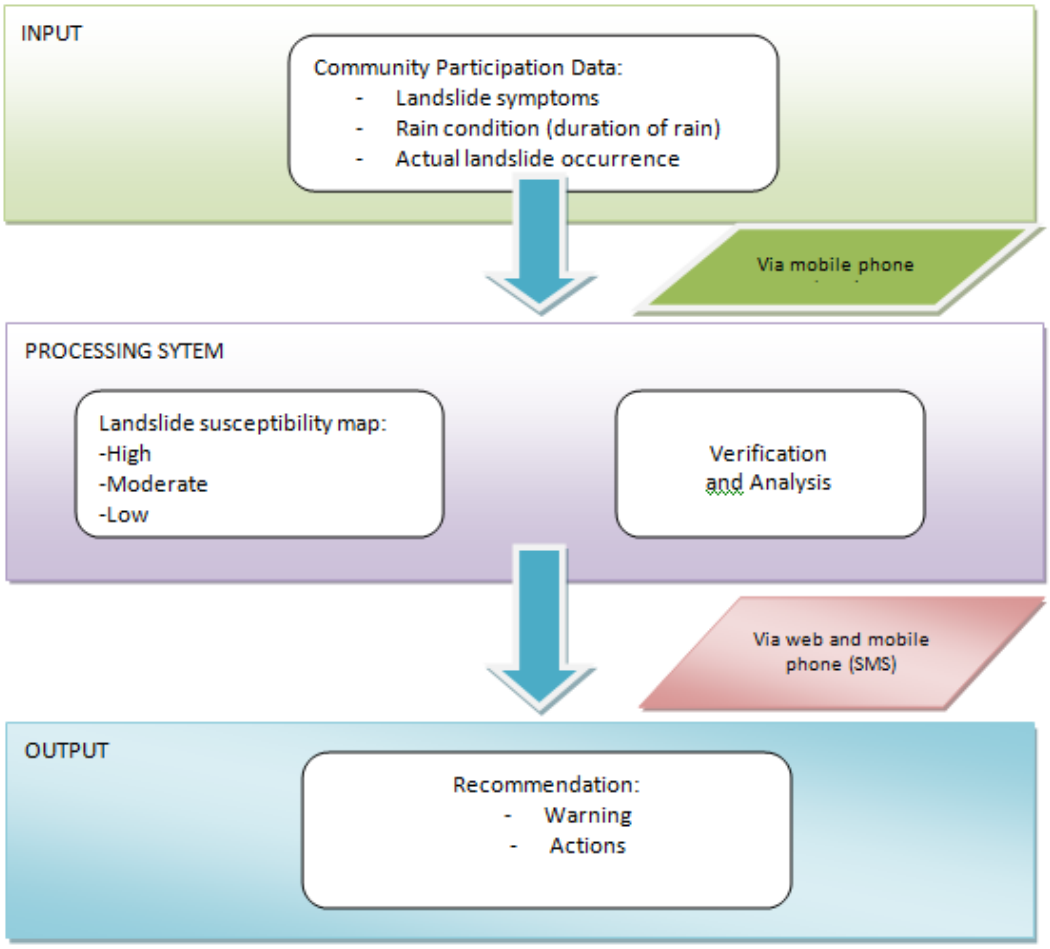


Figure 5.1. A systematic view of the landslide information and warning system application

Figure 5.1 explains the process of landslide information and warning system which consist of three stages; input, processing system and output. Input consists of community participation data which have several information's, such as landslide symptoms, the rain condition or actual landslide occurrence. The rain information comes from the node that already registered in the data base. The condition of rain that can be informed just the duration of rain and the condition of rain (heavy or not). In addition, they also give information about actual landslide that occurred around them. This information comes from people/the nodes that have been listed in the data base. They have role to give information about landslide symptoms and actual landslide occurrence which detected around them.

The second stage is processing system. Information which comes from the nodes will be processed in this stage. There are administrators (BPBD) who manage this system. They have task to monitor and manage all information which come from the nodes. This information also needs verification considering the warning and actions that can be taken by local disaster management.

The third stage is output that consists of the warning and action that must be delivered to the nodes. The result of the analysis and field verification then was transferred back to the reporting nodes as well as to another relevant registered node that have threat from landslide hazards.

5.2. Mechanism of System

The input and output data are from public (node) and for the general public. General public can improve their awareness about emergency situation in landslide prone area by accessing information quickly and accurately from the information system. The node is local community members who have willingness to join with this system. Besides, node has to be registered by the system and listed in the database system. The task of the nodes is to send information or report via SMS about the landslide symptoms and they also can give information about actual landslide events that located around them. The report will be received by administrator who has authorities to manage the report. The data from the nodes that are needed in this system are personal data, cellular phone number, and geographic data related to the coordinate of the node. These coordinates are needed to guide the distribution of early warning so that only the nearby nodes or stakeholders are informed. Therefore, it is necessary to educate and socialize the node regarding with their participation on the emergency response system. They can contribute by sending reports via SMS. Moreover, they need to understand what kind of information is to be reported and how to report the correct format. The mechanism of this system can be seen in Figure 5.2.

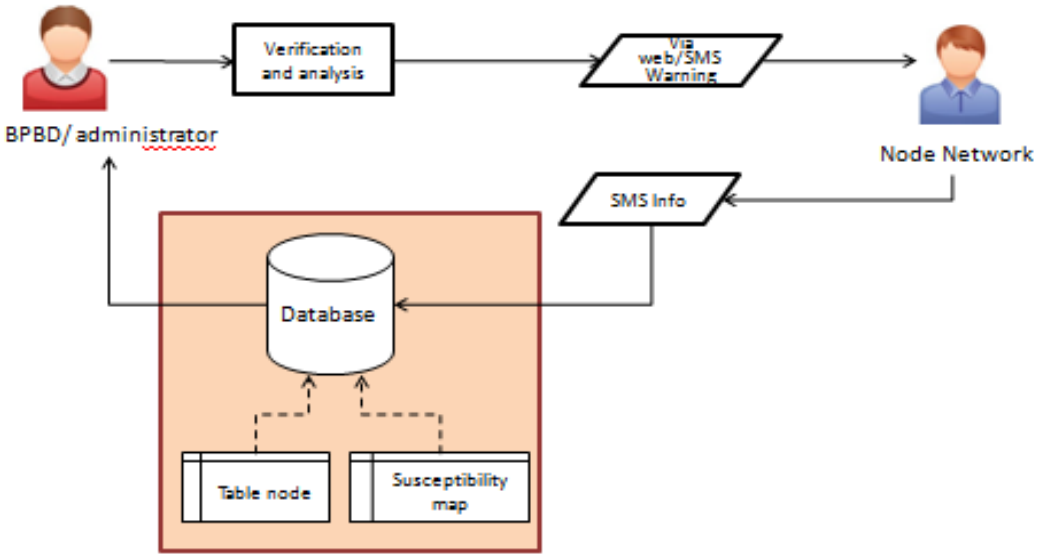


Figure 5.2. Flowchart of the mechanism of landslide information and warning system based on community participation

The flowchart shows that there is a mechanism of landslide information and warning system using mobile phone based on the community participation. It also shows that network node has important role in giving information about the signs of landslide. It also gives information about the rain condition that occurs in their area. This information is sent via SMS to the existing number that available in this sytsem. Any information will go directly into the database in accordance with the node's code which sent the message. The administrator (regional disaster management/BPBD) will verify and analyze the information. Based on the result of the verification and analysis, administrator will send warning to the sender of the message/reporting nodes. So, only information comes from the node that can enter into this system. Information that comes from the number that is not registered into the database cannot display in this system and will not be responded by administrator.

5.3. The Distribution of Base Transceiver Station (BTS) and Visibility Map

One important factor that is needed in developing landslide information and warning system using mobile telephones is the availability of signal network. Without the availability of signal network, this system cannot run because the communication device users need the bridge to connect with the other networks. The equip-

ment that facilitates the wireless communication between user equipment and network is Base Transceiver Station (BTS). BTS is an important infrastructure for reaching the network of quality global system for mobile communication (GSM). BTS is an antenna or transmission tower to receive and transmit signals from cell phones to its customer and vice versa. The spatial distribution of BTS in Samigaluh area can be seen in Figure 5.3.

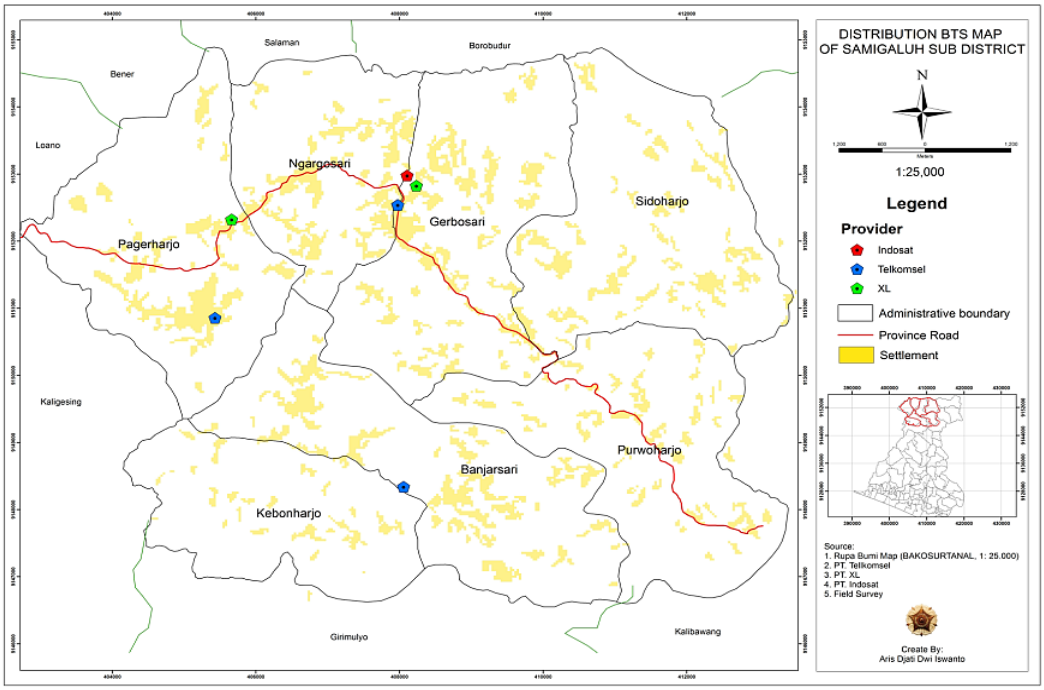


Figure 5.3. The BTS distribution map of Samigaluh subdistrict

The map describes the distribution of BTS which is located in Samigaluh sub district. In general, there are three providers in this area namely Telkomsel, Indosat and XL. Each provider has different amount of BTS. Telkomsel has three BTS located in Pagerharjo, Ngargosari and Banjarsari village. Indosat has one BTS that is situated in Ngargosari village and XL has two BTS which are located in Pagerharjo and Gerbosari village. The distribution of BTS can cover some area in Samigaluh sub district, especially in settlement area. The area which can be covered by BTS in this area is described in Figure 5.4.

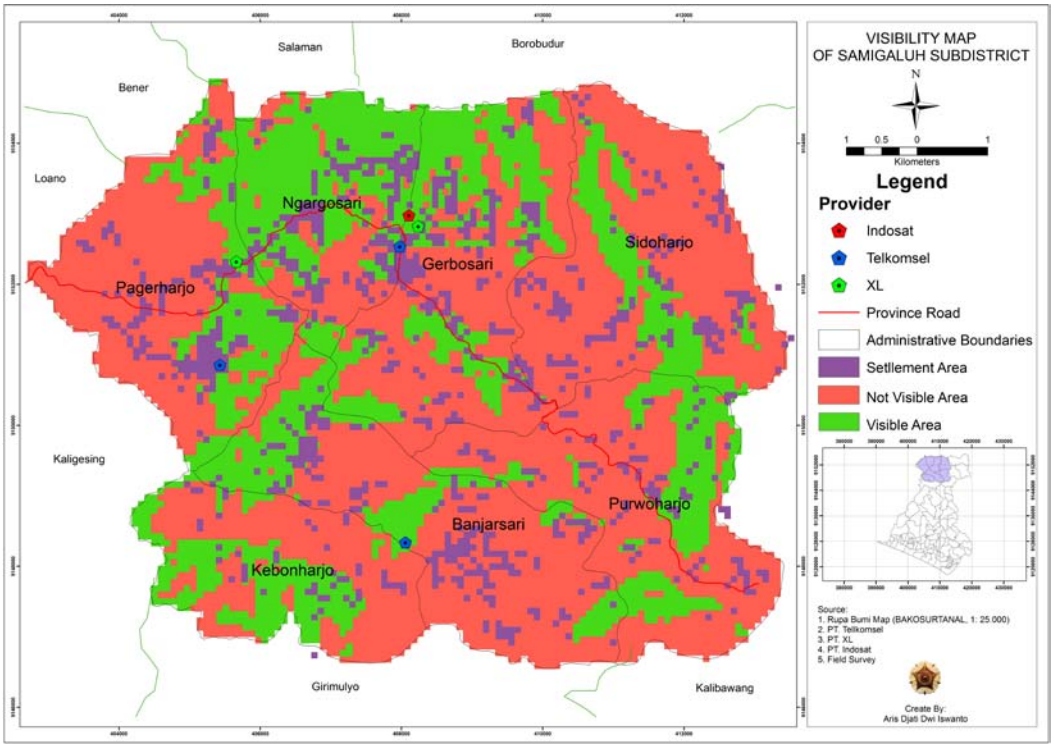


Figure 5.4. The visibility map of Samigaluh sub district

The map shows areas covered by the distribution of BTS in Samigaluh subdisrict. The red and green color represents the visibility of the area. The red color area has no visibility, while the green color reflects the visible area. There are several areas that do not visible from the signal network.

The map also describes the settlement area which are covered and not covered by the signal network. There are several settlement areas which are not covered by signal network, but they can access the signal network by moving around their location or house to get signal network.

The quality of signal can be influenced by geographic conditions. Some factors that affect the quality of signal are relief and land use. Relief is one of the physical conditions of terrain that influence cellular phone service, because it cause the signal reflection and obstacle which lead several areas not visible from the signal network. Moreover, land use can also influence the quality of signal network. Land use can be used as a source of information about the existence of the potential use of cellular phone.

5.4. The user of this system

The web display of landslide information and warning system can be accessed by public who has internet connection. It can be accessed with personal computer or by mobile phones with internet connection. They can see information that is available in the web display. However, the network node can send and receive information using their mobile phone via sms. In general, there are three main users of this system; public user, contributor (node network) and administrator (regional disaster management/BPBD).

5.4.1. Public User

Public user is any user who can access the system but can not log on to the portal. When users access the portal at the first, they access it as public users, whether or not they have the ability to log on. A public user can view any page that has been marked as public by the page owner but cannot edit the content of the pages. They can get all information that is available in this system based on their needs. So, not only people in this region that can access the information, but all people who have internet connection can also access this portal.

5.4.2. Contributor (Node network)

A contributor (network nodes) is a user who has been listed in data base of this system. Their personal identity has been included in the database of the system such as name, location, phone number and the coordinate of a node. The role of a node is delivering/giving information about signs before landslide that takes place around their area or actual landslide occurence. So, they become a key person who gives information in developing this system. Their information is necessary for local disaster management or decision maker in giving warning or action in the frame of disaster risk reduction.

Based on the result of interview with respondents, there are several respondents who have willingness to join with this system. There are 78 network nodes spreading across the study area. The spatial distribution of the network node location can be described in Figure 5.5.

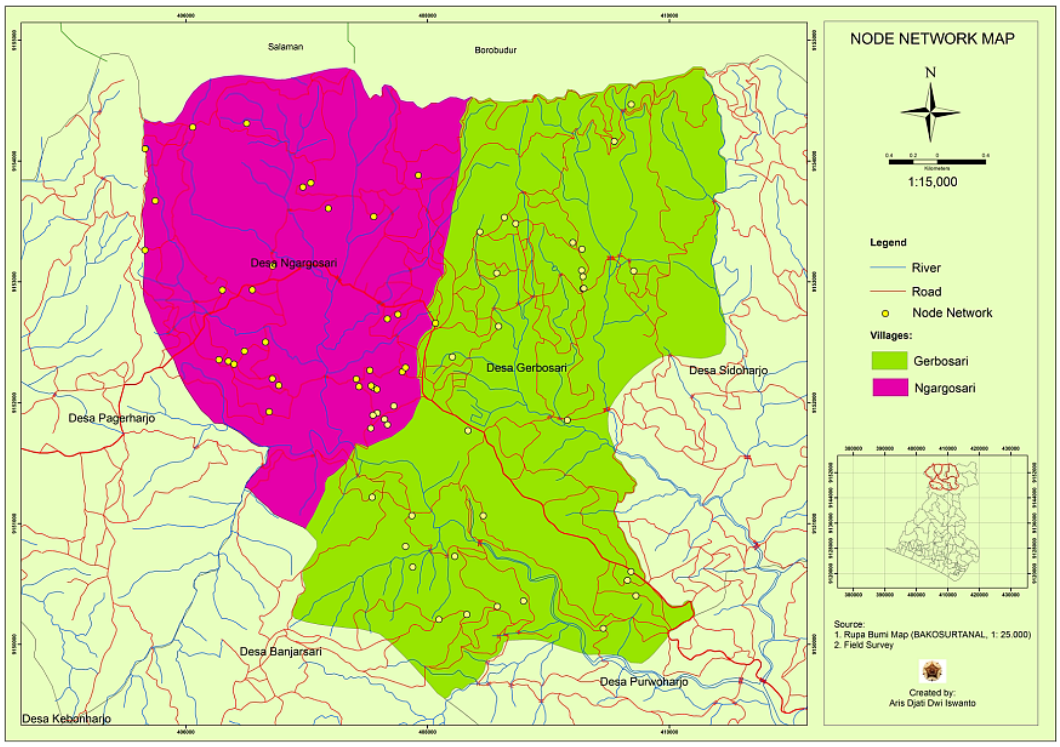


Figure 5.5. Node network map in the study area

The map shows the distribution of network node who join in landslide information and warning system. However, not all respondents in the study area are willing to join with this system. From 140 respondents, there are 116 persons that have mobile phones. But, only 78 respondents were ready and have willingness to join with this system. The location of respondents has visibility to the signal network from the provider that located in the study area. So, they have ability to participate in giving information about the signs before landslide occurrence or actual landslide event that located around them. There are several reasons why some respondents are not ready to join with the system, such as they do not have mobile phones, age and healthy factor, and their ability in using mobile phones. So, these are the disincentive for them if they have to send the information of landslide symptoms via sms. All network nodes must be registered into the database in this system. They need to be registered into database because it is important to know the personal data of each node, and to avoid and to minimize the hoax information from the irresponsible people. So, only the information that comes from the network node that directly included in this system and will get response from the administrator.

5.4.3. Administrator (Regional Disaster Management/BPBD)

Administrator is a user who has permissions to create, read, update, edit, and delete database in this system. Stakeholder who has role as administrator is regional disaster management (BPBD). It needs a person or a team to manage this system. The main task of the administrator is to monitor and manage information that comes from the network node. This information will be verified by team that has responsibility related to the information. Verification results are used as a consideration for regional disaster management (BPBD) in giving warning and actions that will be taken as an effort to enhance community preparedness and disaster risk reduction.

5.5. Role of User

There are two users that have main role in developing this system, i.e. contributor (network node), and administrator (regional disaster management/BPBD). Contributor (network node) has a role to give information about the signs and the rain condition that occurs around their area. This information is necessary for considering the warning and action that are needed in their area. So, information from node network is useful for increasing the preparedness of community in dealing with landslide hazard. Their information is useful for developing this system. Without participation of the communities, this system cannot be developed, because the communities become a sensor for the signs of landslide that appear around them.

The second user is administrator (regional disaster management/BPBD) who have role to monitor information that come from the nodes. Based on their information, the administrator will verify the field condition. The verification result will be used as consideration in giving warning and taking decision about action that will be taken.

5.6. Input Data

Developing landslide information and warning system need some data related to the landslide occurrences. Several data that are needed in this system are susceptibility map, node network data (personal information, location, and phone numbers), the

signs or symptoms before landslides, the condition of rain precipitation and also actual landslide that occur surrounding their environment.

The susceptibility map was built by Center Study of Natural Disaster (PSBA) on 2010. There are three level of susceptibility that situated in Samigaluh subdsistrict: high, moderate, and low.

There are some signs before landslide occurrences that can be detected by visual interpretation. So, the communities who have knowledge and concern in environmental change can detect the symptoms related to landslide hazards. Several signs that can be used to monitor the landslide occurrence are soil cracks, land subsidence, rain condition (duration of rain) and etc. These data are useful in developing landslide information and warning system. It will be used as analysis and consideration in taking the action and giving warning to people located around the impacted area of landslide. There are several signs before landslide events that can be informed by network node to this system, such as:

- The existence of cracks in the soil on the land (agriculture, forests, gardens, residential)
- The existence of bubbles/subsidence on the pavement
- Rain condition (heavy rain more than 3 hours, heavy rain less than 3 hour, not rain)

5.7. Information Produced

This system will produce information about warning and action that have to be done by people who live around the area that may be influenced by the impact of landslide hazards. Information that comes from the nodes, will be monitored and analyze by administrator. Based on the analysis and field verification, administrator will give warning using sms or web that will be received by the nodes who give environmental condition and information around their location. The warnings that are given to the node depend on the information of the signs that enter into the database and the level of the susceptibility of their area. So, the location and information from the node is determining the warning that will they get.

On the other hand, there are several menu or information that can be accessed from this portal, such as the report of landslide occurrences, resources (logistic and equipment), gallery, and map. So, all people who access this portal will obtain all information related to landslide disaster that occurs in this area. Some information and data that can be accessed from this system can be seen in some figures below (www.simpelmas.com).

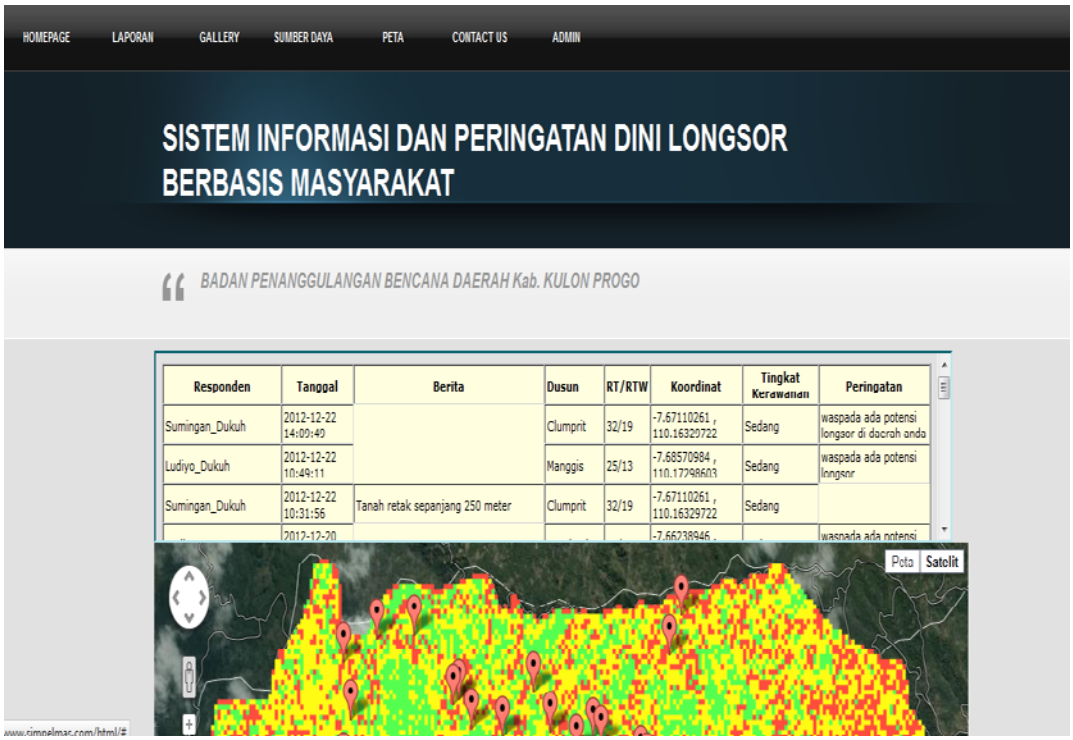


Figure 5.6. The display of the main menu of landslide information and warning system based on community participation (www.simpelmas.com)

This figure shows about the main menu of this system. It contains information from node network about the signs of landslide that occurs in their area. The display evidence the information of the signs before landslide occurrence from the node. The node sends their information to the existing system number. They deliver this information using their mobile phones. The system accepts the SMS and sends a reply SMS mentioning that SMS has been received and will be processed further. Based on the analysis and field verification, administrator will send the warning and action that must be done by the node that giving information and the node that located in dangerous area.

Figure 5.7. The display of the reporting of landslide occurrences in the study area

Other information that can be accessed from this system is the reporting of landslide occurrence. It is shown in Figure 5.7, which consists of the time of occurrence, location, the name of the victim and additional information. These data are obtained from historical data of landslide that occurred in the study area. It consists of landslide events that occurred between 2007 and January 2012. This data can be updated into the web by the administrator after get the reporting of landslide occurrence and field verification.

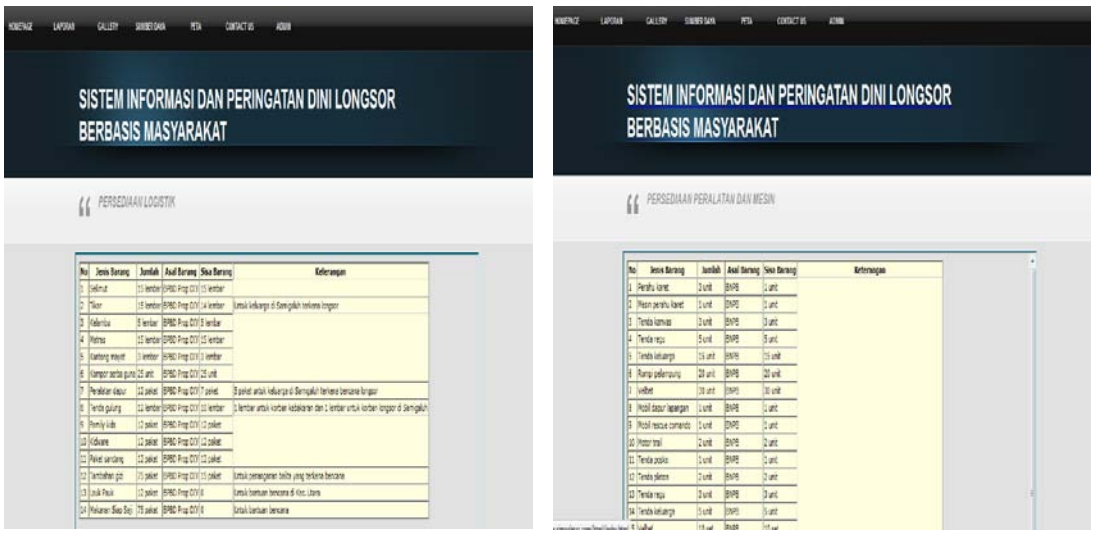


Figure 5.8. The display of resources (logistic and equipment) in local disaster management/BPBD

Figure 5.8 describes about resources menu that is available in regional disaster management. It consists of two types of resources, i.e. stock logistic and equipment. The amount of stock logistic and equipment can change anytime. It depends on the frequency of the disaster that happens in this region and the need of logistic and equipment that they use in dealing with disaster. Based on the information on this display, it can be used to monitor and control the availability of the resources that they have. So, they can plan and prepare the resources needed if the disaster happens in anytime.

Figure 5.9. The display of the map of the landslide threat and the vulnerability map of the geological disaster in Kulon Progo

This menu gives information about the map which is related to disaster in Kulon Progo regency. Figure 5.9 shows a menu which consists of two maps, i.e. the map of the landslides threat and the vulnerability map of the geological disasters in Kulon Progo regency.

5.8. Socialization and Simulation

Developing landslide information and warning system need community participation in susceptible area. One of the most important factor that influenced the success of this system is empowering community to support this system. Without supporting people who live in dangerous area, this system cannot run, because it needs the participation of community in the development of technology for landslide disaster risk reduction. Before empowering community in developing landslide information and warning system, need identifying the local knowledge of the community related to landslide hazards that will influence their perception on the important of disaster risk reduction is needed. Community perception is one factor that affected the willingness of people in the development of landslide information and warning system. This significantly influences the community's willingness to participate in the development of technology for landslide disaster risk reduction (D. Karnawati,*et all*, 2012). Therefore, it needs more socialization and simulation for people who live in susceptible area for increasing their knowledge and capacity in dealing with landslide hazards.

This strategy is necessary to improve the preparedness of the community to reduce the impact of disaster. Socialization and simulation is one way to support the successful implementation of landslide information and the community-based warning system. It is necessary to enhance the role and motivation of the community in the development of appropriate technology for disaster risk reduction. With socialization and simulation, the communities who have willingness to join with this system can understand the process if they will send the information and data related to the signs before landslide. They just send their message via SMS to the existing number in this system. They do not need specific code in giving their information, however they just write the information or the signs of landslide that they know. So, it easy for them in sending the information related to landslide hazards. It can be done by everyone who has mobile phone. However, only people who have already registered into the database that can give information related to the signs before landslide. Moreover, it is not need a code and specific training to join with this system, but only need understand and caution about the signs that appear around them.

Figure 5.10. Socialization and simulation related to landslide information and warning system based on community participation in Ngargosari and Gerbosari village

Figure 5.10 describes the situation of the socialization and simulation for people who have willingness participation in developing landslide information and warning system. The socialization and simulation were held in two villages: Ngargosari and Gerbosari. This activities was conducted within the forum official meetings which held in these village. There are some forums that held in this area, for example the cadres meeting and the meeting of the head of sub village. Participant that involved in these forum are all cadres in the village, government authorities, representatives from community health centers, rural coaching agencies, community leaders and network node that have already registered in data base system. Through this forum, the development of landslide information and warning system is socialized and well conducted trials to transmit information about the signs of landslide via SMS to the existing system number by participant that are included in the net-

work node. They have a high enthusiasm in participating in this activity. According to the socializing and simulating that have been done in this area, it shows that the participant have high motivation and interested with this system. They have opinion that by developing this system can help them in improving their awareness and preparedness to face the landslide hazards that come anytime in their area. They are aware that their area is dangerous from landslide hazard, so they need systematic information and warning system to enhance their capacities.

5.9. Evaluation

After simulating and discussing with the user, there are several feedbacks related to the development of this system. There are some inputs that come from the user. This suggestion can be differentiated into two groups i.e. come from contributor/network node and based on administrator or regional disaster management.

5.9.1. Based on contributor or node network

According to the result of socialization and simulation, there are several inputs from participant related to developing this system. Generally, this system was accepted by users. It is very useful for them. Because, it helps them in enhance their preparedness and awareness to deal with landslide hazard. In addition, this system is easy to use. So, everyone who has mobile phones and has willingness can join with this system. It also gives more information related to the landslide information such as the reporting of landslide, resources, and the map of the threat of landslide in Kulon Progo regency. On the other hand, the participants also have suggestion in developing this system. They have expectations that this system can be used as a media to convey the logistical needs for the victims of landslide that occur in their area. Moreover, they also have suggestion about the network node that they should have specific number of mobile phones that is only used for contributing in this system.

5.9.2. Based on administrator (Regional Disaster Management/BPBD)

In general, developing landslide information and warning system based on community participation is useful for regional disaster management. This system can be applied in their area and very helpful to monitor the condition and situation related to the sign of disaster. On the other hand, the role of community in giving information about the symptom of landslide is necessary for detecting dangerous area. Moreover, these systems simplify and accelerate communication between local community and regional disaster management in improving preparedness and disaster risk reduction. Besides input and suggestion from the contributor/node network, the administrator also gives feedback about the number of node network in village area. The number of nodes network in a village should not be too many, because it can cause difficulties at the time of verification. This is due to the limited number of personnel. So, they suggested determining the specific network node or key person that is located in very vulnerable area and is able to cover the surrounding area.

5.10. Concluding Remarks

Developing landslide information and warning system using mobile phones based on local community participation is one of the effective ways that can be used to reduce the impact of disaster. This system can be accepted and applied in prone area from disaster. Based on the interviews and discussion with the users, there are several advantages of developing this system, i.e.:

- This is a simple system that is easy to apply and is useful for people.
- This system does not need high cost and specific tools.
- They can use their mobile phones to participate in this system.
- Compare to the other system that already developed; there is not specific code or symbol when the nodes give information about the signs of landslide. They just type the information that they know like normal sms. The information can be sent by normal sms with 160 characters, for example;
    - *Cracks in the ground as long as 20 meters and heavy rains over 3 hours*

So, all people who have mobile phones and have ability to send message by sms can join this system. They only write the information that they know and then send their information to the existing number that is available in this system.

Moreover, there is high participation of community in supporting the development of landslide information and warning system. It is shown by the number of people who have willingness to join this system, i.e. 78 persons.

There are several respondents that do not willing to join this system, because they have some reasons, such as they do not have mobile phones, age and health factor, and their ability to use the mobile phones. So, it becomes obstacle for them if they join with this system.

On the other hand, there are also some obstacles for developing this system in this area, i.e;

- A problem related to the coverage of signal network. Not all regions in the study areas are covered by signal network.
- Some respondents have mobile phone and high willingness to join with this system; however they do not have ability using sms by mobile phone.

CHAPTER 6. CONCLUSION AND RECOMMENDATION

This chapter concludes the discussions and summarizes the finding of this research related with the objective of the research. Some recommendations also will also be described in the last part of this chapter.

6.1. Conclusion

The main objectives of this research are to assess community preparedness related to landslide hazard, to identify the local early warning system, and to develop landslide information and warning system using mobile phones based on the community participation. According to the discussions in the previous chapter, some conclusions can be taken.

Community preparedness related to landslide hazards

The first objective of this research is to assess the community preparedness related to landslide hazards. There are three characteristics related to community preparedness; people perception related to landslide, the preparedness planning of the local community and the preparedness planning of the local government. The result shows that the community in the study area has preparedness to deal with landslide hazards. It can be shown by:

- The people have knowledge related to landslide hazards. It can be shown by their knowledge and perception about landslide that consists of the definition, the location, the causes, the occurrence and the signs of landslide hazards.
- The local community has emergency planning and early warning, however it need to be improvement
- The local government has several programs that have been done and developed in this region, such as establishment of PUSDALOPS (Operation Control Center), logistic supply, the establishment of desa tangguh bencana (disaster resilient village), and the establishment of kampung siaga bencana (disaster alert village)

Local early warning system

Local government has not developed formal system to provide warning information related to landslide hazard. To distribute the information and warning related to landslide hazards, people use traditional tool and several equipment that they have. There are several equipments that are available in this area, such as kentongan, loudspeaker, mobile phones and handy talky. Kentongan is a traditional method that is useful for them, because it gives specific sound that alerts the community about landslide hazards. They also use loudspeaker from the mosque to provide information and warning to the community. In addition, there also several organizations and volunteers involved in the early warning system, such as local government, BPBD, TAGANA, RAPI, ORARI, and PSBA.

Developing landslide information and warning system using mobile phones based on community participation

This system is useful and necessary for the community to enhance their awareness and preparedness in dealing with landslide hazard. Using this system, they can participate in giving information about the signs before the landslide, so they have concern over detecting the symptom that appears around their environment. The result shows that:

- Mostly respondent in the study area has mobile phone, so it is a potential to develop landslide information and warning system using mobile telephone.
- The local people have high motivation and interested to participate with this system.
- This system can be accepted by the communities, because this is easy to use, low cost, and useful for people who situated in dangerous area.
- If compare to the other system that already developed, there is not specific code or symbol when the nodes give information about the signs of landslide. They just type the information that they know like normal sms.
- This system is useful for government for monitoring and detecting the symptoms of landslide, so it can be used to anticipate the impact of disaster that may be occurred in their area.

6.2. Recommendation

Based on the result and discussions, there are several recommendations that can be proposed:

1. There should have been more intensive socialization, training and educating for people who live in susceptible area to increase their knowledge and capacity in dealing with landslide hazards.
2. The empowerment and involvement of community and stakeholders in supporting the developing of landslide information and warning system based on community participation should be increased
3. To increase the role and participation of the community in the development of landslide information and warning system, more BTS are needed to cover all susceptible area.

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APPENDIX 1. RESEARCH QUESTIONNAIRE

Research title	:	Developing a Prototype of Landslide Information and Warning System using Mobile Telephones Based on Local Community Participation; A Case Study in Kulon Progo district, Indonesia
Researcher	:	Aris Djati Dwi Iswanto
Questionnaire no	:	
Date/Time	:	
Name of Respondent	:	
Location/GPS	:	Lat: Long:
Village	:	
Sub Village	:	
RT/RW	:	
Subdistrict	:	

A. Information of Respondent Profile

1. Age :
2. Sex : □ Male □ Female
3. Status : □ Married □ Single
4. Education :
5. Occupation/Job :
6. Year of stay in location :
7. Number of families :
   □ Women:..... □ Old people/> 65 years:
   □ Children/< 5 years: ..... □ Disable: .....
   □ Adult (man):……..

B. Building Information

1. Building ownership : □ Own □ Rent □ Other :
2. Building age (year) : □ < 5 □ 5-10 □ 10-20 □ 20-30 □ >30
3. Building size (m^2) : □ <36 □ 36-45 □ 45-70 □ >70
4. Number of floor : □ 1 □ 2 □ >2
5. Wall material : □ Brick □ Concrete brick □ Wood □ Bamboo □ Stone
   □ Brick/concrete – bamboo □ Brick/concrete – wood □ Other :

C. Information about people perception and local knowledge related to disaster

1. What is meant by landslide?
   a. Land mass that moves down on the steep slope.
   b. Subsidence of land mass
   c. Rock and soil fallout
   d. Other, please specify.. .....
2. Where is the location of landslides?
   a. The cliffs on the river
   b. Steep slopes on the roadside
   c. Hilly and high mountain
   d. Other, please specify……
3. When landslides occur frequently (time)?
   a. The rainy season
   b. The dry season
   c. At any time
   d. Other, please specify……
4. Do you have experience with landslide events before?

   □ Yes, once □ Yes, twice □ Yes, more □ No
5. How big landslide which occurred based on your experience?

   □ Low □ Medium □ High
6. Have you been evacuated, when landslide occurred?

   □ Yes, how long:……days □ No
7. Where have you been evacuated when landslide occurred?

   □ Mosque □ School □ Neighbour □ Family □ Government office
   □ Other
8. What kind of losses when landslide occurred?

   □ Death of a family member □ Complete house damage □ Partial house damage
   □ Land destruction □ Loss of livestock □ No loss
   □ Agriculture destruction (Loss of crops)

9. What causes landslides?

□ The Excessive rain □ Deforestation □ Seismic activity □ Construction of roads
□ Construction of houses □ Due to the steep slope □ Due to changes in land use
□ Farming activities □ Don't know □ Other:

10. How often landslide was happen in your village?

a. Frequently (more than 5 events during 10 years)

b. Moderate (2-4 events during 10 years)

c. Rare (1 event during 10 years)

d. Never

11. Do you know the signs/symptom before landslide events?

a. Yes, What;…

b. No

D. **Plan for emergency during disaster**

1. Is the house available safety box (P3K) or essential medicines for family first aid?
   a. Yes
   b. No
2. Is there a family member attend training/skills evacuation/seminar/workshop/meeting on disaster preparedness?
   a. Yes, where:…..
   b. No
3. Is the house available for emergency basic needs (eg food, beverages, flashlights, etc)?
   a. Yes
   b. No
4. Is there a family of alternative communication tools (HP)?
   a. Yes
   b. No
5. Is the house available gear bag and disaster preparedness?
   a. Yes
   b. No
6. Is the house available address/phone number hospital, local disaster management, PLN, etc?
   a. Yes
   b. No

E. Disaster warning system

1. Is there any information about hereditary characteristics of the occurrence of landslide?
   a. Yes., state .....
   b. No
2. Are there any notices of government agencies on disaster warning?
   a. Yes., from whom.....
   b. No
3. What kind of information you received?
   □ Socialization of the susceptible areas
   □ Brochures about how to cope with landslides
   □ Landslide warning board □ Other:
4. Have there been any exercises or simulations that address these issues?
   a. Yes., when?.....From whom? .....
   b. No
5. Are there available early warning system in your village?
   a. Yes., What….
   b. No
6. Are this system can function well?
   a. Yes
   b. No., Why…..
7. Are you ready if involved in early warning system?
   a. Yes
   b. No
8. Could you share your phone's number and location to develop local early warning system?
   a. Yes
   b. No
9. Who is the stakeholder/institution should be involved in early warning system?
   □ Government □ Community □ NGO □ Other

APPENDIX 2. NODE RESPONDENT OF NGARGOSARI VILLAGE

No	Name	Sub Village	RT/RW	Village	X_PROJ	Y_PROJ
1	Budi Purwanto	Canden	48/21	Ngargosari	407790	9152256
2	Karto Utomo	Canden	49/21	Ngargosari	407552	9152125
3	Partiyah	Canden	49/21	Ngargosari	407581	9152112
4	Rini/Sukohadi	Canden	50/20	Ngargosari	407522	9152268
5	Supartilah / Sumarlan (Dukuh)	Canden	48/21	Ngargosari	407817	9152291
6	Tukijan	Canden	49/21	Ngargosari	407533	9152141
7	Suroso (Dukuh)	Ngaliyan	7/2	Ngargosari	406550	9152934
8	Yasir	Ngaliyan	4/2	Ngargosari	406717	9153132
9	Suwawan	Ngaliyan Gunung A	40/17	Ngargosari	407924	9153882
10	Y. Suhartanto	Ngaliyan Gunung B	43/18	Ngargosari	408064	9152659
11	IGN. Susanto	Nguntuk Untuk	54/23	Ngargosari	407432	9152132
12	Ngadilah	Nguntuk Untuk	52/52	Ngargosari	407754	9152731
13	Saban (Dukuh)	Nguntuk Untuk	54/23	Ngargosari	407411	9152197
14	Yustinus wahyu S	Nguntuk Untuk	52/52	Ngargosari	407667	9152694
15	Susanto (Dukuh)	Petet	19/07	Ngargosari	406688	9151925
16	Parinah	Pucung	14/04	Ngargosari	406398	9152319
17	Ponirah	Pucung	16/05	Ngargosari	406716	9152199
18	Poniran	Pucung	14/4	Ngargosari	406658	9152503
19	Suradi	Pucung	16/05	Ngargosari	406769	9152144
20	Tukijo	Pucung	14/04	Ngargosari	406485	9152428
21	Wakijo	Pucung	13/04	Ngargosari	406273	9152356
22	Winarsih/Suharyanto	Pucung	15/4	Ngargosari	406351	9152344
23	Karto Irono	Tegalsari	22/08	Ngargosari	405661	9153263
24	Sukamto	Tegalsari	22/08	Ngargosari	405661	9153263
25	Amat Suratun	Trayu	31/12	Ngargosari	407034	9153819
26	Dalinah	Trayu	31/12	Ngargosari	406969	9153784
27	Y. Kamijo	Trayu	32/13	Ngargosari	407179	9153609
28	Arif	Tritis	29/28	Ngargosari	406503	9154311
29	Iryanto	Tritis	25/10	Ngargosari	405662	9154101
30	Sukardi (Dukuh)	Tritis	29/28	Ngargosari	406057	9154280
31	Suyoto	Tritis	25/10	Ngargosari	405747	9153671
32	Sarti/Budiyanto (Dukuh)	Tulangan	34/14	Ngargosari	407554	9153540
33	Mustohal (Dukuh)	Tegalsari	23/9	Ngargosari	406301	9152933
34	Bambang Widjoyono	Trayu	32/13	Ngargosari	407181	9153464
35	Bambang Sukisno	Trayu	31/12	Ngargosari	406982	9153837
36	Sudarto (Dukuh)	Trayu	31/12	Ngargosari	407036	9153828
37	Suyono Efendy	Tegalsasri	24/09	Ngargosari	406439	9152973
38	Abdul Yurohman Saleh	Ngaliyan	9/3	Ngargosari	406865	9152804
39	Ngadah (Dukuh)	Pucung	16/05	Ngargosari	406761	9152203

APPENDIX 3. NODE RESPONDENT OF GERBOSARI VILLAGE

No	Name	Sub Village	RT/RW	Village	X_PROJ	Y_PROJ
1	Supardal (Dukuh)	Jati	50/25	Gerbosari	408586	9152633
2	Wasilah/Baridi	Clumprit	37/19	Gerbosari	407583	9151914
3	Budi Kartono	Manggis	23/12	Gerbosari	407876	9150640
4	Sumingan (Dukuh)	Clumprit	32/19	Gerbosari	407720	9151972
5	Bambang Suryanto (Dukuh)	Dukuh	57/28	Gerbosari	408794	91528532
6	Sarjono (Dukuh)	Jeruk	12/6	Gerbosari	408094	9150206
7	Sutiyah (Dukuh)	Keceme	76/37	Gerbosari	409544	9154163
8	Dwi Pandoyo (Dukuh)	Kemiriombo	05/03	Gerbosari	408576	9150314
9	Sarjiman (Dukuh)	Kayu Gede	67/33	Gerbosari	409277	9153270
10	Nasiyah (Dukuh)	Menggermalang	72/35	Gerbosari	409704	9153091
11	Poniran (Dukuh)	Ngroto	32/16	Gerbosari	407541	9151219
12	Ludiyo (Dukuh)	Manggis	25/13	Gerbosari	408792	9150359
13	Aris Dwihantara (Dukuh)	Sarimulyo	2/1	Gerbosari	409049	9149699
14	Surahmat (Dukuh)	Sumbo	62/30	Gerbosari	408728	9153483
15	Subar (Dukuh)	Ketaon	30/15	Gerbosari	407817	9150810
16	Slamet Untoro (Dukuh)	Tlogo	54/27	Gerbosari	408635	9153534
17	Muchsin	Kayu Gede	67/33	Gerbosari	409201	9153326
18	Dwi Wartini	Jeruk	12/6	Gerbosari	408323	9150247
19	Edi Purwanto	Pengos A	15/8	Gerbosari	409682	9150602
20	Suyatno	Kayu Gede	69/34	Gerbosari	409284	9153043
21	Jalaludin	Clumprit	37/19	Gerbosari	407530	9151789
22	Mahfud	Clumprit	37/19	Gerbosari	407547	9151896
23	Maryadi	Kayu Gede	69/34	Gerbosari	409285	9152944
24	Sumaryo	Keceme	78/38	Gerbosari	409684	9154469
25	Nurhidayat	Pengos A	16/8	Gerbosari	409723	9150403
26	Darmawan (Dukuh)	Pengos A	16/8	Gerbosari	409652	9150530
27	Haryanto	Kayu Gede	68/33	Gerbosari	409274	9153095
28	Riyanto	Kayu Gede	69/34	Gerbosari	409292	9152946
29	Rejowiyono	Clumprit	38/19	Gerbosari	407668	9151818
30	Sukardi, S.Sos (Dukuh)	Sendat	65/32	Gerbosari	409155	9151855
31	Rusmilah/Sumarjo	Manggis	24/12	Gerbosari	408224	9150730
32	Surahman	Clumprit	37/19	Gerbosari	407642	9151864
33	Yuli Fitriatun	Ketaon	1/23	Gerbosari	407870	9151065
34	Sri sudarmilah/Paryono	Tlogo	53/27	Gerbosari	408433	9153415
35	Parjaelan	Pengos B	19/10	Gerbosari	409452	9150132
36	Suratiman (Dukuh)	Jetis	39/20	Gerbosari	408204	9152379
37	Djuwali (Dukuh)	Pengos B	22/11	Gerbosari	408460	9151065
38	Nasrun (Dukuh)	Karang	43/20	Gerbosari	408334	9151770
39	Sukito	Tlogo	52/26	Gerbosari	408571	9153073

APPENDIX 4. SCRIPT

a. Googlemaps.php

```
var locations = [
<?php
include "config.php";
$conn = mysql_connect($host, $username, $password);
mysql_select_db($database, $conn);
$sqlz = "SELECT * FROM responden";
$resultz = mysql_query($sqlz, $conn);
while ($row = mysql_fetch_array($resultz)){

$id = $row["id"];
$nama = $row["nama"];
$dusun = $row["dusun"];
$rtrw = $row["rtrw"];
$telepon = $row["telepon"];
$latitude = $row["latitude"];
$longitude = $row["longitude"];

echo "['$nama', $latitude, $longitude, $id,";

$sqlz2 = "SELECT * FROM sms where smsid=$id order by no_id
desc limit 1";
$resultz2 = mysql_query($sqlz2, $conn);
while ($row = mysql_fetch_array($resultz2)){
$tanggal = $row["tanggal"];
$message = $row["message"];
$message = rtrim($message);
echo "'$tanggal | $nama : $message'],";

}

}
?>

      ['Supartilah', -7.66821496, 110.16417908, 1,'Supartilah
ada rekahan 20 cm']

];

var myLatLng = new google.maps.LatLng(-7.66821496,
110.16417908);
var mapOptions = {
  zoom: 16,
  center: myLatLng,
  mapTypeId: google.maps.MapTypeId.TERRAIN
}

    var map = new
google.maps.Map(document.getElementById('map'), {
```

```
      zoom: 16,
      center: new google.maps.LatLng(-7.668, 110.161),
      mapTypeId: google.maps.MapTypeId.TERRAIN
    });

    var infowindow = new google.maps.InfoWindow();

    var marker, i;

    for (i = 0; i < locations.length; i++) {
      marker = new google.maps.Marker({
        position: new google.maps.LatLng(locations[i][1], lo-
cations[i][2]),
        map: map
      });

      google.maps.event.addListener(marker, 'click', (func-
tion(marker, i) {
        return function() {
//          infowindow.setContent(locations[i][0]);
          infowindow.setContent(locations[i][4]);
           infowindow.open(map, marker);
        }
      })(marker, i));
    }

var ctaLayer = new
google.maps.KmlLayer('http://www.intersat.net.id/webgis/peta.
kmz');
ctaLayer.setMap(map);
```

b. Gammu-jme.php

```
<?php
class Data
{
      function __construct($a)
      {
            include "/home/jme/public_html/wap/config.php";
            $this->a = $a;
            mysql_connect($host,$username,$password);
            mysql_select_db($database);

            $this->sql ="select * from fungsi where na-
ma='".$this->a."'";
            $this->query = mysql_query($this->sql) or
die(mysql_error());
            $this->data = mysql_fetch_array($this->query);
      }

      function eksekusi($d)
      {
```

```
           if( ! empty($this->data))
           {
           // buka file jika tidak ada otomatis akan dibuat
filenya
                $fo = fopen($this->data["nama"].".php",'w');

                // data yang akan dimasukan ke dalamfile
                $isi = "<?php\n";
                $isi .=  $this->data["fungsi"];

                fwrite($fo,$isi); // simpan isi file
                fclose($fo);

           // include kan file yang tadi dibuat
           //variable $d bisa diakses dari file baru yang ta-
di dibuat
                include($this->data["nama"].".php");
           }
           else
           {
                echo "Fungsi tidak ditemukan";
           }
     }
}
include "/home/jme/public_html/wap/config.php";
mysql_connect($host, $username, $password);
mysql_select_db($database);

// query untuk membaca SMS yang belum diproses
$query = "SELECT * FROM inbox WHERE Processed = 'false'";
$hasil = mysql_query($query);
while ($data = mysql_fetch_array($hasil))
{
  // membaca ID SMS
      $id = $data['ID'];

        // membaca no pengirim
          $noTelp = $data['SenderNumber'];
          $nama = "SELECT * FROM responden WHERE telepon =
'$noTelp' limit 1";
          $namanya = mysql_query($nama);
          while ($data2 = mysql_fetch_array($namanya))
            {
             $nama2 = $data2['nama'];
            }
            // membaca pesan SMS dan mengubahnya menjadi ka-
pital
               //$sms = strtolower($data['TextDecoded']);
             //$sms = str_replace("'","''",$sms);
              $sms = $data['TextDecoded'];
//$sms = 'info.123.123.4545';
```

```
$ex = explode('#',$sms);

$d = new Data($ex[0]);
$d->eksekusi(array($ex));

//mysql_select_db($database);
//mysql_close();
include "/home/jme/public_html/wap/config.php";
mysql_connect($host, $username, $password);
mysql_select_db($database);
  $query18 = "INSERT INTO outbox (DestinationNumb-
er,TextDecoded) VALUES ('+6285641441362','$nama2:$sms')";
  $query19 = "UPDATE inbox SET Processed = 'true' WHERE ID =
'$id'";
  $query20 = "INSERT INTO outbox (DestinationNumb-
er,TextDecoded) VALUES ('+628122519315','$nama2: $sms')";
  $query21 = "INSERT INTO outbox (DestinationNumb-
er,TextDecoded) VALUES ('+6281328016904','$nama2: $sms')";
  $query22 = "INSERT INTO outbox (DestinationNumb-
er,TextDecoded) VALUES ('$noTelp','Terimakasih sudah mengi-
rimkan SMS ke kami, data tsb akan segera kami tindaklanju-
ti')";

//echo $query18;
  mysql_query($query18);
  mysql_query($query19);
  mysql_query($query20);
  //mysql_query($query21);
  mysql_query($query22);

$query4 = "select * from responden where telepon=$noTelp";
$search4 = mysql_query($query4);
while ($row4 = mysql_fetch_array($search4))
{
$smsidku=$row4['id'];
$smsidku=trim($smsidku);
}
//echo "$smsidku";
$query22 = "INSERT INTO sms (smsid,tanggal,message) VALUES
('$smsidku',now(),'$sms')";
mysql_query($query22);
//echo $query22;

}
```