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Farmer's perception and knowledge on landslide occurrences in Beruk Village, Karanganyar Regency, Central Java

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Abstract. Karanganyar Regency is one of the most prone area to landslides in Central Java. According to DIBI records, 77 of the 149 types of natural disasters that occurred in this area were landslides during 2008-2018 and the trend tends to increase. In disaster management, the ability of the community to reduce the risk of landslides is reflected in capacity. The objective of this study is to know the farmers understanding on landslide factor, landslide occurrences and impact, and landslide mitigation in Beruk Village, Karanganyar Regency. The data was collected by interview to 109 farmers household, and the analysis was conducted by descriptive analysis. The result shows that the landslide is mostly caused by heavy and long duration of rain, indicator for landslide is ground cracks, and the mitigation mechanism is based on local knowledge of farmers such as managing irrigation system, planting trees, and managing land utilization. In Beruk Village, disaster management process is more to be responsive rather than preventive and the knowledge of farmers on land management play an important role in disaster risk reduction.

1. Introduction

Indonesia is a country which is prone to natural disasters, both geological or hydrometeorological disasters. This fact is related to the geographic setting of Indonesia that located in convergence zone of three major tectonic plates : Eurasia, Indo-Australia, and Pacific. Moreover, Indonesia is located in tropical area, which has high rainfall intensity, and lead some region in Indonesia prone to hydrometeorological disaster such as flood and storm. Based on geological and meteorological setting, Indonesia is prone to landslide disasters. Indonesia Disaster Data and Information (*Data dan Informasi Bencana Indonesia/DIBI*) recorded in 2008-2018 that there are 19.278 disasters which 4.456 disasters were landslide and still increasing [1,2,3].

Karanganyar Regency is one of the most prone area to landslides in Central Java. According to DIBI records, 77 of the 149 types of natural disasters that occurred in this area were landslides during 2008-2018 and the trend tends to increase. Landslides have also caused relatively large losses during this period, including 1,765 victims and 335 houses damaged [1]. The results of the risk assessment by the National Disaster Management Agency (*Badan Nasional Penanggulangan Bencana/BNPB*) indicated that an area of 17,827 ha of this area has the potential to experience landslides with a potential number of exposed population of 74,688 people and a potential loss of 714.8 billion Rupiah [4]. One area that has the potential to experience landslides is Beruk Village, Jatiyoso District. The



village is located on the slopes of the Lawu Volcano's foot which is experiencing a landslide disaster every year. In fact, a hamlet in the area was closed and the community was relocated to another hamlet due to a landslide disaster in 2016.

Scientists have put forward various theories about the causes of landslides. Landslides are basically the result of a complex combination of geological, topographic, hydrological, historical, climatological and biological factors [5]. Landslides are geomorphological processes related to the conditions of landform, material, structure, hydrology, climate, and vegetation in an area [6]. Certain human activities can also cause landslides, such as deforestation, cutting slopes for roads and buildings, and mining. Other causes of landslides specifically according to other scientists include weathering of materials, increased slope angles, head loading, changes in groundwater level, and destruction of vegetation [7]. Meanwhile, landslide factors according to people's perspectives can vary depending on the level of knowledge and experience with landslides.

The ability of the community to reduce the risk of landslides is reflected in capacity. This is related to various aspects, one of which is the perception and knowledge of the community regarding landslides. By knowing people's perceptions, the response of the community to survive and cope with disasters can be known in the future [8]. Perception of society itself is influenced by various complex factors, such as individual, psychological, social, economic, cultural and political factors. Based on this statement, the main objective of this study is to determine the perceptions and knowledge of farmers in Beruk Village on factors that cause landslides, impacts, and efforts to mitigate disasters. This needs to be studied to determine the actions and decisions of farmers in managing agricultural land in the sloping area, while assessing its capacity to cope with landslides. On the other hand, integration between local farmers' knowledge and scientific knowledge could be a reference in the assessment of landslide susceptibility in an area [9].

2. Methods

The study area is located in Beruk Village, Jatiyoso Sub Regency, Karanganyar Regency, Central Java. Beruk Village has 9 hamlet (*dusun*): Turus, Beruk Kulon, Beruk Wetan, Gunung Lading, Selangkah, Pringombo, Ngantirejo, Pengkok, and Kambanga. Morphologically, Beruk Village is located in hilly area which has steep slope with material from Old Lawu Formation.

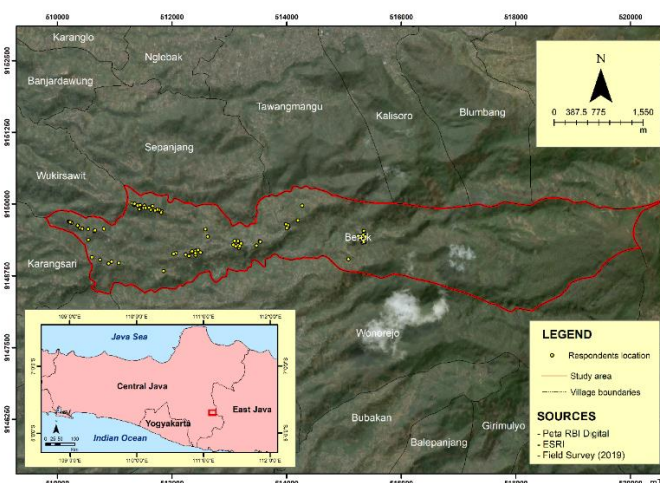


Figure 1. Study area.

The data collection method in this research is interview with 109 of chosen respondent by systematic random sampling (see in Figure 1). Samples were chosen from 550 farmer household population with margin of error 5%. The farmers were chosen to be population of this research because they are more intense in interacting with landslide and the most vulnerable group when the landslide happens. The respondent consists of 46 females and 63 males, and most of them were

between 40-60 years old with relatively low level of education. Questions given to respondent were open questionnaire, which may allow the farmers to give more than one answer. The method of data analysis is descriptive by using statistical data and combine it with some previous research and theories to enrich the analysis.

3. Result and discussion

3.1. Farmers understanding on landslide factors

The most influential factors for landslides according to farmers in Beruk Village varies and can be more than one answer (having the same weight). In general, they answered that the causes of landslides were 4 types, namely rainfall, slope, soil characteristics, and land use. Based on Figure 2, a high percentage of farmers (51%) said that rainfall as the factor that has the most influence on landslide occurrences. It was based on the experience of farmers, where landslides usually occurred after rain. The farmers said that most landslides occurred during the rainy season.

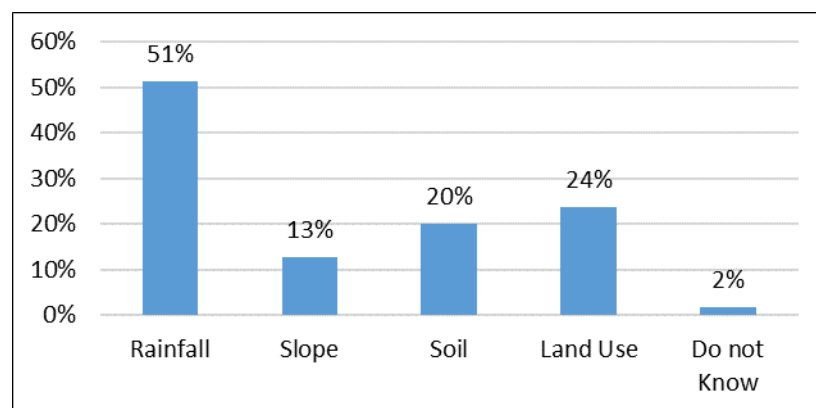


Figure 2. Main factors of landslides (Data Measurement 2019).

Some farmers answered that the main factor causing landslides was land use, soils, and slope. The percentage of farmers that answered those factors are 24%, 20%, and 13%, respectively. Only 2% of farmers do not know the main factors causing landslides. Land use is the second most answered factor by farmers as the main factor causing landslides because most landslides occurred on agricultural land. Soils act as a slip surface in a landslide event. Meanwhile, the number of farmers who answered the slopes as a major factor causing landslides was relatively small. It was different from the landslide hazard or susceptibility assessment that had been conducted by several researchers by using semi-quantitative method, where the slope had a relatively high weight, while land use had a relatively low weight [10,11,12]. Slope is the main factor that causes landslides [11]. Meanwhile, most farmers in Beruk Village did not see it as the main factor causing landslides. It can be caused by the construction of people's thinking where steep slopes have become part of their livelihood so that the slopes are no longer act as main factor in landslides based on their perceptions.

This study also tried to ask the characteristics of rainfall, slope, soils, and land use which caused landslides. Based on the previous analysis, the causes of landslides according to the respondent's answers were the same as the landslide causing factors in the questionnaire that will be asked for their characteristics. In addition, each respondent could answer more than one answer for each factor.

Rainfall characteristics that affect landslides according to farmers vary. Based on Figure 3, most farmers (83%) thought that the characteristics of rainfall that cause landslides are heavy with long duration, while the rest answered heavy with short duration (9%), light with long duration (6%), and do not know (3%). Heavy rainfall in the experience of respondents was the characteristic of rainfall that most often causes landslides because it usually occurred during heavy rains and overnight (about 6 hours). The potential erosion is higher when the heavy rainfall occurs so that the slope of instability

increases [13]. During the rainy season, the duration of the rain is longer so that landslide occurrences will be more frequent [14].

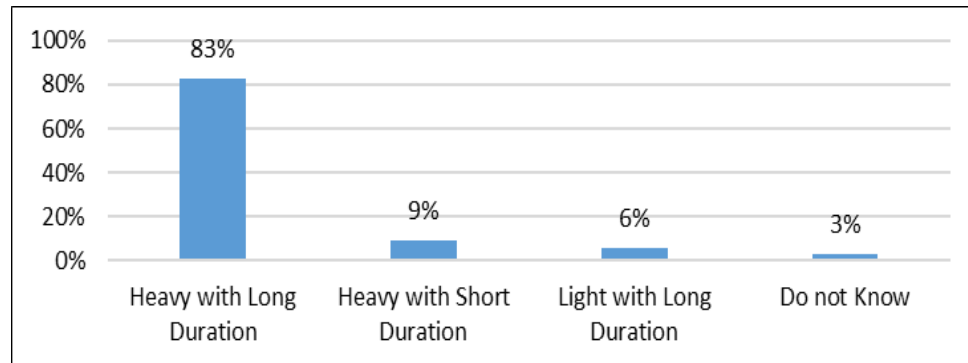


Figure 3. Rainfall characteristics on landslide occurrences (Data Measurement 2019).

Land use types that contribute to landslides according to farmers include rice fields (34%), dry fields (30%), plantations (23%), settlements (14%), and others (17%) (Figure 4). The other categories includes yards, roads, forests, and bare land. Agricultural land as part of their livelihood had the greatest contribution to landslides. Rice fields are found in the gentle slope and have an irrigation system, while plantations and dry fields (*tegalan*) are found in the steeper slope. The agricultural practice adopts several conservation techniques, such as terrace, raised bed (*bedengan*), and contour farming. However, inappropriate farming systems can cause slope failures [15]. The farmers said that irrigation systems affected landslides on agricultural land. Inundation of agricultural land can increase loads. In addition, terrace can also increase pore water pressure so that it triggers slope failures [16]. In addition, the raised bed technique is made to stretch in the direction of the slope. This technique is not appropriate to be applied because it can increase the rate of erosion, which then causes landslides [17].

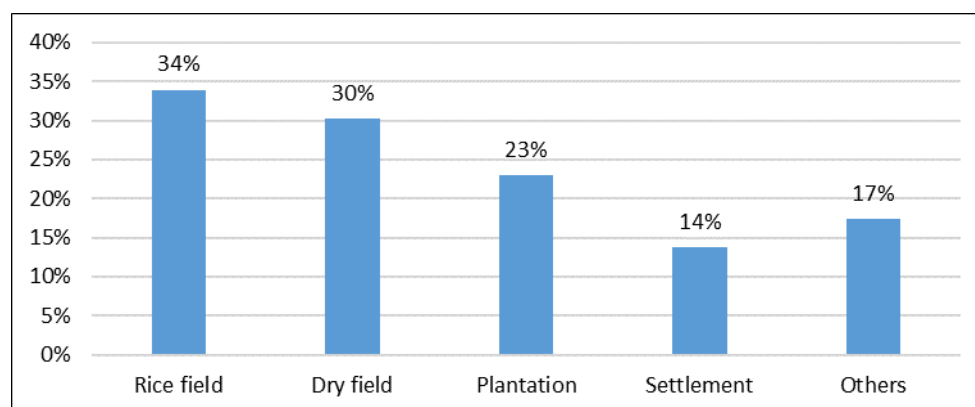


Figure 4. Land use types that contribute to landslide occurrences (Data Measurement 2019).

Based on the interview results (shown in Figure 5), the most influential soil characteristics of landslides according to farmers include friable (65%), clay (14%), stony (10%), compact (4%) and muddy (3%). The rest said that they didn't know. Their answers were greatly influenced by their experience in cultivating the top layers of soils which are generally based on consistency and texture. Soils that have a friable consistency usually have a relatively high sand fraction [18]. The soil also has a high capacity to support plant growth [19]. However, friable soils have the ability to quickly flow water into the soil to penetrate more compact soil or rock as a slip surface.

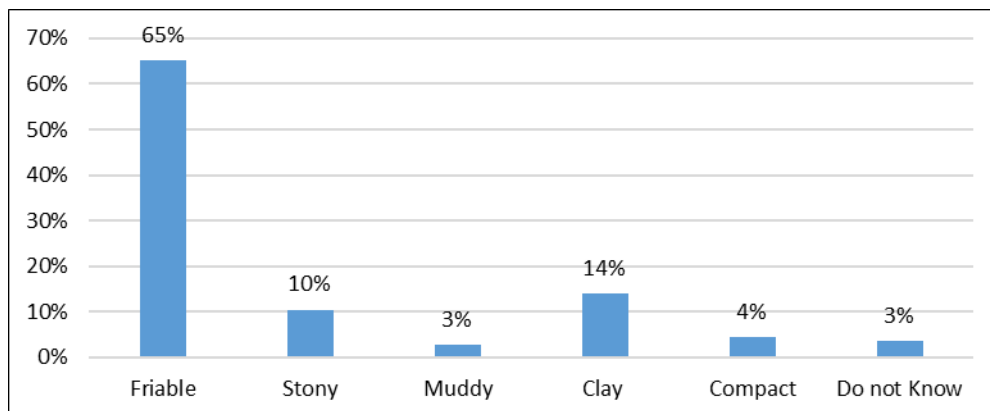


Figure 5. Characteristics of soils with landslides (Data Measurement 2019).

Based on Figure 6, the characteristics of the slopes that most affect landslides according to farmers are precipitous slopes (67%), while the rest answer steep slopes (29%), gentle slopes (1%), and do not know (3%). The slope characteristics were visualized in the form of images when interviewed. The farmers saw that the greater the angle of slope, the higher the susceptibility of landslides, even though the slope is not the main factor that causes landslides based on their perceptions. In general, the angle of slope determines slope stability, especially when associated with safety factors [20].

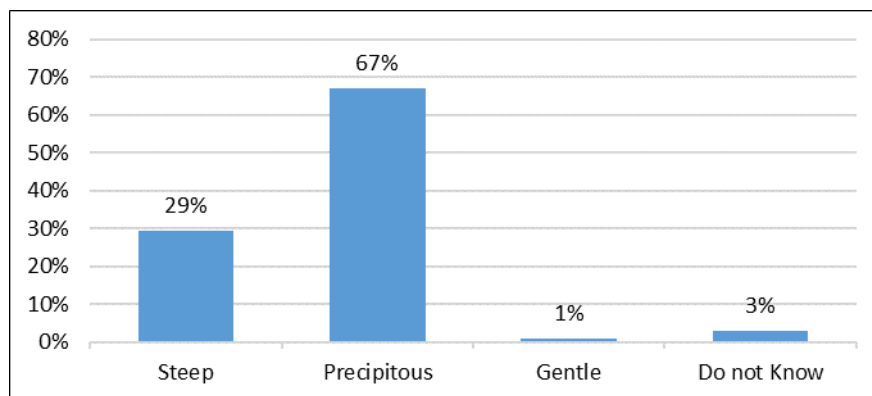


Figure 6. Characteristics of slopes with landslides (Data Measurement 2019).

3.2. Farmers understanding on landslide occurrences and impacts

Landslides dominantly occurred without any specific indication before. The farmers identifying landslides by the rainfall condition that may triggering the emergence of springs and ground cracks. Based on their experience, most of landslides occurred after heavy and long duration of rainfall. Another indication of landslides according to respondent is the occurrences of some small debris fall. Figure 7 show that 54% respondents give answer that landslides were indicated by ground cracks, 10% by spring appearances, 28% by ground vibrations, and 8% do not know. Based on the graph, it can be concluded that ground cracks is the most indicator of landslide that is easy to know by farmers.

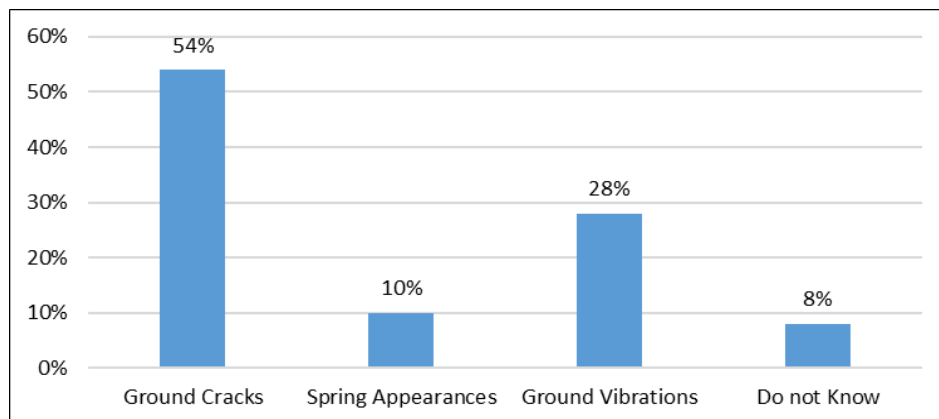


Figure 7. Indicator of landslide (Data Measurement 2019).

Actually, the farmer's answer is influenced by previous experience. Take a case of a big landslide event in Beruk Village at 2nd December 2016, the landslide occurred after heavy rainfall in a night. The landslide buried one hamlet (Dusun Tasin), but fortunately there is no death victims. The hamlet was administratively part of Beruk Village, but it has been closed. According to interview with respondents, the villagers were safe from disaster because they were relocated before the event. Local government took decision to relocated the villagers after some small landslides were occurred. At that time, the villagers were relocated 3 months before big landslide, but actually the agricultural activities still go on. This one is an example that in some case, local government has a preventive action in disaster risk reduction.



Figure 8. The biggest landslide event in Dusun Tasin.

Source : Data Measurement 2019.

Almost all respondents answered that their agricultural land had experienced landslides (106 out of 109 farmers). However, for the financial impacts, the farmers got difficulties in determining how much the financial loss. According to interview, the financial loss become IDR1000000 to IDR5000000 depended on what kind of commodity and how much of the selling price of the commodity. Some farmers determined the financial loss by the budget for land reclamation after landslide, it may be variant, depend on how big the landslide. Based on Figure 9, the landslide impacts to the agriculture land have variation despite it is in the same location, and it could not be predicted.



Figure 9. Landslide occurrences in agriculture land.

Source : Data Measurement 2019.

3.3. Farmers understanding on landslide disaster mitigation

In order to reduce the adverse impact of landslide, the community, especially farmers, should have disaster mitigation mechanism. Disaster mitigation can be structural or non-structural mitigation [21]. The structural mitigation is an effort to reduce the adverse impact by improving disaster infrastructure such as developing geotextiles, gabions, bioengineering, and drainage improvements. Non-structural mitigation is carried out through efforts to raise awareness, increasing the capacity of the community to reduce the risk of landslide and also developing landslide early warning system (EWS),

Based on observation, Beruk Village does not have early warning system, no evacuation sign, and no gabion in slope that is prone to landslide. Moreover, the result from interview conclude that there is less optimum effort from government in preparing community to face landslides. Whenever some region in Indonesia has a *Taruna Siaga Bencana* (community for disaster response in village level), Beruk Village does not have. The local government just have *Linmas* (*Perlindungan Masyarakat*) as fast respond community when disaster happens. Eventhough in previous event the local government did preventive action, but generally the disaster management in Beruk Village just respond the disaster occurrence and do not prevent it. Despite, the farmers still have a mechanism to prevent and reduce the landslide vulnerability in their agriculture land.

Farmers mitigate the landslide hazards by planting some trees in their agricultural land, such as andong (*Cordyline fruticosa*) which can strengthen the slope. They plant this trees for every slope part, mixed with agricultural plant. Another structural mitigation is by managing the irrigation systems, that might prohibit the water infiltrated in slope and caused landslide. The farmers did cementation in their irrigation system, so the water will not infiltrate to the slope and prevent landslide (Figure 10).



Figure 10. Cemented irrigation system in the sloping area.

Source : Data Measurement 2019.

For non-structural mitigation, there is a system of knowledge sharing between farmers who have experienced landslides and non experienced farmers. In Beruk village, there is an annual meeting between housewife which allows them to share experience and knowledge to prevent the landslide. According to interview with Mr. Kasno (villager), if there is an indication of landslide (long duration and intensive rainfall, ground cracks, debris fall) in sloping area, the villagers will move to another family member's house in safe area. This fact is represent the strengthness of social relationship between the villagers. Farmers understanding on landslide mitigation is a manifestation from farmers experiences in facing previous landslide. Then, the agriculture mechanism promote by farmers is being the product of adaptation process. Knowing the farmers understanding in disaster mitigation is important for policy makers to give suitable intervention in disaster risk reduction.

4. Conclusions

Farmers in Beruk Village have different perceptions of landslides. Farmers' answers to factors causing landslides are influenced by their experiences and observations on their agricultural land. Most farmers said that rainfall is the main landslides factor in Beruk Village, especially heavy rainfall with long duration. They also acknowledged that agricultural land, including friable top soils, contributed greatly to landslides. Uniquely, only a small proportion of farmers answered that the slope was the main factor causing landslides, although they also answered that the potential for landslide events are higher if the slope angle are greater.

Most farmers in Beruk Village have known signs of landslides. The ground cracks is the most indicator of landslide that is easy to know by farmers. The farmers understanding of landslide impacts is very related to the past major landslide events, especially in Dusun Tasin on 2nd December 2016. In addition, almost all respondents answered that their agricultural land had experienced a landslide. The financial losses were varied, depending on the size of the landslide and the commodities.

Landslide risk reduction has been carried out by farmers through planting trees and improving irrigation systems. They also held an annual meeting between housewife which allows them to share experience and knowledge to prevent the landslide. However, landslide disaster management in general is still responsive-based, which is characterized by the absence of EWS, evacuation sign, special communities to reduce disaster risk, or other forms of mitigation. Therefore, the government and decision makers must play a role in reducing the risk of landslides in Beruk Village while at the same time utilizing the local knowledge of farmers in managing their agricultural lands that are prone to landslides to promote community-based disaster risk management.

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