

# Household Willingness to Pay for Landslide Hazard Mitigation in Purworejo, Indonesia

Endah Saptutyingsih  
 Universitas Muhammadiyah Yogyakarta,  
 Indonesia  
[endahsaptuty@umy.ac.id](mailto:endahsaptuty@umy.ac.id)

Diswandi  
 Universitas Mataram, Indonesia  
[diswandi@unram.ac.id](mailto:diswandi@unram.ac.id)

Melawati Nur Aziizah  
 Universitas Muhammadiyah  
 Yogyakarta, Indonesia  
[melawatinuraziizah@gmail.com](mailto:melawatinuraziizah@gmail.com)

**Abstract**— Landslide hazard could have severe impacts on public properties including damaged infrastructure, changing land structure, relocation of buildings and roadways, reduction on water quality in streams and irrigation facilities, etc., Household mitigation for landslide hazard is necessary to reduce such hazard intensity and minimize the impacts. This paper has analyzed household's willingness to pay (WTP) for landslide hazard mitigation in a high potential risk for landslide hazard regency in Purworejo, Central Java Indonesia. Contingent Valuation Method (CVM) was employed to capture the household's WTP. Determinants of the household WTP were estimated using the Logistic regression model. 270 households were chosen using a purposive sampling technique as the respondents of this study. Results showed that 76.7 percent of respondents were willing to pay for an average of IDR 4,500 (USD 0.32) for landslide mitigation. Household income, distance to landslide location, frequency of landslide, and educational attainment have significant effects on the WTP. The paper recommends that the local government should pay more attention to the landslide hazard mitigation programs.

**Keywords**— *landslide; contingent valuation method; disaster mitigation; willingness to pay*

## I. INTRODUCTION

A number of studies on the impact of landslide hazards on human well-being take into account the direct and indirect costs of landslides (Fleming & Taylor, 1980; Roberds, 2005; Schuster, 1978, 1996), "including damage to buildings, land, and (or) rebuilding buildings, land and other repairs, so that they are as nearly as to the same condition as prior to the landslide" (Leighton, 1976). In particular, indirect costs include protecting community health and safety, preventing or reducing additional landslide damage, relocating buildings and highways, dealing with secondary physical effects such as flooding, deteriorating water quality, decreasing agricultural or industrial production, decreasing value of affected property. In addition to this is the lost time and decreased income, which leads up to loss of purchasing power and so on. Most of these costs are rarely calculated so damage assessments tend to be very low. According to Schuster (1978), direct costs are tangible and easily estimated or measured in dollars, whereas indirect costs are more difficult to evaluate, albeit they possibly in outweighing the direct costs. The direct and indirect costs associated with the impact of landslides can be identified through two approaches, namely the analysis of the "event tree" and "fault tree" (Roberds, 2005). The former identifies consequences that may arise after landslide hazards. The latter provides information about failures that may occur to

evaluate landslide hazards. The results can then be used as recommendations for decision makers to implement various policies to mitigate the impact of landslides.

Almost all regions in Indonesia have landslide prone points, one of which is Central Java Province. It consists of 35 districts/cities, most of which are in the red zone of landslides, including Purworejo Regency. In just two years there were 3,406 people being evacuated from landslides, 1,905 casualties, 8 missing, 48 injured and 74 died. More than 50% of the victims died in Purworejo Regency, and 288 people were evacuated. Every rainy season, Purworejo experiences a landslide. In 2016, Purworejo District called for an emergency in response to the landslides which caused 46 deaths in Karangrejo Village, Loano Subdistrict and Donorati Village, Purworejo District.

The trade-off between the various impacts of landslides is expressed in the willingness to pay (WTP) to mitigate the impacts (Roberds, 2005). To reduce the hypothetical bias, willingness to pay (WTP) rather than willingness to accept (WTA) should be used (List, 2001). To estimate WTPs in mitigating the impact of natural disasters, especially landslides in the framework of total economic value, the common method is the contingency valuation method (CVM) with survey instruments built to meet the protocol (Mitchell, RC & Carson, 1989, Haab & McConnell, 2002). This study uses CVM to determine household's WTP in mitigating landslides impacts. This method has two advantages. First, it considers two values at once, the use value and the non-use value. Second, it answers questions about WTP or WTA and can be corrected directly in theory by using monetary measures at the level of change. Previous research applying CVM showed that the willingness to support landslide mitigation programs financially had a positive benefit (Koler, 2004, 2005). Studies in this area include those using CVM to identify the determinants of WTP for disaster mitigation in Indonesia (Hidayati & Suryanto, 2015; Rusminah, & Gravitiani, 2012; Saptutyingsih & Suryanto, 2011). A study focusing on the WTP for landslide's mitigation remains an area that requires further exploration.

To fill this research gap, this paper examines respondent's WTP to mitigate the impacts of landslide. We surveyed respondents in villages in Purworejo, Indonesia. There were two landslides in Purworejo regency namely, Tlogoguwo and Kaliharjo landslides. Using a logistic regression model, we examined the impacts of sociodemographic and other factors on the farmers' willingness to mitigate the landslide. This study contributes

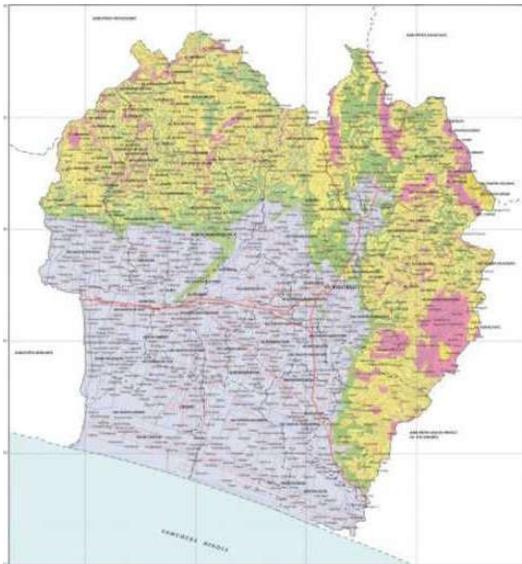
to the body of literature by identifying potential factors of respondents' willingness to aid landslide mitigation.

II. METHODOLOGY

A. Study site

This study was conducted in Purworejo, Indonesia, where natural disaster of landslides occurred. For instance, in 2016, there was a landslide that caused the deaths of 46 people. Landslides hazard potentially occur in several villages such as Tlogoguwo and Kaliharjo in Purworejo District, as shown in Figure 1.

The area of Purworejo Regency is 1,034.82 km consisting of 2/5 lowland and 3/5 mountainous areas. Purworejo Regency is prone to landslides due to its topography which is a mountain with a slope that reaches > 30° and the remaining of the weathered clay soil above the impermeable rock. Mountainous area with steep slopes and high rainfall means a high potential for landslides.



Source : Geology Agency, Center for Volcanology and Disaster Mitigation, 2017  
 Fig. 1. Map of Potential for Landslide in Purworejo

Considering the frequent occurrences of landslides and the amount of material loss, it is necessary to have mitigation efforts to prevent landslides and reduce the impacts. The existence of an Early Warning System (EWS) is also very helpful for disaster preparedness in Purworejo regency. Frequent ground movements and high rainfalls make residents prepared in response to the disaster. Ironically, the impacts of past landslides do not make people vigilant and cautious enough to stay away from landslide-prone areas. Therefore, impact mitigation and approach to the people of Purworejo Regency is very important to reduce the risk of greater natural disasters.

B. Survey design and administration

We surveyed households in the study site to investigate their WTP for landslide mitigation. They were selected from two villages (Tlogoguwo and Kaliharjo) in Purworejo. In order to identify the amount of financial contribution for the mitigation, we conducted a focus group discussion with 15 well-informed respondents from two villages in the landslide prone area. With bids above IDR 2,000 (USD 0.14), results

of a single bound study showed that the informed respondents were willing to pay of IDR 4,500 (USD 0.31) monthly for landslide mitigation.

Thus paper has used the contingent valuation method that constructed a hypothetical market to measure participants' willingness to pay or willingness to accept a certain change in natural resources (Bateman et al., 2002; Cruz, 2007; Haab & McConnell, 2002; Zhongmin et al., 2003). Based on bids above IDR 2,000 (USD 0.14), results of a single bound study showed that the informed farmers were willing to pay of IDR 4,500 (USD 0.31) for landslide mitigation. Based on this estimation, we designed a question to find out whether participants would agree or disagree to pay IDR 4,500 (USD 0.31) monthly for the landslide mitigation.

We surveyed 270 respondents selected from two villages in Purworejo who lived in the landslide-prone area. The sample size was determined by the Slovin formula. The surveys were conducted using two-stage sampling. The survey mode was face-to-face on-site survey (Le Goffe, 1995; Lee & Han, 2002; Lee, 1997; Togridou, Hovardas, & Pantis, 2006). At the first stage, stratified sampling was used to obtain a representative sample from both villages in the landslide prone area. At the second stage, we used random selections of 135 respondents per village.

C. Data Analysis

To identify the determinants of landslide mitigation, this study employed a logistic regression. The dependent variable of the model was the household's contribution to the mitigation, where 1 indicated agreement and 0 disagreement. The independent variables of the model consist of sociodemographic characteristics, asset characteristics, risk characteristics, and social capital characteristics (Table 1).

TABLE I. THE DEFINITION OF EXPLANATORY VARIABLES

Categories	Variables
WTP for landslide mitigation	Contribution to the monthly payment (USD 0.31) for landslide mitigation (1: yes, 0: no)
Sociodemographic characteristics	Respondent's (year) Respondent's sex (1: male, 0: female) Years of schooling (years) Income per month (IDR)
Asset characteristics	House ownership (1: yes, 0: no) Length of stay (years)
Risk characteristic	Distance from home to landslide point (metres) Frequency of landslide experienced
Social capital characteristic	Respondent's participation in social communities (1: yes, 0: no)

The basic model of the logit estimation is as follows:

$$\text{Log}_e \left[ \frac{p(y = 1) | x_1 \dots x_p}{1 - p(y = 1) | x_1 \dots x_p} \right] = \text{Log}_e \left[ \frac{\pi}{1 - \pi} \right]$$

$$= \alpha + \beta_1 x_1 + \dots + \beta_p x_p = \alpha + \sum_{j=1}^p \beta_j x_j$$

(Equation 1)

where  $\pi$  is a conditional probability of the form  $P(Y=1|X_1... X_p)$ . The above log odd is known as the logit transformation of  $\pi$ , and the analytical approach described here is sometimes known as logit analysis. The logistic function followed:

$$\langle P(Y = 1|X_1 \dots X_p) \rangle = \frac{\exp(\alpha + \sum_{j=1}^p \beta_j x_j)}{1 + \exp(\alpha + \sum_{j=1}^p \beta_j x_j)}$$

(Equation 2)

This can be also be transformed into:

$$\langle P(Y = 1|X_1 \dots X_p) \rangle = \frac{1}{1 + \exp(-\alpha - \sum_{j=1}^p \beta_j x_j)}$$

(Equation 3)

The nonresponse probability is:

$$P = (Y = 0|X_1 \dots X_p) = 1 - p(Y = 1|X_1 \dots X_p) = \frac{1}{1 + \exp(-\alpha - \sum_{j=1}^p \beta_j x_j)}$$

(Equation 4)

where  $Y = 1$  (or yes) if the respondents are willing to pay IDR 4,500 (USD 0.31), and  $Y = 0$  (or no) if otherwise. Using the set of predictors, the logistic regression equation for the log odds in favour of contribution for landslide mitigation was estimated as:

$$\log \left[ \frac{p}{1-p} \right] = b_0 + b_1 x_j + \varepsilon_t$$

(Equation 5)

The above log equation is a log-odd ratio, which is the logarithm of the odds that a choice to contribute to landslide will be made by households. The signs of parameter and their statistical significance indicate the direction of the households' response (Gujarati, 2009).

### III. RESULT AND ANALYSIS

The study results indicated that 76.7% of the respondents (n=188) were willing to pay for landslide mitigation as much as IDR4,500, while the 23.3% (n=82) were not willing to do so (see Table 2). Among the sociodemographic characteristics, the ones that had positive and significant impacts on the WTP were education and income. Sex and age, on the other hand, had no significant impact. As for the asset characteristics, house ownership had slightly positive impacts on WTP for landslide mitigation. Meanwhile, the distance from residence to the landslide point had no significant impacts. Frequency of landslide experienced had significantly positive effects on WTP to mitigate landslide impact. Of the social capital characteristics, community had a positive and significant impact on their WTP.

Respondents who were willing to pay a total of IDR 4,500 to mitigate the impact of landslides amounted to 76.7 percent. Respondents who were over 40 years old made up 74.4 percent of the total respondents. As many as 38 percent of respondents were male. Respondents with income less than 1 million rupiah amounted to 74.1 percent. Respondents who own buildings amounted to 92.6 percent, with 70.4 percent living in the property for more than 50 years. The majority levels of education were elementary and high

school graduates. 75.9 percent of the respondents lived less than 1 km from the critical point. About 36.7 percent of respondents had experienced landslides, with 14.1 percent being victims of landslides.

TABLE II. RESULTS OF A LOGISTIC REGRESSION MODEL

Variables	Odds ratio	Stand. error
Constant	0.493	0.632
Age	1.010	0.681
Sex	0.586	0.132
Education	1.730**	0.033
Income	1.000**	0.058
Ownership	2.479 *	0.096
Length stay	0.996	0.791
Distance	0.579***	0.007
Frequency	0.421**	0.466
Community participation	2.320 **	0.019
Nagelkerke R <sup>2</sup>	0.237	
Wald	39.667	0.000

Dependent variable: WTP for landslide mitigation

<sup>a</sup>. \*significant at  $\alpha = 10\%$ ; \*\*significant at  $\alpha = 5\%$ ; \*\*\*significant at  $\alpha = 1\%$

Among the socio-demographic characteristics, education and income has a significant impact on WTP in mitigating landslide impacts. Education has a positive and significant influence on the WTP, which means that people with higher education will have greater willingness to pay for landslide mitigation compared to those with lower education. This is because one's knowledge and awareness to protect themselves from the risk of natural disasters increases with the level of education. In line with previous research conducted by Rusminah and Gravitiani, (2012), education has a positive effect on WTP for flood disaster mitigation. In addition, research by Hidayati and Suryanto (2015) concluded that the respondent's last education level has a significant positive effect on climate change. People were indeed willing to pay for climate change mitigation in Central Java (Gravitiani et al., 2016). In another context, education also affects the willingness of cocoa farmers to insure their farms (Okoffo, 2016).

Income has a positive and significant influence on WTP for landslide mitigation. Communities with higher incomes are willing to pay more money for landslide mitigation than those with low income. This is in line with previous studies on WTP for natural disaster mitigation (Rusminah & Gravitiani, 2012; E. & P. Saptutyingsih, 2013; Suryanto, 2015).

As for the asset characteristics, house ownership had a positive and significant influence on WTP to mitigate landslide impacts. People who own a house has higher WTP for mitigating landslide impact than those who do not. They might feel that it is riskier to leave their house uninsured in case of landslide, so they would pay more for mitigating the landslide impacts.

The distance of residence with landslide points has a significant effect on willingness to pay for landslide

mitigation. This research is in line with previous research which stated that the distance between residence and disaster center has an influence on WTP (Ghanbarpour et al., 2014). In addition, research conducted by Rusminah and Gravitiani (2012) also found that the distance between rice fields and rivers affected people's willingness to mitigate floods. According to the Regional Disaster Management Agency (BPBD), the communities in the study sites were in landslide-prone areas belonged in the natural disaster red zone, but they felt comfortable as they had lived in the area for a long time. They did not want to move to a safer area. One reason was because of work. This research is in line with the research by Hendayana (2012) which found that the distance of residence with agricultural land did not significantly influence the adoption of technology to mitigate the impact of climate change.

The frequency of landslides had a significant positive influence for willingness to pay for natural disaster mitigation. The results of this study differ from previous studies conducted by Rusminah and Gravitiani (2012) which stated that the intensity or frequency of floods did not affect farmers' willingness to pay for flood disaster mitigation. In the research location, respondents live and do their daily activities within the area so people tend to submit to the situation, despite the fact that landslides are likely to occur during the rainy season. This condition decreases the WTP for landslide mitigation.

The social capital characteristic which was proxied by the community participation had a positive and significant influence on WTP in mitigating landslide impacts. Recent studies showed that there is a relationship between social capital and WTP for environmental goods (Halkos & Jones, 2012; Kollmann & Schneider, 2012; Macias & Williams, 2014; Polyzou, Jones, Evangelinos, & Halvadakis, 2011; Yogo, 2015). The literature suggests that individuals and communities endowed with high stocks of social capital tend to work together through cooperation for the benefit of the environment (Jones, Sophoulis, Iosifides, Botetzagias, & Evangelinos, 2009; Pretty & Smith, 2003; Pretty & Ward, 2001). Bourdieu (1986) defined social networks and civic participation as citizens' activation in formal and informal organizations. This generates relevant information flow concerning environmental issues, awareness and behavior (Jones et al., 2010). Both forms of participation in social networks (i.e. at the individual and group level) influence an individual's tendency to engage in collective activities to preserve the environment, hence increase their WTP (Gelissen, 2007; Jin & Shriar, 2013).

#### CONCLUSION

The findings suggest that 76.7% of households in the study area were willing to pay for landslide mitigation. Socio-demographic characteristics that influence the WTP to mitigate the landslide impact were education and income. The property ownership also had a positive and significant impact on WTP. The distance of residence to the landslide points and the frequency of landslide experienced by the participants had a significant effect on WTP for landslide mitigation. The willingness was higher among households with better social capital as indicated by their high participation in social communities. This implies that social capital approach can assist the mitigation of landslide

impacts, especially in landslide-prone areas such as Purworejo. Future research still needed to explore the role of social capital in mitigating disaster impact in other regions with disaster-prone areas in Indonesia.

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