




# Household disaster management capacities in disaster prone II area of Mt. Slamet



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Disaster prone II in Mt. Slamet is the highest risk area for human settlement. Specific household characteristics are needed to live in harmony with natural disaster. Capitals of households and transformation on process and structure were supported by the disaster management. However, households living in disaster prone II area had limitation on their assets and need to identify factors influencing disaster management. To study the factors influencing household disaster management capacities. This research using the sample measurement of Becker and Hursh-Cesar collected 538 households spread across five villages located in disaster prone II area of Mt. Slamet. Sequential mixed methodology combining both qualitative and quantitative research methods were used and samples were collected by a two-stage stratified random sampling to consider the Rukun-Warga-level area and systematic random sampling to choose the sample of households. To analyse the direct and indirect factors supporting disaster management capacity, path analysis through Stata was carried out and multicollinearity was tested prior to path analysis. This research found direct and indirect effects of household characteristics and household capitals on disaster management. This could be influenced by the transformation on process and structure of the local government. The quantitative result has been confirmed by the result of qualitative approach. Social capital owned by households living in disaster prone area supports disaster management practices. The household relationship and networking access has been strongly supported disaster management capacities. Disaster management capacities of household living in disaster prone II could be improved by both internal and external factors. Internal factors include supporting the household members' health, increasing the size of land and vehicle owning. External factors need to be carried out by transforming the process and structure of the village by making the policy to improve the social and cultural belief of households.

## Introduction

Living near the risk of impact from disaster, it is critical for households to have disaster management capacities to improve their life safety and survive hazardous events (Sutton & Tierney 2006). To deal with the environment hazards, a four-option framework described by Lewis (1999) and Wisner et al. (2004) could be applied. However, the fourth framework element, 'Live with hazard and risk' is appropriate to the households that lived in the area with the highest risk of hazard. This framework is integrated into the environmental threats and opportunities and accepts disasters as a usual part of life and protects their livelihoods. Cannon, Twigg and Rowell (2003) and Twigg (2004) used the sustainable livelihoods approach (SLA) in their previous study to reduce disaster risk. Sustainable livelihoods approach by Department for International Development (DFID) explores with a *pentagon* of human capital, social capital, natural capital, physical capital and financial capital, which is influenced by the outside policies, institutions and processes of living in a disaster area. Having sustainable livelihoods is strongly defined for smaller unit analysis, which could be described by households. Based on the literature review, the concept could be applied to support the vulnerable households living in high-risk-prone disaster area.

Indonesia is located in the ring of fire, which has impacted many possibilities of natural hazards, one of which is volcanic disaster. This situation brings Indonesia as the place being vulnerable to the impact of natural hazards. More than 150 active stratovolcano types are spread around all of the big islands, one of them is Mt. Slamet. It is the second highest mountain (3428 m) in Java Island, with more than 50 eruptions since 1988. Mt. Slamet is located on the border of five districts in Central Java province, such as Brebes, Banyumas, Purbalingga, Tegal and Pemalang districts. In March 2014, Mt. Slamet started to have unpredictable fluctuation in seismic activity until January 2015. Large explosion occurred in March, August and September 2014, which was the highest

explosion compared to previous ones in the 20th century. The Indonesian government has set three disaster-prone areas based on the length of the mountain peak (Regulation of Minister of Energy and Mineral Resources of Republic Indonesia 2011). Disaster prone III located 0 km – 4 km from the peak is the highest risk level and this area is forbidden for human settlement or making activities in this area.

Dewanti and Ayuwat (2015) described the condition of disaster prone in volcanic area, one of them is Sawangan village, which is located on the border of disaster prone II and III. This study explained the limitations on capital and brought them a living by self-sufficiency, with little support from the government. Hence, less capital was owned by the households that had already carried out volcanic disaster management and that lived in the disaster prone II area. Several areas in the disaster prone II area of Mt. Slamet had already found their survival practices through their local knowledge. The other area, Guci village, is located in the disaster prone II area of Mt. Slamet. Sawangan hamlet and Guci village were both partly located in the disaster prone II area of Mt. Slamet and practised volcanic disaster management differently. Sawangan implemented disaster management supported by social kinship, while Guci applied a top to bottom leadership system driven by local government construction. It created different disaster management capacities to be employed by the households (Dewanti, Ayuwat & Yongvanit 2016). However, the outside institutions, policies and processes of living in the disaster prone II area influenced the household capitals as household assets to be applied in a disaster management capacity.

However, to recognise which household capitals could influence the disaster management capacities of the households that lived in the disaster prone II area, an analysis was required. Households that lived in the disaster prone II area were mostly working in farming and the tourism sector. Some parts had urban living standards, but others still had underdeveloped livelihoods. Nevertheless, this article is contributed to fulfil the disaster management influenced by the capitals of households that lived in the disaster prone II area of Mt. Slamet, Indonesia.

This research focused on the concept of disaster management capacities for households. The concept of livelihoods and pointed household as the concept of agency that applied the disaster management were described as independent variables (IVs). Disaster is defined as a serious disturbance to the functioning of a society and influence upon losses of human life, materials and environment that impoverish the capability of the society to cope using its own resources (UN 1992). To analyse the factors influencing disaster management, we have to start with the comprehension meaning of disaster and disaster management based on local perspectives.

The development of disaster management cognition is described in Figure 1, with disaster management meaning and perspective. Lewis (1999) and Wisner et al. (2004) described

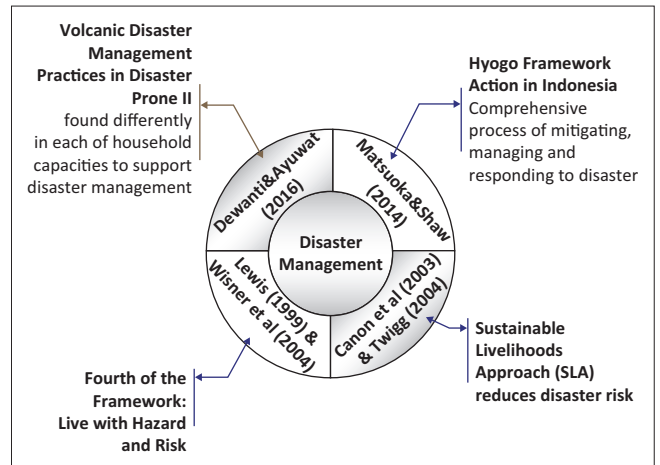


FIGURE 1: Theoretical framework based on meaning and perspective of disaster management.

how to live with hazard and risk in a disaster-prone area. High-risk areas need to balance the resilience capability with their own resources through SLA for mitigating disaster risk (Cannon et al. 2003; Twigg 2014). Hyogo Framework Action (HFA) in Indonesia was established as a comprehensive process for mitigating, managing and responding to disaster. It is in line with the international disaster management framework which was developed by each local wisdom for each area (Matsuoka & Shaw 2014).

Hyogo Framework Action was formulated in 2005 to 2015, which focused on reducing the risk of vulnerable population from many disaster scenarios. The framework explained the cycle of disaster event on before, during and after the occurrence of the disaster as stated mitigation, preparedness, response and recovery phase. Disaster management is defined as comprehensive and integrated activities to cope with the cycle of disaster events. This research is aimed at analysing the disaster management capacities that are linked to the integrated activities on mitigation, preparedness, response and recovery phase. However, there are factors that influence the disaster management, such as household characteristics, household capitals and transformation on process and structures.

The definition of term for disaster management and livelihoods for these research has been define as follows:

- disaster management as a household plan, practice and action for those who live on the border of the disaster prone II area to reduce the risk and recover from the impact of volcanic disaster through integrated activities on mitigation, preparedness, response and the recovery phase
- livelihoods as household capitals that influence the transforming structure and process to have access to livelihood resources

Transforming structure and process as an institution and policy interaction supported by the local culture and belief practices. The definition of terms brought three hypotheses that need to be examined in this study:

- **Hypothesis 1:** Households that lived in disaster prone II areas having more specific characteristics on occupation, dependency ratio, labour force, healthy house members, migration, size of land, amount of machine goods and vehicles influenced disaster management.
- **Hypothesis 2:** Household capitals of those who lived in disaster prone II areas, which consist of certain human capital, social capital, natural capital, physical capital and financial capital, influenced disaster management.
- **Hypothesis 3:** Transformation on process and structure, which consists of land use management, spiritual practices and cultural implementation for households that lived in the disaster prone II areas, influenced disaster management.

Through the hypotheses, a semi-structured guideline was developed and factors influencing disaster management practices were described. Qualitative approach used to further describe how each of the factors in SLA supports disaster management practices. This research aimed to describe the factors influencing the livelihoods of the households that lived on the border of the disaster prone II area of Mt. Slamet, Indonesia.

## Research methods and design

This study used sequential mixed methods, which start with quantitative methods, and had the household as the unit of analysis. As the study area was in the disaster prone II area, the population was spread to five subdistricts of 4268 households. To select the study area, a two-stage stratified sampling was used to choose three districts based on the most impacted areas during previous eruptions, and to choose the villages in each district, it was based on their location in the disaster prone II area of Mt. Slamet. The samples were measured by Backstrom and Hursh-Cesar (1981) formula by increasing the suggested sizes based on calculation of the sample size through measurement of confidence level, sampling error, population heterogeneity and population size. The calculation was as follows: multiply the population with 95% of confidence level and  $\pm 5\%$  sampling error of 50/50 split. A sample size of 357 households was derived and to enlarge the size of the sample, using Bacstrom and Hursh-Cesar's formula, it was multiplied by 1.5; thus, a total sample size of 538 households was found. To choose the respondents, systematic sampling was used to choose the sample households. The systematic sampling was measured with interval 9th and chosen from a list of households in each village (see Table 1). This study identified three dimensions as IVs – (1) household characteristics,

**TABLE 1:** Distribution of sampling of households that lived in disaster prone II area.

| Sub-district | Village      | Population  | Percentage    | Sample size |
|--------------|--------------|-------------|---------------|-------------|
| Bumijawa     | Sawangan     | 664         | 14.35         | 78          |
|              | Guci         | 1020        | 22.04         | 118         |
| Bojong       | Dukuh Tengah | 830         | 17.95         | 97          |
| Baturaden    | Ketenger     | 1012        | 21.87         | 117         |
| Pulosari     | Gunungsari   | 1102        | 23.81         | 128         |
| <b>Total</b> |              | <b>4268</b> | <b>100.00</b> | <b>538</b>  |

(2) capitals of households and (3) transformation on process and structure – and disaster management as the dependent variable.

Household characteristics consisted of occupation, dependency ratio, labour force, number of healthy household members, migration, amount of electrical goods and vehicles, and size of farming land. All of the indicators used ratio data scale except for occupation, which was ordinal scale. However, there were two dummy variables as farming and non-farming occupation. Capitals of households consisted of human capital, social capital, natural capital, physical capital and financial capital. All of the variables used ratio and interval data scales. Transformation, process and structure, consisting of land use management, spiritual practices and cultural implementation, used interval data scales. Disaster management, which consisted of mitigation, preparedness, response and recovery phase, used the interval data scale. The researchers developed these indicators from the field study through a qualitative approach and the literature review of previous studies. Previous research has been conducted as a qualitative approach to design the instruments of this study. A quantitative study was conducted by structured interview schedules (SIS) with multivariate analysis using the Stata version 14 programme. Content validity and measurement of reliability were performed, with Cronbach's alpha at 0.908, to check the quality of the data. Content validity was performed by sending the questionnaire to an expert in environmental studies and disaster management to make improvements to the questionnaire. The experts were selected based on their expertise: two experts from the field of natural resource management and one from statistics. As this study employed multivariate analysis on path analysis, multicollinearity diagnostic was employed to examine the correlation between IVs. This could cause several problems with the estimation of  $\beta$  (unstandardized beta coefficient) and interpretation. Multicollinearity could be used in three ways: (1) examination of the correlation matrix, (2) variance inflation factor (VIF) and (3) eigen-system analysis of correlation (Joshi 2012). This study employed VIF measurement to test whether the data had a multicollinearity problem. Among 25 IVs, no problems of multicollinearity were found, with VIF ranging between 1.09 and 2.15 or less than 10.

The second phase of the study was carried out using qualitative methods. These methods used focus group discussion for three different groups: head of the village, rescue team and head of the household. Each group represents five villages that were selected by previous approach, that is, quantitative methods. It was carried out separately in each group to answer the further description of factors relating to disaster management practices.

## Ethical considerations

Ethical approval to conduct the study was obtained from Khon Kaen University (registration number: HE 583022).

## Discussion

The results of this study described the factors influencing disaster management in three dimensions: household characteristics, capitals of households and transformation of process and structure. Before the path analysis, this study used conceptual framework model as in Figure 2.

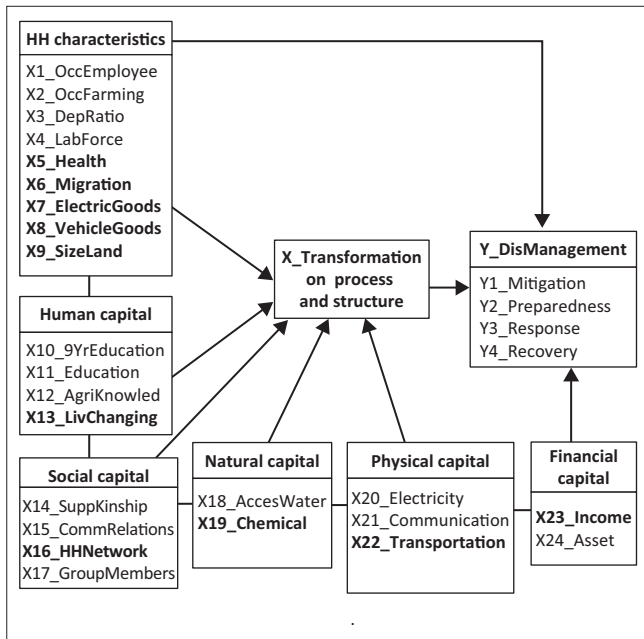
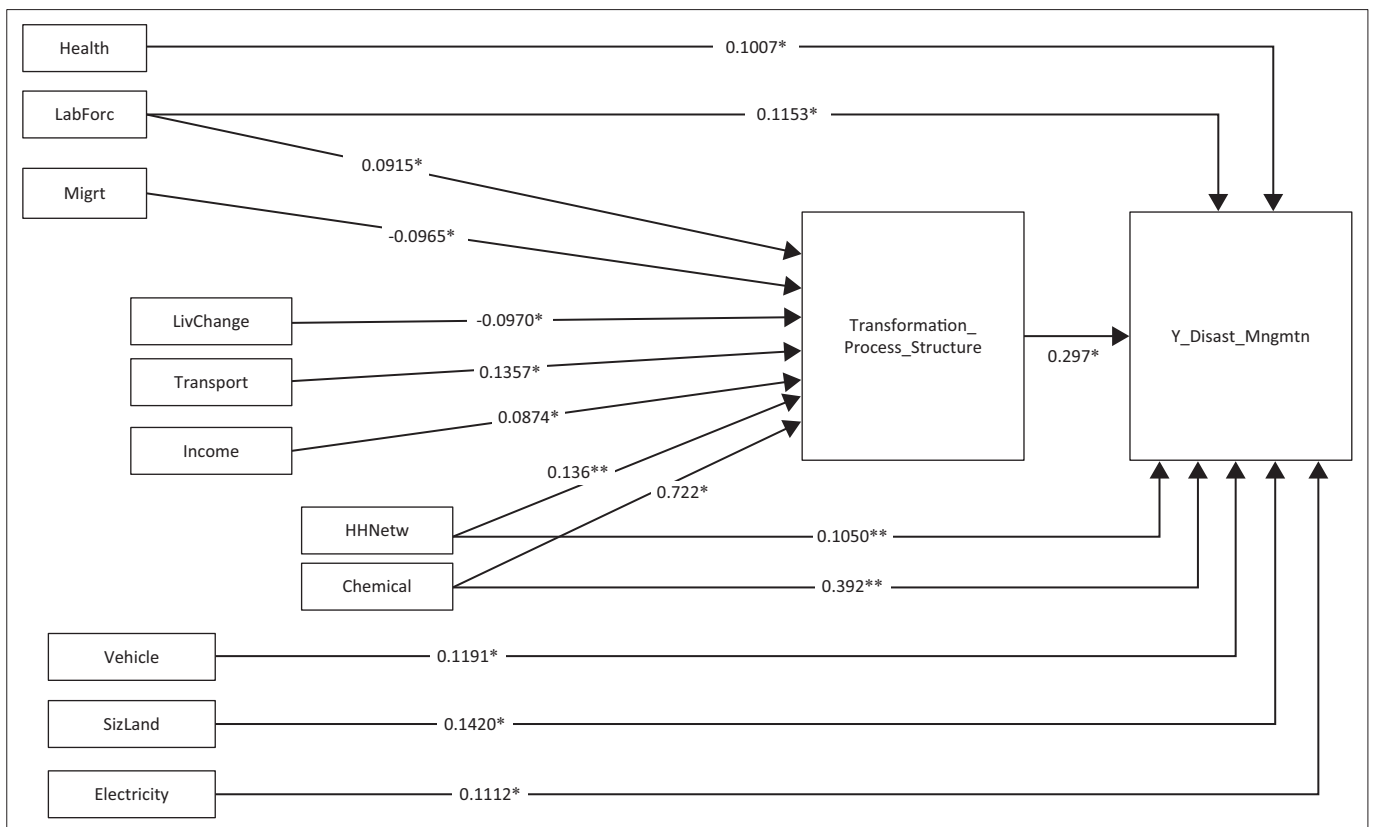


FIGURE 2: Conceptual framework before path analysis.

The conceptual framework has been arranged by theoretical reviews and field study in the disaster prone II area of Mt. Slamet. Before the path analysis, the variables need to be analysed for correlation between them. This study uses multicollinearity checking through the correlation matrix and VIF as an aim to decrease the exact relationship between predictor variables. To identify the goodness of fit of the model, the study used the Pearson chi-square analysis. This analysis indicates the 'badness of fit' from the model and whether the outcome frequencies follow a specified distribution. It is applied in the categorical data and unpaired data from large samples. The computational procedures consisted of five steps: (1) calculate the chi-squared test statistics ( $\chi^2$ ), (2) determine the degrees of freedom of the statistics, (3) consider the desired level of confidence of the result of the test, (4) compare  $\chi^2$  to the critical value from the chi-squared distribution with *df* (degree of freedom) and adjusted confidence level and (5) determine whether the null hypothesis is accepted or rejected ( $H_0$  = no differences between distribution). Through this identification, the whole of the  $\chi^2$  of the 26 variables exceeded the statistical value, which concluded to reject the null hypothesis, or stated that there is a difference between observed data and the expected value.

This path model has *R* squared as 33.44% and is described in Figure 3. There were eight IVs that had a direct effect (DE) on disaster management: health of household members, labour force, amount of vehicles, size of farming land (household characteristics), household networking to others



\*, *p*-value less than 0.05.

\*\*, *p*-value less than 0.01.

FIGURE 3: Path analysis result.

(social capital), chemical fertiliser (natural capital), access to electricity (physical capital) and transformation of process and structure. Chemical fertiliser utilisation and household networking to others were found significantly as 0.000 with the unstandardised coefficient as 0.392 and 0.105.

There were seven IVs having indirect effect (IE) on disaster management through transformation of process and structure as the mediator: labour force, migration (household characteristics), livelihood changing (human capital), household networking to others (social capital), chemical fertiliser (natural capital), access to transportation or road (physical capital) and income (financial capital). Migration and livelihood changing were found as an unstandardized coefficient with values -0.0965\* and -0.0970\* (with the  $p$ -level of significance at 0.05). It could be further found from the data that most household members who migrate were men, the heads of the household and/or the sons having marriage, education or working in another province. Ho et al. (2008) and Kung and Chen (2012) stated that the women are better prepared for disaster management; however, during eruption, they do not have the capacity to bring their family into a safer place. Furthermore, labour force, household networking to others and chemical fertiliser utilisation had both DE and IE on disaster management.

Based on quantitative results, the focus group discussions were enacted to start with the head of the villagers. Heads of the households described the mitigation programmes mostly based on ancestors' advice and brought as what they believed to be Mt. Slamet. Therefore, households refused to move from the disaster prone II area and continued their livelihoods of farming and tourism entrepreneurship in such high-risk areas. However, the previous eruption in 2014 brought greater awareness concerning how gravely Mt. Slamet could harm them during its eruption. As a participated stated:

'... the ancestor has already stated to all household in here. Mt. Slamet will explode as the same time as end of the world. We do not need to be scared. But, on 2014, suddenly Mt. Slamet expended very big explosion sound with earthquake; now we consider to be aware of Mt. Slamet ...' (Participant 4, male, farmer, 54 years)

Local government appointed by the villagers took the lead role in introducing disaster maps. Therefore, several areas have recognised the dangers of their living area and are aware of the evacuation area or meeting point during eruption. On the other side, one of KIs (key informants) from Guci explained that the evacuation signs were missing because of other party of government who manages the tourism attraction fearing that their revenue will decrease. As stated by participant:

'... everytime we saw from TNI ABRI (Indonesian soldier) put evacuation sign and meeting point sign; in the next day it will automatically be missing. Someone takes it out and we do not know who and why they take it. You can see Guci does not have the signs now...' (Participant 1, male, farmer, 46 years)

The preparedness phase designated to the phase when Mt. Slamet indicated in higher seismic activities. During this

phase, the households need to be aware of and prepare the survival kit when the next phase appears anytime. To recognise the warning alarm or warning system owned by each local area has been the most important capacity of each household members. Networking with other parties living in non-risk areas is needed to encourage households that live in disaster prone II areas. Improving the physical capital, such as road access, plays an important role in the preparedness phase before the eruption or response. However, one of the nearest places from the peak of Mt. Slamet faces limitation of infrastructure quality, mainly concerning evacuation road. Statement by participant:

'... local government has agreed but the making of the road took long time. We are running out of our patience, so we keep it that way. The most important road is the evacuation road; it is the road that made us die during evacuation because we could not pass using car or motorcycle, but only bare foot. How can we do the evacuation during Mt. Slamet eruption ...' (Participant 3, male, farmer, 62 years)

Limitations of the physical capital resulted in less disaster management practices. Transformation on process and structure is addressed related to land use management, spiritual implementation and cultural practices. Land use management is the way of cutting less trees and keeping them for environmental balance with nature. In this area, most of the household has Islam as the religion, it define spiritual implementation is practise in Moslem manners. Cultural practices have been described as the traditional and customary practices of a cultural group, for example, the Ruwat Bumi event. Households from Guci described that Ruwat Bumi as the annual event that is celebrated in collaboration with local government for Mt. Slamet, and most of the households invite tourism to their area and thus increase their income.

## Conclusion

From the findings of the direct and indirect effects among 12 IVs, it could be concluded that variables that have DE and IE were supporting disaster management practices for households. Those were the labour force and utilisation of chemical fertiliser. Both these variables positively affected disaster management. The number of households that have members of working age had a total effect of 1.441, with  $p$ -value as 0.05 (see Table 2). Utilisation of chemical fertiliser had a total effect of 1.411, with  $p$ -value as 0.01. Based on the measurement of path analysis, it could be described that when the number of household members had members which are in the labour age, it could raise the disaster management capacity to 1.441. Furthermore, when household members utilise non-chemical fertiliser in their field as 1 meter, it could describe that the disaster management as part of green-sustainability environment implementation increase to 0.392 points.

The interesting finding was migration as in a direct effect with an unstandardized beta coefficient of 0.182, with  $p$  value .05; it could be described that households that add more than

**TABLE 2:** Total effect of factors influencing disaster management and the qualitative findings.

| Independent variables                   | Direct effect | Indirect effect                     | Total effect | Qualitative findings  |
|---|---------------|-------------------------------------|--------------|---|
| Labour force                            | 0.1153        | $0.9150 \times 0.1773 = 0.1622$     | 0.2775       | Providing training to household members who are in the age of labour force group  |
| Number of healthy members in household  | 0.1007        | -                                   | 0.1007       | Households need to be trained as part of rescue team  |
| Migration                               | 0.0000        | $(0.0965) \times 0.1773 = (0.0171)$ | (0.0171)     | Recognise the vulnerable group in which the household members are mostly migrated to other area   |
| Amount of vehicles                      | 0.1191        | -                                   | 0.1191       | Improve the road access   |
| Size of farming land                    | 0.1420        | -                                   | 0.1420       | Increase the green environment awareness  |
| Livelihoods changing                    | 0.0000        | $(0.0970) \times 0.1773 = 0.0172$   | (0.0172)     | Less changing of working characteristics could support their process of earning income and disaster management capacities                         |
| Household networking to others          | 0.1050        | $0.136 \times 0.1773 = 0.0241$      | 0.1291       | Prepare to have evacuation networking on response phase   |
| Chemical fertiliser utilisation         | 0.7220        | $0.392 \times 0.1773 = 0.0695$      | 0.7912       | Participate on green environment awareness  |
| Access to electricity                   | 0.1112        | -                                   | 0.1112       | Updated information among others by media   |
| Income                                  | 0.0000        | $0.0874 \times 0.1773 = 0.0155$     | 0.0155       | Income plays an important role during the eruption and recovery process   |
| Transformation of process and structure | 0.2970        | -                                   | 0.2970       | Land use management, spiritual belief and cultural practices support the disaster management practices to support their living in high-risk areas |

one household member to migration could decrease 0.182 points of disaster management practices. Koks et al. (2015) explained migration as the impact in social vulnerability from flood disaster. In this study, migration of household members brought less disaster management capacity to the household itself and increased the social vulnerability. The results of the findings were drawn from the factors supporting improved disaster management based on household capacity. Furthermore, it could predict which parts could be improved in the household disaster management guideline to strengthen households that live at the high-risk border of disaster prone II area of Mt. Slamet, Indonesia.

Based on the results and findings of this study, it could be concluded that the first hypothesis could find that five IVs had DE and/or IE on the disaster management: (1) labour force, (2) number of healthy household members, (3) migration, (4) amount of vehicles, and (5) size of land. These were the specific household characteristics which could influence the disaster management for households that lived in the disaster prone II area of Mt. Slamet. This hypothesis result is in line with the concept of Onuma, Shin and Managi (2016), who described that disasters could relatively be handled by several characteristics for example age, the younger of the head of the households is more likely they will be prepared for disaster. It also includes the number of healthy household members who could be described as a non-vulnerable group concerning disaster management assessment. As households that lived in the disaster prone II area mostly relied on natural resources and lived in rural households, the size of land influenced disaster management (Card 1999).

The second hypothesis is in line with the core concept of the research by Lewis (1999) and Wisner et al. (2004), who stated that volcanic disasters could be dealt with by using four frameworks. However, in this study, the researchers used the fourth framework, which was described as 'live with hazards and risk', using household assets or capitals to cope or deal with volcanic disaster. Hoffmann and Muttarak's (2017) raises one of the disaster phases, preparedness, through social capital and disaster risk perception of the household. It strengthens the capitals of households caused

by the disaster management capacities in each of the phase. In summary, the capitals of households influenced the disaster management directly, indirectly or both.

The third hypothesis described three parts that were explained as land use management, spiritual implementation and cultural practices. However, the variable of transformation of process and structure had a positive influence on disaster management and played a role to bridge the gap between some variables of household characteristics and the capitals of households. In line with this hypothesis, the researcher has proven that the transformation of process and structure has a positive influence on disaster management as the outcome activities for households that lived in the disaster prone II area of Mt. Slamet. It is supported by DFID (2000) and Scoones (1998) who described transformation of process and structure as the engine of households to achieve an outcome. In this study, spiritual and cultural practices influenced the disaster management capacities of the households. The cultural practice recognised as Ruwat Bumi is an annually held collaboration between households that lived in the disaster prone II area and the local government. Cultural practices are the engine of household beliefs for disaster management capacity. As it was their heritage from the ancestors, it is proof of the transformation of process carried out by cultural practices not only by the households, but also supported by the structure of the government. As this research is important in that it contributes to fulfil the disaster management concept in disaster prone II area, the research materials related to this article can be accessed for completing the academic research gap.

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### Competing interests

The authors declare that they have no financial or personal relationships that may have inappropriately influenced them in writing this article.

### Authors' contributions

D.S.D. contributed to the writing and analysis of the research. D.A. and S.Y. played advisory roles in data collection, analysis and writing.

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