Eduvest – Journal of Universal Studies
Volume 2 Number 2, February, 2022
p- ISSN 2775-3735- e-ISSN 2775-3727

LOCAL KNOWLEDGE OF THE TENGER TRIBE COMMUNITY IN VIEWING THE HAZARD OF MOUNT BROMO ERUPTION

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ARTICLE INFO

Received:
January, 26th 2022
Revised:
February, 17th 2022
Approved:
February, 18th 2022

ABSTRACT

Mount Bromo is a volcano that erupts frequently and Sukapura District, Probolinggo Regency, was severely affected by the eruption. In addition, the community adheres to the local culture. This relationship affects hazard risk reduction efforts that must pay attention to the local culture. If it is not in accordance with local culture, then hazard risk reduction efforts cannot be implemented. Therefore, this research was conducted to explore local characters related to the threat of the eruption of Mount Bromo in order to obtain a reference basis for preparing an appropriate hazard management plan. This study aims to: 1) Mapping the vulnerability of Mount Bromo eruption in Sukapura Regency based on the community based on the IDW interpolation technique; 2) Develop a model of the influence and relationship of traditional intelligence variables on community-based Mount Bromo eruption vulnerability zoning using the SEM-PLS analysis technique. The results showed that the level of vulnerability to the eruption of Mount Bromo which was interpreted by the people of Sukapura District was influenced by the variables of physical semiotics, cultural semiotics, faunal semiotics and vegetal semiotics.

KEYWORDS

Mapping Based Community, Hazard Prone Area, Eruption, Mount Bromo, Semiotics

How to cite: Dwi Rahmawati, Turniningtyas Ayu Rachmawati, Christia Meidiana. (2022). Traditional Intelligence of The Tenger Tribe Community in Viewing the Hazard of Mount Bromo Eruption. Journal Eduvest. *Vol 2*(2): 347-356
E-ISSN: 2775-3727
Published by: https://greenpublisher.id/

INTRODUCTION

Mount Bromo is one of five mountains in the Tengger Mountains and is one of the 129 volcanoes in Indonesia that erupts most frequently (Yuanjaya & Meiwanda, 2021). The time interval between eruptions is only a few months, the average is 4-5 years and the longest interval is 16 years Maeno et al., 2019). The areas affected by the eruption included Probolinggo District (Sukapura and Lumbang Districts), Malang District (Poncokusumo District), Lumajang District (Senduro District). The sub-district around Mount Bromo that was most severely affected by the 2010-2011 and 2015-2016 eruptions is Sukapura District because it is located closest to the crater (0-20 km from the crater).

Efforts to reduce the risk of the eruption of Mount Bromo in Probolinggo Regency have been carried out, including mapping disaster-prone areas, socializing disaster management plans, simulating Mount Bromo eruption management with the community, and installing boundary plaques for the Mount Bromo eruption disaster-prone area. The Disaster-Prone Area Map (DPA) of the eruption of Mount Bromo published by PVMBG shows that Sukapura District is included in DPA III, II and DPA I. DPA III is the area most potentially severely affected by an eruption in the form of hot clouds, heavy ash rain, lava flows, lava avalanches, throwing incandescent rock, hot mud rain, volcanic gas and water with high acidity and the distance to the closest crater (<5 km). DPA II is an area that is quite severely affected and has the same potential impact as DPA III if the eruption enlarges (a distance of 5-10 km from the crater), while DPA I is an area that has the potential to be affected by an eruption in the form of eruptive lava flows and rain lava, water with high acidity, and falling material in the form of ash and will be more severe such as DPA II or DPA III if the eruption expands. Even though there has been a DPA decree, the surrounding community considers the eruption of Mount Bromo to be normal, occurs regularly and even regularly, is not dangerous for residential areas and considers that there are areas that are severely and not badly affected based on experience (Interview results, 2019).

According to the provisions in the map of the disaster-prone area of Mount Bromo's eruption published by the Center for Volcanology, Meteorology and Geophysics (PVMBG), when the status of Mount Bromo is set at the alert level, the public must increase vigilance and not carry out activities in DPA III. When Mount Bromo is at the alert level, the people in DPA II and I must prepare themselves for evacuation preparedness, while the people in KRB III have to evacuate (Matsumoto et al., 2018). When Mount Bromo was set at the alert level, the people in DPA III, II and I had to evacuate (Harpel, Stimac, Avendaño Rodríguez de Harpel, & Primulyana, 2019). When Mount Bromo was set at the alert level in 2010 the people of Sukapura District classified as living in Disaster Prone Areas (DPA) III, II and I as many as 86% did not evacuate (Sugiarto, Hanafi, & Berliana, 2019). In 2015-2016, Mount Bromo was also set at the alert level, but 90% of the people of Sukapura District did not evacuate. They did not ask for help and chose to stay in the area affected by the eruption and try to live a normal life even though some of their activities were disrupted.

Based on the situation described above, there is a difference between the Mount Bromo eruption hazard zoning policy and its implementation. Basically the character of the local community is very influential on how to cope with disaster events (Arif et al., 2022). This shows that the community has its own zoning regarding the vulnerability of

Mount Bromo's eruption. Therefore, researchers Decided to study the vulnerability of Mount Bromo eruption according to the people of Sukapura District. According to the Sukapura community, the vulnerability of Mount Bromo to eruption is depicted on a map that represents the level or boundaries of the vulnerability of Mount Bromo to eruption in three typologies, namely high vulnerability (DPA III), medium (DPA II) and low vulnerability (DPA I). The results of the mapping will be studied further regarding its relation to traditional intelligence variables. The results of the study are expected to be a reference for the implementation of government policies in dealing with the Mount Bromo eruption in synergy with local traditional culture.

RESEARCH METHOD

A. Population and Sample

The research population was all households in Sukapura sub-district with a total of 7564 households. This study does not use the entire population to be analyzed, but uses a sample that is considered to represent the characteristics of the population to be studied. The sampling technique used is simple random sampling, ie the entire population has the same opportunity to be sampled/respondents. In the analysis using SEM-PLS there is a minimum sample limit that must be used based on the desired significance value and R2. The author wants the significance value in the model to be 5%, so the SEM-PLS analysis used requires at least 166 respondents if R2 is 0.1. In this study, the number of respondents was 403 respondents.

B. Community-Based Mapping of Mount Bromo KRB

Social mapping using the interpolation method has been carried out by several experts. Donovan (2010) and Donovan et al (2012) mapped using several interpolation techniques and tested them. The best test result for interpolating social observation data is the inverse distance weighted (IDW) interpolation model compared to Kriging, Spline and natural neighbor interpolation. The community-based Mount Bromo eruption hazard map in this study was also visualized by interpreting it with the help of the IDW interpolation technique. The poll result data is transformed into vector data in the form of points, so that in one area of Sukapura District, 403 sampling points of Mount Bromo eruption vulnerability are obtained which are mapped through public opinion polls. The data becomes the input for interpolation. Next, look for the value of the observation points that are in a grid model using the inverse distance weighted (IDW) interpolation method in the tools available in ArcGis. After identifying the interpolation results, then the results are classified into three typologies, namely the eruption susceptibility of Mount Bromo is high (KRB III), moderate (KRB II) and low (KRB I).

C. Modeling the Relationship of Traditional Intelligence with Community Based Mount Bromo Eruption Hazard Map

The research data analysis technique using SEM aims to explain the contribution of traditional community intelligence to the vulnerability of Mount Bromo eruption. The procedures in the SEM-PLS that will be carried out are as follows (Hussein, 2015):

1. Designing a Structural Model (Inner Model) and Measurement Model (Outer Model)

Designing a structural model and a measurement model is related to the formation of an initial equation model before estimation. The preparation of the model is based on the provisions of the construct in the SEM model. SEM has two types of constructs, namely reflective constructs and formative constructs. Formative constructs are constructs that also change the indicators if the construct changes. Formative constructs are constructs that will change if there is a change in one or more indicators. This study

uses formative constructs in modeling the relationship between traditional intelligence and the zoning of Mount Bromo eruption vulnerability according to the community.

2. Test Outer Model

The coefficient estimation process will be carried out after all data has been collected. The estimation is done using SEM-PLS analysis software. The software that will be used is WarpPLS 7.0.

a. Test on outer model

Because the structural model design on the outer model is a formative measurement model, the model test must pay attention to 2 requirements, namely:

1) The indicator weight must be statistically significant
2) Multicollinearity Variance inflation factor (VIF) is less than 3.3

b. Structural Model Estimation

Estimating variables in the inner model by using latent variables that have been well tested at the outer model stage while still paying attention to the significance and value of VIF in the outer model.

c. Building a Fit Model

The fit model is the best model in the SEM-PLS analysis. The best model can be seen by paying attention to:

1) Average block VIF (AVIF) with a value of <=5, ideally <3.3
2) Average full collinearity VIF (AVIF) with a value <=5, ideally <3.3
3) Sympson's paradox ratio (SPR) with a value > 0.7, ideally 1
4) R-Squared contribution ratio (RSCR) >= 0.9, ideally = 1
5) Statistical suppression ratio (SSR) = with a value >= 0.7
6) Nonlinear bivariate casuality direction ratio (NLBCDR) with a value >= 0.7

RESULT AND DISCUSSION

A. Map of Mount Bromo Eruption Hazards in Sukapura District

The interpretation of the community-based disaster-prone area map is carried out according to the concept and research method, namely using the IDW interpolation analysis method (Sakti et al., 2022). The interpolated data is the result of mapping using an opinion poll on the level of vulnerability in each respondent's residence. The results of the interpretation of the community-based KRB of Mount Bromo eruption consist of 5943.51 ha including KRB III, 2474.27 ha is KRB II, and 3123.43 ha is KRB I. More details of the results of community-based KRB eruption of Mount Brmo can be seen in Table 2.

The difference between the community-based Mount Bromo eruption map and the government map can be compared between Figure 2 and Figure 3, Through the two maps it shows that Pakel Village and Ngepung Village on the government map have zones that are not included as areas prone to the eruption of Mount Bromo. The similarity is that all calderas in community-based mapping and government maps are included as areas classified as KRB III. Striking differences can be seen in the Sariwani and Ngadirejo villages on the community-based KRB map including KRB III while on the government map including KRB II.

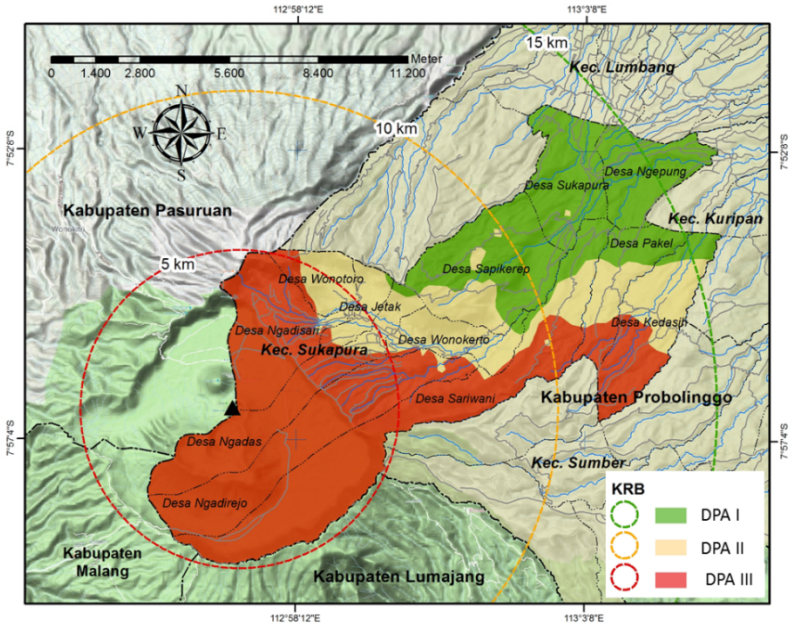


Figure 1. Map of KRB Results of Mount Bromo Eruption by Community

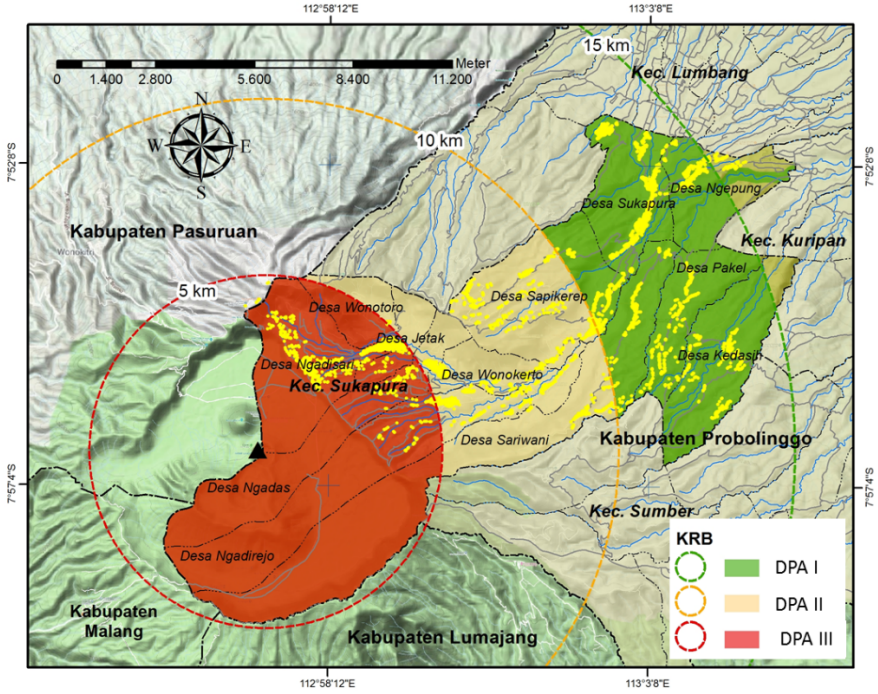


Figure 2. KRB Map of Mount Bromo Eruption Government

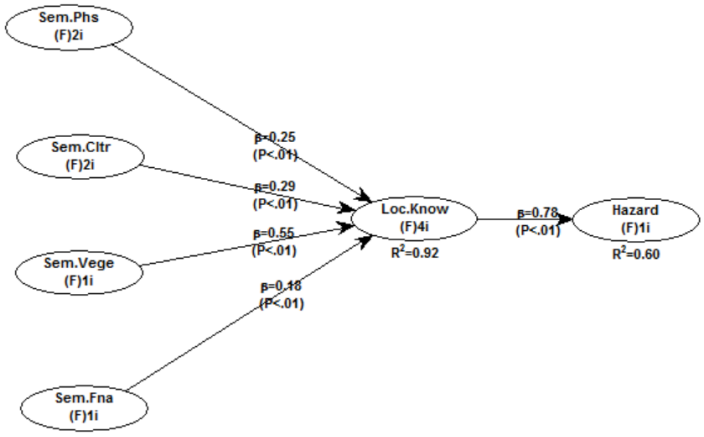
Based on the second map of the KRB map, it can be concluded that the people of Sukapura District interpret the threat of an eruption of Mount Bromo with the awareness that they live in a disaster-prone area (Rachmawati, Rahmawati, & Rachmansyah, 2018). In fact, they claim the area has a more severe impact than government maps based on what they know and experience (Horta et al., 2019). The condition of knowledge about

the threat of disasters is not a problem in disaster management because the community has awareness of the threat of an eruption of Mount Bromo (Yuanjaya & Meiwanda, 2021). This condition becomes a threat if they are aware of it, but in its implementation, they consider the eruption to be normal so that they become unconscious (Monteil, Barclay, & Hicks, 2020).

Awareness of the level of vulnerability to the eruption of Mount Brmo in Sukapura District is a form that information regarding the existence of eruption vulnerability in Sukapura District has been conveyed to the public properly. This happened for several reasons, including the fact that in Sukapura Sub-district, a placard of the boundaries of the KRB zone for the eruption of Mount Bromo has been installed and training simulations for the eruption of Mount Bromo have been carried out. This fact tries to emphasize that the direct transfer of knowledge to the community is the most effective form to make them aware of the level of disaster threat in their area (Titz, Cannon, & Krüger, 2018).

B. Traditional Intelligence Modeling on Community Based Mount Bromo Eruption Hazard Maps in Sukapura District

The vulnerability of Mount Bromo eruption disaster mapped by the community is a subjective view that is influenced by the traditional conditions of the Sukapura District community itself. The modeling will see how far traditional intelligence has an effect on the vulnerability of Mount Bromo's eruption based on the interpretation of the people of Sukapura District. The model generated in the review is illustrated in Figure 1.



Model fit and quality indices

Average path coefficient (APC)=0.409, P<0.001
Average R-squared (ARS)=0.763, P<0.001
Average adjusted R-squared (AARS)=0.762, P<0.001
Average block VIF (AVIF)=1.492, acceptable if <= 5, ideally <= 3.3
Average full collinearity VIF (AFVIF)=3.888, acceptable if <= 5, ideally <= 3.3
Tenenhaus GoF (GoF)=0.784, small >= 0.1, medium >= 0.25, large >= 0.36
Sympson's paradox ratio (SPR)=1.000, acceptable if >= 0.7, ideally = 1
R-squared contribution ratio (RSCR)=1.000, acceptable if >= 0.9, ideally = 1
Statistical suppression ratio (SSR)=1.000, acceptable if >= 0.7
Nonlinear bivariate causality direction ratio (NLBCDR)=0.800, acceptable if >= 0.7

Figure 1. Relationship Model between Community-Based Mount Bromo Eruption Vulnerability and Traditional Intelligence of the Sukapura District Community

Table 1. Correlation between indicators in the research fit model

	F3	F6	G1	E4	E5	H1	Rwn
F3	1.000	0.320	0.526	0.165	0.123	0.221	0.550
F6	0.320	1.000	0.436	0.225	-0.016	0.188	0.561
G1	0.526	0.436	1.000	0.241	0.093	0.282	0.750
E4	0.165	0.225	0.241	1.000	0.134	0.040	0.177
E5	0.123	-0.016	0.093	0.134	1.000	0.190	-0.025
H1	0.221	0.188	0.282	0.040	0.190	1.000	0.226
Rwn	0.550	0.561	0.750	0.177	-0.025	0.226	1.000
lv_Sem.Cltr	0.649	0.776	0.650	0.418	0.080	0.202	0.732
lv_Sem.Vege	0.526	0.436	1.000	0.241	0.093	0.282	0.750
lv_Sem.Fna	0.221	0.188	0.282	0.040	0.190	1.000	0.226
lv_Sem.Phs	0.385	0.437	0.595	0.713	0.222	0.191	0.545

C. Interpretation of the Relationship Model of Traditional Intelligence to the Community-Based Map of Mount Bromo Eruption Hazards in Sukapura District

Through Figure 1, it can be seen that traditional intelligence has a path coefficient of 0.78 which indicates that traditional intelligence affects the public's perspective on the level of vulnerability to the eruption of Mount Bromo in Sukapura District. The more they have high ratioal intelligence they will be more aware of the threat of disasters that are around them (Arif et al., 2022). The correlation coefficient between traditional intelligence and hazard is 0.763 indicating that both are strongly correlated with a positive relationship. It can be said that the more people have traditional intelligence in understanding the eruption of Mount Bromo, the more they perceive that the location around their residence is increasingly vulnerable. On the other hand, the more vulnerable the location inhabited by the community is to eruptions, the more traditional intelligence of the volcanic community is formed (Septiana et al., 2019). This is because the environment is a source of learning for the community. The signs that appear repeatedly will be stored in people's memory and give the same impression as before that he had experienced in an eruption situation (Civitarese, 2021).

a. Sem.Vege. Variable Interpretation

Vegetal semiotics is represented by the recognition of signs of physical changes in plants (G1), the correlation with the KRB of the eruption of Mount Bromo is 0.75. The correlation between vegetal semiotics and the community-based KRB of Mount Bromo's eruption is the largest compared to other constructs in the research model. The more the people of Sukapura District recognize the signs of physical changes in plants, the more they can be said to say that they are prone to the eruption of Mount Bromo.(Yuanjaya & Meiwanda, 2021)

This can be seen from some of the respondents' answers that if the plants around their homes begin to show changes, usually in the form of stunted growth, wilted, dead and dry plants, they will assume that the eruption of Mount Bromo will have a severe impact. The more these signs come, the more they show the community that they must be prepared for the impact of the eruption. The respondent's statement can be a favorable condition if it can always occur in the midst of the lives of the people who live in the Mount Bromo area.

b. Variable Interpretation Sem.Kltr

Cultural semiotics is represented by the intensity of participation in traditional ceremonies (F3) with a correlation coefficient of 0.55 and belief in the recommendations

and statements of traditional leaders (F6) with a correlation coefficient of 0.561. People who carry out traditional ceremonies with higher intensity increasingly assume that their homes have high eruptions. Returning to the survey results, the people of Sukapura District, especially in the upper villages, are very abstinent from performing traditional ceremonies, because they are afraid that something like disaster or logs will happen if the ceremony is violated or abandoned. Even traditional ceremonies were actually carried out by the community during the 2015 eruption of Mount Bromo, namely the implementation of the Kasada Ceremony. The people of Sukapura also carry out the ceremony when Mount Bromo is in turmoil. They are not afraid of being affected by the eruption, they are actually afraid that something big and unwanted will happen if the Kasada Ceremony is not carried out.

Belief in the recommendations and statements of the traditional leaders (F6) also forms assumptions about the vulnerability of the Mount Bromo eruption. The more people believe in the advice of traditional leaders, the more they are indirectly threatened by the eruption of Mount Bromo. This is because the customary leader will be a reference in acting, if the customary leader refuses to evacuate it will be very difficult to persuade them to evacuate. Likewise with the observations of researchers in the field when the eruption took place. Many communities do not immediately clean their roofs from the ashes before being instructed by their traditional leaders.

c. Sem.Fsk. Variable Interpretation

Physical semiotics also has a significant effect on the research model designed. Indicators that have a significant effect according to the model on physical semiotics are signs of an eruption from a decrease in the flow of water sources or wells (E4) and a sign of the eruption of Mount Bromo from an increase in the number of tourists (E5). E4 is correlated with a hazard of 0.177 which means that the relationship between the two is low. Changes in the flow of water sources or wells that are commonly used by the community have little effect on community assessments regarding the level of vulnerability to the eruption of Mount Bromo because not all people feel the changes, the changes are not significant and there are even some people who are used to unstable water discharge conditions.

Another aspect that is very distinctive and may only occur in the people of Sukapura District, Probolinggo Regency is a sign of the eruption of Mount Bromo from the surge in the number of tourists. These signs based on Table 1 have a negative correlation with the level of threat and the correlation coefficient is low. This means that people who get signs of an increase in the number of tourists will assume that Bromo will erupt but the eruption rate will be low. The assumption that Mount Bromo will erupt when the number of tourists soars is due to the belief that Mount Bromo is a sacred mountain. Tourist arrivals make dirty around the Mount Bromo area so it needs to be cleaned. According to the community, when Mount Bromo erupts, it means that the ancestors at Mount Bromo are trying to clean up the area and want to rest from the crowds.

d. Sem.Fna. Variable Interpretation

Faunal semiotics turned out to be the variable with the greatest influence on the social dimension with a correlation to the level of vulnerability of 0.226. Indirectly, it also has a big influence on community-based zoning of Mount Bromo eruption vulnerability.

Faunal semiotics is formed by recognizing eruption signs from animal behavior. The more people get signs related to the eruption of Mount Bromo, the greater will be the influence of the formation of the social dimension of the community related to mapping the vulnerability of Mount Bromo eruption. It can also be said that the emergence of signs of eruption from animal behavior will build public perception that the more these signs appear, the more perceptions will form if Mount Br omo will erupt and impact them.

The Javanese eagle that gives a sign will be used as a source of a sign that an eruption will soon occur and have an impact on the community.(Gunarto, n.d.) Migration of birds and insects will also be a source of signals for them to recognize Mount Bromo will soon erupt and have an impact.(Verkhratsky & Nedergaard, 2018) Based on the recapitulation of the survey results, if birds or insects migrate around people's homes, they feel safe because that is where the birds and insects protect themselves, while the places they leave are not safe.

The presence of eruptive signs from animal behavior can be an advantageous sign of alertness. However, back to the results of the survey data recapitulation which showed that 90% of respondents did not get signs of animal behavior.(Hesselgrave, Troppoli, Wulff, Cole, & Thompson, 2021) Based on this fact, it can be said that 90% of the community did not receive a sign of an impending eruption of Mount Bromo, possibly due to several assumptions, namely because the animals that used to give signs before the eruption had started to disappear because their population was declining, or it could also be said that the respondent was correct. , that the only representatives of certain people who get signs from animal behavior are then that person will spread the news to other people. That fact is indeed what is happening in the field regarding signs of the eruption of Mount Bromo in Sukapura District. The sign is not recognized by everyone but only a few people, including the Javan eagle, and the white tiger they say. Not all know it, even in everyday life these animals do not appear to exist.

CONCLUSION

A community-based map of the Mount Bromo Eruption Hazard Area (KRB) in Sukapura District has been mapped by interpreting the Mount Bromo KRB map with 3 typologies, namely KRB I, II and III where Sukapura District is divided into KRB I with an area of 3123.43 ha; KRB II 2474.27 ha; and KRB III 11541.21 ha. The majority of these maps are the same as the official KRB map for the eruption of Mount Bromo from PVMBG and BPBD Kab. Probolinggo. The striking difference is that Ngadirejo Village, part of Sariwani Village and Kedasih Village have a high level of vulnerability or are classified as KRB II, while on government maps/official maps are classified as medium vulnerable (KRB II). This shows that the Sukapura District community is actually aware of the disaster and understands the level of eruption threat quite well. However, such conditions must still be monitored if the community still thinks that the existing threat will not injure or cause casualties, because there is a high potential for a large eruption to cause casualties if not alerted.

Physical semiotics (Sem.Phs), cultural semiotics (Sem.Cltr), vegetal semiotics (Sem.Vege) and Faunal semiotics (Int.Fna) have a positive influence on the level of community-based Mount Bromo eruption vulnerability. Therefore, it can be concluded that the community-based Mount Bromo eruption vulnerability is an interpretation of physical semiotics which is reviewed by signs of eruption changes in spring or well discharge and an increase in the number of tourists, cultural semiotics in terms of

intensity of traditional ceremonies and belief in traditional leaders, interpretation faunal which is reviewed with eruption signs originating from animal behavior, and vegetal semiotics which is reviewed with eruption signs originating from plants.

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