

A POLICY MODEL OF ADAPTATION MITIGATION AND SOCIAL RISKS THE VOLCANO ERUPTION DISASTER OF SINABUNG IN KARO REGENCY - INDONESIA

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ABSTRACT: The purpose of this research was to determine the level of volcano eruption risk and compile a disaster risk mitigation model for the Sinabung volcano eruption. Analysis technique of volcano eruption disaster risk of Sinabung uses scoring techniques for all indicators. The volcano eruption disaster risk of Sinabung refers to eruption hazard level, vulnerability level, and disaster prevention capacity index. The level of volcano eruption hazard and vulnerability of Sinabung volcano was analyzed by GIS approach using ArcGIS 10.1 software, based on units of sub-district administration. The capacity index was analyzed based on the *Hyogo Framework for Action-HFA 2005-2015*. While the disaster mitigation and policy model of adaptation of volcano eruption Sinabung were analyzed with FGD and AHP. The level of volcano eruption disaster risk of Sinabung is high > 49 (614). As for the mitigation model of the eruption risk of Sinabung volcano and model of adaptation policy based on alternative priorities for disaster risk reduction has 4 main priorities, i.e: 1) Relocation for identify, assess and monitor of disaster risk and implement an early warning system; 2) Utilize of knowledge, innovation and education to build a culture of safety and resilience at all levels; 3) Make of disaster risk reduction a priority of national and region implemented through strong institutions; and 4) the reducing of underlying factors that increase disaster risk.

Keywords: Sinabung Volcano, Disaster Risk, Mitigation Model, Karo Regency

1. INTRODUCTION

The Indonesian archipelago state is also traversed by two active lanes in the world, the Pacific and Mediterranean circums. The Pacific Circum includes islands in Sulawesi island the northern part and Maluku the northern part. The Mediterranean circums is divided into two parts, the arc in the active (*inner arc*) and the outer arc that is no longer active. Inner arc Mediterranean circuits include volcanoes found on the mainland of Sumatra, Java, Bali, Lombok, Nusa Tenggara, part of Sulawesi island and ending in the Banda Sea. The outer arc of the Mediterranean (outer arc) encompasses the islands in Sumatra island the western part such as Mentawai archipelago, Nias archipelago, Enggano island continues to the southern coast of Java island, and Nusatenggara islands cover the Sumba island [1].

One of the active volcano that recently showed its activity is the Sinabung volcano. Sinabung volcano in Karo language "Delen Gunung Sinabung" is a volcano in the Karo highlands, Karo Regency, North Sumatra - Indonesia. [2] [3] adds Sinabung volcano close to Sibayak mount are two active volcanoes in North Sumatra and

become the highest peak in the province of North Sumatra, with the height of the mountain is around 2.460 meters. [4] explained the feasibility of the evacuation route for the risk adaptation of the Sinabung volcano in Kato Regency is done by *Network Analysis* which is found in the Arc GIS 10.1 program. Where *Network Analysis* a system of linear features that are interrelated in each constituent element where a flow of movement in a network system besides that it is also analyzed 1) number of settlements; 2) population; 3) length of the line; and 4) accessibility and feasibility of evacuation routes.

Sinabung volcano has not been recorded erupting since 1.600 years [5], but suddenly active again and erupted at the date of August 27, 2010, this mountain released smoke and volcanic ash. On August 29, 2010 at around At 00:15 pm, this mountain release volcanic fumes and ash. The status of the mountain is raised to "Beware".

Twelve thousand residents around nearby are evacuated and accommodated in 8 locations. The sound of this eruption was heard up to a distance of 8 kilometres. This volcanic dust is sprayed up to 5,000 meters in the air [6]. Based on TRIBUNE NEWS media reports (2015) the ash of Sinabung

volcano tends to slide from the southwest headed the northeast. The partially of Medan city is also covered with ash from Sinabung volcano. Kualanamu and Polonia Airport in Medan City reportedly did experience air travel disruption. One person reportedly died of a respiratory disorder while evacuating from his home. The results of the eruption of Sinabung volcano emit a thick black smog accompanied by the rain of sand and volcanic ash that covers thousands of hectares of farmers' crops that are below a radius of 6 kilometres.

Volcanic dust causes many of the farmers' crops on the mountain slopes to die and damage. An estimated 15.341 Ha of agricultural crops are threatened with crop failure. Gray volcanic dust has covered the forest, villages, and surrounding agricultural land [7], so that the author's mind appeared to research there is a whether danger of volcanic dust to the health of local society, agricultural crops, and livestock of local society.

2. RESEARCH METHODS

2.1 Volcano eruption the risk level of Sinabung

To see the volcano eruption risk level of Sinabung seen from 3 elements, i.e: 1) the volcanic eruption hazard level; 2) the volcanic eruption vulnerability level; and 3) the capacity of handling capacity the volcano eruption of Sinabung in Karo Regency. The volcano eruption risk level of Sinabung is analyzed in each sub-district administrative unit with a scoring method against the volcanic eruption hazard indicator according to the Regulation of the BNPB No. 02 of 2012 based on the danger indicator of a volcanic eruption.

2.2 Policy model of adaptation-mitigation and social risk of the volcano eruption of Sinabung

The formulation of a policy model for mitigating the risk the volcano eruption of

Sinabung in Karo Regency is carried out descriptively based on the results of research that has been carried out as a criterion for the formulation of a mitigation policy model, i.e: 1) the volcano eruption hazard level of Sinabung; 2) the volcano eruption the vulnerability level of Sinabung; and 3) the volcano eruption risk level of Sinabung. The formulation of the volcano eruption mitigation policy model of Sinabung is classified into several stages, i.e: 1) the compile of mitigation policy alternative the volcanic eruption of Sinabung based on further development of primary and secondary data research, in the form of a description of things that must be developed into public policy priorities [8-10]; 2) the formulate of priorities for the volcano eruption mitigation policy of Sinabung [11-13]; and 3) the selection of priorities the volcanic eruption mitigation policy of Sinabung through alternative selection to be made a priority by Bayes method and *Focus Group Discussion* (FGD) [14-17].

3. RESULTS AND DISCUSSION

3.1 Volcano eruption the risk level of Sinabung

Based on the eruption nature and circumstances of the Sinabung volcano, then the potential eruption hazards that may occur are 1) pyroclastic flow (hot clouds); 2) pyroclastic falls (the bursts of incandescent rock and ash rain); and 3) lava flows [18-23]. [24] adds based on the hazard level of Sinabung volcano eruption that might happen, the region of the disaster-prone of Sinabung volcano can be divided into three of the vulnerability level from low to high, however based on the analysis of the eruption hazard indicator according to Head Regulation, *Agency of National Disaster Management* (BNPB) No. 02 of 2012 the volcano eruption risk level of Sinabung belongs on the medium and high hazard levels (Tabel 1).

Table 1 The volcano eruption risk levels of Sinabung

No	Sub-district	Hazard		Vulnerability		Capacity index		Risk	
		corrected standard	criteria	corrected standard	criteria	corrected standard	criteria	corrected standard	criteria
1	Simpang Empat	22.5	medium	18.8	medium	2.75	high	44.05	medium
2	Payung	20	medium	15.3	low	2.5	high	37,8	medium
3	Tiganderket	28	high	19.05	medium	2	medium	49.05	high
4	Kabanjahe	20	medium	27.6	high	2.5	High	50.1	high
5	Kutabuluh	21	medium	17.3	medium	1.75	medium	40.05	medium
6	Leubaleng	19	medium	20.05	medium	1.75	medium	40.08	medium
7	Mardingding	28	high	19.05	medium	2.5	high	49,55	high
8	Tigabinanga	21.5	medium	21.8	medium	1.75	medium	45.05	medium
9	Tiga Panah	21.5	medium	20.8	medium	2.25	medium	44.55	medium
10	Barusjahe	27.5	high	20.8	high	2	medium	50.3	high

No	Sub-district	Hazard		Vulnerability		Capacity index		Risk	
		corrected standard	criteria	corrected standard	criteria	corrected standard	criteria	corrected standard	criteria
11	Namanteran	29	high	10.8	low	2.5	high	42.3	medium
12	Berastagi	27	high	27.6	high	2.25	medium	56.85	high
13	Dolatrayat	29	high	17.3	medium	1.75	medium	48.05	medium
14	Merdeka	27	high	15.3	low	1.5	low	43.8	medium
15	Merek	22.5	medium	20.25	medium	1.75	medium	44.5	medium
16	Munte	21.5	medium	21.4	medium	2	medium	44.9	medium
17	Juhar	19	medium	20.05	medium	1.75	medium	40.8	medium

Source: Results of data analysis, 2018.

The volcano eruption hazard levels of the highest Sinabung i.e in the sub-district of Namanteran, Dolatrayat, Barusjahe, Berastagi, Merdeka, and Tiganderket. As for the volcano eruption vulnerability levels of Sinabung based on Head Regulation BNPB No. 02 of 2012 with indicator of the vulnerability i.e: 1) population density; 2) female sex ratio (%); 3) ratio of age groups 0-14 years and > 64 years (%); 4) ratio of disabled people (%); 5) ratio of poor households (%); 6) the land area of productive (rice fields/agriculture, moor/shrubs, mixed garden) (Ha); 6) number of livestock (tail); 7) number of houses (units); 8) number of public facilities (education, health, and offices) (units); and 9) the

land use, where the result is the highest level of vulnerability located in the sub-district of Berastagi and Kabanjahe. While to the disaster management capability index of the highest volcano eruption of Sinabung is in the sub-district of Simpang Empat, Payung, Kabanjahe, Mardinding, and Namanteran. Based on the map analysis of the volcano eruption risk levels of Sinabung. Showing that in the sub-district of Mardinding, Tiganderket, Dolatrayat, Kabanjahe, and Barusjahe are in the high category or the hazard (Beware). The map of disaster risk levels is obtained based on the results of the map analysis of hazard, map of vulnerability, and map of index capacity that can be seen on the map Fig.1 below.

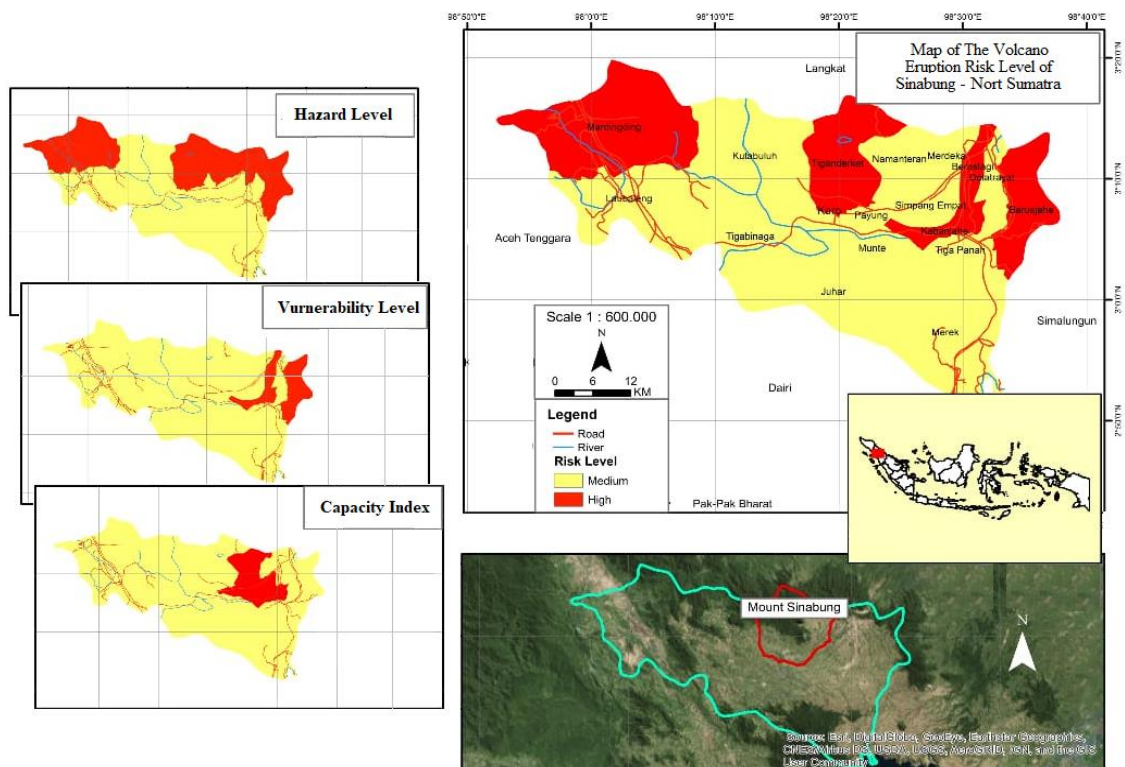


Fig.1 Map of The volcano eruption a risk level of Sinabung.

Based on data records from the Agency of Center Statistics (BPS) of 2017. Demographically, Karo Regency has a population growth rate of

2.3% every year. [25] state that high population growth in a region will create conflict between land uses. [1] adds based on Law No. 24 of 2007

concerning disaster management states that mitigation is a series of efforts to reduce disaster risk. Based on the results of the analysis shows that there are three main alternatives to the direction of disaster mitigation policy, i.e: disaster education, increased socialization in disaster-prone zones, and disaster-based spatial planning.

3.2 Policy model of adaptation-mitigation and social risk of the volcano eruption of Sinabung

Disaster mitigation is an effort made to prevent disasters or reduce the impact of disasters which include preparedness and vigilance as the volcano eruption disaster mitigation model of Sinabung is based on the results of FGD with the society, Agency of National Disaster Management (BNPB), Agency of Sub-National Level Disaster Management (BPBD), Agency of Development Planning of Sub-National Level (BAPPEDA), and NGOs regarding disaster mitigation for sub-districts included in the hazard (Fig 2).

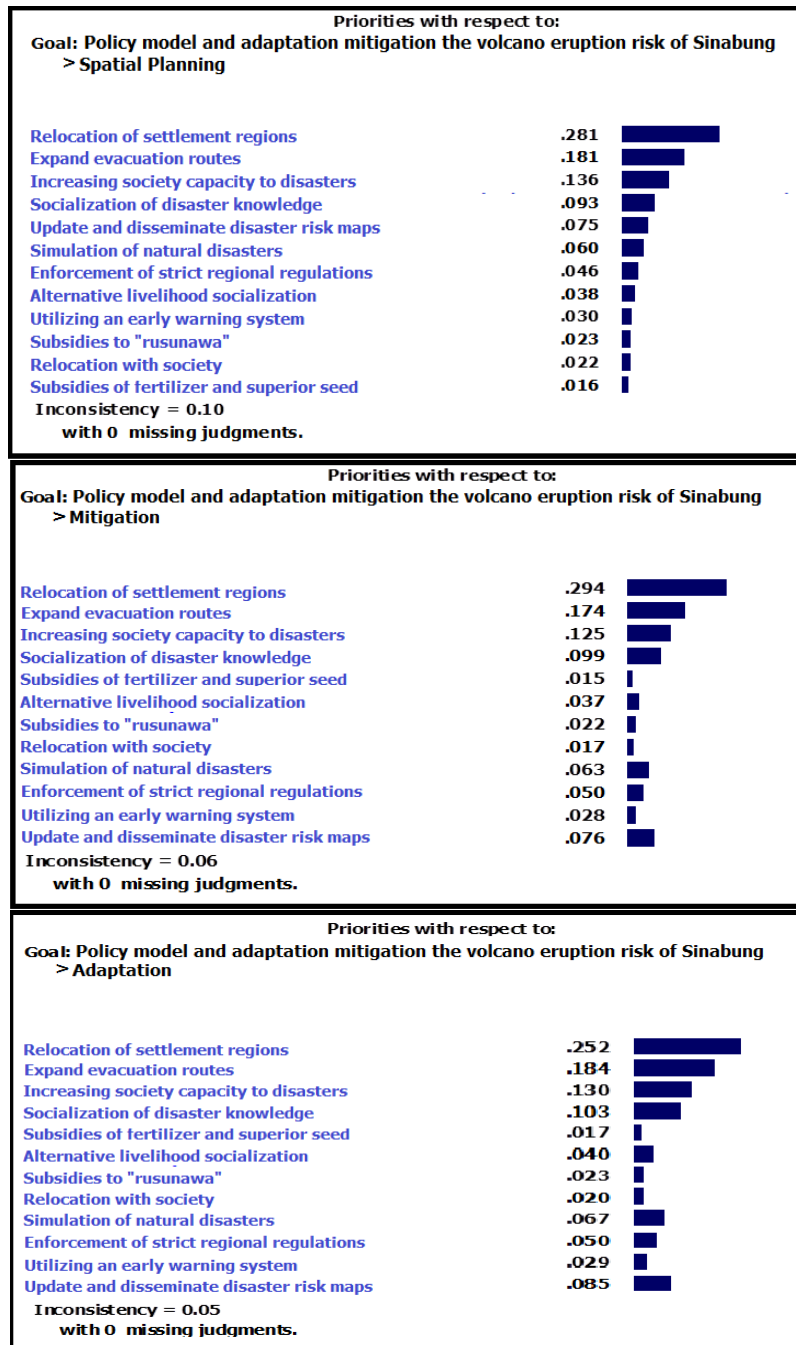


Fig. 2 Policy Model of adaptation mitigation and social risk of the volcano eruption of Sinabung.

Based on the analysis of the volcano eruption disaster risk mitigation and policy model of adaptation of Sinabung volcano in Karo Regency, it can be seen from spatial planning, mitigation, and adaptation that alternative priorities for disaster risk reduction are 4 main priorities, i.e: 1) Relocation identifying, assessing, monitoring disaster risk, and implementing an early warning system; 2) Utilizing knowledge, innovation, and education to build a culture of safety and resilience at all levels; 3) Making "Disaster Risk Reduction/DRR" a national and regional priority implemented through strong institutions; and 4) Reducing factors fundamental causes of the emergence or increase of disaster risk.

[26] stated one effort to reduce the impact of disaster risk by increasing the capacity of the society in dealing with disasters. [27-30] explained disaster education and increased socialization in disaster-prone zones as an indicator to increase society capacity in reducing disaster risk. Enhancement the society capacity to reduce the volcano eruption risk disaster of Sinabung in Karo Regency can be implemented by including disaster education in the school curriculum. With including disaster education curriculum to the society in disaster-prone regions is an effective effort to reduce the risk of disasters. [31-34] states that including disaster education in all elements of society can reduce 40-60% of losses due to disasters. In addition, [35-40] adds that one solution mitigates the vulnerability region of the volcanic eruption disaster by entering the element of disaster in the preparation of spatial planning. This is in accordance with the direction of disaster mitigation policies by including disaster-based spatial planning.

4. CONCLUSION

The volcano eruption disaster risk levels of Sinabung in Karo District is high because > 49 (614), this result is also in line with the IRB BNPB which suggests that the volcano eruption disaster risk level of Sinabung in Karo Regency is high. The volcano of Sinabung in Karo Regency experienced an increase in the volcanic eruption disaster from the frequency of occurrence and the region affected by volcanic ash. Where the volcanic dust that hit the region resulted in many farmers' plants that were on the slopes of the mountain that were dead and damaged. The grayish white volcanic dust covered the forest, village and surrounding agricultural land. The high intensity of volcanic ash distribution and conversion of forest regions to other uses is a factor that causes carbon uptake to be unstable.

About 15.341 Ha of the Karo Regency region is a high hazard level zone against the disaster of volcanic eruptions with settlement regions that are built in high hazard zones are around 27%. Efforts to reduce risk by using disaster risk mitigation and adaptation policy of the volcano eruption in Sinabung, i.e: relocation, disaster education, increasing socialization in disaster-prone zones, and disaster-based spatial planning. It was suggested to the Karo Regency government to include disaster education curricula starting from the elementary to secondary schools, conducting socialization in disaster-prone zones, and conducting disaster-based spatial planning.

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