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THE COMPARISON OF FATALITIES DISTRIBUTION ON THE KRB MAP WITH FATALITIES DISTRIBUTION ON THE ISOVOLCANIC MAP OF THE 2010 MERAPI ERUPTION

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ABSTRACT

The eruption of Merapi Volcano in 2010 was one of the biggest eruptions in the Merapi Volcano history. It caused several impacts such as buildings and environment damages, financial losses, and many fatalities. The objective of this research is to compare between fatalities distribution based on 2010 Disaster-Risked Area Map (Kawasan Rawan Bencana) and fatalities distribution based on Isovolcanic Map. The data source used secondary data which was got from the District Health Agency, supported by interview, observation, and field survey. The analysis then was conducted using ArcMap software. The result showed that the distribution of the most fatalities was in the around of Gendol River stream which was part of KRB III area, meanwhile, on the Isovolcanic Map this distribution was area with intensity more than X or high intensity area. Fatalities were also spread in the KRB II area or area whose intensity between VIII and IX on the Isovolcanic map. In the other side, there were some fatalities in the KRB I area which was safe region of the Merapi eruption hazard, while on the Isovolcanic map there were fatalities distribution in the area with intensity less than VII or low intensity. Many fatalities in the KRB Map and Isovolcanic Map area including in the safe area could be caused by some factors including both direct and indirect factors.

*Keywords***:** Eruption; Merapi; Fatalities; KRB; Intensity; Isovolcanic

1. INTRODUCTION

1.1. BACKGROUND

Merapi Volcano is one of the famous tourism destinations in D.I. Jogjakarta Province. It not only has a beautiful view, attractive history and culture to gain many tourist visited, but also fertilized soil and mineral riches as the product of explosions which has become the income source for people around Merapi Volcano. Even though Merapi has high frequency to erupt, it does not lessen people interest to live around there. This strato-volcano is one of the most active volcano in the world which has 28 km in diameter, 2,978 meter altittude above sea level, 300-400 km^2 coverage area, and 150 km^3 volume, is located geographically on 7º32'5" South Latitude and 110º26'5" East Logitude, and also administrative located on four districts, i.e. Sleman District in D.I. Yogyakarta Province, Magelang District, Boyolali District, and Klaten District in Jawa Tengah Province (Qowo, 2014). Merapi Volcano has erupted for 84 times since it has been recorded, with quite number of fatality and The 2010 eruption was one of the biggest Merapi eruption in the history (Sutaningsih et al, 2011). The eruption happened on the end of October 2010 to the beginning of November 2010 and caused many fatalities, losses and damages in many aspects.

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In order to reduce the risk of Merapi eruption disaster, mainly for fatality, the government – in this case PVMBG and BPPTKG – has specified the area in the certain radius of the volcano peak, which is called Disaster Risked Area Map / Peta Kawasan Rawan Bencana (KRB). In Bappenas and BNPB (2011), the KRB Map all this time has been the only one reference for the people to describe the risk level of living around of Merapi. This map provides disaster type and character of volcano, disaster risked area, evacuation route, refuge, and disaster management post. The classification of disaster risked area by creating the KRB map is conducted based on geomorphology, geology, activity history, distribution of previous eruption product, research, and field study. Disaster risked-area has been cathegorized into three level, i.e. Kawasan Rawan Bencana III (KRB III), Kawasan Rawan Bencana II (KRB II), and Kawasan Rawan Bencana III (KRB III). Kawasan Rawan Bencana (KRB) III is the highest risked area. It is located close to the top of the Merapi Volcano, this area is frequently exposed by pyroclastic flow, lava glowing, rock avalanches, scorch rock throw, and heavy ash rain, hence it's not recommended to be a permanent residential. KRB Map is given in Figure 1.

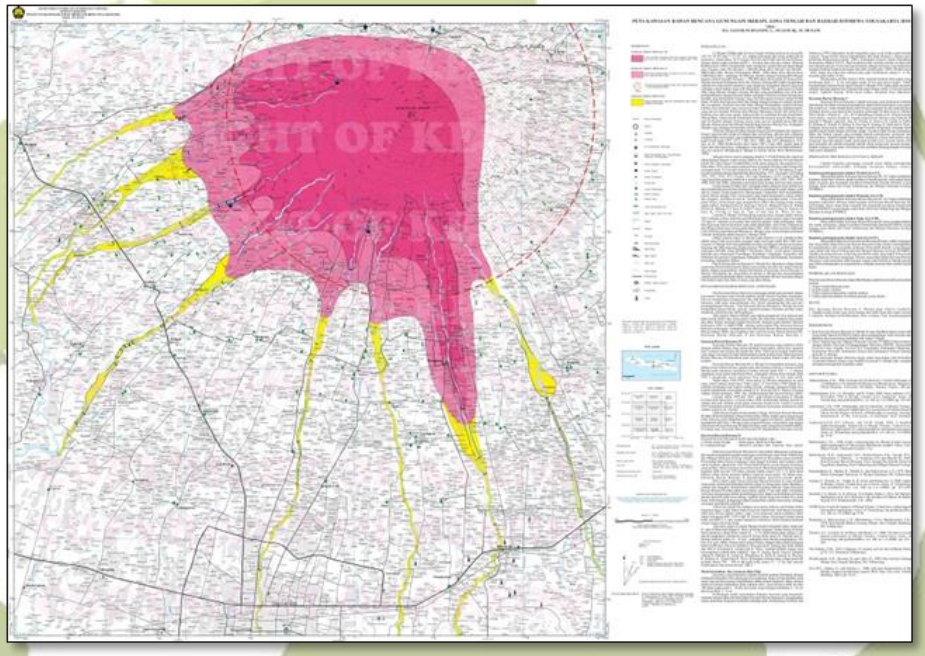

Figure 1 The 2010 KRB Map 2010 was released by PVMBG

In addition to KRB Map, there is another map called Isovolcanic Map which is created based on the intensity similarity. If there is an Isoseismic Map for earthquake, then for volcano eruption it is called Isovolcanic Map. According to Sari (2013), this map was formed of isovolcanic countur lines which was connected due to the similarity of intensity among several locations. Intensity of volcano eruption is obtained based on the people's feeling, object respond, building and environment damage as a scale of intensity volcano eruption (IVE). As studied by Sari (2013), the scale of intensity volcano eruption (IVE) is categorized into 12 scales. This category then was used to collect the intensity data. If there are sufficient data, then it will be known that several places has similar or almost same instensity. If those places were connected each other, then it will form isovolcanic lines and become an Isovolcanic Map as Figure 2. On the

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2010 Merapi Volcano eruption, Isovolcanic map was divided into 8 (eight) area. The lowest intensity area has the IVE scale less than V and the highest intensity area has the IVE of XII. Then by using these two kinds of map, it will be known the differences between the 2010 Merapi eruption fatalities distribution on KRB Map and Isovolcanic Map.

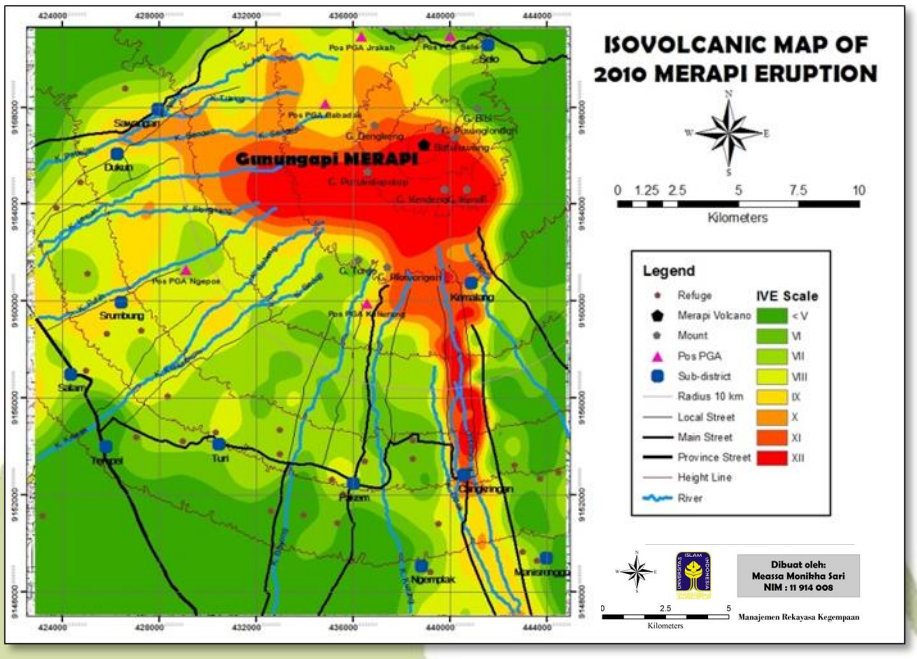

Figure 2 Isovolcanic Map of the 2010 Merapi eruption (Sari, 2013)

1.2. OBJECTIVE

To compare between fatalities distribution on the KRB Map and fatalities distribution on the Isovolcanic Map as a result of the 2010 Merapi Volcano eruption.

2. METHODOLOGY

The data was collected by observation method, field survey, and interview with the victims and stakeholders involved in disaster management of the 2010 Merapi eruption. This research used secondary data, that is the victims were passed away caused by Merapi eruption during October to December 2010 period, obtained from the Health Agency in Sleman District, Klaten District, and Magelang District. Meanwhile, for Boyolali District, fatality data was recorded in the Health Agency of Magelang District. The ArcMap software is used to plot and analyze fatalities distribution into the KRB map and Isovolcanic Map.

3. RESULT

Throughout the history, Merapi volcano has caused fatalities which are represented in Figure 3. The 2010 eruption caused 389 fatalities, compared to the 2006 eruption which only caused 2 casualties where they trapped inside a bunker in Kaliadem (Sutaningsih et al, 2011).

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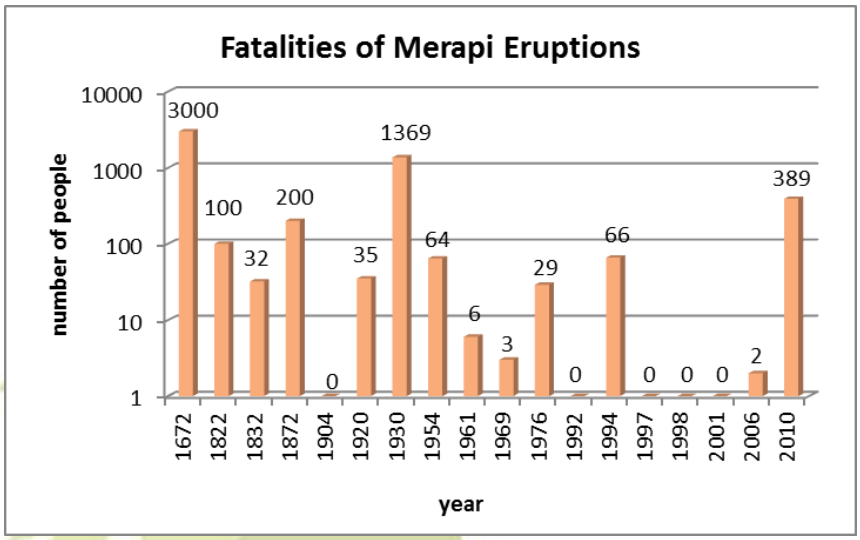

Figure 3 The graph of casualties changed caused by Merapi eruption (Sutaningsih et al, (2011) in Sari, (2013))

When the 2010 eruption happened, the District Disaster Management Agency (BPBD) of four impacted districts were not yet formed, so the fatalities were handled by the District Health Agency (Dinas Kesehatan) and supported by many stakeholders. Based on the obtained secondary data, there were 414 casualties, then there are 414 spots on the fatalities distribution map. The fatality coordinate was defined according to official address in their ID.

The distribution of fatalites caused by the 2010 Merapi eruption on the KRB Map was shown in Figure 4 and the fatalities distribution on the Isovolcanic Map described in Figure 5. Figure 4 shows the total fatalities distribution on KRB Map which the largest number of fatalities distribution was 260 persons spread on KRB III area i.e. Cangkringan Sub-district in the village of Umbulharjo, Argomulyo, Kepuharjo, Wukirsari, and Glagaharjo, then in a little part in Sindumartani Ngemplak Sub-district Sleman District, Balerante village in Kemalang Sub-district in Klaten district, and some number in the Sub-district of Dukun and Sawangan Magelang District. Besides in Magelang, the casualties in these areas were directly impacted by the pyroclastic flow. The fatalities distribution were also spread on the KRB II area with 82 persons, on the KRB I area was 8 persons then there were 64 persons on the non-KRB area. The non-KRB area is an area which is safe from Merapi eruption hazards that spread on i.e. the sub-dictrict of Pakem, Turi, Cangkringan in Sleman District, Srumbung, Dukun and Sawangan in Magelang District, then the district of Kemalang in Klaten District

According to Sari (2013), the casualties in the Isovolcanic Map was shown as Figure 5. The biggest fatalities distribution was 268 persons located in the intensity XII, XI, and X area or the red gradation area i.e. Cangkringan Sub-district in the village of Umbulharjo, Argomulyo, Kepuharjo, Wukirsari, and Glagaharjo, a few of people in Sindumartani Village Ngemplak Sub-district, Sleman District Balerante village in Kemalang Sub-district in Klaten district, and some number in the Sub-district of Dukun and Sawangan Magelang District. There were 54 casualties spread in the yellow gradation area or area with the scale of IX and VIII intensity, then 92 persons were

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located in the intensity VII, VI and V area or the green gradation area around the Sub-district of Pakem and Turi in Sleman District, Srumbung, Dukun and Sawangan in Magelang District, and the last is Kemalang in Klaten District.

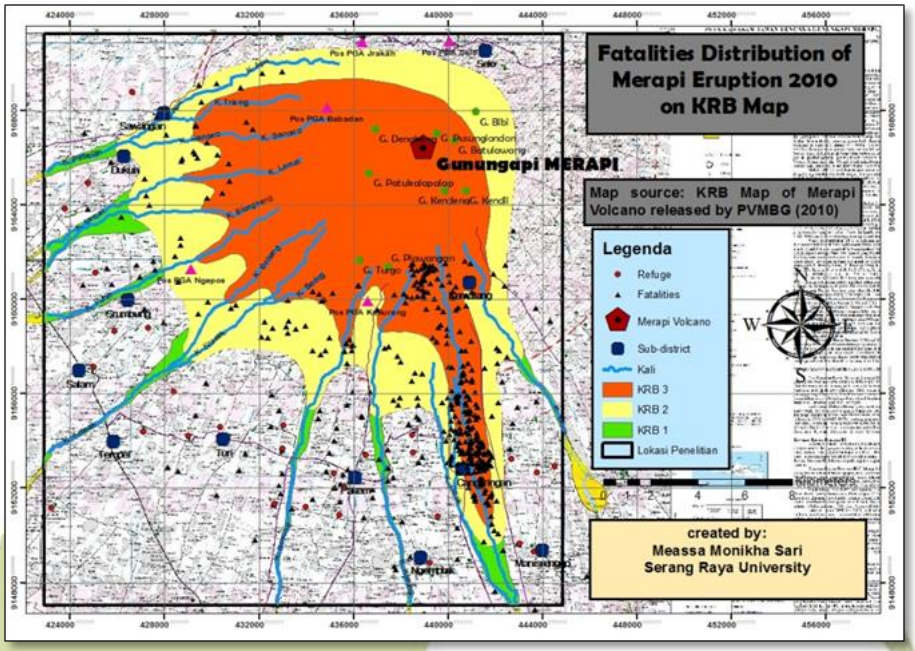

Figure 4 Fatalities Distribution of the 2010 Merapi Eruption on KRB Map

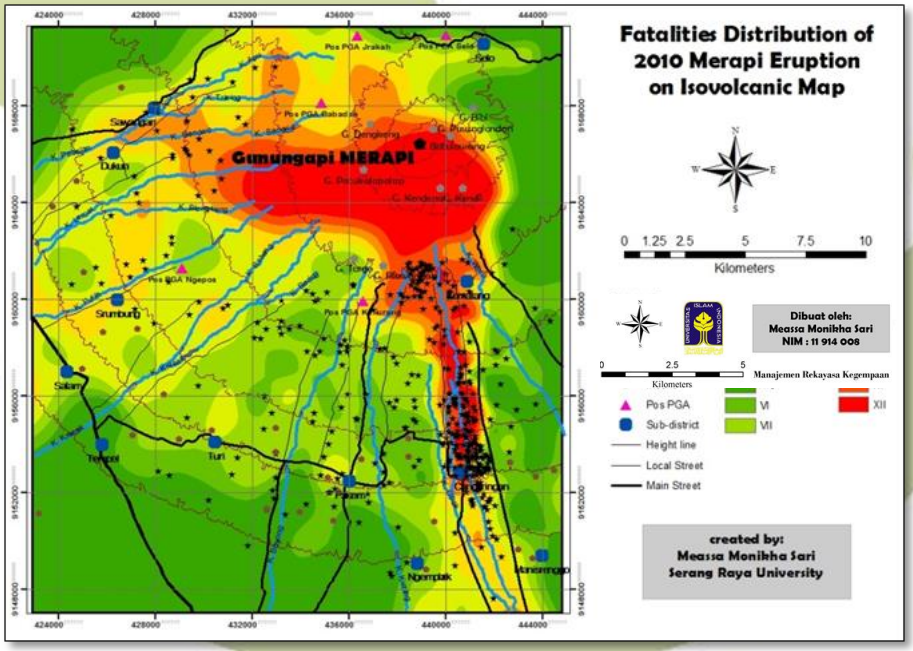

Figure 5 Fatalities Distribution of the 2010 Merapi Eruption on isovolcanic Map (Sari, 2013)

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If KRB Map is overlaid with the Isovolcanic Map, fatalities distribution is shown by Figure 6. The comparison of casualties' distribution between two maps was conducted by comparing the fatalities on KRB III with red gradation area (high intensity area, intensity more than X), the KRB II with yellow gradation area (between VIII-IX intensity), KRB I and non KRB area with green gradation area (intensity less than VII).

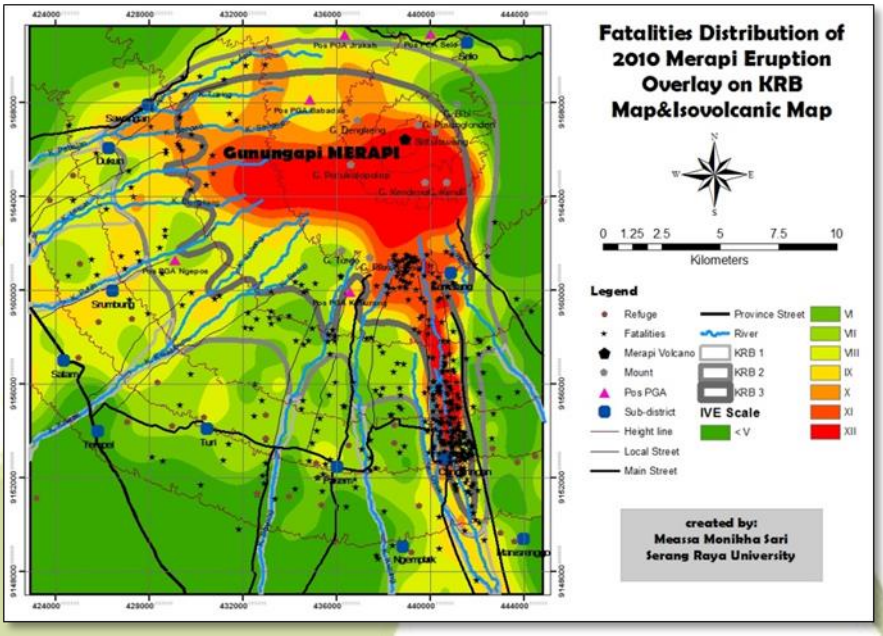

Figure 6 Fatalities Distribution of the 2010 Merapi Eruption overlaid on KRB Map and Isovolcanic Map

In general, the overlaid result of both the KRB map and also Isovolcanic Map shows that the biggest fatalities distribution was located at the Kali Gendol stream, which was directly impacted from the main hazard of Merapi, i.e. pyroclastic flow. The fatalities amount difference between KRB III (260 people) and high intensity area (intensity were more than X, with 268 people) was caused by the difference of decision base when defining the risk level. It was known that on the KRB Map, the radius is a standard to determine risk area whereas every location on the same distance from Merapi peak is not always has a similar risk as well. On the KRB map, 8 fatalities spread in the Magelang District were located in the KRB II, not KRB III, even though in the Isovolcanic map they were located in the high intensity area (more than X).

The fatalities amount in the KRB II was 82 people, much bigger than the fatalities spread on the medium intensity area of Isovolcanic map, i.e. 54 people. This was caused by the coverage area which included in that intensity was much narrower compared to the coverage area of KRB II, hence the fatalities was more distributed in the green gradation color area. In the area which is relatively secured from eruption, like KRB I and non-KRB area, there were 72 fatalities, much fewer than the fatalities amount in the green gradation color area (below VII intensity, 92 fatalities). The difference of fatalities distribution between KRB Map and the Isovolcanic Map occurred due to difference of parameter used in the making of those maps. According to Sari (2013), a certain radius in the KRB map becomes a safe basis from Merapi hazard, even though it cannot be that every location has a risk similarity, i.e. the damage in 5 kilometers west of Merapi peak is not same as the damage at the 5 kilometers east of Merapi Peak. It is

caused by some factors like direction of dome collapse, direction and velocity of wind, topography, the distance of lava flow, etc. On the other side, intensity of an area in the Isovolcanic Map was obtained from the measurement by using intensity volcano eruption scale or IVE. The scale of IVE describes the strength of an eruption based on its losses and damages caused by vibrations, pyroclastic flow, tephra falls, volcanic gasses and lava so that Isovolcanic Map is more complicated than KRB Map.

Based on interview with the District Disaster Management Agency (BPBD) and Health Agency (Dinas Kesehatan) District of Sleman, Magelang and Klaten in Sari (2013), the fatalities on KRB III and high intensity area were directly impacted by the pyroclastic flow because this area not only was close to the Merapi peak (about 5-10 kilometers) but also was located around Gendol River as the main current of pyroclastic flow. Most of them were found in very pathetic condition, such as burned-out, scorched, coverred by ash, even only in the form of bidy parts, making them hard to identify. However, the fatalities in KRB III of Magelang District were not caused by the pyroclastic flow because it did not pass the rivers in Magelang. They were impacted by indirect factors as the fatalities in KRB II, KRB I in the KRB Map, and on yellow and green gradation area in the Isovolcanic Map. The indirect factors are accidents caused by tephra falls and panic, respiration infection, diseases, psychology condition and premature birthing. Lava of 2010 Merapi eruption did not cause any casualties, although it caused high enough level of damage.

4. CONCLUSIONS

The conclusions are:

a. The biggest number of fatality spread both on the KRB III area (260 persons) and red gradation area (area with intensity more than X, 268 persons). Most of them were impacted directly by the pyroclastic flow.
b. There were 82 fatalities on KRB II and 54 fatalities on yellow gradation area (area with intensity about IX and VIII). The different number was caused by the total area of the intensity in isovolcanic map is narrower than that of the KRB II total area.
c. The fatalities distribution in KRB I and non KRB area (72 persons) was much less than the fatalities distribution on green gradation area (area with intensity less than VII, 92 persons). It means there were more fatalities on the safe area of Isovolcanic Map than on the safe area of KRB Map.

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