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Implementation of Volcano Eruption Disaster Management Policy in Magelan Indonesia

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Abstract.
Mount Merapi is one of the most active volcanoes in Indonesia and is located in Magelang. Klakah village is located in the Boyolali regency and is included in the Merapi disaster prone area, while Gantang village is located in the Magelang regency, which is included in the safe zone, away from the threat of Merapi. The purpose of this study is to determine the implementation of the "sister village" policy in the event that Mount Merapi erupts in the Magelang and Boyolali districts. This research was conducted using qualitative methods with data obtained through interviews, observations, and documentation with five research subjects: Klakah village FPRB, Gantang village FPRB, Klakah-Gantang twin village facilitator, Magelang district BPBD, and Boyolali district BPBD. The results showed that based on the indicators of the sister village policy implementation, the sister village has been running since 2019, but there are several indicators that have not been implemented optimally. Thus, there needs to be better cooperation between the BPBD, sister village, and NGOs so that the implementation of the sister village policy can be carried out optimally. The implementation of the sister village policy resulted in the following proposals: (1) an information system, (2) resource assessment, (3) disposition in the form of a committee, and (4) a contingency plan structure.

Keywords: policy, implementation, Sistem village, disaster management, eruptions

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1. Introduction

A disaster is an event or a series of events that threaten or disrupt people's lives and livelihoods, whether caused by natural and/or non-natural factors or human factors, resulting in human casualties, environmental damage, property losses, and psychological impacts. Disasters are divided into three types: natural, nonnatural, and social. *Natural disasters* are those caused by an event or a series of events caused by nature. One example of a natural disaster is a volcanic eruption. (Law No. 24 Year 2007, 2007).

Indonesia is a vast continental shelf area (Sunda Shelf and Sahul Shelf) with the highest-folded mountains in the tropics and perpetual snow (Central Highlands of Papua). In addition, Indonesia is the only country in the world that has a very deep inter-island sea, the Banda Sea (more than 5,000 m), and a very deep sea between two

island arcs, the Weber Trough (more than 7,000 m). Two of the world's major volcanic trails also meet in the archipelago, and several of the world's mountainous folds meet in Indonesia BNPB, [1].

Indonesia's tectonic condition is the result of the meeting of 3 (three) main tectonic plates: the Indo-Australian, Eurasian, and Pacific plates. The meeting zone between the Indo-Australian plate and the Eurasian plate is off the west coast of Sumatra, southern Java, and Nusa Tenggara, while it is off the Pacific plate in the northern part of Papua and Halmahera. This zone is generally characterized by deep troughs.

This tectonic activity has led to the occurrence of a series of volcanoes (arcs of volcanoes) along the islands of Sumatra, Java-Bali-Nusa Tenggara, north Sulawesi-Maluku, and Papua. The volcanic chain in Indonesia is part of the volcanic chain along the Asia-Pacific region, which is often referred to as the Ring of Fire or the Pacific Circumpolar chain. The zone or area between the plate boundaries and the volcanic chain is often referred to as an active zone or a submarine tectonic line (forearc). Meanwhile, zones or areas located on the side after the volcanic chain, which can be known as the back arc, tend to be less active faults and are usually found in many alluvial deposits and swamps, such as on the east coast of Sumatra, north coast of Java, and south coast of Papua. The following is an image of the Asia-Pacific volcano distribution:

While providing many natural resource benefits, including soil fertility, faults, and volcanic activity in Indonesia, it also impacts the risk of several types of disasters, such as earthquakes and tsunamis. Earthquakes and tsunamis in Indonesia are strongly influenced by tectonic fault activity. Meanwhile, volcanic activity, in addition to having an impact on volcanic eruptions, sedimentary rocks that result from volcanic eruptions in the form of a mixture of gravel usually do not have a strong structure, and landslides on steep slopes occur quickly. The following are a series of volcanoes in Indonesia.

Indonesia has the most active volcanoes in the world with 127. The central or local government must have an administrative mechanism that can enhance the role of disaster management to minimize the risk to the affected communities. The government must minimize its impact on the community in various ways. Steps to reduce the impact of disasters can be undertaken with preventive measures, such as developing systems and technologies that can predict the occurrence of eruptions, earthquakes, and tsunamis to minimize the number of disaster victims. The central government or local government, as well as policymakers, also need to create a document containing the administrative process of disaster management that has been agreed upon by all stakeholders Indonesian Institute of Sciences, [2].

Mount Merapi is one of the active volcanoes on the southern coast of Java. Administratively, the area of Mount Merapi is located in 4 districts, namely Sleman Regency which is located in the Special Region of Yogyakarta Province and Magelang Regency, Klaten Regency, Boyolali Regency which are located in Central Java Province and included in the Disaster Prone Area (KRB) of Mount Merapi eruption.

Volcanic disaster-prone areas are those that are affected or identified as potentially threatened by eruptions, either directly or indirectly. The map of volcanic disaster-prone areas was determined as the level of disaster vulnerability of an area in the event of a volcanic eruption or volcanic activity.

Based on the Regulation of the Minister of Energy and Mineral Resources No. 15 of 2011 concerning Guidelines for Volcano, Land Movement, Earthquake, and Tsunami Disaster Mitigation, mapping of volcano disaster-prone areas was carried out to determine areas based on the level of vulnerability to volcanic eruptions and is not limited by administrative areas. This map is used as a basis for anticipation and consideration of decision making for the Government and local governments in disaster mitigation efforts in volcano disaster prone areas which are divided into 3 (three) areas, namely

1. Disaster-prone areas have the potential to be hit by lava or fallout material in the form of ash, rain, and water with high acidity. If the eruption is more prominent, this area has the potential to be hit by hot clouds and fallen material in the form of heavy ash rain and incandescent rock ejection.

2. Disaster-prone area II has the potential to be affected by hot clouds, lava flows, hot rock ejections, lava flows, heavy ash rains, hot mud rains, lava flows, and toxic gases.

3. Disaster-prone area III has the potential to be hit by hot clouds, lava flows, incandescent rock ejections, and toxic gases.

Mount Merapi has unique characteristics in its type of eruption, which produces hot clouds or wedhus gembel in Javanese terms or nuée ardente in scientific terms Brotopuspito, [3]. explain that nuée ardente is the main hazard posed by Merapi eruptions, consisting of gaseous elements, boulders, and volcanic ash that are usually preceded by lava flows and the collapse of lava domes. However, historical records show that Mount Merapi eruptions often occur through different mechanisms; for example, in 1872 and 2010, they occurred explosively Brotopuspito, [3].

The eruption of Mount Merapi shows the characteristics of a quiet eruption in the form of an effusive eruption but can also be an explosive eruption. This effusive eruption is

characterized by incandescent lava flows that form hot clouds. Explosive eruptions often occurred before the 20th century. Currently, the eruption of Mount Merapi generally begins with the formation of a lava dome, then the lava dome undergoes a fall followed by pyroclastic flows. The most recent explosive eruptions occurred in 1930, 1961, and 2010. The various characteristics of these eruptions affect the distribution of materials and the areas affected by disasters. The following is the history of Mount Merapi eruptions from 1930-2010, which had different eruption directions in 2006 and 2010

The written history of the Mount Merapi eruptions began to be recorded during the early Dutch colonial period around the 17th century. Earlier eruptions have been recorded. Meanwhile, significant eruptions in the Mas before the new Merapi period were based only on relative time.

The eruption of Mount Merapi that occurred on October 26, 2010, was followed by eruptions in the following days until early November 2010, which destroyed and paralyzed all activities and lives of the people directly affected by the eruption of Mount Merapi. The disaster resulted in losses, both in life and property. Based on data collected from the Pusdalops BNPB as of December 12, 2010, there were 277 casualties in D.I. Yogyakarta, and 109 casualties in Central Java. A total of 2,682 houses were severely damaged in Yogyakarta Province and 174 houses were severely damaged in Central Java Province.

The next eruption on October 30 resulted in ashfall within a 10 km radius and instructions to evacuate a 10 km radius, especially in the river plains downstream of the volcano, coming from the Center for Volcanology and Geological Hazard Mitigation (PVMBG). On November 3, another eruption occurred with hot clouds and cold lava flows as far as 9 km, prompting the PVMBG to announce an expansion of the safety zone from 10 to 15 km. On November 5, a very large eruption prompted further expansion of the safety zone from 15 km to 20 km. Four districts with a population of 182,446 (53,315 households) were affected by the eruption, namely, Boyolali, Magelang, and Klaten Districts in Central Java Province and Sleman in the Yogyakarta Special Region.

The eruption of Mount Merapi has had an impact on several sectors, namely settlements, infrastructure, socio-economics, and education, so there must be standardization of education in disaster-prone areas and agricultural land as a source of community income, which results in the disruption of activities on the slopes of Mount Merapi. This disaster has an extraordinary impact, causing primary hazards in the form of hot cloud slides and secondary hazards in the form of cold lava floods. These hazards are physically harmful and cause problems in the entire ecosystem. According to data from the Merapi Rehabilitation and Reconstruction Action Plan 2011-2013, the major eruption

in 2010 caused damage and loss of Rp. 2.141 trillion, and Central Java Province Rp. 1.487 trillion. (Trirahayu, 2015).

Magelang District covers 21 sub-districts consisting of 367 villages and five urban villages with a total population of 1,363,290 people, consisting of 686,398 men or around 50.3% and 676,892 women or around 49.7% (Source: Disdukcapil, 2021). Three of the 21 sub-districts, namely Srumbung, Dukun, and Sawangan, are included in Disaster Prone Area (KRB) III of Mount Merapi Eruption. Boyolali Regency covers 19 sub-districts consisting of 261 villages and six urban villages with a total population of 984,807 people, consisting of 484,716 men and 500,091 women (Source: BPS Boyolali 2020 data). Of the 19 sub-districts, 3 them, namely the Selo, Cepogo, and Musuk sub-districts, are included in the Mount Merapi eruption of KRB III. Klaten Regency includes 26 sub-districts consisting of 391 villages and 10 urban villages with a population of 1,171,441 people consisting of 559,464 men and 596,587 women (Source: BPS Klaten 2018).

The Magelang and Boyolali districts are disaster-prone areas. The geographical, geological, and demographic conditions of Magelang District allow disasters to occur, both caused by natural and human factors, that is, Magelang District is an area with potential disaster threats. A disaster threat is an event or occurrence that can cause a disaster (Government of the Republic of Indonesia 2007). The threat posed by the eruption of Mt. Merapi is in the form of volcanic material ejection, which consists of pyroclastic flows to the threat of rain lava floods.

The increased activity of Mount Merapi in 2010, in the form of explosive eruptions and hot clouds, resulted in many injuries, deaths, and property losses in the four districts. The number of deaths caused by the 2010 eruption of Mount Merapi was 347 BNPB [1]. Most of the victims were in Sleman Regency n (246), Magelang Regency (n = 52), Klaten (n = 29), and Boyolali Regency (n = 10). In comparison, refugees reached 410,388 people (BNPB 2012). This shows the lack of preparedness for the community and government to deal with disasters at that time. The BPBD of Magelang District mentioned that in 2010, when Mount Merapi erupted, people in several villages, especially in Magelang District, located in Disaster Prone Areas (KRB) II and III, experienced various problems related to the evacuation site and evacuation management issues. This includes the logistics management.

The impact of the Merapi eruption at the village level is on Klakah Village, Boyolali Regency, Gantang Village, and Magelang Regency. Klakah is a village in the Selo Subdistrict, Boyolali Regency, Central Java, Indonesia. The village is located close to Mount Merapi's peak area. The village is located in a danger zone (4 km from the summit), with the area located on the plateau directly adjacent to Mount Merapi and approximately

4 km from the summit of Mount Merapi. Klakah Village has an area of 626.0890 ha, with 160.109 ha as a residential area (plain) and approximately 465.98 hectares as an agricultural area. Klakah Village is divided into six hamlets, namely Sumber, Bakalan, Bangunsari, Klakah Ngisor, Klakah Tengah, and Klakah Nduwur, with 17 RTs. Based on data from the Village Government in 2019, the total population of Klakah Village was 2,844 people.

The high threat and vulnerability of Klakah Village require preparedness efforts in the face of Mount Merapi's eruption. One way to improve Klakah Village's preparedness is through the Sister Village. Sister Village is a concept of brotherhood between two or more villages during pre-disaster, emergency response, and post-disaster. The history of Sister Village began with the eruption of Mt. Merapi in 2010. Most residents of Klakah Village fled to Gantang Village so that BPBD Magelang took the initiative to improve the relationship between the two villages during the pre-disaster, emergency response, and post-disaster periods. Sister Village makes the two villages help each other and become brothers and sisters, not only during disasters. Klakah Village, which has a higher risk of volcanic eruption, becomes the "Affected Village," which will be assisted by its sister village, Gantang Village, as "Buffer Village."

Gantang Village is one of the villages administratively located in Sawangan Sub-district, Magelang District, Central Java Province. The area of Gantang Village is 468.57 hectares consisting of 11 hamlets. The distance between Gantang Village and the capital of Sawangan Sub-district is $\pm$ 2 km, 11 km from the capital of Magelang District and about 10.6 km from the peak of Merapi. The population of Gantang Village, based on data from the Village Government in 2019, amounted to 3,202 people, consisting of 1,599 men and 1,603 women, with a total of 1,007 households.

The role of Disaster Prone Areas (KRB) in determining Sister Village is very important because through the determination of KRB, the geographical location of an area and whether it is included in the dangerous category can be determined. The following is a map of the Mount Merapi disaster-prone area:

Based on the map of the disaster-prone area (KRB) of the Mount Merapi eruption, Klakah Village is within a radius of $\pm$ 4 km from the peak of Merapi. Klakah Village is in KRB III with high risk, whereas Gantang Village is in KRB I with a safe distance of 10.6 km from the peak of Mount Merapi. One of the efforts made to improve preparedness for Mount Merapi's eruption was through Sister Village. The sister village concept is carried out through an MoU (agreement) between the affected village and buffer village. The MoU explains the division of roles during disaster emergency response.

Based on the above background, the author conducted research on ”Study of the Implementation of Mount Merapi Eruption Disaster Management Policy in Magelang Regency and Boyolali Regency (Case Study of Sister Village of Klakah Village, Boyolali Regency and Gantang Village, Magelang Regency)” where in essence this research examines the concept of implementation and development of the Mount Merapi Eruption disaster management policy using the term ”SisterVillage.”

Based on this background, the problem formulation in this study is as follows: How is the Implementation of Sister Village Policy in Mount Merapi Eruption Disaster Management in Magelang and Boyolali Districts?

2. Methods

A qualitative research approach understands the phenomenon of what is studied based on the research subject, for example, behavior, perceptions, motivations, and actions descriptively in the form of words and language. Within a certain scope, several natural methods were used in this study. Qualitative research can produce results in the form of in-depth descriptions of speech, writing, or behavior that can be observed within a certain scope from a comprehensive perspective. This research intends to explore in-depth information about the Implementation Study of Mount Merapi Eruption Disaster Management Policy in Magelang District and Boyolali District (Case Study of Desa Bersaudara, Klakah Village, and Gantang Village).

3. Results and Discussion

In conveying information related to the activity of Mount Merapi, residents in Klakah Village, Boyolali Regency, use smartphones, handy talkies (HT), and megaphone/TOA. Information dissemination is carried out in conveying the latest status of Merapi, as a tool in coordinating with the Village Alert Team (TSD), and as a tool in coordinating aid delivery as well as a means to gather residents during emergencies.In the disaster risk analysis section at the village level, it is known that Klakah Village is located in disaster-prone area III of Merapi, while Gantang Village is in a much safer place. Therefore, Gantang Village became a reference for Klakah Village residents when Mount Merapi erupted. Both villages analyzed the threat, vulnerability, capacity, and risk of a disaster, namely, the eruption of Mount Merapi. The disaster risk analysis was then integrated into a two-village disaster risk assessment, known as a sister village.

Disaster management plans were implemented in 2019 in the disaster management planning section at the village level. Both villages identified the programs to be carried out in the pre-disaster, emergency response, and post-disaster stages. The participants were representatives from the two villages from various elements of the community, such as Karangtaruna, village officials, religious leaders, community leaders, and 30 volunteers from each village.

In village-level disaster preparedness teams or FPRBs, disaster preparedness/FPRBs were established in buffers and affected villages. The disaster preparedness team consisted of sectors engaged in disaster management (pre-disaster, emergency response, and post-disaster). The village disaster preparedness team is authorized through village regulations (Perdes). The decree is applied according to the agreement in each village. The Alert Village Alert Team is contained in Decree number 141/014/XI/2019 concerning the formation of the Klakah Village disaster alert team, and the Gantang Village Head Decree Number 145/186/009/XI/2019 concerning the formation of the Gantang Village disaster alert team.

The disposition of Klakah and Gantang villages in twinning village committees is that there are twinning village committees that support emergency responses. The Desa Bersaudara Disaster Preparedness Team is composed, but it has not been updated since 2019. This should not happen because, if it is limited to an MOU, the twinned village committee will be difficult to activate in the event of a disaster.

Both villages implemented a sister-village bureaucratic structure based on an early warning system. The early warning system is structured to inform the community about the signs before a disaster occurs. The early warning system built in the sister villages is a community-based early warning system that can build and maintain local wisdom and be fully utilized by the community. The evacuation plan was updated following the Covid-19 pandemic. When a disaster occurs, there is an evacuation route in the brothers' village. There are evacuation sites, evacuation route agreements, and the prioritization of who should be evacuated.

Ground checks were conducted to check vulnerability, capacity, evacuation routes, and evacuation sites. Ground checks are conducted in the affected villages and buffer villages to ensure that evacuation routes, gathering points, and final evacuation sites can function. The contingency plan resulted in the development of scenarios, impact scenarios, objectives and strategies, early warning systems, and evacuation plans, as well as command structures during emergency response in the sister villages of Klakah and Gantang.

An important finding from interviews with all informants was that, in 2010, Klakah Village and Gantang Village took the initiative to help each other during the eruption of Mount Merapi. Residents of Klakah Village fled to Gantang Village, and the residents of Klakah Village received them well. In the last two years, the two villages have helped each other in humanitarian matters, such as holding regular meetings when Gantang village experienced landslides, and Klakah villagers have helped and updated data in the contingency plan document related to vulnerability and capacity every three months.

This study produces the following propositions related to policy implementation:

1. Information System

   This study proposes an information system proposition. The information system is a follow-up to refine the policy implementation theory. It is evident from previous theory that communication is one of the indicators of policy implementation. Communication in the 21st century requires an information system so that implementation can be properly carried out. In this research, the information system studied is the information system in the implementation of Sister Village and becomes a communication plan during the pre-disaster, emergency response, and post-disaster stages.

2. Resource overview

   Capacity studies are a proposition of this research because, in previous studies, resources were one of the indicators of policy implementation. Policy implementation resources require a joint study conducted by policymakers and implementers to determine threats, vulnerabilities, and capacities before implementation so that risks during implementation can be reduced or reduced, and victims and losses can be minimized or even eliminated.

3. Disposition in the form of Committee

   The improvement of disposition in policy implementation in this study was in the form of a committee. The form of the committee in disposition will make cooperation work well between the maker and implementer, so that it will support policy implementation.

4. Contingency plan structure

   The complex nature of policy implementation makes this study produce a contingency plan structure proposition. Policy structure requires contingency plans that allow implementers to know what to do before, during, and after policy implementation. Policymakers and implementers can work well together in the

contingency plan structure because policy implementation is jointly prepared through the contingency plan structure.

4. Conclusion

Based on research on the implementation of sister village policies in Magelang Regency and Boyolali Regency, several conclusions can be drawn, among others.

1. The Sister Village policy was implemented in 2019. The sister villages of Klakah Village and Gantang Village were initiated by the BPBD Magelang District and facilitated by the Pujiono Centre.

2. Sister village communication in Klakah Village and Gantang Village was implemented in the form of a Village Information System. The two villages jointly designed a Village Information System (SID) to accommodate activities during the pre-disaster, emergency response, and post-disaster periods, so that sister villages do not only work together during emergency response. SID design requires cooperation from both villages to be implemented as planned.

3. The sister villages of Klakah and Gantang conducted a joint resource analysis of the village disaster risk analysis, village disaster management plan, and village disaster preparedness team. The resource analysis of these two villages must be updated at least once per year.

4. The disposition of the sister villages in implementing the Sister Village policy was jointly formed by Klakah Village and Gantang Village as sister village committees. The sister village committees of Klakah Village and Gantang Village need to be updated so that existing resources can understand what to do during the pre-disaster, emergency response, and post-disaster stages.

5. The bureaucratic structure in implementing the Sister Village policy for Klakah Village and Gantang Village has been implemented in both villages related to the sister village community-based early warning system, sister village evacuation plan, and sister village contingency plan. The bureaucratic structure in implementing the Sister Village policy requires collaboration from the Village, BPBD, and NGOs so that the bureaucratic structure in implementing the Sister Village policy in Klakah Village and Gantang Village can run well.

6. The implementation of the Sister Village policy resulted in proposals, including (1) information systems, (2) resource assessment, (3) disposition in the form of committees, and (4) contingency planning structures.

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