

The Influence of The Sabo Dam Bronggang on Disaster Mitigationpublic About The Danger of Merapi Mountain Eruption

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Abstract

Mount Merapi In 2010 was the biggest eruption that ever happened to Mount Merapi. Judging from the number of fatalities in this eruption, it reached 277 people and material losses were estimated at 4.5 trillion to the cancellation of flights which resulted in the cessation of access to transportation links. This study aims to determine the impact felt by the community on the construction of the Sabo Bronggang Dam. This study used a descriptive qualitative method with data collection techniques using interviews, observation and documentation. Interviews were conducted by asking the surrounding community about the Sabo Bronggang Dam for the construction of the dam, then comparing before and after the existence of this dam, how was the impact felt, was it effective in dealing with cold lava floods, and whether there is any effectiveness in overcoming cold lava floods, and whether there are any additional developments to provide a sense of security in the awareness of disaster mitigation efforts. From the results of the study, it was stated that the surrounding community felt safe when at any time there was another eruption of the Sabo Bronggang Dam, besides that it could also be used as an attractive destination to visit because of its natural beauty.

Keywords: Eruption, Dam, Society

1. INTRODUCTION

Indonesia is an archipelagic country located at the meeting point of four tectonic plates, namely the Eurasian, Indo-Australian, Indian and Pacific Plates. Indonesia's position also has a volcanic belt that extends from the islands of Sumatra, Java-Nusa Tenggara, and Sulawesi in the form of old volcanic mountains and lowlands in the form of swamps (National Disaster Management Agency, 2023). This geographical location causes Indonesia to have a uniqueness and diversity of regional forms that are different and have their own characteristics which are spread throughout the territory of Indonesia.

The existence of volcanic belts causes Indonesia to have 127 active volcanoes or 13% of the number of mountains in Indonesia. 60% of the total number of volcanoes in Indonesia has a high potential for danger to the surrounding environment, so disaster mitigation efforts are needed to be aware of the dangers that will occur when a volcanic eruption occurs. A volcano is a hole or fracture in the earth's crust which is the location for magma, gas or other liquids to come out onto the earth's surface, which generally forms a cone with a crater where volcanic material comes out (Ministry of Energy and Mineral Resources, 2019)

Mount Merapi is one of the most active volcanoes in Indonesia, to be precise on the border between Central Java Province and Yogyakarta Special Province. In 2010 Mount Merapi experienced a large eruption causing damage and causing many casualties and material losses.

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One of the causes of loss, damage, and high casualties is the Cold Lava Flood which usually occurs in three rivers, namely Kali Gendol, Kali Kuning, and Kali Boyong.

Kali Gendol is a river that flows in the Province of the Special Region of Yogyakarta to the southeast of Mount Merapi and is frequented by cold lava floods when Mount Merapi erupts. The big eruption of Mount Merapi in 2010 recorded 267 deaths, 454 hospitalizations, and 71,579 people had to evacuate to a safer place because most of the hot clouds and cold lava floods headed southeast, namely to Kali Gendol (Cultural Office of the Special Province of Yogyakarta, 2022). So in 2010, with cooperation from Japan, the Sabo Dam was built in Suruh, Argo Mulyo, Cangkringan District, Sleman Regency, Yogyakarta Special Region Province.

Cold lava floods are concentrations of material sedimentation that comes out of volcanoes which then flows as a result of the push of rainwater at high rainfall down the mountain swiftly (Dobran, 2012). The potential for disasters faced by these communities necessitates the need for preparedness to deal with similar disasters in the future. The arrival of the rainy season with high rainfall increases the potential for cold lava disasters (Ainia, 2021)

The construction of the Sabo Dam is in the form of a building that crosses the river body and has the function of minimizing cold lava disasters by holding back the flow of sediment downstream from the river and controlling the flow so it doesn't damage it (Fukuoka et al, 2013). Sabo Dam or Sabo Dam, is a dam building that is built the progressively downstream the looser its density, with the assumption that if the first sabo dam is full of volcanic eruption material carried by cold lava floods, runoff will occur to the next sabo dam so that Cold land floods can be slowed down and give local residents time to evacuate to a safer area from the effects of a volcanic eruption.

The description above made researchers interested in making an article "The Influence of the Sabo Dam Bronggang on the Perception of the Local Community Regarding the Danger of Mount Merapi Eruption". The aim of the study was to find out the public's perceptions and those felt by the community regarding the existence of the Sabo Dam Bronggang in the Mount Merapi eruption alert.

2. METHOD

This study uses a descriptive qualitative approach. According to Strauss and Corbin, qualitative research is research that results from findings that are not achieved by statistics (Grace, 2008). The reason for using qualitative is because the data used is an elaboration related to people's perceptions of the existence of the Sabo Dam Bronggang in Suruh, Argo Mulyo, Cangkringan District, Sleman Regency, Yogyakarta Special Region Province.

The intended research subjects were informants from the community living around the Sabo Bronggang Dam. The object of this research is the Sabo Bronggang Dam. Data collection was carried out by conducting interviews with informants who are people around the Sabo Bronggang Dam.

Sources of data in this study were taken from the process. (a) Interview with questions that have been prepared. (b) Observation by going directly to the field to observe the surrounding environment. (c) Documentation by taking photos of the environment around the Sabo Bronggang Dam.

The data analysis process begins with examining all available data from data sources (Hari, 2019). The results of the existing data are from the results of observations of objects, interviews with relevant sources, photos or pictures in them.

3. RESULTS AND DISCUSSION

Sabo Bronggang Dam is a dam located in Suruh, Argo Mulyo, Cangkringan District, Sleman Regency, Yogyakarta Special Region Province. This dam is located on the Kali Gondol river and aims to reduce the risk of cold lava flooding that occurs when Mount Merapi erupts. This is because when the eruption of Mount Merapi occurred in 2010, in the vicinity of the Sabo Bronggang Dam there were villages that were submerged due to the enormity of the volcanic material released by Mount Merapi during the 2010 eruption.

Sabo Bronggang Dam is one of the sabo dams that was built in the watershed that flows from Mount Merapi, especially in the Gendol River flow. Throughout the Kali Gendol watershed and its sub-streams there are 13 Sabo Dams, namely at GE-D (Kaliadem), GE-D7 (Kaliadem), GE-D5 (Kaliadem), GE-D4, GE-D3, GE-D2, GE-D (Kepuharjo), GE-C13, GE-C12 (Ngancar), GE-C10 (Bakalan), GE-C (Cangkringan I), GE-C (Gadingan), GE-C (Bronggang) (Hanif, 2022).

Besides being used to overcome the risk of cold lava floods from volcanic eruptions, the Sabo Dam can also be developed as tourism with the concept of geotourism. Sabo Dam can be developed into geotourism, geotourism is a tourism activity that makes geological aspects or objects an attraction for tourists, apart from recreation, geotourism can provide education to the public about possible disasters that will occur. (Susatya, 2021). The existence of the Sabo Bronggang Dam has the potential to be used as a location for geotourism, by making the Sabo Bronggang Dam area a tourist area with tours using jeeps which must pay attention to safety factors and environmental sustainability (Munir, 2019).

The eruption of Mount Merapi in 2010 was the largest recorded eruption of Mount Merapi. The large number of victims became one of the main factors. The eruption that began on October 26 2010 and reached its peak on November 4-5 2010 claimed 277 lives (Sleman Regency Government, 2010). One of the reasons for the large number of fatalities was the cold lava disaster in the Kali Gendol river basin.

Cangkringan, which is the location of the Sabo Bronggang Dam, was one of the locations that was badly affected by the 2010 eruption of Mount Merapi. In Cangkringan, the community believes that the mountain is "*jagad gede*" (house of God and home of ancestral spirits). The community thinks that an eruption is a causal event, they believe that if an eruption occurs because the community does not want to protect Merapi, an eruption or anger will occur (Septian, 2021).

Cold lava floods are indeed one of the threats that endanger local residents as a result of volcanic eruptions apart from hot cloud flows, falling pyroclastic material or commonly called ash rain, and toxic volcanic gases (Qudwatunna, 2019). One effort that can be done is to build a sabo dam, in addition to that, education efforts are needed for the surrounding community regarding efforts to mitigate volcanic eruption disasters. Disaster mitigation can be done by increasing the self-awareness of early childhood on volcanic eruption disaster mitigation by using video media that early childhood likes (Ningtyas, 2018). Apart from early childhood,

preparing the community in general for disaster mitigation efforts is one of the most important factors by communicating through a cultural approach, thus reducing the erroneous delivery of information that can lead to uncertainty and make things worse (Hendra, 2018).

The construction of the Sabo Bronggang Dam is one of the dams that was built to overcome the adverse effects that occurred in the eruption of Mount Merapi. The Sabo Bronggang Dam is one of 13 Sabo Dams built in the upper or upper area of the Kali Gendol river. According to one of the local people, the existence of the Sabo Bronggang Dam presents and provides a sense of security from the threat of the Mount Merapi eruption that has occurred and caused a lot of losses or victims both physically and materially. The Sabo Bronggang Dam provides protection from the danger of cold lava floods that hit during the eruption of Mount Merapi in 2010 which claimed quite a large number of victims and losses both physically and materially.

The cold lava flood incident resulted in a village being buried and causing huge losses both in terms of casualties and material losses such as houses that could no longer be lived in, rice fields buried in volcanic material, and many livestock that died as a result of the eruption. So that people have high awareness of the danger of Mount Merapi eruption.

Lahar is a mixture of dust or volcanic material with water that flows swiftly, in high concentrations, and sedimentation that is not mixed properly so that it is coarse from a volcano, lava flows are formed from dissolved material at the top of a volcano or volcanic material at the headwaters of a river. which then flows due to being influenced by high rainfall so that it turns the material deposit into a stream (Yudo, 2020).

The main function of the Sabo Bronggang Dam is to hold back the flow of cold lava that always hits the Gendol River when Mount Merapi erupts. Before there was the Sabo Bronggang Dam, this area was quite badly affected when the eruption of Mount Merapi in 2010, the eruption buried settlements in the area along with the materials in it, so now these settlements have been abandoned by residents to move to safer areas.

Sabo Bronggang Dam apart from functioning to hold back cold lava floods from the eruption of Mount Merapi, now the dam has become one of the attractive destinations to enjoy the beauty of Mount Merapi. There are several "warungs" standing around the Sabo Bronggang Dam, according to sources this dam is usually used by young people to hang out or just to look for signals, besides that the Sabo Bronggang Dam is used by cyclists to stop and rest as well as enjoy the beauty nature. Apart from the establishment of stalls, around the Sabo Bronggang Dam there are also sand and stone miners. According to sources, after the eruption, the location of this dam became one of the large concentrations of volcanic material impacted by the 2010 Mount Merapi eruption.

The tourism potential in the area around the Sabo Bronggang Dam is quite good, this is because there are several locations in the area that are good for use as tourist sites or photographs, such as in the Sabo Bronggang Dam building which has a beautiful background view of Mount Merapi, then there are rocks boom named "*Alien Merapi Stone*" which is in the middle of the road to Sabo Bronggang Dam, "*The Lost World Castle*", Importantsari Tourism Village. Good potential in the area around the Sabo Bronggang Dam which can make the area a new integrated tourist location so that it can benefit the community around the Sabo Bronggang Dam.

Sand mining in the river can give local residents a positive impact by opening up employment and labor opportunities, besides that it can be used as an opportunity for local community businesses so that it becomes a source of income for the surrounding community and becomes a source of Regional Original Income (Arsyad et al., 2020). Sand mining in Gendol River after the eruption of Mount Merapi in 2010 has increased due to the abundance of this material carried by river water.

Sand mining activities often occur in the Gendol River, especially near the Sabo Bronggang Dam. According to sources, sand and stone mining near the Sabo Bronggang Dam has decreased in volume produced over time, large sand and stone mining occurred after the eruption of Mount Merapi with volcanic material that filled the Gendol River flow and also the Sabo Bronggang Dam. The mining of sand and stone by residents if carried out on a large scale, is feared to cause erosion and pollution of river water or siltation that occurs in rivers (Saam et al., 2018).

The positive impacts obtained from sand and stone mining are that the community earns income, reduces the number of unemployed, improves the social and economic conditions of the community, while the negative impacts arising from sand and stone mining are the dangers of erosion, landslides, and changes in river landforms (Zahra, 2018).

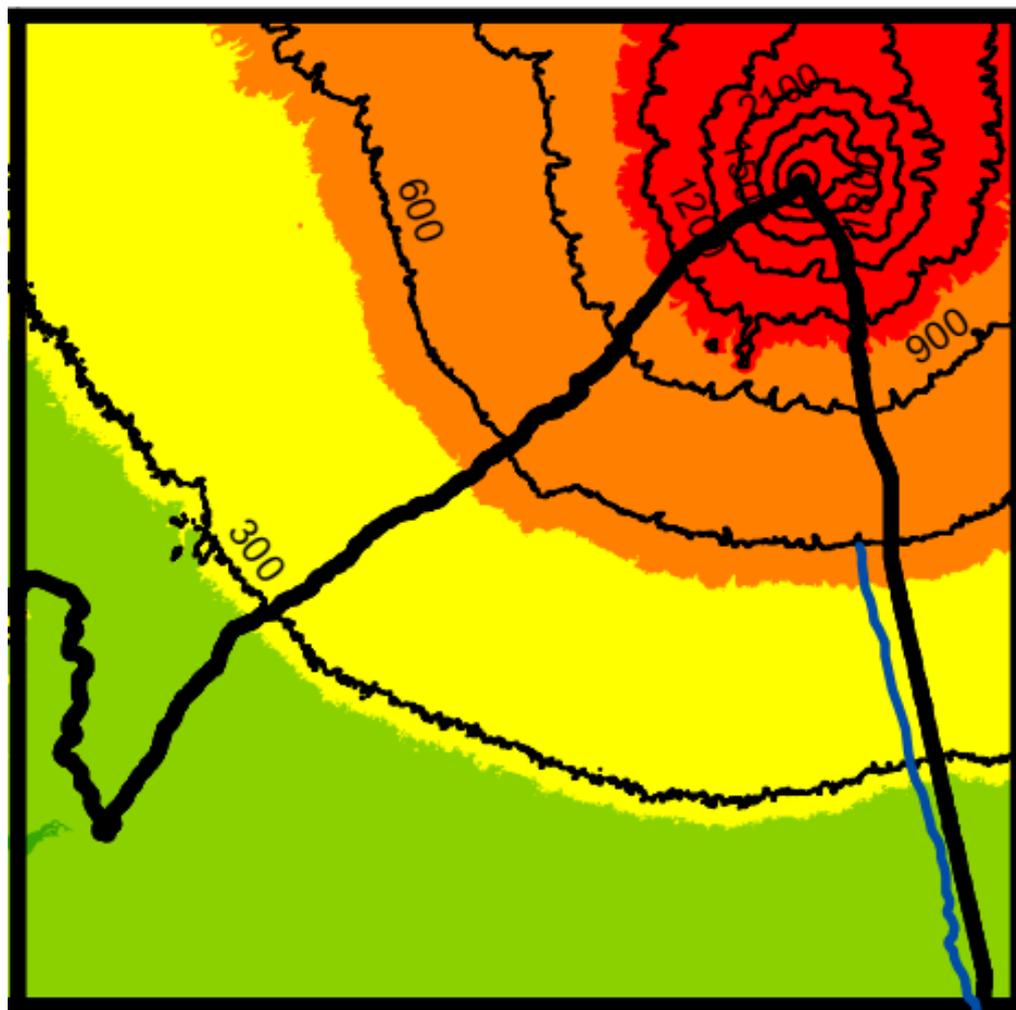


Figure 1. Location of the Sabo Bronggang Dam. Source: Arcgis 10,8 (Location of the Sabo Bronggang Dam is marked with a black dot).



Figure 2. Photo of the Sabo Bronggang Dam Location. Source: Sony Eka, 17 February 2023



Figure 3. Photo of Interview with Local Residents. Source: Sony Eka, 17 February 2023



Figure 4. Photos of the Sabo Bronggang Dam Sand Mining Location. Source: Sony Eka, 17 November 2023

The existence of the Sabo Bronggang Dam not only provides physical protection against the threat of cold lava floods but also has an impact on increasing the collective awareness of the surrounding community regarding the importance of disaster mitigation. This is evident from the change in people's behavior in responding to signs of volcanic activity from Mount Merapi. Whereas in the past the community tended to panic and lacked organization, the presence of the dam has given them greater confidence and readiness, as they feel protected by adequate infrastructure. Thus, the Sabo Bronggang Dam serves both as a symbol of safety and as a catalyst for strengthening community preparedness in facing the threat of eruptions.

The construction of the dam also influences the socio-cultural continuity of the local community. Cultural rituals related to Mount Merapi, such as Labuhan Merapi, are no longer interpreted solely as acts of reverence to the mountain but are also utilized as a medium for disseminating disaster mitigation knowledge. According to Fakhruddin & Elmada (2022), The integration of local wisdom with scientific approaches in the presence of the dam has proven to be effective, as disaster communication is more easily accepted when conveyed through cultural frameworks that the community already believes in. This demonstrates a harmonious balance between traditional values and modern strategies in facing potential natural hazards (Scolobig et al, 2015).

From an environmental perspective, the dam has proven effective as a sediment control structure that helps reduce land degradation in downstream river areas (Fox et al, 2016). This function is crucial for maintaining ecological balance and protecting community agricultural lands that are vulnerable to volcanic flooding (Ágústsdóttir, 2015). Nevertheless, the long-term effectiveness of the Sabo Bronggang Dam depends heavily on continuous maintenance and monitoring. If sedimentation reduces its storage capacity without proper management, new hazards may emerge. Therefore, dam management must be integrated with environmental monitoring systems to ensure its sustainability and effectiveness as a flood-control infrastructure.

The presence of the Sabo Bronggang Dam has created new economic opportunities through its utilization as a geotourism destination. The growth of tourism activities, such as jeep rentals, small food stalls, and local guiding services, has contributed positively to the local economy. However, clear regulations are necessary to ensure that tourism activities respect environmental carrying capacity. If tourism development is not balanced with conservation, environmental degradation could undermine the long-term benefits of the dam as both an educational and recreational geotourism site.

4. CONCLUSION

The people of Cangkringan or the area around Sabo Bronggang Dam consider the existence of this dam to be very helpful and provide a sense of security from the dangers of Mount Merapi eruption based on their experiences during previous eruptions of Mount Merapi which claimed many lives and material casualties. The Sabo Bronggang Dam is considered to be helpful according to the nature of its duties because it controls cold lava floods, but is also able to attract it to become an integrated destination to visit because of the enchanting natural beauty of its surroundings, giving rise to opportunities to open businesses around the Sabo Bronggang Dam location.

Suggestion

Increasing disaster mitigation efforts from the government by intensively providing education to the community using an approach based on the existing surrounding culture so that there will be harmony of local wisdom and disaster mitigation efforts, not only for mature people but also for providing education or teaching through schools from an early age both from kindergarten, elementary school, junior high school, and high school. So that the understanding of disaster mitigation can be understood early on and can be used when a disaster occurs at a later date.

To take advantage of the tourism potential around the Sabo Bronggang Dam location so as to provide economic benefits to the surrounding community and also the government. Utilization of tourism potential can be done because in that area there are several tourist sites that have been active in the area around the Sabo Bronggang Dam so that it can provide benefits to the surrounding community by creating an integrated tourism area to be developed, and can also be used as a task for the surrounding community to maintain sustainability the natural environment around the Sabo Bronggang Dam so that it remains beautiful and interesting to visit.

REFERENCES

- Ágústsdóttir, A. M. (2015). Ecosystem approach for natural hazard mitigation of volcanic tephra in Iceland: building resilience and sustainability. *Natural Hazards*, 78(3), 1669-1691.
- Ainia, DK (2021). Jirzanah.(2021). Arne Naess Deep Ecology Analysis of Merapi Sand Mining Activities Case Study: Merapi Sand Mining Around the Gendol Cangkringan River, Sleman Regency. *Journal of Environmental Science*, 19(1), 98-106.
- Arsyad, A., Rukmana, D., Salman, D., & Alimuddin, I. (2020). Economic Potential and Hydrological Benefits of Sadang River Sand Mining in Pinrang, South Sulawesi. *Journal of Natural and Environmental Sciences*, 11(2).
- Aryuni, Vrita Tri; AHMAD, Rahim; PD, Sukardi S. (2019). *Community Perception of the Government's Role in Overcoming the Cold Lava Flood in Tubo Village*. Pangea: Information Forum for Professional Development and Geography.
- Dewi, Novika Komariona; Ikhsan, Jazaul; Ikhsan, Nursetiawan. (2022). Effect of Land Erosion on Sabo Dam Capacity. *Journal of Water Resources Engineering*. 25-34.
- Dobran, F. (2012). *Volcanic processes: mechanisms in material transport*. Springer Science & Business Media.
- Grace, P.S (2009). *Qualitative Research. EQUIBRIUM*. Vol. 5 (9), January-June 2009. Journal (online),(<http://yusuf.staff.ub.ac.id>, Accessed on 15 October 2016).
- Fakhruddin, I., & Elmada, M. A. G. (2022). Local wisdom as a part of disaster communication: a study on the local storytelling in disaster mitigation. *ETNOSIA: Jurnal Etnografi Indonesia*, 7(2), 154-166.
- Fox, G. A., Sheshukov, A., Cruse, R., Kolar, R. L., Guertault, L., Gesch, K. R., & Dutnell, R. C. (2016). Reservoir sedimentation and upstream sediment sources: perspectives and future research needs on streambank and gully erosion. *Environmental management*, 57(5), 945-955.
- Fukuoka, S., Nakagawa, H., Sumi, T., & Zhang, H. (Eds.). (2013). *Advances in river sediment research*. CRC Press.

- Hanif, MR (2022). Analysis of the Reservoir Capacity of the Sabo Dam Ge-C13 Gendol River. *Collection of Lecturer Research and Service*, 1(1).
- Hendra, Y., Rudianto, R., & Priadi, R. (2018). Analysis of effective communication models in disaster mitigation communication. *Collection of Lecturer Research and Service*, 1(1).
- Kansai, John. (2024). *The impact of sand mining on the Boyong Kemiri River, Sleman Regency, Yogyakarta Special Region on the Sabo Dam*. PhD Thesis. Gadjah Mada University.
- Kholiq, M. A. (2017) Simulation of the flow of lava floods after the 2010 eruption of Mount Merapi on the existence of a sabo dam on the Gendol river. *Technician*, 20 (17), 410-415.
- Munir, M.D. (2019). The sabo dam building, its function and potential as part of Merapi volcano geotourism. *J Environmental and Geological Hazards*, 10(2).
- Ningtyas, D.P, & Risina, DF (2018). Increasing the self-awareness of early childhood through the media of volcanic eruption disaster mitigation videos. *Al-Athfal: Journal of Children's Education*, 4(2), 113-124.
- Permana, S,. (2021). Eling Lan Waspodo as A Local Perception for “Merapi” Volcanic Disaster Preparedness. *COMMUNITY: International Journal of Indonesian Society and Culture*, 13.2.
- Prayogi, M.A. (2021). *Performance Evaluation of Sabo Dam Buildings on the Effects of Cold Lava Disaster (Case Study: Sabo Dam Kali Boyong Bo-Gs 2a) Performance Evaluation Of Sabo Dam Buildings On The Effects Of Cold Lava Disaster (Case Study: Sabo Dam Kali Boyong Bo-Gs 2a)*. PhD Thesis. Yogyakarta Technology University
- Qudwatunna, AH, Maeni, P., & Ds, M. (2019). *Illustration design for an encyclopedia book about mountain eruption. Asiah Hanifah Qudwatunna: 146010052* (Doctoral dissertation, Visual Communication Design).
- Saam, Z., & Siregar, SH (2018). Analysis of Sand-Stone Mining Activities on Erosion, Water Quality and Socio-Economy of Communities Around the Indragiri River. *Photon: Journal of Science and Health*, 8(2), 67-74.
- Scolobig, A., Prior, T., Schröter, D., Jörin, J., & Patt, A. (2015). Towards people-centred approaches for effective disaster risk management: Balancing rhetoric with reality. *International journal of disaster risk reduction*, 12, 202-212.
- Susatya, TM, & Garside, AK (2021, June). The Sabo Dam Building, Its Function And Potential As A Support Of Mountain Semeru Getourism. *In Engineering Seminar Professional Engineer Study Program* (Vol. 1).
- Ulinuha, I., Prasetyo, Y., & Sabri, LM (2019). Spatial analysis of lava flows using hec-hms and hec-ras at the gendol-opaque river in the Merapi volcano area. *Undip Journal of Geodesy*, 9(1), 20-28.
- Zahra, AS, Sylviana, M., & Kusuma, M. (2018). Study of Stone and Sand Mining Activities in the Gung River, Kajen Village, Lebaksiu District through the SETS Approach. *JPMP (Journal of MIPA Pancasakti Education)*, 2(1).