ASSISTANCE OF BIOPORE TECHNOLOGY AS A RAINWATER INFILTRATION METHOD TO REDUCE SURFACE RUNOFF AND FLOODING IN RT.10, SUNGAI DUREN VILLAGE, MUARO JAMBI REGENCY

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Abstract

[Title: Assistance of biopore technology as a rainwater infiltration method to reduce water runoff and flooding in Rt.10, sungai duren village, muaro jambi regency] Community Service (PPM) activity takes place in RT.10, Sungai Duren, Muaro Jambi Regency. This area is prone to flooding and is densely populated. When it rains for an extended period flooding frequently occur. Therefore, team took the initiative to raise awareness about flood disaster mitigation by reducing water runoff, helping to prevent floods. The Community Service Team consists of five lecturers from UNJA from various disciplines and five students, each contributing according to their expertise. The method employed involves raising awareness about biopore technology, which increases the soil's ability to absorb rainwater. This PPM activity is expected to help address the flooding problem in the partner area. Geographically, the PPM partner area is 3 km away from the Batang Hari River, so it is not part of a floodplain. Base on topography, the partner area is located at an elevation of 12,5m-25m with a valley morphology, causing water from higher areas to accumulate in the PPM partner area and its surroundings. Additionally, the existing drainage and canal systems in the area are not functioning properly, contributing to the flooding issue.

Keywords: biopore absorption holes, water_runoff, flooding

PENDAHULUAN

The population growth in Jambi City has experienced a very rapid increase, which corresponds with the city's economic growth, marked by the proliferation of housing developments, hotels, shopping centers, and industrial activities. In 2012, the total population of Jambi City was 557,216 people, with a population growth rate of 2.98%. By 2018, the population had increased to 591,134 people (BPS, 2018). This rise in population and economic activity has led to more green open spaces being converted into built-up areas. The construction of permanent buildings without considering conservation principles and exceeding the area's carrying capacity will result in increased surface runoff from rainwater. If the rainwater flowing on the surface is not absorbed into the ground effectively, it will cause waterlogging or even flooding. Flood disasters affecting parts of Jambi City are not only caused by insufficient water absorption into the soil but also by a lack of environmental awareness. For example, dumping waste into rivers blocks water flow, causing overflow and subsequent flooding (Permana et al., 2019).

The location of the PPM biopore assistance activity is in RT.10, Sungai Duren Village, Muaro Jambi Regency, as shown in Figure 1. Based on observations and discussions with the Head of neighbourhood, several problems faced by the community were identified. First, when rain precipitation occurs, surface runoff leads to prolonged waterlogging. In cases of heavy and prolonged rainfall, this can result in flooding. Second, the household drainage systems in RT.10, Sungai Duren Village, are not interconnected, causing water to flow directly onto the surface, exacerbating surface runoff. Third, many residents show a lack of concern for environmental cleanliness, such as littering, and there is also sedimentation in the main drainage system, which reduces the volume of water it can carry.

An effort to reduce surface rainwater runoff is the creation of biopore infiltration holes. According to Victorianto and Qomariyah (2014), biopore infiltration holes are artificially created holes designed to reduce flooding by accelerating water absorption into the soil. They are called "biopores" because the cylindrical infiltration holes contain pores formed naturally by the activities of soil fauna organisms and plant roots (Brata, 2008). According to the Ministry of Environment Regulation No. 12 (2009), the recommended dimensions for biopore infiltration holes are vertical holes with a depth of approximately 100 cm, but they should not exceed

the groundwater table depth, with a diameter of 10–25 cm.

To maintain good water absorption capacity and to ensure the biopores function effectively, organic waste is added to the biopore holes to attract the activity of organisms such as earthworms, termites, ants, microfauna, and decomposer bacteria (Setyaningsih and Endriastuti, 2018). Based on research by Sari et al. (2017), there are 11 types of microfauna and macrofauna found in biopore holes. Microfauna include Isotomurus sp, Entomobrya clitellaria, Entomobrya socia, and Hypogastrura nivicola, while macrofauna include Dolichoderus sp, Oechophylla smaragdina, Pheretima sp, Oechophylla sargillina, Gryllus vocalis, Forficula auricularia, and Buffo sp. The activity of these organisms, plant roots, and organic waste in the biopore infiltration holes leads to the composting process, resulting in compost soil that can also be used as planting medium and fertilizer for plants (Arifin et al., 2020).

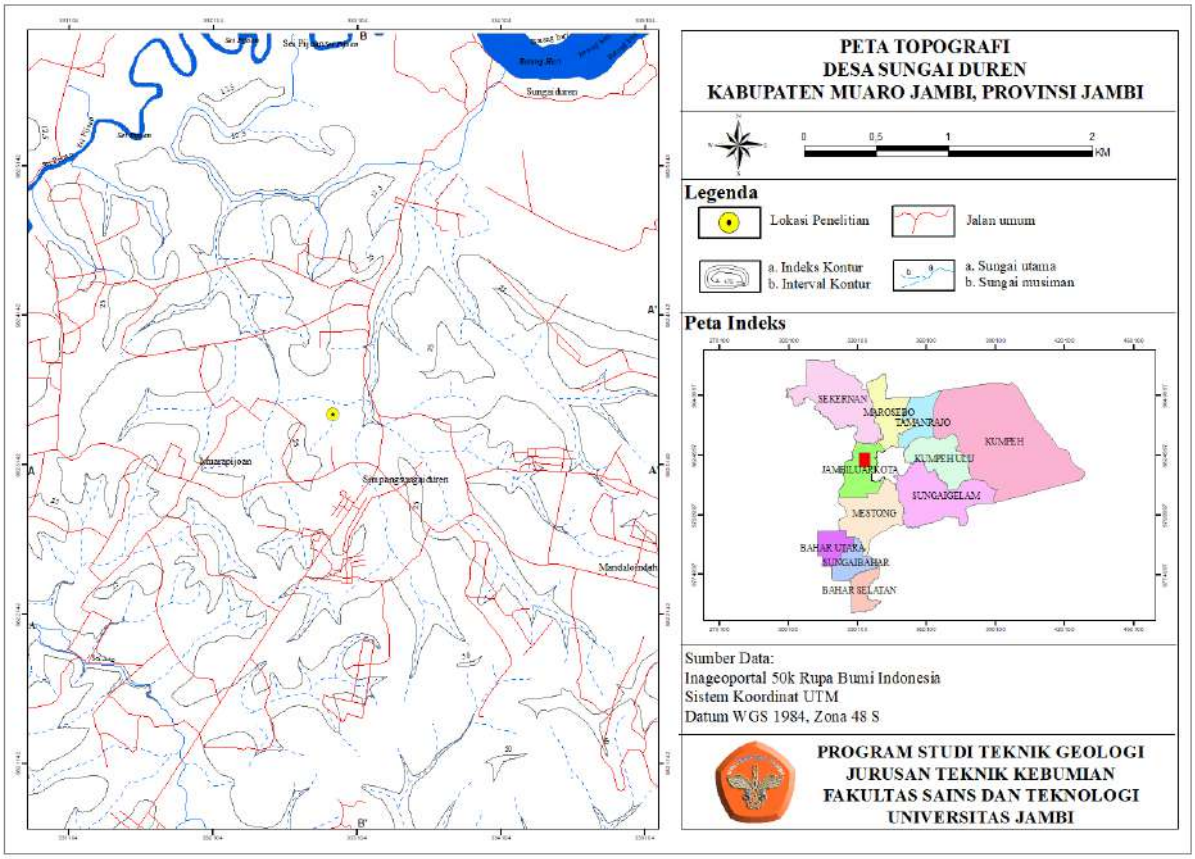

Figure 1. Administrative Map of Muaro Jambi Regency, Jambi Province, as the location of the Community Service activity, which takes place in RT.10, Sungai Duren Village (map content uses RBI Data of Jambi City area)

METHOD

This PPM activity will be carried out in several stages to achieve its main goal, which is to enable the community to decrease flooding disasters through assistance in creating biopores. The first stage the PPM team must take is to familiarize themselves with the environment and the characteristics of the service target. The aim is for the PPM team to understand the community's character and habits through the awareness program. This introduction is important so the team can choose the right method and time for implementation, ensuring that the service activities are completed effectively and provide substantial benefits.

The second stage the PPM team will take is identifying the causes of flooding in RT.10, Sungai Duren Village, Muaro Jambi Regency. At first glance, the core cause of the frequent flooding in this area seems to be that it is located in the lowest-lying part of the region compared to other buildings. However, there are certainly other contributing factors that make the flooding in this area worse over time. Therefore, the PPM team, together with the community, will work to identify several causes that contribute to the flooding in the area.

The third stage the PPM team will conduct awareness sessions on the actions the community can take collectively to minimize the occurrence of

flooding. The team will provide direct instruction on the techniques for creating biopores, which the community can practice firsthand as part of flood prevention efforts. For example, this includes creating water infiltration areas, applying geotechnical engineering, or making biopores. The PPM team will thoroughly encourage the community to learn and then continuously apply these techniques.

The final stage, involves monitoring and evaluation as part of the assistance program, ensuring the activity can continue and provide optimal benefits. This evaluation is intended to assess the implementation of the activities and the challenges faced by the community, allowing the team to respond promptly and assist as needed. The detailed sequence of PPM activities is illustrated in Figure 2.

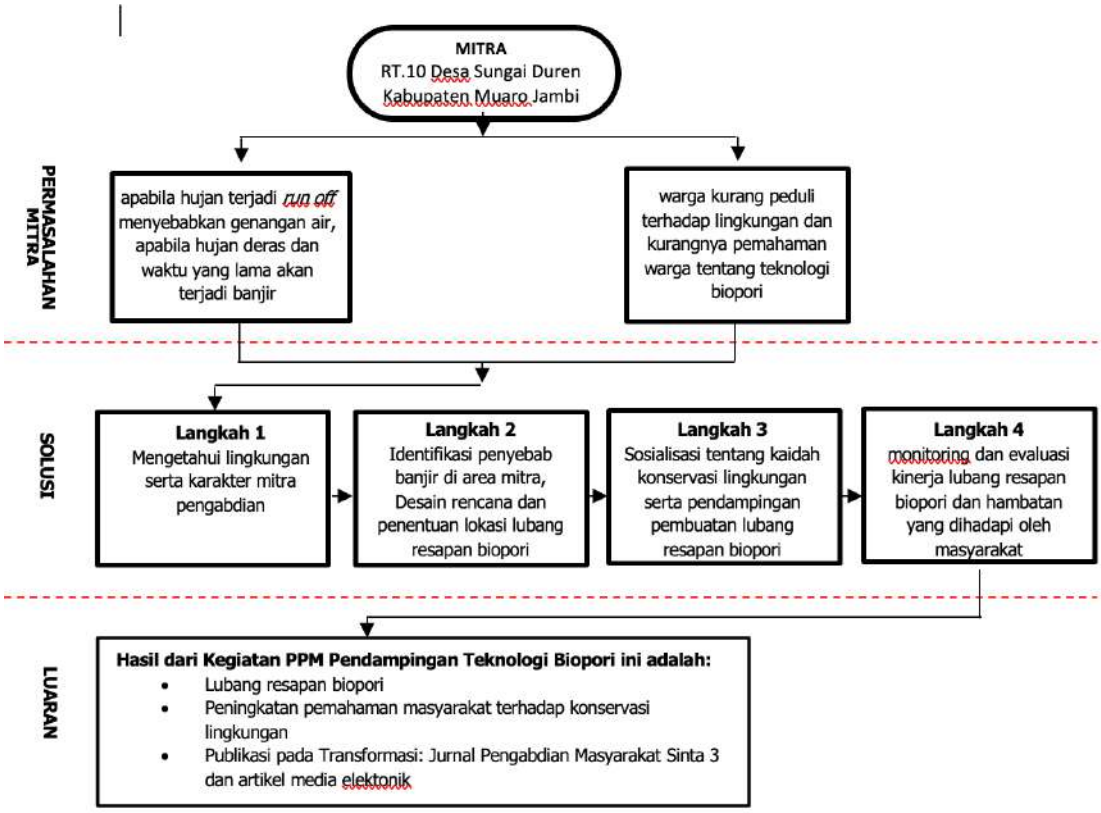

Figure 2. Series of PPM Activities Assisting Biopori Technology (Adhitya et al., 2021)

HASIL DAN PEMBAHASAN

The main problem in the PPM partner location is flooding during the rainy season. Rainwater from precipitation remains on the surface for an extended time due to the low absorption capacity of the soil, and when there is prolonged rainfall with high intensity, it leads to flooding. The solution offered and implemented in the Community Service (PPM) activities is generally structured into four stages, as follows:

1. Understanding the environment and the characteristics of the PPM partner

The drainage systems in the residential area are not interconnected, causing some household wastewater to flow directly onto the concrete-paved ground and streets. Additionally, although there is a canal in the PPM partner area that functions as the main drainage channel, it has become silted due to a buildup of sediment and household waste carried in during floods. Community participation in maintaining environmental cleanliness is minimal, with no efforts to clean the canal or homeowner initiatives to repair their own drainage systems. The silting of the canal has resulted in increased surface water runoff, causing floods to occur more rapidly. The drainage systems and artificial canal can be seen in Figure 3.

Figure 3. A. Disconnected household drainage system that flows onto the ground and concrete-paved road; B. Artificial canal functioning as the main wastewater drainage channel, but has become silted.

2. Identification of Flood Causes in the PPM Partner Area

In addition to the disconnected drainage systems and the silting of the canal, which serves as the main wastewater drainage channel, a geographical assessment was conducted to identify other factors causing floods disaster. Groundwater table measurements taken from local wells showed that the water level is 62,5 cm below the surface. A topographic analysis was then conducted to determine whether the PPM partner area is located within the Batang Hari River floodplain. The analysis revealed that the area is at an elevation of 12,5m to 25m, with a valley morphology. Floodplains influenced by the Batang Hari River are typically at lower elevations, below 12,5m, so it can be concluded that flooding in the area is not directly caused by overflow from the Batang Hari River, which is approximately 3 km from the PPM partner area. The topographic contours and the distance from the Batang Hari River can be seen in Figure 1.

The PPM partner area contains many small and seasonal rivers, where the difference between the river water level and the ground surface is only around 62,5cm during dry conditions. Therefore, during heavy rainfall, the rivers overflow quickly. Additionally, the valley-like morphology of the area causes water from higher elevations to flow into the PPM partner area if it is not absorbed by the soil. The topographic cross-section can be seen in Figure 4.

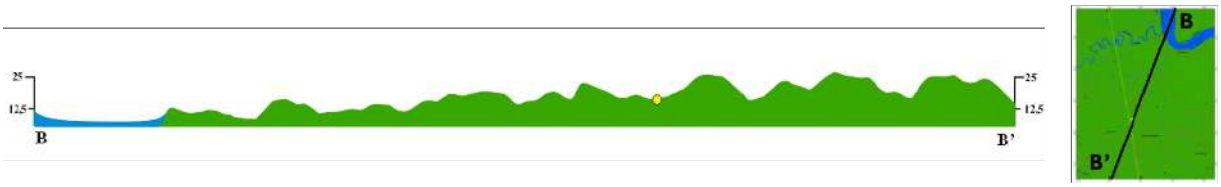

Figure 4. Topographic cross-section showing the PPM partner area in relation to the morphology and the Batang Hari River (the yellow point indicates the PPM partner area)

3. Socialization/awareness about conservation principles and Assistance in Creating Biopore Infiltration Hole

The series of awareness and assistance activities on biopore technology were conducted over two days, on July 20 to 21, 2024. The solution offered and implemented during the Community Service activities included: First, an awareness session on environmental conservation principles. The material on environmental conservation was presented by Muhammad Ikrar Lagowa, S.T.,M.T., a lecturer in the Mining Engineering program. Understanding environmental conservation is essential to maintaining ecosystem balance and preventing environmental degradation. Conservation efforts can include maintaining, protecting, and restoring the environment where we live (Supriatna et al., 2018). The biopore technology awareness activities of the PPM can be seen in Figure 5.

Figure 5. The first session of the awareness activity on environmental conservation principles, introduction to biopore technology, and discussion of challenges faced by the community

The second session, still related to environmental conservation principles, was the awareness session on creating biopore infiltration holes, applied in the yard of the RT.10 Head's house in Sungai Duren Village, Muaro Jambi Regency. The biopore technology awareness aimed to address environmental issues caused by surface water runoff, flooding, and household organic waste. The presentation on biopore technology was delivered by Bagus Adhitya, S.T.,M.T., a lecturer from the Geological Engineering program and the Head of the PPM Team from the Department of Earth Engineering, University of Jambi. After the awareness session and discussion, the assistance activities for creating biopore infiltration holes were conducted, guided by the team of lecturers and students from the Department of Earth Engineering. The biopore technology assistance activities of the PPM can be seen in Figure 6.

Figure 6. The second session of the assistance activity for creating biopore infiltration holes and measuring the groundwater table at the dug well conducted in the yard of the RT.10 Head's house in Sungai Duren Village, Muaro Jambi Regency

4. Monitoring and Evaluation of the Performance of Biopore Infiltration Holes and Challenges Faced by the Community

An essential aspect of this activity is the process of consistent monitoring and evaluation, which truly builds the community's capacity to face flood disasters. The community needs to be made aware that they are capable of addressing the recurrent floods in the partner area of PPM. The monitoring and evaluation activities aim to assess the success level of the biopore assistance program. The parameters that determine the level of success include: understanding of environmental conservation principles, the cleanliness level of the partner area after the implementation of community service activities, improvements in drainage systems, and the performance of the biopore infiltration holes that have been created.

Understanding of conservation principles is evaluated through a pre-test conducted during the socialization activity and a post-test after the socialization has been completed. The results of the post-test indicate an increase in the community's understanding of environmental cleanliness and biopore technology. The pre-test and post-test results can be seen in Figure 7.

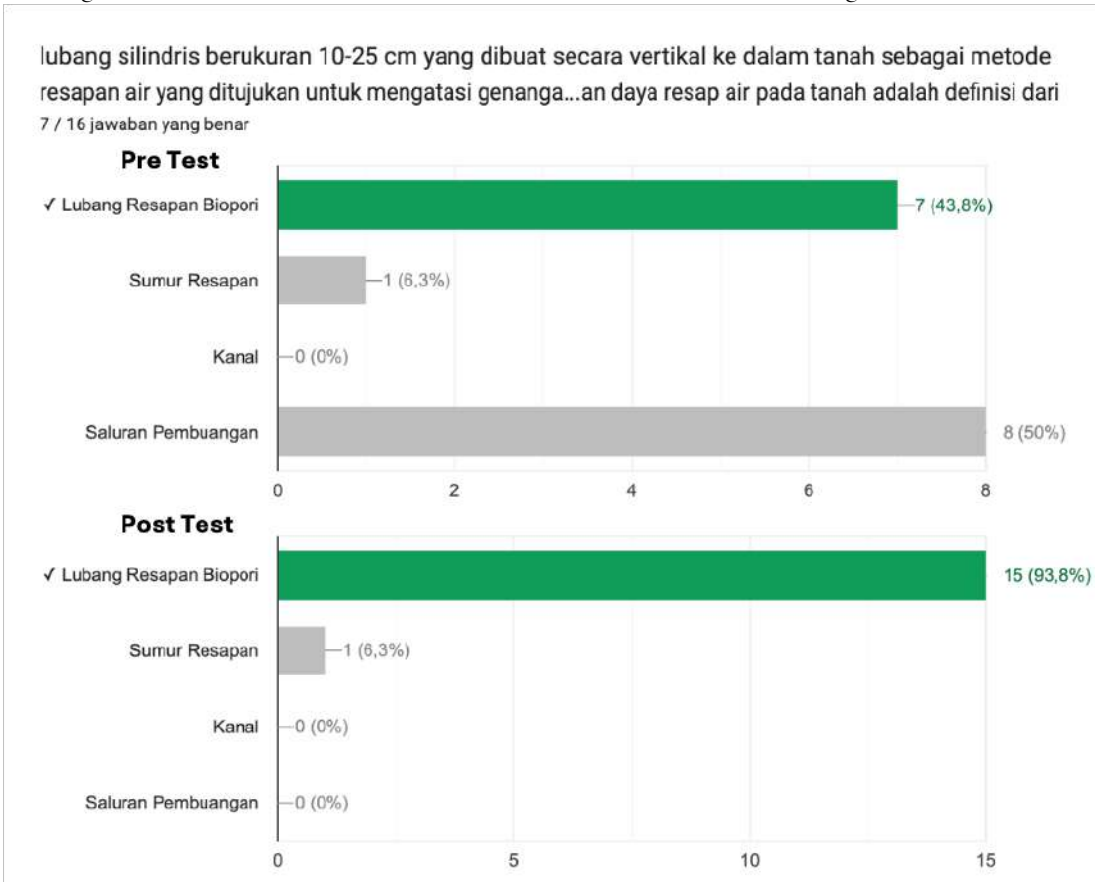

Figure 7. Sample questions from the pre-test and post-test showing an increase in understanding of biopore infiltration holes

Based on direct observations made on September 9, 2024, approximately 50 days after the socialization activities were conducted, the overall cleanliness level of the environment has started to improve. Community service activities have been undertaken by the PPM partner; however, due to heavy rainfall, a significant amount of plastic waste has been washed back into the area. Fortunately, this litter is only present in a few spots, and overall, the partner area has become much cleaner. This situation can actually be managed by maintaining cleanliness in each household's surroundings, rather than waiting for community cleanup efforts. An illustration of the change in community attitudes toward environmental cleanliness can be seen in Figure 8.

Figure 8. Changes in community attitudes toward the importance of environmental cleanliness. Image A shows the condition before the socialization on July 20, 2024, and Image B shows the condition during monitoring and evaluation on September 9, 2024

Improvements to the drainage system and normalization of the canals have not yet been implemented. Significant planning and funding are required for these improvements. Therefore, as of the monitoring date on September 9, 2024, no changes have been made to the drainage system. Evaluations of the biopore infiltration holes were also conducted to assess whether they are functioning correctly and being properly maintained. Discussions with the RT.10 Head of Sungai Duren Village indicate that the infiltration holes are performing well in reducing surface water flow. Organic waste is routinely added to the biopore holes to support the survival of macro and microorganisms within the holes, thereby increasing the number of pores formed in the soil.

From the monitoring and evaluation results, several factors hinder effective flood management. A critical factor that must be addressed promptly is the improvement of drainage systems and the normalization of existing canals. Enhancing drainage systems is crucial to prevent surface runoff and ensure that water is directly directed to the constructed canals. Deepening the canals will increase the volume of water that can be channeled, allowing water stored in rock pores to be retained in the canals, thereby lowering the groundwater table (GWT) and increasing the volume of water absorbed into the soil.

Another challenge is the lack of waste processing areas in the PPM partner area. Residents rely solely on waste management personnel who come twice a week. This can lead to the accumulation of both organic and inorganic waste over three days, making it likely that the collected waste will be washed away during heavy rainfall. To address this issue, collaboration has been established between the community service team, represented by the Faculty of Science and Technology at the University of Jambi, and RT.10 of Sungai Duren Village, Muaro Jambi Regency, Jambi Province. The output from this implementation arrangement will lead to further community service activities in 2025 focusing on independent waste management in the partner area. The condition of the biopore infiltration holes and the signing of the Implementation Arrangement can be seen in Figure 9.

Figure 9. Monitoring and evaluation of the performance of biopore infiltration holes and the signing of the Implementation Arrangement

CONCLUSIONS AND RECOMMENDATIONS

Community Service (PPM) titled "Assistance of Biopori Technology as Rainwater Infiltration method to Reduce Surface Runoff and Flooding in RT.10, Sungai Duren Village, Muaro Jambi Regency" has been carried out up to the monitoring stage and the creation of a cooperation agreement between the Faculty of Science and Technology of the University of Jambi, represented by the PPM Team of the Earth Science Department, and the partners from RT.10, Sungai Duren Village.

Based on geographic analysis and direct observations in the field, it is known that the area of the PPM partner is at an elevation of 12.5m-25m, indicating that this area is not part of the floodplain of the Batang Hari River. The distance between the PPM partner area and the Batang Hari River is approximately 3km, further confirming that the river does not influence flooding in the partner area. According to the topographic map, the PPM partner area is close to a river basin, which contains seasonal rivers that can cause water to overflow to the surface during heavy rain, contributing to flood occurrences.

Field observations in the PPM partner area revealed that the wastewater drainage systems are not integrated; some water flows directly onto the road (surface run-off), accelerating the occurrence of flood disasters. This situation is exacerbated by the main drainage canal, which has become silted due to the high levels of suspended sediments carried during flooding.

The PPM partners must collaboratively normalize the existing water channels and canals to prevent surface run-off, as improving the canal will increase the volume of water that can be channeled, thereby reducing flood disasters. The biopori infiltration technology should also be effectively implemented in the PPM partner's environment; the more biopori infiltration holes that are created, the higher the rate of water infiltration into the ground, which can help prevent flooding. The sustainability of this PPM initiative needs to be carried out to achieve the desired outcome of flood disaster reduction, one of which includes conducting community service activities focused on independent waste management.

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