BIOPORE INFILTRATION TECHNIQUES AND VEGETATIVE MAINTENANCE FOR SUSTAINABLE WATER RESOURCE MANAGEMENT

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ABSTRAK

A major problem faced by the people of Sekarbanyu village was the water scarcity, Sumbermanjing Wetan district, Malang regency, especially during the dry season. Changes in land use and the lack of public awareness of the conservation of natural resources escalated this situation. This community service program aimed to define and investigate the implementation of a water source sustainability initiative program through the utilization of biopore techniques and the management of water-absorbing plants, applying a Participatory Action Research (PAR) framework according to Maqoshid al-Syari'ah principles. The methods applied in the community service program included observation, interviews, group discussions, and collaborative action with the community and village government. The results showed that biopores and reforestation facilitated the improvement of soil absorption, reduced water scarcity, and increased community awareness and participation in environmental preservation. The program also facilitated a synergy between technical solutions and Islamic spiritual values, making it a potential prototype to be replicated, adopted, and adapted in other regions with similar conditions.

Keywords ***:*** *Biopore, Water-Absorbing Plants, and Maqoshid al-Shari'ah*

INTRODUCTION

Sekarbanyu Village is positioned in the Sub-district of *Sumbermanjing Wetan*, Malang Regency. It is well-known as a hilly sub-district with challenging topography and scarce water supply in Malang Regency, particularly during drought. The people depended on scarce water sources. The situation had escalated recently due to changes in land utilization and environmental degradation. Historically, the village depended on natural groundwater and traditional shallow wells for daily water consumption. However, the transformation of forest ecosystems to agricultural and residential areas degraded the terrestrial water cycle. The land transformed from rubber trees, which preserved a lot of water, to sugarcane plants, which depend on a large amount of water. This transformation decreased surface

water movement and resulted in the ineffectiveness of the reservoir. The scarcity of sufficient forested areas led to increased surface runoff, reducing the amount of water absorbed into the ground.

This water shortage impacted many dimensions of people's lives, including health, economy, and social life. Wells were running dry, even during the rainy season. Water projects like the village-owned water company (BUMDes) faced challenges. There was a lack of transparency and community participation, which caused disputes and suspicion. Global Climate change further intensified the complication, causing Inconsistent rainfall patterns that escalated tension on declining water availability. In this challenging situation, empowering water resources using conservation-oriented methods, such as biopore technology, was immediately required.

Biopore holes, cylindrical tunnels dug into the ground and filled with biodegradable waste, were capable of supporting this water shortage. They infiltrated water into the soil, optimized below-ground water storage, restricted land degradation, and promoted environmental sustainability. Implementing biopore systems in lowland areas and residential gardens is a simple yet efficient solution to lessen water runoff and promote groundwater sustainability (Yasa et al., 2022). Papers demonstrated that biopore systems facilitated soil to absorb water more efficiently and promote efficient water management. In ponds with biopore systems, water health tests demonstrated that the hydrogen ion concentration level was better balanced when compared with ponds without them. Supplementing lime and fertilizer to the biopore holes may contribute to the surrounding soil being nutrient-rich, which is crucial because organic-rich soil often suffers from nutrient scarcity (Manunggal et al., 2018).

To efficiently apply biopore technology, it is important to stimulate local awareness about sustainable environmental management and the urgency for appropriate waste management and maintenance of biopore holes. Public awareness is essential for flood prevention and verifying the effectiveness of these environmentally sustainable solutions (Karuniastuti,

2014). This study proposed the implementation of biopore technology as a sustainable solution to the water scarcity in *Sekarbanyu* Village, aiming to improve the environment and encourage community involvement (Cenderawasih, 2024).

The importance of ecological solutions has been emphasized by various studies, such as biopore infiltration holes and vegetation preservation, as ecological approaches to resolve water scarcity. One study demonstrated the effectiveness of biopores in increasing soil absorption capacity (Elsie et al., 2017), while another study revealed that biopores improved water absorption and helped prevent flooding in areas where they were applied (Mustopa et al., 2023). In addition, plants with high rooting depth, such as *trembesi*, *vetiver*, and bamboo, have been demonstrated to strengthen soil structure and optimize water infiltration (Dahliaty et al., 2019; D. S. Lestari et al., 2017). Biopores also offer additional advantages by facilitating organic waste management and producing compost that enriches the soil (Santoso et al., 2019).

To apply biopore technology combined with the preservation of water-absorbing plants has become a holistic approach that is increasingly favored in ecology and community-based service programs. However, active community engagement in the conservation of water resources often becomes the essential component that defines the success or failure of such programs.

Within a Participatory Action Research (PAR) framework based on *Maqoshid al-Syari'ah*, this article offered an approach to strengthening water resources by integrating biopore technology with the maintenance of water-absorbing plants. Its multidimensional approach: ecological, social, and spiritual, became the article's novelty. This approach focused on the integration of technical solutions and highlighted Islamic local values and the wisdom of *pesantren* communities as the philosophy for social change.

Referring to the six pillars of Maqoshid al-Syari'ah (*hifdz al-din, al-nafs, al-aql, al-mal, al-nasl, and al-'ird*), this community service activity

reflected the values of protecting life, intellect, and the environment. A real form of water conservation was an example of this. In addition, this program opened opportunities for the empowerment of local communities, particularly among youth who often experienced stagnation in community involvement.

Based on observations and interviews conducted by the community service program (KKN-PAR) team from the University of Al-Qolam Malang, the primary problems experienced by the residents in *Krajan* Sub village, *Sekarbanyu* Village, are as follows. First, there was a water scarcity during the dry season, where 80% of residents faced challenges accessing water and had to queue every three days for water distribution. Second, a transformation of land use and ecological degradation reduced water absorption because much of the vegetation had been transformed into sugarcane fields. Third, public involvement in water resource management was very low, with the Village-Owned Enterprise (BUMDes), which managed the water, seen as limited in transparency and inclusivity. Fourth, there were no technical or ecological modernizations to preserve water sources, such as biopore programs or plant conservation initiatives. Fifth, there was a low level of ecological awareness and environmental education, as socialization of such programs had been minimal and had not effectively reached the grassroots level.

This article had the objective of describing and analyzing the implementation of a water source strengthening program through the creation of biopore holes and the maintenance of water-absorbing plants, to resolve the water scarcity in *Sekarbanyu* Village. Using a participatory approach based on *Maqoshid al-Syari'ah*, this program targeted technical success and focused on the social and spiritual transformation of the community in environmental conservation. This study was intended to serve as a sustainable and replicable community service model in other villages facing similar issues.

METHODS

This community service activity applied a Participatory Action Research (PAR) approach based on *Maqoshid al-Syari'ah*. This approach placed the community service as the subject in every part of the service process, starting from problem identification, solution formulation, to the implementation and evaluation of activities. The approach was selected to promote that the solutions offered were not only technical but also contextual, harmonizing with the values and local needs of the *Sekarbanyu* Village community.

The PAR based on *Maqoshid al-Syari'ah* was a unique approach developed by the University of Al-Qolam that fused the philosophy of social change with Islamic values. Six principal pillars navigated the implementation of the program: (1) *Hifdz al-Din* (protection of religion), (2) *Hifdz al-Nafs* (protection of life), (3) *Hifdz al-'Aql* (protection of intellect), (4) *Hifdz al-Mal* (protection of wealth), (5) *Hifdz al-Nasl* (protection of offspring), and (6) *Hifdz al-'Ird* (protection of dignity). The application of this approach was targeted to establish social change that was sustainable, fair, and spiritually meaningful.

1. Data Collection Technique

The first technique applied was Participatory Observation. This was conducted by directly observing the condition of water sources, community behavior related to water consumption and distribution, and natural factors that enhanced or limited water absorption. The team also identified land areas appropriate for making biopores and planting water-absorbing plants.

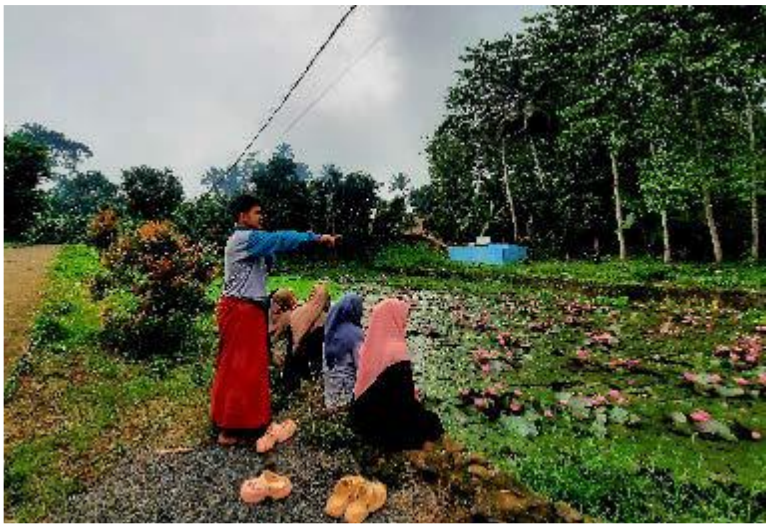

Figure 1. Participatory Observation

In-depth interviews were the second technique applied. This technique involved community leaders, village officials, BUMDes managers, and residents affected by the water scarcity. The objective was to explore the community's perceptions, experiences, and aspires regarding the water problems and the solutions they expected.

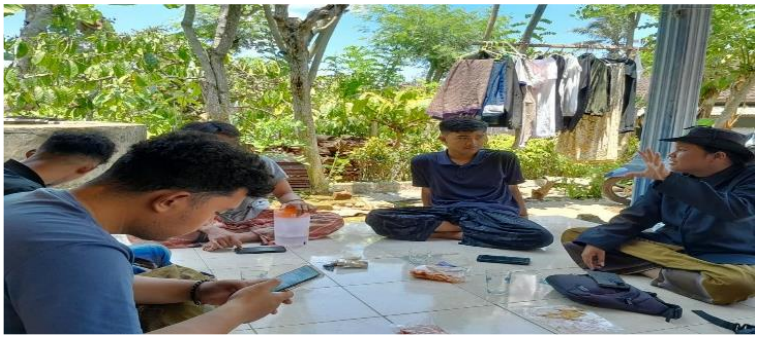

Figure 2. In-depth interviews

The third was Forum Group Discussion. The FGD was conducted by involving residents, village government representatives, the local water company (PDAM), and religious organizations such as *Nahdlatul Ulama* (NU) to facilitate joint solutions. The FGD also served as a medium for educating and training the community about biopore technology and the conservation of water-absorbing plants.

Figure 3. Forum Group Discussion

2. Implementation Process

The first step was Problem and Expectation Identification (Problem & Expectation Tree Diagram). This was generated according to the results of observations and the initial FGD. The problem tree portrayed the root causes of the water scarcity and its impacts, while the expectation tree depicted the ideal conditions that the program interventions aimed to achieve.

Figure 4. Problem and Expectation Identification

Logical Framework Analysis was the second step. The LFA was initiated to develop the general goals, expected outcomes, outputs, success indicators, stakeholder engagement strategies, and risk assumptions for the program.

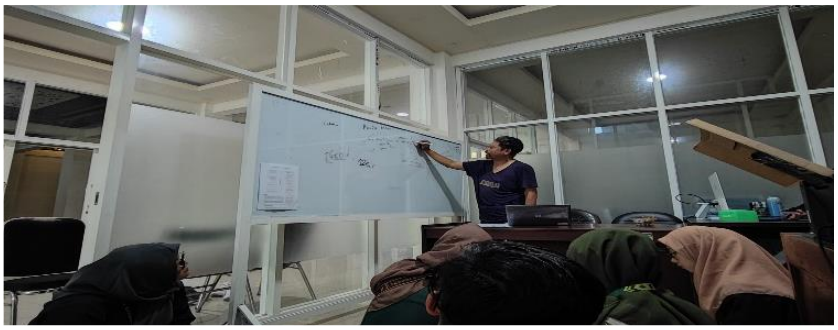

Figure 5. Logical Framework Analysis

3. Program Implementation

The first was Biopore Making. The biopore installation sites were determined based on the results of observations and measurements of water flow in strategic areas, such as near water sources and heavily populated communities.

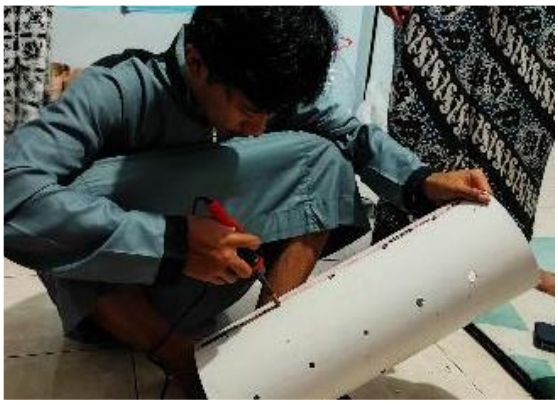

Figure 6. Biopore Construction

The second was Planting Water-Absorbing Plants. The selected plants were species proven to support water infiltration, such as guava trees, rain trees, and bamboo.

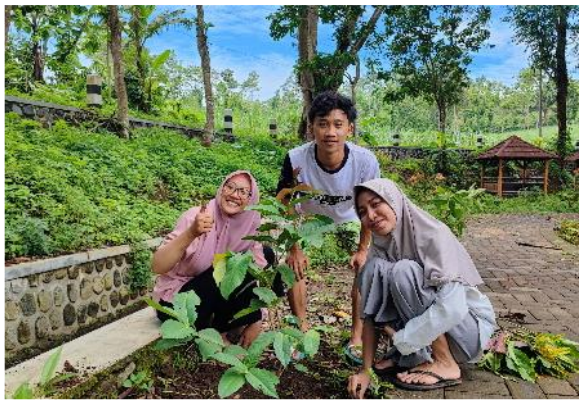

Figure 7. Planting Plants

The third was Public Environmental Education and Engagement**.** It was provided for groups such as *Muslimat* and local youth organizations. It was about the benefits of biopores, the importance of plant maintenance, and the conservation of water sources.

Figure 8. Environmental Socialization and Education

The fourth was the Installation of Signboards**.** They were installed at the biopore sites and green area rehabilitation as a form of visual education and as markers for water conservation zones.

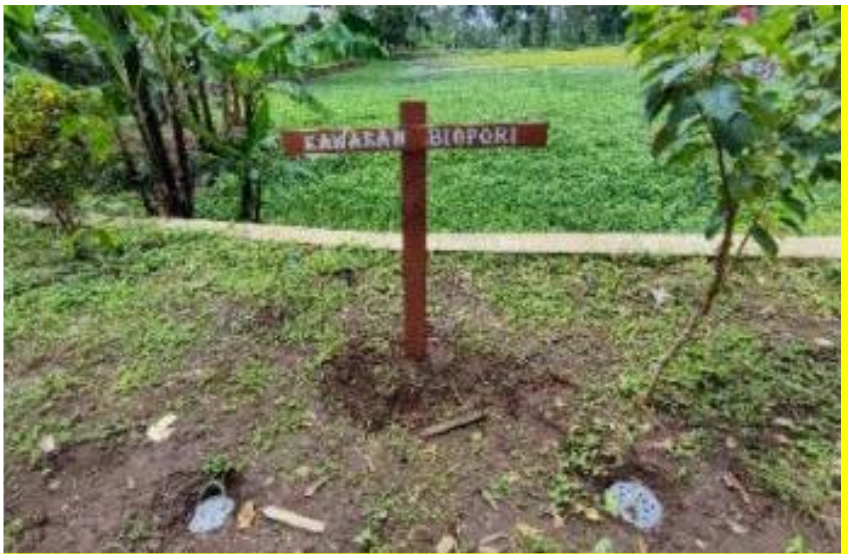

Figure 9. The Installation of Signboards

The last was Monitoring and Evaluation. They were performed in three stages (initial, mid-term, and final stage) by collaborating LP3M, BUMDes, and community leaders. The success indicators included the increase in water flow, the community's perception of environmental changes, and the level of resident participation in water source maintenance activities.

Figure 10. Monitoring and Evaluation

The program sustainability could be maintained through several efforts: (1) establishing an environmental awareness group among residents to continue biopore activities, (2) signing an MOU with the local water company (PDAM) for long-term collaboration in water supply and management, and (3) delegating the responsibility for maintaining the

conservation area to the residents, with regular support and guidance from BUMDes.

RESULTS

The community service activities conducted in *Sekarbanyu* Village indicated significant results in resolving water scarcity and growing community awareness about the importance of ecosystem-based conservation. The program emphasized two main activities: making biopore holes and planting water-absorbing plants, reinforced by education and active community involvement.

A total of 25 biopore holes were successfully made in selected locations near water sources and heavily populated residential areas. This process was conducted after inspecting the water flow and examining the soil conditions. The biopores were absorbing rainwater, mitigating soil erosion, and accelerating water infiltration. It was revealed that post-rainfall observations showed that areas with biopores had better water absorption and no longer experienced water puddles as before. This demonstrated the system's effectiveness of biopores in optimizing water infiltration. These outcomes were in line with (Mudra, n.d.), who stated that it is effective in accelerating water infiltration and preventing surface water runoff using biopore holes.

Several varieties of water-absorbing plants were planted surrounding the biopore sites, for example, guava trees, bamboo, and local ornamental plants. They were chosen according to their root structures, which optimized soil composition and maintained soil moisture. The planting activities were performed through community participation, and the responsibility for plant maintenance was later entrusted to the trained community members. The selection of plants supported the research by (M. Yamassan Jayasin et al., 2022), which reported that deep-rooted vegetation could optimize soil texture and formation and sustainably enhance water absorption volume.

Boards with the words “Biopore Conservation Area” were installed to mark the site and function as visual education tools, assisting residents and

visitors in understanding the importance of the site in the village's water management system. This strategy was in line with the study by (Diantoro et al., 2023), which demonstrated that using visual media can quickly and effectively raise environmental awareness in village communities.

Social engagement activities were performed with *Muslimat* women's groups and youth organizations (*Karang Taruna*) to raise awareness about the significance of water conservation and the contribution of plants and biopores. The socialization was delivered through group discussions and practical simulations of making biopores. Outcomes displayed that more than 75% of the participants understood how the biopore system works and expressed their willingness to create similar biopores in their outdoor space at home. This result was supported by the findings of (Basyaruddin et al., 2022), which justified that participatory-based education improved the effectiveness of environmental conservation technologies.

DISCUSSION

The community service program successfully optimized soil water absorption, minimized waterlogging, and maintained moisture around water sources. The addition of vegetation in a non-direct way helped improve the local environmental conditions. These outcomes were in line with the research by (Marwanto & Mualim, 2021), which showed that the utilization of water infiltration technologies like biopores considerably increases soil infiltration volume and improves the local environmental conditions in the surrounding areas.

There was increased collective awareness about the significance of protecting the environment. Collective activities, including making biopores and planting trees, facilitated stronger social solidarity among various community groups. This phenomenon was supported by the study of (N. Lestari et al., 2022), which demonstrated that public environmental involvement can promote social bonds and raise collective responsibility for local resources.

The decrease in household spending on buying water during the dry season started to be experienced, particularly in the areas surrounding *Krajan* Sub village. Residents started utilizing their water infiltration and harvesting systems based on the socialization they received from the community service team. This finding was in line with the report by (Aji, 2018), which revealed that water conservation through simple yet effective technologies like biopores can lessen community dependence on purchasing clean water, assisting household financial savings.

The utilization of simple technologies, namely biopores, has been demonstrated to be impactful and relevant for the topographical and sociocultural context of *Sekarbanyu* village. However, the success of this program was highly determined by community involvement and the learning continuity. The participatory approach of *Maqoshid al-Syari'ah* was substantial in grounding environmental awareness through Islamic values, promoting spirituality and social harmony. Other reflections included: the necessity to optimize institutional roles, such as BUMDes, to become professional and water management practitioners using participatory approaches, and the need for village regulations to support environmental conservation programs, ensuring they have a legal basis and sustainability of environmental responsibilities. To maintain the program's sustainability, several initiatives were initiated: the initiation of a community-based environmental conservation group (*Gowali*) responsible for maintaining biopore holes and plants, the reporting of water mapping and biopore progress to the village government for long-term budget formulation, and the project proposal for a Village Regulation on Water Conservation based on Biopores and Vegetation.

CONCLUSION

The community service program "Biopore Infiltration Techniques and Vegetative Maintenance for Sustainable Water Resource Management," implemented in *Sekarbanyu* Village, *Sumbermanjing Wetan* District, Malang

Regency, had generated significant outcomes, responding to ecological, social, and spiritual demands through the Participatory Action Research (PAR) approach based on *Maqoshid al-Syari'ah*. The program had successfully optimized soil water infiltration by employing biopore technology, mitigated the effects of clean water scarcity, specifically in the dry season, by widening water absorption areas and vegetation restoration activities, and promoted public awareness of environmental conservation through Islamic-based environmental. It had also stimulated active community participation in ecological conservation and sustainable management of water resources, while facilitating partnership among students, village government, BUMDes, and community organizations. As a result, the community service program had not only offered a technical solution to water scarcity issues but also facilitated to establishment of a strong social and spiritual basis for the village's environmental sustainability.

To confirm the sustained impact of the program and its implementation in other regions, several proposals were promoted: The *Sekarbanyu* Village government should initiate a Village Regulation (*Perdes*) on water resources and environmental conservation based on Biopores and Vegetation to establish a legal framework and promote the program's continuity. BUMDes, as the water resource distribution coordinator, required training in environmental management and technical skills to ensure effective leadership in conservation programs. The participatory approach based on *Maqoshid al-Syari'ah* could be applied as a prototype for other villages, specifically those with *pesantren* communities or Islamic values. Progressive learning and environmental campaigns should be regularly performed, collaborating with local educational institutions, religious discussion forums, and youth community organizations to integrate water conservation into the community's cultural practices. Additionally, ongoing collaboration with PDAM, the environmental authority, and colleges and universities was recommended to be developed to facilitate technical aspects, funding, and continuous monitoring and evaluation of the program.

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