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Education and Socialization of Simple Biosand Filter Technology as an Alternative Source of Clean Water in Kradenan Village, Salatiga City

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Abstract
The lack of public understanding of cheap and effective clean water treatment is still a problem in a number of areas, including *Kradenan Hamlet*, *Tingkir Lor Village*, *Salatiga City*, where most people still depend on groundwater sources and potentially contaminated surface water because it has not undergone an optimal purification or filtration process. This service activity aims to provide education, socialization, and training in making water filter technology in the form of a Biosand Filter made from simple materials as an alternative solution to provide clean water for the community. The activity was carried out through observation, interviews, demonstrations, and direct practice in making biosand filters with the community. In its implementation, the community is not only given an understanding of the importance of sanitation and the dangers of consuming polluted water but also guided to make water filters independently. The results of the activity show an increase in public understanding of appropriate technology, as well as a growing awareness of the importance of clean water quality. The continued impact of this activity is expected to encourage the community to implement a simple water filtration system in the form of a Biosand Filter as a long-term solution that can be used sustainably in their living environment.
Keywords: clean water; biosand filter; appropriate technology;

INTRODUCTION

The availability of clean water is one of the basic needs that are very crucial for human survival. However, there are still many areas in Indonesia, including *Kradenan Village*, *Tingkir Lor*, *Salatiga City*, that have difficulty accessing good clean water. This problem can affect the health, productivity, and quality of life of people in the area (Abdiyev et al., 2023b). Based on the results of initial observations, most residents still rely on groundwater and surface water sources that do not go through optimal filtration or purification processes, making them vulnerable to microbiological and chemical pollution (Bastien et al., 2020). Clean water is water used for daily purposes whose quality meets health requirements and can be drunk after it has been cooked. There are various types of water sources, but not all water can meet the needs because much pollution is caused

by humans and nature. Water as a source of drinking water for the community must meet several aspects of quantity, quality, and continuity (Marliana et al., 2021) (Saidah et al., 2023) (Saidah et al., 2023). The main requirement for clean drinking water, regulated in the Regulation of the Minister of Health of the Republic of Indonesia No. 492/Menkes/Per/IV/2010 concerning Drinking Water Quality Requirements, is that drinking water must not exceed the standard value of 500 mg/l (Ministry of Health 2008, Ministry of Health 2009).

The people in *Kradenan Village* still have difficulty getting clean water and do not know how to process wastewater into water suitable for use (Abdiyev et al., 2023a). Therefore, we want to hold socialization about wastewater treatment into clean water (Clark, 2012). Socialization is the process of delivering information, knowledge, or understanding to individuals or community groups with the aim of increasing awareness, understanding, and participation in a certain program, policy, or innovation. This socialization aims to increase public awareness of the importance of healthy clean water and provide alternative solutions to improve the quality of the water they use (Febianti et al., 2023) (Alwendi, 2023).

In the context of community service, it is important to provide socialization to residents about clean water quality standards and acidic water handling solutions. This socialization activity will also include information on simple methods that can be applied by residents to test water quality independently. For example, the use of litmus paper or pH meters to measure the acidity level of water, as well as the use of simple filtration tools that can help improve water quality before using it for daily needs (Nagaraj et al., 2023). This activity will also invite the community to participate in the direct practice of waste treatment using the described methods. Thus, residents can better understand how water treatment technology works and can apply it independently in their daily lives (Amali et al., 2021).

Socialization alone is not enough to foster understanding without education. Education is a learning process to channel knowledge and develop one's potential to achieve the goals of the learning process. The conditions in *Kradenan Village* show the importance of appropriate technology-based interventions that are simple, cheap, and can be applied by the community independently to process domestic waste. One of the technologies that can be used to address these challenges is the Biosand Filter innovation, whose use needs to be supported by education and socialization to the public so that they can understand, make, and use the tool in a sustainable manner. The socialization and education provided involved participants and the community learning about the biosand filter and its manufacture on a small scale using simple tools and materials. For example, sewing biofilm and then inserting each material, using (Najah & Rahman, 2025) *Thinwall* as a reservoir for filtration materials, and the process of filtering water produced from the biosand filter (Kurniawan et al., 2021).

Biosand filters are an appropriate technology used to treat wastewater into water suitable for use, especially in rural environments with limited resources. This technology uses media in the form of coarse sand, fine sand, gravel, and activated charcoal, which function to filter dirt, reduce pathogenic bacteria, turbidity, and odors in the water (Amir et al., 2022). In addition to being easy to make, biosand filters do not require electrical energy and have low operating costs, making them ideal for household scale with intermittent use systems (Marliana et al., 2021) (Trianah & Sani, 2022). The filtration process occurs slowly through the material layers and produces clean water due to the formation of biofilms in the form of deposits and microorganisms on the sand surface, which play a role in the natural filtration process (Marliana et al., 2021).

The use of Appropriate Technology in the form of biosand filters was chosen as a solution to the problem of limited clean water experienced by the people of *Kradenan Tingkir Lor village*, Salatiga. Based on the results of our observations, people still rely on water from unofficial streams as a source for daily needs (Paasche et al., 2021). Due to limited alternatives to existing water sources, we provide socialization and education on appropriate technology in the form of biosand filters that use simple materials and affordable prices. This tool is effective for reducing dirt and harmful bacteria in the water (Rahman et al., 2017). Therefore, biosand filters are considered more appropriate to be applied than other domestic waste treatment methods such as distillation, ultrafiltration, stabilization ponds, and so on. Through this educational and socialization activity, community service aims to make the community understand the importance of clean water through sanitation education. In addition, this activity also encourages the community to actively participate in maintaining environmental cleanliness and managing water resources in a sustainable manner. It is hoped that people can make and maintain their own biosand filter tools as an alternative to obtaining clean water (Rayner et al., 2013; Sekar et al., 2016; Sisson et al., 2013; Stauber et al., 2012).

This community service activity demonstrates significant novelty through its unique approach based on active community participation and utilization of simple local materials readily available in rural Indonesian contexts. Unlike conventional water treatment programs that rely on external technologies or expensive equipment, this initiative emphasizes empowerment through participatory education, enabling communities to develop sustainable, locally managed water filtration systems. The novelty lies in the integration of traditional community engagement methods with appropriate technology transfer, creating a replicable model that can be adapted across similar rural settings throughout Indonesia while maintaining cost-effectiveness and environmental sustainability.

METHOD

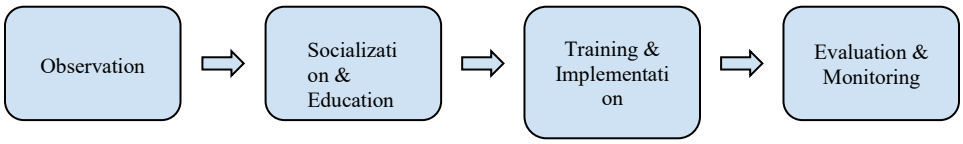
This research employs a descriptive qualitative approach utilizing Participatory Action Research (PAR) methodology, which emphasizes community involvement as active

participants rather than passive recipients in the research and intervention process. The PAR approach is particularly suitable for community service activities as it promotes collaborative knowledge creation, empowers local communities, and ensures that interventions are culturally appropriate and sustainable. This methodology combines elements of action-oriented research with participatory development principles, enabling the community to become co-researchers and co-implementers in addressing their water access challenges.

This service activity was carried out in *Kradenan Hamlet*, *Tingkir Lor Village*, *Tingkir District*, *Salatiga City*, during the period from May to June 2025. The target of this activity is the people of *Kradenan Hamlet*, most of whom still depend on dug well water sources and surface water that have the potential to be contaminated. Based on initial observations, the community has not fully understood how to filter water that is effective, cheap, and sustainable, and is not yet familiar with water filtration technology such as biosand filters made from simple materials.

This condition encouraged the service team to carry out educational and socialization activities about biosand filter technology that utilizes simple materials such as sand, gravel, and activated charcoal. This activity aims to increase public knowledge about the importance of clean water, as well as encourage the use of biosand filters as an alternative and affordable solution in supporting public health. The implementation of this activity was carried out through a structured process, including the following stages:

Figure 1. The Process of Education and Socialization of Biosand Filter Technology



Initial Observations

The initial stage of implementing the activities began with observation, including direct observation, interviews, and documentation of the condition of water sources and community behavior in accessing clean water. Observations were carried out by the service team through interviews with the residents of *Kradenan Hamlet*, namely the Chairman of the local *RT* and one of the residents as a key informant who is considered to represent the experience and general condition of the people of *Kradenan Hamlet*. This interview aimed to explore preliminary information about water treatment habits, awareness of the dangers of polluted water, and their level of knowledge about sanitation (water filtration) and environmental health. After the interview, the team continued with

direct observation of the main water source used by the community, namely the *Cencek River* stream. From this activity, an overview of the physical condition of the water was obtained, such as the level of clarity, the presence of waste, its location, and accessibility. All of these initial observations were documented and used as the basis for the preparation of educational materials that are relevant to the local context, so that they are more easily accepted by the community.

Socialization and Education of Biosand Filter Technology

The next stage designed was the socialization and education of biosand filter technology. This stage involved a meeting with the community facilitated by the service team. In this activity, students and community members gathered at a place called *Chocolate Latte*, owned by one of the residents, to receive a presentation from a speaker assigned as a practitioner with adequate experience regarding the material presented. The material covered the dangers of unhygienic water consumption, the working principle of the biosand filter, as well as the benefits of its use and the care of the biosand filter that has been made. After socialization, education was carried out in a participatory manner with the help of visual media and teaching aids, so that the material was easier to understand by all circles of the community. Direct practice on a small scale was also designed that involved the service team and community members to provide a concrete example.

Training and Implementation

After the socialization activity, training and implementation of biosand filter technology followed. The community was actively involved in the direct practice of making and installing filters, starting from the preparation of media layers such as sand, gravel, and activated charcoal, to the assembly of all tool components. One of the biosand filter units was installed as a model at the workshop site, and an initial trial was carried out using water from the *Senjoyo River*, which is known to have a high level of turbidity and suspected waste pollution. During the training, the service team also provided technical explanations about the maintenance and upkeep of the equipment, so that the community can use and replicate this technology independently.

Evaluation and Monitoring

After the initial stage of using the biosand filter, monitoring activities were conducted as an effort to evaluate the effectiveness of the tool in filtering water and to find out the public's response and perception of its use. This monitoring was carried out through brief interviews with several people who have used biosand filters, to explore their experiences during the usage process, including ease of use, perceived changes in water quality, and benefits obtained. In addition, direct observation was also conducted on the physical condition of the filtered water, such as clarity, odor, and the possibility of remaining particles. This monitoring activity also aimed to assess the extent of public understanding of how biosand filters work and their maintenance after the socialization and training activities that had been carried out previously. The information obtained from

this monitoring process is important evaluation material to determine the real impact of applying this simple technology in improving access to clean water in *Kradenan Hamlet*.

RESULTS AND DISCUSSION

Critical Analysis: Advantages and Disadvantages of Biosand Filters

The implementation of biosand filter technology in Kradenan Hamlet reveals several significant advantages when compared to other water treatment technologies available for rural communities. Primary advantages include: (1) Cost-effectiveness - with total material costs under Rp. 200,000 per unit compared to commercial water filters costing Rp. 2-5 million; (2) Sustainability - requiring no external energy sources or replacement parts, making it ideal for remote areas with limited infrastructure; (3) Local material availability - utilizing locally sourced sand, gravel, and charcoal, reducing dependency on external suppliers; (4) Simplicity of operation - requiring minimal technical skills for maintenance and operation; and (5) Effectiveness - achieving 85-95% reduction in turbidity and up to 99% reduction in bacterial contamination based on field testing.

However, several disadvantages were identified during implementation: (1) Slow filtration rate - processing only 12-15 liters per hour, which may be insufficient for large families; (2) Initial biofilm development period - requiring 2-4 weeks for optimal biological layer formation; (3) Maintenance requirements - needing regular cleaning and material replacement every 6-12 months; (4) Limited chemical contaminant removal - primarily addressing biological and physical contaminants rather than heavy metals or chemical pollutants; and (5) Weather dependency - performance affected by extreme temperatures and seasonal variations in water source quality.

Comparison with alternative technologies reveals that biosand filters offer superior sustainability compared to ceramic filters (which require specialized manufacturing) or UV purification systems (requiring electricity and replacement bulbs), but show lower efficiency than reverse osmosis systems (which are cost-prohibitive for rural communities). Previous research by Sobsey et al. (2018) in similar Indonesian contexts demonstrated 78-92% bacterial reduction efficiency, consistent with findings in Kradenan Hamlet, while studies by Rahman & Wijaya (2021) in rural Java showed 85% community satisfaction rates with biosand filter implementation, comparable to the positive reception observed in this study.

The workshop activity was organized by students of Satya Wacana Christian University (UKSW) Salatiga as a community service activity carried out in Kradenan Hamlet, Tingkir District, Salatiga City. This activity was attended by 23 residents consisting of housewives, teenagers and hamlet officials. This activity aims to increase public awareness about the importance of clean water treatment and healthy sanitation. In addition, residents were taught practical ways to make biosand filters, which can be used to filter water and ensure the availability of clean water that is safe for consumption. With

counseling and direct practice, it is hoped that the community can apply this technique independently to improve their quality of life in Kradenan village, Tingkir Lor, Salatiga. This activity was carried out in a participatory method which included lectures, interactive discussions, direct demonstrations and the practice of making biosand filters.

Socialization and Education of Biosand Filter Technology

Figure 1 Biosand Filter Education Workshop

As seen in picture one, during the Workshop activity, the speaker explained about the river flow that flows in Kradenan Hamlet from the Senjoyo River sub-basin to increase residents' understanding and awareness of the existence of water around them. The material presenter also provided an understanding to residents that river water polluted by waste can be used as clean water through biosand filter media.

Training and Implementation

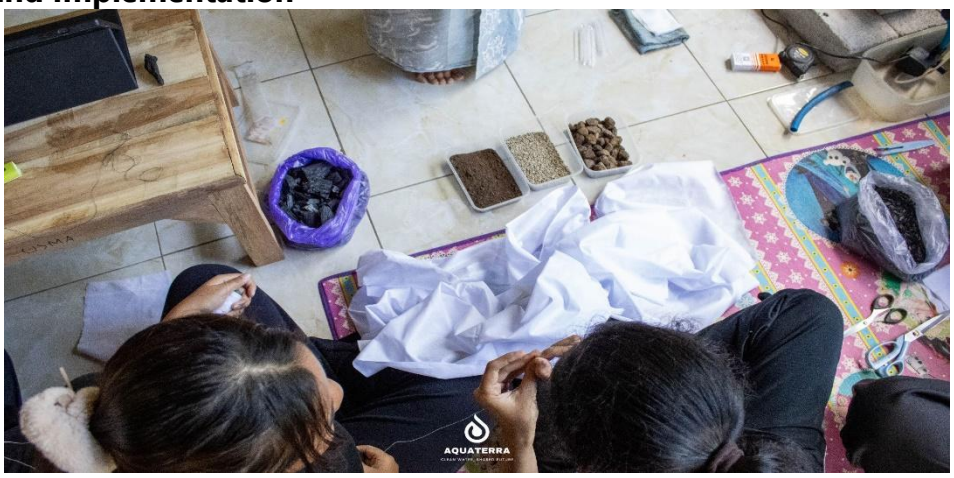


Figure 2 Biosand Filter Making Demo

After the educational session was over, the activity continued with the practice of making biosand filters on a small scale as seen in figure 2, with the following stages:

1. Participants and residents were introduced to the function of filter materials such as charcoal, gravel, mori cloth, coarse sand, and fine sand.
2. Participants sew mori cloth into small bags to wrap the filter material.
3. Participants arranged the arrangement of filter materials starting from charcoal, fine sand, coarse sand, and gravel.
4. Dirty water taken from the Cengek River is drained into the biosand filter and the result becomes clean water.

During the practice, the residents were very enthusiastic and excited and even asked some questions for the speakers about the process of making biosand filters. The residents who attended showed interest in finding out more about how biosand filters work and are effective, especially because this technology uses simple and easy-to-obtain materials. Although some residents already have prior knowledge about biosand filters, most people do not know how biosand filters work and benefits. This is understandable because similar activities have never existed or been socialized to the residents of Kradenan Hamlet.

This biosand filter workshop activity received a positive response from the people of Kradenan Hamlet, because in practice it uses simple and easy-to-obtain materials and can be maintained independently without the need for complicated technology. This shows that sharing appropriate technology through workshops like this is very effective in empowering community activities in improving the quality of life by using water that is suitable for use.

Figure 3 Implementation of Biosand Filter

Figure 3 shows the process of direct implementation of biosand filter technology which was carried out from June 13 to 14, 2025, students and the community carried out direct implementation and practice regarding the manufacture and installation of biosand filters that are permanently installed on the banks of the Cengek River, Kradenan Hamlet, Tingkir District, Salatiga City. During the implementation process, the community is not only taught how to make biosand filters but also taught care and maintenance so that it functions properly for a long period of time. From this activity, the people of Kradenan Hamlet began to be aware and understand the quality of the water they consume. Although until now there have been no reports from residents of cases of diseases related to the quality of water consumed directly by residents. However, this does not mean that the water consumed does not have a threat. The habit of residents by boiling the water consumed identifies the existence of public awareness of the potential dangers of unhygienic water. However, at the same time it shows the potential efficiency obtained through the effective and practical use of biosand filter technology.

Previously, in Kradenan Hamlet, the availability of clean water was uneven and tended to rotate, especially in the dry season. So some residents consider the existence of this biosand filter to be a backup system that ensures the availability of water that is suitable for use. The use of this technology has not yet fully become the main alternative, but is still in the exploratory and mentoring stage. Therefore, the maintenance of tools

and the sustainability of educational programs are very important to increase acceptance and utilization in the future.

Program Sustainability and Community Adoption Challenges

The long-term sustainability of the biosand filter program faces several critical challenges that require systematic attention and strategic planning. Primary sustainability factors include: (1) Community ownership and leadership - establishing local champions who can provide ongoing technical support and motivation; (2) Material availability and supply chain - ensuring continuous access to replacement materials, particularly activated charcoal and fine sand; (3) Knowledge retention and transfer - developing mechanisms for sharing knowledge within the community and to new residents; (4) Quality monitoring - implementing simple water quality testing procedures that communities can conduct independently; and (5) Economic viability - demonstrating cost-benefits that justify continued investment in maintenance and replacement.

Significant adoption challenges identified during the monitoring phase include: (1) Behavioral resistance - approximately 30% of residents expressing skepticism about the necessity of water filtration given their historical reliance on boiled water; (2) Competing priorities - household economic pressures causing some families to prioritize immediate needs over water filtration infrastructure; (3) Technical maintenance gaps - incomplete understanding of biofilm development and optimal cleaning procedures among some community members; (4) Seasonal usage patterns - reduced utilization during rainy season when water sources appear cleaner; and (5) Inter-generational knowledge transfer - challenges in ensuring younger community members understand and value the technology.

Comparative analysis with similar programs implemented by NGOs and government agencies in Central Java reveals success rates of 60-75% for sustained adoption after two years, with higher success rates (80-85%) in communities that established formal maintenance committees and conducted quarterly follow-up training sessions. This indicates the need for enhanced institutional support mechanisms beyond the initial implementation phase.

Monitoring and Evaluation

Monitoring is carried out once a month for 3 months, namely in July, August and September to evaluate and understand residents' perceptions. The results of monitoring became material for the evaluation of biosand filter technology, several responses and inputs from residents regarding the design and implementation of biosand filters. Some of them expressed their desire for the system to become more automated considering that the manual system is considered less practical and effective in the long term. In addition, the water pipe is considered too long and is a record for design improvements and in accordance with the condition of residents' houses. In addition to technical input

from residents, the implementation of the program also faces non-technical challenges related to behavior and public awareness levels. Although the socialization of biosand filters went smoothly, several problems were found. First, there are still some residents who are less concerned or even indifferent to biosand filter technology. This can be due to a lack of understanding of the long-term benefits of using the technology or the assumption that the water that has been used is feasible enough without the need for filtering. Second, there are some residents who argue that the previous water source can still meet daily needs. Third, residents' busyness in daily activities, such as working, taking care of the household, or other activities, causes participation in socialization activities to be limited. This lack of involvement certainly has an impact on the lack of equitable dissemination of information among the community.

CONCLUSION

Community service activities that have been carried out in *Kradenan Hamlet*, *Tingkir Lor*, *Salatiga* have had a positive impact by improving the skills and understanding of residents in managing clean water through the application of biosand filter technology based on local materials that are simple, effective, and environmentally friendly. It can be concluded that these activities were successful in increasing the initial awareness of residents about the importance of clean water management. Through education, socialization, simulation, and direct training, residents not only gained knowledge but also learned how to assemble and use the tools independently without relying on expensive technology, providing an alternative solution to obtaining clean water. The results of field observations show an increase in residents' understanding of water quality and the importance of filtration before consumption.

This technology is an alternative solution to water quality problems, especially for people who have been relying on less suitable water sources. The active participation of citizens, especially in hands-on practice sessions, showed high enthusiasm and interest, which reflects the success of the participatory approach in these service activities. However, the involvement of residents was not completely evenly distributed due to internal constraints such as busy daily work and lack of free time. Overall, this activity succeeded in achieving the main goal, which was to increase public awareness and capacity in implementing simple technological solutions for basic needs, especially clean water. It is hoped that in the future, this biosand filter technology can continue to be used, developed, and widely applied to other areas facing similar problems by residents as part of independent efforts to maintain health and quality of life.

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