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Implementing a Simple Water Filtration System to Enhance Water Quality in Rural Communities: A Case Study of Kalong Liud Village

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Abstract: In response to global challenges outlined by the United Nations Sustainable Development Goals (SDGs), this study addresses the urgent need for clean water in Klong Liud Village, Bogor Regency. The village struggles with inadequate water sources due to shallow wells contaminated by sedimentary rocks, forcing reliance on the Cikaniki River, which fails to meet Indonesian water quality standards. This research implements a Simple Water Filtration System to improve local water quality, employing a multi-stage filtration process that includes activated carbon, aquarium filters, and ijuk (palm fiber). The filtration unit was designed with three sequential stages and constructed together with local residents to ensure community participation and practical skill transfer. Post-implementation observations showed clear improvements in water appearance, odor, and acceptability for domestic use, indicating that the system effectively enhanced physical water quality. Methodologically, the project involved a field survey to assess water quality issues, community engagement to ensure local participation, and the construction of a filtration system capable of providing clean water. The evaluation post-implementation confirmed significant improvements, transforming initially polluted water into clean, odorless water suitable for daily use. This study highlights the effectiveness of simple filtration technologies in addressing water quality issues in rural settings and underscores the importance of sustainable solutions in achieving global water accessibility targets.

Keywords: Clean Water, Kalong Liud Village, Sustainable Development Goals, Water Filtration, Water Quality Improvement.

1. INTRODUCTION

In 2015, the United Nations introduced the Sustainable Development Goals (SDGs), a comprehensive framework aimed at addressing a range of global challenges, with a significant emphasis on environmental sustainability. Central to this framework are the goals related to providing clean water and ensuring adequate sanitation (Mugagga, 2016; Syahruddin et al., 2023). These goals are increasingly critical as climate change exacerbates water crises, particularly in regions that experience prolonged dry seasons (Riski et al., 2023). Subtropical and tropical areas are projected to face water shortages ranging from 10% to 30%, potentially leading to severe droughts (Ghufron et al., 2024). Recent data from Baznas Yogyakarta and BNPB reveal that,

as of September 14-21, 2023, approximately 166,415 individuals across 53 districts in 11 provinces are grappling with a clean water crisis (Mursidi & Sari, 2017).

Water is a fundamental necessity for life, vital for survival and essential for various daily activities. To be deemed safe for consumption, water must meet stringent health standards, often requiring treatment such as boiling. Despite being sourced from diverse locations, water quality can be compromised by pollution from both human activities and natural sources (Ruan et al., 2023). Chemically defined as H_2O, water consists of two hydrogen atoms covalently bonded to one oxygen atom (Litman et al., 2024). While it is colourless, tasteless, and odourless under normal conditions, potable water must adhere to specific safety criteria. Poor-quality water can lead to serious health issues, including diarrhea, vomiting, typhoid, cholera, and bacterial dysentery (Silvia et al., 2021). Additionally, the pH level of water affects bacterial growth, with higher pH levels potentially increasing bacterial colonies and lower levels reducing them (Purwanti et al., 2021).

Water is integral to various aspects of daily life, including household chores, industrial processes, agriculture, and farming. Clean water should be devoid of color, odor, taste, and harmful substances. The growing scarcity of clean water, coupled with high consumption rates, underscores the need for innovative solutions. Rivers, such as the Cikaniki River, play a crucial role by acting as natural reservoirs, capturing and channelling water throughout the hydrological cycle (Yanuar et al., 2020).

Ensuring clean water involves managing both its quantity and quality. Water quality is assessed based on physical, chemical, radioactive, and bacteriological criteria. Indonesian Government Regulation No. 81 of 2001 classifies water into categories: Class I for potable use, Class II for recreational purposes, fish farming, livestock, and irrigation, and Class III for fish farming and irrigation. Effective management requires tailored water treatment technologies suited to local conditions and needs. Despite regulatory efforts, regions like Kalong Liud Village in Nanggug District, Bogor Regency, continue to face significant clean water shortages. This village, relying on shallow wells and the Cikaniki River, encounters challenges as the river water fails to meet Indonesian Minister of Health Regulation No. 32 of 2017 standards. This highlights the urgent need for a Simple River Water Filtration System to provide clean water and ensure ease of use.

2. METHOD

2.1 Materials

The device was constructed using commercially available 2-inch and 4-inch PVC pipes, with 2-inch pipes directing river water to the pump and storage tank and 4-inch pipes housing the filtration media. The filtration system consisted of an initial screening stage to remove large debris, followed by two filtration stages using activated carbon and commonly available commercial aquarium filters to remove fine particles and produce clean, odorless water.

2.2 Methods

The construction involved creating a simple water treatment tool using a multi-stage filtration system to ensure clean water meeting quality standards. The system design included three levels: the placement of a 1000L IBC water tank, two filtration systems in the first tank, and two filtration systems in the second tank. The first tank, sized 3m x 1.2m, can hold 2,880L of water with output rates of 406.78L for the first outlet and 250.35L for the second. The second tank can hold 2,525L with output rates of 434.78L and 364.37L (Figure 1).

2.2.1 Field Survey of Project Conditions

Before implementing the Simple Water Filtration Program, the PPK ORMAWA HIMASKA team conducted a survey of Kalong Liud Village to assess the clean water availability issues and the community's participation in the filtration program. The survey focused on the site of the filtration system, near the Cikaniki River, to ensure proper water intake for the filtration system.

2.2.2 Community Engagement

The implementation of the river water filtration system involved the Kalong Liud Village community, specifically RT 04/RW 03. Forming a community group was intended to involve locals in the construction and maintenance of the filtration system. A community outreach program explained the filtration system and its benefits, aiming to enhance the community's knowledge and skills related to the project. The outreach also educated the community about the advantages of river water filtration and the risks of untreated river water containing harmful chemicals.

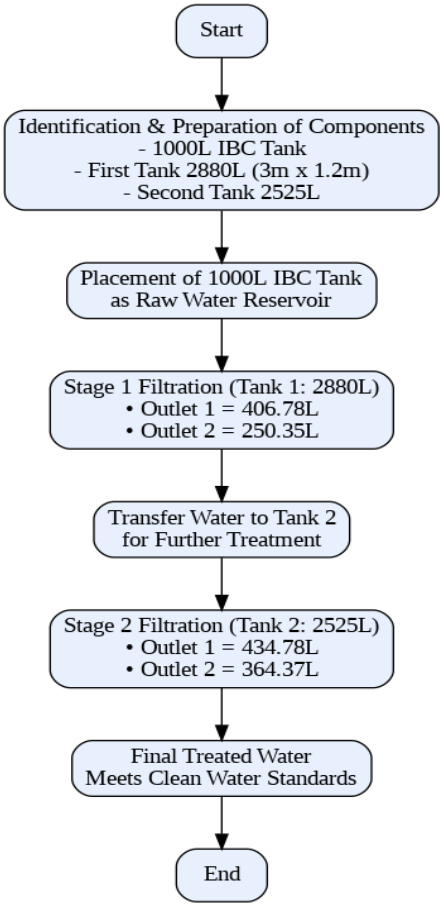

Figure 1. Flowchart Treating Water Activity

2.2.3 Evaluation (Knowledge, Skills, Products, and Economic Aspects)

After community outreach, an evaluation was conducted to assess the improvement in knowledge and skills regarding the Simple Water Filtration Program. The evaluation indicated that, following filtration, the initially brown and odorous Cikaniki River water was transformed into clean, odorless water.

3. RESULT AND DISCUSSION

The PPK ORMAWA Himpunan Mahasiswa Kimia (HIMASKA) team from Universitas Pakuan conducted a preliminary survey of Kalong Liud Village to identify existing problems before implementing their program. The objective was to understand the village's issues and develop solutions aligned with those needs. During the survey, discussions were held with the village head, local RT and RW leaders, and several community members. These discussions provided insight into the village's challenges, including issues with clean water availability and past natural disasters, such as flooding in 2020 and drought in 2021.

The team identified that climate change has exacerbated the water scarcity issue. As a result, they installed a Simple River Water Filtration System in the village to address the problem of clean water availability. The issue is partly due to the shallow wells, which are hindered by sedimentary rocks and cannot provide sufficient water for the community. Consequently, some residents have resorted to using the Cikaniki River for their water needs. Analysis of the Cikaniki River water before filtration indicated that it did not meet clean water eligibility for household use, showing visible turbidity, discoloration, and the presence of suspended particles.

Previous reports and environmental records have noted concerns regarding hazardous substances such as mercury and cyanide in the river; however, this study focused solely on improving physical water quality rather than assessing chemical contaminant reduction. To address the usability of river water, the team implemented a Simple River Water Filtration System using activated carbon filters, which function to adsorb organic compounds, reduce odors, improve color, and enhance overall water clarity. According to Suhartono (2011), activated carbon possesses an amorphous structure with crystalline properties, high porosity, and extensive surface area, making it effective in binding organic matter and reducing unpleasant sensory characteristics in water. In addition, aquarium filters and coir were incorporated to trap fine particles and stabilize flow, supporting a more efficient and consistent filtration process.

The installation of the Simple River Water Filtration System was carried out with the assistance of a community group organized by RT 04. Before the installation, the team administered a pre-test questionnaire to assess the community's knowledge of water filtration systems. The results indicated a general lack of awareness about the filtration system and its benefits (Table 1). Therefore, the team provided educational sessions to inform the community about the Simple River Water Filtration System.

Table 1. Results of the Pre-Education Questionnaire

No.	Aspect	Yes	No
1	Do you know what river water filtration is?	3	7
2	Had you ever studied and practiced the creation of a river water filtration system?	2	8
3	Do you know the sequence of filtration materials used in river water filtration?	3	7
4	Are you aware of the benefits of a river water filtration system?	8	2
5	Do you think a river water filtration system can address drought issues?	5	5
6	Does the presence of a river water filtration system result in clearer water?	9	1

The pre-test results indicated that a significant portion of the community was unfamiliar with the Simple River Water Filtration System and its benefits. To address this knowledge gap, a series of outreach (Figure 2) activities were conducted to educate the community about the filtration system. Following these educational sessions, a post-test questionnaire was administered to evaluate the effectiveness of the outreach efforts. The results showed a noticeable increase in the community's understanding of the water filtration system and its benefits (Table 2).

Figure 2. Community Group Outreach

The installation of the Simple River Water Filtration System aimed to enhance the availability of clean water for the community. The system uses river water, which serves as a primary source for daily needs, and filters it to produce clean water suitable for consumption. The filtration system, located in RT 04/RW 03, comprises four filtration units, providing a two-stage filtration process to ensure the production of clean water (Figure 3).

Table 2. Results of the Post-Education Questionnaire

No	Aspect	Yes	No
1	Do you know what river water filtration is?	10	0
2	Have you ever studied and practiced the creation of a river water filtration system?	10	0
3	Do you know the sequence of filtration materials used in river water filtration?	10	0
4	Are you aware of the benefits of a river water filtration system?	10	0
5	Do you think a river water filtration system can address drought issues?	6	4
6	Does the presence of a river water filtration system result in clearer water?	10	0

Upon completion of the system installation, the team, along with the community, conducted trial and error testing to verify the effectiveness of the filtration process. The results demonstrated that water filtered once was cleaner than the raw river water, and water filtered twice was significantly cleaner than the single-stage filtered water. This indicates that the double-stage filtration system effectively produces water that meets sanitary requirements for the community's needs (Figure 4).

Figure 3**.** River Water Filtration

Based on the implementation and community involvement throughout the program, the activities carried out in Kalong Liud Village have generated several direct impacts. The results of the pre-test and post-test questionnaires indicate a clear increase in knowledge, where initially many residents were unfamiliar with river water filtration systems, but after educational sessions the entire respondent group demonstrated understanding regarding filtration concepts, materials, and benefits. This shows that the program successfully improved the community's knowledge and awareness of water treatment. In addition to knowledge enhancement, the hands-on involvement of residents in building and operating the filtration system has contributed to increased practical skills.

Community members who participated in installation and testing activities are now capable of independently maintaining the filtration unit, demonstrating growth in technical skills and problem-solving abilities related to water management. From a health perspective, the filtration system has provided access to cleaner water, reducing the risk of exposure to hazardous substances such as mercury and cyanide previously

detected in the Cikaniki River. This condition supports improved community health and lowers the potential for waterborne disease incidence in the future.

Figure 4. Water Output from the Simple Filtration System

Economically, the availability of self-filtered water reduces dependence on external clean water sources, especially during drought when access becomes difficult and costly. By having an independent water filtration system, community spending can decrease, and long-term water security becomes more sustainable. Therefore, this program has contributed positively to knowledge, skills, health protection, and economic resilience of the Kalong Liud Village community. Raw river water and water filtered twice was significantly cleaner than the single-stage filtered water. This indicates that the double-stage filtration system effectively produces water that meets sanitary.

4. CONCLUSION

The implementation of the Simple River Water Filtration System in Kalong Liud Village successfully improved the physical quality of water taken from the Cikaniki River through a three-stage filtration process using activated carbon, aquarium filters, and ijuk, producing water that appeared clearer, odorless, and more suitable for daily household use. Community involvement and educational outreach significantly strengthened the program, as reflected in questionnaire outcomes showing that knowledge of river water filtration increased from 30% before the program to 100% after community education, accompanied by a rise in practical participation from 20% involvement to 100% engagement during system construction and operation. Observational evaluation also demonstrated a clear difference between raw, once-filtered, and twice-filtered water, confirming improved turbidity reduction and visual clarity without relying on laboratory analysis. This

initiative supports the United Nations Sustainable Development Goals (SDGs) by providing a sustainable, cost-effective solution for clean water in rural areas.

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