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Utilization of Rainwater into Fresh Water through Electrolysis Method for Communities Affected by Tidal Flooding

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Abstract. Water is an essential resource, crucial for human survival and well-being. In coastal areas like Sayung District, Demak Regency, Central Java, accessing clean drinking water is a significant challenge. This problem is made worse by environmental issues such as tidal flooding, known locally as "rob," which causes the groundwater to become salty and undrinkable. To address this urgent issue, the UNNES (Universitas Negeri Semarang) community service team has launched a project aimed at using rainwater as a source of safe drinking water. The project follows several key steps: first, assessing the current situation to understand the needs and resources of the community; second, training local residents on how to use electrolysis to convert rainwater into potable water; and third, evaluating the effectiveness of the training and the results achieved. The outcomes of this project have been highly positive. The community has gained valuable knowledge about rainwater treatment technologies, developed skills in building electrolysis equipment, and successfully produced fresh water from rainwater. This initiative not only helps to meet the immediate water needs of the community but also provides them with a sustainable solution for their future water needs.

Keywords: electrolysis, fresh water, rainwater, tidal flood

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INTRODUCTION

The need for clean water has emerged as a critical global issue, exacerbated by the impacts of climate change. According to WaterAid's 2016 report, over 40 percent of the population in 16 countries lack access to clean water facilities. This situation forces marginalized communities to spend a substantial portion of their daily income on purchasing clean water (Mu'tashim and Trimurtini, 2024). The scarcity of accessible clean water not only burdens these communities financially but also affects their overall well-being.

Water safety and quality are essential components of human development and health. Ensuring access to clean water is one of the most effective strategies for promoting public health and alleviating poverty (Kurniawati et al., 2020). Potable water, or water that is safe for human consumption, is a fundamental necessity for maintaining good health. The human body relies on water in various critical functions and proportions. For instance, the brain is composed of approximately 74% water, muscles about 75.6%, blood contains 83%, and kidneys around 82.7%. Even bones are made up of 22% water. Given these proportions, the human body's need for adequate hydration is evident.

According to the minimum water needs standard pyramid, each person requires about 10 liters of drinking water daily to meet basic hydration needs (Sa'idi, 2020). This essential requirement underscores the urgency for ensuring widespread access to clean water. Recognizing this, global governments have prioritized clean water development as a central goal within the Sustainable Development Goals (SDGs) established by the United Nations in 2015 (Tortajada and Biswas, 2018). This global commitment highlights the critical importance of addressing the clean water crisis and emphasizes the need for effective solutions, particularly in

regions like Indonesia where access to clean water remains a significant challenge.Sayung District is one of the districts in Demak Regency, located on the westernmost side and directly bordering Semarang City. As a result, the industrial development in this district has been relatively rapid compared to other districts, particularly due to the expansion of industry and trade from Semarang City (Nurdin, Lembang, and Kasmawati, 2019). The Sayung District is characterized by coastal areas typical of northern Java, which makes it particularly prone to tidal flooding, known as "*rob*." This phenomenon has become almost inseparable from the region (Fatimah, Wijaya, and Yusuf, 2023). One of the areas affected by tidal flooding is Banjarsari Village. Based on observations conducted by the team, the current condition in Banjarsari Village is the daily rise in sea level during high tide. This situation is further exacerbated by the emergence of new problems caused by the rising sea levels (Munasikhah, 2021).

The frequent tidal flooding experienced in Banjarsari Village has led to significant contamination of surface water with salty seawater. This contamination renders the water unfit for consumption by the local community (Trihatmoko et al., 2020). Such environmental challenges are not unique to Banjarsari but are also prevalent in other coastal areas within Sayung District. The intrusion of seawater into freshwater sources has severely compromised the quality of water available to residents. In response to this issue, the residents of Banjarsari have been forced to incur additional expenses to obtain potable water (Ilmi, Rezagama, and Zaman, 2017). With well water now largely unsuitable due to its saline content, the community must rely on alternative sources for their drinking water needs. Consequently, residents are faced with the financial burden of purchasing water, with current costs averaging approximately IDR 5,000 to IDR 10,000 per gallon (Nida and Margawati, 2022). This additional expenditure places a strain on the household budgets of many residents, highlighting the economic impact of the water contamination crisis.

The problem of accessing clean (potable) water in Banjarsari Village is part of a broader and more serious issue that affects many regions globally. The lack of access to safe drinking water is a critical concern that has been recognized in the Sustainable Development Goals (SDGs). These goals, established by the United Nations, emphasize the need for sustainable solutions to address water scarcity and contamination issues. The situation in Banjarsari underscores the urgent need for targeted interventions and innovative solutions to ensure that all communities can access clean and safe drinking water. Addressing this problem is essential not only for improving the health and well-being of the residents but also for meeting global development objectives aimed at reducing poverty and promoting sustainable living (Arioen and Dekasari, 2023).

METHODS

This community service program is scheduled to take place on Saturday, July 13, 2024, at the Banjarsari Village Hall in Sayung, Demak. The primary beneficiaries of this initiative are 20 participants from the PKH (welfare improvement programs by the government) residing in Banjarsari, Sayung, Demak. The program aims to address the urgent need for potable water by introducing and implementing rainwater harvesting and electrolysis technology. The implementation of this community service activity will follow a structured series of steps:

1) Observation and coordination, the first stage involves identifying suitable locations for rainwater harvesting within the village. This includes assessing the availability of necessary tools and materials that the community can utilize. Additionally, coordination will be conducted with the Head of Banjarsari Village to ensure that all logistical aspects are aligned and that the program is tailored to the community's needs.
2) Designing the electrolysis device, the next step is to design an electrolysis device that aligns with the laboratory findings regarding the characteristics of rainwater in Banjarsari Village. This design will be customized to meet the specific requirements of the local rainwater, ensuring optimal performance and efficiency.
3) Counseling and socialization, following the design phase, the program will provide counseling and socialization sessions for the community. These sessions will focus on educating residents about the process of rainwater conservation and its conversion into potable water using electrolysis technology. The goal is to increase awareness and understanding of how this technology can improve their access to clean water.
4) Discussions and discussion sessions, to further enhance the community's grasp of technology, discussions and discussion sessions will be held. These interactive sessions are designed to

address any questions or concerns, provide additional insights, and reinforce the practical applications of the electrolysis method for clean water treatment.

The evaluation phase of the program is crucial for assessing its impact and effectiveness. This stage will focus on evaluating the community's understanding of the introduced technology, expanding their awareness of the potential uses of rainwater in their environment, and motivating them to adopt and apply the new science and technology. Additionally, the efficiency of the electrolysis technology will be measured to determine the sustainability of the program and its potential for long-term benefits to the community.

RESULTS AND DISCUSSION

Based on the background provided, there is an urgent need for alternative sources of potable water for the communities in Banjarsari Village, who are severely affected by tidal flooding. In this context, one promising approach is the implementation of rainwater conservation, commonly referred to as rainwater harvesting. This method holds substantial promise due to the considerable amount of rainfall in the region. In Demak Regency, annual rainfall varies between 1.000 and 3.000 mm, with coastal areas experiencing even higher precipitation levels ranging from 2.000 to 3.000 mm (Hariyanti et al., 2021).

Data from the Demak Regency Housing and Regional Infrastructure Office (KIMPRASWIL) and the Semarang Climatology Station reveal that the area receives rainfall on 59 to 109 days each year, with rainfall intensity ranging from 1.801 mm to 2.167 mm (Indirawati, 2017). Specifically, in Sayung District, which is part of Demak Regency, the total annual rainfall is recorded at 1.731 mm, with an average of 75 rainy days (Wulandari, 2023). This considerable rainfall suggests that rainwater harvesting could be a highly effective method for securing a new, reliable source of potable water for the Banjarsari community.

The community service project will employ a downstream application of prior research, which demonstrated the effectiveness of electrolysis in transforming rainwater into ionized alkaline water. This approach not only aligns with the region's rainfall patterns but also leverages innovative technology to enhance water quality. The comprehensive solution to this issue, including detailed methodologies and expected outcomes, is outlined in Table 1.

Based on the situational analysis above, there is a pressing need to address a range of critical issues faced by the partner community, which can be broadly categorized into health, welfare, and education aspects.

1) Health aspect, the health risks associated with

Table 1. Proposed Solutions to the Problems

No	Aspect	Issue	Solution	Assets Provided to Partner	References
1.	Health	Consuming drinking water contaminated with seawater too frequently can cause several health issues for the community.	Applying electrolysis technology to obtain a new source of potable water based on rainwater harvesting.	Household-scale electrolysis device.	(Brauns and Turek, 2020; Kusuma, 2020)
2.	Welfare	The community must spend around Rp5,000 to Rp10,000 per gallon just to obtain potable water.	The application of household-scale electrolysis technology will require an electricity cost of only Rp1,000 per 25 liters.	Supporting devices for the household-scale electrolysis system, such as a power adapter with the specified voltage.	(Nida and Margawati, 2022).
3.	Education	Low knowledge and awareness among the community regarding water conservation methods and water treatment techniques such as electrolysis.	Information and knowledge transfer through outreach activities that cover the fundamental knowledge needed by the community regarding water treatment.	A handbook containing instructions, guidelines, and information required by the partner community.	(Wulandari, 2023; Qudus et al., 2023)

the community's continued consumption of seawater-contaminated water are severe and multifaceted. The high salt content in the water can lead to hypertension and other cardiovascular problems, while heavy metal contamination poses a serious threat to various organs, potentially causing chronic diseases or poisoning. The high lime content can lead to kidney stones and other renal issues, and the presence of microorganisms and pollutants can result in gastrointestinal infections and other waterborne diseases (Khasanah and Nurrahima, 2019). These adverse health effects can result in significant declines in overall well-being, including diminished kidney function, digestive disturbances, and potential impacts on the heart, muscles, and nervous system (Hidayat, Winarno, and Kusumastuti, 2021). Addressing these health risks is crucial to prevent long-term health complications and improve the community's quality of life.

2) Welfare aspect, from a welfare perspective, the community faces significant financial burdens due to material losses caused by tidal flooding. The recurring nature of these floods exacerbates economic strain, as households must allocate additional resources to repair damage and replace lost materials. Furthermore, the need to purchase potable water (because local water sources have become unusable) adds to the financial pressure on the community (Andira, Noorhidayati, and Riefani, 2021). This situation not only depletes household budgets but also affects the community's overall economic stability and quality of life.
3) Education aspect, in terms of education, the community's struggle to find new sources of potable water highlights a broader need for knowledge and skills related to water purification and management. The impact of tidal flooding has made traditional water sources unreliable, necessitating the exploration of alternative methods for ensuring a safe and consistent water supply (Indirawati, 2017). To address this need, it is essential to provide the community with guidance and training on various water processing techniques that can be implemented locally. This knowledge transfer is vital for empowering the community to manage their water resources effectively and sustainably.

These three priority issues “health, welfare, and education" are not only critical to the well-being of the community but also align with key aspects of the Sustainable Development Goals (SDGs). Therefore, it is imperative to undertake this community service program to address these challenges comprehensively. As part of the implementation of this program, training will be provided on the creation of a simple rainwater electrolysis device. The design and functionality of this device, which aims to convert rainwater into potable water through electrolysis, can be seen in the figure below. This training will equip the community with practical skills to improve their access to clean water and contribute to their overall resilience and sustainability.

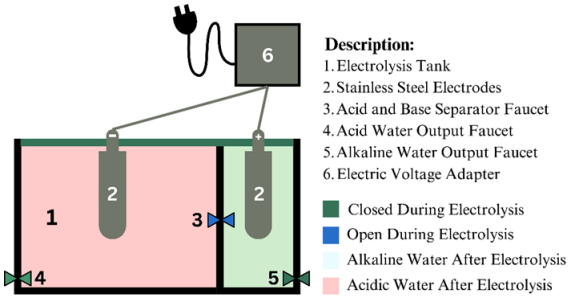

Figure 1. Design of a Simple Household-Scale Electrolysis Device

Figure 2. The Process of Designing a Simple Rainwater Electrolysis Device by Participants

For household scale applications, the electrolysis device is specifically designed with a feed capacity of 25 liters. This setup allows the device to effectively produce 20 liters of alkaline water and 5 liters of acidic water per cycle. The electrolysis process is facilitated by electrical conductors or electrodes made of stainless steel, which are essential for ensuring durability and efficient operation (Kurniawati et al., 2020). To efficiently channel the produced liquids, the device configuration incorporates a series of pipes and

food-grade faucets, ensuring that both the alkaline and acidic water are safely directed and dispensed (Sa'idi, 2020). Additionally, a DC power adapter is included in the design to regulate and control the electric voltage used during the electrolysis process (Fatimah, Wijaya, and Yusuf, 2023). This component is crucial for maintaining the proper functioning of the device and ensuring consistent water quality. The thoughtful integration of these components makes the device user-friendly and suitable for household use, providing an effective solution for producing potable water through rainwater electrolysis.

Figure 3. The Community Service Team with the Head of Banjarsari Village, Mr. Haryanto, S.H., M. Hum, and Training Participants

This outreach activity is meticulously designed to be conducted through a comprehensive and structured series of stages. The outreach encompasses several key components aimed at both education and practical application. Initially, the activity will feature a detailed demonstration of the electrolysis method, which will include an explanation of the principles behind the process and how it can be effectively utilized to produce potable water. Participants will witness firsthand the operation of the electrolysis equipment and observe the testing procedures used to ensure the produced water meets safety and quality standards. A total of 20 participants will be engaged in this outreach, organized into 5 distinct groups. Each group will receive one unit of the simple electrolysis device, and trained students will provide guidance on the setup, operation, and maintenance of the equipment. This hands-on approach is crucial for gaining practical experience and confidence in using the electrolysis device.

The demonstration aims to educate and empower participants, ensuring effective and sustainable operation of the equipment. To evaluate the training's effectiveness and the increase in participants' skills, a comprehensive skill assessment form will be used. This form, completed by the supervising team, will assess various aspects of proficiency in operating the electrolysis device. After the training and evaluation process, a significant improvement in participants' skills is expected. Preliminary results suggest that the increase in skills among the participants has reached an impressive 90%, indicating the success of the outreach activity in equipping the community with the knowledge and abilities necessary to effectively utilize the electrolysis method for producing potable water.

CONCLUSION

In this community service project, the effective implementation of science and technology was realized in Banjarsari Village, Sayung, Demak, through the application of electrolysis technology to convert rainwater into potable fresh water. This innovative approach not only provided a practical and sustainable solution for producing clean drinking water but also played a crucial role in enhancing the community's understanding of rainwater's potential as a valuable resource. By showcasing the benefits of electrolysis, the project demonstrated that rainwater, when treated with this advanced technology, can be transformed into water that is safe for consumption and meets the necessary quality standards. The process not only addresses the immediate need for clean drinking water but also offers long-term benefits by improving the community's awareness of how to utilize rainwater effectively.

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