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EVALUATION AND DESIGN OF COMMUNITY-BASED CLEAN WATER MANAGEMENT SYSTEM IN BANDAREJO, SIDOHARJO VILLAGE, CANDIROTO DISTRICT, TEMANGGUNG REGENCY

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Abstract

Lack of optimal management of water resources becomes a constraint to the development of the well-being of Indonesian people. In Bandarejo's, clean water is still insufficient. Based on surveys and interviews, constraints to managing clean water resources in Bandarejo include restricted access due to a lack of infrastructure, pipeline leaks leading to significant water losses, poor public participation and limited information in decision-making, and inoptimal government roles and limited operational funds. The study aims to evaluate the clean water management system in Bandarejo, identify the constraints encountered, and provide improvements to the design of a community-based clean water system. Quantitative and descriptive analysis methods are used in this study. The research results show that water management in Bandarejo involves communities using water capture tubs and reservoirs. The quality of clean water at microbiological parameters is still high at 2200 MPN/100 mL in raw water sources and 910 MPN/100 mL in reservoirs, not meeting the Permenkes standard of drinking water quality No. 2 Year 2023 of 0 CFU/100 mL. The output water output is 0.41 liters per second, with a water loss percentage of 27.12%. However, the water source can still be used for a certain period. Improvements to the design of the clean water management system were made by adding water treatment units using activated carbon filters, silica sand, zeolite, and pebbles to reduce rottenness and the number of bacteria in the water.

Keywords: Management, Clean Water, Constraints, Improvement

1. Introduction

Water is a vital necessity for all living things on Earth, including humans, animals, and plants. The availability of clean water comes from surface water sources such as rivers, springs, dams, or reservoirs. Population growth, improved living standards, and urban or district development influence increasing water needs. The Central Statistical Agency of Indonesia (2023) noted that the population of Indonesia increased by 1.13% from 2022 to 2023. Water resource management is becoming crucial to addressing increased water needs. Water resource management involves optimum planning, development, distribution, and use. As of 2019, Indonesia has achieved several water resource management targets, including a national water resource capacity of 14.48

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billion m^3 and household access to clean water of 90.2%, of which approximately 23% comes from sanitation systems [9].

The Indonesian government's standards for managing clean water involve ensuring availability and quality through treatment facilities and supporting infrastructure [2]. Inadequate management of clean water hinders the development of well-being in Indonesia. For example, in Bandarejo, clean water distribution has been disrupted due to drainage leaks caused by community activities. This physical loss of water affects availability, especially during the rainy season when water supply is reduced. Unfortunately, there is no clean water treatment system in place in Bandarejo. The study aims to evaluate the clean water management system in Bandarejo, identify constraints, and propose improvements for a community-based clean water system. It seeks to meet government criteria for clean water management in terms of quality, quantity, and continuity. This research provides important insights into the significance of a robust clean water management system for achieving sustainable development.

2. Methods

The data processing method used in this study is quantitative descriptive analysis. The type of data used consists of primary and secondary data. Primary data is obtained from the results of field studies and interviews with relevant parties.

2.1 Observation and Literature Studies

The purpose of this method is to obtain data directly from the events or phenomena studied, namely water quality and obstacles to clean water management systems in Bandarejo, Sidoharjo village, Candiroto district, Temanggung regency (Figure 2.1).

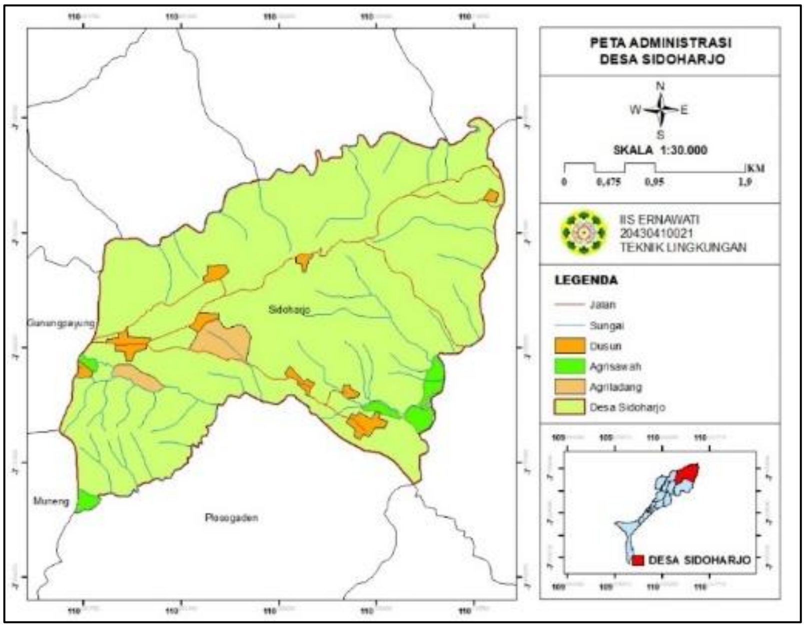

Figure 2.1 Research Location Map

(Source: Sidoharjo Village Map Results 2023)

2.2 Interviews and surveys

In the interview, the source came from one of the citizens to learn about the problems with the existing clean water management system. The questionnaire is used as a tool to present several questions to respondents. As for the questions raised concerning water quality, quantity, and water management carried out by the community.

2.2 Laboratory testing

The laboratory tests that will be carried out in this study include TDS (total dissolved solids), temperature, rigidity, pH, total potassium bacteria, and soluble iron. The method of the tests is shown in Table 2.1.

Table 2.1 Water Quality Samples Test Methods

Parameters	Unit	Test Method
Physics		
Turbidity	NTU	SNI 06-6989.25-2005
TDS *(Total Disolve Solid)*	mg/L	IKP 7.2.2
Temperature	˚C	SNI 06-6989.23-2005
Chemistry		
pH		SNI 6989.11:2019
Metal		
Soluble Iron	mg/L	SNI 6989-84:2019
Microbiology		
Total Coli bacteria	MPN/100mL	APHA Section 2005, 9221 B

3 Results and Discussion

3.1 Community-Based Clean Water Management In Bandarejo

The water sources in Bandarejo come from the inland springs (Figure 3.1). Water discharge decreases during the rainy season, causing insufficient water distribution to meet the daily needs of the population. Disputes between citizens often occur because some houses do not get enough water, especially those far from the reservoirs. The water capture and reservoir tanks were built in 2013 by PTP Nusantara IX Afdeling Bandarejo and handed over to the local community. The public is responsible for the maintenance and monitoring of clean water infrastructure.

Figure 3.1 Water Sources
(Source: Documentation of the researcher)

Figure 3. 1 Reservoir

(Source: Documentation of the researcher)

In Bandarejo, raw water sources for sanitation and drinking are protected with paranet plastic, but there are no fences or boundary buildings that protect water sources from contamination as shown in figure 3.2. Water pollution comes from the use of fertilizers in coffee plants near the water source. While a community-based water resource management system uses parallel pipelines to distribute water from reservoirs or water tanks to communities. These reservoirs are important for the quality of the water distributed. Although the reservoir can store large amounts of water, there is no water treatment system installed in it, so the quality of the water is not guaranteed. The importance of water quality is good for public health and the sustainability of water management systems.

Figure 3. 2 Distribution Pipe

(Source: Documentation of the researcher)

The clean water distribution system in Bandarejo uses a 31/4-inch parallel pipe to flow water from the source to the reservoir tank (Figure 3.3). Furthermore, a 2-inch parallel pipeline is used to stream water from reservoirs to residents' houses through the hole. However, irregular management and arrangement of these distribution pipes often lead to problems such as leakage, cracks, and blockage of the pipes. Piping leaks can be caused by public activity, old pipes, or the use of unqualified piping materials. Pipe fractures often occur due to high water pressure or extreme temperature changes. Pipe blockage can occur due to deposits of mud, dirt, crust, or garbage entering the pipe system. This damage inhibits the flow of water and can cause a drought in Bandarejo.

Water usage is regulated using a water pad. This may include the use of a container or bathtub to store water before use. However, it is important to ensure that the container is clean and protected from contamination to keep the water quality high. The party responsible for water management is the local community. While public participation in the management of water resources is a good step, a better understanding of the principles of water management and the implementation of effective management practices is needed. On the other hand, the standards of water management in the community are not adequate. This indicates the need to improve in terms of monitoring, treatment, and enforcement of appropriate water management standards to ensure good water quality and the sustainability of the water management system in Bandarejo.

3.2 Water Quality

The test was carried out on a sample of the laboratory water quality test in Bandarejo, taken from two points: the raw water source and the reservoir. The parameters tested include pH, temperature, TDS (total dissolved solids), corrosion, total colibacterium, and soluble iron. According to public perception, the water's physical quality is considered quite good because it has no suspicious color, smell, or taste. However, laboratory examinations found that the water had little roughness as samples were taken during the rainy season. The lack of water treatment units is the cause of high-quality water containing pollutants, especially in the case of the microbiology of water. It is important to carry out water quality checks regularly by relevant agencies to ensure that water meets health and environmental standards. In situations without a water treatment unit, independent measures such as boiling water can be taken to kill pathogenic microorganisms. However, water drainage cannot remove chemicals or other pollutants. To ensure that the water in Bandarejo is safe to consume, it is necessary to check the water quality in the laboratory.

3.2.1 Physical Parameters

Table 3.1 Physical Parameter Test Results

Parameters	Sample		Quality Standard	Unit	Information
	Water source	Reservoir			
Water Temperature	19	19	**Air Temperature ± 3**	˚C	Meet
Air Temperature	20	20			
Turbidity	0,4	2,2	**<3**	NTU	Meet
TDS *(Total Dissolved Solids)*	161	105	**<300**	mg/L	Meet

Source: Laboratory Test Result, 2023

Table 3.1 represents the laboratory test result of the water source in the study area. Based on the test results, the water temperature at the water source in Bandarejo is 19˚C at the sample point, which is the raw water source, and the water temperature at the reservoir is also 19˚C. Meanwhile, the air temperature around the water source and reservoir is 20 °C. The temperature difference between water and air can be caused by several factors, one of which is exposure to sunlight. If the water source is exposed to direct sunlight, the water temperature can be higher than the air temperature. However, if the water source is in a shaded environment or is not directly exposed to sunlight, the water temperature may be lower than the air temperature [3]. Temperature variations between water and air generally occur due to differences in thermal conductivity between water and air [4].

In this case, the water source has a turbidity level of 0.4 NTU, while the sample point at the reservoir has a turbidity level of 2.2 NTU. The high turbidity level in the reservoir in Bandarejo is due to the absence of a water treatment basin or sedimentation basin that can make dissolved substances such as soil and mud settle to the bottom of the basin. Sedimentation basins are needed for the sedimentation process or to settle soil or other solutes before water enters the reservoir basin [5]. High turbidity levels in water can be caused by several factors, such as mud particles, soil, microorganisms, and other dissolved substances [6].

A higher TDS value in the source water (161 mg/L) may indicate a higher concentration of minerals or other dissolved materials present in the water, as well as due to geological factors or the nature of the water source. Meanwhile, a lower TDS value in the reservoir (105 mg/L) may indicate dilution or water treatment that causes a decrease in the concentration of minerals and dissolved substances in it. Water treatment processes such as filtration or natural settling can reduce the solute content of water [7].

3.2.2 Chemical Parameters

Table 3.2 Chemical Parameter Test Results

Parameters	Sample		Quality Standard	Unit	Information
	Water source	Reservoir			
pH	7,1	7,1	**6,5 - 8,5**		Meet
Fe	0,03	0,02	**0,2**	mg/L	Meet

Source: Laboratory Test Result, 2023

Table 3.2 shows the chemical parameter test result of the water source in the study area. In this case, the measured pH value of 7.1 indicates that both the water source and the reservoir are close to neutral. The same pH value can occur because there is no water treatment process before the water enters the reservoir, so the particles or chemicals from the water source and reservoir have the same content. Significant changes in water pH can affect the growth of aquatic organisms, the effectiveness of disinfection, chemical precipitation, and the performance of other water treatment units [8].

Based on the test results, the dissolved iron content in the water source in Bandarejo and its reservoir is below the established drinking water quality standard value. The value of dissolved iron in the water source in Bandarejo is 0.03 mg/L, while the reservoir has a value of 0.02 mg/L. This indicates that the iron concentration in the water does not exceed the allowable limit. Low dissolved iron content can be caused by water sources derived from groundwater with low mineral or iron content [1]. The natural process of precipitation in the reservoir also contributes to the decrease in dissolved iron content.

3.2.3 Microbiological Parameters

Table 3.3 Microbiological Parameter Test Results

Parameters	Sample		Quality Standard	Unit	Information
	Water source	Reservoir			
Total Coli bacteria	2200	910	**0**	MPN/100mL	Not Meeting

Source: Laboratory Test Result, 2023

The microbiological parameter test results of the water source are seen in Table 3.3. Microbiological parameters are assessed based on the Total Coliform MPN (Most Probable Number) value. According to the laboratory test results, all samples did not meet the drinking water quality standard set by Permenkes No. 2 of 2023, which is 0 CFU/100 mL [14]. The laboratory testing showed that both samples did not meet the established drinking water quality standards, with values of 2200 MPN/100 mL in the water source and 910 MPN/100 mL in the reservoir.

The high levels of coliform bacteria in the water indicate the presence of a contaminating source. Improper use of fertilizers and pesticides can affect water quality by increasing nutrient content, such as nitrogen and phosphorus [10]. If these nutrients are not absorbed by plants, they can contaminate water sources through seepage or surface runoff, which in turn can promote the growth of water microorganisms, including coliform bacteria. To address this issue, improvement measures such as further water treatment, disinfection, or other treatments need to be implemented to reduce the total coliform bacteria count and ensure the safety of drinking water.

3.3 Water Quantity

The results of the questionnaire showed that the majority of respondents experienced water drain instability in Bandarejo. The minimum standard states that each individual must have access to at least 60 liters of water per day based on Permendagri No. 21 of 2020 concerning the Calculation and Determination of Drinking Water Tariffs [11]. To overcome this, it is necessary to improve water management, such as by increasing storage capacity or finding stable alternative water sources outside the rainy season. Further attention and efforts from the public and government are needed to ensure an adequate and sustainable water supply in Bandarejo. As for the sample used, by counting the water needs of 15 households, The results of the calculations related to such data can be seen below:

a. Production water discharge

= Water volume : time

= 22 liters : 53,09 seconds

= 0,41 liters/s

b. Water Requirements per day

= 60 people x 60 liters/person/day

= 1200 liters/day = 1,2 m^3/day

c. Water Requirements per year

= discharge water x (60 sec/min x 60 minutes/hour x 24 hours/day x 365 days/year)

= 0.41 liters/sec x (60 sec/min x 60 minutes/hour x 24 hours/day x 365 days/year)

= 12.915,6 litres/year = 12.9156 m3/year

d. Total Water Requirements/Seconds 15 Houses

= 0.00345 litres/second x 3600 seconds/hour x 24 hours/day

= 298,8 liters/seconds

e. Percentage of Production Water Loss (%)

$= \left(\frac{\text{Production Water Discharge} - \text{Total Water Requirementsr}}{\text{Products Water Discharge}}\right) \text{ x } 100$

$= \frac{0{,}41 - 0{,}2988}{0{,}41} \text{ x } 100$

$= \frac{0{,}1112}{0{,}41} \text{ x } 100$

= 27,12 %

Based on the above calculations, it can be known that the production water drain has caused a water loss of 27.12%. Where the water loss occurs due to the distribution pipe leakage, the water is wasted just without use. In addition, the water losses occurred due to a lack of care and maintenance on the damaged pipe infrastructure. The activity of communities passing through pipeline distribution lines is also a factor in the leakage of pipelines, causing water loss.

3.4 Obstruction Clean Water Resource Management In Bandarejo

Meeting the clean water needs of the people in the district of Bandarejo, where water is used for everyday needs such as cooking, drinking, and washing, has some barriers related to clean water management. As for the problems that arise, they can be caused by internal and external factors in society. If the problem is not resolved immediately, another, more complex problem will arise. Some of the aspects assessed based on community questionnaire results relating to obstacles encountered and possible solutions can be found in Table 3.4.

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Table 3.4 Results of the Question of the Society of Prevention of Clean Water Management

Aspects assessed	Solution
Access Restrictions	Building adequate infrastructure to improve access to clean water. Conducting an alternative water supply program
Water Resource Management Information	Conduct a consultation on clean water management of the community. Providing posters or other media information on how to maintain hygiene and water quality.
Pipe leakage	Routine maintenance and repair of the water distribution piping system. And permanent monitoring and monitoring.
Clean Water Treatment Unit	Build or upgrade a clean water treatment unit that meets quality standards. Basic training for the community to manage the clean water treatment unit.
Public Involvement In Decision-Making	Organize forums of discussion and community meetings, and form community groups that are directly involved in decision-making.
The Role Of Local Government	Encourage governments and stakeholders to allocate adequate budgets for clean water treatment.
Community Operational Fund	Making monthly payments as an operational fund that can be used whenever there are problems related to the supply of clean water.

3.5 Design of Clean Water Treatment System

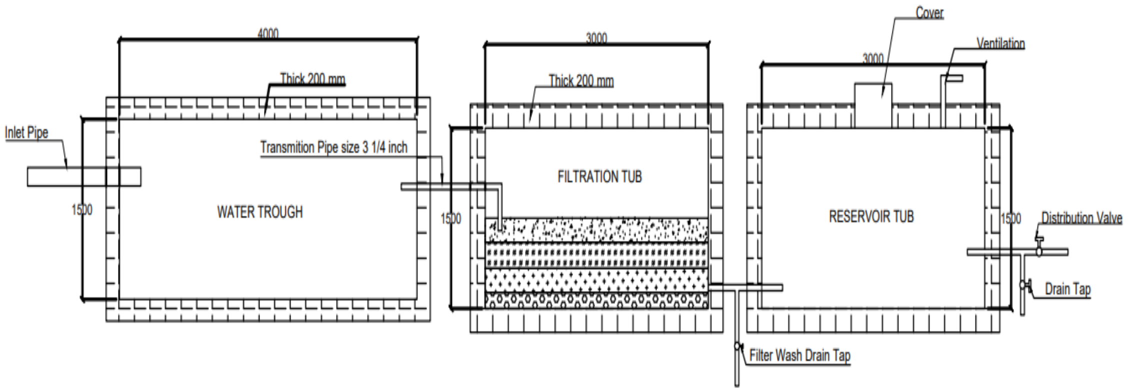

Figure 3.4 Clean Water Treatment Unit

The design of the future clean water treatment system is shown in Figure 3.4. The water treatment unit was planned with some modifications to the water catch basin, reservoir, and water filtration basin. The water catchment basin is equipped with an asbestos-roofed cover building and iron poles, while the reservoir basin is equipped with pipelines, faucets, vents, and covers. The water filtration basins were equipped with pipelines and faucets for filtrant washing. All tanks were constructed from affordable, easy-to-maintain, and durable brick and cement materials.

Filter materials used include activated carbon, silica sand, zeolite, and gravel. Activated carbon has the ability to purify water, reduce hardness levels, and reduce the number of bacteria. In the filtration process, activated carbon interacts with zeolites to absorb particles, metals, and bacteria in the water. This filter can reduce the use of chemicals such as chlorine and sodium that are commonly used in water treatment. Previous research shows that filters with activated carbon, sand, zeolite, and gravel can reduce the number of bacteria by 97% and Coliform by 100% [12]. This modification is expected to increase the effectiveness of water treatment in Bandarejo by using simple methods and reducing the use of chemicals.

4. Conclusion

Clean water management in Bandarejo is managed by local communities with water treatment facilities consisting of water capture tubs and reservoir tubs. The quality of clean water at microbiological parameters is still high enough to be 2200 MPN/100 mL in raw water sources and 910 MPN (100 mL) in reservoirs, so it does not meet the Permenkes standard of drinking water quality No. 2 Year 2023, which is 0 CFU/100 ml. With a water output of 0.41 liters per second and a water loss percentage of 27.12%, the water source can still be used for a certain period. The difficulties faced by the community related to the management of clean water in Bandarejo are to access constraints such as the lack of supporting infrastructure related to clean water treatment units and the presence of pipeline leaks causing significant water losses. The lack of management information and a lack of public and government involvement in decision-making leads to inefficient and sustainable water resource management. The lack of operational funds for clean water management needs in Bandarejo is a factor supporting the fact that the water resource management system is not running optimally. Improved clean water management system design with the addition of a water treatment unit using a filter consisting of activated carbon, silica sand, zeolite, and pebble stone to reduce the rate of rottenness and the number of bacteria in the water.

References

[1] Musofi, S. A. 2020. *Peta Distribusi Kandungan Fe dalam Air Sumur berdasarkan Jenis Tanah di Kecamatan Sewon Tahun 2020* (Doctoral dissertation, Poltekkes Kemenkes Yogyakarta).

[2] Pamsimas.pu.go.id. 2021. POB Perencanaan SPAM Pedesaan. https://pamsimas.pu.go.id/konten/pustaka/pob/2021/pob-perencanaan-spam-perdesaan-2021.pdf

[3] Mukarromah, R. 2016. Analisis sifat fisis dalam studi kualitas air di mata air sumber asem dusun Kalijeruk, Desa Siwuran, Kecamatan Garung, Kabupaten Wonosobo. *Universitas Negeri Semarang. Semarang*.

[4] Maulianawati, D., & Lembang, M. S. 2022. *Kualitas Air Akuakultur*. Syiah Kuala University Press.

[5] Pratama, G. A. P., Dewi, E., & Meidinariasty, A. 2021. Proses Pengolahan Air Pada Prasedimentasi Ditinjau dari Laju Alir dan Waktu Pengendapan Di PLTG Borang. *Jurnal Pendidikan Dan Teknologi Indonesia*, *1*(8), 339-343.

[6] Citrowati, R. L. 2017. *Efektivitas Filter Zeolite Sebagai Absorben Ion Logam Pada Air Sumur* (Doctoral dissertation, Universitas Muhammadiyah Surabaya).

[7] Husaini, A., Yenni, M., & Wuni, C. 2020. efektivitas metode filtrasi dan adsorpsi dalam menurunkan kesadahan air sumur di kecamatan kota baru kota jambi. In *Jurnal Formil (Forum Ilmiah) Kesmas Respati* (Vol. 5, No. 2, pp. 91-102).

[8] Tamjidillah, M., & Nizar Ramadhan, M. 2023. Teknologi Pengolahan Air Bersih. Universitas Lambung Mangkurat.

[9] Ekon.go.id. 2022. Program Pengelolaan Sumber Daya Air Berkelanjutan Untuk Meningkatkan Ketahanan Air Indonesia. Diakses dari https://ekon.go.id/publikasi/detail/3919/program-pengelolaan-sumberdaya-air-berkelanjutan-untuk-meningkatkan-ketahanan.

[10] Salsabila, D. Y. E. 2021. *Faktor Yang Mempengaruhi Keberadaan E. Coli Pada Sumur Gali Di Desa Sei-Lendir Kecamatan Sei Kepayang Barat Kabupaten Asahan Tahun 2021* (Doctoral Dissertation, Institut Kesehatan Helvetia Medan).

[11] Peraturan.go.id. 2020. Berita Negara Republik Indonesia. https://peraturan.go.id/files/bn406-2020.pdf.

[12] Rahmayanti, A., & Hamidah, L. N. 2019. Efisiensi removal bakteri pada filter air payau dengan media karbon aktif. *Journal of Research and Technology*, *5*(1), 80-87.

[13] Temangggungkab. 2018. *Laporan Pendahuluan Penyusunan Kajian Lingkungan Hidup Strategis (KLHS) RPJMD Kabupaten Temanggung*. Retrieved from https://integrasi-opd.temanggungkab.go.id/assets/dok_file/35_tmg-bab-ii-gamum.pdf.

[14] BPK.go.id. 2023. Peraturan Pelaksanaan Peraturan Pemerintah Nomor 66 Tahun 2014 tentang Kesehatan Lingkungan.