JOURNAL OF COMMUNITY EMPOWERMENT FOR HEALTH

JCOEMPH

Vol 5 (2) 2022, 137-142 | Original article
DOI: 10.22146/jcoemph.67490

Implementation of household-scale clean water treatment technology for the mountain farming community, Jajar village, Gandusari district, Trenggalek

Wahyu Dwi Lestari,* Luluk Edahwati, Wiliandi Saputro

Department of Mechanical Engineering, Faculty of Engineering, University of Pembangunan Nasional Veteran Jawa Timur, Surabaya, Indonesia

SUBMITTED: 9 June 2021 REVISED: 29 March 2022 ACCEPTED: 4 July 2022

KEYWORDS
Clean water
Filtration
Jajar health
Technology

ABSTRACT Currently, the need for clean water which is a vital source for people's lives has not been fully met for all Indonesians, including the mountain farming community, Jajar Village, Gandusari District, Trenggalek Regency. So far, the mountain farming community members of Jajar Village have used mountain water for household needs where cloudy and unstable water conditions are a problem that must be faced. If this problem continues, it will lead to serious health problems and social conflicts in the community. Therefore, through community service activities, we made a practical clean water treatment tool, with easily obtained materials, that can be implemented in hilly areas such as in Jajar Village, Gandusari District, Trenggalek Regency. The filtration system used is an upflow and downflow system where the water undergoes a filtration process twice in the material that has been selected and arranged in a systematic way. The materials used are available and easy to obtain in Jajar Village, so that people can discover easily about the benefits of these materials. After making a water filtration system with the community, then physical testing is conducted on the quality of the water produced. From the test results of the effectiveness of the implementation of clean water treatment technology applied to mountain farmers in Jajar Village, it shows that in general the filtered water has met the physical requirements for the level of turbidity, taste, and smell, as well as the quantity and continuity of water are always available when needed.

1.Introduction

Water is an important element in human life that must be fulfilled, even water can show a wider role in maintaining life and social unity.[1,2] The World Health Organization (WHO) estimates that 1 billion people in the world do not have access to safe drinking water and 3.4 million people die each year from water-related diseases. In meeting the daily needs, the average human needs a minimum of 3-5 liters of clean water per day for drinking and 50 liters of water for cooking, bathing, and sanitation.[3] Clean water in a settlement must be readily-available in terms of the availability of water in sufficient quantities to meet daily needs, water quality must meet standards, and continuity in the sense that water is always available when needed.[4,5]

According to data from the Kimpraswil Department in the National Action Plan Study for the Clean Water Sector, 61% of Indonesians do not have access to clean water. Jajar Village is a village that is included in Gandusari District, Trenggalek Regency, East Java, Indonesia.[6] Jajar Village, especially Dukuh Ngasinan is an area that has hilly contours and rocky soil, which makes it difficult for people in Jajar Village to drill groundwater as a source of clean water for residents. As a result, residents only rely on water sourced from the mountains with cloudy water quality and the discharge is always

*Correspondence: wahyu.dwi.tm@upnjatim.ac.id
Department of Mechanical Engineering, Faculty of Engineering, University of Pembangunan Nasional Veteran Jawa Timur, Jl. Rungkut Madya No.1, Gn. Anyar, Kec. Gn. Anyar, Surabaya, 60294, Jawa Timur, Indonesia.

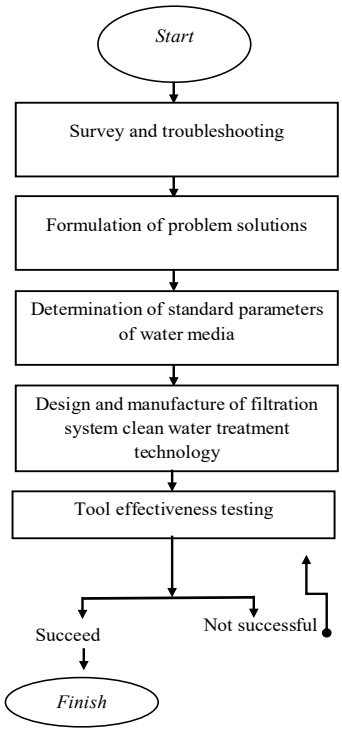

Figure 1. Research flow chart.

changing depending on the season. Based on the requirements for the provision of clean water, the water used by the community in Jajar Village does not meet the standards in terms of quality, quantity, nor continuity.[7,8] If the problem is allowed to continue, there will be serious health problems and social conflicts in the community. Therefore, through community service activities, we had the goal of making a practical clean water treatment tool and assessing how effective the tool's testing results. The test was done by taking into account the physical requirements in accordance with the Regulation of the Minister of Health of the Republic of Indonesia Number 32 of 2017, with parameters such as the level of turbidity, taste, and odor.

2.Methods

The research location was conducted in Jajar Village, Gandusari District, Trenggalek Regency, East Java with a time of seven months of research. The research method started with a survey and identification of problems, formulating problem solutions, determining standard parameters of water media standards, making clean water processing technology with filtration systems, and testing the tool's effectiveness. The research flow chart can be seen in Figure 1.

The first stage began with a survey and problem exploration. At this stage, the problems experienced by mountain farmers in Jajar Village were explored. Then from all the problems found in the early stages, priority problems experienced by residents were considered and raised and then the solution was formulated. The next step was to determine the standard parameters of the water media, referring to the Regulation of the Minister of Health of the Republic of Indonesia Number 32 of 2017, with parameters such as the level of turbidity, taste, and smell. In addition, the standards of quantity and continuity of the water produced were also a consideration in conducting this research. The determination process was done by categorizing the 5 water quality parameters with the Likert scale such as: SS (Strongly agree), S (Agree), R (doubtful), TS (disagree), and STS (Strongly disagree). Moreover, water quality parameters in testing the tool effectiveness are including: 1) The quality of the resulting water clarity is very good; 2) The filtered water is odorless; 3) The filtered water is tasteless; 4) The water quantity is sufficient to meet the needs of the residents; and 5) Water continuity available when needed.

After determining the standard parameters of the water media, the next step was to design and manufacture the technology for processing clean water filtration systems.[9] The design results used can be seen in Figure 2. The clean water treatment technology of this filtration system uses filter media such as bricks, large stones, medium stones, small stones, gravel, and sand.

The filtration system uses an upflow (flow direction from bottom to top) and a downflow (flow direction from top to bottom) filtration system. Based on Figure 2, in the first reservoir the filtration system used is an upflow filtration system with filter media in the form of bricks, large stones, medium stones, small stones, gravel, and sand. The second reservoir uses a downflow filtration system with filter media in the form of bricks, large stones, medium stones,

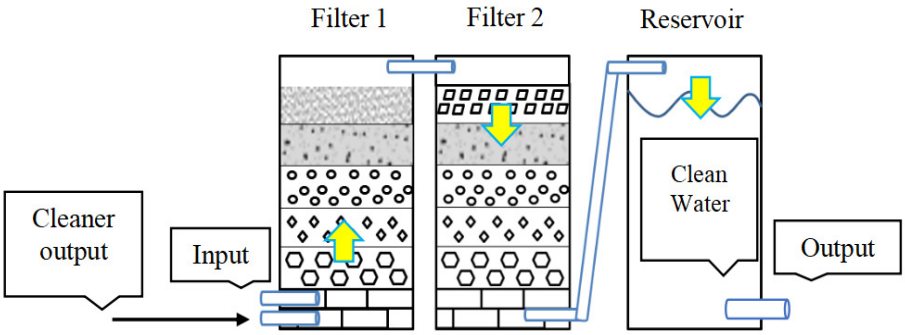

Figure 2. Design of clean water treatment technology filtration system.

Figure 3. The results of the installation of the filtration system clean water treatment technology.

small stones, gravel, and charcoal. The third reservoir is a container for water that has been filtered in clear conditions and is ready to be distributed to the desired place. After the manufacturing process is complete, then we proceeded with installation in a predetermined place as shown in Figure 3.

The last stage was to test the tool effectiveness. Testing the tool effectiveness was done using a sampling technique (probability sampling), where every community member in Jajar Village was randomly selected to be a respondent in the sampling process.[10] In calculating the number of samples, the following data are used: the population in Jajar Village is 2,959 people, the bound of error or the highest sampling error is not more than 5%, and the confidence level used was 95%. By using Equation 1, it can be calculated for the number of samples taken as many as 353 samples.

$$n = \frac{N\ x\ P\ x\ Q}{(N-1)\ x\ D + P\ x\ Q}$$

Calculation of the number of samples:

N = 2959

B = 5% = 0.05

P = Q 0.5 (Moderate estimate of proportion, if population proportion is unknown)

D = B2/4 (to estimate the percentage at the 95% confidence level)

= (0,052 / 4) = 0,000625

(a)

(b)

Figure 4. Comparison of water yield before and after filtration using clean water treatment technology. (4.a) The water before filtration. (4.b) The water after filtration.

Table 1. Water quality parameters in testing the tool effectiveness (%).

No	Parameter	SS	S	R	TS	STS
1	The quality of the resulting water clarity is very good	96	4	0	0	0
2	The filtered water is odorless	98	2	0	0	0
3	The filtered water is tasteless	97	3	0	0	0
4	The water quantity is sufficient to meet the needs of the residents	98	2	0	0	0
5	Water continuity available when needed	96	4	0	0	0

Table 2. The level of public understanding of the criteria for clean water and how to treat clean water before consumption.

Description	Knowing about clean water criteria			Knowing how to treat clean water well before consumption		
	Yes	No	No Answer	Yes	No	No Answer
Respondent (soul)	347	6	0	0	353	0
Percentage (%)	98	2	0	0	100	0

3. Results

3.1 Tool effectiveness

The effectiveness level of the test results of clean water treatment equipment in this study was measured based on five assessment parameters. The study results are shown in Table 1, and the comparison results of water before and after filtration are shown in Figure 4.

Table 3. The level of public understanding of the consequences caused by consuming water that is not/less appropriate.

Description	Knowing the Consequences Caused by Consuming Inappropriate/Inadequate Water		
	Yes	No	No Answer
Respondent (soul)	349	4	0
Percentage (%)	99	1	0

3.2 The level of understanding about clean water

The level of community understanding in Jajar Village about clean water in this study was measured based on three assessment parameters. The study results are shown in Tables 2 and 3.

4. Discussion

The provision of clean water infrastructure is very important in supporting the sustainability of the community in a settlement. Clean water is no longer an item that is available in abundance and freely used, but has become a scarce economic commodity that requires proper management.[11, 12] Based on the effectiveness results of testing clean water treatment equipment, it found that 96% of respondents strongly agreed that the quality of the water clarity produced was very good, while 4% of respondents agreed that the water quality was good.

Then, based on other parameters, 98% of respondents stated that the filtered water was odorless and 97% of respondents stated that the filtered water had no taste. In general, the filtered water obtained shows good quality that meets the physical requirements for the level of turbidity, taste, and odor in accordance with the Regulation of the Minister of Health of the Republic of Indonesia Number 32 of 2017. By fulfilling these physical quality requirements, it shows that the quality of the filtered water can prevent the emergence of suspended solids such as fine sediment, clay, and organic matter which are potential sources of particulates and pose health risks.[13]

Furthermore, as many as 98% of respondents strongly agree that the water quantity produced is sufficient for the needs of the residents, and 96% of respondents strongly agree that the continuity of water is always available when needed, so that the use of clean water for the daily needs of the mountain farmers of Jajar Village can be maintained and fulfilled.

Based on the understanding level of the community in Jajar Village about clean water, the results showed as many as 347 respondents or 98% of respondents knew about what is meant by clean water based on the criteria of "knowing" if one considers: odorless-tasteless-colorless or "don't know" if unable to mention one of the criteria for clean water. Meanwhile, only 6 respondents or 2% of respondents answered that they did not know about the criteria for clean water. Furthermore, to find out the community's understanding of how to treat clean water well before consumption, the results showed that 100% of respondents did not know about how to treat clean water before consumption, based on the criteria of "knowing" if one considers: filtered and deposited using filter media such as stone brick, large stone, medium size stone, small stone, gravel, and sand and use upflow and downflow filtration systems.

Based on these data, the level of public understanding of the criteria for clean water is quite good, but it is necessary to better understand how to treat water properly before consumption.[14,15] Subsequent research was conducted to find out about the level of public understanding of the consequences caused by consuming water that is not / less feasible. Based on the study results as many as 349 respondents or 99% of respondents answered "know" the consequences and as many as 4 respondents or 1% of respondents answered "don't know". The criterion of "knowing" is if the respondent can mention: the occurrence of skin diseases, dysentery, diarrhea, and others in humans who consume the water that is not properly treated.

5. Conclusions

The implementation effectiveness level of the clean water treatment technology applied to mountain farmers in Jajar Village, Gandusari District shows that in general the filtered water has met the physical requirements for the level of turbidity, taste, and smell. By fulfilling these physical quality requirements, it shows that the filtered water quality can prevent the emergence of suspended solids such as fine sediment, clay, and organic matter which are potential sources of particulates and pose health risks. Then, as a result, the water quantity produced in general is sufficient for the needs of the residents and continuity of water is always available when needed.

Acknowledgments

We would like to express our gratitude to the LPPM of the University of Pembangunan Nasional Veteran Jawa Timur for financially supporting this community service activities through the PIKAT (Pemanfaatan IPTEKS bagi Masyarakat) scheme as well as the mountain farming community in Jajar Village, Gandusari District, Trenggalek Regency in the smooth process of activities in the field.

Conflict of interests

No potential conflict of interest was reported by the authors.

References

1. Liu S, Li Q, Liu J, Chen W, Zhang Y. A Realization method for transforming a topology optimization design into additive manufacturing structures. Engineering. 2018;4(2):277–85.
2. Al-Salmi M, Laqbaqbi M, Al-Obaidani S, Al-Maamari RS, Khayet M, Al-Abri M. Application of membrane distillation for the treatment of oil field produced water. Desalination. 2020;494(August):114678.
3. Gleick PH. The human right to water. Water Policy. 1998;1(5):487–503.
4. Hakim DL. Aksesibilitas Air Bersih Bagi Masyarakat di Permukiman Linduk Kecamatan Pontang Kabupaten Serang [Internet]. 2010; Available from: http://eprints.undip.ac.id/23686/1/DIDIN_LUKMANUL_HAKIM.pdf
5. Novotna K, Cermakova L, Pivokonska L, Cajthaml T, Pivokonsky M. Microplastics in drinking water treatment: current knowledge and research needs. Sci Total Environ. 2019;667:730–40.
6. Bappeda. Potensi Kabupaten Trenggalek. 2013;1–11.
7. Messakh JJ, Cendana UN. Pengelolaan Sumber Daya Air. 2021;(June 2020).
8. Goddard FGB, Clasen TF. Household water treatment and safe storage in low-income countries. Second Edition. Vol. 3, Encyclopedia of Environmental Health. Elsevier; 2019. 510–521 p.
9. Rakhecha P. Water environment management in India. 2nd ed. Encyclopedia of Environmental Health. Elsevier Inc.; 2019. 432–442 p.
10. Saleem H, Trabzon L, Kilic A, Zaidi SJ. Recent advances in nanofibrous membranes: Production and applications in water treatment and desalination. Desalination. 2020;478(October 2019):114178.
11. Afkhami A, Marotta M, Dixon D, Ternan NG, Montoya-Jaramillo LJ, Hincapie M, et al. Assessment of low-cost cartridge filters for implementation in household drinking water treatment systems. J Water Process Eng. 2021;39(May):101710.
12. Canales FA, Plata-Solano D, Cantero-Rodelo R, Pereira YÁ, Díaz-Martínez K, Carpintero J, et al. Assessment of carwash wastewater reclamation potential based on household water treatment technologies. Water Resour Ind. 2021;26(May).
13. Ran Y, Fu JM, Sheng GY, Beckett R, Hart BT. Fractionation and composition of colloidal and suspended particulate materials in rivers. Chemosphere. 2000;41. (1-2):33-43.
14. Wang D, Chen Y, Jarin M, Xie X. Increasingly frequent extreme weather events urge the development of point-of-use water treatment systems. npj Clean Water 5, 2022;36. pp 1-7.
15. Prathna TC, Sharma SK, Kennedy M. Nanoparticles in household level water treatment: An overview. Sep Purif Technol. 2018;199(January):260–70.