

Simple Technology of Material Physics of Groundwater Conservation in Dealing with Climate Change in Disaster Areas of North Sumatera

Indri Dayana¹, Habib Satria², Muhammad Fauzi³, Adi Rahwanto³, Martha Rianna⁴

^{1,2}Faculty of Engineering, Universitas Medan Area, Indonesia

³Informatics engineering, Universitas Potensi Utama, Indonesia

⁴Department of Physic, Universitas Syiah Kuala, 23111, Indonesia

⁵Departement of Physic, University Sumatera Utara, Indonesia

*Corresponding author: indridayana@staff.uma.ac.id

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Abstract –Water is a natural resource with a very important function for human life and advancing general welfare, so water is the basic capital and the main development factor. After the eruption in the Mount Sinabung area, the supply of healthy water was inadequate both in quantity and quality, even though the Karo Regency government made efforts to provide this healthy water. For this reason, appropriate technology is needed in post-eruption water treatment in Mount Sinabung to become healthy water and be used by the local community. This research aims to provide information about Groundwater Conservation Technology in Facing Climate Change in the Disaster Areas of North Sumatera. The method used is quantitative with a purposive sampling technique by selecting 6 wells from 348 wells around Mount Sinabung. Chemical parameters for sampling each - each 1 liter of water to be put in bottles previously cleaned and rinsed with distilled water first, then dried. Laboratory Tests then examined them. There is a simple technology in the form of a water filter made from a mixture of sand, activated carbon, and dried starfruit leaves, which can neutralize contamination of substances such as sulfur and others in the water to obtain healthy water suitable for people in the disaster area.

Keywords: physic material, groundwater conservation, activated carbon, *belimbing wuluh*

Introduction

In 2021, the World Organization (UN) issued information whose goal was to achieve sustainable development or Sustainable Development Goals (SDGs). This indicates that in the future, society will face obstacles related to Poverty, climate problems, environmental degradation, and issues of justice (Marshall *et al.*, 2018; Adger *et al.*, 2013; Todd *et al.*, 2021). To meet water needs, water sources will be known as Water Resources, generally interpreted as places to provide water needs (Qiu *et al.*, 2019; Rizal *et al.*, 2018). Water is the source of life. 97% of the water on earth is salt water, and 3% is fresh water. Sources of fresh water can be found underground in the form of groundwater or wells (Sari *et al.*, 2015; Ruhlemann *et al.*, 2021; Sun *et al.*, 2018; Badan Koordinasi nasional, 2017; Gan *et al.*, 2021).

(Thomas, Hardi, Lazrus, Mendez and Orlove 2019) explains that sources of clean water that are widely used by humans still use water from dug wells. Groundwater is obtained partly from rainwater that reaches the earth's surface, seeps into the soil layer, and becomes groundwater. Before reaching the layers, rainwater will pass through several layers of soil and cause the water to contain certain concentrations of mineral substances. (Ishwari, 2022) These minerals include Calcium (Ca), Magnesium (Mg), and heavy metals such as iron (Fe). As a result, using this water will cause side effects (Gan, Oktari, Nguyen, Yuan, and Yu, 2021). In general, the community's water treatment is physical, in the form of sand filters, activated carbon, or zeolite, because of the simple operating system and low operational costs (Lackner, Sajjadi, and Chen, 2022). After the eruption in the Mount Sinabung area, the supply of healthy water was inadequate both in quantity and quality, even though the Karo Regency government made efforts to provide this healthy water. For this reason, appropriate technology

is needed in post-eruption water treatment in Mount Sinabung to become healthy water and be used by the local community.

Biocoagulants from *Averrhoa Bilimbi* fruits are an alternative because they can Precipitate the lime, especially for efficient handling, and are a more economical alternativess in countries where the plants are available. This biocoagulant has been investigated to treat water effluent from liming processes (Wahyuni, Khasanah, Sami and Wibowo, 2019).

Materials and Methods

The research was conducted at the SOS BSD Laboratory and the LIDA laboratory, FMIPA, University of North Sumatra. This research was conducted on September 1– June 15, 2023. The tools and materials used Scissors 1 piece, a Knife Catter 1 piece, 2 bottles of used mineral water, Sand 1/10 kg, used cloth to taste^{1/2} meter water hose, sufficient foam, 1-liter water sample, activated carbon to taste, leaves and Carambola Fruit To taste, container 1 piece. Prepare 2 used bottles of mineral water, the tops of which have been cut off; prepare sand, activated carbon, and leaves fruit wrap the starfruit leaves in used cloth (cotton) with foam until it is neatly covered and put it in the first used bottle, For the second used bottle, fill it from top bottom in the form of activated carbon, sand and cloth, make holes in the bottom of the first bottle and the second bottle. The hole is attached to a water hose. Once ready, put the sample water as well water from the first used bottle until it flows into the second used bottle until you get clean water below. The population in this study is the population of wells in the refugee village, with a total of 348 wells (Dayana *et al.*, 2019; Dayana *et al.*, 2021; Singh *et al.*; 2021).The method of selecting the sample using the purposive sampling technique is as many as 6 wells in the form of 2 close wells, 2 wells that are far, and 2 wells that are far from Mount Sinabung. Each well is taken as much as 1 liter of water (Dayana *et al.*, 2021; Sinaga *et al.*,2021).

Results

The results of this study are in the form of water used in post-eruption mountainous areas, which contain many other elements that will be discussed in physics, chemistry, and biology and solutions in the form of simple technology to overcome healthy water in the area. The following results were obtained based on the results of the researchers' observations of the physical properties of water from 6 water samples taken from the respondent's wells, namely residents of refugee villages.

Table 1. Observation Results of the Physical Properties of Water.

No	Color	pH
1.	Yellow	6.8
2.	White	6.7
3.	White	7.0
4.	White	7.2
5.	Yellow	6.8
6.	Yellow	6.7

Based on the results of the physical quality test of 6 samples of water taken from the respondent's well, namely residents of refugee villages, laboratory data were randomly obtained as follows:

The results of the TDS (Total Dissolved Solid) measurements in Table 1. above show that 2 samples still meet the standards, and the other 4 samples do not meet the standards. Thus, the physical content of the clean water used by the residents of Refugee Village located in the Mount Sinabung area, Karo district, partly does not meet the TDS content threshold due to the presence of residual metal ash which seeps with the water into the well, the number 1.50 is the maximum standard of TDS (Total Dissolved Solid) for drinking water suitable for consumption based on Permenkes no. 492 of 2010 (Simarmata, 2017; Lubis *et al.*, 2018; Siswadiet *et al.*,2021; Setyowati, 2021).

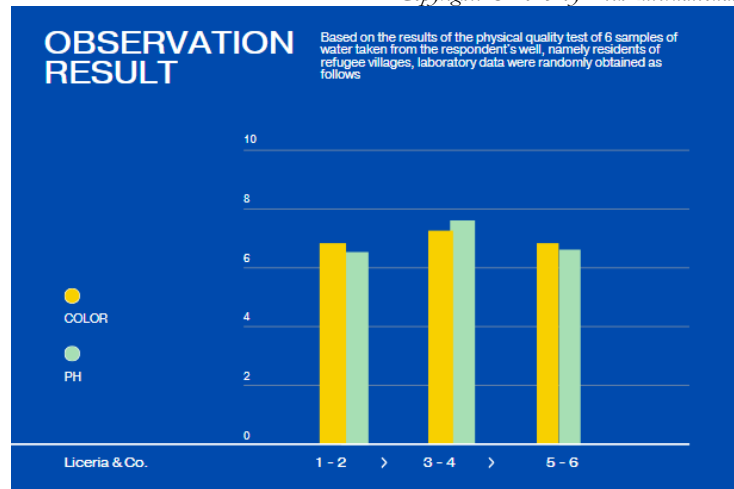


Figure 1. Observation Results of the Physical Properties of Water.

Table 1. Results of laboratory tests for the physical properties of water in refugee villages

Sample	Total Dissolved Solid (TDS) (Mg/L)			Distance from Sinabung Mountain (km)
	Lab.	Standard Max	Note	
1	1.480	1.50	No	5
2	1.590		No	7
3	1.700		No	9
4	1.710		No	11
5	1.270	1.50	Yes	13
6	1.230		Yes	15

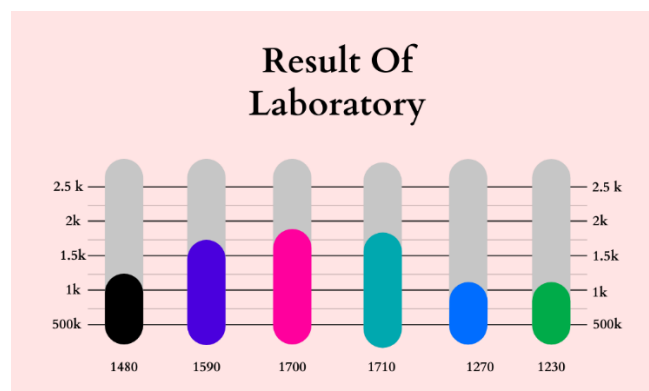
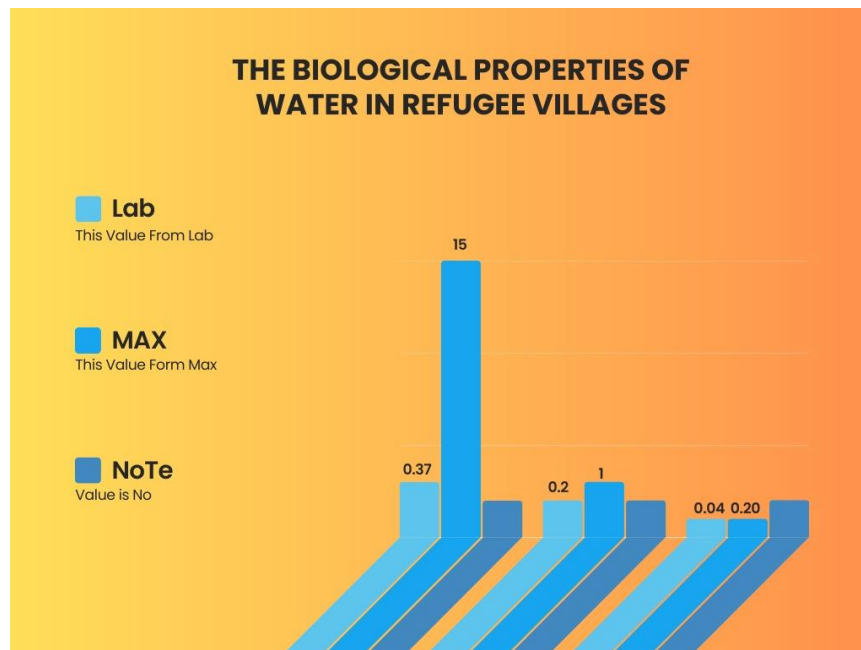


Figure 2. Results of laboratory tests for the physical properties of water in refugee villages

Based on Table 2. This shows that the biological content of the clean water used by the residents of the Refugee Village does not meet the chemical requirements because it contains zinc, iron, and aluminum which is higher than the threshold limit because the accumulation of metal ash left over from production is dissolved by the water and enters the well, The number 15,00 is the maximum standard of Zn (Zink), the number 1,00 is the maximum standard of Fe (Iron), the number 0,20 is the maximum standard of Al (Aluminum) for drinking water suitable for consumption based on Permenkes no.492 of 20102010 (Simarmata, 2017; Lubis *et al.*, 2018; Siswadiet *al.*, 2021; Setyowati, 2021).

Table 2. Laboratory test results for the biological properties of water in refugee villages

Sampel	S Zink (Zn)(Mg/L)			Iron (Fe)(Mg/L)			Aluminum (Al)(Mg/L)		
	Lab.	Standard Maks.		Lab.	Standard Maks.		Lab.	Standard Maks.	
1	0.37		No	0.2		No	0.04		No
2	11.83		No	0.7		No	0.10		No
3	5.33	15,00	No	1.2	1,00	No	0.09	0,20	No
4	2.90		No	28.3		No	4.00		No
5	2.40		Yes	12.6		Yes	2.40		Yes
6	1.41		Yes	5.1		Yes	0.30		Yes

**Figure 3.** Laboratory test results for the biological properties of water in refugee villages**Table 3.** Laboratory test results for the chemical properties of water in refugee villages [40]

Sample	BOD(Mg/L)			Sample	COD(Mg/L)			Distance from waste (m)
	Lab	Maks	Note		Lab	Maks	Note	
1	3		Yes	1	7,82		Yes	4
2	84	6	No	2	250,40	12	No	50
3	26		No	3	78,16		No	15
4	18		No	4	54,71		No	2
5	13		No	5	39,08		No	3
6	15		No	6	46,89		No	6

Based on Table 3. This shows that the chemical content of the clean water used by the residents of the Refugee Village does not meet the BOD and COD content thresholds. The high BOD content is due to the disposal of septic tank waste by residents relatively close to the well, and the high COD content is caused by residual volcanic metal ash carried by the wind directly into the well 2010(Simarmata, 2017; Lubis *et al.*, 2018; Siswadiet *al.*,2021; Setyowati, 2021).

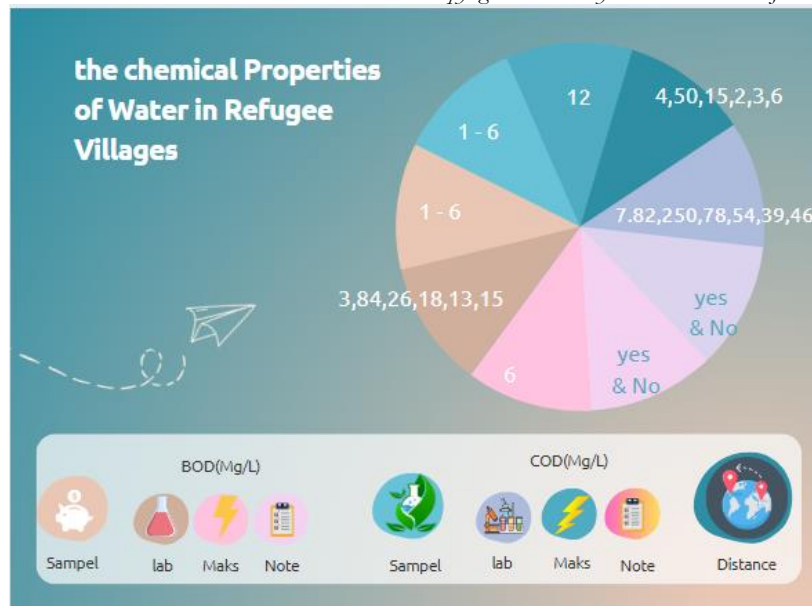


Figure 4. Laboratory test results for the chemical properties of water in refugee villages



Figure 5. Field survey conditions on Mount Sinabung

Discussion

Water is important in fulfilling vital needs for living things such as drinking water or other household needs. The water must be free from disease germs and not contain toxic materials. Sources of drinking water that meet raw water requirements are decreasing due to human activities, both intentionally and unintentionally (Badan Koordinasi Nasional Pengawasan Bencana, 2007). Water is an important factor in Fulfilling the need for drinking water for the people in the Karo district after the eruption of Mount Sinabung was carried out by processing cooperation groups in providing clean water. The increased activity of Mount Sinabung, which causes the release of minerals as waste, such as volcanic ash, still contaminates the quality of water sources (Adi, 2011).

Based on these problems, water sources in the Karo district area that impact the eruption need further research and monitoring for consumption to meet community needs. Therefore, water use must be done wisely; water quality and quantity control activities must be done to ensure the availability of clean water. One solution is to create a water source and use water filter technology, such as activated carbon and starfruit leaves. (Supangat *et al.*, 2021; Raharja *et al.*, 2016; Maridi, 2015; Rice, 2020) explained that the use of activated carbon in Indonesia is increasingly widespread, so the need is even higher. Activated carbon is a solid product from carbonization and activation of lignocellulosic biomass, and several methods and activators include using steam. Activated carbon has absorption (high adsorption) because it has more pores with a small size. (IDMC,2018) explained that *belimbing wuluh* contains formic acid liquid with a high level of acidity. This is useful for neutralizing volcanic ash content, which contains minerals such as Calcium (Ca), Sodium (Na), Potassium

(K), and Magnesium (Mg) which are alkaline (Lackner, Sajjadi and Chen, 2022).

The water source solution is groundwater or dug wells as a source of clean water. The condition of dug wells does not meet the requirements because the average turbidity level is 87.5 mg/L SiO₂, and the average content of e-coli bacteria is 6.8/100 mL. To overcome this problem, filtration is needed to reduce contaminants. The Process of filtering water is often known using a sand filter (Haris, Irianto, Heldi, Hermon, and Yunafatmawita, 2019). Reduced sources of drinking water also occur in Refugee Village, which is located in the area of Mount Sinabung, Karo Regency, as a result of the eruption of Mount Sinabung, which significantly affects the condition of water contaminated with other elements such as sulfur, ferrum (iron) and other elements which can be classified in a physical state., chemistry and biology (Hiwasaki, Luna, Syamsidik and Shaw, 2014). This research also provides a solution for simple technology which is still in miniature form and still needs further development for further research. It can be used as a tool to turn contaminated water into healthy water, even though the precise technology we make is still very simple and necessary. Further development can help to make water healthy from a physical, chemical, and biological point of view.

Quality of Water Used by Residents

Judging from the physical quality of the clean water used by the people of the Refugee Village located in the Mount Sinabung area, Karo district, some of them can still enjoy well water that meets physical quality, namely tasteless, odorless, and colorless. However, some people continue to use their well water for their daily needs, even though they no longer meet the physical requirements because it is cloudy. This fact shows that the quality of clean water in the Refugee Village, which is located in the Mount Sinabung area, Karo Regency, in terms of its physical characteristics, does not meet the standards (Thomas *et al.*, 2019; Adi, 2011; Urbanus *et al.*, 2021). Based on the results of the conclusion of water quality from 6 well water samples, the following results were obtained: It can be concluded that the water quality for samples number 1, 2, 3, and 6 is still below the threshold, while samples number 4 and 5 are polluted so that the well water is not good for consumption because it will cause health problems. In most wells, the water taken as samples contained TDS or Total Dissolved Solids below the set threshold of 12.00 mg/l. The high TDS content in the well water at the refuge, which is located in the Mount Sinabung area, Karo district, post-eruption, other substances enter the well water along with rainwater seeping into the ground.

Meanwhile, in terms of its chemical content, it shows that the water used by the people of Refugee Village located in the area of Mount Sinabung, Karo Regency, did not meet the requirements because most of the wells from which water was taken had a sulfur content above the set threshold of 15.00 mg/l. Biologically, it shows that the water used by the people of Refugee Village located in the Mount Sinabung area, Karo district, does not meet the requirements because it has a BOD content greater than the standard set, which is 6.00 mg/l as well as its COD content which has exceeded the limit. Threshold set at 12.00 mg/l. The high content of BOD or Biological Oxygen Demand for clean water in the village (Simarmata, 2017; Lubis *et al.*, 2018; Siswadiet *et al.*, 2021).

Water Needs

Based on the study's results, it was shown that all the people of the Refugee Village located in the Gunung Sinabung area, Karo district, who were respondents in this study, used groundwater from wells to meet their daily needs. The need for water needed by each family daily is relatively large, namely, on average, 424.4 liters per day, while the standard average is 300 liters/per family/day. The large demand for well water for each family is due to the fact that almost all of the water needed for daily life, namely cooking and drinking, washing motorbikes, washing cars, watering plants, bathing/latrines, and washing clothes, comes from well water. In general, the well water needs of the respondents in this study were never lacking, even though the wells they owned were relatively deep, namely between 3 to 18 meters, but throughout the year, they never lacked water. This is shown by the research results in table 6 which only 7 respondents dug wells due to water shortages from July to September. The water shortage they are experiencing is not due to the difficulty of groundwater sources in the area but rather because the wells they have are still shallow, so they need to dig those wells again to get water in the following dry months (Setyowati, 2021).

Solutions in the form of simple technology are made.

The appropriate technology for healthy water solutions around Mount Sinabung post-eruption is in the form of a simple filter, which in this study is still minimalist in form if further research and application use only needs to be made on a larger scale without having to change the composition of the materials used. This is due to the materials used in appropriate technology, especially the mixing of sand, activated carbon, and starfruit leaves, which can neutralize turbid water (IDMC, 2018). Which is contaminated with substances in the area around Mount Sinabung, North Sumatra; after the eruption, it becomes neutral and becomes healthy water because:

Purify Water

The eruption caused the water in the area around Mount Sinabung, North Sumatra, to become cloudy with the presence of other contaminating substances. A mixture of activated carbon sand and dried starfruit leaves can help clear the water and neutralize substances that contaminate water into healthy water (Triana, Hadi, and Husain, 2017).

Absorbs Bad Odors

The turbidity of water can directly affect the state of the water. Water that is declared fit for consumption is colorless water, does not contain hazardous materials, and does not smell. If the water is declared to smell, it is possible that it contains many bacteria that can cause various diseases (Yenni, Yuniarti, and Khotimah, 2016).

Creates a Fresh Taste for Water

Water that tastes fresh is an indicator of whether or not it is suitable for consumption. In this case, activated carbon can remove substances or contaminants contained in water, thus creating a fresh taste for water.

Prevent Toxic Substances from Entering the Body

The eruption causes water sources to be contaminated with harmful substances contained therein, such as sulfur, ferrum, and so on. The use of a mixture of sand, activated carbon, and dried starfruit leaves is considered to reduce the chances of these harmful substances contaminating the water sources in your residential area so that the water sources are feasible and safe for consumption (Candraningsih *et al.*, 2018; Wenno *et al.*, 2021; Yuliana *et al.*, 2017; Octaviani *et al.*, 2018).

Conclusion

The well water studied in Refugee Village, which is located in the Mount Sinabung area of Karo district, in terms of its physical characteristics, does not meet the requirements because the eruptions in the rainy season look cloudy, yellowish, and white in thickness. In contrast, in the dry season only a tiny portion is cloudy or brownish and has a lower TDS content than standard. The chemical properties do not meet the requirements because they contain zinc, which is higher than the standards, and the biological properties do not meet the requirements because they contain BOD and COD, which are higher than the standards. The daily need for clean water for villagers located in the Gunung Sinabung area, Karo district, is relatively large, namely an average of 424.4 liters/day for each family with an average standard of 300 liters/family/day in the village. There is a simple technology in the form of a water filter made from a mixture of sand, activated carbon, and leaves, and star fruit that can neutralize contamination of substances such as sulfur and others in water so that it becomes healthy water suitable for use for people in disaster areas.

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