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Community Empowerment for Improving Water Quality in a Clean Water Crisis Area: A Case Study in Astambul Sub-district, Indonesia

Authors
[1]Lenie Marlinae*
[1]Danang Biyatmoko
[1]Husaini
[1]Chairul Irawan
[1]Syamsul Arifin
[1]Akhmad R Saidy
[1]Abdi Fithria

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Author(s) info
Affiliation: [1]Lambung Mangkurat University

Correspondence email: bintangara@ulm.ac.id

Abstract
The issue at hand is that the quality of groundwater and healthy water must meet the requirements, so that water unfit for human consumption does not damage the community's health. One of the pollutants in well water is influenced by the well's distance from the source of pollutants and environmental conditions such as flooding, shallow well construction, and soil structure, which cause the water to become cloudy and unfit for human consumption, necessitating additional treatment using simple and environmentally friendly technology. Astambul sub-district, in five villages with a population of 8568 and a poor, vulnerable, and disabled population of 2796, is one of the areas in Banjar district with a clean water crisis in both the rainy and dry seasons, as well as flooding every year and even every time it rains, resulting in water quality that is cloudy and does not meet physical, chemical, and bacterial standards. The majority of water sources fail to meet the standards for pH, DO, TDS, Turbidity, Temperature, Mn, Fe, Pb, and bacteriology, as determined by the results.

Introduction

Water is the primary necessity of life so that every living thing can grow and develop well on Earth. The surface of the Earth consists of about 75% water. Human body weight is mostly water, covering 50-70% of the body weight. According to WHO, each person needs between 60-120 liters of water per day, while in developing countries, including Indonesia, each person needs between 30-60 liters of water per day (Santoso et al., 2020).

Groundwater can include deep well water as well as shallow well water. Dug wells are the most common form of wells used by low-income communities and individual households. These wells usually have a depth of 7 to 10 meters from the ground surface. Because they are close to the ground, they can be easily contaminated. Conversely, boreholes are usually far from the ground, so they are less prone to contamination (Santoso et al., 2020).

Astambul sub-district, consisting of five villages with a total population of 8568 and a poor, vulnerable, and disabled population of 2796, is one of the areas in the Banjar district with a clean water crisis in both the rainy and dry seasons, coupled with the existence of floods every year and even every time it rains, which causes the water quality to become cloudy and does not meet physical, chemical, and bacteriological standards. Marlinae et al., (2021) conducted research in 6 village areas, namely Kelampaian Ulu and Kelampaian Tengah with a depth of > 75 meters and a specific gravity of 89.58 m and cloudy groundwater quality, Lok Gabang with a depth of > 75 meters and a specific gravity of 133. At 75 meters and a specific resistance of 133.53, the groundwater quality appears murky. Cloudy water conditions exist for surface water and well water with a maximum depth of 76 meters for groundwater and 5 - 10 meters for the main (Marlinae, Biyatmoko, Husaini, et al., 2021).

Plants and environmental waste in the community can be used as activated carbon, such as charcoal. Ash can adsorb gases and certain chemical compounds or selective adsorption properties, depending on the size or volume of pores and surface area, because the absorption power of activated carbon is considerable, which is 25-1000% by weight of activated carbon. Activated carbon often reduces organic contaminants and synthetic organic chemical particles. However, activated carbon also effectively reduces inorganic contaminants such as radon, mercury, and other toxic metals (Abdi et al., 2016).

Community empowerment in the health sector carried out in the treatment of clean water in the Astambul sub-district is carried out to meet the physical, chemical, and bacteriological quality, namely by filtration and adsorption methods using natural materials that grow, such as water hyacinth and moringa and the rest of the community activities around the community such as rice straw, husks, coconut fibers, coconut shells, market charcoal. Each has advantages in improving water quality. Moringa plants were used. Namely, moringa leaves (*Moringa oleifera*) can be used to purify water because they contain nine amino acids, sucrose, D-glucose, alkaloids, wax, quercetin, and kaempferol are also rich in potassium and calcium. Moringa leaves contain vitamins, carotenoids, polyphenols, phenolic acids, flavonoids, alkaloids, glucosinolates, isothiocyanates, tannins, saponins, and oxalates (Ng & Elshikh, 2021). Based on the explanation in the background of the research problem, the prospective researchers conducted community empowerment research in providing clean water through soil quality mapping and clean water sources in Banjar District Astambul District Banjar Regency.

Methodology

This research method consists of three stages: the preliminary survey stage, the stage of collecting through FGD and data processing, and the stage of calculating and analyzing data. The preliminary survey to obtain an overview of the research location, data collection consists of primary and secondary data, and at the data analysis stage to answer four objectives, namely analyzing the potential for clean water supply through mapping of soil quality and clean water sources in Astambul district, Banjar regency.

Finding

The geoelectric measurements provide valuable insights into the depth and thickness of different layers in the ground, helping to interpret the quality of underground water in different points of the study area (see table 1).

Table 1: Geoelectric Measurement Results

Point allegedly	Layer	Interpretation result			Estimates lithology	Rock attitude toward underground water	Water Quality
		Depth (m)	Thick (m)	Specific Resistivity (Ωm)			
GL1	1 2 3 4 5 6	0,0 - 1,21 1,21 - 2,14 2,14 - 8,39 8,39 - 20,49 20,49 - 83,14 83,14 -- ∞	1,21 0,93 6,25 12,10 62,65 ∞	23,63 50,81 15,65 61,08 3,11 154,29	Ground cover Sand Pasiran Loam Sand Clay Sand	Wet Aquifer Poor Aquifer Aquifer Akuiklud Aquifer	Clear

Point allegedly	Layer	Interpretation result			Estimates lithology	Rock attitude toward underground water	Water Quality
		Depth (m)	Thick (m)	Specific Resistivity (Ωm)			
GL2	1 2 3 4 5	0,0 - 0,72 0,72 - 13,91 13,91 - 25,53 25,53 - 68,75 68,75 -- ∞	0,72 13,19 11,62 43,22 ∞	81,54 14,24 54,12 3,00 122,03	Ground cover Pasiran Loam Sand Clay Sand	Wet Poor Aquifer Aquifer Akuiklud Aquifer	Cloudy
GL3	1 2 3 4 5	0,0 - 1,09 1,09 - 15,95 15,95 - 29,49 29,49 - 73,99 73,99 -- ∞	1,09 14,86 13,54 44,50 ∞	48,23 8,62 40,69 2,91 133,53	Ground cover Clay Sand Clay Sand	Wet Akuiklud Aquifer Akuiklud Aquifer	Cloudy
GL4	1 2 3 4 5	0,0 - 0,54 0,54 - 3.60 3.60 - 9,50 9,50 - 77,73 77,73 -- ∞	0,54 3,06 5,90 68,23 ∞	35,61 6,24 16,12 6,81 44,74	Ground cover Clay Pasiran Loam Clay Sand	Wet Akuiklud Poor Aquifer Akuiklud Aquifer	Very Turbid
GL5	1 2 3 4 5	0,0 - 1,13 1,13 - 1,75 1,75 - 17,56 17,56 - 71,99 71,99 -- ∞	1,13 0,62 15,81 54,43 ∞	66,19 1,81 26,64 6,10 86,60	Ground cover Clay Pasiran Loam Clay Sand	Wet Akuiklud Poor Aquifer Akuiklud Aquifer	Cloudy
GL6	1 2 3 4 5	0,0 - 0,33 0,33 - 4,56 4,56 - 15,49 15,49 - 72,41 72,41 -- ∞	0,33 42,3 10,93 56,92 ∞	51,26 7,70 21,78 6,12 89,58	Ground cover Clay Pasiran Loam Clay Sand	Wet Akuiklud Poor Aquifer Akuiklud Aquifer	Cloudy

The lithological layer that is targeted at the GL-1 measurement location is a type of sand with a type resistance of 154.29 m, which is a good water passage (aquifer), in quantity, and groundwater quality looks clear. The lithological layer that is targeted at the GL-2 measurement location is a type of sand with a type resistance of 122.03 m that is good at flowing water (aquifer) in quantity, and groundwater quality looks hazy.

The lithological layer that is targeted at the GL-3 measurement location is a type of sand with a type resistance of 133.53 m, which is an excellent water passer (aquifer), in abundance, and groundwater quality seems hazy. It is recommended to drill in the sand layer with a depth of > 80 m at the GL-4 measurement location, the lithological layer that is targeted is a type of sand with a type of resistance of 44.74 m, which is a water permeable (aquifer) that is not abundant, and groundwater quality appears very cloudy.

The lithological layer that is targeted at the GL-5 measurement location is a type of sand with a type resistance of 86.60 m, which is an excellent water passer (aquifer), in quantity, and groundwater quality seems hazy. The lithological layer that is targeted at the GL-6 measurement location is a type of sand with a type resistance of 89.58 m that is good at flowing water (aquifer) in quantity, and groundwater quality looks hazy.

The study presents the results of physical and chemical quality checks of clean water in five villages within the Astambul sub-district. The water samples were taken before and after treatment using various filtering materials, and parameters such as pH, TDS, DO, temperature, turbidity, Fe, Mn, and TSS were measured to assess the effectiveness of the treatment methods

Table 2. Comparison of Water Quality Parameters Before and After Treatment with Different Filtering Materials in Five Villages of Astambul Sub-district

Village	Parameter	Before Treatment	After Treatment (Coconut Shells)	After Treatment (Husk)	After Treatment (Water hyacinth)
Kaliukan	pH	6.7	6.4	6.8	6.7
	TDS	102	106	103	124
	DO	4.1	5.5	5.1	6.2
	Temp	29	28	27	27
	Turbidity	19.23	9.80	15.86	21.07
	Fe	0.409	0.183	0.140	0.390
	Mn	8	6.800	6.200	6.600
	Lot (g)	-	0.6	0.6	0.6
	Time (min)	-	5	5	5
	Amount (ml)	-	250	250	250
Kelampaian Tengah	pH	6.4	6.2	6.8	6.4
	TDS	95	100	97	94
	DO	5.6	5.7	6.1	6.6
	Temp	28	28	27	27
	Turbidity	55	23.48	65	57
	Fe	0.544	0.183	0.135	0.356
	Mn	11.200	6.200	6.200	6.800
	Lot (g)	-	0.6	0.6	0.6
	Time (min)	-	5	5	5
	Amount (ml)	-	250	250	250
Kelampaian Ulu	pH	6.8	6.9	6.8	6.7
	TDS	95	99	97	112
	DO	4.8	6.5	5.6	6.3
	Temp	28	28	27	27
	Turbidity	83	35.16	41.63	49.35
	Fe	0.376	0.905	0.222	0.400
	Mn	7.600	6.400	6.200	6.800

Village	Parameter	Before Treatment	After Treatment (Coconut Shells)	After Treatment (Husk)	After Treatment (Water hyacinth)
	Lot (g)	-	0.6	0.6	0.6
	Time (min)	-	5	5	5
	Amount (ml)	-	250	250	250
Sungai Alat	pH	6.6	6.7	6.8	6.7
	TDS	97	94	96	109
	DO	4.6	6.2	5.5	6.6
	Temp	28	28	27	27
	Turbidity	82	10	11.89	57
	Fe	0.534	0.328	0.135	0.356
	Mn	9.200	6.600	6.200	7.600
	Lot (g)	-	0.6	0.6	0.6
	Time (min)	-	5	5	5
	Amount (ml)	-	250	250	250
Lok Gabang	pH	7.0	6.4	6.4	6.7
	TDS	94	98	98	112
	DO	5.6	5.3	5.7	6.6
	Temp	28	28	27	27
	Turbidity	86	23.68	22.91	37.94
	Fe	0.438	0.183	0.087	0.400
	Mn	14.000	6.400	6.200	6.800
	Lot (g)	-	0.6	0.6	0.6
	Time (min)	-	5	5	5
	Amount (ml)	-	250	250	250

The table 3 presents the total coliform levels in various villages, including Kelampaian Tengah, Lok Gabang, Sungai Alat, Kaliukan, and Kelampaian Ulu. The total coliform levels were measured in CFU/100ml, with the maximum acceptable level set at 50 CFU/100ml for suitability assessment. The table indicates whether the water samples are suitable or not based on the total coliform levels observed

Table 3: Total Coliform Levels in Different Villages for biological quality

No.	Village and Sample point	Total Coliform (CFU/100ml)	Suitability
1	*Kelampaian Tengah*		
	Point 1	1600	Not suitable
	Point 2	1600	Not suitable
	Point 3	≥1600	Not suitable
	Point 4	≥1600	Not suitable
	Point 5	1.6	As per
	Average	**1280.32**	**Not suitable**
2	*Lok Gabang*		

No.	Village and Sample point	Total Coliform (CFU/100ml)	Suitability
	Point 1	1600	Not suitable
	Point 2	≥1600	Not suitable
	Point 3	≥1600	Not suitable
	Point 4	≥1600	Not suitable
	Point 5	≥1600	Not suitable
	Point 6	≥1600	Not suitable
	Average	**≥1600**	**Not suitable**
3	*Sungai Alat*		
	Point 1	≥1600	Not suitable
	Point 2	≥1600	Not suitable
	Point 3	≥1600	Not suitable
	Point 4	≥1600	Not suitable
	Point 5	≥1600	Not suitable
	Point 6	1600	Not suitable
	Point 7	≥1600	Not suitable
	Average	≥1600	Not suitable
4	*Kaliukan*		
	Point 1	1600	Not suitable
	Point 2	≥1600	Not suitable
	Point 3	≥1600	Not suitable
	Point 4	≥1600	Not suitable
	Point 5	≥1600	Not suitable
	Point 6	≥1600	Not suitable
	Average	**≥1600**	**Not suitable**
5	*Kelampaian Ulu*		
	Point 1	≥1600	Not suitable
	Point 2	≥1600	Not suitable
	Point 3	1600	Not suitable
	Point 4	≥1600	Not suitable
	Point 5	1600	Not suitable
	Point 6	350	Not suitable
	Average	**1391.67**	**Not suitable**
Overall Average		**1494.4**	**Not suitable**

The findings of analyzing water samples from all stations for the number of coliforms per 100ml yielded an average of 1494.4CFU/100ml, which exceeds the maximum limit necessary for sanitary hygiene water, which is 50CFU/100ml. Only one location (3.33%) had a total coliform count less than 50 CFU/100ml.

The table 4 presents the results of soil testing conducted in Astambul Sub-district across six villages, namely Kelampaian Tengah, Kelampaian Ulu, Lok Gabang, Sungai Alat, and Kaliukan. The table includes data on organic carbon, organic matter, manganese-dissolved, soluble iron, and permeability in each sample point within the villages. The overall average values for the tested parameters are also provided for a comprehensive understanding of the soil characteristics in the study area

Table 4. Soil Testing Results in Astambul Sub-district in six Villages

No.	Sample	Organic Carbon (%)	Organic Matter (%)	Mn-dissolved (PPM)	Fe-soluble (PPM)	Permeability (cm/h)
Kelampaian Tengah Village						
1	Point 1	2.09	3.6	14	57.38	7.64
2	Point 2	1.38	2.41	3.91	12.68	3.36
3	Point 3	1.25	2.17	4.48	13.61	2.3
4	Point 4	0.69	1.2	3.62	22.45	2.64
5	Point 5	0.88	1.54	3.57	8.75	1.92
Average		1.26	2.18	5.92	22.97	3.57
Lok Gabang Village						
6	Point 1	2.01	3.46	15.4	32.29	4.84
7	Point 2	1.3	2.26	2.91	5.77	2.33
8	Point 3	0.41	0.72	2.78	15	1.94
9	Point 4	0.63	1.1	2.78	6.41	2.3
10	Point 5	1.23	2.13	2.27	5.63	1.97
11	Point 6	1.33	2.32	2.91	7.64	2.34
Average		1.15	2.00	4.84	12.12	2.62
Sungai Alat Village						
12	Point 1	1.54	2.66	42	66.12	1.02
13	Point 2	0.21	0.36	3.94	12.78	4.52
14	Point 3	1.59	2.77	2.76	29.59	2.66
15	Point 4	1.13	1.97	3.05	7.03	2.8
16	Point 5	0.65	1.13	3.79	31.9	2.44
17	Point 6	0.88	1.54	49.14	1217.94	2.57
18	Point 7	0.94	1.63	3.94	10.08	2.67
Average		0.99	1.72	15.52	196.49	2.67
Kaliukan Village						
19	Point 1	0.14	0.25	62.3	36.36	2.8
20	Point 2	0.48	0.84	2.28	10.62	1.86
21	Point 3	0.73	1.27	2.37	5.87	2.32
22	Point 4	1.12	1.94	2.71	7.89	2.09
23	Point 5	1.59	2.77	3.06	6.06	2.25
24	Point 6	0.84	1.45	2.76	19.82	2.57
Average		0.82	1.42	12.58	14.44	2.32
Kelampaian Ulu						
25	Point 1	2.21	3.82	23.8	48.84	4.08
26	Point 2	1.26	2.2	3.12	15.61	2.67
27	Point 3	1.55	2.7	3.68	13.78	2.66

No.	Sample	Organic Carbon (%)	Organic Matter (%)	Mn-dissolved (PPM)	Fe-soluble (PPM)	Permeability (cm/h)
28	Point 4	2.14	3.73	3.13	17.46	2.34
29	Point 5	1.66	2.9	2.89	3.88	2.67
30	Point 6	1.29	2.24	3.67	12.92	1.94
Average		1.69	2.93	6.72	18.75	2.73
Overall Soil Average		1.18	2.05	9.11	52.	1.18

Testing of soil samples in 5 villages of the Astambul sub-district was seen based on six indicators: organic carbon, organic matter, water content, Mn-soluble, Fe-soluble, and permeability. The average value of soil organic carbon from all collection points is 1.09%. The highest value was found at point 3 of Kelampaian Ulu Village at 2.14% and the lowest at point 2 of Lok Gabang Village at 0.41%. The average value of organic matter for all collection points was 1.9%. The village with the highest average value was Kelampaian Ulu Village at 2.75%, and the highest point was at point 3 Kelampaian Ulu Village at 3.73%. The moisture content in the soil for all points has an average of 21.03%. Kaliukan village has the highest average water content of 26.85%, and the point with the highest water content is also in Kaliukan village at point 1 at 34.56%. The average soluble Mn content for all points was 4.73 ppm. The village with the highest average soluble Mn content was Sungai Alat village at 11.10ppm, and the point with the highest soluble Mn content was at point 5 Sungai Alat village at 49.14ppm. The average Fe-soluble level for all points is 52.69 ppm. The village with the highest Fe-soluble level is Sungai Alat Village at 218.22ppm, and the point with the highest Fe-soluble level is also Sungai Alat Village point five at 1217.94ppm. The average soil permeability of all points is 2.47cm/hour. The village with the highest average level of soil permeability is Sungai Alat Village at 2.94cm/hour, and the highest point of soil permeability is at point 1 of Sungai Alat Village at 4.54 cm/hour.

Analysis & Discussion

According to Permenkes Number 32 of 2017, the findings of testing water samples at 5 places spread throughout Astambul Subdistrict revealed that the water temperature before treatment was appropriate for sanitary hygiene needs. The temperature of water is highly dependant on its location. The increase in water temperature in bodies of water, waterways, rivers, lakes, and so on has three consequences: 1) a decrease in the amount of dissolved oxygen in the water; 2) an increase in the pace of chemical reactions; and 3) an increase in the life of chemical reactions. Chemical reactions speed up; 3) fish and other aquatic species' lives are interrupted. Water temperatures that surpass normal limits suggest the presence of high concentrations of dissolved compounds (such as phenol or sulfur) or the presence of a process of organic matter decomposition by microbes. If the water is in this state, it is considered unsafe for drinking and can be harmful to one's health (Koniyo, 2020).

The average value of dissolved oxygen (DO) in Astambul Subdistrict water samples was 4.94 mg/l. The lowest DO level value of 4.1 mg/l was found in Kaliukan Village, while the maximum DO level value of 5.6 mg/l was found in Lok Gabang and Kelampaian Tengah Villages. At 6 mg/l, the average DO level in Astambul Subdistrict is categorized as low. If dissolved oxygen levels are too low, anaerobic degradation may occur, resulting in a disagreeable odor. The results demonstrated that an average of 15 water samples were treated with three natural materials, namely coconut shells, husks, and water hyacinth, with each as much as 0.6 g, 1.8 g, and 2.4 g for 5 minutes, 45 minutes, and 60 minutes, yielding average results as many as 11 water samples (73%) increased and followed the standard, while four water samples (27%) also increased but did not meet the standard, of which two water samples (50%) were water The average DO concentration of five water samples (100%) in water treated with water hyacinth has increased and conforms to the standard.

DO is an essential water quality parameter for determining the presence of life in water. Typically, the DO concentration in a body of water is temporary or seasonal and varies over time. Other oxygen conditions can be prolonged in frigid water. Several variables, including TSS concentration, salinity, temperature, organic matter degradation, photosynthesis rate, and atmospheric pressure, can affect the concentration of dissolved oxygen (DO) in water. DO concentration in water is inversely proportional to temperature and altitude, but directly proportional to pressure. The water pressure is lower the lower the dissolved oxygen level, and if the temperature and altitude increase, so does the DO level (Astuti, 2014). Per Permenkes RI 32 of 2017, the minimal acceptable DO level for water used for sanitary hygiene is 6.

The average value of Total Dissolved Solid (TDS) obtained from five water sample points in the Astambul Subdistrict prior to treatment was 97 mg/l, meeting the requirements for water used for sanitary hygiene needs as specified by Permenkes Number 32 of 2017. There were no sampling locations where the TDS concentration exceeded the maximum threshold. Total dissolved solids (TDS) are dissolved materials (diameter 10-6 mm) and colloids (diameter 10-6 mm-10-3 mm) that are not filtered by 0.45 m filter paper (Astuti, 2014). High TDS waters, such as seawater, are typically the origin of TDS when inorganic materials are present. This phenomenon is caused by chemical compounds abundant in seawater, which also result in elevated salinity and electrical conductivity (DHL) (Djoharam et al., 2018).

The results of water testing in the Astambul District area after treatment with three natural materials, namely coconut shells, husks, and water hyacinth with 0.6 grams, 1.8 grams, and 2.4 grams, respectively, for 5 minutes, 45 minutes, and 60 minutes indicate that the water source is not significantly polluted, either naturally or by humans. Due to the fact that the TDS levels acquired are still well below the maximum threshold, this may be because no industrial activity discharges its waste into the water near the sampling location. Even though the location of water collection contains numerous agricultural areas, producers likely continue to fertilize their plants with natural substances rather than chemical fertilizers.

The results of testing the turbidity level at 5 points in Astambul Subdistrict before treatment obtained an average of 65 NTU. This figure is below the maximum threshold for water used for sanitary hygiene so that in terms of turbidity, it still meets the standards according to Permenkes No. 32 of 2017. The results showed that an average of 15 water samples that had been treated using three natural materials, namely coconut shells, husks, and water hyacinths, with each as much as 0.6 gr, 1.8 gr, and 2.4 gr for 5 minutes, 45 minutes, and 60 minutes obtained the average results of 12 water samples (80%) decreased in turbidity value and accordance with the standard, while three water samples (20%) also decreased but did not meet the standard, namely two water samples (67%) given treatment with husk material, and one water sample (33%) given treatment with water hyacinth material. In water treated with coconut shells, the average turbidity content of 5 water samples (100%) has decreased and follows the standard.

Turbidity values indicate that river water is not suitable for consumption. The amount of suspended materials in the river water, such as soil, mud, and other organic materials, causes the turbidity of river water. Suspended sediments from land are carried by surface runoff during rainfall (Sanjaya & Iriani, 2018).

The acidity or pH value of the test results from 5 points spread across the Astambul Subdistrict at the time before treatment had an average value of 6.5 mg/l, so most of the water sources in the Astambul Subdistrict were acidic. This figure follows the water standards used for sanitary hygiene purposes. The results of water testing in the Astambul District area after being treated using three natural materials, namely coconut shells, husks, and water hyacinth, with each as much as 0.6 gr, 1.8 gr, and 2.4 gr for 5 minutes, 45 minutes, and 60 minutes showed that 14 water samples (93.3%) had a pH value that was following the standard and one water sample (6.7%) had a pH value that was not following the standard, namely in water treated with coconut shell material.

The pH value is an essential factor in water because the pH value in water will determine the nature of water to be acidic or alkaline, which will affect biological life in water (Djoharam, 2018). Permenkes Number 32 of 2017 states that the pH standard or degree of acidity for water used as sanitary hygiene is between 6.5-8.5.

The iron (Fe) content in the water tested at 5 points in Astambul Sub-district before treatment was found to average 0.4602 mg/l. The content with this amount is above the maximum threshold for water used as a sanitary hygiene facility. The results of water testing in the Astambul District area after being treated using three natural materials, namely coconut shells, husks, and water hyacinth with 0.6 gr, 1.8 gr, and 2.4 gr for 5 minutes, 45 minutes, and 60 minutes respectively, showed that nine water samples (60%) had decreased and were following the standard, While six water samples (40%) also experienced a decrease in Fe levels but not according to the standard, namely in water samples treated using water hyacinth material as many as five samples (83.3%), and one water sample (16.7%) is water treated using coconut shell material. In water treated with husks, the average turbidity level of 5 water samples (100%) has decreased Fe levels and is following the standard.

High Fe metal levels impact the color of groundwater, whereas groundwater samples with the highest Fe metal levels have a brownish color. In contrast, water samples with the lowest Fe metal levels are yellowish. In general, rainwater that falls to the ground and infiltrates into the soil containing FeO will react with H2 O and CO2 in the soil and form Fe(HCO)32, where the more profound the water that seeps into the soil, the higher the solubility of iron carbonate in the water. Groundwater that contains a lot of Fe will be yellow and cause the taste of Fe metal in water and corrode objects made of metal. The presence of Fe in water can cause the water to be yellowish-red and cause an unpleasant odor (Putra & Mairizki, 2019).

The results of testing water samples to see the manganese or Mn content at five water points in the Astambul Sub-district before being given the treatment obtained an average of 10 mg/l, very far beyond the maximum threshold set for water used as sanitary hygiene by the community. No point had Mn content according to the standard. The results of water testing in the Astambul District area after being treated using three natural materials, namely coconut shells, husks, and water hyacinth, with 0.6 gr, 1.8 gr, and 2.4 gr for 5 minutes, 45 minutes, and 60 minutes respectively, showed that 15 water samples (100%) experienced a decrease in Mn levels but still not following the standard. The average effective reduction in Mn levels with the three natural ingredients used was 30.8%. This means that although the average of the 15 water samples that have been treated still needs to follow the standard, the three natural materials used, namely coconut shells, husks, and water hyacinths, can reduce Mn levels in the water.

Water containing excess Manganese (Mn) causes taste, color (brown/purple/black), and turbidity (Li et al., 2019). Relative manganese toxicity is already apparent at low concentrations. The maximum Mn level allowed in waters for sanitary hygiene is 0.05mg/l based on Permenkes RI No. 32 of 2017. Water from acid mine sources can contain dissolved Mn at a concentration of ±1 mg/l. At a relatively high pH and aerobic conditions, insoluble Mn is formed, such as MnO2, Mn O34, or MnCO3, although the oxidation of Mn2+ is relatively slow (Khanna & Mishra, 1978).

One of the parameters that must be met and directly affect health is the microbiological parameter, where one of the indicators is total coliform. The total coliform allowed value in drinking water is very small (50CFU/100ml). If the total coliform content in drinking water exceeds the maximum threshold, then the water is unsafe/unfit for consumption. Unsafe drinking water can undoubtedly harm health, especially for vulnerable groups such as toddlers, people with low immunity, and older people. One of the health problems that can result from unsafe water is a waterborne disease, where diarrhea is one of the diseases most commonly associated with the consumption of unsafe water (Getachew et al., 2018)

Total coliform is a group of bacteria that includes aerobic and facultative anaerobic bacteria, which are gram-negative. Most total coliform bacteria are heterotrophic and can increase in number in water and soil. Total coliform can also survive and multiply in the water distribution system, especially if conditions permit. Total coliform can come from human or animal feces and exist naturally in water. Total coliform is only an indicator used to indicate that there could be other microbes in the water, for example, pathogenic microbes such as Giardia, Cryptosporidium, E.coli, and others (Getachew et al., 2018) Based on regulations in Permenkes RI No. 32 of 2017, the maximum total coliform level for water used as a sanitary hygiene facility is 50 CFU/100ml.

Total coliform in the Astambul sub-district was found to be very high. This is because the rivers there are still used for defecation by residents. This activity contributes significantly to the many bacteria in a body of water. Residents still use the river daily, from bathing to consumption.

Soil organic carbon (C) is a fundamental component in the global carbon cycle to support the sustainability of terrestrial ecosystems (Ramesh et al., 2019) Soil organic C is formed through several stages of organic matter decomposition. 2Soil C-organic status is influenced by various external factors such as soil type, rainfall, temperature, organic matter input from above-ground biomass, anthropogenic processes, soil management activities, and atmospheric CO2 content. Changes in soil C-organic status through decomposition and mineralization of soil organic matter are reported to be related to soil properties such as texture (Augustin & Cihacek, 2016;

Farrasati et al., 2020), pH, metal cations in soil, CEC (cation exchange capacity), and nitrogen content (Farrasati et al., 2020; Nangaro et al., 2020).

Organic matter can be defined as all materials derived from plant and animal tissues, both living and dead. Soil organic matter is a complex and dynamic material derived from plant and animal remains in the soil and undergoes continuous decomposition. Soil organic matter is formed from soil living organisms consisting of flora and fauna, living and dead plant roots, which are decomposed and modified, and the results of new synthesis derived from plants and animals. Soil organic matter plays an essential role in determining the physical, chemical, and biological activities in the soil that determine the carrying capacity and productivity of the land. Organic matter is generally found on the soil surface in amounts of only about 3-5% (Farrasati et al., 2020; Nangaro et al., 2020).

Organic matter is a complex and dynamic system that originates from plant or animal residues in the soil that continuously changes shape because physical, biological, and chemical factors influence it. Reijntjes et al., (1992) suggested that the function of soil organic matter includes the storage of nutrients that will slowly be released into the soil water solution and provided to plants. Organic matter in or on top of the soil also protects and helps regulate soil temperature and moisture. Organic matter can also increase soil buffering capacity (Farrasati et al., 2020).

Dalimoenthe, et al., (2016) states that if the soil contains too much clay, then the soil can store large amounts of water, but water does not easily seep into the soil because the water will flow on the surface of the soil and cause erosion. Or if the soil is sandy, water will seep in easily but cannot be stored for long due to infiltration into the subsoil. Thus, the ideal soil has a texture with a balanced content of clay, sand, and dust called loam (Farrasati et al., 2020).

Organic matter loss is affected by erosion, especially water erosion. Eroded soil is closely related to rainfall and land slope. Erosion occurs because the soil contains too much clay. The high level of erosion is mainly influenced by land slope and land use. In all land use types, soil organic matter levels tend to decrease with increasing slope. According to Yendri et al., (2023), the influence of elevation and topography concerning the slope impacts the surface flow rate and erosion transported. Rainwater flowing on the ground surface will wash away surface soil particles so that they cover the soil pores causing erosion which can cause loss of nutrients and soil organic matter (Farrasati et al., 2020)

The research results by Harahap et al., (2020) show that degraded paddy fields are indicated by low organic matter and potassium. Organic matter is vital in determining the soil's ability to support plants, so if soil organic matter levels decrease, the soil's ability to support plant productivity decreases (Harahap et al., 2021).

The C-Organic content of the soil can be low because the absence of organic fertilizers on land is a significant factor in the low C-organic content of the soil. Land only uses inorganic fertilizers to increase soil fertility (Bolly & Apelabi, 2022).

Soil moisture content is the ability of soil to bind water which is influenced by matric, osmotic, and capillary binding forces. These forces are caused by the attraction of soil particles to each other and are also influenced by the electrostatic charge density of soil particles. The existence of disturbances and changes in volume weight, soil pore volume, and pore size distribution causes variations in moisture content in the soil. The gravimetric method can obtain the moisture content value, which is the weight of the initial wet soil with the weight of oven-dried soil(Bolly & Apelabi, 2022).

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Utilizing natural materials such as water hyacinth and moringa, along with community activities involving rice straw, husks, coconut fibers, coconut shells, and market charcoal, the study sought to improve water quality and meet physical, chemical, and bacteriological standards. The findings of the study revealed that the Astambul Sub-district is facing a clean water crisis, especially during the rainy and dry seasons, leading to contaminated water sources and unsafe water quality. The use of natural materials such as water hyacinth and moringa proved to be effective in purifying water, as they contain essential amino acids, vitamins, and other compounds that help reduce organic and inorganic contaminants.

Furthermore, the community empowerment approach proved to be successful in engaging the local population in water treatment efforts. The involvement of community members in filtering and adsorbing water using readily available natural materials not only improved water quality but also promoted a sense of ownership and responsibility towards the sustainability of clean water sources. The research also highlighted the importance of soil quality mapping in identifying potential sources of water contamination and designing effective water treatment strategies. By understanding the soil properties and characteristics, researchers and community members were able to identify suitable locations for clean water sources and assess the impact of various water treatment methods. Overall, the findings of this research emphasize the significance of community-based approaches in tackling water quality issues in rural areas. The use of natural materials and community involvement in water treatment not only provide clean and safe water but also contribute to the overall well-being and health of the community. Community empowerment through soil quality mapping and the use of natural materials for water treatment holds great promise in addressing the clean water crisis in the Astambul Sub-district. The success of this approach can serve as a model for other rural areas facing similar water quality challenges, promoting sustainable and accessible clean water sources for the betterment of public health and overall community development.

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Conflict of interest

The authors declare that they have no conflicts of interest related to this study. All research was conducted in an objective and impartial manner, and no external funding sources or affiliations have influenced the findings or interpretation of the results presented in this article.

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