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Analysis of Dug Well Water Quality as a Source of Clean Water for the Community and Its Influencing Factors on the Coast of Gorontalo Bay

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ABSTRACT

This research aims to analyze the quality of dug well water as a source of drinking water and clean water, examine the factors influencing it, and find appropriate water treatment in community dug wells in Gorontalo Bay. Samples were collected from 13 residential locations within Gorontalo Bay region. Sampling was conducted twice and the parameters examined included temperature, TDS, turbidity, salinity, pH, iron, manganese, hardness, total coli, and E.coli. The analysis was carried out at the Gorontalo District Health Service, UPTD of Water Quality Laboratory Installation. Chemical measurements were carried out at the Integrated Research and Testing Laboratory Universitas Gadjah Mada. The clean water quality benchmark was based on the environmental health quality standards outlined in Permenkes RI no. 02 of 2023. The research results show that in several locations, the TDS, Salinity, Conductivity, Iron, Hardness, Total Coliform and E.Coli parameters do not meet the requirements for drinking water. The factors that influence the decline in water quality include the proximity of wells to septic tanks, with distances ranging from between 3 to 11.5 m, and poor condition of the surrounding environment, characterized by the presence of garbage and animal waste. Water treatment is needed, including filtering, sedimentation, and disinfection.

Keywords: Quality, Well Water, Gorontalo Bay

INTRODUCTION

Gorontalo Bay is also known as Tomini Bay, plays a significantrole as a trade and tourist area. This research was conducted on the coast of Gorontalo Bay, Gorontalo City. The location is in three sub-districts in Gorontalo City. The three locations are Hulonthalangi District, Kota Timur District, and Dumbo Raya District. The population of Hulonthalangi District consisted of 8224 people, Kota Timur District 13,249 people, Dumbo Raya District 9374 people (BPS, 2023). The majority of the population in these three regions resides in coastal areas, which require the availability of clean water and healthy drinking water that is not contaminated with bacteria. One of the sustainable development targets in the SDGs is to ensure that society achieves universal access to clean water and adequate sanitation. Safe drinking water is defined as water that meets physical, chemical, and microbiological requirements.

The quality conditions of well water or groundwater have different characteristics compared to surface water or river water.

Groundwater is generally clear, but often contains quite high levels of minerals or salt, due to the influence of rocks underground. In shallow groundwater, quality and quantity are influenced by environmental conditions, while quantity is influenced by local rainfall.

Access to adequate and safe clean water will support environmental and community health. The need for drinking water is not only seen in quantity but also in quality. Several factors that influence water access are the category of water source used for drinking and the distance of the water source to the waste/sewage/feces reservoirs. The distance between drinking water and appropriate waste water sources must be protected. Well water and pumped water must be at least 10 m from sewage disposal facilities, waste reservoirs, and waste storage areas (Gorontalo City Health Office, 2022).

Groundwater utilization can be carried out by considering: (1) Existing groundwater needs; (2) Planning for groundwater utilization within a certain period to prevent negative impacts (Nurhakim & Firdaus, 2022). A common issue is the limited availability of clean water. Research conducted by Pramesti et al. (2023) shows that treatments combining several systems such as aeration, coagulation, sedimentation and filtration are effective in improving iron parameters, pH, TDS, temperature, odor and color. It is aimed at reducing physical pollution of dug well water in Gorontalo City using activated carbon shows that the use of this material can reduce pH and TDS parameters (Badu et al., 2023). Water quality checks are also important so that people can monitor the use of well water to see whether it is still suitable for use. A research carried out on well water in Papanloe Village around the Bantaeng Industrial Area includes the parameters of smell, taste, color, floating objects, oil layer, TDS, turbidity, conductivity, pH and DO and has met the requirements of Minister of Health No. 2 of 2023 (Nurhajawasri & Haryanti, 2023).

A research conducted on water from dug and drilled wells in Bantan Village, Medan Tembung District, shows that the water quality contains iron levels above the established quality standards. Research by Dappa et al. (2022) in the work area of the Sikumanan Health Center, Kupang City, found that the majority of dug wells had a moderate risk of being contaminated, as much as 47%. A total of 34 samples were examined, and 20 samples did not meet the E.Coli requirements. Thus, it is expected that the community will improve the physical condition of wells, including the distance between the well and the septic tank, the distance between the dug well and other sources of pollution, the floor area of the dug well, the height of the well rim, damage to the well floor, cracks, standing water on the well floor and the height of the dug well. Given the importance of dug well water as a primary water source in the Gorontalo Bay Coastal Area, it is essential to analyze its quality to ensure it remains safe and beneficial, particularly for the fishing communities in coastal areas. This research aims to determine the quality of dug well water, the factors that influence it, and also to find the appropriate water treatment methods to benefit the community. This research will serve as a foundation for monitoring the water quality characteristics of dug wells in the Gorontalo Bay Coastal Area.

MATERIALS & METHODS

The research was carried out on water from community dug wells along the coast of Gorontalo Bay. Sampling was carried out at 13 dug well locations, which include Ferry Harbor, South Leato Beach, Century Beach, Ololalo Beach, Botubarani Beach, Botubarani Settlement, Hiu Tourism Beach, Inento Beach. Talumolo Village Container, Talumolo Bridge, Fish auction, Pohe Sub-District, and Tanjung Kramat Villages. The research locations are shown in Figure 1.

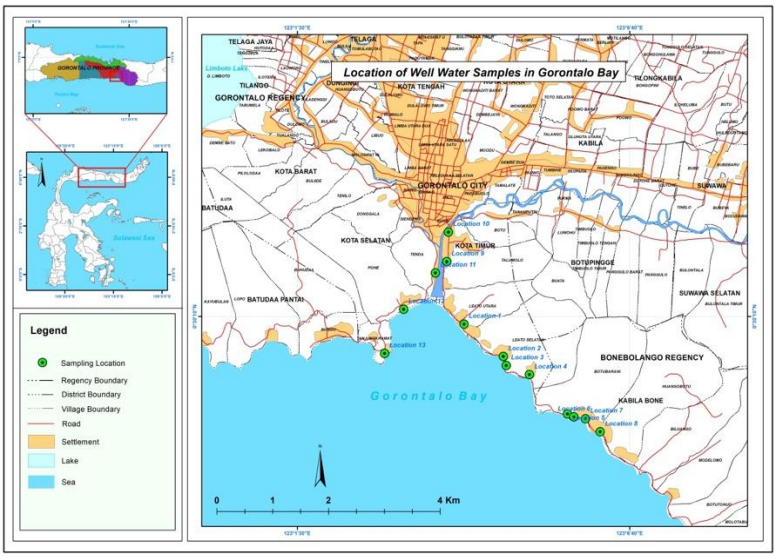

Figure 1. Research Location

Samples were collected twicewith repetitions I and II took samples at the same location. Sampling was done using purposive sampling. The parameters measured consisted of physical factors, including temperature and total dissolved solid (TDS), chemical (iron and hardness) and microbiological parameters (E.coli and total coliform). Physical parameter analysis was carried out in situ while analysis of chemical parameters were anayzed at the Integrated Research and Testing Laboratory at Universitas Gadjah Mada (LPPT UGM). Microbiological parameter analysis was performed at the Gorontalo District Health Service. The benchmark for whether water is suitable or not is the Republic of Indonesia Minister of Health Regulation No. 2 of 2023. The analysis method for the parameters is shown in Table 1.

Table 1. Characteristics of Several Parameters Testing

Parameter	Unit	Analysis Method	Tool/Brand	Specification	Quality Standard
Physical					
Temperature	oC	Expansion	Thermometer / Extech	SNI 06-2413-1991	±3oC
Dissolved Solids	mg/l	TDS metric	TDS Meter / Extech	SNI 06-1136-1989	1000
Turbidity	NTU	Netlometric	Turbidimeter	SNI 06-6989.25-2005	<3
salinity	o/oo	Refraktometry	Refraktometer	SNI 7644-2020	-
DHL	mS/cm	Conductivity	Conductivity Meter	SNI 6989.1:2019	-
Chemical					
Iron	mg/l	Atomic Absorption Spectrophotometry	SSA-flame / ContrAA300 Analitik Jena	SNI 6989.5:2009	0,2
Hardness	mg/l	Atomic Absorption Spectrophotometry	SSA-flame / ContrAA300 Analitik Jena	SNI 6989.5:2009	-
Microbiology					
E.Coli	MPN/100 ml	Most Probable Number (MPN)	MC - Media Pad / Merck	ISO/IEC 17025,2005.	0
Total Coliform	MPN/100 ml	Most Probable Number (MPN)	MC - Media Pad / Merck	ISO/IEC 17025,2005.	0

Factors that influence the quality of well water and its impact on the community were examined through surveys and interviews related to the well, the physical condition of the well, and laboratory conditions on parameters that do not meet drinking water standards in the surrounding environment.

RESULT AND DISCUSSION

Water Quality Analysis Results

Turbidity Parameters

Turbidity is described as an optical property of water which is calculated by the amount of light absorbed and emitted by the materials contained in the water. It is caused by suspended and dissolved organic and inorganic subtances, such as plankton and other microorganisms. Suspended solids are positively correlated with turbidity. The higher the suspended solids, the greater the turbidity value. The results of turbidity analysis on two sampling occasions are shown in Figure 2.

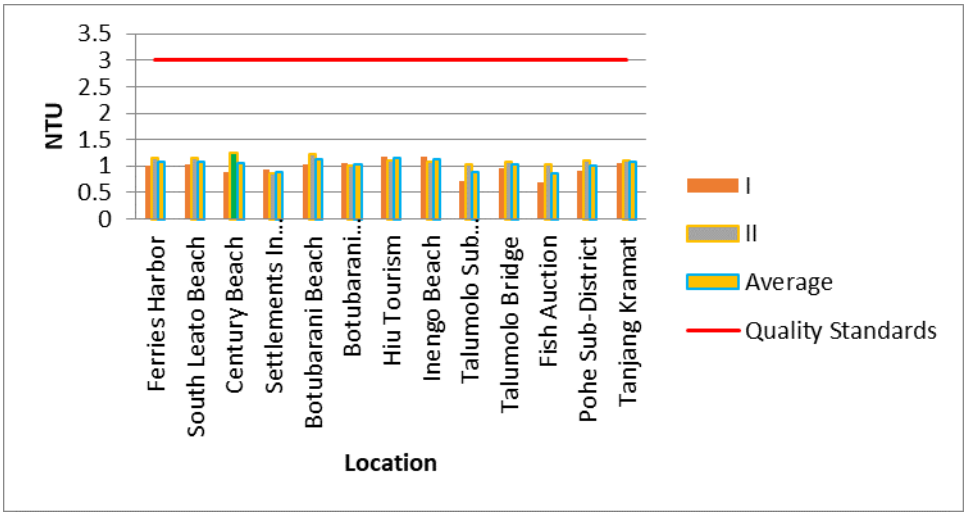

Figure 2. Turbidity Analysis Results

The turbidity analysis results in the Gorontalo Bay area during the first sampling ranged from 0.7 – 1.18 NTU, while the second sampling ranged from 0.86 – 1.24 NTU, with an average results range of 0.86 – 1.125 NTU. Based on these results, the turbidity value is still below the quality standard, namely a maximum of 3 NTU. These results tend to be lower than research conducted in Benoa Bay, where turbidity parameters ranged from 3.21 – 38.01 NTU with 5 sample locations (Ernawati & Restu, 2021). These results tend to be the same as the turbidity parameter conditions in Pasuruan Kidul Village, in which the turbidity was obtained at 1 NTU. Turbidity describes the presence of particles from the soil and possible metal contaminants such as iron and manganese. Many particles and dissolved organic materials can increase water turbidity (Farriya et al., 2021). This difference is because samples taken from water bodies are much influenced by the surrounding environmental conditions compared to those of water from well water.

Total Dissolve Solid (TDS) Parameters

TDS parameters refer to dissolved and colloidal materials, such as chemical compounds and other substances that are not filtered on filter paper with a diameter of 0.45 µm. TDS occurs due to the presence of inorganic materials in the form of ions which are commonly found in waters. Sea water has a very high TDS value due to the abundance chemical compounds, resulting in high salinity values and electrical conductivity (Effendi, 2003a). The results of the TDS parameter analysis are shown in Figure 3.

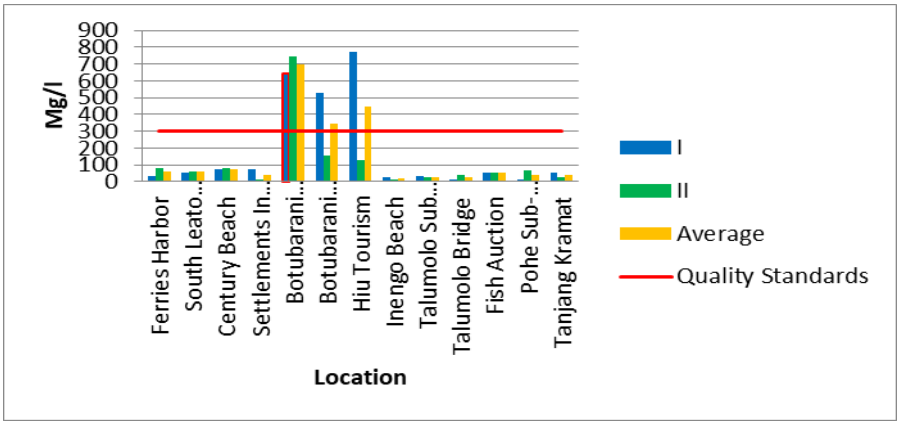

Figure 3. Results of TDS Parameter Analysis in the Gorontalo Bay Coastal Area

Measurement of TDS values in dug well water were conducted to reveal the distribution of TDS in Gorontalo Bay. The TDS value has a positive linear relationship, meaning that the greater the TDS value, the higher the salinity (Khairunnas & Gusman, 2016). The analysis results showed that the TDS parameters at the 13 sampling location in the first repetition ranged from 10.5 – 769 mg/l. In the second repetition, the range ranged between 14.1 – 695.5 mg/l and an average of 19.9 – 695.5 mg/l. There are 3 locations that are above the quality standard, namely Botubarani Beach, the Botubarani Settlement and the shark tourism location, respectively with TDS values of 695.5, 342.5 and 448 mg/l, higher than the quality requirement of 300 mg/l. These results are similar to those carried out on wells in Pasuruan Village which the TDS at three locations, such as - house, mosque and school, which were 417.6, 412.8 and 418.4. TDS is also related to turbidity. The higher the turbidity, the higher TDS of water. High TDS can hinder sunlight penetration into the water, reducing oxygen availability (Farriya et al., 2021).

Salinity Parameters

Salinity describes the total solids in water, after carbonates have been converted to oxides, all the bromide and iodide have been replaced with chloride. The salinity value of freshwater waters is less than 0.5o/oo, brackish waters range from 0.5-30o/oo, and sea waters ranges from 30-40 o/oo (Effendi, 2003b). In hypersaline waters, the salinity value reaches the range of 40-80 o/oo. In coastal waters, salinity values are strongly influenced by freshwater inflows from rivers. The results of the salinity parameter analysis are shown in Figure 4

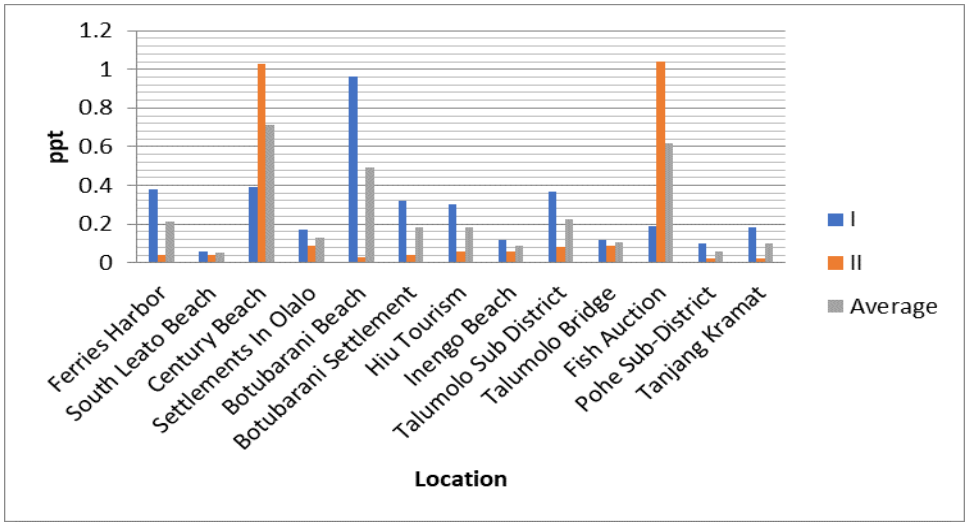

Figure 4. Results of analysis of salinity parameters in the coastal area of Gorontalo Bay

The salt content in most rivers and natural waterways is minimal, classifying the water as fresh water. Its salt content is less than 0.5 ppt. Water with a salt concentration between 0.5–30 ppt is classified as brackish while water with a salt concentration exceeding 30 ppt is considered saline. The technical term for ocean salinity is salinity based on halides, especially chlorides. Salinity is expressed in parts per thousand or ppt or per mil o/oo in oceanography.

Measurement of the salinity of well water in Gorontalo Bay to determine the extent to which the well water has been infused with sea water and whether it is suitable for use. Salinity is a parameter used to measure the level of salinity or dissolved salt content in grams per liter of sea water which determines the quality of ground or sea water. Research conducted by Pamudjianto and Guntur (2023) shows that the salinity of drilled well water in Klasabi Sorong Village is very high at 1180 ppm. When compared with dug well water in Gorontalo Bay, it is lower, indicating that the salinity of the water in the first sampling ranged from 0.06 – 0.96 ppt, and in the second sampling ranged from 0.02-1.04 ppt. The average value ranges from 0.05-0.615 ppt. There are 3 locations including brackish criteria, namely Century Beach, Botubarani Beach and the fish auction location. At certain locations in coastal areas used as samples, the water conditions were brackish; seawater had contaminated them. In this case, better water treatment is needed so that the salt content in the water can be reduced and it can be consumed by the public. There is a close relationship between salinity and conductivity of 0.979. Likewise, TDS has a positive linear relationship with salinity. The higher the TDS value, the higher the salinity value (Khairunnas & Gusman, 2016).

Conductivity or Electrical Conductivity Parameters (DHL)

Conductivity is a numerical description of water's ability to detect electrical currents. Therefore, the more dissolved salts that can be ionized, the higher the DHL value. Water with a DHL of 1 umhos/cm, represents the value of distilled water. Natural waters 20-1500 and sea waters are very high. Quantification is expressed in units of umhos/cm (uS/cm) where S is the abbreviation for Siements. The DHL value is closely related to TDS (Effendi, 2003a). Sea water has high conductivity because it contains many minerals. The conductivity value suitable for drinking is around 42-500 ushos/cm. Based on the high conductivity values ranging from 6310 uS/cm – 14840 uS/cm or 6.3 mS/cm -14.84 mS/cm in well water along coastal areas, it shows that its condition does not meet the requirements as a source of community drinking water. The research results obtained were higher when compared with the conductivity value by Khairunnas and Gusman (2016) with conductivity values varying from 96.5 – 13075 uS/cm in shallow groundwater in the Padang Coastal area. Laboratory test results show that the DHL parameters range between 6.31-97.1 mS/cm as shown in Figure 5.

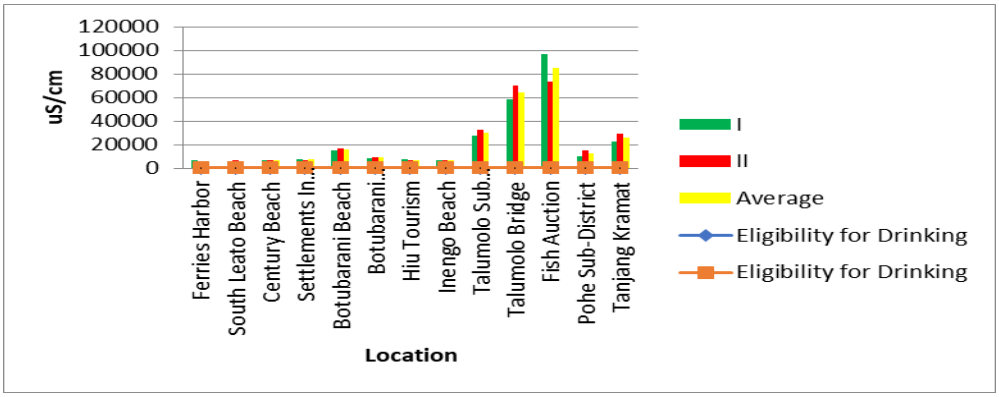

Figure 5. DHL Analysis Results

Temperature Parameter

Temperature can be influenced by changing seasonal conditions, height above sea level, air circulation, cloud cover, flow, and depth of seawater. Increasing temperature has an impact on the physical, chemical, and biological processes of water bodies. Increasing temperature will cause increased viscosity, chemical reactions, evaporation, and volatilization. An increase in temperature also causes an increase in the speed of metabolism and respiration of aquatic organisms and subsequently results in an increase in oxygen consumption. An increase in temperature of 10oC will cause an increase in oxygen consumption by aquatic organisms 2 – 3 times (Effendi, 2003b). This causes temperature to become a limiting factor in the survival of aquatic animals. The results of water temperature measurements are shown in Table 2.

Table 2. Results of Analysis of Temperature Parameters in the Gorontalo Bay Coastal Area

No	Location	Unit	Results of Analysis	
			I	II
1	Ferry harbour	oC	29	29.6
2	South Leato Beach	oC	29.2	29.6
3	Century Beach	oC	29.3	29.5
4	Ololalo Dumbo Raya	oC	29.5	29.7
5	Botubarani Beach	oC	29.2	29.5
6	Botubarani Housing	oC	29.1	29.5
7	Hiu Tourism	oC	29.1	29.5
8	Inengo Beach	oC	29.1	29.4
9	Talumolo (Peti kemas) District	oC	27.9	29.4
10	Talumolo Bridge	oC	29.5	29.4
11	Fish Auction	oC	29	29.4
12	Pohe Sub-District	oC	29.1	27.4
13	Tanjang Kramat	oC	29.7	29.4

Based on these results, the temperature parameters in the well water are at normal conditions in which the normal air temperature is 31oC. Similarly, research on well water in Pasuruan Village reported temperature values ranging from 29.4 to 29.6 and were in the range of 3o C. It is important to note that clean water should not have elevated temperatures, as higher temperatures can promote the dissolution of chemicals from pipes, channels, or other materials (Farriya et al., 2021).

Biological Parameters

Total Coliform Parameters

Coliforms are a group of rod-shaped gram-negative bacteria that produce gas when cultured in lactose medium. One of the members of Coliform is E.Coli, which, which resides in human feces, E.Coli is called Fecal Coliform (Kuswiyanto, 2017). The results of the Total Coliform calculation analysis are shown in Table 3.

Table 3. Results of Total Coliform Parameter Analysis in the Gorontalo Bay Coastal Area

No	Location	Unit	Quality Standard	Results of Analysis	
				I	II
1	Ferry Harbour	CFU/100 ml	0	4	115
2	South Leato Beach	CFU/100 ml	0	7	120
3	Century Beach	CFU/100 ml	0	3	7
4	Ololalo Dumbo Raya	CFU/100 ml	0	31	0
5	Botubarani Beach	CFU/100 ml	0	37	110
6	Botubarani Housing	CFU/100 ml	0	71	100
7	Hiu Tourism	CFU/100 ml	0	80	130
8	Inengo Beach	CFU/100 ml	0	5	0
9	Talumolo District	CFU/100 ml	0	95	0

10	Talumolo Bridge	CFU/100 ml	0	52	0
11	Fish Auction	CFU/100 ml	0	10	0
12	Pohe Sub District	CFU/100 ml	0	100	12
13	Tanjang Kramat	CFU/100 ml	0	105	21

The results of the analysis of Total Coliform bacteria calculations showed that the number of bacteria in dug wells in the Gorontalo Bay Coastal area in replication I ranged from 1 - 105 CFU/100 ml. In the first repetition, all locations did not meet clean or drinking water requirements. There are 7 locations in the Second Test that are above the quality standard. In the second repetition, the Total Coliform parameter ranged from 0 – 130 CFU/100ml. The high level of bacteria in dug well water in Gorontalo Bay is due to the well's physical condition in which the distance between the well and the septic tank is only 3 m. The results of research conducted by Sika (2023), shown a relationship between the well's physical condition and the well water's bacteriological condition. This needs to be paid attention to because it can endanger public health. Likewise, the test results by Khasanah and Ramli (2022) found that the coliform test results were obtained at 25, 26, and 31 MPN at the locations of Genjeng Hamlet, Jetis Hamlet, and Karakan Hamlet. This pollution occurs because the well is close to several water channels.

Parameters of Escherichia Coli (E.Coli)

Escherichia Coli is a normal flora found in the human intestine. Other enteric bacteria, such as Klebsiela sp, Morganella sp, and Providence sp, are also members of the normal intestinal flora. Escherichia Coli is a normal intestinal flora that can produce vitamin K. E.coli bacteria can cause infections in other body tissues. The results of E.coli analysis in the area along Gorontalo Bay are shown in Table 4.

Table 4. Results of E. Coli Parameter Analysis in the Gorontalo Bay Coastal Area

No	Location	Unit	Quality Standard	Results of Analysis	
				I	II
1	Ferry Harbour	CFU/100 ml	0	0	0
2	South Leato Beach	CFU/100 ml	0	0	0
3	Century Beach Housing	CFU/100 ml	0	0	150
4	Settlements In Olalo	CFU/100 ml	0	112	8
5	Botubarani Beach	CFU/100 ml	0	8	0
6	Botubarani Housing	CFU/100 ml	0	0	0
7	Hiu Tourism	CFU/100 ml	0	0	0
8	Inengo Beach	CFU/100 ml	0	2	7
9	Talumolo District	CFU/100 ml	0	0	0
10	Talumolo Bridge	CFU/100 ml	0	0	0
11	Fish Auction	CFU/100 ml	0	0	0
12	Pohe District	CFU/100 ml	0	0	1
13	Tanjang Kramat	CFU/100 ml	0	0	0

The results of the Total Coliform analysis using the CFU/100 ml method showed that E. Coli in the three samples in the first replication exceeded the required quality standard, namely 0 CFU.100ml. In the second repetition there were 4 samples that exceeded the quality standard. In Replication I, the highest sample was 114 MPN / 100 ml at the Ulolalo Beach location. In the second repetition, the highest value was 150 MPN/150 ml in residential locations around Century Beach. The elevated E. coli levels at these locations pose significant health risks to the local community. E. Coli bacteria cause dangerous diarrhea in babies, especially in developing countries. This occurs when E. coli adheres to the mucosal cells of the small intestine and forming pedestal actin filaments that lead to watery diarrhoea.

While this may resolve spontaneously, it can progress to chronic diarrhea if untreated (Kuswiyanto, 2017).

Chemical Parameters

Iron Parameters

Iron concentration in well-aerated waters typically do not exceed 0.3 mg/liter. Naturally occurring iron concentration in water range from 0.05-0.2 mg/l. In groundwater with low oxygen levels, iron concentrations can reach as high as 10-100 mg/l, while in sea waters is 0.01 mg/l. Iron levels > 0.1 mg/l are considered dangerous to aquatic life. Water intended for drinking water should have an iron content of 0.3 mg/l (Effendi, 2003). The results of iron analysis are shown in Figure 6.

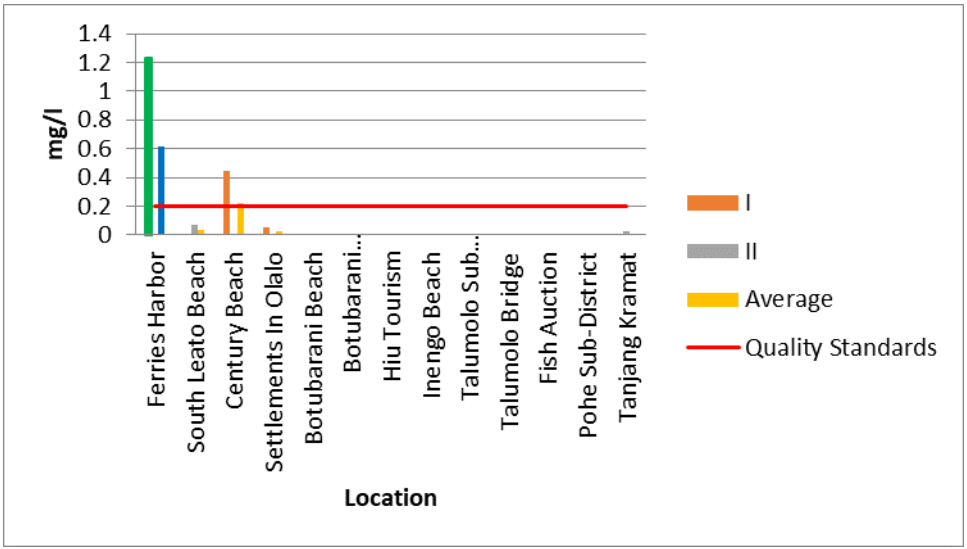

Figure 6. Iron Parameter Analysis Results

The results of iron parameter analysis in replication I ranged from 0-1.23 mg/l. There are 2 locations that are above the required quality standards, namely the Ferry Harbor and dug wells around Century Beach. In the second repetition, iron parameters ranged from 0 – 0.069 mg/l. There are 2 locations that are above the specified quality standard threshold. This must be processed first before being consumed by the public. Efforts to reduce well water with ceramic filters can reduce iron content by up to 95.20% (Febrina & Ayuna, 2014). According to Annisa et al. (2023) activated charcoal from sugar cane bagasse can be used as an adsorbent for ferrous metals. The maximum absorption rate was 99.81%, with a maximum contact time of 120 minutes and a minimum adsorbent amount of 2.5 grams. Research conducted by Najwa and Hendrasarie (2023) found that the use of Clay Ceramic Filter B2 with a base thickness of 1 cm is most effective in reducing Fe levels by 96.67% with a residence time of 4 hours.

Hardness Parameters

Naturally, hardness is more influenced by magnesium and calcium. Water hardness is closely related to the ability of water to form foam. Water around which there are carbonate rocks has a high hardness value. Soft, acidic waters have low calcium, magnesium, carbonate and sulfate contents. If soft water is heated, it will cause rust on the metal. The calcium, magnesium, carbonate, and sulfate contents are usually high in hard water. If heated, it will form a crust. Water classification based on Hardness Value is shown in Table 5. The results of the Hardness analysis in the coastal area of Gorontalo Bay are shown in Figure 5.

Table 5. Water Hardness Classification

Hardness	Water classification
< 50	Soft
50 – 150	Intermediate
150 – 300	Hard
>300	Very hard

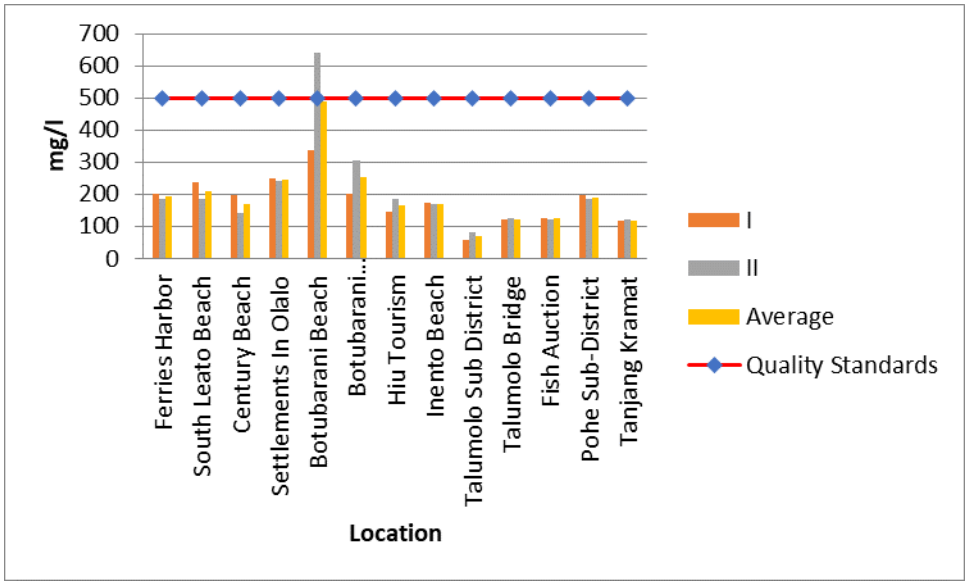

Figure 7. Results of Analysis of Hardness Parameters in the Gorontalo Bay Coastal Area

Based on the analysis results, the hardness value of well water in Replication I on the Gorontalo Bay Coast ranged from 171.58-335.13 - 335.13 mg/l CaCo3. In the second repetition, the Hardness parameters ranged from 79.88 - 639.88 mg/l CaCo3. Based on Table 4.9, the waters of Gorontalo Bay are in the hard category, and the Botubarani Beach location is in the Very Hard category. Water with a hardness of less than 120 mg/l CaCO3 and more than 500 is not good for domestic, agricultural, and industrial purposes (Effendi, 2003a). Water quality above 500 mg/l should be treated first before being used as a source of clean water or drinking water. The results of research conducted by Rosvita et al. (2019) show that hardness levels in well water in Clering Village in Jepara Regency show the same trend, ranging from 326-548 mg/l at location A and ranging from 627.5-898 mgl at location B and 642.5 – 989.9 mg/l at Location C. The same research conducted by Melati et al. (2022) in Cikeusal Kidul Village showed that the total hardness level did not meet the requirements in which the highest value was 843.33 mg/l and the lowest was 492 mg/l l. Hardness is one of the parameters regarding the quality of healthy water because hardness is a measure of water pollution by dissolved minerals such as Ca2+ and Mg 2+. Research carried out in Gegunung Kulon Village was 114 ppm, 102 ppm, and 163 ppm, respectively (Sulistyani et al., 2012). This result is lower than the results obtained in Gorontalo Bay. Hardness in water mostly comes from its contact with soil and rocks. Generally, hard water comes from areas where the soil layer is thick, and there is lime formation. Total hardness due to the presence of Ca and Mg ions together. High hardness can cause health problems. The cation exchange process can be used to remove the hardness (Widayat, 2002).

Factors that influence the condition of well water quality in Gorontalo Bay.

Microbiological Parameters

Rainwater that falls and seeps into the ground is called infiltration. Water that seeps into the ground will form springs and then into rivers and lakes. There are two categories of groundwater, namely shallow groundwater and deep groundwater.

Shallow groundwater ranges from 2 – 10 m. It is located between the waterproof layer and the ground surface. This water flow spreads over the clay layer. This groundwater is sandy and porous. This groundwater can also be taken directly through excavations known as dug wells or shallow drilling. This type of well is called a shallow well (Suyono & Budiman, 2016).

Deep groundwater has a water surface above 10 m. The well is filled with deep water wells. Ground water spreads in the aquifer layer. A rock that stores groundwater, consisting of a free aquifer and a confined aquifer is called an aquifer layer (Suyono & Budiman, 2016). Many factors influence the quality of well water in Gorontalo Bay. One of them is the distance between the well and the septic tank, community disposal patterns and the community's healthy lifestyle. The following is the distance between septic tanks and community dug wells as shown in Table 6.

Table 6. Distance between septic tanks and dug wells

Location	Distance between well and septic tank	Well Height to Ground Water Level	Well Ring Condition	Well Floor	Covered/ Uncovered Wells
Ferry Harbor	3	1	Good	Crack	Uncovered
South Leato Beach	3	0.8	Good	Good	Uncovered
Century Beach	3	0.7	Good	Good	Covered
Settlements In Olalo	3	3	Good	Good	Uncovered
Botubarani Beach	4	0.5	Good	Good	Covered
Botubarani Housing	11.5	0.55	Good	Good	Uncovered
Hiu Tourism	6	1.2	Good	Good	Uncovered
Inento Beach	7	1	Good	Good	Uncovered
Talumolo District	7	2	Crack	Not plastered	Covered
Talumolo Bridge	4	0.5	Good	Good	Covered
Fish auction	6	2.5	Good	Good	Covered
Pohe Sub- District	5	0.8	Many cracks	Many cracks	Uncovered
Tanjang Kramat	3	0.80	Good	Good	Uncovered

Indicators of polluted water are shown by changes in water quality caused by an increase in certain parameters above the established standards. Based on the analysis results, several parameters are above the quality standards, namely Iron, Hardness, E. coli and total coliform parameters. The high iron parameters are due to the natural conditions that water passes through. The high E. coli and total coliform parameters are because the distance between the well and the toilet is only between 3 -12 m.

The source of bacterial pollution can reach a distance of 11 meters in the direction of the groundwater source. For this reason, pumping wells or dug wells must be 11 meters away from sources of bacteriological pollution. Chemical parameter pollution can reach 95 meters in the direction of water flow. For this reason, the well must be 95 m away from sources of chemical pollution (Suyono & Budiman, 2016). Environmental conditions around community wells are shown in Table 7.

Table 7. Environmental conditions around the well and diseases suffered

No	Location	Distance between well and septic tank	Waste	Other pollutions	Diseases
1	Ferry Harbor	3	Abundant	None	Fever, Diarrhea, Cough
2	South Leato Beach	3	Abundant	Chicken Manure	Hypertension, gout, frequent diarrhea
3	Century Beach	3	None	Chicken Manure	Cough
4	Settlements In Ololalo	3	None	Goat manure	Cough, fever
5	Botubarani	4	Abundant	Chicken manure	There isn't any

	Beach				
6	Botubarani Housing	11.5	Scattered	None	Flu, Cough
7	Hiu tourism	6	Abundant	Mossy well	Heat and Cough
8	Inento Beach	7	None	None	Cough and flu
9	Talumolo (Peti kemas) District	7	Abundant	None	Cough, runny nose, diarrhea
10	Talumolo Bridge	4	None	None	Coughing, runny nose, fever. Diarrhea (not frequent)
11	Fish Auction (Before Pertamina)	6	None	None	Coughing, runny nose, fever
12	Pohe Hulontalangi District	5	None	None	Cough, Fever, Gout
13	Tanjang Kramat	3	None	Goat Manure	Cough and Heat

Chemical Parameters

Several other parameters such as DHL, salinity and TDS show that the groundwater condition has a brackish water status, which is that it has a salinity value from medium to high. Based on the results of the analysis of well water hardness values in Replication I on the Gorontalo Bay Coast, it ranges from 171.58-335.13 - 335.13 mg/ l CaCo3. For iron parameters, there are 2 locations that are above the required quality standard threshold, namely Ferry Harbor and dug wells around Century Beach. In the second replication, iron parameters ranged from 0 - 0.069 mg/l. Based on the analysis results, the hardness value of well water in Replication I on the Gorontalo Bay Coast ranged from 171.58-335.13 - 335.13 mg/l CaCo3. In the second repetition, the Hardness parameters ranged from 79.88 - 639.88 mg/l CaCo3. Based on Table 4.9, the waters of Gorontalo Bay are included in the Hard Water category. Generally, hard water comes from areas where the soil layer is thick, and there is lime formation. Total hardness due to the presence of Ca and Mg ions together.

The location of Botubarani Beach is in the Very hard category. Research conducted by Prabowo (2021) shows that well depth and well age significantly positively affect the water quality index (WQI) value. Older wells have better quality than younger wells. Wells that are still young are of worse quality. This is related to older wells lowering compounds, active ingredients and heavy metals that are deposited in the soil layers due to soil activity before use. The depth of the well is also related to the water quality index. The higher the depth of the well, the better the water quality because the lower the material content, the better the water quality. Conversely, the higher the material content, the worse the water quality.

Water Treatment

The aim of drinking water treatment is an effort to obtain clean and healthy water according to water quality standards. Basically, drinking water treatment can begin with water purification, reducing the levels of dissolved chemicals in the water to the recommended limits, eliminating pathogenic microbes, improving the pH, and separating dissolved gases that disturb aesthetics. The process of filtering (filtration) and deposition (sedimentation) can remove residues in water. The addition of coagulants is used to speed up the residue removal process. Thus, alum is a coagulant that is often used to purify water. To maximize the residue removal process, the coagulant should be dissolved in water before being put into the settling tank. Elimination of pathogenic microbes can be carried out using disinfectants. The disinfectants that are widely used are

chlorine and ozone. Generally, these disinfectant ingredients are oxidizing agents so they kill microbes. To find out the chlorine needs, the chlorine absorption capacity must be determined. Chlorine absorption capacity is the amount of active chlorine used by reducing compounds in water. Removal of dissolved gases in water using the aeration process. The aeration process can be useful for separating iron and manganese that are dissolved in water (Mulia, 2005; Samudro et al., 2012, Sulistyorini et al., 2016, Hartini et al., 2013).

CONCLUSION

The results of the water quality analysis on the Gorontalo Bay Coast are:

1. The results of the analysis show that there are 3 locations that do not meet the TDS parameters in the 2 sampling times. The analysis results at Botubarani Beach were 64.3 – 748 mg/l. Botubarani Beach Settlement 527 – 158 and Shark Tourism 12.5-769 mg/l. Quality standards require TDS < 300 mg/l. The results of the highest salinity analysis at 3 well water locations, namely Botubarani Beach, ranged from 0.03 - 0.96 ppt, Century Beach 0.39 -1.03 ppt. near auction 0.19-1.04 ppt. The three locations are in the brackish category because they are above 0.5 ppt, making them unsuitable for drinking water purposes. Furthermore, the conductivity parameter also exceeded the acceptable range for drinking water, which is 42–500 uS/cm. The first sampling showed values ranging from 63,000–97,100 uS/cm, while the second sampling ranged from 5,750–73,240 uS/cm, indicating that the water in these locations is not suitable as a drinking water source. The iron parameter results in the first repetition showed that 2 locations were above the threshold with a value of 1.23 mg/l and the Century Beach settlement was 0.45. Based on the analysis results, the hardness value of well water in Replication I on the Gorontalo Bay Coast ranged from 171.58-335.13 - 335.13 mg/l CaCo3. In the second repetition, the Hardness parameters ranged from 79.88 - 639.88 mg/l CaCo3. area total of 11 locations in Gorontalo Bay waters were categorized as hard , while two beach locations and the Botubarani Settlement were in the very hard category. Microbiological parameters for Total Coliform for the first repeat ranged from 4 – 105 CFU/100 ml to 0 -130 CFU/100 ml for the second repeat, which exceed the standard requirement of 0 bacteria. The E.coli test I ranged from 0 - 112 CFU/100 ml and II ranged from 1-150 CFU/100 ml. Locations failing to meet the E.coli requirements include settlements around Century Beach, Ololalo Beach, Botubarani Beach, Inengo and Pohe Beach.
2. Factors influencing water pollution in the Gorontalo Bay Area include the distance between the toilet location to the well, which ranges from 3 to 11.5 m, making the well water vulnerable to contamination. Moreover, the surrounding conditions contain significant amounts of chicken manures, rubbish, goat manures and mossy well floors. Diseases suffered by the community consist of coughs, flu and diarrhea. Another contributing factor is the wel's coastal location in Gorontalo Bay, where the water contains high levels of salt, requiring proper treatment before use.
3. Water treatment in wells in Gorontalo Bay includes filtration and sedimentation processes. To speed up the residue removal process, a coagulant need to be added. The coagulant material that is often used is alum. The disinfectant ingredients that are widely used are chlorine and ozone. Generally, these disinfectant ingredients are oxidizing agents, so they kill microbes, and the removal of dissolved gases in water uses the aeration process.

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REFERENCES

1. Annisa N, Muhammad, Masrullita, et al. Utilization of sugarcane bagasse waste as an adsorbent for metal and hardness absorption in well water. Chemical Engineering Journal Storage. 2023; 3(1):139-150.
2. Badu RR, Palilati AH, Sahabir BC, et al. Treatment of dug well water using filters with activated carbon to reduce pH and TDS parameters. Civetech. 2023; 45-53.
3. Badan Pusat Statistik (BPS) Kota Gorontalo. Statistics of Gorontalo City. BPS Kota Gorontalo. 2023.
4. Dappa E, Junias MS, Sahdan M. Sanitary inspection overview of dug wells with bacteriological content in the working area of Sikumana Health Center, Kupang City, 2022. Jurnal Sehat Rakyat. 2022; 2(1):23-32.
5. Dinas Kesehatan Kota Gorontalo [Health profile of Gorontalo City]. Profil kesehatan Kota Gorontalo [Health profile of Gorontalo City]. 2022.
6. Effendi H. Water quality review. Kanisius. 2003a.
7. Effendi H. Water quality review for water resource and environmental management. Kanisius. 2003b.
8. Ernawati NM, Restu IW. Physical and chemical parameters of Benoa Bay waters in Bali. Enggano. 2021; 6(1):25-36.
9. Farriya DRI, Yulianti L, Fianti. Analysis of physical properties of well water quality in Pasuruhan Kidul Kudus Village. Physics Communication. 2021; 5(1):23-26.
10. Febrina L, Ayuna A. Study of iron (Fe) and manganese (Mn) reduction in groundwater using ceramic filters. Teknologi. 2014; 7(1):35-44.
11. Hartini S, Sasanti AD, Taqwa FH. Water quality, survival rate, and growth of gabu fish (Canna striata) fingerlings reared in media with probiotic addition. Akuakultur Rawa Indonesia. 2013; 1(2):192-202.
12. Khasanah UKN, Ramli M. Study of biological parameters in the analysis of well water quality in Karakan Village, Weru District, Sukoharjo Regency. Proceeding Biologi Education Conference. 2022.
13. Khairunnas, Gusman M. Analysis of the influence of conductivity, resistivity, and TDS parameters on the salinity of shallow groundwater under high and low tide conditions in the coastal area of Padang City. Bina Tambang. 2016; 3(4):1751-1760.
14. Kuswiyanto. Bacteriology 2 (E. A. Mardella, Ed.). Buku Kedokteran EGC. 2017.
15. Melati L. R., et al. Determination of total well water hardness using complexometric method in Cikeusal Kidul Village, Brebes, Central Java. Jurnal Multidisiplin Madani (MUDIMA). 2022; 2(10):3628-3633.
16. Mulia R. M. Environmental health. Graha Ilmu. 2005.
17. Najwa I., et al. Manufacturing of clay ceramic filters to reduce manganese, iron, COD, and DO content in groundwater. Serambi Engineering. 2023; 8(3):6236-6242.
18. Nurhakim A., et al. Opportunities for groundwater utilization to support water resource sustainability in Parepare City. Teknik Hidro. 2022; 30-36.
19. Pamudjianto A., et al. Analysis of bore well water quality in Klasabi Subdistrict, Sorong Manoi District, Sorong City (Case study of KPR Victory Permata Sakti). Casuarina: Environmental Engineering Journal. 2023; 39-50.
20. Prabowo R., et al. Water quality index of well water in the converted agricultural land. Jurnal Pendidikan IPA Indonesia. 2021; 10(4):560-570.
21. Pramesti A., et al. Treatment of colored dug well water using a combination of aeration, coagulation, and filtration systems. Jurnal Teknologi Lingkungan Lahan Basah. 2023; 11(2):380-386.
22. Samudro S., et al. Water quality analysis and pollution control strategies for Blukar River in Kendal Regency. Media Komunikasi dan Pengembangan Teknik Lingkungan. 2012; 9(2):64-71.
23. Sika P. N. K. D. Relationship between physical condition of dug wells and bacteriological quality of dug well water in Anturan Village, Buleleng District, Buleleng Regency. Poltekes Denpasar. 2023.

24. Suyono, et al. Public health science in the context of environmental health. (M. Ester, Ed.). Penerbit Buku Kedokteran EGC. 2016.
25. Widayat W. Hard water treatment technology. Teknologi Lingkungan. 2002; 3(3):256-266.

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