

Analysis of Shallow Groundwater Quality for Domestic Use by the Community in Anggalomelai Village, Abeli District, Kendari City

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Abstract

Seawater intrusion is a groundwater problem in coastal areas because it can directly affect groundwater quality, resulting in an impact on the quality and quantity of the groundwater itself. Groundwater that was originally suitable for drinking has decreased in quality and is no longer suitable for daily use. This study aims to determine the quality status of shallow groundwater in Anggalomelai Village, Abeli District, Kendari City, using the Pollution Index Method as stipulated in the Decree of the Minister of Environment of the Republic of Indonesia Number 115 of 2003 concerning Guidelines for Determining Water Quality Status. Samples were taken at three different locations in Anggalomelai Village, then tested for parameters such as temperature, Total Dissolved Solids (TDS), Electrical Conductivity, Potential Hydrogen (pH), chloride, sodium, salinity, and E. coli. This research method refers to the quality standards set out in Government Regulation of the Republic of Indonesia Number 22 of 2021 concerning the Implementation of Environmental Protection and Management. The results showed that Sampling Point I was categorized as meeting quality standards with a Pollution Index value of 0.439 and a good status, while Sampling Point II was also categorized as meeting quality standards with a Pollution Index value of 0.283 and a good status. Sampling Point III falls into the category of meeting quality standards with a Pollution Index value of 0.597 with a good status. The conclusion of this study is that the quality status of shallow groundwater in Anggalomelai Village is classified as good.

Keywords: Groundwater, Pollution Index, Quality Status, Saltwater Intrusion.



INTRODUCTION

Kendari City is a city located in the southeastern part of Sulawesi Island with an area of 271.76 km² or 0.7% of the land area of Southeast Sulawesi Province. Currently, Kendari City is undergoing rapid development. This can be seen from the rapid and concentrated growth of settlements and economic areas in the coastal area of Kendari Bay .

Hydrologically, the main water resources for the people of Kendari City in meeting their domestic and industrial needs come from groundwater, both shallow groundwater obtained from dug wells and deep groundwater from bore wells. Water is fundamental to all human biological activities (Djana, 2023). Groundwater, as water that is located and originates from soil or rock layers below the ground surface, has become a source of use for the community (Sulpiana *et al.*, 2023). Groundwater will become a problem if it is overexploited, especially if the exploited area is close to the sea (Irham *et al.*, 2022).

Seawater intrusion is a common phenomenon on small islands and coastal areas where groundwater is absorbed by seawater. It can occur naturally or artificially due to groundwater being frequently extracted for community needs and other purposes without proper control (Baiki *et al.*, 2024). Seawater intrusion can be influenced by various factors, both natural and anthropogenic, such as excessive groundwater extraction and anthropogenic activities in coastal areas .

The distribution of seawater intrusion into shallow groundwater in Kendari City in 2019, analysis results show that there were 26 samples or 26.26% of high intrusion areas spread across several sub-districts, namely part of Abeli Sub-district, part of Mandonga Sub-district, Kendari Sub-district, and West Kendari Sub-district (Kete *et al.*, 2020). Anggalomelai is a village in Abeli District that has been observed to have experienced a decline in groundwater quality and seawater intrusion. Seawater intrusion is the natural entry or seepage of seawater into the pores of rocks in coastal aquifers, causing groundwater quality to degrade (Arliska *et al.*, 2022).

Water quality is the condition and physical, chemical, and biological properties of water compared to the standards of suitability for specific requirements (Koniyo, 2020). Therefore, this study needs to be conducted with the aim of determining the quality status of shallow groundwater from community dug wells in Anggalomelai Village, Abeli Subdistrict , Kendari City, which is used to meet domestic needs based on physical, chemical, and microbiological parameters.





RESEARCH METHOD

Place and Time of Research

This research was conducted in Anggalomelai Village, Abeli District, Kendari City, geographically located at coordinates 03°59'52.82" S and 122 ° 35'22.52" E. Sample testing was conducted at the Biomolecular and Environmental Laboratory of the Faculty of Mathematics and Natural Sciences, Halu Oleo University, the Physical Chemistry Laboratory of the Faculty of Mathematics and Natural Sciences, Halu Oleo University, and the Integrated Laboratory of Halu Oleo University. This research was conducted from March to May 2025.

Materials and Equipment

The materials used in this study were water samples from Sampling Point I, Sampling Point II, and Sampling Point III. The equipment used in this study included a water quality tester, water sampler, sample bottles, camera, writing instruments, Microsoft Excel, ArcGIS, Global Positioning System (GPS), aluminum foil, and an ice cool box.

Research Samples

A sample is a portion of the number and characteristics possessed by the population, or a small part of the population members taken according to certain procedures so that it can represent the population (Siyoto and Sodik, 2015). The sample in this study is shallow groundwater in Anggalomelai Village, which consists of three sampling points. The placement of the three sampling points was based on points that were considered to be representative of the research in Anggalomelai Village, including: Sampling Point I, which is the point closest to the coastline; Sampling Point II, which is located in the middle; and Sampling Point III, which is the point furthest from the coastline.

RESULTS AND DISCUSSION

The test results at Sampling Point I showed that all parameters met the quality standards set in Class 1 of Government Regulation of the Republic of Indonesia Number 22 of 2021, which stipulates that the water can be used as raw water for drinking. At this point, water from dug wells is used to meet domestic needs such as bathing, washing, and cooking. The test results for the parameters at Sampling Point I are presented in Table 5.1.



Table 5.1. Analysis Results of Parameters at Sampling Point I

Parameter	Unit	Class 1 Quality Standards of Government Regulation Number 22 of 2021	Analysis Results	Information
Physics				
Temperature	°C	Deviation 3	1,21	Meets Quality Standards
TDS	mg/L	1.000	385	Meets Quality Standards
Electrical Conductivity	µS/cm	1.000	755	Meets Quality Standards
Chemistry				
pH	-	6-9	6,93	Meets Quality Standards
Chloride	mg/L	300	0,032	Meets Quality Standards
Sodium	mg/L	200	18,54	Meets Quality Standards
Salinity	‰	0,5	0,3	Meets Quality Standards
Microbiology				
E. coli	CFU/100 ml	0	Negative	Meets Quality Standards

Source: Primary data, processed 2025

Test results at Sampling Point II show that all parameters meet the quality standards set in Class 1 Quality Standards of Government Regulation of the Republic of Indonesia Number 22 of 2021, which stipulates that the water can be used as raw water for drinking. At this point, water from dug wells is used to meet domestic needs such as bathing, washing, and cooking. Test results for parameters at Sampling Point I are presented in Table 5.2.

Table 5.2. Analysis Results of Parameters at Sampling Point II

Parameter	Unit	Class 1 Quality Standards of Government Regulation Number 22 of 2021	Analysis Results	Information
Physics				
Temperature	°C	Deviation 3	1,33	Meets Quality Standards
TDS	mg/l	1.000	235	Meets Quality Standards

Electrical Conductivity	$\mu\text{S}/\text{cm}$	1.000	468	Meets Quality Standards
Chemistry				
pH	-	6-9	7,09	Meets Quality Standards
Chloride	mg/l	300	0,017	Meets Quality Standards
Sodium	mg/l	200	8,82	Meets Quality Standards
Salinity	‰	0,5	0,2	Meets Quality Standards
Microbiology				
<i>E. coli</i>	CFU/ 100 ml	0	Negative	Meets Quality Standards

Source: Primary data, processed 2025

Test results at Sampling Point III show parameters that do not meet the quality standards set in Class 1 Quality Standards of Government Regulation of the Republic of Indonesia Number 22 of 2021, which stipulates that the water can be used as raw water for drinking. Water from dug wells is used to meet domestic needs such as bathing, washing, and cooking. Test results for parameters at Sampling Point I are presented in Table 5.3.

Table 5.3. Analysis Results of Parameters at Sampling Point III

Parameter	Unit	Class 1 Quality Standards of Government Regulation Number 22 of 2021	Analysis Results	Information
Physics				
Temperature	$^{\circ}\text{C}$	Deviation 3	0,85	Meets Quality Standards
TDS	mg/l	1.000	91	Meets Quality Standards
Electrical Conductivity	mg/l	1.000	178	Meets Quality Standards
Chemistry				
pH	-	6-9	5,85	Does not Meet Quality Standard
Chloride	mg/l	300	0,03	Meets Quality Standards
Sodium	mg/l	200	16,1	Meets Quality Standards
Salinity	mg/l	0,5	0,2	Meets Quality Standards
Microbiology				

<i>E. coli</i>	CFU/ 100 ml	0	Positive	Does not Meet Quality Standard
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Source: Primary data, processed 2025

Table 5.4. Shallow Groundwater Pollution Index in Anggalomelai Village

Research Location Station	Pollution Index	Quality Status
Sampling Point I	0,439	Meets Quality Standards
Sampling Point II	0,283	Meets Quality Standards
Sampling Point III	0,597	Meets Quality Standards

Source: Primary data, processed 2025

Based on Table 5.4, it is known that the values of the shallow groundwater pollution index in Anggalomelai Village at Sampling Point I, Sampling Point II, and Sampling Point III are as follows: at Sampling Point I, the pollution index value obtained was 0.439, then at Sampling Point II, a Pollution Index value of 0.283 was obtained, and at Sampling Point III, a Pollution Index value of 0.597 was obtained. In accordance with the Decree of the Minister of Environment No. 115 of 2003, the quality of shallow groundwater in Anggalomelai Village at the three sampling points was classified as meeting quality standards with a good status.

1. Shallow Groundwater Quality in Anggalomelai Village

Water is a natural resource that is indispensable and has many benefits for human life. Ideal clean water must be clear, colorless, tasteless, and odorless, and must not contain pathogenic germs or any organisms that are harmful to human health (Singkam *et al.*, 2021). Groundwater is the main source of water for daily needs and has many advantages over other water resources (Mairizki *et al.*, 2023). The community in Anggalomelai Village uses shallow groundwater (dug wells) to meet domestic needs such as bathing, washing, and cooking. Water quality is a condition that must be controlled because it is one of the main and important factors in water resource management (Arif, 2020). In line with population growth and increased community and industrial activities, there have been changes in environmental functions. This has a negative impact on the sustainability of water resources, as indicated by the increasing damage to water (Setyowati, 2015).



This research was conducted from March to May 2025 through several stages. The first stage was to determine the sampling points, and three sampling points were obtained. The next stage was to collect shallow groundwater samples at the three predetermined points, namely Sampling Point I, Sampling Point II, and Sampling Point III. The next stage was to test the samples in the laboratory. The method used in this study was the Pollution Index Method as stipulated in the Decree of the Minister of Environment Number 115 of 2003 concerning Guidelines for Determining Water Quality Status. This study refers to quality standards class 1 Government Regulation of the Republic of Indonesia Number 22 of 2021 concerning the Implementation of Environmental Protection and Management, by comparing each result of the tested parameters with the established quality standards. The results of this parameter analysis will be compared and adjusted to the predetermined quality standards (Sulistyorini *et al.*, 2016).

2. Groundwater Quality Status of Anggalomelai Village

The results of the analysis of shallow groundwater samples from Anggalomelai Village, conducted based on physical, chemical, and microbiological parameters, which were then compared with the quality standards of Class 1 of Government Regulation of the Republic of Indonesia Number 22 of 2021 concerning the Implementation of Environmental Protection and Management and analyzed using the Pollution Index method in accordance with the provisions of the Decree of the Minister of Environment Number 115 of 2003 to determine the quality status of shallow groundwater in Anggalomelai Village. Water quality management based on the Pollution Index can provide input to decision makers so that they can assess the quality of water bodies for a particular purpose and take action to improve quality due to the presence of pollutants. The classification of the shallow groundwater quality status in Anggalomelai Village is based on the provisions of the Decree of the Minister of Environment No. 115 of 2003 by evaluating the river water quality status. A Pollution Index of less than 1.0 meets the quality standards (good condition), Pollution Index 1 - 5.0 is slightly polluted, Pollution Index 5 - 10 is moderately polluted, and Pollution Index above 10 is heavily polluted.

Based on the results of the Pollution Index analysis of shallow groundwater quality (dug wells) in Anggalomelai Village, varying values were obtained at each observation point. At Sampling Point I, the Pollution Index value of 0.439 indicates that the water quality is in the category of meeting quality standards with a good status, as stipulated in the Decree of the Minister of Environment No. 115 of 2003. This reflects that the groundwater condition at Sampling Point I is still relatively safe and suitable for use, with no parameters that do not meet quality standards.





Sampling Point II obtained a Pollution Index value of 0.283. Based on the Decree of the Minister of Environment No. 115 of 2003, Sampling Point II is classified as meeting quality standards and in good condition. The condition of shallow groundwater (dug wells) at Sampling Point II is classified as good because no parameters exceed quality standards. The absence of parameters exceeding quality standards at this point is believed to be closely related to the natural condition of the surrounding environment and the presence of dense vegetation, which provides protection against potential contamination of shallow groundwater.

In contrast to Sampling Point III, where a Pollution Index value of 0.597 was obtained. Although in terms of pollution index, Sampling Point III is still classified as meeting quality standards and in good condition, two parameters were found to exceed the established quality standards, namely Potential Hydrogen (pH) and the presence of *Escherichia coli* (*E. coli*) bacteria. The high values of these two parameters are most likely caused by the location of the dug well, which is close to a septic tank and chicken coop, thereby increasing the risk of biological and chemical contamination through the infiltration of domestic waste into shallow groundwater. Therefore, although the groundwater quality at Sampling Point III is generally still classified as good based on the pollution index, preventive measures need to be taken to minimize the risk of more serious contamination in the future.

CONCLUSION

Conclusion

The conclusion drawn from the results of this study is that the water quality at Sampling Point I and Sampling Point II meets the quality standards for all parameters analyzed. Meanwhile, at Sampling Point III, two parameters were found to not meet quality standards, namely the pH parameter and the presence of *E. coli* bacteria. The results of the analysis of the quality status of shallow groundwater in Anggalomelai Village, Abeli District, Kendari City, using the Pollution Index method, show that Sampling Point I meets quality standards with a pollution index value of 0.439 with a good status, at Sampling Point II, the pollution index value was 0.283 with a good status, and the pollution index value at Sampling Point III was 0.597 with a good status.

Recommendation

Seawater intrusion is a groundwater problem in coastal areas because it directly affects groundwater quality. Groundwater that was originally suitable for drinking has decreased in quality and is no longer suitable for daily use. To maintain the sustainability of groundwater





resources due to seawater intrusion, groundwater conservation efforts are needed, both vegetative and mechanical. Vegetative groundwater conservation can be done by planting mangrove forests around Kendari Bay to slow down the rate of seawater entering the land, while mechanical groundwater conservation can be done by limiting the use of groundwater for both domestic and non-domestic purposes.

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