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Groundwater Quality Analysis Based on Physical Properties of The Gunungtiga and Surrounding Areas

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Abstrak

Daerah Gunungtiga belum pernah diteliti kualitas air tanahnya, selain itu juga terdapat keluhan dari warga tentang kualitas air tanah, hal ini menjadi dasar pemilihan lokasi penelitian. Penelitian ini bertujuan untuk menganalisis kualitas air tanah di Derah Gunungtiga, Provinsi Lampung. Metode yang digunakan adalah pendekatan kuantitatif,penelitian dilakukan dengan cara pemetaan muka air tanah untuk mengetahui ketinggian serta estimasi daerah recharge, dan pengambilan data parameter sifat fisik air tanah meliputi warna, rasa, bau, suhu, pH, TDS, dan EC. Pendekatan berdasar sifat fisik dilakukan karena relatif murah dan mudah untuk diamati, selain itu pengambilan data juga dapat dilakukan insitu. Data parameter sifat fisik kemudian diperiksa apakah sudah memenuhi standar baku mutu berdasarkan Permenkes RI No. 492 Tahun 2010. Hasil pengamatan pada 14 titik menghasilkan bahwa tinggi muka air tanah relatif mendangkal ke arah barat atau kearah dengan topografi lebih tinggi, sehingga diinterpretasikan sebagai daerah recharge dan mengalir kea rah timur yang memiliki topografi lebih rendah. Sifat fisik air tanah pada daerah penelitian tidak memiliki rasa, bau, dan warna. Nilai EC dengan rentang 188,07-1066,82 µs/cm, termasuk ke dalam air tawar, pH pada rentang 5,41-7,5, suhu berkisar antara 27,2-29,7 0C, dan rentang nilai TDS 94,04-542,91 mg/l. Dari 14 titik pengamatan, hanya 1 lokasi yang memenuhi standar baku mutu, yaitu pada 22/DP/02. Berdasarkan hasil penelitian, maka disimpulkan bahwa dibutuhkan perlakuan terlebih dahulu sebelum air tanah dapat digunakan, salah satunya adalah penyaringan.

Kata kunci: *Kualitas Air Tanah, Sifat Fisik, Kualitas Air*

Abstract

Gunungtiga area has never been studied for the quality of groundwater, and residents have also complained about the quality of groundwater, these became the basis for selecting the research location. This study aims to analyze groundwater quality in the Gunungtiga Region, Lampung Province. Quantitative approached was used for this research, it was carried out by mapping the groundwater level to estimate the recharge area and collecting data on parameters of the physical properties of groundwater, including color, taste, odor, temperature, pH, TDS, and EC. The physical properties approach was selected because it is relatively cheap and easy to observe, the data collection can also be done in situ. The physical property parameter data is then checked based on the Republic of Indonesia Minister of Health Regulation No. 492 of 2010. The observations at 14 points showed that the groundwater level in the research area is relatively shallow towards the west or in the direction with higher topography, so it can be interpreted as a recharge area, and it flowed towards the east area which has lower topography. The physical properties of the groundwater had no taste, odor, or color. The EC value ranges from 188.07 to 1066.82 µs/cm, including fresh water, the pH ranges from 5.41 to 7.5, the temperature ranges from 27.2 to 29.7 0C, and the TDS value ranges from 94. 04-542.91 mg/l. Of the 14 observation points, only 1 location met the quality standards, namely 22/DP/02. Treatment is required before groundwater can be used, such as filtering.

Keywords: Ground Water Quality; Physical Properties; Water Quality

1. INTRODUCTION

The Gunungtiga area, Pugung District, Tanggamus Regency, Lampung Province, has never been studied about the groundwater quality; this is the basis for the research at this location. In general, the regional geology condition of the study area is composed of crystalline rocks in the form of diorite and granite as part of Tmgr formation, along with schist, and marble from Pzg formation. Given this condition, so hydrogeological the rocks on research area do not have primary porosity. Porosity that develops in the research area is

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secondary porosity, which is formed due to fractures in rocks due to the influence of geological structures. Water that trapped in the crystalline rocks that rich in minerals, could affect the water quality due to dissolving process of the minerals (Roques et al., 2014; Snæbjörnsdóttir et al., 2020; Walter et al., 2017). The Gunungtiga location is one of the locations where field lecture activities are carried out for several study programs in ITERA. During the implementation of activities in this area, the author also received reports from the surrounding community regarding water quality complaints; in several areas, there were sediment deposits and skin diseases that attacked residents. This research is expected to determine whether the existing water conditions meet the recommended standards for meeting daily needs. The research location can be observed in Figure 1.

Groundwater is an important and strategic natural resource in meeting humans' need for clean water, either directly or through utilization in various sectors such as agriculture, plantations, industry, and others (Abdullahi et al., 2023; Ahmad & Al-Ghouti, 2020; Ikhwali et al., 2022). Groundwater, which is only 0.6% of the total water sources on earth, is still the main source of clean water. The groundwater table/level is an estimate of the surface water elevation in wells that only seep a short distance to the water saturated zone. The water level elevation in the well is closely related to the ground water level, this is if the ground water flows horizontally (Arifianto, 2017; T. Prayogo, 2014). It is due to the presence of groundwater below the surface, so it is considered that layers of rock/soil can function as filters and can protect the water from surface contamination and maintaining its quality (Abdel-Shafy & Kamel, 2016; Çadraku et al., 2016; Sandeep et al., 2023). The quality of groundwater that is used for drinking, industrial, agriculture, and other domestic needs, has a close relationship with the quality of human health; therefore, a method is needed to be able to identify and evaluate the quality of groundwater, one of which is through an analysis of physical properties in the form of color, taste, odor, temperature, pH, and others (Ahmed et al., 2020; Alshehri et al., 2023; Jha et al., 2020). Groundwater quality degradation can be caused by two things, and it is quite hard to separate between the geogenic and anthropogenic (Pant et al., 2021; Sadat-Noori et al., 2014). The condition of the geological material passed by groundwater and the length of contact with a material will greatly affect the quality of the groundwater (Cohen et al., 2022; Hwang et al., 2015). The type of rock in an aquifer plays an important role in the quality of groundwater, the more dissolved minerals in the groundwater, the higher the Total Dissolved Solid (TDS) value (Motlagh, 2022; Onyancha & Nyamai, 2014; Sarikhani et al., 2015).

The main objective of this study was to evaluate the quality of groundwater in the Gunungtiga area, Pugung District, Tanggamus Regency, Lampung Province. By conducting this research, we hope to provide a deeper understanding of the quality of groundwater in the Gunungtiga area and whether the water quality meets the recommended standards for use in daily life. The results of this study are expected to provide important information to local governments, related institutions, and surrounding communities regarding the status of their groundwater quality. In addition, this study is also expected to provide an overview of the hydrogeological conditions of this area, which are useful in protecting groundwater quality from surface pollution.

2. METHODS

The research was conducted using quantitative approach by doing measurement on each parameter for defining the groundwater condition of research area. This method was selected in order to grasp the actual field condition, because no sampling was done for research purpose before and no secondary data or publication that can be used for analysis. Ground water condition consist of the groundwater level and its physical properties. Physical properties approached were chosen due to its measurement can be done in situ and relatively cheap and easy (Mairizki et al., 2020; Wiyono & Adji, 2021).

The data was collected using groundwater level mapping and physical properties test. Groundwater level mapping was carried out by collecting primary data namely the depth of dug wells/shallow wells around the research area. Sampling location then recorded using Global Positioning System (GPS) in order to know the exact location and elevation. This data then processed to produce a map of the depth of groundwater level in the research area. Physical properties test was also done along with the groundwater level mapping, the sample was tested using EZ-9909 5 in 1 water quality tester for acid content (pH), Total Dissolved Solid (TDS), Electric Conductivity (EC), and temperature (^{0}C). Direct observation was done for color, taste, and odor of the water.

The analysis was conducted by comparing data in accordance with the Regulation of the Minister of Health of the Republic of Indonesia No. 492 of 2010 concerning Clean Water Quality Requirements which can be seen in Table 1. Characteristics of each parameter was also compared to related research, in order to give further understanding of research area.

Table 1. Clean Water Quality Requirements

No.	Parameter	Unit	Requirements
1	Color		Colorless
2	Taste		Tasteless
3	Odor		Odorless
4	TDS	mg/l	500
5	pH		6.5-8.5
6	Temperature	^{0}C	Air temperature $\pm$ 3

(Republic of Indonesia Minister of Health Regulation No. 492 of 2010)

3. RESULTS AND DISCUSSION

Result

Based on the results of groundwater level mapping at 14 points in the study area, it was found that the groundwater table was relatively shallow to the west of the study area or to a higher and deeper topography to the east presented in Figure 1. It can also be interpreted that the recharge area is in a west direction which has a higher topography and flows eastward in a lower topography. When measuring the groundwater level, geological data is also collected. In general, the study area is composed of crystalline rock in the form of weathered diorite on the surface. Diorite is exposed to the surface due to uplift which is influenced by the structure of the Great Sumatran Fault. The effect of this structure is not only to expose or uplift diorite, but also to form secondary porosity. In crystalline rocks, weathering and structural influences can produce secondary porosity which functions as a pathway and a place for groundwater to accumulate (Mondal, 2021; W. Prayogo et al., 2021).

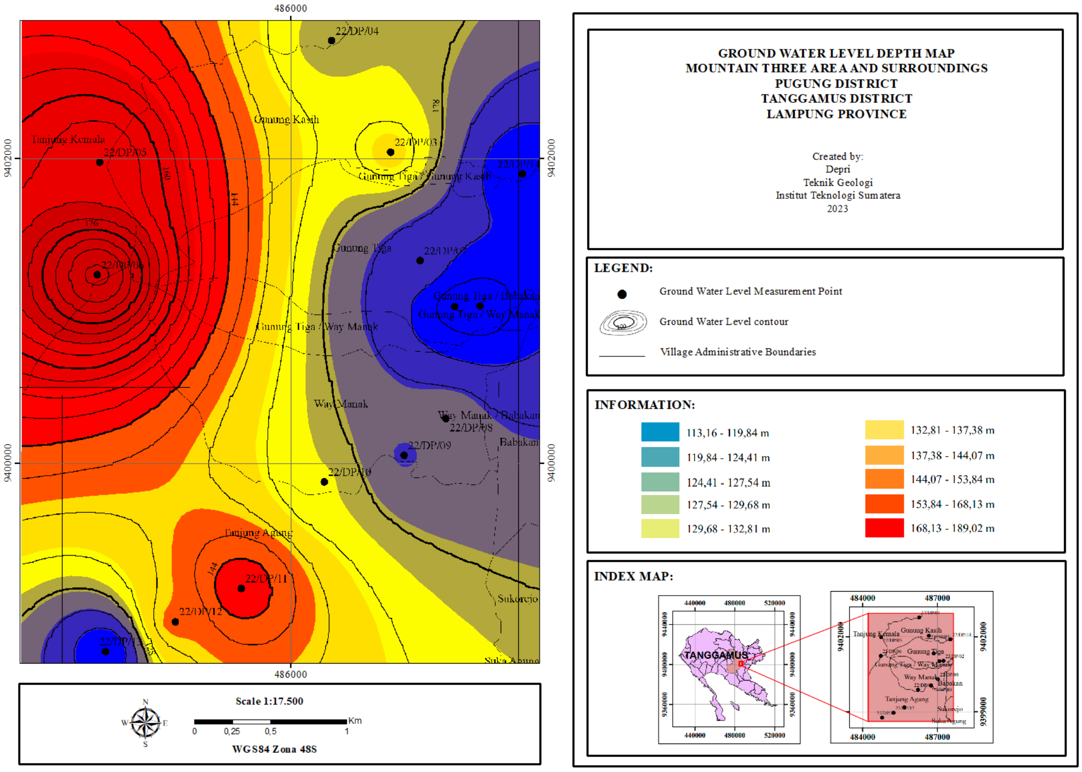

Figure 1. Groundwater Level Map of Research Area

The results of measurements of the physical properties of groundwater carried out at 14 observation points can be seen in Table 2. Based on the color, odor, and taste parameters, all observation points did not show poor quality because they were all colorless, odorless, or tasteless. The type of water from the EC value is Fresh Water because all of them show values below 1200 µs/cm according to Table 3, this classification was carried out by previous research (Mairizki et al., 2020; Wiyono & Adji, 2021); a map of the distribution of EC values in the research area can be seen in Figure 2. The temperature in the research area shows that 6 observation locations are above the standard quality; The temperature value is related to the depth of the groundwater level and is directly proportional; The deeper the groundwater level, the higher the temperature as presented in Figure 3. Temperature also play an important role in chemical reaction that was done in the water (Cai et al., 2018; Purwono et al., 2019). In the study area, there are several anomalous points where temperature is inversely proportional to depth (22/DP/07, 22/DP/08, 22/DP/10, and 22/DP/14); this is suspected to be caused by land cover factors, the more vegetation that covers the land, the lower the land surface temperature will be. Previous research was carried out to look at the correlation between groundwater temperature and land surface temperature, and found that these two parameters were also directly proportional (Kurylyk et al., 2019; Menberg et al., 2014).

Table 2. Data on Physical Properties of Ground Water in the Research Area

Sample	Color	Flavor	Odor	Temperature (^{0}C)	TDS (mg/l)	EC (µs/cm)	pH
22/DP/01	Colorless	Tasteless	Odorless	27.5	406	780	5.96
22/DP/02	Colorless	Tasteless	Odorless	27.2	465	917	6.75
22/DP/03	Colorless	Tasteless	Odorless	29.1	543	1067	6.35
22/DP/04	Colorless	Tasteless	Odorless	28.6	119	235	5.88
22/DP/05	Colorless	Tasteless	Odorless	29.1	174	362	7.08

Sample	**Color**	**Flavor**	**Odor**	**Temperature (^{0}C)**	**TDS (mg/l)**	**EC (µs/cm)**	**pH**
22/DP/06	Colorless	Tasteless	Odorless	29	161	320	7.5
22/DP/07	Colorless	Tasteless	Odorless	29.7	286	566	5.7
22/DP/08	Colorless	Tasteless	Odorless	29.5	270	536	7.23
22/DP/09	Colorless	Tasteless	Odorless	27.7	350	698	6.02
22/DP/10	Colorless	Tasteless	Odorless	27.2	154	308	5.41
22/DP/11	Colorless	Tasteless	Odorless	27.6	163	325	5.83
22/DP/12	Colorless	Tasteless	Odorless	28.1	123	246	6.17
22/DP/13	Colorless	Tasteless	Odorless	27.4	94	188	5.97
22/DP/14	Colorless	Tasteless	Odorless	29	139	277	6.11

(RI Minister of Health Regulation No. 492 of 2010)

* The orange color indicates values that exceed quality standard based on Clean Water Quality Standards

Table 3. Groundwater Salinity Classification Based on EC

No.	**Electric Conductivity**	**Groundwater Salinity Classification**
1	< 1200	*Fresh water*
2	1200-2500	*Brackish water*
3	2500-4500	*Saline water*
4	> 4500	*Brine water*

(Santosa, 2010, in Wiyono & Adji, 2021)

The pH in the study area showed relatively more acid values in northeast to southwest and neutral to alkaline in west to northwest presented in Figure 4. Of the 14 observation points, only 4 had values following quality standards. The pH value in the study area is interpreted to be influenced by anthropogenic factors in the form of waste, which can cause the pH to become more alkaline. The acidic pH content in the study area is thought to be caused by the minerals and rocks composition, higher dissolved silica content means more acidic pH and vice versa for lower dissolved silica content (Pradeep et al., 2016).

TDS value in the research area shows that only one point has a value above the quality standard, namely point 22/DP/03. Several things that can cause high TDS values are anthropogenic factors and the reaction of groundwater with the rocks and minerals it passes through (Bhunia et al., 2018; Sadat-Noori et al., 2014). The TDS value of the study area shows the same pattern as the EC value presented in Figure 5; generally, the two have a directly proportional relationship but are still affected by dissolved ion activity and ionic strength. Groundwater temperature can also affect EC and TDS values. This is because high groundwater temperatures can dissolve more minerals from the surrounding rocks and increase TDS and EC values, but this depends on the characteristics of the rocks, or the ions present in the rocks that are traversed by the groundwater (Loh et al., 2016; Ram et al., 2021).

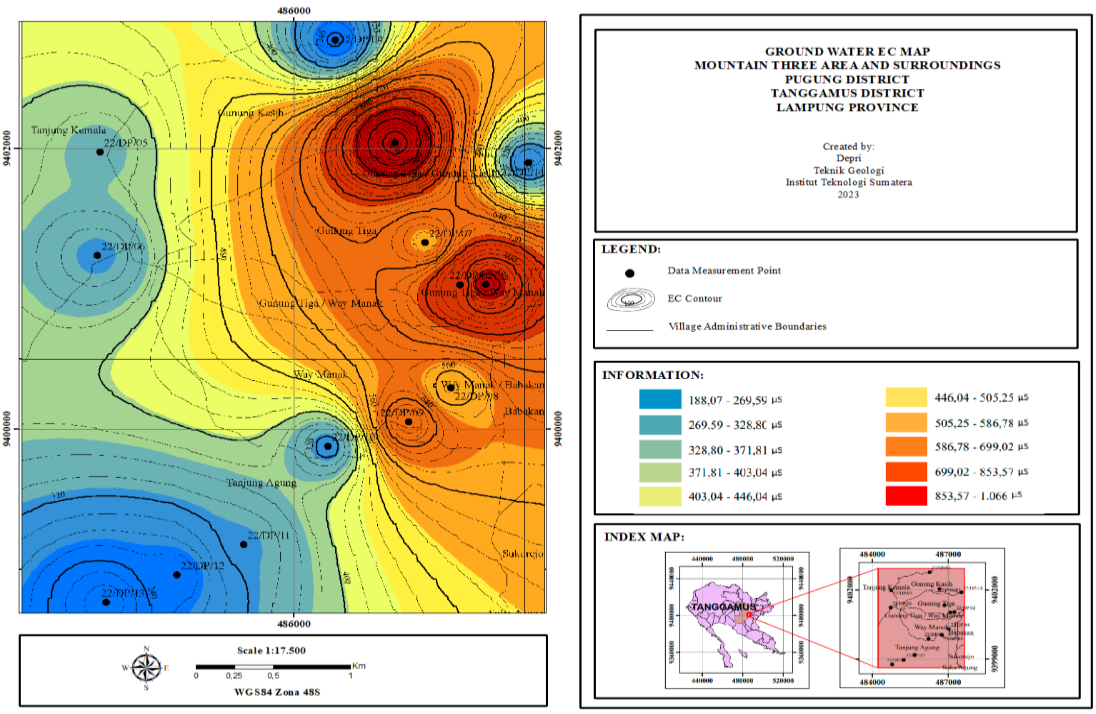

Figure 2. Groundwater EC Map of Research Area

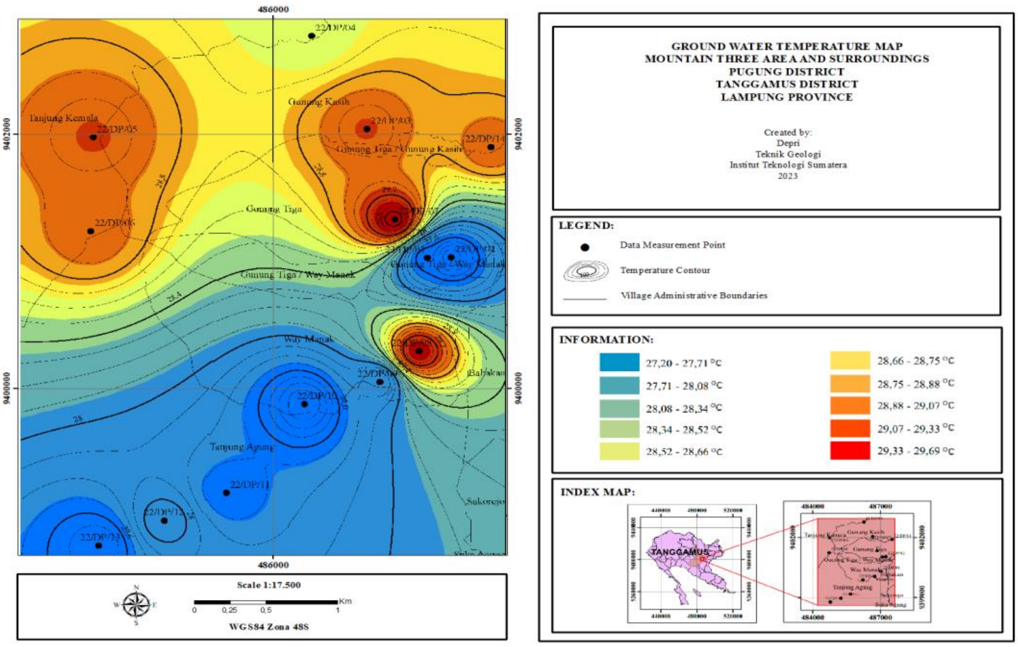

Figure 3. Groundwater Temperature Map of Study Area.

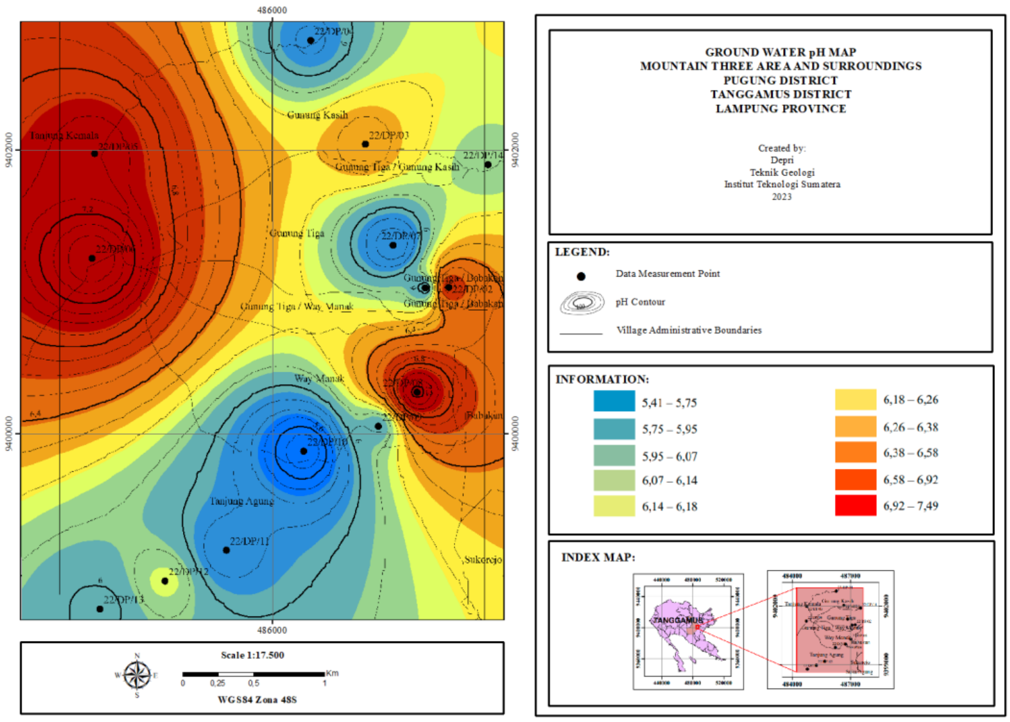

Figure 4. Groundwater pH Map of Research Area

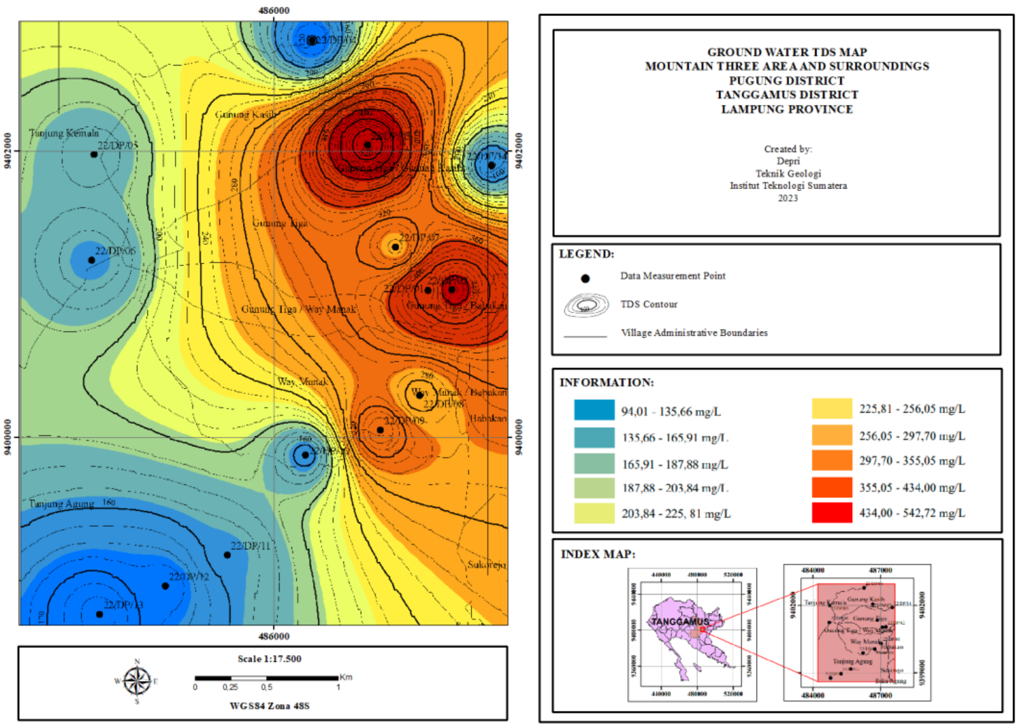

Figure 5. Groundwater TDS Map of Study Area.

Based on all the physical property parameters obtained in the research area, the observation point/location with quality standards according to the Republic of Indonesia Minister of Health Regulation Number 492 of 2010 is 22/DP/02. The people of Gunungtiga and its surroundings are advised to carry out prior filtering or certain treatments to improve the quality of groundwater so that it is suitable for use. Further research is needed regarding the chemical properties of groundwater in the research area to produce a more comprehensive analysis.

Discussion

The results of this study provide deeper insight into the factors that affect groundwater quality in areas with specific geological formations. This understanding can help in groundwater resource management planning. The results of this study can be used to provide recommendations related to the development of water sources in the research area. Point 22/DP/02, which meets quality standards, can be considered a suitable source of water for use. While other points may require treatment or filtration measures so that the water meets drinking water quality standards. This study was conducted with 14 observation points. While this provides initial insight into the groundwater quality in the study area, the limited number of locations may not cover all of the geological and hydrogeological diversity in the area. This research mainly focuses on the physical properties of groundwater, such as color, smell, taste, EC, temperature, pH, and TDS. Further research can expand the scope to consider more detailed chemical parameters. Future research may expand the number of observation sites to understand the greater diversity in groundwater quality in the study area. Further research may consider more detailed chemical parameters to get a more complete picture of groundwater quality.

4. CONCLUSION

The groundwater table shows shallowing in the western area of the study, which has a higher topography; this area is identified as a recharge area. The physical properties of water based on 14 observation points show that the study area has no color, taste, or odor, has EC values in the range of 188.07-1066.82 µs/cm, classified as fresh water, pH in the range of 5.41-7.5, the temperature ranges from 27.2-29.7 ^{0}C, and the TDS value ranges from 94.04-542.91 mg/l. Based on physical properties, the point that meets the quality standards is only 22/DP/02. This means that other sampling locations, need to have a water treatment before being used. One of the recommendations that can be given is by filtering the water.

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