A geoelectrical study of aquifers in the Natar Region, South Lampung

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Article Information:

Received:
18 August 2022

Received in revised form:
28 November 2022

Accepted:
20 December 2022

Volume 4, Issue 2, December 2022
pp. 84 – 87

http://dx.doi.org/10.23960/jesr.v4i2.119

Abstract

The conditions for the development of population growth and development in the area around the City of Bandar Lampung are very fast and starting to get crowded, as happened in the District of Natar South Lampung, especially in the Village of Pemanggilan. This condition causes an increase in the need for clean water resources in line with the increase in groundwater exploitation. Therefore, it is necessary to map the potential of groundwater through aquifer mapping and aquifer rock layers through geoelectrical measurements. This study aims to determine the potential of groundwater from volcanic aquifer systems based on geoelectrical measurements. The method used in this study is geoelectric resistivity using the Wenner-Schlumberger configuration with 3 measurement lines. The results of the study show that using the geoelectrical resistivity method, layers with a resistivity value of ≤ 30.3 Ωm are interpreted as shallow aquifers at depths varying from 1 to more than 24 meters with lithology suspected to be tuff and tuff sandstones, which according to geological data are included in the Lampung Formation. Using the 2D geoelectric method, the distribution of shallow aquifers in the study area to a depth of 24 meters can also be determined. The data obtained is expected to be used as supporting data for the sustainable use of water sources.

Keywords: *aquifer, geoelectric, South Lampung*

I. INTRODUCTION

The conditions for the development of population growth and development in the area around Bandar Lampung City are very fast and starting to get crowded, as happened in Natar District, South Lampung, especially in the Village of Pemanggilan. Apart from being an education and residential area which is densely packed and close to big cities, this area is also still surrounded by resident rice fields which also need a supply of water for crop irrigation. In addition, the geological conditions that are mostly in the formation of quaternary volcanic rocks with metasediment bedrock and the Lampung-Panjang fault structure [1] make this area necessary to study the aquifer conditions further.

Natar area is in the Bukit Barisan physiography, while based on its morphology it is included in the morphology of the foot of the mountain to flat. Based on the geological map of the Tanjungkarang sheet [1] (Figure 1), it is shown that the geological conditions in the study area are influenced by the Lampung-Panjang Fault which is trending NW-SE [1].

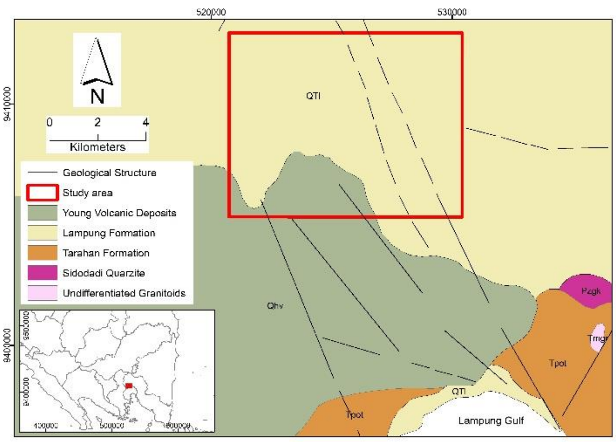

Figure 1. Geological map of the study area [1].

The stratigraphy of the study area is included in the Lampung Formation (QTl), namely in the form of rhyolite–dacite and volcanoclastic tuffs of Pleistocene age and Young Volcano Deposits (Qhvp) in the form of lava (andesite-basalt), breccias and tuff which are Pleistocene and Holocene [1] (Figure 1).

Therefore, it is important to map rock and groundwater aquifers as well as the geohydrological system in the Pemanggilan Village area, Natar with the aim of obtaining information on the aquifer system.

One of the geophysical methods that can be used to determine subsurface conditions is the geoelectric resistivity method [2]. This method has been widely used to determine subsurface conditions both laterally and vertically [3] (Gish and Rooney, 1925). This method is used in environmental studies such as leachate pollution studies in areas around final waste disposal sites [4], as well as in seawater intrusion studies [5]. In geotechnical studies it is used in fault identification, there are slip planes in areas prone to landslides [6]. As for the zoning of groundwater distribution, a lot has been done around the city of Bandar Lampung and its surroundings [7] [8]. One of the configurations that can be used to determine the resistivity of subsurface rocks and groundwater aquifer layers is the Wenner-Schlumberger configuration.

This study area near settlements area which almost every house have well with the deep about 7-12 meter. So we suspect the study area including shallow zone aquifer. This study aim to get information about the aquifer and potential aquifer to fulfil population needs for water in the future.

In this study, an interpretation of the subsurface conditions and the aquifer zone in the Pemanggilan area, Natar, South Lampung was carried out using the 2D Wenner-Sclhumberger configuration geoelectric method. This research was conducted as an effort to obtain data on the availability of sustainable sources of clean water.

II. MATERIALS AND METHODS

This research was conducted in Pemanggilan Village, Natar District, South Lampung (Figure 2). The method used in this study is the 2D geoelectric resistivity Wenner-Schlumberger configuration.

This study uses the Wenner Schlumberger configuration which is a combination of resistivity mapping measurements (determination of the distribution of soil layers horizontally) using the Wenner configuration and resistivity sounding (determination of the vertical distribution of rock conductivity) using the Schlumberger configuration. When compared to the Wenner configuration, the Schlumberger configuration has a 10% greater depth of penetration [9]. An illustration of the measurement points is shown in Figure 2. This measurement uses the Naniura NRD-300 and GF Instrument ARES 3000.

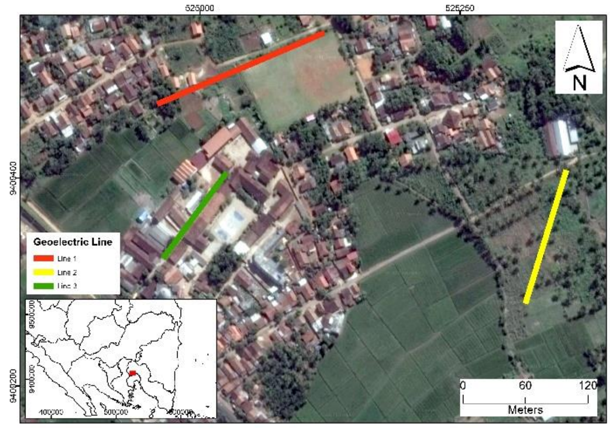

Figure 2. Geoelectric measurement line map.

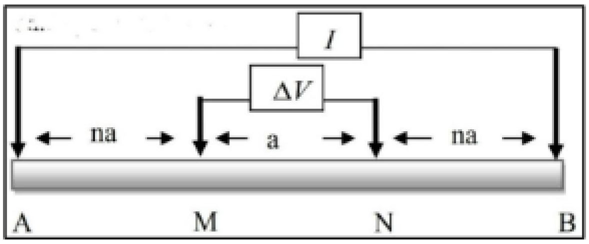

Figure 3. Illustration of the Wenner-Schlumberger configuration measurement points [10].

The first step in geoelectrical resistivity measurement is to determine the central position (0 meters) as the starting point of measurement and the coordinates are recorded using GPS. The next step is to spread the meter to determine the location and spacing of each electrode so that the electrodes and electrode cables can then be installed. The installation of current electrodes (C1 and C2) and voltage electrodes (P1 and P2) according to the Wenner-Schlumberger configuration. The current electrode and potential electrode are connected to a resistivitimeter. Next, the current is injected into the earth through the current electrode. The final step is to record the magnitude of the current (I) and potareential difference (ΔV) measured on the resistivitimeter. Measurements were made on several lines with a length of 120 m for the first line, 120 m for the second line, and 80 m for the third line.

Furthermore, the data that has been obtained in the field is processed using Rest2Dlnv software and then a resistivity cross-section model with an elevation (topography) is obtained. The layers of the subsurface structure can be identified based on the results of the distribution of resistivity values in 2D sections. The next step is to analyze and interpret the data. The data that has been obtained is then analyzed and interpreted to obtain the appropriate results. At this stage, the interpretation of resistivity geoelectrical processed data is correlated with topographic maps, geological maps, and tables of rock resistivity values. The third stage is processing and interpreting data.

III. RESULTS AND DISCUSSIONS

In this study, 3 2D sections were produced on line 1, line 2 and line 3. Each line describes subsurface conditions in the form of rock lithology, layer depth, and groundwater aquifers.

In line 1 (Figure 4) the range of resistivity values is between 1.66 – 1450 Ωm with a depth of 24 meters. The layer with a resistivity value of ≤ 30.3 Ωm which is suspected as an aquifer as an aquifer is located between the 10 and 66 meters with a depth of 5 meters to 24 meters. Along the stretch between the 118 – 125 meter there is an aquifer with a depth of 1-5 meters. On the next stretch of the 70 – 130 meters with resistivity values ranging from 79.7 – 1450 Ωm. According to [2] the resistivity value is a rock layer that is suspected to be tuff and tuff sandstone and according to geological data it is included in the Lampung Formation [1].

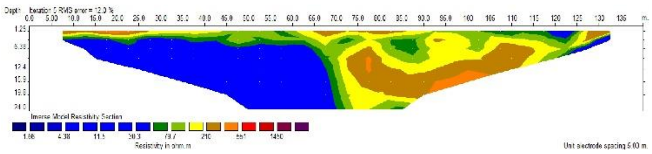

Figure 4. 2D cross-section of the results of geoelectrical measurements in the village of Pemanggilan Natar Line 1.

In line 2 (Figure 5) the range of resistivity values is between 1.66 – 1450 Ωm with a depth of 19.8 meters. The layer with a resistivity value of ≤ 30.3 Ωm which is suspected as an aquifer as an aquifer is located between the 35 and 55 meters at a depth of 15.9 meters to 19.8 meters. Along the stretch between the 56 – 70 meters there is an aquifer at a depth of 3.75 – 19.8 meters. Then on the stretch of the 75th meter to the 105th meter at a depth of 1.25 – 15.9 meters. Whereas in the 5 to 75 meter stretch the resistivity values range from 79.7 – 1450 Ω. According to [2] the resistivity value is a rock layer that is suspected to be tuff and tuff sandstone and according to geological data it is included in the Lampung Formation [1].

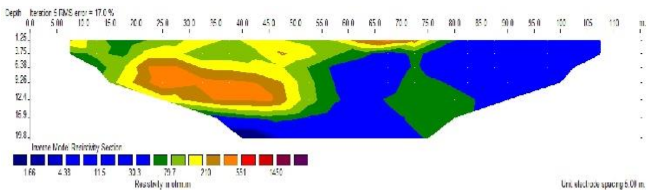

Figure 5. 2D cross-section of the results of geoelectrical measurements in the village of Pemanggilan Natar Line 2.

In line 3 (Figure 6) the range of resistivity values is between 1.66 – 1450 Ωm with a depth of 12.4 meters. The layer with a resistivity value of ≤ 30.3 Ωm which is suspected as an aquifer as an aquifer is located along the 8-to-68-meter stretch which is located from a depth of 3.75 meters to 12.4 meters. This aquifer layer is covered by overlying rock layers with resistivity values ranging from 79.7 – 1450 Ωm. According to [2] the resistivity value is a rock layer that is suspected to be tuff and tuff sandstone and according to geological data it is included in the Lampung Formation [1].

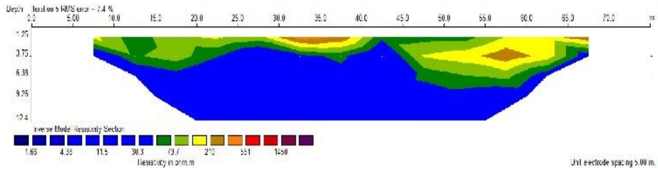

Figure 6. 2D cross-section of the results of geoelectrical measurements in the village of Pemanggilan Natar Line 3.

With the conditions described above, when viewed from the subsurface lithology, it can be concluded that the aquifer in the study area is a shallow aquifer with a presumed lithology of tuff and tuff sandstones which according to geological data are included in the Lampung Formation.

IV. CONCLUSIONS

Based on the research results, the following conclusions can be drawn, using the resistivity geoelectric method interpreted layers with resistivity values ≤ 30.3 Ωm which are suspected as aquifers with depths varying from 1 to more than 24 meters with lithology suspected to be tuff and tuff sandstones which according to geological data are included in the Lampung Formation. By using the 2D geoelectrical method, the Wenner-Schlumberger configuration can also determine the distribution of shallow aquifers in the study area to a depth of 24 meters. The data obtained is expected to be used as supporting data for the sustainable use of water sources.

V. ACKNOWLEDGMENT

The authors would like to thank LPPM Universitas Lampung for providing the research grant.

VI. REFERENCES

[1] S. A. Mangga, Amirudin, T. Suwarti, S. Gafoer, and Sidarto, Peta Geologi Lembar Tanjungkarang, Sumatra, Bandung: Pusat Penelitian dan Pengembangan Geologi, 1994.

[2] W. M. Telford, L. P. Geldart and R. E. Sheriff, Applied Geophysics, Second Edition, United State of America: Cambridge University Press, 1990.

[3] O.H. Gish, and W.J. Rooney, "Measurement of resistivity of large masses of undisturbed earth", Terrestrial Magnetism and Atmospheric Electricity, 30, 161-188, 1925.

[4] M. Juandi, "Analisa pencemaran air tanah berdasarkan metode geolistrik studi kasus tempat pembuangan akhir sampah Muara Fajar Kecamatan Rumbai". Jurnal Ilmu Lingkungan, 3, 02, 2012.

[5] T. Santoso, N. Piyantari, and P. Hiskiawan, "Pendugaan Intrusi Air Laut Dengan Metode Geolistrik Resistivitas 1D di Pantai Payangan Desa Sumberejo Jember". Berkala Sainstek, 1, 1, 17-19, 2013.

[6] R. Mulyasari, I. G. B. Darmawan, D. S. Effendi, S. P. Saputro, Hesti, A. Hidayatika, and N. Haerudin, "Aplikasi Metode Geolistrik Resistivitas untuk Analisis Bidang Gelincir dan Studi Karakteristik Longsoran di Jalan Raya Suban Bandar Lampung", Jurnal Geofisika Eksplorasi, 6, 1, p.66-76, 2020.

[7] I. W. Distrik, "Penerapan Metode Geolistrik Tahanan Jenis Untuk Mengetahui Struktur Geologi Dan Potensi Air Tanah Di Perumahan Bataranila, Lampung Selatan". Jurusan Pendidikan MIPA Fakultas Keguruan dan Ilmu Pendidikan, 25, 2003.

[8] D. Kuswadi, "Deteksi Akuifer Air Tanah Menggunakan Metode Geolistrik (Studi Kasus di Politeknik Negeri Lampung)", Jurnal Ilmiah Teknik Pertanian-TekTan, 11, 3, 143-155, 2019.

[9] Bukhari, , A. D., Saputra, A. H. Pratama, , F. Abdullah, M. Yanis, and N. Ismail, "Identifikasi struktur berpotensi longsor berdasarkan model resistivitas listrik 2D", Prosiding Semirata 2017 Bidang MIPA BKS-PTN Wilayah Barat, 2017.

[10] J. Utiya, As'ari and H. J. Tongkukut, "Metode geolistrik resistivitas konfigurasi Wenner-Schlumberger dan konfigurasi Dipole-Dipole untuk Identifikasi patahan Manado di Kecamatan Paaldua Kota Manado", Jurnal Ilmiah Sains, 15, 2, 2015.