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Analysis of Resistivity Value Distribution for Identification of Aquifer Layers in South Palangga District, South Konawe

Analisis Distribusi Nilai Resistivitas untuk Identifikasi Lapisan Akuifer di Kecamatan Palangga Selatan, Konawe Selatan

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ABSTRACT

This study aims to analyze the distribution of subsurface resistivity values to identify aquifer layers in South Palangga District, South Konawe Regency. The method used was geoelectric resistivity with a Wenner–Schlumberger configuration. Data acquisition was carried out on three lines, each 200 meters long and with electrode spacing of 10 meters. The measured data, in the form of apparent resistivity, were then processed using RES2DINV software to generate a two-dimensional (2D) subsurface cross-section model. The results showed that resistivity values in the study area ranged from 1.61 to 43,164 Ωm, with a penetration depth of 40–55 meters. Interpretation of the resistivity cross-section indicated the presence of two main zones: a conductive zone and a resistive zone. The conductive zone, with resistivity values of 1.61–76.4 Ωm, is interpreted as a water-saturated weathering layer and functions as a shallow aquifer with a thickness of approximately 20 meters. Meanwhile, resistive zones with resistivity values greater than 76.4 Ωm are interpreted as relatively compact limestone bedrock. A comparative analysis between the two tracks indicates that track 2 has the most prospective aquifer potential, characterized by lower resistivity values and a wider lateral distribution. Overall, the resistivity geoelectric method has proven effective in identifying the distribution of shallow aquifers and the characteristics of subsurface lithology. The results of this study are expected to provide a basis for planning the exploration and utilization of groundwater resources in the study area.

Keywords: *resistivity geoelectric, aquifer, Wenner–Schlumberger, groundwater, South Konawe*

ABSTRAK

Penelitian ini bertujuan untuk menganalisis distribusi nilai resistivitas bawah permukaan untuk mengidentifikasi lapisan akuifer di Kecamatan Palangga Selatan, Kabupaten Konawe Selatan. Metode yang digunakan adalah resistivitas geolistrik dengan konfigurasi Wenner–Schlumberger. Pengambilan data dilakukan pada tiga jalur, masing-masing sepanjang 200 meter dan dengan jarak antar elektroda 10 meter. Data terukur, berupa resistivitas semu, kemudian diolah menggunakan perangkat lunak RES2DINV untuk menghasilkan model penampang bawah permukaan dua dimensi (2D). Hasil penelitian menunjukkan bahwa nilai resistivitas di daerah penelitian berkisar antara 1,61 hingga 43.164 Ωm, dengan kedalaman penetrasi 40–55 meter. Interpretasi penampang resistivitas menunjukkan adanya dua zona utama: zona konduktif dan zona resistif. Zona konduktif, dengan nilai resistivitas 1,61–76,4 Ωm, diinterpretasikan sebagai lapisan pelapukan jenuh air dan berfungsi sebagai akuifer dangkal dengan ketebalan sekitar 20 meter. Sementara itu, zona resistif dengan nilai resistivitas lebih besar dari 76,4 Ωm diinterpretasikan sebagai batuan dasar kapur yang relatif padat. Analisis komparatif antara kedua jalur menunjukkan bahwa jalur 2 memiliki potensi akuifer yang paling prospektif, ditandai dengan nilai resistivitas yang lebih rendah dan distribusi lateral yang lebih luas. Secara keseluruhan, metode geolistrik resistivitas telah terbukti efektif dalam mengidentifikasi distribusi akuifer dangkal dan karakteristik litologi bawah permukaan. Hasil penelitian ini diharapkan dapat memberikan dasar untuk perencanaan eksplorasi dan pemanfaatan sumber daya air tanah di wilayah penelitian.

Kata kunci: geolistrik resistivitas, akuifer, Wenner–Schlumberger, air tanah, Konawe Selatan

INTRODUCTION

Groundwater availability is a crucial aspect in supporting community life, especially in areas not yet optimally served by clean water distribution systems. With increasing population growth and development activities, the need for clean water resources continues to increase, while availability is increasingly limited. Therefore, exploration efforts are necessary to determine groundwater potential, particularly in the form of aquifers, which can store and transmit significant amounts of water beneath the surface (Mohammed, Takele, Mechal & Jothimani, 2025; Lubis, Fauzi, & Akbar, 2025).

Aquifers are rock layers with the ability to store and transmit a certain amount of water, which is strongly influenced by physical properties such as porosity and permeability. These layers are generally composed of materials such as sand and gravel, which have specific resistivity values that distinguish them from other layers, such as clay or compacted rock. Therefore, identifying aquifers is crucial not only for determining the presence of groundwater but also for understanding the characteristics of their constituent lithology (Sehah et al, 2021; Darisma, Fernanda, & Syukri, 2020).

Geophysical methods, particularly the geoelectric resistivity method, are widely used in groundwater exploration because they are non-destructive, efficient, and capable of providing a picture of subsurface conditions both laterally and vertically. The basic principle of this method is to measure variations in rock resistivity to the flow of electric current, which is then used to interpret the lithology and fluid content within it. Variations in resistivity values are strongly influenced by water content, material type, and the level of rock saturation (Rakhmanto, 2023; Sitinjak, Muhammad, & Dewi, 2024).

In practice, electrode configurations such as Wenner, Schlumberger, or a combination of Wenner-Schlumberger are often used to increase data resolution both horizontally and vertically. The resulting apparent resistivity values are then processed through an inversion process to produce a two-dimensional cross-section model that represents the distribution of subsurface resistivity. This model serves as the basis for identifying potential aquifer zones, which are generally characterized by low to moderate resistivity values (Kausarian, 2022; Karangan et al, 2024; Alviyanda et al, 2025).

Several previous studies have shown that the geoelectric resistivity method is effective in identifying aquifer layers in various geological conditions. For example, research in Kubu Raya Regency demonstrated that aquifer layers can be identified within a specific resistivity range down to depths of more than 40 meters, while a study in North Minahasa successfully mapped the distribution of aquifers with low resistivity values at shallow to moderate depths. This demonstrates that resistivity distribution analysis plays a crucial role in determining groundwater potential zones (Luthfin et al, 2025; Wowor, Manoppo, & Riogilang, 2021).

Based on this background, this study aims to analyze the distribution of subsurface resistivity values to identify aquifer layers in South Palangga District, South Konawe Regency. Using the geoelectric resistivity method, it is hoped that a subsurface cross-section model can be obtained that can more accurately depict the distribution of aquifers, thus providing a basis for the management and utilization of groundwater resources in the region.

RESEARCH METHODS

Research Location and Time

This research was conducted in South Palangga District, South Konawe Regency, Southeast Sulawesi Province. Geographically, the research location was located along three measurement routes with different coordinates, representing local geological conditions. Data acquisition was *conducted in May 2024 over one working day, considering field conditions representative of the research objective, namely the identification of subsurface aquifer layers.*

Research Methods

The method used in this research is the geoelectric resistivity method, with the aim of determining the distribution of subsurface resistivity values. This method works based on the principle of injecting an electric current into the ground through a current electrode, then measuring the resulting potential difference using a potential electrode. The resulting apparent resistivity value is then used to interpret the subsurface lithological conditions.

Mathematically, the apparent resistivity value (ρa) is calculated using Ohm's law, which is expressed as:

$$\rho_a = K\frac{\Delta V}{I}$$

where ρa is the apparent resistivity (Ωm), K is the electrode geometry factor, ΔV is the potential difference (volts), and I is the electric current (amperes). The geometry factor (K) value depends on the electrode configuration used in the measurement.

The geoelectric resistivity method has been widely used in groundwater exploration because it can provide information on variations in rock electrical properties that are closely related to water content and subsurface geological structure (Loke et al., 2021).

Configuration and Data Acquisition

The geoelectric measurements in this study used the Wenner–Schlumberger electrode configuration, a combination of the Wenner and Schlumberger configurations to achieve better vertical and horizontal resolution.

Each track was 200 meters long with a spacing of 10 meters between electrodes. A total of three measurement tracks were distributed across the study site. The equipment used was a BGS ER-A single-channel resistivity meter equipped with an automatic switching system (gridbox), allowing for efficient measurement and minimizing errors caused by manual electrode switching.

The data obtained consisted of apparent resistivity values from field measurements, organized in tabular form. This data was then used as input in the processing process to obtain a subsurface model.

Data Processing and Analysis

The apparent resistivity data from field measurements was processed using RES2DINV software to produce a two-dimensional (2D) inversion model. The inversion process was performed using the least squares method to minimize differences between the observed data and the calculated model, resulting in a subsurface resistivity distribution that approximates the actual conditions.

The inversion results, in the form of 2D resistivity cross sections, were then analyzed to identify variations in resistivity values related to lithology and the presence of groundwater. Interpretation was carried out based on the range of rock resistivity values, where:

a. Low resistivity values (± 1–100 Ωm) were interpreted as conductive layers with potential aquifers.
b. High resistivity values (> 100 Ωm) were interpreted as compact rock layers such as limestone.

The analysis was conducted qualitatively and quantitatively, considering the lateral and vertical distribution of resistivity values along each trajectory.

Geological and Aquifer Interpretation

The results were interpreted by integrating resistivity data with regional geological conditions. Aquifer zones were identified based on low to moderate resistivity characteristics, indicating the presence of porous and water-saturated materials.

Furthermore, aquifer thickness and depth were analyzed based on color distribution patterns in the inversion cross-section. This approach allows for more accurate determination of groundwater potential zones, thus providing relevant information for groundwater resource utilization in the study area.

RESULTS AND DISCUSSION

2D Resistivity Inversion Results

The results of geoelectric data processing using the two-dimensional inversion method produced a cross-section of the subsurface resistivity distribution for each measurement path. This cross-section represents the lateral and vertical variations in resistivity values down to a maximum depth of approximately 40–55 meters. In general, the inversion results indicate two main groups of resistivity values:

a. Low resistivity (conductive) zone
b. High resistivity (resistive) zone

This distribution indicates significant differences in lithology and the potential presence of aquifers in certain zones.

Traverse 1

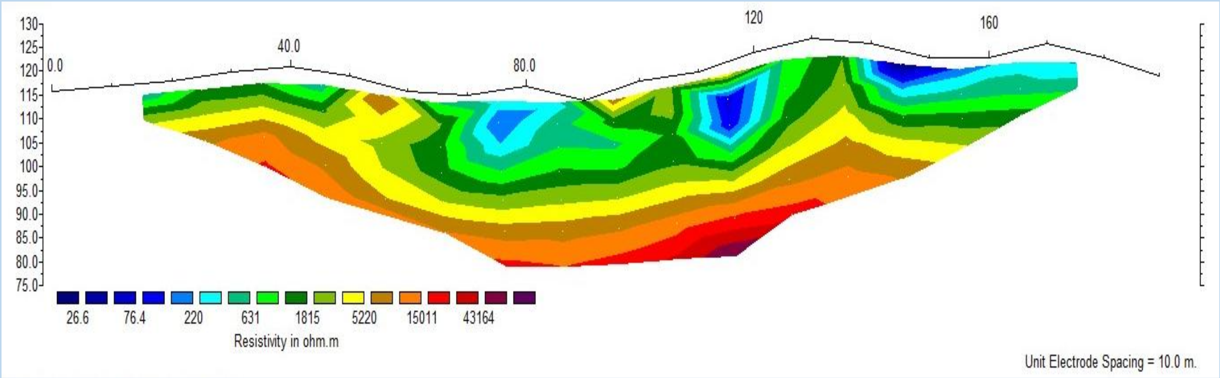

Figure 1. *Traverse 1*

1. *The resistivity value on traverse 1 ranges from 26.6 to 43,164 ohm-meters at a depth of up to 55 meters.*
2. *The resistivity value of 26.6 to 76.4 ohm-meters is suspected to be a conductive layer. This layer is estimated to be a layer of soil resulting from weathering of the main rock present in the measurement area. This zone is estimated to be an aquifer layer with a thickness of 20 meters from the surface, indicated by dark blue.*
3. *The resistivity value of 76.4 to 43,164 ohm-meters is suspected to be a resistive layer. This layer is estimated to be the main limestone rock visible or present in the measurement area.*

The presence of an aquifer on traverse 1 is quite clear at shallow depths (0–20 m). This indicates that the aquifer system at this location is an unconfined aquifer formed by the weathering of carbonate rocks.

Traverse 2

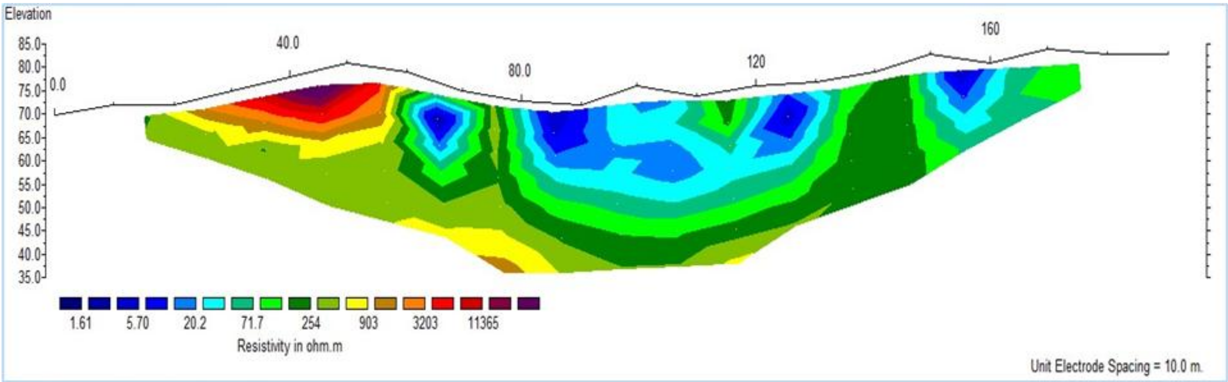

Figure 2. *Traverse 2*

1. *The resistivity value on traverse 1 is in the range of 1.61–11,365 ohm-meters at a depth of up to 40 meters.*
2. *The resistivity value of 1.61–20.2 ohm-meters is suspected to be a conductive layer. This layer is estimated to be a layer of soil resulting from weathering of the main rock present in the measurement area. This zone is estimated to be an aquifer layer with a thickness of 20 meters from the surface, indicated by dark and light blue.*
3. *The resistivity value of 20.2–11,365 ohm-meters is suspected to be a resistive layer. This layer is estimated to be the main rock in the form of limestone visible or present in the measurement area.*

Traverse 2 shows more prospective aquifer conditions than traverse 1, characterized by:
a. *Lower resistivity values (indicating high water saturation)*
b. *Wider lateral distribution*

This indicates that traverse 2 is likely located in a basin zone or groundwater accumulation zone. Hydrogeologically, these conditions are ideal for groundwater well development.

Traverse 3

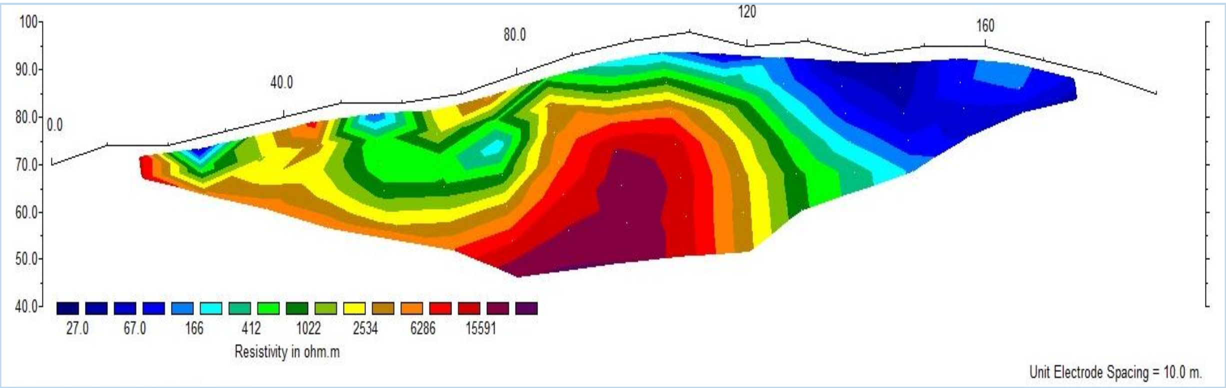

Figure 3. *Traverse 3*

1. *The resistivity value on Traverse 1 is in the range of 27-15,591 ohm-meters at a depth of up to 40 meters.*
2. *The resistivity value of 27-67 ohm-meters is suspected to be a conductive layer. This layer is estimated to be a layer of soil resulting from weathering of the main rock present in the measurement area. This zone is estimated to be an aquifer layer with a thickness of 20 meters from the surface, indicated by dark and light blue.*
3. *The resistivity value of 67-15,591 ohm-meters is suspected to be a resistive layer. This layer is estimated to be the main rock in the form of limestone visible or present in the measurement area.*

The characteristics of traverse 3 are relatively similar to traverse 1, but with:

a. *Slightly higher resistivity values in the aquifer zone*
b. *Good aquifer potential, but possibly lower water capacity than traverse 2*

The obtained resistivity distribution shows a strong correlation between low resistivity values and the presence of an air-saturated zone. Theoretically, rocks containing air have lower resistivity values because air acts as a medium for conducting electrical current, especially if it contains dissolved ions.

The presence of limestone as a base layer also aligns with the regional geology of Southeast Sulawesi, which is dominated by carbonate formations. Under certain conditions, limestone can function as an aquifer if it is fractured (fractured aquifer), but in this study, it predominantly acts as a relatively impermeable layer.

CONCLUSION

Based on research results using the Wenner–Schlumberger configuration geoelectric resistivity method in South Palangga District, South Konawe Regency, it can be concluded that the distribution of subsurface resistivity values indicates the presence of two main zones: a conductive zone and a resistive zone, which represent differences in lithology and hydrogeological conditions in the study area.

The conductive zone, with resistivity values ranging from 1.61 to 76.4 Ωm, is interpreted as a water-saturated weathered layer that acts as a shallow aquifer. This aquifer was identified in all three measurement lines with a relatively uniform thickness of approximately 20 meters from the surface, thus being classified as an unconfined aquifer.

Meanwhile, the resistive zone, with resistivity values exceeding 76.4 Ωm and extending to tens of thousands of Ωm, is interpreted as a relatively compact bedrock, dominated by limestone. This layer has low permeability and therefore acts as an aquiclude to groundwater flow.

A comparative analysis between the two trajectories indicates that trajectories 2 have the most prospective aquifer potential, characterized by lower resistivity values (1.61–20.2 Ωm) and a wider lateral distribution, indicating a higher level of water saturation compared to the other trajectories.

Overall, the results of this study confirm that the geoelectric resistivity method is effective in identifying the distribution of shallow aquifers and the characteristics of subsurface lithology. This information can be used as a basis for planning groundwater exploration and utilization, particularly for determining optimal well drilling locations in the South Palangga District.

REFERENCES

Alviyanda, A., Farduwin, A., Nugraha, P., Widiatama, A. J., Natalia, H. C., Ogara, E. R., & Piqri, H. (2025). Identification Of Aquifer Layers Using The Electrical Resistivity Tomography (Ert) Method In Gunung Kasih Area. JGE (Jurnal Geofisika Eksplorasi), 11(3), 180-192.

Darisma, D., Fernanda, F., & Syukri, M. (2020). Investigation of Groundwater Potential using Electrical Resistivity Method and Hydraulic Parameters in Lam Apeng, Aceh Besar, Indonesia. Journal of Geoscience, Engineering, Environment, and Technology, 5(4), 185-190.

Karangan, R., Massinai, M. A., Haryani, T., & Fhaika, N. (2024, August). Identification of underground aquifer layer using the geoelectric resistivity method, case study: Maros Regency, South Sulawesi, Indonesia. In AIP Conference Proceedings (Vol. 2774, No. 1, p. 050009). AIP Publishing LLC.

Kausarian, H. (2022). Potential Aquifer Exploration using Electrical Resistivity Imaging at Rumbio Jaya, Kampar, Riau. Aceh Int. J. Sci. Technol.,.

Lubis, A. M., Fauzi, H. W., & Akbar, A. J. (2025). Groundwater potential assessment in Pino region, South Bengkulu, Indonesia using geo-investigation, remote sensing, and GIS approaches. Results Earth Sci. 3, 100059.

Loke, M. H., Kuras, O., Chambers, J. E., Rucker, D. F., & Wilkinson, P. B. (2021). Instrumentation, electrical resistivity. In Encyclopedia of Solid Earth Geophysics (pp. 776-782). Cham: Springer International Publishing.

Luthfin, A., Izza, L., Alfania, I. N., Irjan, & Munir, M. M. (2025, January). Identification of Aquifer Layers Using Geoelectric Methods Based on Vertical Electrical Sounding (VES) in Dengkol Village. In IOP Conference Series: Earth and Environmental Science (Vol. 1439, No. 1, p. 012013). IOP Publishing.

Mohammed, A., Takele, T., Mechal, A., & Jothimani, M. (2025). Geospatial and satellite gravity-based assessment of groundwater potential in the Borkena Watershed, Northern Ethiopia. Journal of Hydrology: Regional Studies, 62, 102828.

Rakhmanto, F. (2023). Identification of Aquifer Potential with the Schlumberger Configuration Resistivity Geoelectrical Method and Planning of Deep Water Wells for Clean Water Needs in the Sampang Region, Madura Island, East Java. Indonesian Journal of Contemporary Multidisciplinary Research.

Sehah, S., Hartono, H., Irayani, Z., Prabowo, U.N., Apriyanto, F., Sagita, D.M., Purnamasari, D. (2021). Interpretation of 1D-Resistivity Data to Describe the Aquifer Model in the Serayu Watershed Area of Somagede Village, Somagede District, Banyumas Regency. Jurnal Geologi dan Sumberdaya Mineral, 22(2): 89-98.

Sitinjak, T. M. T., Muhammad, J., & Dewi, R. (2024). Peatland aquifer zone modeling via Wenner and Schlumberger configuration geoelectric strategies in Tarai Bangun Village, Riau Province, Indonesia. Science, Technology, and Communication Journal, 4(2), 51-62.

Wowor, B. M., Manoppo, F. J., & Riogilang, H. (2021). Analysis of aquifers, humidity levels with geoelectric resistivity value, and NDW Index in the geothermal area of North Langowan. Aquatic Science & Management, 9(2), 26-37.