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Groundwater Exploration in Tirtoadi using the Geoelectric Schlumberger Method

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Abstract
Tirtoadi sub-district is one of the areas mentioned as being on alert for meteorological drought, which is a condition of not experiencing a day without rain (HTH) for more than 60 days. This research aims to provide information on the presence of subsurface water using geoelectric methods. Data acquisition was carried out at 20 points in Tirtoadi. The distribution of points is random but evenly distributed in the research area. The equipment used is Syscal Jr and the measuring range is 600 m AB, and the direction of the stretch is relatively north to south. The field data obtained are deltas V and I. These data are used to calculate R and Rho. The resistivity value obtained is the apparent resistivity. To obtain a subsurface model of the actual resistivity, it is necessary to perform a 1-D inversion. The inversion is carried out using the Progress V3.0 software. The results obtained in this study are variations in the value of subsurface resistivity. Resistivity of water-containing aquifers ranges between 10 Ωm – 50 Ωm. The depth of groundwater varies between 50 meters to 80 meters. The thickness of the groundwater varies between 5 meters to 22 meters. The recommended drill point is given at T11 with coordinates 49 S 424996 N 9144372 E because at this point it has the shallowest depth and thick enough thickness.

Keywords: Geoelectric, Groundwater, Resistivity

INTRODUCTION

Humans and all living things on this earth need water. Water is the source of life for the earth, because all living organisms on earth are composed of cells that contain at least 60% water and their metabolic activities take place in aqueous solutions (Kodoatie, 2021). So, it can be said that the availability of water in terms of quality and quantity is absolutely necessary for the benefit of humans.

The availability of water in an area is very important for the people in that area. Mlati district is one of the areas mentioned as being on alert for meteorological drought, which is a condition of not experiencing a day without rain (HTH) for more than 60 days (Detik.com, n.d.; Jogja.tribunnews.com, n.d.). This is compounded by the construction of hotels for tourism development which could potentially reduce ground water reserves in the Mlati District. n 2019, there were 5 star hotels, 6 non-star hotels, and 12 inns (BADAN PUSAT STATISTIK SLEMAN, 2019). o overcome the problems of water availability, it is necessary to explore and collect data on different water sources. One source of water that is available and can be easily used is ground water. Groundwater is water that moves in the soil contained in the spaces between grains and in rock cracks (Todd & Mays, 2004).

The method that can be used for groundwater exploration is the Geoelectric Method. The Geoelectric method is one of the geophysical methods that utilizes electrical propagation and electrical parameters from the medium (sub-surface) (Zakaria, 2019). This method is proven to be able to explain the subsurface well, either in 1-D images (Zakaria, Muhammad Faizal; Suyanto, 2020), or 2-D images (Zakaria & Maisarah,

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2020). The 1-D geo-electric method or often called geo-electric sounding gets the results of resistivity vs depth values at every points acquisition. These resistivity values will be interpreted in terms of geology and rock types (water content). The research was conducted using the Geoelectric Sounding Method in groundwater exploration activities in Tirtoadi Sub-District, Mlati District. The main purpose of the are expected to determine the depth of the groundwater, so it could become the preliminary information for drilling activities. This area is expected to become a pilot project of data collection on the presence of groundwater in a district and can be continued in another sub-district as well.

Geological Setting and Geohydrological Setting

The research was conducted in Tirtoadi sub-district, Mlati district, Sleman regency. Based on the Geological Map of Yogyakarta (Rahardjo et al., 1995), Tirtoadi is located in the Merapi Muda sediment formation with the dominance of tuff lithology, breccias, aglomerat, and inseparable lava flows. Tirtoadi is included in the Yogyakarta Groundwater Basin on a map made by the Indonesian water service. The Yogyakarta Groundwater Basin (CAT) is bordered by Merapi Mountain in the north, the Indian Ocean in the south, Baturagung hills in the west, and Gunungsewu hills in the east. The main lithology in this basin is the Yogyakarta formation at the top, and the Sleman formation at the bottom. Both of these formations are volcaniclastic deposits of Mount Merapi. This formation is a potential aquifer layer in the Yogyakarta CAT (Hendrayana & Putra, 1993).

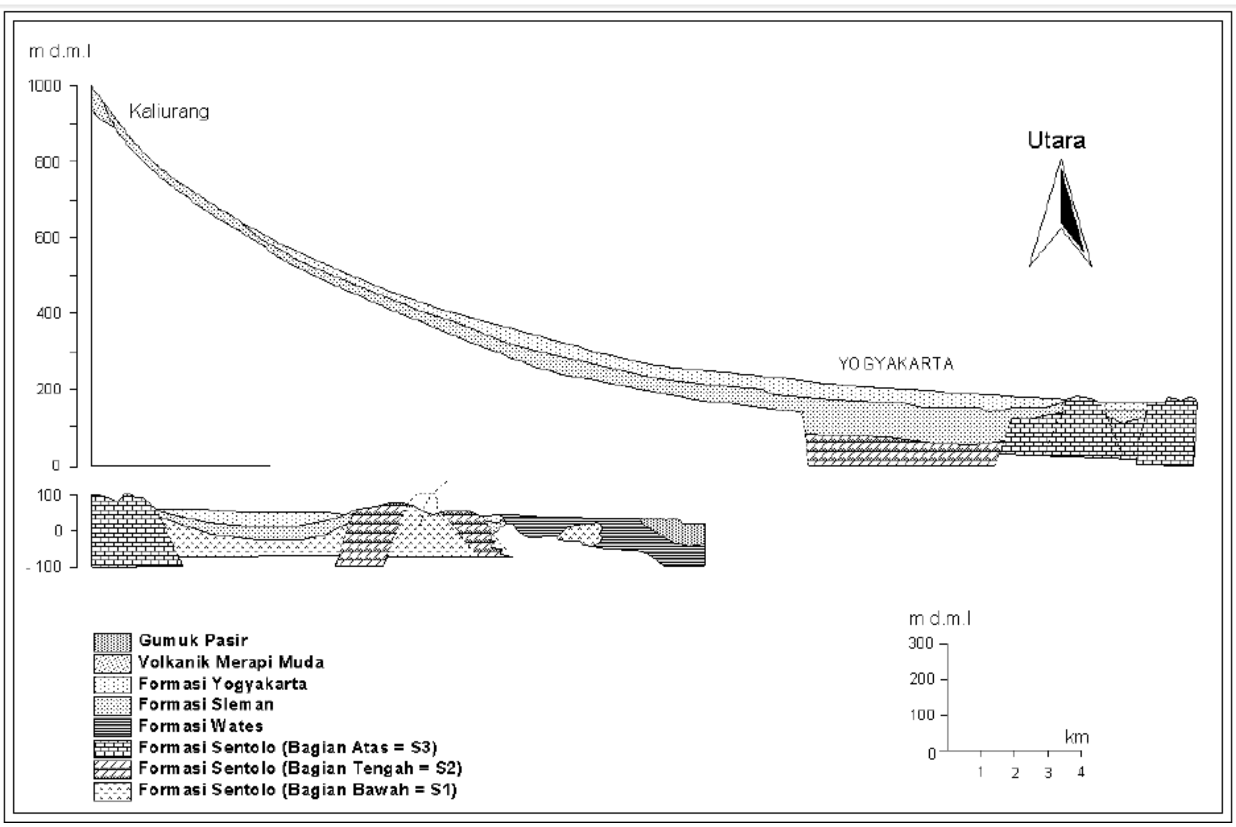

Figure 1. Conceptual Model of Yogyakarta Groundwater Basin Konseptual (Hendrayana & Putra, 1993)

METHOD

Basic Theory

Geophysical measurement method is a method of subsurface investigation by performing measurement tests on the surface. One of the geophysical methods is the geoelectric method, which is a method that utilizes the electrical properties of the medium. This method detects surface effects caused by subsurface currents. There is a wide variety of techniques and uses of geoelectrical methods (Telford et al., 1990). The method used in this research is the Geoelectric Vertical Electrical Sounding (VES) method, or commonly called the geoelectric VES. The Geoelectric VES method will get the results of resistivity vs depth values at a measurement point using 2 current electrodes and 2 potential electrodes in its measurement (figure 2). The potential difference and current are measured and then used to calculate the resistivity value using the equation 1

$$\rho_a = \frac{\pi L^2}{2s}\left(\frac{V_{MN}}{I}\right) \quad (1)$$

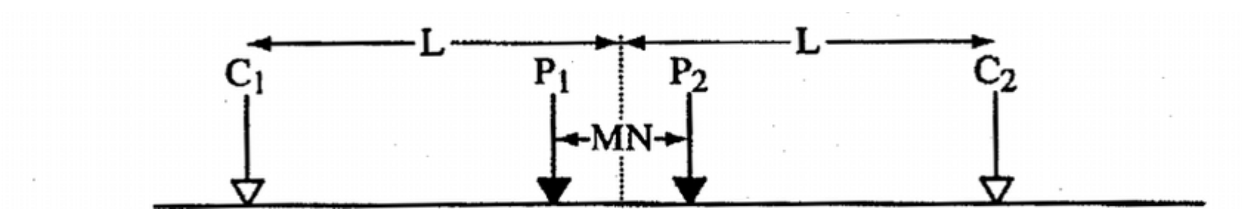

Figure 2. the electrode position of Schulmberger Configuration

Where ρ is the apparent resistivity, L is the distance between the current and potential electrodes (AB, in meters), s is the distance between the potential electrodes (MN, in meters), V_{MN} is the measured potential difference (in mV) and I is the amount of current transmitted (mA).

Data Acquisition

Data acquisition was carried out at 20 points in Tirtoadi. The distribution of points is random but evenly distributed in the research area. The equipment used is Syscal Jr. with a set of acquisition tools are P cable, C cable, Hammer, HT, and other supporting tools (Figure). The measuring range is 600 m AB, and the direction of the stretch is relatively north to south. The field data obtained are deltas V and I. These data are used to calculate R and Rho. The resistivity value obtained is the apparent resistivity. To obtain a subsurface model of the actual resistivity, it is necessary to perform a 1-D inversion. The inversion is carried out using the Progress V3.0 software

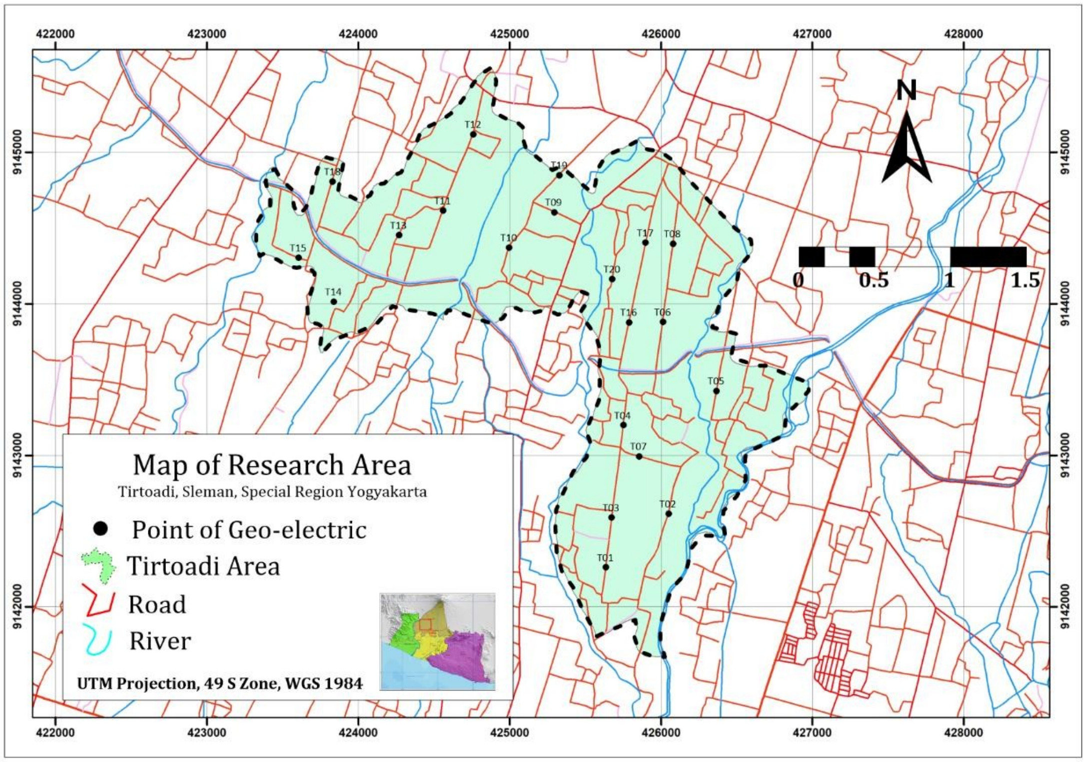

Figure 3. Map of Research Area, Tirtoadi, Sleman, Special Region Yogyakarta

Result and discussion

The results of this study are resistivity vs depth data at each measurement point. The resistivity value will be interpreted in terms of geology and rock type (water content). In the research area in Tirtoadi, the resistivity values of the research results ranged from 1.97 Ωm – 2208 Ωm. The measurement point is on the formation of young Merapi deposits (Rahardjo et al., 1995). This formation consists of Tuff, breccia, aglomerat, and inseparable lava melting. In the research area there are also clays that come from the surrounding rock deposits. Interpretation is done by grouping rock types based on their resistivity values. This grouping is carried out using a reference table of resistivity values from Telford, looking at previous research, and based on geological information and the appearance of rocks on the surface. The grouping of rock types in the research area in Tirtoadi is as follows

1. Soil (surface) : 22 Ωm – 2208 Ωm (depth <10 meters)
2. Lava : > 50 Ωm
3. Clay : < 10 Ωm
4. Aquifer (filled with water) : 10 Ωm – 50 Ωm

The aquifer is identified to be in sandstone which has a fairly large porosity. This sandstone extends throughout the research area. This study focuses on confined aquifer only. confined aquifer has a greater amount because it has a thicker thickness. The depths and elevations of confined aquifer are mapped.

From the depth and thickness maps, recommendations can be made for drilling at certain points. Determination of drilling point recommendations is carried out by considering locations with shallower confined aquifer depths and thickerthicknesses.

Figure 4 shows a confined aquifer depth map. The depth of confined aquifer varies between 50 meters to 80 meters. The deepest depth is at point T07 with a depth of 80 meters, and the shallowest depth is at point T11 with a depth of 50 meters. The image 5 shows a map of the thickness of the confined aquifer. The thickness of the aquifer varies between 5 meters to 22 meters. The thinnest thickness is at point T02 with a thickness of 5 meters and the thickest thickness is at point T11 with a thickness of 22 meters. The recommended drill point is given at T11 with coordinates 49 S 424996 N 9144372 E because at this point it has the shallowest depth and thick enough thickness.

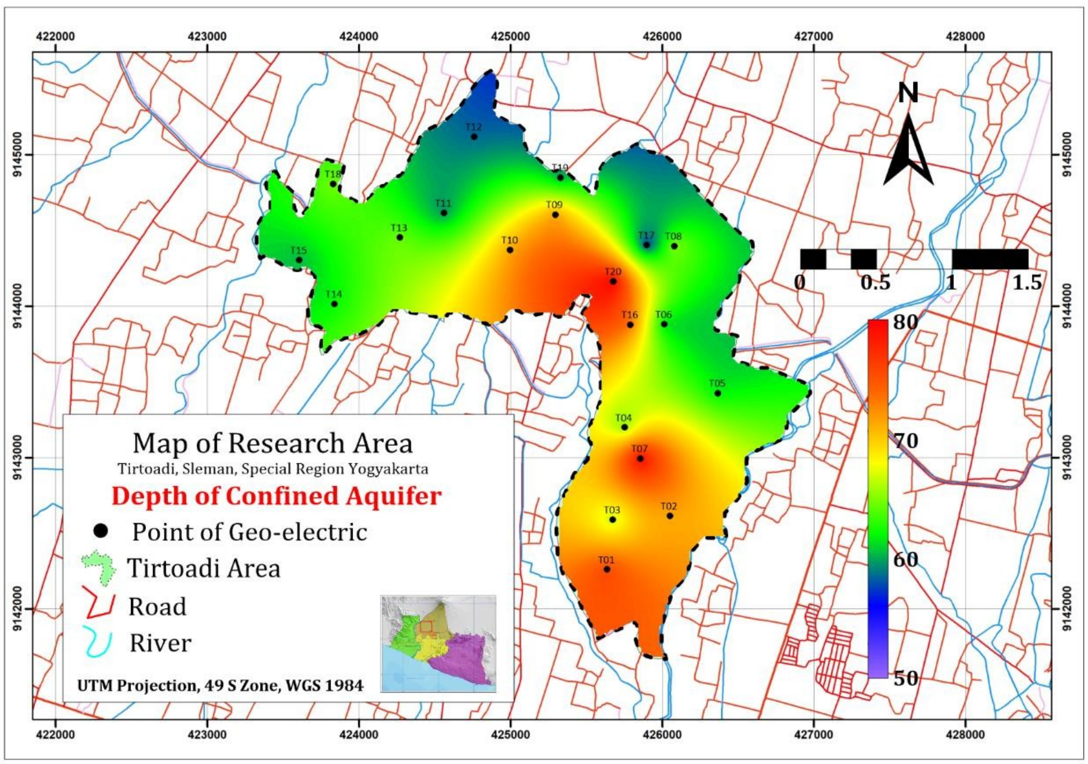

Figure 4. Depth of Confined Aquifer Map

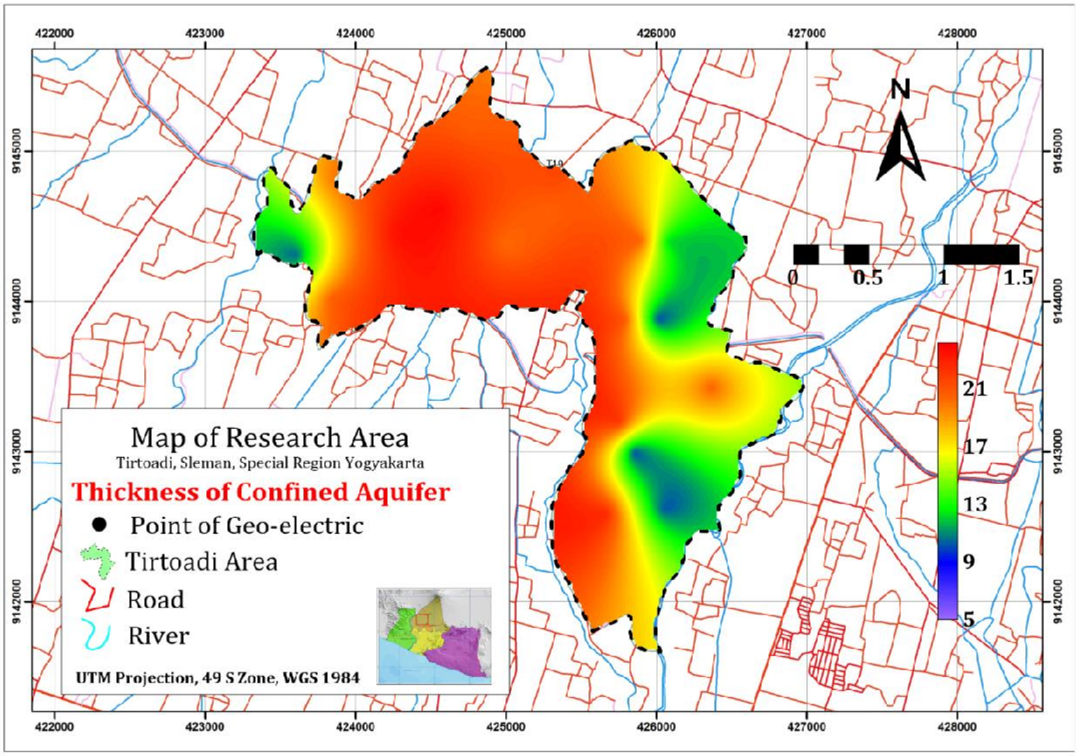

Figure 5. Thickness of Confined Aquifer Map

CONCLUSION

The results obtained in this study are variations in the value of subsurface resistivity. Resistivity of water-containing aquifers ranges between 10 Ωm – 50 Ωm. The depth of confined aquifer varies between 50 meters to 80 meters. The thickness of the aquifer varies between 5 meters to 22 meters. The recommended drill point is given at T11 with coordinates 49 S 424996 N 9144372 E because at this point it has the shallowest depth and thick enough thickness.

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REFERENCES

BADAN PUSAT STATISTIK SLEMAN. (2019). *Kecamatan Mlati Dalam Angka*.

Detik.com. (n.d.). *49 Kecamatan di DIY Berstatus Awas Potensi Kekeringan Meteorologis*. Retrieved April 22, 2021, from https://news.detik.com/berita-jawa-tengah/d-4621460/49-kecamatan-di-diy-berstatus-awas-potensi-kekeringan-meteorologis

Hendrayana, H., & Putra, D. P. E. (1993). *The Improvement of Yogyakarta Groundwater Basic Concept and It's Modelling*. Geological Engineering Departement, Gadjah Mada University, Yogjakarta.

Jogja.tribunnews.com. (n.d.). *BMKG : Sejumlah Wilayah DIY Terancam Dilanda Kekeringan Meteorologis -*

Tribun Jogja. Retrieved April 22, 2021, from https://jogja.tribunnews.com/2020/07/23/bmkg-sejumlah-wilayah-diy-terancam-dilanda-kekeringan-meteorologis

Kodoatie, R. J. (2021). *Tata ruang air tanah*. Penerbit Andi.

Rahardjo, W., Sukandarrumidi, & Rosidi, H. M. D. (1995). *Peta geologi lembar Yogyakarta, Jawa [peta]*. https://opac.perpusnas.go.id/DetailOpac.aspx?id=141772

Telford, W. M., Geldart, L. P., & Sheriff, R. E. (1990). Applied geophysics. 2nd edition. *Applied Geophysics. 2nd Edition*.

Todd, D. K., & Mays, L. W. (2004). *Groundwater hydrology*. John Wiley & Sons.

Zakaria, Muhammad Faizal; Suyanto, I. (2020). Identifikasi akuifer air tanah di Desa Senawang, Kecamatan Orong Telu, Kabupaten Sumbawa menggunakan metode geolistrik schlumberger. In *Jurnal Fisika* (Vol. 10, Issue 1). https://doi.org/10.15294/JF.V10I1.24519

Zakaria, M. F. (2019). Identifikasi Akuifer Air Tanah Dalam Menggununakan Metode Geolistrik Schlumberger di Desa Wedomartani, Kabupaten Sleman. *Jurnal Mineral, Energi, Dan Lingkungan*, *3*(1), 20–25. https://doi.org/10.31315/JMEL.V3I1.2743

Zakaria, M. F., & Maisarah, S. M. (2020). IDENTIFIKASI BIDANG GELINCIR PADA DAERAH RAWAN LONGSOR DESA SRIMARTANI, YOGYAKARTA. *Jurnal Geofisika Eksplorasi*. https://doi.org/10.23960/jge.v5i3.36