Available online at: http://proceeding.rsfpress.com/index.php/ess/index
LPPM UPN "Veteran" Yogyakarta Conference Series
Proceeding on Engineering and Science Series (ESS)
Volume 1 Number 1 (2020): 504-512

Resistivity Modeling of Universitas Pembangunan Nasional "Veteran" Yogyakarta Groundwaters

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Abstract

UPN "Veteran" Yogyakarta is an educational institution that is actively developing various campus facilities. This development certainly cannot be separated from various problems. One of the existing problems is the problem of clean water installation, one of which is to overcome this problem is by developing groundwater sources. To assist in the development of the fulfillment of clean water demands at the UPN "Veteran" Yogyakarta campus, this research was carried out, which aims to detect various potential locations for groundwater development even though geologically and hydrogeological these are areas where it is difficult to determine the depth of good quality groundwater. The research method used is to study geological, hydrogeological, and climatological conditions supported by a study of subsurface conditions using the geoelectric method. From this, it is hoped that the potential points where groundwater can be developed, at the potential points equipped with information on the depth of the aquifer

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Keywords: Resistivity, groundwater, UPN "Veteran" Yogyakarta

I. INTRODUCTION

Clean water is a very vital need for urban growth. Offices in urban areas need a lot of clean water sources. With the increasing need for clean water, adequate facilities and large water sources are needed. Shallow groundwater sources are usually only used for daily community needs, while offices and industries are required to use deeper groundwater. UPN "Veteran" Yogyakarta, is one of the well-known campuses in the Special Region of Yogyakarta, which is currently active in building facilities and infrastructure. With the development of the UPN "Veteran" Yogyakarta campus, there is also an increasing need for clean water that can support campus academic activities and offices. The condition of clean water on the UPN "Veteran" Yogyakarta campus currently has a high Fe content which causes the existing water installations to become corroded and some toilet facilities to turn yellowish. Therefore, exploration is needed that is able to provide an overview of the existence of groundwater, especially regarding the depth and thickness of groundwater.

Various ways can be done to determine the presence of groundwater below the surface, one of which is by investigating the geoelectric method. The geoelectric method is a geophysical method that studies the properties of the propagation of electric currents below the surface. The geoelectric method maps the distribution of the resistivity value below the surface through surface measurements. This resistivity value is able to provide information about the properties of the rock and rock filler minerals including groundwater content. Groundwater is a good conductor of electricity because groundwater contains electrons that are able to conduct electric current well so that it will show a low resistivity value in the measurement of the geoelectric method.

Based on the explanation above, it can be concluded that this research is very important to be carried out, especially with the increased development carried out by the UPN "Veteran" Yogyakarta campus. Through measurement and modeling of the geoelectric method in the UPN "Veteran" Yogyakarta campus area, groundwater conditions around the campus can be identified, so that it can be used as a reference in determining the groundwater drilling location and the depth of groundwater drilling around the campus. It is hoped that the utilization of groundwater from the measurement results of the geoelectric method can be used to support the activities of the UPN "Veteran" Yogyakarta campus.

II. LITERATURE REVIEW

Groundwater is a critical source of clean water demands, and the absorption zone is the key to groundwater availability which must always be protected and monitored continuously (Werner, et al, 2017). The study area is in an area that is potentially a sub-recharge area, which must avoid disturbance in order to maintain the evolution of the quality and quantity of groundwater resources and to protect against significant groundwater subsidence (Purnama, 2018). The structural pattern and distribution of groundwater Physico-chemical properties are used to describe the groundwater compartments in aquifer systems, and to interpret the spatial variability of groundwater physicochemical properties associated with groundwater flow and geological structure.

This study can be used to describe the general direction of geological structure alignment and can be spatially divided into several different zones, analyze hydrochemical properties data to modify various hydrochemical compartments, and map the piezometric and hydrochemical spatial distribution. The results of data analysis and interpretation of the data that will be obtained can contribute to groundwater management in the UPN "Veteran" Yogyakarta.

The regional geology of Sleman Regency is the fluvial volcanic plain of the Young Merapi Volcano, which morphs structurally a graben (Saputra, et Al. 2018). This unit is composed of tuff, ash, breccias, agglomerates, and inseparable lava melts that are Pleistocene - Holocene age and constitute land deposits. Rahardjo et al, (1995) named the Yogyakarta formation, which is composed of volcanic deposits of Mount Merapi, is not aligned above all the older formations, and the east side spread of the Kulonprogo Dome is more than 20 meters thick. The graben arrangement at the top is the deposition of alluvium material resulting from the deposition of pyroclastic material from volcanic eruptions, which is a container that has the potential to collect groundwater. Groundwater will be concentrated in a sustainable manner in this graben, which is a potential groundwater flow path, because on the right and left it is bounded by a fault wall (horst), as a barrier to groundwater flow, namely the fault walls of the Baturagung hills in the east, and the hillside fault walls. Incised in the west. This condition causes the morphology of the Sleman Regency to form a regional groundwater basin, namely the Merapi aquifer system to the coastal aquifer system.

Regional hydrogeology in Sleman Regency and its surroundings is part of the Yogyakarta groundwater basin, which has a varied groundwater distribution. Based on the geomorphological landscape, almost all of Sleman Regency is the fluvial Vulcano plain of Merapi Muda Volcano, which morphs structurally a graben. Graben, the top of which is the deposition of alluvium materials from the overhaul of pyroclastic material resulting from volcanic eruptions, is a container that has the potential to collect groundwater.

The topographic condition of the Sleman Regency in the southern part is relatively flat, except for the hilly areas in the southeastern part of the Prambanan District and partly in Gamping District. Getting to the north is relatively sloping and in the north around the slopes of Mount Merapi is relatively steep. The altitude of the Sleman Regency ranges from 100 meters to 2,500 meters above sea level (m asl). The height of the land can be divided into 4 classes, namely the height <100 meters, 100-499 meters, 500-999 meters, and> 1,000 meters above sea level. Altitude <100 m above sea level covering an area of 6,203 ha, or 10.79% of the total area, found in Moyudan, Minggir, Godean, Gamping, Berbah, and Prambanan Districts. The altitude of 100-499 m above sea level covering an area of 43,246 ha, or 75.32% of the area, is found in 17 districts. Altitude 500-999 m asl covers an area of 6,538 ha, or 11.38% of the total area, found in Tempel, Turi, Pakem, and Cangkringan Districts. Altitude> 1,000 m asl, covering an area of 1,495 ha, or 2.60% of the total area, is found in Turi, Pakem, and Cangkringan Districts.

III. RESEARCH METHODOLOGY

This research was conducted beginning with field measurements using the sounding geoelectric method which has a fairly good vertical penetration. Field measurements are carried out with a stretch of 400 meters which is expected to provide penetration of up to 100 meters. The field data obtained are in the form of injection current strength (I), voltage (V), and pseudo resistance (ρ). The apparent resistivity value is then processed with inversion modeling to obtain the actual resistivity value. The resistivity value is interpreted to determine the type of subsurface rock formation, including the presence of groundwater in the subsurface (figure 1)

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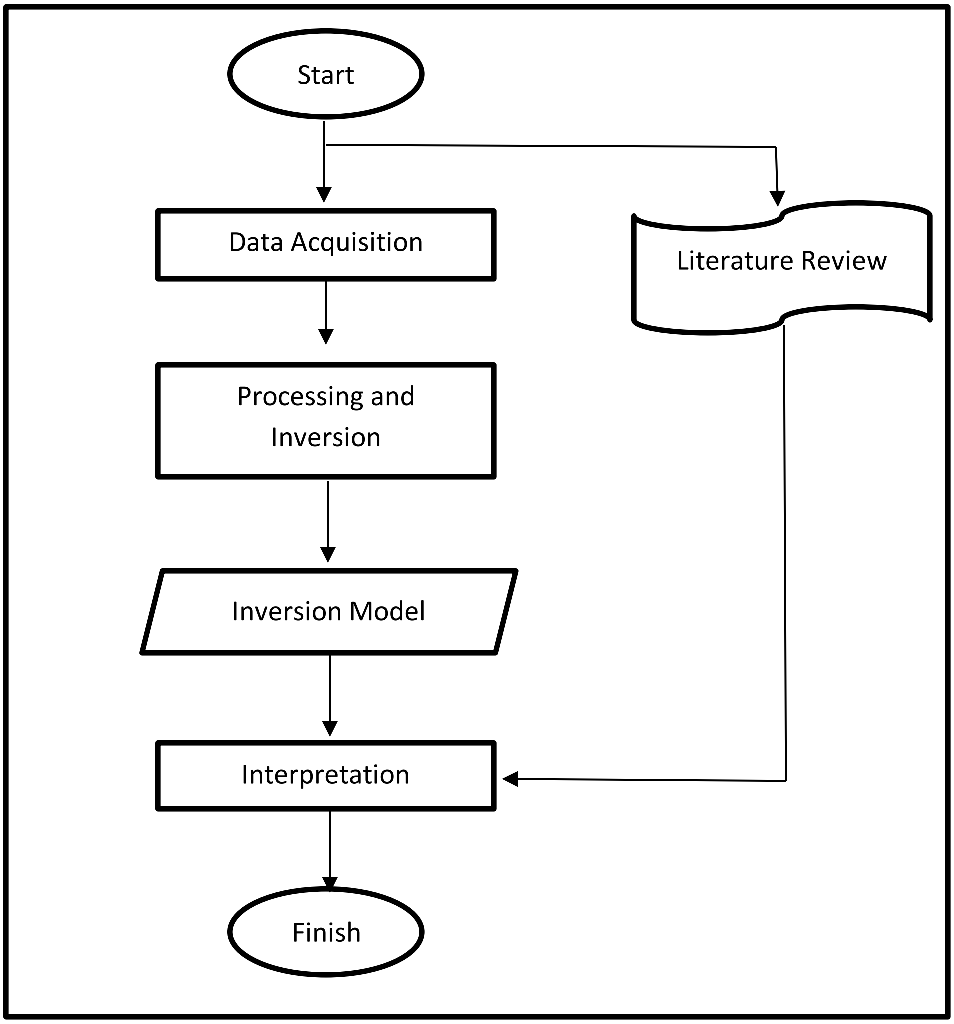

Figure 1. Research Flow Chart

The geoelectric method is one of the geophysical methods used to investigate subsurface conditions, namely by studying the resistivity properties of rocks below the earth's surface. From these measurements, the actual resistivity value can be predicted. Subsurface resistivity is related to variations in geological parameters such as mineral and fluid content, porosity, and degree of saturation of a rock (Loke, 2004). Theoretically, the electricity of the rock is the amount of resistance the rock gives when the current flow to it, and the value of the resistance is expressed as the resistivity value (ρ) (Reynolds, 1997).

The basic principle of the resistivity geoelectric method is Ohm's Law. Where the resistance is obtained by measuring the potential difference and the current that is passed in a conductor.

$$R = \frac{V}{I}$$

Where R is the resistance (resistance) in ohms, V is the potential difference and I is the current flowed. Because the medium beneath the earth's surface is not homogeneous, there is a definition of resistivity/ρ) which depends on the electrode installation current and potential or geometric factor (k), as well as the potential read (V) and the current delivered (I).

$$\rho = k\frac{V}{I}$$

The configuration used for sounding data retrieval is the Schlumberger configuration with eccentricity $e \leq \frac{1}{5}$ The electrode arrangement is as follows: (figure 2).

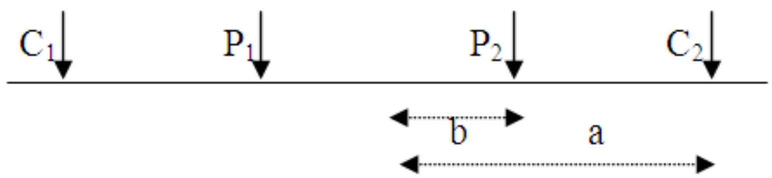

Figure 2. Schlumberger electrode arrays arrangement (Telford, et al, 1976)

For the Schlumberger electrode installation, the relationship between resistivity (ρ), potential difference (ΔV), and current (I) is obtained as follows;

$$K_S = \frac{\left(a^2 - b^2\right)}{2b}\pi$$

IV. RESULTS AND DISCUSSION

The measurement of the geoelectric method was carried out using the VES method with the Schlumberger configuration, in this progress report measurements of two test points of the geoelectric method were carried out around the UPN "Veteran" Yogyakarta Condongcatur campus.

a. Interpretation of line 1

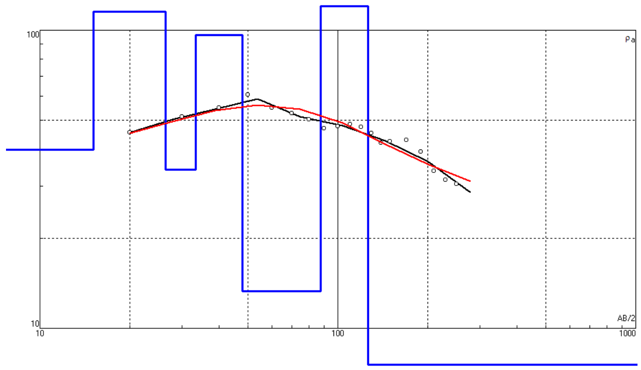

Figure 3. 1D model of line 1

Based on the geoelectric curve of test point 1 above, the variation in subsurface resistivity values is obtained in the following table;

Table 1.Variation in the resistivity value of the test point 1

No	Rho (Ohm.m)	Thickness (m)	Depth (m)	Interpretation
1	39.7	15.1	0 - 15.1	Sand
2	115	11.3	15.1 - 26.4	Sandstone Dry
3	34.1	6.94	26.4 - 33.3	Groundwater
4	96.4	14.5	33.3 - 47.8	Sandstone Dry
5	13.3	39.8	47.8 - 87.7	Groundwater
6	160	38.6	87.7 - 126	Sandstone Dry

Based on the variation in the resistivity value obtained, it can be seen that the subsurface lithology around the UPN "Veteran" Yogyakarta Condongcatur campus is dominated by the sandstones of young volcanic products. There are two layers of groundwater aquifer detected at this measurement point, namely at a depth of 26.4 - 33.3 meters with a resistivity value of 34.1 ohm.m and at a depth of 47.8 - 87.7 meters with a resistivity value of 13.3 ohms. m.

b. Interpretation of Line 2

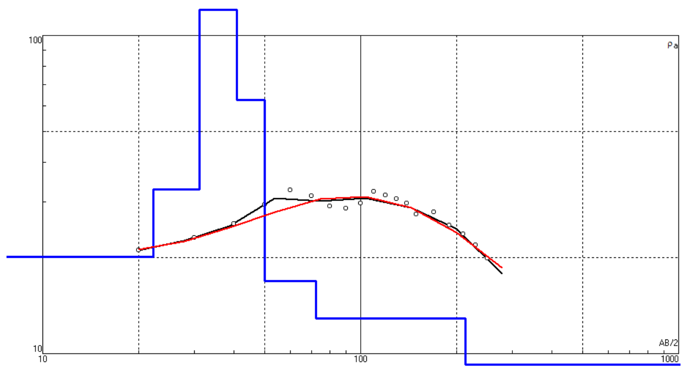

Figure 4. 1D model of line 2

Based on the results curve of the 1 D model, the measurement of the geoelectric method at test point 2, the subsurface resistivity variation values can be known as follows;

Table 2.Variation in the resistivity value of the test point 2

No	Rho (Ohm.m)	Thickness (m)	Depth (m)	Interpretation
1	20.1	22.3	0 - 22.3	Sand
2	32.8	8.84	22.3 - 31.1	Groundwater
3	128	9.67	31.1 - 40.8	Sandstone Dry
4	62.7	9.11	40.8 - 49.9	Sandstone Dry
5	16.9	22.4	49.9 - 72.4	Groundwater
6	12.9	141	72.4 - 114	Siltstone

Based on the variation in the resistivity value at test point 2, it is found that the dominant lithology around the measurement location is the sandstone products of the young Merapi volcano. The groundwater aquifer layer detected at test point 2 is at a depth of 22.3 - 31.1 meters with a resistivity value of 32.8 ohm.m and at a depth of 49.9 - 72.4 meters with a resistivity value of 16.9 ohms.

Based on the measurement of the 1D geoelectric method that has been carried out, it is found that there are two groundwater aquifers around the measurement area. The first aquifer is located at a depth of 22.1 - 33.3 meters below the surface in the form of sandstone lithology with a resistivity value of 32.8 - 34.1 ohm.m. The second groundwater aquifer is deeper, namely at a depth of 47.8 - 87.7 meters below the surface with the aquifer lithology in the form of sandstones.

The clean water well in the UPN "Veteran" Yogyakarta campus area has an average depth of 20 meters from the surface, based on the geoelectric method measurement data at that depth is still shallow groundwater. The shallow groundwater in the Yogyakarta area on average has high Fe content, so it is corrosive to metal water installations. Therefore, based on this research, it is recommended that deeper groundwater drilling at a depth of 70 meters which has a lower Fe content so that it is more friendly to existing water installations and also reduces the impact on the water consumption of the community around the campus.

V. CONCLUSION

The conclusions of this study are:

1. Geologically, UPN "Veteran" Yogyakarta Condongcatur campus I am in the lithology unit of the Young Merapi volcanic deposits, consisting of lumps, fine-coarse sand, tuff, and silt.
2. Groundwater quality in UPN "Veteran" Yogyakarta is classified as poor with quite high levels of iron, manganese, and turbidity levels.
3. Through the measurement of the geoelectric method at the two test points, two groundwater aquifers were obtained, namely at a depth of about 22.1 - 33.3 meters and 47.8 - 87.7 meters.
4. It is recommended to drill deeper clean water well, at a depth of 70 meters.

ACKNOWLEDGEMENTS

This study is carried out because of internal funding of an internal applied research grant from Lembaga Penelitian dan Pengabdian Masyarakat (LPPM) UPN "Veteran" Yogyakarta, so that study can be carried out properly.

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