

Aquifer Investigation in Cibodas Bogor, West Java, Indonesia, using a Geoelectrical Method and 2D Subsurface Modeling

Al Hussein Flowers Rizqi^{1*}, Muhammad Erlandi¹, Muhammad Arifai², Muhamad Ibnu Hibban¹

^{1*} Jurusan Teknik Geologi, Institut Teknologi Nasional Yogyakarta

² PT Sirtu Bumi Nuswantara

*Email Korespondensi : alhussein@sttnas.ac.id

Email : erlandi123.me@gmail.com

Email : rifai_geologist@yahoo.co.id

Email : muhamadibnuhibban0@gmail.com

ABSTRACT

This study was conducted at the location of a cattle pen (Kafeel Farm) in Bogor City, more precisely in the Cibodas village. The purpose of this study is to use subsurface cross-sectional correlations to get a general picture of the lithology, geological structure, and subsurface aquifers. In addition to improving knowledge of the depth and distribution of aquifers in the study area, the contribution of this research will influence residents' groundwater searches. The geoelectrical method with Schlumberger configuration is the methodology employed in this study. In the research area, there were three points of observation in the geoelectrical acquisition data. From oldest to youngest, the study area's lithology consists of sandstone with mudstone intercalations (Serpong Formation) and limestone lithology (Bojongmanik Formation). The weathering of limestone and sediments from the Cisadane River is used to interpret the surface soil. At a depth of 8 to 35 meters and a thickness ranging from 10 to 18 meters, the study area's aquifer contains shallow groundwater. Drilling is advised at observation point 2, at a depth of approximately 8 to 18 meters

Keyword : Aquifer, Serpong Formation, Bogor, Geoelectrical; Schlumberger

INTRODUCTION

The need for water is very important for living creatures. Clean water is a basic need for human life. Its existence is not only limited to human needs, but also for livestock. The need for clean water is also a basic need that cannot be replaced and abandoned, therefore, processing and preserving water is necessary [1]. The safest type of water for human consumption is groundwater. Groundwater is one of the water resources that is very important in meeting human needs, both for domestic and industrial uses [2]. This study was carried out in Bogor City, specifically in the Cibodas neighborhood, at the site of a cattle pen (Kafeel Farm). Enough water must be available to meet the livestock's needs. However, access to clean water is problematic south of Goa Pengantin, along the Cisadane River. The purpose of this research was to find an aquifer because of the challenge of the presence of clean water. Bogor City is situated in the Bogor Basin Zone [3] a basin polybasin, according to regional physiography [4]. From oldest to youngest, the Bojongmanik Formation, Serpong Formation, Young Volcanic Deposits, Sudamanik Volcano Andesite, and alluvial deposits comprise the Bogor Zone's regional stratigraphy, which is included in the study area (Figure. 1)

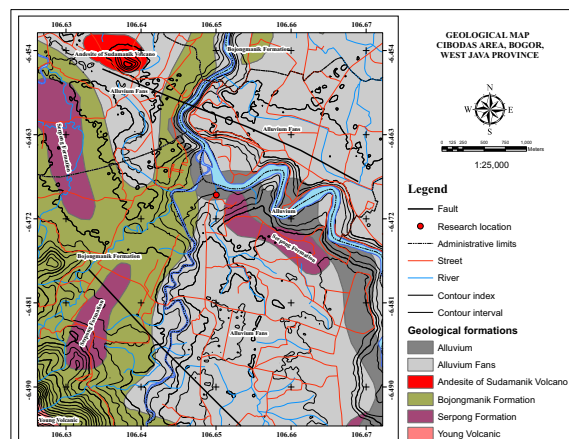


Figure 1. Regional Geological Map of research area (location of research area showed in red dot)

The oldest geological formation in this region is the Bojongmanik Formation (Tmb), which is primarily composed of sedimentary rocks. The Bojongmanik formation is lithostratigraphically composed of mud and mixed sandstone, suggesting a fluctuating deposition environment, and limestone layers, suggesting a shallow marine period. According to previous researcher [5], [6] and [7] the Bojongmanik Formation [8] was deposited in back mangroves [6] and originated between N9 and approximately N15, or the Middle Miocene [9]. The Serpong Formation (Tpss), which is made up of different lithologies and exhibits more intricate deposition environmental dynamics, is situated above the Bojongmanik Formation. The conglomerate, sandstone, siltstone, and mud that make up this formation exhibit different deposition energies. The presence of pumice tuff suggests that this region was impacted by volcanic activity. The study area's younger volcanic activity produced the Young Volcanic Rocks (Qv)[10], which are made up of different volcanic products like lava and breccia that show signs of volcanic activity. Mount Sudamanik's Andesite Volcanic Rock (Qvas) suggests a younger stage of volcanism, which is believed to have been a lava flow or intrusive body. The youngest formation in the study area is Fan Alluvium (Qav), which is composed of tuff conglomerate alternated with fine and sandy tuff lithology.

This difficulty in obtaining clean water prompted researchers to study subsurface conditions using the geoelectric resistivity method. Resistivity geoelectric method is one of the geoelectric methods used to investigate subsurface structures based on differences in rock resistivity [11]. The basis of the resistivity method is Ohm's law, namely, by flowing current into the earth through a current electrode and measuring the potential on the earth's surface using a potential electrode [12]. This research aims to obtain an overview of lithology, geological structure, and subsurface aquifers based on subsurface cross-sectional correlations using the geoelectrical method. The contribution of this research will have an impact on the search for groundwater for residents and increase understanding of the depth and distribution of aquifers in the research area.

METHODS

The method used in this research is divided into several stages, namely the preparation stage, the field data collection stage (field work), the studio analysis and evaluation stages and writing scientific articles (**Figure. 2**).

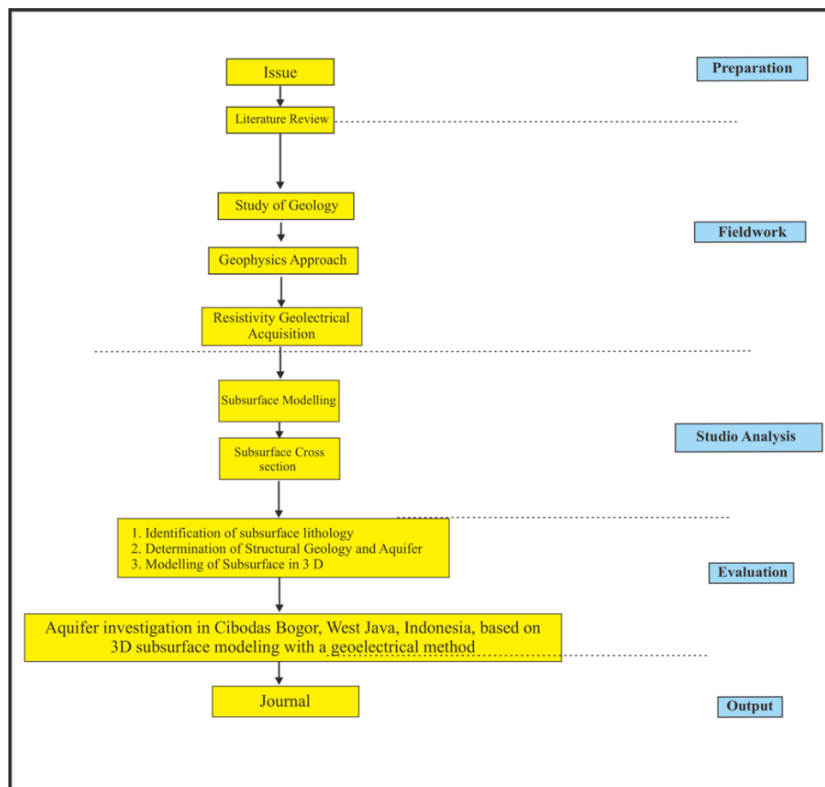


Figure 2. Research method flow chart

Preparation Stages

The preparation stage includes a literature review of previous studies from several researchers in geological studies, including geomorphology, stratigraphy, geological structure, and several studies regarding aquifers around the research area. Apart from that, the preparation of geoelectrical equipment in the form of resistivity meters, cables, electrodes, and equipment for data collection is also required.

Stage of field data collection

The field data collection stage is divided into two stages, namely surface geological data collection and subsurface geological data collection. Surface geological data in the form of observations of geomorphology, lithology, and the appearance of geological structures. Subsurface data collection includes the use of the geoelectric method with the Schlumberger configuration to see vertical variations in resistivity values. Data collection was carried out at 3 location points that were relatively close together and intersected each other.

Studio Analysis Stage

After collecting field data in the form of resistivity values, it is entered into the Progress software to get a vertical picture of the model or profile. Resistivity values are interpreted using the [12] classification. The results of the interpretation of each measurement location are then correlated with other points to obtain a cross-section of the lateral distribution of each lithology.

Evaluation Stage

Evaluation is carried out based on the distribution, depth and thickness of each aquifer which is interpreted from the results of data processing. The aquifer that has been determined is then chosen as a recommended location for drilling the well. The recommendation point is the best location from the integration of tie well data around the location, topography and other geological conditions

RESULT AND DISCUSSION

Data Collection Location

The data collection location was carried out in a cattle drum called Cibodas Village, Bogor, West Java. Data collection was carried out within a radius of no more than 500 meters near the Cisadane River. Data collection was carried out at 3 points around the location where the Kafael farm and cowshed were built in the research area (**Figure 3**).

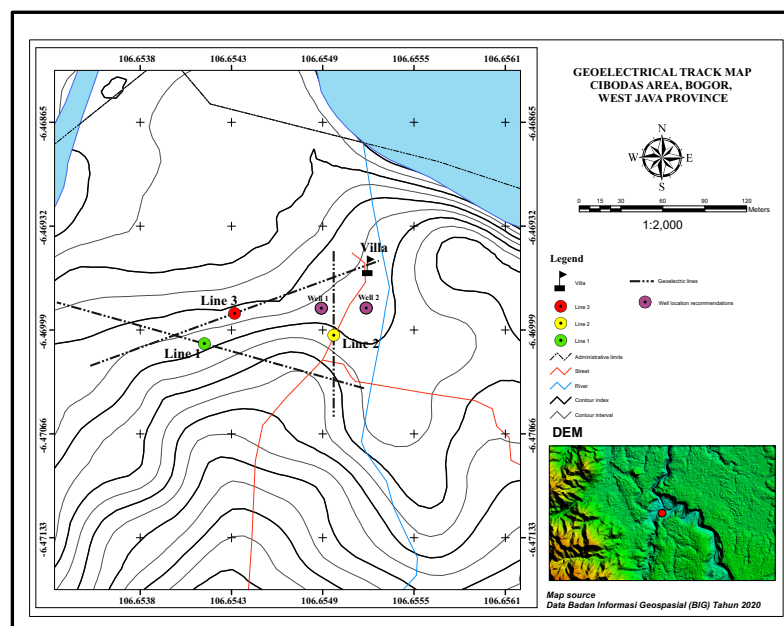


Figure 3. Measurement (Observation Point) Map of Research Area

Track 1 (Measurement Point 1)

At measurement point 1 the relative direction of the cable stretch is N 275 E (relative northwest – southeast). The lithology on the surface is generally soil from young volcanic deposits. The results of geoelectric measurements show a depth that can be interpreted up to a depth of 82 meters. The lithology that makes up point 1 is soil, sandstone, mudstone and limestone. The aquifer is found at a depth of 25 meters (**Table 1**) (**Figure 4**).

Table 1. Interpretation of Rock Formation based on Resistivity Value at Point of observation 1

Depth (meter)	Thickness (meter)	Resistivimeter (ohm meter)	Lithology (rock name)
0 – 15	15	5.12	Soil
15 – 21	6	16.25	Sandstone
21 – 25	4	0.22 – 2.19	Claystone
25 – 43	18	0.83 – 1.39	Sandstone (aquifer)
43 – 57	14	14.08	Sandstone
57 – 83	26	580.46	Limestone

Track 2 (Point of observation 2)

At measurement point 2, the relative direction of the cable stretch is N 181 E (relative north–south). The lithology on the surface is generally soil from young volcanic deposits. The results of geoelectric measurements show a depth that can be interpreted up to a depth of 36 meters. The lithology at observation point 2 is in the form of soil and sandstone. The aquifer can be found at a depth of 8 meters (**Table 2**) (**Figure 5**).

Table 2. Interpretation of Rock Formation based on Resistivity Value at Point of observation 2

Depth (meter)	Thickness (meter)	Resistivimeter (ohm meter)	Lithology (rock name)
0 – 2	2	19.31 – 21.97	Soil
2 – 8	6	9.53 – 60.94	Sandstone
8 – 18	10	0.80	Sandstone (aquifer)
18 – 36	18	5.66 – 6.98	Sandstone

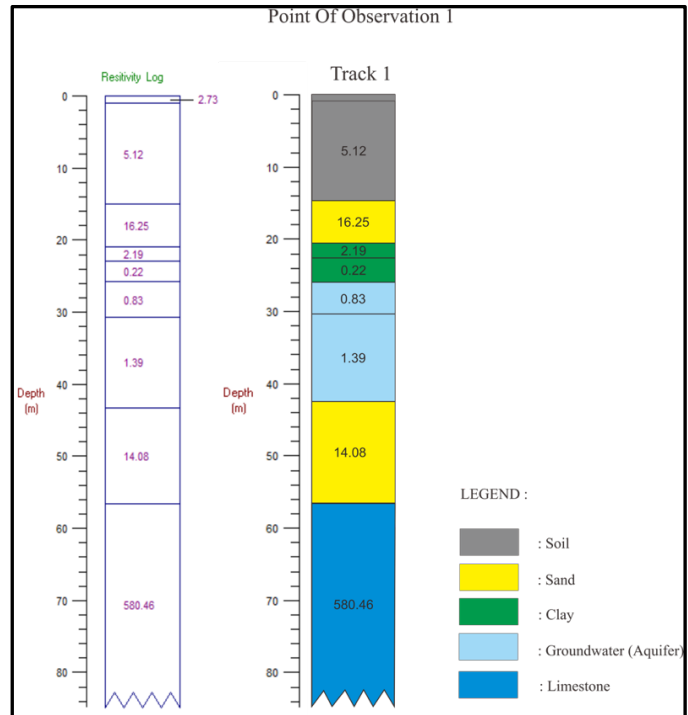


Figure 4. Interpretation of Rock Lithology based on Resistivity Value at Point observation 1

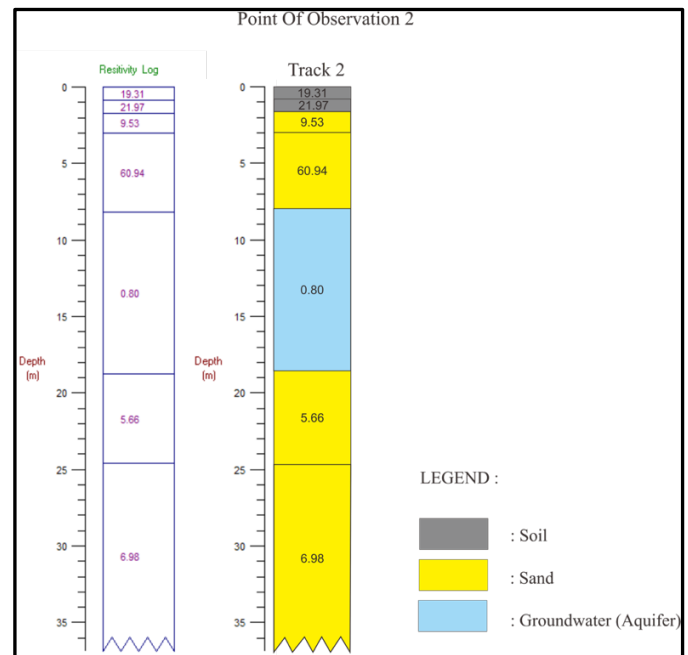


Figure 5. Interpretation of Rock Lithology based on Resistivity Value at Point observation 2

Track 3 (Point of observation 3)

At measurement point 3, the relative direction of the cable stretch is N 35 E (relatively northeast – southwest). The lithology on the surface is generally soil from young volcanic deposits. The results of geoelectric measurements show a depth that can be interpreted as reaching a depth of 76 meters. The lithology at observation point 2 is soil and sandstone. The aquifer can be found at a depth of 25 meters (**Table 3**) (**Figure. 6**).

Table 3. Interpretation of Rock Formation based on Resistivity Value at Point of observation 3

Depth (meter)	Thickness (meter)	Resistivitymeter (ohm meter)	Lithology (rock name)
0 – 2	2	1.53 – 12.80	Soil
2 – 30	28	7.69 – 2.72	Sandstone
30 – 46	16	0.63 – 0.71	Sandstone (aquifer)
46 – 50	16	13.70	Sandstone
50 – 76	26	230.10	Limestone

Lithology Interpretation and Correlation of Subsurface Sections

Lithological correlation is carried out at each observation location point by connecting the same (similar) lithological characteristics. This correlation was carried out from track 1 to track 2, continued to track 3, and back to track 1. The presence of water was interpreted to vary, and the thickness was different for each observation point (Table 4) (Figure 7).

Table 4. Interpretation of Aquifer based on Resistivity Value in research area

Point of observation (line)	Depth (meter)	Thickness (meter)	Resistivitymeter (ohm meter)	Lithology (rock name)
1	25 – 43	18	1.53 – 12.80	Sandstone (aquifer)
2	8 – 18	10	7.69 – 2.72	Sandstone (aquifer)
3	30 – 46	16	0.63 – 0.71	Sandstone (aquifer)

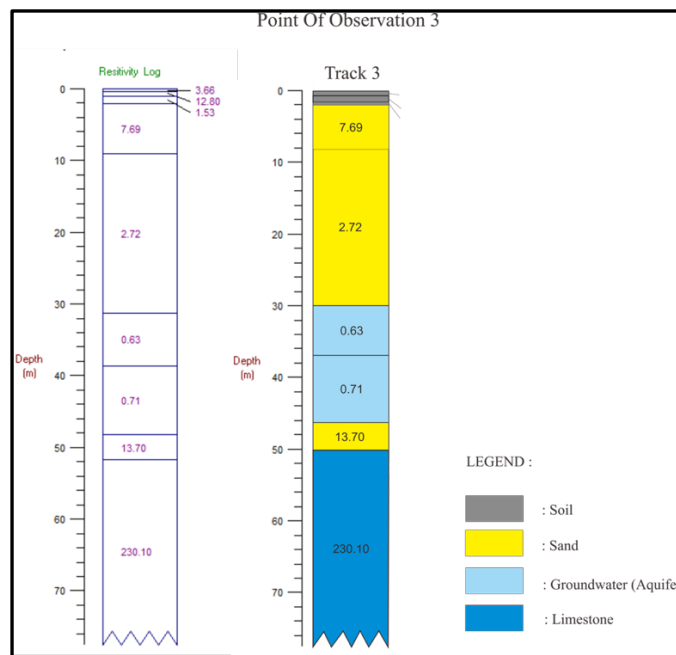


Figure 6. Interpretation of Rock Lithology based on Resistivity Value at Point observation 3

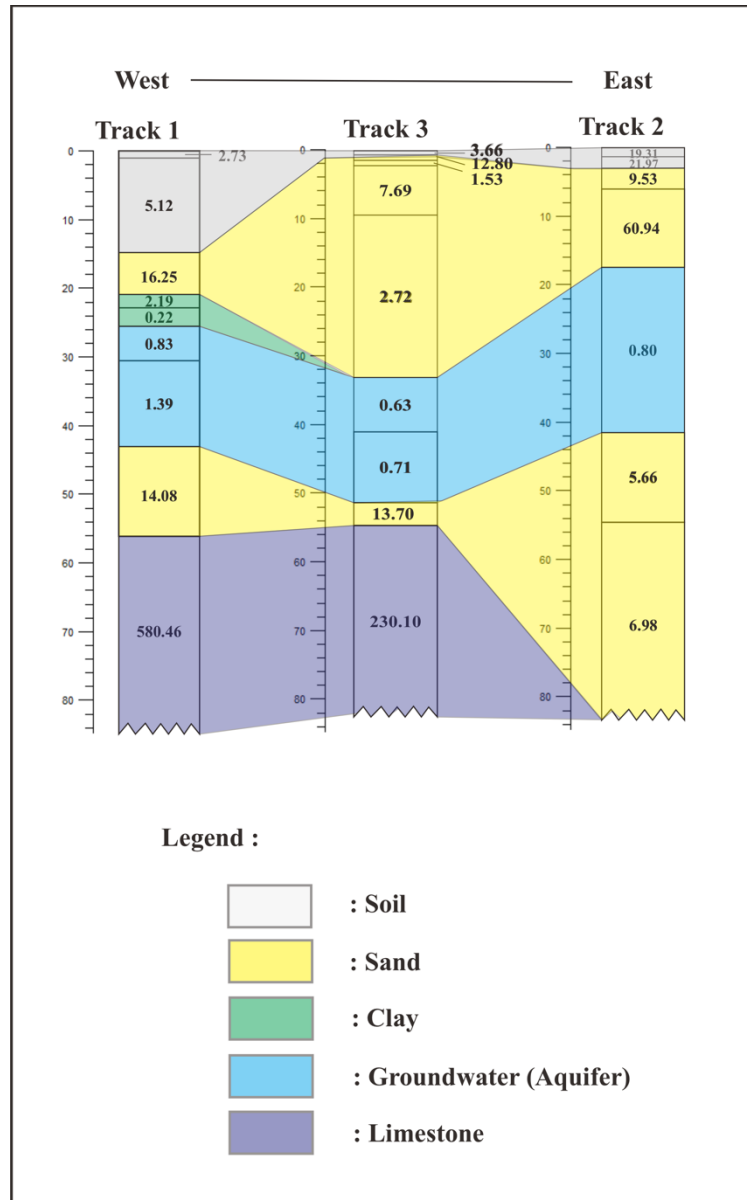


Figure 7. Interpretation of Rock Lithology based on Resistivity Value at Point observation 3

The lithology in the study area includes 3 rock formations. The oldest rock formation is the rock formation from the Bojongmanik Formation, which is characterized by resistivity values varying from 230.10 – 580.46 ohm meters and is interpreted as limestone. This limestone is also found on the surface, with the presence of the Pengantin Cave in the north of the study area. The Bojongmanik limestone in Ciampea Hill (south of the research area) is included in the clastic limestone in the form of red algae packstone, skeletal wackestone, and boundstone, and has a porosity of up to 10% [13]. The structural geology data could not be found due to the presence of thick soil on the surface.

The straightness of the Cisadane River, which tends to be reasonably northwest-southeast, is interpreted as the appearance of the geological structure [14] and [15]. The groundwater-bearing layer (aquifer) is in the Serpong Formation with sandstone lithology and local claystone inserts. This aquifer has a resistivity value ranging from 0.60 – 1.39 ohm meters and is a shallow aquifer. Serpong sandstone has predicted shallow and deep groundwater reserves obtained using the Darcy equation of 2.46 m³/second and 8.64 m³/second. The aquifer in the research area is fairly deep, especially at observation points 1 and 3 which are at depths of 25 meters and 35 – 46 meters. This aquifer is included in the Bogor Groundwater Basin, which is included in the Ciampea Region, which has an average groundwater level of 5 meters at a depth of 5.4 meters. The recommendation for groundwater drilling that can be given for groundwater drilling is at observation point 2

which has a relatively shallow depth, namely at a depth of 8 – 18 meters. This has been proven and groundwater drilling has been carried out in the research area.

CONCLUSION

The lithology of the study area from oldest to youngest, includes limestone lithology (Bojongmanik Formation) and sandstone with intercalations of mudstone (Serpong Formation). The surface soil is interpreted from the weathering of limestone and Cisadane River sediments. The aquifer in the study area includes shallow groundwater at a depth of between 8 - 35 meters and a thickness varying from 10 - 18 meters. The drilling recommendation is at observation point 2 with a depth of around 8 – 18 meters.

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