Analysis of Groundwater Infiltration using the Schlumberger Geoelectric Method

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Abstract. Groundwater is one of the best water resources for clean water, which can be used to meet the needs of people's lives, such as household, irrigation, and industrial needs. Based on the theory that changes in land use will have an impact on groundwater absorption. This study aims to see and analyze underground water absorption around the gate of the University of Riau using the geoelectric method of the Schlumberger configuration. Based on the results of measurements of resistivity values and groundwater infiltration in the Gate area of Riau University, Simpang Baru, Tampan, Pekanbaru, Riau, it is interpreted for the soil layer obtained with resistivity values ranging from 235.38 Ohm-m to 595.66 Ohm-m with a depth of obtained up to 35 m, and for the interpretation of lithological layers, namely clay, distribution of gravel, sandstone, and sand and gravel. The underground water infiltration value obtained from the calculation results is that for the clay layer is 13.42 m³/year, the gravel distribution layer is 13.42 m³/year, the sandstone layer is 40.27 m³/year and the sand and gravel layer is 40.27 m³/year.

1. Introduction

The Groundwater is one of the best water resources for clean water, which can be used to meet the needs of people's lives, such as household, irrigation and industrial needs [1]. Based on the theory that changes in land use will have an impact on groundwater absorption. Extraction of groundwater through clean water wells will result in a depression cone [2]. A new balance can occur if the rate of groundwater uptake is smaller than the filling by rainwater in the catchment area [3]. The groundwater table is generally not horizontal but more or less follows the topographic surface [4]. If there is no rain then the water level under the hill will decrease slowly until it is parallel to the valley, but this does not happen because the rain will fill the recharge. The area where rainwater seeps below the precipitation until the saturation zone is called the recharge area [5].

Clean water is the least fraction of all types of water on earth. Almost 70% of the area on earth is covered by water, but only 2.5% of that water is categorized as clean water. Even only 1% of the total amount of clean water is easy to obtain, the rest is difficult to obtain because it is trapped in glaciers and snowflakes. The problem of water in the world is only 0.007% of the total water on earth that can meet the needs of 6.8 billion people on earth [6]. Lack of water can be caused by the absorption of land into water. Areas that cannot absorb water properly will drain runoff from the surface of the soil directly to rivers and the sea without being preceded by the process of absorbing water into the soil. This has an impact on reducing the volume of groundwater so that groundwater abstraction cannot be
maximized. In addition to natural factors, water absorption is also influenced by human factors. Many areas of vegetation are used as built-up areas, which reduces water absorption. The watershed as a buffer for groundwater also cannot function properly if the water catchment area is damaged.

A water catchment area is an area where rainwater seeps into the ground which becomes groundwater. The catchment area is referred to as the area that is the direction of groundwater flow away from the surface, this area is very important in estimating underground water sources and determining the conservation area of the catchment area.

The geoelectric method is a geophysical method that studies the nature of the flow of electricity on the earth and how to detect the earth's surface [7]. The results of the measurement of electric current for each different potential electrode distance can be obtained a variation of the resistivity value of the structure under the measuring point [8]. The interpretation of resistivity values is usually carried out using the assumption of a horizontally layered earth model and a tropical homogeneity [9].

2. Methodology
The methodology used in this study is the experimental method using the geoelectric method of the Schlumberger configuration. The amount of groundwater infiltration is calculated using the theory proposed by Juandi [5]. The research procedure with measurements using the Schlumberger rule geoelectric method is as follows:
1. Using the length of the path understudy
2. Determine the midpoint of the track length as a reference point for the start of the measurement.
3. Connect the wires to the current and potential electrodes and connect them to the resistivity meter.
4. Inject current and potential electrodes as deep as 15 cm.
5. Adjust the electrode distance, that is, the potential electrode distance (MN) is two meters and the current electrode distance (AB) is 8 m.
6. Connect the resistivity meter to the battery, then record the initial results. Move each current electrode as far as 4 m and each potential electrode as far as 1 m until the measured bar length is complete.
7. Perform data collection at the next point with the steps at the first point by adjusting the space between the current electrode and the potential electrode.

3. Results and discussion
3.1. Data and analysis of resistivity and lithological structure
The data measured in the field for each measurement point has a track length of 150 m at the Riau University Gate with a resistivity device consisting of current and potential difference parameters. Then the data is converted into apparent resistivity and the results are processed using Software Progress.

| Depth (m) | Resistivity Value (Ohm-m) | Type Rock | Thickness (m) |
|-----------|---------------------------|-----------|---------------|
| 0–3.17    | 235.38                    | Clay      | 3.17          |
| 3.17–15.40| 546.86                    | Distribution of gravel | 12.23 |
| 15.40–25.00| 608.48                   | Sandstone | 9.6           |
| 25.00–35.00| 595.66                   | Sand and gravel | 10.00 |

The results of calculations and data processing as shown in Table 1 with the Progress software for the Schlumberger Method obtained an RMS-error value of 8.6462% with a layer depth that reads
software progress of up to 25 m and modeling the distribution of the resistance value of the type of material under the surface along the track as shown in Figure 1.

Figure 1. Data Processing Interface using progress.

The results of the calculation of the value of groundwater infiltration based on the results of the measurement of geoelectrical data on track 1 are shown in Table 2 as follows:

Table 2. Table of results of underground water infiltration.

| Depth (m) | Area (m²) | Infiltration Coefficient (%) | Rock Type      | Infiltration Value (m³/year) |
|-----------|-----------|------------------------------|----------------|-----------------------------|
| 0–3.17    | 7500      | 5                            | Clay           | 13.42                       |
| 3.17–15.40| 7500      | 5                            | Gravel         | 13.42                       |
| 15.40–25.00| 7500    | 15                           | Sandstone      | 40.27                       |
| 25.00–35.00| 7500   | 15                           | Sand and gravel| 40.27                       |

4. Conclusion

Based on the results of measurements of resistivity values and groundwater infiltration in the Gate area of Riau University, Simpang Baru Village, Tampan District, Pekanbaru City, Riau Province, it is interpreted for the soil layer obtained with resistivity values ranging from 235.38 Ohm-m to 595.66 Ohm-m with a depth of obtained up to 35 m, and for the interpretation of the lithology of the layers, namely clay, distribution of gravel, sandstone and sand, and gravel. The value of underground water infiltration around the gate of the University of Riau which is obtained from the calculation results is that for the clay layer is 13.42 m³/year, the distribution layer of gravel is 13.42 m³/year, the sandstone layer is 40.27 m³/year, and the sand and gravel layer is 40.27 m³/year.

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