Aquifer Distribution Based on 1D Resistivity Method at Jatinangor Educational Area, Sumedang Regency, West Java Province

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Abstract. Continuous development in the area of Jatinangor campus is becoming one of the problems threatening the groundwater supply. To support the availability of groundwater in the area of Jatinangor campus, a geophysical investigation with the geo-electric method is conducted to determine the condition of the subsurface based on the value of resistivity of rock. Based on Bandung’s regional geological map of Silitonga in 2003, rocks in the Jatinangor area consist of volcanic rock breccia, tuffs, and lapilli that makes it possible to contain the groundwater. 32 stations of 1-Dimensional (DC sounding) geo-electric measurement using Schlumberger configuration are performed in Jatinangor area. We integrated the results of measurement with geological and hydrogeological observation information with the aim of producing images of subsurface rocks and distribution models. Based on the model, the type of aquifer contained in the study area as well as its potential reserve can be determined. This research aims to know the potential groundwater zone region to support the availability of groundwater for Jatinangor education region. Furthermore, the results are expected to provide insights in implementing conservation strategies for Jatinangor educational area, Sumedang Regency.

1. Introduction
Jatinangor Education Area is located in the 6°52’30”- 7°00'00” of south latitude and 107°45’00”-107°52’30” of east latitude. Administratively, This area lies on the border between The Sumedang Regency and Bandung City. High population growth in this region resulted in a high population density which is around 4,270 people / km² [1]. This research aims to determine the potential groundwater zone region to support the availability of groundwater for Jatinangor education region. Furthermore, the results of this research are expected to provide insights in implementing conservation strategies for Jatinangor educational area, Sumedang Regency.

The resistivity method is a geophysical method that is very popular and frequently used both in geological survey and exploration. The method is better to be used for knowing the geological condition or structure of the subsurface based on the resistivity variety of the rocks. The value depends on several factors, including the age of rocks, electrolyte contents, rock density, a number of minerals it contains, porosity, permeability and so forth. One of the applications of this method is groundwater exploration. When the direct current flows into the earth through two current electrodes A and B, and the flow of the stream causing the potential difference in two potential electrode M and N is measured, we can obtain the apparent resistivity [2].
2. Geological Condition

![Geological Map](image)

**Figure 1.** Geological Map of Study Area, modification of Silitonga [3]

The exposed rocks in study area consists of five main units which all of them are young volcanic products, as can be seen in the Figure 1 [3]. They consist of irreducibly young volcanic deposits which are tuffaceous sand, lapilli, breccia, lava, and agglomerate. These rocks came from The Tangkubanparahu Mountains and also from some parts of The Tampomas Mount, which spread to many places within Sumedang-Bandung Border. These Quarter-age rocks formed a small and flat plains. The rocks also formed lowlands covered by yellowish-grey and reddish-grey soils [4].

3. Hydrogeological Condition

There are two regions of the groundwater basin in this area, namely the area of groundwater with the discharge rate of less than 5 l/second and having deep, widespread moderate productivity aquifer, as can be seen in the Figure 2. This region occupies 60% of the study area especially in the southern part. The second region is the area of the shallow, productive aquifer with a deep water table. There are several springs which were encountered in the area. This region occupies 40% of the study area especially in the northern part [5].

4. Method

The research was conducted on Universitas Padjadjaran Campus by using a single Geoelectric Tool Unit ABEM DC Terrameter - SAZ 2000. We used The Schlumberger configuration of Resistivity method. We placed the potential electrodes M and N between the two current electrodes A and B. We carried out the measurement at 32 points with a range as long as 300 meters between electrodes (AB / 2). The estimation of the depth of each point was expected to reach 175 meters.

Every point of measurement provides an estimation model of rock layers in an upright or vertical direction (stratigraphy) based on the resistance value (ρ). Each point has a coordinates obtained from measurements with GPS, so we can also make a contour map based on the depths.

We also make the cross section model that made of few measurement points with the direction of N-S and NE-SW. The cross section model was made to understand the spread of rock layers in the lateral direction. The Data readings from each measurement tools were processed and correlated with geological and hydrogeological data from the field observations of previous studies that have been done by Geophysics Laboratory, to identify the composition of rock layers in the subsurface.
**Figure 2.** Hydrogeology regional map, modification of Bandung Quadrangle Hydrogeological map [5]

**Figure 3.** The measurement points
5. Result and Discussion

After that, we obtained the variation of the apparent resistivity values and the current electrode spacing stretch (AB / 2). Then, the data were processed by the software Progress ver.3.0 to obtain the ‘true’ resistivity value and the actual thickness of the layer. Each resistivity value has a picture prediction of a rock at a certain depth because every rock has a resistivity value of which varies depending on rock hardness, porosity, permeability, the age of rocks, the content of electrolytes, minerals, rock structures and geological phenomena otherwise influence the value resistivity in these rocks.

Based on the results of the geoelectrical data processing correlated with the geological conditions around the study site, the study area is mostly composed of volcanic activity deposits. Several variations of the resistivity values can be divided into several groups to indicate the type of rock below the surface. Here is the range of resistivity values for each rock:

Table 1. Resistivity variations with their estimated lithology and hydrogeological properties

| ρ (Ω.m) | Estimated Lithology     | Estimated Hydrogeology        |
|---------|-------------------------|-------------------------------|
| < 30    | Fine tuff layer         | Impermeable Layer             |
| 31 - 60 | Sandy Tuff              | Aquifer                       |
| 61 - 100| Tuffaceous sandstones   | Aquifer                       |
| 101 - 200| Matrix supported breccia| Aquifer                       |
| 201 - 350| Grain supported breccia | Impermeable Layer             |
| > 350   | Andesitic Lava          | Impermeable Layer             |

Figure 4. Resistivity cross section GL-31 and Outcrop Picture L-4

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The Isoresistivity maps were created to determine the distribution of resistivity value at each depth. The resistivity map can be used to delineate the distribution of 1D resistivity laterally (Figure 5). The resistivity value distributions on the iso resistivity map can provide a picture of the rock layers below the surface by correlating the existing geological data into it. The table 1 was being used as the reference for the map. The table was made according the existing geological condition in this area based on the previous geological studies of the department of Geology. The sameness resistivity values can be considered as the same layer of a rock while the contrast value is expected to be a striking contact between the different rock layers or it may be the emergence of geological structure. In this study, the authors created a map iso resistivity at a depth of 0m, 1m, 5m, 10m, 15m, 20m, 30m, 40m, 50m, 70m, 100m, to 120m.

![Isoresistivity Map at the depth of 120 m](image)

Figure 5. The Iso resistivity Map at the depth of 120 m

The Geoelectric cross-section can give us a presence, distribution and thickness of the rock layers below the surface concerning the geological data around the study site. It can also provide an overview of the aquifer characteristics beneath the surface. Therefore, the authors made the cross-section line passing through the several measurement points (Figure 6). The authors made at least four cross-section lines through the study area (Figure 3).
Figure 6. The Cross section A-B and its lithology and Hydrogeological properties

The Geoelectric block diagram (Figure 7) also was made to obtain the distribution picture of the rock layers in 3D. The block was created by linking the spread of the rock layers based on the cross-section line reconstruction and, using Rock Work 14 application, producing the distribution of the rock layers in 3D. It is easier to interpret the rock layer distribution in 3D.

The southwestern and northeastern parts of the study area are expected to have the considerable groundwater resources. The rock layer that serves as an aquifer is dominating these two areas including coarse tuff, lapilli tuff, and matrix supported breccia. While the layer of fine tuffs, grain supported pyroclastic flow breccias and fall breccias that serve as aquiclude only exist in a small part of the entire layers that make up this region.

On the contrary, the northwestern and southeastern parts of the study area are expected to have fewer groundwater resources. The grain supported pyroclastic flow breccias and pyroclastic breccias which serve as aquiclue are dominating these two areas. The Distribution of these rock layers is very dominating and quite thick. So that the space for groundwater flow in these areas is very limited.

Besides, the distribution of the aquifer layers such as coarse tuff, lapilli tuff, and matrix supported breccias and also andesitic lava that serves as aquicrack spread only in a few places and depths. The groundwater flow in this area is very narrow and are much less likely to be found with groundwater resources.

There are Cileles Fault and Cikeuyeup Fault found in the study area. The Cileles fault is a normal fault trending from the northwest to the southeast with lowering depth at the east side. While Cikeuyeup fault is a similar fault with lowering depth at the west side. So the situation under the surface in the middle between these faults form a basin. We consider that the groundwater basin in this
area is as a good groundwater. Aquifer layers (coarse tuff, lapilli tuff, and matrix supported breccia) is dominating the basin below the surface. While aquiclude layers (grain supported breccia and fine tuff) are rare in some places and their thickness does not dominate those areas. Besides, both of these faults may act as an exit-entry barrier of the groundwater flow. So that the groundwater cannot flow out properly from the basin.

![Geoelectric block diagram](image)

**Figure 7.** The geoelectric block diagram

### 6. Conclusion
As explained in the discussion, we can see that at least there are two locations that are expected to be aquifers, which are The southwestern and northeastern parts of the study area. The subsurface rock layers in these two areas are dominated by coarse tuff, lapilli tuff, and matrix supported breccia which are considered a good aquifer. While the layer of fine tuffs, grain supported pyroclastic flow breccias and fall breccias that serve as aquiclude only exist in a small part of the entire layers that make up this region.

### References

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