

Soil Investigation for Determining Aquifer Position at Pasir Impun Area, Bandung, West Java Using Resistivity Method Wenner Configuration

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ABSTRACT

At this time, we own many geophysics methods that can be used to optimize investigation and natural source exploration under layer surface, one of them is Georesistivity method. Georesistivity method is one of geophysics method that study about electricity in the earth and also to detect an object in the surface layer area of earth. The following, a technology is showed to investigation and analyzed aquifer at botanical garden area, Mekarmanik village, Pasir Impun, East Bandung West Java, using Georesistivity method, Wenner Configuration. In this research, will be do Georesistivity method with Wenner configuration and be processed with using inversion from software Res2DIV, and Isopach aquifer contour mapping, which previous be done the topography correction. Based on the inversion obtained, we be obtain to interpret some points which showed aquifer position, are as follow : 1). Line 1 on location 1, with the distance of extend is between 78 – 140 metre on surface layer. (It has medium aquifer) which the resistivity is 800 ohm metre, and also has porosity and volum value 25% and 945,9 m³ with the depth is 60 metre. Its formation rocks at this location are sandstone, and limestone, anticline topography, dominated by normal fault which the trend is NE-SW. 2). Line 6 on location 1 (The highest aquifer) with the distance of extend is between 26 – 182 metre 26 - 160 metre, which the resistivity is 100 – 300 ohm metre, porosity and volum value are 14,14 – 18,26% and 1160,85 m³, with the depth target is 70 metre. Its formation rocks at this location are sandstone, alluvial and limestone, syncline

topography, dominated by normal fault which the trend is NE-SW. And then the third is line 8 on location 2 with the distance of extend is between 26 – 182 metre, the resistivity is 100 ohm metre, which its porosity and volum are 14,14 %, and 264 m³, with depth target is 35 metre. It has undulation topography which the trend is SE – SW dominated by normal fault, and its formation rocks are tuff, sandstone, gravel formation.

KEY WORDS: *Geological structure condition, Geophysical method of Wenner Configuration, Interpretation for aquifer position.*

NOMENCLATURE

NE	North East
SW	South West
m ³	Metre Cubic
ρ_a	Apparent Resistivity (Ohm.m)
V	Voltage (mV)
mV	milliVolt
A	Electric Current (mA)
mA	milliAmpere
K	Geometric Wenner factor (metre)

1.0 INTRODUCTION

Water has an important role to human life. Almost 90% human life needs water, because it is needed for human body, water transportation tool, industry, generator, and irrigation. Talk about water usage, in case that happen at Mekarmanik Village, the study area is botanical garden, located in Pasir Impun East

Bandung, in West Jawa Province, where the society in its around is difficult to obtain water. One of the obstacle's factor is difficulties of the geological structure and soil condition at the area, causing some people difficult to find the position of water resources. Tectonic intensity in this area is very high dominated by anticline structure with direction trend from west to east, (NWW-SEE). This Area is normal fracture, which its direction trend is same with anticline structure and its penetration into basement. Pasir Impun consist of reservoir rock which its velocity is moderate (smaller than subsidence velocity) and its rock formation is limestone, color grey (Harsono and Fuadi, 2005). Beside that, this location was formed from volcano residual soil, consisted of breksi, tuff, tuff's grain, sand stone, dust. Some types of its soil are : Red clay, and grey volcano soil (Wesley, 2001). To overcome this problem, we conducted a necessary geophysics method to interpret geological structure and found the information about the location of water resources position in this area. One of the mentioned method is georesistivity method. Georesistivity method is one of the geophysics methods that study about electricity flow inside the earth and to detect it in the earth surface (In this matter to potential measuring, current measuring, and elektromagnetic's field) which happen natural or caused by current injection into the earth. Example : Self Potential method, Telluric current, Magnetotelluric, Electromagnetic, Induce Polarization (IP), Resistivity method, etc. In this research, to identification the location of water resources in this area, we using Georesistivity method, Resistivity Sounding. It also known as Drilling Resistivity, Probing Resistivity, and etc. This method is studying about resistivity rock under earth surface according to vertical direction. In this method, sounding point measurement be done with changed the distance of electrode. To change the distance of electrode, be done beginning from the smallest distance until the largest distance according to gradual. Electrode's distance is comparable with the deepness of earth surface layer which detected. It means, if the distance of electrode is large, then the earth surface layer will be deeper. Sounding Resistivity, was familiar known as various of kind electroda's configuration. Among its are : Wenner's Configuration, Schlumberger, Bipol-dipol, Lee Partision, Line Source, gradien's System 3 point, etc. In this research, our aim is to analyze geological structure condition at botanical garden Mekarmanik village, Pasir Impun, East Bandung, and to find the location of the water resources, using georesistivity method, with Wenner configuration. The location map of aquifer investigation is shown in figure 1.

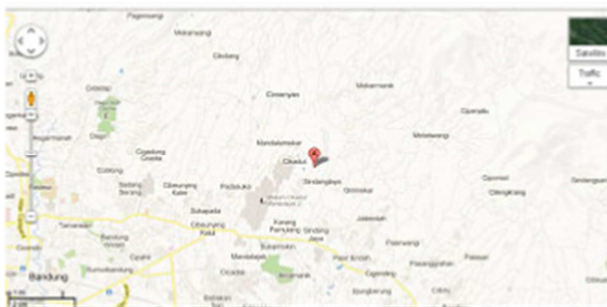


Figure 1: Location map of Mekarmanik Village.

2.0 GEORESISTIVITY METHOD WITH WENNER CONFIGURATION

Georesistivity method Wenner configuration be found by Wenner in 1915, and being famous in America. This Configuration could be done for resistivity mapping and also resistivity sounding. (Adam, A and Hendrajaya L. 2005). this configuration type be done according to the limit value. Example, if the earth is flat, Wenner configuration must be relative for the flat area on its surface. But If this configuration is applied to the oblique surface, we must need some valid correction. For Wenner configuration, the current electrode and potential electrode was showed on figure 2 below. In this matter, the current electrode and potential electrode was set according to symmetrical in sounding point. And the distance of current electrode is triple from the potential electrode distance. As a sample, if the distance of each potential sounding point is $a/2$, then the distance of each electrode current in sounding spot is $3a/2$. We must remembered that the fourth of electrode's with sounding point must be on one line. On resistivity mapping, the space of electrode's distance is not changed for every sounding point (its large for this distance is constant). Then for resistivity sounding, space distance of electrode's is to be large according to gradual, beginning from small value, for a sounding point. Electrode's space is depend to the tool ability which be used. If the current flow result more sensitive and large, it is causing the tool become free to measuring the space of the electrode's distance, which it larger and effecty to the deep on surface layer (be deeper). Configuration Wenner type, can to detect un-homogen local from the location.

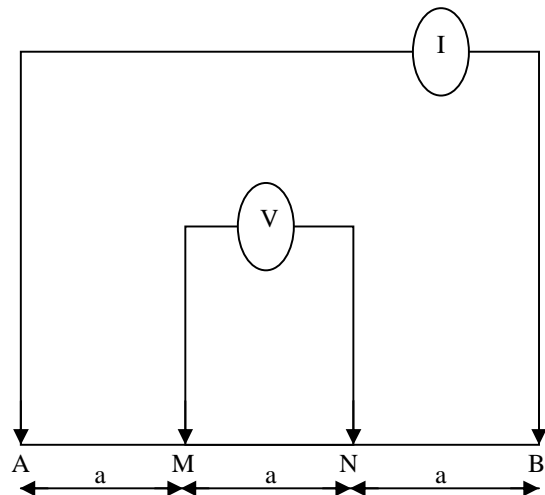


Figure 2: Wenner Configuration

Based on figure 2, configuration Wenner geometry factor can be expressed with defined as follow :

$$K_w = \frac{2\pi}{\left\{ \frac{1}{AM} - \frac{1}{BM} - \frac{1}{AN} + \frac{1}{BN} \right\}}$$

$$= \frac{2\pi}{\left\{ \frac{1}{a} - \frac{1}{2a} - \frac{1}{2a} + \frac{1}{a} \right\}}$$

$$= 2\pi a \tag{1}$$

Then for Wenner Configuration equation is :

$$\rho_{aw} = 2\pi a \frac{\Delta V}{I} \tag{2}$$

Where :

ρ_{aw} = Resistivity on Wenner configuration.

ΔV = Potential Voltage (Volt).

I = Electric Current (Ampere).

3.0 RESEARCH METHODOLOGY

The research area is at Botanical Garden Mekarmanik Village, Cimnyan district, Pasir Impun East Bandung West Java Province, which located at 6o51'15.43"S – 107o41'9.03" E. This reasearch method consist of two part.

1. Pre Processing : On this phase we do some investigation at research location. this Investigation was do to analyze geological structure and the characteristic of water flow. Then from this phase, we mapping 9 line for water track in horizontal direction (is shown in figure 7). Investigation to recognize location was started from early January until 30 June 2014.

2. Data Processing : We measuring and taking the georesistivity data also topography data in each line that have been determined from 1th until with 5th on July 2014. And then, from January until 9th September 2015 the data be processed with using inversion from software Res2DIV, and Isopach aquifer contour mapping, which previous be done the topography correction.

3.1. Instrumentation And Measurement Systems

Instrumentation which used are : 1. Resistivity meter Naniura (NRD) multichannel (is shown in figure 3) as a tool to write the current injection and potential of earth that measured. 2. Switch box, as position domer tool active electrode. 3. *Accu* 12V, as DC current source. 4. Electrode 31 piece, as current conductor and voltage from the tool. 5. Cabel to conduct the current and the swich box. 6. Hammer, handy talky, rolemeter, and GPS (Global Potition System). the Procedure for georesistivity measured is defined as follow (is shown in figure 4) : 1). Putting Resistivymeter Naniura between electrode at point 21 and 22. 2). Connecting the Resistivymeter, switch box, and accu 12 V with connecter cable. 3). Embed the electrode at the point that have been marked with wood pole. 4). Connecting the cable with switch box, to extended out and then be connected with electrode. 5). Lit the Resistivymeter and ascertain the voltage is already connected with accu and electrode current. 6). If the Galvanometer needle was not on the red color, then one of elektroda current was not embed well on surface layer. 7). Ascertain the electrode is already connected with switch box, with changing one of electric switch on position I1 and the other

electric switch to I2. 8). Beginning to measuring with saw the voltage counter digital (volt), and arrange the compensator Coarse until the voltage value become zero. 9). If the voltage value already zero, press the button Start until be obtained current value (mA) are constant, after that press button Hold. We Registered the measured data I and then V data, to form acuitition data. 10). Change the electric switch on position I1, I2, V1, and V2 to switch box which same with acuitition data, until be obtained all the data value that to be wanted. On this method, electrode configuration that to be used is Wenner configuration, is shown in figure 5.



Figure 3: The Instrumentation of Nanniura NRD Multichannel.



Figure 4: Measuring Procedure for the Instrument.

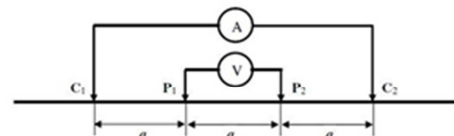


Figure 5: Georesistivity method, Wenner Configuration

'a' is the distance between the electrode in which that the value was change and depending on the extend that to be wanted. Every value 'a' was change, so that the datum point become different. On this investigation, distance between its electrode is 6,5 meter and for its extend foldness more less up to 200 meter. For withdrawal data at this area, we obtained the value of V (voltage)

and I (current) that was read from instrument, and after be fold with Ks (Geometric Factor), be obtained the ρ_a value (apparent resistivity). The equation to obtain apparent resistivity value is (Adam, A and Hendrajaya L. 2005) :

$$\rho_a = K \frac{V}{A} \quad (3)$$

where :

- ρ_a : Apparent Resistivity (Ohm.m)
- V : Voltage (mV)
- A : Current (mA)
- K : Geometric Wenner factor (metre)

($K = 2\pi a$) which a is electrode space.

Next, this value will be processed using the software Res2Div and Isopach contour mapping. The result was showed on image enhancement, which this result will be interpreted be assist with geological map.

4.0 DESCRIPTION AND DATA PROCESSING

For the phase of data processing, we using Microsoft Excel software to calculate the apparent resistivity on each datum point. After apparent resistivity be obtained, the mentioned value be made in Notepad format according to formatted data input from software that will be used for data processing (It was explained in figure 6).

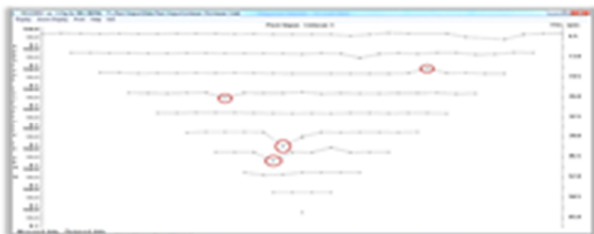


Figure 6: Exterminate bad datum point

Datum point value on red encircled is the bad value. Because of that, be done exterminate for bad option of datum point. And then, we do the inversion process to line data using Res2div with Least-Squares Inversion method to found the image of resistivity section (is shown in figure 8) and Isopach Aquifer mapping contour (is shown in figure 9). Finally, the Result from this processing are : The information of resistivity value, topography, litology, estimate of penetration depth from surface layer, porosity and volum for aquifer information on each line. Data processing result shown in the table 1. below :

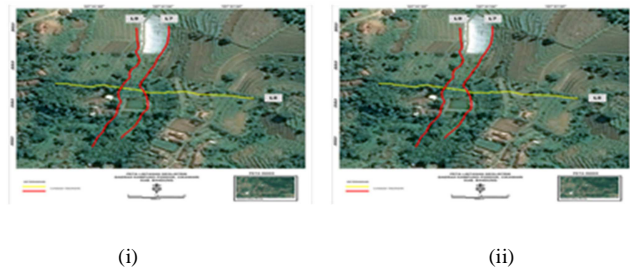


Figure 7. (i) Line map on location 1. (ii) Line map on location 2

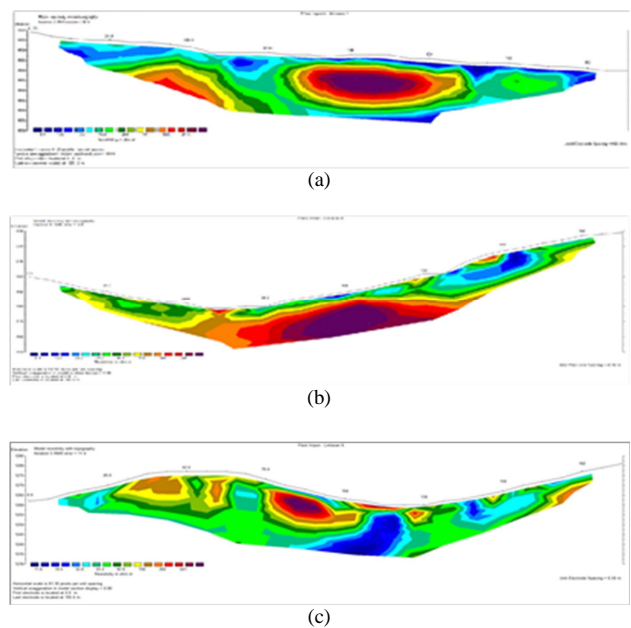


Figure 8. The Resistivity Section for Aquifer prospecting area at line 1 (a) , line 6 (b), location 1 and also line 8 (c) location 2.

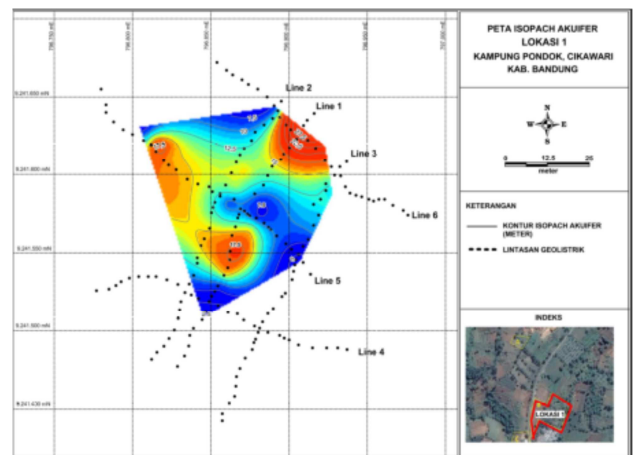


Figure 9. Isopach Aquifer Countur Mapping for Location 1 At Cikawari, Mekarmanik Village

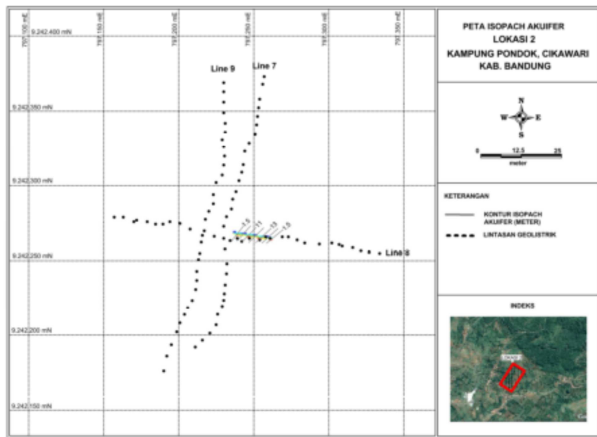


Figure 10: Isopach Aquifer Countur Mapping for Location 2 At Cikawari, Mekarmanik Village.

Table 1: Information of Resistivity (ρ), litology (σ), topograhpy (T), porosity (ϕ (%)), depth (D (m) and volum (V (m^3)) aquifer from each line at location 1 and location 2.

LOCATION 1 & 2						
LINE/ LOC	P	Σ	T	Φ	D	V
1/1	800	Sandstone	Descend	25	70	946
2/1	100	Clay	Descend	14,14	0	0
3/1	150	Clay	Descend	14,14	0	0
4/1	100	Clay	Descend	14,14	0	0
5/1	100	Clay	Descend	14,14	0	0
6/1	300	Sandstone	Descend	18,26	60	1160
7/2	70	Clay	Descend	11,95	0	0
8/2	100	Sandstone	Undulation	14,14	350	264
9/2	90	Clay	Descend	10,54		0

5.0 CONCLUSION

Based on the inversion data processing obtained (is shown in table 1), we interpret some points which showed aquifer position, which it be assist with geological map. Are as follow : 1). Line 1 on location 1, with the distance of extend is between 78 – 140 metre on surface layer. (It has medium aquifer) which the resistivity is 800 ohm metre, and also has porosity and volum value 25% and 945,9 m^3 with the depth is 70 metre. Its formation rocks at this location are sandstone, and limestone, anticline descend topography, dominated by normal fault which the trend is NE-SW. 2). Line 6 on location 1 (The highest aquifer) with the distance of extend is between 26 – 182 metre 26 - 160 metre, which the resistivity is 300 ohm metre, porosity and volum value are 14,14 – 18,26% and 1160,85 m^3 , with the depth target is 60 metre. Its formation rocks at this location are sandstone, alluvial and limestone, syncline descend topography, dominated by normal fault which the trend is NE-SW. And then the third is line

8 on location 2 with the distance of extend is between 26 – 182 metre, the resistivity is 100 ohm metre, which its porosity and volum are 14,14 %, and 264 m^3 , with depth target is 35 metre. It has undulation topography which the trend is SE – SW dominated by normal fault, and its formation rocks are tuff, sandstone, gravel formation.

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