# Predict Environmental Conditions Using Groundwater Interpretation in Subdistrict Hamparan Perak, Deli Serdang, North Sumatera

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## Abstract

**Purpose** – To predict the existence of the aquifer, search the location, position, thickness, deep and dissemination of subsurface aquifer and predict the environmental condition by conducting the groundwater/aquifer condition.

**Design/Methodology/Approach** – The way to know the state of groundwater aquifers, one of which is the Geo-electric Method by using the Resistivity Schlumberger Method.

**Findings** – Pouple activities are not many effects to the groundwater but more time depend on the development, it can many influences to environmental conditions.

**Research Limitations/Implications** – The analysis is conducted to every point but on this research, it is on mentioned and taken from one sample only, it is HPR.

**Practical implications** – In anticipation the effect of the development of the region in general, it is necessary to be able businesses for raw water, irrigation and Industry of the groundwater can be as well as how to control over the distribution and causes of infiltration into the soil.

**Originality/Value** – That is by measuring the resistivity and mapping dealer spread a layer of groundwater (aquifers) that an overview of the groundwater can be known.

**Keywords** Groundwater, Environmental issues, Population activities

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## 1. Introduction

### 1.1. Background

In order to know the groundwater condition in a particular area, we can do it by measuring the resistivity. One of the methods is Geo-electric Method. Particularly to the deep well construction, in advance, it is needed to conduct a geological research and hydrogeology as part of exploration activities. The exploration activity with geo-electric resistivity method is a geophysical method to present the lithology's data arrangement of the subsurface rock through the electrical properties of the rock. The geo-electric exploration prediction follows the Schlumberger electrode array system, by following electric current into the earth

The generated field data is pseudo-data from the electrical properties of the rock. Through the data processing, it will be found the valid electrical properties of the rocks. The interpretation of the field data will describe the condition of the subsurface rock vertically. Through electrical properties of the rocks, it can be interpreted that various aspects can meet the requirements. One is the prediction of subsurface vertically as well as horizontally along with the prediction of the subsurface rock arrangement and the aquifer prediction. To interpret the data horizontally, it demands many measuring points, in this case, these measuring points are arranged systematically (grid system). The scope of the activities covers the geology research and hydrology as well as the field data collecting. This method conducted as a scientific study based on the scientific principles and method of geophysical exploration work. (Departemen Pertambangan dan Energi Sumatera Utara, 2010, 2011, 2013, 2015; Abdul Aziz, 1986; Allan, 1979).

After that we can predict the environmental condition by conjunct to the groundwater condition, there is the environment of natural structure, water catchment area due to infrastructure development, lifestyle and population activities etc. The basis of reference report that we have, only explains the quantity and quality of groundwater. So we try to conjunct it to the environmental condition due to the author capabilities and in the hope of a better improvement future.

### 1.2. Research Location
The research location is located in SubdistrictHamparan Perak, District Deli Serdang, North Sumatera Province with the geo-electrical measuring point as much as 23 points.
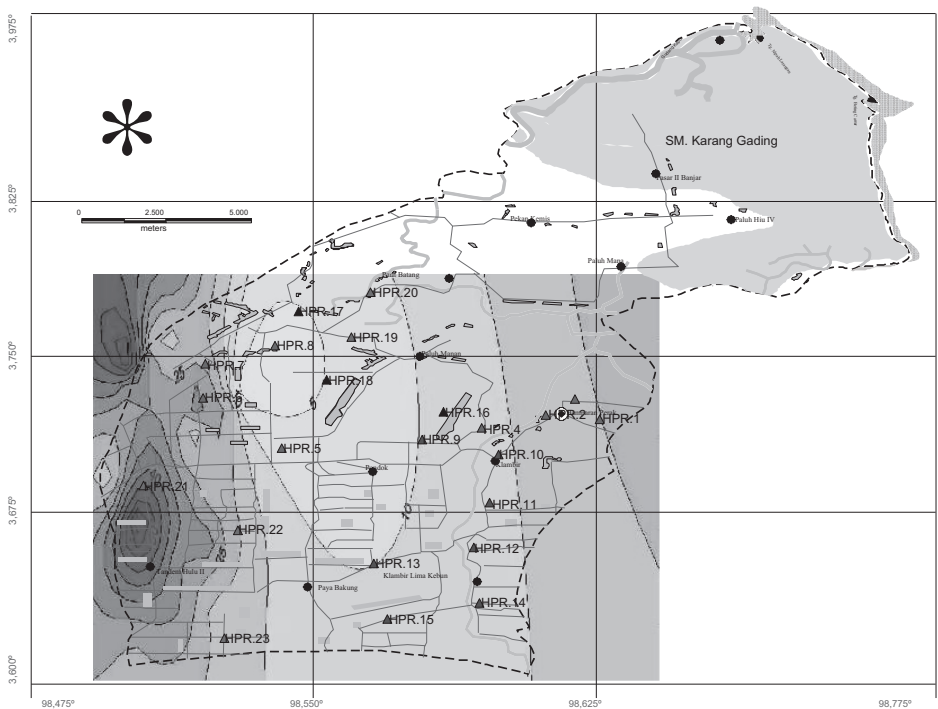


**Figure 1.**
Hamparan Perak
Map for 23 points
with L/2 = 50 mtr

*1.3. Objective and Purpose*

This research using the Schlumberger electrode geo-electric prediction, can aims:

- To predict the existence of the aquifer
- To search the location, position, thickness, deep and dissemination of subsurface aquifer.
- To predict the environmental condition by conducting the groundwater/aquifer condition.

*1.4. Equipment Used*

- The Geo-electric tool consists of: Current transmitter, the capacity of 1.500 watts; Receiver with the sensitivity of 0,10 mVolt; The current cable, length 1.000 meters; Potential cable, length 200 meters; electrodes of 18 pcs, and 1 pcs accu of 12 volts, 50 AH.
- Field Support Equipment and Studio: The geological map sheet with the scale 1: 250.000; RBI Maps with the scale 1: 50.000 (digital), Geology compass, Geology Global Positioning System (GPS), Handy Talky 4 pcs, Computer, Printer, and Digital Camera.

## 2. Hydrogeology

*2.1. Rock Response Toward Water*

Based on the rock outcrop that can be found in the research area, the dominant rocks are sandy clay with the medium sized of sand, with the grey-white color and good texture of porosity. These rocks act as the aquifer to dig well. This aquifer depends on the season that during the dry season, it will have the water debit decrease. In order to apply the drilling, it is predicted that the aquifer includes sandstone and Julurayeu formation. (Departemen Pertambangan dan Energi Sumatera Utara, 2010, 2011, 2013, 2015).

*2.2. Groundwater Condition*

This location is occupied by one household, the water source for daily needs is taken from the dig well with 4 meters depth and 3 meters TKA. This dig well depends on the season that if it is in the dry season then it will have depth decreasing, the water condition is pure and without any smell. The aquifer rocks to the dig well include the sandy clay from the alluvial unit, to deep drilling well, the aquifer is predicted as sandstone from Julurayeu formation. (Departemen Pertambangan dan Energi Sumatera Utara, 2010, 2011, 2013, 2015).

## 3. Geo-Electric Interpretation

*3.1. Research Method and Geo-Physics Analysis*

The hydrogeology research with a geo-electric method that is applied is the Schlumberger electrode arrangement model. The length of the current cable (I) and potential cable (P) is
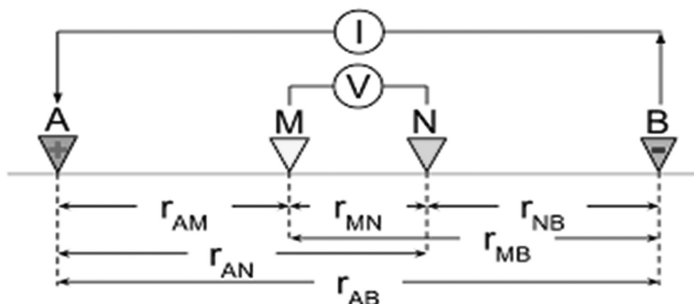


**Figure 2.**
The Schlumberger
Electric Circuit
Measurement

adapted to the requirement. In this case, 600 meters cable length are use for current is ranging from L/2 = 10 to 300 meters and 50 meters cable length are used for potential is ranging from a/2 = 0,5 to 25 meters. The valid resistivity vertical rock (Table*) can interpret the location and position of the groundwater aquifer. On the other hand, the high resistivity can identify the physical properties of the rock as well as the inundated properties of rocks. The morphology and depositional rocks environment affect the groundwater availability (Pict 2. below).

Resistivity: $\rho = K \dfrac{\Delta v}{1}$ whereas K = Geometry Coefitient

$$K = 2\pi \left\{ \left( \frac{1}{AM} - \frac{1}{MB} \right) - \left( \frac{1}{AN} - \frac{1}{NB} \right) \right\}, \quad A - B = L \ \ and \ \ M - N = a$$

$$AM = \frac{L-a}{2}, \ \ AN = \frac{L+a}{2}, \ \ MB = \frac{L+a}{2} \ \ \ and \ \ NB = \frac{L-a}{2}$$

Then $\Delta V$ = the voltage in $M - N$ and $I$ = the electrical current $A - B$ we found that :

$$\rho = 8\pi \left\{ \frac{2a}{L^2 - a^2} \right\} \frac{\Delta V}{1} = \ \left\{ \frac{16\pi a}{L^2 - a^2} \right\} \frac{\Delta V}{1}$$

*3.2. Water Bearer*
The water bearer is based on:

*3.2.1. The pseudo-resistivity on this occasion is L/2 = 10 meter; L/2 = 50 meter; L/2 = 100 meter and L/2 = 300 meter.*

- On the L/2 = 10 meters, theoretically it indicates the depth of the flow-through layers about $1/3 \times 20$ meter = ± 6,5 meter shows that rock sediment pattern with the similar pseudo resistivity rocks < 20 Ωm head from east-west. On this condition, the water quality is predicted salty to brackish, to the north can be ascertained that the water quality is salty to brackish because it is located in the beach/coastal area.

- On the L/2 = 50 meter with the flow through depth/layers depth $1/3 \times 100$ = ± 30 meters can be seen that the sediment rocks pattern with the same line of pseudo-resistivity rocks < 20 Ωm heads from the east to west, the quality of the water is predicted to be salty-brickish filtrate into the Pondok village.

- On the L/2 = 100 meter with the flow through depth/layers, depth $1/3 \times 200$ = ± 65 meters shows the sediment pattern still head from the east to west with the rock sediment zone is getting smaller towards the same line of pseudo-resistivity rocks < 20 Ωm. On the south part, salty-brickish that filtrate the village/Pondok village land. The same line of pseudo-resistivity rocks < 20 Ωm still heads from the west to east is the wider dissemination area.

- On the L/2 = 300 meter with the flow-through layers about 200 meters, shows the sediment rocks to the same line of pseudo-resistivity rocks < 20 Ωm heads from north to south, on this prone area the dissemination is getting smaller, the same line of pseudo-resistivity rocks < 20 Ωm is getting wider, the water quality is predicted to be good, on the part of southwest are can be seen that the sediment rock are the massive rocks formation.

*3.2.2. The valid resistivity of rocks.* From measuring points that are implemented, it can be interpreted that the groundwater rocks are homogeny from the valid vertical resistivity

classification. Based on the grade of vertical resistivity number, towards the resistivity of the rocks > 1.000 $\Omega$m, the porosity grade of water is low and the permeability is very high, this layer can be interpreted as the layer, not as the aquifer. The valid vertical resistivity of the rock is ≤ 10 $\Omega$m. It is predicted that the water quality is not good. For the coastal area, the water is brackish-salty. (Keshari and Datta, 1996; Datta and Harikrishna, 2005; Sreekanth and Datta, 2010; Eheart and Valocchi, 1986).

We use these two points are 8 and 19, because it has the near location as how to make easy to compare with each other, seen in Figures 3 and 4 above.

In experience, we can note that the limit of resistivity with capacity is:

- 0 – 25 or < 25 $\Omega$m = the water is salted to brackish.
- 26 – 50 $\Omega$m = the water is good quality with high to very high capacity.
- 51 – 100 $\Omega$m = the quality is very good and high capacity.
- 101 – 150 $\Omega$m = the quality is very good and the capacity is middle to high.
- 151 – 250 $\Omega$m = the water is good quality with low to middle capacity.
- > 250 $\Omega$m = the water is good quality with very low capacity to waterproof.

From the geo-electric measuring result in point 19 that on the depth 37,20 - ≥ 148,50 meter with the 43 $\Omega$m and valid vertical resistivity 31 $\Omega$m is rock with the good level of porosity, the physicmeter with the solid vertical resistivity is 43 and 31 $\Omega$m is rocks with productive shallow – deep aquifer, pore sized water accumulation. Good water quality, Tufalithology from Tufa Toba unit and layering sandstone, conglomerate, and mudstone from Julurayeu Formation.

**HPR.8**

| No. | Resistivity | Thickness | Depth | |
|---|---|---|---|---|
| 1 | 39 | 0.8 | 0.0 – | 0.8 |
| 2 | 15 | 2.2 | 0.8 – | 3.0 |
| 3 | 29 | 7.3 | 3.0 – | 10.3 |
| 4 | 77 | 31.8 | 10.3 – | 42.1 |
| 5 | 16 | 112.2 | 42.1 – | 154.2 |
| 6 | 18 | | 154.2 – | |
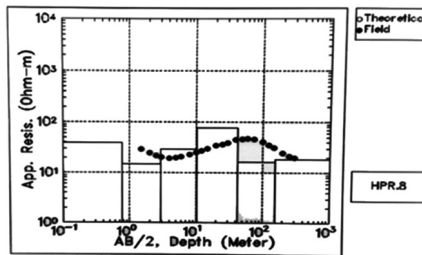


Figure 3.
HPR.8 Result Graph

**HPR.19**

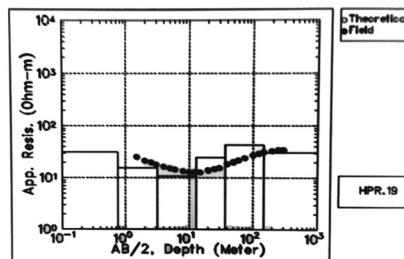| No. | Resistivity | Thickness | Depth | |
|---|---|---|---|---|
| 1 | 31 | 0.8 | 0.0 – | 0.8 |
| 2 | 16 | 2.4 | 0.8 – | 3.1 |
| 3 | 11 | 10.0 | 3.1 – | 13.1 |
| 4 | 25 | 24.1 | 13.1 – | 37.2 |
| 5 | 43 | 111.3 | 37.2 – | 148.5 |
| 6 | 31 | | 148.5 – | |



Figure 4.
HPR.19 Result Graph

Geographically, the point 19 is closer to the sea than point 8, but the lower public activities. That is why the water capacity at point 8 lower than at 19 although the rock formation almost the same the cause of the adjacent position. The change of groundwater condition usually causes of some things ie :

If there is people activity with the high exploitation of water, it will be make low capacity of groundwater in one region and cause the intrusion of seawater. The people activity also can make many infrastructure, building, manufacture, change water catchment area, change the forest and land use etc. All of this indicated the developing region with many activities include the business, lifestyle and the modern technology used. But the other side can influence the groundwater condition and if we think back that groundwater condition as an indicator to predict the environmental condition.

Generally, the people activities always depend on the situation and the material needs in an environmental area that they have. As one of this, there are groundwater conditions which are caused by the natural condition and some pouple activities process which can influence the normal circumstances. The groundwater or water below ground can indicate the environmental condition. The groundwater interpretation includes subsurface water and groundwater up to hundreds of meters deep. The other thing that happened during the time was the intrusion of seawater with the effect of soil porosity. All this happened because of needs, lifestyle and technological advances factors so that factors can accelerate the process of exploitation of natural resources.

## 4. Conclusion

From the field observation and geo-electric measuring result can be concluded that:

- Based on the field observation, therefore, the morphology unit of the research area, in the form of land, that is used as the residence land, farming, and marshes with the basic rocks of the silty sand unit, gravel, with small to medium sized of sand with the shade of white-gray and gray dark.
- Stratigraphy of the research area can be observed in the field are in the form of silty sand unit, sand gravel with the small sized of sand with the white-gray and dark gray shade.
- Based on the outcrop rocks that can be found in the research area, the dominant rocks are silty sand, sand and gravel along with soft to medium sized of sand with the shade of white-gray and the porosity is considered to be good. It can be predicted that the aquifer includes sandstone from Julurayeu formation.
- As the shallow aquifer as well as the depth aquifer or with the other hand the shallow aquifer to the deep. The analysis is conducted to every point but on this research, it is on mentioned and taken from one sample only, it is HPR. 1 measuring point.
- From these all conditions, we can predict that influences of the pouple activities are not many effects to the groundwater but more time depends on on the developing, it can many influences to environmental conditions.

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