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Identification of the Distribution of Leachate in the TPA Terjun, Medan Marelan District, Medan City Using the Resistivity 2D Method

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ABSTRAK

Penelitian ini bertujuan untuk mengetahui distribusi 3D air lindi. Metode geolistrik resistivitas konfigurasi Schlumberger digunakan untuk mengindikasi air lindi. Hasil uji geolistrik menunjukkan bahwa sebaran lindi di Jalur I (Pertama) berada pada panjang lintasan 28 meter – 84 meter, kedalaman 13 meter – 17,4 meter dengan nilai resistivitas 2,18 m, Jalur II (Scond) berada pada lintasan sepanjang 7 meter. – 140 meter, kedalaman 8,93 meter – 13,4 meter dengan nilai resistivitas 2,95 m, dan Track III (Ketiga) sepanjang 80 meter – 110 meter, kedalaman konfigurasi The Wenner menggunakan metode resistivitas geolistrik, dengan nilai resistivitas lindi 0 , 5 – 5 m diharapkan dapat mengidentifikasi sebaran lindi di jalur pengukuran. Hasil uji geolistrik menunjukkan sebaran lindi di Track I berada pada panjang track 28 meter – 84 meter, kedalaman 13 meter – 17,4 meter dengan nilai resistivitas 2,18 m, Track II berada pada panjang track 7 meter. – 140 meter, kedalaman 8,93 meter – 13,4 meter dengan nilai resistivitas 2,95 m, dan Track III dengan panjang 80 meter – 110 meter, kedalaman 13 meter – 17,4 meter dengan nilai resistivitas 0,807 m. Distribusi ini juga dipengaruhi oleh drainase, elevasi tanah, jenis tanah, dan pengelolaan TPA Terjun Kota Medan.

Kata kunci: geolistrik, air lindi, resistivitas, konfigurasi *Schlumberger*

ABSTRACT

This study aims to determine of 3D distribution leachate. Resistivity geoelectrical method Schlumberger configuration is used to indicate leachate. The results of the geoelectric test show that the leachate distribution in Track I (First) is at a track length of 28 meters – 84 meters, a depth of 13 meters – 17.4 meters with a resistivity value of 2.18 m, Track II (Second) is at a track length of 7 meters – 140 meters, 8.93 meters deep – 13.4 meters with a resistivity value of 2.95 m, and Track III (Third) along 80 meters – 110 meters, the depth of The Wenner configuration uses the geoelectrical resistivity method, with a leachate resistivity value of 0, 5 – 5 m is expected to identify the distribution of leachate in the measurement path. The results of the geoelectric test show that the leachate distribution in Track I is at a track length of 28 meters – 84 meters, a depth of 13 meters – 17.4 meters with a resistivity value of 2.18 m, Track II is at a track length of 7 meters. – 140 meters, a depth of 8.93 meters – 13.4 meters with a resistivity value of 2.95 m, and Track III at a length of 80 meters – 110 meters, a depth of 13 meters – 17.4 meters with a resistivity value of 0.807 m. This distribution is also influenced by drainage, soil elevation, soil type, and landfill management in sites city of Medan is the TPA Terjun.

Keywords: geoelectrical, leachate, resistivity, Schlumberger's configuration

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1. INTRODUCTION

Water resources are useful or potential resources for humans. Uses of water include use in agriculture, industry, household, recreation, and environmental activities. The provision of clean water is the activity of providing proper air for use by the community in meeting the needs of the community to obtain a healthy and clean life, including basic human needs with all kinds of activities, including those needed for household purposes such as drinking, cooking, bathing, washing. and other work (Gustira A. *et al.,* 2019). The quantity of water needed in the provision of water for use by the population in terms of the amount of raw water available, meaning that the raw water can be used to meet needs in accordance with the number of residents to be served. In addition, the amount of water people need varies depending on their geographical location, culture, economic level, technology, and the scale of the city in which they live. (Zamzam,2018)

Leachate is a liquid that comes out of a pile of garbage, and this is a form of environmental pollution produced by a pile of garbage. The resistivity value of leachate produced from waste decomposition at the landfill is below 10 Ωm (L. Adeoti, S. 2011). The environment we use is closely related to human activities. Every time we carry out daily activities, we always produce the remains of objects that are considered useless and will be disposed of which is known as garbage or waste (Kahfi, A.,2017). All waste generated by humans can pollute the surrounding environment and contaminate groundwater, garbage, suspended particles, and dissolved materials contained by leachate if left unchecked will have a negative impact on the surrounding environment and human health. (Yu, Y., *et al.*2014). Medan City has a population of 2,524,321 people (according to Badan Pusat Statistik Provinsi Sumatera Utara, 2021) and the whole community disposes of the garbage and then transports it to two TPA locations belonging to the city of Medan. The TPA locations include the Namo Bintang TPA and the TPA Terjun. The TPA Terjun has an area of 137,563 m2 and controlled landfill is carried out every day with a thickness of 20-30 cm of embankment soil. If the garbage is not covered, then insecticide is sprayed (Sari., D. *et al.,* 2016).

The operational system at the TPA Terjun, Marelan is adalah controlled landfill but in the landfill, it can produce leachate. Leachate is a liquid obtained from the decomposition of waste and produces an odor containing hazardous materials from hazardous and toxic waste. Leachate that is not treated will pollute the environment (Yatim, E., *et al.,* 2013). The distribution of leachate below the surface can be affected by the hydrogeology of the site. Just like groundwater, leachate will flow in rocks that can pass through fluids or permeable rock layers. Because the leachate flow below the surface contains metallic elements, the leachate conductivity increases and can be identified in rock layers. The nature of leachate has a different conductivity value from groundwater (Ulfani. *et al.,*,2019).

The Vertical Electrical Soundings (VES) has proved very popular with groundwater studies due to simplicity of the technique. Groundwater has become immensely important for human water supply in urban and rural areas in developed and developing nations alike (Omosuyi, 2010).The proposed geophysical method utilizes the resistivity value parameter to determine subsurface conditions, namely the resistivity geoelectric method. The 2-dimensional (2D) resistivity method is able to provide a more detailed subsurface description, including the distribution of resistivity values in both vertical and horizontal sections (Prapitari. *et al.,* 2013).

2. RESEARCH METHODOLOGY

2.1 Location and time of research

This research was conducted using the Wenner resistivity geoelectric configuration method to determine the 2D distribution of leachate from the TPA Terjun located in Paya Pasir Village, Marelan District, Medan City. Astronomically, the area of Paya Pasir Village, Medan Marelan District, North Sumatra Province, Indonesia is located at 3°43'9,865 South Latitude and at 98°38'59.240 East Longitude on 28-30 July 2021.

Figure 1. Research Sites

2.1.1 Determination Location Track

Location track determined based on topographic maps and field surveys by looking at the direction of the community's surface water flow. The reason for the review is based on the topography and direction of community flow because the contamination by leachate is vulnerable to surface water such as rivers, lakes, and shallow wells that are used by the community. The following is the location of the research location trajectory.

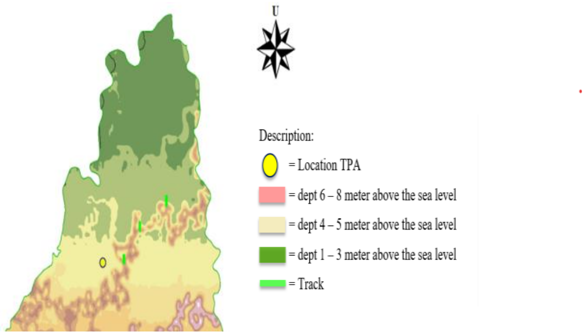

Figure 2. Topography Medan Marelan

Figure 3. Position Track I – Track III in TPA Terjun, Distric Medan Marelan

Figure 4. Map Geology District Medan

2.1.2 Data Collection

Data collection was carried out starting from Track I – III using the Georesist – HJ 3454 geoelectric device. The configuration used was the Wenner configuration because with this configuration it can be seen the distribution of leachate that can contaminate surface water and shallow groundwater. In deep groundwater, leachate cannot be penetrated because of the impermeable layer consisting of marl and clay. In this test, an electric current will be injected into the ground and will be received back by the geoelectric tool because there are current electrodes and potential electrodes that are plugged into the ground.

2.1.3 Data Analysis

The data obtained in the field will be entered into the Ms. Excel with the aim of calculating resistivity values and datum points. Next, the data obtained on Ms. Excel will be plotted into Notepad with form extension (.DAT) so that the RES2DINV software can read the data in Notepad. The RES2DINV software will generate data interpretation by generating a 2-Dimensional (2D) profile/sectional image, making it easier to identify the depth and distribution of material in the soil.

2.1.4 Determination of Material through Resistivity Value

The material can be determined from the resistivity value obtained during field research because each material has a different resistivity and absorption capacity. Previous research conducted by Telford, 1976 resulted in resistivity values for several materials including the leachate resistivity value so that it can see the distribution of leachate around the Waterfall TPA, Medan Marelan District. This aims to provide certainty to researchers and readers in determining the type of material contained in the subsoil. The table of resistivity values according to Telford, 1990 can be seen in Table 1.

Table 1. Grid Standardization and Rating

No	Material Type	Resistivity (Ωm)
1	Surface water	80 – 200
2	Groundwater	30 – 100
3	Leachate	< 10
4	Sand and Gravel	100 – 1000
5	Sand and Gravel with freshwater	50 – 500
6	Sand and Gravel contains sea water	0,5 – 5
7	Clay	2 – 20
8	Sand	1 – 1000
9	Alluvium	10 – 800
10	Clay Sandstone	0,5 – 50

3. RESULTS AND DISCUSSION

The distribution of leachate below the surface can be affected by the hydrogeology of the site. Just like groundwater, leachate will flow in rocks that can pass through fluids or permeable rock layers. Because the leachate flow below the surface contains metallic elements, the leachate conductivity increases and can be identified in rock layers. Leachate has a different conductivity value than groundwater. In this study, the identification of leachate distribution was carried out using a geoelectric device in the TPA Terjun area with 3 (three) measurement lines, each of which was 150 meters long. Geologically, the TPA Terjun area in Marelan district is an alluvial unit that is not compact with materials consisting of sand, gravel, and clay.

3.1 Results and Discussion on Track I

Figure 5. Position Track I

This first line is a location close to the Waterfall TPA, located in the northeastern part of the TPA location with a track length of 150 meters and is very vulnerable to contamination from leachate water generated from the Waterfall TPA. This shows that there was an increase in the depth of spread of leachate as deep as more than 2.7 m, from that obtained by (Mahanani .,C D. 2011). Data collection in this place aims to get a comparison of the pollution that occurs in the soil affected by leachate.

Based on modelling using RES2DINV software, Path I have an RMS error (Root Mean Square) error value obtained in Figure 6 above 17.7% with 3 iterations. Based on the RMS error value obtained below 20%, it can be ascertained that the conditions in the field with the data that has been processed are by the RES2DINV software, the data and Figure 6 obtained are suitable for use as actual interpretations in the field. High RMS error can be influenced by soil conditions that are too dry so that electricity is difficult to inject into the soil, weather factors, and conditions of equipment and cables in the field (multicable error).

In Line I, alluvium contaminated with leachate was found in a horizontal stretch of 91 meters – 126 meters with a red line with a resistivity value of 26 Ωm at a depth of 1.75 meters – 5.25 meters. At a distance of 28 meters - 42 meters and at a distance of 77 meters - 91 meters, sand with a green line with a resistivity value of 2.18 Ωm was found which was contaminated with leachate which resulted in very low resistivity values found at a depth of 5.25 meters - 8.93 meters. The research location also found groundwater contaminated with leachate at a distance of 28 meters - 84 meters at a depth of 13 meters - 17.4 meters.

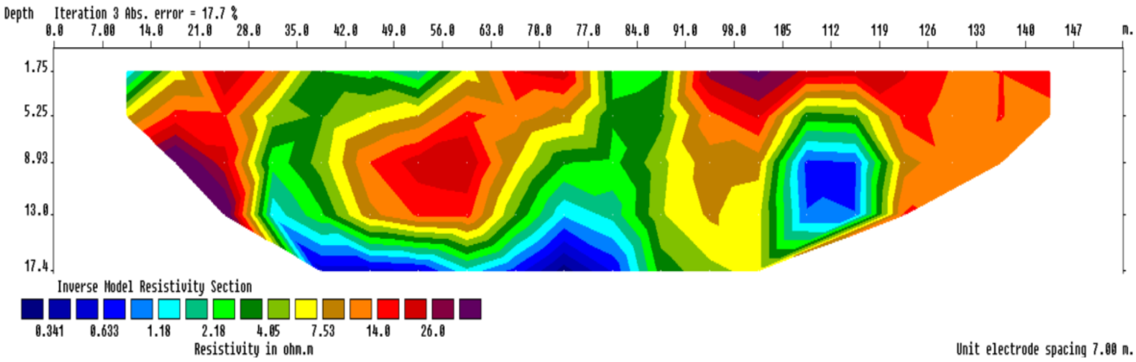

Figure 6. Resistivity 2D Track I using RES2DINV

Figure 7. Position Track II

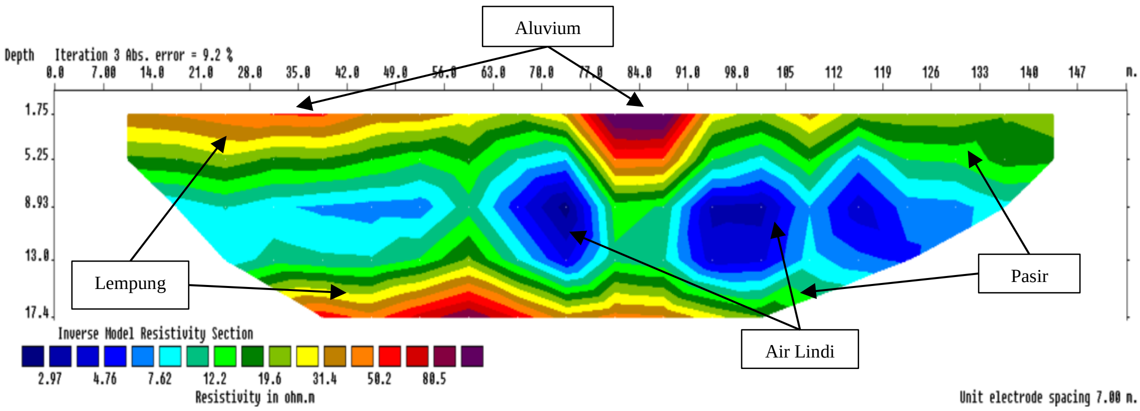

Figure 8. Resistivity 2D Track II using RES2DINV

Figure 9. Position Track II

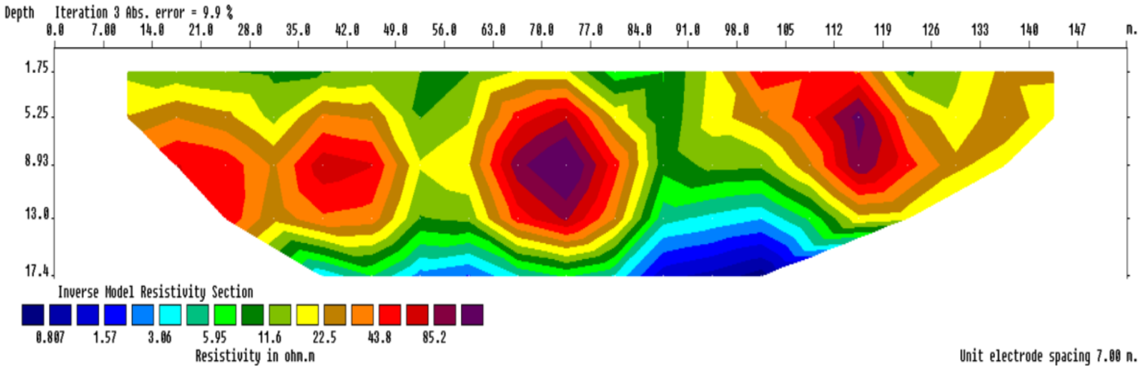

Figure 10. Resistivity 2D Track III using RES2DINV

3.2 Results and Discussion on Track II

The second location is 600 meters to the northeast of Track I and TPA Terjun. The selection of this location was carried out to compare the distance with the distribution of leachate from the Waterfall TPA area, Medan Marelan District to the second location.

Based on the modeling of Figure 8 using the RES2DINV software, the RMS error value obtained is 9.2% with 3 (three) iterations. In the top layer of Track II, an alluvium layer is found at a distance of 77 meters - 91 meters at a depth of 1.75 meters - 5.25 meters which is red with a resistivity value of 80.5 Ωm. Meanwhile, at a horizontal distance of 7 meters – 63 meters at a depth of 1.75 meters – 5.25 meters found clay in yellow line with a resistivity value of 31.4 Ωm and sand in green line with a resistivity value of 12.2 Ωm. Next, at a horizontal distance of 7 meters – 140 meters at a depth of 8.93 meters -13 meters, groundwater with a resistivity value of 2.97 Ωm can be determined so that it can be determined that there is leachate in the water.

3.3 Results and Discussion on Track III

The third location, located in the northeast, is 600 meters from Track II and TPA Terjun. The selection of this location was used as comparative data between the first and second locations to see the distribution of leachate to groundwater in the TPA Terjun area. The results of data processing using RES2DINV software on Track III are variations in resistivity values in the form of a 2D cross-section. This section provides information about the subsurface conditions in Track III.

In Track III at a horizontal distance of 98 meters – 119 meters at a depth of 1.75 meters – 13.0 meters, was found soil unit with a resistivity value of 85 Ωm in red line and it was suspected that the soil type was alluvium.. Meanwhile, at a horizontal distance of 7 meters – 77 meters from Track III, at a depth of 17.4 meters found clay in yellow line a resistivity value of 22.5 Ωm and sand in green line with a resistivity value of 5.95 Ωm. At a track length of 84 meters – 112 meters and a depth of 13 meters – 17.4 meters, groundwater mixed with leachate was found with a resistivity value of 0.807 – 1.57 m. According to Dong (2009) in general, leachate migration from TPA has potential contaminate groundwater because leachate will seep into the ground and then spread follow the groundwater flow.

4. CONCLUSION

Based on the 2D resistivity value model using this geoelectric tool, the leachate distribution is obtained with details including the horizontal distance on each track, depth and groundwater resistivity values. The difference in resistivity values can be seen from the different colors produced on each track at the research location, such as track which is on a horizontal Track I with a track length of 28 meters - 84 meters, a depth of 13 meters - 17.4 meters with a resistivity value of 2.18 Ωm. Likewise, Track II is on a horizontal Track II length of 7 meters – 140 meters, with a depth of 8.93 meters -13 meters with a resistivity value of 2.95 Ωm. Meanwhile, on Track III, it is on a horizontal Track III length of 80 meters – 110 meters, a depth of 13 meters – 17.4 meters with a resistivity value of 0.807 Ωm. This distribution is also influenced by drainage, soil elevation, soil type and management TPA Terjun in tackling the spread of leachate in the area (Musa et al., 2020).

This research is closely related to the science of hydrology and geology in identifying the distribution of leachate that occurs in the soil. So with the influence of hydrogeology, the distribution of leachate around TPA Terjun, Paya Pasir Area, Medan Marelan District can be identified in the direction of distribution towards the northeast following the lower contour towards Medan Belawan, where Track I is at an elevation of 7 meters above sea level, Track II is at an elevation of 5 meters above sea level and Track III is at an elevation of 3 meters above sea level. The groundwater depth on each track is at a depth of Track I at 17.4 meters, Track II at 8.93 meters and Track III at 17.4 meters.

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