Distribution Analysis of Leachate Using the Wenner Configuration Resistivity Method at Sambutan Tpa, Samarinda City, East Kalimantan, Indonesia

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Abstract. The research located in Sambutan TPA, Samarinda City, East Kalimantan Province, Indonesia, with an area of ±350 m^2. This study aims to interpret the resistivity and direction of the distribution of subsurface leachate using the resistivity method of the Wenner configuration with a track length of 90 m per pass. The leachate is known to have a resistivity value of <10 Ώm. The results of the analysis of the measurement location and the indicated depth of leachate have different variations, on the path 1 leachate in the north - south direction has a resistivity value range of 0.467–8.76 Ώm with a depth of 0–12.4 m, path 2 leachate with the direction of Northeast – Southwest has a resistivity value range of 5.77 Ώm with a depth of 0–12.4 m, path 3 leachate in a South – Northwest direction has a resistivity value range of 2.55–9.34 Ώm with a depth of 0–15 m and track 4 of leachate in the Southwest – Northeast direction has a value range of 6.49–8.78 Ώm with a depth of 0–7.82 m. The results of the interpretation of the geoelectric trajectory have the direction of the leachate distribution in the Northeast – Southwest direction in the study area.

Keywords: geoelectric · leachate · Sambutan TPA

1 Introduction

The increase in population, especially the city of Samarinda, has resulted in an increase in the amount of waste produced [1]. This problem arises because the production of waste every day will continue, where for the Samarinda area itself the total waste produced reaches 400–600 tons per day. This makes the Sambutan TPA a new place for the Samarinda city government to minimize waste in the city of Samarinda [1].

Leachate is liquid waste arising from the entry of external water into the landfill, dissolving, and rinsing dissolved materials, including organic matter resulting from the biological decomposition process [2]. From this process it can be predicted that the quality and quantity of leachate will vary and fluctuate. It can be said that the quantity of leachate produced will depend a lot on the entry of water from outside, mostly from

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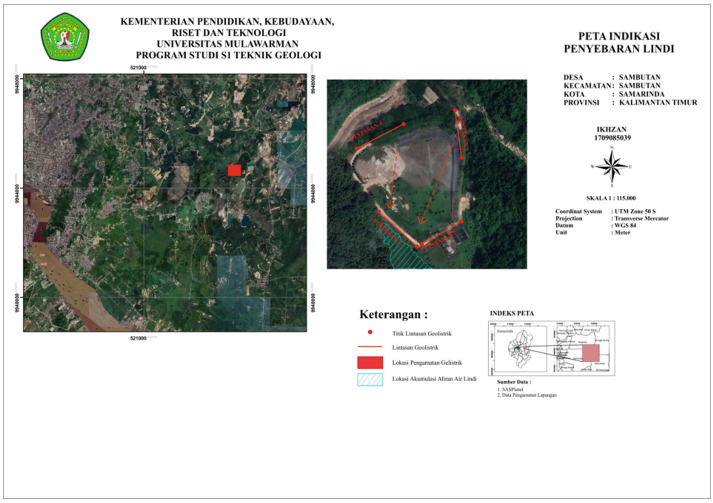

Fig. 1. Location is in Sambtutan TPA, Samarinda City, East Kalimantan Province, Indonesia.

rainwater, besides being influenced by operational aspects applied such as soil cover application, surface slope, climatic conditions and so on [3].

Therefore, from these problems, it is necessary to conduct research on leachate seepage using geoelectric resistivity, because it utilizes resistivity variations that can be used to detect liquid contaminants in soil which are often associated as conductive fluids [4]. Which will later be used to identify the resistivity value of subsurface leachate and identify the direction of leachate distribution in the research area.

2 Methods

2.1 Research Location

The research location is in Sambutan TPA, Samarinda City, East Kalimantan Province, Indonesia (Fig. 1).

2.2 Research Procedures

The research procedure is divided into several stages, namely, preparation, data collection, data processing, data interpretation and drawing conclusions. The stages of this research can be seen in Fig. 2.

a. Preparation

In this process, the path determination consists of 4 tracks with a length of 90 m each and an electrode distance of 5 m. Data collection was carried out using a Naniura resistivity meter.

Fig. 2. Step line Sambutan TPA Location.

b. Data Collection Process

This process determines the measurement trajectory and the direction of the trajectory using a geological compass. Followed by the installation of electrodes with a distance of 5 m wide. After that, compose a resistivity meter circuit based on the Wenner configuration and activate the resistivity meter then inject electric current into the ground through the electrodes that have been installed. Furthermore, measurements are made on the track and record the electric current (I) and potential difference (ΔV) between the 2 electrode points and calculate the resistivity (ρa) of the measurement results.

c. Data Processing

The data that has been obtained in the field is processed based on the apparent resistivity equation, so that the apparent resistivity value (ρa) is obtained by entering the values of V, I, a and K into the Microsoft Excel program. Then the data is processed using Res2dinv Software [5].

d. Data Interpretation

Based on the color image and the difference in resistivity, leachate can be interpreted based on the actual resistivity value.

e. Conclusion

At this stage, conclusions are drawn based on the results of the data obtained in the field.

f. Data Analysis

This research procedure is divided into several stages, namely, determining the depth of leachate and estimating the distribution of leachate.

g. Leachate Depth

Estimating the depth of leachate from the results of data processing that has been obtained from the use of Res2diV Software.

h. Leachate Spread

The interpretation of the leachate distribution is based on the results of depth data processing and the accumulation of leachate obtained on each track.

3 Result and Discussion

3.1 Research Area Sounding Point

Data acquisition was carried out at the Sambutan TPA, Sambutan District, Samarinda City. At TPA Sambutan, the topography is sloping – rather steep, dominated by hills [6]. This research was conducted at 4 different sounding points, where the coordinates use UTM Zone 50 S projection. Sounding point 1 is located at coordinates X = 524350, Y = 9944763 and Z = 34 masl. Sounding point 2 is located at coordinates X = 524362, Y = 9944571 and Z = 23 masl. Sounding point 3 is located at coordinates X = 524284, Y = 9944528 and Z = 26 masl. Sounding point 4 is located at coordinates X = 524180, Y = 9944697 and Z = 37 masl.

3.1.1 Track 1

Track 1 is a track that stretches from North – South with a stretch of 90 m from the point (0°29′59.07" S–117°13′7.80" E) – (0°30′1.74" S–117°13′8.19" E) with topography the starting point of the measurement is 36 m above sea level, while the end point of the measurement is at the topography of 23 m above sea level. The result of the resistivity value of clean water (fresh) is between 10–100 m, while the resistivity value of ground water contaminated with leachate around the landfill is below 10 m. Based on the results of imaging using the Res2Dinv software, a resistivity model of the subsurface layer was obtained with values ranging from 0.467 to 79.0 m (Fig. 3).

The resistivity cross-section for path1 (Fig. 3) shows different color variations, based on the color image it will be known the subsurface distribution at the measurement location which will be associated with (Table 1) [7].

The results on track 1 obtained a conductive anomaly which has a range of rock and mineral resistivity values based on Table 1. The conductive anomaly is seen at the measuring point 0–90 m. Loke (1999) mentions that this anomaly is thought to be a rock

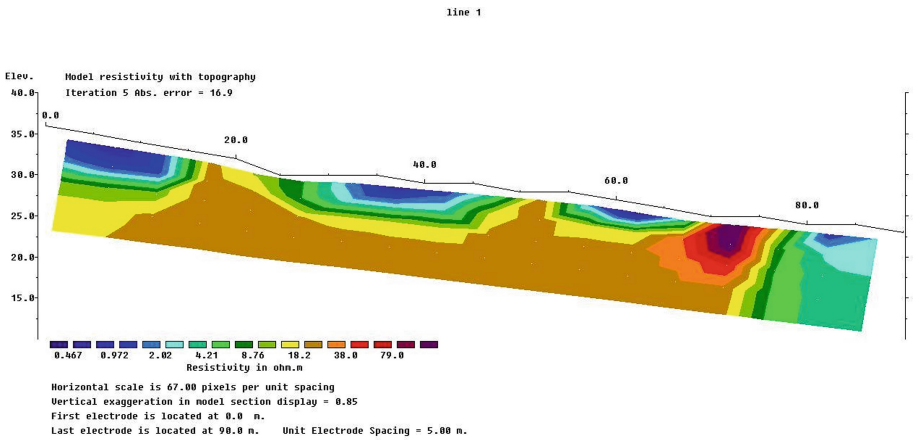

Fig. 3. Results of Wenner 2D Geoelectric Processing for Track 1

Table 1. Results of Geoelectrical Data Processing for Track 1

No.	Resistivity Value (Ωm)	Color	Measurement Location (m)	Depth (m)	Layer Type
1	0.467 - 0.972		0-12	0-3.75	Leachate
			37-42	0-2.25	Leachate
			57-65	0-2	Leachate
			82-90	0-2	Leachate
2	2.02-8.76		0-16.25	0-6	Leachate
			25-49	0-6	Leachate
			54-69	0-3.5	Leachate
			79-90	0.12.4	Leachate
3	18.2-38.0		0-78	0-12.4	Clay, Sand
4	38.0-79.0		64-71	0-9.5	Clay, Sand

layer filled with leachate with a value range of 04.67–8.76 m with a depth of 0–12.4 m, thought to be a layer filled with leachate. The values range from 18.2–79.0 m with a depth of 0–12.4 composed by layers of clay and sand.

3.1.2 Track 2

Track 2 is a track that runs from Northeast – Southwest with a stretch of 90 m from the point (0°30′5.32” S–117°13′8.19” E)–(0°30′6.59” S–117°13′5.93” E) with the topography the starting point of the measurement is at 23 m above sea level, while the end point of the measurement is at the topography 27 m above sea level. The result of the resistivity value of clean water (fresh) is between 10–100 m, while the resistivity value of ground water contaminated with leachate around the landfill is below 10 m. Based on the results of imaging using the Res2Dinv software, a resistivity model of the subsurface layer was obtained with values ranging from 5.77–772 m (Fig. 4).

The resistivity cross section for track 2 (Fig. 4) shows different color variations, based on the color image the subsurface distribution at the measurement location will be known. To facilitate the description of the conditions on track 2, it is described in (Table 2) [8].

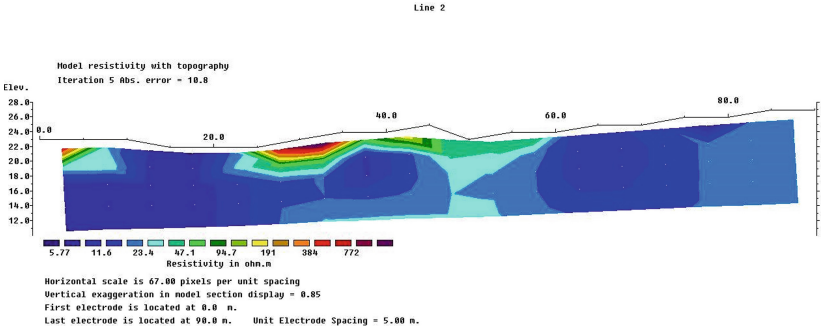

Fig. 4. Results of Wenner Geoelectric Processing 2D Track 2

Table 2. Results of Geoelectrical Data Processing for Track 2

No.	Resistivity Value (Ωm)	Color	Measurement Location (m)	Depth (m)	Layer Type
1	5.77		0-20	0-12.4	Leachate
			37-38	3.75-7.82	Leachate
			78-79	0-2	Leachate
2	11.6-23.4		0-90	0-12.4	Groundwater
3	47.1-94.7		0-8	0-3.75	Clay, Sand
			23-59	0-6.38	Clay, Sand
4	165-348		0-5	0-2	Sand
			25-43	0-5.5	Sand

The results on track 2 obtained a conductive anomaly which has a range of rock and mineral resistivity values based on (Table 3.1). The conductive anomaly is seen at the measuring point 0–90 m. Loke (1999) stated that this anomaly was thought to be a rock layer filled with leachate with a value range of 5.77 m with a depth of 0–12.4 m, thought to be a layer filled with leachate. Values ranging from 11.6–94.7 m with a depth of 0–12.4 m are thought to be composed of a layer of groundwater, values ranging from 47.1–94.7 m with a depth of 0–6.38 m are thought to be composed of clay – sand. And the value range of 165–348 m with a depth of 0–5.5 m is thought to be composed of a layer of sand.

3.1.3 Track 3

Track 3 is a track that stretches from South – Northwest with a stretch of 90 m from the point (0°30′6.72” S–117°13′5.67” E) – (0°30′4.77” S–117°13′3.53” E) with the topography of the starting point of the measurement is at 26 m above sea level, while the end point of the measurement is at the topography of 34 m above sea level. The result of the resistivity value of clean water (fresh) is between 10–100 m, while the resistivity value of ground water contaminated with leachate around the landfill is below 10 m. Based on the results of imaging using the Res2Dinv software, a resistivity model of the subsurface layer was obtained with values ranging from 2.55 to 52.0 m (Fig. 5).

The resistivity cross section for track 3 (Fig. 5) shows different color variations, based on the color image, the subsurface distribution at the measurement location will be known. To facilitate the description of the conditions on track 2, it is described in (Table 3) [9].

The results on track 3 obtained a conductive anomaly which has a range of rock and mineral resistivity values based on (Table 3.1). The conductive anomaly is seen at the measuring point 0–90 m. Loke (1999) stated that this anomaly is thought to be a rock layer filled with leachate with a value range of 52.55–9.34 m with a depth of 0–15 m, thought to be a layer filled with leachate. The range value of 22.2–51.5 m with a depth of 0–15 m is thought to be composed of clay – sand.

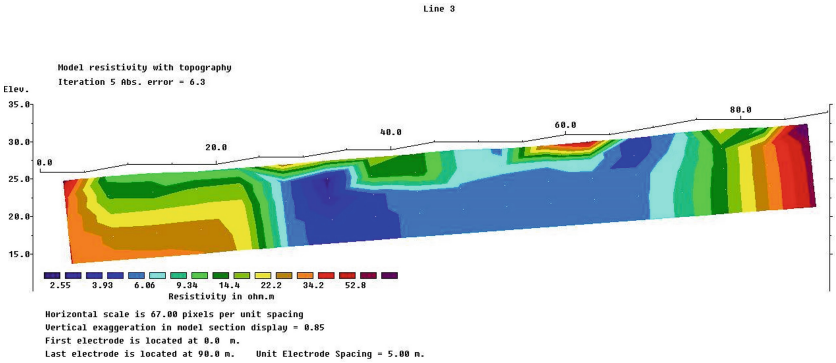

Fig. 5. The Result of Wenner 2D Geoelectric Processing for Track 3

Table 3. Results of Geoelectrical Data Processing for Track 3

No.	Resistivity Value (Ωm)	Color	Measurement Location (m)	Depth (m)	Layer Type
1	2.55-3.93		28-41	3.50-15	Leachate
			65-70	0-3.75	Leachate
2	6.86-9.34		7-75.	0-15	Leachate
			82-83	0-1.25	Leachate
3	22.2-34.2		4-23.	0-15	Clay, Sand
			26-49	0-3.75	Clay, Sand
			56-70	0-3.75	Clay, Sand
			76-86	0-15	Clay, Sand
4	51.5		0-3	0-1.25	Clay, Sand
			63-64	0-1.25	Clay, Sand
			86-90	0-15	Clay, Sand

3.1.4 Track 4

Track 4 is a track that runs from Southwest – Northeast with a stretch of 90 m from the point (0º30′1.22” S–117º13′2.30” E)–(0º29′59.85” S–117º13′4.92” E) with topography the starting point of the measurement is at 37 m above sea level, while the end point of the measurement is at the topography of 42 m above sea level. The result of the resistivity value of clean water (fresh) is between 10–100 m, while the resistivity value of ground water contaminated with leachate around the landfill is below 10 m. Based on the results of imaging using the Res2Dinv software, a resistivity model of the subsurface layer was obtained with values ranging from 6.49 to 53.9 m (Fig. 6).

The resistivity cross section for track 4 (Fig. 6) shows different color variations, based on the color image, the subsurface distribution at the measurement location will be known. To facilitate the description of the conditions on track 2, it is described in (Table 4).

The results on track 4 obtained a conductive anomaly which has a range of rock and mineral resistivity values based on (Table 3.1). The conductive anomaly is seen at the measuring point 0–90 m. Loke (1999) mentions that this anomaly is thought to be a rock

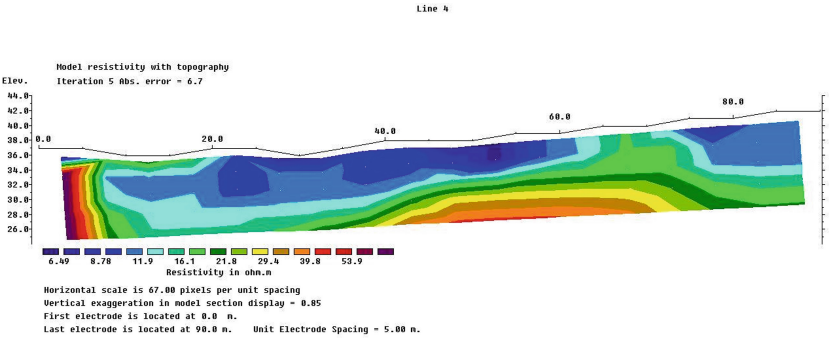

Fig. 6. Results of Wenner Geoelectric Processing 2D Track 4

Table 4. Results of Geoelectrical Data Processing for Track 4

No.	Resistivity Value (Ωm)	Color	Measurement Location (m)	Depth (m)	Layer Type
1	6.49-8.78		0-6	0-3	Leachate
			20-58	0-7.82	Leachate
			74-82	0-3.75	Leachate
2	11.9-16.1		0-90	0-12.4	Clay, Sand
3	21.8-29.4		0-8	2.75-12.4	Clay, Sand
			12-14.	0-1.25	Clay, Sand
			32-90	7.25-12.4	Clay, Sand
4	39.8-53.9		0-7	3.25-12.4	Clay, Sand
			40-72	10.50-12.4	Clay, Sand

layer filled with leachate with a value range of 6.49–8.78 m with a depth of 0–7.82 m, thought to be a layer filled with leachate. Values ranging from 11.9–53.9 m with a depth of 0–12.4 m are thought to be composed of clay – sand.

3.2 Direction of Distribution and Depth of Leachate

Based on the results of interpretation and analysis on each geoelectric path of the study area, the point indicated the presence of leachate seen from the color image shown in each path which can be seen in (Fig. 3, Fig. 4, Fig. 5 and Fig. 6) on path 1 the leachate has The resistivity range of 0.467–8.76 m with a certain distance at the measurement location varies from 0–90 m at a depth of 0–12.4 m can be seen in (Table 1). Trajectory 2 leachate has a resistivity value range of 5.77 m with a distance at the measurement location of 0–79 m located at a depth of 0–12.4 m can be seen in (Table 2). Pathway 3 leachate has a resistivity value range of 2.55–9.34 m with a certain distance at the measurement location varying from 7–83 m located at a depth of 0–15 m can be seen in (Table 3). Path 4 leachate has a value range of 6.49–8.78 m with a certain distance at

measurement locations that vary from 0–82 m with a depth of 0–7.82 m can be seen in (Table 4).

From the interpretation and analysis of the geoelectrical trajectory, it is assumed that the direction of the leachate distribution is predicted to be in the Northeast – Southwest [10]. This is also obtained based on the results of the analysis of contour patterns at the Sambutan landfill which has a gentle – rather steep slope. In addition, it can be seen in the color image that track 2 and track 3 have a relatively lower height and have more leachate accumulation than track 1 and 4.

4 Conclusion and Suggestion

4.1 Conclusion

Based on subsurface survey data using the geoelectrical method of resistivity at the Sambutan landfill, it can be concluded [11]:

1. Based on the results of the subsurface analysis, the leachate resistivity value at the Sambutan landfill has a resistivity value, the measurement location and the depth indicated that the leachate has different variations, on track 1 leachate has a resistivity value range of 0.467–8.76 m with a depth of 0–12, 4 m, path 2 leachate has a resistivity value range of 5.77 m with a depth of 0–12.4 m, path 3 leachate has a resistivity value range of 2.55–9.34 m with a depth of 0–15 m and path 4 water The leachate has a value range of 6.49–8.78 m with a depth of 0–7.82 m.
2. From the results of the analysis of the geoelectric trajectory, it is interpreted that the direction of the leachate distribution at the Sambutan landfill is in the Northeast – Southwest.

4.2 Suggestion

Suggestions given by the author for further research on leachate at the Sambutan TPA. In the next study, groundwater quality data was added in areas that were potentially indicated to be contaminated with leachate.

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