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ANALYSIS OF LEACHATE WATER DISTRIBUTION IN BAKUNG FINAL WASTE DISPOSAL LOCATION (TPA) USING RESISTANCE GEOELECTRIC METHODS IN KETEGUHAN PERMAI HOUSING BANDAR LAMPUNG

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Abstract

Poor waste management is one of the most frequent environmental problems in Indonesia. We know that the waste generated as a result of daily human activities will be transported, then disposed of at the Final Disposal Site (TPA). The lack of attention to WWTP maintenance at the Daffodil TPA can be seen from the thickness of the sediment at the WWTP dam. The thickness of the sediment in the WWTP causes leachate from the TPA not to fully enter the WWTP but flows directly into the river and seeps into the ground. Thus, this research was conducted as an aim to explain the spread of leachate pollution in shallow groundwater in the Keteguhan Permai housing complex. The method is quantitative. The results of this study indicate that groundwater is shallow in the study area, namely, Keteguhan Permai housing has been polluted by leachate. The average leachate intrusion depth in this study area is less than 13 meters with a resistivity value of less than 10Ωm

Keywords: leachate; waste management; disposal

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INTRODUCTION

Poor waste management is one of the most frequent environmental problems in Indonesia. We know that the waste generated as a result of daily human activities will be transported, then disposed of at the Final Disposal Site (TPA) (Sasaki & Araki, 2013). Furthermore, the waste will be managed according to the system used in the TPA. In Indonesia, the most widely used disposal system is the open dumping system, even though this system has long been abandoned by other countries because of the high risk of environmental pollution (Angrianto et al., 2021). In fact, the law itself has regulated this open dumping system, as stipulated in Law no. 18 of 2008 concerning Waste Management. One of the TPAs that still uses an open disposal system is the Bakung TPA located in Bandar Lampung City. The open dumping system of waste management causes many negative effects, especially for the environment and the people around the TPA. TPA which is operated by open dumping will produce by-products in the form of methane gas and leachate.

The Bakung TPA is located on Jalan Tulung Buyut, Bakung Village, Teluk Betung Barat District, Bandar Lampung City. This landfill started operating in 1994 and has an area of 14.2 hectares (Rasimeng et al., 2021). This landfill accommodates around 800 tons of waste per day which is transported by 100 garbage trucks belonging to the Environmental Service. The increasing amount of garbage caused around 90% of the landfill area to be covered with piles of garbage. One of the problems that occur at the Bakung TPA comes from the waste by-product, namely leachate.

Leachate is a liquid that seeps through a pile of waste by carrying dissolved material resulting from the decomposition of the waste material (Harjito et al., 2018). Leachate from waste at the Bakung landfill is channeled to the Wastewater Management Installation (WWTP) which is near the Keteguhan Permai Housing Complex. Where the WWTP is also located adjacent to a river in a residential area. Leachate that enters the drainage or river will contaminate the water. Various organisms including fish can die so that some species will disappear, this will change the biological aquatic ecosystem (Amalia, 2016).

The lack of attention to WWTP maintenance at the Daffodil TPA can be seen from the thickness of the sediment at the WWTP dam (Andjani et al., 2017). The thickness of the sediment in the WWTP causes leachate from the TPA not to fully enter the WWTP but flows directly into the river and seeps into the ground. Leachate infiltration into the soil has the potential to impact the quality of shallow groundwater. Where the shallow ground water is used by local residents for household needs through wells. The depth of the residents' well water in the Keteguhan residential area is around 10-20 meters. The contamination of the shallow groundwater by leachate will affect the quality of the residents' well water sources.

Every day humans produce waste as a result of their daily activities (Kahfi, 2017). Garbage has many impacts, both on humans and the environment (Yusmiati et al., 2017). In Indonesia, the method of waste disposal that is commonly used is the open dumping method, which is a waste disposal system by simply dumping waste in open fields where final disposal is carried out without any follow-up (Prajnawita, 2020).

Prior to conducting this research, the authors had conducted a literature study on several types of the same research. The research reviewed is research that has been conducted for the last five years. The following table shows the results of previous studies:

Table 1
Table of Previous Research Results

No.	Research Title	Research methods	Research result
1.	Leachate Distribution Study Based on Correlation of 2D Resistivity Data, Test Data Laboratory and Drilling Data of TPA Ngipik, Gresik Regency (Arsyadi et al., 2017)	Wenner-Schlumberger Configuration Geoelectrical Method	The leachate intrusion area is shown at a resistivity of 0.1 – 1.5 Ωm.
2.	Study of Leachate Seepage Accumulation Using Geoelectrical Resistivity Wenner Mapping Configuration Method (Hakim et al., 2017)	Geoelectric Method of Wenner Mapping Configuration	The leachate intrusion area is shown at a resistivity of 0.74 -5.32 Ωm
3.	Application of the Wenner Mapping Geoelectrical Configuration Method to Determine Leachate Seepage at TPA Talang Gulo Jambi (Pratiwi, 2018)	Geoelectric Method of Wenner Mapping Configuration	The leachate intrusion area is shown at a resistivity of 0.0288 – 1.50 Ωm.
4	Based on Gampong Jawa TPA Leachate Delineation Analysis 2D Resistivity Modeling with Geoelectric Method (Fitria et al., 2018)	Wenner-Schlumberger Configuration Geoelectrical Method	The leachate intrusion area is shown at a resistivity of 0.0 – 0.4 Ωm.
5	Determination of Leachate Distribution Using the Method Geoelectrical Wenner Configuration and Geochemical Tests at Muara Fajar TPA (Simanjuntak, 2021)	Wenner Configuration Geoelectrical Method	The leachate intrusion area is shown at a resistivity of 0.729 - 4.38 Ωm.

Based on the above, it is necessary to conduct research on the spread of leachate pollution in shallow groundwater in the Keteguhan Permai housing complex. Research on leachate pollution can be carried out using the resistivity geoelectric method. The principle of this method is to measure the variation of vertical and horizontal electric currents as an indication of the position, boundaries and apparent resistance of various subsurface conditions. Where in research that was conducted by Hakim, et al (2017), the resistivity of leachate is at a low resistivity value (<10 Ωm).

METHOD

The study used quantitative research method (Creswell, 2017). The data used in this study are grouped into primary data and secondary data. Components, types, data sources, and data collection methods are presented in Table 2.

Table 2
Components, Types, Data Sources, and Data Retrieval Methods

No	Component	Data Type	Data source	How to Take
1	Geoelectric Measurement Data	Primary	Naniura Geoelectric Tool	Field Data Collection
2	Geological Map of Study Area	Secondary	Mango, 1993	Literature review

Research Stages

This research was carried out in several stages including:

1) The first stage was to conduct a field survey of the research location, namely the Bakung Final Disposal Site (TPA) and the Keteguhan Permai Housing Complex.

2) The second stage is to design a geoelectric measurement line using the Wenner Method at the Keteguhan Permai Housing location. The measurement area is 2.6 hectares with 4 measuring lines. Each line has a length of 155 meters with an estimated depth of measurement of 24 meters.

3) The third stage is to collect geoelectrical data using the Wenner configuration at the Keteguhan Permai Housing location and perform data processing using Res2dinv software and analyze data based on literature and research that has been done before. In geoelectric measurements the data obtained is electric current data and rock potential data. Furthermore, the two data will be processed to obtain the true resistivity value of the rock.

4) The fifth stage is to analyze the pattern of distribution of leachate in the Keteguhan Housing based on the results of geoelectrical data processing.

Analysis Method

1) 2D Geoelectric Data Analysis with Wenner Configuration

From geoelectrical measurements in the field of the 4 measurement lines that have been made, the value of electric current and potential difference is obtained. Based on these two values, the value can be searched *resistivity* of the constituent rocks with the formula:

$\rho_{a=K}\frac{\Delta V}{I}$..(iii)

where,

ρ = Resistivity

K = Geometry factor of the electrode configuration used

ΔV = Potential Difference

I = Current

With a value of K is

$K = \frac{2\pi}{\left(\frac{1}{AM}+\frac{1}{NB}\right)-\left(\frac{1}{AN}+\frac{1}{MB}\right)}$ = 2 ....(iv). πa

where a = AM = MN = NB is the spacing between the electrodes.

From the resistivity value obtained from the calculation above, it can be seen that the leachate distribution pattern vertically and horizontally using Res2dinv software. The following is an example of a 2D cross-section of the distribution of leachate that will be displayed:

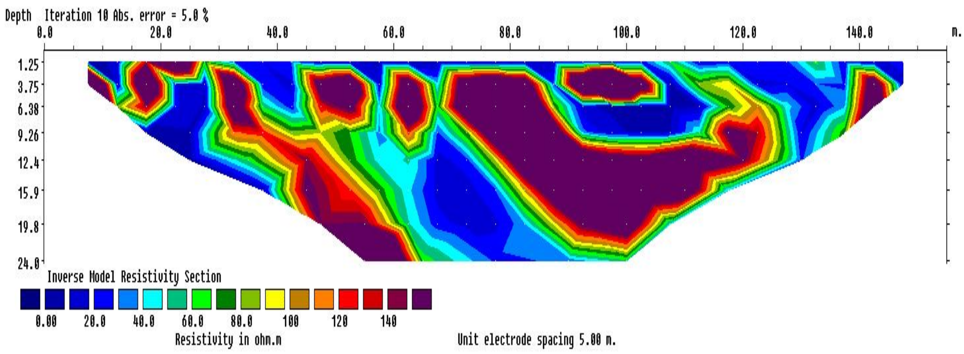
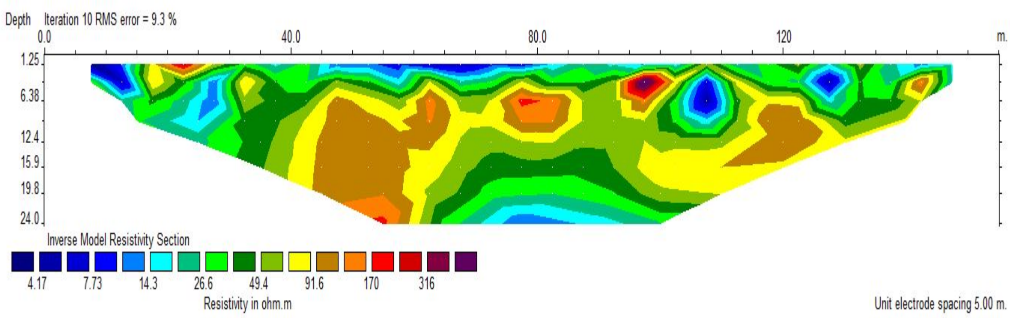


Figure 1. 2D Cross-section of Geoelectrical Data

The distribution of leachate in this measurement area is indicated by the dark blue areas, where the resistivity values range from <10 Ωm.

RESULTS AND DISCUSSION

Geoelectrical data collection is carried out on four measurement lines, the length of each line is 155 meters with an estimated depth of measurement of 24 meters. The electrode spacing used in this measurement is 5 meters with leachate indicated by layers that have a low resistivity value of <10 Ωm.



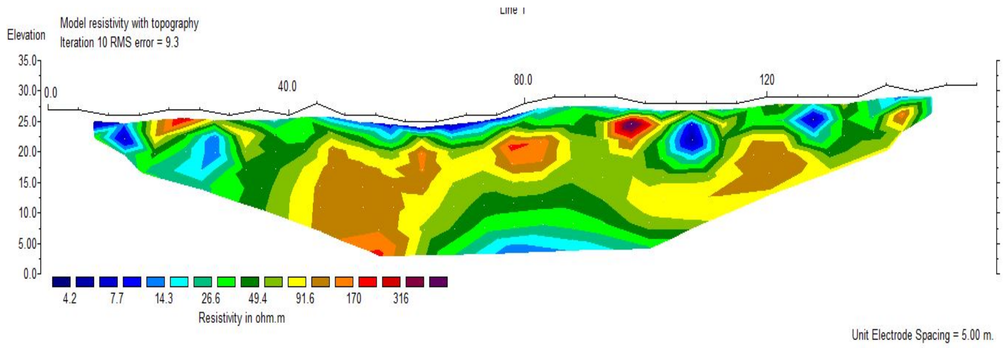


Figure 2. Cross Section 2D Line Measurement 1

Line Measurement 1 is located at coordinates 105.2425340 LE and -5.4614390 LS. Leachate seepage is indicated by a dark blue layer with a resistivity value of 4.17 Ωm – 7.7 Ωm at a depth of 1.25 m – 8.89 m. The error value obtained in processing this data is 9.3% with 10 iterations. The green to red layers with a value of 26.6 Ωm -170 Ωm are assumed to be tuff layers, while the dark red to purple layers with a resistivity of 316 Ωm are assumed to be breccia layers. In the cross-section of measurement line 1 it can be seen that the dominating layer is a layer that is green to brown in color, so it is assumed that this measurement line 1 is dominated by tuff rock.

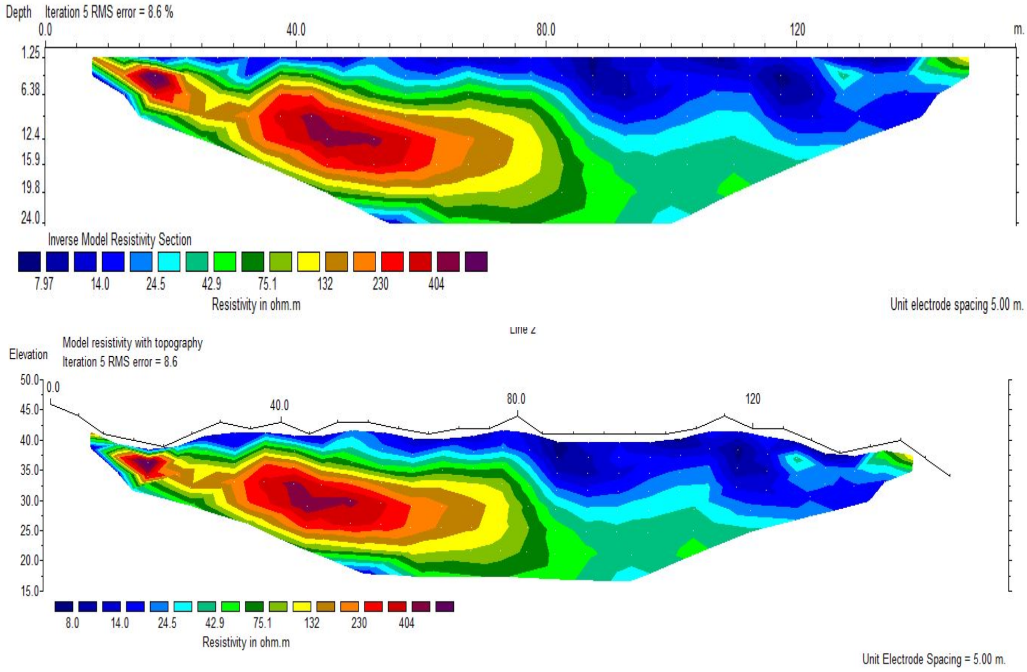


Figure 3. Cross Section 2D Line Measurement 2

Line measurement 2 is located at coordinates 105.2424410 LE and -5.4607650 LS. On this measurement line leachate seepage is indicated by a dark blue layer, with a resistivity value of 7.97 Ωm. Where the layer is at a depth of 1.25 m - 8.8 m. The error value obtained in processing this data is 8.6% with 5 iterations. For resistivity values of 24.5 Ωm – 132 Ωm which are indicated by blue to brown layers, it is assumed to be tuff rock layers. Then for the orange to purple layers that have a resistivity value of 230 Ωm – 404 Ωm it is assumed to be a layer of breccia rock.

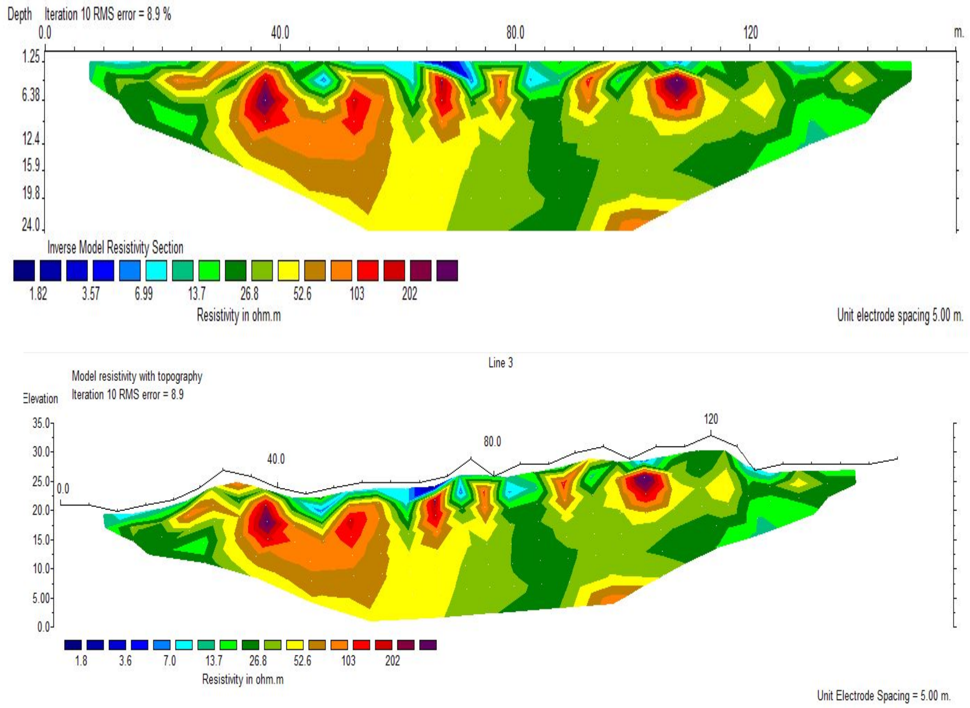


Figure 4. Cross Section 2D Line Measurement 3

Line measurement 3 is located at coordinates 105.2419070 LE and -5.4614780 LS. In this measurement area, leachate seepage is shown by dark blue to light blue areas, with a resistivity value of 1.82 Ωm – 6.99 Ωm at a depth of 1.25 m – 6.38 m. Based on the 2D section above, it can be seen that the layers in this measurement area are dominated by layers with a resistivity value between 26.8 Ωm – 202 Ωm, where the resistivity value is assumed to be a layer of tuff rock. The error value obtained in this data processing is 8.9% with 10 iterations.

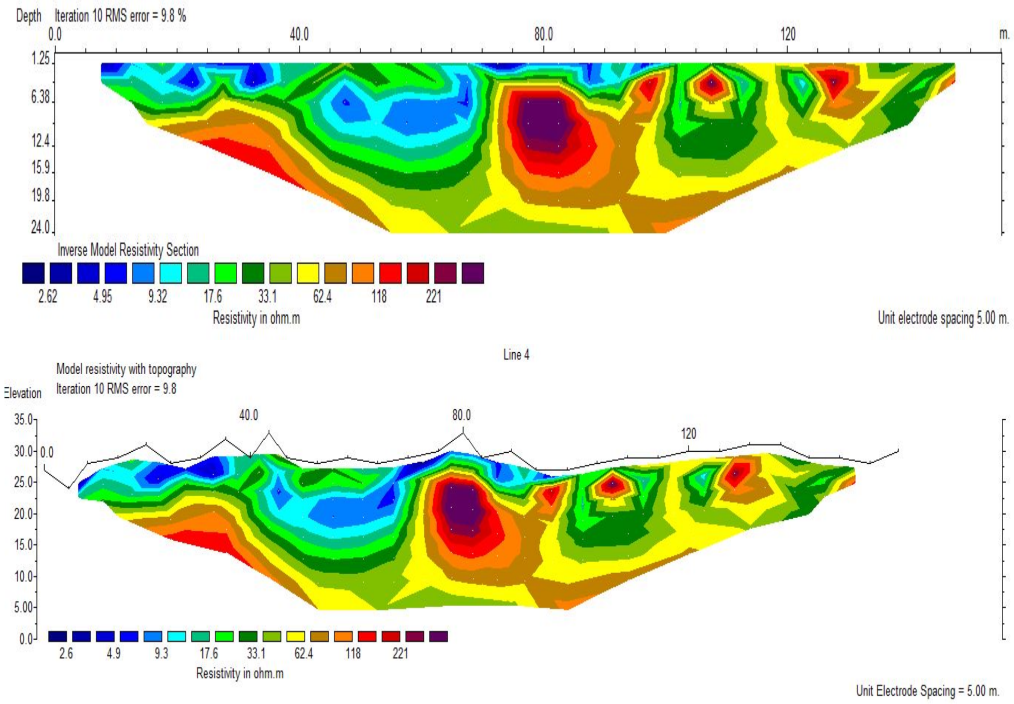


Figure 5. Cross Section 2D Measurement Line 4

Line measurement 4 is located at coordinates 105.242600 LE and -5.4622940 LS. In this measurement area, leachate seepage is indicated by areas that are dark blue to light blue, with a resistivity value of 2.62 Ωm – 9.32 Ωm at a depth of 1.25 m – 12.4 m. Based on the 2D section above, it can be seen that the layers in this measurement area are dominated by layers with a resistivity value between 33.1 Ωm – 221 Ωm, where the resistivity value is assumed to be tuff rock layers. The error value obtained in this data processing is 9.8% with 10 iterations.

Table 3
Processing Results on the Geoelectrical Measurement Line

Measurement Tracks	Coordinate	Anomaly	Color	Resistivity Value
1	105.242534^0 LE and -5.461439^0 LS	Leachate	Dark blue	4.17 Ωm – 7.7 Ωm
		Tuff Rock	Green - Red	26.6 Ωm -170 Ωm
		Breccia rock	Dark Red - Purple	316 Ωm
2	105.242441^0 LE and -5.460765^0 LS	Leachate	Dark blue	7.97 Ωm
		Tuff Rock	Blue - Brown	24.5 Ωm – 132 Ωm
		Breccia rock	Orange - Purple	230 Ωm – 404 Ωm
3	105.241907^0 LE and -5.461478^0 LS	Leachate	Dark Blue - Light Blue	1.82 Ωm – 6.99 Ωm
		Tuff Rock	Green - Purple	26.8 Ωm – 202 Ωm
4	105.242600 LE and -5.462294^0 LS	Leachate	Dark Blue - Light Blue	2.62 Ωm – 9.32 Ωm
		Tuff Rock	Dark Green - Purple	33.1 Ωm – 221 Ωm

CONCLUSION

The results of this study indicate that the shallow groundwater in the research area, namely, Keteguhan Permai Housing has been polluted by leachate. The average leachate intrusion depth in this study area is less than 13 meters with a resistivity value of less than 10Ωm. Based on the geological map of the study area, the constituent rocks in this area are tuff and breccia. Where tuff rock has 20-100 Ωm while the resistivity value of breccia rock is > 250 Ωm.

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