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Interpretation of subsurface layers using the Wenner configuration geoelectric method and geochemical tests: Case study at Muara Fajar landfill – Rumbai, Pekanbaru

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ABSTRACT

The need for water daily is a big problem for people living around Muara Fajar landfill – Rumbai, Pekanbaru. This study aims to identify the depth of subsurface structures around the Muara Fajar landfill area using the Wenner configuration dielectric method and determine the water quality in the community wells around the landfill site. The data obtained in the acquisition process are used to calculate the apparent resistivity value at each measurement point and analyzed quantitatively and qualitatively. Then proceed with the inversion process using the progress program so that obtained resistivity value and layer thickness at each point of measurement. The results of measurement in track-1 get a range of resistivity values ranging from 62.9 – 171 ohm-meters and track-2 from 32.4 – 70.6 ohm-meters. Underground water taken is residents' well water in the research area as many as 5 sample points using GPS. This underground water sample will be tested with parameters such as pH, TDS, BOD, COD, NH_3, and turbidity. Underground water cannot be consumed from the results of the water quality test with the parameters mentioned at the beginning if referring to the Regulation of the Minister of Health of the Republic of Indonesia because the pH obtained in all underground water samples is < 6.5 or acidic, the value of the BOD, COD, NH_3, and turbidity parameters, the values are by the quality standard.

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1. INTRODUCTION

The functional activities of the landfill have generated waste in the form of liquid, solid, gas, dust, and noise. According to residents, the existence of the Muara Fajar landfill has caused several problems such as noise and also the water from dug wells being contaminated by liquid waste [1-3]. The waste processing process at the Muara Fajar landfill takes place regularly every day, which means that leachate is also produced continuously [4, 5]. Surface water and rainwater around leachate reservoirs and landfill waste will experience a process of seepage into the underground layers and some will flow over the surface. Water affected by seepage will cause health and comfort problems for consumers [6-8].

The Muara Fajar landfill began operating in 1985 with an effective area of ± 8.6 hectares and can accommodate 1722 m^3/day of waste. Muara Fajar landfill processes 90% of waste using an open dumping system, and 10% using a controlled landfill system [9, 10]. Both systems speed up the process of breaking down waste by soil microbes and producing leachate. Rainwater that passes through leachate seeps and flows into the lower layers of the soil, so that underground water is more easily polluted [11-13].

Leachate is a source of groundwater and surface water pollution. As a result, it affects the physical, chemical, and microbiota properties of water. This results in decreased water characteristics [14, 15]. Decreased water quality due to the accumulation of leachate results in contamination of groundwater around the landfill, such as resident wells as the source of raw water (water for cooking, drinking, bathing, and washing) [16-18]. However, the people around the Muara Fajar landfill have processed their wells by concreting them, or what we usually hear as ring wells. This minimizes the seepage process both during rain and regular seepage.

Wells built by communities around the landfill does not guarantee that the water they use is of good quality. Polluted water cannot be judged only by the outer surface. The importance of ground surface investigations provides an overview of the location of the water. The geoelectric method is one of the methods used to investigate groundwaterv [19, 20].

Geoelectricity is a method of detecting the nature of electric currents in the earth which is explored from the surface [21-23]. This method consists of measuring electric currents, potential, and electromagnetic fields that occur, both by injecting current into the subsurface and naturally. The geoelectric method is a method that has quite good results so it is often used [24, 25]. Different types of materials have different types of resistance. One of the geoelectric methods that is often used to estimate geological conditions and measure electrical flow is the resistivity or resistivity method [26].

The resistivity method or resistivity method utilizes differences in resistivity values in each layer, both rock resistivity values and subsurface soil resistivity values, to detect geological structures or rock structures below the surface. The type of rock that exists determines the level of aquifer permeability. This is what will find out what pollutants are entering underground water and its quality is decreasing [27-29]. Given this, the author wants to conduct research with the aim of calculate the resistivity value and analyze the lithology of the subsurface layer using the Wenner configuration geoelectric method at Muara Fajar landfill – Rumbai, Pekanbaru. Determine water quality based on pH, TDS, BOD, COD, NH3 and turbidity content.

2. RESEARCH METHODS

This research discusses the process of processing geoelectric resistivity data using software or Res2DInv so that resistivity cross sections are obtained which represent the subsurface layer. The Schlumberger configuration geoelectric method is useful for analyzing the resulting subsurface layers. Furthermore, this research discusses water quality by taking 5 samples of residents' well water at different coordinate points and testing the parameters pH, TDS, BOD, COD, NH_3, and turbidity.

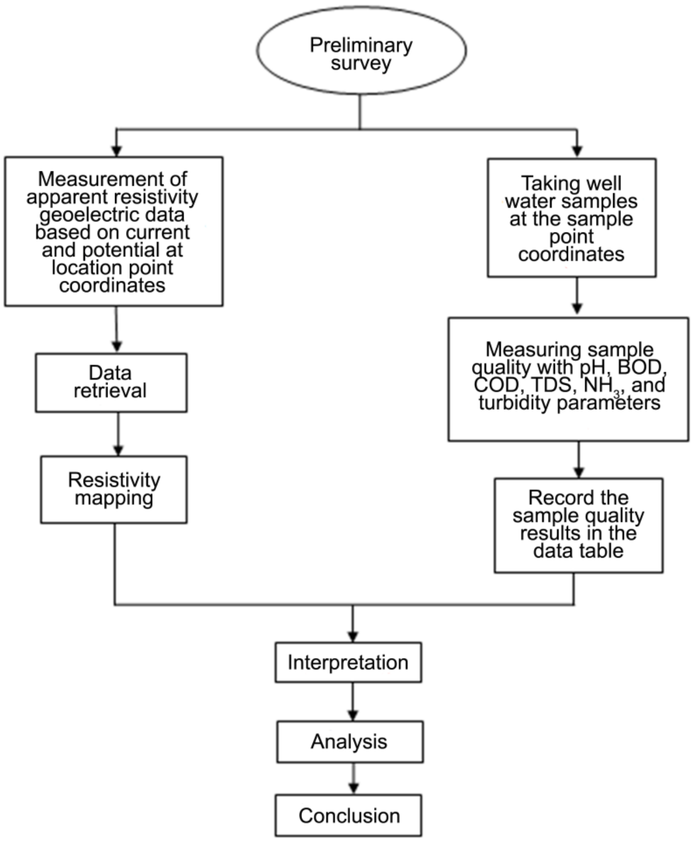

Figure 1. Composition of research methods

3. RESULTS AND DISCUSSIONS

This research aims to determine the subsurface layer and to determine the quality of groundwater using several parameters.

3.1. Interpretation of Resistivity and Lithology Data for Track 1

The results of calculations and data processing using res2dinv software are located at coordinates 0º38'46.7" N and 100º26'37.7" E with a measurement path length of 150 meters and a spacing between electrodes of 5 meters. A cross-sectional image can be seen in Figure 2.

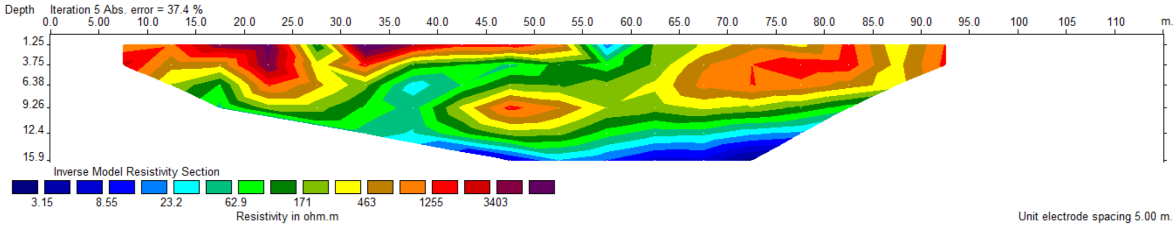

Figure 2. Lithological resistivity of track 1

The first layer with a resistivity value of 62.9 – 171 ohm-meters from the surface to a depth of 0 – 2 meters is interpreted as a layer of clay rock and gravel, the second layer with a resistivity value of 171 – 463 ohm-meters at a depth of 2 – 5 meters is interpreted as gravel. The third layer with a resistivity value of 8.56 – 23.2 ohm-meters at a depth of 5 – 8 meters is interpreted to be a clay layer. The fourth layer with a resistivity value of 463 – 1,256 ohm-meters at a depth of 8 – 10 meters is interpreted to be a layer of sand and alluvium. The fifth layer with a resistivity value of 1,256 – 3,403 ohm-meters at a depth of 10 – 12 meters is interpreted as a slate layer and the last layer with a resistivity value of > 3,403 ohm-meters at a depth of 12 – 15 meters is interpreted as dry gravel and granite.

3.2. Interpretation of Resistivity and Lithology Data for Track 2

The results of calculations and data processing using res2dinv software are located at coordinates 0º38'42.0" N and 101º26'25.5" E with a measurement path length of 150 meters and a spacing between electrodes of 5 meters. A cross-sectional image can be seen in Figure 3.

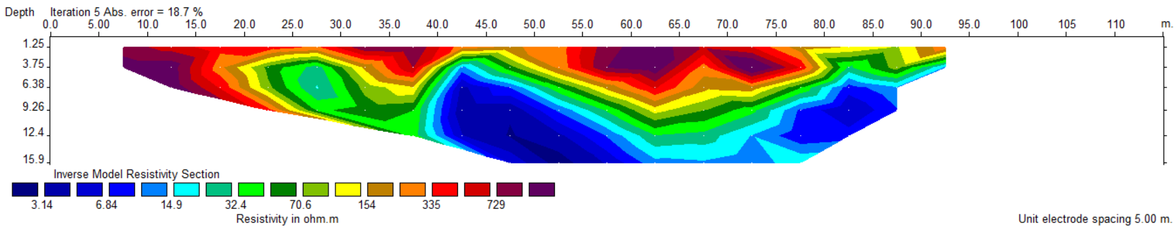

Figure 3. Lithological resistivity of track 2

The first layer with a resistivity value of 32.4 – 70.6 ohm-meters from the surface to a depth of 0 – 5 meters is interpreted as a layer of clay rock and gravel, the second layer with a resistivity value of 70.6 – 154 ohm-meters at a depth of 5 – 8 meters is interpreted as gravel. The third layer with a resistivity value of 6.84 ohm-meters to 14.9 ohm-meters at a depth of 8 – 10 meters is interpreted to be a clay layer. The fourth layer with a resistivity value of 154 – 335 ohm-meters at a depth of 10 – 11 meters is interpreted to be a layer of sand and alluvium. The fifth layer with a resistivity value of 335 – 729 ohm-meters at a depth of 11 – 12 meters is interpreted as a slate layer and the last layer with a resistivity value of > 729 ohm-meters at a depth of 12 – 15 meters is interpreted as dry gravel and granite.

3.3. Analysis of pH, TDS, BOD, COD, NH_3, and Turbidity

Standard Quality Standard Water pH parameters normally range from 6.5 – 8.5, maximum TDS 1,000 mg/L, maximum BOD 1,000 mg/L, maximum COD 1,000 mg/L, maximum NH_3 1,000 mg/L, and maximum turbidity 25 NTU. The results of water sample tests based on these 6 parameters are shown in Table 1.

Table 1. Water sample test results

No	pH	TDS	BOD	COD	NH_3	Turbidity
1	4.56	11	22	68	0.28	0.28
2	5.62	71	2	13	0.18	0.12
3	3.57	274	12	38	0.23	1.63
4	5.6	27	2	6	0.25	0.73
5	6.31	52	56	176	0.19	3.91

Measurement of water samples resulted in the pH of all samples being acidic ($pH < 6.5$). Acidic water has a low pH level and this has an impact on the health of living things that consume it. Metal water pipes will also experience corrosion and as a result, the water that passes through the pipes will retain dissolved metals.

Table 1 shows the average value of dissolved solids measurements in residents' wells around the Muara Fajar landfill, the highest being 274 mg/L and the lowest 11 mg/L. By Minister of Health Regulation Number 492/MENKES/PER/IV/2010, the maximum TDS level for clean water is 1,000 mg/L, so the water in residents' wells is still considered suitable for use. The BOD value obtained from the results of this research is also still suitable for consumption because it still complies with quality standards according to (SNI 06-2503-1991). The lower the BOD value, the cleaner the water, the more the water quality will improve. The results obtained for the COD value were the highest value was 176 mg/L and the lowest was 6 mg/L. By the quality standards (APHA 5220 C 2012) that the maximum COD level for clean water is 1000 mg/L, then the water in the residents' wells is still classified as suitable for consumption. The NH_3 value obtained from the results of this research is still very suitable for consumption because it is still by the quality standards (USEPA) that the maximum NH_3 value for clean water is 1,000 mg/L. The results obtained for the turbidity level of community wells around the Muara Fajar landfill are classified as suitable for use because the measurement results are far below the quality standards that have been set [30].

4. CONCLUSION

Based on the results of resistivity measurements around the Muara Fajar landfill – Rumbai, Pekanbaru, for track-1 the soil layer resistivity value ranges between 62.9 – 171 ohm-meters with a maximum depth of 15 m, and for track-2 the soil layer resistivity value ranges from 32.4 –70.6 ohm-meters with a maximum depth of 15 m. Meanwhile, the layer lithology is gravel and clay. The water quality in residents' wells around the Muara Fajar landfill is classified as unfit for use. This is due to the existence of several test parameters that are not in sync with the established quality standards.

REFERENCES

[1] M. Juandi, "Analisa pencemaran air tanah berdasarkan metode geolistrik studi kasus tempat pembuangan akhir sampah Muara Fajar Kecamatan Rumbai," *Jurnal Ilmu Lingkungan*, vol. 3, pp. 95-104, 2009.

[2] Z. Zulkarnain, *et al.*, "Water seepage rate in composted soil," *Science, Technology and Communication Journal*, vol. 3, pp. 91-96, Jun 2023.

[3] R. F. Rahman, *et al.*, "Predictive analysis of waste generation at the Babussalam Islamic Boarding School, Pekanbaru City," *Science, Technology and Communication Journal*, vol. 4, pp. 5-10, Oct 2023.

[4] P. R. Nurhedi and J. Muhammad, "Analisis penurunan kadar air gaplek menggunakan alat pengering kabinet berbasis biomassa tempurung kelapa," *Indonesian Physics Communication*, vol. 20, pp. 123-126, Jul 2023.

[5] M. Handayani and J. Muhammad, "Aplikasi uji coba skala laboratorium implementasi prototype alat inovasi teknologi pasca panen berbasis biomassa untuk deteksi temperature dengan sistem internet of things," *Indonesian Physics Communication*, vol. 19, pp. 69-74, Jul 2022.
[6] S. Azwar, "*Reliabilitas dan validitas*," Pustaka Pelajar: Yogyakarta, 2004.
[7] I. R. Husein, *et al.*, "Electrical discharge of butane and propane for carbon plasma with air impurities, slightly ionized at high pressure," *Science, Technology and Communication Journal*, vol. 1, pp. 104-111, Jun 2021.
[8] Y. Yustina, *et al.*, "Observation of growth rate of catfish (Pangasius sp.) Against mixed feed fermentation of mustard and cabbage waste flour," *Science, Technology and Communication Journal*, vol. 2, pp. 26-31, Oct 2021.
[9] A. P. Yasmin and M. Juandi, "Interpretasi lapisan bawah permukaan dengan menggunakan metode geolistrik konfigurasi Schlumerger dan geokimia: Studi kasus TPA Muara Fajar Rumbai," *Komunikasi Fisika Indonesia*, vol. 18, pp. 22-28, Mar 2021.
[10] D. Defrianto, *et al.*, "Analysis of lightning events due to rainfall and wind speed in Pekanbaru City," *Science, Technology and Communication Journal*, vol. 2, pp. 89-93, Jun 2022.
[11] J. S. Slamet, "*Kesehatan Lingkungan*," Gajah Mada Universitiy Press: Yogyakarta, 1994.
[12] M. Adjisetya, *et al.*, "Modelling and control of nonlinear compressor unit in biohydrogen plant using multivariable model predictive control (MMPC)," *Science, Technology and Communication Journal*, vol. 3, pp. 63-70, Jun 2023.
[13] A. Rangga, *et al.*, "Integrated production facilities clustering and time-series forecasting derived from large dataset of multiple hydrocarbon flow measurement," *Science, Technology & Communication Journal*, vol. 2, pp. 32-45, Feb 2022.
[14] M. C. Rand, *et al.*, "Microbiological examination of water," *Standard Methods for the Examination of Water and Wastewater*, 1975.
[15] S. Saktioto, *et al.*, "Effect of chemical ions on oil palm midribs and leaves by direct electric voltage treatment," *Science, Technology & Communication Journal*, vol. 3, pp. 71-78, Jun 2023.
[16] N. Hikma, *et al.*, "Utilization of phase changing materials as air conditioning alternatives in eco-green systems," *Science, Technology and Communication Journal*, vol. 2, pp. 81-84, Jun 2022.
[17] Z. Zulkarnain, *et al.*, "Temperature stabilization based on passive cooling technology in the initial design of an eco-friendly mini greenhouse," *Science, Technology and Communication Journal*, vol. 3, pp. 47-50, Feb 2023.
[18] S. Saktioto, *et al.*, "Effect of direct current electric field on the root growth of oil palm seedlings," *Science, Technology and Communication Journal*, vol. 3, pp. 51-56, Feb 2023.
[19] M. Juandi and M. Sarkowi, "2D groundwater depth for analysis of the zone unconfined aquifer," *INSIST*, vol. 1, pp. 16-19, Oct 2016.
[20] U. Malik, *et al.*, "One-dimensional analysis of underground water using geoelectric methods," *Science, Technology and Communication Journal*, vol. 4, pp. 11-14, Oct 2023.
[21] M. Juandi, "Penyelidikan pola sebaran limbah deterjen bawah permukaan tanah dengan applikasi geolistrik," *Jurnal Ilmu Lingkungan*, vol. 5, 29-44, 2011.
[22] D. Arvianti and J. Muhammad, "Interpretasi kualitas air bawah tanah di Kelurahan Tangkerang Tengah Kecamatan Marpoyan Damai menggunakan metode geolistrik dan geokimia," *Komunikasi Fisika Indonesia*, vol. 18, pp. 124-130, Jul 2021.
[23] A. Rega and U. Malik, "Penggunaan metode geolistrik resistivitas konfigurasi Schlumberger untuk mengetahui lapisan struktur litologi bawah tanah di Taman Ilmu Universitas Riau," *Komunikasi Fisika Indonesia*, vol. 19, pp. 35-38, Mar 2022.
[24] M. Juandi, "Penyelidikan pola sebaran limbah karet bawah permukaan tanah dengan metode geolistrik," *Jurnal Ilmu Lingkungan*, vol. 4, pp. 36-45, 2010.
[25] R. Syech and M. Listianto, "Analisa potensi akuifer di Kecamatan Rumbai Pesisir Kota Pekanbaru dengan menggunakan metode geolistrik aturan Schlumberger," *Komunikasi Fisika Indonesia*, vol. 17, pp. 46-49, Mar 2020.
[26] P. Ramadani, M. Juandi, dan U. Malik, "Pemetaan potensi sumber daya air bawah tanah di kecamatan rumbai pesisir dengan menggunakan metode geolistrik aturan Schlumberger," *Aptek*, vol. 12, pp. 22-26, Jan 2020.
[27] M. Juandi, "Quantitative models to study the soil porosity as function of soil resistivity," *Open Journal of Modern Hydrology*, vol. 6, pp. 253-262, Sep 2016.

[28] T. E. S. Siregar and U. Malik, "Identifikasi air tanah di Perumahan Graha Mustamindo Permai 3 menggunakan metode geolistrik resistivitas konfigurasi Schlumberger," *Komunikasi Fisika Indonesia*, vol. 17, pp. 150-154, Nov 2020.
[29] M. Peslinof, *et al.*, "Perancangan sistem pemantauan parameter fisis air berbasis internet of things (IoT) menggunakan Raspberry Pi," *Komunikasi Fisika Indonesia*, vol. 18, pp. 208-216, Nov 2021.
[30] R. I. Departemen Kesehatan, "*Pengkajian kuantitatif rumah tangga sehat dengan metode survey cepat*," Republik Indonesia – Departemen Kesehatan: Jakarta, 2010.