Identification of distribution changes of leachate in a landfill

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Abstract. The distribution of leachate in the Kawatuna landfill, Palu City, which is still implementing the Open Damping system, has been researched in 2011 where it was detected up to a depth of 7 meters and led to reservoir of leachate. The Landfill Control system has been implemented, but the leachate pipe was not functioning, and part of the storage pool was damaged during the earthquake on September 28, 2018, so that leachate is scattered everywhere. This study aims to determine changes in the distribution of leachate used geoelectric-resistivity method with Wenner-Schlumberger configuration. Data were collected at 3 points within the landfill site and 1 point outside the location, with a length of 48 meters each and processed using EarthImager 2D software. From the research results, it is obtained that the resistivity value of leachate is 1–9.7 ohmmeter. Based on the cross-sectional resistivity analysis, leachate was spread to a depth of 9.7 m, which indicates an increase depth of 2.7 m and the distribution direction was not leading to reservoirs of leachate

1. Introduction

The development of an urban area and population growth will have a direct effect on waste productivity. All human and industrial activities make waste production continue and are disposed of in landfills. Garbage disposed of at the landfill site is generally organic and inorganic waste which decomposes easily and produces leachate which can seep into the soil. Leachate will cause pollution if it enters the groundwater layer or river [1]. Leachate has a different conductivity value from groundwater, indicating that this pollutant has a higher conductivity value than groundwater. The resistivity of clean water (fresh) is between 10-100 Ωm [2].

The only landfill in Palu City is Kawatuna Landfill, located in Kawatuna Village and has an area of 25 hectares, but only 5 hectares is used. Every day as much as 400 m³ of garbage from Palu City residents with various types of garbage is collected at this landfill [3]. As a waste disposal location, Kawatuna Landfill will certainly always produce leachate. The existence of leachate in this landfill has been studied by Mahanani at 2011th using the geoelectric-resistivity method. The results showed that the value of leachate resistivity ranged from 0-80 Ωm, spread to a depth of 7.0 meters in the landfill location [4]. Currently, the waste management has been upgraded from an Open Damping system to a Landfill Control where leachate is channelled to a holding pond through pipes. However, in reality, leachate water is still found above the ground surface. The pipes used to channel leachate to the storage pool were not functioning and the holding pond was damaged after the earthquake on September 28, 2018 so that leachate was scattered everywhere. There is a change in the management system and the damage that occurred after the earthquake, and it is necessary to conduct research to determine changes in the distribution of leachate in the last 9 years at Kawatuna Landfill.
2. Materials and methods
2.1. Description of the study area
Geographically, the location of the Kawatuna Landfill is located at 0°54'30" -0°54'45" S and 119°56'00"-119°56'15" E as shown in Figure 1. Western topography and the south at Kawatuna Landfill are generally lowlands with an altitude of 150-170 meters mean sea level (msl), while the North and East regions are generally hills and mountains with an altitude of 200-250 msl. The vegetation in the research location contained cactus plants, trambesi trees and shrubs. The soil surface in the research location is dominated by sandstones, sand and gravel in dry conditions.

According to the Reconnaissance Geological Map Of The Palu Quadrangle, Sulawesi [5] the rock formation in this research location were dominated by the Molasa Celebes Sarasin and Sarasin. This formation consists of conglomerate, sandstone, mudstone, coral limestone and marl. In addition, in the western part of the research location there are Alluvium and Coastal Deposits, consists of sand, gravel, mud and coral limestone, while the eastern part contains the Metamorphic complex.

![Figure 1. Map of the research location of Kawatuna Landfill Palu](image)

2.2. Field survey and data analysis
This research uses a geoelectric-resistivity method with the Wenner-Schlumberger configuration. The measurement method used is the Automatic Array Scanning (AAS) method by making repeated and sequential measurements to obtain a certain depth of penetration [7-11]. The number of lines is 4 lines, where Line 1, 2 and 3 are inside the TPA Kawatuna location and Line 4 is outside the location as control lines (Figure 1). A total of 25 electrodes were used with a distance between the electrodes (a) of 2 meters. The measurement starts with the electrode distance 1a, then enlarges it to na, where n is a discrete number. The data obtained are current data (I), potential difference (V), electrode distance (a). The data
from the measurement results were processed using EarthImager2D software and obtained resistivity cross-section, length and depth of the stretch and then interpreted [12-13].

3. Results and discussion
To support data interpretation, measurements were taken directly at the location where there was a pool of leachate using the same method. The measurement results show that the resistivity value of the leachate contaminated layer is 1-9.7 Ωm. This value is in accordance with that obtained by Juandi [11], Bahaa-el-din [14] and Zulis [15] at different landfill locations, that the value of the resistivity contaminated layer by leachate is below 10 Ωm. These results are used as the basis for interpreting the leachate-contaminated layer at each measurement lines.

3.1. Line 1
Line 1 is located beside to the waste pile in Zone 2, at coordinates 0˚54’38.97”S and 119˚56’12.18 E with an altitude of 197 msl with a stretch direction of N295˚E. Along the this line there is leachate at Electrode 1-2 10-11, 22-25. The surface condition is quite flat and contains sandstone, gravel and sand.

Based on the resistivity cross-section of Line 1 in Figure 2, the distribution of leachate was detected near the ground surface to a depth of more than 9.7 m, almost evenly throughout the cross-section. At the meter 8–16 the distribution of leachate was detected from ± 2.4 m to ± 8.4 m depth. At the meter 20-40 was detected from surface to a depth more than 9.7 m. The condition was caused by the pipe installation at the disposal of Zone 2 is not functioning because it was damaged due to the earthquake on 28 September 2018. Leachate did not flow in the pipeline but seeps into the ground, not leading to the storage pool.

3.2. Line 2
The measurement location for Line 2 is at coordinates 0˚54’41.55”S and 119˚56’9.56”E at an altitude of 175 msl with the direction of the N 222˚ E trajectory, within ± 10 m from the leachate holding pool. The current condition of the leachate holding pool is not functioning properly and there are cracks in the concrete so that there is a pool of leachate on outside.

Based on Figure 3, the presence of leachate in Line 2 was only detected at a few locations along the cross-section. Leachate was detected at meter 6 from ± 4.6 m to ± 4.8 m depth, at meter 22 from ± 2.4 m to ± 4.8 m depth and at meter 30-40 from ± 6.0 to more than 9.7 m depth.
3.3. Line 3
The measurement location for Line 3 is at coordinates 0°54'28.43"S and 119°56'16.5"E at an altitude of 226 msl with the direction of the trajectory from West to East (N94°E). Measurements were made in the former landfill which was previously Zone 1 with the Open Dumping system. Currently, the zone has become a place for biogas processing. Line 3 is also a measurement point that has been studied by Mahanani [3]. Surface conditions are dry landfills and are generally flat and contain sand and gravel material.

Based on Figure 4, this track has detected the distribution of leachate to a depth of more than 9.7 m along the track, more evenly compared to other trajectories. Leachate is detected at meter 0-12 from ±2.4 m depth, at meter 12 - 48 was detected near the ground surface to maximum depth, more than 9.7 m. Even though the location of Line 3 is no longer used as a garbage dump, if it rains the garbage still produces leachate. If it is dug to a depth of 40 cm under the pile of garbage, leachate is still found.
3.4. Line 4

The location of the measurement Line 4 is at coordinates 0°54′27.96″S and 119°56′2.35″E with an altitude of 196 msl with the direction of the trajectory from West to East (N97°E). Measurements were made outside the Kawatuna Landfill area, ± 400 m to the west of Line 1. The measurement location is a plain covered with shrubs, cacti and johar trees. Soil conditions are dry and quite flat. Based on the resistivity cross-section of Line 4 in Figure 5 indicates that leachate was not detected at this location.

Figure 5. Cross-section resistivity and location condition Line 4

The results of the analysis and interpretation for Lanes 1, 2 and 3 show that the leachate water resistance value is 1 - 9.7 Ωm. The distribution of leachate was detected from the surface to a depth of more than 9.7 m. 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 [3] in 2011 th. Based on the results obtained on Line 4, which is outside the Kawatuna landfill area shows that is no layer that contains leachate. This shows that the distribution of leachate is still below the surface in the landfill location, not yet spread outside the area.

4. Conclusion

From this research, it can be concluded that the value of leachate resistivity ranges from 1 - 9.7 Ωm. The spread of leachate seeps in below the soil surface to a depth of more 9.7 m and there has been an increase in the depth of distribution of leachate by more than 2.7 m.

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