The Level of Leachate Contamination in Groundwater Quality at Kawatuna Landfills Palu City

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Abstract - Municipal solid waste has been a government concern due to its wicked problem for the environment. Not only its management complexity, but leachate that potentially leaks to specific groundwater in Palu can pull impacts. The study explores the groundwater quality level surrounding the Kawatuna landfills through the physical, chemical, and microbiological parameters. The STORET method was carried out by comparing the results with the Storage and Retrieval of the Water Quality Data System. The samples were collected from three monitoring-well spots by which 28 indicators of three (3) environmental parameters got analysed in the laboratory. All 28 indicators analysed from the sample did not exceed the groundwater standard. Prevention and periodic monitoring are necessary to prevent leachate-contaminated groundwater.

1. INTRODUCTION

Solid waste is a common issue facing nowadays in big cities that come through domestic waste. It is one consequence of growing population led to increasing of solid waste in many areas, including facing with its disposal and collection issues [1]. Many ilhabitants littering or dumped their waste at any places around.

It was confirmed that, the problem of solid waste resulted by no regular waste collection activity and insufficient containers to routinely collect the waste [2]. Managing the waste needs feasible technology, stable costs, and environmentally friendly. Hence, in some cases, on a large scale of the solid waste is discharged to the final destination landfill [3].

In Palu City, Indonesia, domestic waste is disposed of at the Kawatuna landfill which is 7.5 KM from the city center and 2.5 KM from the nearest settlement [4]. The system used by Kawatuna is a control landfill approach in the block and cell zone areas. Commonly, the disposal system is called open dumping.

The problem of solid waste, not only in its physical form but in a liquid called leachate, needs to be concerned. Leachate has a possibility to leak to the areas around if it is not very well absorbed into pond, particularly in high rainfall areas [5]. Leachate has to meet permission standards and require treatment, once it releases into the environment, particularly to the water bodies [6]. Indonesian regulations mandate every landfill must complete a leachate treatment system. However, the leachate treatment plant system is quite similar everywhere regardless of the nature of the leachate. Lack of management of leachate means failure of treatment to control its effluent quality meeting the allowable standards to be discharged into the environment [6].

The composition of transfer station leachate can vary depending on several factors, including the degree of compaction, waste composition, climate, and the moisture content of the waste [7]. A study conducted in Nigeria by Golden and Inichinbia showed that groundwater around their landfill-contaminated area contains highly conductive leachates like sulfur, methane, and ammonia gas at depths > 16 m. This indicates that the study area is not a good aquifer zone [8]. Another study in India showed that leachate intrusion resulted in concentrations of chemical parameters in the soil that exceeded the WHO quality standard [9].

Based on the aforementioned data, the groundwater around the Kawatuna landfills needs to be studied further. The purpose of this study was to determine the amount of leachate contamination at the Kawatuna landfill.

II.RESEARCH METHOD

The research was conducted at Kawatuna Landfill by collecting groundwater samples in 3 (three) areas or points, namely to the Landfill area, Perum KORPRI, and monitoring well. The well water sampling method refers to SNI 06-2412-1991

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regarding "the method of taking water quality samples". The STORET method is used by comparing the results of the analysis of each parameter in the laboratory with a standard table according to applicable regulations.

In general, the data collection method carried out in this study are as follows:

1. Observation; aims to visit the research site in advance for observation and sampling.
2. The literature Study; aims to add references and additional information.
3. Documentation: aims to obtain data supporting research

A. Sampling Location

The sampling location is based on the purposive sampling technique, which is the criteria set by the researcher. In this case, the sample was chosen as a representative of groundwater that has the potential as a leachate seepage area. Other criteria are based on; the groundwater closest to the leachate, the groundwater as a reference for leachate safety for the surrounding area, and the nearest residential place from landfill that may potentially get impacted by leachate.

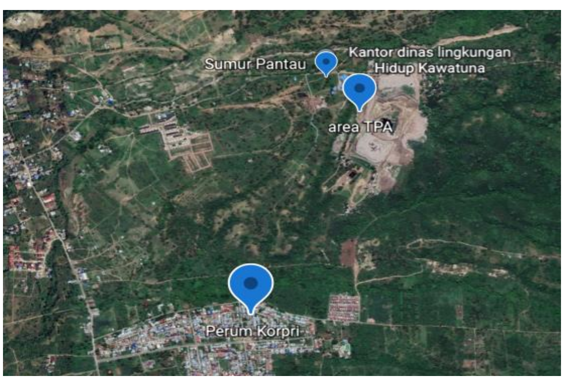

Figure 1. Well water sampling points

Coordinate points were also recorded using GPS to specify the distance and points of sampling from Kawatuna, which are 1) Landfill area (S 0° 54, 430°, E 119° 58, 279), 192.15 m, 2) Perum KORPRI (S 0° 54.973°, E 119° 56.177°) 1,113.66 m in distance, 3) Monitoring well (S 0° 54.962°, E 119° 56 164°) 648.24 m in distance.

B. Sampling Location

Field observations and sampling were carried out on October 5, 2021. Right after collecting the samples, they were taken immediately to the laboratory for water quality analysis from physical, chemical to biological parameters. The indicators measured are:

1. Physical: Turbidity, color, dissolved residue (TDS), temperature, taste, and odor
2. Chemical: pH, iron, fluoride, hardness, manganese, nitrate, nitrite, cyanide, pesticide detergent, mercury, arsenic, cadmium, chromium, selenium, zinc, sulfate, lead, benzene, and organic substances
3. Biology: Total Coliform, E.coli

C. Tools and Materials Used

1. Tool.

Sampling in the 3 sites used dark glass bottles as a standardized measurement of biological parameters and ordinary bottles for physical and chemical parameters. Cool box for storage of sample bottles, neat rope as a tool to facilitate sampling in wells, spiritus for glass bottle sterilization, cameras for documentation, GPS (Global Position System) for recording coordinates, and labels.

2. Ingredient

The materials used are alcohol for hand, and ice cubes to preserve groundwater samples.

C. Sampling point position

Sampling points are taken using a GPS that has been calibrated in advance so that the points taken are appropriate and do not deviate.

III. RESULT & DISCUSSION

Based on the 28 analysed parameters from three sampling points are below the threshold limit. Following the results of microbiology parameters analysis from three sampling points, the total coliform ranged from 18-28 CFU/100 ml of sample water. This means that all three water samples met the permissible limit of 50 CFU/100 ml of the total coliform for water quality standard. Including the content of *E.coli* with a value of 0 (zero) which is safe.

Table 1. Coliform Total And E.Coli Based On The Distance To The Kawatuna Landfill

Sampling points	Distance (m)	Coliform Total	E.coli
Landfill Area	192.15	24	0
Monitoring well	648.24	28	0
Perum Korpri	1,113.66	18	0

Regarding the distance of the sampling area, it is clear in the Table 1. that the area closest to the landfill has a high total coliform number. At a radius of 100-600 m, the total coliform is high (24-28) and decreases at a distance of > 1000 m. The indication is that the environment around the landfill up to a radius of 500 meters has been contaminated with total Coliform and faecal Coliform bacteria [10]. Widiastuti, et al (2018), confirmed that the further the distance the lower the pollution occurred of leachate to the sampling sites [11]. The high number of coliforms can also correspond with contamination from other sources [10].

Table 2. Results Of Physical Parameter Analysis

No	Indicator	Unit	Standard	S1	S2	S3
1	Turbidity	NTU	25	4.2	3.4	3.5
2	Color	TCU	50	13.6	13.5	34.1
3	TDS	mg/L	1000	246	192	224
4	temperature	C	3	24.1	23.6	23.8
5	taste	-	No taste	No taste	No taste	No taste
6	odor	-	No odor	No odor	No odor	No odor

In Table 2, the results for turbidity are far below the quality standard. The low rate of turbidity is likely caused by the suspended solids reduction. It is a result of the sedimentation process of these particles after ion equilibration [7]. The temperature of the three sampling points was 24.1 C 23.6 C 23.8 C. The results were not much different from those discovered by [12], which were 24 C, 24.4 C, and 23.9 C. The low TDS indicator is a result of low inorganic material in the three samples [13]. The leachate's composition is influenced by the type of garbage and the age of the landfill [14]. The low results indicate that the leachate value is still at a safe level for the environment.

Table 3. Results Of Chemical Parameter Analysis

No	Indicator	Unit	Standard	S1	S2	S3
1	pH	mg/L	6.5-8.5	7.52	7.33	7.21
2	Fe	mg/L	1	0.19	0.13	0.15
3	F	mg/L	1.5	0.09	0.1	0.07
4	$CaCO_3$	mg/L	500	24	21	30
5	Mn	mg/L	0.5	0.02	0.02	0.02
6	NO_3-N	mg/L	10	1.5	1.7	1
7	NO_2-N	mg/L	1	0.001	0.002	0.002
8	CN	mg/L	0.1	0.007	0.007	0.007
9	MBAS	mg/L	0.05	0.004	0.006	-
10	Total Pesticide	mg/L	0.1	0.03	0.03	-
11	Hg	mg/L	0.001	0.0001	0.0001	0.0001
12	As	mg/L	0.05	0.003	0.001	0.016
13	Cd	mg/L	0.005	0.0002	0.0002	0.0002
14	Cr^{6+}	mg/L	0.05	0.0002	0.002	0.0001
15	Se	mg/L	0.01	0.0001	0.0001	0.0001
16	Zn	mg/L	15	0.02	0.01	0.01
17	SO_4	mg/L	400	27	20	43
18	Pb	mg/L	0.05	0.006	0.006	0.006
19	Benzene	mg/L	0.01	0.001	0.001	-
20	$KMnO_4$	mg/L	10	4.2	4.2	-

Based on the results of chemical parameter analysis in Table 3, the pH indicator is neutral, this is similar to the research obtained by Reddy and Nandini [13] with a neutral pH of around 7.4-7.8. Meanwhile, by the statement of Budihardjo et al. [15], a high concentration of Fe will affect the taste of the water, turbidity, and change the color to yellow. Monitoring parameters such as phosphorus and nitrogen should be obligatory as they have significant impact on the effluence of leachate treatment in sewage treatment plansts. [16] Groundwater with a manganese concentration above 0.10 mg/L may alter color, smell, or taste. The low level of Fe and Mn implied water is to be in good condition [15]. Regarding heavy metal is represented for instance by mercury (Hg) that are below the permissible standard. Other than leachate, the availability of mercury can be affected by pH concentration. Hg can experience precipitation or somewhat dissolve in the water [17].

Rhouat [18] stated that pH solubility affects the concentration of heavy metals. As the pH is neutral, it has influenced the level of Pb which is below the threshold limit. Regarding low NO3-N concentration has been also strong evidence that leachate percolation in Kawatuna is not significant. This is in line with the statement of Reddy and Nandini [13] that the Cl, NO3-, and COD could indicate the occurrence of leachate percolation in groundwater. The landfill's age is a factor in the fluctuations in the concentrations of the aforementioned in situ parameters [14].

The assessment of the STORET method used in this study is based on water quality requirements established by the Ministry of Environment Decree No. 115/2003 [19]. The results of water quality analysis using the STORET method are presented in below Table 4.

Table 4. Storet Method For Water Quality Classification By Epa

Total Sample	value	Parameters		
		Physics	Chemistry	Biology
<10	Maximum	-1	-2	-3
	Minimum	-1	-2	-3
	Average	-3	-6	-9
≥10	Maximum	-2	-4	-6
	Minimum	-2	-4	-6
	Average	-6	-12	-18

Water quality classification with the STORET method based on EPA (Environmental Protection Agency) is classified into four classes:

1. Class A : very good, score = 0 is still under the water quality standards
2. Class B : good, score = -1 to -10 light polluted
3. Class C : moderate, score = -11 to -30 moderate pollutant
4. Class D : poor, score > - 31 severely polluted

Table 5. Parameter Scores of Water Sample based on STORET Method

Parameters	Score
Physics	0
Chemistry	0
Biology	0

Looking at criteria mentioned in Table 5, groundwater quality at Kawatuna landfills is classified as *very good* because the total score from the three parameters shows 0 scores. It means the groundwater fits with water quality standards. The groundwater is not polluted with leachate as the leachate scatters underground the landfill and has not yet flocked outside of the current area [20].

The leachate affecting the groundwater quality around the landfill generally comes from percolation in the subsoil [13]. The concentration of groundwater pollutant parameters decreases with increasing distance from the landfill [15]. Kawatuna landfill has to implement a sanitary landfill system as a regenerative method of waste processing. The existing system only requires monitoring by all parties concerned and awareness to improve the process of sorting waste [21].

IV. CONCLUSION

Referring to the Storet method, the quality of groundwater around the Kawatuna landfill still meets water quality standards. However, it is necessary to consider maintaining the leachate quality so that it does not contaminate groundwater in the future. Treatment or management of leachate, control, and monitoring should be directed to maintain the environmental quality of Kawatuna.

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