Water Quality Monitoring using ONLIMO Automatic Water Monitoring Device in Water Pollution Monitoring Efforts

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Abstract

Water quality is one of the key indicators of environmental health that impacts aquatic life and human health. Water quality monitoring is important to measure the impact of human activities and ensure water meets quality standards. Conventional methods of manual water sampling face challenges such as distance, safety risks, and long analysis times, making it less effective for rapid monitoring to address environmental pollution. Following Law No. 32 of 2009, the government requires environmental information for environmental management policies. The Ministry of Environment and Forestry encourages using ONLIMO *(online monitoring)* technology for automated monitoring, with data published through the MoEF's ONLIMO website. This study was conducted to introduce and analyze the efficiency of ONLIMO technology in water pollution control so that policies and actions can be taken quickly and appropriately. Field verification shows physical factors such as indicators of garbage around the Cipinang River water flow, visible murky watercolor, pungent smelling water, dense residential settlements around the Cipinang River water flow, and the number of industries built in the Cipinang River flow indicate that the Cipinang watershed water quality recorded through ONLIMO water quality monitoring sensors and field verification shows a state of mildly polluted conditions. This factor suggests that the ONLIMO KLHK automatic monitoring tool has the effectiveness and efficiency of water quality monitoring because the data entered into the ONLIMO KLHK *database* through *data loggers* and field conditions directly show data similarities. Therefore, the ONLIMO KLHK automatic monitoring tool can be an effective *early warning system* and allows increased efficiency in water pollution control because the data obtained *is real-time* and by the original water quality conditions at the location.

Keywords: Water quality, ONLIMO, Water pollution, Water monitoring technology

INTRODUCTION

Water quality is one of the key indicators of environmental health and has a direct impact on the sustainability of aquatic life and human health. Water quality monitoring is an important aspect of water resources management. Water quality monitoring is done to determine the extent to which human activities affect the quality of a water source, which is also used to support human life. Water quality must be maintained to always meet water quality standards following its designation class. The decline in water quality can be in the form of physical, chemical, or biological pollution. Several water quality parameters including BOD (Biochemical Oxygen Demand), COD (Chemical Oxygen Demand), DO (Dissolved Oxygen) or RDO (Residual Dissolved Oxygen), pH, Temperature, TDS (Total Dissolved Solids), TSS (Total Suspended Solids), Nitrate, Turbidity, Ammonium and DHL (Electrical Conductivity) need to be understood to assess the status of water quality (Sunandar and Ulyanto, 2023).

Conventional methods often used to evaluate water quality usually involve taking water samples manually or directly from the site and then analyzing the samples in a laboratory. However, such methods have several challenges, including long distances between sampling sites and analysis laboratories, and safety risks when taking samples directly from rivers or other water sources. In addition, analyzing samples in the laboratory takes a considerable amount of time, making it ineffective for monitoring or recording rapid changes in water quality. Therefore, these conventional methods cannot be used as an early warning for extreme and sudden water pollution events that are difficult to predict (Wahjono, 2016).

According to Law Number 32 of 2009 concerning environmental protection and management, Article 62 and Article 65 mandates that the government requires environmental status information in developing an environmental information system to support the implementation and development of environmental protection and management policies (Anggraeni *et al.,* 2021). Efforts made to implement the obligations of the law, the Ministry of Environment and Forestry encourages the application of ONLIMO technology for automatic water quality monitoring, then publishes it to the public through the ONLIMO KLHK *website*. Therefore, this observation activity aims to prove the efficiency of ONLIMO technology in monitoring water pollution, so that with accurate and *real-time* data, policies and actions can be taken more quickly and precisely for water pollution control.

METHOD

A. Time and Location

Observation activities were carried out from February 12, 2024 to March 12, 2024. Activities were carried out for 5 days a week, running from Monday to Friday, from 07.30 to 16.30 at the Directorate General of Pollution Control and Environmental Damage, Directorate of Water Pollution Control, Subdirectorate of Water Quality Protection and Management Planning, Ministry of Environment and Forestry of the Republic of Indonesia.

B. Tools and Materials

Tools used include computers, stationery, documentation tools, and the MoEF's ONLIMO water quality monitoring *website*, *which was* used to collect water quality data from all ONLIMO stations in Indonesia during the study.

C. Activity Method

The method applied in the implementation of this activity is a participatory method, which involves participation activities in working at the site. The study was conducted through observational observation, focusing on water quality monitoring at all ONLIMO monitoring stations in Indonesia using MoEF's ONLIMO *website*. This approach allows direct involvement in field activities, while observational observations are used to gain a holistic understanding of water quality at each ONLIMO station in Indonesia.

D. Data Retrieval

Data collection is carried out after the *database* enters the KLHK data center from ONLIMO monitoring sensors throughout Indonesia which are *updated in real-time*. The data is then stored on a computer and further processed using *Ms. Excel* before in-depth analysis is carried out to make policies and publications to the ONLIMO KLHK *website*.

RESULT

Stages of activities in the office include water quality monitoring at 194 ONLIMO KLHK monitoring stations throughout Indonesia based on retrieving the monitoring *database* on the ONLIMO KLHK *website*. Furthermore, data analysis is carried out on *Ms. Excel* to produce a graph of ONLIMO water quality status of 15 priority watersheds for the period January 2023 - February 2024 (Figure 1). A watershed (DAS) is an ecosystem unit that functions as a hydrological system, consisting of rivers, tributaries, and waterways. In Indonesia, 15 priority watersheds including the

Asahan Toba, Siak, Musi, Citarum, Sekampung, Cisadane, Ciliwung, Serayu, Bengawan Solo, Brantas, Kapuas, Saddang, Jenengberang, Moyo, and Limboto Bongo Bolango Rivers are the focus of KLHK's ONLIMO water quality status monitoring.

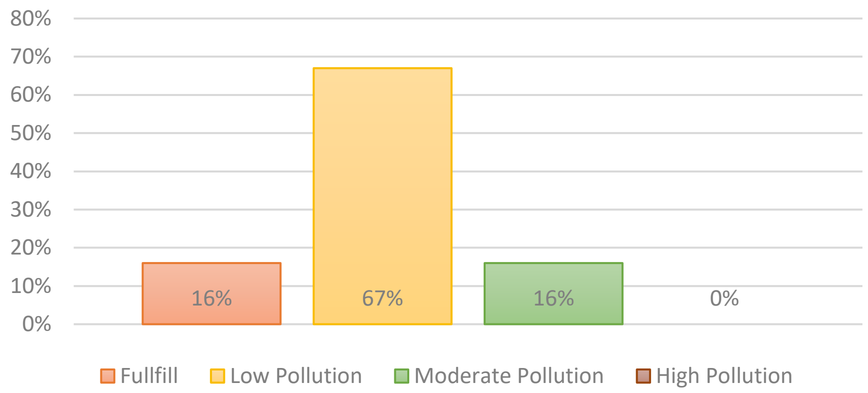


Figure 1. ONLIMO water quality status graph of 15 prioritized watersheds
Period January 2023 - February 2024

The next stage is the creation of trends in the quality status of ONLIMO KLHK for the period January 2023 - February 2024 from 194 ONLIMO KLHK monitoring stations. The stage of making the trend of the quality status of ONLIMO KLHK also involves a *database* from the ONLIMO KLHK *website* which is then processed and analyzed using *Ms. Excel* with the *slope* formula to get the trend of ONLIMO KLHK water quality status, then sorting the location of monitoring stations that have the highest and lowest pollution index (Figure 2). These results become material for discussion regarding the location of monitoring stations that have the highest and lowest pollution indices to make policies regarding water pollution control.

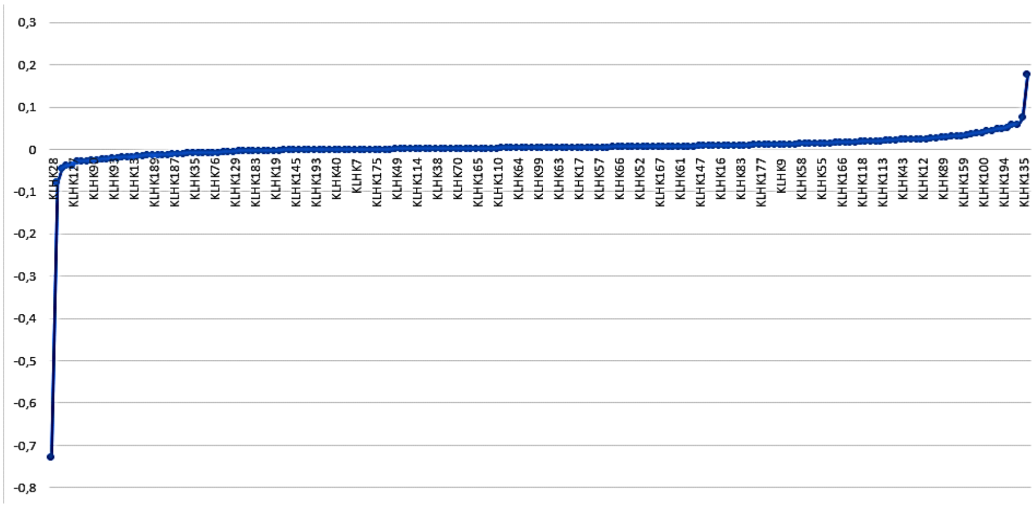
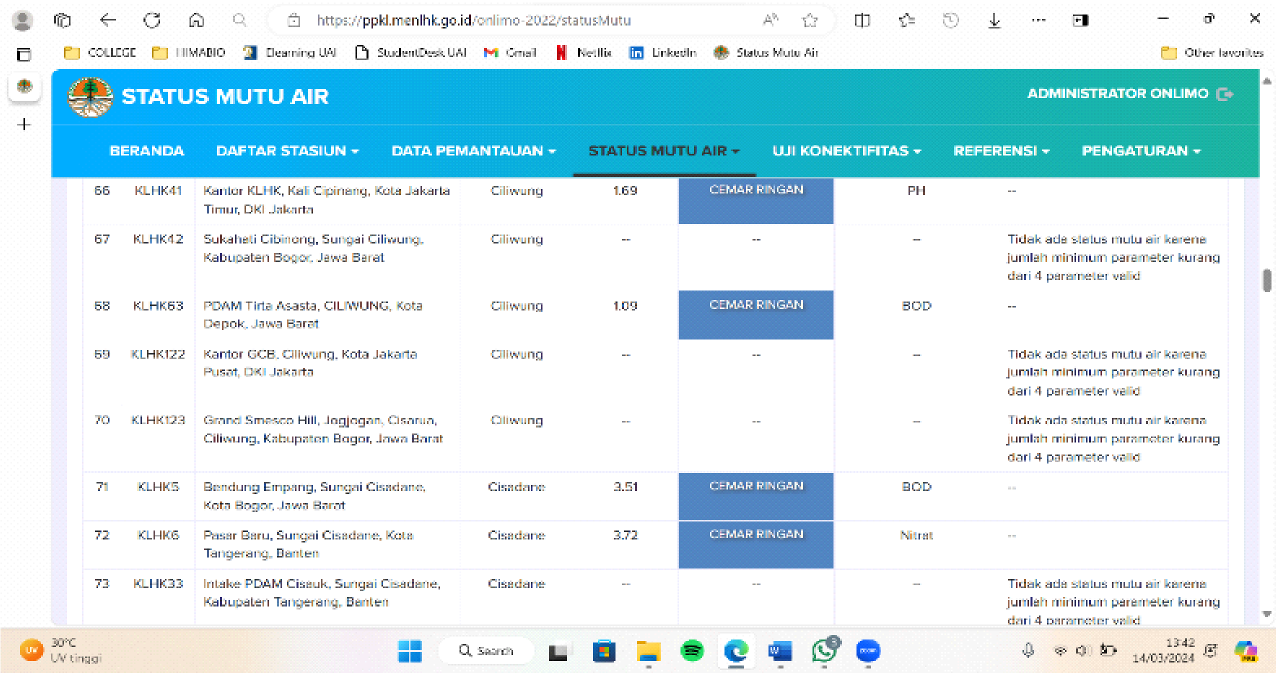


Figure 2. The trend in the quality status of MoEF's ONLIMO
January 2023 - February 2024

The trend of ONLIMO KLHK quality status for the period January 2023 - February 2024 shows that KLHK 28 Pameungpeuk Sukasari station has a low pollution index with an *ONLIMO value* of -0.73 and KLHK 135 PDAM Tirta Perwitasari station has the highest pollution index value with an *ONLIMO value of* 0.174735. This condition indicates that the KLHK 135 PDAM Tirta Perwitasari station requires further attention to overcome the pollution problem that occurs by contacting the station operator to find out the state of the sensor equipment or directly conducting field verification to find out the state of water flow at the station, then conducting a division discussion stage to discuss further policies.

Table 1. Monitoring Data of MOEF *ONLIMO* Station 41 Ciliwung Watershed (Cipinang River)

Time	Parameter											
	BOD	COD	DO	pH	Temperature	TDS	TSS	Nitrat	*Turbidity*	*Ammonium*	High Water Level	DHL
23:00	0,19	0,93	0,69	1,13	26,6	256,65	14,59	0,13	25,9	0	-500	29,5
22:00	0,21	1,05	0,7	0,49	26,7	255,78	14,57	0,11	26,6	0	-500	29,4
21:00	0,21	1,01	0,71	0,72	26,8	255,78	15,77	0,15	28,8	0	-500	29,4
20:00	0,23	1,16	0,75	0,16	26,9	254,04	16,3	0,23	28,2	0	-500	29,2
19:00	0,24	1,2	0,86	1,05	27	252,3	17	0,35	29,7	0	-500	29
18:00	0,29	1,43	0,89	3,9	27,1	251,43	17,74	4,78	29	0	-500	28,9
17:00	0,62	3,05	0,86	5,15	27,4	240,12	28,24	19,72	26,8	0	-500	27,6
16:00	1,91	9,43	0,85	5,72	26,7	276,66	9,51	5,45	6,8	0	-500	31,8
15:00	1,92	9,46	0,79	5,7	26,8	276,66	9,34	6,69	6,9	0	-500	31,8
14:00	1,93	9,49	0,81	6,08	26,9	277,53	9,06	8,84	6,8	0	-500	31,9
13:00	1,92	9,45	0,79	5,64	27,1	277,53	9,28	8,07	6,8	0	-500	31,9
12:00	1,92	9,45	0,79	5,46	27,2	277,53	9,21	5,12	6,8	0	-500	31,9
11:00	1,92	9,45	0,78	5,78	27,3	276,66	9,16	3,42	6,9	0	-500	31,8
10:00	1,92	9,46	0,78	5,05	27,4	277,53	8,99	4,38	6,6	0	-500	31,9
09:00	1,92	9,46	0,79	4,51	27,5	277,53	8,87	3,86	6,6	0	-500	31,9
08:00	1,92	9,47	0,78	4,52	27,6	277,53	8,87	2,71	6,7	0	-500	31,9
07:00	1,93	9,48	0,78	5,4	27,7	277,53	8,81	5,92	6,4	0	-500	31,9
06:00	1,93	9,5	0,78	5,15	27,7	277,53	8,65	2,29	6,5	0	-500	31,9
05:00	1,93	9,48	0,77	3,71	27,8	278,4	8,71	2,51	6,5	0	-500	32
04:00	1,93	9,5	0,77	4,07	27,9	277,53	8,63	2,18	6,6	0	-500	31,9
03:00	1,93	9,52	0,78	3,89	28	276,66	8,46	2,53	6,6	0	-500	31,8
02:00	1,94	9,53	0,76	4,64	28,1	276,66	8,37	3,35	6,6	0	-500	31,8
01:00	1,93	9,52	0,77	4,21	28,2	276,66	8,4	3,11	6,3	0	-500	31,8
00:00	1,93	9,52	0,77	4,56	28,3	277,53	8,31	4,29	6,6	0	-500	31,9



66	KLHK41	Kantor KLHK, Kali Cipinang, Kota Jakarta Timur, DKI Jakarta	Ciliwung	1.69	CEMAR RINGAN	PH	--
67	KLHK42	Sukahati Cibinong, Sungai Ciliwung, Kabupaten Bogor, Jawa Barat	Ciliwung	--	--	--	Tidak ada status mutu air karena jumlah minimum parameter kurang dari 4 parameter valid
68	KLHK63	PDAM Tirta Asasta, CILIWUNG, Kota Depok, Jawa Barat	Ciliwung	1.09	CEMAR RINGAN	BOD	--
69	KLHK122	Kantor GCB, Ciliwung, Kota Jakarta Pusat, DKI Jakarta	Ciliwung	--	--	--	Tidak ada status mutu air karena jumlah minimum parameter kurang dari 4 parameter valid
70	KLHK123	Grand Smesco Hill, Jogjogan, Cisarua, Ciliwung, Kabupaten Bogor, Jawa Barat	Ciliwung	--	--	--	Tidak ada status mutu air karena jumlah minimum parameter kurang dari 4 parameter valid
71	KLHK5	Bendung Empang, Sungai Cisadane, Kota Bogor, Jawa Barat	Cisadane	3.51	CEMAR RINGAN	BOD	--
72	KLHK6	Pasar Baru, Sungai Cisadane, Kota Tangerang, Banten	Cisadane	3.72	CEMAR RINGAN	Nitrat	--
73	KLHK33	Intake PDAM Cisauk, Sungai Cisadane, Kabupaten Tangerang, Banten	Cisadane	--	--	--	Tidak ada status mutu air karena jumlah minimum parameter kurang dari 4 parameter valid

Table 1 shows that the water quality status focusing on the KLHK ONLIMO station 41 located at the KLHK Office, Cipinang River, East Jakarta City, DKI Jakarta with the Cipinang watershed flow on the monitoring date taken March 9, 2024, is in a mildly polluted condition (Figure 3), this condition shows the value of the pollutant index (IP) in the system which is 1.69 in the range of 1 - 5 according to the reference for Water Quality Status based on the Minister of Environment and Forestry Regulation Number 27 of 2021.

Figure 3. Water quality status of station 41 ONLIMO MoEF
[Source: https://ppkl.menlhk.go.id/ONLIMO]
[Accessed on March 09, 2024]

Direct field visits were conducted to determine whether the conditions recorded on the ONLIMO KLHK website show results that match the conditions directly in the field on the same date. The visit was made to ONLIMO KLHK station 41 (Figure 4) because the *website* shows mildly polluted water conditions. In the field activities, the stages carried out include observing the condition of the water sensor tool and an explanation by the Directorate of Water Pollution Control staff on how the ONLIMO KLHK water quality monitoring sensor tool works directly. The sensor tool at the ONLIMO KLHK station shows good condition. Furthermore, field verification is carried out on the

Cipinang watershed water flow (Kali Cipinang water flow) by comparing the physical condition of water quality directly in the field and the *database* from the ONLIMO KLHK *website* to prove the effectiveness of the ONLIMO KLHK automatic monitoring sensor tool with direct conditions around the water flow (Figure 5).

Figure 5. Field verification of Cipinang watershed flow (Cipinang River water flow)
[Source: personal documentation]
[Taken on March 09, 2024]

DISCUSSION

The focus of monitoring 15 priority watersheds is based on several important reasons, namely, these watersheds have a vital role in supporting the lives of the surrounding communities, both for domestic, agricultural, and industrial needs. The watersheds have also shown signs of significant water quality degradation due to industrial pollution, domestic waste, and agriculture (Prasetiadi and Ramdani, 2020). The 15 watersheds have high biodiversity and vulnerable ecosystems, so water quality monitoring is essential to maintain ecosystem sustainability. The government and various institutions have identified these 15 watersheds as priorities in various national water resources management plans and programs. Intensive water quality monitoring in these 15 watersheds is expected to serve as a model for the management of other watersheds in Indonesia because these watersheds also include areas that are vulnerable to natural disasters such as floods and landslides, so good monitoring can help in disaster risk mitigation. Accurate data collection from these 15 priority watersheds can provide a clearer picture of water conditions nationwide, which will be very useful in the formulation of water management policies and strategies (Nurdin *et al.,* 2024).

The creation of a *database-based* water quality status graph from KLHK's ONLIMO monitoring station serves to see the percentage value of pollution within a certain monitoring period. This value will be used as material for discussion at the discussion stage to take steps and policies to restore flow and control water pollution at the location of the 15 priority watersheds, which are priority watersheds according to the Medium-Term Development Plan (RPJM). The ONLIMO water quality status graph of 15 Priority Watersheds in 2023-2024 (Figure 1), shows that the majority of 67% of the area is still classified as having a light pollution load, 16% of the area has met the quality standards, but there are 16% of areas with moderate pollution levels and 0% of heavily polluted areas. The presentation value shows that areas with light pollution and areas of moderate pollution in the January 2023 - February 2024 period require more *intensive* handling to control the pollution load detected in the system. Furthermore, field verification and further studies are carried out to overcome these pollution problems (Sulandari and Purba, 2023).

Based on the literature, the general factor of pollution along the Cipinang River flow is due to the large number of industries that stand around the Cipinang River water flow which consists of various tofu and tempeh industries, the electronics industry, the food industry (biscuits, milk, baby food), the drug and chemical industry, textiles, cosmetics, batteries, paints and metals that discharge waste directly into the river flow without treatment. The density of community settlements around the river flow also causes many community activities that directly dispose of domestic waste and garbage into the river flow (Yudo, 2014).

The state of mildly polluted water quality status at KLHK station 41 shows that of the 12 parameters contained in the ONLIMO KLHK automatic water monitoring sensor tool, several parameters are not met such as the pH value is a critical parameter recorded in the system, the pH recorded in the ONLIMO KLHK *database* has a value range of 1.05 - 6.08 or below neutral pH (pH 7) (Table 1). This critical parameter indicates that the pH value in the Cipinang watershed (Cipinang River water flow) is included in acidic conditions. Water conditions that have an acidic pH indicate that water quality conditions are not good for health, especially for drinking water because the permissible pH limit of water according to the Minister of Health Regulation No. 492 of 2010 is 6.5 - 8.5 and water that is physically clear, odorless and tasteless (Handayani *et al.*, 2023).

Based on the analysis of pollution factors from the KLHK ONLIMO *website database*, there is a need for an appeal or socialization from the Directorate of Water Pollution Control directly to the community around the cipinang river water flow to dispose of garbage or domestic waste in its place and make policies for industry players to be able to re-treat waste before disposal so that it does not pollute the environment. Based on the results of field verification in the Cipinang River water flow also show the physical characteristics of pollution that can be observed directly, such as indicators of garbage around the cipinang river water flow, turbid water color, pungent smelling water, dense residential settlements around the cipinang river water flow and the number of industries built in the cipinang river flow (Yudo, 2014). The physical factors of pollution are following the ONLIMO KLHK *website database* which shows that the water quality of the Cipinang watershed recorded through water quality monitoring sensors is lightly polluted. This factor shows that the ONLIMO KLHK automatic monitoring tool has the effectiveness and efficiency of water quality monitoring because the data entered into the ONLIMO KLHK *database* through the *data logger of the* water quality monitoring sensor automatically and the field conditions directly show *data* similarities. Therefore, the ONLIMO KLHK automatic monitoring tool can be an effective *early warning system* and allows increased efficiency in water pollution control because the data obtained *in real-time* and by the original conditions of water quality at the location (Sunandar and Yulyanto, 2023).

This analysis is expected to serve as a basis for policy-making in water pollution control. In addition, continuous monitoring is expected to increase public awareness of the importance of maintaining water quality. Community involvement in pollution prevention efforts is also an important factor that needs to be considered. In this case, education about the impact of water pollution must be improved. The use of ONLIMO technology in water quality monitoring is expected to provide accurate and real-time data. Thus, corrective measures can be taken quickly and appropriately. Further research is needed to explore the factors that affect water quality in each watershed. In addition, collaboration between the government, communities, and academics is essential in water pollution control efforts. Through a holistic approach, it is hoped that water quality in Indonesia can be maintained and improved.

CONCLUSION

The concluding statement should contain summary and suggestion. The summary should exemplify the answers provided to the hypothesis and/or research objectives or acquired findings. The summary should not contain repetition of research results and discussions, and it should instead contain a summation of research results and findings as expected in the research objective or hypothesis. The suggestions should present matters that will subsequently be conducted in relation to the research's ensuing concepts.

ONLIMO automatic water quality monitoring and data analysis in the Cipinang watershed proves that the direct water flow conditions and the data entered in the ONLIMO KLHK *website database* have results that match the reality of the water flow conditions at the location. The KLHK

ONLIMO automatic water monitoring tool can be an effective *early warning system* and allows increased efficiency in water pollution control because the data obtained is *real-time* and in accordance with the original conditions of water quality at the location. Data analysis on water quality in 15 Priority Watersheds is a reference for making policies in restoring water flows in Indonesia, such as making Wastewater Treatment Plants (WWTP), appealing to the public to dispose of waste and garbage according to their place, making policies and socialization to industry players and stakeholders to re-treat waste before disposal so that it does not pollute the environment.

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