

## EVALUATION OF WASTE HANDLING USING TRASH BARRIERS IN THE LAMPENAI VILLAGE RIVER, EAST LUWU

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### ABSTRACT

The lack of public awareness about the prohibition of littering in rivers, especially among those living around the Lampenai River, has resulted in a significant amount of waste flowing into the sea. This behavior, which has been ongoing for years without awareness, has caused river pollution. River pollution can actually be overcome if the government intervenes strongly with the community, while at the same time installing trash barriers at certain points in an effort to prevent trash from flowing into the sea. This study uses observational and quantitative methods, where the researcher directly observes the objects and phenomena being studied without manipulation or special treatment of the variables. This study aims to determine the amount of waste captured by trash barriers in the Lampenai River by linking ecological conditions and average daily waste collection data based on population size. The effectiveness of the trash barrier in collecting heavy waste was 123.2% at station one, 111.4% at station two, 108.1% at station three, and 103.8% at station four.

**Keywords:** Evaluation; handling; waste generation; Trash barrier

### 1. INTRODUCTION

Population growth, increased economic activity, and changes in consumption patterns contribute to increased waste generation. Suboptimal waste management causes some waste to be poorly handled and end up in water bodies, particularly rivers, either through direct disposal or carried by drainage flows (Shah *et al.*, 2021). However, the effectiveness of *trash barriers* in handling waste generation is highly dependent on various factors, such as river *hydrology* and *hydraulics*, *trash barrier* design and type, flow rate, waste characteristics, and the follow-up management system after the waste is captured. If not properly planned and operated, *trash barriers* have the potential to cause new problems, such as flow blockages, structural damage, and increased flood risk. The results of President Prabowo Subianto's speech included in his priority program on waste processing and management, according to the Minister of Environment and the Environmental Control Agency, have been outlined in the national medium-term development plan (RPJMN) (Asiva Noor Rachmayani, 2015). This includes residential and non-residential areas, as well as rivers throughout Indonesia. Based on data from the National Waste Management Information System (SIPSN, 2024), in 2024 South Sulawesi produced 1,582,378.09 tons of waste, with an average of 4,335.28 tons per day.

According to the Environmental Agency (DLH Luwu Timur), the volume of waste generated in the Wotu sub-district is 14.40 tons per day, consisting of several types of household waste containing hazardous materials, used batteries, camphor, used floor cleaner packaging, cosmetics, clothing bleach, hair dye, medicines, electronic devices, food waste,

plant waste, and most dominantly, plastic waste. Disposing of waste into rivers is a common practice among residents living near rivers. This habit of dumping waste into rivers can harm downstream residents, especially fishermen. The river has become very shallow due to the accumulation of waste at the bottom, causing the water to overflow when it rains and, in the worst case, leading to flooding. Another impact of the waste is on animal life (Iman Darmawan *et al.*, 2024).

The lack of public awareness in implementing the concept of reduce, reuse, recycle, especially among communities living along rivers, has resulted in plastic waste being found in the propellers of fishing boats. Inadequate waste disposal and transportation facilities, such as trucks, three-wheeled motorcycles, and labor costs, as well as weak management of waste transportation from temporary storage sites to landfills, have contributed to this problem. (Dzulkipli, Maradinata, and Anas, 2022). The Lampenai village river has an average width of 4-5 meters and an average depth of 50 cm – 1 m. The water flow rate, based on the floating method measured with a 5-meter bypass length, averages 0.10 cubic meters of water flow in the Lampenai village river.

The trash barrier was constructed and then tested in a river with a small width and water flow. This was done to see if the device worked as intended (Aini *et al.*, 2023). The results of the trial showed that the device was able to block trash carried by the river current and was able to follow the ebb and flow of the river.

This is based on the large amount of household trash, even the most dominant type of waste on the banks of the Lampenai River in Wotu District, East Luwu Regency. Rivers are directly related to the process of tidal fluctuations. Indonesia has 5,590 major rivers, but less than 10% of rivers in Indonesia use *trash booms* (Dzulkipli, Maradinata and Anas, 2022).

Therefore, this study proposes an evaluation of waste management in the Lampenai River using trash barriers.

River pollution not only affects water quality but also damages marine and river biota, reduces biodiversity, and diminishes the potential of natural resources that can be utilized. Therefore, the problem of river pollution must be addressed immediately with a comprehensive and sustainable approach, starting from community education, improvement of waste management systems, to stricter supervision and law enforcement.

## **2. MATERIALS AND METHODS**

### **2.1. Study area**

This study uses observational and quantitative methods. Observational methods are research methods in which researchers directly observe the objects or phenomena being studied without manipulating or treating the research variables in any special way. Quantitative methods are research methods that collect and analyze data in numerical form to measure variables objectively and systematically. Observational and quantitative research is a research method that involves measuring and quantifying the characteristics of the population or phenomenon being studied.

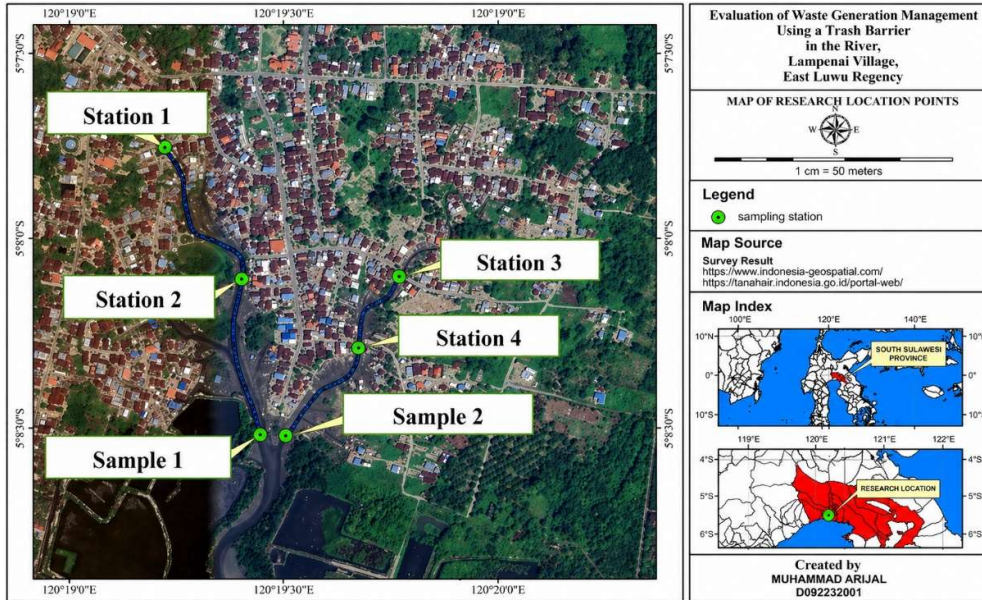


Figure 1: Map of Research Location

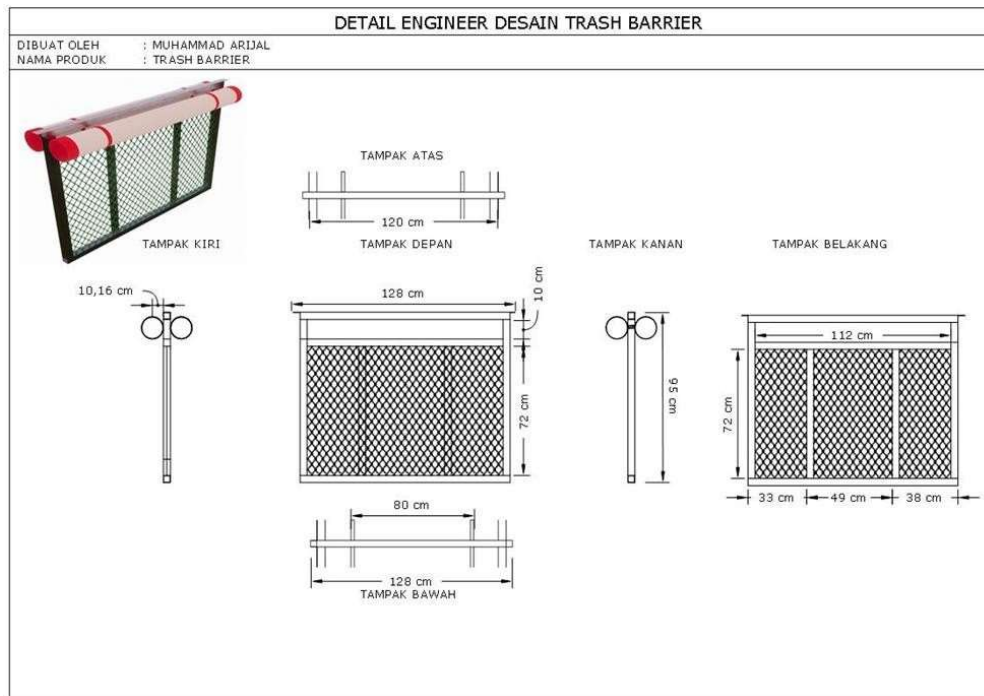


Figure 2: Detailed Engineering Design

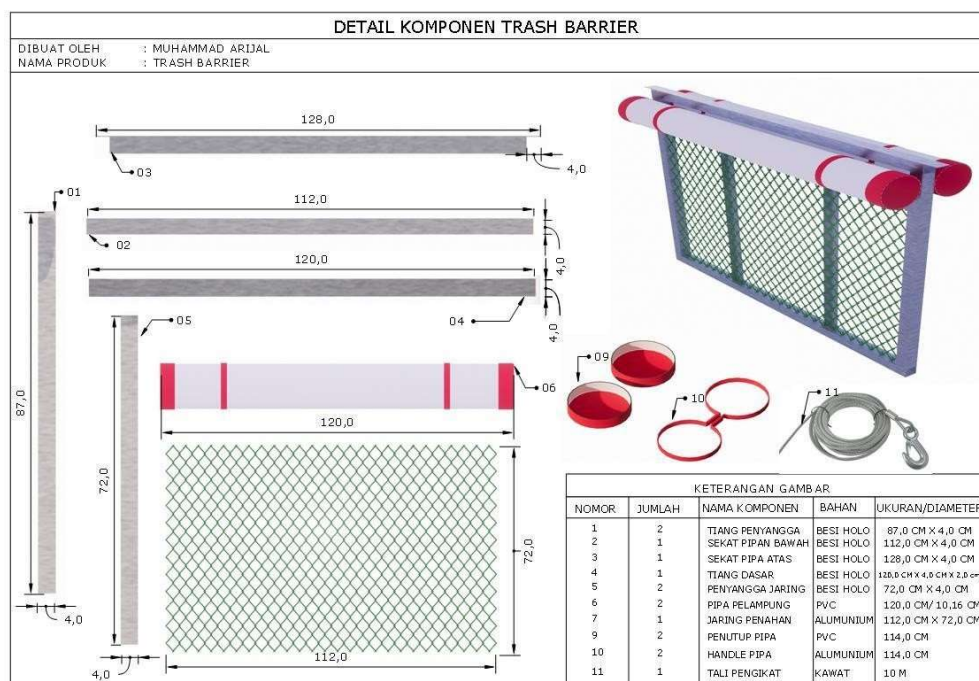


Figure 3: Detail of Trash Barrier Components

## 2.2. Data Analysis

Data analysis in this study involved using Excel to calculate the amount of waste caught by the trash barrier, processing data on the collection and measurement of the composition of household waste and similar waste according to SNI 3964-2025.

## 3. RESULTS AND DISCUSSIONS

### 3.1. Volume of waste generated

Geographically, Luwu Regency is located south of the equator. Specifically, it is located between 2°03'00" - 3°03'25" South Latitude and 119°28'56" - 121°47'27" East Longitude, with an area of 6,944.88 km<sup>2</sup>. Luwu Timur Regency covers approximately 11.14 percent of the total area of South Sulawesi Province. It is the easternmost regency in South Sulawesi Province, bordering Central Sulawesi Province to the north. To the south, it borders Southeast Sulawesi Province and Bone Bay. Meanwhile, its western border is with Luwu Utara Regency.

In table 1 shows that the volume of waste generated in East Luwu Regency is 126.40 tons/day and 46,136 tons/year. Meanwhile, the sub-district with the highest volume of waste generated is Malili Sub-district because it has the largest population. Wotu Subdistrict is one of the subdistricts in East Luwu Regency with a population of 32,292 and an area of 130.52 km<sup>2</sup>, covering 1.88 percent of the total area of East Luwu Regency. Lampenai Village is the village with the largest area, covering 22.31 km<sup>2</sup> or 17 percent of the subdistrict's total area. Administratively, Wotu is divided into 17 villages, namely Lera, Bawalipu, Arolipu, Lampenai, Bahari, Kalaena, Karambua, Kanawatu, Maramba, Tarengge, CendanaHijau, Balo-Balo, Pepuro Barat, Rinjani, Madani, Tarengge Timur, and Tabaroge. Astronomically, Wotu Subdistrict is located west of the capital of East Luwu Regency, precisely between 2°

31° 58" - 2° 39' 57" South Latitude and 120° 45' 20" - 120° 55' 38" East Longitude. Six of its villages are coastal areas.

**Table 1:** Waste Generation Volume of Luwu Timur Regency

No.	District	Population	Waste Generation (Ton/Day)	Waste (Ton/Year)
1	Nuha	24,507	9.80	3,578
2	Towuti	48,507	19.50	7,118
3	Wasuponda	22,415	8.97	3,273
4	Malili	46,646	18.66	6,810
5	Angkona	25,922	10.37	3,785
6	Kalaena	12,225	4.89	1,785
7	Mangkutana	22,609	9.04	3,301
8	Tomoni	27,949	11.18	4,081
9	East Tomoni	13,963	5.59	2,039
10	Wotu	35,019	14.01	5,113
11	Burau	35,990	14.40	5,255
<b>Total</b>	—	<b>316,000</b>	<b>126.40</b>	<b>46,136</b>

### 3.2. Biodiversity conditions

The table 2 Below shows that the number of species found in the upper and lower reaches has decreased significantly. The upper reaches of a river are the zone between terrestrial and aquatic ecosystems and are often areas rich in biodiversity. The middle reaches of a river have a wider morphology than the upper reaches. The water depth in this section is relatively deep and turbidity is low, so organic matter produced from the water (*autochthonous*) dominates. The lower reaches of a river have a winding shape.

**Table 2:** Longitudinal distribution of species along the Lampenai River

Species	Local Name	Upper	Middle	Lower
<i>Oreochromis mossambicus</i>	Tilapia	+	+	-
Striped snakehead	Snakehead fish	+	+	-
<i>Osphronemus goramy</i>	Gourami fish	+	+	-
<i>Oreochromis niloticus</i>	Tilapia	+	-	-
<i>Trichogaster trichopterus</i>	Swamp gourami/Baba	+	-	-
<i>Barbonymus gonionotus</i>	Tawes/Kampuleng fish	+	+	+
Giant armored catfish	Freshwater pomfret	-	+	-
<i>Siganus</i> sp.	Baronang fish	-	+	+
Grouper	Milkfish/Bolu	-	+	+
Family <i>Tetraodontidae</i>	Pufferfish	-	+	+
<i>Hemiramphus</i> sp.	Julung fish	-	+	+
Brown shrimp	Black shrimp	-	+	-
<i>Penaeus monodon</i>	Windu shrimp	-	+	-
<i>Acetes</i>	Red shrimp/Cani	+	+	-
<i>Orthetrum sabina</i>	Slim dragonfly	+	+	-

<i>Agriocnemis pygmaea</i>	Dwarf dragonfly	+	+	-
<i>Tholymis tillarga</i>	Cloud dragonfly	+	+	-
<i>Brachythemis contaminata</i>	Orange sun dragonfly	+	-	-
<i>Euploea crameri</i>	Black spotted swallowtail butterfly	+	+	-
<i>Neptis hylas</i>	Common sea butterfly	-	+	+
<i>Phrynoidis asper</i>	Giant frog	-	+	-
<i>Fejervarya cancrivora</i>	Frog	+	-	-
<i>Varanus salvator bivittatus</i>	Water monitor	+	-	-
<i>Eutropis multifasciata</i>	Brown lizard	+	-	-
<i>Homalopsis buccata</i>	Water snake/Lenrong	-	+	+
<i>Cosymbotus platyurus</i>	Wall gecko	+	-	-
Tree sparrow	Eurasian tree sparrow	+	+	-
Yellow-bellied Bulbul	White-cheeked bulbul	+	+	+
Egret	White heron	-	-	+

The distribution of Lampenai River species is greatly influenced by the environmental conditions in each segment of the river. Some species prefer the upper reaches, such as tilapia, gabus fish, gurami fish, nila fish, sepat rawa/baba fish, tawes/kampuleng fish, rebon/cani shrimp, slender dragonflies, cebol dragonflies, cloud dragonflies, orange dragonflies, black spotted moths, frogs, water monitor lizards, brown lizards, wall lizards, Eurasian tree sparrows, and ketilang birds because the water temperature is lower, so they prefer cold water that has a higher oxygen content. The upper reaches often have rocky substrates, strong currents, and plenty of oxygen, which is suitable for organisms that attach themselves to rocks. The upper reaches have coarse organic material such as leaves and twigs that fall from the surrounding forest. Organic waste (food scraps) can reduce oxygen levels due to decomposition. Inorganic waste (plastic, metal) obstructs water flow and causes microplastic toxins. Sensitive species (which should live in the upper reaches) are reduced or become extinct, leaving only species that are resistant to pollution or dirt.

Then there are species that prefer the middle, such as tilapia, gabus fish, gurami fish, tawes/kampuleng fish, freshwater pomfret, baronang fish, bandeng/bolu fish, buntal fish, julung fish, black shrimp, windu shrimp, rebon/cani shrimp, slender dragonflies, cebol dragonflies, cloud dragonflies, black spotted moths, common sea moths, giant frogs, water snakes/lenrong, Eurasian church birds, and ketilang birds because the current is moderate, not too fast like upstream and not too calm like downstream. This allows many species to adapt because it is not too extreme. The water temperature is moderate, as it is warmer than upstream but not as hot and polluted as downstream. Dissolved oxygen is still quite high, as the current is still fast enough to mix with the air. In the middle section, the water carries coarse and fine organic matter from upstream. As a result, there are two types of food sources: coarse matter for shredders and chewers. Fine material and phytoplankton for collectors and filter feeders. These conditions support high species diversity. In the middle of the river, human influence (waste, pollution, heavy sedimentation) is not as strong as in the downstream. However, it receives sufficient nutrients from upstream, so that ecosystem productivity increases without excessive pollution. Organic waste (food scraps, decaying leaves) causes oxygen depletion due to decomposition. Plastic and metal waste pollute the riverbed habitat. Sensitive species (those requiring clean water) will decrease or migrate, leaving only pollution-tolerant species to survive.

Meanwhile, species prefer downstream areas such as tawes/kampuleng fish, baronang

fish, bandeng/bolu fish, buntal fish, julung fish, common sea butterflies, water snakes/lenrong, ketilang birds, and white herons because the water current is slower, so species do not have to fight strong currents, which is suitable for species that are weak swimmers.

The water is warmer because it is far from the mountain water source. Many tropical species actually prefer higher temperatures. Nutrient content is higher because the downstream receives organic matter and sediment from the entire watershed. The upstream produces coarse organic matter (leaves, twigs), but downstream this matter has decomposed into fine particles. Species in the downstream are usually collectors or filter feeders; they eat small particles carried by the water or deposited on the bottom. In addition, phytoplankton and detritus thrive in the downstream because the water is rich in nutrients and there is sufficient light. The riverbed in the downstream area is generally muddy or fine sandy, suitable for organisms that live in sediment. Due to the calm currents, large aquatic plants (macrophytes) can also grow on the downstream banks, providing shelter for fish and invertebrates. The downstream area is often connected to estuary, swamp, and coastal ecosystems, where many species migrate or forage. Debris from the headwaters and middle reaches is carried downstream and accumulates there. In addition, the lower reaches are usually close to large cities, industries, and densely populated areas, so household waste, plastics, and chemicals often enter the river. Some species can live in turbid water, organic-rich mud, polluted waters, and low-oxygen environments.

### 3.3. Ecological conditions

The table 4 shows that the number of species found in each group provides an initial picture of the biodiversity index and condition of the Lampenai River. The more species found, the healthier and more diverse the ecosystem. However, to assess the level of diversity quantitatively, the *Shannon-Wiener* or Simpson indices are usually used, which take into account both the number of species and their relative abundance. Moderate to high diversity values indicate that no species dominates and that the distribution of individuals is relatively even. The physical condition of the river affects the habitat and distribution of organisms in the river. Sufficient depth and width, as well as sandy mud, provide a varied habitat for various species that cannot withstand strong currents.

**Table 4:** Ecological condition and biodiversity indices

Parameter	Results
Fish species	11
Shrimp species	3
Dragonfly species	4
Butterfly species	2
Herpetofauna	6
Birds	3
Depth	0.28–1.00 m
River width	2–3 m
Current speed	0.10–0.30 m/s*
Substrate base	Sandy mud

From the table above, it can be seen that the weight composition of waste at station 1 is 157 kg with a waste volume of 544 liters and station 2 is 140 kg with a waste volume of 490 liters.

**Table 5:** Waste generated in sample one

<b>Waste Composition</b>	<b>Station 1 Weight (kg)</b>	<b>Station 1 Volume (L)</b>	<b>Station 2 Weight (kg)</b>	<b>Station 2 Volume (L)</b>
Food waste	37	123	29	97
Park trash	10	33	9	32
Wood	11	37	12	40
Paper, cardboard, and paperboard	8	29	7	24
Plastic – sheets	9	32	8	29
Plastic – hard	14	53	13	45
Metal	19	65	18	63
Fabrics and textile products	7	24	7	24
Rubber and leather	6	22	5	17
Glass	18	63	17	62
Hazardous waste	10	35	9	32
Diapers (disposable diapers, sanitary pads, etc.)	5	17	4	16
Other waste/residue	3	11	2	9
<b>Total</b>	<b>157</b>	<b>544</b>	<b>140</b>	<b>490</b>

Meanwhile, the weight composition of waste in the Lampenai village settlement is presented using the following formula:

$$\text{Weight \%} = \left( \frac{\text{Weight of waste type } i \text{ (kg)}}{\text{Total waste weight (Bs) (kg)}} \right) \times 100$$

$$\text{Volume \%} = \left( \frac{\text{Volume of waste type } i \text{ (L)}}{\text{Total waste volume (Bs) (L)}} \right) \times 100$$

Presentation of the weight composition of waste found in the Lampenai village settlement at station one and two. The composition of waste generated in the Lampenai Village settlement was analyzed based on both weight and volume at Stations One and Two. The analysis was conducted to identify the dominant waste types and to compare the distribution of waste composition using these two measurement approaches. The results provide insight into the characteristics of waste generated by the local community and support the evaluation of waste management practices in the study area.

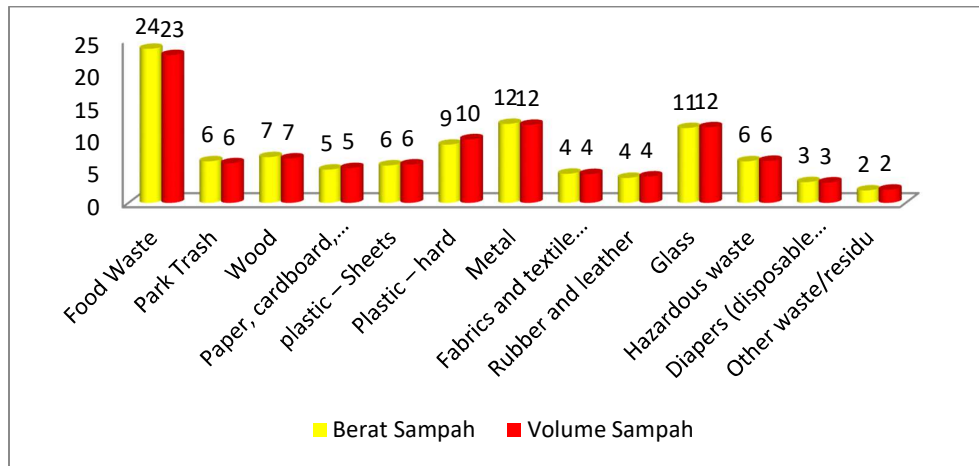


Figure 4: Presentation of the weight and volume of waste at station one

Figure 4 above shows the presentation of the weight composition of waste found in the Lampenai village settlement at station one. With the presentation of waste weight and volume, it can be seen that the presentation of food waste weight is higher than the volume of food waste, while the presentation of plastic-hard and glass waste volume is higher than the weight of waste. while the weight and volume of waste are the same for garden waste, wood, paper, cardboard and cartons, plastic sheets, metal, cloth and textile products, rubber and leather, hazardous waste, nappies (diapers and disposable sanitary napkins, etc.) and other waste/residues. The sorting of waste by weight and volume at station two can be seen in the figure below:

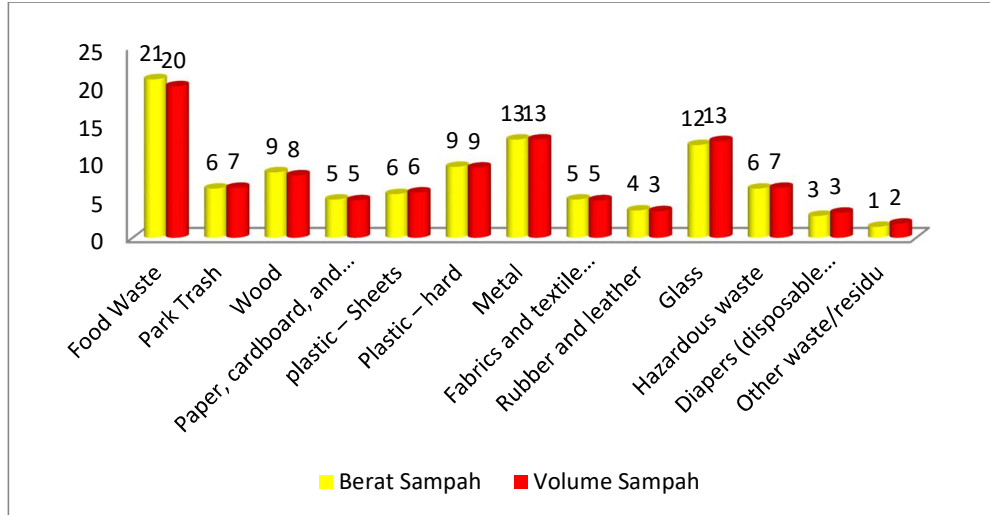


Figure 5: Presentation of the weight and volume of waste at station two

Figure 5 shows the presentation of the weight composition of waste found in the Lampenai village settlement at station one. With the presentation of waste weight and volume, the presentation of food, wood, rubber, and leather waste weight is higher than the waste volume, while the presentation of garden, glass, B3 waste, and other/residual waste volume is higher than the waste weight presentation. while the weight and volume of waste are the same for paper, cardboard and carton, plastic sheets, hard plastic, metal, cloth and textile products, rubber and leather, nappies (diapers and disposable sanitary napkins, etc.).

**Table 6:** Waste generated in sample two

Waste Composition	Station 3 Weight (kg)	Station 3 Volume (L)	Station 4 Weight (kg)	Station 4 Volume (L)
Food waste	19	63	17	57
Garden waste	9	29	9	29
Wood	10	32	10	32
Paper, cardboard, and paperboard	8	23	9	30
Plastic – sheets	6	22	6	20
Plastic – hard	9	29	8	25
Metal	16	53	14	43
Fabrics and textile products	8	23	6	19
Rubber and leather	9	27	8	25
Glass	13	39	11	34
Hazardous Waste	11	35	13	40
Diapers (disposable diapers and sanitary pads, etc.)	6	19	3	11
Other waste/residue	2	8	2	8
<b>Total</b>	<b>126</b>	<b>402</b>	<b>116</b>	<b>373</b>

From the table above, it can be seen that the weight composition of waste at station 3 is 126 kg with a waste volume of 402 liters and station 4 is 116 kg with a waste volume of 373 liters. Meanwhile, the weight composition of waste in the Lampenai village settlement is presented using the following formula:

$$\text{Weight Percentage (\%)} = \frac{\text{Weight of waste type } i \text{ (kg)}}{\text{Total waste weight (kg)}} \times 100$$

$$\text{Volume Percentage (\%)} = \frac{\text{Volume of waste type } i \text{ (L)}}{\text{Total waste volume (L)}} \times 100$$

Presentation of the weight composition of waste found in the Lampenai village settlement at stations three and four.

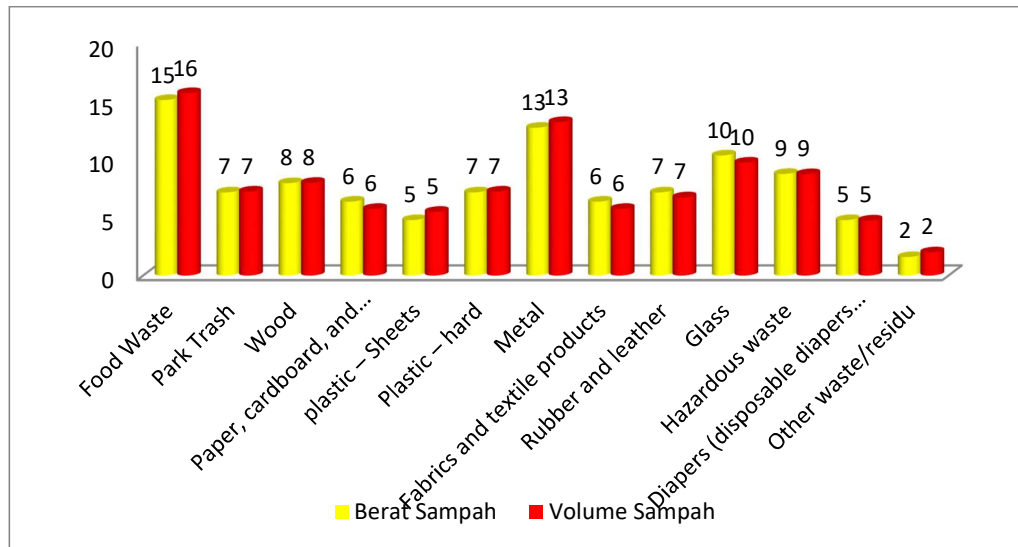


Figure 6: Presentation of waste weight and volume types at station three

Figure 6 above shows the presentation of the weight composition of waste found in the Lampenai village settlement at station three. Based on the volume of waste, the volume of food waste is higher than the weight of food waste, while the weight and volume of garden waste, wood, paper, cardboard and cartons, plastic sheets, hard plastic, metal, cloth and textile products, rubber and leather, glass, hazardous waste, nappies (diapers and disposable sanitary napkins, etc.), and other waste/residues are the same. The sorting of waste by weight and volume at station four can be seen in the figure below:

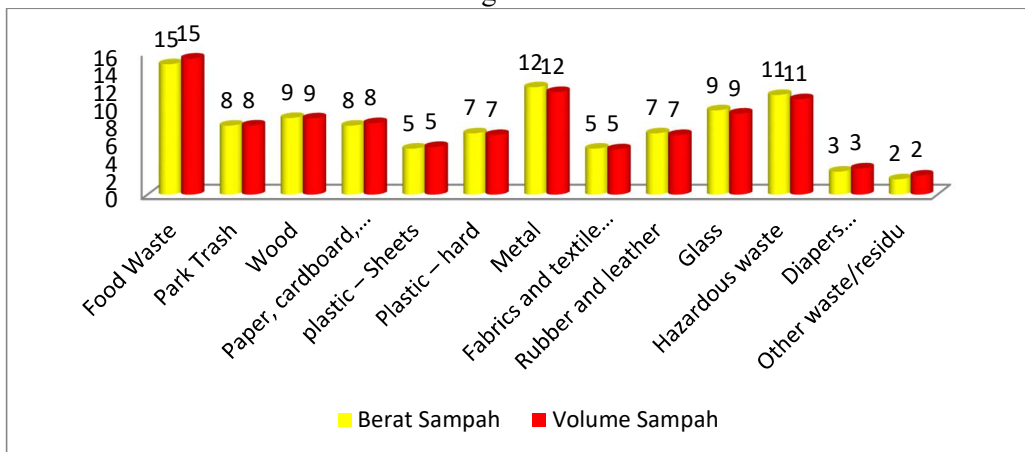


Figure 7: Presentation of waste weight and volume types at station four

Figure 7 above shows the presentation of the weight composition of waste found in the Lampenai village settlement at station four. The weight and volume of waste are the same for food waste, garden waste, wood, paper, cardboard and cartons, plastic sheets, hard plastic, metal, cloth and textile products, rubber and leather, glass, hazardous waste, nappies (diapers and disposable sanitary napkins, etc.), and other waste/residues.

Table 7: Waste captured by the trash barrier

Station	Fri day	Satur day	Sun day	Mon day	Tues day	Wedne sday	Thur sday	Fri day	To tal

									<b>(k g)</b>
Stat ion One	40. 0	33.5	22.0	16.0	14.0	12.0	10.5	9.3	<b>15 7.3</b>
Stat ion Two	24. 0	22.5	22.0	19.0	17.5	16.0	11.0	8.4	<b>14 0.4</b>
Stat ion Thr ee	22. 5	20.5	20.0	18.6	14.5	11.5	10.5	8.2	<b>12 6.3</b>
Stat ion Fou r	21. 8	19.3	18.4	16.9	12.6	9.2	8.8	9.4	<b>11 6.4</b>

From the table above, it can be seen that the trash caught by the trash barrier was 157.3 kg at station one, 140.4 kg at station two, 126.3 kg at station three, and 16.4 kg at station four. Then, the effectiveness of the trash barrier was calculated using the following effectiveness formula:

$$E = \frac{W_{tb}}{W_{total}} \times 100\%$$

The effectiveness of the trash barrier in the Lampenai village settlement is as follows.

1. Station one

$$E = \frac{157,3}{127,7} \times 100\%$$

$$E = 123,2\%$$

2. Station two

$$E = \frac{140,4}{126} \times 100\%$$

$$E = 111,4\%$$

3. Station three

$$E = \frac{126,3}{116,8} \times 100\%$$

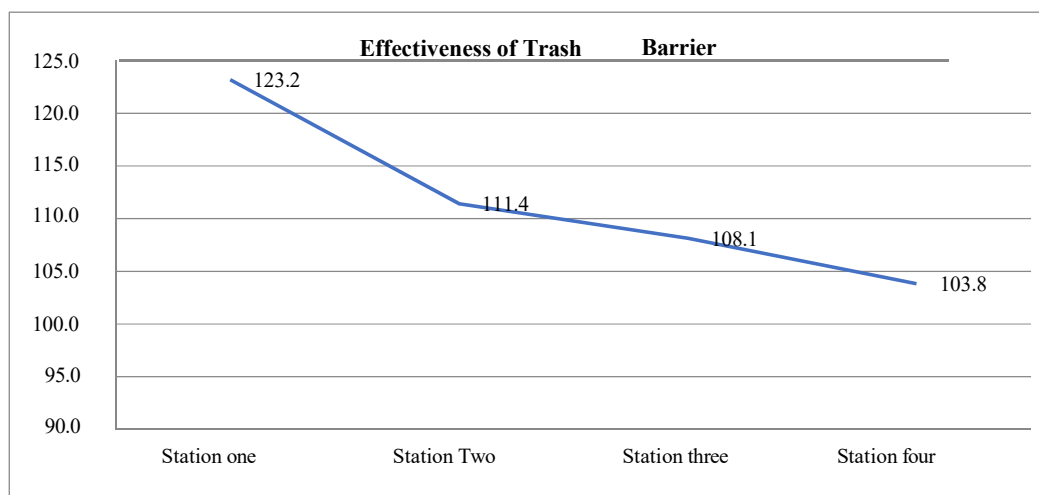
$$E = 108,1\%$$

4. Station four

$$E = \frac{116,4}{112,1} \times 100\%$$

$$E = 103,8\%$$

The effectiveness of the trash barrier in the Lampenai village settlement can be seen in the following graph:



**Figure 8:** Trash Barrier Effectiveness Graph

Figure 8 shows that under low to moderate flow conditions, the effectiveness of the Trash Barrier tends to be higher because the flow velocity allows trash to be retained optimally. Conversely, under high flow conditions, effectiveness tends to decrease due to increased flow thrust, causing some trash to escape the retention system.

#### **4. CONCLUSION**

This study has provided an overview of the ecological conditions, biodiversity index, and waste prevention in the Lampenai River. The behavior of the community over the years has provided education to the local community about the prohibition of littering. The application of trash barriers is able to capture waste every day, reducing waste accumulation in the sea and final disposal sites (TPA). This research can be expanded on a larger scale and with the use of Internet of Things (IoT) technology in an effort to monitor all connected rivers in East Luwu that are potentially polluted by human activities.

#### **CONTRIBUTIONS OF AUTHORS**

Muhammad Arijal: Research concept and design, All authors: Manuscript preparation for publication. Asiyanti T Lando suggested SNI 3964-2025 as the latest analysis, and Ibrahim Djamaluddin provided ecological conditions and biodiversity data. The East Luwu Environmental Agency helped provide secondary data, and the Wotu sub-district community helped monitor and evaluate the trash barrier device. We are grateful for their assistance and support during the data collection process.

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## CONFLICT OF INTEREST

There is no conflict of interest in this research. All research and publication costs were covered independently without financial assistance from other parties.

## REFERENCES

1. Aboyitungiye, J.B., Suryanto, S., & Gravitiani, E. (2021). River pollution and human health risks: assessment in the locality areas proximity of Bengawan Solo River, Surakarta, Indonesia. *Indonesian Journal of Environmental Management and Sustainability* 5(1). <https://doi.org/10.26554/ijems.2021.5.1.1-6>
2. Aini, M., et al. (2023). Development of trash traps as protection for the sea from the threat of plastic waste. *Jurnal Abdi Insani*, 10(2), pp. 1157–1167. <https://abdiinsani.unram.ac.id/index.php/abdiinsani/article/view/880>
3. Anggriani, D., Purba, B., Saragih, I.J. and Aisyah, S. (2024). Analysis of the effects of household waste on environmental pollution in Medan City. *Journal of Environmental Science*, 4(1), pp. 187–192. <https://journal.unnes.ac.id/sju/index.php/jil/article/view/xxxx>
4. Ardani, F., Caesaron, D., and Kusnaty, A. (2023). Design of flood barrier with developed IoT-based flood detection and monitoring systems. *Jurnal Teknik Industri*, 25(2), pp. 111–120. <https://journal.unpar.ac.id/index.php/jti/article/view/xxxx>
5. Azmar, N.A. and Abd Manaf, L. (2024). Assessment of waste generation, composition and revenue loss estimation due to floatable riverine litter at Log Boom Sungai Pinang, Klang, Malaysia. *Planning Malaysia*, 22. <https://doi.org/10.21837/pm.v22iXX.XXXX>
6. National Standardization Agency (2025). *SNI 3964:2025 Methods for sampling and measuring the amount and composition of household waste*. Jakarta: BSN. [https://sni.bsn.go.id/index.php/sni\\_main/sni/detail\\_sni/x xxx](https://sni.bsn.go.id/index.php/sni_main/sni/detail_sni/x xxx)
7. Higuchi, C., et al. (2024). Scenarios for reducing plastic waste emissions guided by probability distribution models to avoid additional plastic pollution in the ocean in the 2050s. <https://doi.org/10.1016/j.marpolbul.2024.XXXX>
8. Darmawi, A. (2017). Potential waste generation at coastal tourism sites. *Journal of Industrial Technology Research*. <https://ejournal.kemenperin.go.id/jpti/article/view/xxxx>
9. Dawud, M., Namara, I., Chayati, N., and Taqwa, F.M.L. (2016). Analysis of the Cisadane River water pollution control system in Tangerang City based on the community. *Proceedings of Semnastek*, 6, pp. 1–8. <https://jurnal.umj.ac.id/index.php/semnastek/article/view/xxxx>
10. Dodds, R., et al. (2022). Sustainability gets thrown in the trash. *Event Management*, 26(5), pp. 1145–1159. <https://doi.org/10.3727/152599521X16288605371165>
11. Dzulkifli, M.I., Maradinata, A., and Anas, I. (2022). Trash boom design based on load. *Civil Engineering Journal*. <https://journal.unila.ac.id/jts/article/view/xxxx>
12. Foedarsono, C.A., et al. (2025). From trash to treasure: the benefit of adopting eco-block as a construction material. *IOP Conference Series: Earth and Environmental Science*, 1564, 012116. <https://doi.org/10.1088/1755-1315/1564/1/012116>
13. Friantoro, D. (2025). Si Keruk: a floating waste IoT system and river quality for flood mitigation in Tangerang. *Journal of Development*. [https://ejournal.bappenas.go.id/index.php/jurnalpe\\_mbangunan/article/view/xxxx](https://ejournal.bappenas.go.id/index.php/jurnalpe_mbangunan/article/view/xxxx)
14. Hafizhah, I. (2025). Pandawara Group's communication strategy in the river adoption program. *Bandung Conference Series: Public Relations*, 5, pp. 353–362. <https://proceedings.unisba.ac.id/index.php/bcspr/article/view/xxxx>

15. Hasibuan, R. (2016). Analysis of the impact of household waste on environmental pollution. *Scientific Advocacy Journal*, 4, pp. 42–52. <https://jurnal.uisu.ac.id/index.php/advokasi/article/view/xxxx>
16. Hawking, T. (2023). Taking out the trash. *ReNew: Technology for a Sustainable Future*, 162, pp. 50–59. <https://www.renew.org.au/renew-magazine/issue-162>
17. Ministry of Environment and Forestry of the Republic of Indonesia. (2024) *National Waste Management Information System (SIPSN)*. Online portal. <https://sipsn.menlhk.go.id/>
18. Kim, S., Kim, T., & Kim, H. (2024). Monte Carlo simulation-based cost estimation for floating trash barrier maintenance. *KSCE Journal of Civil and Environmental Engineering*, 44(2), pp. 231–235. <https://doi.org/10.1007/s12205-024-1056-9>
19. Karmiati, B.T. (2020). Designing the shape of trash filters on river trash filter devices. *JTTM*, 1(1), pp. 1–11. <https://jurnal.polines.ac.id/index.php/jttm/article/view/xxxx>
20. Marliani, N. (2014). Utilization of household waste as an implementation. *Formatif*, 4(2), pp. 124–132. <https://journal.lppmunindra.ac.id/index.php/Formatif/article/view/xxx>
21. Mohd Shah, M.N., et al. (2020). Design and development of trash trap of stream for mini hydro. *Materials Today: Proceedings*, 46, pp. 2105–2111. <https://doi.org/10.1016/j.matpr.2020.10.389>
22. Nugroho, B.S., et al. (2024). Quick assessment study on condition of marine debris. *Barakuda*, 6(2), pp. 150–167. <https://ejournal.kkp.go.id/index.php/barakuda/article/view/xxxx>
23. Rachmayani, A.N. (2015) *The direction of RPJMN policy in the management of settlements, non-settlements and rivers in Indonesia*. Jakarta: Bappenas. <https://www.bappenas.go.id/id/data-dan-informasi-ressources/rpjmn/>
24. Ramdhani, M.T., et al. (2025). Making trash barriers as an effort to combat water pollution. *Abdi Nusa*, 5(3), pp. 313–318. <https://journal.unusia.ac.id/index.php/abdinusa/article/view/xxxx>
25. Schuller, P., et al. (2010). Use of beryllium-7 to study effectiveness of woody trash barriers. *Soil and Tillage Research*, 110(1), pp. 143–153. <https://doi.org/10.1016/j.still.2010.07.003>
26. Sugiester, S., et al. (2021). The impact of river pollution in Indonesia on health disorders. *Health Research Journal*, 13(1), pp. 120–133. <https://ejournal.poltekkes-smg.ac.id/ojs/index.php/jrk/article/view/xxxx>
27. Syafari, M.R., et al. (2023). Trash bombing of riverbank communities. *International Journal of Political, Law, and Social Science*, 4(3). <https://ijplss.org/index.php/ijplss/article/view/xxxx>