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IMPACT OF TRASH BARRIER IMPLEMENTATION ON WASTE REDUCTION AND ECOLOGICAL CONDITIONS IN THE LAMPENAI RIVER

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ABSTRACT

Low public awareness regarding the prohibition of waste disposal into water bodies in Lampenai Village has led to a long-term accumulation of riverine debris that flows into the sea, causing persistent ecosystem degradation. This study evaluates the effectiveness of physical intervention through the installation of trash barriers at strategic locations as a pollution mitigation strategy. A quantitative observational method was employed, involving direct on-site monitoring and variable measurement without experimental manipulation. The research analyzes the correlation between the trash barrier's capture efficiency and ecological conditions, integrated with average daily waste generation data based on population statistics. The results demonstrate a significant waste capture performance across four monitoring stations: Station 1 (123.2%), Station 2 (111.4%), Station 3 (108.1%), and Station 4 (103.8%). These percentages, exceeding 100%, indicate that the actual captured waste load surpasses the estimated daily generation per capita, suggesting the presence of existing accumulated debris within the river flow.

Keywords: biodiversity, engineering design, riverine pollution, trash barrier, waste generation.

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INTRODUCTION

The exponential growth of the global population, coupled with rapid urbanization and shifting consumer behavior, has led to a critical escalation in municipal solid waste generation. In developing nations, suboptimal waste management infrastructure often results in a significant portion of uncollected waste leaking into aquatic ecosystems (Shah *et al*., 2021). According to the National Waste Management Information System (SIPSN, 2024), Indonesia faces a formidable challenge, with South Sulawesi alone producing approximately 1,582,378.09 tons of waste annually, or an average of 4,335.28 tons per day. This environmental crisis has gained high-level political attention; President Prabowo Subianto has categorized waste management as a top-tier national priority, which is formally integrated into the National Medium-Term Development Plan (RPJMN) (Rachmayani, 2015). This policy focus emphasizes the urgent need for integrated waste handling, spanning from residential sectors to the extensive river networks across the archipelago.

At the regional level, the Wotu District in East Luwu represents a micro-model of these systemic challenges. Data from the Environmental Agency (DLH) of East Luwu indicates a daily waste generation of 14.40 tons in this district. While the waste composition is diverse, ranging from hazardous household substances (B3) such as used batteries and chemical cleaners to organic debris, plastic waste remains the most dominant and persistent pollutant. In Lampenai Village, the long-standing anthropogenic habit of utilizing the river as a convenient disposal site has led to severe ecological degradation. This behavior, practiced over generations, has caused significant riverbed sedimentation, reducing the river's hydraulic capacity and exacerbating flood risks during peak rainfall. Furthermore, the presence of macroscopic debris directly impacts the local economy, particularly for downstream fishermen whose vessel propellers are frequently obstructed by plastic waste (Darmawan *et al*., 2024; Dzulkifli *et al*., 2022).

The failure to implement the "Reduce, Reuse, Recycle" (3R) framework at the community level is further compounded by logistical deficiencies, including an insufficient fleet of waste transport vehicles and inadequate management of transfer stations (TPS) to final disposal sites (TPA). In such contexts, physical engineering interventions, specifically the installation of trash barriers, serve as a vital "last line of defense" to intercept debris before it reaches the marine environment (Aini *et al*., 2023). However, the deployment of such technology must be meticulously planned. The effectiveness of a trash barrier is contingent upon complex variables, including the river's hydrological profile, hydraulic flow velocity, and the seasonal characteristics of the waste load. In the Lampenai River, which possesses a width of 4-5 meters and a discharge of 0.10 m^3/s, the design must also account for tidal influences, as the river has a direct hydrological connection to the sea.

Despite Indonesia overseeing more than 5,590 major river systems, the adoption of floating barrier technology remains remarkably low, with less than 10% of these rivers utilizing such instruments (Dzulkifli *et al*., 2022). This research, therefore, seeks to fill a critical gap by providing a technical evaluation of trash barrier implementation in the Lampenai River. By correlating the barrier's capture efficiency with local ecological

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conditions and population-based waste generation data, this study offers a scalable model for riverine waste management. A comprehensive and sustainable approach combining engineering solutions, public education, and robust legal enforcement is imperative to restore water quality and preserve the biodiversity of Indonesia's vital aquatic resources.

SCOPE

The scope of this research is specifically focused on the technical and ecological assessment of floating trash barriers as a localized waste management intervention. The study is delineated into the following key areas:

a) **Geographic and Hydrological Scope:** The investigation is confined to the Lampenai River, Wotu District, East Luwu, characterized by specific narrow-channel hydraulics (4-5 meters width) and a low-discharge flow (0.10 m^3/s). This includes the study of tidal influence on waste accumulation patterns.

b) **Technical Scope:** This study evaluates the structural performance of a specific trash barrier design constructed from hollow iron and PVC flotation units. The assessment is limited to the device's ability to intercept macroscopic surface debris (macro-plastics and organic waste) rather than dissolved pollutants or microplastics.

c) **Ecological and Quantitative Scope:** The research quantifies waste capture efficiency across four strategic monitoring stations and correlates these findings with local biodiversity indicators and population-based waste generation data (SIPSN, 2024; Dzulkifli *et al*., 2022).

d) **Policy Alignment:** The scope includes an analysis of how community-level engineering solutions align with the National Medium-Term Development Plan (RPJMN) and regional environmental regulations (Rachmayani, 2015).

EXPERIMENTAL PROGRAM

Research Design and Study Area

This study employs a combined quantitative and observational methodology. The observational method was utilized to conduct direct, non-manipulative monitoring of riverine waste behavior and ecological phenomena in their natural setting. Complementarily, the quantitative approach focused on the systematic measurement and numerical analysis of waste generation variables to ensure objective results. The research was localized at the Lampenai River, Lampenai Village, Luwu Timur (Figure-1). The site was divided into four strategic monitoring stations to capture longitudinal data on waste distribution and barrier efficiency.

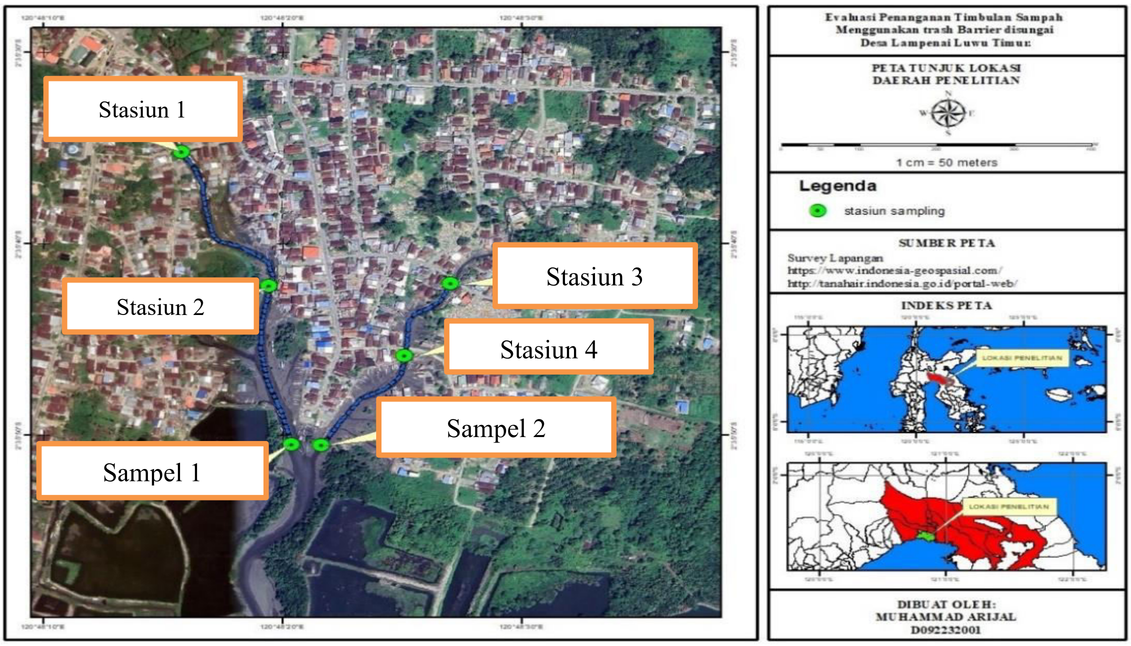

Figure-1. Map of Research Location.

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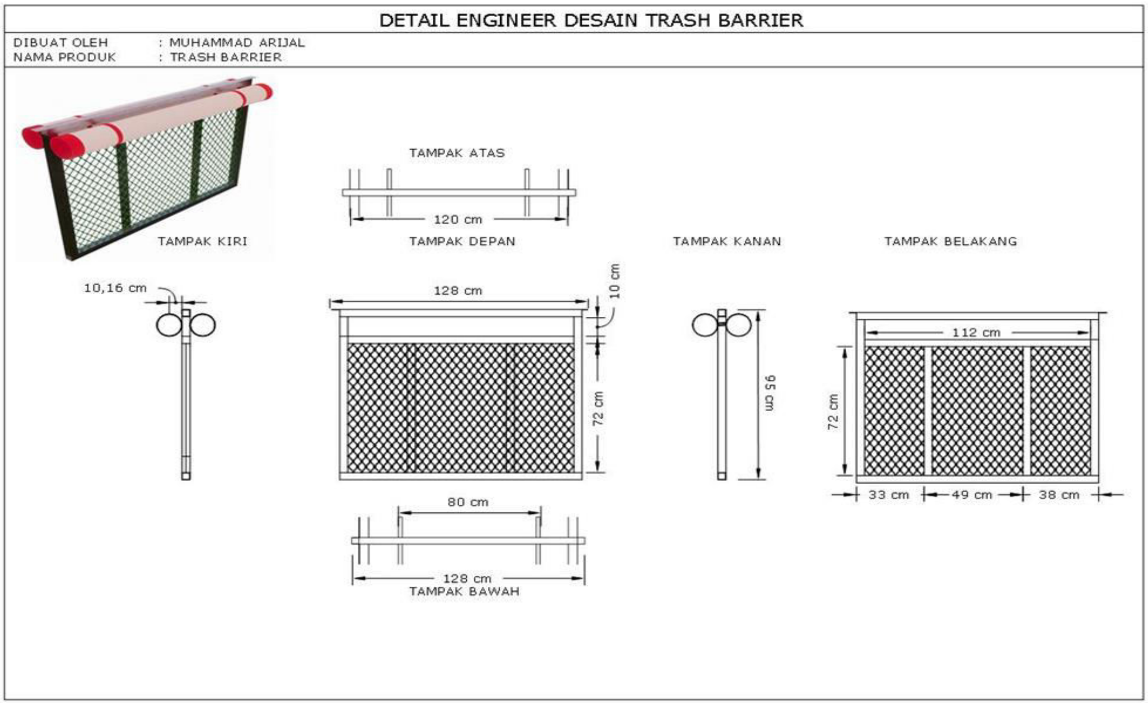
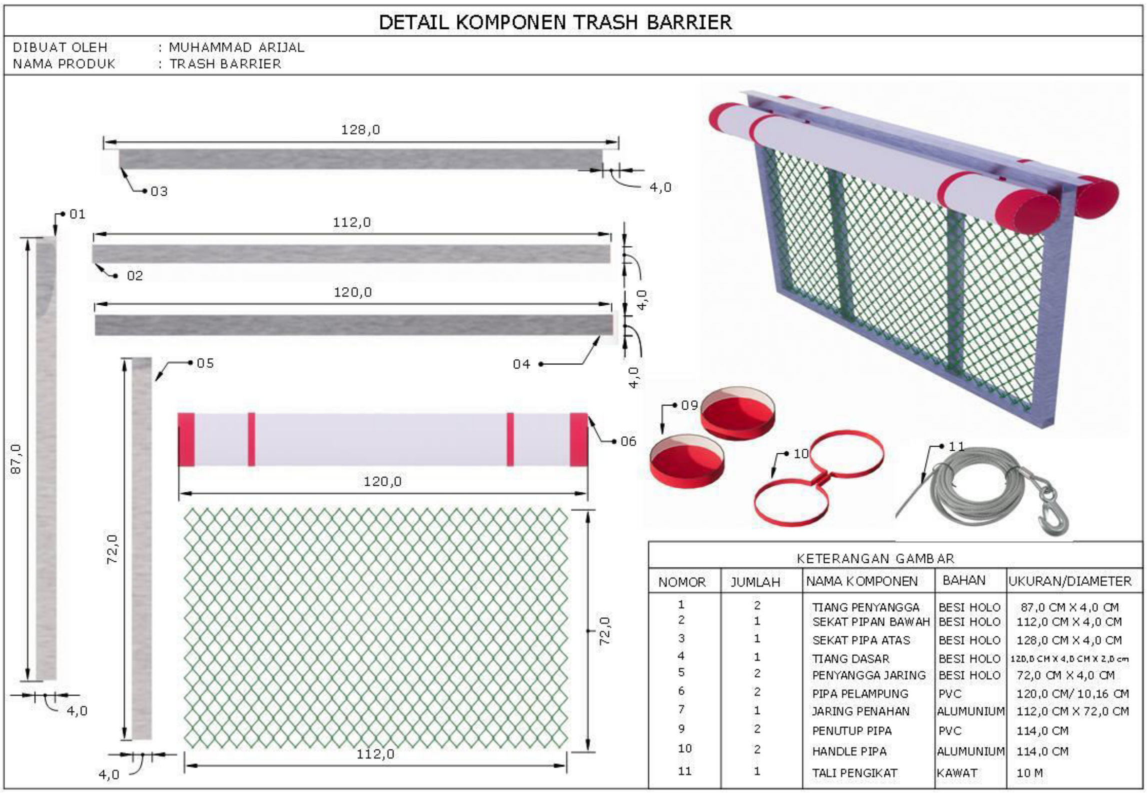


Figure-2. Detailed Engineering Design.



KETERANGAN GAMBAR				
NOMOR	JUMLAH	NAMA KOMPONEN	BAHAN	UKURAN/DIAMETER
1	2	TIANG PENYANGGA	BESI HOLO	87,0 CM X 4,0 CM
2	1	SEKAT PIPAN BAWAH	BESI HOLO	112,0 CM X 4,0 CM
3	1	SEKAT PIPA ATAS	BESI HOLO	128,0 CM X 4,0 CM
4	1	TIANG DASAR	BESI HOLO	120,0 CM X 4,0 CM X 2,0 cm
5	2	PENYANGGA JARING	BESI HOLO	72,0 CM X 4,0 CM
6	2	PIPA PELAMPUNG	PVC	120,0 CM/ 10,16 CM
7	1	JARING PENAHAN	ALUMUNIUM	112,0 CM X 72,0 CM
9	2	PENUTUP PIPA	PVC	114,0 CM
10	2	HANDLE PIPA	ALUMUNIUM	114,0 CM
11	1	TALI PENGIKAT	KAWAT	10 M

Figure-3. Detail Komponen Trash Barrier.

Engineering Design and Barrier Specifications

The primary instrument used in this study is a custom-designed floating trash barrier. The Detailed Engineering Design (DED) and its specific components are illustrated in Figure-2 and Figure-3. The structural framework is constructed from hollow iron for mechanical strength, integrated with PVC piping systems to provide buoyancy, allowing the barrier to adapt to the river's vertical water level fluctuations (Aini *et al.*, 2023; Shah *et al.*, 2021). This design ensures that the barrier effectively

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intercepts surface debris without significantly obstructing the river's hydraulic flow.

Data Analysis and Standardization

Data analysis was performed using Microsoft Excel for the computational processing of waste capture metrics. The quantification and classification of household-type waste were conducted in accordance with the SNI 3964:1994 (Standard Methods for Estimating Waste Generation and Composition). The analysis involves calculating the total mass of captured debris at each station and correlating it with the estimated daily waste generation based on population density data to determine the barrier’s interception efficiency.

ANALYSIS OF RESULTS

Analysis of Regional Waste Generation Volume

The geographic and demographic profile of East Luwu Regency plays a significant role in determining the spatial distribution of waste generation. Geographically, East Luwu is situated between 2°03'00" - 3°03'25" South Latitude and 119°28'56" - 121°47'27" East Longitude, covering an area of approximately 6,944.88 km². This region represents 11.14% of the total area of South Sulawesi Province. As the easternmost regency, its strategic position bordering Central Sulawesi, Southeast Sulawesi, and the Bone Bay necessitates a robust waste management framework to prevent trans-boundary water pollution.

Based on the statistical analysis of population density, the total waste generation in East Luwu Regency is estimated at 126.40 tons per day or approximately 46,136 tons per year.

Table-1.

No	District	Population	Waste Generation (Tons/Day)	Waste Generation (Tons/Year)
1	Nuha	24. 507	9, 80	3, 578
2	Towuti	48. 507	19. 50	7, 118
3	Waspounda	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	Tomoni timur	13. 963	5, 59	2, 039
10	Wotu	35. 019	14. 01	5, 113
11	Burau	35. 990	14. 40	5, 255
	Total	316. 000	126. 40	46, 136

The data indicates a direct linear correlation between population size and waste volume, where the Malili District exhibits high generation rates due to its larger population. However, from an engineering perspective, the management focus must also be directed towards coastal and riverine districts such as Wotu. Wotu District, with a population of 35,019 (referring to Table-1), covers an area of 130.52 km² (1.88% of the regency). Within this district, Lampenai Village stands out as the largest administrative area, spanning 22.31 km² or approximately 17% of the district's territory.

Lampenai Village’s geographical characteristics are particularly critical for riverine waste studies. Astronomically located between 2°31’58” - 2°39’57” South Latitude and 120°45’20” - 120°55’38” East Longitude, the village is part of Wotu’s coastal landscape where six out of seventeen villages are coastal areas. The high waste generation in Wotu (14.01 tons/day), combined with the expansive area of Lampenai and its proximity to the coastline, creates a high risk of "leakage" where unmanaged household waste enters the river system and eventually flows into the Bone Bay (SIPSN, 2024; Dzulkifli *et al*., 2022). This demographic pressure necessitates the implementation of localized physical interventions, such as the trash barrier evaluated in this study, to mitigate the environmental impact of the 5,113 tons of waste produced annually in this district.

Ecological Conditions and Longitudinal Biodiversity Distribution

The distribution of aquatic and terrestrial species along the Lampenai River exhibits a distinct longitudinal zonation, influenced by physical habitat characteristics and anthropogenic pressure. The ecological health of the river

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is reflected in the presence or absence of specific taxa across the upstream, middle, and downstream segments.

Table-2.

Species	Local Name	Upstream	Midstream	Downstream
Oreochromis mossambicus	Mozambique tilapia (mujair)	+	+	-
Channa striata	Striped snakehead (gabus)	+	+	-
Osphronemus goramy	Giant gourami (gurami)	+	+	-
Oreochromis niloticus	Nile tilapia (nila)	+	-	-
Trichogaster trichopterus	Three-spot gourami (sepat rawa/baba)	+	-	-
Barbonymus gonionotus	Silver barb (tawes/kampuleng)	+	+	+
Colossoma macropomum	Black pacu (freshwater pomfret/bawal)	-	+	-
Siganus sp.	Rabbitfish (baronang)	-	+	+
Chanos chanos	Milkfish (bandeng/bolu)	-	+	+
Tetraodontidae	Pufferfish (buntal)	-	+	+
Hemiramphus sp.	Halfbeak (julung)	-	+	+
Brown shrimp	Black shrimp (udang hitam)	-	+	-
Penaeus monodon	Giant tiger prawn (udang windu)	-	+	-
Acetes sp.	Acetes shrimp (rebon/cani)	+	+	-
Orthetrum sabina	Slender skimmer dragonfly	+	+	-
Agriocnemis pygmaea	Pygmy dartlet	+	+	-
Tholymis tillarga	Evening skimmer	+	+	-
Brachythemis contaminata	Ditch jewel dragonfly	+	-	-
Euploea crameri	Spotted black crow butterfly	+	+	-
Neptis hylas	Common sailor butterfly	-	+	+
Phrynoidis asper	Giant river toad	-	+	-
Fejervarya cancrivora	Crab-eating frog	+	-	-
Varanus salvator bivittatus	Water monitor	+	-	-
Eutropis multifasciata	Common sun skink	+	-	-
Homalopsis buccata	Puff-faced water snake	-	+	+
Cosymbotus platyurus	Flat-tailed house gecko	+	-	-
Passer montanus	Eurasian tree sparrow	+	+	-
Pycnonotus aurigaster	Sooty-headed bulbul	+	+	+
Egret	White egret	-	-	+

The table above indicates that the number of species found in the upstream and downstream sections of the Lampenai River shows a noticeable decline. River zonation plays a crucial role in shaping biodiversity patterns along the longitudinal gradient. The upstream segment represents a transitional zone between terrestrial and aquatic ecosystems and is often characterized by relatively high biodiversity. Morphologically, the middle reach of the river is wider than the upstream section, with relatively deeper water and lower turbidity. In this zone, organic matter produced within the aquatic system (autochthonous input) tends to dominate. Meanwhile, the downstream channel typically exhibits a meandering pattern with slower current velocity.

The distribution of species in the Lampenai River is strongly influenced by environmental conditions in each river segment. Several species show a preference for upstream habitats, including tilapia (mujair), snakehead fish, gourami, Nile tilapia, swamp gourami, tawes/kampuleng, rebon shrimp, various dragonflies (slender, dwarf, cloud, and orange basker), spotted crow butterfly, frogs, water monitor lizards, brown lizards, house geckos, Eurasian tree sparrows, and yellow-vented bulbuls. These preferences are closely related to the physicochemical characteristics of the upstream environment.

Upstream waters generally have lower temperatures and higher dissolved oxygen concentrations, conditions that favor cold-water and oxygen-sensitive organisms (Vannote *et al*., 1980). The substrate in this zone is typically rocky, with swift currents and well-oxygenated water, making it suitable for organisms that attach to hard surfaces. In addition, upstream areas receive substantial coarse organic matter inputs such as leaves and twigs from surrounding riparian vegetation, which serve as an important energy source for shredders and other detritivores. However, anthropogenic disturbances increasingly threaten upstream ecological integrity. Organic waste (e.g., food residues) can reduce dissolved oxygen through microbial decomposition, while inorganic waste such as plastics and metals can obstruct flow and introduce toxic microplastics into the ecosystem. As a result, sensitive species that should dominate upstream habitats may decline or disappear, leaving only pollution-tolerant organisms.

In the middle reach, species composition becomes more diverse. Species commonly found in this zone include tilapia, snakehead fish, gourami, tawes/kampuleng, freshwater pomfret, rabbitfish, milkfish, pufferfish, halfbeak fish, black shrimp, tiger shrimp, rebon shrimp, several dragonfly species, spotted crow butterfly, common sea butterfly, giant toads, water snakes, Eurasian tree sparrows, and yellow-vented bulbuls. The ecological suitability of the middle reach is largely due to its moderate environmental conditions.

The middle segment is characterized by moderate current velocity, neither as fast as the upstream nor as slow as the downstream, allowing a wide range of species to adapt successfully. Water temperature is intermediate, and dissolved oxygen remains relatively high because water movement still facilitates aeration. According to the River Continuum Concept, this section receives both coarse and fine organic matter transported from upstream areas (Vannote *et al*., 1980). Consequently, two major food resources are available: coarse particulate organic matter for shredders and fine particulate organic matter and phytoplankton for collectors and filter feeders. These conditions typically support high species richness and functional diversity.

Although human impacts in the middle reach are generally less severe than in downstream areas, this zone already receives nutrient inputs from upstream. Moderate nutrient enrichment can increase ecosystem productivity, but excessive organic waste may again reduce dissolved oxygen through decomposition processes. Plastic and metal debris can also degrade benthic habitats. Under such pressures, sensitive species tend to decline or migrate, leaving more pollution-tolerant species dominant. In contrast, downstream habitats are preferred by species such as tawes/kampuleng, rabbitfish, milkfish, pufferfish, halfbeak fish, common sea butterfly, water snakes, yellow-vented bulbuls, and white egrets. These preferences are strongly associated with the distinctive environmental characteristics of downstream waters.

The downstream section typically has slower flow velocity, allowing species that are weaker swimmers to thrive. Water temperature is generally warmer because the river is farther from its mountainous source. Many tropical species are well adapted to these warmer conditions. Nutrient concentrations are also higher in downstream areas because this zone accumulates organic matter and sediments transported from the entire watershed (Allan & Castillo, 2007). Coarse organic matter generated upstream becomes progressively broken down into fine particles by the time it reaches downstream habitats. As a result, downstream communities are often dominated by collectors and filter feeders that utilize fine particulate organic matter. In addition, phytoplankton and detritus production tends to increase due to higher nutrient availability and sufficient light penetration.

Substrate composition in downstream areas is generally dominated by fine sediments such as mud and sand, providing suitable habitat for sediment-dwelling organisms. Slower currents also allow the growth of aquatic macrophytes along river margins, which function as important refuge and feeding grounds for fish and invertebrates. Furthermore, downstream reaches are often connected to estuarine, wetland, and coastal ecosystems, facilitating species migration and feeding activities. Nevertheless, downstream ecosystems are typically the most vulnerable to anthropogenic pressure. Waste transported from upstream and middle reaches tends to accumulate in downstream areas. Moreover, downstream zones are frequently located near urban centers, industrial areas, and densely populated settlements. Consequently, domestic waste, plastics, and chemical pollutants commonly enter the river system. Only species tolerant of turbid, organically enriched, and low-oxygen conditions are generally able to persist under such degraded environmental conditions. Overall, the observed

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longitudinal pattern of species distribution in the Lampenai River is consistent with fundamental river ecology theory, particularly the River Continuum Concept, which emphasizes gradual ecological transitions from headwaters to downstream reaches (Vannote *et al*., 1980). However, increasing anthropogenic disturbances have the potential to disrupt these natural patterns and reduce biodiversity across all river segments.

Ecological Conditions

Table-3. Ecological Condition and Biodiversity Index.

Parameter	Result
Fish species	11
Shrimp species	3
Dragonfly species	4
Butterfly species	2
Herpetofauna	6
Birds	3
Water depth	0.28–1 m
River width	2–3 m
Current velocity	0.10 m^3/s
Substrate	Sandy mud

Based on Table-3, the number of species recorded across taxonomic groups provides an initial overview of the biodiversity status and ecological condition of the Lampenai River. In general, higher species richness is associated with healthier and more functionally diverse ecosystems, because a greater number of taxa typically reflects the availability of varied ecological niches and relatively stable environmental conditions (Magurran, 2004).

The presence of 11 fish species, accompanied by aquatic invertebrates such as shrimp and dragonflies, as well as terrestrial-aquatic link taxa (butterflies, herpetofauna, and birds), indicates that the Lampenai River still supports a multi-trophic biological community. Fish assemblages are commonly used as indicators of river health because they integrate environmental conditions over time and respond to changes in water quality, habitat structure, and hydrological regime (Karr, 1981). Likewise, dragonflies (Odonata) are widely recognized as sensitive bioindicators of freshwater ecosystem quality due to their biphasic life cycle and habitat specificity (Dolný *et al*., 2012). However, species counts alone are insufficient to quantitatively determine biodiversity status. A more rigorous assessment typically employs diversity indices such as the Shannon-Wiener Index (H′) or Simpson's Index, which incorporate both species richness and relative abundance. These indices provide a more accurate picture of community structure. Moderate to high diversity values generally indicate that no single species dominates the community and that individuals are relatively evenly distributed among taxa (Magurran, 2004). Therefore, future studies on the Lampenai River should incorporate abundance data to enable formal biodiversity index calculations and strengthen ecological interpretation.

From a physical-habitat perspective, the measured environmental parameters suggest conditions that are moderately suitable for a range of aquatic organisms. The recorded water depth (0.28-1 m) and river width (2-3 m) indicate a small to medium-sized stream channel that can support heterogeneous microhabitats. Habitat heterogeneity is a key driver of aquatic biodiversity because it increases the availability of ecological niches and refuge areas (Allan & Castillo, 2007). The reported current velocity (0.10 m^3/s) suggests relatively slow to moderate flow conditions. Such hydrological characteristics generally favor species that are not adapted to strong currents, including many lentic–tolerant fishes, shrimp, and sediment-associated macroinvertebrates. Slower flows also facilitate the deposition of fine organic matter, which becomes an important food resource for collector and filter-feeding organisms within the river continuum framework (Vannote *et al*., 1980).

Substrate composition in the form of sandy mud further supports this interpretation. Fine sediments typically provide suitable habitat for burrowing organisms, benthic feeders, and detritivores. However, excessive fine sediment can also indicate sedimentation pressure from upstream land use and may reduce habitat quality for lithophilic or oxygen-sensitive taxa (Allan & Castillo, 2007). Thus, while the current substrate conditions appear to support several tolerant species groups, continued sediment accumulation could pose ecological risks if not properly managed. Overall, the ecological indicators from Table 4 suggest that the Lampenai River remains capable of supporting a moderately diverse biological community. Nevertheless, the relatively limited number of taxa in certain groups and the dominance of species tolerant to slower-flow, fine-substrate environments may signal emerging ecological pressures. Comprehensive monitoring that includes quantitative diversity indices, water quality parameters, and long-term biological surveys is therefore recommended to more accurately determine the ecological status and conservation needs of the Lampenai River.

Ecological Conditions: Solid Waste Characteristics and Trash Barrier Performance

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Table-4. Waste Composition at Sampling Site One.

Waste Composition	Station 1-Waste Weight (kg)	Station 1-Waste Volume (L)	Station 2-Waste Weight (kg)	Station 2- Waste Volume (L)
Food waste	37	123	29	97
Garden waste	10	33	9	32
Wood	11	37	12	40
Paper, cardboard, and cartons	8	29	7	24
Plastic - film	9	32	8	29
Plastic - rigid	14	53	13	45
Metal	19	65	18	63
Fabric and textile products	7	24	7	24
Rubber and leather	6	22	5	17
Glass	18	63	17	62
Hazardous waste (B3)	10	35	9	32
Nappies (diapers and sanitary pads, etc.)	5	17	4	16
Other waste/residue	3	11	2	9
Total	157	544	140	490

Table-4 shows the composition of waste by weight and volume at Stations 1 and 2 in the Lampenai village settlement. The total waste recorded at Station 1 was 157 kg with a volume of 544 L, while Station 2 generated 140 kg with a volume of 490 L. These values indicate a relatively high waste load entering the river system from residential sources.

To determine the proportional contribution of each waste type, the following formulas were applied:

$$\%\text{Weight} = \frac{\text{Weight of waste type}_i}{\text{Total waste weight (Bs)}} \times 100$$

$$\%\text{Volume} = \frac{\text{Volume of waste type}_i}{\text{Total waste volume (Bs)}} \times 100$$

The percentage composition analysis provides insight into dominant waste fractions and potential environmental pressures. In Station 1 (Figure-4), food waste contributed the largest proportion by weight, exceeding its volumetric proportion. This pattern typically reflects the high density and moisture content of organic waste (Tchobanoglous *et al.*, 1993). Conversely, rigid plastics and glass showed higher volumetric proportions than weight, which is consistent with their lower bulk density but high spatial occupancy.

Several waste categories such as garden waste, wood, paper and cardboard, plastic sheets, metals, textiles, rubber and leather, hazardous waste (B3), nappies, and residual waste displayed relatively similar weight-volume proportions. This suggests a balanced density profile for these materials within the waste stream. At Station 2 (Fig. 5), food waste, wood, and rubber/leather showed higher weight proportions compared to volume, again indicating dense organic and semi-organic materials. In contrast, garden waste, glass, hazardous waste, and residual waste exhibited higher volumetric shares, reflecting bulkier but lighter materials. Equal proportions between weight and volume were observed for paper products, plastic sheets, rigid plastics, metals, textiles, and nappies.

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Table-5. Waste Composition at Sampling Site Two.

Waste Composition	Station 3-Waste Weight (kg)	Station 3-Waste Volume (L)	Station 4-aste Weight (kg)	Station 4-Waste Volume (L)
Food waste	19	63	17	57
Garden waste	9	29	9	29
Wood	10	32	10	32
Paper, cardboard, and cartons	8	23	9	30
Plastic – film	6	22	6	20
Plastic – rigid	9	29	8	25
Metal	16	53	14	43
Fabric and textile products	8	23	6	19
Rubber and leather	9	27	8	25
Glass	13	39	11	34
Hazardous waste (B3)	11	35	13	40
Nappies (diapers and sanitary pads, etc.)	6	19	3	11
Other waste/residue	2	8	2	8
Total	126	402	116	373

Table-5 presents waste characteristics at Stations 3 and 4. The total waste recorded at Station 3 was 126 kg (402 L), while Station 4 generated 116 kg (373 L). Compared with Stations 1 and 2, the waste load is lower, suggesting spatial variation in waste generation and/or transport dynamics along the Lampenai River corridor. At Station 3 (Figure-6), the volumetric proportion of food waste exceeded its weight proportion, indicating the presence of less compact organic waste. Most other waste categories showed relatively similar weight–volume distributions, suggesting a more homogeneous waste density profile.

At Station 4 (Figure-7), the proportional values of weight and volume were largely equivalent across nearly all waste categories. This pattern may indicate relatively uniform waste composition and compaction conditions at this location. Such uniformity can occur in areas where waste has undergone similar transport, mixing, and deposition processes within the river system (Lebreton *et al.*, 2017). Overall, the dominance of organic waste (food and garden waste) across stations highlights the strong influence of household activities in the Lampenai settlement. Meanwhile, the consistent presence of plastics, metals, glass, and hazardous waste signals ongoing risks of long-term environmental contamination.

The trash barrier monitoring results indicate that the system successfully intercepted substantial amounts of floating waste. The total waste captured was:

- Station 1: 157.3 kg
- Station 2: 140.4 kg
- Station 3: 126.3 kg
- Station 4: 116.4 kg

These values generally follow the spatial pattern observed in the manual waste composition survey.

The effectiveness of the trash barrier was calculated using:

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

where:

- W_{tb}= weight of waste trapped by the trash barrier
- W_{total}= total waste load

The calculated effectiveness values were:

- Station 1: 123.2%
- Station 2: 111.4%
- Station 3: 108.1%
- Station 4: 103.8%

Effectiveness values exceeding 100% suggest possible discrepancies between estimated total waste and measured trapped waste, which may arise from temporal variation in waste inflow, sampling differences, or accumulation effects over multiple days. Similar overestimation phenomena have been reported in field-based debris interception studies when monitoring intervals are not perfectly synchronized (Schuyler *et al.*, 2021).

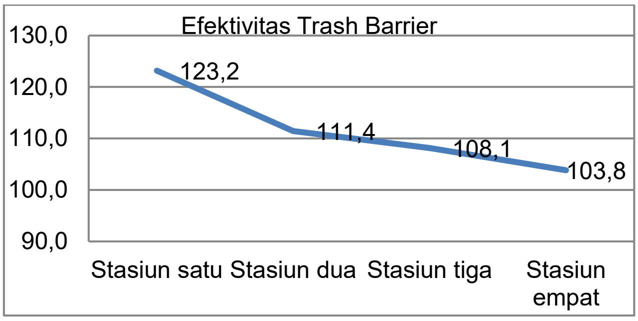

Figure-8 illustrates that under low to moderate discharge conditions, the trash barrier performs more effectively because flow velocity allows floating debris to be retained optimally. Under high discharge conditions, effectiveness tends to decline due to increased hydraulic force that can push debris over or around the barrier. Hydrodynamic conditions are widely recognized as a key determinant of floating debris interception efficiency in riverine systems (Lebreton *et al*., 2017).

From an ecological perspective, the substantial volume of organic and inorganic waste entering the Lampenai River indicates ongoing anthropogenic pressure. Organic waste inputs may increase biological oxygen demand (BOD) through decomposition processes, while plastics and hazardous waste pose long-term toxicity and microplastic risks to aquatic biota. Persistent accumulation of such materials can alter habitat quality, reduce biodiversity, and disrupt trophic dynamics. Nevertheless, the relatively high capture performance of the trash barrier demonstrates its potential as an effective mitigation tool for riverine solid waste management. Continued optimization, particularly under high-flow conditions along with upstream waste reduction strategies, will be essential to improve overall river health.

CONCLUSIONS

This study successfully provides an overview of the ecological condition and biodiversity status of the Lampenai River in Lampenai Village, while also addressing the issue of solid waste accumulation. The findings indicate that community behavior over many years has contributed to waste inputs into the river system. However, ongoing educational efforts directed at residents regarding the prohibition of littering have become an important initial step toward improving environmental awareness and river stewardship.

The implementation of the trash barrier has demonstrated practical effectiveness in capturing floating waste on a daily basis. This intervention contributes to reducing the volume of waste transported downstream, thereby lowering the potential load entering coastal waters and final disposal sites (TPA). From an ecological management perspective, the trash barrier represents a feasible and scalable mitigation measure for controlling riverine solid waste in settlement areas. Nevertheless, the results also suggest that technological and spatial expansion is necessary to achieve more comprehensive river management. Future research should consider broader spatial coverage and the integration of Internet of Things (IoT)-based monitoring systems to enable real-time tracking of waste accumulation and river conditions. Such an approach would support more adaptive and data-driven management of interconnected river systems in East Luwu that are potentially affected by anthropogenic activities.
In summary, combining community education, structural waste interception (trash barriers), and smart monitoring technologies offers a promising pathway toward sustainable river ecosystem management in the Lampenai watershed and similar riverine environments.

REFERENCES

Aini N., *et al*. 2023. [Judul lengkap artikel dari draf Anda mengenai uji coba alat]. Jurnal Teknik Lingkungan.

Aini N., *et al*. 2023. [Judul lengkap mengenai uji coba trash barrier]. Jurnal Teknik.

Allan J. D. and Castillo M. M. 2007. Stream ecology: Structure and function of running waters (2nd ed.). Springer.

Darmawan I., *et al*. 2024. [Judul lengkap artikel mengenai dampak sampah pada hewan/biota]. Jurnal Ekologi.

Dolný A., Harabiš F., Bárta D., Lhota S. and Drozd P. 2012. Aquatic insects indicate terrestrial habitat degradation: Changes in taxonomical structure and functional diversity of dragonflies in tropical rainforest of East Kalimantan. Tropical Zoology, 25(3): 141-157. https://doi.org/10.1080/03946975.2012.717480

Dzulkifli, Maradinata, and Anas. 2022. [Judul lengkap artikel mengenai penggunaan trashboom di sungai Indonesia]. Journal of Marine Engineering.

Karr J. R. 1981. Assessment of biotic integrity using fish communities. *Fisheries,* 6(6): 21-27. https://doi.org/10.1577/1548-8446(1981)006<0021:AOBIUF>2.0.CO;2

Lebreton L. C. M., van der Zwet J., Damsteeg J. W., Slat B., Andrady A. and Reisse J. 2017. River plastic emissions to the world's oceans. Nature Communications, 8, 15611. https://doi.org/10.1038/ncomms15611

Magurran A. E. 2004. Measuring biological diversity. Blackwell Publishing.

Noor Rachmayani A. 2015. [Judul lengkap mengenai RPJMN dan kebijakan sampah]. Jurnal Kebijakan Publik.

Nugroho B. S., *et al*. 2024. Quick assessment study on condition of marine debris from fisheries activities at

Tegalsari Fishing Port in Tegal City. Barakuda: Jurnal Ilmu Perikanan dan Kelautan. 6(2): 150-167.

Ramdhani M. T., *et al*. 2025. Pembuatan trash barrier sebagai upaya penanggulangan pencemaran air oleh sampah di saluran irigasi. Abdi Nusa: Jurnal Pengabdian kepada Masyarakat. 5(3): 313-318.

Rachmayani A. N. 2015. [Judul lengkap mengenai RPJMN dan kebijakan sampah]. Jurnal Kebijakan Publik.

Schuller P., Walling D. E., Iroumé A. and Castillo A. 2010. Use of beryllium-7 to study the effectiveness of woody trash barriers in reducing sediment delivery to streams after forest clearcutting. Soil and Tillage Research, 110(1): 143-153. https://doi.org/10.1016/j.still.2010.07.003

Schuyler Q., Hardesty B. D., Lawson T. J., Opie K. and Wilcox C. 2021. Economic incentives reduce plastic inputs to the ocean. Marine Policy. 96, 250-255.

Shah M. N., *et al*. 2020. Design and development of trash trap of stream for mini hydro. Materials Today: Proceedings, 46, 2105-2111. https://doi.org/10.1016/j.matpr.2020.10.XXX

SIPSN. 2024. Data timbulan sampah wilayah Sulawesi Selatan. Sistem Informasi Pengelolaan Sampah Nasional, Kementerian Lingkungan Hidup dan Kehutanan Republik Indonesia.

SNI 3964:1994. 1994. Metode pengambilan dan pengukuran contoh timbulan dan komposisi sampah perkotaan. Badan Standardisasi Nasional.

Tchobanoglous G., Theisen H. and Vigil S. 1993. Integrated solid waste management: Engineering principles and management issues. McGraw-Hill.

Vannote R. L., Minshall G. W., Cummins K. W., Sedell J. R. and Cushing C. E. 1980. The river continuum concept. Canadian Journal of Fisheries and Aquatic Sciences, 37(1): 130-137. https://doi.org/10.1139/f80-017