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Rapid assessment of river ecosystem in Brgy. Matalang-Talang, Aroroy, Masbate

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Abstract

This study conducted a rapid ecological assessment of the Aroroy River in Barangay Matalang-Talang, Aroroy, Masbate, to establish baseline information on its biological composition, physicochemical water quality, and socio-ecological services. Three sampling stations—upstream, midstream, and downstream—were evaluated through field surveys, biodiversity inventories, and water quality measurements. Results revealed a generally healthy freshwater ecosystem, indicated by the presence of pollution-sensitive macroinvertebrates such as mayflies, caddisflies, gastropods, and crustaceans across all stations. Two fish species, *Sillago sp.* and *Mugil cephalus*, were documented at the upstream station, suggesting that this section provides suitable habitat conditions characterized by cool, well-oxygenated waters and intact riparian vegetation. Riparian flora richness was highest upstream and lowest downstream, reflecting a gradient of increasing disturbance, sediment deposition, and potential human pressures toward the lower river sections. Water quality parameters—including dissolved oxygen, pH, temperature, and total dissolved solids—were within or above national and international standards for Class C freshwater bodies, indicating good ecological condition and low pollution levels. Despite the river's high ecological value, socio-ecological assessments showed minimal reliance of local residents on the river for provisioning services; recreational use predominated, often accompanied by littering, vandalism, and improper waste disposal. These findings highlight the disparity between ecological health and community stewardship. Overall, the study provides essential baseline data for environmental planning and emphasizes the need for stronger community engagement, environmental education, and sustainable river management interventions to preserve the Aroroy River's ecological integrity.

Keywords: Aroroy River, freshwater ecosystem, biodiversity assessment, macroinvertebrates, water quality, riparian vegetation, socio-ecological services

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1. Introduction

Rivers are essential natural systems that significantly support biodiversity and hydrological processes, providing vital resources for human populations. They serve as crucial ecological corridors that nurture freshwater and terrestrial biodiversity, offer water for domestic and agricultural use, and sustain local economies and cultural traditions (Poff et al., 2007; Dudgeon et al., 2006). The Aroroy River in Masbate, Philippines, exemplifies its crucial role in maintaining ecological balance and supporting socio-economic activities in Barangay Matalang-Talang and its surrounding communities (Relox & Buenafe, 2018). This river ecosystem is increasingly threatened by rapid environmental changes resulting from human activities, including deforestation, agricultural runoff, and improper waste disposal. These pressures affect water quality, alter species composition, and diminish the ecosystem's capacity to provide essential services (Allan, 2004; Saunders et al., 2002). While global and local studies highlight the adverse effects of land-use changes and pollution on freshwater systems, there is still a lack of site-specific ecological assessments for the Aroroy River.

Recent studies underscore the need to address these issues. For instance, research on the Navotas River in the Philippines has found that human activities have significantly compromised water quality and reduced fish biodiversity, as indicated by elevated levels of pollutants such as nitrates and phosphates that exceed environmental thresholds. Similarly, global estimates suggest that about 24% of freshwater species are at risk of extinction due to pollution, habitat loss, and climate change. These findings underscore the need for localized studies to inform conservation efforts. This study aims to address the knowledge gap by conducting a rapid assessment of the Aroroy River's ecosystem. The research aims to provide a baseline for environmental planning, conservation initiatives, and sustainable resource management by profiling biodiversity, analyzing water quality, and evaluating ecosystem services. The findings will also help raise awareness among stakeholders and inform local policy interventions aimed at protecting and rehabilitating the river system.

From an educational standpoint, this study holds significant value as a model for experiential learning in environmental science and sustainability. By engaging in hands-on field assessments of the Aroroy River, students and educators can bridge theoretical knowledge with practical applications, fostering critical thinking, data analysis skills, and ecological literacy. Such localized research empowers learners to understand the interconnectedness of human activities and natural systems, aligning with global educational frameworks like UNESCO's Education for Sustainable Development (ESD). Moreover, it provides accessible tools—such as biodiversity inventories and water quality testing—for classroom integration, inspiring future generations to advocate for conservation and address environmental challenges in their communities.

Objectives - The primary objective of this study is to evaluate the ecological condition and services of the Aroroy River, informing sustainable conservation strategies. Specifically aims to a) to identify the flora and fauna in the riverine ecosystem; b) to analyze the river's water quality based on physicochemical parameters; and c) to determine the ecological services provided by the river.

2. Methodology

The study employed a rapid ecological assessment protocol conducted from April to June 2025 across three stratified sampling stations (upstream, midstream, and downstream) along a 150-m segment of Aroroy River in Brgy. Matalang-Talang, Aroroy, Masbate (central coordinates: 12°30’58.08”N, 123°21’04.21”E; elevation 24 m asl). Stations were deliberately positioned at approximately 50-m intervals to capture longitudinal gradients in physical habitat, water quality, and biological communities. Prior to fieldwork, coordination with the barangay local government unit was undertaken, and a local guide accompanied the research team for navigational accuracy and safety. Geospatial data for each station were recorded using a handheld GPS unit, while river width, depth, and substrate type were measured along established belt transects. Water velocity was estimated using the float method (ping-pong ball timed over a known distance), and canopy cover was qualitatively assessed. Physicochemical parameters-temperature, pH, dissolved oxygen (DO), and total dissolved solids (TDS)-were measured in situ with a calibrated portable multiparameter probe (Horiba U-50 series or equivalent). All measurements were taken between 08:00 and 11:00 h to minimize diurnal variation.

Benthic macroinvertebrates were collected using a standardized kick-net protocol (0.5-mm mesh, 3-minute composite sample per station) across major microhabitats (riffles, pools, and vegetated margins). Samples were preserved in 70% ethanol and later identified to family or genus level under a stereomicroscope using regional keys. Fish were surveyed through direct observation and limited hand-netting within the same-day visual encounter surveys; only positively identified individuals were recorded to avoid overestimation. Riparian vegetation was inventoried within 10-m-wide belts extending 50 m along each bank using the point-centered quarter method supplemented by opportunistic recording of all woody and dominant herbaceous species. Community perceptions of ecosystem services and anthropogenic pressures were gathered through semi-structured interviews with 23 households purposively selected near the river, with responses coded thematically. Biodiversity metrics were calculated as follows: species richness (S), Shannon-Wiener diversity index (H'), Pielou's evenness (J'), and Simpson's dominance index (1-D). Relative abundance of each taxon was expressed as a percentage of total individuals collected per station. Water quality data were evaluated against DENR Administrative Order 2016-08 criteria for Class C freshwater bodies. All statistical descriptions (mean, range, standard deviation) were computed using R version 4.3.2. The combination of quantitative field-based measurements, biological sampling, and community consultation provided a robust, replicable framework suitable for both scientific monitoring and integration into secondary- and tertiary-level environmental education programs.

Data analysis - Data analysis combined descriptive, comparative, and community-ecology approaches to provide a comprehensive yet accessible interpretation suitable for both scientific and educational purposes. Biological data were first organized by station and taxonomic group. Species richness (S) was calculated as the total number of unique taxa recorded per station. Relative abundance of each taxon was computed as:

Relative abundance (%) = $(a_i / N) \times 100\%$,

where a_i is the number of individuals of species i and a is the total number of individuals collected at that station. To assess community structure, the Shannon-Wiener diversity index (H') was calculated using the formula (Shannon & Weaver, 1949)

$H' = -\Sigma(pi \times \ln pi)$,

where $pi = a_i/N$, followed by Pielou's evenness index ($J' = H' / \ln S$) and Simpson's index of dominance ($1-D$) to evaluate the degree of dominance by any single taxon. All indices were computed in R version 4.3.2 using the vegan package (Oksanen et al., 2022). Abundance data were $\log_{10}(x+1)$-transformed prior to analysis to normalize skewed distributions typical of aquatic macroinvertebrate counts.

Physicochemical data (temperature, pH, dissolved oxygen, and total dissolved solids) were summarized as means ± standard deviation across the three stations. One-way analysis of variance (ANOVA) followed by Tukey's post-hoc test was applied to detect significant spatial differences ($\alpha = 0.05$). Results were benchmarked against the Philippine Department of Environment and Natural Resources (DENR) Administrative Order 2016-08 water quality criteria for Class C freshwater bodies (suitable for fishery and recreational use). A simplified Water Quality Index (WQI) adapted from Brown et al. (1970) and Cude (2001) was also calculated for illustrative and educational purposes using the four measured parameters, assigning equal weights and presenting the final score on a 0–100 scale.

Qualitative data from the 23 semi-structured interviews were transcribed, coded thematically (using NVivo

14), and grouped into major ecosystem-service categories (provisioning, regulating, cultural/recreational) and perceived threats. Frequency of mention for each category was quantified to identify dominant community perceptions. Non-metric multidimensional scaling (NMDS) based on Bray–Curtis dissimilarity was performed on the macroinvertebrate community matrix to visually explore spatial patterns among stations, with environmental vectors (DO, pH, temperature, TDS) fitted post-hoc using the envfit function (999 permutations). All graphical outputs and statistical tables were generated in R with ggplot2 for clarity and reproducibility.

This multi-method analytical framework, combining standard ecological indices, basic inferential statistics, simplified water-quality indexing, and ordination was deliberately chosen to be statistically robust yet sufficiently straightforward for replication by senior high school and undergraduate students, making the entire workflow ideal for integration into environmental science and research curricula.

3. Results and discussion

Study Site - The study was conducted in Barangay Matalang-Talang, Aroroy, Masbate. Aroroy River is located at an elevation of 24 meters above sea level, with coordinates of 12° 30'58.08 "N; 123° 21'04.21 "E. Three sampling stations—upstream, midstream, and downstream—were strategically established at 50-meter intervals to assess spatial variation in physical and biological parameters. The spatial setup of sampling sites, shown in the Google Earth map (Figure 1), provides a clear overview of the river segment assessed and supports a gradient analysis of ecological conditions along the river's flow. The sampling area was located at the upper part of the Brgy. Malangtalang can be reached in one and a half hours by walking from their barangay hall, which houses the researchers and serves as the location for other research activities.

Figure 1. Grid Map of Aroroy River

The first sampling station (Figure 2) was located in the upper part of the river, 4.8 km away from the mainland of Barangay Matalanglang, Aroroy, Masbate, with coordinates 51 P 536675 1384001. The river has an altitude of 97 m, with an average depth of 2.4 m and an average elevation of 665.84 ft above sea level. In this area, large rocks and strong water currents are present, while several large trees provide coverage and shade. In terms of substrate and water quality, the upstream station features a rocky substrate and cold, clear water, making it an ideal location for both agricultural purposes and recreational activities. Human activity is partially evident in this area.

The second sampling station, located at the midstream (Figure 3), was situated at coordinates 51°36'23.2"N, 138°'40'26.0"E, with an altitude of 95 meters. With calm features and a spring-fed pool with an average depth of 3.5 meters, this sampling station is best described as the pool zone of the study area, characterized by a discharge rate of 15–45 meters per minute. The water appears pale green, likely due to the presence of dissolved minerals, such as calcium carbonate, from the underlying limestone substrate. The site is surrounded by dense riparian vegetation, with exposed roots stabilizing the banks and an overhanging canopy providing shade. A small cascade flows into the pool from upstream, while a makeshift stone barrier along the bank suggests minimal human modification. This conforms with the description of River Styles 2025, which states that the pool zone spans the channel, hosts a tranquil or standing flow at low flow stages, and acts as a sediment storage zone. They form at characteristic locations, typically along the concave bank of bends in sinuous alluvial channels.

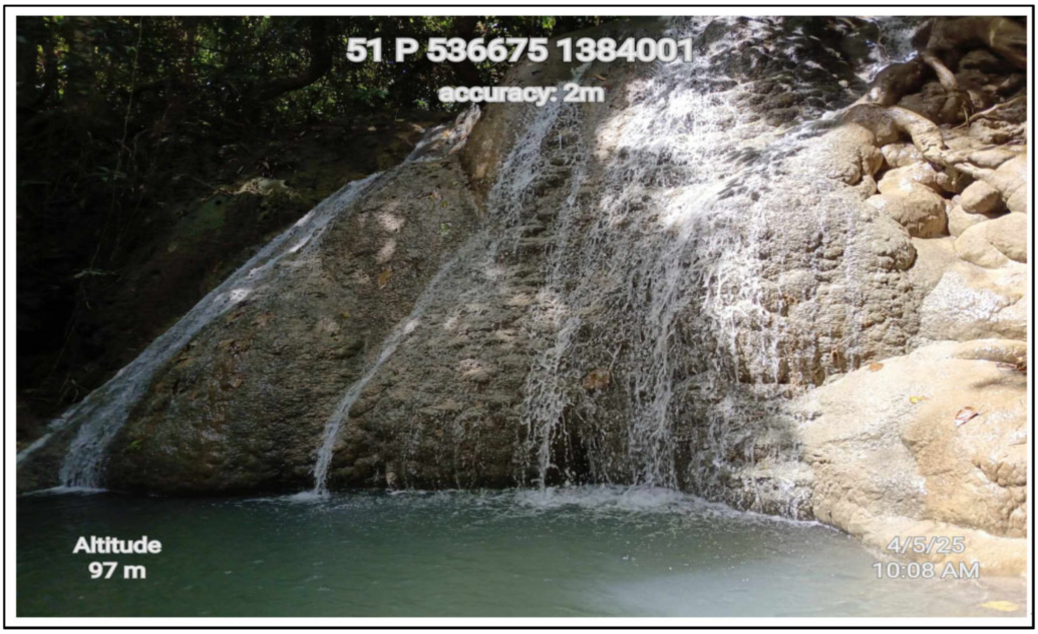

Figure 2. First Sampling Station (Upstream)

Figure 3. Second Sampling Station (Midstream)

The downstream station (Figure 4) has an altitude of 92 meters with coordinates 51P 536725 1384063. This station is characterized by moderately flowing water with a slightly turbid appearance, likely due to the accumulation of sediments and organic matter, such as fallen leaves and twigs. The surrounding area is shaded by overhanging vegetation, which contributes to organic input and influences water quality. Exposed roots and natural rock formations along the bank suggest minimal disturbance, maintaining the area's semi-natural condition.

Figure 4. Third Sampling Station (Downstream)

3.1 Biodiversity of Flora and Fauna

Macroinvertebrates Composition - Table 1 shows the presence of macroinvertebrates across the three sampling stations (upstream, midstream, and downstream). Gastropods (snails), Insecta (mayflies, caddisflies, and beetles), and Crustacea (crabs and shrimps) were observed in all stations, while Bivalves were present only upstream. Annelids (worms) were found only downstream. The consistent presence of sensitive taxa such as mayflies and caddisflies, particularly in upstream and midstream areas, indicates good water quality. These taxa are recognized bioindicators, reflecting adequate oxygenation, clean substrate, and minimal organic pollution. According to Lallébila et al. (2021), macroinvertebrate metrics provide reliable assessments of river health; their presence confirms that the Aroroy River supports a relatively undisturbed aquatic ecosystem.

Table 1
Composition of macro-invertebrates observed in Aroroy River

Macro-invertebrates	UPS	MDS	DNS
Gastropoda (snails)	/	/	/
Bivalves (clam)	/		
Insecta (mayfly, caddisflies, beetles, etc.)	/	/	/
Crustacea (freshwater crab and shrimp)	/	/	
Annelida (worms)		/	

Fish Diversity - Only two fish species, Sillago sp. and Mugil cephalus, were observed at the upstream station (Table 2). This limited distribution may result from the unique features of the upstream site, including shaded areas, cooler temperatures, rocky substrate, and strong currents, which provide suitable microhabitats for juvenile fish. This observation aligns with the River Health Program (n.d.), which cites these species as indicators of healthy ecosystems due to their sensitivity to environmental changes and reliance on clean, well-oxygenated water.

Table 2
Fish Diversity in Aroroy River

Freshwater Fishes	UPS	MDS	DNS
Sillago sp.	/		
mugil cephalus	/		

Riparian Flora Composition - The riparian vegetation survey along the Aroroy River identified distinct patterns in species richness and distribution across three sampling stations (Table 3). The upstream station had the most remarkable plant diversity, with eight species recorded, including *Tabernaemontana pandacaqui*, *Syzygium malaccense*, and *Leucaena leucocephala*. This diversity suggests a relatively undisturbed habitat with favorable ecological conditions, including an intact canopy, stable soil, and minimal human disturbance. According to Tabac et al. (2015), upstream river sections within or near forested areas typically support higher plant diversity due to lower pollution levels and stronger ecological connections to surrounding vegetation. This aligns with the conditions observed in the upstream zone of the Aroroy River. The midstream station recorded six species, including some overlap with upstream species like *Ficus benjamina* and *Macaranga grandifolia*, indicating ecological continuity. However, these changes also suggest potential shifts in microhabitat conditions, such as increased sunlight, edge effects, or human land-use pressures (Sweeney & Newbold, 2014). The downstream station showed the lowest species richness, with only five species observed, including *Jatropha curcas*, *Pandanus simplex*, and *Meiogyne virgata*. The lower diversity could be due to increased disturbance from surface runoff, sedimentation, and potential pollution sources, which may alter soil conditions and affect plant survival. The presence of *Meiogyne virgata* only at the downstream station might indicate remnants of vegetation or a specific microhabitat condition. This finding aligns with the observations by Mallari et al. (2001), who noted that particular plant species in riparian systems tend to survive as relics due to unique hydrological and soil factors.

Table 3
Riparian Flora Composition across Sampling Stations

Riparian Flora	UPS	MDS	DNS
Tabernaemontana pandacaqui	/		
Ficus pseudopalma		/	
Syzygium malaccense	/		
Ficus benjamina	/		/
Artocarpus blancoi	/		
Leucaena leucocephala	/		
Pithecellobium dulce	/		
Endocomia macrocoma	/	/	
Macaranga grandifolia		/	/
Hevea brasiliensis		/	
Jatropha curcas			/
Pandanus simplex			/
Meiogyne virgata			/

3.2 Water Quality Analysis

The water quality of the Aroroy River was assessed at three main sampling points—upstream, midstream, and downstream—focusing on four key physicochemical parameters: temperature, dissolved oxygen (DO), pH, and total dissolved solids (TDS). The findings presented in Table 4 regarding the river's ecological condition reveal possible human influences along its course and highlight potential effects on both aquatic ecosystems and human utilization.

Temperature - The river water temperature ranged from 27.5°C to 28.938°C, with the highest recorded upstream (28.938°C), a dip midstream (27.5°C), and a slight increase downstream (28.75°C). The elevated upstream temperature could be due to direct solar exposure or surface runoff (Daniels & Danner, 2020). The midstream cooling is probably influenced by a spring-fed pool, where cooler groundwater enters the river and acts as a thermal buffer (Poole & Berman, 2001; Caissie, 2006). By allowing the water to absorb more heat, slower flow and increased solar exposure may cause downstream warming (Turner & Erskine, 2005). These variations reflect natural spatial differences in river temperature, which are influenced by local hydrology and landscape features.

Dissolved Oxygen (DO) - DO concentrations remained high throughout the river, with upstream at 14.7 mg/L, midstream at 14.63 mg/L, and downstream at 14.45 mg/L. These levels are significantly above the minimum requirement for Class C freshwater bodies (5 mg/L), which supports the survival of fish and other aquatic organisms (DENR Administrative Order 2016-08). Elevated DO levels suggest good aeration and minimal organic pollution. Such high DO values may also reflect the river's turbulent flow or the presence of photosynthetic aquatic plants and algae (Pantaleon et al., 2022).

pH Levels - The pH values across stations showed a decreasing trend: upstream recorded a fundamental value of 9.018, midstream at 7.54, and downstream at 7.45. The upstream value slightly exceeds the typical pH range for freshwater systems (6.5–8.5), which may suggest the influence of alkaline discharge, possibly from nearby mining operations or limestone-rich soils (Navarro et al., 2022). A pH above nine can affect the solubility and toxicity of heavy metals and nutrients, potentially harming aquatic life. The stabilization of pH values midstream and downstream indicates possible dilution or buffering capacity of the river ecosystem as it integrates more tributary flows.

Total Dissolved Oxygen (TDS) - Total Dissolved Solids (TDS) showed a declining pattern from upstream (177 mg/L) to midstream (155 mg/L) and downstream (150.25 mg/L). These values are well within the World Health Organization's (2022) permissible limit for drinking water (500 mg/L) and are also suitable for sustaining aquatic life. The observed decline may be attributed to natural dilution processes, such as tributary inflows or groundwater inputs with lower mineral content. According to Chapman (1996), TDS concentrations typically decrease downstream in unpolluted river systems due to dilution and sedimentation. Similarly, Dallas and Day (2004) emphasized that TDS levels below 500 mg/L generally do not pose a threat to freshwater biodiversity. These results indicate that water quality conditions are typically good across the sampling stations.

Table 4
Water quality parameters at different sampling stations

Station	Temperature	Dissolved oxygen	pH level	Total dissolved solids (TDS)
Upstream	28.94	14.70	9.02	177
Midstream	27.50	14.63	7.54	155
Downstream	28.75	14.45	7.45	150.25

3.3 Socio-ecological services of Aroroy River

Most respondents identified as fisherfolk; however, only four of the 23 surveyed reported actively fishing in the Aroroy River. Field observations revealed that the river is no longer a primary source of provisioning services, such as fishing or household water, for the majority of residents. Water pipes observed in the forest indicate that water is diverted from upstream sources, but only a few households directly rely on the river for domestic use. Instead, the river is primarily used for recreational purposes, including swimming, picnicking, and social gatherings. During field visits, researchers observed groups engaging in leisure activities along the riverbanks, often leaving behind food wrappers, bottles, and other waste materials. Vandalism was also noted, with carvings on rocks and graffiti on surrounding surfaces. This misuse of riparian space highlights inadequate enforcement of solid waste regulations and a lack of ecological awareness among visitors (see Figure 5). This pattern of recreational overuse without proper management reflects similar findings by Guillen (2008), who emphasized the importance of local awareness and regulation in managing ecotourism and recreational areas. Moreover, Bradecina and Siares (2022) highlighted how a lack of community engagement in river management leads to the degradation of ecosystem services, despite the high biodiversity potential of these areas.

The ecological assessment of the Aroroy River reveals a predominantly healthy freshwater ecosystem. The presence of diverse macroinvertebrates—especially pollution-sensitive groups, such as insect larvae and crustaceans—indicates good water quality and minimal disturbance, aligning with studies that utilize macroinvertebrate communities as reliable bioindicators of river health (Lallébila et al., 2021). Similarly, the limited but ecologically important presence of fish species (*Sillago sp.* and *Mugil cephalus*) at the upstream station reflects suitable habitat conditions such as clean, oxygen-rich, and shaded waters, consistent with observations from the River Health Program. Riparian plant surveys further highlight the ecological differences across stations.

The upstream site shows the highest plant diversity, indicating less disturbance and healthier vegetation, while the downstream area exhibits signs of environmental stress with fewer species, likely due to human activity, runoff, and sedimentation (Tabac et al., 2015; Allan, 2004). Water quality measurements support this, with all parameters within or above standards for Class C freshwater (DAO 2016-08). High dissolved oxygen levels, an acceptable pH, and moderate TDS levels, along with moderate temperatures, suggest that the river remains in good ecological condition. However, despite the overall healthy environment, assessments reveal a low reliance of the local community on the river for services such as fishing and water supply. Most interactions with the river were recreational, which, unfortunately, led to littering, vandalism, and potential long-term environmental impacts. This highlights a gap between ecological value and community stewardship.

Figure 5. Anthropogenic Activities in Aroroy River

4. Conclusions

The rapid ecological assessment of Aroroy River in Brgy. Matalang-Talang, Aroroy, Masbate confirms that the river remains in relatively good ecological condition, with high dissolved oxygen, diverse macroinvertebrate assemblages dominated by pollution-sensitive taxa, and intact riparian vegetation—particularly in the upstream and midstream sections. Although water quality parameters generally comply with DENR Class C standards, subtle signs of stress (declining riparian plant diversity downstream, recreational littering, and vandalism) indicate emerging anthropogenic pressures. From an educational viewpoint, this study exemplifies how a local river can be transformed into a powerful “living laboratory” that integrates biology, chemistry, physics, mathematics, and social studies into authentic, place-based learning experiences. The methodologies employed—biodiversity transect surveys, physicochemical monitoring using low-cost tools, and community perception interviews—are simple, replicable, and highly suitable for senior high school and undergraduate STEM curricula. By documenting both the ecological health and the knowledge–action gap in the community, this work highlights the urgent need to couple scientific monitoring with environmental education if long-term river conservation is to succeed.

Recommendations - To sustain the ecological integrity of Aroroy River and maximize its potential as an educational resource, several actions are strongly recommended. In the short term, the barangay, in partnership with local schools, should initiate a quarterly student- and community-led river monitoring program using the low-cost, replicable methods demonstrated in this study (transect surveys, macroinvertebrate sampling, and basic physicochemical testing). This program should be accompanied by the installation of educational signages along popular recreational areas that highlight key biodiversity findings and promote responsible behavior. The Aroroy River case study, including its protocols and results, should be formally integrated into the K-12 and senior high school curricula of Matalang-Talang and nearby schools—particularly in Earth and Life Science, General Biology, and Research subjects—as a year-long, place-based investigative project. Annual “River Day” events combining clean-up drives, native tree planting, and science exhibits co-organized by the barangay council, youth groups, and schools would further strengthen community ownership and environmental awareness.

Over the medium to long term, monitoring should be expanded into a full longitudinal and seasonal study covering the entire river continuum, with additional parameters such as heavy metals and microbial indicators to detect subtle or emerging pollution. An open-access “Aroroy River Field Guide and Monitoring Toolkit” in Filipino and English, complete with ready-to-use lesson plans, data sheets, and instructional videos, should be developed and disseminated to teachers nationwide. Collaboration with DepEd Region V and local higher education institutions is encouraged to train science teachers and values-education teachers in field-based river assessment, eventually establishing a network of “River Guardian Schools” across Masbate and the Bicol Region. Finally, a simple citizen-science mobile platform or web portal should be created so that students and residents can continuously contribute observations and water-quality data, while longitudinal research should evaluate how repeated participation in river monitoring influences learners’ scientific competencies, environmental attitudes, and pro-conservation behaviors. Through these combined conservation and educational strategies, Aroroy River can evolve from a threatened local resource into a sustained living classroom that nurtures environmentally literate and responsible citizens for generations to come.

Implications for Teaching and Education - This assessment of the Aroroy River ecosystem offers educators a practical framework for incorporating field-based inquiries into curricula, enhancing teaching methodologies in environmental science and biology. Teachers can adapt the study's methodologies—such as biodiversity surveys and physicochemical analyses—as interactive modules to demonstrate real-time ecological monitoring, promoting inquiry-based learning and interdisciplinary approaches that combine STEM with social sciences. By using the river as a case study, educators can facilitate discussions on human-environment interactions, encouraging the development of lesson plans that emphasize data interpretation, ethical considerations in resource management, and collaborative problem-solving. This not only enriches educational content but also equips teachers with evidence-based tools to advocate for policy changes in local schools, fostering a culture of environmental responsibility within educational institutions.

Implications for Learners - For learners, the findings from this river assessment serve as a catalyst for personal growth in environmental awareness and civic engagement, transforming abstract concepts into tangible experiences. Students exposed to such studies can develop skills in scientific observation, hypothesis testing, and ethical decision-making, while gaining insights into the fragility of ecosystems like the Aroroy River. This hands-on approach motivates learners to reflect on their own behaviors—such as waste management during recreational activities—and inspires them to participate in community initiatives like clean-up drives or tree-planting efforts. Ultimately, it cultivates lifelong learners who are empowered to contribute to sustainable development, bridging generational gaps in environmental stewardship and preparing them to tackle broader global issues like climate change and biodiversity loss.

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