

Exploration of biodiversity, the ecological role and educational potential of the Brantas River Riparian Ecosystem, East Java

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Abstract. The Brantas River is the largest river in East Java that flows from upstream Batu and Malang and passes some cities to downstream Surabaya and Sidoarjo. It plays a vital role as a natural resource that sustains the needs of those around it. Rivers play an important role on the river's edge, serving as a transitional area between aquatic and terrestrial. It boasts a unique and specific ecosystem called the riparian zone. At this preliminary study, it aims to explore the biodiversity of the vegetation in the river's border zone and identify previous studies on the Brantas River. The study employs a mixed (quantitative and qualitative) approach. Exploration, inventory of vegetation, field observations, and environmental analysis had been carried out the previous year. Meanwhile, studies of river ecology function and environmental literacy concepts have been conducted over the past three months. This research is based on research from scientific (digital library) articles at some unfortunate universities. Research into the riparian Brantas ecosystem indicates that the river's bank plays a key role as a mainstay of ecological balance and biodiversity. The exploration of the riparian vegetation shows significant potential in support of the stability of environmental quality. Riparian vegetation also serves as a natural medium that reduces pollution levels. Besides ecological improvement functions, riparian ecosystems also have strategic value as eco-education media and literacy for communities, schools, and communities. Thus, the

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riverside/riparian ecosystem not only serves as an ecological fortress for the brantas river but also as a learning platform to strengthen awareness of the conservation and sustainability of biodiversity.

1 Introduction

The brantas river flows from the headlands, rocks and the poor, to the lower regions, Surabaya and Sidoarjo. The brantas river is the largest river in east Java, which lies in 110 courses 30' bt to 112 measures 55' bt and 7 delinqu01 'ls to 8 centimeters 15' ls. The brantas river has a 500-mile (320 km) length and has an area of rp14.103 km² river, which comprises 25% of the province of east Java or 9% of the area of Java [1]. The brantas river plays a vital natural resource that supports the needs of communities around it. The brantas river is a major source of raw water needs for domestic consumption, irrigation, health, industry, recreation, power plants, and so on [2]. Rivers also benefit from freshwater ecosystems that support biota.

Rivers play a crucial role in the channel, as they serve as a transition between water and land. These areas are unique and specific ecosystems called the riparian zone. The riparian zone is also a vegetation that is located between land and water ecosystems. The presence of riparian vegetation may help reduce the transfer of soil particles to the body of water as a result of rushing water. Erosion from both pressure of the flow of water and heavy rainfall on the riparian zone can be reduced by the riparian vegetative system. The riparian vegetation's function in maintaining the quality of river water and the existence of riparian ecosystems makes the riparian ecosystem a great potential for environmental enrichment [3].

The potential for river water is disrupted daily by various organic and organic pollutants that cause a decline in water/disorder can be biologically reduced through the fittings of the riparian vegetation [4]. It can be attributed to the quality of river water, especially the level of pollution, as the riparian vegetation is in direct contact with the body of the river's water. Reduced riparian vegetation around the body of the river can cause waste and heavy metals to enter the river easily [5]. The quality of water becomes the primary component of plant life that functions in the abiotic company, while plants as a biotic component will affect other abiotic bodies such as soil and air. Plants are able to keep the soil in good condition and contribute to oxygen in the air to form an ecosystem balance. Ecosystem balance has a significant effect on the harmony and well- being of humans and other living creatures, both animals and plants [6]. The riparian vegetation equilibrium in human conversion and land use could cause a change in the provision of these ecosystem services.

Human interest in the conversion of land in the riparian zone is another phenomenon, such as monocultures agriculture, ranches or tourist attractions can influence both the water and ecological processes in the riparian zone [7]. The opening of the riparian zone also frequently reduces the width and density of trees in the riparian zone. These changes can result in changes in the quality of river water. Ignorance of the importance of the riparian zones along the river would significantly impact the quality of river ecosystem services. One such river is the brantas river. Because of this, this preliminary study aims to explore the biodiversity of the vegetation in the riparian zone, to analyze the ecological function of the riparian ecosystem toward the quality of the water environment, and to identify the potential of the riparian ecosystem as an environmental education and literacy tool for people around the brantas river. The results of this study are expected to provide strategic recommendations for riparian management, particularly on the brantas rich-based river with biodiversity conservation and environmental education.

2 Research methods

2.1 Kind of research

The study is included in the category of descriptive exploration research with mixed quantitative approaches. This approach is selected to gain comprehensive understanding. Quantitative methods are used to measure numerical data such as water parameters and biodiversity of vegetation, while qualitative methods are used to explore educational potential through literature studies and stakeholder interactions.

2.2 Research site

The study is carried out at several strategic points in the brantas river region, which includes upstream, central, and downstream. Map of the river area and point of location of the ward quality sampling can be seen in figure 1. Selection of this site is important for comparing the environment and biodiversity along the river, which often varies because of the differences in human and geographic activity.

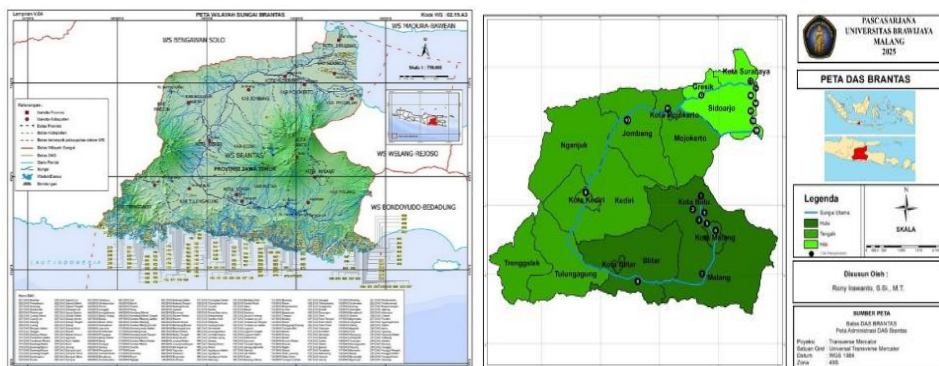


Figure 1. Map of the Brantas River Basin and Environmental Sampling Locations

2.3 Data Collection Techniques

The study is carried Data collection will take place through direct observation in the field and study literature.

Inventory of Biodiversity: The data-collecting technique uses a line to identify the flora and fauna the transek line will be drawn at every point research to record the species and number of vegetation found in the three sections (lower and lower) the riparian brantas river in east Java. Vegetation identification will be done based on previous year's photo of vegetation and literature to provide a theoretical basis and collect primary data at the site.

Environmental Quality: measurements at each research point, covering water parameters: pH, water temperature, and TDS (total dissolved solids), whereas air parameters are: air temperature, humidity and light intensity. All the above parameters are measured using portable devices.

Education Potential: Data on the educational potential will be collected through literature studies stemming from research in scientific articles (digital library) at some universities in malang. The university election is based on the proximity of the location, and it is expected to reveal more about the stone (upstream) source of the brantas river. Recent

literature reports that Malang has a total of 59 state and private higher education institutions [8]. Based on the results of previous research articles relating to the brantas river at four public universities in malang (Brawijaya University, Maulana Malik Ibrahim State Islamic University, Muhammadiyah Malang Univeristy, Malang State Univeristy). Word on the globe is 5754 scientific article records on the digital library [9]. The data are then analyzed, discreening, sorted and grouping to identify the links to biodiversity, education and environmental literacy on the brantas river. The results of the above data analysis are presented in both a chart and a descriptive description of the discussion.

3 Results and discussion

3.1 Ecological buffer and biodiversity center

The riparian ecosystem of the brantas region is an effective ecological buffer that helps to stabilize the quality of the water and to strengthen the resilience of ecosystems along the body of the river, particularly through the riparian vegetation that has the potential for fitoakumulator :

Table 1. Literature Review on Biodiversity and Ecological Functions of the Brantas River Riparian Ecosystem.

Citation	Title	Biodiversity	Function
[10]	Vegetation Analysis in The Arboretum Sumber Bumiaji Batu City.	<i>Cupressus sp.</i> , <i>Diospyros kaki</i> , <i>Cinnamomum verum</i> , dan <i>Eucalyptus alba</i>	Have the role of resistant erosion, be water storage, and maintain ecosystem balance.
[6]	Underwater Vegetation Analysis at The Arboretum Sumber Brantas Bumiaji Batu City.	<i>Oplismenus hirtellus</i> , <i>Ageratina riparia</i> , <i>Centella asiatica</i> , dan <i>Colocasia esculenta</i>	Has a role to prevent erosion, to preserve moisture, and to increase nutrients in the soil.
[11]	Earth Insects Diversity on The Brantas Sumber Arboretum And Potato Ground Ground Ground Potash.	family <i>Isotomidae</i> dan family <i>Entomobrydae</i>	Acting as a useful decoder in the breakdown of organic matter in the soil and as detritivor insects.
[12]	The Potential Hardplant Characteristics as a Resistance To Erosion Across The Brantas River Borkp Based on a Different Environment In East Java.	<i>Gigantochloa apus (Schult. f.) Kurz ex Munro</i> , <i>Calliandra houstoniana (Mill.)</i> , <i>Pinus merkusii Jungh.</i>	Can prevent erosion because they meet the criteria of a strong rooting system and have economic value.
[13]	Quality of The Vegetation Zone of The Riparian by Using The Index of Riparian Quality in Coban Talun, Batu City, East East	<i>Phragmites australis</i> , <i>Shorea leprosula</i> , <i>Pennisetum purpureum</i> . <i>Pennisetum purpureum</i>	Vegetating roots play a key role in maintaining ecotypes and supporting the annual cycle of nutrition

[14]	Butterfly Biodiversity in The Riparian Zone in The Rice Forest District District.	<i>Ypthima horsfieldii</i> dan <i>Mycalesis horsfieldi</i> dari famili <i>Nymphalidae</i> .	Butterflies serve as pollinators that support the natural reproduction of plants in ecosystems
[15]	The Kinds And Functions of Plants in The Traditional Village Landscape of DAS Brantas (Case Study: Village Claket, Mountain Village).	Bambu apus (<i>Gigantachloa apus</i>)	To act as a cliff suppressant, to absorb groundwater, as well as a small animal habitat in the vicinity of riparian.

Based on literature studies, the brantas river riparian ecosystem shows an important role as both an ecological buffer and a center of biodiversity.[10] research found 31 plant species of 28 genus and 17 families with the dominance of different species at each growing stage, such as the *Cupressus sp.*, *Dispyros sp.*, *Cinnamomum verum*, and *Eucalyptus alba* that act to maintain soil stability, water cycles, and microclimes. This data is supported by [16], which highlight the benefits of *Cupressus sp.* for land conservation. [17] also demonstrate the high adaptability of Eucalyptus under varying environmental conditions. A study by [6] found 15 underwater species in the Arboretum Sumber Brantas that act as natural soil cover, thats can emphasize the importance of lower vegetation in preventing erosion. In addition, [11] recorded 16 families of ground insects that function as decomposers, predators, and indicators of ecosystem health, consistent with [18] who highlight the role of surface insects in maintaining soil fertility.

Table 2. Riparian Vegetation Structure and Composition in Selected Brantas River Sites.

No.	Sampling Location	Tree	Herb/Cover
1	Arboretum	<i>Agathis dammara</i> <i>Brugmansia suaveolens</i> <i>Brugmansia x candida</i> <i>Calliandra houstoniana</i> <i>Dalbergia latifolia</i> <i>Ficus benjamina</i> <i>Michelia champaca</i> <i>Pinanga coronata</i> <i>Ricinus communis</i> <i>Syzygium acuminatissimum</i> <i>Tithonia rotundifolia</i>	<i>Ageratina riparia</i> <i>Ageratum conyzoides</i> <i>Alternanthera sessilis</i> <i>Bryonia laciniosa</i> <i>Centrosema pubescens</i> <i>Cyperus kyllingia</i> <i>Emilia sonchifolia</i> <i>Equisetum ramosissimum</i> <i>Euphorbia pulcherrima</i> <i>Hydrangea macrophylla</i> <i>Leersia hexandra</i> <i>Polygonum chinense</i> <i>Taraxacum officinale</i>

2	Coban Talun Waterfall	<i>Araucaria heterophylla</i> <i>Brugmansia suaveolens</i> <i>Cyathea contaminans</i> <i>Dendrocalamus asper</i> <i>Engelhardia spicata</i> <i>Eucalyptus alba</i> <i>Ficus padana</i> <i>Microcos tomentosa</i> <i>Pinus merkusii</i> <i>Saurauia reinwardtiana</i> <i>Senna surrattensis</i> <i>Tithonia rotundifolia</i>	<i>Ageratina riparia</i> <i>Alternanthera sessilis</i> <i>Centella asiatica</i> <i>Drymaria cordata</i> <i>Murdannia nudiflora</i> <i>Plantago major</i> <i>Trema orientalis</i>
3	Pendem Bridge	<i>Albizia procera</i> <i>Artocarpus heterophyllus</i> <i>Cassia fistula</i> <i>Cocos nucifera</i> <i>Dendrocalamus asper</i> <i>Ficus benjamina</i> <i>Hibiscus similis</i> <i>Leucaena leucocephala</i> <i>Musa acuminata</i> <i>Syzygium littorale</i>	<i>Ageratina riparia</i> <i>Alocasia macrorrhizos</i> <i>Centella asiatica</i> <i>Cyperus rotundus</i> <i>Pennisetum purpureum</i>
4	Sengkaling Bridge	<i>Anthocephalus cadamba</i> <i>Arenga pinnata</i> <i>Lagerstroemia speciosa</i> <i>Muntingia calabura</i> <i>Pinus merkusii</i> <i>Samanea saman</i> <i>Swietenia macrophylla</i>	<i>Nephrolepis biserrata</i> <i>Pandanus amaryllifolius</i> <i>Spathiphyllum wallisii</i>
5	UMM Bridge	<i>Acacia tomentosa</i> <i>Dendrocalamus asper</i> <i>Dysoxylum densiflorum</i> <i>Ficus benjamina</i> <i>Flacourtia rukam</i> <i>Jatropha curcas</i> <i>Muntingia calabura</i> <i>Musa acuminata</i> <i>Saccharum officinarum</i> <i>Tectona grandis</i>	<i>Alocasia macrorrhizos</i> <i>Coix lacryna-jobi</i> <i>Dieffenbachia seguine</i> <i>Ludwigia octovalvis</i>

Further studies show a wider variety, such as [12] of the 49 species of hare-vegetation at the brantas border, with a *Gigantochloa apus's* dominance, *Calliandra houstoniana*, And *Pinewood pine* effective against erosion, in line with the data [19], emphasizing the role of bamboo groups in infiltrating water and flood prevention. [13] recorded 88 species at the top of brantas, by the dominance of the *Phragmites australis*, *Shorea whales whales*, and *Pennisetum Purwhales* that support the stability of the ecosystem. [14] found 739 individual butterflies of 32 species, particularly the *nymphalidae* family, which act as important pollinators as defined by [20]. In harmony with that, research presenter by [15] also highlighting the benefits of the bamboo apus (*Gigantochlolous apus*) at das brantas holding a cliff, absorbing water, and small animal habitats, shows that the riparian brantas vegetation is both ecologically, economically, and landscaping.

Based on the data presented in the table, the vegetation composition across the sampling sites exhibits considerable diversity. At Site 1 (Arboretum), approximately 11 tree species including *Agathis dammara*, *Brugmansia suaveolens*, and *Ficus benjamina* were recorded, along with 13 herbaceous or ground-cover species such as *Ageratina riparia*, *Ageratum conyzoides*, and *Taraxacum officinale*. Site 2 (Coban Talun Waterfall) comprised around 11 tree species, including *Araucaria heterophylla* and *Eucalyptus alba*, and 7 herbaceous species such as *Centella asiatica* and *Plantago major*. At Site 3 (Pendem Bridge), 10 tree species such as *Albizia procera* and *Musa acuminata* and 5 herbaceous species, including *Ageratina riparia* and *Pennisetum purpureum*, were identified. Site 4 (Sengkaling Bridge) supported 7 tree

species, including *Anthocephalus cadamba* and *Swietenia macrophylla*, together with 3 herbaceous species, namely *Nephrolepis biserrata*, *Pandanus amaryllifolius*, and *Spathiphyllum wallisii*. Finally, Site 5 (UMM Bridge) contained 10 tree species such as *Acacia tomentosa* and *Tectona grandis* and 4 herbaceous species, including *Alocasia macrorrhizos* and *Ludwigia octovalvis*. Overall, these findings indicate that each sampling location possesses distinct vegetation structures, reflecting site-specific environmental conditions and varying levels of vegetation density.

The plants and animals of the riparian brantas region indicate a functional, mutually reinforcement relationship. Plants provide a place of living, food source, and a compatible microclimate of soil insects that contribute to the nutrient cycle and keep the ecosystem dynamic balanced. Thus, the riparian brantas region doubles as a key exponent of ecological function as well as a center of biodiversity to safeguard its return.

3.2 Environmental Pollutant

Natural phylacement is one of the most effective strategies for reducing environmental pollutants, especially in water and river - flow ecosystems. Studies have shown that both acupuncture and riparian plants have the ability to absorb, accumulate, and even degrades of the organic and inorganic pollutants seen in table 3.

Table 3. Literature Review Results of Environmental Pollution Remediators.

Citation	Title	Species	Pollutant Category
[21]	The role of the riparian vegetation in lowering the nutrient load in the brantas basin.	<i>Limnocharis flava</i> , <i>Ipomoea aquatica</i> , <i>Fimbristylis globulosa</i> , <i>Vetiveria zizanooides</i> , <i>Equisetum ramosissium</i> , <i>Typha angustifolia</i> , <i>Sesbania grandiflora</i> , <i>Scirpus grossus</i>	TDS, Tom, orthophosphate, ammonium, nitrate, phosphate, organic material, DO improvements.
[22]	Riparian vegetation functions as a buffer of ecosystems in sub das konto, brantas.	<i>Dendrocnide meyeniana</i> , <i>Ageratina riparia</i> , <i>Oplismenus hirtellus</i> , <i>Cenchrus purpureus</i> , <i>Jasminum auriculatum</i> , <i>Neonauclea truncata</i> , <i>Petasites pyrenacius</i> , <i>Dracaena fragrans</i> , <i>Austroecupatorium inulifolium</i> , <i>Xanthosoma taioba</i>	Nutrient absorption (N, P), decline of ammonia and nitrous, pollutant filtration, soil stabilizer.
[23]	The potential of aquatic plants as a Pb bioindicator at das brantas.	<i>Ipomoea aquatica</i> , <i>Eichhornia crassipes</i> , <i>Lemna minor</i> , <i>Salvinia molesta</i>	Heavy metal Pb (a floating acupuncture plant as a bioindicator and an asset of phytodization).

[24]	Analysis of content of aquatic plants at the brantas Mojokerto river.	<i>Ipomoea aquatica</i> , <i>Eichhornia crassipes</i> , <i>Limnocharis flava</i>	Heavy Cu.
[25]	The accumulated Cd of acupuncture on the brantas river	<i>Ipomoea aquatica</i> , <i>Eichhornia crassipes</i> , <i>Limnocharis flava</i>	Heavy metal Cd (fitoakumulation of aquatic plants, above quality threshold).
[26]	Analysis of das brantas sustainability: aspects of water quality.	Vegetasi riparian dan akuatik secara umum	Increase in bod (>8 mg/ l), the impact of domestic waste.

Based on table 3, riparian vegetation in das brantas plays an important role as a phytoremediator through phytoaccumulation mechanism. In the lower regions, particularly as acacos, malang, acupuncture plants such as *Limnocharis flava*, *Aquatica ipomoean globulosa*, *Vetiveria zizanoides*, *Equisetum ramosissium*, *Typha angustifolia*, *Sesbania grandiflora*, and *Cyperus grossus* has been shown to effectively absorb major pollutants such as nitrates, amphetamines, and orthophosphates, leading to a reduction in Total Dissolved Toxicity (TDT) and an increase in Dissolved Oxygen (DO) [21]. Meanwhile, upstream of the Konto Sub-Watershed (Coban Rondo, Pujon), plants such as *Dendrocnide meyeniana*, *Ageratina riparia*, *Oplismenus hirtellus*, *Cenchrus purpureus*, *Jasminum auriculatum*, *Neonuclea truncata*, *Petasites pyrenacius*, *Dracaena fragrans*, *Austroecupatorium inulifolium*, and *Xanthosoma taioaba* plays a role in nutrient absorption, pollutant filtration, and soil stabilization [22].

In addition to the riparian vegetative function, acupuncture plants in das brantas are also effectively accumulating heavy metals. *Aquatica ipomoea*, *Eichhornia crassipes*, *Lemna minor*, and *Salvinia molesta* were able to absorb Pb by 0.068 mg/kg [23]. Other studies record the accumulation of Cu in *Aquatica ipomoea* (0.315- 0.333 PPM), *Eichhornia crassipes* (0.229-0.258 PPM), and *Limnocharis flava* (0.232-0.253 PPM) while not relating significantly to water levels (Masrurroh & Purnomo, 2024). Meanwhile, CDS accumulated in the species also exceed quality threshold, with the highest value of 0.235 CMS in *Aquatica ipomoean* [25]. Generally, the quality of the brantas river has been a significant decline in a recent decade, with grades down to grade 4 and bod rising from grade 4 to >8 mg/ l since 2017 due to domestic, agricultural, and industrial wastes, thus increasing the importance of the phytoemediator both upstream and downstream [26].

Table 4. Literature Review Results of Environmental Pollution Remediators.

No.	Sampling Location	pH	TD S	Water Temperature	Lux	Tempera ture	Humi dity
1.	Arboretum	7,8	38	23,3	104X 100	22,9	40%
2.	Coban Talun Waterfall	8,1	67	25,0	175X 100	25,9	44%
3.	Pendem Bridge	7,8 5	20 0	33,5	410x 100	33,6	43%
4.	Sengkaling Bridge	8,5	16 1	28,0	215x 100	35,2	35%
5.	UMM Bridge	8,3	18 2	33,2	770x 100	32,3	37%

The library study shows that the quality of the brantas river was closely associated with the composition of the riparian vegetation and the acupuncture plants. Vegetation serves as a buffer of ecosystems that resist pollutants, while aquatic species accumulate organic material and heavy metals (Cd, Cu, Pb). Therefore, das brantas's management will need to stress not only on waste control and water rehabilitation but also on the preservation of phytoremedial vegetation as an integral part of natural pollution control.

Based on the measurement results, the environmental physical parameters across the sampling sites exhibited notable spatial variation. Site 1 (Sumber Arboretum) recorded a pH of 7.8 with low total dissolved solids (38 ppm), an air temperature of 22.9°C, and a relative humidity of 40%, characterizing a cool and moderately humid environment. Site 2 (Coban Talun Waterfall) showed a slightly higher pH (8.1) and TDS (67 ppm), with an air temperature of 25.9°C and relative humidity of 44%, reflecting relatively stable microclimatic conditions. In contrast, Sites 3 (Pendem Bridge) and 4 (Sengkaling Bridge) exhibited elevated air temperatures (33–35°C) accompanied by reduced humidity levels (43–35%), indicating warmer and drier conditions. Site 5 (UMM Bridge) demonstrated the highest light intensity (770×100 lux), with an air temperature of 32.3°C and humidity of 37%, suggesting exposure to strong solar radiation and reduced moisture levels. Overall, these findings indicate a clear ecological gradient from cooler, more humid environments to hotter, drier areas with higher light intensity

3.3 Ward literacy and literacy tools

Brantas creek (DAS) has great potential as an environmental educational and literacy tool, since it is one of the principal rivers in east Java that support social, economic, and ecological activities of society. Studies confirm that rivers serve not only as providers of water and resources but also as an effective learning space for communities on the importance of conservation, pollution control, and sustainable resource management [27]. Environmental education programs at DAS brantas have been shown to increase awareness among communities, especially the rising generation, through participation - based approaches such as river schools, educational ecotourism, and community activities that emphasize the connectivity between humans and river ecosystems [28]. In addition, the environmental literacy developed through the media education around das brantas plays a key role in establishing pro-environment behavior, which is long term expected to support the continued management of das [29]. To summarize the main findings of the research as follows:

Table 5. Literature Studies Of The Educational Tools And Environmental Literacy In Brantas (DAS) Areas

Citation	Title	Learning Media	Main Objective
[30]	Development of Flood Disaster Preparedness E-Book for High School in the Brantas River Basin (DAS Brantas)	Flood Preparedness E-Book for High School in the Brantas River Basin based on ADDIE	To foster disaster preparedness among high school students against floods in the Brantas River

[31]	Development of an E-Module on Environmental Changes Based on Water Quality Research of the Brantas River to Improve Problem-Solving Skills, Environmental Awareness, and Attitudes of High School Students	Water Quality E-Module of the Brantas River based on Problem- Based Learning (PBL)	To improve problem-solving skills, environmental knowledge, and attitudes of high school students
[32]	Development of an Augmented Reality- Assisted E-Module Based on the Study of Herpetofauna Communities in the Brantas River to Improve Digital Literacy and Environmental Attitudes	Augmented Reality (AR)- Assisted E-Module on Herpetofauna Community Structure in the Brantas River	To improve digital literacy and environmental attitudes of university students
[33]	Development of an Electronic Module on Ecosystems and Water Pollution in the Brantas River Based on Problem-Based Learning to Develop Critical Thinking Skills, Environmental Attitudes, and Cognitive Abilities of Students	Problem-Based Learning (PBL)-based E-Module	To develop critical thinking, environmental attitudes, and cognitive abilities of high school students
[34]	Planning for Forest and Critical Land Rehabilitation in the Brantas River Basin Area in Bumiaji District	Integrated Planning (Top- Down & Bottom- Up Planning)	To design rehabilitation plans for forest and critical lands to ensure sustainability of the Brantas River
[35]	Synergy between Government and Community in the Conservation of Brantas Spring Water in Batu City	Partnership Approach & Good Governance	To analyze the forms of synergy between government and community as well as supporting and inhibiting factors in spring water conservation
[36]	Implementation of Environmental Policy in the Conservation of Brantas River Water Resources (A Study at the Environmental Office of Batu City)	Environmental Policy (Batu City Regulation No.16/2011 & Law No.32/2009)	To analyze the implementation of environmental policies in Batu City as well as supporting and inhibiting factors

Based on literature studies on the environment education and literacy tools at das brantas show variety, from local problem-based learning media to policy and conservation studies. In education, [30] emphasizes disaster preparedness through addie's effective e-book model

increases students' understanding of the threat of flooding. The result of the research [31;33] developed an e-module based learning about water pollution, which has proved to improve critical thinking skills, problem solving, and environmental attitudes, although it still needs support outside of class for real-life activities. Augmented reality to enhance our diversity of herpetofauna, strengthen digital literacy, and ecological awareness, confirms macrobiodiversity potential as a natural laboratory [32]

The urgency and importance of synergy between governments and communities in forest rehabilitation and critical land at Brantas resource. Point out that water conservation and environmental policies are only effective where there is collaboration, political support, and public participation [35;36]. Emphasized the role of civil society organization. Overall, literature indicates that local issues such as flood, pollution and biodiversity can become contextual learning media, while also reinforcing synergy of education, policy and community participation in preserving basket-sustainability.

In general, the study of this literature indicates that the ecological and social wealth at Brantas has great potential as an environmental educational and literacy tool. Studies exploit local issues such as flood, pollution and biodiversity as contextual learning media, while also emphasizing the importance of synergy of policy, conservation and civic participation. Thus, Brantas can be viewed as a natural laboratory linking education, policies, and social practices to foster sustainable environmental awareness and action

4 Conclusion

The riparian ecosystem of the Brantas River plays a critical role as a primary buffer zone for maintaining ecological balance and supporting biodiversity. The exploration of riparian vegetation reveals its substantial potential in sustaining environmental stability and improving overall ecosystem quality. Functioning as a natural mediator, riparian vegetation mitigates pollution through phytoremediation processes, acting as a biofilter that absorbs heavy metals, excess nutrients, and organic waste, thereby facilitating the natural recovery of water quality. Beyond its ecological functions, the riparian zone holds strategic importance as an educational platform, fostering environmental awareness and literacy among local communities, schools, and broader society. Consequently, the riparian ecosystem of the Brantas River not only serves as an ecological safeguard but also as a living laboratory that promotes biodiversity conservation and long-term environmental sustainability.

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