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VEGETASI RIPARIAN DAN PERSEPSI LAYANAN JASA EKOSISTEM DI SUNGAI GAJAHWONG BAGIAN ATAS YOGYAKARTA, INDONESIA

RIPARIAN VEGETATION AND PERCEPTION OF ECOSYSTEM SERVICES IN THE UPPER GAJAHWONG RIVER, YOGYAKARTA, INDONESIA

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Abstrak

Abstrak Penelitian mengenai vegetasi riparian dan persepsi jasa ekosistem perlu dilakukan untuk membantu masyarakat agar terlibat dalam pengelolaan kawasan sungai. Sehingga, penelitian ini bertujuan untuk mempelajari komposisi vegetasi riparian di Upper Gajahwong River and 2) persepsi masyarakat terhadap *ecosystem services* yang disediakan oleh biodiversitas riparian. Penelitian mengenai komposisi vegetasi dilakukan dengan survei floristik dengan menggunakan plot yang diletakkan pada transek di tiga lokasi yakni di Hargobinangun, Sardonoharjo, dan Minomartani. Sedangkan penelitian mengenai persepsi masyarakat dilakukan dengan melakukan survey terhadap 60 residents yang terpilih secara acak. Penelitian menemukan lebih dari 70 spesies tumbuhan di masing-masing lokasi, sedangkan indeks keragaman sangat tinggi dengan angka >4. Beberapa famili yang dominan diantaranya adalah Araceae, Fabaceae, dan Moraceae. Ketiganya memiliki fungsi provisioning dan regulating yang penting bagi ekosistem. Terkait dengan persepsi masyarakat, penelitian menemukan bahwa masyarakat memahami fungsi ekosistem dalam bentuk *provisioning services*, *regulating services*, dan *socio-cultural services*. Pengetahuan mereka terhadap *ecosystem services* ini dipengaruhi oleh nilai budaya, khususnya budaya Jawa yang menekankan pentingnya konsevasi alam.

Kata kunci: Ecosystem services; Gajahwong; Perception; Riparian; Vegetation

Abstract

Research on riparian vegetation and community perceptions of ecosystem services is needed to engage communities in river basin management. Therefore, this study aims to investigate the composition of riparian vegetation in the Upper Gajahwong River and the community's perceptions of ecosystem services provided by riparian biodiversity. The research on vegetation composition was conducted through floristic surveys using plots placed along transects at three locations: Hargobinangun, Sardonoharjo, and Minomartani. Meanwhile, the research on community perceptions involved surveys of 60 randomly selected residents. The study found over 70 plant species at each location, with very high diversity indices exceeding 4. Some dominant families include Araceae, Fabaceae, and Moraceae. All of them play important provisioning and regulating functions in the ecosystem. Regarding community perceptions, the research discovered that communities understand ecosystem functions in terms of provisioning services, regulating services, and socio-cultural services. Their knowledge of these ecosystem services is influenced by cultural values, particularly Javanese culture, which emphasizes the importance of nature conservation.

***Keywords**: Ecosystem services; Gajahwong; Perception; Riparian; Vegetation*

INTRODUCTION

Riparian ecosystem comprises the biotic and abiotic assemblages along the river and stream netwok that is influenced by water dynamics (Olokeogun & Kumar, 2020; Urbanič et al., 2022). Riparian systems are threatened by multiple pressures from human and agricultural activities (Lu et al., 2022), climate change (Rogers, Stein, Beck, & Ambrose, 2020), biodiversity threats, and changes in landuse patterns (Soeprobowati et al., 2021; Xu et al., 2023).

Riparian vegetation encompasses a group of plants living of the banks of rivers, creeks, or streams that provide ecosystem services for native biodiversity, abiotic environments, and people inhabited along the water edges. It provides diverse ecosystem services, such as regulating a microclimatic fluctuation, providing water, food, and any kind of benefit to people (Nóbrega et al., 2020; Riis et al., 2020), and expanding economic opportunities through ecotourism (Gkiatas et al., 2021). Riparian vegetation also offers protection from flood events and hydrologic drought associated with fluctuating precipitation (Albano et al., 2020; Gkiatas et al., 2021).

Research on riparian ecosystem in Indonesia has received attention in recent years. Some of the research focus on diversity of riparian vegetation (Lukas et al., 2021; Pramadaningtyas et al., 2023; Saputra et al., 2021), assessment of river health (Setyoasri & Prastica, 2020), asessment of environmental services (Waskita et al., 2022). Moreover, study on riparian ecosystem in Indonesia has not discussed the importance of the ecosystem in providing cultural benefit to people. It is observed from other studies that cultural aspect is pertinent to successful management of the overall ecosystem. Lee at al. (2020), for example, incorporates social value of residents to develop planning and management of riparian zones. In another work, Saklaur (2022) recognized sociocultural dimension of riparian inhabitants to develop a sustainable relatioship between the ecosystem and the people.

Considering the importance of socio-cultural aspects to riparian management, this research aims to study the vegetation along the banks of the Upper Gajahwong River in the Yogyakarta Province, as well as the socio-cultural perceptions of residents in the area. The choice of the watershed is motivated by the lack of studies on riparian ecosystems in small rivers, particularly within the Yogyakarta Province. Most of the published work on riparian vegetation focus on big rivers in Indonesia, such as in Sebangau River, Kalimantan (Lukas et al., 2021) and Brantas River, East Java (Irawanto & Afifudin, 2024). Furthermore, the Gajahwong river serves as a significant water channel in the eastern part of Yogyakarta City, providing invaluable ecosysyem services residing within its watershed (Ahdiaty & Fitriana, 2020). For many decades, the river has been used for diverse domestic and industrial purposes, thereby encountering anthropogenic pressures and pollutants (Risyanto & Widyastuti, 2004).

Understanding the multifaceted-dimensions of biodiversity and the socio-cultural aspects holds significance in formulating strategies for the sustainable management of river ecosystems. Consequently, there arises a need to develop knowledge on biodiversity and the socio-cultural aspects inherent to riparian zones. Thus, the overaching objectives of this study encompass 1) studying biodiversity and composition of riparian vegetation in the Upper Gajahwong River and 2) exploring the communities' perception of general ecosystem services provided by riparian biodiversity.

MATERIALS AND METHODS

The study was conducted in the Upper Gajahwong River, in the Yogyakarta Province, encompassing three villages, Sardonoharjo, Hargobinangun, and Minomartani. The entire Gajahwong River is a part of the Opak Watershed, which is one of three main rivers in the Province of Yogyakarta.

The vegetation survey was performed using a linier transect positioned along both the left and right edge of the river. All vegetations within the transects were identified and counted. Each transect spanned approximately 100 meters in length, with 20 squared 2x2m plots were placed along the transect. All vegetation was identified on-site with the assistance of Google Lens, and books such as, the Flora of Java (Backer, et al., 1963) and Flora (Steenis, 1998). If identification at sampling sites was not feasible, vegetation samples were collected for identification at the Ecology

Laboratory of UIN Sunan Kalijaga, Yogyakarta. Several parameters of floristic surveys were also calculated, including the number of species, the count of individual species, density and frequency. The parameters were calculated using the following formula:

$$\text{Density} = \frac{\text{Total number of species A}}{\text{Total area (m}^2\text{)}}$$

$$\text{Relative Density} = \frac{\text{Density of species A}}{\text{Total density of all recorded species}} \times 100\%$$

$$\text{Frequency} = \frac{\text{Total number of plots inhabited by species A}}{\text{Total plots}}$$

$$\text{Relative Frequency} = \frac{\text{Frequency of all species}}{\text{Total frequency of all species}} \times 100\%$$

Importance value= Relative density+Relative frequency

The Shannon-Wiener Diversity Index (H') is used to calculate the diversity index, as follows:
H'= -Σ Pi ln (Pi), where Pi = (ni/N)
H'= Shannon-Wiener diversity index
ni = number of individuals of species i
N = The number of individuals of all species
The criteria for the diversity index's score are:
H' < 1: low diversity
1< H' ≤3: moderate diversity
H'> 3:high diversity

Regarding the socio-cultural perception on biodiversity of vegetations in riparian zones, the data were collected by conducting interviews with reseidents from 3 villages. Respondents were selected randomly, with each village represented by 20 respondents. In total, we had 60 respondents representing each location. The respondents were asked several questions, encompassing questions about provisioning services of biodiversity, regulating services of riparian zones, and the socio-cultural services of the ecosystem.

One of the topics explored in this simple survey is the public's knowledge regarding regulating services provided by riparian vegetation. Respondents were asked about their knowledge about the role of riparian vegetation in regulating microclimates, preventing floods and landslides, and providing habitat for other organisms. In this regard, respondents were given the option to answer yes or no to these questions. Subsequently, researchers elucidated respondents' answers through open interviews.

In addition, the study explored about the importance of riparian vegetation in contributing to the socio-cultural dimensions of the people. In this instance, the study employed a simple survey, prompting respondents to articulate the role of riparian vegetation in supporting their socio-cultural activities. Subsequently, the findings were summarized in charts and tables.

RESULTS

a. Vegetation surveys

In total, the vegetation surveys recorded 71 species in Hargobinangun, 76 species in Sadonoharjo, and 79 species in Minomartani. The plants were surveyed from riparian zones with varying cliff and water body configurations. The riparian zone in Hargobinangun was characterized by moderately steep cliff with slopes of 20-30%, whereas in Sardonoharjo and Minomartani were featured by mild cliff slopes (Table 1).

Table 1. The environmental conditions and vegetation in the riparian zones of the Upper Gajahwong River

	Hargobinangun	Sardonoharjo	Minomartani

Cliffs and river banks	Steep riverbanks with slopes of 20-30%	Less steep riverbanks, somewhat gentle cliffs	Gentle riverbanks, sloping cliffs, fertile agricultural areas present
Water body	The water body is 5-6 meters wide with a swift current	The water body is 6-7 meters wide, with a fast-flowing stream and dammed in several places due to sand mining sites.	The water body is 5-7 meters wide, with constriction due to embankments.
Substrate	Sand, gravel, and pasir, kerikil, fairly large stones, medium-sized stones"	Sand, gravel, and medium-sized stones	Sand, gravel, mud
The number of species	71	76	79
The number of family	34	30	37
Most diversified family	Araceae	Araceae	Fabaceae dan Araceae
H' index value	4.11	4.22	4.21
H' index intepretation	Intact ecosystem, high diversity	Intact ecosystem, high diversity	Intact ecosystem, high diversity

Riparian plants found in Hargobinangun consisted of 71 species from 34 families. The highest species diversity came from the Araceae Family (8 species), including *Caladium bicolor*, *Colocasia esculenta*, *Alocasia macrorrhizos*, *Diffenbachia seguine*, and *Xanthosoma sagittifolium*. In Sardonoharjo, there were 76 species from 30 families. The most abundant species come from the families Araceae, Poaceae, and Euphorbiaceae. Conversely, the families with the fewest species were ferns from the Selaginellaceae and Marsileaceae families. The segment was dominated by flat riverbanks with relatively low cliffs, providing a suitable habitat for grasses. Meanwhile, in the Minomartani segment, there were 79 species recorded from 37 families. The most abundant species belong to the Fabaceae family. Among the Fabaceae members were shrubs such as *Mimosa pudica* and *Clitorea ternatea*, and *perennial/tree* species including *Albizia chinensis*, *Leucaena leucocephala*, and *Samanea saman*. Table 2 presents an overview of the composition and parameters of the floristic survey, including the number of individuals, abundance, frequency, and importance value index (IV) at three research locations.

Table 2. Species with the highest IV index at the Upper Gajahwong River

Species	Family	Number of individual	Frequency	Abundance (n/m^2)	IV (%)
a. Hargobinangun					
Ficus racemosa	Moraceae	4	17	0.08	3.11
Sellaginella doederleinii	Selaginellaceae	1	15	0.02	2.69
Colocasia argentea	Araceae	9	14	0.18	2.68
Desmodium gigantea	Fabaceae	5	14	0.1	2.60
Gomphrena globosa	Amaranthaceae	13	13	0.26	2.58
Celocasia esculenta	Araceae	3	14	0.06	2.56
Areca catechu	Arecaceae	2	14	0.04	2.54
Ficus benjamina	Moraceae	8	13	0.16	2.48
Manilkara kauki	Sapotaceae	8	13	0.16	2.48
Melia azedarach	Meliaceae	15	12	0.3	2.44
b Sardonoharjo					
Diffenbachia seguine	Araceae	18	19	0.36	4.40
Chromolaena odorata	Asteraceae	15	19	0.3	4.09
Caliandra hematocephala	Fabaceae	12	19	0.24	3.78
Acalypha indica	Euphorbiaceae	14	17	0.28	3.72

Species	Family	Number of individual	Frequency	Abundance (n/m²)	IV (%)
Albizia chinensis	Fabaceae	10	19	0.2	3.57
Jatropa curcas	Euphorbiaceae	10	19	0.2	3.57
Hippobroma longiflora	Apocynaceae	15	15	0.3	3.56
Eriochloa procera	Poaceae	14	15	0.28	3.45
Manihot glaziovii	Euphorbiaceae	7	20	0.14	3.39
Wedelia trilobita	Asteraceae	18	11	0.36	3.34
c. Minomartani					
Acalypha indica	Euphorbiaceae	14	13	0.28	3.59
Alocasia macrorrhizos	Araceae	8	6	0.16	3.58
Eleusina indica	Poaceae	10	13	0.2	3.58
Digitaria longiflora	Poaceae	12	10	0.24	3.38
Chromolaena odorata	Asteraceae	15	9	0.3	3.38
Amaranthus tricolor	Amaranthaceae	15	4	0.3	3.31
Mangifera indica	Anacardiaceae	14	6	0.28	3.28
Blumea lacera	Asteraceae	7	17	0.14	3.26
Gnetum gnemon	Gnetaceae	14	6	0.28	3.12
Salacca zalacca	Arecaceae	4	13	0.08	3.10

b. Perceptions of ecosystem services

The first dimension explored in this section was the importance of biodiversity to contribute to provisioning services. Respondents recalled at least 19 species that provides provisioning services, such as food supply and medicinal supplies, animal feed, construction materials, and firewood (Table 3).

Table 3. Species that provides provisioning services

Species	Local name	Utilization	Parts utilized
Medicine			
Acalypha indica	*anting-anting*	Wound treatment	Leaf
Blumea lacera	*sembung kuwuk*	High blood pressure medicine	Leaf
Melia azedarach	*mindi*	Stomachache medicine	Leaf and fruit
Artocarpus altilis	*Sukun*	Diabetes medicine	Leaf
Mimosa pudica	*puteri malu*	Gout medicine	Leaf, stem, and root
Food			
Alocasia macrorrhizos	*Senthe*	Vegable and source of carbohydratet	Leave, tuber
Digitaria longiflora		Vegetable	Leaf
Amaranthus tricolor	*Bayam*	Vegetable	Leaf
Mangifera indica	*mangga*	Fruit	Leaf
Gnetum gnemon	*Melinjo*	Food, vegetable	Seed, seed shell leaf
Salacca zalacca	*Salak*	Fruit	Fruit
Pandanus amaryllifolius	*Pandan*	Spice	Leaf
Artocarpus heterophyllus	*Nangka*	Vegetable	Fruit, seed
Cattle feed			
Chromolaena odorata	*Kirinyu*	Goat feed	All parts
Vernonia cinera	*sawi-sawian*	Cattle feed	Leaf
Ageratum conyzoides	*babandotan*	Goat and rabbit feed	Leaf
Sphagneticola trilobata	*seruni jalar*	Goat feed	Leaf f
Building material and firewood			

Albizia chinensis	*Sengon*	Buiding materia;	Stem, branch
Ficus racemosa	*Loa*	Firewood	Stem, branch

Next, a survey was conducted on the regulating services of biodiversity to assess public knowledge regarding the role of biodiversity in regulating microclimates, preventing floods and landslides, as well as protecting other living organisms (Figure 1). The survey revealed that 82.56% of respondents lacked awareness regarding the protective role of riparian vegetation for other organisms. Conversely, a majority of respondents (56.4%) were aware of the contribution of riparian vegetation to flood and landslide prevention.

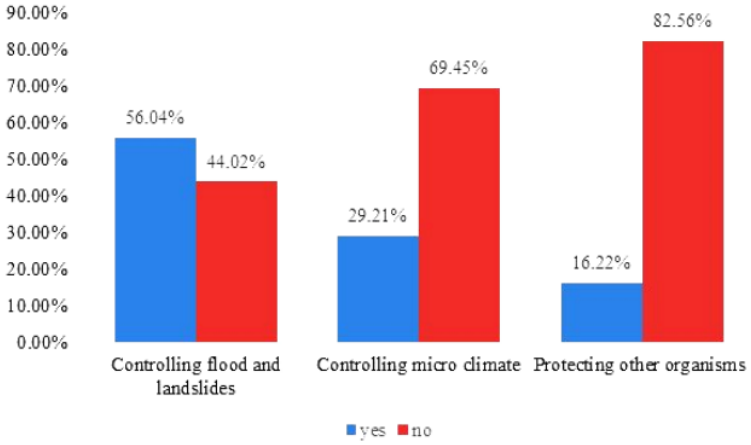

Figure 1.The percentage of respondents who answered yes and no to the questions regarding the regulating services provided by riparian vegetation

We inquired about the social and cultural activities related to riparian vegetation. Most people (64.79%) said that vegetation in riparian areas is linked to activities such as finding food and medicine, and many (53.52%) are involved in protecting these areas (Figure 2).

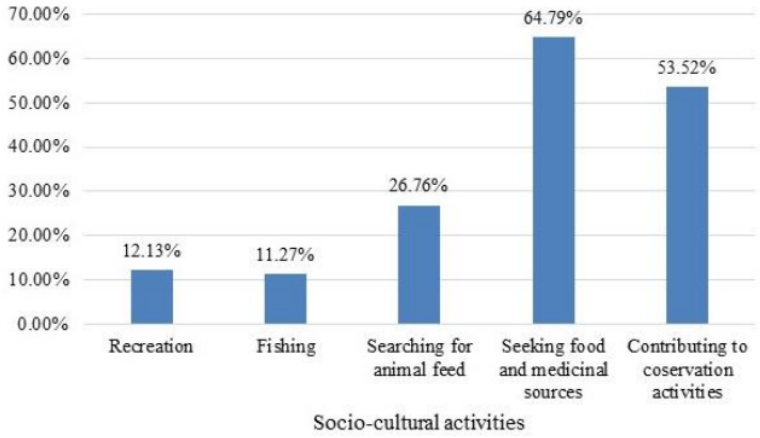

Figure 2. The percentage of respondents stating social activities related to riparian vegetation

DISCUSSION

Riparian plants diversity recorded in the Upper Gajahwong varied according to habitats. Riparian vegetation could be found submerged, attached to cliff of riverbank, and inhabited moist

habitat in the river bank. The diversity index values at the three research locations were nearly similar, all above H'=4. The highest diversity index is found in Sardonoharjo, reflecting a high level of biodiversity. This high biodiversity provides numerous ecosystem services, including oxygen provision, protection of riverbanks from erosion, flood control, food sources, and medicinal resources.

In the Hargobinangun segment, the Araceae Family is the most abundance. Most members within the Araceae Family exhibit a preference for aquatic habitats and have hydrophytic characteristics, as indicated by distinct leaf and stem morphology. Besides Araceae, many members of the Poaceae Family, including *Pennisetum purpureum* (elephant grass), were also found along the riverbanks. The presence of elephant grass was not due to natural growth but rather its cultivation by residents for livestock feed.

Next, in the Sardonoharjo segment, it was dominated by flat riverbanks with relatively low cliffs, providing a suitable habitat for grasses. Therefore, members of Poaceae such as *Eleusina indica*, *Digitaria longiflora*, and *Eriochloa procera* could easily be observed. The plants belong to this family was mostly used for cattle feed. Additionally, grasses from the Poaceae Family have the potential to improve the stability of banks in shallow erosion channels., as reported by Zegeye et al. (2017). In fact, the fine roots of Poaceae exhibits mechanical properties to improve soil protection (Liu, Meng, Huang, Shi, & Wu, 2022).

In Minomartani, the presence of Fabaceae is particularly interesting considering its location in densely populated areas and being a research site with relatively steep cliffs. Fabaceae is known as a family whose species can store water within their bodies (Ow, Ghosh, & Yusof, 2019). One particularly dominant member of the Fabaceae in the segment is the rain tree (*Samanea saman*). This tree is large, with extensive branching, buttress roots capable of erosion control, and water storage. Moreover, several species of Fabacae promise a high level of carbon sequestration, such *Albizia saman* and *Senna* sp (Fajariani, Hendra, & Susanto, 2020). Therefore, Fabacae plays an important role in protecting the environment from the effects of carbon and pollution

In recent times, there is growing concern regarding the perception of the service ecosystem as communities play the most crucial and direct role in making decisions and managing the ecosystem in which they reside. (Teixeira, Vermue, Cardoso, Peña Claros, & Bianchi, 2018). Thus, environmental management must consider the communities' knowledge of ecosystem services (Muhamad et al., 2014). In this regard, this research confirmed that the residents had been able to comprehend knowledge about the contribution of riparian vegetation to ecosystem services. For example, respondents could mention four types of utilization of riparian vegetation. However, their knowledge of provisioning services is limited to the general use of plants. Some other services such as aromatic sources, genetic pools, and sources of chemical compounds were not mentioned by the respondents.

In terms of regulating services, people agree that riparian vegetation exhibit important properties in controlling bank erosion, regulating microclimate, and protecting other organisms. Respondents mentioned that there are plant species capable of preventing erosion and maintaining water, such as the banyan tree. (*Ficus benjamina*) from the Moraceae family. This tree is known for its water storage capacity and is often found near water sources. The presence of large tree species indicates that the riverbanks are still in good condition (Abernethy & Rutherfurd, 2001).

Furthermore, this research confirms that communities possess a strong comprehension of the socio-cultural services provided by riparian vegetation. Moreover, cultural values and lifestyles significantly influence their perception of these services (García-Llorente et al., 2020). In this context, respondents most influenced by Javanese culture exhibit a profound appreciation for nature and conservation as integral components of their daily values (refer to Figure 2). Terms such as

"*niteni*" (pay careful attention), "*gemati*" (nurture), and "*nguri-uri*" (conserving for the next generation) (Wijaya & Faturochman, 2019) serve as driving forces for socio-cultural values within the society.

CONCLUSION AND SUGGESTION

The Upper Gajahwong region exhibits diverse riparian plant species across various habitats, from submerged areas to moist riverbanks. High diversity index values could be observed in the region, with Sardonoharjo exhibiting the highest diversity. In Hargobinangun, the dominance of Araceae species adapted to aquatic environments is notable, while in Sardonoharjo, Poaceae grasses thrive on flat riverbanks, serving as cattle feed. In Minomartani, Fabaceae, particularly the rain tree, aids in water storage and erosion control, crucial in populous areas. In terms of the community' perception, this research acknowledges that the community showcases understanding and knowledge of ecosystem services provided by the riparian vegetation. Regarding provisioning services, the community understand the contribution of plants to provide food, medicine, and other utilization. People also know the contribution of riparian vegetation in controlling erosion and microclimate, and protecting other organisms. Finally, people accept the socio-cultural services of riparian vegetation and the Javanese values play a significant role in shaping attitudes towards environmental conservation, highlighting the need for culturally sensitive conservation approaches.

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