



RIPARIAN VEGETATION PROFILE IN THE BOYONG RIVER SEGMENT, SLEMAN, YOGYAKARTA

PROFIL VEGETASI RIPARIAN DI SEGMENT SUNGAI BOYONG, SLEMAN, YOGYAKARTA

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Abstract

Boyong River is upstream of Code River and one of the areas potentially affected by volcanic mudflow and pyroclastic flow of Mount Merapi. Boyong River is the upstream of Code River that passes through Hargobinangun Village to Sinduharjo Village. Vegetation data collection in this study used the Belt Transect method as far as 50 meters. Each station consisted of 10 continuously placed plots, and vegetation measurements were taken on each 10 × 10 m plot. Data were analyzed using the Spatially Explicit Individual-based Forest Simulator (SEI-FS) software version 2.1.0. The diversity of riparian vegetation in the Boyong River was found to be as much as 29 species. *Albizia falcataria* had the highest IVI rate, with 96% and 63% at stations 1 and 3, respectively. *Swietenia mahagoni* had the highest IVI rate at station 2, with 91%. The Boyong River has varied canopy stratification, and there is one location that has complete strata (strata A, B, C, and D), namely Candibinangun Village, while Hargobinangun Village and Sinduharjo Village only have three canopy strata. Canopy closure in the Boyong River still left canopy gaps that allowed other plants to grow and occupy empty space, while Candibinangun and Sinduharjo Villages formed layers that overlapped each other.

Keywords: Belt transect; Boyong River; Canopy; Riparian vegetation; Strata

Abstrak

Sungai Boyong merupakan hulu dari Sungai Code dan menjadi salah satu daerah yang berpotensi terkena banjir lahar dan awan panas Gunung Merapi. Sungai Boyong merupakan hulu dari Sungai Code yang melewati Desa Hargobinangun sampai Desa Sinduharjo. Penelitian ini bertujuan untuk mendapatkan informasi mengenai struktur vegetasi yang ada di Sungai Boyong. Pengambilan data vegetasi dalam penelitian ini menggunakan metode Belt Transect. Masing-masing stasiun terdiri dari 10 plot yang diletakkan secara continue dan pengukuran vegetasi dilakukan pada setiap plot berukuran 10 × 10 m. Data dianalisis menggunakan perangkat lunak Spatially Explicit Individual-base Forest Simulator (SEI-FS) versi 2.1.0. Keanekaragaman vegetasi riparian di Sungai Boyong ditemukan sebanyak 29 spesies. *Albizia falcataria* memiliki nilai IVI tertinggi dengan 96% dan 63% di stasiun 1 dan 3, sedangkan *Swietenia mahagoni* memiliki nilai IVI tertinggi di stasiun 2, yaitu 91%. Sungai Boyong memiliki stratifikasi tajuk yang bervariasi dan ada satu lokasi yang memiliki stratum lengkap (stratum A, B, C, dan D), yaitu Desa Candibinangun, sedangkan Desa Hargobinangun dan Desa Sinduharjo hanya memiliki tiga stratum tajuk. Penutupan tajuk di Sungai Boyong masih tersisa gap-gap kanopi yang memungkinkan tumbuhan lain untuk bisa tumbuh dan menempati ruang kosong, sedangkan untuk Desa Candibinangun dan Desa Sinduharjo membentuk lapisan-lapisan yang saling overlap..

Kata Kunci: Belt transect; Stratum; Sungai Boyong; Tajuk; Vegetasi riparian

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INTRODUCTION

Riparian zones are transitional areas (ecotones) between aquatic and terrestrial ecosystems whose areas are influenced by freshwater, one of which is a river (Paramitha & Kurniawan, 2017; Popescu et al., 2021). The presence of meandering natural rivers inevitably leads to diverse microenvironments within the associated riparian habitats along the riverbank (Li et al., 2024). The character of the transition area (ecotone) in the riparian zone is sometimes obvious because it is lowland, but changes in the riparian transition are sometimes difficult to differentiate a wide gradient or spread over a larger distance (Malanson, 1995).

The balance of the riparian ecosystem is influenced by its constituent components. River ecosystems (aquatic and terrestrial systems) are very sensitive to human presence and have the potential to threatened the health of the river (Koskey et al., 2021). Riparian vegetation has a potential and important role in river ecosystems, especially in supplying litter needed by aquatic macroinvertebrates as food. Riparian vegetation can also function as a barrier to protect pollution, prevent flooding and abrasion, as a habitat for wild animals (Mohan & Joseph, 2024), and as a regulator of microclimate (Ainy et al., 2018; Nurika et al., 2019). The impacts that can be caused by the reduction of the riparian zone are: a) abrasion of riverbanks; b) deterioration of river water quality; and c) extinction of a number of species that live in association with riparian ecosystems.

In general, the presence of riparian vegetation in a place has a positive impact, but the effects vary depending on the structure and composition of the vegetation growing in the area. Changes in composition, structure, and diversity of riparian vegetation can be determined by natural factors, including periodic flooding or tree fall, climate change, and influences of upland on the fluvial corridors (Koskey et al., 2021).

Boyong River is upstream of Code River that passes through Hargobinangun Village to Sinduharjo Village and is one of the areas potentially affected by volcanic mudflow and pyroclastic flow of Mount Merapi. The ecological impact of lava flooding can damage objects in its path and will make the riverbank wider (Rukmorini & Firdaus, 2022). The pyroclastic flow activity released by Merapi can burn trees and floor vegetation on either side of the river. In addition, the eruption material that was collected in the Boyong River caused many sand and stone mining activities, resulting in changes in river flow. This is a factor that causes riparian vegetation to be damaged. Considering that Boyong River is one of the conservation areas, it is necessary to analyze the riparian vegetation in the area to obtain information about the existing vegetation structure so that it can be useful for predicting the dominance of vegetation in the future. The type and structure of vegetation can then be visualized in the form of vegetation profiles to see a schematic representation of the percentage of canopy cover on the land and the type of cover that dominates.

MATERIALS AND METHODS

The research was conducted in riparian areas in the Boyong River segment (Figure 1), which has an altitude ranging from 212 masl to 654 masl. Data collection was from September to December 2022. The research location was divided into three stations, namely station 1 in Hargobinangun Village, station 2 in Candibinangun Village, and station 3 in Sinduharjo Village. Each station was taken as 1,000 m².

Vegetation data collection in this study used the Belt Transect method as far as 50 m. Each station consisted of 10 continuously placed plots, and vegetation measurements were taken on each 10 × 10 m plot (Figure 2). Data collection was carried out on vegetation with a height of ≥1.5 m. Riparian vegetation parameter data collected included: a) species name, b) vegetation coordinate position (x,y), c) diameter of tree trunk at breast height (DBH), c) tree height (height), d) canopy thickness (crown depth), e) crown curse, and f) canopy area/radius (crown radius).

The identification process was carried out with the help of several references. The references used include the book "Plant in Tropical Cities" (Boo et al., 2014), "*Biodiversitas UIN Sunan Kalijaga Yogyakarta seri Flora*" (Rohmah et al., 2017), "The Mountain Flora of Java (Steenis et al., 2006), "*Panduan Lapangan Vegetasi Riparian*" (Ma'ariti, 2019), "*Inventaris Tanaman Obat*

Indonesia” (Katno et al., 2006), and several websites on the internet such as inaturalist.org (iNaturalist, 2022), indiabiodiversity.org (India Biodiversity Portal, 2022), and others websites.

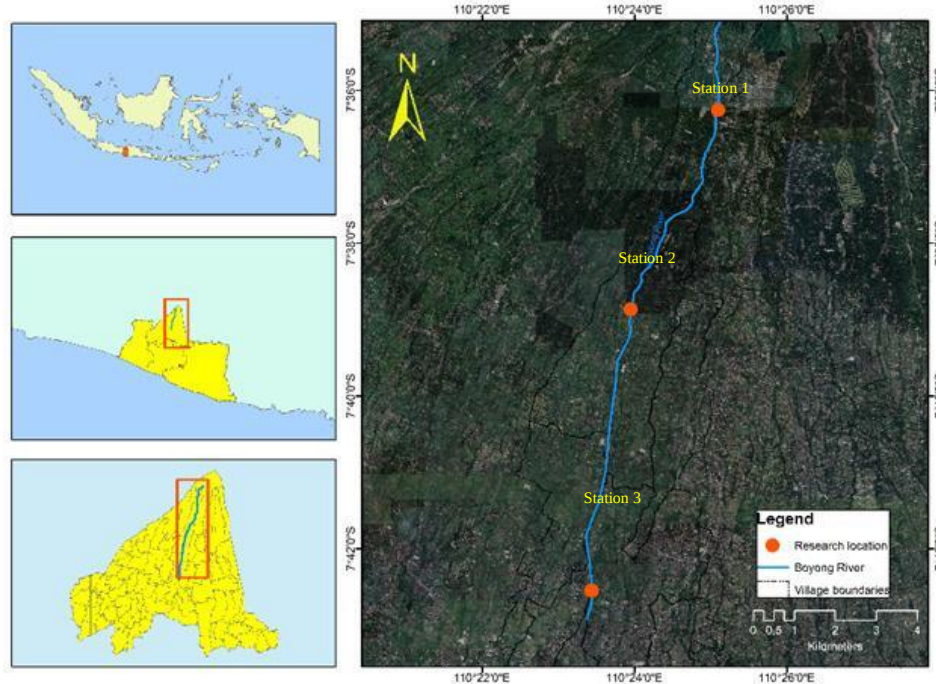


Figure 1. Sampling study area along the Boyong River in Sleman, Indonesia

Data were analyzed using the importance value index (IVI) and spatially explicit individual-based forest simulator (SexI-FS) software version 2.1.0. Riparian vegetation profiles were used to visualize riparian vegetation in the Boyong River, both horizontally and vertically. Data collected were: tree position (x, y), diameter (DBH), total height (height), crown depth, crown curve, and crown radius.

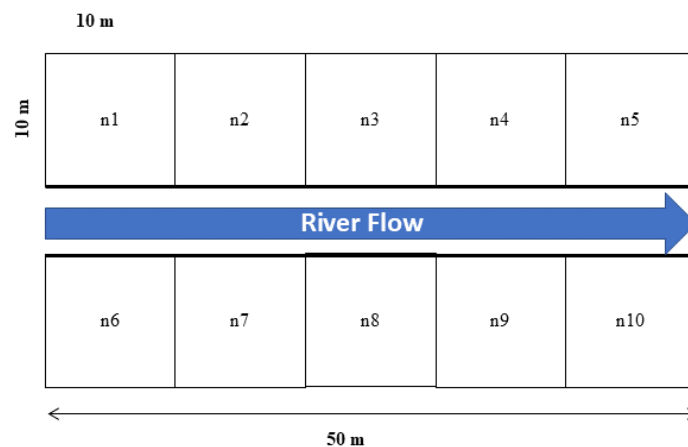


Figure 2. Riparian vegetation data collection design

RESULTS

Based on the research, it is known that each species has a diverse Important Value Index (IVI) (Table 1). The Important Value Index is related to the number of individuals found at each data collection location.

The results of measuring riparian vegetation located in Hargobinangun Village are that some vegetation types have widespread canopy cover, such as *Albizia falcataria* and *Melia azedarach*. In addition, there are only three strata at the research location: stratum B, stratum C, and stratum D. Stratum C has the highest species diversity, with five species found: *Albizia falcataria*, *Calliandra calothyrsus*, *Leucaena leucocephala*, *Hibiscus macrophyllus*, and *Melia azedarach* (Table 2). The stratification of riparian vegetation in Hargobinangun Village is presented in the form of a picture that can visually describe the real condition of the position of riparian vegetation (Figure 3).

Table 1. Important value index at each data collection location

Species name	IVI value (%)		
	Station 1	Station 2	Station 3
<i>Albizia falcataria</i>	96	29	63
<i>Artocarpus camansi</i>		7	
<i>Artocarpus heterophyllus</i>			8
<i>Bambusa blumeana</i>			15
<i>Bambusa tuldooides</i>		38	
<i>Calliandra calothyrsus</i>	91		
<i>Cecropia obtusifolia</i>			9
<i>Claoxylon indicum</i>		5	
<i>Cocos nucifera</i>		23	
<i>Dalbergia latifolia</i>			26
<i>Dysoxylum gaudichaudianum</i>			12
<i>Erythrina fusca</i>			14
<i>Ficus benjamina</i>			4
<i>Gliricidia sepium</i>	19		6
<i>Gnetum gnemon</i>		8	15
<i>Hibiscus macrophyllus</i>	15		
<i>Inocarpus fagifer</i>			10
<i>Leucaena leucocephala</i>	8		
<i>Mangifera foetida</i>			8
<i>Mangifera indica</i>			5
<i>Melia azedarach</i>	71	25	
<i>Musa Paradisiaca</i>		22	
<i>Polyalthia longifolia</i>			4
<i>Pterocarpus indicus</i>			5
<i>Pterospermum javanicum</i>			23
<i>Samanea saman</i>			38
<i>Swietenia mahagoni</i>		91	6
<i>Tectona grandis</i>			5
<i>Terminalia catappa</i>		51	21

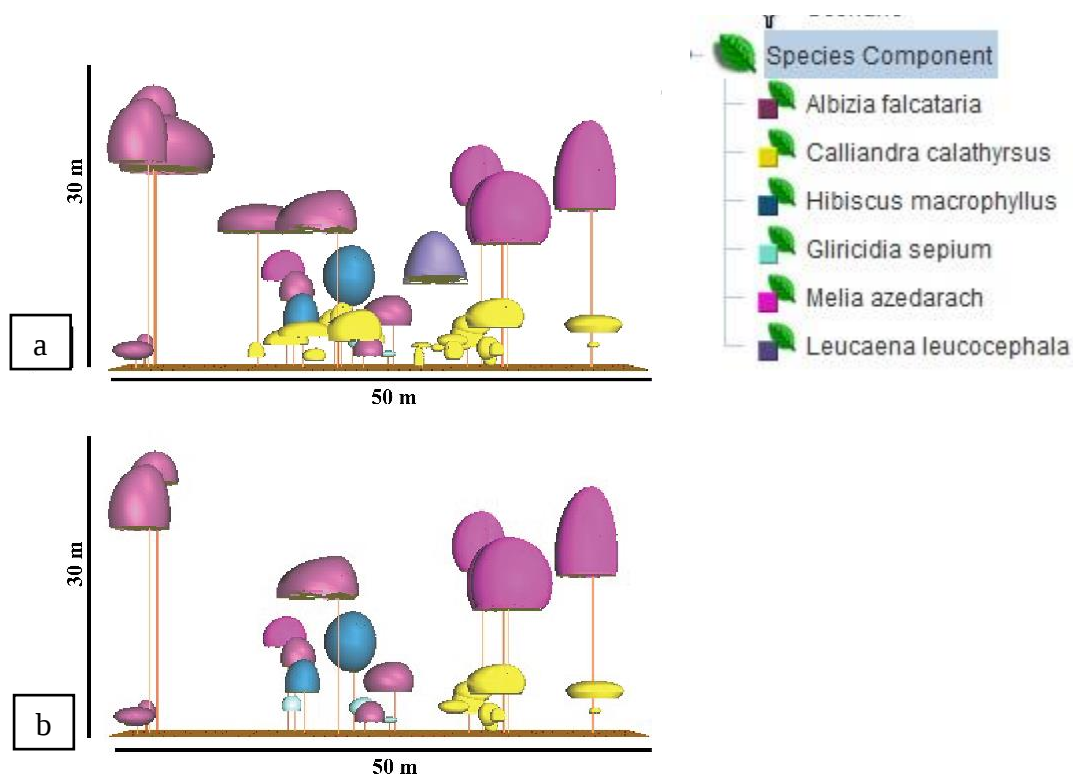
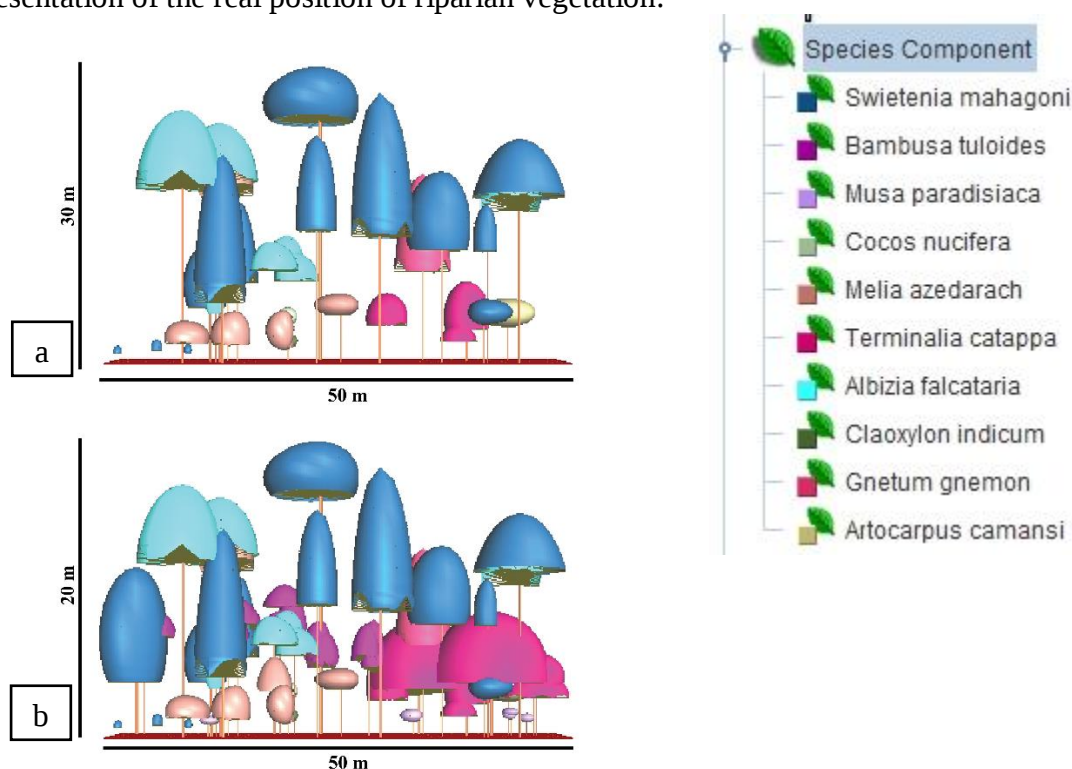
**Figure 3.** Visualization of the horizontal structure of riparian vegetation in Boyong River, Hargobinangun Village. Right side of the river (a) and left side of the river (b)

Table 2. Types that form canopy stratification in Hargobinangun Village

Stratum	Number of species	Species name
B	1	<i>Albizia falcataria</i>
C	5	<i>Albizia falcataria</i> , <i>Calliandra calothyrsus</i> , <i>Leucaena leucocephala</i> , <i>Hibiscus macrophyllus</i> , <i>Melia azedarach</i>
D	2	<i>Albizia falcataria</i> , <i>Gliricidia sepium</i>

Riparian vegetation in Candibinangun Village shows a different distribution pattern. The right riparian zone follows the pattern seen in the horizontal vegetation structure, while the left riparian zone tends to cluster. Some vegetation, such as *Terminalia catappa* and *Albizia falcataria*, has wide crowns. In addition, the study site has a complete stratification, consisting of stratum A, stratum B, stratum C, and stratum D. Stratum C has the highest species diversity, with eight species identified: *Albizia falcataria*, *Swietenia mahagoni*, *Bambusa tuldoidea*, *Cocos nucifera*, *Melia azedarach*, *Terminalia catappa*, *Gnetum gnemon*, and *Artocarpus camansi* (Table 3). The stratification of riparian vegetation in Candibinangun Village is illustrated in Figure 4, which provides a visual representation of the real position of riparian vegetation.

**Figure 4.** Visualization of the horizontal structure of riparian vegetation in Boyong River, Candibinangun Village. Right side of the river (a) and left side of the river (b)**Table 3.** Types that form canopy stratification in Candibinangun Village

Stratum	Number of species	Species name
A	1	<i>Swietenia mahagoni</i>
B	4	<i>Albizia falcataria</i> , <i>Swietenia mahagoni</i> , <i>Gnetum gnemon</i> , <i>Melia azedarach</i>
C	8	<i>Albizia falcataria</i> , <i>Swietenia mahagoni</i> , <i>Bambusa tuldoidea</i> , <i>Cocos nucifera</i> , <i>Melia azedarach</i> , <i>Terminalia catappa</i> , <i>Gnetum gnemon</i> , <i>Artocarpus camansi</i>
D	4	<i>Musa paradisiaca</i> , <i>Swietenia mahagoni</i> , <i>Melia azedarach</i> , <i>Gnetum gnemon</i>

Riparian vegetation in Sinduharjo Village exhibits a clustered distribution pattern, as observed in the horizontal vegetation structure. Some species, such as *Samanea saman* and *Erythrina fusca*, have wide crowns. Additionally, the study site consists of only three strata: stratum A, stratum C, and stratum D. Stratum C has the highest species diversity, with 15 species identified, including *Tectona grandis*, *Terminalia catappa*, *Cecropia obtusifolia*, *Albizia falcataria*, *Calliandra calothyrsus*, *Pterocarpus indicus*, *Bambusa blumeana*, *Artocarpus heterophyllus*, *Mangifera foetida*, *Inocarpus*

fagifer, *Gliricidia sepium*, *Swietenia mahagoni*, *Pterospermum javanicum*, *Polyalthia longifolia*, and *Gnetum gnemon* (Table 4). The stratification of riparian vegetation in Sinduharjo Village is illustrated in Figure 5, which provides a visual representation of the real position of riparian vegetation.

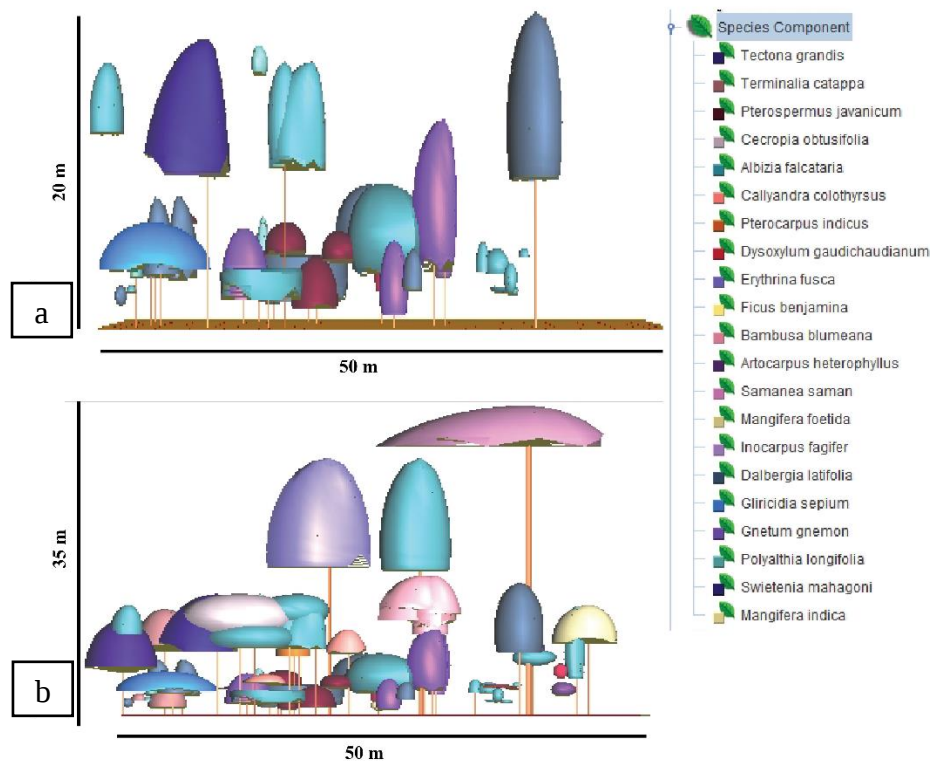


Figure 5. Visualization of the horizontal structure of riparian vegetation in Boyong River, Sinduharjo Village. Right side of the river (a) and left side of the river (b)

Table 4. Types that form canopy stratification in Sinduharjo Village

Stratum	Number of species	Species name
A	1	<i>Samanea saman</i>
C	15	<i>Tectona grandis</i> , <i>Terminalia catappa</i> , <i>Cecropia obtusifolia</i> , <i>Albizia falcataria</i> , <i>Callyandra calothyrsus</i> , <i>Pterocarpus indicus</i> , <i>Bambusa blumeana</i> , <i>Artocarpus heterophyllus</i> , <i>Mangifera foetida</i> , <i>Inocarpus fagifer</i> , <i>Gliricidia sepium</i> , <i>Swietenia mahagoni</i> , <i>Pterospermum javanicum</i> , <i>Polyalthia longifolia</i> , <i>Gnetum gnemon</i>
D	6	<i>Terminalia catappa</i> , <i>Pterospermum javanicum</i> , <i>Dysoxylum gaudichaudianum</i> , <i>Ficus benamina</i> , <i>Albizia falcataria</i> , <i>Dalbergia latifolia</i>

Table 5. Environmental parameter values at riparian vegetation data collection sites in the Boyong River

Environmental parameter	Station 1	Station 2	Station 3
Light intensity (lux)	47,189	21,521	5,110
Air temperature (°C)	35	30	29
Air humidity (%)	65	83	86
Soil humidity (%)	32	35	51
Potential of hydrogen (pH)	7	7	7

The presence of riparian vegetation in the Boyong River is not only influenced by disturbance but also by environmental and climatic parameters. Environmental parameters and climate change are important factors in determining the presence of vegetation. The results of measurements of environmental parameters such as light intensity, air temperature, air and soil humidity, and pH values at three stations show varying values (Table 5). In addition, data from BMKG in 2022 on temperature, humidity, rainfall, and sunshine were also compared (Table 6).

Table 6. Sleman climate indicator value 2022

Climate parameters*	September	October	November	December
Minimum temperature (°C)	23.4	23.26	23.31	23.46
Maximum temperature (°C)	31.42	29.64	30.5	30.91
Average temperature (°C)	26.47	25.56	25.81	26.18
Average humidity (%)	83.87	90.06	90.77	89.39
Total rainfall (mm)	94.9	285.3	341.6	361.1
Average sunshine (hour)	5.8	3.3	2.9	3.79

Note: (*)= Indonesian Agency for Meteorology, Climatology, and Geophysical (BMKG Dataonline, 2022)

DISCUSSION

The results of observations at the research site, the types of vegetation distributed are very diverse. The results of observations and data analysis at the research site, that vegetation were found 29 species (Table 1). The value of IVI in Table 1 indicates that the species that has the highest value at station 1 and station 3 is *Albizia falcataria* with IVI values of 96% and 63%, meaning that the plant is found most compared to others. Based on information from the community around the Boyong River, this type of plant is deliberately planted by the community because the plant is easy to cultivate and has high economic value in its wood. Station 2, mahoni trees (*Swietenia mahagoni*) had the highest IVI, with a value of 91%. This high value indicates that mahoni trees have a large number at that location in line with the number of seedlings of the same species. It can be assumed that the mahoni species has a lot of seeds and is easy to grow in the Boyong River.

Vegetation structure consists of species that form a stand in a space. The structure of riparian vegetation profiles can be viewed from two dimensions, namely horizontal vegetation structure and vertical vegetation structure. Horizontal vegetation structure is based on the density, distribution of riparian vegetation, and projection of the canopy onto the forest floor surface. The vertical vegetation structure is expressed by a diagram that describes the canopy layer (stratification).

Boyong River is the upstream of Code River. Based on the land use map, the Boyong River has eight segments. These segments include primary and secondary forests, built up land (industry, trade, offices, settlements), mix gardens, shrubs, agriculture, and other plantations (BPDAS Serayu Opak Progo, 2022). The Boyong River in Hargobinangun Village and Candibinangun Village is a source of material for residents, while in Sinduharjo Village, it is close to settlements.

Riparian vegetation in Hargobinangun village is difficult to grow and develop because the Boyong River in Hargobinangun village is very vulnerable to cold lava flows. River vegetation traversed by volcanic mudflow will experience primary succession. This process can last for a long time until the climax stage (Wijayani et al., 2019). This is also influenced by rainfall data from September to December, with a total rainfall of 94.9–361.1 mm/month in Sleman Regency, meaning low rainfall for September, medium rainfall for October, and high rainfall for November and December (Table 6). Indonesian Agency for Meteorology, Climatology, and Geophysical (BMKG) categorizes total rainfall into three categories, namely low (0–100 mm), medium (100–300 mm), and high (300–500 mm) (Anggraini et al., 2023; Safitri, 2021). This can be evidenced by the absence of stratum A and leaves only young vegetation (Stratum B, C, and D) (Table 2). Factors that cause the regeneration process to be disrupted include human activities, the presence of dominating invasive species, natural disasters, unsuitable microclimatic conditions, and the absence of adequate seed banks (Waskitaningtyas et al., 2018).

The canopy cover at the research site in Candibinangun Village forms overlapping layers in the canopy area (Figure 4). In addition, Candibinangun Village has four canopy strata: A, B, C, and D (Table 3). This indicates that the condition of the vegetation community is stable and there is no disturbance. Meanwhile, riparian vegetation in Sinduharjo Village has three canopy strata, namely strata A, C, and D (Table 4). The condition of riparian vegetation in Sinduharjo Village is still relatively stable with a fairly dense canopy cover and the number of riparians found in the river area.

According to Wijayani et al. (2019), based on the research results obtained by plants from 25 families and there are 36 species. Lichen habitus vegetation, *Parmelia saxalitis*, which had the

highest IVI rate with 154.9509% in plot 2, herbaceous herbals with the highest value index is *Cynodon dactylon* 158.5050%. The highest importance index of shrub habitus was 64.6450%. The highest important index of stand habitus is *Tamarindus indica* 124.3808%. In addition, according to Junardi et al. (2018), the structure of riparian vegetation in the Mount Poteng area shows that the average diameter size of vegetation revealed in the location is 20–80 cm. This shows that the regeneration rate in the Mount Poteng area is still very good and still natural.

Riparian vegetation with various sizes of canopy area will form a complex canopy cover. Vegetation conditions that are able to grow large with a wide canopy can suppress the vegetation below it from growing simultaneously. Purnomo et al. (2018) states that crown closure has a significant effect on the presence of understory plants and tree saplings, the denser the crown the number of understory plants will also decrease, and the understory plants will find it difficult to grow due to a lack of sunlight. This is evidenced by the light intensity in Hargobinangun Village of 47,189 lux, Candibinangun Village of 21,521 lux, and Sinduharjo Village of 5,110 lux (Tabel 5).

The Boyong River has five strata, namely stratum A, B, C, and D (Figures 5, 6, & 7). The completeness of the stratum illustrates the associations formed by all plant species of the forest vegetation. A high and wide crown layer can result in dominant cover, making it difficult for trees with lower crowns to gain space and sunlight. The canopy layer (stratification) formed by trees is caused by two things, namely, due to competition between plants and the nature of tolerance of tree species to sunlight intensity (Zulkarnain et al., 2015).

Vegetation stratification is very important for hydrological and soil erosion aspects. Variations in stratification are related to its ability to trap water. Forest vegetation with, its structure and composition, and wide distribution will play an important role in regulating the hydrological cycle (Naharuddin, 2017). In addition, the structure and composition of vegetation can describe the condition of an environment in the future. The interaction or reciprocity of a particular community in the ecosystem can be used as a bioindicator of environmental quality, recognize all problems in the area, and predict possible environmental changes that will occur in the future (Martuti et al., 2020).

CONCLUSION

The diversity of riparian vegetation in the Boyong River was found to be as much as 29 species. *Albizia falcataria* had the highest IVI rate, 96% and 63% at stations 1 and 3, while *Swietenia mahagoni* had the highest IVI rate at station 2, with 91%. The Boyong River has varied stratification, and there is one location that has complete strata (Strata A, B, C, and D), namely Candibinangun Village. The canopy cover in Boyong River still has gaps in the canopy that allow other plants to grow and occupy empty spaces. The findings of this study highlight the importance of vegetation conservation in the Boyong River to increase the biological value of the riparian vegetation of the Boyong River so that it can replace the function and presence of mature trees in the future.

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