QUALITY PROFILE OF RIPARIAN ZONE AND VEGETATION QUALITY IN AMPRONG RIVER, TUMPANG DISTRICT BASED ON QBR INDEX AND NDVI**PROFIL KUALITAS ZONA RIPARIAN DAN KUALITAS VEGETASI DI SUNGAI AMPRONG KECAMATAN TUMPANG BERDASARKAN QBR INDEX DAN NDVI**Hamdani Dwi Prasetyo^{1)*}, Majida Ramadhan¹⁾

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ABSTRACT

Riparian zones provide ecosystem services depending on the quality of riparian vegetation and vegetation health. The role of riparian vegetation was determined by the total cover, cover structure, vegetation cover quality, and channel alteration of the riparian zone. Vegetation health was to determine the condition of the riparian zone of the Amprong river. In determining the quality of the riparian zone and the quality of the vegetation, it is done by observing the riparian zone of the Amprong river. The results of field observations were analyzed using the QBR index. Vegetation quality was also observed using the Normalized Difference Vegetation Index. The quality profile of the Amprong river riparian zone is in the medium category, while stations 4.2 and 4.3 are in a good category. The good category is obtained from the high total cover dam cover structure value. Meanwhile, the low QBR value is caused by the value of disturbance in the riparian zone in the form of agricultural activities, community settlements, garbage, land conversion to permanent buildings in the riparian zone. The size of the tree canopy at several stations has an impact on the QBR index value. Vegetation connectivity to rivers also helps in maintaining the quality of the riparian zone. Vegetation health on a scale of 0.012 to 0.371 indicates that the sampling site is in good condition. However, this condition will worsen if there is pressure from human activities. Sustainable management is needed by improving the quality of vegetation and reducing disturbance to the riparian zone.

Keywords: disturbance, riparian zone quality, vegetation quality, riparian zone

ABSTRAK

Zona riparian memberikan jasa layanan ekosistem bergantung pada kualitas vegetasi riparian beserta kesehatan vegetasinya. Peran vegetasi riparian ditentukan dari total cover, cover structure, cover quality vegetasi dan channel alteration zona riparian. Kesehatan vegetasi juga diduga menentukan kondisi zona riparian sungai Amprong. Dalam penentuan kualitas zona riparian dan kualitas vegetasi dilakukan dengan mengobservasi zona riparian sungai Amprong. Hasil observasi lapang dianalisis menggunakan indeks QBR. Kualitas vegetasi juga diamati menggunakan Normalized Difference Vegetation Index. Profil kualitas zona riparian sungai Amprong berada dalam kategori sedang, sementara stasiun 4.2 dan 4.3 pada kategori baik. Kategori baik diperoleh dari tingginya nilai total cover dam cover structure yang tinggi. Sementara rendahnya nilai QBR disebabkan oleh nilai gangguan pada zona riparian berupa aktivitas pertanian, pemukiman masyarakat, sampah, konversi lahan hingga bangunan permanen yang terdapat di zona riparian. Besarnya kanopi pohon pada beberapa stasiun berdampak pada nilai QBR index. Konektivitas vegetasi terhadap sungai juga membantu dalam menjaga kualitas zona riparian. Kesehatan vegetasi dalam skala 0.012 sampai 0.371 menunjukkan bahwa sampling site dalam kondisi baik. Namun kondisi ini akan memburuk jika terjadi desakan aktivitas manusia. Dibutuhkan pengelolaan secara berkelanjutan dengan meningkatkan kualitas vegetasi serta menurunkan gangguan terhadap zona riparian.

Kata kunci: gangguan, kualitas zona riparian, kualitas vegetasi, zona riparian

How to cite:Prasetyo, HD, M Ramadhan. 2021. Quality profile of riparian zone and vegetation quality in Amprong River, Tumpang District based on QBR index and NDVI. *Journal of Tropical Biology* 9 (3): 229-236.**INTRODUCTION**

The riparian zone is a transitional area between the river and terrestrial ecosystems that provide heterogeneous microhabitats [1] for both terrestrial and aquatic populations, thus supporting biodiversity [2]. Vegetation in the riparian zone helps connect aquatic and terrestrial systems, both

aquatic consumers obtain energy from leaf litter input, and then these consumers will be preyed upon by riparian predators, thus facilitating energy transfer through food webs [3]. In addition, the emergence of aquatic insects and consumers of riparian invertebrates, including spiders and beetles, plays a key role in linking riverine and

terrestrial trophic networks [4] and contributes to biodiversity at local and catchment scales.

However, riparian zones are often highly degraded to agricultural areas. Land-use change, deforestation (including riparian trees), overgrazing, pesticides, and nutrients from agricultural sources threaten riparian biodiversity and ecosystem services at different spatial scales. Thus, protecting and improving its quality is often seen as the first step to protecting biodiversity in riparian zones resulting from agricultural land use [5].

Recently the riparian buffer zone, not planted along the river basin. However, it is known that the presence of vegetation in the buffer zone plays an important role in maintaining the integrity of the riparian zone in degraded areas [6]. Vegetation can act as a remediation agent for pesticide and fertilizer contaminants present in the riparian zone. Vegetation of phytoremediation agents such as *Ipomoea aquatica*, *Typha* sp., and *Sesbania grandiflora* can reduce orthophosphate and ammonium levels within a certain period [7].

Amprong River that flows in Tumpang District, Malang Regency, has various human activities. Residential activities, rice fields, and gardens can be found, which will impact the quality and biodiversity of organisms in the Amprong River. Several points on the Amprong river are also used by the community for bathing and washing

activities. Tourist activities in the form of fishing ponds can also be found along the river. Several human activities along the river have been going on for a long time, from upstream to downstream. For example, the dense activity in the upper Brantas River will result in greater disturbance to biodiversity [8]. Thus, the ecosystem services provided cannot be obtained optimally for all living things around the riparian zone.

Based on the things above, it is very important to observe the condition of the riparian zone and the vegetation in the Amprong river. This is because the riparian zone has an important role in maintaining the stability of aquatic and terrestrial ecosystems. Thus, after obtaining information regarding the riparian quality profile and the level of vegetation health, it is hoped that it can be a recommendation for land management in the Amprong River riparian zone that supports the sustainability of endemic diversity organisms.

METHODS

The research location was carried out in the Amprong River, Tumpang District, Malang Regency. The Amprong River which has a length of 37 km passes through the villages of Belung, Pulungdowo, Pandanajeng, Banjarejo, Kedungrejo, Sumberkradenan, and Sekarpuro.

Figure 1. Sampling site at Amprong River

The Amprong River observed was focused on Tumpang District due to community activities in the more diverse riparian zone. Therefore, the Amprong River, which passes through the villages of Pulungdowo, Pandanajeng, and Banjarejo, is the focus of observation. The determination of the observation station was 1 km away for each station which was chosen randomly to avoid the subjectivity of determining the location. Observation stations were determined as many as five stations with three repetitions (Figure 1). Furthermore, the determination of the riparian zone profile was carried out followed by processing the data and analyzing the quality of the riparian using the QBR index [9] and the Normalized Difference Vegetation Index (NDVI) in the Mathematics and Natural Sciences Laboratory, Integrated and Halal Center Laboratory, University of Islam Malang.

Determination of riparian quality (QBR Index). The QBR index (*Qualitat del Bosc de Ribera*) was an easy-to-use field method to assess the quality of riparian zones [9]. The analysis of the quality of the riparian zone could be divided into two parts, namely, the determination of the observation area and the calculation analysis for the QBR index. In this study, the riparian area was determined with an optimal length of 100 m. Furthermore, the QBR index analysis was based on a score-based index that covers four categories, including (1) Total Cover (TC), (2) Cover Structure (CS), (3) Cover Quality (CQ), and (4) Channel Alteration (CA). In determining the riparian vegetation cover, the percentage of vegetation cover to the riparian zone was observed, and the vegetation connectivity with river banks was determined. The tree cover structure is determined by assessing the percentage of the tree canopy to the riparian zone and the connectivity of tree vegetation with river banks. To determine the quality of riparian vegetation cover, the geomorphological type of the river must first be determined, including (a) the slope and shape of the edges of the riparian zone, (b) assessment of river substrate, and (c) assessment of the quality of vegetation cover, in this case, the number of local trees and tree communities and their canopy. Changes in waterways were carried out by observing whether there were changes or modifications to river channels (Table 1).

Table 1. Riparian quality scale based QBR index

Category	Range
Riparian habitat in natural conditions	≥ 95
Some disturbance, good quality	75 – 90
Disturbance important, fair quality	55 – 70
Strong alteration, poor quality	30 – 50
Extreme degradation, bad quality	≤ 25

Normalized Difference Vegetation Index (NDVI) detects vegetation consistency by measuring the difference between near-infrared (reflected by vegetation) and red light (absorbed by plants). Healthy vegetation reflects more near-infrared (NIR) and green light than other wavelengths. However, vegetation also absorbs more red and blue light. The index value ranges from -1 (possibly aquatic ecosystems that reflect solar radiation) to +1 (in the form of green reflections from leaves that absorb solar radiation) and includes all types of land use so that vegetation from agriculture, plantations, settlements can reflect green [10]. The NDVI analysis stage is carried out by preparing a data source in the form of a base map of the Malang Regency. This base map contains information on river flow, administrative boundaries, and land use in the Amprong River area. To obtain a base map, it is done by opening the Indonesia Geospatial Portal website, and then the Malang Regency area was selected and downloaded. In addition, data sources for NDVI analysis were carried out by downloading satellite image maps on the earthexplorer.usgs.gov website. The observation area and the time range for taking satellite imagery data were determined. The selected and downloaded data sets were Landsat 8 Operational Land Imager (OLI) and Thermal Infrared Sensor (TIRS) C2 L2. NDVI analysis was performed by running the Quantum Geographic Information System Desktop (QGIS) version 2.18.28. The base map of Malang Regency was displayed in QGIS, which was then selected according to the observation area. Landsat 8 maps with OLI Band 4 red (0.64 – 0.67 m) and Band 5 Near-Infrared (0.85 – 0.88 m) sensors were inputted in QGIS [10, 11]. NDVI analysis was calculated by the following formula.

$$NDVI = \frac{(NIR - Red)}{(NIR + Red)}$$

Note: NIR (Band 5); Red (Band 4)

RESULTS AND DISCUSSION

Riparian zone quality profile. In the results of determining the quality of the riparian zone based on the QBR score, it can be seen that the value of the quality of the riparian zone of the Amprong River ranges from a value of 55 to 75 based on Table 2. According to the quality scale of the QBR index, the quality of the Amprong River is included in the good to moderate quality category. In the assessment of water quality from all stations, the majority experienced moderate quality. Some of these stations have a land cover of 25-50%. Although the riparian vegetation cover reaches

more than 80%, the vegetation connectivity is not too great. This is due to the lack of vegetation on the banks of the river, which is directly connected to the river. The lack of vegetation connected to the river is also influenced by the presence of people who use the river from the bank.

Many people do activities such as washing and bathing on the banks. When there is vegetation (especially undergrowth) on the banks of the river, it will interfere with human activities. Therefore, vegetation is removed from the riverbanks to support the activities of the surrounding community. The level of connectivity depends on the level of activity and the steepness of the land. It is known that some observation sites with high steepness are minimally utilized by the community so that not much of the surrounding vegetation is removed. The activity of degrading vegetation around the riparian zone is contrary to the positive

impact of the vegetation. Many studies state that the presence of vegetation on the river banks is beneficial in absorbing pollutants from human activities. Agricultural runoff, household waste can be reduced by vegetation that grows in the riparian zone. On the other hand, degrading vegetation will reduce water and soil quality, eliminate habitat, and reduce the diversity of aquatic and terrestrial organisms [12, 13].

In dealing with this problem, a study is needed to determine the impact of river water quality after the degradation of plants community on the river bank. This is important to know how significant the impact of riparian vegetation degradation is. As for efforts to overcome the decline in water quality, it can be done by restoring the riparian zone and replanting with plants useful in remediating pollutants that enter the riparian zone [7].

Table 2. Details of riparian quality based QBR Index

No	Site	TC	CS	CQ	CA	QBR score	Category	Land use	Disturbances
1	1.1	20	5	25	10	60	Fair	Silvopastoral system and fodder bank	Agricultural activities, some coffee and banana plantation
2	1.2	15	5	25	10	55	Fair	Fruit crop, bamboo population, fodder bank	Agricultural activities, some coffee and banana plantation
3	1.3	15	5	25	10	55	Fair	Fodder bank, bamboo population, and low tree	Agricultural activities, bridge, and road
4	2.1	15	15	25	10	65	Fair	Some bamboo population, some fruit tree, agricultural with annual crops	Agricultural activities and farmland
5	2.2	15	15	30	10	70	Fair	Some bamboo population, some fruit tree, agricultural with annual crops	Agricultural activities and farmland
6	2.3	15	20	20	10	65	Fair	Some bamboo population, some fruit tree, agricultural with annual crops	Agricultural activities and farmland
7	3.1	15	15	25	10	65	Fair	Some bamboo population, weeds, and fodder banks	Agricultural activities, garbage dumps, public facility
8	3.2	15	15	25	10	65	Fair	Some bamboo population, few fodder banks	Agricultural activities, human habitation
9	3.3	20	5	30	10	65	Fair	Some bamboo population, few fodder banks	Bridge and road, garbage dumps, human habitation
10	4.1	15	15	25	0	55	Fair	Semi-permanent crops, bamboo population, fodder bank, farmland	Agricultural activities
11	4.2	20	20	25	10	75	Good	bamboo population, fodder bank, farmland	Agricultural activities
12	4.3	20	20	25	10	75	Good	bamboo population, fodder bank, farmland	Agricultural activities
13	5.1	15	20	30	10	75	Good	Bamboo forest, fodder bank	human habitation
14	5.2	15	15	30	10	70	Fair	Bamboo forest, fodder bank	human habitation
15	5.3	15	15	30	10	70	Fair	Bamboo forest	Land conversion for human habitation, bridge

Note: TC: Total cover; CS: Cover structure; CQ: Cover quality; CA: Channel alteration

Figure 2. Map of Amprong River watershed analyzed by NDVI (top); Map of anthropogenic usage at three villages along Amprong River (bottom)

Assessment of tree cover structure in the riparian zone mostly 50-75% of the tree canopy covers the riparian zone. In addition, 25% understorey cover was available at some observation points. However, there was also more than 75% of the tree canopy covering the riparian zone.

Some trees located in plantations provide shade for cultivated plants and cover the river from direct sunlight. The tree canopy also provided benefits for the community because it made the surrounding temperature. However, the connectivity of trees and shade to the river was still minimal. Assessment of the quality of riparian vegetation cover was seen from the presence of local trees. The local trees on the banks of the Amprong River were very diverse. More than three local tree species could be found in one observation point, such as *Hibiscus tiliaceus*, *Bambusa blumeana*, *Ficus septica*, *Dendrocalamus asper*, and others. The majority of trees that live around the riparian zone were bamboo. The presence of bamboo in the riparian zone provided ecosystem services for the riparian zone in the form of a canopy. However, the presence of human structures caused the quality of the riparian vegetation cover to decline. The presence of waste also caused disturbance to the ecosystem [8].

Garbage in the riparian zone of the Amprong River was generally made of plastic. The presence of plastic waste would lead to microplastic pollution in the riparian zone soil and waterways [14]. The occurrence of microplastic pollution was also not only from plastic waste present in the riparian zone, but small fragments of plastic waste on the road, household waste, agricultural and industrial activities also contribute to this pollution. Microplastics would accumulate by organisms in the riparian zone and disrupt marine, freshwater, atmospheric and terrestrial ecosystems.

Figure 3. NDVI score of sampling site

The results of the NDVI analysis (Fig. 3) carried out in all areas showed that the range score reached 0.012 to 0.371 (Fig. 2). Station 1 had NDVI score of 0.073 ± 0.00 . This score was lower than other stations. Station 4 had the highest score of

vegetation health level, which was 0.327 ± 0.08 . From the correlation test between the QBR and NDVI values, there was a positive relationship. It showed that the QBR value had an impact on increasing the value of vegetation health. In the quality of the riparian zone, the aspect of total vegetation cover was very influential on the quality of vegetation health.

The riparian zone was covered by more than 80% riparian vegetation. Vegetation connectivity with riverbanks was also more than 50%. The size of the area covered by vegetation with vegetation connectivity to the river would support ecosystem health. In addition, the high connectivity of vegetation supported the life of both terrestrial and aquatic organisms. High vegetation connectivity helped maintain river water quality. Vegetation around riverbanks helped remediate pollutants carried by water runoff, and other water flows entering the river [15, 16]. If there was little vegetation, the pollutant residue could not be remedied, resulting in water and soil pollution. Pollutant residues will also disrupt the organ systems of aquatic and terrestrial organisms to cause death.

The cover structure of the Amprong river was in good condition. The tree canopy against the river and surrounding area was 50-75%. Tree canopy on the environment was very important in maintaining the environmental temperature. Tree canopy could reduce the intensity of light entering the environment. If the intensity of incoming light were high without a tree canopy, it would cause ecosystem disturbance. The microbial community that acts in the decomposition of organic waste would be hampered. Changes in chemical composition also occurred in plants due to the intensity of light received. Biomass and morphology in plant root systems could be modified. The mineral nutrient cycle in the soil would also change due to change in the composition of the soil bacterial community and biomass [18].

CONCLUSION

The quality profile of the riparian zone of the Amprong river was in moderate to good condition. The total cover, cover structure, and cover quality were in good condition, as indicated by high vegetation coverage, wide tree canopy, and vegetation connectivity to riverbanks. Disturbances that occur in the form of agricultural activities, community settlements, garbage, land conversion to permanent buildings are present in the riparian zone. Disturbances had an impact on the quality of the riparian zone. Vegetation health at the whole sampling site was in good condition. However, vegetation in the riparian zone was

reduced by the use of land for agriculture, plantations, settlements. Changes in land use without being supported by sustainable environmental management would result in losses to the environment and the organisms that live there, especially humans. Therefore, we recommend reducing disturbance and maintaining the quality of vegetation in the riparian zone of the Amprong River so that environmental services can be provided properly.

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