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RIPARIAN TREES AND ITS ROLES TO WATER QUALITY IN NIUKBAUN SPRINGS

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ABSTRACT

Riparian trees play an essential role in maintaining the quality of the springs. This research was conducted to determine riparian tree types and water quality in Niukbaun Springs, Kupang district. Tree samples were measured by using the Quadrat Sampling Technique. Meanwhile, water quality measurement included physical, chemical, and microbiological parameters. All data collected were analyzed to determine the Shannon-Wiener diversity index, tree endemism status, and gap analysis (conformance of water quality profiles with water quality standards). The results revealed that there were 11 families consisting of Anacardiaceae, Arecaceae, Bombacaceae, Dendrocnide, Elaeocarpaceae, Euphorbiaceae, Meliaceae, Moraceae, Oxalidaceae, Sapindaceae, and Verbenaceae with a total of 149 individuals. The endemism status of the 15 tree species found was 80% classified as endemic and 20% classified as exotic. From the results of the physical and chemical quality tests of water, it was found that almost all parameters met the water quality standards, except for nickel (dissolved metal), which did not meet the water quality standards. Microbiological test results revealed a type of bacteria with similar characteristics to the bacteria *Proteus mirabilis*, *Klebsiella aerogenes*, and *E. coli*. Human activities impact the diversity of riparian trees and the quality of water in Niukbaun Springs.

1. INTRODUCTION

Conserved springs provide groundwater, an important water resource for the lives of the surrounding communities. One of the factors that play an essential role in maintaining the quality of water in springs so that it is maintained properly is the presence of natural riparian vegetation, which includes trees, shrubs, and herbs. Along with the increase in population and needs, human activities around springs also increase. These activities put pressure on the sustainability of spring water resources. Human activities that do not match geographical conditions, such as settlements, agriculture, animal husbandry, fisheries, industry, and infrastructure that have utilized the riparian zone along springs and canals, have resulted in erosion and sedimentation.

Meanwhile, uncontrolled human activities can cause pollution due to the presence of waste. Excessive waste entering water bodies can change water's physical, chemical, and biological properties, which will affect the decline in water quality (Semiun et al., 2020). One of the biotic components that maintain the quality of springs is the spring trees.

Springs are one of the constituent components of riparian ecosystems (such as springs). Riparian is included as a special conservation area that needs to be preserved the original vegetation because if the riparian vegetation shrinks, it will have an impact on decreasing biodiversity and the loss of function of the riparian vegetation (Oktaviani & Yanuwiadi, 2016). Information about the diversity of riparian tree vegetation needs to be known for managing and preserving springs and their channels. Riparian trees maintain river water quality by regulating water temperature, litter suppliers, and habitats for organisms (Mamulak & Semiun, 2021).

Previous research on the diversity of riparian vegetation that grows in the spring area in Belo and Labat, Kupang City, East Nusa Tenggara Province, Indonesia, had been conducted by Semiun and Lenggur (2018). It was a descriptive study that applied a systematic random sampling method. The results revealed that both naturalness and spring hemeroby in Belo showed the same index of 4, while in Labat, they were 3 and 5, respectively. It was clear that the species richness index in Belo was higher (3.1) than in Labat (1.6). However, the diversity index of riparian trees in Belo (1.83) and Labat (1.45) was categorized as low compared to the diversity index according to Krebs (1985). Follow-up research by Mamulak and Semiun (2021) found that the diversity of riparian tree vegetation in the three springs of the Soba village, sub-district, was classified as bad and very bad, while species richness was classified as low to spring. It is due to the high anthropogenic activity around these springs.

This research was conducted to determine riparian tree types and water quality in Niukbaun Springs, Kupang district. Information regarding the role of riparian trees around springs and canals in water quality still needs to be improved. As a first step, it is essential to identify the diversity profile of riparian trees by collecting data on the quality of tree vegetation and water quality in springs and their canals. The information obtained can be used as recommendations for appropriate restoration, rehabilitation, and remediation strategies of degraded riparian tree vegetation and springs.

2. METHODS

2.1 Research Location and Time

This study was conducted in springs located in Niukbaun village, West Amarasi, Kupang regency. It was done in October 2022. The research location is presented in Figure 1.

Figure 1 Research location

2.2 Research Tools and Materials

The tools used in this research were GPS, Soil Tester 4 in one, a camera, meter rolls of 50 m and 100 m to create transect lines, rope for making plots, a label used to provide information on the sample, plastic as a mat for taking pictures of plants, scissors, and stationery. The materials used in this study were riparian trees found in spring and water samples.

2.3 Research Working Procedures

The sampling technique was the Quadrat Sampling Technique and was done randomly. The quadratic method is a method of vegetation analysis by using observation of sample plots; the area is measured in square units (Ufiza et al., 2018). In each plot, the researcher identified the plants. The identification of the plant used local names, then referred to scientific or binomial names of the plant. In general, the procedure for identifying plants follows the procedures: (1) using a dichotomous key, (2) matching specimen photos with pictures in reference standard books (3) asking botanists.

Furthermore, the number of individuals of each species was calculated. Plant specimens were taken to be photographed as evidence in the form of a "Digital Herbarium ."Furthermore, water quality measurements were also carried out with physical, chemical, and biological parameters. The measurement of biological parameters was done by using the MPN method.

2.4 Data Analysis

Data analysis applied in the study were endemism status, the Shannon-Wiener Diversity Index, and gap analysis between the physical-chemical water variable data at the observation site and the standard water quality criteria.

2.4.1. *Endemism status*

A literature study was conducted to determine the endemism status of tree species. The endemism boundaries used were species that grow naturally within the Malesiana photo region. On the other hand, species originating from outside the area were considered exotic plants.

2.4.2. *Shannon-Wiener Diversity Index*

$$H' = -\sum P_i LNP_i$$

Note:
H : Shannon-Wiener Diversity Index
Pi : Proportion of density of –I type= (ni/N)
Ni : Density of -i
N : Density of all types
K : Density

The range of the diversity index from the most damaged community to the most stable community is 1.5 – 3.5 (Liunima et al., 2022). Based on that diversity index range, each stage of the range was grouped as follows:
0 < 1.5 indicates a very poor diversity index
1,5 - 2,0 indicates a poor diversity index
2,1 – 2,5 indicates a moderate diversity index
2,6 – 3,0 indicates a good diversity index
> 3,0 indicates a very good diversity index

2.4.3. *Gap analysis*

The water quality profile was analyzed using gap analysis (comparison) between the physical and chemical variable water quality data with the standard water quality criteria based on Government Regulation No. 22 of 2021 and Permenkes No. 32 of 2017. Variables that can reach the established quality standard criteria then become an advantage. On the other hand, if a variable does not meet quality standards, it is considered a weakness and can become an ecological problem.

3. RESULTS AND DISCUSSION

3.1. Results

3.1.1. *Types of Riparian Trees in the Spring*

The vegetation habitat of riparian trees around spring in Niukbaun villages has been observed. All observed springs were surrounded by riparian vegetation. Riparian tree vegetation habitat was observed at less than 500 m dpl and categorized as a lowland.

Around the springs, the land is used for residential needs, which results in anthropogenic activities such as washing, bathing, and filling water tanks. Riparian is covered with three vegetation strata (B, C, and D). There are natural trees and some cultivated trees, for example, mango and coconut, with a riparian width of more than ≥ 50 m. There are 15 species of riparian tree vegetation found in the Niukbaun Springs, belonging to 11 families (Table 1). The species that are often found are from the Arecaceae family. Of the 15 tree species found, 20% are classified as exotic, and 80% are classified as endemic. It shows that native trees still dominate the Niukbaun Spring's habitat.

Table 1 Types of riparian trees in Niukbaun Spring

Family	Local name	Scientific Name	∑	Endemism status
Anacardiaceae	Mangga	*Mangifera indica* L.	7	Exotic
Arecaceae	Kelapa	*Cocos nucifera* L.	29	Endemic
Arecaceae	Pinang	*Areca Catechu* L.	32	Endemic
Arecaceae	Aren/enau	*Arenga pinnata* Merr	30	Endemic
Bombacaceae	Kapuk	*Ceiba pentandra* (L.) Gaertn.	4	Endemic
Dendrocnide	Jelatang Gajah	*Dendrocnide stimulans* Chew.	1	Endemic
Elaeocarpaceae	Belimbing hutan	*Aceratium oppositifolium* DC	1	Endemic
Euphorbiaceae	Kemiri	*Aleurites moluccana* (L.) Willd	1	Endemic
Meliaceae	Mahoni	*Swietenia mahagoni* (L.) Jacq.	34	Exotic
Moraceae	Beringin	*Ficus benjamina* L.	2	Endemic
Moraceae	Nangka	*Artocarpus heterophyllus* Lam	1	Endemic
Sapindaceae	Kesambi	*Schleichera oleosa* (Lour.) Oken	1	Exotic
Oxalidaceae	Belimbing	*Averrhoa carambola* L	1	Endemic
Verbenaceae	Jati merah	*Tectona grandis* L. f	1	Endemic
Verbenaceae	Jati putih	*Gmelina arborea* Roxb.	4	Endemic
Total			149	

3.1.2. *Diversity Index*

The index of the diversity of riparian trees found in the Niukbaun Spring is classified as poor, with a value of H' = 1.9. Based on Figure 2, *Swietenia mahagoni* (L.) Jacq., *Areca catechu* L., *Arenga pinnata* Merr, and *Cocos nucifera* L. have the highest H' values. It is due to the highest proportion of the four tree species found.

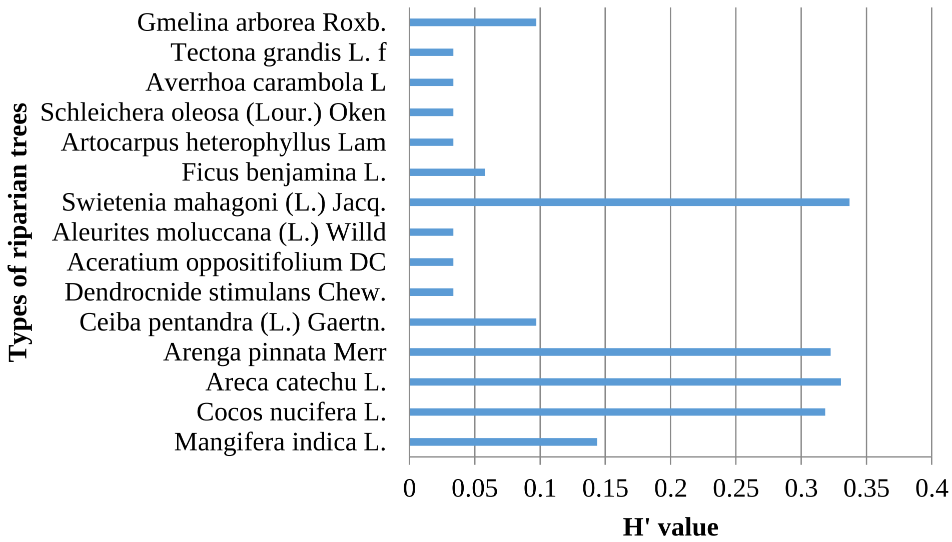

Figure 2 The value of the Riparian Tree Diversity Index in Niukbaun Spring

3.1.3. *Gap Analysis of Water Quality Parameters with Quality Standards*

Based on Table 2, almost all water quality parameters have met the quality standards, except for nickel (dissolved metal) which still needs to meet the specified quality standards. The nickel (dissolved metal) levels found were 0.094 mg/L, higher than the quality standard of 0.05 mg/L.

Table 2 Water quality in Niukbaun Spring

Water quality parameter	Result	Unit	Quality standard	Information
Physic				
TDS	386.5	Ppm	1000*	√
Water temperature	26.5	^{0}C	± 3	√
Conductivity	774.5	ms/cm		
Color	Colorless		Colorless**	√
Smell	No smell		No smell**	√
Chemistry				
pH	6.835		6-9*	√
DO	5.99	mg/L		
Salinity	0.03	$^0/_{00}$		
COD	< MDL	mg/L	10*	√
Iron (Dissolved metal)	0.036	mg/L	0.3*	√
Manganese (Dissolved metal)	< MDL	mg/L	0.4*	√
Cadmium (Dissolved metal)	< MDL	mg/L	0.01*	√
Nickel (Dissolved metal)	0.094	mg/L	0.05*	-
Nitrate	2.689	mg/L	10**	√
Nitrite	< MDL	mg/L	1**	√
Chloride	18.97	mg/L	300*	√
Sulfate	12.333	mg/L	300*	√

Note: * = quality standard of *PP NO 22 Tahun 2021*; ** = quality standard of *Permenkes NO. 32 tahun 2017*; MDL (*Method Detection Limited*), MDL COD = 3 mg/L; MDL Manganese = 0.03 mg/L; MDL, MDL Nitrite = 0.01 mg/L; MDL Cadmium = 0.02 mg/L; √ = Fulfill; - = no fulfill

3.1.3. *MPN testing*

Based on the Microbiology laboratory examination results at Widya Mandira Catholic University, the MPN/100 ml prediction test and confirmation test were 27. Then a complementary test was carried out using EMBA media at 37^{0}C and 44.5 ^{0}C. The observations at 37^{0}C revealed that there were bacteria with similar characteristics to *Proteus mirabilis*, *Klebsiella aerogenes*, and *E. coli*. Meanwhile, at 44.5^{0}C, bacteria with the same characteristics as *E. coli* were found. The bacteria indicate that the water in Niukbaun Springs did not meet the minimum water quality standards. The water in Niukbaun Springs can be used directly for bathing and washing, but if people want to consume it, it must first be boiled.

3.2. Discussion

Observations at the Niukbaun Springs location showed that there were 15 species of riparian trees belonging to 11 families consisting of Anacardiaceae, Arecaceae, Bombacaceae, Dendrocnide, Elaeocarpaceae, Euphorbiaceae, Meliaceae, Moraceae, Oxalidaceae, Sapindaceae, and Verbenaceae with a total of 149 individuals. The Arecacae family, along with the number of individuals, is the most commonly found species. It is because plants from this family can adapt to the habitat conditions of springs.

The riparian tree species with the most individuals are *Swietenia mahagoni* (L.) Jacq. With 34 individuals, *Areca catechu* L. with 32 individuals, *Arenga pinnata* Merr with 30 individuals, and *Cocos nucifera* L. with 29 individuals. Most riparian trees do not grow naturally but are cultivated by local people. Conditions around springs have been influenced by human activities such as bathing, washing, and paved road access, which can affect the diversity of spring trees. The diversity of riparian trees needs to be maintained, considering the essential functions and benefits of riparian vegetation in maintaining the quality of spring utilized by local communities. Decreasing the diversity of riparian vegetation can impact decreasing water quality (Semiun et al., 2020). The endemism status of the 15 tree species found in Niukbaun Springs was 80% classified as endemic and 20% classified as exotic. A plant species is endemic if its existence is unique and not naturally found in other areas. The term is usually applied to the geographical unit of an island or group of islands but may sometimes include a country, habitat type, or region. In this study, endemism was determined based on the Malesiana photo region, while species originating from outside the area were considered exotic plants.

The diversity of plant species in riparian ecosystems was analyzed using the Shannon-Wiener diversity index. The diversity index ranges from the most damaged to the most stable, 1.5 – 3.5. The diversity value found in these springs is classified as bad because the proportion of the abundance of tree species is not evenly distributed. Several species are very dominant, namely *Swietenia mahagoni* (L.) Jacq., *Areca catechu* L., *Arenga pinnata* Merr, and *Cocos nucifera* L. A good level of diversity can occur due to the distribution of abundance number of individuals in each family is evenly distributed (Liunima et al., 2022). Around springs, anthropogenic activities can change the structure and function of organisms that live in an aquatic ecosystem. Usually, the ecological response caused by pollution or other disturbances is in the form of a decrease in taxa richness, abundance and a shift in taxa composition from sensitive to tolerant taxa (Sudarso et al., 2013). There is a family that has a large abundance, namely Arecaceae. Differences in the structure and composition of an ecosystem cause differences in ecosystem characteristics that affect the diversity of biota that live in it (Paramitha & Kurniawan, 2017). The riparian vegetation at each station shows differences. Each region has its characteristic area of riparian vegetation that distinguishes it from other areas (Ainy et al., 2018).

The results of the physical and chemical water quality tests showed that almost all parameters met the water quality standards. Physical parameters meet water quality standards, while the chemical parameters of nickel (dissolved metal) do not meet the quality standards for water quality. The value of nickel content (dissolved metal) is 0.094 mg/L (>0.05 mg/L). Nickel is a type of heavy metal that is difficult to decompose, so it easily accumulates in the aquatic environment that can cause death to organisms, ecosystems, and humans (Wali et al., 2020). Research conducted by Wibowo et al. (2020) showed a relationship between community activities and the high nickel content that accumulates in the waters. Domestic waste/garbage dumped into the waters and accumulates impacts high levels of nickel.

Microbiological test results showed a type of bacteria with characteristics similar to the bacteria *Proteus mirabilis*, *Klebsiella aerogenes*, and *E. coli*. All three types of bacteria are classified as coliforms. Coliform bacteria are included in the bacteria that are dangerous for health because coliform bacteria are toxigenic. Coliform bacteria are used as indicators of faecal pollution and unfavorable conditions in water and food. If there are coliform bacteria in food or drink, then there are microbes that are harmful to health. The higher the level of coliform bacteria contamination in food or drink, the higher the risk of other pathogenic bacteria that normally live in human and animal feces in the food or drink, so water used for daily purposes is dangerous. It can cause infectious diseases (Razi & Syahputra, 2021).

4. CONCLUSION

In Niukbaun Springs, 15 species of riparian trees belong to 11 families consisting of Anacardiaceae, Arecaceae, Bombacaceae, Dendrocnide, Elaeocarpaceae, Euphorbiaceae, Meliaceae, Moraceae, Oxalidaceae, Sapindaceae, and Verbenaceae with a total of 149 individuals. Arecacae family and the number of individuals were the most common species found. The diversity index could have been better in Niukbaun spring. The results of the water's physical and chemical quality tests revealed that only the chemical parameters of nickel (dissolved metal) did not meet the water quality standards. The nickel content (dissolved metal) was 0.094 mg/L (>0.05 mg/L). In addition, microbiological tests found that the type of bacteria has similar characteristics to the bacteria *Proteus mirabilis*, *Klebsiella aerogenes*, and *E. coli*. Human activities impact the diversity of riparian trees and the quality of water in the Niukbaun Spring.

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