Research Article

Environmental Quality Analysis as An Environmental Restoration Evaluation Effort in Jajang Village River Basin District Poncokusumo Malang

Choirul Anam *, Lupita Oktaviona, Argus, Catur Retnaningdyah, Luchman Hakim

Laboratory of Animal Ecology, Department of Biology, Faculty of Mathematics and Natural Science, Brawijaya University, Malang

ABSTRACT

This study aims to determine the environmental quality of the watershed based on benthic macroinvertebrate community structure and riparian vegetation. Benthic macroinvertebrate sampling was conducted at two stations located in Jajang Dusun River. Each station is sampled at three different points each of ± 100 individuals. While the riparian vegetation takes place on the right and left of the river. The samples were identified and then determined the structure of the community which consisted of the abundance (K) and frequency (F) and performed further analysis by finding relative abundance (KR), relative frequency (FR), Importance Value Index (INP), Shanon-Wiener Diversity Index H). Riparian vegetation was analyzed by Taksa Richness (TR) and Eveness Index (E). Analysis of physiochemical data was done by measuring pH, conductivity, turbidity and temperature at each point. Based on vegetation analysis, station 1 has abundant riparian diversity with value of H, TR and E are much higher than station 2. It is also supported by benthic macroinvertebrate analysis which has important value index value, H and TR higher than station 2 and lower ID value. While the measurement of abiotic factors on both stations is quite balanced. Based on these results, although the quality of the two sites is good, there is a decrease in station 2 due to sand mining activities that affect station quality 2 and reduced riparian vegetation so that the absorption of pollutants becomes more reduced.

Keywords: Benthic macroinvertebrata, sand mining, riparian, watershed

Introduction

Watersheds (DAS) are part of aquatic ecosystems that are widely used as human activities, both associated with the utilization of riparian zones and river basin utilization activities. Watershed area in Jajang Village Poncokusumo District is an anthropogenic area that will affect the quality of waters there. Das Poncokusumo district is included in the Bromo Tengger Semeru Mountainous region. So increased human activity in the mountainous region of Bromo Tengger Semeru has an impact on the declining biodiversity of vegetation, fauna and river quality.

Water pollution generally is caused by the inclusion of organic and inorganic substances above the specified threshold [1]. Riparian vegetation can safeguard the quality of river water through the regulation of water temperature, erosion control and sedimentation, as a source of litter (energy) and pollutant pollutants from land that is brought to the river through runoff water [1,2,3,4,5]. Riparian vegetation is also an terrestrial wildlife habitat, a place for animals to seek shelter, mating and spawning [6].

The benthic community's diversity and abundance can also serve as an indicator of the physical and chemical quality of contaminated waters [7]. This is because benthic with their habitat is found in the substrate of the river bed which is relatively fixed, so it is affected by environmental changes due to environmental pollu-
tion. Macrobentos contribute substantially to the functioning of aquatic ecosystems [8] and play an important role in mineralization processes in sediments and organic material cycles [9].

The importance of riparian vegetation and benthic macroinvertebrate in aquatic ecosystems so that if the vegetation and benthic communities are disturbed, it will undoubtedly lead to disruption of the aquatic ecosystem. Therefore, the purpose of this study was to analysis at the quality of the watershed environment in Jajang Village, Poncokusumo Subdistrict, Malang Regency as an effort to conducted in river flow from the Mountain of Bromo Tengger Semeru.

Material and Methods

Study Area

This research was conducted on March 25, 2018, located at Jajang Dusun River, Sumberejo Village, Poncokusumo Subdistrict, Malang Regency. Location of station height 1 and 2 is at coordinate S 08 05'17.7" E 112 49'11.9" with height 1018 mdpl. Identification and calculation of benthic macroinvertebrata and data analysis were conducted at Ecology and Biodiversity Laboratory, Biology Department, Faculty of Mathematics and Natural Sciences, Brawijaya University, Malang.

Material and Methods

Study Area

This research was conducted on March 25, 2018, located at Jajang Dusun River, Sumberejo Village, Poncokusumo Subdistrict, Malang Regency. Location of station height 1 and 2 is at coordinate S 08 05'17.7" E 112 49'11.9" with height 1018 mdpl. Identification and calculation of benthic macroinvertebrata and data analysis were conducted at Ecology and Biodiversity Laboratory, Biology Department, Faculty of Mathematics and Natural Sciences, Brawijaya University, Malang.

Data Analysis

The benthic macroinvertebrate samples and riparian vegetation were identified subsequently determined by the community structure which consisted of the abundance (K) and frequency (F) of each species per station on three samples. Further analysis is performed by finding relative abundance (KR), relative frequency (FR), Important Value Index (INP), Shanon-Wiener (H) Diversity Index [5]. On riparian analysis was also analyzed Taksa Richness (TR) and Evenness Index (E). Analysis of physiochemical data was done by measuring pH, conductivity, turbidity and temperature at each point. Physiochemical data were then presented in graphical form.

Results and Discussion

Land Use Profile

Jajang River is a river that is located on the south side of Mount Semeru precisely in the area Poncokusumo located at an altitude of 1000 mdpl. The river cuts 2 parts that belong to TNBTS (river right) and Perhutani (left river). Based on Google Map image results, TNBTS area has a higher canopy intensity than Perhutani area. Much of Perhutani land has undergone agriculture land conversion. The practice of land conversion affects the decline of forest ecosystems, including productivity, biomass, standing structures, and species composition [11].

Differences in diversity (H’) and evenness (E) at the TNBTS and Perhutani areas are significant (Figure 2). Station 1 is a reference
site/natural zone for forest conservation in the mountains. The area is declared an important conservation area to protect high biodiversity in the forests of Bromo Tengger Semeru Mountains [12].

Figure 2. Diversity index, abundance and dominance of shrub level in Jajang river

Profile of Community Structure Benthic Macroinvertebrate on Jajang River

The benthic macroinvertebrate community structure in the Jajang river has different variations of taxa at both stations. The number of variations of taxa is more abundant at station 1 than station 2. The number of benthic macroinvertebrates identified are 14 species consisting of Psepenidae, Chironomidae, Perlodidae, Leptophelebiidae, Setipalpia, Leuctridae, Epimella, Rhyacophilidae, Elmidae, Heptageniidae, Dytiscidae, Filipalpia and Planaria. At station 1 the type of benthics is uniform and dominated by Coenagrionidae whereas in station 2 it is dominated by Perlodidae and Coenagrionidae (Figure 3).

Figure 3. An important benthic macroinvertebrate value index in in the Jajang river

The dominant taxa groups at station 1, Odonata, Coleoptera, Tricoptera, Ephemeroptera and Tricoptera are benthic macroinvertebrate groups that can only live in waters with good quality [10]. The Ephemeroptera taxa also belong to the benthic macroinvertebrate group which is sensitive to the high salt content indicated by the conductivity value [13]. In addition, the survival of Odonata taxa is supported by the presence of riparian vegetation. Similarly, a high current velocity factor determines the presence of Coleoptera taxa in aquatic ecosystems [14]. Types of taxa that dominate at station 2 consist of Odonata and Plecoptera which both indicate that the quality in the waters is quite good.

Water quality can be seen from Shannon-Wiener's diversity index (H'). Based on the value of H'(Figure 3), the water quality at station 1 (2.2) has a higher value compared to station 2 (3.2). The quality of the waters at both stations 2 in the category is not polluted because the H' value is above 2 which is a condition of uncontaminated waters. The value of H' can also describe the level of water pollution [15].

Figure 4. Diversity index, richness taxa and benthic macroinvertebrate dominance in Jajang river

The TR value at each station has different value with little difference. Station 1 is known as benthic abundance value of 14 and station 2 has value 11 thereby the largest benthic abundance is at station 1. The dominant index says that on station 1 there is little dominance marked with an ID
value less than 2. While dominance is strong at station 2 with the value of dominance close to 1.

**Abiotic Factor Profile in Jajang River Waters**

Water quality in both stations is almost the same. The pH value at the first location is about 6.52 and is not much different from the second location of 6.67 where the water quality is close to neutral pH (Figure 5a). This becomes a suitable place for benthic macroinvertebrate growth. The measured conductivity value has a fairly high difference (Figure 5b). The location of 1 river water conductivity ranges from 51 while in location 2 is 87. However, the conductivity value at the site meets the standards for drinking water or is good. The conductivity value for drinking water was <200μS/cm [16].

**Evaluation of Water Quality and Riparian Vegetation in Jajang River**

Based on the results of the analysis of the existence of sand mining activities in the river (station 2) have an impact on aquatic ecosystems. Despite the diversity index value, richness taxa and benthic macroinvertebrate dominance in both locations are considered good need attention. Long-term sand mining activities will destroy benthos macroinvertebrate habitats and will trigger erosion along the river.

The result of riparian vegetation structure analysis is good and there is a decrease in station 2. The steep river cliff condition and Perhutani area have few trees will trigger the landslide during the rainy season. Reduced number of trees in Perhutani area due to land conversion. Factor causes decline in water quality due to agricultural land use [19]. Land owned by Perhutani is leased to surrounding communities for agriculture.

Aquatic quality declined due to increased sediment activity and load on agriculture [20]. In addition, reduced vegetation as a surface water absorber and the inclusion of organic/inorganic substances from the use of fertilizers or pesticides [19]. The decreasing quality of these waters will be felt directly by aquatic organisms.

**Conclusion**

However, there are 2 factors that affect the quality of river ecosystem in Jajang Village that is the function of Perhutani land and sand mining activities. Sand mining activities should be monitored to avoid major damage in the river. Excessive sand mining will cause river erosion and affect the survival of aquatic organisms. There is a need for tree planting/revegetation in Perhutani to support environmental services and prevent landslides during the rainy season. The action can be done by giving insight and understanding to the people who are in Jajang Village. By means of persuasif expected to build their awareness to participate in maintaining the environment there. This is important considering the function of the area will be felt directly by them.

**Acknowledgment**

Authors thanks to Departement of Biology, Faculty of Mathematics and Natural Science. Therefore, we are grateful for this funding and support of this research.
References
1. Mason, CF. 1991. Biology of freshwater pollution. Longman Scientific and Technical. John Wiley & Sons. Inc, New York: 73-148.
2. Mitsch WJ & Gosselink JG. 1993. Wetlands. Ed. ke-2, New York: Van Rostrand Reinhold.
3. Jones EBD, Helfman GS, Harper JO, Bolstad PV. 1999. Effects of riparian forest removal on fish assemblages in Southern Appalachian streams. Conservation Biology 13 (6):1454-1465. doi.org/10.1046/j.1523-1739.1999.98172.x
4. Johnson, BL, Richardson WB, Naimo TJ. 1995. Past, present, and future concepts in large river ecology: how rivers function and how human activities influence river processes. BioScience 45 (3): 134-141. doi.org/10.2307/1312552.
5. Tourbier JT. 1994. Open space through stormwater management. Journal of Soil and Water Conservation 49 (1):14-21.
6. Mitsch WJ & Gosselink JG. 1993. Wetlands. Ed. ke-2. Van Rostrand Reinhold, New York.
7. Sawitri R & Bismark M. 2005. Keragaman benthos sebagai indikator kualitas ekosistem perairan hutan produksi. Jurnal Penelitian hutan dan Konservasi Alam 2(5):519-526. doi.org/10.20886/jphka.2005.2.5.519-526.
8. Vyas V & Bhawar A. 2013. Benthic community structure in barna stream network of Narmada river basin. Intl J Environ Biol 3 (2): 57-63.
9. Vyas V, Bharose, S. Yousuf S. Kumar, A. 2012. Distribution of makrozoobenthos in river Narmada near water intake point. Nat Sci Res 2(3): 18-25.
10. Bae YJ, Kill HK, Bae KS. 2005. Benthic macroinvertebrates for uses in stream biomonitoring and restoration. KSCE Journal of Civil Engineering 9 (1): 55-63.
11. Foley JA, Defries R, Asner GP, Barford C, Bonan G, Carpenter SR, Snyder PK. 2005. Global Consequences of Land Use. Science 309(5734): 570–574.
12. Bennett EM, Carpenter SR, Caraco NF. 2001. Human impact on erodible phosphorus and eutrophication: A global perspective: Increasing accumulation of phosphorus in soil threatens rivers, lakes, and coastal oceans with eutrophication. Bioscience 51(3):227-234. doi.org/10.1641/0006-3568(2001)051[0227:HOEPA]2.0.CO;2.
13. Dunlop J, Gregor Mc,G, Horrigan N. 2005. Potential impacts of salinity and turbidity in riverine ecosystem. national action plan for salinity and water quality, State of Queenslands.
14. Badawy RM, El Hoseny I, Talal M. 2013. Biodiversity and seasonal fluctuation of aquatic and semiaquatic insects in rashid stream, kafr el zayat (Gharbeya governorate). Egyptian Academic Journal of Biological Sciences (A.Entomology) 6(1): 47-66. doi:10.21608/EAJBSA.2013.13819.
15. Kalyoncu H & Zeybek M. 2011. An application of different biotic and diversity indices for assessing water quality: A case study in the Rivers Çukurca and Isparta (Turkey). African Journal of Farming Research. 6(1): 19-27. doi: 10.5897/AJAR09.323.
16. National Health. 2004. Australian Drinking Water Guidelines. National Health and Medical Research Council, Sydney.
17. Mandaville SM. 2002. Benthic macroinvertebrates in freshwater-taxa tolerance values, metrics, and protocols. Soil and Water Conservation Society of Metro Halifax.
18. Veronica E, Leksono AS, Soemarno, Arifiati D. 2014. Effect of water quality on phytoplankton abundance in hampalam river and fish pond of Batanjung village. Journal of Environmental Science, Toxicology And Food Technology 8(1):15-21.
19. Wood S, Sebastian K, Scherr SJ, Pilot. 2000. Analysis of Global Ecosystems: Agroecosystems. International Food Policy Research Institute and World Resources Institute,Washington, DC.
20. Pagiola S, Rosés JH, González JF. 2016. Evaluation of the permanence of land use change induced by payments for Environmental Services in Quindío, Colombia. PLoS ONE 11(3):1-18. doi.org/10.1371/journal.pone.0147829.