The Effect of Land Use on Vegetation Diversity and Naturalness Level at Amprong's Riparian Zone in Tumpang District

Hamdani Dwi Prasetyo[1] and Majida Ramadhan[1]

[1] Biology study program, Faculty of Mathematic and Natural Science, University of Islam Malang, East Java, Indonesia
hamdani.dwiprasetyo@unisma.ac.id

Abstract. Land use often causes environmental degradation to decrease. The land conversion carried out is thought to have an impact on the diversity of vegetation in the riparian zone. Thus, this study was conducted to determine the impact of land use on vegetation diversity and the natural level of the riparian zone. The sampling location was determined by purposive sampling based on the land use along the Amprong river, Tumpang sub-district. Furthermore, human activities are determined in the riparian zone of the Amprong river according to land use at five observation points. Vegetation diversity is determined by measuring relative density, relative frequency, and relative dominance. In addition, the Naturalness level is measured from the level of land use based on the three-level classification system of the Corine Land Cover (CLC) Nomenclature. The value of the hemeroby index is determined based on the results of the classification based on the nomenclature. The results show that the majority of agricultural community activities occur along the riparian zone of the Amprong river. The use of the riparian zone as a settlement is of rare intensity. In the riparian zone, there are anthropogenic activities that occur which have an impact on plant diversity. Plant diversity in the riparian zone is dominated by O. hirtelus, G. quadriradiata and Syngonium sp. at each station. The most common agricultural areas are rice fields, and agriculture with annual crops and natural vegetation. Both are included in the category of arable land and heterogeneous agricultural area. The hemeroby level of all stations is at the Euhemerobic level with moderate human impact, and -Euhemerobic with strong human impact.

Keywords: Diversity, Hemeroby, Land use, Naturalness.

1 Introduction

Ecosystems provide a variety of material and non-material services that contribute to human well-being. Ecosystems supply necessary resources for the organisms. Ecosystems provide a range of direct materials such as food and freshwater production. Then, non-material services such as climate regulating, carbon sequestration, water purification and aesthetic benefits (MEA, 2005). The provision of ecosystem services

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is directly related to the type of land use and land cover and management practices in a particular area.

Globally, ecosystem services is declining due to overexploitation, invasive species, pollution, and climate change, which often act synergistically to alter ecosystems (MEA, 2005). Changes in land use and land cover can alter the provision of ecosystem services and affect human and natural well-being. Land use change is currently causing many changes in natural ecosystems (Vitousek et al., 1997; Wrbka et al., 2004; Zhao et al., 2006; Rockström et al., 2009; Costa et al., 2017).

Amprong riparian zone has been reduced in area due to the development of human activities and is under great anthropogenic pressure. Ecosystems contribute to economic development by providing various services (Vargas et al., 2019). Changes in the Amplong riverbanks due to anthropogenic activities such as land-use change, urbanization, agriculture and overexploitation have been reported. Land-use dynamics are the basis for significant impacts on nature and ecosystem services. The consequences of recklessness and exploitation of natural resources are becoming highly hostile and threatening to future generations (Xiao et al., 2019; Western, 2001).

The Amprong riparian has been largely converted to other land uses, mainly for agribusiness activities. Agribusiness is the main driving force behind the transformation of the Ampron Waterfront. The agricultural comodity (e.g. rice field, vegetables, sugar cane field, etc) generates impacts for the natural systems, due to hydro-chemical changes, pesticide input, and the erosion occasioned by marginal vegetation degradation, a situation that directly reduces the provision of water ecosystemservices (Mello et al., 2020). Another implication of land-use change is the loss of the landscape's naturalness and, consequently, the biodiversity loss (Fonseca & Venticinque, 2018; Hidasi-Neto et al., 2019). Areas with intensive agricultural use, for example, tend to have a lower degree of landscape naturalness and ecological stability (Rüdisser et al., 2012; Silva et al., 2017).

The situation is even alarming. For example, observations of herpetofauna in West Java show that the presence of species depends on the existing vegetation in the ecosystem. A number of vegetation are economically dominant in several places. Much consists of settlements, shrubs, ricefields, agroforestry, production forests, ricefield, and swidden cultivation (Megantara et al., 2022). Intensive use of chemical pesticides and fertilizers in agriculture makes amphibians exposed and can cause death within a period of one hour to one week (Brühl et al, 2013). The negative effects of pesticides on amphibians are assumed due to their highly permeable skin properties, allowing gas, water, and electrolytes from their bodies with the surrounding environment (Lillywhite 2009; Brühl et al. 2013). Many human activities can potentially disrupt ecosystem services.

Therefore, it is imperative to develop approaches to verify land-use change and assess ecosystem services. Such measures will inform decision-making and enable management of natural ecosystems, especially in the Amplong riparian zone. Furthermore, analyzes that consider watersheds help examine the impact of direct (indirect) drivers on ecosystem service delivery and assessment of natural system function (Periotto & Tundisi, 2018).

We hypothesize that the land use change at Amprong riparian zone is capable of promoting the reduction of ecosystem services provision. Therefore, we evaluated the land use of a watershed characterized by the anthropogenic activities and mapping of land use. Vegetation analysis is used to evaluate the level of diversity of land use change impacts. Structural landscape indicators are employees to verify naturalness and a matrix to verify the main structures that provide ecosystem services.

2 Methods

Study Area. The research location was carried out in the Amprong River, Tumpang District, Malang Regency. 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. Sampling site consist of five sites with three repetitions.

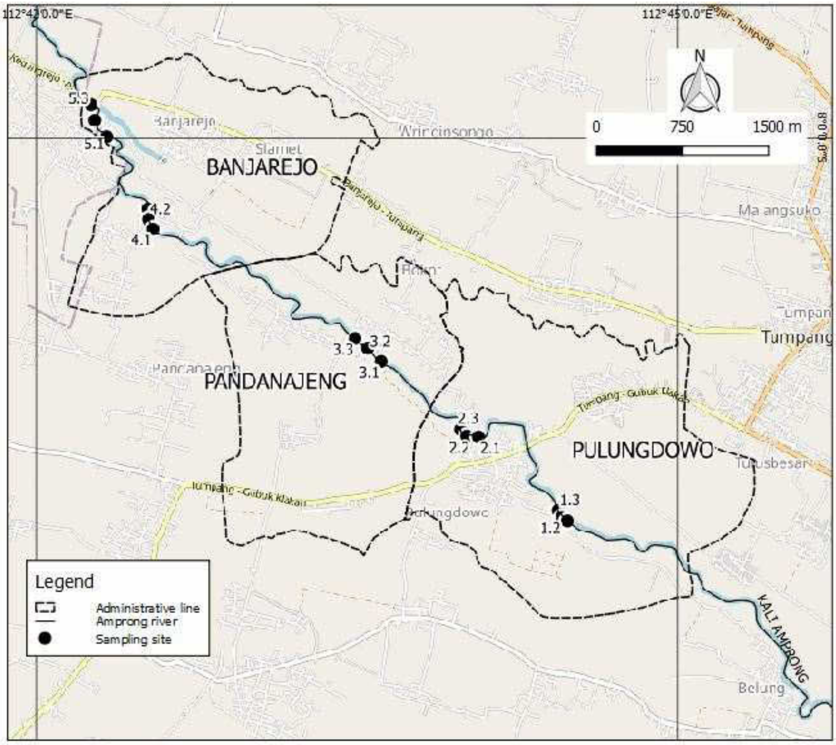


Fig. 1. Sampling site of study area

Our study is located in the Amprong River (8°01'18.7"S 112°44'29.0"E to 7°59'24.1"S 112°42'15.3"E) with 9 sample points. The Amprong River is a lowland water flow with catchments dominated by agricultural activities. The observed amprong riparian zone is 50 meters from the riverbank based on the riparian management zone for protection of habitat features, functions, and fish conservation processes (Miller et al., 2000).

Coordinate retrieval was carried out at 9 sample locations. The sample locations were marked using a Garmin Oregon 650 gps. The data was transferred from the GPS to the computer. Data was processed using Quantum Geographic Information System Desktop version 2.18.28. To obtain a base map, it is done by opening the Indonesia Geospatial Portal website, then the Malang Regency area is selected and downloaded.

Diversity Measurement. Data collection was carried out by making plots, each at station 1 to station 3 (Table 1) in August 2021. Plant communities were surveyed in August when aboveground biomass was at its peak. Nine quadrats (200 cm x 200 cm) were selected to determine species richness, frequency and coverage. Sedges, grasses, and legumes, were found in amprong riparian zones are classified. The coverage was estimated by the visual method (Nau et al., 2019). The collected information was used to measure the basal area, Relative Frequency (RF), Relative Density (RD), and Relative Abundance (RA), which were then used to calculate the IVI of each species. After calculating the IVI, it is followed by measuring the level of diversity for each observation location. The level of diversity measured by Berger Parker Index using Paleontological Statistics (PAST) software version 4.04 (Hammer, et al., 2001).

Hemeroby Level. This study was guided by the analysis of naturalness, which was based on hemeroby level. Hemeroby is an index that classifies the landscape according to the naturalness degree, therefore, it is classified from the natural to the cultural. Sukopp (1972) defines hemeroby as an integral measurement of human interventions over the ecosystem, that is, the total result of the impacts on a particular area based on land use.

Table 1. Hemeroby Level

Degree of hemeroby		Typical habitats and vegetation types
1	Ahemerobic	Almost no human impacts
2	Oligohemerobic	Weak human impacts
3	Mesohemerobic	Moderate human impacts
4	β-euhemerobic	Moderate-strong human impacts
5	α-euhemerobic	Strong human impacts
6	polyhemerobic	Very strong human impacts
7	metahemerobic	Excessively strong human impact; Biocoenosis destroyed

In determining the value of the disturbance index or Hemeroby index, direct observations are made in each area. Observations carried out in the field are observing human activities in each area. After making observations, records of disturbances caused by human activities are recorded. The level of disturbance is characterized by human activity in the form of soil mechanical disturbance (including soil compression, plowing, drainage, and waste deposition). In addition, activities in the form of direct mechanical disturbance to vegetation (logging of plants) as well as chemical disturbances (fertilization and use of pesticides) are parameters in determining the Hemeroby disturbance index value (Steinhardt, 1999).

3 Result and Discussions

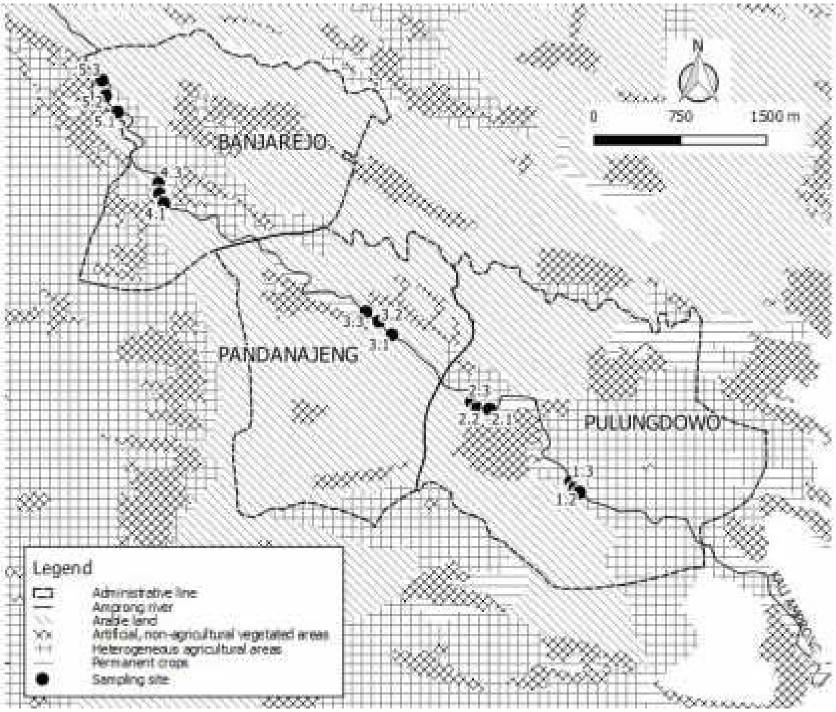


Fig. 2. Map of Land use of Amprong riparian zone

The Amprong River passes through the villages of Pulungdowo, Pandanajeng and Banjarejo. Based on Figure 2, there are several types of land use that can be found, namely arable land, heterogeneous agricultural areas, and permanent crops. Three types of land use around the Amprong river are the result of human modification for economic needs. Arable land in the Amprong riparian zone is planted with rice. Meanwhile, the heterogeneous agricultural area is planted with Multipurposes Tree Species such as jackfruit (Artocarpus heterophyllus), banana (Musa paradisiaca Linn.), avocado (Persea americana Mill.), mango (Mangifera indica L.), durian (Durio zibetinus Murr.), coffee (Coffee canephora Pierre.). The majority of people choose a number of these plants because they are useful from an economic standpoint. Multipurposes Tree Species are very easy to find in the fields and are able to provide for the needs of the community. Understanding of economic concepts also influences community entrepreneurship (Firdaus, 2017). However, MPTS planting also has an impact on biodiversity. According to Wulandari et al. 2018, MPTS planting has a low diversity value. To support conservation activities, it is necessary to increase the number of tree species, product volume, and the educational role of MPTS. This will have a positive impact on the environment and society.

Table 2. Land use of Amprong riparian zone based on CORINE Land Cover (CLC) Nomenclature

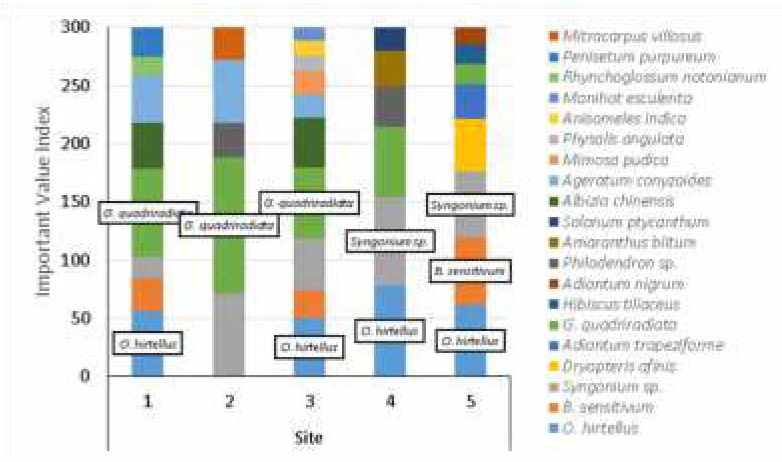
Site	Land Cover Class	Degree of Hemeroby
1.1	Land principally occupied by agriculture, with significant areas of natural vegetation	α-euhemerobe - β-euhemerobe
1.2	Fruit trees and berry plantations, Complex cultivation patterns	α-euhemerobe - β-euhemerobe
1.3	Complex cultivation patterns, Road and rail networks and associated land	α-euhemerobe – metahemerobe
2.1	Land principally occupied by agriculture, with significant areas of natural vegetation	β-euhemerobe
2.2	Land principally occupied by agriculture, with significant areas of natural vegetation	β-euhemerobe
2.3	Land principally occupied by agriculture, with significant areas of natural vegetation	β-euhemerobe
3.1	Land principally occupied by agriculture, with significant areas of natural vegetation, Dump sites	β-euhemerobe - polyhemerobe
3.2	Complex cultivation patterns, Road and rail networks and associatedland	α-euhemerobe - metehemerobe
3.3	Complex cultivation patterns, Road and rail networks and associatedland, dump sites	α-euhemerobe - polyhemerobe
4.1	Land principally occupied by agriculture, with significant areas of natural vegetation	β-euhemerobe
4.2	Complex cultivation patterns, Road and rail networks and associated land	α-euhemerobe - metahemerobe
4.3	Complex cultivation patterns	α-euhemerobe
5.1	Green urban areas	β-euhemerobe
5.2	Green urban areas, Road and rail networks and associated land	β-euhemerobe - metahemerobe
5.3	Green urban areas	β-euhemerobe

Based on table 2, the majority of land cover classes at each observation point are Land principally occupied by agriculture, with significant areas of natural vegetation (site 1.1; 2.1; 2.2; 2.3; 3.1; 4.1). This condition is often found because the community's agricultural areas are close to areas that are still natural. Some wild plants are still found and there has been no land conversion. Land conversion was not carried out because the area is a riparian buffer. The community understands that there is a riparian buffer that needs to be maintained because it can protect the soil fromerosion. This is good in maintaining soil consistency in agricultural areas. The presence of a riparian buffer is very important in mitigating river sediments that flow through agricultural areas (Sirabahenda et al., 2020). In addition, the riparian buffer becomes a habitat for wild species thereby supporting the diversity of flora and fauna. Riparian buffers are important sites in providing ecosystem services both for themselves and for the surrounding area (Cole et al., 2020). Even so, there is still a dump site at site 3.1. The dump site was indeed built by the community. The existence of a dump site in this area is enough to disrupt the ecosystem. Unorganized domestic waste causes waste to enter agricultural areas, rivers and settlements. But this is not considered a problem for the community. The lack of knowledge about the impact of waste entering the area of human activity tends to cause people to ignore the environment. Incoming waste will endanger human health and the environment (Hidayat et al., 2019). Educational efforts on waste management need to be carried out in order to avoid disturbance to the Amprong Riparian Zone area.

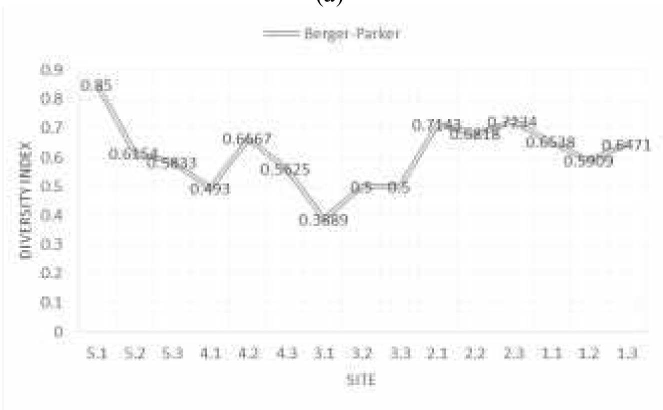
Another land cover that is mostly found in the Amprong riparian zone is Complex cultivation patterns. Agriculture in the villages of Pulungdowo, Pandanajeng, and Banjarejo is indeed dominated by paddy fields with rice plants, but at several sites, several complex cultivation patterns were found. Many lands are found planted with various vegetables such as chilies (Capsicum annum and Capsicum frutescens), tomatoes (Solanum lycopersicum syn.), shallots (Allium cepa var.), garlic (Allum sativum Linn.), kenikir (Cosmos caudatus Kunth.) , kale (Ipomoea aquatica Forsk.), etc. These plants are cultivated plants that are needed and have a sale value.

Site 5 is a unique place with many settlements found close to a riparian buffer filled with bamboo. Site 5.1 has a fairly wide riparian buffer of almost ± 20 meters filled with bamboo plants. While site 5.2 is adjacent to a road with little buffered riparian vegetation. But at site 5.3 there is a construction area. In the construction area there is almost no vegetation to be found because soil excavation has been carried out. The escavation process often ignores the presence of species in the environment. This construction process causes biodiversity loss. Destruction of ecosystems leads to the loss of publicly known or unknown species. This is due to the lack of understanding regarding the potential use of ecosystems (Handayani, 2018).

Hemeroby levels at several sites are similar. Based on table 2, it is known that the majority for sites 2 and 5 are in the β-euhemerobe category. It can be interpreted that sites 2 and 5 are relatively far from natural. Because sites 2 and 5 are included in that level is the use of fertilizers and pesticides. The escavation activities for urban settlement development are included in the metahemerobe category. While site 1 has similarities with site 4 which is in the category of α-euhemerobe, β-euhemerobe, and metahemerobe. α-euhemerobe conditions were found at sites 1.2, 1.3, 4.2, and 4.3 which indicated deep plowing and intensive application of pesticides and fertilizer. In general, the conditions for α-euhemerobe and β-euhemerobe tend to be similar, but there is a polyhemerobe condition which is indicated by the presence of a dump site. The existence of a dump site causes the closure of the biotope which has an impact on biocenosis destruction (Steinhardt et al., 1999; Jasinavičiūtė & Veteikis, 2022).



(a)



(b)

Fig. 3. Importance Value Index (a) and Berger-Parker Diversity Index (b)of Riparian Zone at Amprong's River

In general, the Amprong riparian zone has a large abundance of pioneer species and is concentrated in the riparian buffer shown in fig 3a. Site 1 found seven species, among others, Oplismenus hirtellus, Hibiscus tiliaceus, Syngonium sp., Dryopteris afinis, Biophytum sensitivum, Adiantum trapeziforme, Adiantum nigrum, and Galinsoga quadriradiata. The results of the Importance Value Index (IVI) assessment show that site 1 is dominated by Galinsoga quadriradiata and Oplismenus hirtellus in the riparian buffer area. The type of land cover at site 1 is land principally occupied by agriculture, with significant areas of natural vegetation, fruit trees and berry plantations, complex cultivation patterns, road and rail networks and associated land.

Site 2 found five species including, G. quadriradiata, Syngonium sp., Ageratum conyzoides, Philodendron sp., and Mitracarpus villosus. The results of the Importance Value Index (IVI) assessment show that site 2 is dominated by Galinsoga quadriradiata and Syngonium sp. in the riparian area of the buffer. The land cover type at site 2 is predominantly land occupied by agriculture, with significant areas of natural vegetation. Vegetation at site 2 is less compared to site 1. The presence of species at site 2 is less because the agricultural system is more destructive by cutting most of the vegetation because the community suspects it to be a weed.

Site 3 is similar to site 1 where the vegetation is dominated by Galinsoga quadriradiata and Oplismenus hirtellus. However, 10 species were found at site 3 including Manihot esculenta, Anisomeles indica, Physalis angulata, Mimosa pudica, Ageratum conyzoides, B. sensitivum, Albizia chinensis, Syngonium sp., O. hirtellus, and G. quadriradiata. Site 3 is close to community settlements. The community grows several cultivated plants that are used for daily needs. In contrast to sites 1 and 2, the type of complex cultivation patterns is carried out by the community. Land cover complex cultivation patterns are generally planted with several fruit and vegetable crops.

Site 4 found 6 species including Solanum ptychanthum, Amaranthus blitum, Philodendron sp., G. quadriradiata, Syngonium sp., and O. hirtellus. The dominant land cover type at site 4 is complex cultivation patterns. While site 5 found 8 species including Adiantum nigrum, Hibiscus tiliaceus, G. quadriradiata, Adiantum trapeziforme, Dryopteris afinis, Syngonium sp, B. sensitivum, and O. hirtellus. Based on previous results, site 5 was excavated, but the species richness at site 5 was greater than site 4. This was due to the narrower riparian buffer site 4. In addition, more human settlements are present in the riparian zone, resulting in less richness of site 4's taxa. In contrast to site 5 which has a riparian buffer in the form of a large number of bamboo trees to provide shade that supports the growth of a number of species.

Based on fig 3b, some sites have high index values. Sites 1, 2, 4 and 5 have an average index value of > 0.5 which indicates the community is dominated by the most common species. Under disturbance, the community was dominated by common species namely G. quadriradiata, Syngonium sp., and O. hirtellus. However, in this study it is also known that site 3 has high β-diversity. The high β-diversity indicates that the dominance of the most common species is not too large. This indicates that disturbance at site 3 does not significantly affect diversity. Meanwhile, disturbances at sites 1, 2, 4 and 5 put pressure on vegetation so that plants that are sensitive to disturbance cannot survive. The survivability of sensitive plants is also inseparable from human activities in eliminating a number of species that are considered weeds (Pigino & Migliorini, 2006).

4 Conclusions

Amprong riparian zone has land cover types of arable land, heterogeneous agricultural, and permanent crops. Land cover conditions are affected by anthropogenic activities in the three villages. Land cover changes are intended to gain profits by planting cultivated plants that have high economic value. Thus, the majority of land cover is land principally occupied by agriculture, with significant areas of natural vegetation and complex cultivation patterns. Ecosystem disturbance in the form of dump sites is the cause of the decrease in the degree of hemorrhoids. The impact of this ecosystem disturbance is the destruction of the biocenosis due to the presence of external material in the form of waste. Other impacts can be seen with the dominance of the most common species such as G. quadriradiata, Syngonium sp., and O. hirtellus. This greatly affects the survivability of species that are vulnerable to disturbance.

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