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Ecological functions of vegetation of riparian in preventing landslide of upper Ranoyapo River, North Sulawesi - Indonesia

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Riparian as an ecosystem plays an important role in maintaining river water quality. Riparian vegetation located on the banks of rivers has ecological functions that ensure riparian functions run optimally. The upstream river has ecological functions as an area designated as a soil and water conservation area so that the functions and benefits of a river can be sustainable. The Ranoyapo River which is the main river of the Ranoyapo River Basin is an important ecosystem for human and wildlife. This function and value can work well if the ecological function of riparian vegetation at the upstream part of the Ranoyapo River is also maintained. This study aims to analyze the ecological function of riparian vegetation in preventing prone landslides from the upper reaches of the Ranoyapo River, North Sulawesi, Indonesia. The method used is the survey method with direct observation at three points in the upper reaches of the Ranoyapo River. The results of the study indicate changes in land use from forest to agricultural land. The upstream part of the dam is built to drain irrigation water. Natural riparian vegetation in the form of trees is not much caused by the use of land as agricultural land. Riparian vegetation in the form of trees found, among others, *Ficus* and *Syzygium*. Riparian vegetation in the form of fruit trees. The many vegetation found is in the form of understorey vegetation. The pattern of land clearing upstream which causes a landslide of a cliff at some point. High rainfall can increase the flow and strong flow of the river so that the flow of river water erodes the cliffs of the river resulting in cliff landslides. This can cause changes in river morphology and river organism structures.

Keywords: riparian vegetation, cliff landslides, cliff erosion, landslide mitigation, Ranoyapo River

INTRODUCTION

Ranoyapo River which is the largest river of the Ranoyapo River, South and Southeast Minahasa, which plays an important role for residents and wildlife. The Ranoyapo River upstream serves as an area of soil and water conservation. During the rainy season, the flow of the upstream Ranoyapo River is very strong which can cause a landslide that can threaten the safety of residents who live or utilize riparian as agricultural land. Riparian vegetation found in riparian has an ecological multifunction that is important in maintaining river water quality. One of the mechanisms carried out by riparian vegetation in maintaining river water quality is maintaining the stability of river banks. The roots of certain vegetation can maintain the soil structure so that it is not an landslide. This cliff landslide is not only detrimental to residents living on the banks of the river but also decreases the water quality of the Ranoyapo River. The purpose of this study was to analyze the riparian vegetation to maintain the water quality of the Ranoyapo River through the control of the landslide of the Ranoyapo River cliff.

MATERIALS AND METHODS

The study was conducted in nine (9) points along the upstream Ranoyapo River in South Minahasa Regency. The observation points are scattered in various different land uses, namely secondary forests, mixed gardens, and bushes of 3 points each. The research was conducted during the dry season. This study uses a purposive random sampling method. Determination of purposive sampling sites in each type of riparian land use for cliff landslide mapping and vegetation analysis. The line transect method (Soerianegara and Indrawan 2008) was used in vegetation analysis in riparian. The location can be on the left and / or right bank of the Ranoyapo River depending on the edge of the vegetation types.

Analysis of vegetation is carried out at all levels of trees (seedlings, poles, saplings and trees) and understorey (lianas, herbs, shrubs and grass). The plot length is adjusted to the width of the riparian vegetation zone. Plot size of 20 mx 20 m for tree observation (diameter> 20 cm), 10 mx 10 m for poles (diameter 10-20 cm), 5 mx 5 m for stakes (height ≥ 1.5 m, diameter <10 cm) and 2 mx 2 m for seedlings (up to 1.5 m high). Observation of root morphology is done visually by paying attention to the root type. Riparian vegetation samples were collected and preserved with 96% alcohol. Furthermore, the vegetation is dried in an oven at 40-50ºC for about 48 hours before identification.

RESULTS

Research shows the occurrence of cliff landslides at several points. Riparian vegetation in the form of trees include *Ficus* and *Syzygium*. High rainfall will increase the flow velocity and flow of river water so that cliff erosion will occur. Soil structures that contain a lot of sand will accelerate cliff erosion. The pattern of land use which was originally forested into agricultural land in the Ranoyapo River Basin played a role in increasing the speed of this flow. Buildings in the form of dams upstream, Station I, have caused changes in riparian vegetation. Dams have eliminated riparian vegetation which has the potential to maintain the stability of river cliffs. This change decreases the ecological function of riparian vegetation.

The Ranoyapo River has economic value for people's prosperity. This can be seen from the utilization of the Ranoyapo River water as an irrigation source for agriculture, especially lowland rice. The pattern of changes in cliff land, especially in the upstream area, has reduced the function of the Ranoyapo watershed in storing rainwater in the rainy season. The ability of vegetation in the form of trees can store rainwater in the rainy season so that the surface flow is not large which will maintain the speed of the river flow. This pattern of change will cause an increase in river currents, thus affecting cliff landslides.

The pattern of changes in land cover has caused quite dangerous erosion in the upstream Ranoyapo River. The roots of the tree riparian vegetation are not strong enough to withstand the erosion of strong river water. This can cause changes in river morphology which on one side can cause an increase in habitat but on the other hand can change the structure of river organisms. Cliff erosion can change the structure of the river bed which can threaten the sustainability of river aquatic organisms.

The pattern of changes in land cover in the upstream Ranoyapo watershed has caused sharp river fluctuations. Research in the dry season shows low river water levels. This greatly threatens the sustainability of aquatic organisms, especially in the upstream. Another thing that is high water discharge in the rainy season will cause strong river cliff erosion.

Riparian utilization as agricultural land causes a decrease in the ability of riparian vegetation to prevent cliff landslides. Riparian vegetation at Station III (downpart) in the form of bushes and grasses cannot suppress cliff avalanches by strong river currents. The soil structure that contains a lot of sand causes the stiffness to become stronger.

CONCLUSION

This geomorphological process is a natural process that impacts riparian vegetation. The increasing of landslide processes occur due to changes in land use in the Ranoyapo Watershed. Agricultural activities can increase the flow of the river thereby increasing the pressure on riparian vegetation. The pattern of land clearing in the upstream area causes cover of riparian vegetation to decrease. The effort that can be done is to maintain the integrity of riparian vegetation along the upstream.

CONFLICT OF INTEREST

The authors declared that present study was performed in absence of any conflict of interest.

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AUTHOR CONTRIBUTIONS

RS designed the research, collected survey data, analyzed the data and wrote the manuscript. NSA carried out the laboratory work. PS collected survey data. All authors read and approved the final version

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