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Submission date: 08-May-2023 07:36AM (UTC+0700)
Submission ID: 2086897685
File name: 10_Akbar_2021_BP_13414D_230506_211123.pdf (259K)
Word count: 2785
Character count: 15234

Chapter 10
Print ISBN: 978-93-5547-176-5, eBook ISBN: 978-93-5547-177-2

Soil Vegetation Engineering Model to Maintain Distribution from Water Debit at Watershed Area of Krueng Pase North Aceh

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DOI: 10.9734/bpi/rppsr/v3/13414D

ABSTRACT

The increasing land use changes can alter the existence of vegetation cover on open land such as paddy fields and mooring into grass or shrubs, plantations, and tend to increase the proportion of land area built. Vegetative technology is often chosen because in addition to reduce erosion and sedimentation in rivers also have economic value (productive crops) and can restore the water system of a watershed. The researcherr used a model of soil vegetation engineering to maintain water distribution in Krueng Pase watershed in North Aceh District. To achieve these objectives, a model of grass vegetation was adopted as a water and land conservation strategy in the Krueng Pase Basin of North Aceh Regency. The model of grass vegetation can withstand runoff and increase infiltration. The average of plant retention to hold rain water in this research is for land (without vegetation) 33%, grass and herbs 77%, and shrub 81%. Meanwhile, to know the water denit used non-linear regression equation. The results show that vegetation grasses and other soil cover crops can withstand erosion and sediment. The relationship between water discharge and sediment was obtained by coefficient of determination (R^2 = 0.98). This shows the water debit due to precipitation affecting the sedimentation volume.

Keywords: Land use; vegetative technology; grass vegetation; watershed; water discharge.

1. INTRODUCTION

The Increasing land use changes can alter the existence of vegetation cover on open land such as paddy fields and mooring into grass or shrubs, plantations, and tend to increase the proportion of land area built. Vegetation density is one of the factors affecting infiltration capacity in one place. The function of vegetation can effectively reflect the soil's ability to absorb rainwater, maintain or increase infiltration rate, and demonstrate the ability to retain water or water retention capacity (Schwab 1997 in Agustina, Fanny, & Rita, [1]). According to Hardjowigeno [2] infiltration is the process of entering water from the soil surface into the soil. Infiltration effect on the start of surface runoff or run off. Hydrological infiltration is important, as it marks the rapid transition of surface water to groundwater that moves slowly from groundwater. Vegetative technology is often chosen due to the decreasing erosion and sedimentation in rivers also have economic value (productive crops) and can restore the water system of a watershed [3]. The vegetative approach is an effort to control erosion and/or soil/water preservation by utilizing the role of plants to reduce soil erosion and preservation. Vegetation implementation may include reforestation and reforestation activities, planting cover crops, planting contour lines, planting in strips, rotating crops, and mulching or utilizing plant litter. Different land uses have an impact on different soil characteristics, giving different effects on the infiltration rate. Based on the above problems, it is necessary to study the rate of soil infiltration on various land use, slope and soil type in the Krueng Pase watershed [4].

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The Watershed Areas (DAS) is a water catchment area that can regulate the water system. Therefore, the watershed needs to be preserved so that it can function optimally so that the water needs is sufficient [5]. The Krueng Pase watershed is located in North Aceh Regency with an area of 43,587 ha, which has the type of soil, slope and different land cover. Land cover in Krueng Pase watershed consists of secondary forest area of 11,207.41 ha, 2,660.88 ha of shrub, dry land of 7,032.79 ha, mixed plantation covering 4,919.26 ha, plantation with an area of 11,141.50 ha, with an area of 4,892.17 ha, open land with an area of 45.57 ha and a water body of 1,524.68 ha [6]. In addition slope is another factor affecting the condition of a watershed in addition to land use. Upper river basin area located on the plateau which is generally dominated by land with slope above 15% [7]. Meanwhile, Arsyad [8] adds that the slope of the slope shows the angle of the slope in percent or degree. Two horizontally spaced points 100 meters high 10 meters apart form 10% slopes. The steepness of the slope is 100% equal to 45 degree steepness. Apart from enlarging the number of surface streams, the steeper the slope also increases the water transport energy. If the slope grew larger, then the number of grains of soil splashed down by the rain fall will be more and more, so that the infiltration rate of the soil will be disturbed. Another thing that makes the potential of critical land in the Krueng Pase watershed increases, due to forest conversion. Critical land increased by 38,682.99 ha consisting of: critical 15,797.35 ha, critically critical 3,403.22 ha, very critical 18,786.58 ha, critical potency 695.85 ha and uncritical 4,904.82 ha [6]. As the population increases, the forest conversion becomes more agricultural land and other land uses, which also leads to lower water infiltration into the soil. This is in accordance with the proposed by Huat, Ali, & Low [9] that forest conversion resulted in a decrease in the amount of water reserves in the soil reservoir and increased surface flow. Decreasing the amount of water reserves in the reservoir results in a decrease in the availability of clean water that can be utilized by the community. In this research, a model of soil vegetation engineering was created to maintain water distribution in Krueng Pase watershed in North Aceh District.

2. METHODS

The vegetative model in soil and water conservation strategies is the management of plants in such a way as to suppress the rate of erosion and surface flow. Vegetative model is chosen because in addition to reducing erosion and sedimentation in rivers also have economic value (productive crops) and can restore the water system of a watershed. The model is used to determine the flow of water in Krueng Pase watershed North Aceh. Debit measurement, calculated using non linear regression equation.

To know the flow and sediment discharge, made in the form of a graph depicting the position of a series of coordinate points as a result of data ploting. The vegetation modeling steps, shown in Figure below:

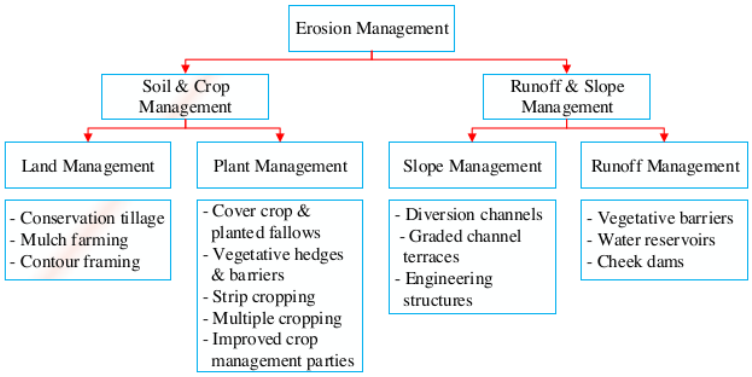

Fig. 1. Soil vegetation model

3. RESULTS AND DISCUSSION

Krueng Pase Watershed is one of the Watershed Areas located in North Aceh District, which has a land area of 43,587 ha with territorial boundaries, the north is bordered by Krueng Mane watershed, south by Jambo Aye watershed, with Krueng Peusangan watershed and the East bordering Krueng Keuretau watershed. Vegetation is an important component of the watershed ecosystem. One of the role of green land around the watershed according to Wikantika, Sinaga, Hadi, & Darmawan [10] is a component of erosion and drought support. The diversity of vegetation in the basin of trees and lower floor plants can serve as an indicator in determining the quality of the cliffs around the watershed so that it can be used as an alternative to prevent landslides and erosion around the watershed Maridi & Saputra [11] because vegetation cover affects the soil's ability to retain water. The potential of vegetation in supporting water and soil conservation in the watershed can be realized by applying the vegetative model as a watershed conservation strategy [11].

Implementation of the vegetative model as a water and land conservation strategy in the watershed with grass planting. Vegetation of grasses and other cover crops can withstand erosion and sediment. The grass vegetation based on Maridi & Saputra [11] is able to withstand the average sediment of 1.2 m^3/hectare. This is supported by the results of [12] study which stated that vegetation and thick grass are effective types of vegetation in preventing erosion when compared with overlapping plants, cotton plants, and corn crops. Plant roots can significantly improve soil stability and act as anti-erosion. The potential of bush and grass plants in soil and water conservation in the watershed is reinforced by Maridi & Saputra [11] in the Samin Basin that the presence of shrubs and grasses such as Mimosa pudica, Ageratum conyzoides, Tridax procumbens, and various other grass species in the middle and downstream areas is an important potential in the conservation of the Samin watershed. Bush and grass plants have the potential to be developed in water and soil conservation efforts. This is as shown in the results of [13] studies that grass vegetation can withstand runoff and increase infiltration. The average of plant retention to hold rain water in this research is for land (without vegetation) 33%, grass and herbs 77%, and shrub 81%. The highest percentage was in shrubs, ie 81%. This means that bush plants can hold water at 81% of the discharge water. The shrub is a woody floor covering and has a good root system, and high ground cover. When compared to open land (without plants) there is a considerable difference in retaining rainwater retention. Open land is only able to withstand rainwater retention on average by 33%.

The results of the model analysis, show the flow of water due to rainfall to the volume of sedimentation. The analysis shows that the increase of sedimentation rate is influenced by rainfall. If rainfall increases, the sediment increases, and vice versa if the sedimentation rate decreases, the rainfall also decreases. More is shown in Fig. 2 below.

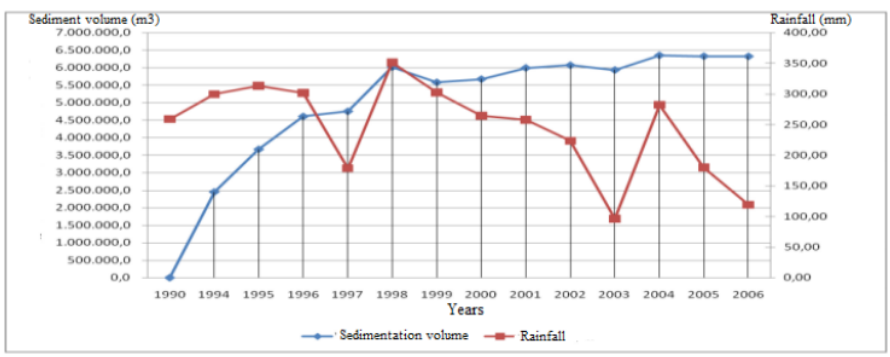

Fig. 2. The relationship of rainfall with sedimentation rate of Krueng Pase River

Based on the result of non linear regression analysis data from year of measurement (X as independent variable) to sedimentation rate (Y as dependent variable) with several times non linear

regression analysis by exponential regression model, rank regression, logarithmic regression and the corresponding multiple regression is the polynomial regression. The results of the analysis are shown in Fig. 2. The model of sedimentation rate in Krueng Pase watershed due to erosion occurring in the upper watershed of Jambo Aye Sub-basin, the result is developed by Polynomial Order-2, namely: with the coefficient of determination (R^2 = 0.98) (time measurement) to the sedimentation rate (variable Y) is 98% while the remaining 2% is determined by other variables. The model has been tested with a 95% confidence level accepted with degrees of freedom for two-way test obtained thus the boundary of the confidence region is by standard deviation hence obtained the trust area.

4. CONCLUSION

Implementation of the vegetative model as a water and land conservation strategy in the watershed with grass planting. Vegetation of grasses and other cover crops can withstand erosion and sediment. The model of grass vegetation can withstand runoff and increase infiltration. The average of plant retention to hold rain water in this research is for land (without vegetation) 33%, grass and herbs 77%, and shrub 81%. The highest percentage was in shrubs, ie 81%. This means that bush plants can hold water at 81% of the discharge water. When compared to open land (without plants) there is a considerable difference in retaining rainwater retention. Open land is only able to withstand rainwater retention on average by 33%. Result of analysis of water debit and sediment with non linear regression equation obtained relationship: with coefficient of determination (R^2 = 0.98). This shows the water debit due to precipitation affecting the sedimentation volume. If rainfall increases, the sediment increases, and vice versa if the sedimentation rate decreases, the rainfall also decreases.

COMPETING INTERESTS

Author has declared that no competing interests exist.

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Halim Akbar is a lecturer at Universitas Malikussaleh, Aceh Utara who was born in Banda Aceh, 6 June 1967. He was graduated from Soil Science Department, Faculty of Agriculture, Universitas Syiah Kuala in 1993. He later obtained his master's degree in Watershed Management, IPB University in 2006 where he also earned his doctorate in 2013. He is now also teaching at several private universities in Aceh Utara beside his full-time career as a lecturer at Universitas Malikussaleh. He also has completed and published a scientific book and several journal articles.

Book:
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Journal Articles:

1. Treatment Limbah Industri Pulp dengan Metode Filtrasi untuk Menjaga Kualitas Air DAS Ciujung (2015),
2. Optimalisasi Lahan Usahatani Berbasis Kakao Untuk Pembangunan Pertanian Berkelanjutan Di Das Krueng Seulimum Provinsi Aceh (2015)
3. Evaluasi Kemampuan Lahan dan Teknik Konservasi Di DAS Krueng Seulimum Kabupaten Aceh Besar (2015)
4. Pemetaan dan Kesesuaian Lahan Tanaman Pangan di DAS Krueng Pasee Kabupaten Aceh Utara (2017)
5. Estimated Contaminated Area of Air Pollutant from Industrial In Cilegon (2017)
6. Erosion Prediction and Soil Conservation Planning in Krueng Seulimum Watershed Aceh Province (2018)
7. Tingkat Laju Infiltrasi Tanah Pada Das Krueng Mane Kabupaten Aceh Utara (2018)
8. Climate-based Land Optimization to Increase Agricultural Production in Banten Province (2019)
9. Amelioration Technology to Overcome of Water Stress in Sub-Optimal Paddy Fields and its Relationship with Growth and Yield of New Types of Local Rice (*Oryza sativa* L.) (2019)
10. Mapping of Soil Infiltration Rate in Krueng Meueh Watershed Aceh Province (2019)
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