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Critical Land Rehabilitation Strategy with Agroforestry Pattern

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A B S T R A C T

Critical rehabilitation must provide economic and social contributions to the community around critical land. This study aims to determine the strategy for the essential rehabilitation of land, especially in areas of community land. The research method with secondary data collection consists of basic and thematic maps, climate, population, and socio-economic data, as well as the potential for suitable forest plants. Land units are units of analysis obtained from overlaying slope maps, soil types, and land cover. The observation location is the representative sample location in land units selected using stratified random sampling techniques. The socio-economic survey locations are several villages around critical land whose communities interact directly or indirectly with critical land. The survey results show several limiting factors that will inhibit the development of vegetation types, namely climate, slope, and soil. Patterns that can be developed include a combination of fruit-producing NTFPs, annual plants in legumes, and applying gold terraces with terrace reinforcements in the form of elephant grass as animal feed. Another pattern combines fruit-producing vegetation types planted according to contour lines

INTRODUCTION

Critical land is one area with an important meaning, is very strategic, and has experienced deforestation and degradation. In Indonesia, the area of degraded land reaches 12,744,925 Ha, with details in the Forest Area of 7,410,751 Hectares and outside the Forest Area of 5,334,174 Ha. (BPS, 2022). Efforts to rehabilitate critical land have been carried out through various programs, including the Forest and Land Rehabilitation Movement (German). On the other hand, rehabilitation efforts must provide economic and social contributions to the community around the critical land and align with the objectives of managing the critical land itself (Indah et al, 2023). Thus, choosing the correct location, with potential types and appropriate silviculture techniques, is important. Land degradation conditions or degradation potential can be used to determine the target location for critical land rehabilitation (Andriyani et al., 2017). One of the potential types that can be developed in critical land rehabilitation efforts is the development of vegetation tree plants. This is logical because using critical land can potentially increase industrial and housing raw materials in the form of wood products. The selection of types to be developed must also consider aspects of market availability, mastery of cultivation technology, land suitability, and aspirations of the community around critical land (Anang et al, 2025).Almost all critical land areas have cultivators in them. Therefore, a mixed pattern between forest and annual plants plants is an alternative planting pattern while still aiming to restore and maintain the ecological function of critical land (Austin et al, 2019).

LITERATURE REVIEW

Critical land management is currently carried out by the community in Nganjuk Regency, namely by having independent farmer groups supported by the local government with various critical land areas. According to the results of the land inventory, the quality of land cover conditions in Nganjuk Regency is ± 32,372 ha in the form of less productive dry land. In comparison, the fairly productive land area with moderate density is ± 43,052 ha for forest land ± 47,007 ha (BPS, 2021). Therefore, efforts are needed to rehabilitate critical land to return to its function and be more productive (Syafjanuar et al., 2021). This study aims to determine the strategy for rehabilitating critical land, especially in the land area owned by the community in Nganjuk Regency. Rehabilitation strategies include locations to be rehabilitated, appropriate plant types, and planting patterns. In addition, it is also expected that this can provide an alternative picture of the process that needs to be carried out to rehabilitate critical land in other plac.

METHODOLOGY

This research was conducted in the critical land area owned by the community on the slopes of Mount Wilis in 2023. In the initial stage, secondary data collection was carried out consisting of basic and thematic maps, climate, population and socio-economic data as well as the potential for suitable forest plants.

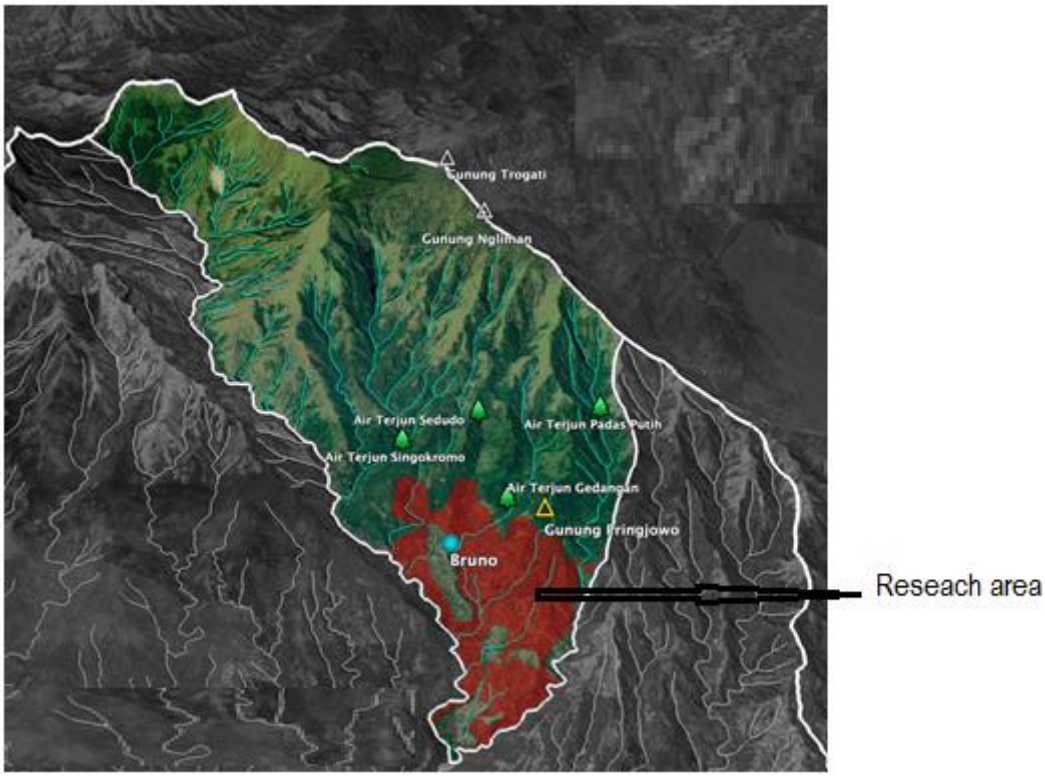

Figure 1. Critical land Area Research

The next stage, based on the collected data, is preparation before the field survey activity, consisting of determining the land unit, the location of field measurements and observations, and the location of the community's socio-economic survey. Land units are analysis units obtained from overlaying slope maps, soil types, and land cover. The observation location is the representative sample location in land units selected using stratified random sampling techniques. The socio-economic survey locations are several villages around critical land whose communities interact directly or indirectly with critical land.

The main activities in the field survey are observation and measurement of geophysical conditions, soil sampling, and socio-economic surveys. The location of geophysical observations and soil samples is a land unit determined in the previous stage. The geophysical data observed are land characteristics (landform, condition, and type of vegetation), soil characteristics (soil solum, soil drainage, soil structure), surface rocks and rock outcrops, and dominant vegetation. The soil samples taken are disturbed and undisturbed. They are then analyzed to determine their properties, including texture, permeability, soil nutrients such as N, P, and K, C-organic, pH, Cation Exchange Capacity (CEC),

and soil Cations. The community socio-economic survey was conducted using an interview method using a questionnaire. Important information explored was community participation in critical land management, especially rehabilitation activities, community perceptions of critical land, benefits of critical land, and community interaction with critical land. Respondents were selected using purposive sampling.

Rainfall and climate data were analyzed using simple arithmetic consisting of monthly and yearly amounts and averages. If there is more than one rainfall station, then it is necessary to create a Thiessen polygon first. The climate type is determined based on the grouping according to Schmidt and Ferguson (Schmidt and Fergusson, 1951). Other biophysical data such as land conditions, soil properties, and vegetation are analyzed descriptively, both qualitatively and quantitatively, using descriptive statistics

Indicative locations must be rehabilitated based on a combination of landslide and erosion vulnerability in each land unit. The unit of analysis is the land unit. The level of landslide and erosion vulnerability in this study was determined using the scoring method. The cross table for determining rehabilitation priorities is presented in Table 1.

Table 1. Cross Table of Priorities that Must be Rehabilitated

llandslide vulnerability		**erosion vulnerability**			
	very vulnerable	**vulnerable**	**somewhat vulnerable**	**slightly vulnerable**	**not vulnerable**
Very Vulnerable	1	1	2	2	2
Vulnerable	1	2	2	3	3
Somewhat Vulnerable	2	2	3	3	4
Slightly Vulnerable	2	3	3	4	4
Not Vulnerable	2	3	3	4	4

The socio-economic data obtained is divided into data sourced from secondary data collection and interview results. Several variables determined based on secondary data and support from interview results are geographic population density, agrarian population density, dependence on land, basic regional activities (LQ), and population pressure (TP).

A type suitability analysis is carried out to determine the appropriate type for the rehabilitation of critical land at each location that must be rehabilitated. The kind of suitability analysis unit is the location's land unit that must be rehabilitated. The types of vegetation analyzed are several types that have been utilized by the community or have the potential to be developed on critical land within the rehabilitation framework. Land suitability classification is carried out using the matching method.

RESULTS AND DISCUSSION

Socio-Economic Conditions of Communities Surrounding Critical Land

The critical land area on the slopes of Mount Wilis, Nganjuk Regency, is included in 3 Districts and 40 Villages. The population density of villages around critical land ranges from 110 people/km2 to 814 people/km. The agricultural sector is the primary activity sector in most villages around critical land; this is indicated by an LQ value of more than 1. Based on the agrarian density value, villages around critical land generally only have one farmer working on less than 1 ha of agricultural land. This is also supported by data on average land ownership of 0.48 ha/KK for villages around critical land. This condition shows that most of the land in villages around critical land cannot accommodate many more farmers in agricultural activities. The population's dependence on land is also relatively high, as indicated by a TP value > 1, and the proportion of income derived from agricultural activities is quite large. The results of interviews in several villages around critical land show that the population's average income ranges from Rp. 2,000,000 – Rp. 2,700,000/month and more than 75% of the revenue comes from agricultural activities. Therefore, as a consequence, critical land areas are targeted to meet the population's need for land so that they are vulnerable to degradation. In terms of institutions, some institutions have the potential to be actively involved in land rehabilitation, namely land farmer groups

Locations to be Rehabilitated

The critical land area on the slopes of Mount Wilis, which is directly adjacent to settlements, has a relatively enormous potential for degradation. This is based on the socio-economic conditions of the surrounding community, which include a high level of population pressure on land (TP> 1), high population dependence on land, and low land ownership area. The selection of erosion and landslide vulnerability in determining the location to be rehabilitated is based on the fact that landslides and erosion will affect the ecological function of critical land as a life support and water system regulator (Miles et al., 2016). Figure 2 presents a map of priority rehabilitation locations based on the results of the analysis.

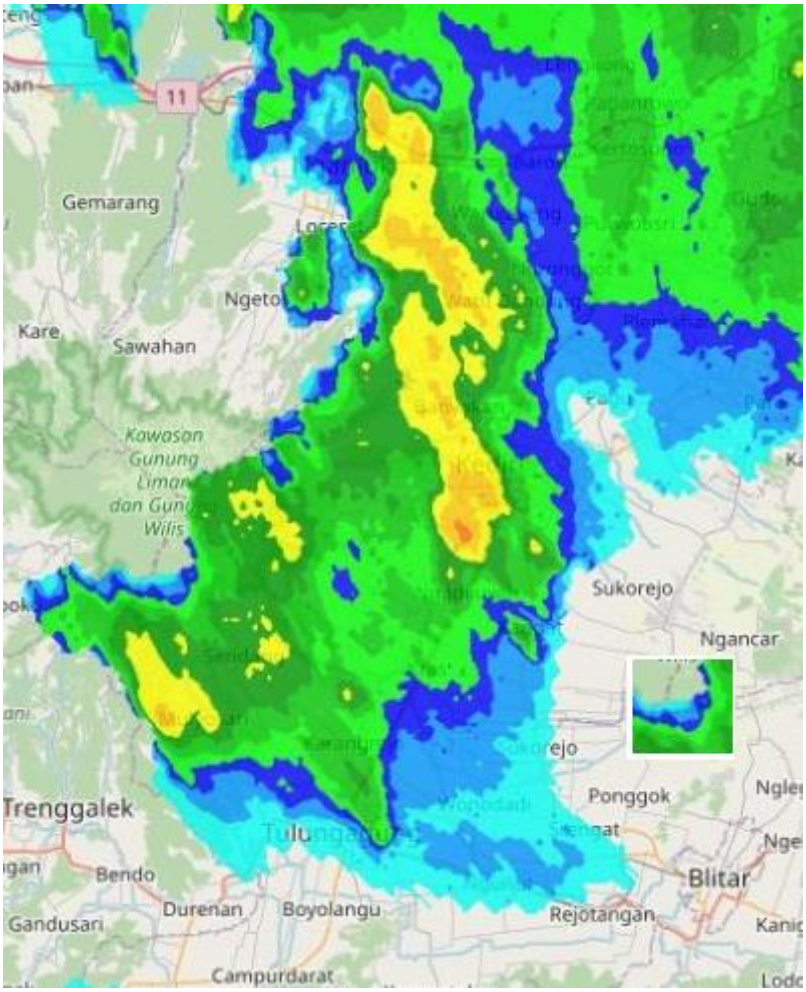

Figure 2. Distribution of Priorities for Critical Land Rehabilitation on The Slopes of Mount Wilis

The results of the geophysical analysis show that priority location 1 is dominated by steep slopes, with land cover in the form of shrubs and mixed agriculture. Priority 2: the hill is more varied from gentle to steep, and land cover is dominated by secondary land. Priorities 3 and 4 also have varying slopes and primary land cover. Generally, the soil in locations that must be rehabilitated has a low C-organic content and N elements but relatively high P and K elements.

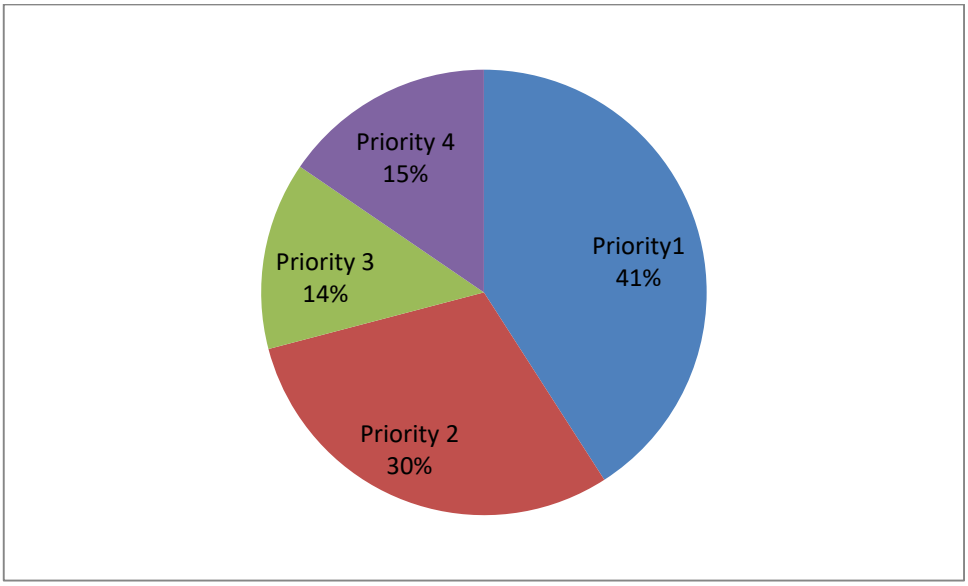

Figure 3. Geophysical Location Analysis of Reseach Area

Suitability of Vegetation Types for Critical Land Rehabilitation

The suitability of the type of vegetation to be developed with the land conditions and aspirations of the community is another essential factor. In this study, an analysis of the land suitability of each priority location that must be rehabilitated has been carried out. Based on the results of interviews with the community around the critical land, the type of vegetation that produces fruit is the leading choice for development in the essential rehabilitation of land. However, other Biofuel (BBN) sources, such as sampling, depth, and essential oil producers, can be used as alternatives. Results of the Land Suitability Analysis on table 2.

Tabel 2. Results of Suitability Analysis of Several Types of Vegetation

Rehabilitation Priority	**limiting factors**	**appropriate type (S2) and marginal (S3)**
1	Slope,climate ,land	eucalyptus, jackfruit, sapodilla, kepuh, breadfruit, mango, soursop
2	Slope,climate ,land	candlenut, agarwood, durian, clove, jackfruit, sapodilla, breadfruit, mango, soursop , aren
3	Slope,land	candlenut, agarwood, durian, clove, jackfruit, breadfruit, mango, soursop, cempedak, aren
4	climate ,land	, cempedak, aren , agarwood, durian, clove, eucalyptus, jackfruit, sapodilla, kepuh, breadfruit, mango

Results of the Land Suitability Based on the suitability analysis of the type, several limiting factors will inhibit the development of vegetation types, namely climate, slope, and soil. The limiting factor of climate is closely related to water availability, including relatively longer dry months and annual rainfall. Several limiting factors related to soil properties are soil texture and nutrient content. In some locations, the nutrient content is included in the low or even very low category according to Hossain et al. (2020) classification. Steep slopes are another limiting factor in rehabilitating critical land based on perennial plants.These limiting factors can be overcome with different resource and technology use levels. In general, to overcome the limiting factors of water, soil, and topography availability, applying appropriate Soil and Water Conservation (SWC) techniques is the best solution (Ramadhan et al., 2016).

The SWC strategy must increase water reserves in the plant root zone by controlling surface flow, increasing infiltration, and reducing evaporation (Sundawati et al., 2020). Fertilizer application in critical land rehabilitation activities based on NTFPs can be carried out on lands with macronutrient limitations. The fertilizer used can be organic, readily available around the location, and can be adjusted to the needs of plants and land conditions. Several research results show that organic fertilizers have been able to improve soil structure, determine the level of soil structure development, and play a role in the formation of soil aggregates to increase moisture storage capacity because organic materials have a high moisture storage capacity (Wiryono et al., 2022).

Figure 4. Agroforestry Planting Patterns Applied to Critical Land Rehabilitation

Agroforestry Patterns in Critical Land Rehabilitation

The agroforestry pattern is suitable to be applied in the framework of critical land rehabilitation in the mountain wilis with the appropriate NTFP-producing staple crops. Some of the considerations behind this are that most of the locations that need to be rehabilitated already have cultivators, so they need to be involved in a partnership pattern (Fadillah et al., 2020), more optimal land use so that it can provide additional income for cultivators, and most importantly, agroforestry is a vegetative KTA technique that can criticize the soil from the destructive power of raindrops, criticize the soil from the destructive power of surface flow, improve soil infiltration capacity, and maintain soil moisture so that it can support plant growth (Gebremeskel et al, 2021). Some patterns that can be developed include a combination of types of NTFPs that produce fruit, annual plants in legumes, and the application of gold terraces with terrace reinforcements in the form of elephant grass as animal feed. Another pattern is a combination of types of fruit-producing vegetation planted according to contour lines

CONCLUSION AND RECOMMENDATION

The rehabilitation strategy for critical land on the Wilis slopes generally aims to restore critical functions, benefit the surrounding community, and be by the management plan. The strategies that have been carried out are as follows: Determining the correct location with parameters that can be used are vulnerability to landslides, erosion, and socio-economics. Selection of the correct type of vegetation based on land suitability, community aspirations, market availability, and potential for future development. Vegetation can be developed as a fruit producer and a source of BBN and essential oils. The agroforestry pattern is the right choice for rehabilitating critical land by combining types of vegetation as staple crops with annual plants and sources of animal feed.

FUTHER STUDY

This research still has delays, so further research related to the Critical Land Rehabilitation Strategy With Agroforestry Pattern needs to be conducted to enhance this study and broaden the readers' understanding.

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