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POLICY MODEL OF DEGRADED LAND CONTROL IN THE ANAI WATERSHED WEST SUMATRA PROVINCE - INDONESIA

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ABSTRACT: Increasing population growth has an impact on the need for land, giving rise to conflicts in its utilization. Land use conflicts lead to the growth of degraded land. The aim of this research is to determine the degraded land index and policy directions for controlling degraded land in the Anai watershed. To determine the degraded land index using a GIS approach with four indicators, namely: percentage of land cover, slope, soil depth, and land management. Next, to determine the direction of degraded land control policies using the AHP approach. The research results show that around 48% of the Anai watershed is degraded land. The results of the analysis of the AHP approach to policy strategies in controlling degraded land show that there are three priority directions, namely: 1) increasing community knowledge about forests; 2) increasing community skills regarding the added value of forest products; and 3) strengthening the institutions of indigenous community groups in forest areas.

Keywords: AHP approach, degraded land, GIS approach land change, policy

1. INTRODUCTION

The population always observes an increase every year, so the need for land also increases. Limited land that can support human life encourages conflicts of interest in land use [1]. Land use conflicts always overpower natural functions to become non-natural land, resulting in reduced catchment areas [2]. The impact of uncontrolled land change will cause land degradation [3,4]. In addition, changes in land use also cause loss of soil fertility due to erosion [5,12]. Furthermore, uncontrolled changes in land use will eventually have an impact on increasing the area of critical land [6,7].

Improving the community's economy in an area can have an impact on changes in land use. Increasing the community's economy has resulted in changes in protected areas to other uses, both for plantations, settlements, and industry [8]. Furthermore, this condition is exacerbated in many places by the weak government control to prevent and stop it [9]. In addition, the economic factors of landowners cause land around forest areas that serve as buffers to be sold for plantation areas [10, 11]. This condition contributes greatly to environmental degradation and natural disasters. Future environmental crises include loss of biodiversity, ecosystem damage, and soil nutrient poverty [13].

According to Minister of Forestry Regulation No. P.32/Menhut-II/2009, critical land is defined as land that is in a condition that is not functioning properly based on its designation as a medium for production and water management. Degraded land is influenced by several factors, namely: changes in land use, slope, erosion, and area management. According to these factors, the Anai watershed has great potential for the formation of degraded land. Because based on land use around 5-7% every year the forest area has decreased, high sedimentation in rivers, and 35% more has steep to steep slopes. Therefore, the purpose of this research is to develop a degraded land control model in the Anai watershed.

2. METHODS

2.1. Place and time of research

The Anai watershed has an area of 70.046,45 ha, most of which are administratively located in Padang Pariaman Regency. Astronomically the watershed is located at longitude 100º12'-100º28' E and latitude 0º21'-0º51' LS. The Meteorology, Climatology and Geophysics Agency for the Sicincin Climate Station West Sumatra, recorded that the Anai watershed for the period 2000-2020 had an average rainfall of 4.056 mm/year with 172 rainy days. The Bogor Soil Research Institute

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described six types of soil in the Anai watershed, namely: Alluvial, Regosol, Padsolic, Latosol, Organosol and Andosol. In the lowlands along the river flow there are Alluvial, Regosol and Andosol soil types, while in hilly areas there are Podsolic and Latosol. Demographically, the population of the Anai watershed in 2022 is recorded at 64,568 people with 92 people/km^2. Furthermore, this research was conducted for 8 months, from July 2022 to February 2023. Figure 1 presents the research location of the Anai Watershed.

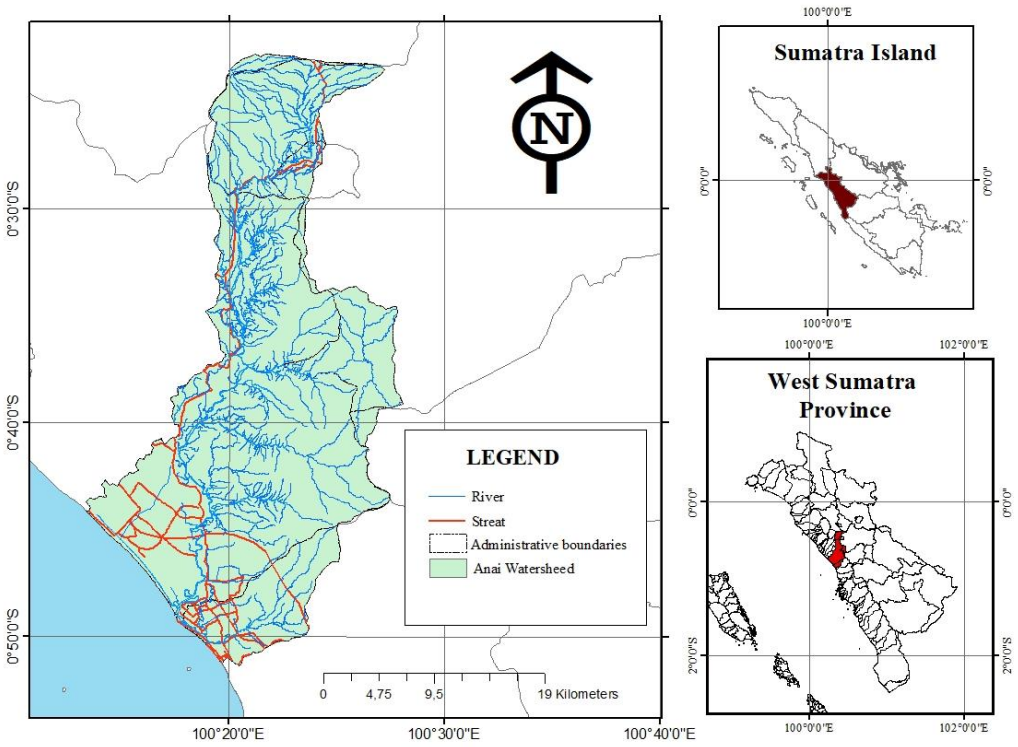


Fig.1 Research location map

2.2. Data analysis technique

Degraded land can be determined using four indicators, namely: the percentage of land cover, slope, surface erosion, and land management [16]. To determine the percentage of land use, it can be determined using Operational Land Imager / OLI Landsat 8 imagery in 2021 with a resolution of 30 meters [8]. The slope of the slope can be determined using Shuttle Radar Topography Mission/SRTM imagery. Furthermore, to determine the soil erosion hazard level it can be known from the effective depth of the soil by looking at the soil solum [16]. Forest management is based on the completeness of boundary data, area security, and supervision [17]. Table 1 presents indicators for determining critical land.

Table 1. Degraded land indicators

Indicator	Sub Indicator	Score
Land cover (LCLU)	>80 %	5
	61-80%	4
	41-60%	3
	21-40%	2
	<20%	1
Slope (Sl)	Flat (0-9%)	5
	Ramps (9-16%)	4
	Slightly steep (17-26%)	3
	Steep (26-40%)	2
	Very steep (>40%)	1
Soil depth (S)	Very deep (>90 cm)	5
	Deep (60-90cm)	4
	Medium (30-60cm)	3
	Shallow (10-30 cm)	2
	Very shallow(<10cm)	1
Land management (LM)	Complete	5
	Incomplete	3
	There isn't any	1

Source: Minister of Forestry Number P.32/Menhut-II/2009

The Degraded land index is determined using equation 1. Where**,** Cli is the degraded land index**;** LCLU is the percentage of land cover**;** Sl is the slope**;** S is the soil depth**;** and LM is land management. Each indicator has a different weight, and the weight will be multiplied by the score.

$$Cli = (15.LCLU)+(10.Sl)+(5.S)+(5.LM) \quad (1)$$

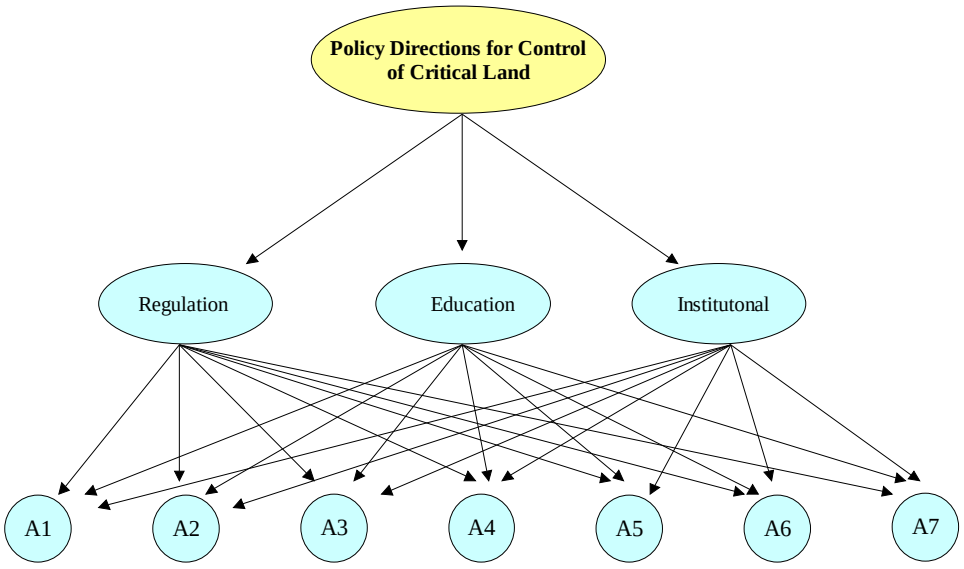
Furthermore, to determine degraded land intervals using equation 2. Where, *Ci* is an interval class; *c* is the highest total score; *b* is the lowest total score; and *k* is the number of desired interval classes. The highest total score is 175, the lowest total score is 35, and the desired number is 5 classes. Using equation 2, the class interval is 28, and Table 2 shows the degraded land interval class.

$$Ci = \frac{c-b}{k} \quad (2)$$

Table 2. The degraded land interval class

No	Interval class	Index	Notes
1.	147-175	Very good	Not degraded
2.	119-146	Good	Degraded potential
3.	91-118	Middle	Towards Degraded
4.	63-90	Bad	Degraded
5.	35-62	Very bad	Very degraded

To determine the policy directions for controlling degraded land in the Anai watershed, the Analytical Hierarchy Process/AHP approach is used, and this method uses expert opinion. Selection of experts can be determined based on educational level, structural position, and experience [14]. The AHP method is an approach that can structure complex problems, so that it can be easier to make decisions [15]. In this study, 15 experts from various institutions were used, such as: NGOs, the Center for Environmental Studies, university experts, government elements. The AHP analysis has several stages, including: goal setting, determination of criteria and sub criteria, and determine alternatives [4]. In this study, there are three criteria used, namely: institutional, regulatory, and education. Figure 2 shows the hierarchy of policy directions for controlling degraded land in the Anai watershed.



Notes :

A1. Consistent in law enforcement
A2. Making clear rules
A3. Increasing community knowledge about forests
A4. The search for an alternative economy for forest area communities
A5. Increasing the skills of the community on the added value of forest products
A6. Institutional strengthening of customary community groups in forest areas
A7. Increasing community cooperation with government agencies in forest management

Fig. 2 The hierarchy of policy directions for controlling critical land in the Anai watershed

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3.RESULTS AND DISCUSSION

Population growth is closely related to land requirements. With the increase in population, the need for land for agriculture, plantations, services, industry and settlements will increase. The Anai watershed has population growth of 1.2% per year for the 2000-2020 period. This population growth had an impact on land conversion of 4-9% of forest land to other uses during that period (Umar et al. 2023). Based on analysis of Lansat 8 OLI imagery in 2022 with a resolution of 30 meters, the research area has 37.11% forest, 19.97% mixed gardens, 31.27% settlements, 10.51% rice fields, and 10.51% for other uses of bushes. .15%. Next, to determine the vegetation density, it is analyzed based on the NDVI (Normalized Difference Vegetation Index) value. The results of the vegetation density analysis show that there are 22% with very dense density, around 46% in the medium category, and the remaining 32% in the sparse vegetation category.

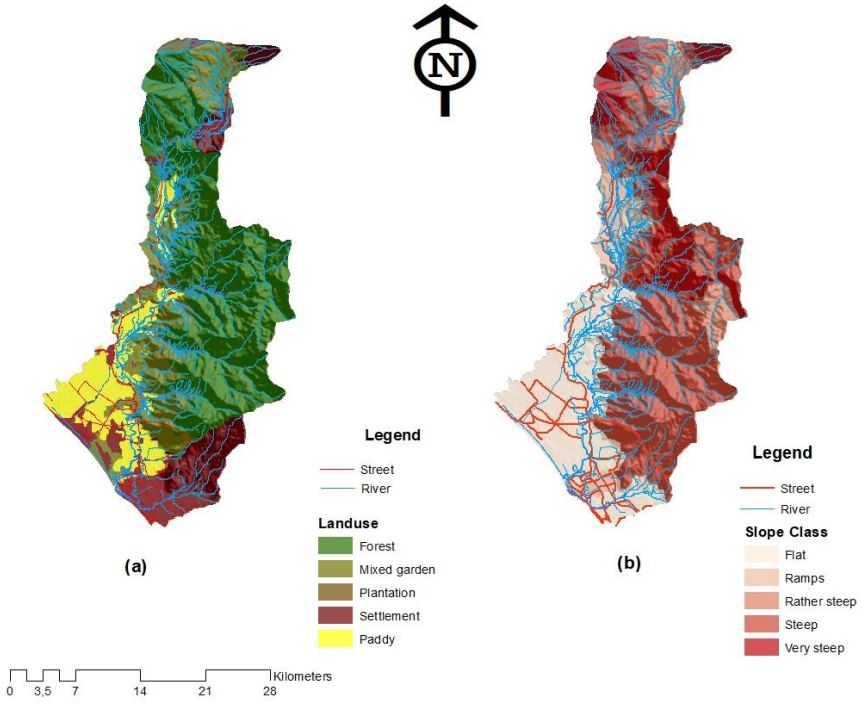

Fig. 3 Landuse map (a) and slape map (b) in the Anai watershed

Furthermore, the slope is very closely related to the formation of degraded land. Areas that have wavy morphology will experience and form critical land more quickly [18,19]. To determine the slope of the slope, SRTM images are converted into a Digital Elevation Model (DEM), and then a slope slope map is produced. Based on the slope, most of the Anai watershed has slopes of more than 15%. With these slope conditions, the rate of degraded land is significant.

The slope of the slope also contributes to the depth of the soil solum, the greater the slope, the higher the soil erosion [20]. In the research area the slope of the slope contributes to the depth of the soil solum. This is proven from field samples where the deeper the solum becomes, the deeper the slope. Figure 4a. The distribution of solum depth at the research location is presented. In addition, contributing land management is one of the criteria in determining degraded land. In the land management criteria, the aspects assessed include clarity of area boundaries, community education and monitoring [21]. Figure 4.b is a land management index map at the research location, where most of the area does not have complex management

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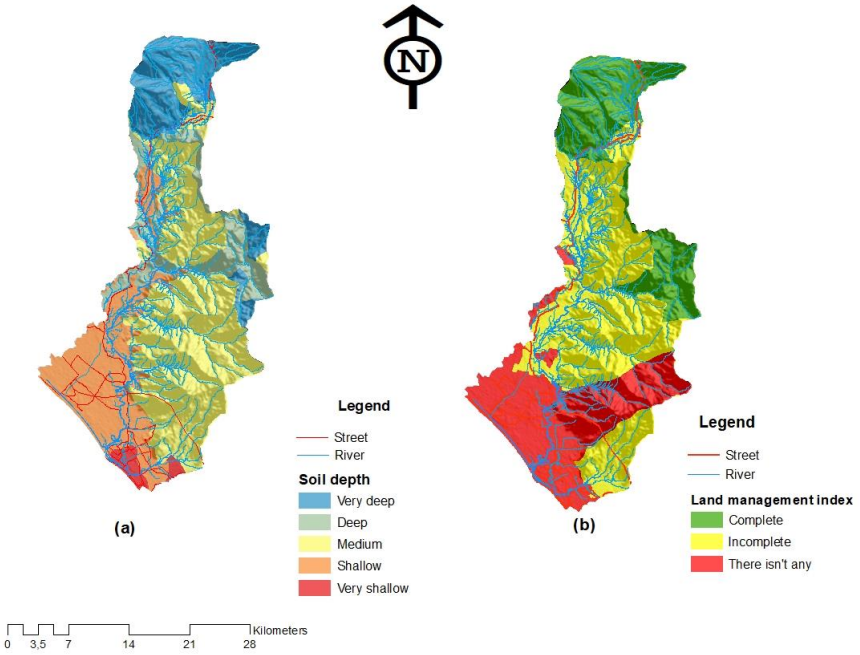

Fig. 4 Soil deep map (a) and land management map (b) in the Anai watershed

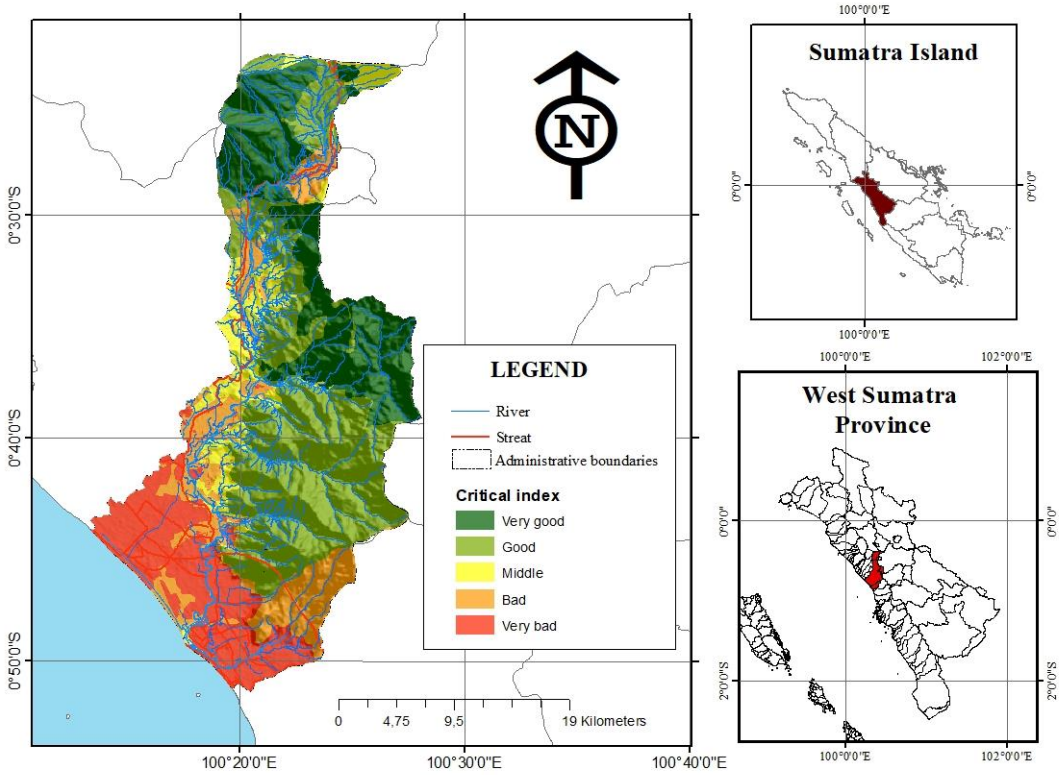

Fig. 5 Degraded index map in the Anai watershed

Figure 5 is a degraded land index map in the Anai watershed, with results where around 48% is degraded to very degraded land. Based on the results of the analysis, the indicators used in this research are highly correlated with the formation of degraded land. Melo (2018) states that changes in land use, sullum depth, slope, and land management are factors that greatly influence the formation of degraded land [22].

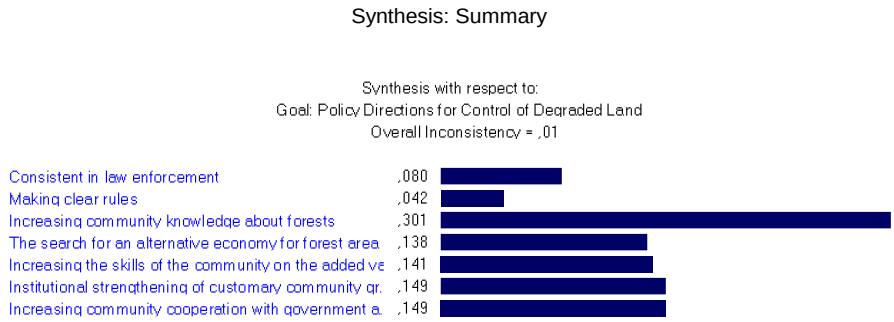

Fig. 6 Policy directions for control of degraded land in the Anai watershed

The results of the analysis of policy directions using the AHP approach involving experts from various fields show that there are three priority policy directions, namely: 1) increasing public knowledge about forests; 2) increasing community skills regarding added value of forest products; and 3) strengthening the institutions of indigenous community groups in forest areas. The increase in degraded land is driven by economic factors and the community's lack of knowledge [22]. Increasing community knowledge about forest functions and increasing community skills are efforts to overcome degraded land [23]. In addition, efforts to strengthen forest community institutions contribute to reducing degraded land, because by strengthening community institutions they have a role in improving forests in the future [21].

4.CONCLUSION

Every year the Anai watershed changes its land cover to cultivated land. These changes encouraged the formation of degraded land in the research area. The research results show that around 48% of the Anai watershed is degraded land. The results of the analysis of the AHP approach to policy strategies for controlling degraded land show that there are three priority directions, namely: 1) increasing community knowledge about forests; 2) increasing community skills regarding the added value of forest products; and 3) strengthening the institutions of indigenous community groups in forest areas.

5.ACKNOWLEDGEMENTS

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