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Status of Land Degradation for Biomass Productionand Management Efforts inTabang Sub-districts, Kutai Kartanegara Regency

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ABSTRACT

The objectives of the study of land degradation status for biomass production are: (1) to collect data and information on initial soil conditions on land use for biomass production; (2) determine land degradation status for biomass production on land use for biomass production; and (3) mapping the status of land damage in Tabang sub-District, Kutai Kartanegara Regency. The research was carried out for 4 months, the research location was in Sidomulyo, Umaq Dian, Buluq Sen and Tukung Ritan Villages, Tabang sub-District, Kutai Kartanegara Regency. Research activities carried out include: preparation, field observations, soil sampling, soil sample preparation, soil analysis in the laboratory, data processing and interpretation, and reporting. The results showed that: (1) Land with not degradated status was found at four location i.e TB 2, TB 4, TB 10 and TB 11; (2) lightly degradated status occurred in 7 location i.e TB 1, TB 3, TB 5, TB 7, TB 8 dan TB 9; (3) land with moderate degradated statusoccurred at TB 6. Land degradation for biomass production mostly occurs in dryland caused by damage to the basic properties of the soil which includes soil pH, soil erosion, and bulk density.

Keywords: land degradation, biomass production, land management.

INTRODUCTION

The excessive use of natural resources in order to meet development needs has led to a decrease in the quality of the environment which has resulted in various ecological disasters, ranging from global warming, land degradation, scarcity of natural resources to loss of germplasm, all of which are losses that are not only experienced by people living today but also by future generations. A good and healthy environment is the basic right of every Indonesia citizen as mandated in Article 28 of the 1945 Constitution of the Republic of Indonesia; therefore, it is the obligation of all parties to maintain the quality of the environment so as to encourage all parties to implement it.

Soil is classified as a renewable natural resource, meaning that damage to land can still be repaired, but with different efforts depending on the level of damage. However, for land that has suffered severe damage (severe degradation) it requires a great deal of effort to restore it both in terms of cost, time and other resources. Land degradation caused by land management that does not pay attention to soil conservation principles (exceeding its carrying capacity). Examples of land degradation that is difficult to repair are salinization, severe erosion, peat subsidence, increased soil acidity due to oxidation of pyrite compounds and the entry of pollutants that are difficult to degrade into the soil system. Land degradation has direct implications for reducing the ability of the soil to produce biomass. For land use to produce biomass, land use must be controlled and must not exceed the damage threshold. Soil degradation can occur in the physical, chemical and biological properties of the soil (Saragih, Nasrul, and Idwar, 2013; Hartanto et al, 2022).

Land degradation can be caused by the natural nature of the soil, it can also be caused by human activities which cause the land to be disturbed/degradated so that it is no longer able to function to support its productivity. According to Winarso (2005) that the main problems of land in relation to land management are poor soil and nutrient deficiency, soil erosion and degradation, inefficient use of water, low pH loss of organic matter, soil compaction, drought, flooding and poor drainage.

Human activities that make uncontrolled use of land and other natural resources and do not pay attention to conservation principles can result in soil damage, thereby reducing its quality and function, which in turn can threaten the survival of humans and other living things. The government has issued Government Regulation (PP) Number 150 of 2000 concerning Land Damage Control for biomass. With the issuance of the PP so that land use can be carried out wisely, taking into account the interests of presentand future generations, so that land can be used sustainably with good and optimal quality levels (Suzana, 2019).

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An inventory of potential land damage needs to be carried out because it is an important step in overcoming land damage. The results of the inventory are the initiation of regional development and development planning that takes into account aspects of the sustainability of land or soil resources. According to Sukisno et al., (2011) that mapping the potential and status of land damage can determine appropriate soil and land management actions so that land damage can be prevented and/or repaired. The aim of the study was to determine the status of the level of land degradation for biomass production in Tabang District, Kutai Kartanegera Regency and efforts to improve it.

MATERIAL AND METHODS

Time and Location

The research was carried out for 4 months, the research locations were in Sidomulyo Village, Umaq Dian Village, Buluq Sen Village and Tukung Ritan Village, Tabang sub-District, Kutai Kartanegara Regency.

Materials and Tools

Materials used: soil samples, chemicals for soil analysis in the laboratory; The equipment used in this study includes field equipment and laboratory equipment. Field observations and taking soil samples as well as compiling maps include; sample rings, soil drill, field knife, GPS (geographic positioning system), meter, documentation, abney level, stationery, label stickers and plastic bags as well as geographic information system (GIS) tools for making work maps and yield maps. While laboratory equipment is used to measure and determine soil characteristics.

Research Implementation

Research activities carried out include: preparation, field surveys, soil sampling, soil sample preparation, soil analysis in the laboratory, data processing and interpretation, reporting.

Data Collection

There were 3 locations for soil sampling/land observation in Sidomulyo Village, 3 locations in Umaq Dian Village, 1 location in Buluq Village and 4 locations in Tukung Ritan Village. The data collected are: (1) soil properties obtained through field surveys, namely: soil solum, surface rock and soil erosion; and (2) soil properties obtained through analysis in the laboratory, namely: soil pH, fraction composition, bulk density, total porosity, degree of water permeability, electrical conductivity (DHL), redox value and number of microbial.

Assessment of Land Degradation for Biomass Production

After identifying the initial soil conditions, analyzing the basic properties of the soil, then evaluating it. The evaluation was carried out by comparing the average values of the same parameters for biomass production which are similar to the results of analysis of the basic properties of the soil with the standard criteria for soil degradation to land based on Minister of Environment Regulation No. 7 (2006). The basic properties of the soil used to determine the status of land degradation for biomass production are 11 parameters. If one of the basic soil property thresholds is exceeded, the soil status is considered degradated. Furthermore, the level of soil degradated is divided into four categories based on the number of basic soil properties that have exceeded the critical limit, namely: (1) not degradated, (2) slightly degradated, (3) moderately degradated and (4) heavily degradated. The following categorizes the level of soil damage status for biomass production presented in Table 1 and Table 2.

Table 1. Soil degradated evaluation for biomass production

No.	Basic Soil Properties	Critical Limid
1.	Solum	< 20 cm
2.	Surface rocks	> 40 %
3.	Fraction Composition	< 18 % clay; > 80 % sand
4.	Bulk density	>1,4 g/cm^3
5.	Porosity	< 30 % ; > 70 %
6.	Permeability	< 0,7 cm/hour; > 8,0 cm/hour
7.	Erosion	0,9 mm/years
8.	pH	< 4,5; > 8,5
9.	Electric Conductivity	> 4,0 mS/cm
10.	Redoks	< 200 mV
11.	Number of Microba	< 10^2 cfu/g

Source: government regulation number 150 (2000)

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Table 2. Category of land degradated status

Soil Damage Status	Number of Basic Soil Properties Exceeding Critical Limits
Not degradated	0
Lightly Degradated	1-2
Moderate Degradated	3-5
Heavily Degradated	>5

Source: Compilation Team (2022)

RESULTS AND DISCUSSION

General Information on Sampling Locations

Administrative research locations include Sidomulyo Village, Umaq Dian Village, Buluq Sen Village and Tukung Ritan Village. Land use consists of paddy fields, mixed gardens, shrubs, agroforestry plantations and dry land agriculture. The physiography of the land consists of plains, undulating plains and hills. Dry land in Tabang District is the dominant land use because it fits the land typology in the form of undulating plains to hills. Dry land use types consist of mixed plantations, oil palm plantations and rubber plantations. Mixed gardens are not managed properly, without the provision of agricultural inputs and the condition of the land is not maintained. Wetlands are only found in Sidomulyo Village with an area of around 40 ha. The type of paddy field is in the form of technically irrigated rice fields so that the land can be planted twice a year. An overview of the research locations is presented in Table 3.

Table 3. General information of soil sampling locations/land observation

No	Field code	Village	Coordinate		Physiography	Slope (%)	Land Use Type
			°BT	°LU			
1	TB1	Sidomulyo	116,0215	0,5803	Plains	3-5	Pasture
2	TB2	Sidomulyo	116,0050	0,5842	Hills	20-25	Agroforestry
3	TB3	Sidomulyo	116,0012	0,5896	Hills	35-35	Dryland farming ex preparation for oil palm land
4	TB4	Umaq Dian	116,0200	0,5605	Undolating	3-5	Forest plantations and shrubs
5	TB5	Umaq Dian	116,0130	0,5528	Hills	5-20	mixed farm
6	TB6	Umaq Dian	115,9948	0,5198	Hills	25-35	Small scale oil palm plantations
7	TB7	Buluq Sen	116,0458	0,4398	Hills	15-20	Small scale oil palm plantations
8	TB8	Tukung Ritan	116,0588	0,3900	Hills	20-25	Mixed farm and shrubs
9	TB9	Tukung Ritan	116,0595	0,3964	Hills	15-20	Rubber and palm plantations
10	TB10	Tukung Ritan	116,0649	0,3991	Hills	15-20	Small scale oil palm plantations
11	TB11	Tukung Ritan	116,0693	0,4017	Hills	15-20	Small scale oil palm plantations

Basic Properties of Soil

The soil at the study location has a solum thickness of 66 cm to more than 120 cm. The solum is likened to a body of soil, where there are minerals, water and air in it. Good land is land that has deep soil solum. Deep soil solum (more than 100 cm) can support the uprightness of plants, and is also able to provide water in the soil body. The thickness of the soil solum is greatly influenced by soil-forming factors, such as topography and parent material (Khanifar and Khademalrasoul, 2020). Apart from that, surface rocks are found in a low percentage, namely less than 5% or still below the critical limit for soil damage for surface rock parameters. The low percentage of surface rock makes it easier to cultivate the land. Other basic soil properties, namely unit weight, DHL, redox value and number of microbial also show values that do not exceed the critical limit.

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Basic properties of soil that exceed the critical limit are fraction composition, soil erosion, soil pH, and permeability. Clay as a soil colloid has an active surface so it is able to exchange cations adsorbed on the clay surface with cations in the soil solution. This condition allows nutrients (most of which havea positive charge) to be exchanged to prevent soil nutrient loss (Bi et al, 2023). The results of observations on the basic properties of the sat the study site are presented in Table 4.

Table 4. Soil basic properties in tabang sub-district

Location Code	Solum (cm)	Surface rock (%)	Erosion(mm/ years)	Sand (%)	Clay (%)	Bulk Density (g/cm^3)	Porosity (%)	Permeability (cm/h)	PH	DHL (mS/cm)	Redox Value (mV)	Number of Microbial (cfu/g)
TB 1	>120	< 5	0,2	26,06	56,06	1-,20	54, 83	0, 55*	4, 70	0, 65	310, 15	2, 6x10
TB 2	104	< 5	0,4	22,65	44,94	1,11	58,26	1,02	4,62	0,65	305,7	4,2 x 10^5
TB 3	85	< 5	1,1*	14,88	47,07	1,22	54,13	1,02	4,40 *	0,76	213,1	2,0 x 10^4
TB 4	>120	< 5	0,4	55,07	29,08	1,06	59,99	7,90	4,75	0,80	347,1	3,1 x 10^5
TB 5	>120	< 5	0,5	65,72	20,42	1,14	57,07	3,58	4,24 *	0,61	331,7	4,8 x 10^5
TB 6	80	5-10	1,1*	19,74	3,07*	0, 93	64,72	7,63	4,29 *	0,62	319,5	2,2 x 10^5
TB 7	66	5-10	1,2*	68,87	29,97	1,1	57,134	0,79*	4,70	0,79	359,7	2,5 x 10^5
TB 8	110	<5	0,4	47,41	35,37	1, 12	57,74	5,10	4,43*	0,51	344,0	3,4 x 10^5
TB 9	112	<5	0,4	53,64	32,50	1, 15	56,60	4,55	4,42*	0,53	256,1	3,1 x 10^5
TB 10	98	<5	0,5	54,40	31,10	1, 04	60,75	3,24	4,54	0,51	310,4	2,7 x 10^5
TB 11	89	<5	0,4	26,06	56,06	1, 13	57,36	3,81	4,56	0,59	334,2	2,1 x 10^5

Information: * = exceeding critical limit
Source: Results of Laboratory Analysis and Field Observations (2020)

Land degradation Status

The results of the assessment regarding the status of land degradation for biomass production in Tabang District arepresented in Table 5 below.

Table 5. Status of land degradation for biomass production

No	Location Code	Number of Limited Factors	Status
1.	TB 1	1	Lightly Degradated
2.	TB 2	0	Not degradated
3.	TB 3	2	Lightly Degradated
4.	TB 4	0	Not degradated
5.	TB 5	1	Lightly Degradated
6.	TB 6	3	Moderate Degradated
7.	TB 7	2	Lightly Degradated
8.	TB 8	1	Lightly Degradated
9.	TB 9	1	Lightly Degradated
10.	TB 10	0	Not degradated
11.	TB 11	0	Not degradated

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Based on the data in Table 4 to Table 5, the results of evaluating the status of land degradation for biomass production in Tabang District obtained the status of land damage as follows:

Not Degradated

There are four locations of dry land with not degradated status, i.e TB 2, TB 4, TB 10 and TB 11. Types of land use in these locations include agroforestry, forest plantations and shrubs and smallholder oil palm plantations. None of the basic soil properties exceeds the critical limit. Land management carried out on these lands can maintain land sustainability. Therefore, land/land management needs to be maintained to protect the land from degradation.

Slightly Degradated

Land with lightly degradated status was found in 6 locations, namely TB 1, TB 3, TB 5, TB 7, TB 8, and TB 9. At least there are one to two basic soil properties that exceed the critical limits at these locations, namely fraction composision, soil pH, soil erosion and degree of water permeability. These lands experienced light damage, where the damage did not significantly affect the land's ability to produce biomass, except for the TB 3 location, so that overall the land could still be restored with low input. In addition, land use in the form of plantations and mixed gardens can naturally improve the basic properties of the soil. At the TB4 location, low soil pH and erosion are the basic soil properties that exceed the critical limit. The slope of the land at the TB 3 location is large, so that land management on smallholder plantation land use types has not been able to reduce the rate of erosion to below the critical limit. Therefore, it is necessary to improve land management, according to Munawar (2010) to increase soil pH by liming, adding organic matter or planting tolerant plants. Furthermore, stated by Aeni (2021) thatto reduce the rate of soil erosion can be done through several efforts, namely soil conservation, terracing, counter farming, reforestation/greening.

Moderately Degradated

Land with moderately damaged status is located at TB 6 location, there are three basic soil properties that have exceeded the critical limit, namely soil pH, soil erosion and fraction composition. The type of land use in that location is smallholder oil palm plantations. The land has a steep slope, with a moderate land cover density, that is, without using a cover crop. Land conditions like this cause high erosion rates, where erosion reaches 1,1 mm/year.

The high erosion rate is thought to cause a lot of clay colloids to erode and if left unchecked can cause damage to other soil properties, such as the degree of water permeability and the number of soil microbes. Therefore, efforts to restore basic soil properties that have exceeded critical limits need to be prioritized at the TB 7 location for soil damage restoration activities for biomass production in Tabang District, especially prevention of soil erosion.

Efforts to restore land damage at TB7 locations are suggested through vegetative methods, namely by planting cover crops. Cover crop leaves that are very dense can prevent soil aggregates from being dispersed by rainwater and the root system of these plants can increase rainwater infiltration so as to reduce surface runoff. The combination of these benefits can reduce the rate of soil erosion below a critical limit, and can also restore damage to the physical properties of the soil that has been caused by erosion. As stated by Kartasapoetra et al. (2000) cover crops can function as a protector of the soil surface from the blows of raindrops, slow down surface runoff, and can increase soil organic matter levels. Furthermore, Arsyad (2010) stated that legume plants are more suitable as ground cover plants because they can add soil nitrogen and their roots do not provide heavy competition to staple crops; and Sharma et al. (2018) explained that leguminous cover crops are plants that can increase soil fertility, reduce soil erosion, add and protect soil, both in terms of soil nutrition and water availability and soil quality.

In general, Land degradasion in Tabang District, Kutai Kartanegara Regency is caused by low soil pH, soil erosion, and fraction composition. The results of this study are similar to the results of research reported by Zulkarnain (2022) that the status of damage to dry land in Marang Kayu Village District, Kutai Kartanegara Regency is classified as moderate due to low soil pH and high sand fraction. A map of the location of land damage status in Tabang District, Kutai Kartanegara Regency is presented in Figure 1 below

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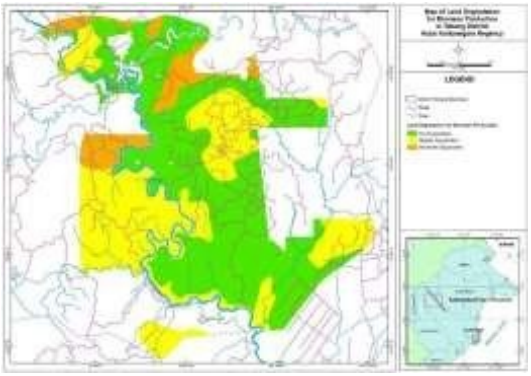

Figure 1. Map of land degradation for biomass production in tabang district

CONCLUSIONS

Based on the results of research and discussion, conclusions are drawn, namely land with not degradated is found inTB 2, TB 4, TB 10 and TB 11. Land with lightly deradated status occurs at locations TB 1, TB 3, TB 5, TB 7, TB 8, and TB 9. Land with moderate dedradated occurred at location TB 6 andno experienced severe degradated. Land degradation for biomass production is caused by damage to thebasic properties of the soil which include low soil pH, soil erosion, and fraction composition.

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