

ANALYSIS OF THE POTENTIAL SOIL DAMAGE FOR THE PRODUCTION OF BIOMASS IN ACEH TENGAH DISTRICT

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ABSTRACT

The purpose of analyzing the status of soil damaged is for the planning and management of maintenance, improve soil quality to produce biomass in Aceh Tengah District. Research has been going on for seven months in 2014, which includes the Pegasing and Atulintang Subdistrict. This study used survey method and the combination of qualitative and quantitative analysis techniques. Procedure and observations of variable customized research with government regulations of the Republic of Indonesia Number 7 of 2006, 150 of 2000 and number 20 of 2008. The results showed that the effective area of land for biomass production in 2014 in Aceh Tengah District is 14019.86 Ha. An area of 8618.9 Ha (61.6%) are in Pegasing and 5400, 96 Ha (38, 5%) is located in Atulintang Subdistrict. Land in the Subdistrict have been damaged and must be presented to the public by the government of Aceh Tengah District. The limiting factors of land use that has been damaged is the texture and soil permeability.

Keywords: Soil damage, biomass production, Aceh Tengah

INTRODUCTION

Generally in central Aceh land use is a coffee plantation since the Dutch colonial period and has been the source of livelihood of more than 34.476 families [1]. Coffee from this region is one of the most expensive coffee in the world as shown in the exhibition organized by the world's coffee Specialty Coffee Association of America (SCAA) in Portland, Oregon Convention Center, United States [2].

Land management that do not follow the rules of soil and water conservation can damage land for biomass production [3]. This condition can degrade the quality and function of the soil that could eventually threaten the survival of the farmers themselves and the lives of other organisms. This indication is at least reflected in coffee production in Central Aceh which has decreased due to the phenomenon of global warming, pests and soil degradation [7].

Under Indonesian Government Regulation No. 150 which was published in 2000 on Damage Control land to produce biomass, and No. 38 of 2007 on the coordination between levels of government, the implementation of damage control of land and/or soil to produce biomass is done by local government namely: 1) Establish standard criteria for soil degradation districts; 2) Mapping the condition of land and/or soil area of the district; 3) To supervise and determine the status of land degradation and/or soil.

Until recently in Central Aceh has not provided sufficient information about the status of the land damage, the condition, spacious and distribution. Therefore, for the supervision and control of soil degradation as well, must be subjected to an inventory of land information that has been damaged and then poured in land degradation status map for biomass production.

This study aims to determine the potential damage and the status of the land and / or land which will be used by the government of Aceh Tengah management planning, maintaining, preserving and improving its quality to produce biomass

METHODOLOGY

Research status of degraded land to produce biomass has been conducted in the Pegasing and Atulintang Subdistrict during June to November 2014. This study used survey method for data collection, while the soil sample analysis takes place at the Faculty of Agriculture Soil Research Laboratory. Data analysis technique used a combination of qualitative and quantitative methods.

Materials used are topographic maps (Bakosurtanal), maps Spatial Plan (RTRW) of Aceh Tengah District, maps of soil type, slope maps, rainfall maps, image spots 7. Hardware field include: GPS, compass, Abney level, audio-visual equipment, soil analysis equipment in laboratory. Soil samples were taken randomly within each unit of land maps that include: (a) the soil is disturbed by the drill, and (b) the land is undisturbed by the ring sample. Disturbed soil samples taken at random, and performed at least 5 points to be composited.

The soil damaged measuring procedures adapted to the regulations the Minister of Environment of the Republic of Indonesia Number 07 of 2006. Criteria standard of soil damaged for the production of biomass, including measured parameters and methodology followed the Indonesian Government Regulation No. 150 of 2000. The calculation of the percentage of soil damaged for biomass production to follow Regulation of the Minister of Environment of the Republic of Indonesia No.20 of 2008

RESULT

Effective Working Area

Selection of an effective working area is the first phase of the preparatory work map with overlay regional status map and a map of the Spatial Plan of Aceh Tengah District. The area is an agricultural area and the plantations to produce biomass. Results showed that the total effective area in 2014 was 1.4019,8 Ha. Area in Pegasing Subdistrict 8.618,9 Ha consisting of: (i) wetlands of 1.260 Ha (6,7%), (ii) agricultural 43 Ha (0,2%), and (iii) plantation 7.315,9 Ha (39,1%), and area in Atulintang Subdistrict 5.400,9 Ha which consists of 1.832,3 Ha of production forests (12,5%), and (ii) plantation area of 3.568,96 ha (24,4%).

Initial Conditions of Land

Climate

Climate is the average weather conditions for a long time covering vast areas of the earth. Rainfall is the most important element of the climate and become the main agents of land degradation through erosion process. These data are needed to determine the potential damage to the soil [9]. Rainfall information from the Ministry of Agriculture of Central Aceh for 4 (four) years known that; (a) precipitation in Pegasing Subdistrict between 1.541 to 3.743 mm per year (an average of 2358.4 mm per year), (b) in Atulintang Subdistrict between from 2.202,8 to 3.291 mm per year (average 2.656,6 mm per year). Rainfall this raises the potential damage to land or land that is classified as moderate.

Type of Soil

Field observations have known there are three (3) orders effective land to produce biomass that is Ultisols, Inceptisol, and Andisol. The third area of land on the order of Aceh Tengah District are presented in Table 1.

Table 1. Soil types and distribution in the Aceh Tengah District

No	Soil types (Ordo)	Pegasing subdistrict	Atulintang subdistrict
		Ha	Ha
1.	Ultisol	4.975,8	3.694,1
2.	Inceptisol	10.524,4	6.085,7
3.	Andisol	3.186,9	4.847,1
Total		18.687,1	14.626,9

Source: Spatial Plan Central Aceh District 2012-2032

To estimate the potential damage to the land to produce biomass, then the order Inceptisol potentially high damage (rating 4), Ultisol moderate (rank 3), and very high Andisol (rating 5). Therefore, the type of soil in the study area generally have the potential damage to the land or land which is high to very high (Andisol).

Topography

It is known that the slope of the land within two (2) districts studied very complex beginning from 0-8% to over 40%. The slope steepness conditions in the Pegasing and Atulintang Subdistrict can be seen in Table 2.

Land Use

Results of the study are based on the analysis of Landsat Map and field observations obtained from various types of land use in the Pegasing and Atulintang Subdistrict. It is known that in the Pegasing Subdistrict there have been eight (8) types of land use, and in the Atulintang Subdistrict has 4 (four) types of land use by area as shown in Table 3

Table 2. Slope land and the area in the Aceh Tengah District

No	Slope (%)	Physiography	Pegasing Subdistrict	Atulintang Subdistrict
			Ha	Ha
1.	0-8	Flat-ramps	4.681,0	3.434,91
2.	8-15	Wavy	1.898,6	2.610,6
3.	16-25	Wavy	2.458,3	1.865,2
4.	26-40	Montane	4.406,9	598,3
5.	>40	Steep/steep	5.242,3	6.117,8
Total			18.687,1	14.626,87

Source: Results of the digitized map RBI Indonesia (RBI)

Table 3 shows the areas effective to produce biomass in Pegasing subdistrict is wetlands, farms and plantations, whereas in Atulintang is forest and plantation. The rest is a protected forest, residential, industrial zones, tourist areas and hunting parks.

Table 3. The use of land and the area in the Aceh Tengah District

Land use	Pegasing Subdistrict	Atulintang Subdistrict
	Ha	Ha
1. Rural settlements	321,6	1.168,46
2. Protected Forest (HL)	9.703,8	8.057,5
3. Production forest	-	1.832,3
4. wetlands	1.260,0	-
5. Industry	40,2	-
6. Cultural tourism	2,2	-
7. Agriculture	43,0	-
8. Plantation	7.315,9	3.568,6
Parks Hunting	0,4	-
Total	18.687,1	14.626,9

Source : RTRW Aceh Tengah District 2012-2032

Land Analysis of Potential Damage

Potential soil damage alleged by summing the weighted scores of each thematic map. Potential assessment is done through a process of overlaying a map, the accumulated value of these scores ranged from 10 to 50. The maximum value is obtained if all the values of the attributes of each thematic map a very high potential for damage to the soil. The potential value of land degradation are grouped into five classes, is potentially damaged soil is very low, low, medium, high, and very high. In principle, the higher the score given value, the higher the potential area of damaged land.

The results of the analysis of potentially defective region (PD) on any type of land use in the Pegasing and Atulintang subdistrict presented in Figure 1, a scoring value of each variable soil damage. Score weighting potential for damage to land is obtained by multiplying the rating value of each element of thematic maps of soil damage with weight value of each thematic maps (maps of soil, slope maps, maps of rainfall and land use map).

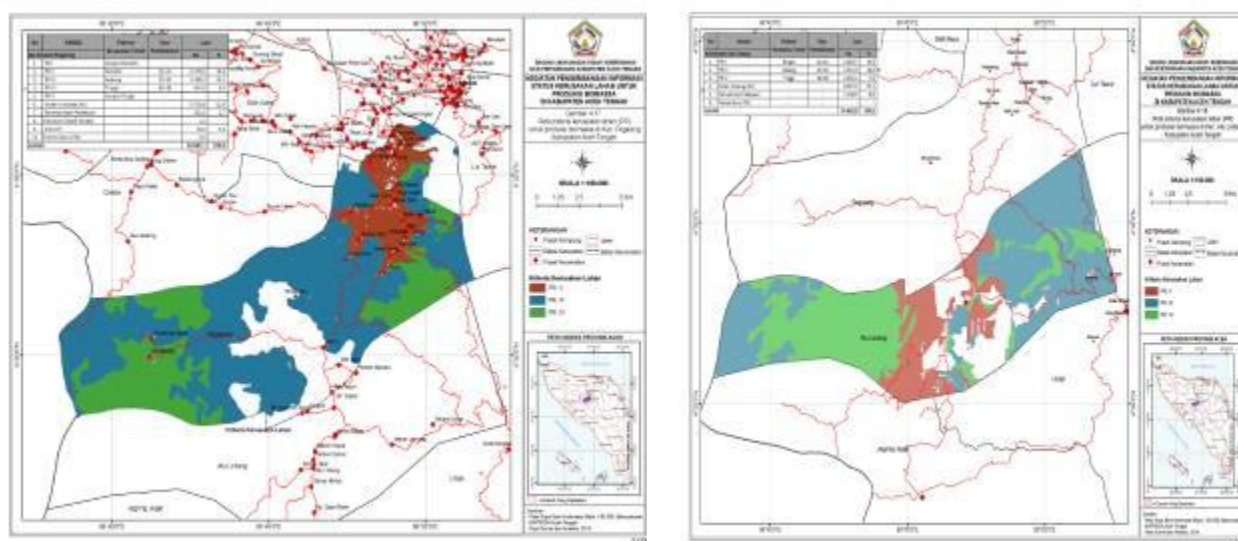


Figure 1. Map of the potential damage to land (PD) in the Aceh Tengah District

Assigned rating ranging from 1 to 5, while the value of the weights based on the accuracy of any information the matic maps. Land use maps and maps of soils rated (2), and maps of slope and rainfall is worth three (3). The higher the values obtained score weighting, the higher potential areas of damaged land. Value rating and weighted scoring each the matic maps are presented in Table 4.

Table 4. Score weighting of potential land damaged in Aceh Tengah District

No	SIMBOL/ Potential soil damaged	Skoring	Subdistrict	
			Pegasing Area (Ha)	Atau Lintang Area (Ha)
1.	PD II (Low)	22-24	3.478,5	2.028,7
2.	PD III (Medium)	25-34	4.496,4	2.341,0
3.	PD IV (High)	36-38	644,0	1.031,1
Land for producing biomass (ha)			8.618,9	5.400,8
Land area not to produce biomass (ha)			10.068	9.226,1
Total			18.687,1	14.626,9

Table 4 shows the scores of potential damage to the land for biomass production in Pegasing and Atulintang. It is known that effective land for biomass production in the two districts there are three (3) the level of potential damage to the soil is low (PD II), moderate (PR III) and high (PD IV). In other words, undis covered lands with very low levels of potential damage (PD I) or very high (PD V).

In the Pegasing Sub-district there is land with potential for minor damage (PD II) is an area of 3.478,5 Ha, moderately damaged (PD III) 4.496.4 Ha, and heavily damaged (PD IV) 644 Ha. While in the Sub-district Atulintang area encountered potentially minor damage (PD II) 2.028,7 Ha, moderately damaged (PD III) 2.341 Ha, and the highly damaged (PD IV) 1.031,1 Ha.

Basic Characteristics of Land

Results of a preliminary analysis of the soil physical properties on the potentially damaged land to produce biomass in Aceh Tengah District includes solum, loose rocks and rock outcrops on the surface of the soil, the composition of the soil fraction, bulk density, total porosity, and permeability. The results of the analysis are shown in Table 5.

Table 5 shows that the solum, bulk density, and porosity of the soil at the site of research is still in the normal category. While the composition of the fractions and the permeability of the soil in the Atulintang Subdistrict has exceeded the threshold quality standards set by the government. Fraction of land in this district is 7-19% clay, and sand 63-88%, while the quality standards of land or land damage was <8% clay fraction (clay) and> 80% of the sand fraction. Thus the land potentially unit moderate damage (PD III) in this district, including broken (R). According to research [6], there has been a correlation between the fraction of land for the production of plantation crops (oil palm) where a decline in oil palm bunches of fresh weight of 0.7 kg each 1% increase in the sand fraction. These properties are permanent, which is more influenced by the characteristics of the parent material and not the actions of the management of land to produce biomass [11].

Permeability is the ability of the hydraulic ground through capillary pores that are interconnected. Soil with high permeability can increase the infiltration rate, thereby reducing run-off [12]. Table 5 is known that the permeability of the soil on land units potentially damaged in Pegasing and Atulintang the Subdistrict is 6.39 to 9.87 cm h⁻¹. While the standard limit destruction of land between <0.7 cm h⁻¹ to > 8.0 cm h⁻¹. Based on that, the land can be classified Atulintang Subdistrict of potentially faulty low (PDII), and heavily damaged (PDIII) and should be set as a land with broken status (R).

Table 5. The physical properties of the soil on land potentially damaged

Sub-district	Pegasing Subdistrict			Atulintang Subdistrict		
Symbol/Potential of land Damage	PD II (Low)	PD III (Moderate)	PD IV (High)	PD II (Low)	PD III (Moderate)	PD IV (High)
Solum:						
Quality standards	<20 cm					
Value (cm)	>150	50-100	>150	>150	>150	>150
Surface Rock:						
Quality standards	<40%					
Value (%)	0	1	3	1	2	7
The composition of the soil fractions (texture):						
Quality standards	18% colloid; Clay> 80% quartz sand, coarse sand					
Value (% Clay/% sand)	34/26	26/45	29/34	19/63	7/88	16/75
Bulk density:						
Quality standards	>1,4 g cm ⁻³					
Value (g cm ⁻³)	1,24	1,37	1,37	1,07	1,30	1,35
Total porosity:						
Quality standards	<30%; >70%					
Value (%)	53,19	52,04	50,05	50,78	49,94	50,67
Permeability						
Quality standards	<0,7; >8 cm h ⁻¹)					
Value (cm h ⁻¹)	6,39	6,82	7,30	9,87	7,49	8,85

Soil Chemical Properties

Early analysis of the soil chemical properties on land that is potentially damaged to produce biomass in Aceh Tengah District includes pH, electrical conductivity (EC), Eh, and the number of microbes, and the results are shown in Table 6. Table 6 shows that the chemical characteristics of the soil in the Pegasing subdistrict led to the indication lands have not been damaged.

Table 6. Chemical properties of the soil on the land damaged in Aceh Tengah District

Symbol/Potential of Land Damage	Pegasisng Subdistrict			Atulintang Subdistrict		
	PD II (Low)	PD III (Moderate)	PD IV (High)	PD II (Low)	PD III (Moderate)	PD IV (High)
pH (Soil reaction)						
Quality standards	<4,5; >8,5					
Value	5,4	5,6	5,9	5,5	5,8	5,6
Electrical Conductivity (EC)						
Quality standards	>4,0 mScm ⁻¹)					
Value (mScm ⁻¹)	0,4	0,4	0,4	0,4	0,3	0,3
Redoks Potential (Eh)						
Quality standards	<200 mV					
Valuei (mV)	23,2	23,7	24,4	23,4	21,5	21,0
Microbial count (cfu g ⁻¹)						
Quality standards	<10 ² cfu g ⁻¹					
Value (cfu g ⁻¹)	122.500	178.800	183.500	332.100	64.200	238.100

Determination of Status of Soil Damage

Map status Damaged land for biomass production is the end result that contains information about the status, distribution and level of soil damage. These maps are compiled through data matching between the parameters of soil damage with the criteria (Regulation No. 150 of 2000) in each point of observation.

Table 7. Status of soil Damage in the Aceh Tengah District

NO	PARAMETER	Status of Soil Damage					
		Pegasing Subdistrict			Atulintang Subdistrict		
		PDII	PDIII	PDIV	PDII	PDIII	PDIV
1	Solum (s)	N	N	N	N	N	N
2	Survace Rocks (b)	N	N	N	N	N	N
3	Sand Fraction (f)	N	N	N	N	R	N
4	Bulk Dencity (d)	N	N	N	N	N	N
5	Total Posity (v)	N	N	N	N	N	N
6	Permeability (p)	N	N	N	R	N	R
7	pH (H2O) 1:2,5 (a)	N	N	N	N	N	N
8	Electrical Conductivity (EC) (e)	N	N	N	N	N	N
9	Potential Redok (r)	N	N	N	N	N	N
10	The Number of Microbes (m)	N	N	N	N	N	N
Status of Soil Damage		N	N	N	R-p	R-f	R-p

The results are grouped into the Soil damage (R) and undamage (N) as shown in Table 7. Table 7 shows that in Pegasing Subdistrict all analyzed parameters are within normal limits that can be tolerated. Therefore, the status of the land damage on each unit of land in this area is undamaged (N). While in the Atulintang Subdistrict there are two different parameters as the cause of damage to the soil so that the value has exceeded the thres hold allowed by the government. The parameter is the permeability (p) found in land potential low damaged (PD II) and potentially heavy damaged (PD IV), and texture (f) on a unit of land potentially moderate damaged (PR III). The distribution of land titles are undamaged (N) and damaged (R) in the study area in 2014 can be seen in Table 8 and Figure 2.

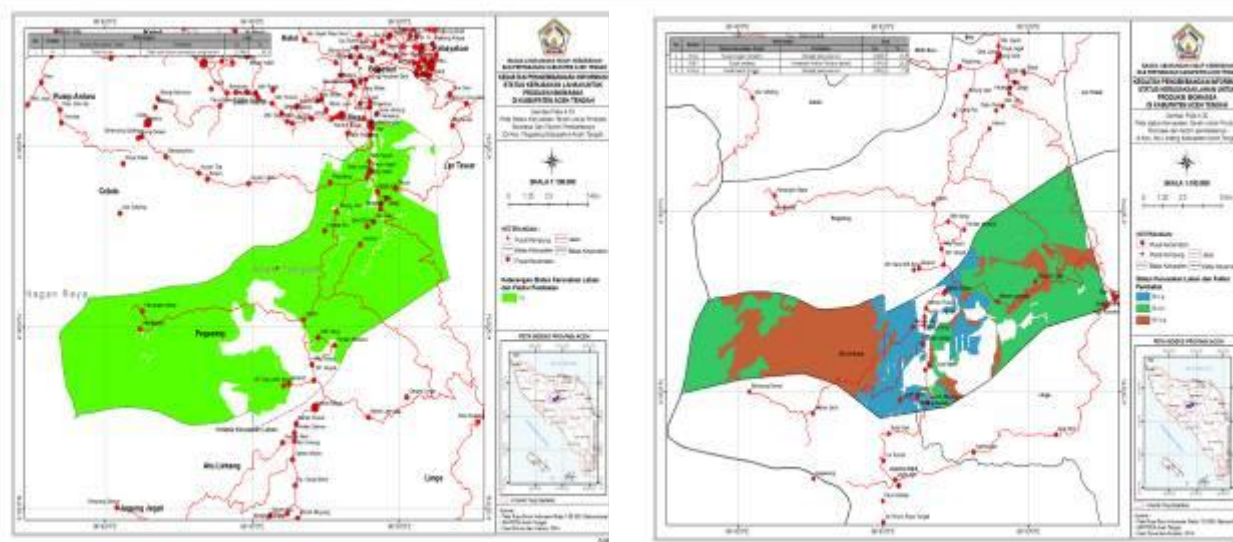


Figure 2. Map of Land Damage status and the limiting factor in Aceh Tengah District

Table 8. The Status of soil Damage and limiting factors in Aceh Tengah District

No	Simbol	Description		Area	
		Status of soil damage	Limiting Factor sage	ha	%
A	Pegasing Subdistrict			8.618,9	61,5
1	N	Undamaged	No factor user uides	8.618,9	61,5
B	Atulintang Subdistrict			5.400,96	38,5
1	R.II-p	Low damaged	Permeability	2.028,7	13,9
2	R.III-f	Moderate damaged	Texstur	2.341,0	16,0
3	R.IV-p	High damaged	Permeability	1.031,1	7,0
Total				14.019,86	100,0

Table 8 shows that the land in the Pegasing Subdistrict classified in categories undamaged (N), with potential low damage, moderate or high potential damaged. The total area of land that is undamaged (N) is 8618.9 ha or 46.1% total of effective area for biomass production in the district, or 61.5% total area designated for land and / or soil for producing biomass at 2014 in Aceh Tengah District. Hence there is no factor inhibiting the use of the land for

biomass production in this area, but the management is required prudence. More explicitly, required the application of the principle of soil and water conservation.

Table 8 also shows that the land is damaged (R) in Atulintang subdistrict includes three unit area by a factor of soil damage is permeability (p) on a unit of land potentially low damaged (PR II-p) and potentially heavy damage (PR IV-P) and texture (f) on land that is potentially moderate damaged (PR III-f). Land lightly damaged (R II-p) is 2028.7 ha (13.9%), moderate damaged (R III-f) 2,341 Ha (16.0%), Soil heavy damaged (R IV-P) is 1.031.1 ha (7.0%) by a factor limiting the use of soil permeability.

DISCUSSION

Some soil physical properties determine the land degradation in Aceh Tengah district, while the chemical properties soil is still within the limits of the land or land quality standards. The physical of the soil which contributes greatly to the area is the texture which is the ratio between the clay with sand > 1: 2 and permeability > 8 cm h-1. In accordance with the results of research Muyassir et al. (2015) that the lands are very critical in Aceh Besar district has a textured sandy loam to sandy clay loam, solum medium, C -organik very low to low. Character of soil physics is correlated with other soil physical properties, is the bulk density and total porosity of the soil [13]. The composition of clay and sand fraction is greater than 1: 2 direct effects on the porosity of the alleged infiltration so intrusive. Porosity of the soil is ideal for growing this plant is about 50% occupied by air and water. If the permeability of the soil is good then the excess water can be reduced through the pores of the soil so that the pore space back in the balance of air and water respectively 50% [17]. Porosity less well able to make the run-off, which in turn will increase the damage to the soil in which the top soil, organic matter and plant nutrients are transported out of the farming system through erosion [18].

CONCLUSION

Effective land for biomass production in Aceh Tengah District in 2014 was 14.019,86 Ha, in the Pegasing subdistrict 8.618,9 Ha (61.5%) and Atulintang Subdistrict 5.400,96 Ha (38.5%). Land in the subdistrict letter has damaged, but in the Atulintang subdistrict been damaged. The soil damaged due to soil texture and permeability are not in accordance with the quality standards set by the government. In 2014 the status of soil damaged must be notified to the public by the government of Aceh Tengah.

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