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Assessment of Land Damage for Biomass Production

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Abstract: *Padang City is the center of growth for the province of West Sumatra, with an area of 694.96 km2 with a population of Padang City reaching 913448 people in 2021. Padang City is planned to utilize space with the development of a harmonious area between settlements, socio-economic activities, and efforts conservation. The rapid population growth and regional development will also have implications for land needs. One of the potential developments of the Padang City area when viewed from the economic activity of the agricultural potential area. Continuous use of land can result in land damage. This study aims to determine the status of land damage and its limiting factors. The method used in the research is the survey method, through direct observation and soil sampling in the field, followed by laboratory analysis. Parameters of soil damage and sampling procedures are guided by Government Regulation No. 150/2000 and Regulation of the Minister of the Environment No. 7/2006. Based on laboratory data analysis, the status of land damage can be determined by using the matching method and scoring the weight of each parameter on the entire sample point, so that based on The results of laboratory analysis show that Padang City has a level of land damage, with a moderate damage index (38-59), with two limiting parameters for soil damage factors, namely; redox and Electrical Conductivity (DHL).*

Keywords: *Land Damage, Biomass Production, Assessment, Environmental, Padang.*

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Introduction

Padang City is the center of growth for the Province of West Sumatra, which has an area of 694.96 km² and in 2021 the population of Padang City will reach 913448 people (BPS Padang, 2022). The rapid development of Padang City in various sectors is accompanied by an increasing number of city residents. The increase in population in Padang City can also provide some consequences for the area.

The increase in the population of Padang City and the diversity of behavioral activities in it will of course also have an impact on population pressure on the environment. Population growth is also a driving factor for land use change, this is due to the increase in the population of Padang City which will also increase the demand for agricultural and plantation products needed for food security. Meanwhile, the availability of land to increase production is decreasing in number due to land conversion. So that agricultural intensification, plantations are a logical choice to increase production.

The increase in population will also increase the demand for settlements, industries, and services which will eventually change the natural vegetation of the land. Changes in land use as a result of human activities have the potential to degrade land through deforestation, removal of natural vegetation, and urban sprawl, agricultural land management practices that do not pay attention to sustainability aspects. The consequences caused by errors in land management and land use also have a negative impact causing utility, biodiversity, soil fertility, and overall soil health will decline, if these problems are not observed, this will certainly increase the area of critical land and unproductive land in the city of Padan. Quoted from the *United Nations Conventions To Combat Desertification (UNCCD)* that the impact of land degradation will be felt by most of the world's population. Land degradation is also associated with disrupted rainfall patterns, exacerbating extreme weather such as droughts or floods, and driving further climate change. This results in social and political instability, which promotes poverty, conflict, and migration (Lala, 2016; Paz-Ferreiro & Fu, 2016; de Paul Obade, 2019). To achieve the SDG (Sustainable Development Goal) target, *the United Nations Conventions To Combat Desertification (UNCCD),* has set a target of *zero net land degradation by 2030*. This is aimed at improving the environment, preserving nature, and improving human welfare. Sustainable soil health management is very important to achieve the SDG targets, especially those related to poverty alleviation, ending hunger, improving health, clean water, economic growth, and climate action (Lala, 2016**)**. This certainly requires efforts and seriousness to tackle land degradation from upstream to downstream.

Soil as a component of land is a living area, environmental media, and production factor including biomass production, supply of raw materials, contaminants, and also archives of cultural gatherings (Panagos *et al*., 2020). Soil quality is related to food security, water security, energy security, and human well-being. However, over time, due to the use of inappropriate resources, the soil can experience a decrease in quality or damage, depletion of soil nutrients, and soil pollution that can threaten the balance of the ecological function of the soil (Zhang *et al*., 2022).

According to the Minister of Environment Regulation No. 7/2006, that soil damage for biomass production can be caused by the nature of the soil and can also be caused by human activities. The standard criteria that can be used to determine the status of soil damage are based on the basic properties of the soil, including physical, chemical, and biological properties of the soil. These basic properties can determine the ability of the soil to provide good water and nutrients for plant life. Parameters used to determine the level of land damage according to Government Regulation No. 150/2000 include Solum thickness, fraction composition, bulk density, soil permeability, soil texture, porosity/TRP, pH, DHL, Redox, and microbiological counts. Soil damage is dynamic with many influencing factors, so it is necessary to assess and evaluate soil damage regularly (Qurrahman *et al*., 2016). Based on the above problems, information on the status of the level of land damage in Padang City is needed, because degraded land requires a long time to recover. Therefore, prevention or efforts to minimize the possibility of land degradation by knowing the causes and environmental conditions where the land is degraded is more advisable than land restoration.

Methods

This research was conducted in potential areas designated for biomass production (such as agriculture, plantations, and plantation forests) of Padang City, based on Regional Regulation No. 4/2012 concerning the Spatial Planning of Padang City 2010-2030. The method used in this study is a survey method, through direct observation and soil sampling in the field, followed by laboratory analysis. Observation and sampling of soil are carried out at the location of the soil that has the potential to be damaged by the indicators as stated in the Regulation of the Minister of the Environment No. 20/2008. Soil sampling represents the administrative area of Padang City,

represents the diversity of rainfall, represents the slope of the land, represents the type of soil, and represents the types of land use in Padang City.

Laboratory test results of soil samples with parameters: the thickness of solum, the structure of 3 fractions, permeability, bulk density, specific gravity, TRP, pH, Redox, DHL, and the amount of microbiology, then performed quantitative analysis by matching and scoring with the criteria of the level of damage in Table 1. These criteria are factors that can affect soil quality for biomass production. The criteria for the level of damage are the minimum standard criteria set by the Environment Agency. These criteria can be increased or decreased for certain areas according to the characteristics of the region.

Table 1. Criteria for the level of land damage

Parameter	Damage Rate				
	B	BPAR	AR	ARPR	R
Solum Thickness (cm)	>150	150-100	100-50	50-20	<20
Surface Rock (%)	<10	10-20	20-30	30-40	>40
Texture 3 Fractions (%)					
Sand	<20	>20-40	>40-60	>60-80	>80
Dust	<50	50-60	60-70	70-80	>80
Clay	<40	40-50	50-60	60-70	>70
Filling Weight/BV (g/cm^3)	<0.8	>0.8-1	>1-1.2	>1.2-1.4	>1.4
Permeability	0.05	0.05-2	2-6.5	6.5-7	>7
Water release rate(cm/hour)	5	5-6	6-7	7-8	>8
Porosity/TRP (%/vol)	45-50	40-45	35-40	35-30	<30
	45-50	50-55	55-60	65-70	>70
pH (units)					
pH H_2O	6-5.5	5.5-5	5-4.5	4.5-4	<4
	6-6.5	6.5-7	7-7.5	7.5-8	>8
DHL (µS/cm)	<1	>1-2	>2-3	>3-4	>4
Redox (mV)	>350	<350-300	<300-250	<250-200	<200
Microbiological Amount (cfu/g)	$>10^8$	$<10^8$ - 10^6	$<10^6$ -10^4	$<10^4$ -10^2	$<10^2$

Note: B=Good (weight 5), BPAR= Good Potential Slightly Damaged (Weight 4) , AR= Slightly Damaged (Weight 3), ARPR=Slightly Damaged (Weight 3), R=Potentially Damaged (Weight 2), R= Broken (Weight 1)

(Source: PERMENLH No. 20/2008).

The results or total values obtained are then scored by weighting each variable with an index and interval based on T Table 2 below.

Table 2. Scoring Standard soil damage criteria for biomass production

No	Index	Interval
1	Well	60-80
2	Currently	38-59
3	Bad	16-37

Source: data analysis by PPKLH UNP.

Results and Discussion

Padang City has an area of 694.96 km², which consists of 11 sub-districts and 104 urban villages. Padang City also has 19 small islands that spread along the coast of Padang City, in addition to the mainland of the island of Sumatra. The largest sub-district in the Padang City area is Koto Tangah District, which is 232.25 km2 or 33.42 % of the total area of Padang City. While the smallest sub-district is West Padang District, which is 7 km² or 1.01 % of the total area of Padang City. Padang City as the capital of West Sumatra Province, has the largest population in West Sumatra, with a fairly high intensity of development in various sectors. There is a lot of potential for the development of the Padang City area when viewed from economic activity, one of which is the potential for agriculture. Efforts to maintain agriculture in the Padang city area are not only in the context of food security but rather in structuring the urban *landscape* as a form of effort to maintain a balance to limit the occurrence of population urbanization and not to shift livelihoods from agriculture to others so that the allocation of urban areas is maintained between land and land. built and undeveloped land. Agriculture in urban areas is sought to be maintained and most of it is developed for polders or flood management systems.

Padang City land is used to support various activities and various urban service facilities. Land use in Padang City by type from 2018 to 2021 did not experience changes as presented in Graph 1, however, there was a reduction in land use types in the use of technically irrigated rice fields from a total of 4932.9 km² to 4133.31 km², there was a reduction of 9066.21 km². The reduction in the land area was followed by the addition of residential use, company land, industrial land, and services from 8863.79 km² increased to 9640.34 km², an increase of 776.55 km², in the same period.

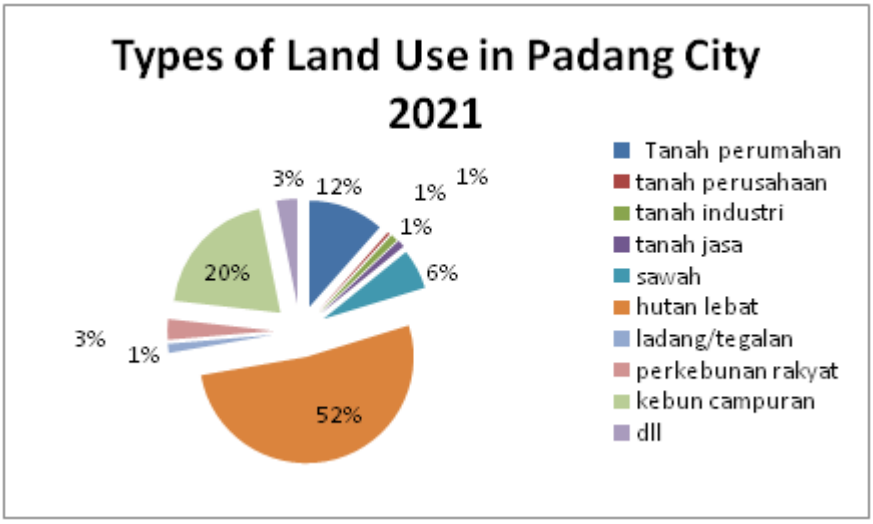

Fig 1. Types of Land Use in Padang City 2021

Table 3. Laboratory Test Results by Sample Point

No	Parameter	Sample point					
		1	2	3	4	5	6
1	Solum Thickness(cm)	80	93	80	94	100	98
2	Surface Rock (%)	<1%	<1%	<1%	<1%	<1%	<1%
3	Texture 3 Fractions (%)						
	Sand	6.32	1.08	6.75	0.9	10.08	3.42
	Dust	19.35	44.9	49.46	59.37	52.13	55.11
	clay	74.33	54.03	43.79	39.72	37.79	41.47
4	Filling Weight/BV	1.05	0.7	1.05	1.22	1.34	1.32

	(g/cm³)						
5	Permeability (cm/hour)	0.57	5.1	2.23	0.52	1.53	0.51
6	Porosity / TRP (%/vol)	60.37	71.7	60.38	53.96	49.43	50,19
7	pH (units)						
	pH H_2O	5.11	5.43	5.84	4.84	6.31	6.3
8	DHL (µS/cm)	30.5	28.9	127	93.8	0.205	92.1
9	Redox (mV)	29.5	30	29.5	29.5	29.5	29.5
10	Microbiological Amount (cfu/ml)						
	Mold	20.10^5	83.10^3	20.10^5	20.10^5	20.10^5	20.10^5
	Bacteria	76.10^3	298.10^5	76.10^3	76.10^3	76.10^3	76.10^3

Source: Laboratory test results.

The results of laboratory tests for each parameter of land damage quality standards are presented in Table 3. The results obtained are then compared with the critical threshold for each parameter. The results of matching and scoring according to Table 1 and Table 2 of the research area have a moderate level of damage, with a total score index of 38-59, where there are two parameters limiting land damage in Padang City, namely; redox parameters and DHL parameters. Where the overall sample points tested have values that exceed the critical threshold with a value of less than 200 mV, while the DHL parameter at the four sample points has a value that exceeds the critical threshold with a value greater than 4 S/cm.

The test results for the depth parameter of Padang City solum mostly have a depth of 80-100 cm. Solum thickness is the vertical distance from the soil surface to the layer that limits the flexibility of the root system development (Abdulkarim *et al*., 2015). The thickness of the soil solum will affect the elements or minerals that plants need to grow properly. Based on the results of laboratory tests, in general, the research area has a solum thickness value that is still above the critical threshold (<20). Sample three (3) has a thinner solum than the other samples, this happens because the point of sample three is located in a gentle area (23% slope) so it has a thin solum thickness, this is due to erosion factors, as found in the sample. three (3), which has a thinner solum thickness than the other samples. While land that is in a flat area will have a thick solum, this happens because of the sedimentation factor.

The results of laboratory tests for texture parameters in Padang City are generally dominated by clay and dust textures. The texture is the composition of the ratio of the fractions between sand, dust, and clay. Based on the results of laboratory tests, samples one and two have high clay content, this is influenced by the reduced diversity of organisms in the soil and reduced organic matter in the soil, besides that it can also be influenced by factors of soil humus formation and others. Temperature and rainfall also affect the weathering of soil-forming materials, indirectly it will also affect the amount of organic matter produced.

Based on the results of laboratory tests, the overall sample of the research area has surface rocks that are still below the critical threshold (>40%). The average sample has a surface rock value <1 percent (%). Surface Rock is the percentage of rock cover on the ground surface. Stone is any coarse material measuring > 2 mm in diameter. Based on the results of laboratory tests, the overall sample of the research area has surface rocks that are still below the critical threshold (>40%). The average sample has a surface rock value <1 percent (%). If the soil is dominated by rock, the area may have experienced high erosion or a lower level of soil formation compared to soil loss. The topography of land on sloping land has faster erosion by water which will have an impact on surface rocks (Widiatiningsih *et al*., 2018). Based on the results of laboratory tests for the bulk density/BV parameter in Padang City, the average density of the six (6) sample points is below

1.4g/cm 3. Bulk weight/BV is the ratio between the weight of the lump of soil and the total volume of the soil. Soil is said to be problematic if the BV of the soil is >1.4 g/cm³ where the roots are difficult to penetrate the soil. The average density of soil samples from 6 (six points) is still below the critical threshold.

Permeability parameters based on laboratory test results can be seen from six sample points having permeability values ranging from 0.5-5.1cm/hour. Permeability is the velocity of water passing through the soil body vertically. The research data shows that the soil permeability of Padang City is still categorized as good because it is below the permeability threshold value > 0.7 cm/hour.

Parameters Total soil porosity is the percentage of pore space in the soil to the volume of the soil. The soil porosity level in Padang City for the six samples was > 30.5 %/v. Soil porosity is generally influenced by soil texture, structure, and organic matter in the soil. Soil with good porosity means soil with large porosity because plant roots will more easily penetrate the soil, looking for organic matter. In addition, the soil can hold rainwater, so the plants have enough water. However, if the porosity of the soil is too high, the material received by the soil will fall too quickly to other layers below it, which has bad consequences. This type of soil will form large fractures in the dry season. The research data shows that the TRP value or total porosity in Padang City in sample one is said to be damaged because it exceeds the critical threshold for total porosity > 70%.

The pH parameter is the level of soil acidity which is reflected by the concentration of H + in the soil. From the results of the labor test, it can be seen that the six samples have pH > 4 and < 7. pH is the level of soil acidity which is reflected by the concentration of H + in the soil. The pH value is said to be problematic if the pH is < 4.5 or > 8.5 for soil in dry land and the pH value is < 4.0 or > 7.0 for soil in the wetland. Based on the soil pH conditions, it can be concluded that the land for biomass production in Padang City is still between the threshold so it is still suitable for plant growth.

The Electrical Conductivity Parameter (DHL) is a qualitative approach to the ion content in the soil solution, outside of the soil absorption complex. If the ionic content of the solution is large, the DHL value will be greater. At 25º C, DHL has units of mS/cm or S/cm. DHL values > 4 mS caused root rot due to plasmolysis. The results of the DHL test in Padang City, it can be seen that the DHL value for samples 1, sample 2, sample 3, sample 4, and sample 6 has passed the critical threshold >4, while for sample 5 it is still below the critical threshold of 0.205 (µS/ cm **)**. DHL is also called soil salinity value because it describes the level of salt in the soil. If the DHL value > 4 S/cm will cause root rot due to plasmolysis. The data from the laboratory test results of the six samples showed that the DHL (Electricity Conductivity) value of the soil in Padang City had exceeded DHL's critical threshold is >4.0 S/cm. High salt solubility or salinity in the soil can cause causes the absorption of water and nutrients by plants to be hampered due to osmotic pressure (Abdulkarim *et al*., 2015).

The parameter is the oxidation-reduction atmosphere of the soil which is related to the availability or unavailability of oxygen in the soil. If the value of Eh < 200 mV means the soil atmosphere is reductive (soil in dry land) if the value of Eh > - 100 mV pyrite can be oxidized (pyrite soil in wetlands), and if the value of Eh > 200 mV peat can be oxidized/degraded. From the results of the Redox test in Padang City, it can be seen that the six samples were already below the critical threshold. High redox potential values usually occur in soils that have good ventilation or aeration and more oxygen in the soil solution so that more compounds are oxidized. While the redox potential low levels occur in poor or oxygen-deficient soils so many compounds are reduced. Data from laboratory test results for the six samples showed that the soil redox in Padang City was below the critical threshold of <200 mV. Factors that affect redox are the activity of microorganisms. The low redox value in the soil indicates a reductive soil condition. This condition is usually related to

poor drainage or soil conditions that contain too much water (Shangguan, Dai, Liu, Ye, & Yuan, 2012).

The number of soil microbes is the number of microbial populations in the soil as measured by a *colony counter*. The presence of total microbes in the soil can also describe the quality of the soil. The higher the presence of the number of microbes, the atmosphere both chemical and physical in the soil is very supportive. Data from laboratory test results for the six samples showed that the number of soil microbiology in Padang City for the six samples was still above the critical threshold and it could be concluded that it was still in the good category.

Conclusions

Land damage in Padang City based on laboratory analysis that has been matched and scored has a level of soil damage with a moderate damage index category (38-59), with two limiting parameters for soil damage factors, namely; redox and Electrical Conductivity (DHL).

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