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Assessment of Land Damage Status Using Frequency Method on Several Land Use for Biomass Production in Payakumbuh City

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ABSTRACT: Intensive use of land for agricultural businesses causes the land to become very dynamic and causes a decrease in soil quality for producing biomass. This research aims to determine environmental conditions (level of damage to land and soil for biomass production) and the factors that cause soil damage in Payahkumbuh City. Land surveys were carried out using the research method in five sub-districts. Samples taken in the field are disturbed soil samples for analysis of physical properties (*texture, BV, TRP, and permeability*). In contrast, disturbed soil samples are used to analyze chemical soil properties (*c.organic, pH, DLH, Redok*). Apart from that, he also observed environmental conditions such as rocks on the surface and the depth of the soil. Next, the soil samples are explained in the soil laboratory of the Department of Soil Science and Land Resources. Data from soil physical and chemical property variables are processed, averaged, and compared with soil health standards following PP No. 150 of 2000. The research results show that the results of land identification and verification show that the land in the five sub-districts of Payakumbuh City in the research area has a Light Damage Status (RI) covering an area of 2391.65 ha and Moderate Damage (RII) covering an area of 1856.76 ha. From 10 observation points, the land in the research area has two levels of soil damage: moderate and light. Soil damage is caused by limiting factors. In moderate damage status, the limiting factors are (RII-vpre), namely soil porosity, degree of air escape, redox reactions, and electrical conductivity. Meanwhile, the limiting factors in soil with mild damage are (RI-vre) soil porosity, redox reactions, and electrical conductivity.

KEYWORDS: soil degradation, biomass, soil properties, damage

INTRODUCTION

Background

The basis of national development policies implemented so far is aimed at sustainable and environmentally sound development. This development pattern means seeking the best results from available natural resources by preserving the quality and potential of these natural resources throughout the ages. Therefore, the threat of environmental damage must continue to be monitored, both by the government as a policy maker and by practitioners from all elements of society.

Deforestation and land degradation have significant impacts, ranging from decreasing biodiversity, floods, landslides, droughts, decreasing water and soil quality to the global climate change that we are currently facing. Industrial development in agricultural areas has reduced the area of productive agricultural land and also polluted the land and water bodies. As a result, the quality and quantity of agricultural products decreases, as well as causing discomfort and health problems for humans or other living creatures. Agricultural activities can also have negative impacts.[Aprisal et al., 2019]. Soil erosion and damage occurs due to agricultural cultivation that exceeds the carrying capacity of the soil (Bekele, 2019) and its ecosystem. Apart from that, excessive use of chemical fertilizers can also result in water and soil pollution and reduce soil fertility. Based on research conducted, the sustainability of biomass production is greatly influenced by soil conditions and damage. Damaged soil can inhibit the growth and productivity of biomass plants.

Damaged soil can have poor physical, chemical, and biological qualities, such as rapid soil structure, inappropriate pH, and low organic matter content. Apart from that, soil damage can also result in erosion which ultimately affects soil fertility and groundwater availability. Soil damage can also affect the soil nutrient cycle, so that plant biomass will have difficulty getting the nutrients needed for growth. Therefore, to assess soil conditions more comprehensively, it is necessary to carry out an assessment that covers various aspects, from physical, chemical, to soil biology quality (Basak et al., 2021)

The development of industrial areas in agricultural areas and their surroundings has reduced the area of productive agricultural land and polluted the land and water bodies. As a result, the quality and quantity of agricultural products has decreased, causing disruption to human comfort and the welfare of other living creatures. Agricultural activities can also have detrimental impacts – excessive farming causes erosion and soil damage that exceeds the carrying capacity of the land and ecosystem. In addition, excessive use of chemical fertilizers can result in water and soil pollution. Apart from that, it is also necessary to consider external factors such as land use, fertilizer use, and irrigation techniques which can affect long-term soil health and the sustainability of biomass production (Environmental Sustainability, 2023). Excessive use of agrochemicals can pollute the environment and disrupt land sustainability. Agricultural cultivation methods that do not heed land conservation principles cause land quality to decline in line with the loss of fertile soil layers due to erosion and leaching of nutrients. Land and environmental damage increases when agricultural areas are expanded to develop economic commodities by opening up new land that is not in accordance with the capabilities and suitability class of the land. Soil as a natural resource, living area, environmental medium and production factor including biomass production which supports human life and other living creatures must be protected andits sustainability is maintained (Basak et al., 2021)

An environmental problem that continues and is increasingly becoming a serious concern that we can look at together is land use that does not pay attention to soil conservation aspects, thereby accelerating the degradation of soil fertility levels. This problem is not only the responsibility of the Regional Government with all its policies, but must also be the responsibility of all elements of society in Payakumbuh City. Law Number 32 of 2009 concerning Environmental Protection and Management explains that basically everyone is obliged to maintain the preservation of environmental functions and prevent and overcome environmental pollution and damage. The influence on the environment can be a disturbance of the balance of the ecosystem which supports life, experiencing changes and even damage due to activities and processes such as pollution and so on. In terms of biomass production, soil damage can disrupt the balance of the ecosystem and cause perspiration (Kardol et al., 2018). The aim of this research is to determine environmental conditions (level of land damage and/or land for biomass production), to determine the factors that cause land damage in Payahkumbuh City.

MATERIALS AND METHODS

Determining Study Locations

The study of the status of land damage for biomass production in Payakumbuh City in 2022 covers five sub-districts, namely; East Payakumbuh District, North Payakumbuh District, West Payakumbuh District, South Payakumbuh District, and Payakumbuh Lamposi Tigo Nagari District. More details can be seen at Table 1. the following.

Table 1. Sampling Location for Payakumbuh City Study Area

No	Sample Code	Administration Location		Geographical Position	
		Subdistrict	Ward	L.S	BT
1	KPY S1	South Payakumbuh District	Limbukan	0°15'57.30" S	100°36'53.90" E
2	KPY S2	South Payakumbuh District	Padang Kerabi	0°15' 8.20" S	100°37'41.80" E
3	KPY T1	East Payakumbuh District	Batimah Hall	0°13'17.10" S	100°39'36.80" E
4	KPY T2	East Payakumbuh District	Payobasung	0°12'28.20" S	100°39'37.20" E
5	KPY U1	North Payakumbuh District	Taruko	0°12'31.30" S	100° 39' 9.70" E
6	KPY U2	North Payakumbuh District	Talawi	0°11'14.40" S	100°38'8.30" E

7	KPY LS1	Payakumbuh Lamposi Tigo Nagari District	Durian River	0°11'57.50" S	100°36'54.50" E
8	KPY LS2	Payakumbuh Lamposi Tigo Nagari District	Padang Sikabu	0°12'43.46" S	100°36'38.76" E
9	KPY B1	West Payakumbuh District	Gutter	0°13'41.60" S	100°35'45.20" E
10	KPY B2	West Payakumbuh District	Gutter	0°13'51.50" S	100°35'41.30" E

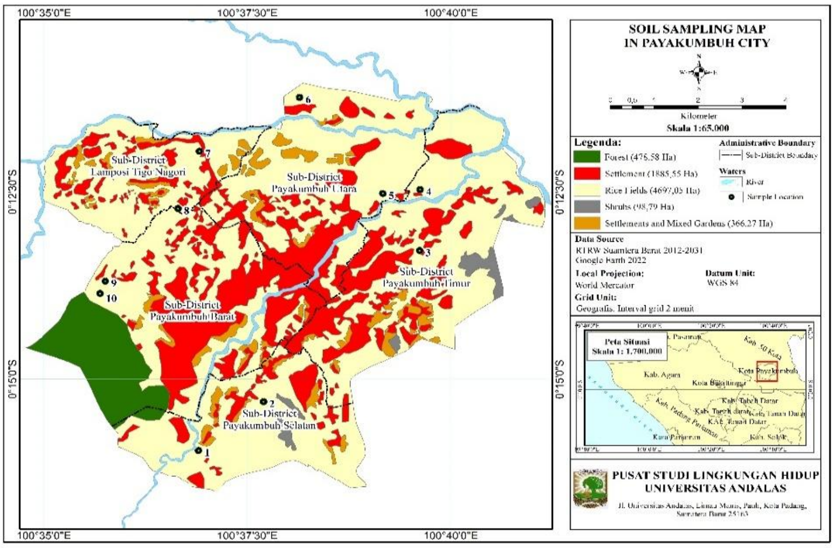

Figure 1. Map of sample points for potential soil damage in five sub-districts in Payakumbuh City

Primary Data Collection

Primary data collection is taking soil samples at predetermined locations. The soil samples taken consist of:

a. Undisturbed soil samples were taken using a sample ring. Soil samples are needed to determine bulk density (BI), total porosity and degree of water flow (permeability).

b. Disturbed soil samples were taken using a mineral drill. Representative soil samples for designated locations are carried out compositely. Incomplete soil samples are needed to determine texture, pH (H2O), DHL redox, and microbial counts.

Laboratory soil analysis

Soil parameters for dry land as regulated in Minister of the Environment Regulation No. 7 of 2006 concerning Procedures for Measuring Land Damage Criteria for Biomass Production include: Solum Thickness, Surface Unity, Fractional Composition, Bulk Density, Total Porosity, Degree of Water Permeability, pH. Electrical Conductivity, Redox Value, Number of Soil Microbes (Table 2).

Table 2. Standard Criteria for Soil Damage in Dry Land

No	Parameter	Critical Threshold (PP 150/2000)	Unit of Observation/Analysis Results	Measurement Method
1	Solum Thickness	< 20 cm	cm	Direct Measurement
2	Surface Rockery	> 40 %	%	Direct measurement of rock balance and land area units
3	Fraction Composition	< 18 % colloid ; > 80% quartzite sand	%	Gravimetrics and Texture Analysis

4	Content Weight	> 1.4 g/cm3	g/cm3	Gravimetric
5	Total Porosity	< 30 % ; > 70 %	%	Calculation of Fill Weight (BI) and Specific Gravity (BJ)
6	Degree of Water Release	< 0.7 cm/hour; >8.0 cm/hour	cm/hour	Permeameter uses Darcy's Law
7	pH (H2O) 1 : 2.5	< 4.5 ; > 8.5		Potentiometric
8	Electrical Conductivity / DHL	> 4.0 mS/cm	mS/cm	Electrical resistance with EC meter equipment
9	Redox	< 200 mV	mV	Electrical voltage with pH meter equipment and platinum electrodes
10	Number of Microbes	< 102	cfu/g soil	Petridis and coloni counter
11	Soil erosion • Solum < 20 • Solum 20 - 49 • Solum 50 – 99 • Solum 100-150 • Solum > 150	< 1 1 – 2.9 3 – 6.9 7 – 9 > 9	tons/ha/year	Direct observation in the field

Table 3. Assessment of Potential Soil Damage Based on Soil Type

No	Land	Potential Soil Damage	Symbol	Ratings	Weighting Score (Rating x Weight)
1	Vertisol, Soil with aquic moisture regime	Very Light	T1	1	2
2	Oxisols	Light	T2	2	4
3	Alfisols, Molisols, Ultisols	Currently	T3	3	6
4	Inceptisols, Entisols, Histosols	Tall	T4	4	8
5	Spodosols, Andisols	Very high	T5	5	10

Table 4. Assessment of Potential Soil Damage Based on Land Slope

No	Slope (%)	Potential Soil Damage	Symbol	Ratings	Weighting Score (Rating x Weight)
1	1 – 8	Very Light	L.1	1	3
2	9 – 15	Light	L.2	2	6
3	16 – 25	Currently	L.3	3	9
4	26 – 40	Tall	L.4	4	12
5	>40	Very high	L.5	5	15

Table 5. Assessment of Potential Soil Damage Based on Annual Rainfall

No	Rainfall (mm)	Potential Soil Damage	Symbol	Ratings	Weighting Score (Rating x Weight)
1	<1000	Very low	H1	1	3
2	1000 – 2000	Low	H2	2	6
3	2000 – 3000	Currently	H3	3	9
4	3000 – 4000	Tall	H4	4	12
5	>4000	Very high	H5	5	15

Table 6. Assessment of Potential Soil Damage Based on Land Use Type

No	Land Use	Potential Soil Damage	Symbol	Ratings	Weighting Score (Rating x Weight)
1	Natural forests, rice fields, pure reeds	Very low	T1	1	2
2	Mixed gardens, bushland, meadows	Low	T2	2	4
3	Production forest, Farming	Currently	T3	3	6
4	Moorland (annual plants)	Tall	T4	4	8

Table 7. Criteria for Classification of Potential Soil Damage Classes Based on Score Values

No	Symbol	Potential Soil Damage	Weighting Score
1	PR I	Very low	<15
2	PR II	Low	15 – 24
3	Homework III	Currently	25 – 34
4	PR IV	Tall	35 – 44
5	PR V	Very high	– 50

Soil Damage Status for Biomass Production

Evaluation of soil damage status for biomass production is carried out through 2 stages as follows:

a. Matching Method

The Matching method is to compare the measured soil damage parameter data with standard soil damage criteria for Biomass Production based on Government Regulation No. 150 of 2000 or (Table 3, 4, 5, 6, and 7).

b. Soil Damage Frequency Scoring Method.

The scoring method is carried out by considering the relative frequency of those classified as damaged in a polygon. The relative frequency of soil damage (%) is the percentage value of soil damage based on a comparison of the number of damaged soil samples, namely the results of measuring each parameter of soil damage according to standard criteria for soil damage quality.

The steps in determining land damage status are as follows:

1. Calculate the relative frequency (%) of each soil damage parameter.
2. Provides a score value for each parameter based on relative frequency values with a range from 0 to 4 (Table 7).
3. Add up the score values for each parameter of the soil damage criteria.
4. Determination of land damage status based on the sum of the score values (8 and 9).

Table 8. Soil Damage Score Based on Relative Frequency

No	Relative Frequency of Damaged Soil (%)	Score	Land Damage Status
2	11 – 25	1	Light Damage
3	26 – 50	2	Moderately Damaged
4	51 – 75	3	Heavy Damaged
5	76 – 100	4	Very Heavy Damaged

Table 9. Soil Damage Status Based on Accumulated Soil Damage Score Values for Dry Land

No	Symbol	Land Damage Status	Accumulated Soil Damage Score Value
1	N	Not broken	0
2	R.I	Light Damage	1 – 14
3	R. II	Moderately Damaged	15 – 24
4	R. III	Heavy Damaged	25 – 34
5	R. IV	Very Heavy Damaged	35 – 40

RESULTS AND DISCUSSION

The results of land identification and verification show that the land in the five sub-districts of Payakumbuh City in the research area has a Light Damage Status (RI) covering an area of 2391.65 ha and Moderate Damage (RII) covering an area of 1856.76 ha. From 10 observation sample points, the soil in the study area has two levels of soil damage; namely moderate damage and light damage. Soil damage is caused by limiting factors. In moderate damage status, the limiting factors are (RII-vpre), namely soil porosity, degree of water escape, redox reactions and electrical conductivity. Meanwhile, in soil with mild damage status, the limiting factors are (RI-vre), namely soil porosity, redox reactions and electrical conductivity (Suryadi et al., 2020); (Nursita, 2020) hilly land typology. (Land degradation, 2023); (Hudson & Alcántara-Ayala, 2006) The results of the study show that the limiting factors that influence the level of soil degradation for biomass development in the study area are as follows: (Nursita, 2020), ; (Suryadi et al., 2020)

Based on a combination of soil damage factors such as soil type, slopeslope, rainfall and land management systems in five sub-districts of Payakumbuh City have an impact on land damage. This can be seen from the results of studies, observation results and soil analysis results in the laboratory which show that there are several parameters that exceed the critical threshold for soil damage. The parameters that exceed the critical threshold for soil damage are porosity, degree of water permeability, redox potential and electrical conductivity at several observation locations..

Parameters of porosity, soil permeability or degree of water leakage are influenced by levelroomsoil pores and soil density. The degree of water release that is beyond the standard threshold for damage is land that has a value beyond the standard threshold. This shows that the degree of water discharge is low so that surface water runoff will increase which will increase erosion on upland land. However, it will be different from paddy fields, which require the land to be flooded. If the erosion is large, it will thin the treated layer, thereby affecting other soil properties such as pH value, redox and also the electrical conductivity of the soil.

Technology for improving porosity, permeability, redox and electrical conductivity can be carried out using an environmentally friendly land management system; namely by soil management accompanied by the addition of organic materials, harvest residues, other ameliorant materials such as agricultural lime such as dolomite. Organic material left over from the harvest needs to be chopped into fine pieces with a copper tool, so that the organic material decays quickly and releases nutrients into the soil which are absorbed in the plant tissue.

Redox (reduction-oxidation) is considered damaged because the value is less than the critical threshold, namely 200 mV. This is because most of the land studied has slopes that are flat and gentle. Use is dominated by rice fields and moorlands. When it rains on flat land, runoff water will easily saturate the soil pores, in this condition reduction will usually be more dominant than oxidation. Therefore the Eh value of redoxi is lower. This low Eh value usually occurs in rice fields. This is because paddy soil has a low redox value. (Nursita, 2020); (Shehrawat & Singh, 2003) Reclamation of moderately or lightly damaged land can be done by improving the land management system such as; conservation tillage, also return plant residues to the soil and avoid burning crop residues.

Table 10. Recapitulation of Land Damage Status Evaluation

Land Units	Solum thickness	Surface rockiness	Composition of colloidal fractions	Content weight B.V	Total porosity	Degree of water flow	pH (H2O) 1:2.5	Power Send Electric/DH L	Redox	Number of microbes	Total Score	Land Use	Status Soil Damage	Symbol
KPY S1	0	0	0	0	4	4	0	4	4	0	16	ricefield	Moderately Damaged	RII-vpre
KPY S2	0	0	0	0	4	4	0	4	4	0	16	moor	Moderately Damaged	RII-vpre
KPY T1	0	0	0	0	4	4	0	4	4	0	16	moor	Moderately Damaged	RII-vpre
KPY T2	0	0	0	0	4	0	0	4	4	0	12	ricefield	Light Damage	RI-vpre
KPY U1	0	0	0	0	0	4	0	4	4	0	12	ricefield	Light Damage	RI-pre
KPY U2	0	0	0	0	4	0	0	4	4	0	12	moor	Light Damage	RII-vre
KPY LT1	0	0	0	0	4	0	0	4	4	0	12	ricefield	Light Damage	RI-vre
KPY LT2	0	0	0	0	4	4	0	4	4	0	16	moor	Moderately Damaged	RI-vpre
KPY B1	0	0	0	0	4	0	0	4	4	0	12	ricefield	Light Damage	RI-vre
KPY B2	0	0	0	0	4	0	0	4	4	0	12	moor	Light Damage	RI-vre

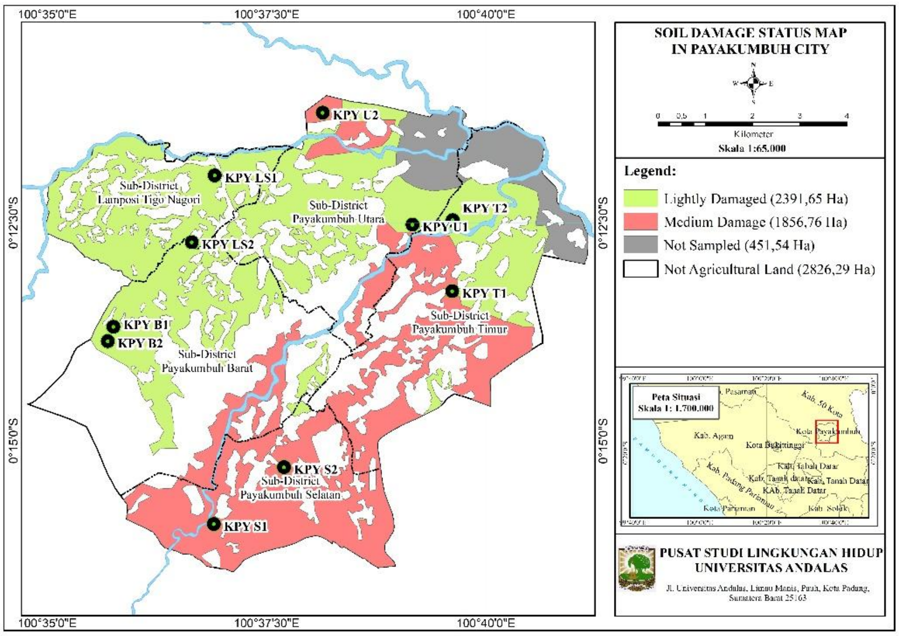

Figure 2. Map of land damage status

CONCLUSION

1. Based on the results of land identification and verification, it shows that the land in the five sub-districts of Payakumbuh City which is included in this study area has a slightly damaged (RI) status covering an area of 2391.65 ha and moderately damaged (II) covering an area of 1856.76 ha.
2. Soil damage in the five sub-districts of Payakumbuh City which are included in the study area all have land damage status of Lightly Damaged (RI) with limiting factors of porosity, redox and DHL, and Moderately Damaged (II) with limiting factors of porosity, degree of water flow, redox and DHL.

REFERENCES

1) Aprisal. Istijono, B., Mimin, H., Juniarti. 2018. Soil quality index analysis under horticultural farming in Sumani Upper Watershed. International Journal of Geomate, April 2019, Vol.16, Issue 56, pp. 191 - 196 ISSN: 2186-2982 (P), 2186-2990 (O), Japan.
2) SoilDegradation.https://www.sciencedirect.com/topics/earth-and-planetary-sciences/soil-degradation.(2023,January 1).
3) I. Virto, M. Imaz, O. Fernández-Ugalde, N. Gartzia-Bengoetxea, A. Enrique, and P. Bescansa, "Soil Degradation and Soil Quality in Western Europe: Current Situation and Future Perspectives," Sustainability, vol. 7, no. 1, pp. 313–365, 2014, doi: 10.3390/su7010313.
4) B. Aghasi, A. Jalalian, and N. Honarjoo, "The comparison of some soil quality indices in different land uses of Ghareh Aghaj Watershed of Semirom, Isfahan, Iran," World Acad. Sci. Eng. Technol., vol. 71, no. 11, pp. 167–171, 2010, [Online]. Available: http://www.scopus.com/inward/record.url?eid=2-s2.0-78651552119&partnerID=40&md5=a96513203da26f1161af3aad1cf1cec2.
5) DS Aspects and SS Properties, "Influence of Different Slope Aspects on Some Soil Properties and Forest Soils Evolution (Case Study: Rostam Abad Region, Guilan Province)," pp. 1–8, 2022.
6) (2022, April 5). Climate change, agriculture and food security. https://www.greenfacts.org/en/climate-agriculture-food-security/index.htm
7) Basak, N., Mandal, B., Kumar, A., & Basak, P. (2021, March 1). Soil quality and productivity improvement: Indian story. https://doi.org/10.1007/s43538-021-00007-8
8) Bekele, T. (2019, May 13). Effect of Land Use and Land Cover Changes on Soil Erosion in Ethiopia. https://doi.org/10.17352/2455-815x.000038
9) Environmental Sustainability. (2023, January 1). https://www.sciencedirect.com/topics/agricultural-and-biological-sciences/environmental-sustainability

10) Kardol, P., Fanin, N., & Wardle, D A. (2018, May 1). Long-term effects of species loss on community properties across contrasting ecosystems. https://doi.org/10.1038/s41586-018-0138-7
11) Agustina, C., Rayes, M L., & Rosidha, E. (2020, July 1). Soil Quality Mapping on Rice Fields in Turen District, Malang Regency. Brawijaya University, 7(2), 367-373. https://Doi.Org/10.21776/Ub.Jtsl.2020.007.2.22
12) Hudson, P F., & Alcántara-Ayala, I. (2006, February 1). Ancient and modern perspectives on land degradation. https://doi.org/10.1016/j.catena.2005.11.003
13) Land degradation. (2023, January 17). https://en.wiktionary.org/wiki/land_degradation
14) Nursita, D. (2020, December 30). Soil quality index analysis in efforts to overcome land degradation in Nganjuk Regency., 15(2), 96-106. https://doi.org/10.29122/jstmb.v15i2.4564
15) Shehrawat, P S., & Singh, S. (2003, January 1). Management of Dryland Sustainable Agriculture. https://econpapers.repec.org/RePEc:ags:ifma03:24308
16) Suryadi, S., Dharmawan, A H., & Barus, B. (2020, August 31). Palm Oil Plantation Expansion: Social, Economic and Environmental Issues (Case Study of Pelalawan District, Riau). Diponegoro University, 18(2), 367-374. https://doi.org/10.14710/jil.18.2.367-374