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Soil erosion sensitivity of rubber plant, oil palm, and teak in Ogan Komering Ilir District

Sensitivitas erosi tanah pada tanaman karet, kelapa sawit, dan jati di Kabupaten Ogan Komering Ilir

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ABSTRAK

Erodibilitas tanah adalah mudah tidaknya suatu tanah untuk tererosi. Tujuan dari penelitian ini adalah mendapatkan besarnya nilai erodibilitas tanah pada lahan karet, kelapa sawit dan jati di PT. Waimusi Agroindah. Metode yang digunakan adalah survei sangat detail di bantu peta digital. Sampel tanah diambil berdasarkan luas lahan penelitian. Sampel tanah diambil pada kedalaman 0 – 30 cm dan tanah lapisan atas untuk analisis permeabilitas tanah serta kelengkapan alat dan bahan yang perlukan. Didapatkan perhitungan besarnya nilai erodibilitas tanah pada lahan karet, kelapa sawit dan jati memiliki kriteria sedang. Persamaan kriteria tersebut secara angka kuantitatif lahan kelapa sawit memiliki angka sebesar 0,18 teringgi dari lahan karet sebesar 0,15 dan lahan jati sebesar 0,13. Sedangkan pada lahan hutan didapat nilai erodibilitas tanah sebesar 0,04 sehingga masuk kedalam kriteria sangat rendah. Kesimpulan penelitian ini adalah bahwa lahan karet, kelapa sawit dan jati didapat nilai kepekaan erosi tanah dengan kriteria sedang, Untuk hasil nilai kepekaan erosi tanah pada lahan hutan yaitu tergolong sangat rendah. Penelitian ini merupakan satu dari rangkaian beberapa faktor untuk mengetahui potensi erosi lahan, perlu dilakukan penelitian lanjut agar potensi erosi dapat diketahui dari keseluruhan faktor yang mempengaruhi potensi erosi tersebut.

Kata kunci: konversi lahan hutan, lahan karet, kelapa sawit dan jati, erodibilitas tanah, sifat fisik dan kimia tanah

ABSTRACT

Soil erodibility was the ease with which soil erodes. The study aimed to determine the value of soil erodibility on rubber, oil palm, and teak land at PT Waimusi agroindah. The method used was a very detailed survey, assisted by digital maps. Soil samples were taken based on the study area. Soil samples were taken at 0–30 cm deep and topsoil for soil permeability analysis as well as the completeness of the tools and materials needed. The calculation of the value of soil erodibility on rubber, oil palm, and teak land has moderate criteria. The equation of these criteria in quantitative numbers for oil palm land has a value of 0.18, which was higher than rubber land at 0.15 and teak land at 0.13. While on forest land, the soil erodibility value was 0.04, so it falls into very low criteria. The conclusion of this research was that rubber, oil palm, and teak land obtained soil erosion sensitivity values with moderate criteria, and the results of soil erosion sensitivity values on forest land were classified as very low. This research was one of a series of several factors used to determine the potential for land erosion. Further research needs to be done so that the potential for erosion could be determined from all the factors that affect the potential for erosion.

Keywords: conversion of forested land, rubber, oil palm, and teak land, soil erodibility, soil physical and chemical properties

INTRODUCTION

The conversion of forest land to other uses can result in degradation and a decline in soil properties (Tanaman et al., 2024). Land cover changes of each type of vegetation have different shading and rooting (Achmadi et al., 2023). According to (Najmudin et al., 2022) forest land and plantations on the same slope have different erosion rates. One of them is caused by different land vegetation (Hartati et al., 2023). Land is a physical component, including climate, topography, soil, hydrology, and vegetation (Mubarokah & Hendrakusumah, 2022). Continuous land clearing results in degradation (Ferry et al., 2024). It is known to cause changes in soil physical, chemical, and biological properties (Mamangkay et al., 2023).

Soil physical properties are an element of the environment that affects the availability of air and water in the soil space (Puspita Sari, 2023). Soil chemical properties are needed to help plant life (Maharany et al., 2023). Soil biology has a role in maintaining soil stability and health (Murni et al., 2023). Indirectly affects plant nutrients (Rosita & Baharuddin, 2023). These properties also affect soil fertility so that plants grow well (Sakiah et al., 2020). Crops could indirectly protect the soil from land damage, especially due to surface flow that could increase the value of soil erosion sensitivity (Fakhrudin et al., 2023).

Differences in soil properties can lead to differences in soil erodibility values (Hotmartua & Pasaribu, 2023). Soil erodibility is the ease of soil erosion (Kalaati et al., 2019). Soil erodibility is influenced by factors such as soil texture, organic matter content, soil structure, and soil permeability (Tanaman et al., 2024). Land use at PT Waimusi Agroindah was previously forest land converted into rubber, oil palm and teak land. Therefore, the function of land as a hydrology regulator for the surrounding area has changed. The purpose of this research was to assess and compare the magnitude of soil erodibility on rubber, oil palm and teak land at PT Waimusi Agroindah.

MATERIALS AND METHODS

Study Area

The study site was located at PT Waimusi Agroindah, Sedyo Mulyo village, Mesuji Raya sub-district, Ogan Komering Ilir, South Sumatra, Indonesia. Geographically located 105º 03'57.4"-105 03º 32 5" East and 03º 40'12" LS. PT Waimusi Agroindah was a national private company engaged in rubber and oil palm plantations. HGU (Cultivation Rights Title) 9,718, 70 ha consists of 5,772 ha of oil palm plantations and 3,411.97 ha of rubber. The altitude of the research location was between 25-50 meters above sea level (Figure 1).

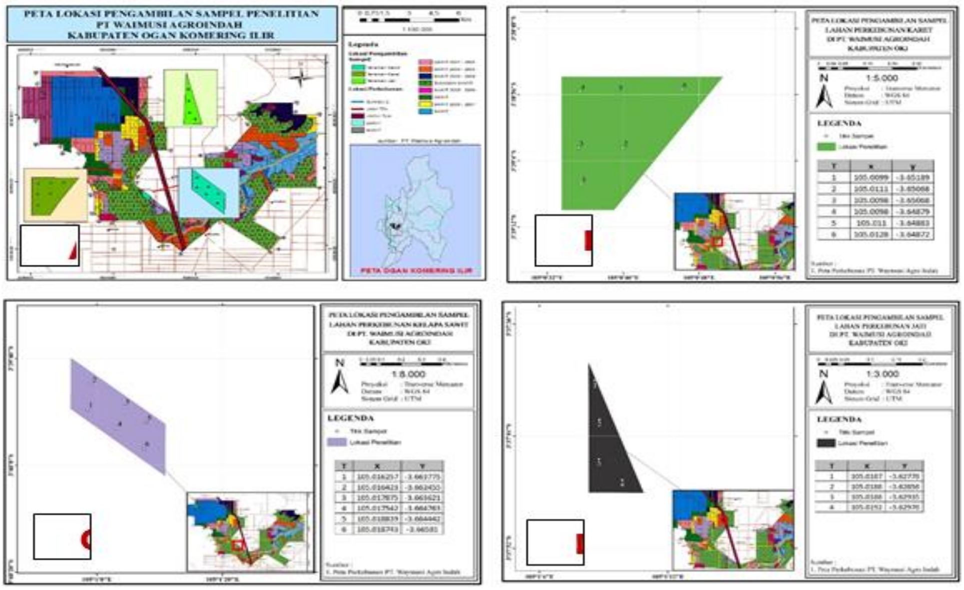

Figure 1. A digital map of the research location: A. PT Waimusi Agroindah area; B. rubber land; C. oil palm land; and D. teak land

Field and Laboratory Activities

Field activities have been carried out: coordinating, observing, and determining the place based on three fields at PT Waimusi Agroindah; determining the point of soil samples taken on the land (rubber in afdeling 3 plot d5 with a plant age of 20 years and a plant distance of 3×5 m; oil palm in afdeling I plot a25 with a plant age of 19 years and a plant distance of 9×9 m; teak in afdeling 3 plot d13 with a plant age of 18 years and a plant distance of 3×3 m). Sampling in rubber, oil palm, and teak fields totaled 16 soil sample points. Soil physical properties observed in the field were soil structure by assessing the durability of the structure, or great (Oktavia, 2018). Soil analysis has been carried out in the laboratory of Conservation Physics and Soil Fertility Chemistry at Sriwijaya University.

Methods

This study used a very detailed survey method. The scale of the map was 1:5,000 for rubber land, 1:8,000 for oil palm, and 1:3,000 for teak (Nugroho, 2022). The area of rubber land was 20 ha, 17 ha of oil palm, and 3.5 ha of teak. Soil sampling based on land area: 6 sample points were taken on rubber and oil palm land, 1 sample point representing 3.4 ha of rubber, 1 sample point representing 2.9 ha of oil palm land, and 4 sample points of teak land, 1 sample point representing 0.874 ha (Megayanti et al., 2022). Disturbed soil samples were taken using a Belgie drill with a depth of 0–30 cm, and undisturbed soil samples were taken using a soil sample ring (Injiliana et al., 2021). The materials used were literature, an administrative map of PT Waimusi Agroindah, soil samples, and chemicals used for laboratory soil analysis. The tools used were: stationery, drill belgi, GPS type 64s, gauge, plastic bag, rubber band, label paper, meter, hammer, board, knife, and ring sample.

The Observed Parameters

Organic matter using the Walkley and Black methods (Dwi Saputra et al., 2018), permeability using the constant head permeameter method (Chen & Sentosa, 2020), and soil texture using the hydrometer method (Br.Tarigan et al., 2014). Furthermore, calculations were carried out to obtain the value of soil erosion sensitivity.

Data Analysis

By collecting all observations in the field and laboratory. Then all the data was interpreted so that it could be presented descriptively in the form of a report. To find the value of soil erosion sensitivity using the Wischmeier and Smith equation (Hanifa & Suwardi, 2022), 100 K = 1.292 [2.1 M1.14 (10-4)(12-a)+3.25(b-2)+2.5(c-3)] Description: K = soil erosion sensitivity value, M = percentage of very fine sand and dust (100 percent of clay), a = organic matter (%) (% C-organic × 1.724), b = soil structure class code, c = soil cross-sectional permeability code. With the equation formula, we will see the results of the soil erosion sensitivity value on plant species at PT. Waimus Agroindah.

RESULTS

Land Use

The vegetation that grows on the rubber land between the plantations was quite diverse, including weeds, wood, and shrubs. The condition of oil palm land was cleaner than that of rubber land, so the vegetation that grows was not as dense as in rubber land. Teak fields have weeds and reeds. PT Waimusi Agroindah leaves forest land with natural conditions so that the vegetation that grows was very dense Figure 2.

Soil Physical and Chemical Conditions Soil Organic Matter

The results of the analysis of C-organic content and soil organic matter in the laboratory were presented in Table 1. The percentage content of organic matter in the soil in rubber, oil palm, and teak land showed different results. Rubber land was 4.76% and oil palm was 4.00% with medium criteria, but teak land was 3.51% with low criteria. On forest land, the percentage content of soil organic matter was 9.82%, so it was included in the very high criteria.

Soil Permeability

The results of permeability laboratory analysis were presented in Table 2. The results of the permeability analysis showed that the teak field has a permeability rate of 5.20 cm/hour. Rubber land showed 4.92 cm/hour and oil palm at 4.59 cm/hour. With these results, the three lands fall into permeability class 4 and moderate criteria. The forest land showed a quantitative figure of 11.39 cm/hour, falling into permeability class 3 and meeting rather fast criteria.

Table 1. C-Organic and soil organic matter content (%)

Land	C-organics	Organic material	Criterion
Rubber	2.76	4.76	Medium
Oil palm	2.32	4.00	Medium
Teak	2.04	3.51	Low
Forest	5.69	9.82	Very high

Source: Chemistry Laboratory, Department of Soil, Faculty of Agriculture, Sriwijaya University (2019).

Table 2. Soil Permeability Rate (cm/h)

Land	Permeability	*Pc	Criterion
Rubber	4.92	4	Medium
Oil palm	4.59	4	Medium
Teak	5.20	4	Medium
Forest	11.39	3	Rather fast

Source: Physics Laboratory, Department of Soil, Faculty of Agriculture, Sriwijaya University (2019).
Note: *Pc = Permeability class

Soil Strutrue

The result observations of soil structure in the field were presented in Table 3. The observation of soil structure showed that the structure type of rubber and oil palm land was coarse and granular. Teak and forest land soil structures were fine granular, and they were classified as structure class 2.

Table 3. Soil structure class

Land	Structure	Structure class
Rubber	Coarse granular	3
Oil palm	Coarse granular	3
Teak	Fine granular	2
Forest	Fine granular	2

Source: Field observations (2019).

Soil Texture

The results of the analysis of soil texture content in this study were presented in Table 4. The analysis results showed a variety of soil fraction percentages, such as very fine sand, sand, clay, and silt, were quantitatively different. However, rubber, oil palm, teak, and forest land have the same general criteria as sandy loam.

Table 4. Soil texture class (%)

Land	Soil fraction				Criterion
	*Vfs	Sand	Clay	Silt	
Rubber	5.51	61.15	19	14.33	Sandy loam
Oil palm	5.61	61.06	18	15.33	Sandy loam
Teak	5.25	68.25	14	12.05	Sandy loam
Forest	1.28	64.72	12	22.00	Sandy loam

Source: Chemistry and Physics Laboratory, Department of Soil, Sriwijaya University (2019).
Note: *Vfs = Very fine sand.

Figure 2. Rubber plant, oil palm, teak, and forest land research

Soil Erodibility

Based on all data, such as organic matter, permeability, soil structure and texture, and the calculation of soil erodibility, the results of soil erodibility calculations were presented in table 4. The results of the calculation of rubber, oil palm, and teak land were moderate. With the criteria equation, the quantitative figure of oil palm land has a figure of 0.18, the highest for rubber and teak. While forest land has several 0.04, it falls into very low criteria.

DISCUSSION

Soil organic matter content in forest land is higher than that in rubber, oil palm, and teak land. The high content of organic matter in the soil is due to dense vegetation and alpine land conditions. Based on (Frania et al., 2023), it is known that c-organic in all research lands is in the very high category. The high soil organic matter content in forest land is in line with the soil's ability to pass water well among rubber, oil palm, and teak lands, which have a low soil organic matter content. Vegetation and litter on the soil surface and the activity of soil-living organisms play a role in decomposition so that the condition of soil properties can be maintained (Suryani, 2014). In rubber, oil palm, and teak land, the contribution of vegetation to soil organic matter sources is not as much as in forest land. In some types of land use, forest land has the best chemical properties compared to chemical properties in other uses, which are generally relatively low (Bahri et al., 2016).

A phenomenon where teak land has a low soil organic matter content, but the permeability has a higher number. This condition is influenced by the physical properties of the soil, where the percentage content of the sand fraction is higher while the percentage of dust and clay fractions is the lowest. The rarer the condition of soil, the faster its permeability (Tipe et al., 2023). He argued in his research (Rahayu et al., 2015) that the fast or slow permeability of the soil is influenced by the amount of soil porosity, because the greater the porosity of the soil, the greater the rate of soil permeability. On forest land, it falls into the criteria rather quickly. This is due to the density of vegetation that grows and is supported by soil properties such as a low percentage of clay fraction and a very high content of organic matter so that the soil structure becomes looser. (Serman et al., 2020). The high permeability rate in the study area was influenced by the high content of sand fraction in the soil texture, resulting in higher soil porosity.

The structure type of rubber, oil palm land, is coarse granular. While teak land is a fine-granular structure type, this is in line with the results of the analysis of permeability and soil texture. (Holilullah et al., 2015), In his research, he found that soil with a granular or crumbly structure type has a high porosity compared to soil with a massive structure. Forest land shows the results of observations of fine granular soil structure; this type of structure is also in line with the results of the analysis of soil organic matter content, which is very high and the permeability rate is rather fast. Furthermore, (Kehutanan et al., 2018) found in his research that soil structure plays an important role in increasing the rate of infiltration and soil permeability, so if the soil structure is good, it will be easy to pass water into the soil.

Conversion of forest land in the research location has not resulted in major changes to soil texture. In line with (Jasmin et al., 2017), his research argues that soil texture on forest land is dominated by the sand fraction. (Riduan et al., 2018) It was mentioned that soils that have a high sand content have more macropores than micropores, resulting in good aeration and good water conductivity.

The level of soil erodibility is qualitatively medium in rubber, oil palm, and teak land; very low criteria are found in forest land. This can be seen from the difference in soil texture conditions. This content causes soil conditions to be easily transported by rainwater. This is also in line with the statement (Hasan & Pahlevi, 2017), which states that dust and very fine sand in the soil makes it difficult to form a stable structure, so the soil conditions will be more sensitive to erosion. Soil erodibility in rubber, oil palm, and teak land is the lowest in teak land. This is influenced by the permeability rate factor, which is quantitatively higher than rubber and oil palm land. (Sulistyaningrum et al., 2014), that the greater the permeability rate of a soil, the lower its erodibility to erosion. On forest land, soil erodibility is included in very low criteria compared to rubber, oil palm, and teak land. This condition is influenced by the very high organic matter content of the soil. Affects other soil properties. So the value of soil sensitivity to erosion becomes very low.

CONCLUSION

Based on the research process, it was concluded that rubber, oil palm, and teak plantations had moderate soil erosion sensitivity values. However, these lands showed different sensitivity values, and the sensitivity value of soil erosion in forest land was classified as very low. This research is part of a series of studies on various factors influencing land erosion. Further research is needed to determine the full potential for erosion, considering all factors that contribute to erosion risk.

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