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SURFACE RUN-OFF AND SOIL EROSION IN 11 YEAR OLD ACACIA AND SENGON STANDS

Limpasan Permukaan dan Erosi Tanah pada Tegakan Akasia dan Sengon Umur 11 Tahun

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ABSTRACT

Indonesia is a country with geographical conditions located in tropical rain climates, causing variations in rainfall levels. High and varied rainfall can lead to surface run-off and soil erosion. This study aims to determine (1) the rate of surface run-off and soil mass erosion in acacia (*Acacia mangium/A. mangium*) stand, sengon (*Falcataria moluccana/F. moluccana*) stand, and open land; (2) the status of erosion hazard index, erosion hazard class, and erosion hazard levels occurring in *A. mangium* stand, sengon stand, and open land; (3) the relationship between rainfall and surface run-off and soil mass erosion. Erosion Measurement Plots (EMP) measuring 4 m × 10 m were established in the study site, consisting of three plots namely EMP *A. mangium*, EMP sengon, and EMP open land with steep slopes (25-45%). The total measured surface runoff (SR) during the study period at EMP *A. mangium* was 335.37 m³/ha/year, EMP sengon was 950.77 m³/ha/year, and EMP open land was 2,646.95 m³/ha/year. Meanwhile, Eroded Soil Mass (ESM) during the study period at EMP *A. mangium* was 0.85 tons/ha/year, EMP sengon was 2.39 tons/ha/year, and EMP open land was 195.45 tons/ha/year. The Erosion Hazard Index (EHI) value at EMP *A. mangium* and EMP sengon was classified as low, while at EMP open land was classified as very high. The Erosion Hazard Class (EHC) in EMP *A. mangium* and EMP sengon belongs to EHC I (very low), while in EMP open land belongs to EHC IV (high). Erosion Hazard Level (EHL) at EMP *A. mangium* and EMP sengon was included in the currently class, while at EMP open land was included in the very heavy class. The information about surface runoff and soil erosion on different land covers can be used as considerations in soil management, especially for post-mining lands.

Keywords: *Acacia mangium; Falcataria moluccana;* open land; soil mass erosion; surface run-off

ABSTRAK

Indonesia merupakan negara dengan kondisi geografis yang beriklim hujan tropis, sehingga menyebabkan terjadinya variasi intensitas curah hujan. Curah hujan yang tinggi dan bervariasi dapat mengakibatkan terjadinya limpasan permukaan dan erosi tanah. Penelitian ini bertujuan untuk mengetahui (1) laju limpasan permukaan dan erosi massa tanah pada tegakan akasia mangium (*Acacia mangium*), tegakan sengon (*Falcataria moluccana*), dan lahan terbuka; (2) status indeks bahaya erosi, kelas bahaya erosi, dan tingkat bahaya erosi yang terjadi pada tegakan *A. mangium*, tegakan *F. moluccana*, dan lahan terbuka; (3) hubungan antara curah hujan dengan limpasan permukaan dan erosi massa tanah. Plot Pengukuran Erosi (PPE) berukuran 4 m × 10 m dibuat di lokasi penelitian, yang terdiri dari tiga plot yaitu *A. mangium*, *F. moluccana*, dan lahan terbuka dengan kemiringan lereng terjal (25-45%). Total limpasan permukaan terukur selama masa penelitian di PPE *A. mangium* sebesar 335.37 m³/ha/tahun, PPE *F. moluccana* sebesar 950.77 m³/ha/tahun, dan PPE lahan terbuka sebesar 2,646.95 m³/ha/tahun. Sementara itu, Erosi Massa Tanah (EMT) selama masa penelitian di PPE *A. mangium* sebesar 0.85 ton/ha/tahun, PPE *F. moluccana* sebesar 2.39 ton/ha/tahun, dan PPE lahan terbuka sebesar 195.45 ton/ha/tahun. Nilai Indeks Bahaya Erosi (IBE) di PPE *A. mangium* dan PPE *F. moluccana* tergolong rendah, sedangkan di PPE lahan terbuka tergolong sangat tinggi. Kelas Bahaya Erosi (KBE) pada PPE *A. mangium* dan PPE *F. moluccana* termasuk KBE I (sangat rendah), sedangkan pada lahan terbuka PPE termasuk KBE IV (tinggi). Tingkat Bahaya Erosi (TBE) pada PPE *A. mangium* dan PPE *F. moluccana* termasuk dalam kelas sedang, sedangkan pada PPE lahan terbuka termasuk dalam kelas sangat berat. Informasi tentang limpasan permukaan dan erosi tanah pada berbagai tutupan lahan dapat digunakan sebagai pertimbangan dalam pengelolaan tanah, terutama untuk lahan pascatambang.

Kata kunci: *Acacia mangium; Falcataria moluccana;* lahan terbuka; erosi massa tanah; limpasan permukaan

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A. INTRODUCTION

Indonesia, as a country geographically located in a tropical rainy climate area, has a variety of rainfall levels (Sitepu *et al.* 2017). Rainfall that is greater than the infiltration capacity has the potential to cause flooding (Herol *et al.* 2022). Surface flow and soil transport are influenced by vegetation cover, slope and slope length factors, and soil type (Sarminah *et al.* 2018).

Surface runoff is a condition where water cannot seep into the soil due to the dense physical soil inhibiting infiltration. Lestari (2023) states that surface runoff can transport soil particles released from their aggregates to lower places such as water runoff channels, rivers, lakes, and oceans.

Surface runoff can be more significant in areas with open soil conditions that can be reduced by planting vegetation (Banuwa 2013). The application of a combination of vegetative systems or the use of plants and terraces for soil and water conservation can be applied to land with different slope classes that are beneficial from silvicultural, hydrological, and economic aspects in the short term from the agricultural yield of food crops and in the long term from the elements of soil and water conservation and the environment (Karyati *et al.* 2018; Karyati *et al.* 2019). Soil slope affects the results of planting *Neolamarckia cadamba - Phaseolus vulgaris* using a terrace system where steep slopes are more economically beneficial with less runoff and erosion than on very steep slopes (Karyati *et al.* 2021).

Suitable plant species are essential to increase planting success, including on post-mining lands. Planting *Acacia* (*Acacia mangium* Willd.) as revegetation on post-mining land can increase land productivity, minimize erosion, restore biodiversity, and improve microclimate so that forest areas can function according to their designation (Wasis & Islamika 2019). Sengon (*Falcataria moluccana*) is a pioneer species often planted in the early stages of post-mining land planting before being planted with local plant species (Syauqie *et al.* 2019).

Indonesia is a country with a long history of mining. Much post-mining land is left open and exposed, making it vulnerable to soil erosion caused by wind and rainwater. Soil erosion threatens to damage local ecosystems and can impair water quality, reduce soil fertility, and disrupt animal and plant life that is just beginning to recover in the area. Land reclamation is critical in restoring and maintaining environmental balance after mining or other activities that damage the environment. Reclamation activities on land can be successful if the erosion rate is minimized as small as possible.

This study aims to determine (1) the rate of surface runoff and eroded soil mass in *A. mangium* stands, *F. moluccana* stands, and open land. (2) the status of the erosion hazard index, erosion hazard class, and the erosion hazard level that occurs in *A. mangium* stands, *F. moluccana* stands, and open land. (3) the relationship between rainfall, surface runoff, and eroded soil mass. This research not only provides essential insights into the relationship between reclamation surface runoff and soil erosion, but will also make a meaningful contribution to the development of reclamation policy and mining industry practitioners.

B. METHODS

This research was conducted in the post-mining land of PT. Gerbang Daya Mandiri, Bangun Rejo Village (L3), Tenggarong Seberang District, Kutai Kartanegara Regency, East Kalimantan. The study was conducted 6 months, from December 2023 to May 2024.

Materials and Tools

The tools used in this research include a clinometer, a simple rainfall meter (ombrometer), a collection drum, carpentry tools, a wooden stirrer, a ruler, a 500 ml bottle, and a camera. The materials used included a 1000 ml measuring cup, filter paper, funnel, oven, analytical balance, board, block wood, PVC pipe, plastic cover for the collection drum, nails, raffia, and writing tools.

Procedures

1. Erosion Measurement Plots (EMP) Preparation

A 4 m x 10 m EMP has been established within the 20 m x 20 m research plot in each *A. mangium* stand, *F. moluccana* stand, and open land. Boards were arranged according to the perimeter of the EMP and given a block at each end of the board to be used as a link between one board and the next. The arrangement of the boards was made in two layers so that they became tight and avoided surface runoff and erosion out of the EMP. At the lowest part of the EMP, a 3-inch pipe was installed to channel runoff water and eroded soil into a collection container. The container is made from a drum cut into two parts. The drums were then connected using 3/4-inch pipes. An ombrometer was placed in a shade-free location. A map of the research locations is presented in Figure 1. A sketch of the EMP is illustrated in Figure 2, while Figure 3 shows the EMP in *A. mangium*, *F. moluccana*, and open land stands.

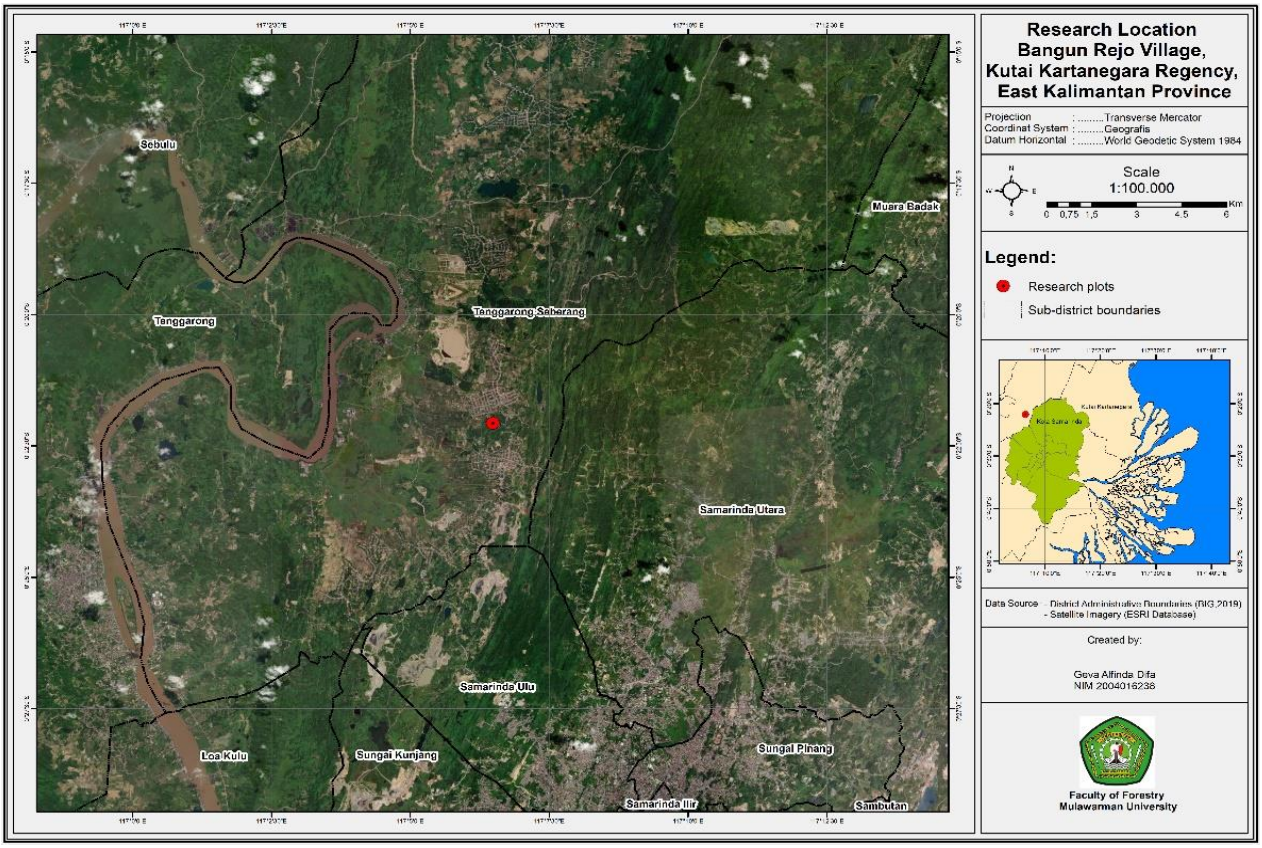

Figure 1. Map of the research location

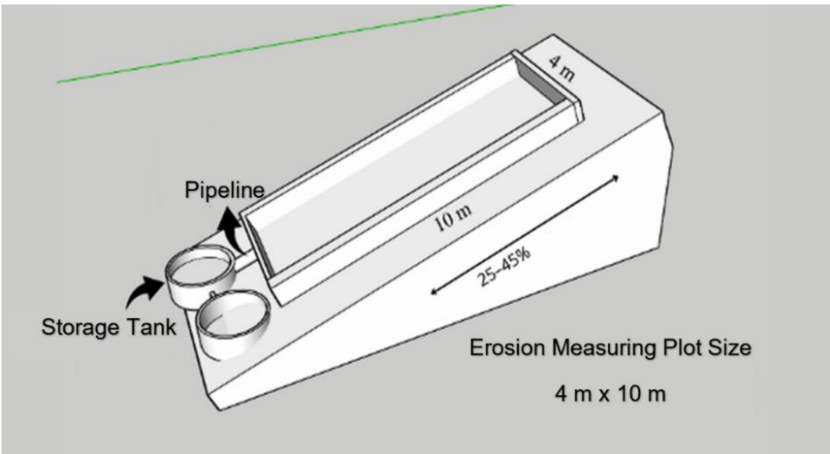

Figure 2. Erosion Measurement Plot (EMP) sketch

Figure 3. Erosion Measurement Plots (EMP) in *A. mangium* stand (a), *F. moluccana* stand (b), and open land (c)

2. *Data Collection*

Data collection in the field consisted of:

a. Determination of the number of surface runoff water samples and eroded soil masses. The surface runoff water and eroded soil mass were sampled immediately after the rain stopped. The water collected in the drum was measured using an iron ruler to determine the volume of water collected. The following process was to stir the water collected in the drum until it was flat, then take a 500 ml water sample. The number of samples taken was 30 rain events. The samples were then brought to the laboratory for dry sample weight measurement.
b. Rainfall measurement. Rainfall observations were made using a rainfall gauge (ombrometer) for each rainfall event. The rainfall gauge was placed at a height of 150 cm from the ground to avoid possible measurement errors due to various causes. The amount of rainfall (mm) was calculated based on the volume of water collected in the rainfall gauge (cm^3) divided by the surface area of the indicator (cm^2), then converted into mm units.
c. Measurement of the volume of water collected in the drum. The water collected in the drum is the surface flow on the plot, so the amount of surface flow can be indicated from the volume of water collected in the drum. The formula used to determine the total volume of water collected is as follows:

$$Vt = \pi \times r^2 \times t$$

Where, Vt is the total volume of water collected (ml), π is 3.14, r is collector radius (cm), and t is the water height in the collector measured after rainfall (cm).

d. Soil erosion. The amount of soil mass eroded in the research plot was calculated based on 500 ml of water taken from the collector and analyzed in the laboratory.
e. Minipit Creation. Making mini pits aims to find the T value (soil erosion that can still be allowed) by looking at the depth of the soil solum at the research site. Soil solum is the adequate depth of soil that the root system can penetrate. The depth of soil solum varies depending on the level of soil development.

Data Processing and Analysis

Surface runoff and eroded soil mass were calculated using the following formulas:

a. Surface Runoff (SR) per rainfall event (Sarminah & Karyati 2019)

$$SR = A\ (ml) \times \frac{Vt}{500\ ml}$$

Where, SR is surface runoff (ml), A is the volume of surface runoff water from the sample (ml), and Vt is the total volume of water collected (ml).

b. Eroded Soil Mass (ESM) per rainfall event (Sarminah & Karyati 2019)

$$B = (BST + BK_2) - BK_1$$

Where, B is eroded soil mass sample (g), BST is oven dry weight of the sample (g), BK_1 is the weight of filter paper before screening (g), and BK_2 is the weight of filter paper after screening (g).

$$ESM = B\ (g) \times \frac{Vt}{500\ ml}$$

Where, ESM is eroded soil mass (g), Vt is the total volume of collected water (ml), and B is eroded soil mass sample (g).

c. Surface runoff (m^3/ha/year) (Sarminah & Karyati 2019)

$$\frac{SR}{1.000} \times \frac{10.000}{EMP\ area} = m^3/ha/i = m^3/ha/tahun$$

Where, i is 12/number of months of observation.

d. Eroded soil mass (tons/ha/year) (Sarminah & Karyati 2019)

$$\frac{ESM}{1.000.000} \times \frac{10.000}{EMP\ area} = ton/ha/i = ton/ha/tahun$$

Where, i is 12/number of months of observation.

e. Erosion Hazard Index (EHI). The EHI value determines the erosion rate that occurs and whether it has the potential to jeopardize soil productivity in the area. The determination of the erosion hazard index is calculated using the formula (Sarminah & Karyati 2019):

$$EHI = \frac{A \text{ (ton/ha/year)}}{T \text{ (ton/ha/year)}}$$

Where, A is actual erosion and T is tolerable erosion. The T value is the soil loss tolerance based on soil depth (Sarminah & Karyati 2019). The T value criteria are presented in Table 1. The EHI classification is used to assess and predict an area's erosion threat level (Table 2).

Table 1. The amount of soil erosion that can still be tolerated

Soil Depth	**T (tons/ha/year)**
Deep (>100 cm)	14
Medium (30-100 cm)	10
Shallow (<30 cm)	5

Source: Sarminah & Karyati (2019)

Table 2. Classification of EHI

EHI	**Criteria**
<1,0	Low
1,01-4,0	Medium
4,01-10,0	High
>10,01	Very High

Source: Sarminah & Karyati (2019)

f. Erosion Hazard Class (EHC). EHC can be determined based on the rate of erosion that occurs on land to determine the classification of the erosion hazard class as presented in Table 3.

Table 3. Classification of EHC

Erosion Rate (tons/ha/year)	**EHC**	**Criteria**
<15	I	Very Low
15-60	II	Low
60-180	III	Medium
180-480	IV	High
>480	V	Very High

Source: Sarminah & Karyati (2019)

g. Erosion Hazard Level (EHL). The results were obtained by calculating the amount of potential erosion (A) and then grouped into the EHL based on the depth of soil solum, as shown in Table 4.

Table 4. Classification of EHL

Solum Depth Soil (cm)	**Erosion Hazard Level Category**				
	I	**II**	**III**	**IV**	**V**
	Soil Erosion Rate (tons/ha/year)				
	<15	**15-60**	**60-180**	**180-480**	**>480**
Deep (>90)	SR	R	S	B	SB
Medium (60-90)	R	S	B	SB	SB
Shallow (30-60)	S	B	SB	SB	SB
Very Shallow (<30)	B	SB	SB	SB	SB

Source: Regulation of the Minister of Forestry of the Republic of Indonesia Number: P. 32/Menhut-II/2009
Description: SR is Very Light, R is Light, S is Medium, B is Heavy, SB is Very Heavy, I is Very low, II is Low, III is Medium, IV is High, V is Very High

h. Relationship between Rainfall, SR, and ESM. The linear regression equation used to determine the relationship between rainfall to surface runoff and eroded soil mass is (Steel and Torrie, 1993):

$$Y = a + bX$$

Where, Y is the dependent variable (surface runoff and eroded soil mass), X is the independent variable (rainfall), a is the intercept value on the Y-axis (constant), and b is the linear regression coefficient value. The correlation coefficient criteria can be seen in Table 5.

Table 5. Criteria for correlation coefficient value

Correlation Coefficient Value	Criteria
0	No correlation
> 0-0,25	Very weak correlation
> 0,25-0,50	Moderate correlation
> 0,50-0,75	Strong correlation
> 0,75-0,99	Very strong correlation
1	Perfect correlation

Source: Sarwono (2006)

C. RESULTS AND DISCUSSION

Rainfall, Surface Runoff, and Soil Mass Eroded

Rainfall measured during 30 rainfall events in the site area ranged from 5 to 52 mm. In this study, surface runoff must also be observed because surface runoff can lift soil grains, resulting in erosion. The results showed an eroded soil mass of 0.85 tons/ha/year in EMP *A. mangium* stands, 2.39 tons/ha/year in EMP *F. moluccana* stands, and 195.45 tons/ha/year in EMP open land (Table 6). Evaluation of erosion hazard is an assessment or prediction of the amount of soil erosion and its potential danger to a plot of land. To determine whether erosion occurs at a dangerous level or is a threat of land degradation, it can be determined from the land's erosion hazard level.

Table 6. Total Surface Runoff (m^3/ha/year) and Soil Mass Eroded (tons/ha/year)

Erosion Measurement Plots	Plant Age (year)	Slope (%) /Slope Class	Surface Runoff (m^3/ha/year)	Soil Mass Eroded (tons/ha/year)
A. mangium stand	11	43 / Steep	335.37	0.85
F. moluccana stand	11	41 / Steep	950.77	2.39
Open land	-	32 / Steep	2,646.95	195.45

Status of Erosion Hazard Index (EHI), Erosion Hazard Class (EHC), and Erosion Hazard Level (EHL)

Based on mini pit observations in the research area, the soil solum at each location has different depths. The soil solum in *A. mangium* stands is 32 cm, in *F. moluccana* stands is 37 cm, while in open land is 10 cm (Table 7). Based on the criteria, the allowable erosion (Edp) for soil depth <30 cm is 5 tons/ha/year, and for soil depth 30-60 cm is 10 tons/ha/year.

Table 7. Status of EHI, EHC, and EHL

Erosion Measurement Plots	Depth Soil Solum (cm)	EHI Status	EHC Status	EHL Status
A. mangium stand	30-60	Low	Very Low	Very Light
F. moluccana stand	30-60	Low	Very Low	Very Light
Open land	<30	Very High	High	Very Heavy

Notes: EHI = Erosion Hazard Index; EHC = Erosion Hazard Class; EHL = Erosion Hazard Level.

The EHI in *A. mangium* stands is 0.08 (low level), the EMP of *F. moluccana* stands is 0.24 (low level), and the EMP of open land is 39.09 (very high level). The results show that the eroded soil mass in the EMP of open land exceeds the allowable threshold (A>Edp), while in the EMP of *A. mangium* stands and EMP of *F. moluccana* stands, the eroded soil mass can still be tolerated (A<Edp).

Soil and water conservation is based on comparing actual erosion and allowable erosion. If actual erosion is smaller than the allowable erosion (A<Edp), then conservation in an area must still be done. Meanwhile, if the actual erosion exceeds the allowable erosion (A>Edp), then an area needs soil and water conservation planning by considering plant factors and land management (Dewi *et al.* 2012).

EMP *A. mangium* stands and EMP *F. moluccana* stands have erosion rates <15 tons/ha/year, which are included in the EHC criteria, namely erosion hazard class I (low). Furthermore, EMP open land has an erosion rate of 180-360 tons/ha/year, which is included in the EHC, namely class IV (high mark), as presented in Table 2.

The EHL in all erosion measuring plots with shallow soil solum depth (30-60 cm) with soil erosion rates of <15 tons/ha/year in EMP *A. mangium* stands and EMP *F. moluccana* stands is moderate. Erosion measuring plots with very shallow soil solum depth (<30 cm) with soil erosion rates of 180-360 tons/ha/year in open land EMPs are very heavy.

Based on the status of the EHI, EHC, and EHL, it can be stated that the reclamation activities were successful in following their objectives because *A. mangium* and *F. moluccana* plants were able to reduce the rate of surface runoff and soil erosion on post-mining land from PT Gerbang Daya Mandiri. The vegetation factor is one factor that plays a significant role in the success of a reclamation activity on post-mining land.

Sarminah *et al.* (2018) reported that *F. moluccana* (*Falcataria moluccana*) and groundnut (*Arachis hypogaea*) stands planted in the 15-25% slope class had potential erosion of 20.05 tons/ha/year with an erosion hazard index of 0.80 (low) and a low erosion hazard level. In the 25-40% slope class, the potential erosion is 45.50 tons/ha/year with an erosion hazard index of 3.25 (medium) and a low erosion hazard level.

The results of the analysis show that land use with high erosion rates occurs in open land areas. This is caused by land cover, so the soil is easily carried away by water from surface flow in the absence of vegetation. According to Akbar *et al.* (2021), the lack of vegetation causes the land to be less than optimal, and the land cannot inhibit surface flow, so the soil is exposed to hard rain. In addition, the significant slope and length of the land accelerate surface flow, causing high erosion rates.

On the other hand, land use that experienced low levels of erosion occurred in EMP *A. mangium* stands and EMP *F. moluccana* stands. This can happen because the age of the plantation is quite old, namely 11 years and the planting distance is 3 m x 3 m, so the crown layer becomes dense in *A. mangium* stands and *F. moluccana*. Tewonto *et al.* (2020) added that canopy layer stratification has good potential to minimize soil erosion. The arrangement of the canopy layer is responsible for regulating how much kinetic energy of rain reaches the ground, where the area and shape of the canopy layer will affect the amount of rainwater retained and the number of water droplets formed.

One of the erosion factors is soil erodibility. Soil erodibility characteristics are influenced by the sand, dust, and clay proportion. Soils with dust content tend to be more susceptible to erosion than soils with sand or clay texture. Soils with dust content usually have low water-holding capacity and are quickly saturated. On the other hand, sandy soil has a higher infiltration capacity because it has large pores, so the surface flow rate tends to be slower. Clay soils, with strong soil aggregates mainly dominated by micropores, have a higher resistance to erosion (Nugroho 2008). However, this occurs in the EMP of *A. mangium* stands, which can be overcome very well due to vegetation, the leaf shape of *A. mangium* trees, ground cover plants, and mulch.

Litter is also essential in reducing surface runoff rates and eroded soil mass. Litter consisting of undecomposed leaves, twigs, and other organic matter covering the soil surface protects against erosion by rain. In addition, the litter also slows down the water flow over the soil surface, thereby inhibiting water flow at lower velocities (Asdar *et al.* 2021).

Relationship Between Rainfall, Surface Runoff, and Eroded Soil Mass

1. Relationship Between Rainfall and Surface Runoff

The calculation shows that the relationship between rainfall and surface runoff has a powerful R^2, respectively, in the EMP of *F. moluccana* stands (0.80), EMP of open land (0.83), and EMP of *A. mangium* stands (0.86) (Table 8). A graph of the relationship between rainfall and surface runoff in the three EMPs is shown in Figure 4. The increase in surface runoff in the EMP of open land tends to be higher than the EMP of *A. mangium* stands, and EMP of *F. moluccana* stands. This is because there is no land cover in the EMP of open land, so the infiltration rate becomes slow, which accelerates surface runoff.

Table 8. Results of regression analysis of rainfall and surface runoff

Erosion Measurement Plots	Regression Equation	R^2
A. mangium stand	Y = 0.62X – 0,24	0.86
F. moluccana stand	Y = 3.03X – 24.28	0.80
Open land	Y = 3.08X + 31.33	0.83

Notes: R^2 = coefficient of determination; Y = dependent variable (surface runoff); X = independent variable (rainfall)

2. Relationship Between Rainfall and Eroded Soil Mass

The relationship between rainfall and eroded soil mass has an extreme correlation coefficient in each measuring plot, with R^2 values ranging from 0.70 to 0.89 (Table 9). EMP with coefficient values from the lowest to the highest are EMP open land, EMP zincon stands, and EMP *A. mangium* stands. The three measuring plots have an extreme correlation value, indicating that the higher the rainfall, the higher the eroded soil mass on land. Based on rainfall data and eroded soil mass for 30 days of observation, the relationship between rainfall and eroded soil mass is presented in Figure 5.

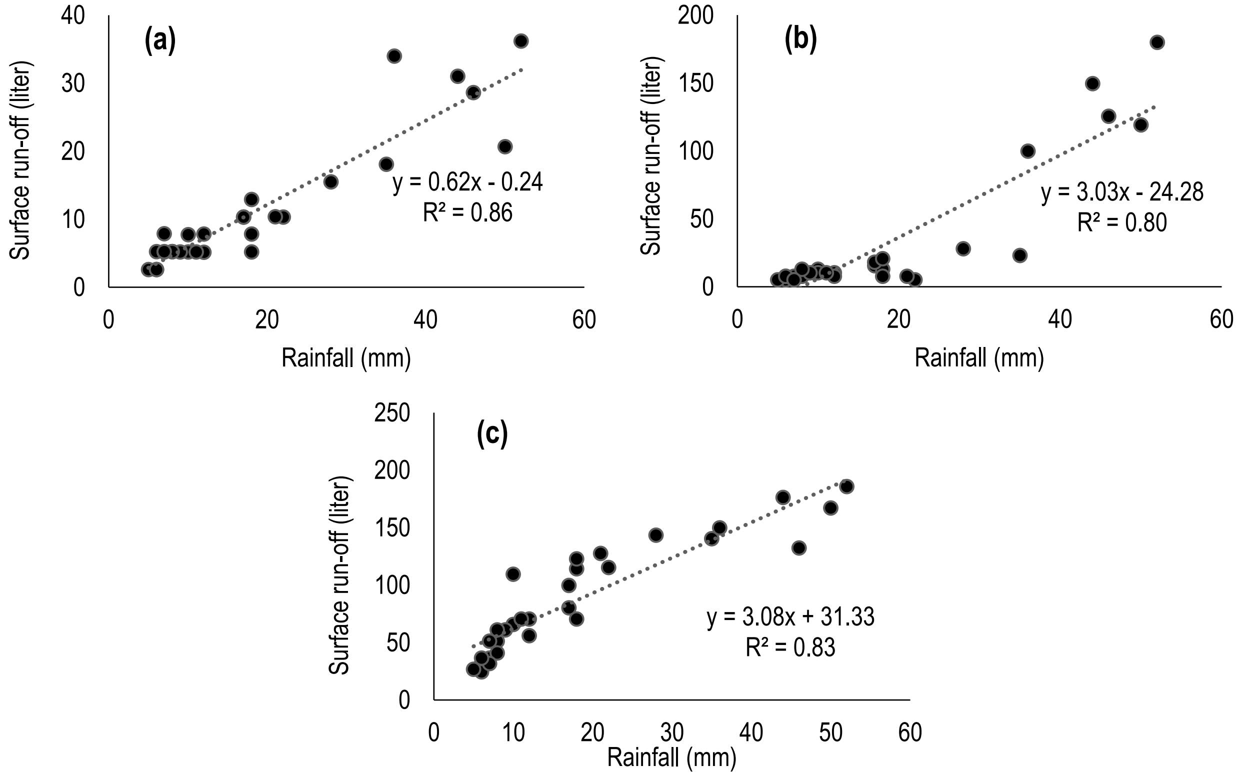

Figure 4. Relationship between rainfall and surface runoff EMP *A. mangium* stands (a), *F. moluccana* stand (b), and open land (c)

Table 9. Results of regression analysis of rainfall and eroded soil mass

Erosion Measurement Plots	Regression Equation	R^2
A. mangium stands	Y = 1.88X – 6.35	0,70
F. moluccana stand	Y = 8.80X – 82.93	0,76
Open land	Y = 354.44X – 30.27	0,89

Notes: r = correlation coefficient; R^2 = coefficient of determination; Y = dependent variable (surface runoff); X = independent variable (rainfall)

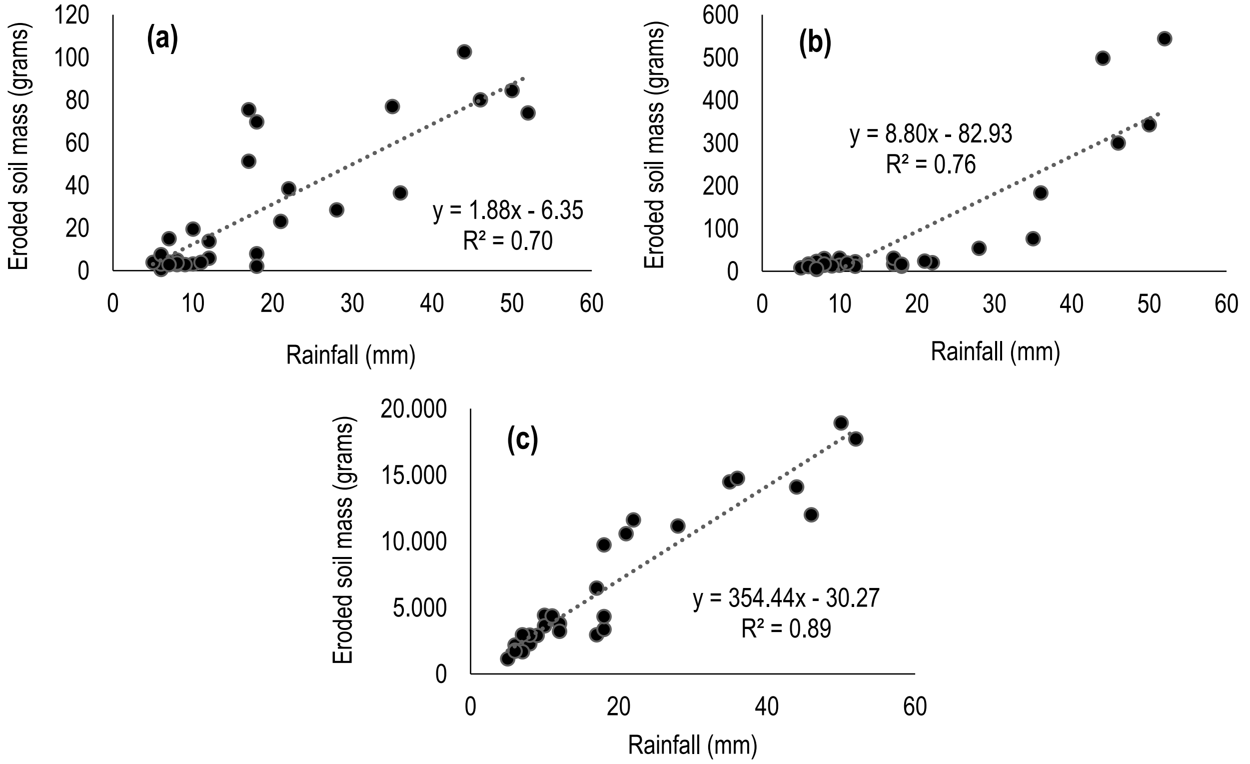

Figure 5. Relationship between rainfall and eroded soil mass EMP *A. mangium* stands (a), *F. moluccana* stand (b), and open land (c)

D. CONCLUSION

1. Surface runoff in the EMP of *A. mangium* stands is 335.37 m³/ha/year, EMP of *F. moluccana* stands is 950.77 m³/ha/year, and EMP of open land is 2,646.95 m³/ha/year. The eroded soil mass (ESM) in the EMP of *A. mangium* stands is 0.85 tons/ha/year, EMP of *F. moluccana* stands is 2.39 tons/ha/year, and EMP of open land is 195.45 tons/ha/year.
2. The Erosion Hazard Index in the EMP of *A. mangium* stands, and EMP of *F. moluccana* stands has a low value, while the EMP of open land has a very high value. Erosion Hazard Class in EMP *A. mangium* stands and EMP *F. moluccana* stands have a meager value, while in EMP open land has a high value. The Level of Erosion Hazard in EMP *A. mangium* stands and EMP zincon stands is classified as moderate, while in EMP open land is classified as very heavy.
3. The relationship between rainfall with surface runoff and eroded soil mass has an extreme coefficient of determination (R^2) with a value range of 0.70-0.89 in each EMP.

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