INTERNATIONAL JOURNAL OF CONSERVATION SCIENCE
ISSN: 2067-533X Volume 14, Issue 1, January-March 2023: 371-384 www.ijcs.ro
DOI: 10.36868/IJCS.2023.01.25

SOIL CONSERVATION MODEL USING INTERCROPING SENGON-COFFEE METHOD TO REDUCE EROSION YIELD

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Abstract

The increasing demand of sengon wood (paraserianthes falcataria) as an industrial material that has high price in East Java province, especially in Jember district leads to increase deforestation on people forest as well as land use land cover change (LULCC) on agriculture areas. Study on Tanggul watershed which is the one of three biggest watersheds in Jember where LULCC into sengon plantations shown that erosion yields on sengon plantations was dominating by medium to very high erosion hazard level. The identification and conservation method used in this study is RUSLE and the conservation model used is sengon-coffee intercropping. The effeciveness criteria used is erosion yield on the field decreases until low level of erosion hazard level (below 60 tons/hectares/year). The 208 samples of sengon plantations were used to identify erosion yield and the results show that 75.9% of sengon plantations in Tanggul watershed have moderate to very high erosion hazard level with an average erosion yield at 257.49 tons/hectares/year. While simulation of scenario 1st, 2nd and 3rd intercropping conservation model resulting erosion yield 158.2; 131.8; and 97.7 tons/hectares/year respectively. In this case, 3rd scenario is effective to reduce erosion yield to low level of erosion hazard level by 65% of total plantations. However, other conservation model still needed to be added in the sengon plantation to reduce erosion in low hazard level.

***Keywords**: Erosion; Intercropping; RUSLE; Sengon-coffee; Soil conservation*

Introduction

The increasing demand on the sengon wood *(paraserianthes falcataria)* as an industrial material that has a high price in East Java province, especially in Jember district leads to increase deforestation on people forests as well as land use land cover change (LULCC) on agriculture areas [1]. A rapid assessment during preliminery research, using RUSLE model to predict erosion yield was applied in the Tanggul watershed in Jember District, resulting in the majority of areas are in the medium to very high erosion hazard level. In another hand, the Tanggul watershed is one of three biggest watersheds in Jember which provides irrigation water and play important role on providing natural resources for sustainable agricultural system [1]. Sengon plantation has a high contribution to erosion yield in the watershed due to sengon tree characteristics, such as less land cover by sengon leaf which causes crop cover [1]. Moreover, less soil holding capacity by sengon root increases the number of soils erodibity [1]. The erosion yields on sengon plantations were dominating by medium to very high erosion hazard level. In this sense, soil conservation is necessary to be implemented. However, the implementation of soil conservation model must not only able to reduce erosion yield but also

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give more benefits for farmers. Therefore, an effective soil conservation model needs to be identified. The study aims to identify the effectiveness of intercropping sengon-coffee to reduce erosion yield as a soil conservation model. The RUSLE model used to run the scenarios of intercropping sengon-coffee model. There were three intercropping scenarios ran. The criteria used to identify the effectiveness is erosion yield on the field decreases until low level of erosion hazard level (below 60 tons/hectares/year). The 208 samples of sengon plantations were used to identify soil erodibility, slope factor, crop covering, and soil conservations practiced as well as erosivity factor data. In this sense, conservation to reduce erosion is necessary in the sengon plantations. The intercropping sengon-coffee model was choosen not only because coffee has high density leaf cover on soil (low C value) which increasing soil protection from rainfall energy destruction, but also for its increasing farmer additional income from coffee bean production. Moreover, farmers can reduce the costs for fertilizer because coffee needs the same types of fertilizer as sengon [2] and [3].

Experimental part

Materials

The study has been carried out from June 2022 to August 2022 for the data collecting, and September 2022 for running scenarios. Geographically, the location of the study was in Tanggul watershed Jember District East Java Province Indonesia. Tanggul watershed is located at 7° 58’ 00’’S - 8° 22’ 00’’S - dan 113° 14’ 00’’E - 113° 40’ 00’’E. The location is shown in figure 1.

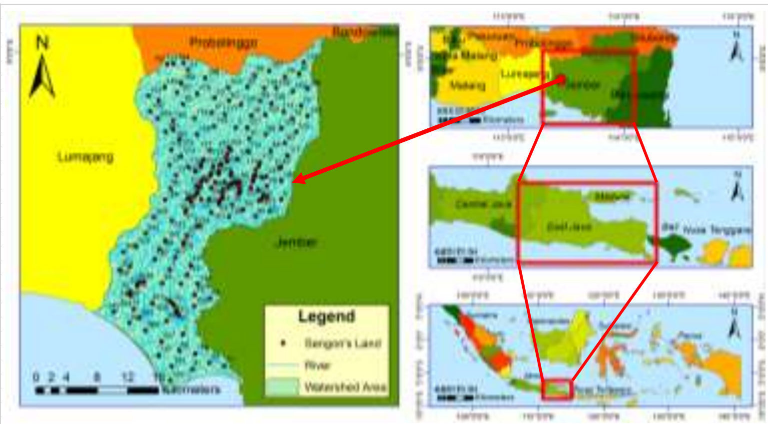

Fig. 1. Geographic location of study area in Tanggul Watershed, Jember, East Java, Indonesia

Research Source Data

The data used in this study is: i) Rainfall annual data is provided from the Department of water, years 2010 to 2021; ii) Digital elevation model (DEM) Landsat Imagery – 8 from United States Geological Survey (USGS); iii) Soil Map of Exploratory Java and Madura 1960 validated using soil survey in the field on July 2022; iv) Field survey to collect data: prior landuse (PLU); sengon’s age; type of plantation; total plantation (F); height of Plantation (H); canopy-cover subfactor (CC); surface-cover subfactor (SC); land-area covered by surface cover (SP); roughness of surface before disturbance and roughness of the undisturbed portion of surface (RU); surface-roughness subfactor (SR); and slope steepness at which contouring is most effective (SM), length and slope of the plantations.

Tools

The instruments that were used in this study are a GPS, abney level; Phone; Camera; and stationary. The application that was used in this study is ArcGIS 10.3, IBM SPSS 25 and Microsoft Excell 2013. Also, ring soils sample and laboratorium equipment was used to identify soil erodibility.

Methods

Survey

The 208 sengon plantations sample were randomly chosen in the study area. All the parameters of RUSLE model ware collected from those 208 plantations conditions.

Revised Univsersal Soil Loss Equation (RUSLE) Method (A)

RUSLE is a model used to predict the average annual soil loss carried away by runoff water from certain land slopes in certain planting, management and area systems. This model is used to predict erosion in soil conservation planning on agricultural land and non-agricultural such as construction sites/buildings using RUSLE as Eq.1 [4].

$$A = R \times K \times LS \times C \times P \qquad \text{(Eq. 1)}$$

Rainfall Erosivity Factor (R)

Rainfall erosivity is the value of the erosivity of certain rains associated with the amount and intensity of rain in a place or rain stations [5]. It can be calculated using using Mononobe equation as Eq. 2 [6].

$$I = (R24/24) \times (24/t) \times (2/3) \qquad \text{(Eq. 2)}$$

where: I am rainfall intensive (mm/hours); R_{24} is maximum 24 hours rainfall (mm); and t is rainfall time (minute). The cinetics rainfall energy using EK as Eq. 3 [7].

$$EK = 210.3 + 89 \text{ Log } I - 30 \qquad \text{(Eq. 3)}$$

where: *EK* is *kinetic*s Energy (MJ/hectares.cm); and I_{30} is maximum rainfall in 30 minutes (mm). The maximum rainfall intensity for 3 minutes using EI as Eq. 4 [8].

$$EI_{30} = EK \times (I - 30 \times 10 - 2) \qquad \text{(Eq. 4)}$$

where: EI_{30} is erosivity index for 30 minutes; *EK* is *Kinetic*s Energy (MJ/hectares.cm); and I_{30} is maximum rainfall intensity for 30 minutes (cm).

Soil Erodibility Factor (K)

Soil erodibility is a factor that indicate the sensitivity value of a soil type to the destruction and washing away of rainwater [9, 10]. The high erodibility index of soil is a classification of soil that is sensitive and easily eroded, while the low erodibility index of soil is a classification of soil that is resistant and resistant to erosion. Nomograph graphic used to identify erodibility factor.

Lenght and Slope Factor (LS)

Lenght and Slope is factor that is calculated from where the start of the flow of water above the ground to where the start of precipitation caused by reduced slope [11]. The calcuation of LS value is using converted formula in Digital Elevation Model (DEM) in ArcGIS as Eq. 5 [12].

$$LS = (\text{Flowacc} \times \text{Cell Size})/22.13)^{0,4} \times (\text{Sin Slope} \times 0.01745)/0.0896)^{1.3} \quad \text{(Eq. 5)}$$

where: *LS* is lenght and slope factor; and *FlowAcc* is flow accumulation.

Landuse Factor (C)

Landuse Factor is a comparison between the amount of erosion on land with certain plants and management of erosion in the open ground [13]. The calculation of landuse factor is using Laften Formule to calculate the soil loss ratio value on the land as Eq. 6 [3].

$$SLR_{Total} = PLU \times CC \times SC \times SR \times SM \qquad \text{(Eq. 6)}$$

where: SLR is soil loss ratio; PLU is prior landuse subfactor; CC is canopy-cover subfactor; SC is surface-cover subfactor; SR is surface-roughess subfactor; and SM is sloping steepness at which contouring is most effective. Based on the laften formula, the parameters of equation are:

a. *Canopy Cover equation* using CC as Eq. 7 [3, 10].

$$CC = 1\text{-}F \times \exp(-0.1 \times H) \qquad \text{(Eq. 7)}$$

where: F is Percentage of land surface fraction covered by plants (grass, canopy); and H is canopy height (m), which is the distance rain falls after touching the canopy.

b. *Surface-cover subfactor* using SC equation as Eq. 8 [3, 14].

$$SC = \exp[-b \times Sp \times (0.24/Rw)\ 0.08) \qquad \text{(Eq. 8)}$$

where: B is empirical coeficient; Sp is percentage of land area covered by surface cover (litter, mulch, and paving); and RW is surface roughness (in.).

c. *Surface roughness (RW)* consist of Forest Area (0,05); Distrubed Area (0.025); Agriculture area (0.035); and Grass (0.045).

d. *Surface-roughness subfactor* using SR equation as Eq. 9 [3, 15].

$$SR = \exp[-0.66\ (Rw - 0.24)] \qquad \text{(Eq. 9)}$$

where, exp is exponential value.

e. Soil Moisture Subfactor using SM equation as Eq. 10 [3, 16].

$$SM = 1 - 0.5 \times \exp(-9 \times s) \qquad \text{(Eq. 10)}$$

where: s is plotting slope.

Conservation Practice Factor (P)

The value of human/management practices factor in soil conservation is the comparison between the amount of erosion yield on land with a certain conservation action and land without conservation action [17]. Based on the field investigation, there's no practice conservation in Tanggul watershed and the value of P is 1.

Erosion Yield (A)

Erosion yield is the value that is determined by comparing the amount of actual soil erosion with soil that is allowed or tolerated. The erosion yield range present in the Table 1.

Table 1. Erosion Yield Class (A)

Soil Solum (cm)	Erosion Class				
	I	II	III	IV	V
	Erosion (tons/hectares/year)				
	<15	15-60	60-180	180-480	>480
Deep	VL	L	M	H	VH
>90	0	I	II	III	IV
Moderate	L	M	H	VH	VH
60-90	I	II	III	IV	IV
Shallow	M	H	VH	VH	VH
30-60	II	III	IV	IV	IV
Very Shallow	H	VH	VH	VH	VH
<30	III	IV	IV	IV	IV

where: VL is very low; L is low; M is moderate; H is High; VH is very high

Intercroping Model Scenarios

Erosion can be reduced by planting more plants or add plant residues as additional land cover [16]. Plants or plant residues can be used as a ground cover that protects the soil from destruction by rainfall or against the carrying capacity of surface water flow (runoff), also increasing the rate of soil infiltration. Canopies are used to restrain the rate of rainfall grains, reduce the *kinetic* energy of rainfall to soil particles. The water that passes through the canopy (interception) will be partially evaporated into the atmosphere due to evaporation, so soil loses due to run off is reduced. Moreover, the close spacing planting system generally gives more pretection for soil surface. On another hand, the roots are able to improve the condition of soil properties by creating a good habitat for organisms in the soil as a source of organic matter, as well as strengthen the grip on the soil to stabilize soil aggregation [18, 19]. Intercropping sengon-coffee model is presented in figure 2.

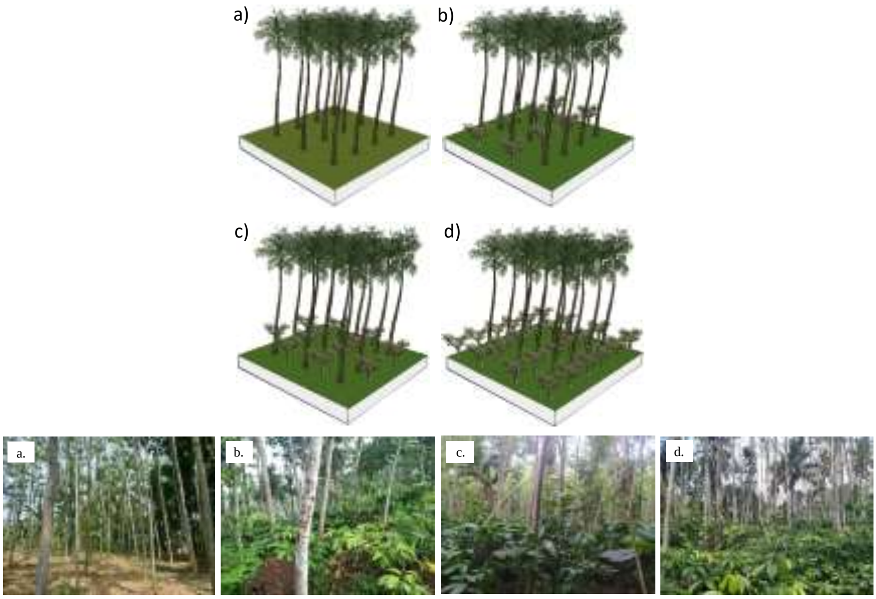

Fig. 2. Sengon-coffee intercropping model for: (a) Existing sengon plantation; (b) 1st scenario 1:0.8 ratio of sengon:coffee; (c) 2nd scenario with the ratio 1:1; (d) 3rd scenario with the ratio 1:1.5

This model was developed on the plantation with the LS value of 4% or flat class and creates more than 109.5 tons/hectares/year erosion yield (moderate level). In this sense, vegetative conservation needs to be applied in those plantations. Figure 2 is an illustration of an intercropping model.

1st Scenario: Sengon-Coffee Intercropping in 1:0.8 Ratio

The scenario under the condition 1 area sengon: 0.8 area coffee. In this condition the total plants per hectare of sengon plants are 1,667 trees, while coffee plants are 1,600. The area for sengon tree is 2×3m^2 and area for coffee plant is 2.5×2.5m^2. Moreover, the area covered by grass is 25% of the total of ground land. The age of sengon is 2.5 years with average height of 8 meters. In this scenario, land cover by sengon was 55%, coffee 45%, and grass 25%, and gives the C value of 0.089 calculated using Eq. 6.

2nd Scenario: Sengon-Coffee Intercropping in 1:1 Ratio

The scenario under the condition 1 area sengon: 1 area coffee. In this condition the total plants per hectare of sengon plants are 1,667 trees, while coffee plants are 1,667. Area for sengon tree is 2×3 meters^2 and area for coffee plant is 2×3 meters^2. Moreover, the area covered by grass is 50% ground land. The age of sengon is 2.5 years with average height of 8 meters. In this scenario, land cover by sengon was 50%, coffee 50%, and grass 50%, and gives the C value of 0.072 calculated using Eq. 6.

3rd Scenario: Sengon-Coffee Intercropping in 1:1.5 Ratio

The scenario under the condition 1 area sengon: 1.5 area coffee. In this condition the total plants per hectare of sengon plants are 1,667 trees, while coffee plants are 2,500. Area for sengon tree is 2×3 meters^2 and area for coffee plant is 2×2 meters^2. Moreover, the area covered by grass is 50% ground land. The age of sengon is 2.5 years with average height of 8 meters. In this scenario, land cover by sengon was 50%, coffee 60%, and grass 50%, and gives the C value of 0.065 calculated using Eq. 6.

Results and Discussion

Existing Erosion Yield

Based on the result of RUSLE calculation, the exsiting erosion yield and each parameter will be shown in figure 3.

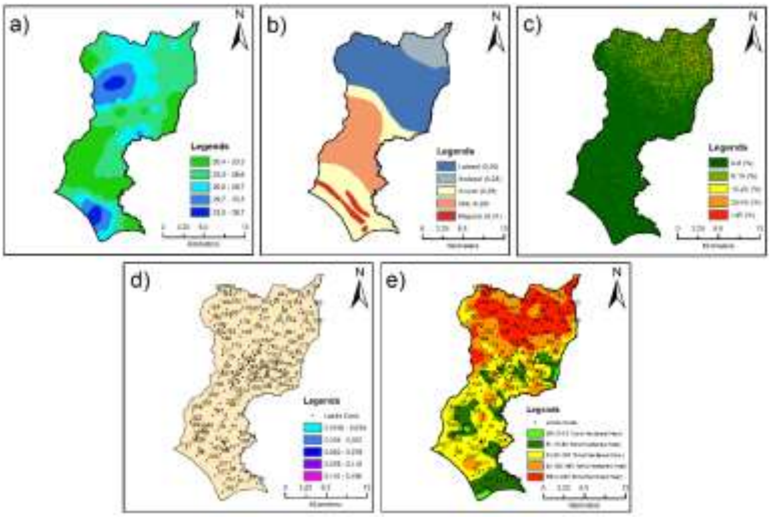

Fig. 3. a) Rainfall erosivity; b) Soil erodibility; c) Lenght and slope; d) Landuse and practice conservation; e) Existing erosion yield in sengon's land in Tanggul watershed

The rainfall erosivity (R) was calculated using Mononobe (Eq. 2). Figure 3a present that R value minimum on the study area was 18.176 MJ.cm/years owned by Kencong Rain Station which cover 3734 hectares area. While the maximum value is 43.067 MJ.cm/years owned by Bedodo Rain Station which covers 4,503 hectares area. The higher rainfall intensity creates higher erosivity that has more energy to destroy soil agregates leads to increase propobality of soil erosion (increase potential erosion yield) and reduce the rate of infiltration [17]. It leades to increased runoff that can affect the runoff and sediment yield that brings nitrogen from soil losses to the river and become pollutant sources for river water [19].

Figure 3b present that average soil erodibility in Tanggul watershed was in moderate level. This value is mostly dominated by the erodibility value of Latosol soil that covers 27,078 hectares (40% of total area). While the lowest contribution of erodibility value was from Andosol soil type that covers 5,827 hectares or 8.68% of total area. The erodibility value indicates the ability and sensitivity of the soil on reducing surface flow and other natural phenomenas. Erodibility influence by soil texture, structure organic matter and permeability which related to infiltration [20].

LS factors present on Figure 3c, where study area was dominated by flat class or 0-8% (68.5% of study area). However, upstream area (11.76% of total area) was dominated by shallow class 15-25% of LS. The length of an area increases the volume of runoff while slope increases the velocity of runoff [21]. Moreover, based on field survey, there's no mechanical conservation practice applied in Tanggul watershed, in this situation, the soil strength in holding runoff velocity decrease (land with slope >15%) and increase landslide potential [19].

Figure 3d present the field survey of the C value, which was dominated by class 1 (low) with 70 total sengon's per hectares. While the highest class 5 was 14 sengon tree per hectares area. Moreover, there's no land that applies a mechanical conservation practice in the field lead to highest P value 1. It increases the calculation of erosion yield. The sengon has high C value due to less canopy and less the root on soil holding capacity, it leads to high value of erosion yield [8]. The second factor that influenced erosion yield was the LULCC that affects the soil texture and structure, while inapproriate fertilizer doses reduce the organic matters on the soil [22].

The calcuation of erosion yield (A) is interpreted in figure 3e. 208 sengon plantation was investigated in the Tanggul watershed to identify the plantation impacts on erosion yield. The average erosion yield is dominated by moderate classification, or 60-180 tons/hectares/year produced by 85 plantations. The maximum average erosion yield is very high classification or >480 tons/hectares/year produced by 35 plantations. The total average erosion yield is 257.49 tons/hectares/year with high classification and 158 lands. The higher erosion yield influenced by all factors mentioned above [18]. In the study area, the value of erosion yield influenced by the high rainfall intensity, high erodibility and less soil cover as well as high value of LS factors. It is becoming higher when the plantation located in the sloping area (LS >15%) in this sense, conservation practice to reduce erosion yield is necessary[12]. LULCC can be a critical factor for enhancing the soil erosion risk and land degradation process in the watershed and basin [22]. In this sense vegetative conservation model through intercoping sengon-coffee was purposed as a model of conservation in the sengon plantations. Intercropping will increase canopy and reduce C value [23]. Moreover, leaf litter increases soil protection and organic matter for soil which may reduce the disadvantage of chemical fertilizer of sengon farming system. The overuse of anorganic fertilizer increases erodibility value due to less organic [24].

Using RUSLE model to run all the scenarios, the results shown in figure 4 and table 2.

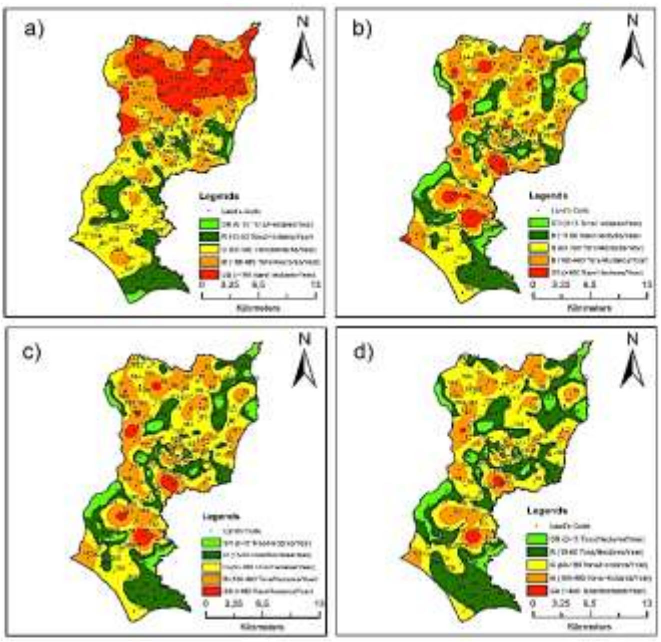

Fig. 4. a) existing erosion yield; b) scenario 1; c) scenario 2; d) scenario 3 on sengon's land in Tanggul watershed

Table 2. Erosion yield of sengon land for each scenario

No.	Model	Classification					Number plantation needs to be reduced the erosion yeild	Average of A (tons/hectares/year
		VL	L	M	H	VH		
1.	*Existing*	1	49	85	38	35	158 (76% need to reduce)	258.15
2.	Scenario 1	4	94	60	35	15	110 (53%) effective to reduce to 47%	158.25
3.	Scenario 2	4	104	54	36	10	100 (48%) effective to reduce to 52%	131.83
4.	Scenario 3	5	130	38	32	3	73 (35%) effective to reduce to 65%	97.69

(a) VL is very low; (b) L is Low; (c) M is moderate; (d) H is high; (e) VH is very high need to reduce

Erosion Yield Under 1st Scenario (Ratio 0.8:1)

Table 2 and figure 5 present result of intercropping scenario. The intercropping model applied on 158 plantations or 76% of total plantations. In this scenario, the C factor decreases the number of plantations that have erosion yield above low level. The erosion yield decreases up to 30.3% in moderate-very high-level total plantation, while the average erosion yield decreased by 38.7%. The 1st scenario implies the increasing of the total trees per hectares area plantation which increase the area covered and reduces the C value [6]. The lands that have high density of canopy are able to control and reduce the erosivity of rainfall destructive power, intensity and duration in the surface [25].

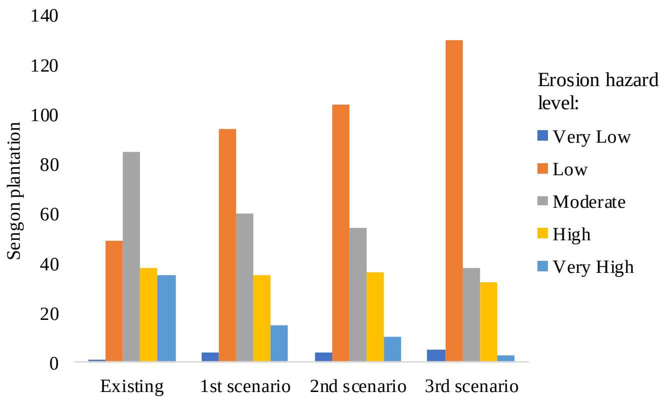

Fig. 5. Erosion hazard level on the sengon plantations

a) Erosion Yield Under 2nd Scenario (Ratio 1:1)

Table 2 and figure 5 present result of intercropping scenario 2. The intercropping model applied on 158 plantations or 75.9% of total plantations. The C value decreases to 0.029 resulting an erosion yield decreased up to 36.7% in moderate-very high erosion yield, while the average erosion decreased by 48.1%. The C value decrease due to increasing 3,334 plantations intercropping of trees and the value of plantations increasing land cover. Factors that cause a decrease of C is the increasing of soil surface total, the increase of soil roots and soil fertility, and the use of same fertilizer that can increase the optimization of plantation growth [22].

b) Erosion Yield Under 3rd Scenario (Ratio 1:1.5)

Table 2 and figure 5 present result of intercropping scenario 3. The intercropping model applied on 158 plantations or 75.9% of total plantations. The C value decreases to 0.022 resulting an erosion yield decreased up to 53.7% in moderate-very high erosion yield while the average erosion decreased by 62,16%. The C value decrease due to increasing 4,155 pantations intercropping of trees and the value of plantations increasing land cover. Factors that cause a significant decrease of erosion yield is the density of land cover subfactor. The higher land cover density, the higher ability of vegetation on the land to reduce the rainfall destructive power [26]. Surface flows that occur due to high rainfall intensity can be reduced by existing vegetation due to existing cropping patterns and density [27].

The Effectiveness of Intercropping Sengon-coffee model to reduce erosion yield

To identify the effectiveness of this model, the results obtained were tested using normality test to determine the data distribution of erosion yield for each scenario on each plantation. The first step is a statistic analysis to identify significantly results.

Based on table 3, the skewness diagram will be shown in figure 6.

Table 3. Normality Test Result

No.	Model	Kolmogorov-Smirnov[a]		
		Statistic	*df*	*P-Value*
1.	Existing	0.256	208	0.000
2.	Scenario 1	0.267	208	0.000
3.	Scenario 2	0.267	208	0.000
4.	Scenario 3	0.276	208	0.000

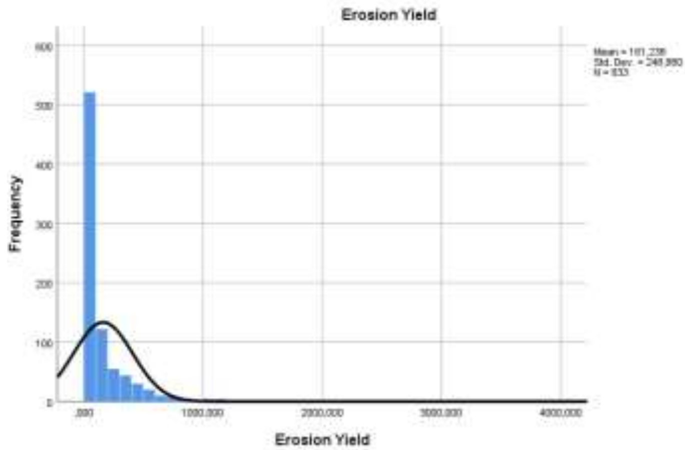

Fig. 6. Skewness diagram of sengon land erosion yield for each parameter

Table 3 and Figure 6 presents the erosion yield results for each scenario on each plantation is in positive moderate class with the average statistic value of 0.265, which mean it's under 0.708 (from Kolmogorov-Smirnov table). The data shown an abnormal distribution, in this sense the erosion yield data will be tested using non-parametric test [7].

Non-Parametric Test – Kruskall Wallis

The Kruskall-Wallis non-parametric test was conducted to determine the difference in statistical data of erosion yield on each plantation of the proposed scenarios, as well as to determins the mean rank or average rank value of each scenario.

Table 4. Kruskall-Walli's test result

Parameter Test	Erosion Yield Data Result
F_{Crit}	79.11
F_{Table}	7.81
df	3
Asymp. Sig.	4.76×10^{-17}

The 832 data is represented by 208 plantations by 3 scenarios and 1 existing plantation analyzed using Kruskall-Wallis non-parametric test. The differences of average erosion yield are caused by the differences of C and P values. Based on Table 4, the result of Kruskall-Wallis

H test is significantly different between existing model and 1st scenario – 3rd scenario. The model scenario has F_{critis} of 79.11 and F_{table} of 7.81. The significance level is 4.76×10^{-17} which mean that the entire data is significantly different. It concludes that each scenario has significanly different results or each scenario reduces erosion on each plantation.

Post hoc test – Mann Whitney U

The Post hoc test used after Kruskall-Wallis is Mann-Whitney U test to determine the difference between two different sample groups that already exists and the model scenario.

Table 5. Significance level of mann whitney test result

Model	**Model**			
	Existing	**Scenario 1**	**Scenario 2**	**Scenario 3**
Existing	1.000	0.000	0.000	0.000
Scenario 1	0.000	1.000	0.103	0.000
Scenario 2	0.000	0.103	1.000	0.004
Scenario 3	0.000	0.000	0.004	1.000

(a) Yellow indicates the significance is above 0,05 (H_0 accepted and H_1 dennied, No difference); (b) Green indicates the significance is under 0,05 (H_0 dennied and H_1 accepted, Different)

Table 5 shows that the erosion yield data that was tested is from 4 engineering scenario. Result states that there are seven models which have significant differenences. The existing samples and scenario 1 have 3.12×10^{-6} significance; the existing samples and scenario 2 have 1.37×10^{-9} significance; the existing samples and scenario 3 have 6.08×10^{-18} significance; scenario 1 and scenario 2 have 0.103 significance; scenario 1 and scenario 3 have 1.42×10^{-7} significance; and scenario 2 with scenario 3 have 0.004 significance. All scenarios are significantly different due to differences of erosion yield.

Analysis of Effectiveness in Model Scenario

Analysis of effectiveness for engineering scenario erosion yield in sengon lands on Tanggul watershed will be shown in figures 7 and 8.

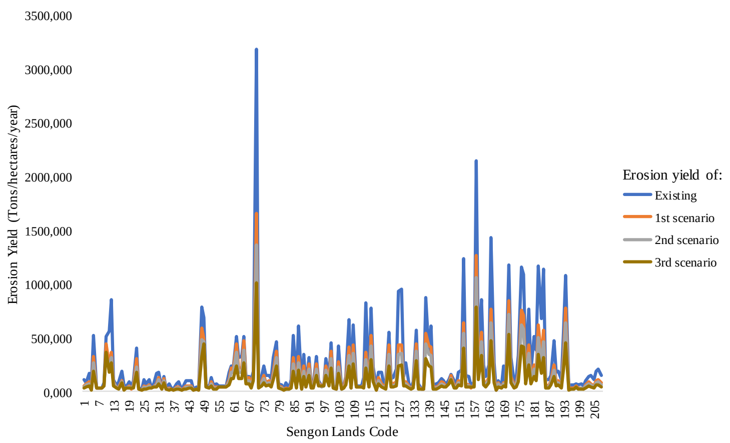

Fig. 7. Erosion yield on sengon lands comparion for each scenario

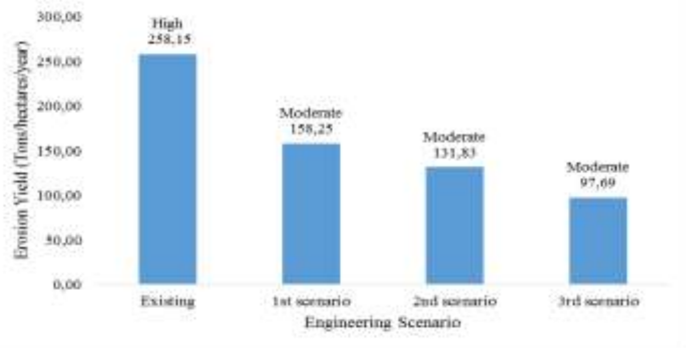

Fig. 8. Erosion yield average for engineering scenario

The average of erosion yield in existing condition is 258.15 tons/hectares/year; 1st scenario is 158.25 tons/hectares/year with 38.7% effectiveness; scenario 2 is 131.83 tons/hectares/year with 48.14 effectiveness; and scenario 3 is 97.29 tons/hectares/year with 62.16% of effectiveness. Scenario 3 has the largest effectiveness due to the amount of land with medium-very heavy classification is 73 land or 53% of moderate-very high erosion yield total plantation. The most effective engineering scenario is Scenario 3 which sengon and robusta coffee intercropping with 1:1.5 ratio. Scenario 3 can reduce 62.16% erosion yield from the existing samples. This is due to a significant decreas in C value to the use of vegetation in form of robusta coffee. Robusta coffee can reduce the SLR (C) value because it has a high density of land cover subfactor value so it can make soil structure stronger due to the existing roots. The higher density of land cover subfactor, the higher plantation ability to reduce the destructive rainfall power in the ground. The sengon's canopy will be effective in reducing the rainfall power if the addition of robusta coffee intercropping is increased. Another factor is the planting pattern that can increase stem density so it can reduce the runoff in the surface [28].

Conclusions

The increase of land use land cover change for sengon in Tanggul watershed leads to the increase of erosion yield which is more than 75% of plantations that have a moderate to very high level of erosion yields (258.15 tons/hectares/year). In this sense, soil conservation is necessary to be applied in the sengon plantations. However, for sustainability soil conservation practices, the soil conservation method must have not only soil conservation benefit but also financial benefit for farmers. This research develops three scenarios of intercropping sengon-coffee as sustainable soil conservation method. The scenarios applied in plantations have medium to very high erosion hazard levels. The ratio of sengon:coffee per hectares is 1st scenario which is 1:0.8; 2nd scenario is 1:1 and 3rd scenario is 1:1.5, respectively. These scenarios reduce erosion hazard level to low levels by 47%, 53% and 65% of total plantations, respectively for 1st, 2nd and 3rd scenario. These results are statistically different tested using Kruskall-Wallis and Mann-Whitney U tests. However, additional other conservations method needs to be applied in the remain plantations (with high erosivity and high erodibility values) to reduce erosion hazard level. Thus, mechanical soil conservation methods are recommended to be applied.

Acknowledgments

This work is supported by "Penelitian Terapan Unggulan Perguruan Tinggi Tahun 2022 Kementrian Pendidikan dan Kebudayaan Indonesia".

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Received: August 02, 20222
Accepted: February 20, 2023