International Journal of Biosciences | IJB |
ISSN: 2220-6655 (Print), 2222-5234 (Online)
http://www.innspub.net
Vol. 21, No. 3, p. 85-94, 2022

INNSPUB

RESEARCH PAPER OPEN ACCESS

Assessment of erosion hazard levels on various land cover types in Panjaratan sub watershed

Syarifuddin Kadir[1], Wahyuni Ilham[1], Ichsan Ridwan[2], Ahmad Kurnanin[3], Badaruddin[1], Wisda Hartati[1], Hanif Faisol Nurofiq[4], Nurlina[2,5*]

[1]*Faculty of Forestry, Lambung Mangkurat University, Banjarbaru 70714, South Kalimantan, Indonesia*

[2]*Faculty of Mathematical and Natural Science, Lambung Mangkurat University, Banjarbaru 70714, South Kalimantan, Indonesia*

[3]*Faculty of Agriculture, Lambung Mangkurat University, Banjarbaru 70714, South Kalimantan, Indonesia*

[4]*Ministry of Environment and Forestry, Jakarta Indonesia*

[5]*Doctoral Program of Agriculture Science, Postgraduate Lambung Mangkurat University, Banjarbaru, South Kalimantan, Indonesia*

Key words: Land use, Erosion, Watershed, Erosion hazard level, Universal soil loss equation (USLE).

http://dx.doi.org/10.12692/ijb/21.3.85-94 Article published on September 09, 2022

Abstract

Direct land use causes land-use changes. Land deterioration from land use changes without evident damage prevention generates erosion, sedimentation, and low rainwater infiltration. Tanah Laut Regency has a lot of improper land conversion. This study calculated erosion based on land cover in the Panjaratan sub-watershed and analyzed the Level of Erosion Hazard (LEH). The Universal Soil Loss Equation (USLE) and purposive sampling are utilized. The results showed that the Panjaratan Sub-Watershed had 60.97 tons $ha^{-1}yr^{-1}$ of probable erosion, with an average of 6.77 tons $ha^{-1}yr^{-1}$. The highest erosion value was in Land Unit 3 in wood tuber farming with 14.47 tons ha $ha^{-1}yr^{-1}$ and erosion hazard class I. The lowest value was in Land Unit 4 in Jackfruit Plantations with 1.99 tons $ha^{-1}yr^{-1}$ and erosion hazard class I. LEH class 0- VM (very mild) is found in LU 1 Corn plantation, LU 2 reeds, LU 4 Jackfruit Plantation, LU 5 Shrubs, LU 6 Shrubs, dryland agriculture at LU 3, and Oil palm plantations at LU 7 and 8. On bare land, LEH class 1-M (mild) is LU 9.

* **Corresponding Author: Nurlina** ✉ nurlina_abdullah@ulm.ac.id

Introduction

Erosion is one of the environmental problems that occur in many places and the long term there is an increase in erosion on surface runoff which can lead to a decrease in soil fertility in areas affected by erosion (Kadir *et al.*, 2016, 2017). The increasing rate of human growth has an impact on changes in land use, resulting in a greater erosion rate on the soil surface and the bottom of the waters. Land use causes a rapid increase in the rate of erosion due to residents who clear land which can cause environmental damage such as erosion, flooding, drought and so on which are not suitable for agriculture and plantations with land that is carried out without considering conservation measures.

Changes in land use in a watershed are caused by direct land use resulting in damaged land degradation accompanied by prevention of damage that indirectly causes high levels of erosion and sedimentation processes to be low and the level of rainwater infiltration to increase. Vegetation factors and land management generally can change land use change caused by humans and are found in a watershed. The increase in the rate of erosion hazard causes high fluctuations in sediment flow in the watershed area (Hardiana *et al.*, 2019).

The function of forest land is converted into agricultural land and plantations, causing rainwater to be unable to be retained by the soil optimally. Erosion that occurs continuously results in the erosion of a layer of organic matter on the soil surface. High rainfall is a problem so that river water overflows and causes flooding, sedimentation on the soil surface increases, which reduces the capacity of the river to hold water and erosion occur. Forest areas have been damaged and several watersheds need to be restored, including Tanah Laut Regency, including areas where there are many land use experts, such as plantations, mining areas, settlements, shifting fields, and offices. Watershed problems in the area are very common and do not function properly. Therefore, it is necessary to analyze the possibility of erosion in the type of land cover found in the area with several observation methods. One method to estimate the amount of erosion in the Panjaratan sub-watershed of the Tabunio watershed is the method proposed by Wischmeier and Smith, namely the Universal Soil Loss Equation (USLE). Based on the conditions that often occur due to a large number of land use changes in the area where erosion occurs a lot, the authors are interested in conducting research on the study of the level of erosion hazard in various types of land cover in the Panjaratan sub-watershed in the Tabunio watershed, Tanah Laut Regency.

The objectives of this study are (1) to calculate the amount of erosion based on the type of land cover in the Panjaratan sub-watershed, (2) to analyze the level of erosion hazard (LEH) in various land covers in the Panjaratan sub-watershed.

Methodology

This research was conducted in the Penjaratan sub-watershed in the Tabunio watershed, Tanah Laut district. The time needed to carry out this research is up to ± 4 (four) months starting from January to April 2022, which includes preparation activities, sampling in the field, data processing, and making research reports. The map of the research location can be seen in Fig. 1.

The equipment used in this research is GPS (*Global Positioning System*), sample ring, soil drill, and hammer. The materials used in this study were the Tabunio watershed administration map, the Tabunio watershed land unit map, the Tabunio watershed slope map, the Tabunio watershed soil map, and the Tabunio watershed land cover map. The research procedure for the level of erosion hazard in various types of land cover includes the activities of determining the research location, data collection, data collection, analysis of observations in the Soil Laboratory and data analysis.

The research location was determined by overlaying three types of maps, namely land cover maps, slope maps and soil type maps. This is done for land units in the Tabunio watershed, Tanah Laut Regency.

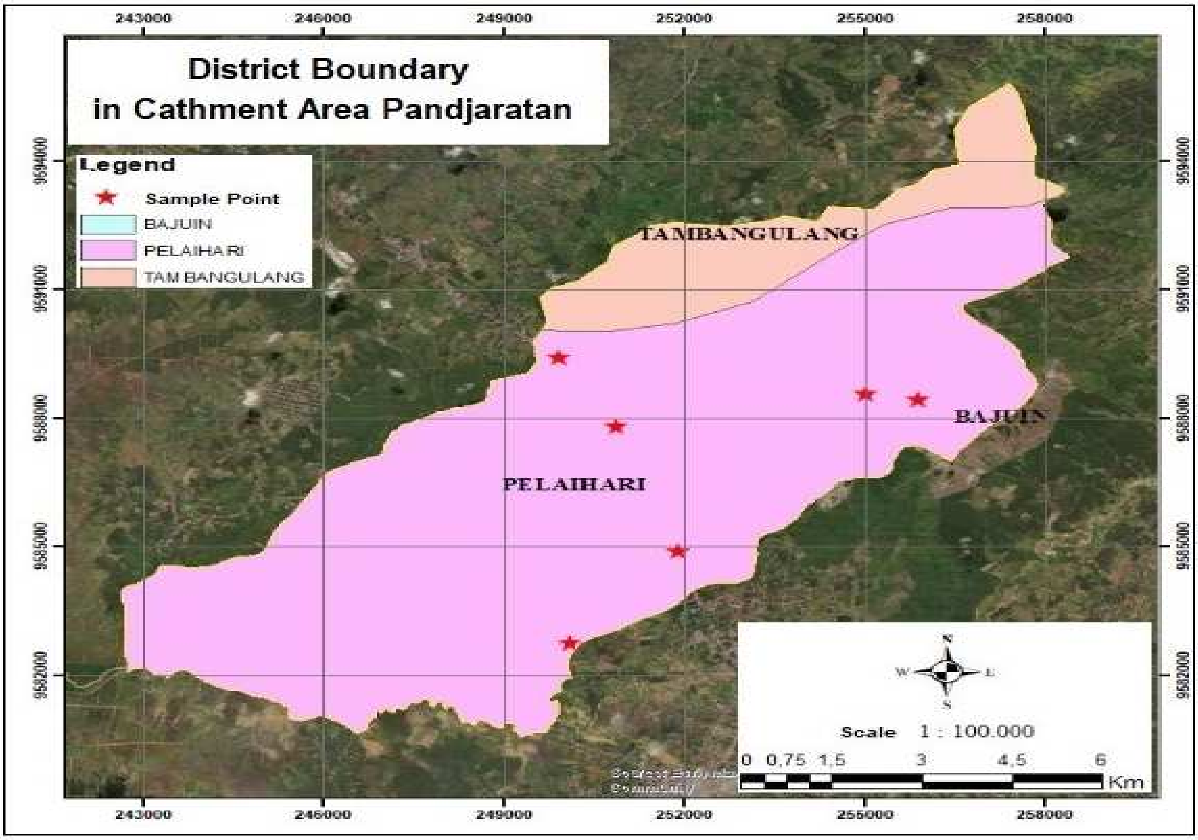

Fig. 1. Panjaratan Sub-watershed Administration Map.

The results of the map overlay obtained 6 observation points with 9 land cover. A sampling of data is done by purposive sampling technique, which means that the sample point of the data is determined intentionally by determining the unit of land to be observed. Sample points were taken based on soil type, land cover and slope class which was adjusted to the land unit from the land unit map (overlay). Sampling used two methods, namely by using a soil drill to analyze the depth of the soil solum, structure, texture, and organic matter and using a ring sample to observe the permeability of each observed land unit. Primary data collection is done by conducting field survey methods. Data collection techniques are carried out by observation or direct observation in the field. The data treated include soil erodibility factor (K), slope length factor (L), slope (S), land use factor (C), and soil conservation factor (P). Secondary data collection is obtained from literature studies, reports, or information from various government agencies and other parties concerned with the completeness of the data required in the study. The secondary data needed in this study are data about the general description of the research location and monthly rainfall data for the last 10 years which represent the research area in the Panjaratan sub-watershed. Soil samples obtained from the field included disturbed soil and soil in the sample ring which was then analyzed at the Soil Laboratory of the Faculty of Agriculture ULM to obtain texture data (sand, silt, clay, and very fine sand), organic matter content and permeability.

Erosion value

The estimated amount of erosion is calculated using the Universal Soil Loss Equation (USLE) formula developed by Wischmeier & Smith in 1978 in the form of an equation as follows:

$$A = R.K.LS.C.P.0,61$$

A is Amount of land lost (tonnes $ha^{-1}year^{-1}$), R is the average annual rainfall erosion factor ($mj.cm/ha^{-1}hour^{-1}year^{-1}$), K is Soil erodibility factor ($ton (ha.hour)^{-1}ha^{-1}(mj.cm)^{-1}$). L is slope length factor (m), S is slope factor (%), C is plant management factor, P is soil conservation factor, 0.61 is correction factor (Ruslan 1992).

Rain erosivity (R)

According to the Ministry of Forestry (2009) the method that can be used to calculate rainfall if there is only average monthly rainfall data is the Lenvain equation (1975) (Vrieling *et al.* 2014):

$Rm = 2.21\ Rain^{1.36}$

$$R = \sum_{m=1}^{12} Rm$$

Rm is monthly rain erosivity factor, Rain is average monthly rainfall (cm), R is total Rm for 12 months.

Soil erodibility (K)

The value of K is determined using the equation created by (Wischmeier, W. H., and Smith 1978)

K = {(2.713 M 1.14 (10-4) + (12-a) + 3.25 (b-2) + 2.5 (c-3)/100)}

K is Soil erodibility, M is Particle size (% dust + % fine sand) x (100 - % clay), A is Organic matter content, for organic matter content >6% (high-very high), then 6 is the maximum value used, b is Soil structure class, and c is Permeability class.

Results and discussion

Rain erosivity factor

The value of rain erosivity is determined using monthly rainfall data in the last ten years, namely from 2012 to 2021. Rainfall data is obtained from the BMKG Banjarbaru. Rainfall data obtained is calculated by the equation of Lenvain (1975). The results of the calculation of rainfall can be seen in Table 1. The results obtained include the total number of erosivity in a period of 10 years starting from 2012 to 2021 of 2039.53 (units/year). High rainfall value is caused by several factors impacting the soil surface caused by rainwater so that soil particles erode and pressure forces when they fall to the ground. The collection of rainwater causes surface runoff to become an event of erosion that results in damage to soil pores.

Table 1. Erosivity Value of Sub-watershed 2012 – 2021.

Month	Year										Average (cm)	rm
	2012 (cm)	2013 (cm)	2014 (cm)	2015 (cm)	2016 (cm)	2017 (cm)	2018 (cm)	2019 (cm)	2020 (cm)	2021 (cm)		
Jan	25.36	32.62	27.45	42.13	27.46	38.51	28.89	31.54	33.17	68.03	35.52	283.8
Feb	18.94	41.78	26,70	42.52	30.32	24.31	50,17	33.08	38.31	34.02	34.01	267.6
Mar	29.15	34.11	38.23	24.66	39.93	21.23	50,18	26.64	75.86	27.17	36.72	296.9
April	35,40	21.01	19.43	26.90	27.05	17.50	21.89	32.62	26,70	15.95	24.45	170.7
May	14.00	25.44	24.87	20.21	26.63	31.35	10.27	11.42	22.64	18.27	20.51	134.5
Jun	13.92	12.49	26,20	16.97	20.02	26,20	16,16	26.91	18.94	21.70	19.95	129.5
Jul	17.08	21.18	11.07	5.19	12.41	18.85	9.01	2.14	23.21	15.57	13.57	76.7
Aug	4.76	15.66	9.27	1.80	8.45	12.09	3.92	2.40	12.70	26.42	9.75	48.9
Sep	3.71	12.80	3.13	0.11	17.24	13.23	4.88	0.73	17.96	22.15	9.59	47.9
Oct	15,16	8.26	0.75	2.57	23.83	14.06	7.35	7.67	22.51	28.08	13.02	72.5
Nov	28.92	34.66	15.95	12.47	35.55	32.63	19.98	13.54	39.22	34.34	26.72	192.7
Des	42.60	41.83	33.87	44.05	30.45	31,20	54.76	26.54	42.10	38.69	38.61	317.9
R	Rm = Rain Erosivity (unit/year)											2039.53

Source: Meteorology, Climatology and Geophysics Agency, 2021.

Rain erosivity has an impact on the soil, the amount and surface flow experience a level of damage caused by the erosion process so that it is influenced by the rainfall that occurs and the intensity of the duration of rain falling to the ground surface which causes the soil to quickly erode and sedimentation occurs (Ridwan and Putri 2022). According to Kartika *et al.* (2016), high rainfall erosion can cause high erosion so that the soil has a low value located on sloping slopes as well as improved management for the better even the high intensity of rain the more the soil experiences particle blows released along with splashing water.

Soil erodibility factor (K)

Soil erodibility is one of the most influential factors in determining the erosion that occurs. The higher the erodibility value of the soil, the more susceptible it is to erosion, conversely, the lower the erodibility value of land will be resistant to erosion. The level of soil erodibility is listed in Table 2. Based on Table 1, the highest soil erodibility is in land unit 3 with a land cover of 0.336 for tuber plantations including moderate soil erodibility and the lowest erodibility value is in corn plantation land unit 1 of 0.033.

The higher the erodibility value, the easier the soil is to erode. Factors that affect the high and low value of soil erosion include soil texture that comparing sand, silt, and clay so that the highest value is found in jackfruit plantations and the lowest is in corn plantations due to soil conditions and soil structure, organic matter, and clayey clay soil types experience differences in soil absorption. to water and the pores of the soil that are slow to absorb water result in differences in the capacity of the soil.

Table 2. Soil Erodibility Value of Panjaratan Sub-watershed.

No	Land Cover	Unit Land	K	Erodibility Rate
1	Corn plantation	UL1	0.033	Very low
2	reed	UL2	0.043	Very low
3	Tuber Farming	UL3	0.336	moderate
4	Jackfruit plantation	UL4	0.300	moderate
5	Shrubs	UL5	0.129	Low
6	reed	UL6	0.105	Low
7	Palm plantations	UL7	0.170	Low
8	Palm plantations	UL8	0.245	moderate
9	Open field	UL9	0.080	Very low

The organic matter content also affects the erodibility value, as seen from the results of the lab analysis, the c-org value at UL 5 is lower than UL 6, namely 0.18 and 2.12. The erodibility is influenced by the depth and the nature of the soil layer which is related to the characteristics of the soil profile which can determine the level of soil erodibility. The depth of the soil to the impermeable layer or parent material will determine the amount of water that seeps into the soil. While the nature of the soil layer affects the rate of water infiltration into the soil and soil fertility with high erodibility will experience rapid erosion compared to low erobility that occurs because the soil has a lot of vegetation.

Table 3. Value of Slope Length and Slope Slope (LS) of Panjaratan Sub-watershed.

No	Land Cover	Unit Land	L (m)	S (%)	LS
1	Corn plantation	UL1	52.64	1.64	0.242
2	reed	UL2	14.84	4.12	0.296
3	Tuber Farming	UL3	29.88	1.64	0.182
4	Jackfruit Plantation	UL4	0.64	1.64	0.027
5	Shrubs	UL5	18.08	1.64	0.142
6	reed	UL6	6.64	4.12	0.198
7	Palm Oil CLA	UL7	4.5	1.64	0.071
8	Palm Oil CLA	UL8	22.52	1.64	0.158
9	Open field	UL9	0.54	4.12	0.057

L is Length of slope, S is Slope (%).

Slope length and slope factor (LS)

Based on the observations, the length and slope values of the slopes are shown in Table 3. Based on Table 2, the results of the analysis of the length and slope of the slope are relatively not too much different because the research location is located in the downstream area where the slope is relatively gentle. The results of the analysis of the length and slope of the highest slope are land units 2 on alang alang with a total of 0.296 and the length and slope of the lowest slope are land units of 9 on open land cover.

The length and slope of the slope vary from low to high where the height and length of a slope in land cover have an influence on surface runoff which causes erosion.

Table 4. The Value of Factor C in Various land use of the Panjaratan Sub-watershed.

Land Cover	Land Unit	C
Corn plantation	UL1	0.64
reed	UL2	0.25
Tuber Farming	UL3	0.19
Jackfruit Plantation	UL4	0.20
Shrubs	UL5	0.30
reed	UL6	0.25
Palm plantations	UL7	0.50
Palm plantations	UL8	0.50
Bare land	UL9	1.00

The longer the slope of land causes more surface water to accumulate so that the surface runoff becomes higher in depth and speed. The greater the slope, the higher the runoff rate and the smaller the ability of the soil to absorb water, this is what causes areas with large slopes to have greater erosion potential (Surono *et al.*, 2013).

Cover crop management factor (C)

Based on the results obtained from observations in the field, the value of cover crops (C) is listed in Table 4.

Based on Table 4, the results show that there are two observation points that have the same C factor value, namely in oil palm plantations located on land units 7 and 8, the land cover factor value is 0.50. The condition of land that does not have vegetation can increase soil absorption quickly, causing soil erosion and eventually the land is transformed into critical land that has no vegetation and is prone to landslides and other environmental problems on the land. Vegetation or growing plants can inhibit and surface flow can absorb into the soil and the infiltration process becomes large due to the absorption of water through the roots.

The influence of vegetation has an impact on the amount of erosion that occurs when rainwater is accommodated and does not enter the soil directly, this causes the power of water to destroy soil aggregates to be reduced due to the presence of vegetation on the soil surface. Roots play an important role in the process of water absorption in the soil to be stable so that the soil is not easily saturated and the erosion process does not occur chemically and mechanically in its application. Soil runoff has a direct impact on erosion, the more vegetation there is on the soil, the lower the rate of erosion that occurs but on the contrary the less or no vegetation on the soil, the greater the chance of erosion due to absorption of water that directly enters the soil causing the land to be damaged. and can make the land critical and easily damaged.

Soil conservation factor (P)

The P factor is closely related to the ways of managing the land, management according to the rules will have a good impact, and vice versa if the land is managed only modestly it will have a negative impact on the land. Conservation efforts or land management actions to reduce soil erosion are listed in Table 5. According to (Arsyad 2010), the soil conservation factor (P) is the ratio between the amount of soil erosion and certain conservation action on the amount of soil erosion that is processed according to the direction of the slope. Table 12 shows that the P factor in the Panjaratan sub-watershed has no conservation action so the P value for all land cover is 1. According to Indriati (2012) the absence of soil conservation (P = 1), the P index does not affect the size of the calculation of erosion that occurs in a land. Land management is strongly influenced by human intervention, in addition to land cover factors and slope levels, inappropriate management systems also cause land degradation so soil erosion is increasing.

Table 5. Soil Conservation Factor (P) Value of Panjaratan Sub-watershed.

No	Land Cover	Land Unit	P	Information
1	Corn plantation	UL1	1	No conservation action
2	reed	UL2	1	No conservation action
3	Dryland farming	UL3	1	No conservation action
4	Jackfruit plantation	UL4	1	No conservation action
5	Shrubs	UL5	1	No conservation action
6	reed	UL6	1	No conservation action
7	Palm plantations	UL7	1	No conservation action
8	Palm plantations	UL8	1	No conservation action
9	Open field	UL9	1	No conservation action

According to Arsyad (2010) in high slope areas generally, the decline in land quality and quantity occurs more quickly. Land conservation is carried out so that destructive energy (rain grains and runoff) can be reduced as small as possible so that it does not damage and soil aggregates are more resistant to raindrops and surface runoff so that land resources are maintained. According to Kartika *et al.* (2016), soil conservation and plant management are useful for protecting soil from rainwater collisions and increasing soil sensitivity in rainwater absorption.

According to Banuwa (2013), it is humans themselves who determine whether the land they cultivate will be damaged and become unproductive or repair it so that it becomes productive and sustainable. Erosion control depends on good land management, in the form of planting cover crops or managing the land properly.

Estimation of erosion rate

The values of all the supporting parameters for estimating the erosion rate are accumulated in order to obtain the erosion value for each land unit. Based on the results obtained, the erosion value is presented in Table 6.

Table 6 shows the erosion value for each land unit, the highest erosion value is in the Land Unit (UL) 3 with an erosion value of 14.47 tons/ha/year and the land cover is dryland agriculture. While the lowest value is at UL 4 with an erosion value of 3.96 tons/ha/yr found in alang-alang land cover and plantation land cover at UL 4, which is 1.99. Land cover and slope are closely related to erosion values. According to Arsyad (2010), the good land cover will be able to suppress erosion so that its value will decrease. Tree crowns and litter can also reduce raindrops so that when they hit the ground, the kinetic energy of rainwater is not too large.

Land cover that has a steep slope is very influential because the larger the slope, the more difficult it will be for water to enter the soil and the infiltration will be low and the soil will be more easily carried away by water.

Table 6. Recapitulation of Erosion Value of Panjaratan Sub-watershed.

No	Land Cover	Unit Land	Large (Ha)	Slope (%)	R (mm)	K	LS (m/%)	C (%)	P	Fk	A (tons/ha/year)
1	Corn plantation	UL1	1,933	0-8	2039.5	0.033	0.242	0.64	1	0.61	6.41
2	reed	UL2	102	8-15	2039.5	0.043	0.296	0.25	1	0.61	3.96
3	Wood tuber farming	UL3	947	0-8	2039.5	0.336	0.182	0.19	1	0.61	14.47
4	Jackfruit plantation	UL4	1,836	0-8	2039.5	0.300	0.027	0.20	1	0.61	1.99
5	Shrubs	UL5	101	0-8	2039.5	0.129	0.142	0.30	1	0.61	6.81
6	reed	UL6	111	8-15	2039.5	0.105	0.198	0.25	1	0.61	6.47
7	Palm plantations	UL7	2,043	0-8	2039.5	0.170	0.071	0.50	1	0.61	7.47
8	Palm plantations	UL8	2,033	0-8	2039.5	0.245	0.071	0.50	1	0.61	7.78
9	Bare land	UL9	791	8-15	2039.5	0.080	0.057	1.00	1	0.61	5.65

R = Rainfall Erosivity, K = Soil Erability, LS = Length and Slope Factor, C = Vegetation Factor (Land Cover), P = Soil Conservation Factor, F = Correction factor (0.61), A = Soil Erosion.

The value of erodibility (K) means in the calculation of erosion because the number is the same in each land unit, the greater the value of K, the greater the effect on erosion. For the value of erosivity, soil conservation factors and correction factors do not have much effect.

Erosion hazard level (TBE)

The erosion hazard level is obtained from the calculation of the erosion hazard class where the results of the erosion calculation (A) are grouped and entered into the erosion hazard class table. The results of the analysis of the Erosion Hazard Class (EHC) are associated with the soil solum class so that several classes of Erosion Hazard Levels (EHL) are obtained. The following details the level of erosion hazard which can be seen in Table 7.

Based on the data from Table 7, it can be seen that the deeper the soil solum, the lighter the erosion hazard. The depth of the soil solum plays an important role in the size of erosion on land. Erosion can be minimized by deep soil solum that provides space for water on the surface of the soil. According to Rauf (2011), the thicker the soil solum, the higher the ability of the soil to recover soil damage due to erosion. Indriati (2012) added that the level of erosion hazard is determined based on the level of the erosion rate with the thickness of the soil solum. The level of erosion hazard is classified based on the soil solum because the thin soil solum can increase the erosion rate even though the erosion rate is the same as the thicker solum.

The results obtained in the erosion hazard class varied from very light (0-SR), mild (IR), moderate (II S), severe (III B) and very heavy (IV-SB). The level of erosion hazard in all land units and land cover shows EHL class 0-SR (very light) is found in 8 land units, namely corn plantations, alang alang, tuber farming, jackfruit plantations, shrubs and oil palm plantations. While EHL class IR (mild) is found on land unit 9 on open land cover.

The EHL value that occurs from the existing erosion value results in the EHL value on each slope depending on the total length and slope of the slope as well as the soil erodibility factor. The greater the value of K, the greater the effect on erosion. In this study, the value of erosivity, soil conservation factor and correction factor did not have much effect on the calculation of erosion because the value is the same for each land unit.

The type of land cover in measuring the rate of erosion hazard was found in land unit 1, namely, corn plantations, land unit 2 contained shrubs and tuber farming, land unit 3 contained land cover for jackfruit, alang alang and shrubs plantations, land units 4 and 5 contained the same land cover, namely oil palm plantations and land unit 6 there is open land.

Table 7. Value of Erosion Hazard Level of Panjaratan Sub-watershed.

No	Land Cover	Unit Land	Large (Ha)	Slope (%)	Solum Depth		Erosion Level		EHL
					cm	Class	(tons/ha/yr)	Class	
1	Corn plantation	UL1	1,933	0-8	> 90	deep	6.41	I	0-VM
2	reed	UL2	102	8-15	> 90	deep	3.96	I	0-VM
3	Wood tuber farming	UL3	947	0-8	> 90	deep	14.47	I	0-VM
4	Jackfruit plantation	UL4	1,836	0-8	> 90	deep	1.99	I	0-VM
5	Shrubs	UL5	101	0-8	> 90	deep	6.81	I	0-VM
6	reed	UL6	111	8-15	> 90	deep	6.47	I	0-VM
7	Palm plantations	UL7	2,043	0-8	> 90	deep	7.47	I	0-VM
8	Palm plantations	UL8	2,033	0-8	> 90	deep	7.78	I	0-VM

The results of the observations show that the land condition where there is no vegetation on the land causes a lot of erosion, but inversely proportional to doing the calculations, the results of the tuber farming with a flat slope (0 - 8%) experience a very high value of erosion that occurs due to the land that is processed as agricultural land resulted in very large surface runoff and the lowest level of erosion hazard was found in jackfruit plantation land cover which had a lot of vegetation and very good soil conditions resulting in very slow water absorption and flat land cover slopes (0 - 8%) causing low erosion values (Sun *et al.*, 2014). Due to the lack of surface runoff and good soil conditions, plants thrive (Febrianti *et al.*, 2018; Nurlina *et al.*, 2022).

Conservation actions are carried out by paying attention and taking into account the high danger of erosion on land by planting trees taking into account the spacing and types of trees that fall into the fast-growing category, such as Jabon (*Anthocephalus cadamba*), Acacia (*Acacia mangium*), and Sengon (El Kateb *et al.*, 2013; Mohammad and Adam 2010). (*Falcataria moluccana*) and land plants to reduce the magnitude of erosion and other damage caused by humans, actions that can be taken to address the high erosion hazard.

Conclusion

The conclusions obtained from the results of the study on the level of erosion hazard in various types of land cover in the Panjaratan sub-watershed are: The value of erosion in the Panjaratan sub-watershed is 60.97 tons/ha/year with an average of 6.77 tons $ha^{-1}yr^{-1}$ and categorized very light erosion with details The highest erosion value is in Land Unit 3 in tuber farming with an erosion value of 14.47 tons $ha^{-1}yr^{-1}$ with erosion hazard class I (very light) with a land cover slope of 0 – 8% (flat), While the lowest value is in Land Unit 4 in jackfruit plantations with an erosion value of 1.99 tons/ha/year with erosion hazard class I (very light) with land cover slopes 0 - 8% (flat). The level of erosion hazard in all land units and land cover shows TBE class 0-SR (very light) is found at UL 1 Corn Plantation, UL 2 Alang-alang, UL 4 Jackfruit Plantation, UL 5 Semak Belukar, UL 6 Alang-alang, Timber tuber farming at UL 3, oil palm plantation at UL 7 and 8 While TBE class IR (light) is UL 9 on open land.

References

Arsyad S. 2010. Konservasi Tanah dan Air. IPB Press.

Arsyad S. 2012. Konservasi Tanah dan Air. (H. Siregar, Ed.) (Edisi ke 2., p. 466). Bogor: IPB Press.

Asdak C. 2014. Hidrologi dan Pengelolaan Daerah Aliran Sungai. Yogyakarta: Gadjah Mada University Press.

Banuwa IS. 2013. Erosi. Prenadamedia Group. Jakarta.

El Kateb H, Zhang H, Zhang P, Mosandl R. 2013. Soil erosion and surface runoff on different vegetation covers and slope gradients: A field experiment in Southern Shaanxi Province, China. Catena **105,** 1–10. https://doi.org/10.1016/j.catena.2012.12.012

Febrianti I, Ridwan I, Nurlina. 2018. Model SWAT (Soil and Water Assesment Tool) untuk Analisis Erosi dan Sedimentasi di Catchment Area Sungai Besar Kabupaten Banjar. Jurnal Fisika FLUX, **15(1),** 20. https://doi.org/10.20527/flux.v15i1.4506

Hardiana E, Kadir S, Nugroho Y. 2019. Analisis Tingkat Bahaya Erosi (TBE) Di Das Dua Laut Kabupaten Tanah Bumbu. Jurnal Sylva Scienteae **2 (3),** p 529-539.

Indriati N. 2012. Indeks dan Tingkat Bahaya Erosi Kawasan Hutan Pendidikan Gunung Usalat Kabupaten Sukabumi. IPB. Bogor

Kartika I, Indarto I, Pudjojono M, Ahmad H. 2016. Pemetaan tingkat bahaya erosi pada level Sub-DAS: Studi pada dua DAS Identik. Jurnal Agroteknologi **10(01),** 117-128.

Kadir S, Badaruddin, Nurlina, Farma E. 2017. Power Recovery Support Tabunio Watershed Based on Analysis of Erosion Based on Geographic Information System in the Province of South Kalimantan. Mediterranean Journal of Social Sciences **8 (4–1)**, 73–81. https://doi.org/10.2478/mjss-2018-0075

Kadir S, Badaruddin, Nurlina, Ridwan I, Rianawaty F. 2016. The recovery of tabunio watershed through enrichment planting using ecologically and economically valuable species in south Kalimantan, Indonesia. Biodiversitas **17(1),** 140–147. https://doi.org/10.13057/biodiv/d170121

Mohammad AG, Adam MA. 2010. The impact of vegetative cover type on runoff and soil erosion under different land uses. Catena **81(2),** 97–103. https://doi.org/10.1016/j.catena.2010.01.008

Nurlina, Kadir S, Kurnain A, Ilham W, Ridwan I. 2022. Analysis of soil erosion and its relationships with land use/cover in Tabunio watershed. IOP Conference Series: Earth and Environmental Science **976(1).** https://doi.org/10.1088/1755-1315/976/1/012027

Ridwan I, Putri WE. 2022. Estimation of Peatland Fire Carbon Emissions Using Remote Sensing and GIS Physics Study Program , Faculty of Mathematics and Natural Sciences Lambung Mangkurat. International Journal of Biosciences **6655,** 246–253. http://dx.doi.org/10.12692/ijb/20.6.246-253

Ruslan M. 1992. Sistem Hidroorologi Hutan Lindung Daerah Aliran Sungai Riam Kanan Kalimantan Selatan [Institut Pertanian Bogor]. http://repository.ipb.ac.id/handle/123456789/23160

Rauf A. 2011. Dasar- Dasar Pengelolaan Daerah Aliran Sungai. USU Press. Medan.

Surono, Jailani Husain, Yani EB, Kamagi, dan Jeane Lengkong. 2013. Aplikasi Sistem Informasi Geografis dalam Memprediksi Erosi Dengan Metode USLE di Sub DAS Dumoga. Jurnal unsrat **3(5),** Tahun 2013.

Sun W, Shao Q, Liu J, Zhai J. 2014. Assessing the effects of land use and topography on soil erosion on the Loess Plateau in China. Catena **121,** 151–163. https://doi.org/10.1016/j.catena.2014.05.009

Vrieling A, Hoedjes JCB, Van der Velde M. 2014. Towards large-scale monitoring of soil erosion in Africa: Accounting for the dynamics of rainfall erosivity. Global and Planetary Change **115,** 33–43. https://doi.org/10.1016/j.gloplacha.2014.01.009

Wischmeier WH, Smith DD. 1978. Predicting rainfall erosion losses a guide to conservation planning. U.S. Department of Agriculture, Agriculture Handbook No. 537. https://naldc.nal.usda.gov/download/CAT79706928/PDF