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ANALYSIS OF THE LEVEL OF EROSION HAZARD IN THE FRAMEWORK OF THE GREEN REVOLUTION IN WATERSHED MALUKA PROVINCE SOUTH KALIMANTAN

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ABSTRACT

This study aims to analyze the rate of erosion and identify the level of erosion hazard in the Maluka watershed. The method used in the study is the USLE (Universal Soil Loss Equation) method. The results showed that the values obtained from the calculation of erosion rates were the highest existed in open land valued 708.77 tons/ha/year and the lowest value was in young secondary forests of 30.33 tons/ha/year. This shows that the absence of vegetation has an impact on the soil so that it is damaged and gives effect to the erosion rate, especially on steep slopes. The level of erosion hazard varies from medium class (II S and III S), weight (III B) and very heavy (IV-SB), very heavy classes are on open land. The value of the erosion hazard level is obtained from the value of the erosion rate with the class into the soil solution.

Keywords: Soil Erosion, Watershed Maluka, Erosion Hazard Level

INTRODUCTION

Hydrological conditions generally Indonesia is currently characterized by the increasing incidence of extremes such as floods and droughts with high content of impurities in water bodies such as rivers and lakes. Water crisis is also increasingly felt, especially leading up to and during the dry season, especially for Java which was already anticipated to be experiencing serious water shortages due to population pressures are acute and conditions of land use change. It is thought that as the impact that needs to be observed from land use change in wide scale has been decline of rainfall and hydrological regimes in a number of regions in Indonesia, including the island of Java. The influence of land use change and forests towards aspects of hydrology and watershed flood frequency has been the focus of much research (Tran and O'Neill, 2013; Zégre, Maxwell and Lamont, 2013; Zhang, et al., 2015).

BACKGROUND AND RATIONALE

The development of land use in a number of watersheds in Indonesia in three decades this raises a wide range of environmental impacts, such as a decrease in water quality, increased frequency of flooding, flood discharge, and the volume of flood inundate area settlements and public infrastructure that results in damage and losses of material and non-material (Tomer and Schilling, 2009; Öztürk, Copty and Saysel, 2013; Royall, 2014; Fan and Shibata, 2014). The incidence of floods during the rainy season resulted in disorder and the damage is very serious, and encourage the need for immediate corrective action to avoid the recurrence of similar incidents. watershed hydrology studies are indispensable for analysing hydrological functions, in particular that there is a relation to rainfall and the management of rainwater, runoff coefficient, the concentration, and climate change factors and the dynamics of the use of the land, as well as the management of the forest resource (White and Greer, 2006; Lin, et al., 2007; Lin and Wei, 2008; Sriwongsitanon and Taesombat, 2011; Ghimire and Johnston, 2013; Shaw, et al., 2014).

The occurrence of the opening of the land in various areas including South Kalimantan province raised many issues, one of which is the critical land opportunity against the occurrence of erosion. Land damage in South Kalimantan reach 641,586 Ha or about 17.07% of vast forest areas and there are 31 watershed to do recovery (Hall management watershed Barito, 2013). watershed Maluka is one of the areas that are in the land of the Sea so that vulnerable environmental decline will be erosion. Seen from this type of use of the land is dominated by garden Palm and mixed plantations, this can influence the occurrence of erosion on land use which does not comply with the rules, especially against the palm plantations that are not able to do absorption well. Map of critical land shows that most of the land in the watershed Maluka is included in the critical group with an area of 10,369.88 ha da bit arises with 55,214.73 ha, in which aka tone quite serious threat for resource support watershed in the function area forest. Some areas in the watershed flood-prone area is Maluka and experiencing drought season drought, this indicates that the area of Watershed Maluka has undergone changes due to land over the function so that the watershed does not function properly. Therefore, it is necessary to analyze the prediction's chances of occurrence of erosion. The purpose of this research is to analyze the magnitude of the rate of erosion and identifying the level of danger of erosion Watershed Maluka.

LITERATURE REVIEW

Erosion is the event's move or terangkutnya land or portions of land from a place to another place by the natural media, namely, water or wind (Arsyad 2010). Furthermore, according to Yu et al.(2003), the low infiltration capacity cause the magnitude of erosion as a result of the high flow surface.

Asdak (2010) suggests that the erosion processes consists of three sections made up; exfoliation, transport, and deposition. Further stated that some types of erosion surfaces common in tropical areas are: 1) the erosion of pericik (splash erosion); 2) Skin Erosion (sheet erosion); 3) Erosion grooves (real erosion); 4) ditch Erosion (gully erosion); and 5) the river bank Erosion (streambank erosion).

According to Utomo (1994), the management of the factors that affect the occurrence of erosion is as follows: energy Factors include: a) erosivitas; b) permukaaan flow: c) wind; d) relief; e) angle slopes; f) long slopes; and h) distance between terrace; Resilience factors include: a) erodibilitas; b) infiltration; and c) land management; and protective Factors include: a) overcrowding; b) plant cover; d) the value of usability; and e) land management.

Indarto (2010) suggests that human activity against the erosion of the once highly influential as there are changes in land use that often occur in the watershed. Next Arsyad (2010), suggests that overall there are five factors that cause and affect the magnitude of erosion include: factors of climate, Vegetation, soils, topography, and humans.

Jacob at al. (2009) suggests that the incidence of erosion on farmland causing changes in farming practices. Next Roig-Munar et al. (2012) suggests that land degradation causing erosion occur that affect changes in the condition of the river. Further Samuels (2008) suggests that the beach jutting out into the Atlantic Ocean are involved in a continuous process of erosion. Next Lantican, Guerra, and Bhuiyan (2003) suggests that the impact of the erosion occurrence consists of: a) the increasing trend of consequent superficiality of the Canal; b) result in a significant decrease in the productivity and income of farmers; c) the rising cost of routine operation and maintenance of the river.

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METHODOLOGY

Place and time Study

This research was carried out in watershed Maluka Subdistrict Bati-bati District land sea and analyzed in the laboratory of Soil Biology Faculty of Agriculture University of gastric Mangkurat Banjarbaru Kalimantan Selatan. Implementation of the research conducted for 3 months includes preparation, data capture in the field up to the preparation of research results.

Tools and materials Research

Tools used in this research in the form of a map, map of soil types and sloping land cover maps, GPS (Global Position System) to determine the position and take the point of observation, Clinometer to measure the slope of the slopes, soil drill for observations of the solum, ground, ring samples used to take samples of soil, plastic bags to put soil samples and paper labels as a marker of the sample as well as other supporting tools. The ingredients needed in this research in the form of soil samples that will be on the analysis of laboratory data and rainfall during the last 10 years.

Research Procedure

The specified location

The location specified with the overlay using three map be map of kelerengan map of soil types, and land cover map. This is done to determine the land units that are on watershed Maluka.

Data Retrieval

Sampling data is performed by using purposive sampling engineering i.e. the sample point determined in purpose. The point of the samples taken from the farm unit based on a map of land units (overlay). Samples were taken using two way form retrieval using a drill ground to observe solum, ground, structure, texture, and organic ingredients and use a sample ring to find out the permeability at each venue.

Data Collection

Efforts are being made to collect the necessary data in this research in the form of primary data obtained by observing it directly in the field (observation), for the activities conducted to observe some of the factors that influence against soil erosion in the form of erodibilitas factor (K), the long slope factor (L), the slope of the escarpment (S), (C) land use and soil conservation (P). Secondary data retrieval is performed to complete the study, the data collected in the form of data about an overview of the location of the research obtained from the relevant agencies, the rainfall data for the last 10 years representing the area of watershed Maluka retrieved from BMKG Station Climatology Banjarbaru, as well as the administrative map, map, map of land cover watershed, maps and soil type map sloping.

Data Analysis

Prediction erosion and erosion hazard level would be done using the formula of Universal Soil Loss Equation (USLE) who consider rain, length, slope the slope, soils, land conservation actions and closure. USLE equation expressed by Wischmeirer and Smith (1978), written as follows:

$$A = R.K.L.S.C.P$$

Description:

A = the rate of soil erosion (tons/ha/year)

R = Rain erosive factors (KJ/ha)

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K = Factors of erodibilities land (ton/KJ)
L = Slope length factor (m)
S = Slope the slope factor
C = Cover crop factor
P = Processing factors of land or soil conservation actions

Factors erosive the rain (R)

The value of erosive is obtained from the data of rainfall during the last 10 years that has been available. The calculation of the value of the erosive the rain is done using the Lenvain equation is calculated using the data of annual rainfall average. The value of the erosive factors of rain (R) was calculated by using the formula of Bols (1978)

$$R_m=6,119(Rain)_m^{1,21} \text{ x } (Days)_m^{-0,47} \text{ x } (MaxP)_m^{0,53}$$

Description:

R_m = Erosivitas monthly rainfall average (EI30 (mj.cm/ha/h/month)
$(Rain)_m$ = Rainfall monthly average (cm)
$(Days)_m$ = The number of rainy days monthly average (days)
$(MaxP)_m$ = Rainfall average daily maximum (cm)

Factor erodibilities the soil (K)

Erodibilities or sensitivity of the soil against erosion is the durability of the land against the release depending on soil properties, such as texture, structure, permeability and the content of soil organic matter. K factor value is determined by analyzing the nature of the soil in the form of texture, structure, permeability and content of organic matter. Erodibilities land use factor equation created by Wischmeier and Smith (1978), namely:

$$K = \{ 2,173 M^{1,14}(10^{-4}).(12-a) + 3,25 (b-2) + 2,5 (c-3) \}/100$$

Keterangan :

K = Erodibilitas land ; M = % dust + % very fine sand x (100 - % clay),
A = Content of organic materials (%)
B = The value soil structure and
C = The value soil permeability.

Slope length and slope factors (LS)

LS factor is a combination of a long slope factor (L) with a slope of slope (S). Slope length factor (L) is the specified value between the magnitudes of erosion with long slopes. Slope steepness factor is a value between the magnitudes of erosion of the slope with a degree of slope. The value of the slope length factor (L) and slope the slope factor (S) integrated into a factor of LS and is calculated by the formula advanced by Asdak (1995) as follows:

$$S = (0,43 + 0,043 s2)/6,61$$
$$LS = L1/2(0,0138S2+0,00965 S + 0,00138)$$

Description:

LS The value of the slope and the slope factor
S The actual slope slope (%),
S The slope of the slopes (%).

Crop factor cover (C) and soil conservation (P)

Crop cover and management factor plant (C) is a comparison between the magnitudes of soil erosion on a land that is present on the plant cover is accompanied with the management at the plant. P factor is closely related to the ways of the management of its land, the management in accordance with the rules will provide a good impact, so conversely if land is managed only a potluck this can give a negative impact to the land. Soil conservation actions can be the management and cultivation of the based on contour or guludan.

The determination of the value of the crop management factor (C) using the table's factor C Soewarno research results (1991), Utomo (1994) and Asdak (1995). The determination of the value soil and water conservation factor (P) using a table of P factors developed by Dephut (1994). Having regard to the conditions on the ground in each land unit can be known whether or not the actions of conservation land use

Erosion Hazard Levels

Erosion hazard levels obtained from the calculation of the erosion hazard classes where erosion calculation results (A) classified and entered into the table class of the danger of erosion. The results of the analysis of the Erosion Hazard Class (KBE) is connected with the ground, so the solum class gained some level of Erosion Hazard class (EHC). The following details the level dangers of erosion can be seen in Table 1.

Table 1. Erosion Hazard Level

Solum Land (cm)	Erosion Hazard Class				
	I	II	III	IV	V
	Erosion (tons/ha/yr)				
	< 15	15 - < 60	60 - < 180	180 - 480	> 480
	Erosion Hazard Level				
In (> 90)	0 - SR	I - R	II – S	III - B	1V – SB
Is being (> 60 - 90)	I - R	II - S	III – B	IV - SB	IV – SB
Shallow (30 - 60)	II - S	III - S	IV - SB	IV - SB	IV – SB
Very shallow (< 30)	III - B	IV - SB	IV - SB	IV - SB	IV – SB

Source: the Ministry of Forestry of INDONESIA (2009)

RESULTS AND DISCUSSION

Erosivity Rain (R) Watershed Maluka

The value of the data specified by erosivity rain annual rainfall average of 7.7 retrieved beach and is calculated by using the equation Lenvain is indicated in Table 1.

Table 1. The value of Erosivity Precipitation Period 2008 – 2017

No.	month	Rainfall (cm)	Rain Erosivity
1	January	36,33	292,65
2	February	30,22	227,82
3	March	30,11	226,69
4	April	20,57	135,02
5	May	19,19	122,85
6	June	10,41	53,47
7	July	11,27	59,57
8	August	6,17	26,25
9	September	8,94	43,47
10	October	13,67	77,45
11	November	21,26	141,21
12	December	37,93	310,32
	Total	**180,83**	**1.716,79**

Source: Agency of the Climatology and Geophysics (2018)

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The calculation result shows a total value of erosivity in the past 10 years (2018-2017) of 1,716.79 cm. These values indicate that the precipitation that occurs in watershed Maluka is high enough so that the effect on the occurrence of erosion. The value of a great erosivity give impact on the soil surface. According to Kartika et. Al (2016) value erosivity is influenced by precipitation rates impacting against the magnitude of erosion. Rainfall and land conversion are the two important factors that affect surface runoff and soil erosion (Xiao et al., 2015).

Erodibilities Land (K) Watershed Maluka

The value erodibilities value is obtained from the soil physical and chemical properties of soils, as contained in table 2. The following:

Table 2. The Value Soil Erodibilities

No	Sample	Erodibilities	level Erodibilities
1	the tares	**0,29**	being
2	Scrub	0,17	Low
3	Dry Land Agriculture	0,10	Very low
4	Open Land	0,24	Being
5	Garden Mix 1	0,16	Low
6	Garden Mix 2	0,24	being
7	Palm	0,11	Low
8	Rubber Gardens	0,13	Low
9	Secondary forest	0,08	Very low

Source: Primary Data Field

Based on the results of observations in each sample is then retrieved the value of the erodibilities and are very low. Most are of the highest value there is in a sample with land cover in the form of reeds of 0.29 and a very low value on the young secondary forest of 0, 8, it can be seen in table 2. Big nothingness of values erodibilities at a farm show that erosion happens. The higher the value soil erodibilities the more prone to erosion, otherwise the lower value erodibilities a land will be resistant to erosion. This is caused by the percentage of the structure on the ground as well as its frequent changes on the land. According to Nugroho (2008) textured soil dust is more susceptible to erosion than the sand and clay-textured soils. Soil dust has the ability to retain water at low and easily saturated. Sand absorbency higher power because it has large pores so that the rate of surface tend to be smaller. The soil clays have a resistance to erosion because the aggregate aggregate-the soil is strong (dominated by micro pore). A positive significant relation was observed between the capacity of holding water with the content of organic matter and clay fraction content, whereas a negative relationship was found between the content of the sand fraction with WHC (Nath, 2014).

Water quality is often better on a forested watershed area, the management of forest ecosystems is also very influential to the quality and quantity of water from a watershed results (Gibson, 1976; Shepard, 2006; Komatsu, et al., 2011). At this time of great vegetation and forested watershed patrolled to ensure the quantity and quality of the raw water supply for consumption of the metropolitan cities of the world (Ensign and Mallin, 2001; Fiquepron, Garcia and Stenger. 2013.

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Slope length and Slope (LS) Watershed Maluka

Based on the observations obtained the value of the length of the slope and the slope of the slopes shown on Table 3.

Table 3. The value of Slope length and Slope

No	Sample code	description	LS (m)
1	the tares	0-8%	2,01
2	Scrub	0-8%	2,17
3	Dry Land Agriculture	8-15%	1,40
4	Open Land	8-15%	2,82
5	Garden Mix 1	0-8%	1,98
6	Garden Mix 2	15-25%	0,84
7	Palm	8-15%	3,17
8	Rubber Gardens	0-8%	2,33
9	Secondary forest	15-25%	3,62

Source: Primary Data Field

Table 3. Indicates that the value of the highest LS exists on the Young secondary forest of 3.62 m this is because land is at position slope 15-25%. Big nothingness of values a slope give influence on the erosion occurs, it can be observed in Table 3. According to Kadir (2014) and the length of ramp slope factor (LS) effect very greatly to the level of danger of erosion that occurred. According to Kurdish (2015) the slope is the fundamental factor of impending floods and erosion. Flat slopes and ramps lead to surface flow (run off) more slowly so that annihilation happens is smaller compared to a steep and very steep.

The slope of the escarpment is one of the factors that largely determine the large to the small level of erosion, in addition to soil type and intensity of precipitation. Relationship between slope slopes with erosion rate is positive, the greater the slope the slope factor the greater the potential erosion, and vice versa (Arsyad. 2010). R.V. (2007) long slope, steep slopes and slope form can influence the magnitude of the surface flow.

Employee administration Plant cover (C) and Land Conservation (P) Watershed Maluka

Based on the value gained from observations in the field then the value of the plant cover and soil conservation are listed in Table 4.

Table 4. The value of the Crop cover and Management factor of soil conservation

No	Sample code	C	P	Description
1	the tares	0,25	1	Without conservation action
2	Scrub	0,30	1	Without conservation action
3	Dry Land Agriculture	0,60	1	Without conservation action
4	Open Land	1,00	1	Without conservation action
5	Garden Mix 1	0,50	1	Without conservation action
6	Garden Mix 2	0,50	1	Without conservation action
7	Palm	0,50	1	Without conservation action
8	Rubber Gardens	0,15	1	Without conservation action
9	Secondary forest	0,10	1	Without conservation action

Source: Primary Data Field

Based on the data in table 4 Note that the highest value on the management of the plant of 1.00 on open land and the lowest value there is in a forest land cover of 0.10. The existence of very large land closing its influence on surface flow and erosion, the more vegetation then the greater the water absorption and decrease the rate of erosion. According to Bhan and Bahera (2014) has a great influence on vegetation against erosion due to the presence of vegetation capable of breaking down and prevented rain water in order not to fall to the ground, so that the power of the water is reduced.

Table 4 shows that the factors of P in watershed Maluka is not yet the presence of conservation action so that the value of all samples at each land cover is 1. According to Indriati (2012) in his research declaring inaction soil conservation (P = 1), then the index P do not affect the magnitude of erosion that occurred on a farm. Essentially land management were heavily influenced by human intervention towards land in the direction of the slope. In addition to the factors of land cover and the level of sloping, the system of cultivation is not appropriate also causes land degradation so that soil erosion is increasing (Nandi and Luffman, 2012). Arsyad (2010) stated on high slope areas generally decrease the quality and quantity of land occurs more quickly.

Prediction Value Erosion Watershed Maluka

The values of all parameters-parameter erosion prediction rate of accumulated supporters to get the value of each unit land erosion using USLE. Based on the results obtained the value soil erosion presented at Table 5.

Table 5. Recap of the Value Soil Erosion Watershed Maluka

No	Land Cover	R	K	LS	C	P	A
1	the tares	1.716,79	0,29	2,01	0,25	1	152,61
2	Scrub	1.716,79	0,17	2,17	0,30	1	115,90
3	Dry Land Agriculture	1.716,79	0,1	1,40	0,60	1	87,97
4	Open Land	1.716,79	0,24	2,82	1,00	1	**708,77**
5	Garden Mix 1	1.716,79	0,16	1,98	0,50	1	165,88
6	Garden Mix 2	1.716,79	0,24	0,84	0,50	1	105,56
7	Palm	1.716,79	0,11	3,17	0,50	1	182,59
8	Rubber Gardens	1.716,79	0,13	2,33	0,15	1	47,58
9	Secondary forest	1.716,79	0,08	3,62	0,10	1	**30,33**

Source: Primary Data Field

Results retrieved from calculation of the rate of erosion it is known that the value the highest exists on the open land of 708.77 tons/ha/year and lowest value is on young secondary forest i.e. 30.33 tons/ha/year. Badaruddin, et al. suggested that 2013 in forested land, the actual erosion that occurs is smaller than the grassy land or overgrown by Reed, scrub and gardens. The cause of the erosion on the open land of great value is the absence of absorption of water to accommodate and keep so that the rain water that falls just passes through the surface and carries the particles within, in contrast to the case with land coverage of secondary forest the young are more able to absorb the rain water that falls because there is tree roots. According to Akbar (2017) the difference in the average value of the erosion is influenced by factors of plant cover (C) and the long slope factor (LS), the plant cover is a forest and a rubber erosion value smaller than the open land, mining, reeds, bushes and shrubs.

Increased erosion often caused by land use change from forest plantations, agriculture and housing for it needs to be regulated land use and management to protect water quality. Another impact of the changes in the functions of land for settlements has also increased erosion due to land other functions will change along with the human activity in the area

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(Wikantika, et al., 2005). Land use change can also increase erosion process much as the main mechanisms that cause soil erosion by rainwater (Moghadam 2015 et al.)

Erosion Hazard levels (EHL) watershed Maluka

Calculation result based on the value of the level of danger of the erosion of those values obtained in Table 6.

Table 6. The Value of the Level of Danger of Erosion

No	Land cover	Solum depth (cm)	categories	Hazard of Erosion (ton/ha/year)	class	EHL
1	the tares	75	being	152,61	III	III - B
2	Scrub	75	Being	115,9	III	III - B
3	Dry Land Agriculture	75	being	87,97	III	III - B
4	Open Land	30	Shallow	708,77	V	IV - SB
5	Garden Mix 1	75	Being	165,88	III	III - B
6	Garden Mix 2	100	Depth	105,56	III	II - S
7	Palm	60	Shallow	182,59	IV	IV - SB
8	Rubber Gardens	75	Being	47,58	II	II - S
9	Secondary forest	50	shallow	30,33	II	III - S

Source: Primary Data Field

Based on the data Table 6. The results obtained on the class level of the danger of erosion varies from medium class (II's and III's), heavy (III B) and very heavy (IV-SB). The class is very heavy on open land. On table 6. Erosion hazard rate values retrieved from the value of the rate of erosion with class into solum ground. According to P et al. (2012) expressed the depth of soil have a solum, become significantly to his little big erosion on a farm. Solum land in giving space to water the soil's surface, thus there is erosion that occurs can be reduced. According to Indriati (2012) the level of danger of erosion is determined based on the level of the rate of erosion thickness of the solum of the soil. The rate of erosion hazards are classified based on the solum on the ground as the thin soils can increase the rate of erosion despite rate erosion the same as the solum is bolder.

CONCLUSIONS

With the highest value erosion exists on the open land of 708.77 tons/ha/yr. and the lowest value is on the young secondary forest i.e. 30.33 tons/ha/yr. The level of danger of erosion varies from medium class (II's and III's), heavy (III B) and very heavy (IV-SB). The class is very heavy on open land.

SUGGESTIONS

Conservation action in the area of the watershed should be increased so that more Maluka danger of erosion can be reduced and the danger of disaster can be minimized.

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