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Prediction of the Magnitude of Erosion that Occurs in Some Units of the Wae Tomu Watershed Sirimau District, Ambon City

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***Abstract* – This research aims is to predict the magnitude of erosion that occurs in some units of the Wae Tomu watershed Sirimau District, Ambon City. Estimation of erosion that occurs is calculated by calculating the number of rain erosivity, soil erodibility factor, long factor and slope, plant factor and erosion control factor. The results show that the calculation of erosion hazard that occurs in Wae Tomu watershed results vary from very light to very heavy. Therefore the possibility of erosion in the Wae Tomu watershed is very high considering the results that show the qualifications up to very heavy. With this result is expected to be a reference material for the prevention of natural hazards that may occur in the Wae Tomu watershed, which can harm the surrounding environment and humans living around the Wae Tomu watershed.**

***Keywords* – Wae Tomu; Watershed; Erosion.**

I. INTRODUCTION

Land is a very important natural resource for human life. Almost most of the food and clothing needs can be filled with the type of material that comes from the soil. Proper land use is a matter to be taken into account in order to meet those needs, in order to ensure survival and improve human well-being.

Human activities such as tree felling, forest burning, shifting cultivation, resulting in a decline in land productivity due to erosion and the formation of degraded land. Erosion is the loss of soil or parts of the soil transported by water from one place to another. Erosion causes serious environmental problems. Erosion affects and destroys soil fertility, both biological fertility and silting of the river by depositing materials [1] [2].

The dangers of erosion are always a problem in the development of a watershed, due to land use mismatches with the ability of the land itself. Watershed is a plain region that holds and stores rainwater for water to be channeled into the sea through the main river. Watershed is formed from elements of vegetative, soil and water as well as human and everything done in the watershed. So that action or influence on one will affect all elements within the basin overall area [3].

Wae Tomu watershed is one of the catchments located in downtown Ambon. In addition to agricultural land is also a place of resettlement and a source of water for the needs of surrounding communities. Various community activities around the watershed such as tree felling, shifting cultivation or expansion of agricultural land and settlements to steep slopes and the existence of various agricultural activities that are inconsistent with land capability and not accompanied by soil and water conservation measures will accelerate the erosion [4] [5].

To predict erosion occurring in the Wae Tomu watershed, a slope unit system may be used. The advantage of this system is that it can calculate erosion by water in detail and more easily in calculating the slope length factor when compared with other systems. Recognizing the harm caused by land use that is not in accordance with its ability,

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it is necessary to conduct research on the prediction of the magnitude of erosion that occurs in some units of the Wae Tomu watershed Sirimau District, Ambon City.

II. METHODOLOGY

2.1. Place and Time of Research

This research was conducted on Wae Tomu watershed from October to November 2017.

2.2. Tools and Materials

The tools and materials used in this research are: abney level, compass, ground observation manual, profile description card, zet pH field, HCL, H_2O_2, aquades, munsell soil color chart, meter roll, machetes, wood gauge, shovel , hoe, field knife, land unit map, topographic map and stationery.

2.3. Research Methods

The research method used is land survey method.

a. Measurement of rainfall erosivity factor (R)

The value of rainfall erosion index can be determined or calculated from rainfall data measured by regular rainfall, based on normal rainfall, based on parameter: monthly rainfall (R) and cm, monthly rainfall (D), maximum rainfall for 24 hours M).

$$EI \quad 6{,}119R^{1{,}21} + D^{-0{,}47} + M^{0{,}53} \quad \ldots\ldots (1)$$

b. Measurement of soil erodibility factor (K)

To obtain soil erodibility value, the analyzed are texture, structure, organic material and permeability. The soil erodibiltas value can be calculated when the analysis of: (a) The percentage of dust and sand is very fine, (b) percentage of coarse sand, (c) percentage of organic matter, (d) soil structure and, (e) soil permeability is known.

c. Measurement of long and slope factor (LS)

For a uniform slope and slope to slope unit then use equation 7 to generate the LS value of the slope.

If the slope is in a state that is not uniform then first slope must be divided into segments. Then the measurements are done on each slope unit and firstly the fraction of ground loss must be determined by each slope segment using equation 8. Where the slope segment is obtained from slope measurement (%) by using abney level. Then the LS segment of the slope is determined by multiplying equation 2 and equation 3.

$$LS \quad = \sqrt{X}(0{,}0138 + 0{,}00965\, s + 0{,}00138\, s^2) \quad \ldots\ldots (2)$$

Where :

X: slope length (m)
s: slope steepness (%)

$$FKT \quad = \frac{J^{m+1} - (J\text{-}1)^{m+1}}{N^{m+1}} \quad \ldots\ldots (3)$$

Where :

J: segment sequence number (top segment numbered 1)
m: long exponent of the slope
N: number of segments

d. *Measurement of plant management factor (C)* and erosion control measures (P).

Determining the value of plant management factor and erosion control measures then the observation is done in each segment of some slope unit.

e. Prediction of actual erosion

The estimation of the actual erosion occurring can be calculated after the value of rain erosivity, soil erodibility factor, long factor and slope, plant factor and erosion control factor are known, then the value of each factor is included in equation 4 to obtain the actual erosion value that happened.

$$A = R \times K \times LS \times C \times P \quad (4)$$

III. Results

3.1. Assessment of erosion factors

3.1.1. The value of rain erosivity (R)

The value of rain erosivity based on the calculation shows that rainfall erosivity index is high enough value: 2347,02 ton m/ha/cm of rain. It is seen that the monthly R value for the last 3 years (2013 - 2016) is the highest in July of 523.31 ton m/ha/cm of rain. While the lowest was in November, the low R value was 15.91 ton m/ha/cm.

High erosivity of rainfall indicates that the erosion in July is very large while the possibility of erosion in November is very small. The monthly R value distribution can be used as one of the approaches in shaping the planting time, in order for the plant to effectively reduce erosion. For example, when the monthly high R value is cultivated the plant already has a thick dense canopy (dense) so that in this condition it is able to decrease the kinetic energy of rain through the interception of rain, as well as slow the flow of the surface. Conversely when the low monthly R value can start with planting.

3.1.2. The value of soil erodibility (K)

The value of soil erodibility in the study sites on four slope units turned out to yield results varying from low to high. In kambisol soils the K value is categorized as low (0.22), then podsolic soil type (0.25) and litosol soil type (0.39).

Differences in soil erodibility values in each soil type related to differences in soil properties are: texture, organic matter content and soil permeability [6] [7] [8].

Soil type Litosol has a K value is very high because of very low clay content that is 3.5%. Although the sand content is very fine, the organic material and dust content is higher but it has a cube structure and slow permeability. Given the slow permeability it will provide the opportunity for soil to absorb less water so that the total amount of surface flow will increase and result in increased soil erosion.

The degree of erosion sensitivity of the podsolic soil type is rather high when compared to the kombosil soil type. This is because the podsolic soil type has a low organic matter content of 1.40. Although the sand content is very smooth, dust and clay is quite high. The low content of organic material will be easier to erode because the aggregate stability becomes reduced and the soil becomes unstable, so that the rain with kinetic energy can destroy the aggregate of the soil.

Type of soil kombisol has a lower K than the type of soil Litosol and Podsolic. This is because the soil type kombisol has a very fine sand content and low dust, although it has a moderate organic material content of 1.47% and soil permeability is rather slow.

3.1.3. Values of length and slope

The results show that the topography of the four slope units varies from ramps (3-8%) to very steep (> 65%) and the mean has a short slope length.

Slope with sloping topography (4%) has a slope length of 8.5 m is the shortest slope and has the most narrow area of 0.03 ha or 1.96% while slopes with steeper topography generally dominate the slope of the research location with the area of 0.46 ha or 330.10% and has a slope length of 9.60 to 24.5 m.

Sloping topographic slopes (15-30%) and steep (45 - 65%) also have a fairly wide spread of 0.41 ha or 26.80% and 0.34 ha or 22.22% with a slope length of 14 , 60 - 15.60 m and 12 - 38.5 m. while the slopes with topography are slightly slanted (8-15%) and very steep (> 65%) have slopes of 21.10 - 27.7m and 8.60 - 15m.

Although the slopes of the four slope units all have short slopes but that does not mean erosion will not occur. This is because the slopes have a slope of 30 to more than 65%, ie slopes with steep to very steep topography mostly located at the study site. Where this situation is in accordance with references [9] that the steeper the slope, the number and the speed of the flow of the greater the surface.

For slopes that are sloping to slightly sloping (3-15%) the possibility of erosion is very small because it has a short slope length.

The LS value of a segment on a slope unit varies with length and slope. the lowest LS segment value is shown on the unit of slope B segment 1 (0.04). This corresponds to the length and slope of the segment of 8.5 m and 4%. While the highest segment LS value is on the slope segment A segment 2 and unit slope D segment 7, where this segment although has a short slope length but has a very steep slope of 98% and 90%.

There are also some slope segments which have low enough LS values, the C segment 1 slope units, and the C segment 3 slope units with the LS values of 0.10 and 0.32

respectively, are mainly related to the slope length of 21.10 - 27.7 m and slope of 8 - 15%.

3.1.4. C and P values at the study sites

Types of land use in the study sites are natural forest, mixed plantation, shifting cultivation, scrub and vacant land, with C values ranging from 0.001 to 1.00. While its P value = 1.00. This is because there is no conservation action found in the study sites.

The use of mixed garden land is commonly encountered with an area of 0.66 ha or 43.14% and is on sloping slopes. Land use is often found with the area of 0.54 ha or 3.37% and for very steep slopes this land use is very narrow that is an area of 0.05 ha or 3.27%.

The use of forest land is very little spread of only 0.05 ha or 3.27% and spreads on steep slopes up to very steep with 0.01 ha or 0.65% and 0.03 ha or 1.96%. Utilization of this forest land still looks original because it has never been opened or done farming efforts. While the use of shifting cultivation land associated with shrubs dominates the state of slopes until steep slopes with an area of 0.41 ha or 26.80%.

On the slopes tilted to a slight slope found empty land with an area of 0.14 ha or 9.15%. Where empty land is a former mixed garden that has been burned by the surrounding community. And if this situation continues or is left then the erosion will happen very large. While the use of shrubland and shifting cultivation is encountered in slopes and steep slopes with an area of 0.17 ha or 11.11% and 0.10 ha or 6.54%.

3.2. Erosion Hazard Level (EHL) at the study site

The results of the research on four slope units showed that the erosion hazard rate resulted varied from very mild to very severe. From the erosion calculation on the 22 slope segments, the smallest erosion hazard level is very light at 0.02 ha or 1.31% (Slope A segment 2) and occupies the most narrow area when compared with other erosion hazard levels.

While the largest erosion hazard level is very heavy area of 0.87 ha or 56.86% (slopes B segments 2 and 3, slopes C. segments 5,6 and 7, slopes D. segments 2,3,4,5,6 and 7) and occupies the largest area when compared with other erosion hazard levels.

Judging from this condition, the condition of land in the research location. Need to get serious attention, considering the greatest erosion hazard is very heavy.

3.2.1. The degree of erosion hazard is very mild

Very mild erosion hazard at the study site was 0.02 ha or 1.31% with erosion of 5.16 ton/ha/year and located on the slope unit A segment 2. Short slope length (15 m), soil condition with moderate erosion sensitivity ie, posolik, natural forest land use, although it has a very steep slope (98%).

Although this segment has a larger slope slope compared to other slope segments, it has an unspoiled vegetation, namely primary forest with C = 0.001.

With the more natural and dense vegetation cover of a land, the erosion will be reduced so as to minimize kinetic energy from rain. This is in accordance with the opinion of references [9] which says that the closer the canopy, the less rain energy reaches the ground.

3.2.2. Mild erosion hazard level

The degree of light erosion hazard at the study site was 0.03 ha or 1.96% with erosion of 6.2 ton/ha/year, located on the slope unit of B segment 1. This is caused by the influence of erosion factors such as soil type with very low erosion sensitivity ie kombisol. The slope of the slopes slope, has a short slope with the plant factor is shrubs.

This segment has a C value is quite large that is 0.3 but has mild erosion. Because of this segment, there are other erosion factors that can suppress high C value such as soil type with very low erosion sensitivity (0,22), short slope length (8,5m) and sloping slope factor (4%). This can be attributed to the opinion of reference [10] which states that lands with a higher K value will more easily experience erosion.

3.2.3. Mean erosion hazard level

The level of erosion hazard being located in the study area is 0.47 ha or 30.72% with 1.93 - 65.13 ton/ha/year and located on slope unit A (segment 1,3,4 and 5), slope unit C (segments 1,2 and 3), and unit slope D segment 1.

This is particularly related to the combination of erosion factors such as soil types with very low to very high erosion sensitivity ie kombisol, and lithosol, the slopes of slope slightly to steep, short to medium slopes with natural forest land use and mixed gardens.

Plant species Litosol with very high erosion sensitivity (K = 0.39) but moderate erosion. This relates primarily to short slope length (8.6 - 9.70 m), low land use C, ie forest (0.001), although it lies on steep to very steep slopes (44-76%).

The level of moderate erosion hazard generally occurs on slopes with topography rather tilted, tilted, rather steep and very steep (14-76%). This is related to short to medium length slopes, low to very high K values (0.22 to 0.39) and moderate C values of 0.100 - 0.3.

Slopes that are moderately eroded generally have a natural forest land use pattern and a mixed garden with an area of 0.03 ha and 0.44 ha. If we compare between A segment 4 and C 4 segment slopes C there is a difference of erosion due to different land use factors. This means that the lower and more dense the canopy of a plant, the erosion will be reduced, and in accordance with reference [9] which says high vegetation where the canopy is far above the surface of the soil, the rain drops out of the canopy, the velocity will increase again so the energy when it reaches the surface of the ground will increase again.

3.2.4. The degree of serious erosion hazard

The degree of serious erosion hazard at the study site was 0.09 ha or 9.15% with erosion of 87.78 ton/ha/year, located on the C segment 4 segment.

Long slope conditions in areas with severe erosion are only on short to moderate slopes. This is due to the sloping sloping topography and the sensitivity of mixed erosion and shifting cultivation associated with shrubs with an area of 0.08 ha and 0.09 ha. When viewed on the slope unit C segment 4 the amount of erosion caused by the influence of land use. On the slope unit C segment 4 with a value of C = 0.5; K = 0.22; LS = 0.34 experienced erosion of 87,78 ton/ha/year. Can be explained that the greater the value of C then the erosion of chances of erosion is higher. This is in accordance with the opinion of reference [11] which states that the lower the density of plants, then the rain presentation that redeem the canopy will be greater.

3.2.5. The degree of erosion hazard is very severe

The results showed that the most severe erosion hazard was 0.87 ha or 56.86% with erosion of 187.95 - 1254.72 ton/ha/year. This is particularly related to a combination of erosion factors such as the type of kombisol, the slope of the slopes to very steep, long to long slopes, with mixed garden land use patterns, vacant land, shrubs and shifting cultivation. Although the soil erosion level is very heavy, it has the same soil type and soil sensitivity level that is kombisol (K = 0.22), but has other differences, such as slope length factor, slope inclination and land use factor.

On the slope unit D segment 3 with the value L = 11.40 m; S = 78%; K = 0.22; C = 0,400 experienced erosion of 832,35 ton/ha/year, and on slope segment C unit 6 with value L = 17,0 m; S = 44%; K = 0,, 22: C = 1.00 has erosion of 1254,72 ton/ha/year. Seen from an increase in slope length (from 11.440 to 17.0 m), the erosion will increase, although slope decreases (from 78 to 44%). This is in accordance with the opinion of reference [12] which states with increasing length of slope, so the loss of land perunit area will increase.

The most severe erosion pattern of land use is mixed plantation, vacant land, shifting cultivation of 1.90 ha from very heavy erosion area. While for the shrubs experienced a very heavy erosion of 0.75 ha. This is mainly due to the moderate slopes and steep slopes.

IV. Conclusions

Calculation of erosion hazard that occurs in Wae Tomu watershed results vary from very light to very heavy. Therefore the possibility of erosion in the Wae Tomu watershed is very high considering the results that show the qualifications up to very heavy. With this result is expected to be a reference material for the prevention of natural hazards that may occur in the Wae Tomu watershed, which can harm the surrounding environment and humans living around the Wae Tomu watershed.

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