STUDY EFFECT OF LAND MANAGEMENT OF HORTICULTURAL ON SOIL ERODIBILITY AT THE UPSTREAM OF SUMANI WATERSHED

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STUDY EFFECT OF LAND MANAGEMENT OF HORTICULTURAL ON SOIL ERODIBILITY AT THE UPSTREAM OF SUMANI WATERSHED

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ABSTRACT: Upstream watersheds in Sumani, is a large horticulture farming area widely cultivated by vegetables, such as cabbage, onions, potatoes etc. Due to intensive farming business activities, which tend to have an impact on the level of erodibility inherent soils, a large portion of land is destroyed by rain leading to erosion. The purpose of this study, therefore, is to determine the erosion level and determining erodibility factor on farm lands on the upstream of Sumani Watershed. The research method adopted is purposive random sampling. Furthermore, soil samples were taken in order to analyze its physical properties (texture, organic matter, structure, permeability) at a depth of 0-20 cm. The samples were analyzed in the soil Department laboratory at the Faculty of Agriculture Andalas University. Data analysis was processed using the soil erodibility equation and to determine the factors, the principal component analysis (PCA) was utilized. The results of the analysis showed the value of soil erodibility against rainfall which was determined by using its organic matter, structure and permeability. The soil was also prepared by applying the conservation method. The resh organic material of the harvest is capable of improving its durability damaged by rainfall.

Keyword; watersheds, soil, horticultural, erodibility, rainfall

1. INTRODUCTION

The use of various poor farming management activities leads to land damage. Agricultural ventures, which fail to implement the conservation rule, tend to make the land susceptible by rainfall thereby, leading to erosion. Furthermore, this is influenced by several factors which are dependent on the soil's characteristics, precipitation, land management, and its cover vegetation.

To determine the erosion factor and predict the misplaced land, the researcher used the Universal soil loss equation (USLE) method, therefore, the lost soil's arbiter factor was analyzed. According to some researchers, erosion is sometimes in the form of land resistance owing to heavy rainfall. According to [1] K factor is an integrated effect from rainfall precipitation and land resistance to the detachment particle and transportation. This process is influenced by soil characteristics such as particle size distribution, structural stability, organic material content, land chemistry, loam mineralogy, and water transmission characteristic. Therefore, erodibility is a combined influence of land attributes with very powerful conditions used to arrange the power which can refuse the debris potency from rainfall erosivity.

To appraise and decide the land misplaced across the globe, the researcher used soil erodi-bility.The research proved that there is a strong relationship between the soil erodibility value and proved-lost land [2] [3]. Furthermore, it consists of several land characteristics which include physique, chemical, biology, and mineralogy capable of influencing the land [4]. This is also related to the combination of actions from rainfall, run-off, and land infiltration. K factor is the effect of land and its profile reduction features [5]. Nowadays, it has been considered as erosion indicator due to its detachment sensitivity and particle transportation [6].

Land erosion has become a reduction problem at farming soil regions, especially at sulfur regions such as the upstream watersheds in Sumani (DAS). Furthermore, this research aims to review the land erodibility value of horticulture farming. The purpose of this study, therefore, is to determine the erosion level and determining erodibility factor on farmlands on the upstream of Sumani Watershed.

2. MATERIALS AND METHOD

2.1 The Research Setting

The research is located in the upstream watersheds Sumani (DAS). *Andisol* and *Inseptisol* are dominant materials found in volcanic ash. The rainfall precipitation in this area is 2.333 mm/year. The research is agriculturally grouped into A, B, C and D. Group A cultivates radish, potato, and tomato, B consists of chili, radish, and tomato, while C comprises of onion, chili, and potato, and group D (chili, radish, and tomato). Therefore, it is the center of horticulture production.

2.2 The Derivation of Rainfall Precipitation Data

The rainfall precipitation data is taken from suppressor station in Alahan Panjang, to determine soil erosivity. This was calculated using the Lenvain 1989 formula as follows; $R = 2{,}21\ P^{1,36}$ in which R represents rain erosivity and P the monthly average rainfall precipitation in the research setting [7].

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2.3 Management Area

The land is cultivated by hacking it twice in each agriculture season conventionally. The hacking location is made different in line with its gradient. Furthermore, the land surface is refined and clear from organic material residue. Afterward, group B returned the harvest residue and used it in cultivating the land

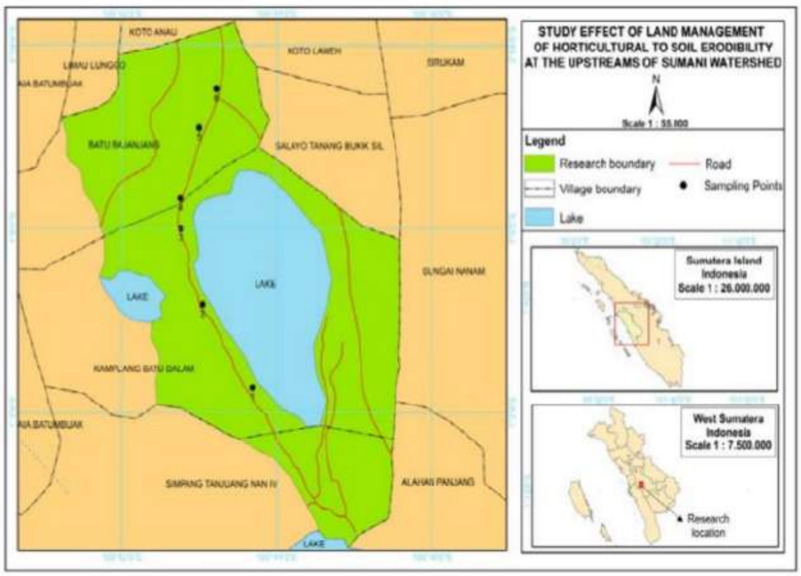

Figure 1. Map of research location at The Upstream Sumani Watershed, Padang Indonesi

2.4 The Taking of Soil Sample

A total of 12 sample points were randomly taken by the researcher using the purposive technique in the horticulture area (Figures 1 and 2). These are indicated in chart 1 at four agriculture groups. Group A was at points 1, 2, and 3, B at 4, 5, and 6, C at 7, 8-9, while D was at points 10, 11, and 12. The researcher took the land sample at depth of 0-20 cm, with the agitated land sample for four fractions of texture analysis, and organic materials. While the unagitated land is examined by permeability analysis and soil structure. To determine the land sample and analysis, the Soil Department, Faculty of Agriculture, Andalas University's laboratory was utilized

2.5 Deciding the Land Erodibility Value

Furthermore [8], the researcher also made use of the nomograph formula to decide the land erodibility value using factors such as texture, structure, organic substance, and land permeability. The equation is as follows:

$$100\ K = 1{,}292\ [2{,}1\ M^{1{,}14}\ (10^{-4})\ (12\text{-}a)] + 3{,}25\ (b\text{-}2) + 2{,}5\ (c\text{-}3)$$

that:

- K = soil erodibility
- M = the percentage of the very fine sand and silt (diameter 0,1 – 0,05 and 0,05 – 0,02 mm) x (100 – % cay)
- a = organic matter content (% c x 1,724)
- b = soil structure
- c = soil permeability

Figure 2. Location of research area

To determine the land susceptibility, its erodibility value is obtained comparing the formula with the criteria in Table 1.

2.6 The Main Component Analysis of Land Characteristic to the Erodibility

The Principal Component Analysis (PCA), is used to ascertain the land's deteriorating ability as a result of heavy rainfall. The researcher also uses this method to decide the main factor which influences its value using a PC with an eigen value ≥ 1 as its independent variable. Therefore, it consists of the highest correlated independent value in PC, [9]. The researcher also uses Minitab 17 to analyze.

3. RESULT AND DISCUSSION

3.1 Rainfall Erosivity

Approximately 2333 mm/year of rainfall data were obtained for ten years from Kembar lake climate. From these numbers of precipitations, the erosivity energy capable of running the structure became fragmented, thereby, leading to smooth particles which later floated off the surface. The calculation using the Lenvain formula results in rainfall erosivity energy of 1535, 99. Its energy is big huge enough to destroy the land structure on the surface area. Furthermore, it causes erosion velocity in the horticulture region too often open when cultivated.

3.2 Land Erodibility Value at Upstream of Sumani Watersheds (DAS)

The erodibility land result (Table 2) taken at 12 sample points in the horticulture region ranges from low to high, with the highest value at 0,33. Furthermore, this is drawn from the susceptible and precipitation of erosivity, with a higher value. Some factors like texture, structure, organic material and soil permeability influence its value. However, these these factors are also influenced by land management. In the horticulture region, the cultivation management and plant types have a high impact on soil erosivity precipitation. The plants which cover the land surface also reduces the rain erosivity. According to [10], vegetation or plant has the ability to push rain energy and increase the infiltration rate into the land.

Table 2. criteria of soil erodibility

No	Class	Criteria
1	Very slow	0,00 – 0,10
2	Slow	0,11 – 0,20
3	Average	0,21 – 0,32
4	Slightly high	0,33 – 0,43
5	High	0,44 – 0,55
6	Very high	0,56 – 0,64

The land surface closure by plants tends to reduce rainfall kinetic energy and in turn, the land can be pushed, thereby lowering its erodibility. The percentage increase in content, improves the infiltration rate while decreasing its flow rate [10].

Therefore, the loamy fraction content helps to reduce the particle thereby, lowering its erodibility value.

3.3 The Analysis of Main Component (PCA) Erodibility Value in Horticulture Area.

The dominant factors influencing the erodibility value is determined by analyzing the principal component (PCA). The analysis result in Table 3 shows that in eigen value the two PCA pools have scores above 1 which is the most influencing land erodibility value. The biggest value in PCA1 is smooth sand variable and dust.

The land erodibility (Table 2) also has the highest value found in sand content and dust which plays an essential role in determining the land erodibility value.

Table 2. The soil erodibility value in the research setting

Sample	fine sand	dust	clay	a	b	c	M	K
1	8.3	29.0	29.5	6.9	3.0	5.0	2630.7	0.21
2	10.1	16.4	33.3	8.6	3.0	5.0	1767.5	0.16
3	9.8	28.9	22.0	6.9	2.0	6.0	3017.8	0.18
4	1.0	24.5	70.6	8.1	2.0	5.0	750.4	0.13
5	0.8	81.4	14.4	2.2	2.0	6.0	7039.7	0.30
6	6.4	60.9	7.1	3.4	2.0	5.0	6253.9	0.26
7	11.8	40.8	0.3	1.7	3.0	3.0	5245.1	0.32
8	6.3	13.7	54.9	2.9	3.0	5.0	899.5	0.31
9	8.6	43.8	13.4	6.9	3.0	6.0	4539.2	0.22
10	10.6	42.7	4.1	3.4	3.0	6.0	5116.0	0.31
11	11.8	36.9	4.3	3.4	3.0	3.0	4658.5	0.27
12	10.5	21.4	25.9	2.9	3.0	6.0	2367.1	0.33

Note; a = organic material, b = structure, c = permeability, M = the percentage of the very fine sand and silt (diameter 0,1 – 0,05 and 0,05 – 0,02 mm) x (100 – loam percentage), K = soil erodibility

Table 3. The land variable analysis result with PCA

Eigenvalue	2.7829	2.0248	0.9003	0.2743	0.0176	0
Proportion	0.464	0.337	0.15	0.046	0.003	0
Cumulative	0.464	0.801	0.951	0.997	1	1
Variable	PC1	PC2	PC3	PC4	PC5	PC6
K	0.54	0.04	0.443	0.02	0.714	0
Very Fine sand	0.288	-0.542	-0.371	0.433	0.031	-0.545
Silt	0.261	0.575	-0.317	-0.431	-0.021	-0.561
Clay	-0.487	-0.044	0.611	0.009	-0.009	-0.622
a	-0.518	-0.185	-0.412	-0.289	0.666	0
b	0.229	-0.581	0.149	-0.737	-0.212	0

3.4 The Texture Relation with Land Erodibility

The land texture is very relevant to its erodibility. For instance, in Figure 3, there is polymial relation between its clay fraction using a coefficient value of $R^2 = 0,92$. It means that in each loam improvement, about 1 % value land erodibility reduction value of 0,005 at 0,34 with the credibility of 91 % is obtained. In addition, the relationship between silt and land erodibility also has a negative relation with determination R^2 having a value of 0,89. Figure 4 shows that the improvement of 1% leads to a

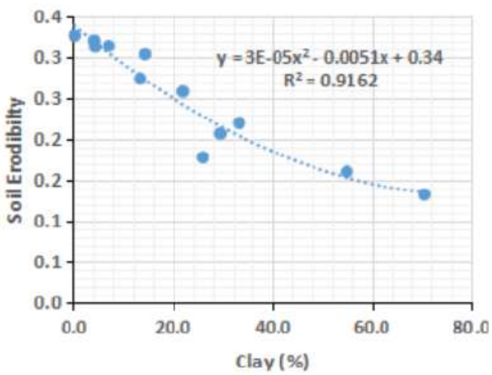

Figure 3. The relation of clay fraction with the soil erodibility.

reduction of about 0.003 and a credibility level of 89% at 0.37. The land fraction or texture is an important characteristic owing to its ability to retain the water movement rate through the land matric. Furthermore, the land texture influences the soil fertility and the cultivation rate. While the relation of silt fraction with land erodibility is linear in relation to R2 = 0.89. This means, that each dust improves by 1% with a reduction rate of 0.003 while the soil erodibility value 0,37 has a credibility level of 0,92%.

Dust is a smooth fraction with no capacity and incapable of making ligament without adhesive content therefore, it will be easy for erosion to occur on the surface flow [11]. In addition, the loamy fraction has the capacity and capable of creating a ligament. Therefore, this fraction will be hard difficult to undergo erosion compared to the dusty fraction. The land which is dominant by loamy fraction will be very cohesive and hard to get ruined. The Organic Substance relation with erodibility

The organic substance seems to influence the land erodibility (Figure 5) with power relation between it and the organic substance using a coefficient R^2 value of 0,92. This means that each improvement in accordance with the organic material degree of 1% influences the land erodibility by 0,43 with credibility level of 92%.

According to [12], the positive effect of organic carbon is for aggregate stabilization and the land structure, while [13] stated that organic material functions as a layer and loamy fraction in increasing the land aggregate stability, thereby reducing its degradation. Previously [14], people argue that aggregation improves land endurance towards the rainfall boundary, thereby, reducing its fall

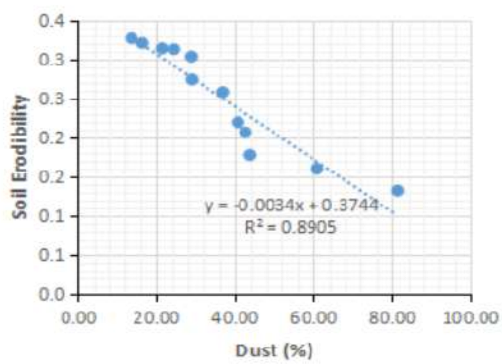

Figure 4. The relation of dust fraction with the soil erodibility

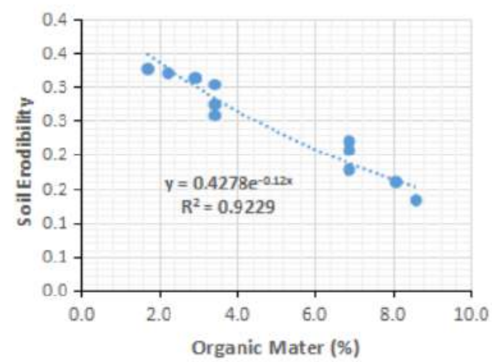

Figure 5. The relation of organic matter relation with the soil erodibility

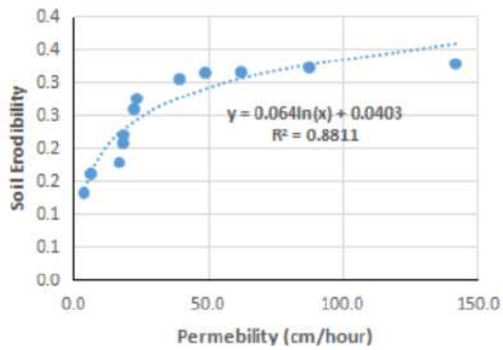

Figure 6. The relation of permeability with the soil erodibility

3.6 The Relation of Permeability with Erodibility

The land erodibility has a logarithm relation (Figure 6) with determinant R^2 of about 0,88. It means that each land permeability increases by 1 cm/hour which reduces the land erodibility reduction by 0,06 cm/hour an erodibility of 0,04, and a credibility level of 88%. Its permeability lead to the drop of rainfall in the land surface therefore it is capable of reducing stagnant water. According to [15], the soil permeability rate is influenced by the total amount of land pore with macropore being the primary factor. According to [16] the soil which has a high infiltration and percolation rate has low relative value.

4. CONCLUSION

From the result, the following conclusions were made as follows:

1. The soil erodibility at upstream Sumani Watershed is low to slightly high with average criteria.
2. Based on the PCA analysis, the dusty fraction content and smooth sand are the main factors that improve the value in this region.
3. In addition, there are other factors that indicate the relationship between the land erodibility with loamy content, organic matter and soil permeability which also influences it.
4. The other environmental factor which influences this value is horticulture management enter-prise by the farmer...

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