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Analysis Of Land Erosion Due To Sand Mining In River Progo Area Kulonprogo RegencySpecial Region Of Yogyakarta

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Abstract

The Progo River originates from the slopes of Mount Sundoro-Mount Sumbing which passes to the southeast and then to the south along 140 km. When Mount Merapi erupts, the material from the eruption, namely cold lava will flow into the Progo river and in the area around the estuary, there are much sand and stone mining. The problem from this research is that there is a very high level of erosion due to sand mining due to the absence of vegetation, so soil erosion is easy when there is high rainfall. The purpose of this study was to analyze the level of soil erosion. The method used in this study is the USLE method. To test soil samples in the laboratory, three methods were Walkley and black for organic matter content, hydrometer for soil texture analysis, and de boot for soil permeability. The calculation of the erosion hazard level using the USLE equation has an erosion hazard level in the category of very light to very heavy class. The results of the estimation of the rate of soil erosion are as follows: from the erosion hazard level which has a very heavy erosion hazard level, namely 1 at location 09. For moderate erosion hazard levels, namely 2 at location points 013 and 0.14. There are 2 levels of low erosion hazard, namely at locations 05 and 08. On heavily eroded land, efforts to conserve land, both mechanically and vegetatively, are necessary to reduce land erosion.

Key words: Erosion, land, mining

1. INTRODUCTION

Sand and stones as natural resources in taking need to be considered so as not to disturb the ecosystem which results can be detrimental to human interests [1]. It is important considering that excessive exploitation without being controlled by natural resources in the slopes of Mount Merapi and on the River River Progo can cause environmental degradation. The high in making natural resources in this mining sector can accelerate land damage in a relatively short time. This will result in a decline in environmental quality [2].

Mining activities around the Progo River resulted in disruption of soil quality, causing land degradation, and is estimated to be vulnerable to erosion and sedimentation along the river. The region along the river will require an analysis of land erosion around the Progo River.

2. MATERIALS AND DATA

The research location is on the banks of the Progo River between Bantul Regency and Kulon Progo Regency. The estuary of the Progo River is administratively located in the Special Region of Yogyakarta Province and is the territorial boundary between Kulon Progo Regency and Bantul Regency. Soil sampling was carried out manually using equipment such as a tube pipe with a diameter of 4" and a ring specifically for soil permeability testing and GPS to take sample coordinates. Sampling was done by the random sampling method. The number of samples taken as many as 5 pieces at the sand mining location, for samples taken at the research site. Sampling was carried out at the sand mine site and its surroundings. The sample was taken at the mine site and vegetation plants around the mine. The samples taken were given the sample code 005, 008, 009, 013, 014. The sample coordinates can be seen in Table 1 and the map for the sampling location can be seen in Figure 1.

Table 1: Sample Locations Based on GPS

No	Sample Code	Easting	Northing	Elevate
1	005	414793	9119281	22
2	008	415827	9120415	23
3	009	415442	9120818	26
4	013	415471	9120688	23
5	014	415411	9120648	24

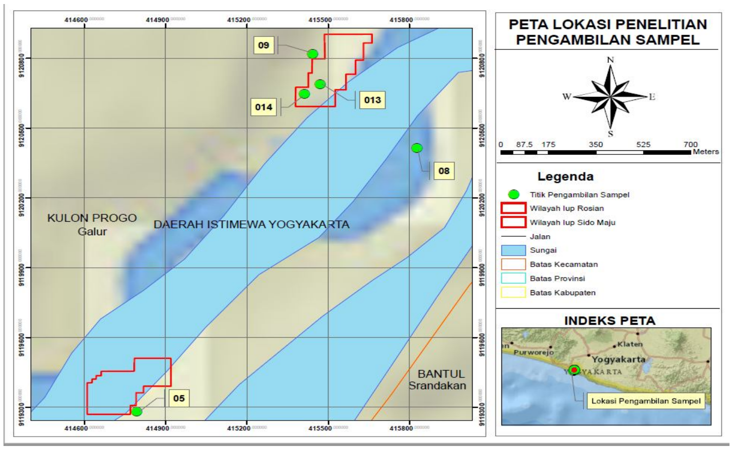

Figure 1: Sampling Location

3. RESEARCH METHODOLOGY

This studies used the strategies look at of literature and survey, to evaluation to the soil rete erosion and erosion danger degree the usage of the technique Universal Soil Loss Equation (USLE).

3.1. Analysis Soil Erosion with Method Universal Soil Loss Equation (USLE)

The USLE version was carried out to evaluate soil erosion within the Sidorejo Village Sleman District, Yogyakarta. The calculation of estimation of abrasion charge via way of means of the USLE technique is to multiply all elements that have an effect on soil erosion (Wischmeier and Smith, 1978). Where the USLE system may be written as follows;

$$A = R \cdot K \cdot LS \cdot C \cdot P \qquad (1)$$

where:

A = The soil erosion rate (tons/ha/ year),
R = Defined as rainfall-runoff erosivity factor (MJ mm ha/ year)
K = Soil erodibility factor (t ha MJ/mm)
LS = Length and Slope Factor (LS) (unites)
C = Land cover and management factor (unites)
P = Stands for conservation practices factor (unites).

Erosion Hazard Classes are given to every unit of land with a matrix that makes use of soil solum facts and erosion estimates consistent with USLE formulas. Erosion labeled as very low, low, moderate, heavy, and really heavy may be visible in Table 2. Based at the table, it could be labeled that the fee of abrasion may be very low 480 tons /ha/year.

Table 2: Classification of Erosion Hazard Levels

Class	Erosion hazard level (tons /ha /year)	Category
1	<15	Very low
2	15-60	Low
3	60-180	Moderate
4	180-480	Heavy
5	>480	Very heavy

Source: Morgan (1974).

3.2. Conservation Priority Analysis

Changes withinside the control and use of land as a consequence of human sports can boom soil erosion inflicting irreversible harm to the environment (Fiorio et al.,2016); (Da Silva et al., 2016). The flowers withdrawal because of the insertion of plantations can boom as much as 600% soil erosion (Chaplot et al., 2005). Conservation precedence is given primarily based totally at the elegance of abrasion danger stage (Ministry of Forestry, 1998). The stage of abrasion danger may be very heavy, getting the concern way straight away to do land conservation. The conservation precedence desk is provided in Table 3.

Table 3: Conservation Priorities.

Class	Erosion Hazard Class	Category
1	Very heavy	I
2	Heavy	II
3	Moderate	III
4	Low	IV
5	Very low	V

Source: Ananta (1987).

Based on **Table 3** Priorities conservation land forgiven to the value erosion is very heavy, the second for heavy, moderate, and very low, and the last for low erosion. Conservation priorities land was given based on class erosion.

4. RESULTS AND DISCUSSIONS

4.1 Analysis of Soil Erosion Levels Using the USLE Method

The results of the analysis using five parameters, namely the erosivity of rainfall, the soil erodibility factor, the terrain factor: the length and slope factor (LS), the land cover factor or vegetation and the conservation practice factor. Data processing is performed using Microsoft excel software. Each parameter of the method has a value for the rate of soil erosion from the product of all factors. The greater the value of the erosion rate, the higher the value of the erosion hazard. Data processing is performed using Microsoft excel software. Each parameter of the method has a value for the rate of soil erosion from the product of all factors. The greater the value of the erosion rate, the value of the erosion hazard level is also higher [3].

4.1.1 Rainfall Erosivity Factor (R)

Rainfall data was used in calculating the erosive factor (R) obtained from the Yogyakarta BMKG from 2010–To 2018. From the processing of rainfall data, the amount of rainfall (P) from 2008-2017 can be calculated, so that the erosive calculation can be carried out according to equation 3.1, then the value for the total erosivity of rain in 10 years is 1486.54 cm and the average erosivity (R) for each month of 1988,5 cm. In the literature (Mujiharjo,1989) to determine the magnitude of the rain aggressiveness index could use the formula as follow [3]:

$R = 2{,}21\ R_m^{1{,}36}$ (2)

where: R = erosivity Index;
P = run off (cm).

Table 4: Rainfall data

Tahun	Jan	Feb	Mar	Apr	Mei	Jun	Jul	Ags	Sep	Okt	Nov	Des
	Bulan (mm)											
2010	189	211	138	225	362	11	31	28	290	126	159	351
2011	255	367	314	151	100	0	0	0	0	0	263	412
2012	399	206	232	18	53	0	0	0	0	32	181	201
2013	346	250	63	66	64	85	25	0	0	28	265	385
2014	342	170	122	155	57	39	48	0	0	0	188	438
2015	433	126	431	411	89	0	0	0	0	0	100	198
2016	120	274	298	134	98	111	16	43	252	204	252	488
2017	324	260	367	122	42	74	2	0	74	48	659	240
2018	457	243	339	65	2	5	0	0	0	0	208	230

4.1.2 Soil Erodibility Factor (K)

Soil erodibility factor is the value of the sensitivity of the soil to the ease with which the soil is eroded. The average value of soil texture (M) is based on the percentage (%) of dust, sand, and clay as seen from the results of laboratory tests. The average value of soil texture (M) is based on the percentage (%) of dust, sand, and clay as seen from the results of laboratory tests.

Based on the laboratory analysis of texture, permeability, organic matter content, and observations in the field, after calculating the erodibility value of the soil (K) the research area obtained a value of 0.3 - 1.19 tons / Kj. The results of the laboratory test analysis can be presented in Table 5. and the calculation of the soil erodibility index is presented.

Table 5: Laboratory Test Results for Soil Texture

No	Sample Code	Texture		
		sand (%)	dust (%)	clay (%)
1	005	69.38	22.02	8.60
2	008	50.36	34.22	15.42
3	009	33.93	45.84	20.23
4	013	25.32	45.63	29.05
5	014	34,18	40.72	25.10

In Table 5 it can be shown that for the results of laboratory testing of soil texture for percent sand the highest value is at 005, which is 69.38% and the lowest value is at 013, which is 25.32 %. In the percentage of dust, the highest value is at 009 at 45.84% and the lowest value is at 005, which is 22.02%. The highest percentage clay value is in 013 at 29% and the lowest value is at 005, which is 8.6%.

4.1.3 Length and Slope Factor (LS)

The length and slope factor (LS) is obtained from measuring the length and slope of the slope using a topographic map and using ArcGIS software to measure the actual length in the field. From the measurement results, the actual slope length value in the field is 262 meters, while calculating the slope with a topographic map is 2.39%, so the calculated LS value in the research area shows the long and high slope value index, which ranges from 0.78 to 2.39 is presented in Figure 2 and Table 6 The landform of the research area is in the form of plains to mountains with steep slopes.

Table 6: LS Value in Research Area

No	Land Unit	*LS* %
1	005	1,04
2	008	0,78
3	009	1,32
4	013	1,04
5	014	2,39

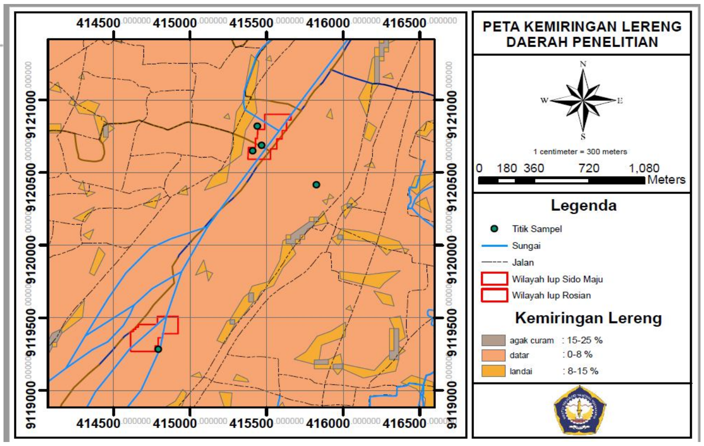

Figure 2. Slope Map

4.1.4 Vegetation Factor (C)

Plant management factors indicate the extent of plant protection against rain erosivity. The land cover factor in the research area is determined by direct observation in the field, the land cover factor (C) in the research area has four values (C) on land use, namely Irrigated rice fields (C) 0.001, natural forest (C) 0.001 and open plantations. without crop value (C). The way to get the value of C is by adding up the value of the vegetation factor index and dividing it by the number of samples.

4.2 Soil Erosion Rate Analysis

The rate of soil erosion can be calculated through estimation using the Universal Soil Loss Equation (USLE) method. Based on field observations, the type of erosion that occurred at the study site was classified as very heavy erosion. In the study, the level of very heavy erosion that occurred was a type of groove erosion.

The method of calculating the rate of erosion is by multiplying all the factors that affect the occurrence of soil erosion. These factors are soil erodibility (K), rain erosivity (R), slope length and slope (LS), soil management (P), and crop management (C) so the average erosion rate can be calculated as follows:

Ea = R x K x LS x C x P

Ea = 1163.88 MJ/ha× mm/hour x 0.965 tons ×ha ×hour /ha×MJ × mm x 1.32 x 1 x 1

= 1487.3m3/ha/year.

Tahun	Bulan (mm)											
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Sumber : Badan Meteorologi Klimatologi dan Geofisika Yogyakarta tahun 2010-2018

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Sumber : Badan Meteorologi Klimatologi dan Geofisika Yogyakarta tahun 2010-2018

Analysis of the level of soil erosion using the USLE method has five (5) parameters, namely rain erosivity, soil erodibility factor, slope length and slope factor, vegetation factor, and land conservation factor. Data processing was carried out using Microsoft Excel software for calculating the rate of soil erosion using the USLE (Universal Soil Loss Equation) method. From the erosion hazard level, the erosion hazard level is very severe, namely 1 at location 09. For moderate erosion hazard levels, namely 2 at location points 013 and 0.14. There are 2 low erosion hazard levels, namely at locations 05 and 08.

One of the causes of very western erosion is because conservation efforts have not been carried out at that location and only in the form of vacant land without any plants. For this reason, it is necessary to conserve land at that location to minimize erosion.

5. CONCLUSION

Based on the results of the study, the following conclusions were obtained: The results of the estimation of the rate of soil erosion are as follows: from the erosion hazard level which has a very heavy erosion hazard level, namely 1 at location 09. For moderate erosion hazard level, namely 2 at location points 013 and 0.14. There are 2 low erosion hazard levels, namely at locations 05 and 08.

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