SOIL ERODIBILITY AND ITS EROSION POTENTIAL IN SADAWARNA DAN AND SURROUNDING AREA, CIBOGO DISTRICT, SUBANG REGENCY, WEST JAVA PROVINCE

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ABSTRACT

The Sadawarna Dam and its surroundings, which are located in Subang Regency, are currently under construction. Change in land use caused by the construction occurred. Land management and soil conservation are needed to prevent uncontrolled erosion because it can caused slopes in critical condition, flood occurred in the downstream areas of river, and silting of dam. One of the information in land management and soil conservation is by identifying the soil erodibility which aims to find out the sensitivity of the soil to erosion in the research area. Soil erodibility affected by grain size distribution, soil structure, soil organic matter, and soil permeability. In this research area, the soil erodibility was calculated based on disturbed sample in the field which was then tested in the laboratory. The laboratory tests include sieve analysis, hydrometer analysis, and %c organic. Soil permeability obtained from previous studies. The research area is dominated by clay-sized soil which are the result of weathered claystone in Subang Formation. Soil erodibility value in the research area ranged from 1,100 – 0,448 t ha h/ha MJ cm with dominance of low soil erodibility classes. The dominance of clay-sized soil causes low soil erodibility value because clay sized soil has cohesive properties so it tends to be difficult to erode.

Keyword: Basic properties of soil, Erosion Potential, Soil Erodibility. Soil Classification

INTRODUCTION

The development of industrial areas in Subang Regency is regulated by the Subang Regency Regional Regulation No. 3 of 2014 on the Subang Regency Spatial Planning Plan for 2011 – 2031 (Peirisal, 2015). In this regional regulation, the regional spatial structure plan is specified, namely the Sadawarna Dam (Kabupaten Subang, 2014). This regional development plan creates a change land use, which may lead to a reduction in green open land, so when it rains, air infiltration into the soil will decrease, resulting in increased erosion intensity (Asdak, 2002 and Kusumandari, 2003 in Khoirullah and Sophian, 2019).

The change in land use without considering the surrounding conditions can accelerate the degradation of land use, which can later affect the erosion process in the area (Sulaksana et al., 2015). Therefore, if there is a change of land use, of course it is necessary to consider soil and plant management in the area because the quality of soil will have a positive affect from the accumulation of plant residues, which can produce good soil aggregate stability and soil that is resistant or resistant to the destructive forces caused by rain (Rachman, 2003 in Sulistyaningrum et al., 2014). Soil control or management is also needed to prevent uncontrolled erosion

because it can cause various phenomena such as area that had slope become critical, flooding in downstream areas of rivers, shallowing of harbors and dam, and many others (Haryanto, 2994 in Sulaksana et al., 2015). Erosion itself is the process of disintegration of soil aggregate material that can move through media in the form of water and wind (Belasri et al., 2017). Therefore, this research aims to identify the soil erodibility value in the Sadawarna Dam area so that we can find out how resistance the soil is in the area. Erodibility values are obtained from the results of soil distribution mapping and laboratory testing of soil physical properties.

Before taking any action on soil conservation or land management, it is necessary to know information about the sensitivity of the soil to erosion or what is commonly referred to as erodibility (Harmayani et al., 2015). Soil erodibility can also be defined as the resistance of soil to rainwater or surface runoff (Zhang et al., 2016).

The research was located in the Sadawarna Dam area, which is administratively divided into several sub-districts and districts. A small part is in Gantar District which is in Indramayu Regency, Surian District which is in Sumedang Regency, and Cibogo District and Subang District which are in Subang Regency.The coordinates of the research area are

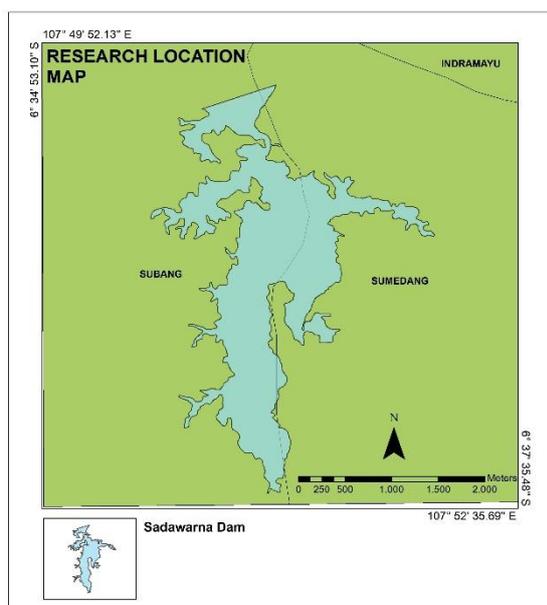6°34'53.10" - 6°37'35" .48" E and 107°49'52.13" - 107°52'35.69" S (Figure 1)

Figure 1 Research Location Map

and the research area is about 25 km² and the research object is the residual soil in the area.

RESEARCH METHOD

The soil types in the study area were determined by engineering geological mapping, which included field descriptions and sampling. The sample is then tested in the laboratory. The classification used to determine soil type refers to the Unified Soil Classification System (Cassagrande, 1948 in Das et al., 1995). Soil erodibility values are also obtained from laboratory tests and data from previous research.

The erodibility value is determined by several parameters, namely soil texture, soil structure, permeability class and soil organic matter content. The following equation (1) is used to calculate the erodibility value (Wischmeier and Smith, 1978).

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

K = Soil erodibility (0,1 ton acre hour/acre foot-ton inch)

M = Particle percentage (% very fine sand+ % silt x (100 - % clay))

a = Organic matter percentage

b = Soil structure class

c = Soil permeability

Laboratory tests were conducted to determine the type of soil and to obtain the parameters of the soil erodibility value in this research:

Atterberg limit test, the purpose of this test is to determine the value of soil consistency limits, which include liquid limit, plastic limit, and plastic index. These values are used to determine soil type in the research area. The test procedures are based on ASTM D4318-05.

Sieve analysis, the purpose of this test is to determine the distribution of grain size and its gradation. Grain size distribution can also be used to determine soil type and also can be used to calculating soil erodibility values. The test procedures are based on ASTM D2487-06.

Hydrometer analysis, the purpose of this test is to determine the distribution of soil grains larger than mesh No. 200 (clay and silt). The results of this test are also used in soil erodibility formula. The test procedures are based on ASTM D422-63.

Soil %C-Organic test, the purpose of this test is to determine the percentage of carbon (C) in the soil and the organic matter of the soil. The results of this test are also used in soil erodibility formula. The test procedure is based on Walkley-Black (1947) in Reeuwijk, 2002.

The permeability class refers to average hydraulic conductivity value from Carsel and Perrish (1988) in Vogel et al., 2000). Soil structure obtained from field observation.

RESULT AND DISCUSSION

The focus of this research is to identify the soil type and the soil erodibility value on the research area.

Geotechnical Condition

Soil type in the research area refers to the USCS (Unified Classification System) classification. Soil characteristics is based on soil description, color, particle size, plasticity level (fine-grained soil) or gradation properties (coarse-grained soil), and weathering level. The study area is divided into three soil type units, namely High Plasticity Silt (MH), High Plasticity Clay (CH), and Silty Sand (SM) (Figure 4). The results of grain size distribution and consistency limits are shown in Figure 2 and Figure 3.

MH soils have a gray to brown color, silt grain size, high plasticity, moisture content in the

field is dry to moist, cohesiveness of the unit is cohesive, the bedding structure is generally uniform and the degree of weathering in the unit is Highly Weathered Zone (HWZ) to Completely Weathered Zone (CWZ). The hardness of this unit varies from S3 to S6. This soil unit is the weathered soil of several formations referring to Silitonga (1973). The tuffaceous sandstones of Citalang Formation and Kaliwangu Formation (Silitonga, 1973) tend to produce silt grain sized soils. The claystone of Subang Formation tends to produce clay-sized soil.

CH soils have gray to dark brown color, clay grain size, high plasticity, moisture content in the field is slightly moist to moist, the cohesiveness of this unit is cohesive, the layer structure is generally uniform and the level of weathering in this unit is Highly Weathered Zone (HWZ) to Completely Weathered Zone

(CWZ). The soil hardness in this unit varies from S3 to S6. The claystone of the Subang Formation (Silitonga, 1973) tend to produce clay-sized soils.

SM soils have greenish brown to orangish brown color, sand to silt grain size, moisture content in the field is slightly moist to moist, the layer structure is generally uniform, and the level of weathering in this unit is Moderatey Weathered Zone (MWZ) to Completely Weathered Zone (CWZ). The hardness of this unit varies from S2 to R1. The tuffaceous sandstones of the Qos and Citalang Formations (Silitonga, 1973) tend to produce sand and silt grain-sized soils. This soil unit does not have a consistency limits value because on the Unified Soil Classification System (USCS) classification this unit belongs to the coarse-grained soils or <50% of the soil passes the No. 200 sieve.
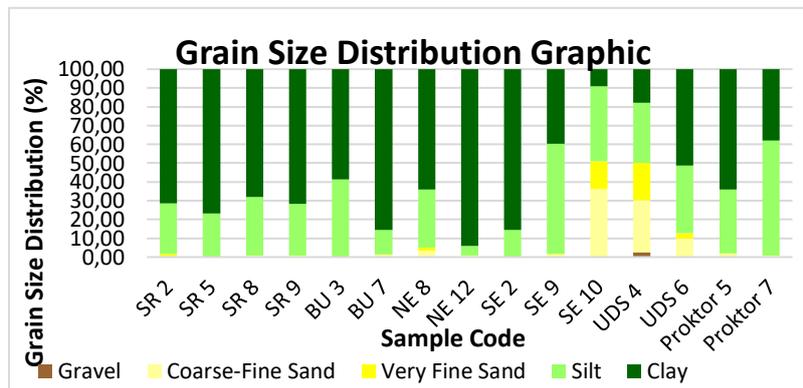

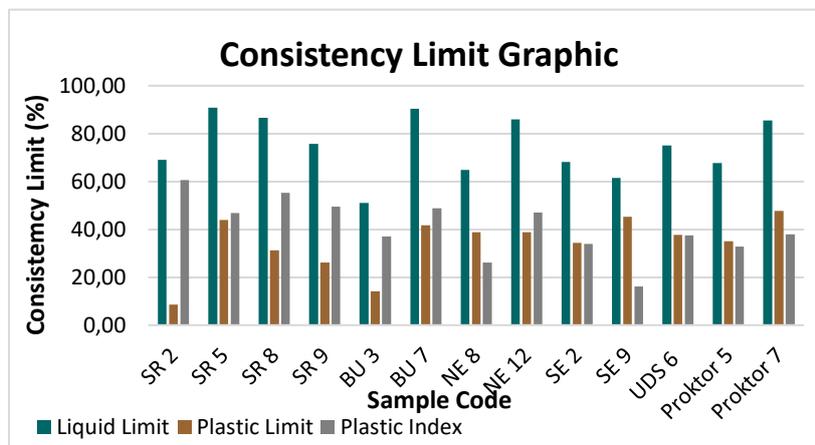Figure 2 Grain Size Distribution in The Research Area

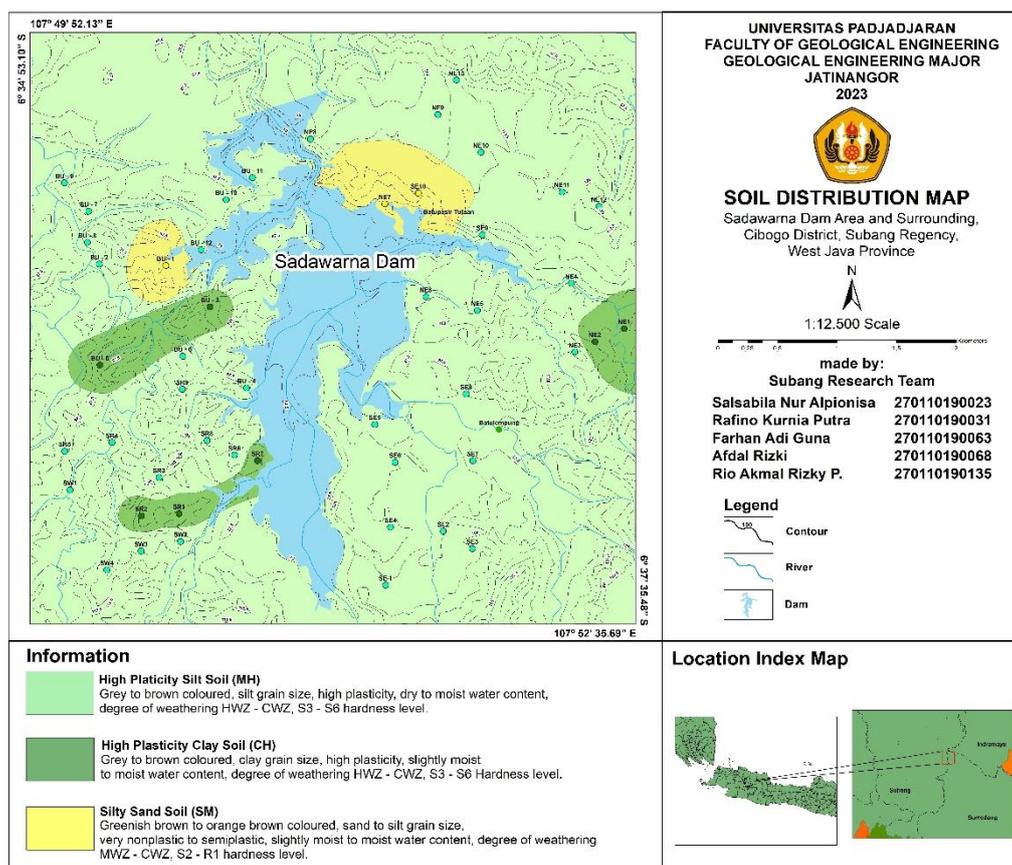Figure 3 Consistency Limit in The Research Area

Figure 4 Soil Distribution Map

Soil Erodibility

The parameter of erodibility value is obtained from laboratory testing, namely grain size test (sieve analysis), hydrometer analysis (hydrometer analysis), and organic carbon percentage soil test. Based on the test results, the grain size percentage in the study area is dominated by clay-sized grains. This can result in a low erodibility value because clay soil tends to have cohesive properties or binding power between particles so that the soil tends to be difficult to erode. The erodibility value will decrease with the increasing presence of clay grain size and increase with the number of silt to very fine sand sized grains (Morgan, 2005).

The value of organic content in the study area ranges from 1.84% - 8.34%. The soil structure in the study area is dominated by blocky soil structure which has a class 4 value and other soil structures are fine granular with a class 2 value (Wischmeier and Smith, 1978). The higher the soil structure class, the smaller the erodibility value. Soil permeability in the study area is dominated by class 6, which is very slow (Arsyad, 2010). This is because the study area is dominated by clay grain sizes that tend to be impermeable.

Overall, the research area is dominated by low erodibility class with details showing very low erodibility class in 2 out of 15 samples, low erodibility class in 8 out of 15 samples, moderate erodibility class in 2 out of 15 samples, and slightly high erodibility class in 3 other samples (Table 1). The classification is based on the USDA-SCS erodibility class (Dariah et al., 2004).

Table 1 Grain Size and Soil Erodibility in The Research Area

Sampel Code	%VFS	%SILT	%CLAY	M	a	b	c	K (US)	K (SI)	Erodibility Class (USDA)
SR 2	1,18	26,75	71,47	796,8551519	3,36	4	6	0,177	0,232	2 (Low)
SR 5	0,1	22,93	76,79	534,6008045	5,6	4	6	0,157	0,207	2

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Sampel Code	%VFS	%SILT	%CLAY	M	a	b	c	K (US)	K (SI)	Erodibility Class (USDA)
SR 8	0,04	31,11	68,13	992,4849263	3,04	2	6	0,124	0,163	2 (Low)
SR 9	0,04	27,49	71,75	777,6934947	3,24	2	6	0,111	0,146	2 (Low)
BU 3	0,1	41,30	58,56	1715,45874	4,32	4	6	0,218	0,287	3 (Low)
BU 7	0,08	13,09	85,51	190,8370618	1,86	2	6	0,083	0,110	1 (Very Low)
NE 8	1,5	30,87	64,17	1160,072455	2,4	2	6	0,138	0,181	2 (Low)
NE 12	0,08	5,02	94,08	30,2401765	2,18	2	6	0,076	0,100	1 (Very Low)
SE 2	0	14,35	85,61	206,5039035	2,86	4	6	0,148	0,195	2 (Low)
SE 9	0,46	58,68	39,58	3572,873147	2,76	2	6	0,293	0,385	3 (Moderate)
SE 10	14,54	39,94	9,18	4948,225116	4,06	2	5	0,321	0,422	3 (Moderate)
UDS 4	19,7	31,95	17,99	4236,365726	1,84	2	5	0,341	0,448	4 (Slightly High)
UDS 6	2,82	36,12	51,20	1900,647897	8,34	4	6	0,182	0,239	2 (Low)
PROKTOR 5	0,12	33,87	64,07	1221,438933	3,52	4	6	0,199	0,261	2 (Low)
PROKTOR 7	0,08	61,02	38,06	3784,217449	1,86	2	6	0,330	0,434	4 (Slightly High)

In the silty sand soil unit (SM) the soil erodibility value has a range of 0.321 - 0.342 with an average of 0.331 in US customary units which are categorized as slightly high erodibility class. The erodibility value is affected by the grain size in this unit that is dominated by silt-sized grains so that the soil tends to be susceptible or easily eroded. In the high plasticity clay soil unit (CH) the soil erodibility value has a range of 0.177 - 0.218 with an average of 0.918 which in the US customary units is classified as low soil erodibility class. In this unit, clay-sized grain is dominant so that the soil tends to be difficult to erode. In the high plasticity silt soil unit (MH) the soil erodibility value has a range of 0.076 - 0.330 with an average of 0.168 which in the US customary units is classified as low soil erodibility class. This unit has an average of low erodibility class because at some observation points the percentage of clay-sized grain is relatively dominant. This is because the distribution of soil size is not a factor that affects the behavior of fine-grained soil (consistency limits) (Hardiyatmo, 2002), so that the soil can be characterized as high plasticity silt (MH) with the percentage of grain size is dominated by clay-sized grain.

CONCLUSION

The research area consists of three types of soil units, namely High Plasticity Silt (MH), High Plasticity Clay (CH), and Silty Sand (SM). The three units are the result of rock weathering in the research area, namely claystone of Subang Formation and tuffaceous sandstone of Qos, Kaliwangu Formation, and Citalang Formation referring to Silitonga (1973). The unit that dominates the study area is the High Plasticity Silt Unit (MH). In terms of grain size distribution, the research area is dominated by clay-sized grain. This causes the results of soil erodibility calculations in the research area to be dominated by low value of soil erodibility. Clay soil tends to have cohesive properties or between grain particles have a binding force to attract each other, so the soil tends to be difficult to be eroded. The cohesive nature also causes clay soil to have a very small permeability value or categorized as class 6 (very slow) according to (Arsyad, 2010). Silt and fine sand soils tend to have slightly high erodibility values, as they are generally not as cohesive as clay soils.

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