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SOIL ERODIBILITY IN POST COAL MINING LAND RECLAMATION AREA IN BACKFILLING MTBU TAMBANG AIR LAYA (TAL) PT. BUKIT ASAM TBK, TANJUNG ENIM MINING UNIT (UPTE) MUARA ENIM, SOUTH SUMATERA

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ABSTRACT

Reclamation activities will be realized and practical, with is necessary to carry out for knowing the level of soil erodibility, knowing the influence erodibility, and can minimize the risk of inhibiting vegetation growth. An Erosion Study is crucial in the mining area, particularly in the ex-mining area, which will be revegetated, because it will affect vegetation growth. Therefore trusted necessary protection of good soil mechanically, vegetatively also chemical so that soil sustainability & soil productivity permanent awake. The survey method obtains field data using observation and systematic recording of the phenomena being investigated. At the same time, the analytical method used on the data obtained is through a study of several theoretical foundations and theoretical calculations on the supporting parameters of the object and research subject. Physical properties of the soil in the reclamation of ex-mining land show a moderate value of soil erodibility is 0.29. The moderate erodibility value indicates that the soil in the area is susceptible to erosion caused by rainwater. The impact is a Loss of a layer of soil that is relatively rich in nutrients and organic matter, and Land productivity declines or even cannot be used for production. A moderate erodibility value indicates that the soil in the area is susceptible to erosion caused by rainwater. Things that can minimize this impact are to improve the condition of the chemical properties of the soil so that vegetation can grow well, and further studies are carried out on efforts to control erosion.

Keywords: *Erodibility, Mining, Erosion, Vegetation, Soil*

INTRODUCTION

Indonesia is a country that is rich in natural resources, such as oil, gas, and coal. The three sectors of that mining are also highly demanded in this country (Azzahrah et al., 2019). In this era of globalization, every country builds its economy through industrial activities that process its natural resources. This is done to compete with other countries and promote their economic development. Therefore, many companies process mining products for production, and each mining activity will have two sides, in the form of positive and negative impacts (Firdaus, et al 2018).

The positive impacts of mining include job creation for the community, and mining production can be used to meet domestic and international market demands so that mining exports can increase state revenues and economic growth. In addition, the mining industry can also attract foreign investment to Indonesia.

On the other hand, the mining industry also has a negative impact, namely environmental damage, if these activities are not managed properly. Mining activities will

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cause changes in the landscape such as topography, vegetation cover, hydrological patterns, and damage to soil structures. The landscape changes make it difficult to recover and restore ex-mining land according to its designation. Reclamation is an activity that aims to improve or manage the use of disturbed land as a result of mining business activities, so that it can function and be efficient according to its designation. Mine reclamation activities must be carefully planned so that later ex-mining land can be utilized optimally by the government and the community around the mine (Triantoro, A, 2017). Topsoil, planting cover crops, planting pioneer crops, and handling heavy metals (Juniah & Susetyo, 2019).

Soil erosion is a process of loss of the topsoil surface layer or topsoil, either caused by the movement of water or wind (Kartika, I, 2016). Erosion as a process in geomorphology is influenced by various factors, one of which is the sensitivity of soil erodibility (Ashari, A, 2013). Many factors are associated with soil erosion, namely erosivity rainfall, soil erodibility, slope length and slope, vegetation, and people (Sandi, D. K, et al 2019). Soil erosion is one of the most important problems in Indonesia's coal mining reclamation area because located in tropical areas which have a high average of rainfall (Shimada, 2014)

Severe soil erosion fails to proceed with regeneration on the surface of open-pit mines due to the impact on steep slopes and the limitation of seedling formation. Soil erosion reduces soil chemical and physical properties, such as loss of nutrients and organic matter, increases soil density and resistance to infiltration, and decreases soil permeability and capacity soil water holding capacity (Sitanala, 2010). Considering the impact of soil erosion on the mining industry, The Indonesian government has issued several regulations to protect against erosion. Rianfall is one of the main drivers of soil erosion (Panagos et al., 2015) It determines soil loss and total sediment volume. The purpose of soil erosion assessment is Soil susceptibility to water erosion. Soil texture, organic matter content, soil structure, and soil are considered in the estimation. The two main causes of erosion are erosion naturally caused and erosion caused by human activities (Alie, M. E. R, 2015). Human activities are mostly related to cutting slopes, cultivating land on sloping areas that do not pay attention to the environment, cutting roads with steep slopes, felling perennials, lack of reforestation, and so on. Community activities affect the stability of the soil and can cause erosion (Naryanto, S, H. et al 2020).

PT. Bukit Asam, Tbk Tanjung Enim Mining Unit, is located in Tanjung Enim District, Muara Enim Regency, South Sumatra Province. The company engaged in the management and supply of coal resources, PT. Bukit Asam, Tbk has been conducting mining activities since 1981. PT. Bukit Asam, Tbk is an open-pit mining system using an open pit. Mining activities certainly cause infinite environmental damage. Changes in environmental conditions that occur at the mine site and its surroundings are a consequence of the process of mining activities (Burhanuddin, 2019). Mining activities in PT. Bukit Asam can cause changes in landform. Changes in landform due to mining activities can be permanent or temporary, so carrying out reclamation activities requires different approaches and technologies (Dariah et al., 2010), decreased soil productivity caused by the mining process, soil compaction caused by the transportation process (Dariah et al., 2010).

In addition, hauling, erosion, and sedimentation caused by runoff, noise caused by working tools, and loss of ground cover vegetation resulting from the land clearing process will cause environmental damage.

Therefore, to restore the quality of ex-mining land to become strategic and productive land, it is necessary to do reclamation to be used sustainably to support increasing community economic income. For reclamation activities to be realized to be effective, it is necessary to carry out several stages such as the presence of cover vegetation or plants growing on the land able to avoid the occurrence of rainwater hitting the soil particles, so that the soil particles cannot be carried away by surface runoff. Vegetation reconstruction on opencast coal-mine dumps effectively reduces runoff and soil erosion and is a key to restoring ecosystems in ecologically sensitive regions. (Zhang et al., 2015).

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However, the high probability value indicates that the soil in the area is very susceptible to erosion caused by rainwater. (Hasan & Rinto, 2017).

Erosion studies are critical in mining areas, especially in ex-mining areas that will be revegetated, because they will affect the rate of vegetation growth. Soil erodibility has a vital role in carrying out conservation and soil management actions so that the actions taken can be carried out in a precise and targeted manner, this has an impact on soil sustainability, and soil productivity is maintained. So it is deemed necessary research to study the extent to which the soil erodibility on coal reclamation land at PT. Bukit Asam Tbk.

In their research, Zhang et al (2007) in Ayuningtyas, (2018) explained that soil erodibility is a factor determinant of land loss. Through the erodibility of the soil, the rate of erosion can be estimated through soil characteristics (Tejada et al., 2006). Furthermore, Veihe (2002) described that physical, chemical, and soil biology and soil minerals can affect the value of soil erodibility.

RESEARCH METHOD

The method used in this research is the survey method and analytical method. The survey method is for obtaining field data using observation and systematic recording of the phenomena being investigated. At the same time, the analytical method used on the data obtained is through a study of several theoretical foundations and theoretical calculations on the supporting parameters of the object and research subject — calculation using the Weschheimer equation to get the value of the Erodibility Index (K).

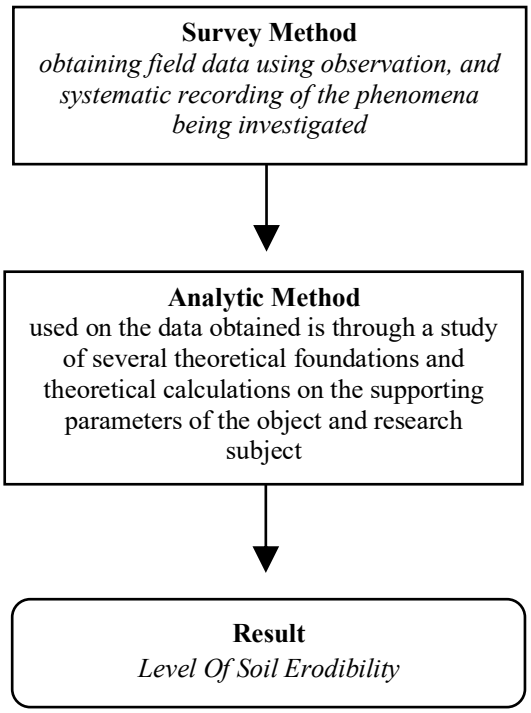

Figure 1. Research method flow chart

RESULTS AND DISCUSSION

Condition of Reclaimed Land

The ex-mining land located in the IUP (Izin Usaha Pertmabangan) Tambang Air Laya for Reclamation Planning Blocks 62, and 63 (Figure 1) is ± 2 years old, has been reorganized, and has been planted with several types of plants. Block 62 is 19,368 m2, and Block 63 is 109,832.47 m2. Based on topographic map analysis, the research location is at an elevation of 50-100 masl, which shows that the land condition is in a hilly area and can be ignored, and there is no standing water in the ex-mining land reclamation site. Therefore, efforts to reclamation ex-coal mining land are not only carried out post-mining but must be carried out from the beginning of the mining plan, namely starting at the pre-construction stage, construction, operation stage, to the post-operation.

The plants grown in the revegetation area are relatively diverse, namely legumes and non-Leguminosae. The selection of plant types and arrangements in the field can consider the ecological, aesthetic, and economic aspects. The types of plants that are classified as adaptive in the PTBA revegetation area are *Acacia auriculaiformis* (narrow-leaved acacia), *Acacia mangium*

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(broad-leaved acacia), *Eucalyptus sp* (eucalyptus), *Glyricidia mucronata* (Gamal), *Leucaena glauca* (Chinese petai), *albizia falcata* (Saigon), *Hibiscus tiliaceus* (waru), *Gmelina Arborea* (white teak), *Bambusa sp* (bamboo), *Peronema canescens* (sungkai), *Pterocarpus indicus* (Angsana) and *Cassia siamea* (ki rain) (Figure 2).

Climatic Conditions

The intensity of rainfall has an influence that is directly proportional to erosion. High rainfall intensity will increase the rate of soil erosion. The purpose of making rainfall parameters is to see the distribution of the average annual rainfall in the study area (Setiawan, H. 2020). The high rainfall of 2,645.7 mm/year causes covers crop plants in the form of *Bambusa sp* (bamboo), *Albizia falcata* (Saigon), longkida, *Nauclea orientalis*, *Pterocarpus indicus* (Angsana), etc, to show results that are not yet significant. This is due to the land condition that is eroded by runoff and the vulnerability of the soil to erosion. It can be seen from the physiography of the Tanjung Enim Regency area, including the tropical climate.

Erodibility Rate

Erodibility Soil is a determining factor for soil loss so through the erodibility of the soil Estimated erosion rate is based on soil characteristics (Triyudanto et al, 2021). According to Amiril S (2009) in Rianto (2019) erodibility cannot absorb water when it rains, making fine soil particles drift along with soil nutrients. Therefore, high runoff and erosion on the land indicate high nutrient loss, reducing crop productivity in the rainy season. Soil erodibility factor (K) can be calculated using the Hammer formula (1978) in Rianto (2019), as follows:

$$K = \frac{2.713M^{1.14}(10)^{-4}(12-a) + 3.25\,(b-2) + 2.5\,(c-3)}{100}$$

Which is:

M = (% ash + % sand) (100% clay)
a = organic material content (1,724 x C organic)
C organic = %
b = soil structure code
c = soil permeability value

Table 1. Soil Structure Assessment

Type of Structure	Value
Very fine granular	1
Fine granular	2
Medium, coarse granular	3
Blocky, platy, massif	4

Source : Arsyad (2010) in Lidia (2020)

Based on the results of field observations and available data, in general, the material is clay siltstone, where the percentage of fractions with average values can be seen in Table 3.

High and low levels of soil erodibility, based on USDA-SCS recommendations (1973) in Dariah, (2004) is, divided into six levels of erodibility as follows:

Table 2. Level of Erodibility

USDA-SCS Level	K Value	Description
1	0-0.10	Very low
2	0.11-0.20	Low
3	0.21-0.32	Moderate
4	0.33-0.43	Moderate to high
5	0.44-0.55	High
6	0.56-0.64	Very High

Permeability

The data (permeability) on the material can be seen in Table 3**.** These results indicate that the value of water absorption (permeability) is categorized slowly, ranging from 0.20 to 0.49 cm/hour. With an average value of 0.34 cm/hour. Soil texture significantly affects soil permeability. Soil permeability affects the flow rate, at which water can seep through the soil profile (Yamani, 2012).

This is because the water will pass through the soil texture when it is on the soil surface or the material. For example, sand-textured soil will easily pass water into the soil, while clay-textured soil will be very slow to pass water. Therefore, soil or material that is

very slow in passing water will accumulate water on the surface, which will become puddles and flow depending on the slope of the media.

The water movement on the soil will gradually erode the soil's surface or material, resulting in depletion of the soil on the surface (topsoil). In comparison, plants need topsoil, which is the fertile part of the soil, to grow well. Of course, this will be a problem in the process of reclamation activities.

Erodibility

The physical properties of the soil in the reclamation of ex-mining land show a moderate value of soil erodibility, which is 0.29. The easy soil erosion is caused by the soil's physical condition, which is directly in the general fill material, above 50 cm of humus material.

Table 3. Grain size particle percentage of fractions with an average value

Layer	Materials	Parameter Statistics	Grain Size- Particle		
			Clay (%)	Silt (%)	Sand (%)
Dumping (BF.01- BF.10)	Clayey Siltstone	Min	35.3	33.3	1.3
		Max	45.1	55	31.4
		Avg	42.13	48.1	9.78
		Med	44.05	52.05	3.2
		Spl Error %	-	-	-
		CL. %	89.11	79.22	-
		Count	4	4	4
Dumping (BF.11- BF.20)	Clayey Siltstone	Min	32.5	41.4	11.6
		Max	41.7	53.8	24.9
		Avg	37.1	46.5	18.24
		Med	37	46.1	18.15
		Spl Error %	20	20	20
		CL. %	92.48	90.08	-
		Count	10	10	10
Dumping (BF.21- BF.30)	Clayey Siltstone	Min	38.5	44.5	3.9
		Max	48.9	52.5	13.9
		Avg	43.21	48	7.78
		Med	41.4	47.75	6.55
		Spl Error %	20	20	20
		CL. %	90.26	94.01	-
		Count	10	10	10
Dumping (BF.11- BF.30 combined)	Clayey Siltstone	Min	35.3	41.4	3.9
		Max	46.4	53.8	24.9
		Avg	40.42	47.78	12.04
		Med	40.2	48.4	12.25
		Spl Error %	25	25	25
		CL. %	91.17	91.84	-
		Count	24	-	24

Sources: Data analysis Geotechnic PT. Bukit Asam (2013)

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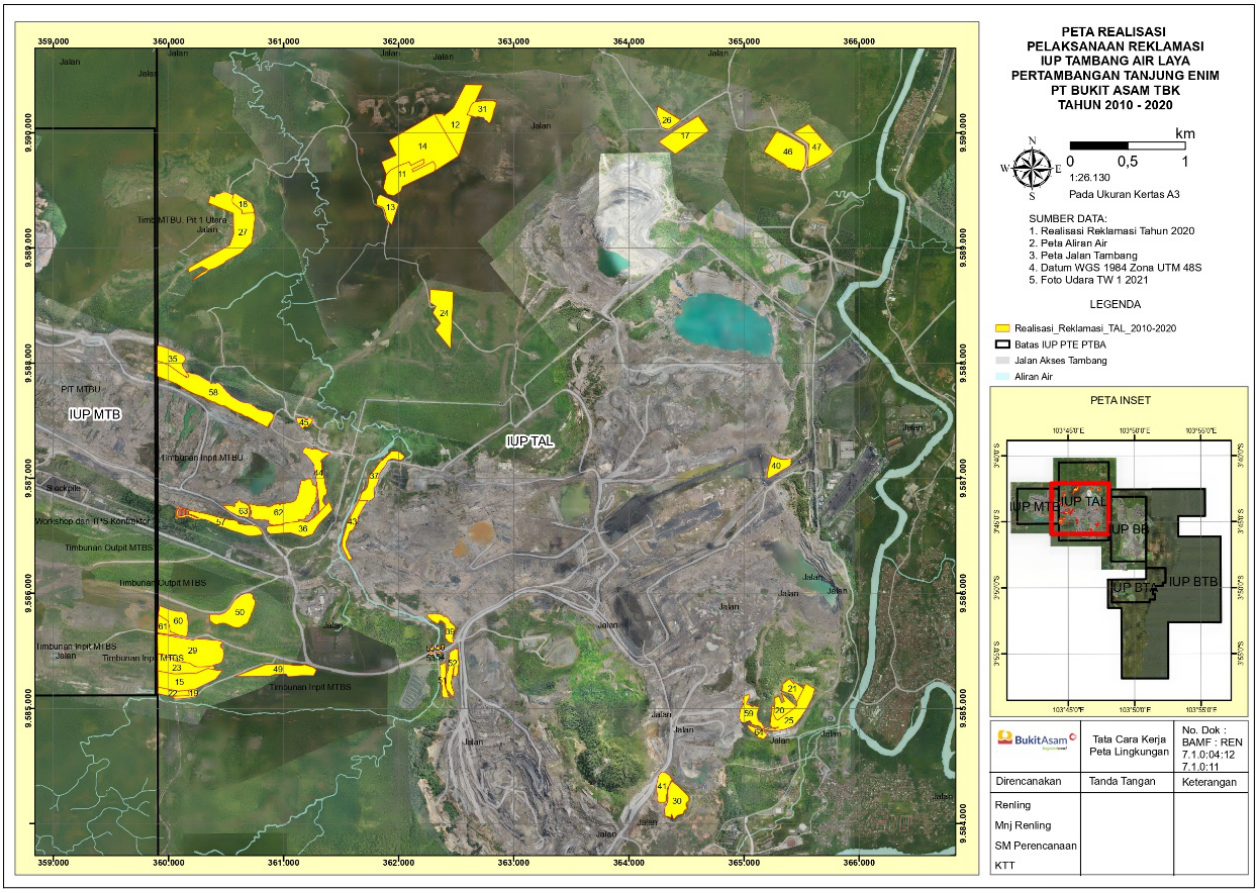
Table 4. Data (permeability) on the material

Lab Code	Sample Code	Texture			Permeability (cm/hour)	Characteristic
		% Sand	% Clay	% Ash		
213	ID 62	50.57	37.24	12.19	0.49	Slowly
214	ID 63	46.38	39.35	14.28	0.20	Slowly

Sources: Data analysis Environmental PT. Bukit Asam (2021)



Sources: PT. Bukit Asam

Figure 1. Plan for Reclamation of Ex-Coal Mine Land through Zoning the Area into Productive Land

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Figure 2. Revegetation on ID 62-63

CONCLUSION

The physical properties of the soil in the reclamation of ex-mining land show a moderate value of soil erodibility is 0.29. The value of erodibility caused condition of physical and chemical soil has & C organic with value 1.08 (low). This condition has a risk for compression and will be nonstable. The easy soil erosion is caused by the soil's physical condition, which is directly in the general fill material, above 50 cm of humus material.

So it is concluded that it is necessary to take serious handling in soil conservation. The moderate erodibility value indicates that the soil in the area is susceptible to erosion caused by rainwater. The impact is a loss of a layer of soil that is relatively rich in nutrients and organic matter, and land productivity declines or even cannot be used for production.

A moderate erodibility value indicates that the soil in the area is susceptible to erosion caused by rainwater. Things that can minimize this impact are to improve the condition of the chemical properties of the soil so that vegetation can grow well, and further studies are carried out on efforts to control erosion on reclaimed land.

RECOMMENDATIONS

A moderate erodibility value indicates that the soil in the area is susceptible to erosion caused by rainwater. Things that can minimize this impact are to improve the condition of the chemical properties of the soil so that vegetation can grow well, and further studies are carried out on efforts to control erosion on reclaimed land.

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