THESIS

CONTENT OF SOIL ORGANIC MATERIALS IN VARIOUS AGES OF LAND RECLAMATION POST COAL MINING

SOIL ORGANIC MATTER IN DIFFERENT RECLAMATION'S AGE OF COAL POSTMINING

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SUMMARY

ESTI KUNCOWATI. Soil Organic Matter in Different Reclamation's Age of Coal Postmining (Supervised by **SATRIA JAYA PRIATNA** and **ABDUL MADJID ROHIM).**

In open mining system, all layers of soil that are above the mining material are peeled so that the mining material canbe extracted. As a result, topsoil and subsoil layers containing organic matter are lost. Organic matter is one component of soil which is very important in creating soil fertility. Therefore, research on soil organic matter content at various ages in post-mining coal reclamation. The method used in this research is survey and analysis methods in the laboratory and uses a Randomized Block Design (RBD). Where the treatment in this study is based on field conditions in the form of age of land reclamation denoted by R, which consists of 5 levels of treatment R0 (-3 months), R1 (3 years), R2 (4 years), R3 (5 years) and R4 (10 years). With soil sampling done intentionally (purposive sampling) at a depth of 0-30 cm and repeated 5 times. Soil sampling is done by composite. Thus, in this study there were 25 main sample points, where the test sample points were taken from 5 composite sample points originating from around the main point. The results showed that the increasing age of land reclamation could quantitatively increase each soil organic matter, soil pH value and soil N-total.

Key words: land reclamation, soil organic matter, soil pH and soil N-total.

SUMMARY

ESTI KUNCOWATI. Soil Organic Matter Content at Various Ages of PostCoal Mining Land Reclamation (Supervised by**SATRIA JAYA PRIATNA and ABDUL MADJID ROHIM).**

In an open-pit mining system, the entire layer of soil above the mining material is removed so that the mining material can be extracted.

As a result, layers top soilandsub soilcontaining organic matter is lost. Organic matter is one of the most important soil components in creating soil fertility. Therefore, a study was conducted on the content of soil organic matter at various ages of post-coal land reclamation. The method used in this study is a survey and analysis method in the laboratory and using a Randomized Block Design (RAK). Where the treatment in this study is based on field conditions in the form of land reclamation age denoted by R, which consists of 5 levels of treatment R0 (-3 months), R1 (3 years), R2 (4 years), R3 (5 years) and R4 (10 years). By taking soil samples on purpose (purposive sampling) at a depth of 0-30 cm and repeated 5 times. Soil samples were taken using a composite method. Thus, in this study there were 25 main sample points, where the test sample points were taken from 5 composite sample points originating from around the main point. The results showed that the increasing age of land reclamation could increase soil organic matter, soil pH and total soil N.

Keywords: land reclamation, soil organic matter, soil pH, and total soil N.

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Submitted As A Requirement To Get A Degree Bachelor of Agriculture at the Faculty of Agriculture Sriwijaya University

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LEMBAR PENGESAHAN

KANDUNGAN BAHAN ORGANIK TANAH PADA BERBAGAI UMUR REKLAMASI LAHAN PASCA TAMBANG BATUBARA

SKRIPSI

Sebagai Salah Satu Syarat untuk Mendapatkan Gelar Sarjana Pertanian
pada Fakultas Pertanian Universitas Sriwijaya

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BIOGRAPHY

The author was born on August 15, 1998 in Sumber Mulyo. The author is the second of three children. His parents are Shodikun and Sri Mahanani. The author started his first education at Madrasah Ibtidaiyah. The author is an alumnus of MI Nurul Ulum 2 Muara Burnai 1 graduated in 2010. Then the author continued his education at SMPN 2 Lemembu Jaya and graduated in 2013. His further education entered SMAN 2 Kayuagung for 3 years and the author graduated in 2016. The author was accepted at Sriwijaya University through the SBMPTN route. The author is enrolled in the Soil Science Study Program, Faculty of Agriculture, Sriwijaya University and the author is one of the students who received the BIDIKMISI scholarship.

During his education at state universities, besides being active in the world of lectures, the author is also actively involved in campus organizations such as being a member of the student association majors (HIMILTA) in 2016/2017, a member of BWPI in 2016/2017, secretary of the SENIOR HIMILTA department in 2017 /2018, member of UNSRI Martial Arts UKM Taekwondo division in 2018/2019, internal treasurer of UNSRI Taekwondo Division of Martial Arts in 2019/2020. In addition, in 2018 the author was also trusted to be a lecturer assistant in the Soil Improving Materials practicum and in 2019 he was again trusted to be a lecturer assistant in the Soil Improving Materials practicum, lecturer assistants in the Soil, Water and Plant Analysis course practicum (2019) and assistant lecturers in the Soil and Water Quality course practicum (2020).

FOREWORD

Alhamdulillah, the author praises and thanksgiving for the presence of Allah SWT. God Almighty because of His blessings, grace and blessing, the writer was able to complete the Thesis with the title "Content of Soil Organic Materials at Various Ages of Land Reclamation after Coal Mining". In this opportunity, the writer would like to express his gratitude to:

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In the preparation of this thesis, the author realizes that there are still many shortcomings and mistakes that the author is not aware of. Therefore, the author asks all parties to provide constructive criticism and suggestions for the perfection of this thesis. Finally, the author would like to say thank you very much and hopefully this thesis in the future can provide benefits and contributive thoughts for the readers.

Indralaya, July 2020

Writer

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CHAPTER 1
PRELIMINARY

1.1. Background

Companies engaged in mining, such as coal mining, carry out mining business using open-pit mining techniques (method of mining). open pit mining) (Burhanudinet al., 2013),This process causes a lot of
environmental damage, including loss of topsoil due to stripping, loss of vegetation (Patiunget al., 2011), soil pH becomes very low (acidic) (Rismawati, 2012) as well as reduced soil organic matter content due to stripping of the top soil layer (Erfandi, 2017). In open-pit mining systems, layerstop soilandsub soilcontaining soil organic matter is lost because all layers of soil above the mining material are excavated so that the mining material can be taken.

One of the most important soil components in creating soil fertility is soil organic matter. In general, the ideal soil component has a soil organic matter content of 5%. According to Ernawati (2008) that if the organic matter content of the soil is low, then reclamation efforts will be hampered so that it is necessary to fertilize the soil. With the low organic matter content of the soil, it causes the source of nutrients in the soil to decrease and the availability of energy (food) for soil organisms will also decrease.

In a study conducted by Ernawati (2008) conducted in post-coal stockpiles, it was stated that with increasing age of embankment soil, the organic matter content decreases. Thus, reclamation activities on postmining land are very important to improve the land. According to Permana (2010) that post-mining land reclamation is carried out by restoringtop soilor overburdenand soil material into the post-mining pit. There is the possibility of mixing soil material withoverburdenThis makes the soil on post-mining land low in fertility. Therefore, revegetation activities on reclaimed land need to be carried out to improve soil quality so that it can return to its original state. According to Aguset al. (2014) post-mining activities further exacerbate soil C-Organic losses, therefore revegetation can re-supply soil C-Organic lost due to mining. To see the results of post-coal mining land reclamation activities, a study was conducted on the content of soil organic matter at various ages of post-coal mining land reclamation.

1.2. Destination

The purpose of this study was to compare the organic matter content of the soil at various ages of post-coal land reclamation.

1.3. Hypothesis

The hypotheses in this study are:

1. It is suspected that the longer the age of land reclamation will increase the content of organic matter in the soil.
2. It is suspected that the increase in the age of land reclamation will affect the increase in soil organic matter so that it will affect the total N-value of the soil.

1.4. Benefit

The benefits of this research are that it is hoped that the results obtained can be used as information and references for planning further reclamation activities.

CHAPTER 2
LITERATURE REVIEW

2.1. Coal Mining Activities

Coal mining has the potential to cause damage to land such as damage to land ecosystems. Thus, the land is no longer able to carry out its functions as before. such as soil protection, water management, weather regulation, and other functions in regulating the protection of the natural environment (Hidayatet al.,2017). The coal mining system uses an open-pit mining system (methodopen pit)by making a well or calledpit. As for the mining operations using tools in the form of digging, loading and transporting (bulldozer,
hydraulic excavatoranddump trucks). The method of extracting coal is done by making a ladder with a height of 6 meters and a ladder width of 12 meters (Yustianet al., 2009).

Ex-mining rock/ex-mining materials are generally piled up to form small hills. The shape of the land is relatively flat with a flat area of 10-15 m (Erfandi, 2017). The soil embankment is formed in a tiered system (
bench) with a degree of inclination $30_0$and 6 meters high. Everybench formedback slope(slope of 2 – 5%). Land that is ready and undisturbed is then covered with topsoil as thick as 30-50 cm. Furthermore, planting is carried out using terrace strengthening plants and types of ground cover plants such asLegume Cover Crop(LCC) combined with perennial plants such as eucalyptus (Melaleuca leucadendra), sengon (Albazia falcataria) and acacia (Acacia mangium) (Ernawati, 2008).

All topsoil is taken carefully using heavy equipment to be filled at the topsoil stockpile location (top soil bank). In the reclamation land that has been completed with land management, the topsoil is spread back with a thickness of 50 cm. The land is protected from land damage such as erosion by plantingcover crop. Furthermore, the reclaimed land is ready to be planted with the prepared revegetation plants. In addition, there is overburden which is a layer of soil between the topsoil and the coal seam which is removed from the mining site to be stockpiled outside the mine site. and into the mine site where it has been mined. The soil cover is estimated to be acidic (potentially acid formation) which is then treated specifically based on the Company's Standard Operating Procedures. The overburden is stockpiled in a special place where liming has been carried out so that it does not cause damage to the environment (PT BA, 2019).

2.2. Condition of Ex-Coal Mining Land

Coal mining activities contribute a large amount of regional income. However, these activities cause severe environmental damage in the form of land clearing due to lost vegetation due to the processland clearingand the excavation process causes loss of nutrient content and soil organic matter, changes in topography (landscape) and has an impact on water and soil pollution. The main problems in post-coal mining land are environmental changes and chemical changes that have an impact on groundwater and surface water. Continued physically to changes in morphology and topography of the land. Reclamation activities are carried out to improve exmining land (Purnamayaniet al., 2016).

In general, post-mining land is in the form of land that has an irregular landscape with truncated hills and ex-mining holes (void). Changes in topography, physiography and morphology cause the soil on post-mining land to have no profile and no structure. Mining waste consists of rock/sand (tailings) in the top layer. In addition, the waste causes acid mine drainage which contains heavy metals. Soil in postmining land is very heterogeneous, toxic, has a high density and low population of soil microbes. Generally, macro nutrients are not available to plants so that plants cannot grow and produce (Erfandi, 2017). The post-mining land has low levels of nutrients such as macronutrients N, P and K, all of which are very low in the upper and lower layers. Acid soil reaction and very low cation exchange capacity (Purnamayaniet al., 2016).

2.3. Land Reclamation

Based on the 2009 Regulations of the Republic of Indonesia number 4 that reclamation is an activity carried out throughout the stages of the mining business to organize, restore and improve the quality of the environment and ecosystem so that it can function again according to its designation. The success of reclamation in the Regulation of the Minister of Energy and Mineral Resources of 2014 Number 07 includes land management activities, spreading topsoil (top soil), erosion control and water management, revegetation and prevention and control of acid mine drainage (AAT). As a result of mining activities, every coal mining company has an obligation to reclaim ex-mining land and disturbed surrounding areas. The land is reclaimed by arranging stockpiled soil (overburden/OB). Next, the topsoil is sown (top soil). After that, the land is given a layer of ground cover such as mulch to reduce the splash of rainwater that falls to the ground surface (Patiunget al., 2011).

Reclamation activities in Wary's researchet al. (2018) conducted by PT Bukit Asam Tbk. Tanjung Enim consists of the following stages: 1) Recontouring, including: land management carried out in accordance with coal mining operations using heavy equipment. Furthermore, placing topsoil 1 m thick, making drainage systems and preventing erosion, 2) Designing pioneer plantings, such as eucalyptus andlegume

cover crop(LCC) likeCentrocema pubescenswhich uses a 4 mx 4 m planting pattern. Meanwhile, insert plants, such as merbau, are planted with a spacing of from the distance between pioneer plants, 3) Land revegetation activities. Starting from nursery activities by planting cover crops and types of plants that grow fast on marginal land. Furthermore, plant maintenance includes: watering, replanting plants, cleaning weeds, fertilizing and controlling pests and diseases.

2.4. Soil Organic Ingredients

Soil consists of four components, namely solids (minerals and organic matter), air and water. Generally, soil organic matter is around 5% of the total weight of the soil. Although only a small amount, organic matter plays an important role in creating soil fertility, both physical, chemical and biological soil fertility. According to Hanafiah (2013) apart from being a component of soil, organic matter also plays a role in the growth and development of plants and soil microbes.

According to Anwar and Sudadi (2013) that soil organic matter is the total organic compounds present in the soil, including organic matter that has been partially or completely degraded/decomposed. Meanwhile, according to Hairiah and Rahayu (2007) that the remains of living things such as plants, animals and humans that undergo a partial or complete decomposition process are called soil organic matter, which has a particle size of <2 mm. The role of organic matter is to protect the soil against raindrops that fall to the ground. In addition, organic matter can also play a role in inhibiting the velocity of surface runoff. Organic matter has the ability to absorb and hold high water, which is two to three times its weight (Arsyad, 2012). According to Hanafiah (2013) there are two sources of soil organic matter, namely primary sources, covers all plants. While secondary sources, including all fauna including feces.

The overhaul of organic matter includes the process of degradation and decomposition of organic matter, as well as resistance to new organic compounds that make up humic compounds. The reshuffle of organic matter is often referred to as the decomposition of organic matter which is a transformation process into the final product in the form of CO .$_2$and H_2O. The final product of the decomposition of organic matter which is relatively stable is called humus (Anwar and Sudadi, 2013). Organic matter in the soil can increase the cation exchange capacity of the soil. Thus, it can exchange basic cations which relatively reduce acidic cations such as aluminum (Al) which can cause soil pH to increase (Amelia and Suprayogo, 2018).

The important role of soil organic matter is as a trigger for soil fertility, supplying nutrients to autotrophic organisms such as plants and acting as a source of energy for heterotrophic organisms such as fauna and microorganisms.
is in the ground (Subowo, 2010). In Rahmah .'s researchet al.(2014) states that organic matter can play a role in liberating N elements and other compounds through the decomposition process by the activities of soil organisms. Leguminosa

is a type of legume that plays a very effective ground cover as a provider of organic matter and can increase soil fertility (Erfandi, 2017).

The amount of carbon describes the amount of organic matter in the soil, because the element carbon is the main constituent of soil organic matteret al., 2008). Regarding the criteria for assessing soil organic matter, it is shown in Table 2.1. These criteria are based on the assessment criteria for % C-Organic of the soil converted into soil organic matter, namely by multiplying the percent C-Organic with a conversion value of 1.724. According to Utomoet al. (2016) the organic matter conversion value of 1.724 was obtained from 100/58 where according to Rakhma (2002) the organic carbon content in organic matter was 58 percent, then the amount of organic matter in the soil = C-Organic x 100/58 = C-Organic x 1.724.

Table 2.1. Criteria for assessing soil organic matter content according to the Balai soil research 2009

Organic Ingredients Value (%)	Criteria
< 1.7	Very low
1.7 – 3.5	Low
3.5 – 5.2	Currently
5.2 – 8.6	Tall
> 8.6	Very high

Source: Soil Research Institute 2009

According to Siringoringo (2014) that carbon is exchanged between the soil and the atmosphere through the processes of photosynthesis and decomposition. The total and quality of carbon supply to the soil is a function of the presence of vegetation. Soils formed under grass vegetation have twice as much organic matter as forest soils. There are three suppliers of carbon into the soil, namely: plant crowns that enter the soil as litter, roots from plants and soil biota (Diara, 2017).

The high C-Organic in reclaimed land is caused by the presence of existing vegetation on the land, the increase in the age of reclamation causes the growth of vegetation and types of vegetation that grows so that the production of organic matter produced also increases (Hamidet al., 2017). In addition, according to Siringoringo (2014) stated that the higher the percentage of clay texture, the greater the ability of the soil to hold carbon.

2.5. Soil pH

Soil pH shows the reaction of acidity or alkalinity in the soil where the reaction is determined by hydrogen ions (H) in the soil solution. Soil acidity is indicated by a low soil pH value. Post-mining land that has been rehabilitated has a soil pH of 4.4 – 5.3 which is classified as very acidic (Sudaryono, 2009). Acidic soil pH is caused by the exchange complex on the colloid surface and the soil solution is dominated by acidic cations, especially Al cations$_{3+}$so that the pH value of the soil becomes low and the Al saturation is very high (Rahmy and Biantary, 2014).

According to Budianaet al. (2017) that soil reactions have a major effect on soil chemical properties, nutrients and soil microbiological activity. In soils that have an acidic pH, acidic cations such as iron, manganese and aluminum can be toxic to plants. In acid soil conditions, the availability of macro nutrients for plants is reduced (in a fixed state). The low soil pH in ex-coal mining areas is caused by the mineral pyrite (Fe 2S) which is oxidized to sulfuric acid. Meanwhile, soil pH will increase due to carbonate weathering (Ca/MgCO .).$_3$) that overlies minerals and rocks. Soil pH will quickly drop if the carbonate in ex-mining land does not rot, causing a greater accumulation of pyrite so that the soil pH becomes acidic (Erfandi, 2017).

2.6. N-Total Land

Nitrogen is the nutrient with the highest source availability when compared to macronutrients such as P and K. The availability of N nutrients in the soil is influenced by the N cycle. According to Hanafiah (2013), the nitrogen cycle is

N starts from the fixation process N_2atmosphere that supplies the soil with precipitation (rain). In addition, N in the soil is supplied through microbes that contribute N through their host plants and then die. After death, the plant will become organic material that is ready to be decomposed and through the mineralization process will release mineral N which will then be immobilized by plants or microbes.

Nitrogen in the soil functions in the vegetative growth of plants. Plants with sufficient N have a greener color. N deficiency in plants has symptoms that are stunted or small, limited root development and yellow leaves (Sudaryono, 2009). According to Mawardianaet al. (2013) that nutrient N is an essential nutrient that is mobile. In addition, nitrogen is very soluble in water and easily disappears (evaporates) into the atmosphere. Nitrogen deficiency in plants causes non-optimal plant growth and reduces productivity. The N cycle in natural forests is a closed cycle. The cycle is an internal cycle between soil, plants and microorganisms.

The availability of N in the soil is influenced by the rate of mineralization of organic matter (Wijanarkoet al., 2012). The increase in total soil N is caused by the presence of organic matter which provides input of N nutrients into the soil. Stimulants of increasing nitrogen in the soil are caused by the process of overhauling organic matter into the soil. In addition, a decrease in the amount of organic matter will cause a decrease in soil nitrogen in a field (Rahmahet al., 2014).

CHAPTER 3
RESEARCH IMPLEMENTATION

3.1. Place and time

This research was conducted on the reclamation land of PT Bukit Asam Tbk. Cape Enim, Muara Enim Regency, South Sumatra Province at the age of reclamation - 3 months, 3 years, 4 years, 5 years and 10 years in the Air Laya Mining Mining Business License (TAL) (Appendix 1). As for the analysis in the laboratory, it was carried out at the
Chemistry, Biology and Soil Fertility Laboratory, Department of Soil, Faculty of Agriculture, Sriwijaya University. This research was conducted from December 2019 to February 2020.

3.2. Materials and Methods

The tools used in this research are: 1) tools for analysis in the laboratory, 3) stationery, 4) belgian drills, 5) plastic buckets, 6)global
positioning system(GPS), 7) camera, 8) plastic bag, 9) label. While the materials used in this research are: 1) materials for laboratory analysis, 2) soil samples.

This study used survey and analysis methods in the laboratory and used a Randomized Block Design (RAK). Where the treatment in this study is based on field conditions in the form of land reclamation age which is denoted by R, which consists of 5 levels of treatment, namely:

R0 : reclamation age - 3 months (2019 reclamation year)
R1 : 3 year reclamation age (2016 reclamation year)
R2 : 4 years reclamation age (2015 reclamation year)
R3 : 5 year reclamation age (2014 reclamation year)
R4 : 10 reclamation age year (year of reclamation 2009)

Soil sampling is done intentionally (purposive sampling) at a depth of 0-30 cm and repeated 5 times. Soil samples were taken using a composite method (Appendix 2). Thus, in this study there were 25 main sample points, where the test sample points were taken from 5 composite sample points originating from around the main point.

3.3. Procedure

The ways of working carried out in this research are:

3.3.1. Preparation phase

The activities carried out at the preparation stage include:

1. Literature study, data collection and other support needed in research.
2. Prepare tools and materials used in research.
3. Reviewing the research location and determining the location points for soil sampling.

3.3.2. Activities in the Field

3.3.2.1. Determination of Soil Sampling Point

Soil sampling points were taken as many as 5 points on each of the reclaimed lands. Determination of soil sampling points using GPS with the following coordinates (Appendix 3):

Coordinate point of soil sampling in treatment R0 : T1

: X = 360145 Y = 9585658

T2 : X = 360049 Y = 9585690

T3 : X = 360124 Y = 9585754

T4 : X = 360040 Y = 9585809

T5 : X = 359948 Y = 9585848

Coordinate point of soil sampling in treatment R1 : T1

: X = 365556 Y = 9585160

T2 : X = 365508 Y = 9585072

T3 : X = 365441 Y = 9584945

T4 : X = 365368 Y = 9584878

T5 : X = 365268 Y = 9584872

Coordinate point of soil sampling in treatment R2 : T1

: X = 360020 Y = 9585547

T2 : X = 360110 Y = 9585497

T3 : X = 360199 Y = 9585543

T4 : X = 360285 Y = 9585491

T5 : X = 360379 Y = 9585528

Coordinate point of soil sampling in treatment R3 : T1

: X = 359992 Y = 9585248

T2 : X = 360088 Y = 9585263

T3 : X = 360179 Y = 9585227

T4 : X = 360275 Y = 9585255

T5 : X = 360360 Y = 9585303

Coordinate point of soil sampling in treatment R4 : T1

: X = 361963 Y = 9585255

T2 : X = 361862 Y = 9585250

T3 : X = 361762 Y = 9585240

T4 : X = 361662 Y = 9585248

T5 : X = 361563 Y = 9585252

3.3.2.2. Field Observation

Field observations include observations of the types of vegetation that found in the research area and the thickness of the litter layer. For the observation of vegetation types, it is observed directly in the field by paying attention to the vegetation contained in the research area. Observation of the thickness of the litter layer was carried out semi-quantitatively by plugging a ruler into the litter layer until it touched the soil layer (Appendix 9).

3.3.2.3. Soil Sampling

Soil sampling was carried out at pre-determined locations determined. 5 samples of each land will be taken for testing from 25 composite points. Soil samples were taken using a Belgian drill (Appendix 9) with a depth of 0-30 cm and 500 g was taken for analysis in the laboratory.

3.3.3. Laboratory Analysis

As for the analysis in the laboratory includes analysis of soil pH (H_2O), CSoil organic and N-total soil carried out at the Laboratory of Chemistry, Biology and Soil Fertility, Department of Soil, Faculty of Agriculture, Sriwijaya University (laboratory analysis activities are in Appendix 10). The steps for determining COrganic and N-total soil are contained in Appendix 5 and Appendix 6.

3.4. Observed Variables

The observed variables included: soil organic matter (conversion from percent C-Organic soil), soil pH (H . extraction$_2$O 1: 1) and N-total soil (Kjeldahl method).

3.5. Data analysis

3.5.1. Variety Print Analysis

The data obtained were analyzed statistically by analysis of variance (Anova). If the results of the variance have no significant effect, further tests are not carried out. Meanwhile, if the results of the variance have a significant effect, a further test is carried out with the Least Significant Difference (BNT) test to see the differences between treatments.

3.5.2. Regression Analysis

This regression analysis uses simple linear regression analysis which is used to determine the relationship between the two observed variables which are expressed in graphical form with the equation: $Y = a + bX$.

CHAPTER 4
RESULTS AND DISCUSSION

4.1. General Condition of Research Site

This research was conducted on a post-coal reclaimed land owned by a coal mining company located in Tanjung Enim, South Sumatra. Geographically, the research location is in the IUP Tambang Air Laya (TAL) which is located between $3_0$40'24.8" LS - $3_0$46'24.8" South and $103_0$44'18.4" BT

- $103_0$48'03.9" East Longitude. In general, the research area is in a plain area with a land slope of 0-8% which has an elevation between 88-119 meters above sea level. The soil types at the Air Laya Mining Business License (TAL) location consist of A. alluvial brownish brown, A. podzolic brown and lit, A. podzolic yellow and hydro, A. podzolic yellow and podso, podzolic yellow and podzolic red yellow (Appendix 4).

Table 4.1. Air Laya Mining Mining Permit monthly rainfall data in 2019

Month	Rainfall (mm)		
	Laya Water	Mahayung	Average
January	486.10	466.50	476.3
February	448.45	495.50	471,975
March	277,80	313.00	295.4
April	441.50	413.50	427.5
May	65.45	47,50	56,475
June	53.15	52.00	52.575
July	70.00	53.50	61.75
August	106.80	106.80	106.80
September	15,30	15.00	15,15
October	54.20	19.50	36.85
November	241.15	203.00	222,075
December	371.85	371.85	371.85

Amount	2631.75	2557.65	2594.7

Source: Environmental Planning PT Bukit Asam Tbk. Cape Enim 2019

Based on data information obtained from Environmental Planning PT Bukit Asam Tbk. Tanjung Enim, the highest average rainfall in 2019 occurred in January, which was 476.3 mm. Meanwhile, the lowest rainfall in 2019 occurred in September, which was 15.15 mm. According to Hanafiah (2013) rainfall is closely correlated with biomass formation (organic matter) soil, because water is the main component of plant growth and development. So, if the rainfall is reduced it will cause stunted plant growth and development.

4.2. Cultivation History and Soil Condition at the Research Site

This research was conducted on reclaimed land with a land reclamation age level of which consists of R0 (reclamation age - 3 months), R1 (reclamation age 3 years), R2 (reclamation age 4 years), R3 (reclamation age 5 years) and R4 (reclamation age 10 years). (Appendix 3).

Table 4.2. Year of reclamation, land area and types of plants

Year of Reclamation	Land Area (Ha)	Plant Type
2019	4.1	Angsana andlegume cover crop(LCC)
2016	5.9	Sengon Buto, Eucalyptus, Johar, Merbau and Cherries
2015	4.9	Eucalyptus, Johar, Acacia and Guava
2014	7.1	Sengon Buto, Eucalyptus, Johar and Merbau
2009	34.3	Sengon Buto, Eucalyptus, Johar and Merbau

Source: Environmental Planning PT Bukit Asam Tbk. Cape Enim 2019

Table 4.2. shows the types of plants planted on the reclaimed land used as the research location. In the early stages of reclamation, the plants planted were

reclaimed plants that had been planned by the revegetation planning division in the form of Angsana, Sengon Buto, Johar, Eucalyptus, Merbau, Cherry and Guava plants with a spacing of 4 meters x 4 meters. Before planting, the reclaimed land is first planted withlegume cover crop or LCC, the aim is to protect the soil from raindrops that fall to the ground, so as to reduce erosion on reclaimed land. Furthermore, in the first three months after planting, the dead plants are replanted. After that, in the first year fertilizing with inorganic fertilizers is carried out.

The condition of the land in the R0 treatment is that it has just been planted with plants legume cover cropand reclamation plants in the form of Angsana plants and overgrown with thorny wild plant. In the R1 treatment, the plants had grown tall and had produced litter, although there was still a small amount. The treatment of R2 and R3 has begun to close the plant canopy, the dead LCC plants have been replaced with grass and overgrown with wild plants and a large amount of litter is produced. Meanwhile in the R4 treatment, the condition of the land resembled a forest with the plant canopy tightly closing and the grass being more dominantly covering the ground surface (Appendix 11).Treatment (Land Reclamation Age) Figure 4.1. Graph of the average thickness of litter at the research site From Figure 4.1. stated that the increase in the reclamation age of the thickness of the litter is increasing. According to Hairiahet al. (2004) the thickness of litter is able to maintain a favorable soil microclimate for the development of soil macrofauna (humidity and soil temperature) such as earthworms and the development of plant roots. Thus, active soil organisms will affect the decomposition process of soil organic matter. The increase in litter thickness is influenced by the state of the vegetation that grows on the land. The presence of parts of plants such as leaves, branches and twigs that fall every year forms a layer of litter on the surface of the soil. In addition, the thickness of the litter is also influenced by climatic factors. In the research of Sudomo and Widiyanto (2017) stated that plants usually shed their leaves much more in the dry season. This is a strategy to survive water shortage conditions. The amount of litter that falls during the dry season will accumulate so that it affects the thickness of the litter layer. According to Hairiahet al.(2004) that litter plays an important role in soil cover so that soil moisture will be maintained.

In addition, litter also plays a role in maintaining the high organic matter content of the soil.

4.3. Soil Organic Ingredients

Observations on soil organic matter were carried out at 5 different age levels of land reclamation. The results of the analysis of soil organic matter were obtained from the results of the C-Organic analysis of the soil which was converted by multiplying the percent C-Organic of the soil with a conversion value of 1.724. Thus, the results of the conversion into percent soil organic matter are presented in Table 4.3.

Table 4.3. Soil organic matter analysis data

Treatment	Average Soil Organic Ingredients	Criteria
R0	0.98 a	Very low
R1	1.28 a	Very low
R2	1.49 a	Very low
R3	2.12 a	Low
R4	4.23 b	Currently

Note:

BNT 1% : 1.56

Numbers followed by the same letter in the same column are not significantly different

The results are in Table 4.3. showed that the percentage of soil organic matter content ranged from an average of 0.98% - 4.23% with very low to moderate criteria. The highest percentage of soil organic matter content was found in the R4 treatment where the treatment was based on the age of land reclamation which was 10 years old or the year of reclamation in 2009 with a soil organic matter value of 4.23%. Meanwhile, the lowest percent of soil organic matter content found in the R0 treatment with reclamation age - 3 months or 2019 reclamation year with a value of 0.98% organic matter content.

The results of analysis of variance (Appendix 7) state that the content of soil organic matter in various treatments of land reclamation has a very significant effect, where the results show the f-count value is greater than the f-table value.

which was then tested using the 1% level BNT test. The results showed that the soil organic matter in treatment R4 (reclamation age 10 years) was significantly different and had the best soil organic matter content compared to other treatments. Soil organic matter in treatments R0, R1, R2 and R3 showed no significant difference. The lowest soil organic matter value was found in the R0 treatment. The R0 treatment is land that has just been reclaimed for ± 3 months, so that the plants that have just been planted on the reclaimed land are still in the process of adapting to growth and the amount of litter produced is still low. Whereas in the R4 treatment with a reclamation age of 10 years, the land form already resembles a forest and the vegetation that grows is also increasingly diverse so that the litter produced is also increasing.legume cover crop(LCC) can contribute biomass (organic matter) so that organic matter will increase along with increased plant growth and development on reclamation land. According to Patiunget al. (2011) that vegetation on reclaimed land contributes to litter production, root development and activity of soil organisms. The increase in soil organic matter content in reclaimed land is influenced by the presence of vegetation that grows on the land. As the age of reclamation increases, the diversity of vegetation that grows will increase, so that it will affect the production of litter. Litter is one of the primary sources of soil organic matter, so the increase in litter production will affect the increase in soil organic matter. According to Hairiahet al. (2004) that the accumulation of organic matter will increase every year as plant growth increases. Plants donate organic matter through plant litter which is produced from leaves, branches and twigs that fall and then fall to the ground. The litter will rot completely or partially through the decomposition process, the results of the decomposition will contribute organic matter and elements needed by plants.

The results of the decomposition of organic matter will contribute nutrients to the soil. This is in accordance with the opinion of Sudomo and Widiyanto (2017) in their research that sengon plant litter that falls to the ground provides input dry weight of fallen litter of 0.8 tons ha per month.1and able to provide input of C nutrients per month of 0.36 tons ha_{-1}. This shows that plant litter that falls on the soil surface provides nutrient input for the soil. The amount of C (carbon) nutrient input will continue to increase along with the increasing age of the plant which will improve the quality of the reclaimed land. The longer the age of reclamation can increase the COrganic of the soil in accordance with the opinion of Setyawan and Hanum (2014) in their research which states that reclamation generally increases soil organic carbon content from 1-1.5% within 5-6 years. According to Hamidet

al. (2017) that there is an increase in C-Organic in reclaimed land caused by the presence of existing vegetation on the land, the increase in the age of reclamation causes vegetation growth and types of vegetation to increase so that the production of organic matter produced also increases which will affect the availability of C-Organic soil.

The increase in soil organic matter at various ages of land reclamation is also influenced by the absence of processing activities on the land after planting (revegetation). According to Yulnafatmawita's opinionet al. (2012) stated that the increase in organic matter occurs because the land is left uncultivated or not processed so that the organic matter produced will still accumulate in the soil, while tillage causes soil organic matter to be easily evaporated into the atmosphere and easy to reach by microbial decomposers, so the process of oxidation of materials enzymatically accelerated organic

The increase in soil organic matter content affects the energy source for soil organisms. According to Subowo (2010) that organic matter is a source of energy that can activate the role of soil organisms such as heterotrophs. According to Annisa (2010), the increase in organic matter will affect the organisms and fungi in the soil. statueet al. (2011) explained that organic matter causes soil moisture to be maintained thus spurring the activity of soil organisms that can form burrows or cavities in the soil so as to reduce soil density on reclaimed land. Soil organisms will assist in the overhaul of the litter, producing organic matter that can improve soil aggregates. Soil fertility, such as physical, chemical and biological soil fertility, will improve with increasing soil biological activity.

4.4. Soil pH

The results of the laboratory analysis of soil pH at various ages of land reclamation can be seen in Table 4.4.

Table 4.4. Soil pH analysis data

Treatment	Average Soil pH	Criteria
R0	3.94 a	So sour
R1	4.07 a	So sour
R2	4.10 a	So sour
R3	4.21 a	So sour
R4	4.66 b	Sour

Note:

BNT 1% : 0.43

Numbers followed by the same letter in the same column are not significantly different

From Table 4.4. stated that the pH of the soil at various ages of land reclamation ranged from 3.94 to 4.66 with the criteria from being very acidic to acidic (Appendix 8). The longer the age of reclamation, the pH of the soil will increase even though it is still in the acidic criteria. Based on the results of analysis of variance (Appendix 7) shows that soil pH in various treatments of land reclamation age has a very significant effect, where the f-count value is greater than the f-table value. Thus, further tests were carried out using the 1% level BNT test. The results obtained showed that the soil pH was not significantly different in the treatments R0, R1, R2 and R3. Meanwhile, the soil pH in the R4 treatment was significantly different when compared to other treatments.

The pH value of acid soil is caused by the type of soil on the reclaimed land. The condition of the soil on the reclaimed land comes from heapsoverburden and heapstop soilwhich may have different soil properties from soil

the original. According to Dariahet al. (2010) heapoverburdencauses the soil to become acidic this is becauseoverburdencomes from a layer of soil containing pyrite, then mixed with other parts of the soil. A low soil pH indicates that the concentration of H . ions$_{+}$in the soil increases. In Agus' opinionet al. (2014) that acidity in post-mining land is due to coal mining leaving acid mines containing sulfate. Plus the very large rainfall that exceeds the evapotranspiration, causing the soil to erode and leachate. If the leaching process occurs continuously, metal elements such as iron and aluminum will be oxidized so that the soil becomes very acidic. Sulfur on the surface will react with water (H_2O) and Oxygen (O_2), causing acidic water. When it settles in the soil, it causes the soil to become acidic. With the increase in the content of organic matter, it can increase the pH value of the soil on reclaimed land. This is because over time the plants on the reclaimed land increase in size so that there are parts of the fallen plants such as leaves, branches and twigs that fall to the surface of the soil so that they form a layer of tranquility. The seresah will undergo a decomposition process that can increase soil biomass. The result of the decomposition of such organic matter will produce humus. According to Amelia and Suprayogo (2018) organic matter that has undergone an overhaul (humus) can increase the capacity of soil cation exchange (KTK). According to Hanafiah (2013) the KTK value of soil organic matter (humus) is around 200-300 me/100 g. According to Suryani (2014) that the high value of soil KTK, causes more and more cations to be drawn and exchanged. Therefore, heavy metals that cause acid in the soil such as Al will be bound by soil organic colloids so that soil pH can increase.

4.5. N-Total Land

The results of the analysis of N-total soil at various ages of land reclamation show that at the reclamation age - 3 months (R0) has the lowest value of N-total soil content (0.017%) when compared to other treatments. This is because the land has just been reclaimed, so that The plants found on the land have not been able to produce a lot of litter that can contribute N to the soil. While the land that is 10 years old (R4) has the highest N-total soil value of 0.139% which is included in the medium criteria. In the treatment of R4, the condition of the land already resembled a forest, so there is a possibility that the cycle of soil improvement on the land has gradually improved over time. In addition, the organic matter content of the soil increases as the age of land reclamation increases so that it affects the N element in the soil.

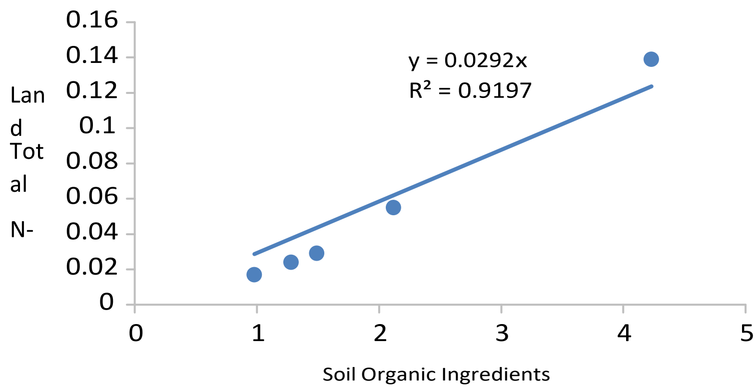

Figure 4.2. Simple linear regression graph between N-total soil (Y) and soil organic matter (X)

Figure 4.2. Shows a simple linear regression graph between N-total soil and soil organic matter. The graph states that there is a relationship between the independent variable X (soil organic matter) and the dependent variable Y (N-total soil) which has a coefficient of determination (r2) of 0.9197 or equal to 0.92. This value means that 92% of the independent variable X (soil organic matter) can affect the increase in the dependent variable Y (N-total soil) and 8% is influenced by other factors not studied. An increase of every 1% of soil organic matter can increase the total N-of the soil by 0.029%. This is in accordance with the opinion of Annisa (2010) in her research that the organic matter content of the soil affects the amount of total N content in the soil. According to Hanafiah (2013) that the results of the decomposition of organic matter such as plant and animal remains,

rainwater and fertilization are sources of N in the soil. According to Nagur (2017) in his research states that low organic matter causes low N-total in the soil. The increase in the age of reclamation will increase the N-total value of the soil, this is in accordance with Permana's research (2010) in his research that there has been an increase in the total N-of the soil, although it is still in the very low category. The high N-total soil is due to the presence of organic matter that provides N input in the soil. The activity of soil organisms causes an overhaul of organic matter, so that in the process it releases N and other compounds. This proves that the addition of N in the soil comes from the process of overhauling soil organic matter. In addition, a decrease in the amount of organic matter and soil microorganisms in a field causes a decrease in nitrogen (N) in the soilet al., 2014).

CHAPTER 5
CLOSING

5.1. Conclusion

The conclusions obtained from the results of this study are:

1. Quantitatively, increasing the age of land reclamation can increase the organic matter content of the soil and treatment R4 (10 years of land reclamation) has the highest organic matter content compared to other treatments.
2. Increasing the age of reclamation causes soil organic matter to increase so that it affects the increase in total soil N. Every 1% increase in soil organic matter can increase total soil N by 0.029%.

5.2. Suggestion

Suggestions that can be given in this study are for further research, it is necessary to conduct further research on evaluating the level of land fertility in various ages of post-coal mining land reclamation.

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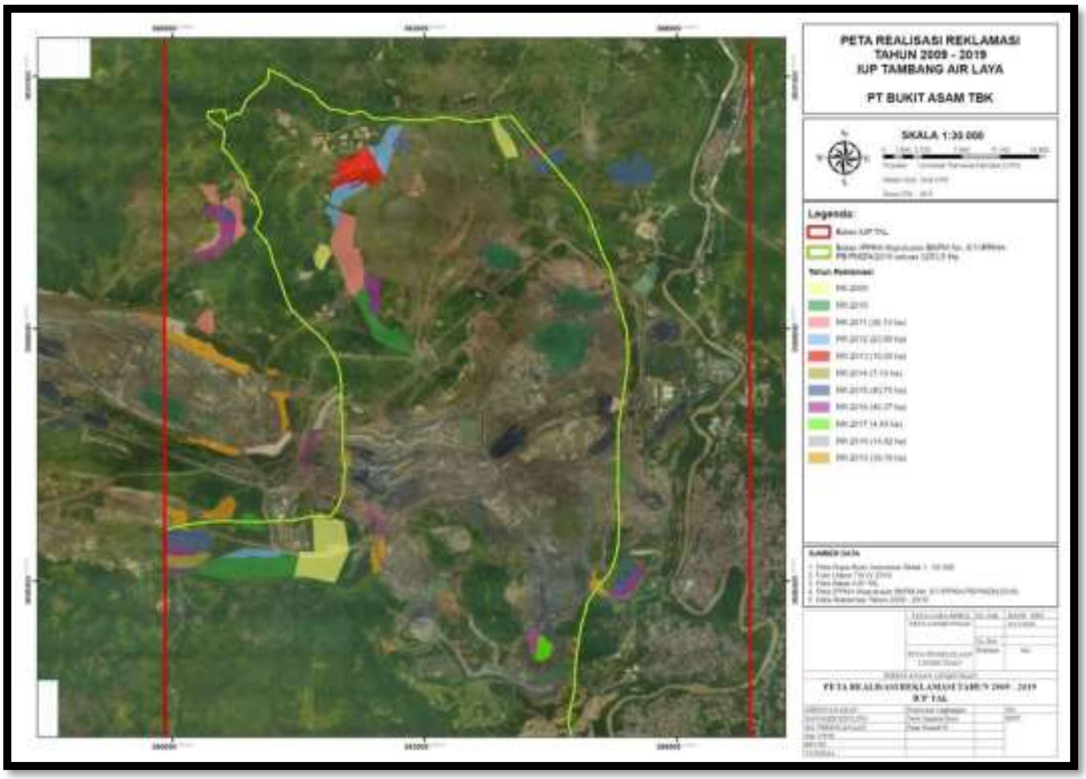
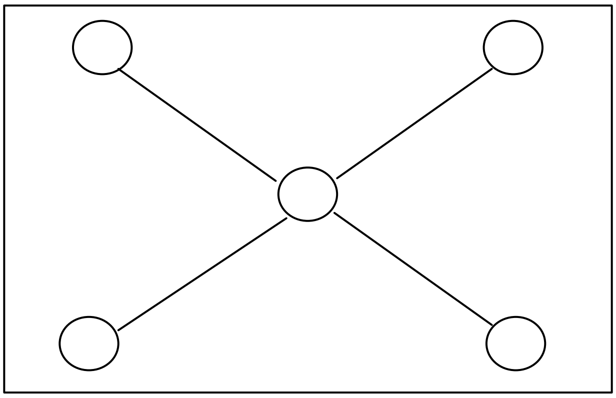
ATTACHMENT

Appendix 1. Research site map

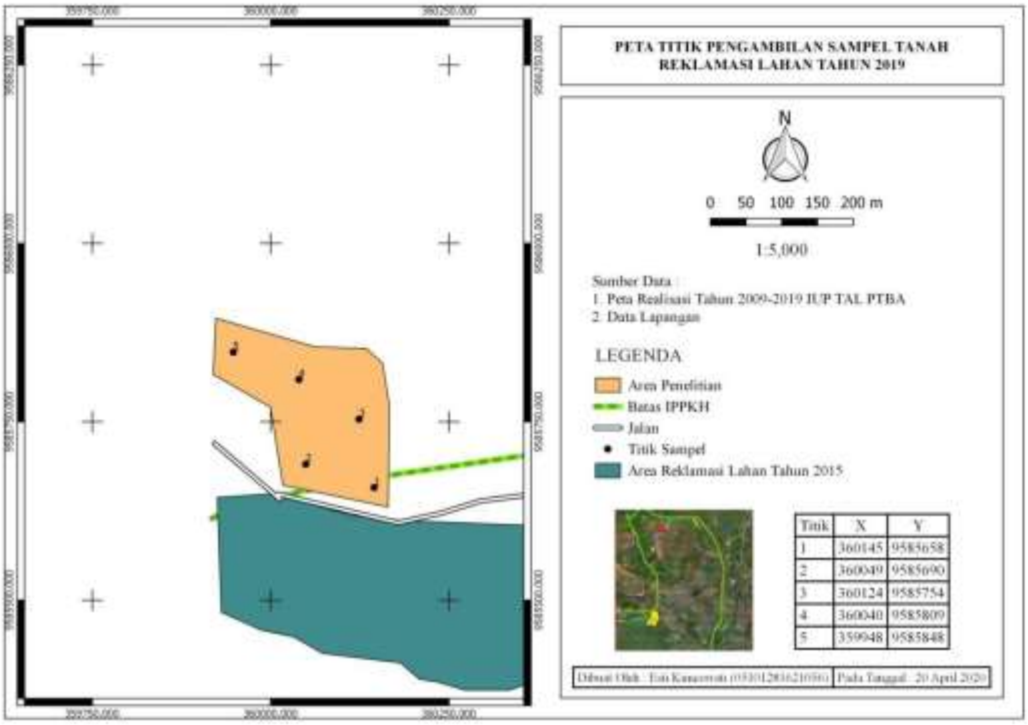


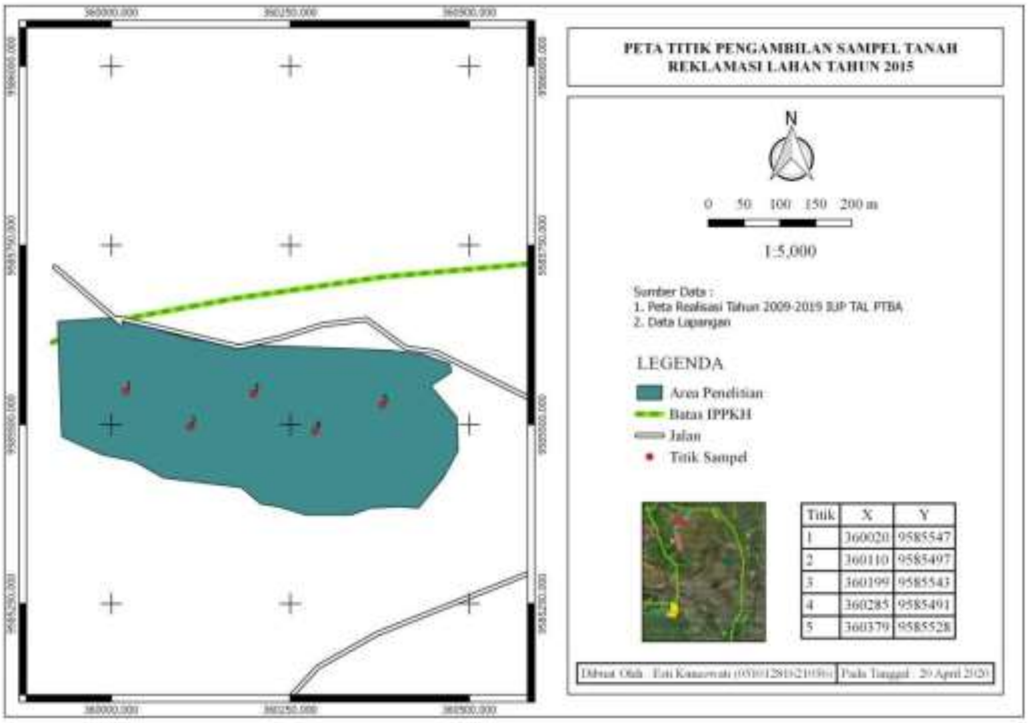
Source: PT Bukit Asam Tbk Environmental Management Unit. Cape Enim

Appendix 2. Distribution pattern of composite soil sampling points with systematic way



Appendix 3. Map of the location of soil sampling points

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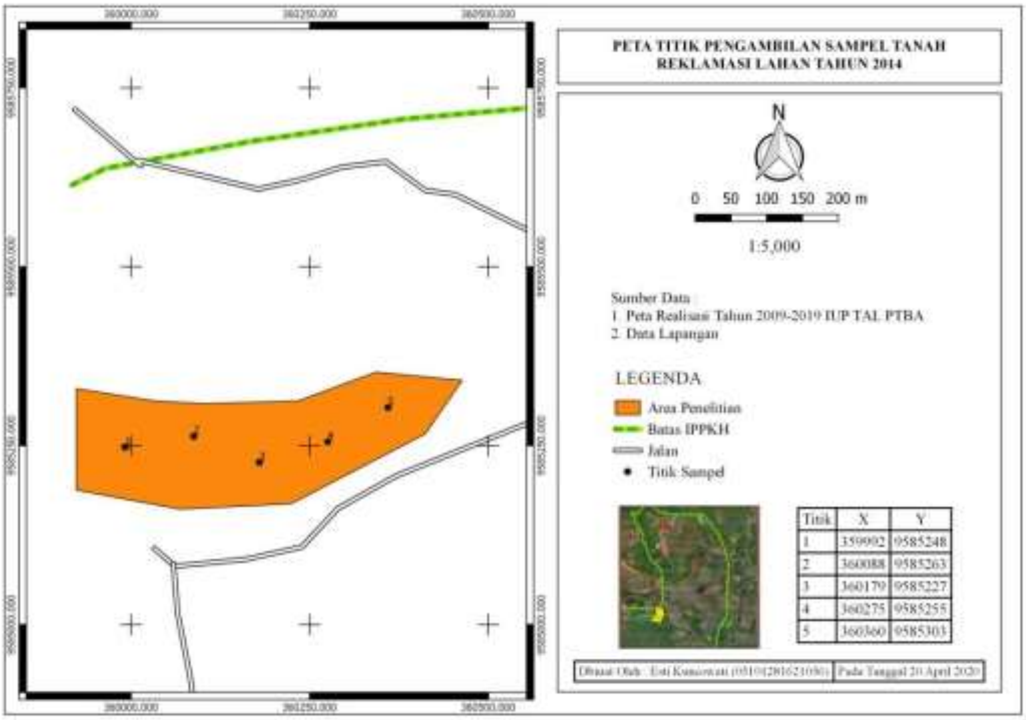
REKLAMASI LAHAN TAHUN 2015
N
0 50 100 150 200 m
1:5,000
Sumber Data :
1. Peta Realisasi Tahun 2009-2019 IUP TAL PTBA
2. Data Lapangan
LEGENDA
Area Penelitian
Batas IPPKH
Jalan
Titik Sampel
Titik | X | Y
1 | 360020 | 9585547
2 | 360110 | 9585497
3 | 360199 | 9585543
4 | 360285 | 9585491
5 | 360379 | 9585528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REKLAMASI LAHAN TAHUN 2014
N
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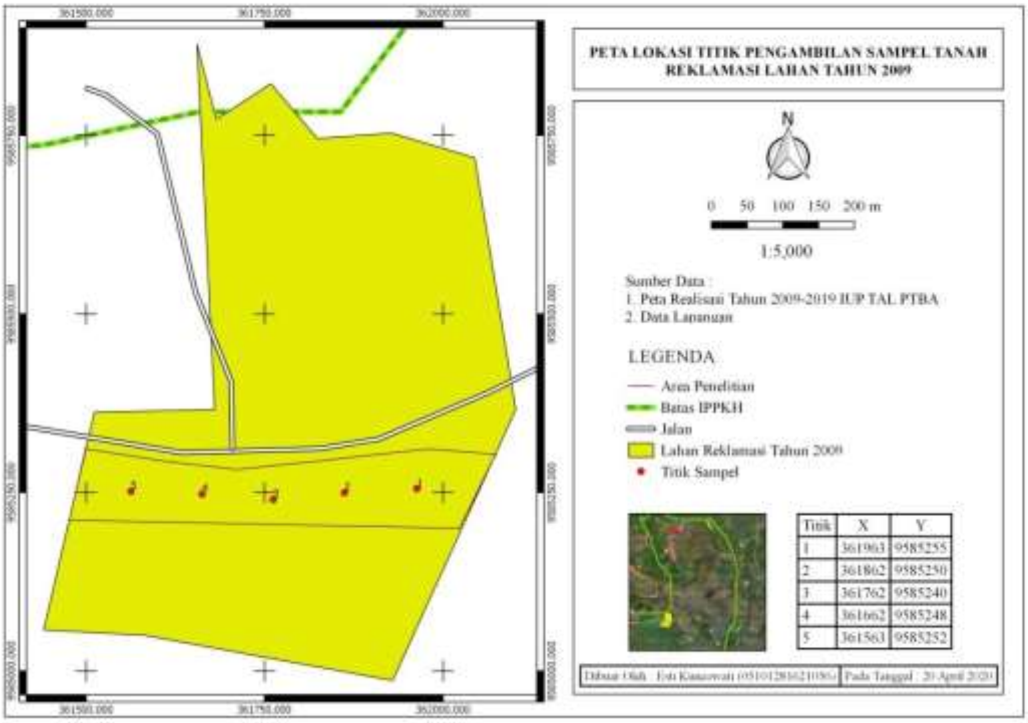
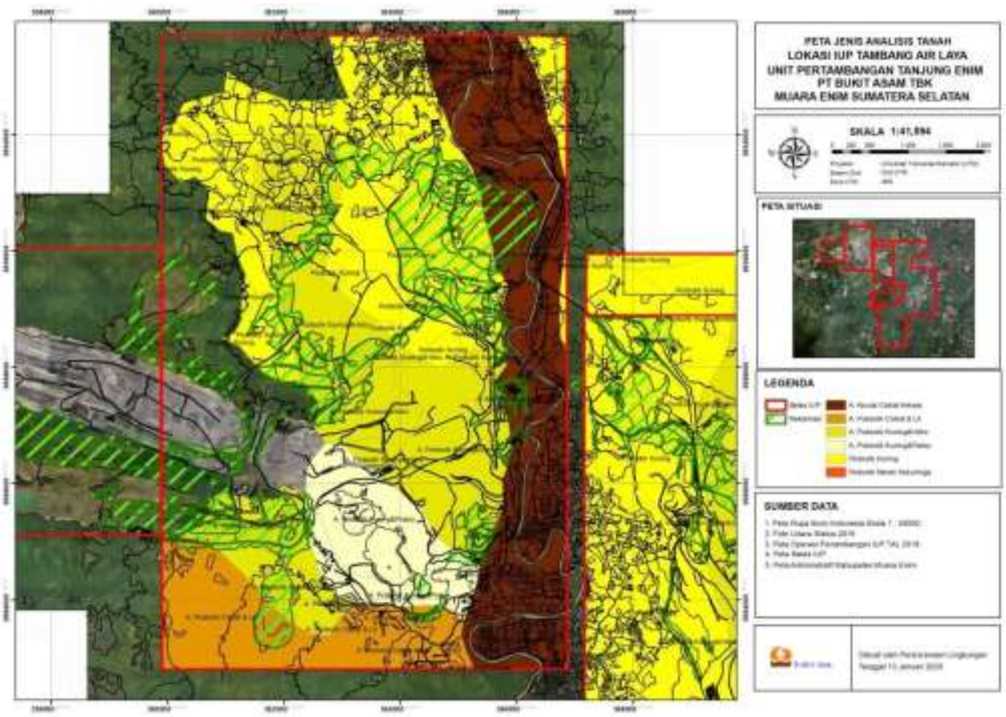
1:5,000
Sumber Data :
1. Peta Realisasi Tahun 2009-2019 IUP TAL PTBA
2. Data Lapangan
LEGENDA
Area Penelitian
Batas IPPKH
Jalan
Titik Sampel
Titik | X | Y
1 | 359992 | 9585248
2 | 360088 | 9585263
3 | 360179 | 9585227
4 | 360275 | 9585255
5 | 360360 | 9585303
Pada Tanggal 20 April 2020


361500.000
361750.000
362000.000
PETA LOKASI TITIK PENGAMBILAN SAMPEL TANAH REKLAMASI LAHAN TAHUN 2009
N
0 50 100 150 200 m
1:5,000
Sumber Data :
1. Peta Realisasi Tahun 2009-2019 IUP TAL PTBA
2. Data Lapangan
LEGENDA
Area Penelitian
Batas IPPKH
Jalan
Lahan Reklamasi Tahun 2009
Titik Sampel
Titik | X | Y
1 | 361963 | 9585255
2 | 361862 | 9585250
3 | 361762 | 9585240
4 | 361662 | 9585248
5 | 361563 | 9585252
Pada Tanggal : 20 April 2020

Appendix 4. Map of soil types in PT Bukit Air Laya Mining Mining Business License (TAL) Asam Tbk. Muara Enim South Sumatra



Appendix 5. Working steps of soil C-Organic determination in the laboratory (walkey and black method)

1. Weigh the 0.5 gram air dry soil sample into a 250 ml Erlenmeyer.
2. Then add 10 ml of 1 N potassium dichromate with a burette.
3. Then add 10 ml of concentrated sulfuric acid pa with a measuring cup.
4. Then shake it with a horizontal and circular motion.
5. The color must remain red and orange, if it is red, green or blue, add more $K_2Cr_2O_7$with H_2SO_4pa and the amount added should be recorded. Let stand until cold (30 minutes). For blanks also use the same procedure.
6. After cooling, add 100 ml of distilled water, 5 ml of phosphoric acid and 2.5 ml of sodium fluoride.
7. Add 10 drops of diphenylamine indicator, then titrate with ferrous ammonium sulfate until a diamond blue color is obtained. Calculation:

% C-Organic Soil = (BT) x N x (36/12000) x (100/77) x (100/W) =

% Organic Ingredients 1,724 x % C-Organic

Information :

T : ml titration

B example : ml blank

W : weight of soil sample

Appendix 6. Steps for determining soil N-total in the laboratory (kjeldahl method)

1. Destruction
   a. Weigh 0.5 gram of air dry soil sample.
   b. Put it in a 50 ml Kjeldahl flask.
   c. Add a little bit of sellen mixture and grind it with a little aquadest, add 5 ml of concentrated sulfuric acid pa.
   d. Heat it on a destructive device, first with a low flame, then increase the flame until the smoke disappears and the color of the solution becomes greenish/colorless, then remove and then cool.
2. Distillation

e. After the solution in the Kjeldahl flask has cooled, add 100 ml of distilled water, then the solution is put into a distillation flask (500 ml Kjeldahl flask). How to enter the solution is to pour repeatedly with distilled water.
f. Take a 250 ml Erlenmeyer filled with 25 ml of boric acid with 3 drops of N indicator.
g. The Erlenmeyer (f) is placed under the distillation cooler in such a way that the tip of the cooler is submerged under the acid surface.
h. Carefully add (with a measuring cup) 75 ml of 40% NaOH in (e). The addition of NaOH must pass through the walls of the Kjeldahl flask. Distillation is stopped when the volume has reached approximately 100 ml.
i. After the distillation is complete the Erlenmeyer is taken (the blue flame can be extinguished/removed if the Erlenmeyer has been removed).
j. Rinse with distilled water the upper and lower ends of the cooler (this water is inserted into the Erlenmeyer)

3. Titration
   k. The solution in Erlenmeyer is titrated with 0.1 N sulfuric acid until a red color is obtained. Record the titration reading.
   l. Work a to k is also carried out for blanks, namely without using soil.

Calculation:

% N total = (tb) * N * 0.01401 * 100/W

Description : t : ml titration b example : ml

blank N : Normality (0.1 N). :

W weight of soil sample

Appendix 7. Results of analysis of variance

Data Analysis of Soil Organic Matter Variety

SK	DB	JK	KT	F Count	Information	F Table 5%	F Table 1%
Group	4	4.30	1.08	1.51	mr	3.01	4.77
Treatment	4	34.03	8.51	11.89	* *	3.01	4.77
Error	16	11.44					
Total	24	49.77					

0.72

KK : 41.81%

Information : mr : F Count < F Table : n F Count > F Table * : real (F Count > F 5%)
* * : very real (F Count > F 1%)

Soil pH Variety Analysis Data

SK	DB	JK	KT	F Count	Information	F Table 5%	F Table 1%
Group	4	0.42	0.10	1.93	mr	3.01	4.77
Treatment	4	1.52	0.38	7.08	* *	3.01	4.77
Error	16	0.86					
Total	24	2.76					

0.05

KK : 5.52%

Information : mr : F Count < F Table : n F Count > F Table * : real (F Count > F 5%)
* * : very real (F Count > F 1%)

Appendix 8. Criteria for assessing the results of soil analysis based on the Balai soil research (2009)

Nature Soil	Score					
	Very Sour	Sour	Rather Sour	Neutral	Rather alkaline	Alkalis
pH	< 4.5	4.5 – 5.5	5.5 – 6.5	6.6 – 7.5	7.6 – 8.5	> 8.5

Appendix 9. Activities in the field

Field

Soil

Thickness

Observations on

Sampling

Measurement Sampling litter Soil

Appendix 10. Activities in the laboratory

N-Destruction Process
Total Land

N- Distillation Process
Total Land

N-Total Titration Process
Soil

Add Aquades
on Check C-
Soil Organic

Adding Acid
Phosphorus on Check
C-Soil Organic

C-Titration Process
Soil Organic

Sample Weighing

Soil

Mixing Process of Soil

Samples and Aquades Agar
Homogeneous

Soil pH Check

Appendix 11. Land conditions at the research site

R0 (Reclamation Age ± 3 Months)

R1 (3 Years of Reclamation Age)

R2 (Reclamation Age 4 Years)

R3 (Reclamation Age 5 Years)

R4 (10 Years of Reclamation Age)