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Research Paper

SUCCESSION INDICATIONS FROM VEGETATION IN TAILING DEPOSITION AREAS BASED ON VEGETATION PROFILE DIAGRAM

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Abstract

One example of marginal land is land mined and sandy soil. This land tends to be difficult to overgrow vegetation. Environment 19 Mile is part of the ModADA or Ajkwa watershed that has been modified as a PTFI tailing deposition area. The effect of high natural erosion and transport of mineral soils during the tailings drainage process causes soil structure in ModADA, especially in the double dike area to form faster, and allow natural vegetation. Characteristics of succession in the area were observed by vegetation profiles. The combination of making transects and sampling plots was used as a method for observing characteristic vegetation in the double dike area. The results showed that based on differences in vegetation height and canopy area there were 3 layers of vegetation, namely A, B, and C in the Double levees with flooded or tend to dry area. In the flooded area, *Paraserianthes afalcataria* and *Timonius timon* were dominated by an average plant height of 17.33 m; and layer B is dominated by *Pandanus lauterbachii* with an average plant height of 6.83m. In areas that tend to be dry, layer A species is dominated by *Timonius Timon, Ficus armiti Miq, Glochidion macrocarpa*, and *Sterculia sp* with an average plant height of 14.75 m; while layer B is dominated by *Casuarina equisetifolia, Ficus armiti King, Ficus armiti Miq, Glochidion macrocarpa, Antiaris sp, Macaranga aleuroitoides*, and *Campnosperma brevi petiolata* with an average plant height of 8.39 m. Layer C is in both types of soil occupied by species *Phragmites karka*. The vegetation profile shows that the area is an area with double dikes in the early stages of succession. This proves that this region is able to develop into natural revegetation of ModADA and accelerated through reclamation.

Keywords

Vegetation Profile, Succession, ModADA, double leeves

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1. INTRODUCTION

Ajkwa lowland areas in Papua, Indonesia were used as precipitation and tailings management area of PT Freeport Indonesia. The region became known as Ajkwa Modified Deposition Area (ModADA). Land tailing is one example of marginal land. In ModADA there is an area which is used as a pilot area for studying the development of a potential tailings deposit into land and productive called Ganda dike area.

The composition of the tailings in the Double levees dominant area of sand and a particle size varies from coarse particles (>175μ), medium (150-175μ), smooth (38-75μ) and very smooth (<38μ) (Husin and Susetyo, 1999) resulted in the cation Exchange Capacity (CEC) tends to be slow. As a result of marginal land tends to poor nutrition and infertile Windusari et al. (2012). CEC magnitude of the soil depends on soil texture, the type of clay minerals and organic matter content. The higher levels of clay or the finer texture of the CEC will be bigger. Similarly, the soil organic matter content, the higher the material organic land, and then CEC will be higher.

Rehabilitation of ex-mining forests is very important to restore the function of forest ecosystems. Forest restoration program is efforts to restore biotic elements (flora and fauna) and abiotic (soil, climate, and topography) of forest areas, so that activities aim to restore ecological integrity and prosperity of people in the forest landscapes that experience deforestation and degradation (Mukhtar and Heriyanto, 2012)

Lack of influence to actively lead tailings deposits double levels area develops as a relatively stable area and began to be observed and developed as a succession of natural vegetation and reclamation (PTFreeportIndonesia, 2000). The development of natural vegetation classified as fast as within about 5-15 years of natural vegetation thrives in nutrient-poor areas tend to them. Husin and Susetyo (1999) stated nutrient content and organic material in the tailings lower by a factor of high water, and the pH value of the tailings are relatively high (>7) showed no fertile

Figure 1. Transect Map Location Point

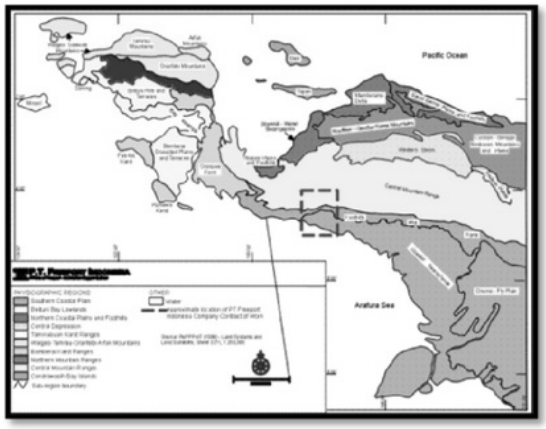

Figure 2. Location map of PT. Freeport Indonesia

land. Taberima (2009) states that over time, tailings sediment may develop into a good growing medium and a relatively stable condition in the Double levees cause developmental process go faster.

The different types of vegetation that occupied the region along the Embankment Ganda are also affected by the process of settling particles in tailings ModADA. Husin and Susetyo (1999) explains that the tailings particles are distributed based on particle size of coarse particles (>175μ), medium (150-175μ), smooth (38-75μ) and very smooth (<38μ) which settles gradually.

According Windusari et al. (2009), these conditions led to several areas in the Double levees become stagnant or dried. It affects different chemical content of the soil and the type of vegetation that grows naturally in the Double levees (Windusari et al., 2011, 2012). Plant communities in logged-over forests can change rapidly. Tjhiaw and Djohan (2009) stated that the minimum nutrient content on ex-mine land causes only adaptive plant species to survive.

Change in composition the type of plant that describes the quantification and qualification of the condition of the plant community that occurs indicates the dynamics of the forest community. Therefore, this study aims to obtain information about the acceleration of natural succession that occurred in the previous tailing area. And based on the physical and chemical characteristics and dynamics of the plant community observed, it is important to study the structure and composition of vegetation in the previous tailing area using a 2-D profile diagram. The map location point can be shown in Figure 1.

2. RESEARCH METHOD

2.1 Description of The Study Area

Double levees area with an area of approximately 1,500 ha with ordinate point 136°45'00 "-137°07'00" E and 04°20'00 "- 04°55'00" LS. Develop as a regional monitoring and evaluation of the process of reclamation and natural vegetation succession. The condition is characterized by thin content of organic matter and essential nutrients, texture and properties of the limiting factors of tailings particle size affects the structure and composition of the vegetation. Determining the location of sampling performed elected (purposive sampling) based on particle size distribution and the distribution of vegetation in the tailings deposition area ModADA Double levees, further samples were tagged with GPS location. The map location of PT. Freeport Indonesia is shown in Figure 2.

2.2 Research Implementation

The sampling method is a combination of line transects method and terraced lines based Indriyanto (2006). Vegetation conditions considered in sampling and plot size of 20mx20m considered representative of the 2-10% area sampling locations. Vegetation analysis conducted to observe the various levels of vegetation growth (seedlings, saplings, poles, and trees). Vegetation in the observation area depicted in the form of vegetation profile diagram based on the structure and composition of the vegetation.

3. RESULTS AND DISCUSSION

Succession that took place in the Double levees tailings deposition area categorized as a type of secondary succession. Secondary succession occurs due to human interference with nature, such as mining or forest fires that caused the loss of natural vegetation, but it still leaves the seed and the root system in the soil. In this type of succession, the initial substrate is provided so that it can be used as growing medium seed dormancy or carried by the wind and wild animals. Succession begins with the reversal of extreme environmental conditions by pioneer vegetation, resulting in increased nutrient and organic matter in the soil. Brown and Lugo (1990) also states that secondary succession forests are characterized by low tree density, and vegetation is generally short with a small diameter.

Based on observations and analysis of vegetation that have been done, it shows that the succession in the Double levees

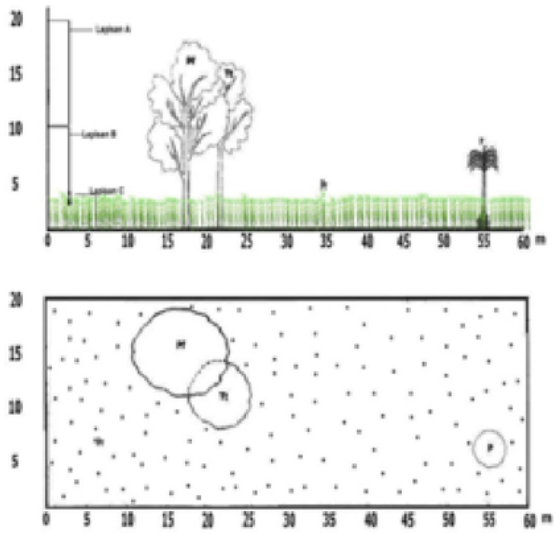

Figure 3. Profile Diagram of Vegatation on Inundated area MP19 (P: *Pandanus lautebachii*; Pf: *Paraserianthes falcataria*; Tt: *Timonius timon*)

category secondary succession. Although the development of the vegetation in some areas have dominated by rate of growth of the tree or pole, but the dominance of vegetation seedlings and undergrowth still control large areas of Double levees. *Phragminthes karka* a species seedlings dominate dry areas and stagnant in Atlantic Ganda. It resembles a statement of secondary succession, proposed by Brown and Lugo.

Vegetation profile in Figures 3 and 4 show the dike area MP19 Dual particular area dominated by grass species *Phragmites karka* although sometimes encountered vegetation of trees and poles level with a very low density.

Observation of the region tend to be inundated show that *Phragmithes karka* dominated grass area and found the presence of vegetation stands little pole or tree. *Phragmithes karka* is a pioneer dominant grass species in the tailing deposition area ModADA. The presence of more than 72 individuals/ha of the species showed dominance in the area MP19 compared with the presence of vegetation stands poles and trees that are less than 53 individuals / ha. Windusari et al. (2009) explains that grass vegetation *P. karka* widespread ModADA tailings deposition area and cover more than 50% Double levees area with a variety of physical environmental conditions (stagnant and tends to dry), but more dense colonization in the region were flooded. Calculation of the index value *Phragminthes karka* important species of 48.8% was increasingly showing dominance in the deposition area.

Vegetation profile is a composed of vegetation namely *Pandanus lauterbachii, Paraserianthes falcataria* and *Timonius timon*. Broad canopy cover the widest found in species *Paraserianthes falcataria* (20.60 cm^2) with 18.33 m height of the tree, followed by *Timonius timon* area of 6.65 m^2 and a high canopy of trees 16,33m, and *Pandanus lautebachii* has extensive editorial 4,34m^2 with 6,83m high. *Phragmites karka* cover the start point 0 observations to near an observation point where *Pandanus lauterbachii* found. This shows that the region is an area inundated best for the development of the *P. karka* species.

Unlike the situation in the inundated land, the vegetation on dry land or to dry in the MP19 area tend to be occupied more tiers of vegetation for further development. The type of vegetation that emerged in the region is more varied, although *P. karka* still dominance. There are still many open space for the entry of sunlight to the forest floor affects the development of seedlings and saplings of trees in the region. Some species of vegetation were found to be present in the region tend to dry are *Casuarina equisetifolia, Timonius timon, Ficus armiti King, Ficus armiti Miq, Glochidion macrocarpa, Anthiaris, Macaranga aleuroitoides, Campnosperma brevipetiolata*, and *Sterculia sp.*

Similar to the appearance of vegetation profiles vertically on inundated area, then the succession of natural vegetation is also composed of three layers of vegetation with the same criteria. A layer occupied *Timonius Timon, Ficus armiti Miq, Glochidion macrocarpa*, and *Sterculia sp* with the average height of 14,76m, layer B occupied by the species *Casuarina equisetifolia, Ficus armiti King, Ficus armiti Miq, Glochidion macrocarpa, Anthiaris sp, Macaranga aleuroitoides*, and *Campnosperma brevipetiolata* with the average height of 8,39m, while the C layer is occupied by plants under the dominance *P karka.* Canopy cover broad ranges 1.56-5.06 m^2.

Based on the characteristics of the vegetation was observed in the profile and standing vegetation in an area to dry contained in the tailings deposition area MP19 can be said that the natural vegetation growing an early stage in the process of vegetation succession. Gomez-Pompa and Vazquez-Yanes (1981) states that the succession is indicated through their dominance of herbaceous plants, grasses, seedling and sapling that needs a lot of light, was short with a low growth rate, and is able to take advantage of favorable environmental conditions.

Plant growth and nutrient absorption result in the accumulation of biomass. In the line with the increasing age of the vegetation and the changing conditions of the biophysical environment, it formed a class in primary forest vegetation. The high density of ground vegetation and grass than trees is an indication of the ongoing restoration of the land. The results of observations on the level of growth and species diversity for each growth rate on different ex-mining land age shown in profile diagram. The diagram illustrates the differences in the dominance and diversity of species from each level of growth.

According to figures from the vertical profiles observed that forest succession of natural vegetation in the region were inundated as if composed of 3 layers of vegetation. These layers are determined based on the height of the vegetation that grows in the area of observation. Layer is occupied by high vegetation between 10-20m species *Paraserianthes falcataria* and *Timonius timon* with an average height 17,33m, to layer B is occupied by

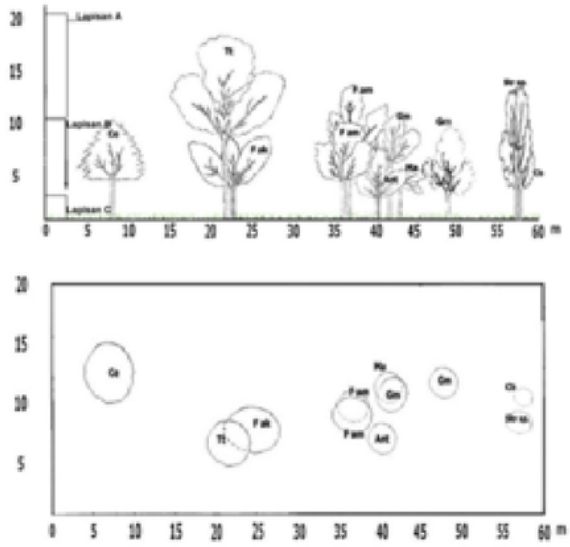

Figure 4. Diagram of vegetation profile on dry area MP19 (Ce : *Casuarina equisetifolia*; Tt : *Timonius timon*; F.ak : *Ficus armiti king*; F.am: *Ficus armiti miq*; Gm : *Glochidion macrocarpa*; A : *Anthiaris*; Ma : *Macaranga aleuroitoides*; Cb : *Campnosperma brevipetiolata*; Str : *Sterculia sp*)

high vegetation 5-10m. *Pandanus lauterbachii* with high average 6,83m, and for layers of vegetation occupied with high C <5m namely the seedling stage and dominated by *P. karka* and always found to be present at high frequency on all the observation plots.

Ewusie (1990) states humidity factor is an important environmental factor and plays a role in determining the presence of a plant or animal species in a habitat, although sometimes human intervention was instrumental in the spread of a species. (Windusari et al., 2009, 2010) stated that *P. karka* pioneer vegetation has characteristics that tend to be damp soil or relatively poor drainage conditions and with high light intensity. As a result of poor environmental conditions, vegetation pioneers emerged dominant in early succession in PTFI's tailings land and cause other vegetation present difficult or even not be able to grow.

The existence of pioneer vegetation plays an important role in improving the microclimate of the region. Hupp (1992) adds that the pioneering vegetation growth and rapid regeneration, and is generally not a woody plant with little branching, and the widespread distribution because the seeds easily carried by the wind or a wild animal.

Distribution of seeds that easily carried by the wind and weather conditions supported by the mining areas are classified as Type A1 with a wet month throughout the year in high intensity, and the average monthly rainfall for 334,57mm cause *P. karka* pioneer species has a very wide distribution in the region ModADA.

Bunting et al. (1999) suggested that the species diversity of undergrowth and ground cover decreases due to the dominance of grass. In extreme environmental conditions such as low nutrient content, high humidity and drainage tend to be poor is a condition that supports the growth of vegetation pioneer tolerant. In the reclaimed area, the pioneer vegetation will be easily lost due to the competition to survive. Pioneer vegetation generally require an open area, so that the reclamation plant shade better support the colonization of vegetation lower level than make room for the development of pioneer vegetation.

As time goes by, ex-mine land will experiencing succession. Land conditions open and barren slowly will overgrown with tolerant pioneers against the condition of land of mines which minim nutrient Isnaniarti et al. (2017). Roberto's (2012) research results about the study of pioneer plants on land former community gold mine in the Nature Reserve Foreman, shows the level of regeneration and plants that a[illegible]varied, good in number or type in the area former mines aged 1-3 years, 4-5 years, 6-10 years, and 11-15 years.

Vegetation such as *Pandanus lauterbachii, Paraserianthus falcataria* and *Timonius Timon* is a species which is often found to be present even in low frequency areas that are starting the process of succession. The presence of these species in the region are dominated by *P. karka* inundated due to the growing area of relatively higher and drier than the growth of *P. karka* region.

4. CONCLUSIONS

The observation of the characteristics of the forest vegetation natural succession in the area of the tailings deposition shown by profiles vegetation concluded that forest succession of natural vegetation in the area of stagnant or tends to dry in the MP19 is composed of 3 layers vegetation are differentiated according to height and size of the vegetation, and the succession of natural vegetation which took place in the area MP19 is still an early stage of succession.

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