SOIL MORPHOLOGICAL PROPERTIES OF REFORESTATION AREA PLANTED WITH *SHOREA MACROPHYLLA* IN SAMPADI FOREST RESERVE

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Soil morphological properties of reforestation area planted with *Shorea macrophylla* in Sampadi Forest Reserve.

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This project is submitted in partial fulfilment of the requirement for the degree of Bachelor of Science with Honours

(Plant Resource Science and Management)

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Soil morphological properties of reforestation area planted with Shorea macrophylla in Sampadi Forest Reserve.

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ABSTRACT

Taking into consideration the importance of in-situ environmental variables when managing an area for reforestation purpose, a preliminary study was conducted in an attempt to clarify the soil morphological properties in the reforestation area planted with Shorea macrophylla under various age stands at Sampadi Forest Reserve, Sarawak. Study plot with the size of 50 m x 50 m was constructed at various age stands in the reforestation area planted with Shorea macrophylla in the year 1997, 1998, and 1999. In addition, a study plot was constructed in the adjacent secondary forest at the reforestation area for comparison mainly on the effect of reforestation on A horizon dynamics in the soil morphological. Field observation and evaluation by soil profile description of soil pit with the depth of approximately in 1 m depth and 1.5 m width located at the center of the study plot. The in-situ information such as the horizon, color, texture, biological activity, and root were recorded on Soil Characterization Data Sheet based on soil morphological characterization as proposed by USDA-NRCS (2002). The soil morphological properties in that area were clarified. The result of this study shows that soil in the study area was in the group of Grey White Podzolic soil group with derived parent material from Bako and Saratok series. This type of soil suitable for reforestation activity with Shorea macrophylla proves to be the right species that manage to survive on this soil. In facts, the effect of reforestation on A horizon was identified.

Keyword: reforestation, Shorea macrophylla, soil, morphological properties, Sampadi Forest Reserve.

ABSTRAK


Kata kunci: penghutanan semula, Shorea macrophylla, tanah, ciri-ciri morfologi, Hutan Simpan Sampadi
1.0 INTRODUCTION

The forest in the world plays many important roles such as a source for renewable raw materials and energy, stabilize the ecology and biodiversity, maintaining land structures and water resources. In facts, forest helps in maintaining the supply of oxygen by being a place where the uptake of carbon dioxide used in photosynthesis and produce the oxygen for other living organisms to breathe in and stay alive including us as human. However, improper utilization of resources in the forest such as land usage, water supply, and timber production cause disruptions to the ecological systems and eventually effect the environment.

Logging leads to deforestation activity in which is the main threats to the forests in the world. Deforestation involves the permanent clearing of forest for use in shifting cultivation, permanent agriculture or settlements (Lamb, 1994). In order to prevent imbalance ecology and biodiversity, some forests have been reclaimed as forest reserve for the conservation of the forest resources.

There are five (5) types of forest in Sarawak which are Hill Mixed Dipterocarp Forest, Peat Swamp Forest, and Mangrove Forest are the predominate. The other two types are Kerangas Forest and Montane Forest (Sarawak Forestry Department, 2012). The advantages of planting indigenous species for reforestation or plantation activities is that the species are considered to be better adapted to the local environment and consequently less susceptible to diseases and pests (Appanah and Weinland, 1993). Reforestations also have been conducted at such forest reserve to sustain the resources in long terms and improve soil structure for plant growth. Deforestation had caused all the roots from the plants that hold soil before this gone. When there is no longer barrier to hold the structure of the soil, it will be carried away by heavy rain that consequently, may cause flood and landslide. Deforestation can cause significant alteration in many biophysical processes,
however the magnitudes of alterations depend on the method of land clearing (Lal, 1990). The soils have lost the capability to absorb the water and begin to lose the structure when mixing with the water in which, lead to loss of nutrient and mineral in soil by leaching or runoff. Some will go deep in the soil and this is not suitable for the plant growth and even for forest succession.

Each of the forest types depends on the altitude, soil conditions and water availability. Different forest has various types of soil, which means that not all plant can grow well in certain forest. The heterogeneity of the soil in our environment plays an important role in the succession of forest as it control the growth of root underneath. As the soil texture, structure, depth and color represents water availability, aeration, nutrient and mineral. Without a strong and healthy root, plant will not grow as it does not hold strong to the soil and soon will fall or collapse when there is strong wind or heavy flood. Thus, succession of forest seems to be impossible without enough knowledge on soil. It is because the progressive change in forest type depends on the soil where it is a medium of every single vegetation start to grow and give rise to the names of forest types.

The objective of this study is to clarify the soil morphological properties of reforestation area planted with *Shorea macrophylla* in further detail for the purpose of designating whether the current status of the soil in the reforested area are suitable for reforestation activities.
2.0 LITERATURE REVIEW

2.1 Forest ecosystem in the tropics and its function

Ecosystem represents a system which consists of living organisms such as plants and animals with the non-living things such as soil, water and air. Each of these interact with each other to produce a stable and balance of ecology in which the exchange of materials between energy and nutrients. In facts, they play important role in maintaining the survival of forest. Today, the area covered by secondary or ‘fallow’ forests is expanding faster than the area covered by any other tropical forest ecosystem (Lanly, 1982). According to Lowman & Bouricius (1995), rainforests cover less than 7 percent of the Earth’s surface but the land area consists about half of the plants and animals species on the planet. Since it is a home to so many plants and animals species, the level of biodiversity may be higher in rainforest than in any other place on Earth. For example, an average of 20 to 86 tree species exist per acre in tropical rainforest while there are about four tree species per acre in a temperate zone forest.

The type of forest depends on these factors as it represents the ecosystem in the forest. Our forest, known as evergreen forest because of the main layer is a dense and continuous canopy of trees that are around 30 to 60 meters in height with another layer consists of even taller trees that protrude above the canopy from place to place (Jusoh, 2011). A discontinuous understory of trees below the canopy is the third layer that makes our forest full covered with trees. The forest are wet with precipitation of rainfall around 2000 – 2500 mm per year and evenly distributed throughout the year. The seasons are wet and dry with constant temperature between averages of 25 – 31 °C which results the soils poor in nutrients (Jusoh, 2011). Meanwhile, tropical rainforest are warm with temperature ranging from 24 to 31°C (75 to 88°F) all year round. Located near to equator, tropical
rainforests receive at least 2000 millimeters (80 inches) of rain every year, with distinct dry season from the end of December until April and during that period it receive only about 300 millimeters (12 inches) of rain (Lowman & Bouricius, 1995).

Forest succession in the moist and wet lowland tropic is extremely rapid (Ewel, 1982). The forest functions as regulatory of essential ecological processes and life support system to maintain the ecosystem such as water and mineral cycles. It also serves as home and shelter for wild animal and plants to live and reproduce generation with genetic diversity and the evolutionary process. Carbon and nitrogen cycles in the forest contribute to the production of oxygen with the conversion of energy and later, consumed by secondary producers. Humans use forest as a source for food and raw materials to energy resources and genetic material in their daily life.

Any plants communities supported by the combination of interaction between the sun, earth’s atmosphere, water, and components of soils get the chances to grow and reproduce well in the variation of species. As this process takes time to disperse in large area, the thickness of forest forms a layer, which covers up the land surfaces. It happens to be the ground layer, understory layer, canopy layer, and emergent layer. Each of these layers has their own height and different types of species where the sunlight and humidity influence the growth. It certainly acts as a roof and protection for the living things that live in the forest ecosystem. Besides that, with huge growing crown of tree cover up the space in the forest keeps the cool environment together with the accumulation of oxygen that helps in maintaining the temperature.
2.2 Forest type in Malaysia and its ecological characteristics

There are many types of forest in Malaysia such as lowland Dipterocarp forest, hill Dipterocarp forest, oak -- laurel forest, Montane ericaceous, Peat swamp forest, and Mangrove forest. According to Sarawak Department Forest (2012), Hill mixed Dipterocarp Forest covering about 10.4 million hectares, Peat Swamp Forest comprising about 1.5 million hectares, Mangrove Forest occupying slightly more than 0.09 million hectares and the others are minimal in size.

The forest in Malaysia are mostly dominated by trees from the *Dipterocarpaceae* family, hence the term ‘Dipterocarp forest’ and it occurs on dry land just above sea level to an altitude of about 900 meters (WWF, 2012). Each type of forest is different from each other because of certain factor such as altitude, soil condition, and water availability. Each areas results to significant changes in underground resources that may negatively affect the growth and survival of forest. According to Sarawak Forestry Department (2012), Hill Mixed Dipterocarp Forest is mainly located in the interior upriver areas extending from coastal peat swamps up to heights of 1,500 meters above sea level. Montane Forest takes over beyond this altitude. Peat Swamp Forest is low lying coastal plains with a high water table reaching inland along the lower reaches of major river systems, and Mangrove Forest is found in tidal and estuarine stretches extending from mud flats to where saline water starts while Kerangas Forest occurs on poor, sandy soil and terrain.

Within this environment, the Mangrove Forest plays an important role in protection of coastline as a natural barrier and a line separation between salt water and river. Dipterocarp Forest is where the home for more than 2000 species of tree and plant, even thousands of animal and insects. In facts, it serves as center for producing resources for food and forest product such as timber. As for the hill Dipterocarp forest, it is also acts as watershed compared to the other types of forests. This forest has hilly terrain that tends
to get more water from the rains as clouds pass by. The rainfall will flow down the hill and
traps to certain places where the land is flat enough to hold the water from moving on.
Over the time, the waterfall forms and the water are freely move to the other rivers nearby
and been supply throughout the place.

Forest is well known to be a place where the uptake of carbon dioxide and the
production of oxygen or in other words, Carbon Sink. It is defined as a natural or manmade
reservoir that accumulates and stores some carbon-containing chemical compound for an
indefinite period (Jusoh, 2012). This process use photosynthesis to remove excessive
carbon from the atmosphere, incorporating it into biomass and release oxygen as products.
The forests serve as a supply of oxygen, stabilize the climate and in the same time shape
the landscape.
2.3 Soil characteristics in Sarawak

There are Montane and peat swamp forest which both having the organic soil but differ in morphological properties and surface vegetation. According to Ismawi (2012), Peat swamp forest of Sarawak have vegetative and edaphic characteristics similar to those in Sumatra and Peninsular Malaysia which is predominantly organic matter built up behind mangrove swamps. They are ombrogenous, or rains fed, and are recent in origin (Morley, 1981). Over a long time of period, the organic matter accumulated and rises up to certain thickness in the forest layer.

In Sarawak, peat soils occurs in large basin swamps and in small interior valleys that have developed in comparatively recent times (Andriesse, 1988). Meanwhile in Sampadi FR, the soil is moist and wet because of poor drainage of water from the rain. The area often having flood when in certain times of heavy rain because the river nearby will easily rise up and flood the forest nearby. Because lack of ability to absorb water efficiently, the flood will last for several days and moisten the soil. This will lead to the built up of organic matter and based on Ismawi (2012), they occur in three geomorphic situations which are lowland coastal swamp, inland swamp and valley with high altitude and free drainage situation.

The study of soil morphological features in the field was conducted through field observation, description and visual interpretation. This was done through soil survey which is a process of analysis to determine soil compositions and soil fertility. Depth, texture and drainage are also the important factors that affect the survival and growth of the indigenous species. Almost all soil properties are variables which change with time and it is very difficult to evaluate the degree of development of one soil by analyzing each property. In logged forests, substantial areas are cleared of topsoil and compacted leading to nutrient
loss, increased soil temperatures, reduced water availability, and changes in the soil microflora (Malmer and Grip, 1990; Nykvist et al., 1994; Nussbaum et al., 1995a).
2.4 *Shorea macrophylla* and its potential in reforestation activity

This species is quite famous and well known in Malaysia as one of the indigenous tree species that usually been used either in reforestation activity or forest plantation. Until nowadays, taxonomist have decided that this unique species still survive through generation with a genus of about 196 species of mainly rainforest trees in the family of *Dipterocarpaceae* distributed in certain parts of Asia and Northern India.

It can be recognized through distinct characteristic that derived from its family which are simple leaf with alternate in a plane, presence of paired stipule at nodes with swollen petiole at upper end (about 2/3) of the petiole or knee-shaped petiole, and presence of resin aromatic smell when bark/stem being slashed. The leaves of this species turns into reddish brown color when old and fell off the tree results in covering the ground surface. That is why this species was known as Light Red Meranti. *Shorea macrophylla* is a flowering species that produce unique winged-seed that most likely seed characteristic pollinate through wind. According to research done by Leysia (2012), *Shorea* are insect pollinated and a variety of insects has been implicated, with species within the sections of *Shorea* sharing the same insect pollinators.

*Shorea macrophylla* become the choice of people in doing reforestation activity because it reduces the risk of loss and failure of project. This is because of this species have the ability to adapt in a variety of condition mostly our local weather and environment. In facts, this species can thrive well under minimal management. It needs medium shade at the early stage of planting and under shade it grows with excellent form (Appanah and Weinland, 1993). This will certainly ease the working of maintenance and even reduce the cost of management. Resistance to damp condition makes *Shorea macrophylla* extremely competent at combating insect attacks and decay (Leysia, 2012).
In economic value, this species grow a well-structured form of tree that absolutely fulfills the characteristic of good timber. Furthermore, it has a very fast diameter growth but after initial fast height growth this levels off (Azman et al., 1990). *Shorea macrophylla* has been identified as having potential for forest plantation in the logged-over forest sites with unique stem and wood characteristics for processing and the products have an international market demand (Leysia, 2012). It’s spreading crown and big limbs provide a well-protected shade for other wildlife comfortable living in the forest. This contribute to the ecosystem serve a balance ecology to the flora and fauna and very suitable to be choose in the reforestation activity.

Even though this kind of species takes longer time to reach stages that it is ready to be harvested compare with other crop plantation such as oil palm. Nevertheless, the effect of plantation on soil must be considered too. The time taken for the growth of this species will improve the soil condition either by strengthen the soil structure through rooting system or improve the organic matter on the ground surface through amount degradation fell off leaves. It also can be considered as an investment of future supply of raw material for utility use.
Reforestation efforts in Malaysia and methodologies in restoring the tropical rainforest through reforestation of indigenous tree species

Reforestation refers to the establishment of plantations for individual and non-industrial uses and does not include natural regeneration of old tree crops (Lamb, 1994). These tree species can be used as a source of timber in the future as their adaptability to the forest. This is an alternative to restore back the degraded forest by using valuable sources. It also helps to maintain the ecosystem and the soil structure in the forest for a longer period. Enrichment planting in Malaysia has been motivated by the need to improve regenerating forest for future timber production, and by the desire to restore and thereby protect degraded unproductive areas (Appanah and Weinland, 1993; Kollert et al., 1996).

Planting indigenous tree species in the forest plantations can be uneconomical in most tropical countries due to the long rotation period and high cost of establishment and maintenance (Primack et al., 1989). The study related before this mostly done either in selectively logged forests or in areas that been used as shifting cultivation. Both areas results to significant changes in underground resources that may negatively affect the growth and survival of plantation trees. While there has been extensive silvicultural research for plantation establishment in the tropics generally (Evans, 1996). Forest departments in Malaysia routinely apply nutrients to Dipterocarps when planted in secondary, degraded forests (Appanah and Weinland, 1993; Krishnappillay, 2002).
Forest Department Sarawak (2009) reported that Sampadi Forest Reserve is among the area allocated for reforestation activities of indigenous species. The area size in Sampadi FR comprised of 5163 hectares. Apart from that, Sampadi Forest Reserve also involve in Oita-Sarawak Friendship Forest Project whereby, the project gathers participants including students and teachers from the Mie Agriculture High School since 1996 till the year 2000 to conduct reforestation activities with local community. In 1996, 1.6 hectares were planted with Shorea macrophylla while in 1997 and 1998, 1.1 and 1.2 ha respectively were planted. Another 1.3 ha were planted in August 1999.

The main objective of the reforestation is for the purpose of conservation and rehabilitating the forest resource in Sarawak. Previously the landscapes of Sampadi Forest Reserve are mostly planted with Acacia mangium plantation for the purpose in supplying materials for pulp and paper industry. However, due to poor management and disease attack in the plantation area, some patches within the forest reserve were allocated for Friendship Forest Project. Participation from several agencies from abroad was initiated in this area to enrich the areas that been deforested by forest fires as well as from shifting cultivation into mature tropical forests through reforestation of indigenous tree species. A reforestation programme in Sarawak is vital for the purpose of rehabilitating degraded forestland that has been subjected to logging followed by shifting cultivation (Lee and Lai, 1981). It helps to restore soil fertility in degraded land and maintain the supply of timber production continuously.
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