EVALUATION ON SOIL CHARGE CHARACTERISTIC AND SESQUIOXIDE BETWEEN SECONDARY AND REHABILITATED FORESTS IN UPM BINTULU CAMPUS, SARAWAK

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By

MOHAMAD ZAWAWI BIN AB RAHMAN

A Project Report Submitted in Partial Fulfillment of the Requirements for the Degree of Bachelor of Forestry Science in the Faculty of Forestry Universiti Putra Malaysia

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DEDICATION

For my beloved family:

My father,

Ab Rahman Bin Yusoff

My mother,

Noriza Binti Mohamed

Also my siblings.

To all my friends,

Thank you for your encouragements supports

And the sacrifices that you have given.

Thank you for everything. May Allah Bless All of us.

ABSTRACT

Conversion of forests into other land use types causes forest degradation. This forest degradation will affect soil structures and fertility. This study was conducted to evaluate and compare the status of charge characteristics and sesquioxides of a rehabilitated and a secondary forest. The soil samples were prepared by previous researchers. Soil samples were collected at two sites, namely a secondary forest and rehabilitated forests. Sampling plot (20x20m) was established at both study sites. In each plot, there were six subplots established, and from that subplots, soil samples were taken from two different soil profiles, i.e. were topsoil (0- 15 cm) and subsoil (15- 30 cm). Soil samples were air-dried and passed through a 2 mm sieve. Soil properties of sesquioxides was determined using Dithionite-Citrate-Bicarbonate (DCB) and Ammonium Oxalate. The DCB method was used to extract the non-crystalline (amorphous) of Al, Fe and Si oxides and hydroxides (Alo, Feo and Sio). The crystalline of Al, Fe and Si oxides and hydroxides was determined using Ammonium oxalate method. The concentrations of extracted Al, Fe and Si were determined by atomic absorption spectroscopy. Charge characteristic properties included Point of Zero Salt Effect (PZSE) and residual charge of PZSE (σρ) was determined using Modified Salt Titration (STPT). Organic matter also determined using Total Organic Carbon (TOC) Analyzer. The results showed the amount of sesquioxides contents was low at all plots in the rehabilitated and secondary forests. This means that the status of soils in the rehabilitated and Nirwana secondary forests had undergone similar highly weathering and leaching. Charge characteristics of PZSE showed that the value mostly was below four at all plots. PZSE and σρ in rehabilitated and Nirwana secondary forests did not show clear difference between the plots. This suggests that the former two soils had a relatively similar degree of weathering. Soil fertility was similar in both forests due to similar high weathering process. In conclusion, the soils in rehabilitated and Nirwana secondary forests showed that the forests had undergone high weathering and leaching processes but the low presence of sesquioxides suggested that they were yet to reach the ultimately weathered phase.

ABSTRAK

Pembukaan hutan untuk pelbagai jenis kegunaan menyebabkan punca kemerosotan hutan. Degradasi hutan ini akan menjejaskan struktur tanah dan kesuburan. Kajian ini dijalankan untuk menilai dan membuat perbandingan status ciri-ciri caj dan sesquioxides hutan rehabilitasi dan hutan sekunder. Sampel tanah telah diambil oleh penyelidik terdahulu. Sampel tanah dikumpulkan di dua lokasi iaitu hutan sekunder dan hutan rehabilitasi. Plot pensampelan (20x20m) dibuka di kedua-dua tapak kajian. Dalam setiap plot, terdapat enam subplot yang dibuka, dan dari subplot tersebut, sampel tanah diambil dari dua kedalaman tanah yang berbeza iaitu lapisan atas tanah (0-15 cm) dan lapisan bawah tanah (15-30 cm). Sampel tanah dikeringkan dan disaringkan mengunakan penapis 2 mm. Sifat tanah sesquioxides ditentukan dengan menggunakan Dithionite-Citrate-Bicarbonate (DCB) dan Ammonium Oxalate. Kaedah DCB digunakan untuk mengekstrak bukan kristal (amorfus) Al, Fe dan Si oksida dan hidroksida (Alo, Feo dan Sio). Kristal Al, Fe dan Si oksida dan hidroksida ditentukan menggunakan kaedah Ammonium oxalate. Kandungan ekstrak Al, Fe dan Si ditentukan menggunakan spektroskopi penyerapan atom. Ciri-ciri cas termasuk Point of Zero Salt Effect (PZSE) dan caj sisa PZSE (σρ) ditentukan menggunakan titisan garam diubahsuai (STPT). Bahan organik juga ditentukan menggunakan Analisa Karbon Total Organik (TOC). Keputusan menunjukkan jumlah kandungan sesquioxides adalah rendah di semua plot dalam hutan rehabilitasi dan sekunder. Ini bermakna status tanah dalam hutan rehabilitasi dan hutan sekunder Nirwana telah mengalami proses luluhawa yang tinggi. Ciri-ciri caj PZSE menunjukkan nilai di bawah empat di semua plot. PZSE dan σp dalam hutan rehabilitasi dan sekunder tidak menunjukkan perbezaan yang jelas antara setiap plot. Ini menunjukkan bahawa kedua-dua tanah mengalami proses luluhawa yang agak sama. Kesuburan tanah menunjukkan hampir sama di kedua-dua hutan kerana mengalami proses luluhawa yang tinggi. Kesimpulannya, tanah hutan rehabilitasi dan hutan sekunder Nirwana menunjukkan bahawa hutan telah mengalami proses luluhawa dan pelarut yang tinggi tetapi kehadiran sesquioxides yang rendah menunjukkan bahawa mereka masih belum mencapai fasa terakhir proses luluhawa.

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APPROVAL SHEET

I certify that this research project report entitled “Evaluation on Soil Charge Characteristic and Sesquioxide Between Secondary and Rehabilitated Forest in Upm Bintulu Campus, Sarawak” by Mohamad Zawawi Bin Ab Rahman has been examined and approved as a partial fulfillment of the requirements for the Degree of Bachelor of Forestry Science in the Faculty of Forestry, Universiti Putra Malaysia.

_____

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Date: January 2018

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LIST OF ABBREVIATIONS

CH_3COONa	Sodium Acetate
CIFOR	Center for International Forestry Research
$(COONH_4)_2H_2O$	Ammonium Oxalate Monohydrate
DCB	Dithionate-Citrate-Bicarbonate
FAO	Food and Agriculture Organization
ICP	Inductively Coupled Plasma
ITTO	International Tropical Timber Organization
$NaHCO_3$	Sodium Hydrogen Carbonate
$Na_2S_2O_4$	Sodium dithionate
NaCl	Sodium Chloride
PZSE	Point of Zero Salt Effect
PZC	Point of Zero Charge
SPSS	Statistical Packages for Social Science
STPT	Modified Salt Titration Method
TOC	Total Organic Carbon

CHAPTER I

INTRODUCTION

1.1. Background of The Study

The tropical rainforest is the most productive type of forests in the world. In Malaysia, tropical forests play an essential role in human and wildlife. According to Department of Statistics Malaysia (2016) estimated about 0.5 million persons would increase in 2016 compared to 31.2 million persons in 2015. That's means population in 2016 is 31.7 million persons. As a result, more forest needs to convert into different land uses, such as logging activities, agriculture, urbanization and plantation to supply resources for all populations. During the 1990s, the annual loss of natural forests in the tropics was estimated at 15.2 million hectares, of which 14.2 million hectares were converted to other land-uses (ITTO, 2002). When forest degradation occurs, it will bring negative impact on soil.

The soil is essential for life, in the forest, the main importance of soil is to provide the medium for plant growth and other important such as providing habitat for wildlife, carbon store. “Soils support plant growth by providing anchorage, nutrients, water, air, and warmth and protection from toxins" (Osman, 2013). Soil fertility is one of the factors that influence and limiting plant growth. Soil fertility can refer to the ability of soil to supply nutrients and soil water for support plant growth (Hardarson, 2015). The soil nutrients can be divided into two categories known as organic and inorganic materials. Waste of

living organisms such as plants and animals that decomposed in the soil known as organic matter, whereas inorganic matter is a natural element in soil that naturally exist from the geological system (Gufrin Amlin *et al*., 2014). Essential nutrients are provided by soil can be categories into macronutrients and micronutrient. The macronutrient elements such as nitrogen (N), phosphorus (P), potassium (K), calcium (Ca), magnesium (Mg) and sulphur (S). The micronutrients are such as manganese (Mn), iron (Fe), boron (B), zinc (Zn), copper (Cu), molybdenum (Mo) and chlorine (Cl). Where, the fertility of soil related to its capacity to store, retain and release the nutrients that are required for plant growth especially C and N (Gufrin Amlin *et al*., 2014). However, every plant species need a different amount of nutrient to support and increase their productivity. Mineral weathering and organic-matter decomposition are processed to make nutrient available in the soil (Gachene and Kimaru, 2003). The problem is soil fertility has been declining because of human activities that exploit the forest land base on the wrong concept or misuse the land. Human activities are the dominant factor that reduces soil structure and fertility in the forest (ITTO, 2002). Degradation in soil fertility causes by humans may happen within some year but to restore the soil fertility may take about thousands of years. Forming soil of a furrow slice (15 cm depth) and accumulating enough materials to make the soil fertile needs about 3000 years (Osman, 2013). That's why the process of rehabilitation should be carried out intensely to restore the soil faster.

Rehabilitation is challenging process that takes a long time to achieve the purpose of forest rehabilitated. Rehabilitation program involves the process of restoring the ecosystem, and wildlife habitat or in other term rehabilitation is the process of making land useful again after degraded (Arifin *et al*., 2010). Factors which are soil compaction, aeration, relation, soil temperature and soil fertility will affect the plant growth (Malik *et al*. 2012). To restore this soil, one research need be done especially on soil properties. Through that study, we can plan the best strategies to overcome this issue. The example of the solution can be practiced such as accelerating natural regeneration, enrichment planting, altering rotation cycles, cultivating fast-growing species, using improved genetic stock, reducing the impacts of logging and establishing mixed plantations with fast growing and shade tolerant species (CIFOR, 1998). One thing should be considered during rehabilitation process is the condition of soil properties in terms of morphology, sesquioxides and clay minerals for better management of forest rehabilitation program in tropical regions.

1.2. Problem Statement

Forest degradation can be conversion forests into other land use types or maybe causes of deforestation. This forest degradation will lead to decrease in soil fertility. To restore and to rehabilitate of degraded and secondary forests, we should include some criteria such as soil fertility, nutrient cycle, and production of organic matter. These all aspects are important to improve the forest ecosystem stability. Forest restoration, secondary forest management and the

rehabilitated of degraded forest land are more likely to succeed if they improve in local soil fertility, hydrological conditions and the quality of the water supply and if the self-regeneration processes of the ecosystem are exploited, and the dependence on outside inputs (e.g., planting, soil treatment, etc.) is minimized (ITTO, 2002).

In University Putra Malaysia Bintulu Campus Sarawak, most of their forest has been degraded because of past logging, conversion agriculture and shifting cultivation. Some technique has been practicing in this area including dense planting. This method was used in Bintulu, Sarawak to rehabilitate the degraded shifting cultivation areas with indigenous tree species (Hazandy *et al*., 2010). However, information or data on charge characteristics and sesquioxides for this degraded forest are limited. Therefore, this study was conducted to evaluate and make a comparison the status of charge characteristics and sesquioxides of a rehabilitated and secondary forest.

1.3. Objectives

i. To determine the soil charge characteristics and sesquioxides at secondary and rehabilitated forests.

ii. To compare and evaluate the status of soil in term of charge characteristics and sesquioxides at plots in secondary and rehabilitated forests.

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