Analysis of Heavy Metal and Clay Mineral in Heath Forest and Post Tin Mined Land on Belitung Island, Indonesia

DINA OKTAVIA

INDONESIA

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Kyoto University GSGES Short-Term Scholarship Program
Terrestrial Ecosystem Management Laboratory
Graduate School of Global Environmental Studies
Kyoto University, JAPAN

Introduction

Name	:	DINA OKTAVIA
Duration of study	:	6 Months
Supervisor	:	Prof. SHINYA FUNAKAWA
Affiliation	:	Terrestrial Ecosystem Management (GSGES)
Current Affiliation	:	Tropical Silviculture, Bogor Agricultural University (IPB), INDONESIA
Undergraduate	:	Forest Resources Conservation and Ecotourism, Faculty of Forestry, Bogor Agricultural University (IPB), INDONESIA

Topic of Master Thesis:
"Ecology Restoration in Damaged Heath Forest which caused by Tin Mining Activity"

Background

Source:http://www.eoearth.org/article/Sundaland_heath_forests?topic=49597>

- Lost of biodiversity and damaged of soil
- Heavy metal contamination as a potential soil pollutant.
- Effects of heavy metals on plants result in growth inhibition.
- Clay fraction has high potential to bind heavy metals
- Type of clay minerals is one of factor which determine the soil's ability to retain and immobilize heavy metals

Objectives

Study in IPB

- To understand soil properties
- To understand vegetation composition
- To develop recommendation for ecosystem restoration

Study in Kyoto University

1. To clarify heavy metal potential
2. To identify clay mineral composition

Study Site

Location: East Belitung District, Bangka Belitung Province, Indonesia


forest ecosystem


Post shifting cultivation land


Padang vegetation


post tin mined land < 100 years


post tin mined land > 100 years

Heavy Metal

- Extraction Method

BCR three step sequential extraction procedure (Rauret *et al.* 1999)

Step	Fraction	Target	Solution
S1	Exchangeable, water and acid soluble	Soluble species, carbonates, cation exchange site	Acetic Acid 0.11 M
S2	Reducible	Iron and manganese oxyhydroxide	Hydroxylammonium Chloride 0.5 M
S3	Oxidisable	Organic matter and sulphide	Hydrogen Peroxyde 8.8 M followed by Ammonium Acetate 1 M

The metal content was measured by Inductively Coupled Plasma Atomic Emission Spectrometry (ICP-AES)

ICPE 9000

Clay Mineral

- Method

X-Ray Diffraction Techniques

Clay sampling

↓

Saturation by Mg
(1N $MgCl_2$, 1N $(CH_3COO)_2Mg.4H_2O$)

Saturation by K
(1N KCl and 1N CH_3COOK)

Air dried and glycerol

Air dried, heated 350^0C, and 550^0C

Analysis by XRD machine

XRD machine

- Sillicate mineral is the most dominant mineral as a rock formed and found in the soil.
- Primary sillicate mineral: Quartz (poor nutrient), Feldspar (rich nutrient)
- Secondary sillicate mineral: kaolinite (1:1), vermiculite, illite (2:1)
- Secondary non-sillicate mineral: gibbsite

Results of Heavy Metal Analysis

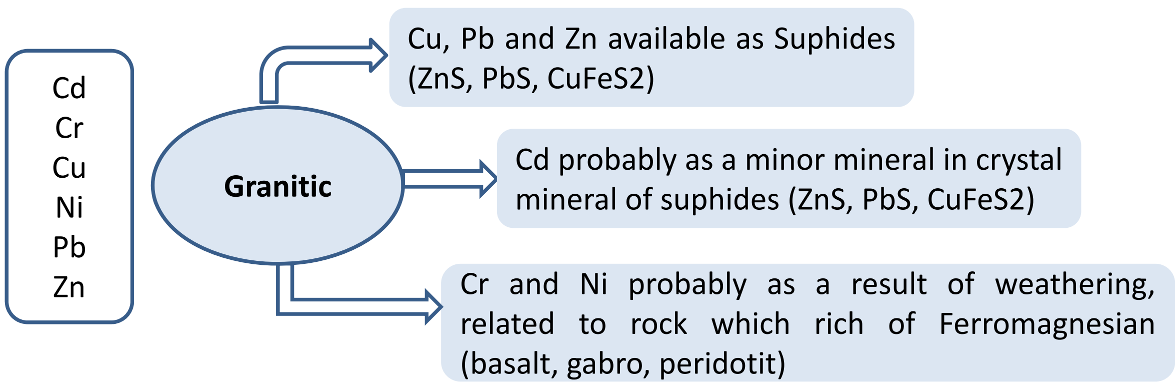
The Highest Concetration Among All Fraction of Heavy Metal in Forest and Post Tin Mined Land

Concentration of Heavy metal [mg/kg]	Forest	PML > 100 (sandy)	PML > 100 (forest)
Cadmium (Cd)	Non reliable	Non reliable	Non reliable
Chromium (Cr)	3,615 (S3)*	0,1 (S1)	0,02 (S1)
Copper (Cu)	2,728 (S2)	2,524 (S2)	1,425 (S2)
Nickel (Ni)	0,372 (S1)	0,76 (S1)	0,428 (S1)
Lead (Pb)	Non reliable	Non reliable	Non reliable
Zinc (Zn)	1,616 (S1)	0,175 (S3)	0,46 (S1)

* : Detected

All concentrations of heavy metal are below the treshold of ecology risk (*Ecological Investigation Level, Department of Environment and Conservation, Australia (2010).*

Source of heavy metal



- Cu is a mobile element and adequate high concentration than other elements.
- Undetected Cu in fraction 3 is supposed by completely leached in step 1 and 2. Then, remained the minor mineral which contain Cr and Ni can be detected in sulphide.
- Cr, Cu, Ni, relatively decreased, after natural succession.
- ZnS is supposed as the main sulphide mineral followed by PbS. Thus, Zn can be detected in all fractions.

Qualitative correlation with other soil properties

Properties	EPSC (Forest)	PML> 100 ys (sandy)	PML > 100 ys (small forest)
Sand [%]	52,94	96,96	70,85
Silt [%]	10,19	1,32	17,8
Clay [%]	36,87	1,72	11,35
pH	4,7	6,0	4,5
C-org [%]	2,00	0,08	1,17
N [%]	0,19	0,04	0,12
CEC [me/100g]	5,83	0,60	6,04
Ca [me/100g]	0,52	0,27	0,41
Mg [me/100g]	0,24	0,05	0,16

- Cr in forest is more potential than open area, due to pH more acidic than post tin mined land.
- The highest concentration of Cr, Cu, Zn is in the forest.
- The spatial distribution of Cu and Zn correlated to the soil organic matter distribution.
- There were indications that the immobile fraction of the heavy metals was adsorbed onto Mn-oxides (Aydinalp et al. 2003).

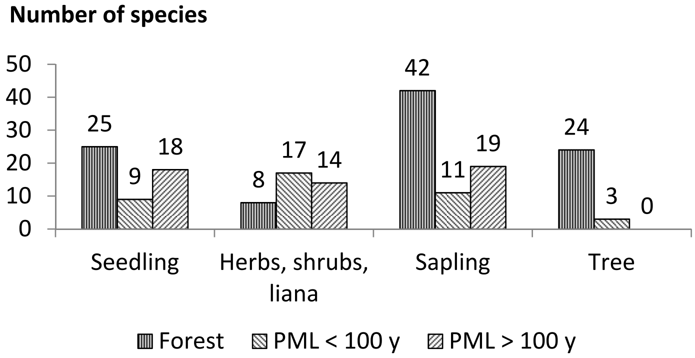
Results of Clay Mineral Analysis

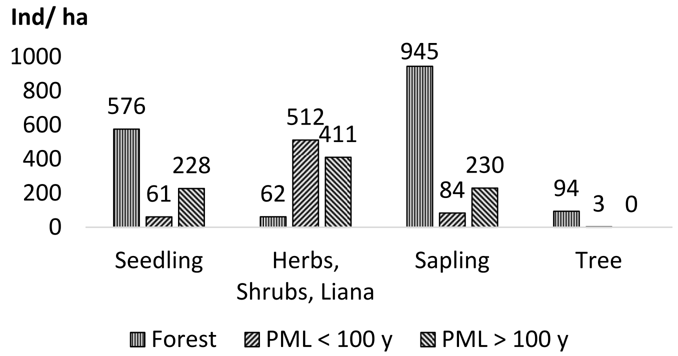
Clay Mineral Composition in forest and post tin mined land

Clay mineral	Forest	PML > 100 (sandy)	PML > 100 (forest)
Quartz	-	±	+
Orthoclas	-	+	+
Microcline	-	±	+
Vermiculite	+	-	+
Illite	+	++	++
Kaolinite	++	++	++
Gibbsite	+	+	±

- Dominant of kaolinite indicated the low of Cation exchange capacity.
- Found quartz is supposed by mining acitvity which digging the inside soil to the surface and indicated poor of nutrient
- Thus impact to sandy soil in that area, which need long time to recover the soil texture

Vegetation Composition





- Number of species and individual relatively decreased from forest ecosystem to PML < 100 years and PML > 100 years except for herbs,shrubs, liana species.
- Succession phase is still going on in post tin mined land. Thus, found some herbs, shrubs and some liana are pioneer species there.
- Presence of vegetation could influence the soil development process in soil organic matter availability.

Growth performance of some species

Rhodomyrtus tomentosa grow as shrubs and produced sufficient litters

Stunted *Callophylum lanigerum* which grow and produced fruit (generative phase)

Root of *Malaleuca leucadenron* grow on the soil surface

High density of saplings and small tree (thin), as a characteristic of heath forest ecosystem

Conclusion

- ✓ Heavy metal concentration in all locations are low and below the standard of Ecological Investigation Level. Thus, it is not necessary to conduct bio-remediation or phyto-remediation.
- ✓ Some heavy metals were detected in forest ecosystem in high concentration, it means that forest has a function to keep some elements and minerals.
- ✓ Heavy metal can be non essential nutrient for plant.
- ✓ For soils with low clay contents and/or low cation exchange capacity, application of organic fertilizer maybe an effective option to improve or maintain nutrient levels by providing nutrients and organic colloids

GSGES Experiences

Wakayama Field Trip (21-22 June 2014)



❖ Wakayama area has high potential to be developed as Agrotourism Area (from forest, slope plantation area, lowland and coastal area).

Visit Satoyama in Otsu and Kamigamo Experimental Station (26-27 July 2014)



❖ Kamigamo Experimental Station is invaded by fern which cover the forest floor. It is hindering the natural regeneration.

Lesson Learned during Study in Kyoto University

- My study in Kyoto U is very useful for my research in Indonesia, data and information about Heavy Metal and Clay Mineral will support my data to understand about soil condition in forest and post tin mined land in Belitung comprehensively.
- By learning soil properties (chemical, physical, biology), vegetation composition, geology and mineralogy history , I try to understand about ecology proccess.

京都大学

K : KEEN people
Y : YOKATTA....
O : Optimistic
D : DISCIPLINE atmosphere
A : ADVANCE technology
I : INSPIRE place

***Think Globally, Act Locally*!**


梅採り体験で交流
田辺高生徒と京大院生

「もし100人の村だったら」
世界の現状学ぶ
ユネスコ協会セミナー

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THANK YOU VERY MUCH ☺