ACACIA MANGIUM AS A NATURE BASED SOLUTION (NBS) FOR BIOREMEDIATION OF EX-TIN TAILINGS IN THE TROPICS

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OUTLINE

Issues in Mining Areas

Nature Based Solutions

Area of Interest & Methods

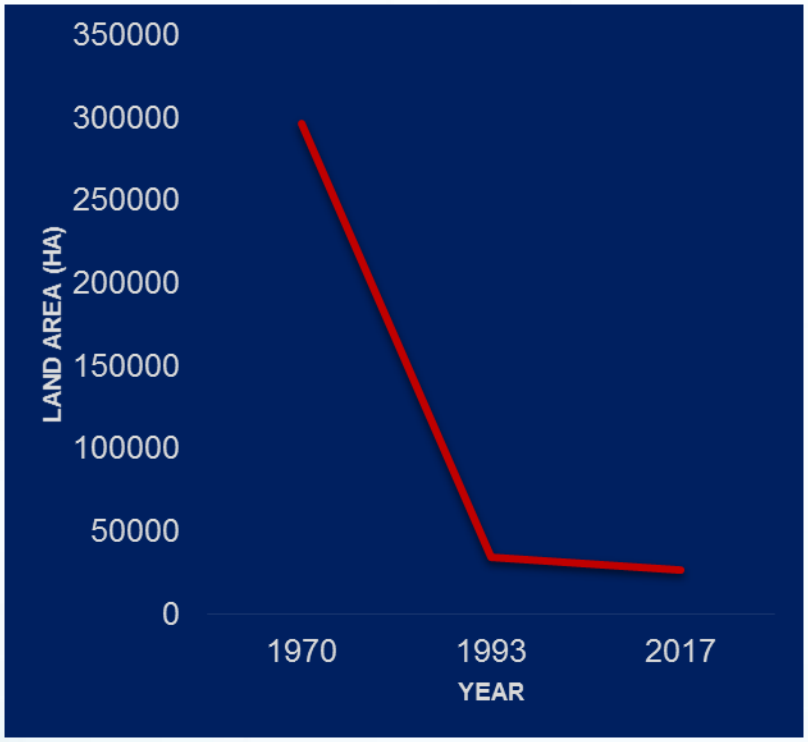
Results & Discussions

Summary

ISSUES IN MINING AREAS

- Land degradation : soil erosion, sinkhole formation, forest & biodiversity loss, **potentially toxic elements (PTE) such as Pb, Cd, Hg, Ni, As etc**.
- PTE: Although essential in small quantities, can be toxic to plants/ humans
- Availability is affected by soil pH, redox status, macronutrient levels, water and temperature
- Present in ex-mining areas in high quantity

ISSUES IN MINING AREAS



Historical data on land area of tin mining land in Malaysia, (Mineral & Geoscience Department of Malaysia)

- Mineral Development Regulations 2007 (Operational mining scheme)
- 'rehabilitation'… with forestry species
- 'pollution control'…… with phythoremediation
- Cheaper than engineering means but takes time
- Establishment of *new forests* ecosystems

NATURE-BASED SOLUTION

The main goals of NBS *actions is* ***to protect, sustainably manage and restore natural or modified ecosystems*** *that address societal challenges effectively and adaptively, simultaneously providing* ***human well-being and biodiversity benefits****".*

land

IUCN 2016. MDPI

Article

Soil-Related Sustainable Development Goals: Four Concepts to Make Land Degradation Neutrality and Restoration Work

Saskia Keesstra [1,2,*], Gerben Mol [3], Jan de Leeuw [4], Joop Okx [1], Co [illegible]
Margot de Cleen [5] and Saskia Visser [6]

ELSEVIER

Science of The Total Environment
Volumes 610–611, 1 January 2018, Pages 997-1009

Review

The superior effect of nature based solutions in land management for enhancing ecosystem services

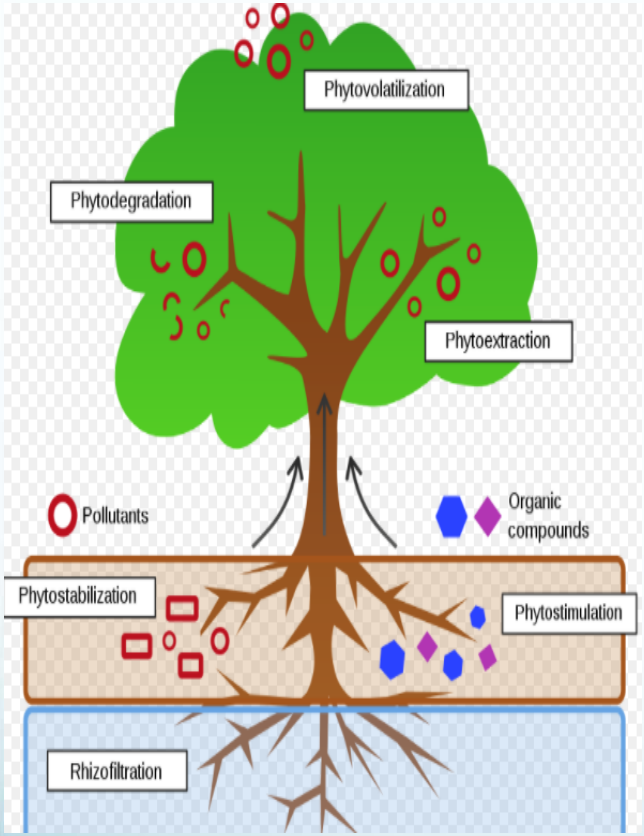
Saskia Keesstra [a, b], Joao Nunes [a, c], Agata Novara [d], David Finger [e], David Avelar [f], Zahra Kalantari [g]

NATURE-BASED SOLUTION

Acacia mangium

- Phytoremediation : process that utilizes plants to filter and remove contaminants via plant uptake (Muske et al., 2016)
- Acacias : non food crop; rapid growth; dense foliage; high absorption and tolerance to PTE
- Acacias can store PTE in leaves, shoot and roots (Veronica et al., 2011)
- Absorbs Zn, Pb, Cd, Cr in large amounts from sewerage sludge (Nik et al., 2012)

NATURE-BASED SOLUTION



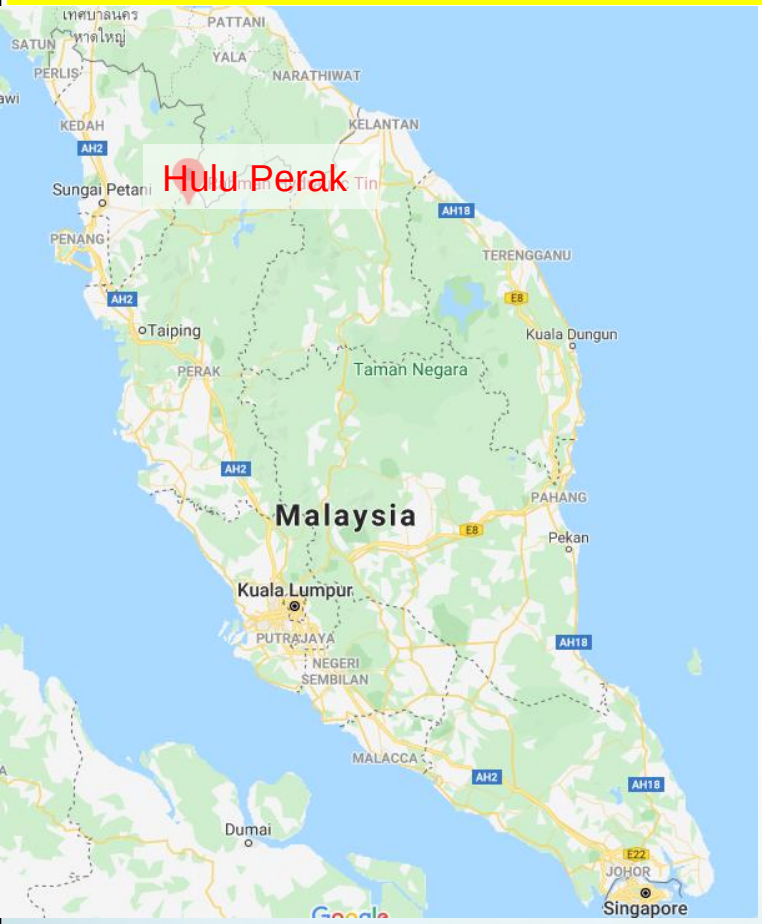
Acacia mangium

Jeyanny et al., (2017)

Elements	Plant parts	Level
Fe	Small roots, wood discs	High
Al	Small roots, wood discs	High
Zn	Leaves, wood discs	Medium
As	Leaves	Low
Pb	Small roots	Low
Ni	Small roots	Negligible
Hg	Nd	Negligible
Cu	Leaves, small roots	Negligible

High ***:> 50% Fe; > 25 mg/kg Al***
Medium ***: 3.5 - 30 mg/kg***
Low ***: < 5 mg/kg***

AREA OF INTEREST



- Hulu Perak, Perak
- Used for tin mining since 1900's
- Ex-tin mining ponds with mud, liquid, sand, silt & sand
- December 2011: *Acacia mangium* was planted in 4 ha, spacing 2 x 2 and 4 x 4 m as pioneer species.
- Planting holes mixed with fertilizer and composts

Then

Now

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METHODS

Soil sampling up to 65 cm depth, Feb 2016

PTE analysis in soil using Aqua-regia method

Sampling of plant parts at site

RESULTS

Table 1: Bioconcentration factor and translocation factor for 4 year old *Acacia mangium* trees on tin tailings.

Metal concentration	Al	Fe	S	Pb	Zn	Ni	Cu
	mg/kg						
Bioconcentration factor	<0.00	0.08	40.00	0.22	0.25	0.23	0.16
Translocation factor	**175.82**	**623.90**	0.41	0.50	**4.64**	0.50	**1.73**

BCF : Element concentration ratio of roots to soil
TF : ratio of heavy metals in aerial parts to roots **(Yoon et al., 2006)**

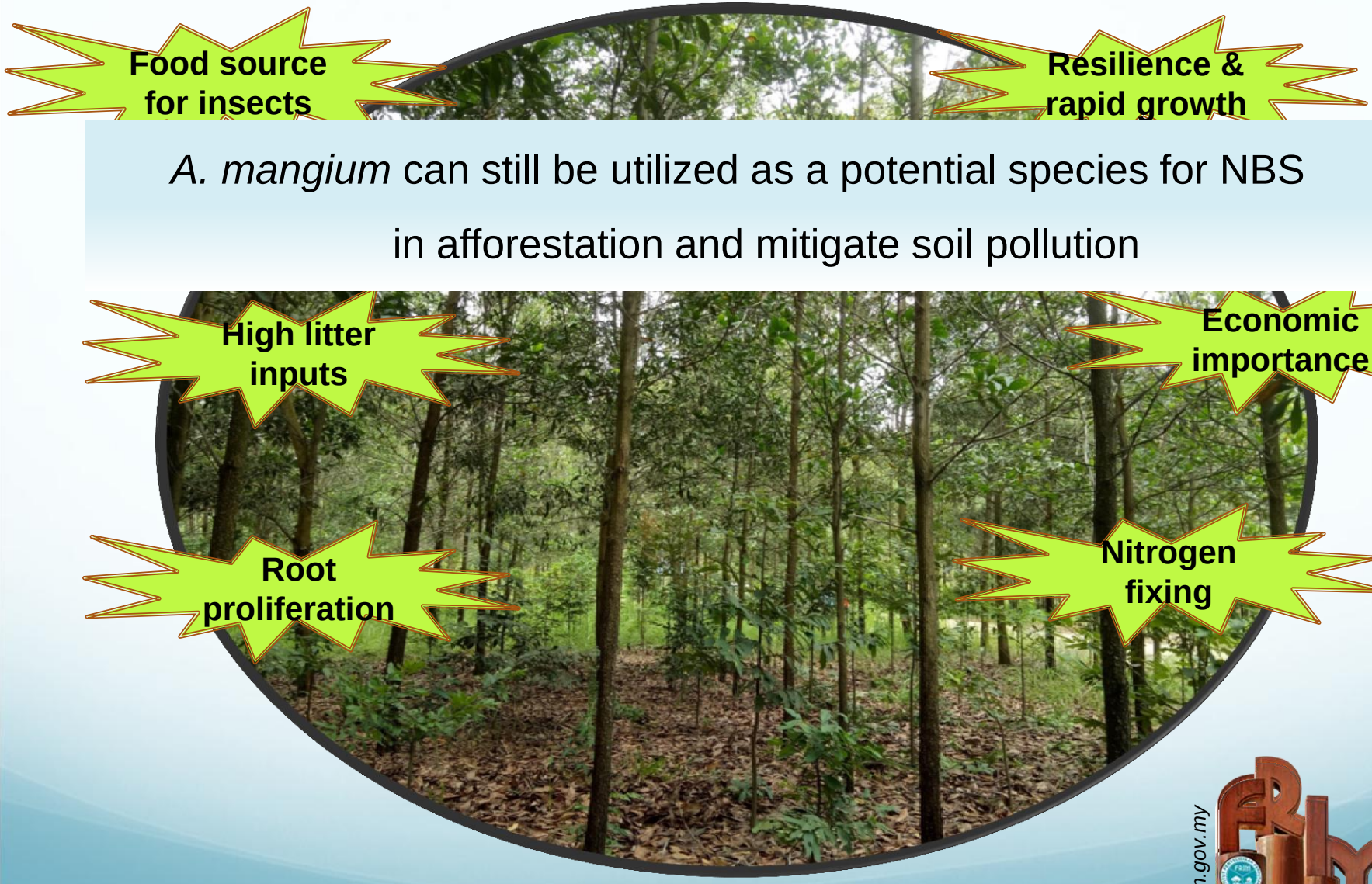
TF < 1 : metal excluder
TF > 1 : metal accumulator **(Baker et al., 1981)**

DISCUSSION

- Phytoaccumulators are noted for having high TF and high BCF (Yoon et al., (2006)
- *A. Mangium* in this study had high TF and low BCF following Nik et al., (2012)

- Soil pH < 5.5, Al toxicity occurs (Mossor-Pietraszewska et al., 1997)
- Pb may have bind with Fe, Mn and Al oxides (Angelova et al., 2009), hampering absorption

SUMMARY



A. mangium can still be utilized as a potential species for NBS in afforestation and mitigate soil pollution

4 yr old Acacias with 3 yr old *Shorea roxburghii*

NbS: New Forests

Voluntary Guidelines on Sust'. Soil Mgt

GLOBAL SOIL PARTNERSHIP

3.1 Minimize soil erosion

3.3 Foster nutrient balance

Germplasm pool

3.7 Biodiversity Enhancement

Maintenance & Measurement

Tree planting

Site Assessment

New Forests

3.5 Minimize contamination

3.2 Enhance SOM/Carbon pool

Income generation

UPDATES

- Introduction of endemic timber species in November 2018
- Regular maintenance of nurse trees and endemic species
- Further investigations on soil and plant tissue properties on PTE absorption

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