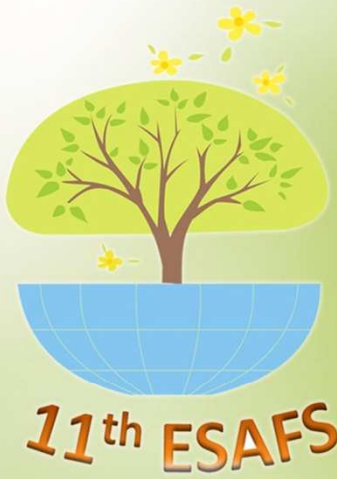

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LANDSCAPE FUNCTION ANALYSIS, A SIMPLE PROCEDURE FOR MONITORING SOIL SURFACE CONDITION IN REHABILITATED MINE SITES

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Abstract

The protocol of Landscape Function Analysis (LFA) has been utilised to assess rehabilitated mine sites by observing 11 key factors of soil surface condition that range from soil cover to soil texture (Tongway and Hindley, 1995). Individual transect of 50-m long was established at revegetation sites and undisturbed forest respectively. Recent results from two mine sites (coal mine sites at PT Tambang Batubara Bukit Asam, Tanjung Enim) and ex-tin mine site of PT Kobatin in Central Bangka demonstrated the potential use of this protocol. Soil recovery is indicated by increasing aggregate stability from 30 % to about 60 %. The values of individual LFA indices (stability, infiltration and nutrient cycling index) vary by up to 10 % between the sites, which reflects characteristics of the dominant surface zones for the whole landscape. Patch area index (PAI) increased steadily with age of revegetation to nearly 60 % which is close to the value for forest. The infiltration (mean 34 %) and nutrient cycling indices (mean 27 %) for the revegetation sites are considerably lower than values for the forest site (infiltration 55 %, NCI 48 %) largely due to differences in litter abundance and vegetation cover.
Keywords: landscape function analysis, minesite rehabilitation, recovery index

Introduction

With environmental regulations increasingly stringent, liability for environmental remediation is already part of the mining operation plans (Johnson *et al*., 1994; Danielson and Nixon, 2000). Use of land surface conditions as a basis for evaluation provides a range of facilities and practicality (Tongway and Ludwig, 2002). Monitoring method can provide a good prediction of functional or non-functional tendency an ecosystem so that corrective action can be implemented immediately (trajectory analysis). Further monitoring of the potential use of the LFA method has been tried in various types of post-mine land in Australia (Tongway *et al*., 2003) and elsewhere in Africa and Iran, but the LFA method has never been widely applied in the tropics of Indonesia. The purpose of this study was to examine the use of LFA procedures on a variety of post-mining landscapes.

Materials and Methods

The first year of study (Setyawan *et al*., 2007) seeks to determine the suitability of the LFA indicators for the assessment of land condition recovering from post-mining activities. Research was done on-site for coal mine (PTBA Tanjung Enim) and tin mine (PT Kobatin at Koba, Central Bangka). Observation of landscape function analysis was done in stages as follows. The first is to recognize landscape zones that influence accumulation or erosion of resources (soil particles, litter, and water). The second is to set up transect (50-m long) that can represent various land landscape zones based on observations in the first stage. Based on the value (score) obtained for each of the land surface properties, a further set of three sorts namely the index of stability, infiltration and nutrient cycles (Tongway and Hindley, 1995).

Results and Discussion

Stability index generally increases more rapidly than two thers (Table 1). Species for revegetation contributes to enrich soil surface due to litter accumulation and decomposition. Post-mining land in Tanjung Enim was mostly planted with *Acacia formis* and *Acacia mangium*, eucalyptus (*Melaleuca leucadendron*). Several species of shrubs and grasses have

naturally colonized the land. At the older site (2000) revegetation in Muara Tiga Besar Utara also planted bamboo and sengon (Albizia).

History of the post-mining land revegetation in PT Kobatin had started in 1976, while the tin mine operation itself has been running in the area Nibung since 1973. Revegetation conditions quite varied with different types of plants used for reforestation. Some plant species have also been growing naturally in the post-mining area. Materials used for the reclamation consist of tailings sand, slime and clay, humus soil and laterite soil. These materials have different properties and characteristics therefore revegetation success may vary with plant species and even the same age. Type of plant that is widely used *Acacia formis, Acacia mangium, E. urophylla,* and eucalyptus. Initial composition of the plant began in 2000 was changed to include more local forest tree species such as melangir (Shorea belangeran), nyato (Palagioum), Leban (*Vitex pubescens*), ubak (*Eugenia* sp). Until 2004 PT Kobatin has rehabilitated 3,635 hectares of land and 446 acres of former pit.

Table 1. Index of stability, infiltration and nutrient cycling of coal and tin mined lands

Mine type	Site revegetation	Stability (%)	Infiltration (%)	Nutrient cycle (%)
Coal mine	Land ready 2007	40.3 ± 1.0	21.8 ± 1.0	11.2 ± 0.7
	Reveg 2006	55.1 ± 6.1	33.7 ± 2.7	25.8 ± 2.4
	Reveg 2005	50.3 ± 1.1	34.5 ± 3.3	26.2 ± 4.7
	Reveg 2000	59.7 ± 5.7	33.6 ± 4.2	28.7 ± 4.8
	Secondary forest	71.8 ± 0.8	54.9 ± 0.1	47.9 ± 0.1
Tin mine	Bemban South 2003	56.5 ± 0.4	37.4 ± 2.0	29.5 ± 2.7
	Bemban 12000/2001	61.7 ± 1.8	37.3 ± 3.8	30.5 ± 0.6
	Jongkong-12 1993	51.6 ± 0.4	37.3 ± 0.2	26.5 ± 0.4
	Secondary forest	77.5 ± 3.5	61.0 ± 4.3	52.8 ± 4.1

Conclusions

Recovery takes place relatively fast in the former location of Tanjung Enim coal mine. The three indices of landscape function analysis (stability, infiltration and nutrient cycling) increased with increasing age of revegetation. Whereas in the former tin mining land in Koba these index values change slowly and tend to fluctuate because of potential interference by local miners.

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