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Research Article

Ecosystem evaluation of post sand mining land in Cimalaka, Sumedang

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Abstract: This research was conducted to evaluate ecosystem function of post-sand mining land in northern side of Layapan, Cimalaka, Sumedang, West Java (S 6^o 47' 33.68" and E 107^o 58'18.73", 744 m above sea level). Microclimate and soil characteristics measurements were carried out to describe the physical and chemical characteristics of the land. Vegetation analysis was conducted with plotting method. Ecosystem Function Analysis, including Landscape Function Analysis (LFA) has been used to analyze the function of landscape. The results showed that average light intensity, air temperature and humidity were $15.2 x 10^3 \pm 7.3 x 10^3$ lux, 29.1±1.02^{o}C and 69.7±7.5%. High light intensity made the air temperature rouse higher than normal, which is between 17.1^{o}C to 22^{o}C. As for the soil, soil organic content was 4-11%, porosity 4.65-24.43%, macronutrient content was low and C/N ratio was high. The results showed that LFA value for land stability was 33.24%, water infiltration 37.2%, nutrient cycle rate 15.28%. Those numbers showed that land condition was poor. From the LFA data, it was also known that vegetations had the highest contribution for all LFA parameters. From vegetation analysis, herbs species were 67 while bushes only 9, which at least 40 species were invasive alien species. Species with highest Important Value (IV) from herb was *Cajanus scarabaeoides* and from bush was *Mimosa pigra*. Both of them are members of Fabaceae. It was concluded that the soil of this post sand mining land was highly nutrient poor; critical and couldn't perform the regulation, habitat and biomass production function of ecosystem.

***Keywords**: ecosystem analysis, sand mining*

Introduction

Imbalance interaction of human and its technology with natural life leads to the ecosystem degradation. Human has every tendency to treat nature as "limitless resources" without compromising the sustainability aspect (Hopkinson and Stern, 2002). Human beings utilize natural resources within short term interest without thinking about the sustainable future of the resources, or even, the sustainable future of human race itself (Balakrishnan, 1994). Yet, it is not wrong to utilize the natural resources, for every living organism needs to do it. The question is how to use it wisely. An example of a less wise use of natural resources is the un-properly managed sand mining in Cimalaka, Sumedang, West Java. Cimalaka is well known for its high quality sands for building material, as the sands have quite little part of soil. As well, the area plays an important role as catchment area and supplying water for several natural springs. Naturally, it was forested and the forest play as a shield towards erosion, for it was located in hills area. Unfortunately, the sand mines opened in the area are less managed and have degraded the local lands heavily. Yet, there was very little scientific data about it to say if the ecosystem was damaged. This research was conducted to evaluate ecosystem condition of post sand mining land in Cimalaka, Sumedang as well as describing the environmental impacts of the activity.

Methods

The research was conducted in northern side of Layapan, Cimalaka, Sumedang, West Java on February to April of 2011. Geographically, it was located at S 6^o 47' 33.68" and E 107^o 58' 18.73" and its altitude was 744 ± 3 m above sea level. It was adjacent with 'Tempat Pembuangan Akhir' (TPA) Gunung Karang and Taman Wisata Alam (TWA) Gunung Tampomas. Naturally, it was classified as temperate type climate according to Schmidt-Ferguson Classification, the location has B type climate (wet) with ratio of dry months to wet months about 14%-33% (Whitten *et al*., 2000).

A field study was conducted with modifying Ecosystem Function Analysis (EFA) method from Tongway and Hindley (2004). It was including microclimate (light intensity, air humidity and temperature) and soil characters (including macronutrients content) measurements and Landscape Function Analysis (LFA, www.cse.csiro.au). With LFA, the site was described including its geographic location with GPS receiver, type of soils, vegetation type and land use. Then, the landscape organization was characterizing to collect information about the type and size of each landscape patch and inter patch. Soil surface assessment was conducted in each patch and inter patch.

Vegetation analysis was conducted using plots method, 1x1 m^2 x 78 plots for herbs and 4x4 m^2 x 25 plots for bushes. Parameters measured were including coverage, frequency, important value for herbs and coverage, frequency, abundance, important value for bushes. The plants were identified using Flora for Indonesian Schools (van Steenis, 1997), Flora of Java (Backer and Brink, 1963; 1965; 1968) and The Mountain Flora of Java (van Steenis, 1972).

Results and Discussion

Low vegetation cover led to high light intensity, about $15.2 x 10^3 \pm 7.3 x 10^3$ lux. Average temperature was 29.1±1.02°C with air humidity about 69.7±7.5%. In van Steenis (1972), it was stated that average temperature at sea level in Java was 26,3°C and decreased with 0.61°C per 100 m height. From this, we could say that the temperature of the site (744 m above sea level) should be about 21.76°C. There was a gap about 7.34°C. It showed that low vegetation cover has changed the microclimate condition of the site including increase the total radiation received by soil surface and the temperature-rise of the almost bare site.

The soil has no organic horizon with pH 6.97±0.3, soil humidity 10-21.67%, soil temperature 24.33-29.5°C. The soil condition could vary locally depending on type of substrate, litter coverage, topography and shading and vegetation coverage. Table 1 shows another soil characteristics measured and how the soil has low macronutrient content, with standard on Hardjowigeno (1987), including nitrogen. In Mitsch and Jorgensen (2004), it was stated that low nitrogen content was a characteristic of post mining land.

Table 1 Soil characteristics of the site

Parameters	Sand	Sandy Loam
Bulk density	0.045	0.11
Organic content (%)	4.5	11
Porosity (%)	10.74	24.43
C organic (%)	0.56	0.96
N organic (%)	0.01	0.03
C/N	70.5	30
Phosphor Olsen (mg/kg)	10.3	18.3
Potassium Morgan (mg/kg)	290.05	451.4
K_2O (HCl) (mg/kg)	371.55	577.5

This result will impact on the vegetation life on site. As the land has low macronutrient content, it would only the poor soil adaptive plants could life on site. The site landscape has the critical condition with value for land stability was 33.24%, water infiltration 37.2%, soil nutrient cycle 15.28% (Table 2) thus could not perform its regulation function. These low values for stability and water infiltration were the major causes for erosion and land sliding in the area. As stated in long term regional planning of Sumedang Regency, sand mining and post sand mining areas in Cimalaka are classified as disaster-prone areas.

Table 2 Landscape Function Analysis results

Transect	Stability (%)	Water Infiltration (%)	Nutrient Cycle (%)
1	34.42 ± 1.44	38.57 ± 0.16	18.42 ± 1.04
2	35.53 ± 2.45	37.94 ± 0.67	15.82 ± 0.98
3	35.41 ± 2.66	37.07 ± 0.84	14.52 ± 1.17
4	29.96 ± 1.06	36.40 ± 0.35	13.59 ± 0.47
5	30.89 ± 1.09	36.02 ± 0.42	13.05 ± 0.57
Average	33.24 ± 2.63	37.20 ± 1.06	15.08 ± 2.14

The LFA results showed that the perennial herbs were contributing 69.45% for land stability, 70.18% for water infiltration and 71.19% for soil nutrient cycle. It meant vegetations had the highest contribution for landscape condition.

The land was covered by herbs and bushes. Total vegetation consisted of 67 species of herbs and nine species of bushes. Predominant herb species was *Cajanus scarabaeoides* which is adaptive to the dry region (Backer and Brink, 1963; van Steenis, 1997), while predominant bush was *Mimosa pigra*. Both of *C. scarabaeoides* and *M. pigra* are members of Fabaceae.

All top five herbs species were from Fabaceae family, except for *Pennisetum polystachion* from Poaceae family (Figure 1). All four Fabaceae species are known ad common species found in disturbed open land ecosystem (Backer and Brink, 1963; 1965; 1968). The others two herbs families with high important value were Asteraceae and Poaceae. The two were adaptive on the site due to physical condition of the open land site which was suitable for the dispersion of their seeds by wind (Backer and Brink, 1963; 1965; 1968). *Mimosa pigra*, the predominant bush had important value (IV) of 108.3%. In SEAMEO (2011), it was stated that *M. pigra* is an alien invasive species. Another bush, *Eupatorium inulifolium* (IV 66.8%) was known as weed and indicator plant species for disturbed land (JICA, 2006). Other bushes found on site were *Gliricidia sepium* (IV 45.8%), *Calliandra calothyrsus* (IV 33.3%), *Cassia siamea* (IV 8.5%), *Ricinus communis* (IV 8.5%), *Leucaena leucocephala* (IV 6.5%), *Psidium guajava* (IV 6.5%) and *Carica papaya* (IV 5.8%). Total important value for shrubs was 300%. All of bushes species found on site were adaptive to intensive sunlight, low soil nutrient content and drought (Backer and Brink, 1963-1968; SEAMEO, 2011).

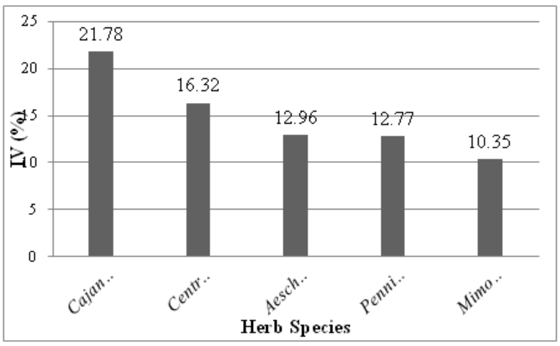

Figure 1. Top five of herbs species Important Value (IV). Total IV for all 67 herbs species was 200%.

The land was mined repeatedly without appropriate reclamation effort, thus supported the invasive plants species to cover the site. There were about 40 invasive plants species, i.e. *E. inulifolium*, *M. invisa*, *M. pudica*. *Gynura crepidiodes*, *Porophyllum ruderale*, *Sonchus arvensis*, *Cyperus iria*, *Kyllinga brevifolia*, *C. eragrostis* and *Peperomia pellucida* (SEAMEO, 2011). The results also showed that the site was undergoing succession. There were *Mikania cordata*, *Erigeron sumatrensis*, *Nephrolepis exaltata* and *Stachytarpeta jamaicensis* indicating the characteristic of young secondary forest. As well, there were propagules of trees counted as bushes, such as *Calliandra calothyrsus*, *Cassia siamea*, *L. leucocephala* and *Psidium guajava*. The succession was classified as secondary succession for the site's substrate was not totally change (Luken, 1990).

Conclusion

The research showed that the northern side of Layapan, Cimalaka, Sumedang was in critical condition with low level of stability, water infiltration; had macronutrient poor soil content and couldn't perform its regulation, habitat and biomass production function.

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