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Plant Species Richness After Revegetation on The Reclaimed Coal Mine Land of PT Adaro Indonesia, South Kalimantan

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Abstract

The focus of monitoring was the plant purposely cultivated because after re-vegetation, there were a very few of other plants growing naturally on reclimed coal mining area which were recorded, whereas these plants had important values. The research aimed to record all plants and to identify predominant plants over the reclaimed land of PT Adaro Indonesia. There were four sampling locations with 13 squares of 50 × 20 m^2 on each location established and on each square there were 5 plots of 2 × 2 m^2 plotse made. Both plant species and its individual number of woody-plant saplings were recorded on each square, so in each plot, there were small species and its individual number of either woody-plant seedlings or non-woody plants (herbs/shrubs, grasses, ferns). The relative density and the relative frequency of woody or non-woody plants were summed to obtain the important value index (IVI) of each successional stage. There were 107 plant species consisting of 32, 43, 27, and 5 species of saplings, seedlings/herbs/shrubs, grasses, and ferns respectively. From those species, 16 species of woody plants and 2 species of herbs were planted purposely,other species grew naturally and even some of them were dominants. Either the number of plants or the dominating plant is varied according to the sampling location and the growing stage.

Keywords: plant, revegetation, richness, sapling, seedling

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Introduction

Almost all coal minings in Indonesia use open mining system. The system converts the landforms and influences the biotic components (plants, animals), the abiotic components (physical, chemical), and the community (social, economics, culture). According to Subowo (2011), open coal-mining should be conducted carefully, due to the conversion of the landform, the damage of soil structure, the lack of top soil, the change of top soil ecosystem equilibrium, the decrease of land productivity, and the reduce of the environmental quality.

Based on *Perjanjian Karya Pengusahaan Pertambangan Batubara (PKP2B)* with Indonesian Government, PT Adaro Indonesia, the coal-mining company operating in Balangan Regency and Tabalong Regency, South Kalimantan Province, commits to reduce the negative impact of coal mining as maximum as possible. Basically the commitment is an obligatory and has to be realized by all coal-mining companies. After mining coal, the company has to reclaim the ex-coal-mining area and then conducts re-vegetation on this area. The plants for re-vegetation have to fulfil the conditions of government's regulations. The development of vegetation is monitored periodically suitable with the guidances mentioned in the environmental documents. Monitoring results are reported to the related institution (Ministry of Environment, Ministry of Forestry).

The main focus of environment monitoring by the coal companies in Indonesia is the plants planted purposely. Not many plants growing naturally after re-vegetation are recorded. In fact, such plants are not less important than the plants for re-vegetation. The research was conducted not only to entirely record all plants growing after re-vegetation on the reclaimed coal mininge land, but also to identify the predominant ones based on the successional stage.

Data on plants after re-vegetation is necessary. They can be used as an initial standard relation with what the company will do or what it has to do later. In the other words, it is necessary to develop a standardation to evaluate the success of re-vegetation and to soundly plan the next treatments (planting, replanting, enriching, maintaining) on the reclaimed land.

Methods

Data were collected in December 2013 on the reclaimed ex-coal-mining area of PT Adaro Indonesia. There were four sampling locations representing the area. The coordinate of the sampling locations and the date of planting were presented in Table 1, but the positions were shown in Figure 1.

On each location, 13 squares of 50 × 20 m^2 were established systematically, and on each square, 5 plots of 2 × 2 m^2 were made. One plot was positioned on the center of the

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Table 1 Coordinate of sampling locations and date of planting

Loc. no.	Sampling location	Area (ha)	Coordinate		Date of planting (re-vegetation)	Age till December 2013	
			E	N		Year	Month
1	Disposal C 6-7	1.39	338619	9760701	September 2012	1	3
2	Disposal Wara	1.36	330507	9758599	May 2012	1	7
3	Disposal S-7	3.21	330914	9753890	February 2012	1	10
4	Disposal IPBF	2.27	330932	9752964	February 2012	1	10

Figure 1 Four sampling locations.

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square and the others were on each corner of the square.

Data recorded on each square were about both the plant species and the number of sapling species, but on each plot, the data were about the plant species and the number of seedling species for woody plants and herb/bush, grass, or fern for non-woody plants. The initial survey showed that no woody plant was pole (diameter 10 − < 20 cm) or even tree (diameter ⩾ 20 cm). The existing woody plants were seedlings (height < 1.5 m) or saplings (height ⩾ 1.5 m with diameter < 10 cm).

Data were analyzed to obtain important value index (IVI) for each growing stage. IVI of seedling is the sum of RD (relative density) and RF (relative frequency). The similar way is for both IVI of sapling and IVI of non-woody plant. The formulas are as shown in Equation *[1]*, Equation *[2]*, Equation *[3]*, and Equation *[4]*,

$$D_i = \frac{\text{Individual number of species - i}}{\text{The area of sampling plots or square}} \times 100\% \qquad [1]$$

$$RD = \frac{\text{Density of species - i}}{\text{Density of all species}} \times 100\% \qquad [2]$$

$$F_i = \frac{\text{The number of plots of squares species - i found}}{\text{The number of plots or squares}} \qquad [3]$$

$$R = \frac{\text{The number of plots of square species - i found}}{\text{The number of plots or squares}} \qquad [4]$$

Results and Discussion

There were 107 plant species found in four sampling locations namely 32 woody sapling species, 43 species of seedlings/herbs/shrubs, 27 species of grasses, and 5 species of ferns (Table 2). From this number, there were 16 woody plant species and 2 species of herbs which were proposely planted. The others were the wild plant species which grew naturally.

Table 2 Plant species and its IVI in each sampling location

No.	Family	Scientific name	Indonesian name	Loc-1	Loc-2	Loc-3	Loc-4
A	**Woody plants**						
1	*Caesalpinaceae*	*Cassia siamea*	Johar	**45.53**	26.12	12.20	22.07
2	*Caesalpinaceae*	*Sesbania grandiflora*	Turi	39.52	0.94	**57.37**	3.75
3	*Euphorbiaceae*	*Hevea brasiliensis*	Karet	0.00	3.85	0.00	0.00
4	*Lamiaceae*	*Gmelina arborea*	Gmelina	7.06	34.26	0.00	0.00
5	*Malvaceae*	*Ceiba pentandra*	Randu	0.00	0.94	1.48	0.00
6	*Mimosaceae*	*Acacia auriculiformis*	Akasia daun kecil	0.00	0.00	9.06	15.78
7	*Mimosaceae*	*Acacia mangium*	Akasia daun lebar	0.00	10.97	13.05	11.05
8	*Mimosaceae*	*Calliandra callothyrsus*	Kaliandra	10.22	3.45	15.07	4.04
9	*Mimosaceae*	*Leucaena glauca*	Lamtoro	23.03	12.67	47.06	**43.30**
10	*Mimosaceae*	*Paraserianthes falcataria*	Sengon	37.91	**37.33**	9.60	7.65
11	*Mimosaceae*	*Samanea saman*	Trembesi	0.00	0.00	9.19	0.00
12	*Myrtaceae*	*Eucalyptus alba*	Alba	0.00	0.00	3.95	0.00
13	*Myrtaceae*	*Eucalyptus* sp.	-	0.00	9.49	9.68	0.00
14	*Myrtaceae*	*Melaleuca cajuputi*	Galam	0.00	8.77	0.00	0.00
15	*Papilionaceae*	*Gliricidia sepium*	Gamal	6.27	0.00	0.00	0.00
16	*Rubiceae*	*Anthocephalus cadamba*	Jabon	0.00	12.77	0.00	0.00
17	*Euphorbiaceae*	*Endospermum malaccense*	Merbulan, kayu labu,	0.00	0.00	0.00	1.21
18	*Euphorbiaceae*	*Homalanthus populneus*	Kareumbi	0.00	14.51	0.00	0.57
19	*Euphorbiaceae*	*Macaranga gigantea*	Mahang	0.00	3.75	0.00	0.00
20	*Euphorbiaceae*	*Macaranga heynei*	-	0.00	0.00	0.00	4.47
21	*Euphorbiaceae*	*Macaranga trichocarpa*	-	9.34	0.00	0.00	12.64
22	*Euphorbiaceae*	*Macaranga triloba*	Mahang damar	0.00	2.24	0.00	2.83
23	*Euphorbiaceae*	*Mallotus paniculatus*	Balik angin	0.00	0.00	0.00	2.98
24	*Lamiaceae*	*Vitex pubescens*	Halaban	0.00	2.91	0.00	32.54
25	*Malvaceae*	*Commersonia bartramia*	Blencong	2.54	8.30	0.00	2.84
26	*Moraceae*	*Ficus grossularioides*	Ara perak	0.00	0.00	0.00	3.12
27	*Moraceae*	*Ficus uncinata*	Entimo, maning	15.58	1.12	4.62	0.00
28	*Myrtaceae*	*Syzygium polyanthum*	Salam	0.00	0.00	0.00	2.63
29	*Rubiaceae*	*Pavetta wallichiana*	-	0.00	0.00	0.00	2.34
30	*Rutaceae*	*Melicope* sp.	-	0.00	0.00	0.00	6.67
31	*Ulmaceae*	*Trema cannabina*	-	2.98	0.00	7.66	0.00
32	*Ulmaceae*	*Trema orientalis*	Angrung, mengkirai	0.00	5.60	0.00	17.54
		IVI total for woody plants		200.00	200.00	200.00	200.00
B	**Seedlings/herbs/shrubs**						
1	*Caesalpinaceae*	*Centrosema pubescens*	Kekacangan, kibesin	31.50	9.29	37.70	4.15
2	*Papilionaceae*	*Pueraria phaseoloides*	Kacang ruji, krandang	3.99	**75.72**	20.86	3.64
3	*Acanthaceae*	*Asystasia intrusa*	Gandarusa	-	-	2.21	-
4	*Amaranthaceae*	*Amaranthus spinosus* L	Bayam duri	-	-	1.69	-
5	*Asteraceae*	*Ageratum conyzoides*	Bandotan	10.27	-	-	7.82
6	*Asteraceae*	*Crassocephalum crepidioides*	Sintrong, jambrong	3.61	-	-	2.53
7	*Asteraceae*	*Eupatorium odoratum* L	Kirinyuh	0.37	-	17.92	10.29

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Table 2 Continued

No.	Family	Scientific name	Indonesian name	Loc-1	Loc-2	Loc-3	Loc-4
8	*Asteraceae*	*Mikania micrantha*	Mikania	-	14.26	-	0.84
9	*Asteraceae*	*Porophyllum ruderale*	Ketumbar bolivia	7.97	-	14.86	9.31
10	*Asteraceae*	*Vernonia cinerea*	Sapapulut, sawi langit	0.31	-	2.16	3.31
11	*Asteraceae*	*Wedelia trilobata*	Seruni rambat	19.22	-	1.69	-
12	*Butomaceae*	*Limnocharis flava*	Genjer	7.41	-	-	-
13	*Caesalpinaceae*	*Cassia alata*	Gulinggang	0.93	-	-	-
14	*Caryophyllaceae*	*Drymaria villosa*	Cemplongan	0.99	-	-	-
15	*Convolvulaceae*	*Merremia peltata*	Bidaraan, mantangan	28.20	2.96	15.75	13.60
16	*Cycadaceae*	*Cycas* sp.	-	-	-	-	0.22
17	*Hemerocallidaceae*	*Dianella ensifolia*	Jambaka, menuntil	-	3.23	1.11	-
18	*Hypoxidaceae*	*Molineria capitulata*	Bedur, congkok	3.29	-	-	20.31
19	*Lamiaceae*	*Hyptis capitata*	Kenop	1.87	-	-	0.29
20	*Malvaceae*	*Hibiscus radiatus*	Mrambos merah	2.42	-	2.69	-
21	*Malvaceae*	*Melochia corchorifolia*	-	-	0.67	-	1.16
22	Ma*lvaceae*	*Sida rhombifolia*	Sidaguri, otok-otok	-	-	3.85	-
23	*Malvaceae*	*Urena sinuata*	Pulutan	-	-	-	9.53
24	*Melastomataceae*	*Melastoma affine*	Karamunting (kecil)	-	4.18	-	**29.05**
25	*Melastomataceae*	*Melastoma malabathricum*	Karamunting (besar)	2.24	5.12	-	22.99
26	*Menispermaceae*	*Cyclea laxiflora*	-	5.10	0.94	1.23	10.98
27	*Mimosaceae*	*Mimosa pigra*	Pamayahan	-	11.04	2.27	-
28	*Mimosaceae*	*Mimosa pudica*	Putri malu	5.10	-	15.15	1.73
29	*Myrtaceae*	*Rhodomyrtus tomentosa*	Jejambuan	-	4.44	3.79	9.46
30	*Papilionaceae*	*Cajanus cajan*	Kacang gude	-	-	-	0.22
31	*Papilionaceae*	*Crotalaria micans*	Orok-orok (runcing)	**36.63**	56.42	**38.22**	14.00
32	*Papilionaceae*	*Crotalaria pallida*	Orok-orok (bundar)	0.93	3.23	7.39	-
33	*Papilionaceae*	*Crotalaria retusa*	Orok-orok (runcing)	4.36	-	1.11	-
34	*Papilionaceae*	*Desmodium heterocarpon*	Buntut meyong sisir	-	1.48	-	1.35
35	*Papilionaceae*	*Flemingia macrophylla*	Pok kepokan	2.50	-	-	-
36	*Passifloraceae*	*Passiflora foetida*	Permot	8.09	-	5.13	4.55
37	*Phyllanthaceae*	*Phyllantus reticulatus*	Mangsi	-	6.07	-	0.95
38	*Phyllanthaceae*	*Sauropus* sp.	Kekatukan	0.62	-	-	14.80
39	*Polygalaceae*	*Polygala paniculata*	Sasapuan, jukut rindik	3.11	-	-	-
40	*Rubiaceae*	*Borreria alata*	Rumput setawar	6.22	-	-	2.73
41	*Rubiaceae*	*Mitracarpus hirtus*	-	0.37	-	-	-
42	*Verbenaceae*	*Stachytarpheta indica*	Pecut kuda	2.36	-	3.21	-
43	*Zingiberaceae*	*Alpinia malacensis*	Lengkuas hutan	-	0.94	-	0.22
		IVI total for seedllings/herbs/shrubs		200.00	200.00	200.00	200.00
C	**Grasses**						
1	*Cyperaceae*	*Cyperus difformis*	-	**26.24**	-	0.46	-
2	*Cyperaceae*	*Cyperus eragrostis*	-	16.84	10.04	7.47	15.26
3	*Cyperaceae*	*Cyperus flavescens*	-	8.93	0.76	5.62	-
4	*Cyperaceae*	*Cyperus iria*	-	12.26	9.65	26.45	-
5	*Cyperaceae*	*Cyperus rotundus*	Teki ladang	20.28	16.49	0.92	-
6	*Cyperaceae*	*Eleocharis dulcis*	Purun tikus	-	7.89	19.63	**64.20**
7	*Cyperaceae*	*Fimbristylis dichotoma*	Jukut mata-munding	-	4.64	2.30	-
8	*Cyperaceae*	*Fimbristylis littoralis*	Tumbaran	12.81	15.88	10.97	-
9	*Cyperaceae*	*Fuirena ciliaris*	Rumput halia	9.04	5.49	26.17	2.61
10	*Cyperaceae*	*Rhynchospora corymbosa*	Rumput sendayan	-	-	6.54	-
11	*Cyperaceae*	*Rhynchospora rubra*	-	1.02	-	-	4.31
12	*Cyperaceae*	*Scleria bancana*	-	19.61	1.29	13.36	14.71
13	*Poaceae*	*Andropogon aciculatus*	Rumput jarum	-	16.16	2.03	-
14	*Poaceae*	*Axonopus compressus*	Rumput karpet	9.39	19.66	5.35	-
15	*Poaceae*	*Brachiaria mutica*	Rumput janggalan	10.54	6.67	-	13.68
16	*Poaceae*	*Digitaria eriantha*	Rumput pangola	-	19.90	-	17.90
17	*Poaceae*	*Cynodon dactylon*	Rumput grinting	-	-	16.49	-
18	*Poaceae*	*Imperata brevifolia*	Ilalang bunga kuning	-	4.96	-	13.14
19	*Poaceae*	*Imperata cylindrica*	Ilalang	1.33	7.82	-	35.17
20	*Poaceae*	*Panicum dichotomiflorum*	-	1.20	7.92	11.71	-
21	*Poaceae*	*Panicum repens*	Lempuyangan	5.97	-	1.11	-
22	*Poaceae*	*Paspalum conjugatum*	Paitan, rumput kerbau	2.74	-	-	-
23	*Poaceae*	*Paspalum distichum*	-	5.62	**23.05**	**30.04**	-
24	*Poaceae*	*Paspalum longifolium*	-	17.69	13.27	0.55	-
25	*Poaceae*	*Paspalum scrobiculatum*	Rumput gegenjuran	17.62	6.33	11.80	14.64

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Table 2. Continued

No.	Family	Scientific name	Indonesian name	Loc-1	Loc-2	Loc-3	Loc-4
26	Poaceae	*Pennisetum purpureum*	Rumput gajah	0.86	1.22	-	3.44
27	Poaceae	*Saccharum spontaneum*	Gelagah	-	0.88	1.01	0.94
		IVI total for grasses		200.00	200.00	200.00	200.00
D	**Ferns**						
1	Gleicheniaceae	*Dicranopteris linearis*	Paku garpu	-	**164.14**	-	**96.56**
2	Lycopodiaceae	*Lycopodiella cernua*	Paku kawat	-	-	-	9.61
3	Lygodiaceae	*Lygodium scandens*	Paku ribu-ribu	**200.00**	-	-	8.38
4	Nephrolepidaceae	*Nephrolepis* sp.	-	-	-	-	18.25
5	Selaginellaceae	*Selaginella doederleinii*	Riyu-riyu, cakar ayam	-	35.86	-	67.20
		IVI total for ferns		200.00	200.00	0	200.00

1) Loc-1, Loc-2, Loc-3, Loc-4 = Location-1, Location-2, Location-3, Location-4
2) Plants planted purposely (woody plants were mentioned on the board which was stuck into the ground of the location, but no non-woody plant was)
3) The plant's name written on the board was the Indonesian name, including akasia and eukaliptus consisting of 2 species each.
4) No board was on Location-4.
5) The bold number is the highest IVI.

Plant species number varied according to the location and the growing stage (Figure 2). The number of species of Location 4 (64 species) was the highest of all locations, where the number of species in Location, Location 2, and Location 3 was 59, 58, and 54 species, respectively.

The plant species number in the reclaimed ex-coal-mining area of PT Adaro Indonesia was relatively higher than the research results on the other coal mining areas. Akbar *et al.* (2005) identified 11−16 understorey and seedling species under stands growing on the reclaimed areas of two coal-mining companies in South Kalimantan. Adman *et al.* (2012) recorded 58 plant species on the pre-coal-mining area in East Kalimantan. Solviana *et al.* (2012) found 6 seedling species and 43 sapling species on the pre-coal-mining area, but 5 seedling species and 10 sapling species on the post-coal-mining area in West Sumatera. Hilwan *et al.* (2013) found 24 understorey plant species under 6 year stands; 22 species under *Enterolobium cyclocarpum* stand and 17 species under *Samanea saman* stand on the reclaimed coal mining land in East Kalimantan. Wiryono and Siahaan (2013) recorded 16 understorey plant species growing under 1.5 year old *Gmelina arborea* stand of the coal mining land. In spite of the different condition, approximately one year after the eruption of Mt. Merapi, Sutomo and Fardila (2013) found 72 species in the burnt site and 79 species in the unburnt site.

The plant species can grow and develop on the reclaimed land, because their seeds, rhizomes, or seedlings are supposed to be present or dormant on the surface and in the top soil. Those grow slowly as top soil is returned to the ex-coal-mining area. If the environment supports, they will form the complete individuals and even simultaneously a forest ecosystem. Gulshan *et al.* (2013) state that soil seed bank reserves viable seeds present on the surface and in the soil and provides an immediate and main source of propagules for recruitment after disturbance. Zhang *et al.* (2013) conclude that firstly, plantation soil seed banks are the potential for regenerating understorey vegetation.

Secondly, they are dispersed to other locations after the seeds or the seedlings are transported by abiotic componentssuch as wind and water. The plants which seeds are dispersed by wind are *Mikania* (ISSG 2005; Tripathi *et al.* 2012), *Saccharum* (Mani 2013), and *Imperata* (Yager *et al.* 2011). Water flow can disperse seeds of *Acacia mangium* (Suyanto & Soendjoto 2007), *Cyperus rotundus* (ISSG 2009), and *Eleocharis dulcis* (LRC 2013).

Thirdly, they are dispersed after being transported by human activities and by animals which have high mobility, such as insects, birds, and mammals. Fruits of *Melastoma*, *Ficus, Vitex,* and grasses are diets for birds, whereas those of *Trema* and *Passiflora* are diets for small mammals. Seeds are dispersed to other locations by frugivore birds, such as *Pycnonotus* (Spiegel & Nathan 2007; Kunz *et al.* 2008; Kerdkaew *et al.* 2014) through faeces or vomit. In Nigeria, seeds of *Ageratum conyzoides, Amaranthus* spp., *Centrosema pubescens,* and *C. rotundus* are disseminated to other areas through the faeces of ruminant animals (Jolaosho *et al.* 2006).

Based on dispersal mechanism, vegetation surrounding the mining land, the land where top soil and overburden are piled temporarily, should be in a good condition. The vegetation could be a source of both seeds and seedlings. According to Boer (2009), the primary forest surrounding the reclaimed land is a source of species which plays an important role for succession and accelerates the growth of plants on the area. Widyati (2011) stated that the healthy forest could be developed to produce seeds of hyper-accumulator plants for neutralizing toxic metals ofex-coal-mining area.

The development of plant Some planted plants were not recorded on the locations because of three causing factors. Firstly, the plant died or did not grow, because it was not able to adapt to the reclaimed land which was marginal. It was no cover crop, lack of organic matter, and lack of nutrient. The health of plant would be disturbed, if land nutrients, i.e. N, P, K, and Ca, reduce (Setiadi & Adinda 2013). Lack of P constrains the development of new plant species or natural succession (Yassir & Omon 2003). Secondly, there was no plant on the sampling plot/square. Plant could be present, but it was on outside plot/square. Thirdly, plant was recorded with other name, because it was morphologically similar (particularly in seedling or sapling) to other plant which was known by a researcher.

On the other hand, a lot of plant species growing naturally

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were able to grow and develop in less than 2 years after reclamation and re-vegetation. Even on the suitable location, those were most noticeable on the location as shown with the highest IVI (Table 2). The predominating plant differed according to the successional stage and the location. The predominant plant of Location-1 was *Cassia siamea* as woody plants, *Crotalaria micans* as herbs, *Cyperus difformis* as grasses, and *Lygodium scandens* as ferns. On Location-2, the predominant plants in accordance with the successional stage were respectively *Paraserianthes falcataria*, *Pueraria phaseoloides*, *Paspalum distichum,* and *Dicranopteris linearis*. On Location-3, the plants were *Sesbania grandiflora*, *C. micans*, *P. distichum,* and on Location-4, the plants were *Leucaena glauca*, *Melastoma affine, E. dulcis, D. linearis.* There was no fern on Location-3.

In general, the reclamation area is categorized as a marginal land due to various limiting factors for biomass production such as low soil pH, very low P_2O_5, and high Al saturation (Table 3). However, the soil is potentially good enough to supply water and air for root growth as indirectly showed by its soil texture of loam.

Many plants growing naturally are positive for land surface covered and protected from rainfall which can easily break the soil to be smaller particles and transport them to a lower area. Both the physical and the chemical properties of lands are getting better. The bond of soil particles will be strong so that erosion reduces. The plants provide the various organic matters with various concentrationsas a result the land fertility improves.

The variety of plants triggers the variety of micro-climate under the plants and accelerates the animal biodiversity. The vegetation development is influenced by duration of ex-tin-mining and the changes of soil both physical and chemical properties determine biodiversity of soil namely mesofaunas and macrofaunas (Hilwan & Handayani 2013). The longer age of vegetation is the more increase of organic matter and the Collembola's density (Nurtjahya *et al.* 2007). As vegetation is near 3 years old, the soil biology is getting

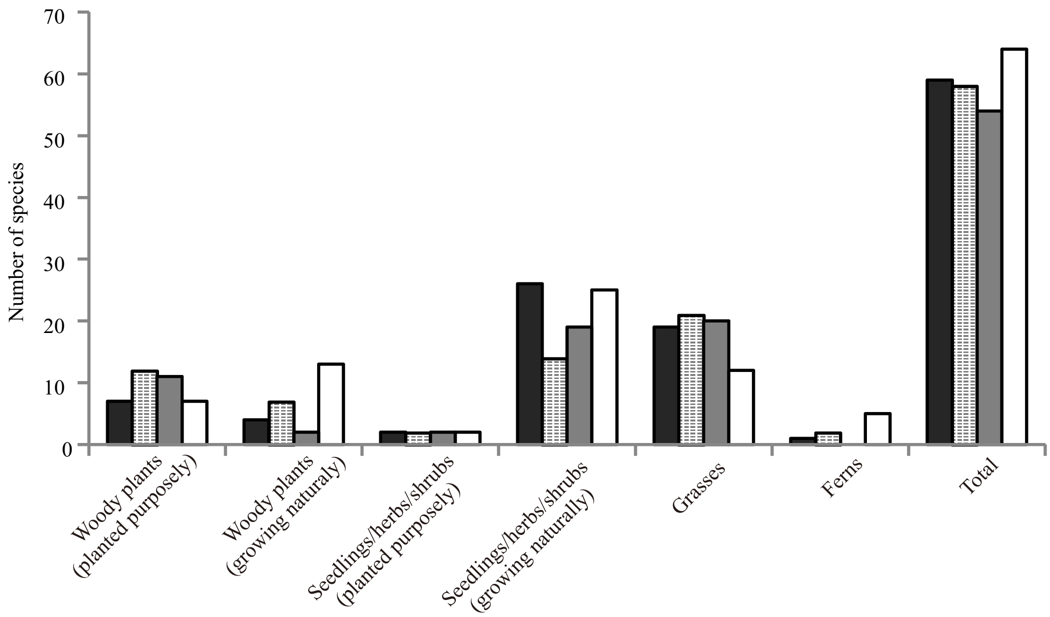

Figure 2 The number of plant species in each location. Location 1 (■), Location 2 (▤), Location 3 (■), Location 4 (□).

Table 3 Soil properties of each location

Depth	Location	Texture			C-org	N-tot	pH	P_2O_5	Cation Exchange Capacity	Al^{3+} exchangeable
		Sand (%)	Silt (%)	Clay (%)	%	%		ppm	cmol (+) kg	cmol (+) kg
0−5 cm	1	44	29	27	1,85	0,15	4,7	3,6	5,49	0,20
	2	26	42	32	2,87	0,20	4,3	4,6	9,79	1,73
	3	51	23	26	3,21	0,26	4,8	2,1	9,94	0,30
	4	51	26	23	1,48	0,18	4,3	2,7	4,88	1,00
5−20 cm	1	46	34	20	1,36	0,11	4,4	4,4	7,00	3,26
	2	26	39	35	1,65	0,16	4,3	2,3	6,52	0,48
	3	35	28	37	2,50	0,17	6,0	3,0	10,61	0,00
	4	57	17	26	0,81	0,10	4,6	2,3	4,71	0,68

Note: Soil samples collected by QHSE PT Adaro Indonesia in 2014 better; worms (*Lumbricus* sp.), termites (*Macrotermus* sp.), and ants are present (Yassir *et al.* 2011).

However, plant species developing nearly 2 years after re-vegetation actually have not completely covered the area. Some parts of the reclaimed land were not covered. Plants, even understorey could not able to cover the area because of top soil which was not scattered evenly or not sufficiently enough to cover the surface of land. Top soil was also getting thinner and thinner then it was soon unavailable on the land, because it was eroded during the land open. The erosion paths were extremely obvious, moreover on the slope.

Few plants are able to live in or adapt to the marginal land. Some of such pioneer plants are *Macaranga trichocarpa, Homalanthus populneus, Mallotus paniculatus,* and *Trema orientalis* (Kiyono & Hastaniah 2000), *Macaranga gigantea* and *M. hypoleuca* (Edwar *et al.* 2011), *Calliandra callothyrsus* (Darmawan & Anggraeni 2011; Mukhtar & Heriyanto 2012), *Acacia mangium* (Krisnawati *et al.* 2011a), *P. falcataria* (Krisnawati *et al.* 2011b), *Vitex pinnata* (Nugroho & Adman 2011; Mukhtar & Heriyanto 2012), *Hevea brasiliensis* (Tistama *et al.* 2009; Tjahyana & Ferry 2011), and *M. gigantea* (Adman *et al.* 2012). Those plants found in the sampling plots/squares grew naturally, except *C. callothyrsus* and *P. falcataria* including *H. brasiliensis* which were proposely planted *and* found on Location 2 but in a single individual.

Other identified plants were *Nepenthes mirabilis* and *Jatropha curcas.* The *Nepenthes* grew naturally on Location 4 and *Jatropha* was planted on Location 3. However, both of plants were outside of the sampling plots squares^{-1}. A lot of *Nepenthes* were found in an area which was lack of nutrient (N, P, K), acidic soil (pH 2−4.5), and high humidity (Ellison & Gotelli 2001; Mansur 2006; Mardhiana *et al.* 2012). *Jatropha* is a pioneer plant and able to adapt to the environment which is ex-tin-mining land (Gedoan *et al.* 2011).

Land rehabilitation and re-vegetation remain necessary, particularly for opening spots of the reclaimed land. Land rehabilitation is directed to optimize top-soil availability, improve nutrient concentration or soil fertilization, and minimize erosion. The thickness of top soil in a reclaimed land should be more than 20 cm (Subowo 2011). The land fertility should be improved by fertilizing, liming, scattering organic fertilizer (Subowo 2011; Yassir *et al.* 2011), and increasing organic matter (Hadi & Sudiharto 2004; Subowo 2011).

Revegetation is directed to accelerate land covering, accelerate the plant growth, increase the species diversity, and conserve the local species, so land supports many important purposes. Oxygen cyclic operates and then oxygen is obtained chiefly and easily. There are potential plants functioning as hyper-accumulator and playing a role in phyto-remediationsuch as *Ipomoea* sp., *Azolla,* and *Limnocharis flava* for accumulating cyanide, *Mikania cordata* and *Azolla* for accumulating Pb (Juhaeti *et al.* 2005); and Brassicaceae family for accumulating more than one toxic metal (Gratao *et al.* 2005). In addition, the area could be developed as a habitat for many mammals (Rustam & Boer 2007), orangutan and birds (Puslitbanghutka 2009). In East Kalimantan Province, the reclaimed coal mining land which was revegetated in 16 years ago forms forest ecosystem supporting *Pongo pygmaeus*, the biggest non-human primate in Indonesia (Mukhtar & Heriyanto 2012). The similar case happens in South Kalimantan Province. The coal mining land of PT Adaro Indonesia (Paringin Site) that had also been reclaimed and re-vegetated in more than 16 years ago becomes a suitable habitat for proboscis monkey *Nasalis larvatus*, the non-human primate which is endemic to Borneo (Soendjoto & Gunawan 2012) and 69 avifauna species as well (Soendjoto & Riefani 2014).

Conclusion

There were 107 plant species growing on the reclaimed coal mining land in less than 2 years after re-vegetation. Eighteen of them were purposely planted, but others were grown naturally or as natural regeneration. The number of both plant species and the predominant species is varied according to the location and the growing stage.

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