



## Research Paper

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# Vegetation diversity in the high-severity burned over forest areas in East Kalimantan, Indonesia

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## ABSTRACT

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The forests in Kalimantan, Indonesia were burned several times. Almost half of the forest area was burned and the vegetation in the forest was destroyed. This research is generally aimed at finding what disturbed the forest vegetation towards its rehabilitation process. Particularly, the purpose of this research was to find out the diversity of species. The plot used in this research was a single plot, the scope was 100 × 100 m (1 ha). The result of the study found that there were 74 species at the trees and poles level, 108 species at the stakes level and 55 species at the seedlings level.

**Key words:** Vegetation diversity, high severity burned.

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## INTRODUCTION

East Kalimantan, Indonesia is covered with low land tropical rain forest which is dominated by different types of trees from Dipterocarpaceae family. Tropical rain forest is enriched with its flora diversity compared to other forest formation (Whitmore, 1984). Pristine tropical rain forests encompass various types of vegetation. The forest in Kalimantan covers 40,000 types of different vegetation, and is considered as one of the richest forests in the world. However, the forests in Kalimantan were on fire for several times, just like what happened in 1982/1983 (Matius, 1998), in 1994 (Kustiawan et al., 1999), and in 1997/1998 (Bratawinata, 2002). Hence, almost half of the forest area was burned severely and the vegetation in the forest was destroyed. The condition of the damaged forest vegetation began to recover gradually. After nearly 16 years since the forest fire, the condition of forest vegetation was in secondary level.

## MATERIALS AND METHODS

The research was conducted from December 2013 to January 2014 in the burnt forest areas in Bukit Soeharto (from 0°49 to 0°56 south latitude and from 117°00 to

117°08 east longitude), Kutai Kartanegara district, East Kalimantan Province, Indonesia. The plot used in this research was a single plot, the scope was 100 × 100 m (1 ha). This plot was then divided into several subplots with the scope of 10 × 10 m so as to observe the vegetation at the tree and pole level. Moreover, the subplots were divided into sub-subplots with the width of 5 × 5 m to study the stake vegetation and sub-subplot with the width of 1 × 1 m to identify the vegetation at seedling level. Morphological observation was performed directly in the field. To identify the name of the species at the tree, stake, stand, and bush level which were not recognised directly, thus specimen was done. Afterward, the specimen sample was identified at the Herbarium.

## RESULTS AND DISCUSSION

The result of the study found that there were 74 species at the trees and poles level, 108 species at the stakes level and 55 species at the seedlings level. Those species are shown in Tables 1 to 3.

Tables 1 to 3 showed differences in the number of species

**Table 1.** Species and families at the trees and poles level.

No	Species	Family	No	Species	Family
1	<i>Alseodaphne elmeri</i> Merr.	Lauraceae	38	<i>Gironniera nervosa</i> Planch.	Ulmaceae
2	<i>Antidesma neurocarpum</i> Miq	Euphorbiaceae	39	<i>Gluta wallichii</i> (Hook.f.) Ding Hou	Anacardiaceae
3	<i>Antidesma tetandrum</i> Blume	Euphorbiaceae	40	<i>Horsfieldia irya</i> Warb	Myristicaceae
4	<i>Aporosa frutescens</i> Blume	Euphorbiaceae	41	<i>Horsfieldia</i> sp.	Myristicaceae
5	<i>Aporosa nitida</i> Merr.	Euphorbiaceae	42	<i>Knema pallens</i> W.J.J.O. de Wilde	Myristicaceae
6	<i>Artocarpus anisophyllus</i> Miq.	Moraceae	43	<i>Lithocarpus conocarpus</i> (Oudem.) Rehder	Fagaceae
7	<i>Artocarpus dadah</i> Miq.	Moraceae	44	<i>Lithocarpus coopertus</i> (Blanco) Rehder	Fagaceae
8	<i>Artocarpus elasticus</i> Blume	Moraceae	45	<i>Lithocarpus gracilis</i> (Korth.) Soepadmo	Fagaceae
9	<i>Artocarpus lanceifolius</i> Roxb.	Moraceae	46	<i>Litsea angulata</i> Blume	Lauraceae
10	<i>Artocarpus nitidus</i> Trec.	Moraceae	47	<i>Litsea firma</i> (Blume) Hook.f.	Lauraceae
11	<i>Artocarpus tamaran</i> Becc.	Moraceae	48	<i>Litsea garciae</i> Vidal	Lauraceae
12	<i>Buchanania sessifolia</i> Blume	Anacardiaceae	49	<i>Litsea odorifera</i> Vahl	Lauraceae
13	<i>Calophyllum venulosum</i> Zoll	Guttiferae	50	<i>Macaranga bancana</i> (Miq.) Müll.Arg.	Euphorbiaceae
14	<i>Canarium decumanum</i> Gaertn	Burseraceae	51	<i>Macaranga conifera</i> (Zoll.) Mull.Arg.	Euphorbiaceae
15	<i>Canarium hirsutum</i> Willd	Burseraceae	52	<i>Macaranga gigantea</i> (Reichb.f. & Zoll.) Müll.Arg.	Euphorbiaceae
16	<i>Canarium littorale</i> Blume	Burseraceae	53	<i>Macaranga hypoleuca</i> (Reichb.f.& Zoll.) Mull.Arg.	Euphorbiaceae
17	<i>Canthium</i> sp.	Rubiaceae	54	<i>Macaranga pearsonii</i> Merr.	Euphorbiaceae
18	<i>Cleistanthus myrianthus</i> (Hassk.) Kurz	Euphorbiaceae	55	<i>Magnolia lasia</i> Noot.	Magnoliaceae
19	<i>Cratoxylum formosum</i> (Jack) Dyer	Hypericaceae	56	<i>Mallotus affinis</i> Merr	Euphorbiaceae
20	<i>Cratoxylum sumatranum</i> (Jack) Blume	Hypericaceae	57	<i>Mallotus echinatus</i> Elm	Euphorbiaceae
21	<i>Dacryodes costata</i> (A.W.Benn.) H.J.Lam	Burseraceae	58	<i>Mallotus leucodermis</i> Hook f	Euphorbiaceae
22	<i>Dacryodes rugosa</i> (Blume) H.J.Lam	Burseraceae	59	<i>Mallotus paniculatus</i> (Lam.) Müll.Arg.	Euphorbiaceae
23	<i>Dillenia excelsa</i> (Jack) Gilg	Dilleniaceae	60	<i>Mallotus sumatranus</i> (Miq.) Airy Shaw	Euphorbiaceae
24	<i>Dillenia reticulata</i> King	Dilleniaceae	61	<i>Pentace laxiflora</i> Merr.	Tiliaceae
25	<i>Dillenia sumatrana</i> Miq	Dilleniaceae	62	<i>Pternandra galeata</i> (Korth.)	Melastomataceae
26	<i>Dipterocarpus humeratus</i> Sloot	Dipterocarpaceae	63	<i>Pternandra</i> sp.	Melastomataceae
27	<i>Durio acutifolius</i> (Mast.) Kosterm.	Bombacaceae	64	<i>Schima wallichii</i> (DC.) Korth.	Theaceae
28	<i>Durio conicus</i> Becc	Bombacaceae	65	<i>Shorea hemsleyana</i> King	Dipterocarpaceae
29	<i>Eusideroxylon zwageri</i> Teijsm. & Binn.	Lauraceae	66	<i>Shorea johorensis</i> Foxw	Dipterocarpaceae
30	<i>Ficus aurata</i> Miq.	Moraceae	67	<i>Shorea parvifolia</i> Dyer	Dipterocarpaceae
31	<i>Ficus geocarpa</i> Teysm & Binnd	Moraceae	68	<i>Shorea seminis</i> (de Vriese) Slooten	Dipterocarpaceae
32	<i>Ficus grossularioides</i> Burm.f.	Moraceae	69	<i>Sterculia</i> sp.	Sterculiaceae
33	<i>Garcinia celebica</i> L	Guttiferae	70	<i>Timonius borneensis</i> Vahl	Rubiaceae
34	<i>Garcinia parvifolia</i> (Miq.) Miq.	Guttiferae	71	<i>Timonius</i> sp.	Rubiaceae

**Table 1 Contd.** Species and families at the trees and poles level.

No	Species	Family	No	Species	Family
35	<i>Garcinia</i> sp.	Guttiferae	72	<i>Vernonia arborea</i> Buch.-Ham.	Compositae
36	<i>Gardenia anisophylla</i> Jack	Rubiaceae	73	<i>Vitex pinnata</i> L.	Verbenaceae
37	<i>Gardenia forsteniana</i> Miq	Rubiaceae	74	<i>Vitex vestita</i> Wall.	Verbenaceae

**Table 2.** Species and families at the stakes level.

No	Species	Family	No	Species	Family
1	<i>Actinodaphne glabra</i> Blume	Lauraceae	55	<i>Gironniera nervosa</i> Planch.	Ulmaceae
2	<i>Aglaia laxiflora</i> Miq	Meliaceae	56	<i>Glochidion arborescens</i> Blume	Euphorbiaceae
3	<i>Alseodaphne elmeri</i> Merr.	Lauraceae	57	<i>Glochidion sericeum</i> (Blume) Zoll. & Mor.	Euphorbiaceae
4	<i>Alstonia iwahigensis</i> Elmer	Apocynaceae	58	<i>Guioa pubescens</i> (Zoll. & Moritzi) Radlk.	Sapindaceae
5	<i>Anthocephalus chinensis</i> (Lamk.) A.Rich. ex Walp.	Rubiaceae	59	<i>Hedyotis</i> sp.	Rubiaceae
6	<i>Antidesma neurocarpum</i> Miq.	Euphorbiaceae	60	<i>Hopea rudiformis</i> P.S.Ashton	Dipterocarpaceae
7	<i>Aporosa confusa</i> Gage	Euphorbiaceae	61	<i>Horsfieldia irya</i> (Gaertn.)	Myristicaceae
8	<i>Aporosa dioica</i> (Roxb.) Müll.Arg.	Euphorbiaceae	62	<i>Lepisanthes amoena</i> (Hassk.) Leenh.	Sapindaceae
9	<i>Aporosa frutescens</i> Blume	Euphorbiaceae	63	<i>Lithocarpus coopertus</i> (Blanco) Rehder	Fagaceae
10	<i>Aporosa nitida</i> Merr.	Euphorbiaceae	64	<i>Litsea firma</i> (Blume) Hook.f.	Lauraceae
11	<i>Aquilaria malaccensis</i> Lam.	Thymelaeaceae	65	<i>Macaranga bancana</i> (Miq.) Müll.Arg.	Euphorbiaceae
12	<i>Archidendron clypearia</i> (Jack) I.C.Nielsen	Leguminosae-Mim.	66	<i>Macaranga beccariana</i> Merr.	Euphorbiaceae
13	<i>Archidendron jiringa</i> (Jack) I.C.Nielsen	Leguminosae-Mim.	67	<i>Macaranga conifera</i> (Zoll.) Mull.Arg.	Euphorbiaceae
14	<i>Artocarpus anisophyllus</i> Miq.	Moraceae	68	<i>Macaranga gigantea</i> (Reichb.f. & Zoll.) Müll.Arg.	Euphorbiaceae
15	<i>Artocarpus dadah</i> Miq.	Moraceae	69	<i>Macaranga hypoleuca</i> (Reichb.f.& Zoll.) Mull.Arg.	Euphorbiaceae
16	<i>Artocarpus elasticus</i> Blume	Moraceae	70	<i>Macaranga pearsonii</i> Merr.	Euphorbiaceae
17	<i>Artocarpus lanceifolius</i> Roxb.	Moraceae	71	<i>Macaranga trichocarpa</i> (Reichb.f. & Zoll.) Müll.Arg.	Euphorbiaceae
18	<i>Artocarpus tamaran</i> Becc.	Moraceae	72	<i>Madhuca sericea</i> (Miq.) H.J.Lam	Sapotaceae
19	<i>Baccaurea parviflora</i> (Müll.Arg.) Müll.Arg.	Euphorbiaceae	73	<i>Melicope glabra</i> (Blume) T.G.Hartley	Rutaceae
20	<i>Baccaurea tetrandra</i> Müll.Arg.	Euphorbiaceae	74	<i>Memecylon</i> sp.	Melastomataceae
21	<i>Barringtonia macrostachya</i> Jack	Lecythidaceae	75	<i>Nauclea subdita</i> Merr.	Rubiaceae
22	<i>Beilschmiedia madang</i> Blume	Lauraceae	76	<i>Neolitsea</i> sp.	Lauraceae
23	<i>Beilschmiedia dictyoneura</i> Kosterm	Lauraceae	77	<i>Nephelium cuspidatum</i> Blume	Sapindaceae
24	<i>Bridelia glauca</i> Blume	Euphorbiaceae	78	<i>Paracroton pendulus</i> (Hassk.) Miq.	Euphorbiaceae
25	<i>Camellia lanceolata</i> (Blume) Seem.	Theaceae	79	<i>Pentace laxiflora</i> Merr.	Tiliaceae
26	<i>Canthium glabrum</i> Blume	Rubiaceae	80	<i>Phoebe</i> sp.	Lauraceae
No	Spesies	Family	No	Spesies	Family

Table 2 Contd. Species and families at the stakes level.

No	Species	Family	No	Species	Family
27	<i>Carallia brachiata</i> (Lour.) Merr.	Rhizophoraceae	81	<i>Polyalthia microtus</i> Miq.	Annonaceae
28	<i>Chaetocarpus castanocarpus</i> (Roxb.) Thwaites	Euphorbiaceae	82	<i>Polyalthia rumphii</i> (Blume) Merr.	Annonaceae
29	<i>Cleistanthus myrianthus</i> (Hassk.) Kurz	Euphorbiaceae	83	<i>Popowia pisocarpa</i> (Blume) Endl.	Annonaceae
30	<i>Cratoxylum formosum</i> (Jack) Dyer	Hypericaceae	84	<i>Pternandra azurea</i> (Blume) Burkill	Melastomataceae
31	<i>Cratoxylum sumatranum</i> (Jack) Blume	Hypericaceae	85	<i>Pternandra coerulescens</i> Jack	Melastomataceae
32	<i>Crypteronia griffithii</i> Clarke in Hook.f.	Crypteroniaceae	86	<i>Pternandra galeata</i> (Korth.) Ridley	Melastomataceae
33	<i>Dacryodes costata</i> (A.W.Benn.) H.J.Lam	Burseraceae	87	<i>Pternandra rostrata</i> (Cogn.)	Melastomataceae
34	<i>Dacryodes rostrata</i> (Blume) H.J.Lam	Burseraceae	88	<i>Quassia indica</i> (Gaertn.) Noot.	Simaroubaceae
35	<i>Dacryodes rugosa</i> (Blume) H.J.Lam	Burseraceae	89	<i>Rhodamnia cinerea</i> Jack	Myrtaceae
36	<i>Dillenia excelsa</i> (Jack) Gilg	Dilleniaceae	90	<i>Schima wallichii</i> (DC.) Korth.	Theaceae
37	<i>Dillenia reticulata</i> King	Dilleniaceae	91	<i>Scorodocarpus borneensis</i> (Baill.) Becc.	Olacaceae
38	<i>Diospyros borneensis</i> Hiern	Ebenaceae	92	<i>Shorea balangeran</i> (Korth.) Burck	Dipterocarpaceae
39	<i>Diospyros buxifolia</i> (Blume)	Ebenaceae	93	<i>Shorea leprosula</i> Miq.	Dipterocarpaceae
40	<i>Durio acutifolius</i> (Mast.) Kosterm.	Bombacaceae	94	<i>Shorea seminis</i> (de Vriese) Slooten	Dipterocarpaceae
41	<i>Dysoxylum acutangulum</i> Miq	Meliaceae	95	<i>Sterculia rubiginosa</i> Vent	Sterculiaceae
42	<i>Elaeocarpus beccarii</i> A.DC. ssp. beccarii	Elaeocarpaceae	96	<i>Sterculia</i> sp.	Sterculiaceae
43	<i>Embelia javanica</i> DC.	Myrsinaceae	97	<i>Symplocos fasciculata</i> Zoll.	Symplocaceae
44	<i>Endospermum diadenum</i> (Miq.) Airy Shaw	Euphorbiaceae	98	<i>Syzygium lineatum</i> (DC) Merr. & Perry	Myrtaceae
45	<i>Enicosanthum paradoxum</i> Becc.	Annonaceae	99	<i>Syzygium polyanthum</i> (Wight) Walp.	Myrtaceae
46	<i>Eugenia heteroclada</i> Merr.	Myrtaceae	100	<i>Syzygium tawahense</i> (Korth.) Merr. & Perry	Myrtaceae
47	<i>Eurycoma longifolia</i> Jack	Simaroubaceae	101	<i>Tabernaemontana macrocarpa</i> Korth. ex Blume	Apocynaceae
48	<i>Eusideroxylon zwageri</i> Teijsm. & Binn.	Lauraceae	102	<i>Teijsmanniodendron bogoriense</i> Koord	Verbenaceae
49	<i>Fagraea racemosa</i> Jack ex Wall.	Loganiaceae	103	<i>Timonius lasianthoides</i> Valet	Rubiaceae
50	<i>Ficus aurata</i> Miq.	Moraceae	104	<i>Timonius flavescens</i> (Jacq.) Baker	Rubiaceae
51	<i>Ficus obscura</i> Blume	Moraceae	105	<i>Urophyllum arboreum</i> (Reinw. ex Blume)	Rubiaceae
52	<i>Galearia fulva</i> (Tul.) Miq.	Euphorbiaceae	106	<i>Vatica odorata</i> (Griff.) Sym.	Dipterocarpaceae
53	<i>Garcinia parvifolia</i> (Miq.) Miq.	Guttiferae	107	<i>Vernonia arborea</i> Buch.-Ham.	Compositae
54	<i>Gardenia tubifera</i> Wall	Rubiaceae	108	<i>Xanthophyllum affine</i> Korth.ex Miq.	Polygalaceae

**Table 3.** Species and families at the seedling level.

No	Species	Family	No	Species	Family
1	<i>Actinodaphne glabra</i> Blume	Lauraceae	29	<i>Knema furfuracea</i> Warb.	Myristicaceae
2	<i>Anacolosa frutescens</i> (Blume) Blume	Olacaceae	30	<i>Knema glauca</i> (Blume) Warb	Myristicaceae
3	<i>Aporosa dioica</i> (Roxb.) Müll.Arg.	Euphorbiaceae	31	<i>Koompassia malaccensis</i> Maing.ex Benth.	Leguminosae-Caes.
4	<i>Aporosa frutescens</i> Blume	Euphorbiaceae	32	<i>Litsea elliptica</i> Blume	Lauraceae
5	<i>Aquilaria malaccensis</i> Lam.	Thymelaeaceae	33	<i>Litsea firma</i> (Blume) Hook.f.	Lauraceae
6	<i>Archidendron clypearia</i> (Jack) I.C.Nielsen	Leguminosae-Mim.	34	<i>Macaranga gigantea</i> (Reichb.f. & Zoll.) Müll.Arg.	Euphorbiaceae
7	<i>Archidendron jiringa</i> (Jack) I.C.Nielsen	Leguminosae-Mim.	35	<i>Macaranga hypoleuca</i> (Reichb.f.& Zoll.) Mull.Arg.	Euphorbiaceae
8	<i>Artocarpus lanceifolius</i> Roxb.	Moraceae	36	<i>Neolitsea</i> sp.	Lauraceae
9	<i>Beilschmiedia</i> sp.	Lauraceae	37	<i>Payena acuminata</i> Pierre	Sapotaceae
10	<i>Bridelia glauca</i> Blume	Euphorbiaceae	38	<i>Phoebe</i> sp.	Lauraceae
11	<i>Camellia lanceolata</i> (Blume) Seem.	Theaceae	39	<i>Polyalthia lateriflora</i> Blume	Annonaceae
12	<i>Cratoxylum formosum</i> (Jack) Dyer	Hypericaceae	40	<i>Polyalthia rumphii</i> (Blume) Merr.	Annonaceae
13	<i>Cratoxylum sumatranum</i> (Jack) Blume	Hypericaceae	41	<i>Pternandra</i> sp.	Melastomataceae
14	<i>Dimocarpus longan</i> Lour.	Sapindaceae	42	<i>Rhodamnia cinerea</i> Jack	Myrtaceae
15	<i>Diospyros borneensis</i> Hiern	Ebenaceae	43	<i>Shorea seminis</i> (de Vriese) Slooten	Dipterocarpaceae
16	<i>Diospyros</i> sp.	Ebenaceae	44	<i>Symplocos fasciculata</i> Zoll.	Symplocaceae
17	<i>Fagraea racemosa</i> Jack ex Wall.	Loganiaceae	45	<i>Syzygium lineatum</i> (DC) Merr. & Perry	Myrtaceae
18	<i>Ficus aurata</i> Miq.	Moraceae	46	<i>Syzygium nigricans</i> (King) Merr. & Perry	Myrtaceae
19	<i>Ficus obscura</i> Blume	Moraceae	47	<i>Syzygium tawahense</i> (Korth.) Merr. & Perry	Myrtaceae
20	<i>Galearia fulva</i> (Tul.) Miq.	Euphorbiaceae	48	<i>Tabernaemontana macrocarpa</i> Korth. ex Blume	Apocynaceae
21	<i>Garcinia parvifolia</i> (Miq.) Miq.	Guttiferae	49	<i>Timonius</i> sp.	Rubiaceae
22	<i>Gardenia</i> sp.	Rubiaceae	50	<i>Urophyllum</i> sp.	Rubiaceae
23	<i>Gironniera nervosa</i> Planch.	Ulmaceae	51	<i>Vatica odorata</i> (Griff.) Sym.	Dipterocarpaceae
24	<i>Glochidion arborescens</i> Blume	Euphorbiaceae	52	<i>Vernonia arborea</i> Buch.-Ham.	Compositae
25	<i>Goniothalamus macrophyllus</i> (Blume) Hook.f. & Thomson	Annonaceae	53	<i>Villebrunea rubescens</i> Blume	Urticaceae
26	<i>Hopea rudiformis</i> P.S.Ashton	Dipterocarpaceae	54	<i>Walsura</i> sp.	Meliaceae
27	<i>Horsfieldia</i> sp.	Myristicaceae	55	<i>Xanthophyllum affine</i> Korth.ex Miq.	Polygalaceae
28	<i>Irvingia malayana</i> Oliv.	Simaroubaceae	56	-	-

between vegetation level. It happened due to the competition for growing space, nutrient, and enough sunlight while not all species were able to compete and survive up to the stand and tree level. High-severity burnt forest had smaller number of species compared to primary forest. This was because high-severity burnt forest had experienced horrible disturbance with severe vegetation damage, which led to the loss of many types of vegetation. Thus, pioneer plants started to dominate the forest areas,

such as; *Macaranga gigantea*, *M. bancana*, *M. conifera*, *M. hypoleuca*, *M. pearsonii*, *Mallotus affinis*, *M. echinatus*, *M. leucodermis*, *M. paniculatus*, *M. sumatranus*, *Vernonia arborea*, *Vitex pinnata*, *V. vestica*. Consequently, when the forest was burned severely, the open forest area became wider which made the pioneer plants grew abundantly.

In the high-severity burned over forest areas, pioneer plants like *Macaranga* spp would be easily found at the tree and stake level, hence it produced flower and seed. The

seeds were produced in abundance. Then, they fell down to the ground and grew to be seedlings which then became stakes.

The presence of Dipterocarpaceae at the stake level in the climax forest was abundant, however, only a small number could be found in the burned over forest areas. It happened because of the narrow gap of the canopy which led to stimulated Dipterocarpaceae seedlings. The wide canopy gap would actually make Dipterocarpaceae to become scarce. Therefore, plenty sunlights would lead to the growth of pioneer plants either their species or their number.

### **Conclusion**

It can be concluded that the more severe disruption experienced by the vegetation, the more the number of the vegetation would be more abundant and the species of pioneer vegetation became more varied. The number of Dipterocarpaceae families in the burned over forest areas was limited.

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