# TREE SPECIES COMPOSITION OF 1.8 HA PLOT SAMBOJA RESEARCH FOREST: 28 YEARS AFTER INITIAL FIRE

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TREE SPECIES COMPOSITION OF 1.8 HA PLOT SAMBOJA RESEARCH: 28 YEARS AFTER INITIAL FIRE. Repeated forest fires highly impact on tree species composition. Forest planning requires information about the current condition of species composition. This paper investigates the current tree composition of natural regeneration after repeated forest fires, regeneration process after repeated fires, and strategy of secondary growth related to ecological restoration issues. Re-observation of the 1.8 hectares permanent plot in Samboja Research Forest was conducted in 2011. All trees with diameters above 10 cm at breast height (DBH) were re-numbered and mapped. Herbarium specimen was collected for species identification. Number of taxon was determined, Important Value Index was calculated, species trait of light response was identified based on the references and dispersion index species was calculated. Results show after twenty eight years initial forest fire, 191 species naturally regenerated in the burnt area. *Macaranga gigantea*, a light demanding pioneer species of Euphorbiaceae was the most dominant species, followed by *Vernonia arborea* belonging to Asteraceae. Both, *M. gigantea* and *V. arborea* had clumped distribution. Eight species identified survived from repeated fires, are *Anthocephalus chinensis*, *Dipterocarpus cornutus*, *Diospyros borneensis*, *Eusideroxylon zwageri*, *Shorea ovalis*, *Syzygium borneensis*, *Pholidocarpus majadum* and *Vatica umbonata*. All surviving species was distributed uniformly in the plot. Dominant pioneer species which has grown after repeated fires indicates that the current condition of burnt forest is in the early succession. Protecting forest, assisting natural regeneration and monitoring dominant species are suggested as activities for the ecological restoration.

Keywords: Ecological restoration, East Kalimantan, forest fire, species composition

*KOMPOSISI JENIS POHON PADA PETAK SELUAS 1,8 HA DI HUTAN PENELITIAN SAMBOJA: 28 TAHUN SETELAH KEBAKARAN PERTAMA. Kebakaran hutan berulang berdampak besar terhadap komposisi jenis pohon. Perencanaan restorasi hutan memerlukan informasi mengenai komposisi jenis yang beregenerasi secara alami pada hutan bekas terbakar. Tulisan ini mempelajari jenis yang beregenerasi secara alami, proses regenerasi yang terjadi setelah kebakaran berulang, dan rekomendasi untuk implementasi restorasi pada hutan yang sedang beregenerasi. Pengamatan ulang terhadap petak permanen di KHDTK Samboja, Kalimantan Timur dilakukan tahun 2011. Semua pohon berdiameter di atas 10 cm pada sub-petak 10 m x 10 m dicatat, diukur DBH, dipetakan posisi koordinatnya dan diambil contoh daun untuk identifikasi tingkat jenis. Komposisi taksa, Indeks Nilai Penting dan indeks persebaran jenis dihitung. Karakter jenis berdasarkan responnya terhadap cahaya diidentifikasi. Dua puluh delapan tahun setelah kebakaran pertama, 191 jenis beregenerasi pada hutan bekas terbakar.* Macaranga gigantea, *jenis pionir tergantung pada cahaya, famili Euphorbiaceae merupakan jenis paling dominan diikuti* Vernonia arborea *dari Asteraceae. Kedua jenis tersebut memiliki pola sebaran mengelompok. Delapan jenis diidentifikasi mampu bertahan dari kebakaran yaitu:* Anthocephalus chinensis, Dipterocarpus cornutus, Diospyros borneensis, Eusideroxylon zwageri, Shorea ovalis, Syzygium borneensis, Pholidocarpus majadum *dan* Vatica umbonata *yang semuanya menyebar secara seragam. Dominasi jenis pionir yang beregenerasi setelah kebakaran dan regenerasi spesies yang mampu bertahan dari kebakaran menunjukkan bahwa*

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*kondisi hutan berada pada tahap awal suksesi. Perlindungan hutan, pemeliharaan permudaan alami, dan pemantauan spesies dominan merupakan kegiatan yang dianjurkan dalam restorasi ekologi.*

*Kata kunci: Kalimantan Timur, kebakaran hutan, komposisi spesies, restorasi ekologi*

## I. INTRODUCTION

Samboja Research Forest in East Kalimantan was suffered by major fires twice in 1982/1983 and 1997/1998. Fire is an important natural force which influences plant communities and affects the health of certain ecosystems (Nasi, Dennis, Meijaard, Applegate, & Moore, 2001). However, wildfires change plant communities by reducing some species dominance, while enhancing the abundance of others and creating vegetation patches in different successional states (Baeza, Valdecantos, Alloza, & Vallejo, 2007; Pyke, Brooks, & D'Antonio, 2010). Moreover, repeated fires cause tree species losses (Kim & Arthur, 2014; Peterson & Reich, 2008), because of the direct damage by fire, as well as its indirect impact due to ecological consequences after fire event that result in regeneration failure (Van Nieuwstadt & Sheil, 2005; Slik et al., 2010). For instance, in 2003 observations (twenty years after initial forest fire) on the permanent plot of Samboja Research Forest, only 60% of the species had recovered (Simbolon, 2005).

*Macaranga gigantea* was a minor species before fire developed vastly and was categorized as one of the three most dominant species in terms of population (Simbolon, 2005; Kartawinata et al., 2008). As a research forest, Samboja Research Forest, East Kalimantan, is an important site to study forest regeneration process after repeated fires. Furthermore, this basic data of the regeneration process providing an important information to set up ecological restoration program in disturbed forest of Samboja Research Forest, even as a model to develop similar activities for similar ecosystem condition.

Based on the succession theory of Clement (1916), initial growth of vegetation establishment and competition which are the early succession phases are dominated by light demanding pioneer species that can reach up to 35 years (Riswan, Kenworthy, & Kartawinata, 1985). Re-observing the permanent plot after 28 years since the initial fire or thirteen years after the second fire is important to get serial data from previous observations in 1981 and 2003 to understand the current condition, and the dynamic of species after affected by repeated fires. This paper investigates the current tree composition after repeated forest fires, the succession process after thirteen years repeated fires, and provides recommendation in the secondary growth related to ecological restoration issues.

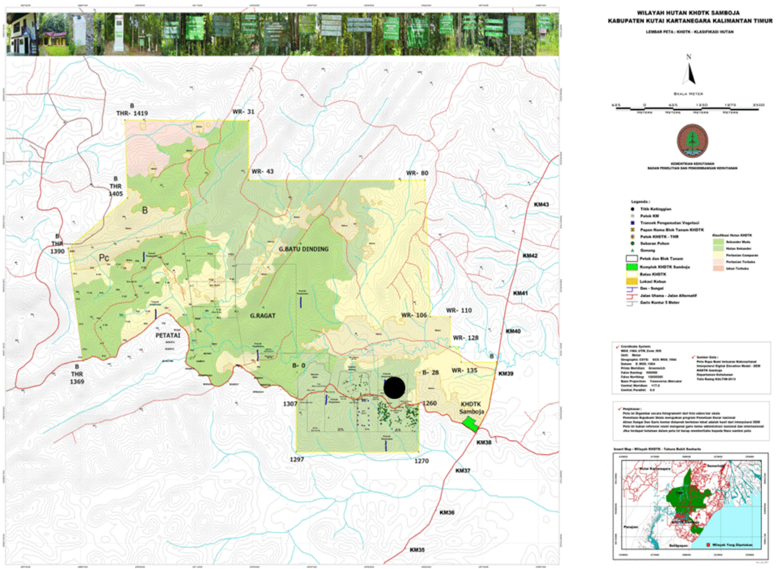
## II. MATERIAL AND METHOD

### A. Study Site

Tree species inventory was conducted in 2011 for 1.8 ha of the 10.5 ha permanent plot established by Indonesian Institute of Sciences (LIPI) during 1979-1981 as published by Kartawinata et al. (2008). Administratively, Samboja Research Forest is located in Kutai Kertanegara and Penajam Paser Utara Districts, East Kalimantan and geographycally is situated at 0°59'23" – 0°59'27" S and 116°57'31" – 116°57'51" E (Figure 1). This area was affected by repeated major fires in 1982/1983 and 1997/1998 and currently it is in the recovery process.

### B. Methods

Enumeration of all trees above 10 cm diameter at breast height (DBH) was done in 10.5 hectare area that was divided by 10 m x 10 m sub-plots during 1979 – 1981. Tree DBH were recorded, tree positions were mapped and tagged. Herbarium specimens were collected for species identification purpose, identification process was conducted in Herbarium




Remarks:• is sample plot location

Figure 1. Samboja Research Forest

Bogoriense, Bogor (Kartawinata et al., 2008). Re-enumeration of all trees above 5 cm DBH was done in 2003 after affected by major fires 1982/1983 and 1997/1998 in 1.65 hectare (110 m x 150 m). Tree DBH were recorded, but only trees above 10 cm DBH were tagged during this observation (Simbolon, 2005). Re-enumeration of trees above 10 cm DBH was done in 2011 in 1.8 hectare (120 m x 150 m). Tree DBH was recorded and tree position was mapped.

## C. Analysis

Number of individuals, genera and species of each family were determined. Tree position and DBH were visualized in the bubble graph. Important Value Index (IVI) was calculated from Relative Dominance, Relative Density and Relative Frequency of each species (Curtis, 1959):

$$IVI = RD + RF + RCi \qquad \text{.............................(1)}$$

Where:
*RD* = relative density, *D* = density of species *i*, *RF* = relative frequency, F = frequency of species *i*, *RCi* = relative dominance, *C* = dominance species *i*, *IVI* = Important Value Index.

Dispersion Index to quantify spatial distribution of each species in the sampled plot (Ludwig & Reynolds, 1988) was calculated using formula:

$$I_D = \frac{S^2}{\bar{x}} \qquad \text{...........................................(2)}$$

Where:
$I_D$ = dispersion index; $S^2$ = variance; $\bar{x}$ = average. Species distribute random if $I_D = 1$, uniform if $I_D < 1$ and clumped if $I_D > 1$.

Comparison to pre-fire species survey in 1981 as done by Kartawinata et al. (2008) was performed to determine whether tree species survived after repeated fires or not.

Functional group of succession stage was determined based on light demanding and shade tolerant species based on literatures.

# III. RESULT AND DISCUSSION

## A. Taxonomic Composition

There were 1075 surviving trees (dbh>10 cm) belonging to 191 species, 101 genus and 41 families that were recorded in the 1.8 ha hectare of twice burnt forest (i.e 1982/1983 and 1997/1998). Euphorbiaceae, Asteraceae and Moraceae were the families with the highest number of trees in the sample plot (Figure 2), which is occupied by *Macaranga gigantea*, *Vernonia arborea* and *Artocarpus anisophyllus*.

Euphorbiaceae, Rubiaceae and Lauraceae have the highest *genus* member, more than 5; Euphorbiaceae, Myristicaceae, Myrtaceae have the highest *species* member, more than 15 (Figure 3). Eight species were recorded belonging to *Macaranga* and two species of *Mallotus* as members of Euphorbiaceae.

## B. Tree Density Composition

Tree density distributed unevenness among families (Figure 4). Euphorbiaceae has the highest number of trees in the sample plot, in which 263 trees from 10 genus and 25 species that covered 25% of the total population; followed by Asteraceae with 133 trees (12% of total population) belonging to a single genus and species of *V. arborea*. Twenty one families have less than 10 trees in the sample plot, which included Thymelaceae, Lecythidaceae, Burseraceae, Dilleniaceae, Sapindaceae, Rosaceae, Monimiaceae, Flacourtiaceae, Elaeocarpaceae, Combretaceae, Alangiaceae, Hypericaceae, Olacaceae, Melastomataceae, Apocynaceae, Rhizophoraceae, Sterculiaceae, Fagaceae, Ulmaceae, Theaceae and Clusiaceae. Eighten families have 10 to 100 trees, i.e. Dipterocarpaceae, Lauraceae, Rubiaceae, Anacardiaceae, Bombacaceae, Meliaceae, Sapotaceae, Tiliaceae, Fabaceae, Magnoliaceae, Moraceae, Verbenaceae, Rutaceae,

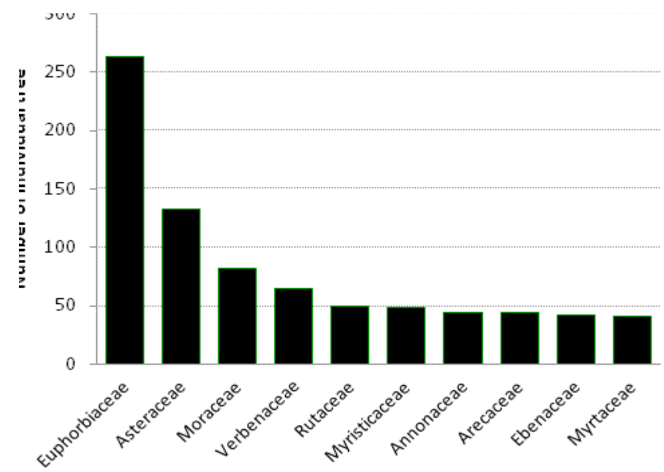



Figure 2. Families with highest number of trees

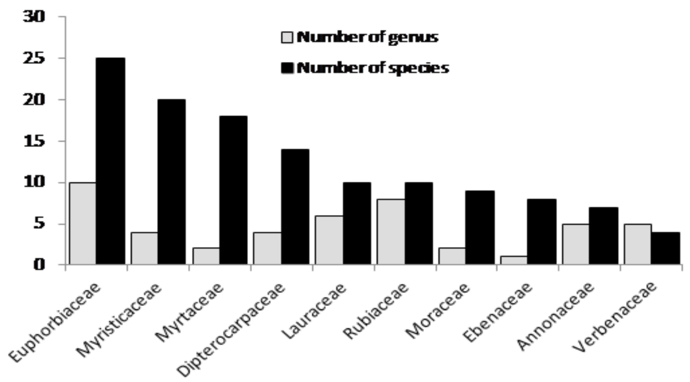



Figure 3. Ten families with highest number of genus and species

Myristicaceae, Annonaceae, Arecaceae, Ebenacea and Myrtaceae.

In the sample plot, the only a species of *Macaranga gigantea* (Euphorbiaceae) has more than 100 trees, nine species of *Vernonia arborea* (Asteraceae), *Artocarpus anisophyllus* (Moraceae), *Melicope glabra* (Rutaceae), *Pholidocarpus majadun* (Arecaceae), *Penorema canescens* (Verbenaceae), *Croton laeivifolius* (Euphorbiaceae), *Cananga odorata* (Meliaceae), *Macaranga hypoleuca* (Euphorbiaceae) and *Geunsia pentandra* (Verbenaceae) have 10 – 100 trees and another 80 species have 1 – 10 trees (Figure 5).

*Diospyros borneensis*, *Antho* , and *Cratoxylum racemosum* are surviving species with the highest tree density in the sample plot, mostly in the 10 – 20 cm DBH class.

## C. Dominance Species

Important Value Index calculation in the sample plot found that 2 of 191 species has the highest IVI, i.e. *Macaranga gigantea* (35.3) and *Vernonia arborea* (30.5) that covered more than 20% of the total IVI. As well as, 3 of 191 species covered 30% of the total IVI, which included *Pholidocarpus majadun* (13.0), *Artocarpus anisophyllus* (12.3) and *Melicope glabra* (12.2).

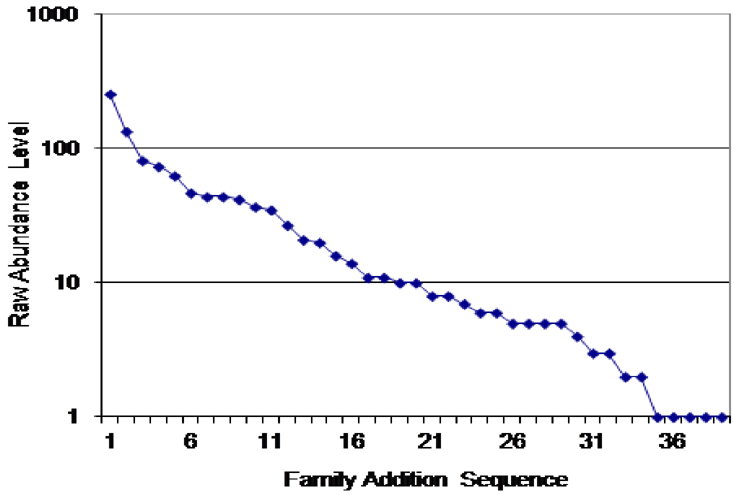



Figure 4. Family rank abundance curve

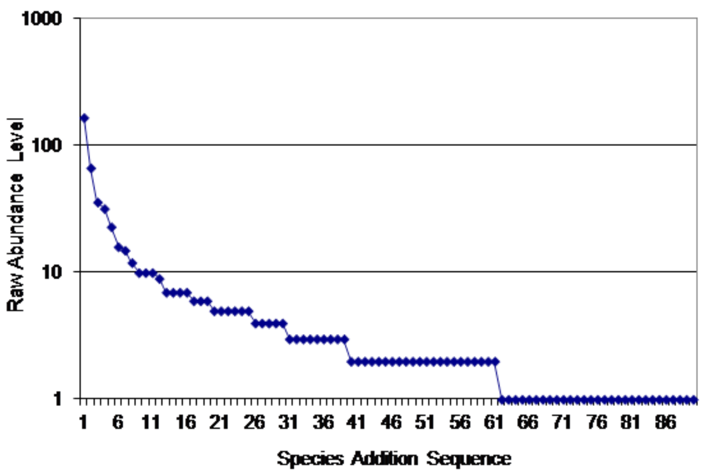



Figure 5. Species rank abundance curve

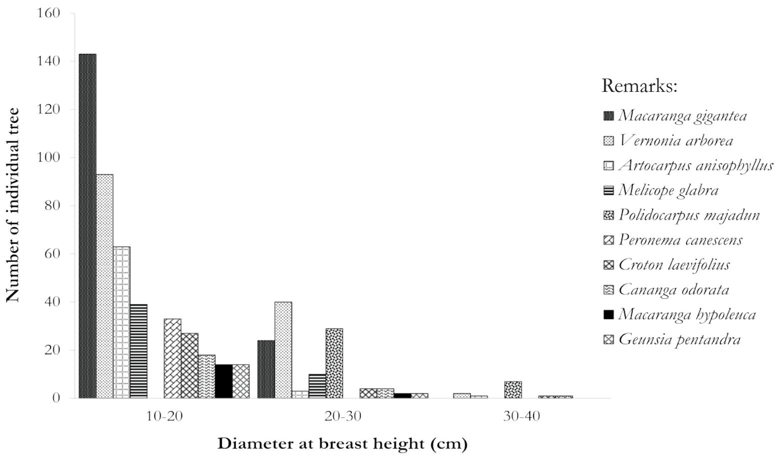



Figure 6. Ten species with the highest number of trees and the distribution among DBH

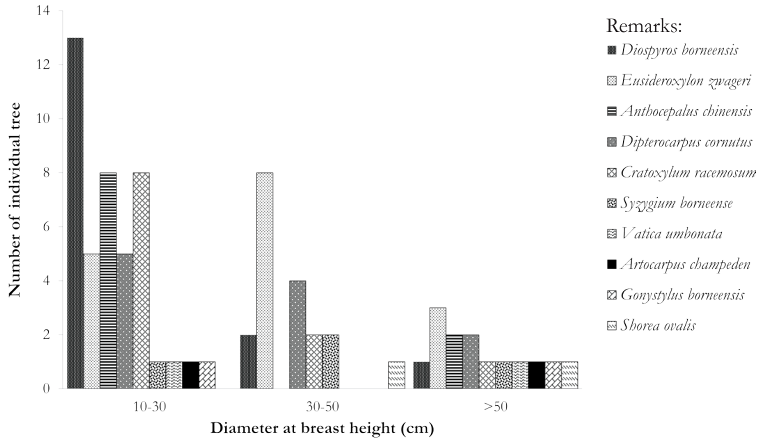



Figure 7. Eight species with individual trees above 50 cm DBH

## D. Functional Group Composition

Twenty eight years after being affected by repeated fires in 1982/1983 and 1997/1998, light demanding species (pioneer and sub-climax species) reached up to 75% of the total population in the sample plot. Trees with DBH 10 – 20 cm and 20 – 30 cm are very common (Figure 6).

## E. Spatial Distribution

The five most dominant species in the sample plot had clumped distribution at various degree of dispersion index. *Artocarpus anisophyllus*, *Macaranga gigantea* and *Vernonia arborea* indicated high clumping index, but *Melicope glabra* and *Pholidocarpus majadun* tend to be uniform. *Artocarpus anisophyllus* which indicated clumped distribution with highest dispersion index at 5.28 (black dot in Figure 6). The bigger bullet size expresses bigger tree DBH.

All surviving species distributed uniformly in the sample plot. Mapping surviving species, which are *Anthocephalus chinensis*, *Diospyros borneensis*, *Dipterocarpus cornutus*, *Eusideroxylon zwageri*, *Pholidocarpus majadun*, *Shorea ovalis Syzygium borneense*, *Vatica umbonata*, clearly showed that big trees with DBH >50 cm are found for each species, except *P. majadun* (Figure 7).

Observation in 2003 of the same sample plot found 188 of 254 species recruited in the 1.65 hectare plot and 148 species of 188 reach > 10 cm DBH (Simbolon, 2005). In the same plot with an additional 150 m$^2$ (1.8 hectare)

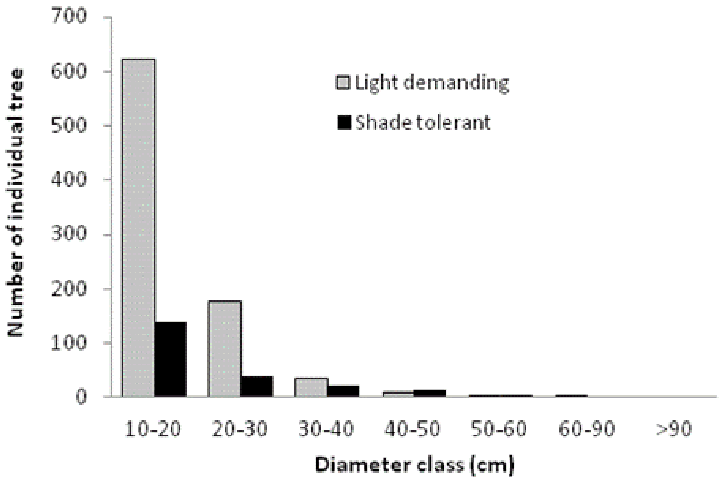



Figure 8. Tree population of light demanding and shade tolerant species in each diameter class

we found 191 of 273 species > 10 cm DBH. Referring to Simbolon (2005), during 1980 – 2003 188 species recruited in the secondary forest of Samboja Research Forest. However, 2011 observation found 191 species in the same plot. It means that stagnation species recruitment occurred during 2003 – 2011.

Euphorbiaceae had the highest species member contributed by two genera of *Macaranga* and *Mallotus*. Both *Macaranga* and *Mallotus* are generally pioneer species that characterize forest disturbance. The genus *Macaranga* is associated with intermediate to high level of disturbance and *Mallotus* is an indicator of low to intermediate disturbance (Slik, Kebler, & van Welzen, 2003). High population of *Macaranga* species regenerated in the secondary forest after being affected by repeated fires indicate that high level disturbance occurred in this area.

Furthermore, according to Slik et al. (2003), *Macaranga* recruit only after disturbance and they were found immediately after fire and until at least 25 years. In the sample plot of Samboja Research Forest 13 years after the second fire, *Macaranga*, particularly *M. gigantea* occupied the area, even as major species indicated by the highest IVI 35.3. The other seven species of *Macaranga* grew as minor species with a total IVI of 10.6.

The consequence of the high level disturbance in the sample plot of Samboja Research Forest is low survival of species. Only 36 of 90 species 5 – 10 cm DBH developed to >10 cm DBH during 2003 – 2011. Changing ecological conditions after fires, both biotic and abiotic may influence species survival. Unfortunately, this paper cannot identify the survival and surviving species due to unavailable of the species list of the 2003 survey.

Tree density in 2003 observation reached 45% of the pre-fire value (Simbolon, 2005), but rapidly increased to 100% during 2003 – 2011. *Macaranga gigantea* had the highest tree density in the sample plot, followed by *Vernonia arborea*. *Macaranga gigantea* was a minor species in the forest area before fire (Kartawinata et al., 2008), but colonized rapidly after the fires from 205 trees of 5 – 10 cm DBH and 35 trees of 10 – 20 cm DBH in 2003 survey (Simbolon, 2005) increased to 143 trees of 10 – 20 cm DBH and 24 trees of 20 – 30 cm DBH in 2011 survey. Increasing tree >10 cm DBH density It indicated that 70% of tree 5 – 10 cm DBH in 2003 observation survived up to >10 cm DBH. Suitable environment condition after repeated fires is the main factor that stimulates the high survival rate of secondary species such as *Macaranga gigantea*.

The rapid increase of tree species after fires was mostly characterized by species with high light preference, small stature, low wood density, large leaves and/or small seeds, as well

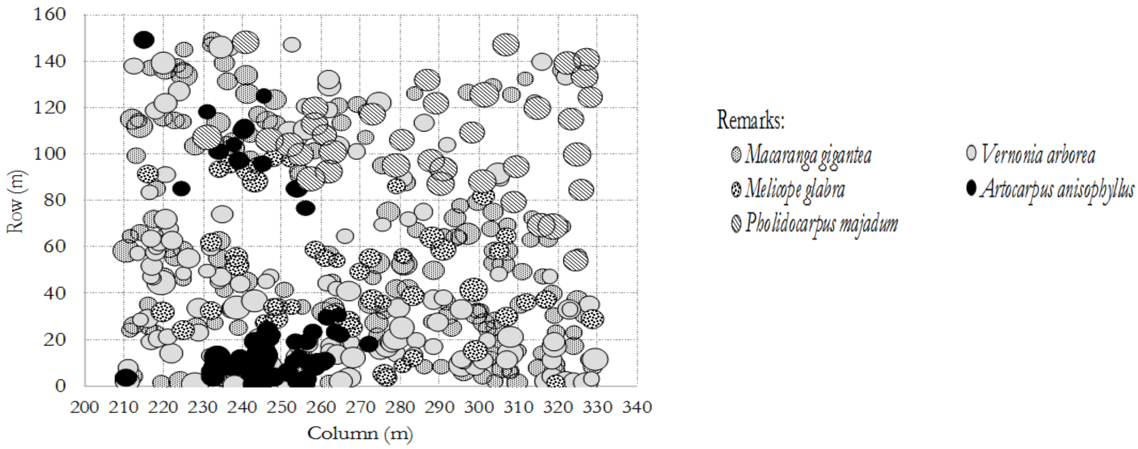



Figure 9. Map of tree position and DBH of the five most dominant species

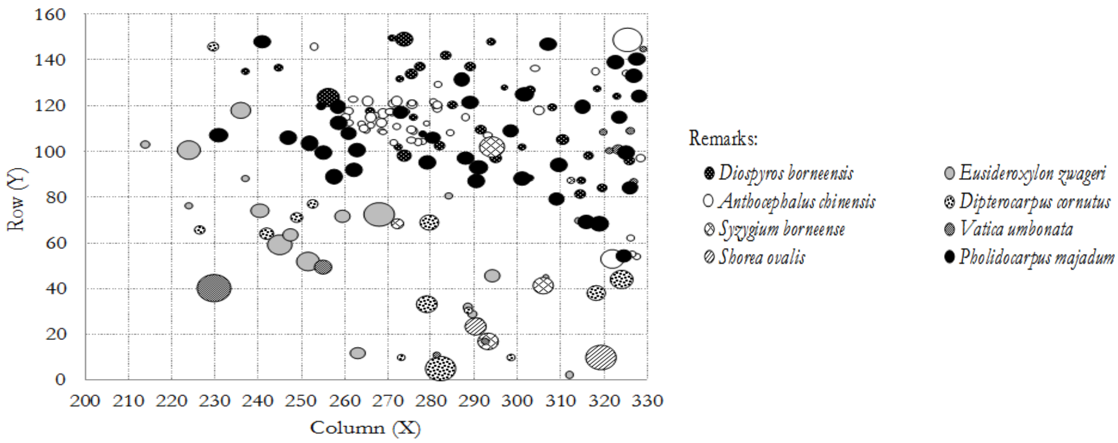



Figure 10. Map of tree position and DBH for six surviving species from repeated fires

as high sprouting capacity (Slik et al., 2010). Small seeds of *M. gigantea* disperse easily in the open area after fire by the wind (Blackham, Webb, & Corlett, 2014).

Two occurrences of fires reduced canopy cover in Samboja Research Forest significantly, then providing an open area with high penetration of light to forest floor and stimulating the seed bank of *M. gigantea* to germinate.

Referring to Kartawinata et al. (2008), changing dominance species that indicated by IVI occurred between 1981 and 2011 survey. Three highest IVI of 1981 survey were *Pholidocarpus majadun*, *Diospyros borneensis* and *Eusideroxylon zwageri*, but changed to *Macaranga gigantea*, *Vernonia arborea* and *Pholidocarpus majadumin* in the 2011 survey.

*Pholidocarpus majadun* is an endemic species of Borneo that is constantly dominant indicated by its relatively stable IVIs (15.2 and 13.0) and unaffected by repeated fires. This species was found particularly in the lowland and swamp forests, distributed uniformly in the sample plot. During 2003 – 2011, the tree population of *Pholidocarpus majadum* in the sample plot was relatively constant, from 37 (Simbolon, 2005) to 36 trees. Population dynamic occurred due to mortality and due to recruitment which resulted in the balance of the vegetation (Krisnawati, Wahjono, & Imanuddin, 2011). Most *Pholidocarpus majadun* survived in the sample plot and grew in the flat area that was not affected by fires (Simbolon, 2005). Moreover, vascular structure of the palm is a benefit for the tree to survive fire and was impacted by low mortality, less than 10% (Van Nieuwstadt & Sheil, 2005).

The second dominant species in the 2011 survey is a newly recruiting species of *Vernonia arborea*. This species was not found in the 1981 survey (Kartawinata et al., 2008), but found in both 2003 (Simbolon, 2005) and 2011 surveys. This species is categorized as light demanding with similar traits of *M. gigantea* (Van Nieuwstadt & Sheil, 2005). *V. arborea* is also recorded in the top ten dominant species in the burnt forest of Samboja and Sungai Wein that immediately colonized the burnt area at 2, 3 and 7 years after fires (Slik, Bernard, van Beek, Breman, & Eichhorn, 2008). The clumped dispersion pattern of *V. arborea* is related to the open area availability in the sample plot after fires.

Surviving species both from two and one fires are potential sources of seed in forest regeneration process. Remnant trees after fires play an important role as nuclei of forest regeneration (Balch, Brando, Nepstad, & Curran, 2013). All surviving species have individual trees above 50 cm DBH in 2011 survey. Individual trees with DBH of 10 to 50 cm of surviving species indicate that they recruited during 1983 – 2011.

*Cratoxylum racemosum* is not considered as survival from two occurrences of fires, because this species is recorded as recruiting species in the 2011 survey. However, it was found individual tree above 60 cm DBH in the plot. The individual tree may be regenerated after the first fire and survived the second fire. This species is categorized as a fast growing species. Study in Malaysia found that diameter increment of *Cratoxylum arborescens* seedling which is the same genus to *Cratoxylum racemosum* is 0.276 mm per week or about 1.5 cm per year (Mojiol, Wahyudi, & Nasly, 2014).

In the other hand, there were no *Pholidocarpus majadum* trees above 60 cm DBH, because this species is a member of Arecareae family with DBH ranged from 20 – 40 cm which is relatively constant from young to mature tree; but, tree height is used as survival indicator.

*Anthocephalus chinensis* grows in the area that has not been impacted by fire then develops as source of seeds of new individual trees that currently regenerating in the sample plot. This species is typically pioneer light is the most important factor, but large individual tree sometime can be found in primary rainforest (Verburg & van Eijk-Bos, 2003). Based on the current DBH of about 10 – 15 cm and growth rate of about 2 cm per year (Krisnawati, Kallio, & Kanninen, 2011), most individual trees are considered regenerated after the second fire. Uniform distribution of the species is a high relationship to availability of environmental condition in the plot. *Anthocephalus chinensis* was distributed in the flat area in the sample plot. High potential seed germination encourages certain species to survive. Fresh seeds of *Anthocephalus chinensis* give about 80% germination (Krisnawati, et al., 2011).

*Diospyros borneensis* is also recorded as survived species after forest fire at Bukit Soeharto education forest, East Kalimantan, with and without sprouts for 10 – 20 cm DBH (Delmy, 2001). Two DBH classes of 10 – 20 cm DBH and 20 – 30 cm DBH were found in the sample plot. Uniform distribution, but tend to be random at index of dispersion 0.07 which is related to the dispersal mode by animals, size of fruit that is categorized as medium, about 4.5 cm diameter and type of fruit that usually solitary but contain many seeds (Seidler & Plotkin, 2006)

*Dipterocarpus cornutus*, *Shorea ovalis* and *Vatica umbonata* are important Dipterocarp species that produce good quality timber that survived the fires. The capacity of *Dipterocarpus cornutus* to produce re-sprouting reach up to 100% in 9 – 10 months after fire; bark thickness of *Shorea ovalis* influence the persistency of species from fire. Both *Dipterocarpus cornutus* and *Shorea ovalis* seeds are wind dispersed that is highly random depend on the wind direction and velocity.

Different from the other Dipterocarp members, *Vatica umbonata* seed is wingless and dispersed by squirrel (Phillipps, 2016).

*Eusideroxylon zwageri* is a native species in Sumatera and Kalimantan that reported to be almost extinct (vulnerable in IUCN Red List), prominent species that survived with and without sprouts, can produce sprouts easily and resistant to fire (Delmy, 2001). Resprouting capacity now is widely recognized as a key functional trait of woody plants (Clarke et al., 2013). This species is categorized as slow growing tree with growth rate of about 0.5 cm per year. Tree diameter of *Eusideroxylon zwageri* in the sample plot in 2011 survey was mostly above 20 cm DBH and was distributed randomly with water and porcupines as potential dispersal agent. As reported by Kartawinata (1978), naturally regenerated seedlings are usually restricted to the area near seed parents and poor seedlings regeneration in logged-over forests. High level of sprouting capacity shows the persistence of individual tree from disturbance (Van Nieuwstadt & Sheil, 2005). High wood density of *Eusideroxylon zwageri*, 1.04 g cm-3 and bark thickness up to 9 cm (Martawijaya, Kartasujana, Kadir, & Prawira, 1992) contribute to the persistence from fire (Delmy, 2001; Van Nieuwstadt & Sheil, 2005).

All trees 10 – 20 cm and 20 – 30 cm DBH assumed to be new recruits after the second fire of 1997/1998; 50% of them came from *Macaranga gigantea* and *Vernonia arborea*; 80% of tree < 30 cm DBH is light demanding species. In opposite, tree >30 cm DBH dominated by shade tolerant species 65% for 30 – 50 cm DBH and 95% for >50 cm DBH.

Individual trees 30 – 50 cm DBH were considered to be regenerated after the first fire that survived after the second fire. Species richness in the sample plot indicates balance among light demanding and shade tolerant, but tends to be higher in species richness of shade tolerant species for larger diameter (>50 cm).

The current tree compositions indicate that two major fires in lowland mixed Dipterocarp forest caused high impact on tree mortality, particularly trees with less than 40 cm in diameter. However, highest recruitment occurred for some light demanding species that colonize immediately in the burnt area. Shade-tolerant species tend to be resistant fire better than light-demanding species. The existence of some individual trees above 50 cm DBH is evidence that those trees had affected by fire, but have capability to survive. In balance, species richness changes between light demanding and shade tolerant species of smaller trees less than 40 cm DBH indicate that during the succession process, some light demanding species colonize the open area and form canopy closure while the seed of shade tolerant species from the remnant forest start to regenerate under the canopy. However, increasing diversity of shade tolerant species above 40 cm DBH indicate that the individual tree species that survived from the second fire of 1997/1998 actually had recruited after the first fire of 1982/1983. Unaffected by fires due to located in the swampy areas in the plot such as *Pholidocarpus majadun*, *Anthocephalus chinensis* and *Diospyros borneensis* perhaps as survival factor of species. Survived shade tolerant species from fire plays an important role as source of seed in forest regeneration. However, some shade tolerant species contain limited number of individual trees, even single individual tree or less than 5 trees in each species. The single tree is vulnerable to local extinction due to various factors. Martinez-Garza and Howe (2003) suggested that 1 – 5 individual in a forest fragment less than 10 hectares area is still far from minimum viable population value.

## IV. CONCLUSION

Twenty eight years after initial fire or thirteen years after the second fire, Euphorbiaceae was found as dominant family with highest number of tree population, genus and species in the sample plot of Samboja Research Forest. Family dominance was changed from Dipterocarpaceae before fire 1982/1982. *Macaranga gigantea* a light demanding pioneer species member of Euphorbiaceae is the most dominant species, followed by *Vernonia arborea* belong to Asteraceae. Low sapling species survival occurred during 2003 – 2011 due to changing of ecological conditions after repeated fires. Smaller trees <30 cm DBH dominated by light demanding pioneer species up to 80%, but 65% of tree 30 – 50 cm DBH and 95% of trees >50 cm DBH is shade tolerant species. All surviving species from both 1982/1983 and 1997/1998 fires distributed uniformly in the sample plot, but the most dominant species had clumped distribution due to similar ecological condition requirement after fire. Based on the current species composition, we identified that the secondary forest of Samboja Research Forest is in its early succession dominated by pioneer species with high risk to fire. Protecting the area from disturbance, assisting natural regeneration while monitoring the dominant species and enrichment planting of late-successional species that were lost due to the fires are recommended activities to accellerate species composition recovery.

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