https://ejournal.forda-mof.org/ejournal-litbang/index.php/GLM
Diterima: 09-02-2022 Disetujui: 28-02-2022
p-ISSN 2723-4924 *e-ISSN 2723-5084*

Artikel

THREE YEARS POST FIRE AREAS NATURAL REGENERATION OF PEAT SWAMP FOREST IN MERANG, MUSI BANYUASIN DISTRICT, SOUTH SUMATERA

Regenerasi Alami 3 Tahun Setelah Kebakaran Hutan Rawa Gambut di Kawasan Merang, Kabupaten Musi Banyuasin, Sumatera Selatan

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ABSTRACT

This study examines natural regeneration of tropical peat swamp forest after fire. The study area is located in Merang Peat Swamp Forest (PSF) in Musi Banyuasin District. Merang PSF is situated over *a large peat dome* that *stores* huge amount of carbon. 23 sample plots were established in the area burned in 2015. The regeneration of understorey, seedlings, and saplings was recorded in each plot. Meanwhile, peat depth and its maturity were identified to determine the soil characteristic of study area. After 3 years of fire, the area already covers densely by understorey mainly pakis udang (Stenochlaena palustris), pakis tanah (Nephrolepis exaltata), and resam (Gleichenia linearis) with depth of root zone reach about 40 cm in some plots. The native peat swamp species showed minimal regeneration during third years after fire due to understorey covering and limited number of surviving trees. The natural regeneration of woody species was dominated by bangun-bangun (Melicope glabra) and sepongol (Evodia sambuciana) which were calculated about 371 saplings/ha and 200 saplings/ha respectively. Those all two species also founded in the seedlings stage. The peat depth varied from 0.32 m to 4.71 m with peat maturity is dominantly hemic in the subsurface. This regeneration information provides useful indications for restoration options, which could be done by assisted natural regeneration.

Keywords: native species, peat depth, restoration, understorey, vegetation analysis

ABSTRAK

Penelitian ini mempelajari regenerasi alami dari hutan rawa gambut setelah terbakar. Lokasi penelitian berada di Kawasan Hutan Rawa Gambut Merang di Kabupaten Musi Banyuasin Kawasan hutan Merang memiliki kubah gambut yang menyimpan cadangan karbon yang besar. Plot pengamatan sebanyak 23 buah ditempatkan di area kebakaran tahun 2015. Regenerasi dari tumbuhan bawah, semai dan sapihan di data dalam setiap plot. Disamping itu, kedalaman lapisan gambut dan tingkat kematangannya diidentifikasi untuk menentukan karakteristik tanah di areal penelitian. Tiga tahun setelah kebakaran, kawasan tersebut telah ditutupi tumbuhan bawah sangat rapat, utamanya terdiri dari pakis udang (Stenochlaena palustris), pakis tanah (Nephrolepis exaltata), dan resam (Gleichenia linearis) dengan zona perakaran mencapai kedalaman 40 cm pada beberapa plot pengamatan. Jenis tumbuhan asli hutan rawa gambut menunjukkan regenerasi alami yang rendah dalam 3 tahun tersebut yang disebabkan oleh rapatnya tutupan tumbuhan bawah serta terbatasnya tumbuhan yang bisa bertahan hidup. Regenerasi alami dari tumbuhan berkayu didominasi oleh bangun-bangun (Melicope glabra) dan sepongol (Evodia sambuciana), dengan kerapatan pancang masing-masing 371 batang/ha dan 200 batang/ha. Kedua jenis tersebut juga ditemukan pada tingkat semai. Ketebalan gambut di areal penelitian bervariasi antara 0,32 m – 4,71 m dengan tingkat kematangan didominasi tingkat hemiks pada bagian bawah permukaan tanah. Informasi regenerasi

DOI: 10.20886/GLM.2022.2.2.125-134

alami ini sangat bermanfaat sebagai indikator dalam pilihan kegiatan restorasi, antara lain adalah mendorong berjalannya regenerasi alami.

Kata kunci: analisis vegetasi, jenis asli, ketebalan gambut, restorasi, tumbuhan bawah

INTRODUCTION

Ecosystem of the tropical peat swamp forests is dynamic. The excessive forest exploitation and improper land management such as the massive drainage channel construction has led the function of the ecosystem as the water storage decline and the excessive drought occurs. As a consequence, the ecosystem has become so prone to the forest fire and the loss of any critical function of this ecosystem (Page et al., 2009).

Total area of South Sumatra peatland is estimated about 1.2 million hectares (8% of total Indonesian peatlands) (Anda et al., 2021). Peatlands are essential ecosystems provide valuable environmental services such carbon storage, biodiversity conservation, and hydrological regulation. Since the 1980s, however, the pressure on natural peat swamp forests of South Sumatra has increased due to logging, drainage, plantation development, and fires. Naturally, peatlands are waterlogged almost all of the years and need to be drained to plant crops. However, once peatlands have been drained, the water table drawdown make them susceptible for fire in a prolonged dry season. The last fire crisis in 2015 has burned approximately 600,000 ha peatlands of South Sumatra (South Sumatra Forest Service, 2016).

Fires associate with smoke haze in 2015 has caused negative effect on economy, health, and ecology. Fires and other anthropogenic disturbance might change pattern and process of forest dynamics (Mirmanto, 2009; Van Eijk, Leenman, Wibisono & Giesen, 2009; Nieuwstadt & Sheil, 2005). Fires is responsible for changing of structure and composition of vegetation (Putra, Mulyana & Junio, 2016; Costa, Menezes, De, & Nascimento, 2017; Agus *et al.*, 2018). On the other hand, the recovery process of a tropical forest after disturbance by a fire is highly depend on seed sources provided by the surviving trees and by resprouting (Costa, *et al.*, 2017; Yamada Kumagawa & Suzuki, 2001).

Merang peat swamp forest is the largest peat dome in South Sumatra, and one of this province's last remnant peat swamp forests is located in this peat dome (Moder, Siegert & Schlessinger., 2008). It covers an area of about 1,400 km^2 and is estimated to store 0.1 Gt of carbon (Ballhorn., 2007). Merang peatland hosts at least 106 woody tree species (Putra, Manuri, Heriyanto & Sibagariang, 2011; Heriyanto, Priatna, & Samsoedin, 2020). During fire even in 2015, approximately 430 km^2 of Merang peatland has burned (Saputra, Setiabudidaya, Setyawan, Khakim, & Iskandar, 2017), causing reduction of canopy and

ground cover, lowering tree species richness and diversity, and contributing to the carbon emissions and smoke haze hazards. This research aims to examine the possibility of the natural regeneration of peat swamp forests after fires. The information gathered from this research is essential in managing and restoring Merang peatland.

MATERIAL AND METHODS

Study area

The research was conducted in Merang Area, Musi Banyuasin District, South Sumatra. Geographically the peatland area is located between $1^0$45'-$2^0$03' S and $103^0$51'- $104^0$17' E. The peat depth is up to 6 m in the centre of the dome, with an average depth of approximately 1.3 m (Moder et al., 2008). The average rainfall is about 2,400 mm/year, with the temperature range from 24 ^{0}C to 33 ^{0}C and humidity 82% (Heriyanto et al., 2020). Some timber and oil palm plantation concessions were established and operated (Fig. 1), including PT. Global Alam Lestari (GAL) licenced for carbon sequestration and peat restoration activities.

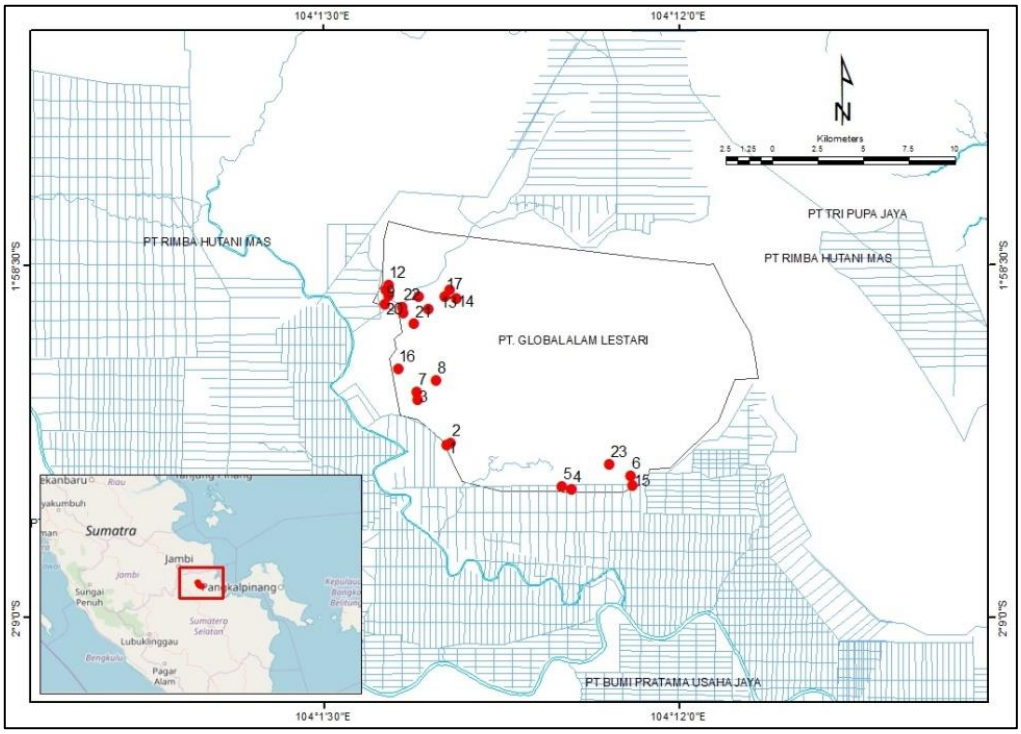

Figure 1. Location of study area at Merang Forest, Musi Banyuasin district, South Sumatera (Red dot showed the established plot)

Methods

The research was carried out in August - September 2018. For sampling of the regeneration tree and shrub, 23 nested square plots of 20 x 20 m (400 m^2) were established and distributed randomly in different elevation. The number of trees species was calculated within 400 m^2 plots, while the number of poles and sapling species were recorded in 10 x 10 m and 5 x 5 m plots. The number of shrub and understorey species were measured from plot of 2 x 2 m made inside those three plots. Species dominancy was calculated based on importance value index summed from value of relative density, relative frequency, and relative dominance (Krebs, 1978). Fire history of study area identified using hotspot data acquired from MODIS satellite, while burnscar year of 2015 collected from Regional Peatland Restoration Agency (TRGD) of South Sumatra based on Landsat 8 satellite imagery analysis. The physical parameters observed in this research were including *pakis* root zone, peat depth, and peat maturity.

RESULT AND DISCUSSION

Result

Land covers change of Merang peatland

Since the late 1970s, the forest of Merang peatland has been selectively logged by timber concession operations (Moder et al., 2008). By 2008, almost 75% of the closed-canopy forest had been degraded (Moder et al., 2008). Another important driver of land cover change in this peatland area is the existence of timber and oil palm plantation concessionaires. A canal scheme was established in the early 2010s for timber and oil palm plantation purposes. The drainage of peatland accelerates the degradation of peat soil due to lowering the water table, thus increasing decomposition of peat soil, particularly at above groundwater table as an increase of microbial activity. In response to water table drawdown, the surface peat layer become rapidly dry and prone to fire in the dry season (Sazawa, Wakimoto, Fukushima, Yustiawati, Syawal, Hata, Taguchi, Tanaka, Tanaka, & Kuramitz, 2018). The infrastructure established by timber concession and an increasing number of canals for plantations led to increases illegal logging activity due to ease of access.

Fire history

The fire history information in the last 15 years has been obtained from hotspot retrieved from MODIS Satellite. The hotspot data used is hotspot with confidence level ≥80% that represented a fire spot. Five times of fires occurred and affected to the study area during the period of 2004 –2018, in which year of 2015 were recorded as the worst fires crisis. The number of hotspots within the PT GAL concession area in 2015 was 329 hotspot (Figure 3).

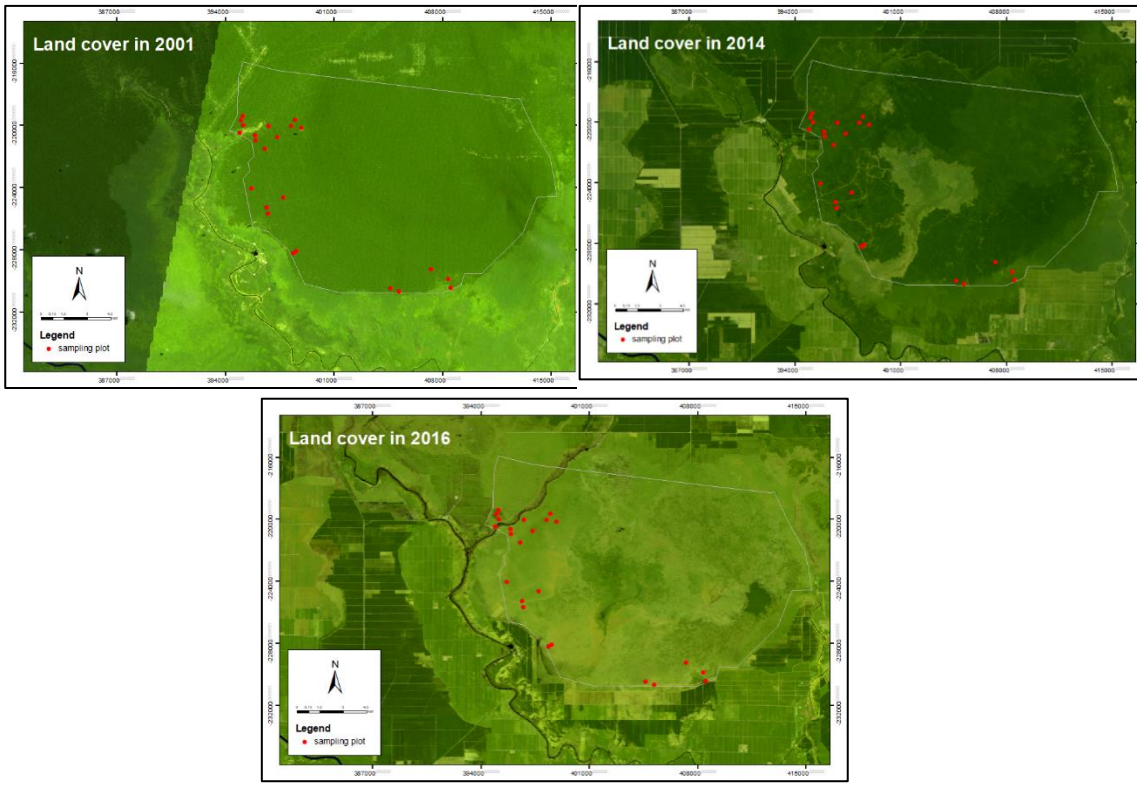

Figure 2. Landcover change of the study area

Figure 4. presents the effect of fires year of 2015 that burnt almost all of the PT GAL concession area in which the sampling plot taken place. The fire has severe impact to the peat soil since the burning fuel is the soil and its organic matter. The prolonged heating of ground fire would kill roots, seeds, and plant stems causing collapse on huge number of trees. The massive fire has burnt almost all vegetation unless some species that could survive such perepat (*Combretocarpus rotundatus*), punak (*Tetramerista glabra*), and meranti (*Shorea* spp.) that found sporadically.

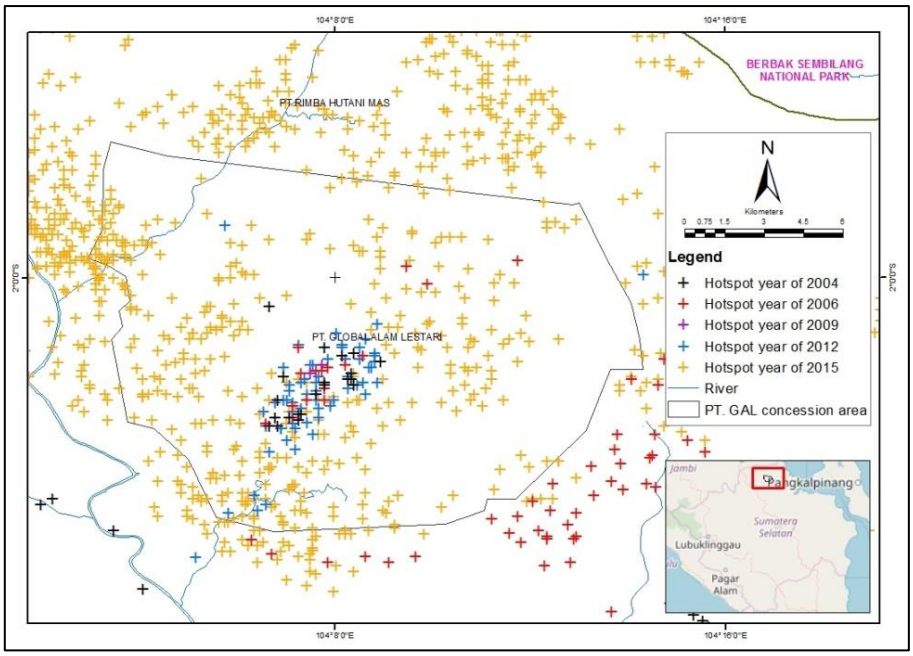

Figure 3. Hotspot in the period year of 2004 - 2019

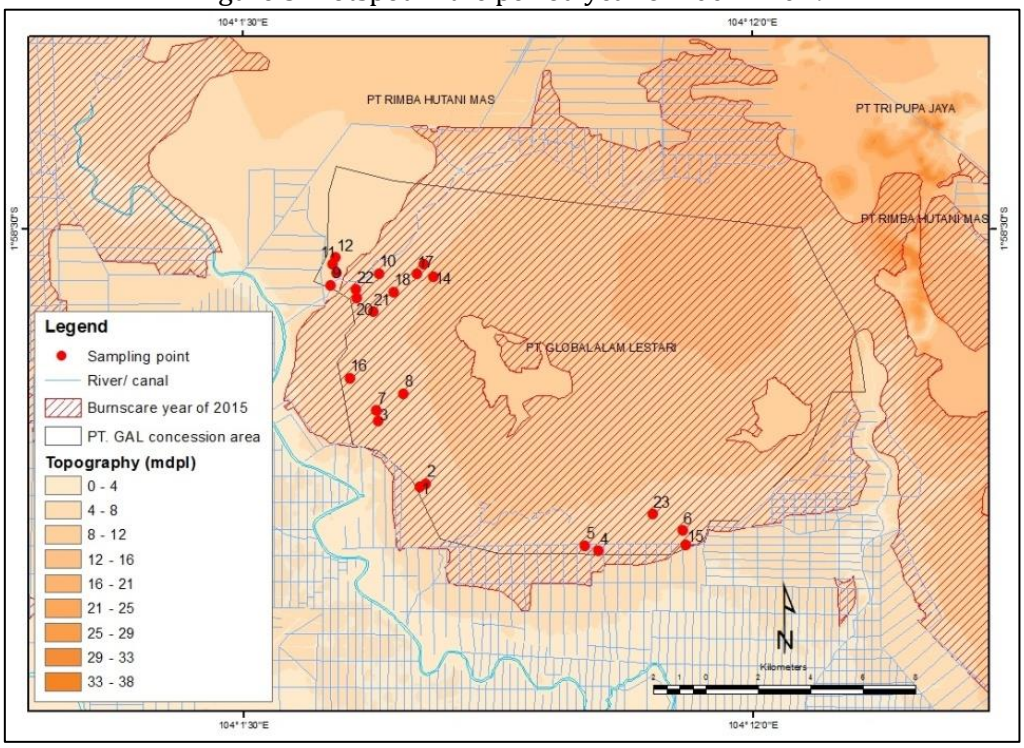

Figure 4. Sampling plots and burnscare year of 2015

Natural regeneration

In total, 11 woody species were identified in the sampling plots which 3 species were classified as poles class, while 6 and 3 species were clasified as saplings and seedlings respectively (Table 1). Saplings and seedlings abundance reflect the natural regeneration of

the peat swamp forest. Sapling class were dominated by bangun-bangun (*Melicope glabra* (Blume) T.G. Hartley) and mahang (*Macaranga* sp.), while seedlings were dominated by *Melicope glabra* and spongol (*Evodia sambuciana*). The species of understorey were dominated by pakis udang (*Stenochlaena palustris*), pakis tanah (*Nephrolepis exaltata*), and resam (*Gleichenia linearis*), while *Melastoma malabathricum* covering all forest floors with high density and 2 m height in some areas. The dominance of *pakis* species on the forest floor has increased the thickness of root biomass at surface layer up to 40 cm at certain places. The peat depth at the sampling site varied from 30 cm to 470 cm. Peat decomposition is dominantly sapric at the surface layer and hemic in the subsurface layer.

Table 1. Species dominancy in three stages of growth.

No	Species	D	RD	F	RF	Dm	RDm	IVI
	Poles							
1	Meranti (*Shorea* spp)	6.67	33.33	0.07	33.33	1.31	40.82	107.48
2	Punak (*Tetramerista glabra*)	6.67	33.33	0.07	33.33	1.06	33.06	99.73
3	Jelutung (*Dyera lowii*)	6.67	33.33	0.07	33.33	0.84	26.12	92.79
	Saplings							
1	Bangun-bangun (*Melicope glabra* (Blume) T.G. Hartley)	346.67	37.14	0.40	37.50	9.48	39.24	113.89
2	Mahang (*Macaranga* sp)	266.67	28.57	0.13	12.50	6.40	26.47	67.54
3	Sepongol (*Evodia sambuciana*)	186.67	20.00	0.27	25.00	3.42	14.15	59.15
4	Banitan (*Polyalthia hypoleuca*)	26.67	2.86	0.07	6.25	1.88	7.80	16.90
5	Kayu kelat (*Eugenia* sp)	26.67	2.86	0.07	6.25	1.88	7.80	16.90
6	Gelam (*Melaleuca cajuputi*)	53.33	5.71	0.07	6.25	0.26	1.08	13.05
	Seedlinggs							
1	Bangun bangun (*Melicope glabra* (Blume) T.G. Hartley)	2666.67	57.14	0.20	50.00			107.14
2	Sepongol (*Evodia sambuciana*)	1333.33	28.57	0.13	33.33			61.90
3	Pulai (*Alstonia* sp.)	666.67	14.29	0.07	16.67			30.95

Remark: D = density; RF = Relative frequency; IVI = Important value index; RD = relative density; Dm = Dominance; F= Frequency; RDm = Relative dominance

Discussion

Research conducted by Siahaan, Sumadi, Kunarso & Purwanto, 2018 shows that natural regeneration of peat forest 1 year after fire in this landscape were dominated by *Macaranga* sp. in the seedlings stage. While, some woody trees such *Combretocarpus rotundatus*, medang beruang (*Notaphoebe* sp.) and medang keli (*Alseodapne* sp.) were still growing although in few numbers. The species of understorey recorded were relatively same with that in the last inventory. *Macaranga* sp. is known as pioneer species that will facilitate other species to ocupied the degraded area. The potential for regeneration is a biological legacy

that determines the direction of regeneration of degraded peat swamp forests; in this case, the dominance of pioneer species should be the concern if their dominance can inhibit the presence of the following seral type (Rachmanadi Faridah, Sumardi & van der Meer, 2017).

The frequency and duration of fire in one area affect to the recovery process of peat swamp forest. Fire disturbance will impact to the seed bank and seed source that commonly provided by adult tree species. While physical conditions of site such peat soil maturity, organic matter content, water level will affect to the germinations process of seed (Agus *et al.*, 2018). Based on field observation, the depth of pakis root associated with thickness layer of litter has affected the germination of seeds. Seeds falling to the forest floor would not grow unless they reach peat soil. However, large of burnt area already covers by dense of *pakis* which produce amount of litter which decomposing very slowly. This condition affected to the regeneration process of peat forest that recorded (Blackham *et al.*, 2014).

On the other hand, the huge amount of litter in the forest floor might be become fuel load in the upcoming fire season (Usup, Hashimoto, Takahashi & Hayasaka, 2004). Consequently, the recovery processes of the area will not success without human intervention from parties. Assisted regeneration is needed to accelerate the regeneration (Rachmanadi *et al.*, 2017). The native tree species that potentially recommended to be used in restoration such as jelutung (*Dyera polyphylla*), pulai (*Alstonia pneumatophora*), kempas (*Kompassia malaccensis*), terentang (*Campnosperma* sp.), meranti rawa (*Shorea pauciflora*), bintangur (*Callophylum* spp.), punak (*Tertamerista glabra*), nyatoh (*Palaquium* spp.) (Lampela, Jauhiainen, Sarkkola, and Vasander., 2017).

CONCLUSIONS

Saplings and seedlings abundance reflect the natural regeneration of the peat swamp forest. Total 11 species of woody species had been identified growing in the research areas. Sapling stages were dominated by bangun-bangun (*Melicope glabra* (Blume) T.G. Hartley) and mahang (*Macaranga* sp), while seedlings were dominated by *Melicope glabra* and spongol (*Evodia sambuciana*). The natural regeneration in the study area is very slow due to thickness layer of understorey and litter which has inhibited the germination of seed and limited number of surviving trees as seeds sources. Assisted regeneration is needed to accelerate the recovery process of the site in study area, such as protected area from fire, weeding the understorey, and thinning.

ACKNOWLEDGMENT

We gratefully acknowledge pak Sugeng and pak Zulfikar from PT. GAL.

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