Abstract No: A-330

SPECIES COMPOSITION AND ENVIRONMENTAL FACTORS OF GRASSLANDS DEVELOPING ON THE BURNT PEATLANDS IN SUMATRA, INDONESIA

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SUMMARY

In Sumatra, peat fire is a serious problem for the last two decades. It is a major cause of degradation that leads to loss of biodiversity and carbon stocks in peat swamp forests. After peat fire, grasslands will develop in the early successional stage there. To understand the relationship between grassland vegetation and environmental factors, field observations were conducted in Riau province, Sumatra, Indonesia. Fifty-one 2 × 2 m plots in the various grassland communities were set-up which spent several years after peat fire disturbance. Species compositions and coverage rates of all species in each plot were checked. The ground water levels were measured on October/December (wet season), 2014 and February (dry season), 2015. Groundwater sample was collected at the same time. In situ pH and electrical conductivity (EC) were measured by a compact pH and EC meter, respectively. In the laboratory, dissolved organic carbon (DOC) and total dissolved nitrogen (TDN) concentrations were determined using a total organic carbon (TOC) analyzer. Forty five plant species were found from our plots (total 204 m2). There were only a few tree species were found in site that experienced fire, although many kinds of forb and grass species were found. They were seventeen forbs, eight grasses, nine ferns, nine shrubs and two trees. Dominant families were *Asteraceae*, *Cyperaceae* and *Poaceae*. Species composition seems to be decided by the groundwater level and water quality.

Keywords: *forest degradation, recovery, environmental impact assessment, anthropogenic disturbance, forest management*

INTRODUCTION

Most of the tropical peatlands (24.8 Mha, 56 %) are found in the Southeast Asia region (47 % in Indonesia, 6 % in Malaysia, 3 % in Papua New Guinea, with small pockets and remnants in Brunei, Myanmar, the Philippines, Thailand and Vietnam) (Page *et al*. 2011). Tropical peat swamp forests are unique ecosystems, because of their extreme acidic, anaerobic and nutrient poor conditions. They support diverse forms of flora, fauna and microbes with manyendemic and endangered species. Anderson (1963) recorded 927 species of flowering plants and ferns in the peat swamp forests of Borneo. Most of tree families that are present in lowland dipterocarp forests are also presented in peat swamp forests, but many of species in peat swamp forests are specific to this habitat (Yule 2010, Rahajoe *et al*. 2016). The tropical peatland ecosystems sustain distinctive biodiversity and ecosystem values (Riely and Page 2005), and important refuges for many endangered species including orangutans. At the same time, tropical peatlands are one of the largest sink of organic carbon. The carbon is stored not only in the living biomass, but also in the peat soil. In Southeast Asia, their high carbon density results in a large regional peat carbon store of 68.5 Gt, equivalent to 77 % of the tropical and 11 – 13 % of the global peat carbon pools (Page *et al*. 2011). Indonesia has the largest stock of tropical peat carbon (57.4 Gt, 65%). This data is used to provide revised estimates for Indonesian forest soil carbon pools of 77 Gt, and total forest carbon pools (biomass plus soil) of 97 Gt. Peat carbon contributes 74 % to the total forest soil carbon pools in Indonesia. However, Indonesia is also the third largest emitter of greenhouse gases from peat fires. However, all regional peatlands are threatened by either logging, drainage, agricultural conversion (mostly to oil palm, as well as rice, rubber, coconut and pineapple), fire or other human activities. In Sumatra, peat fire has been a serious problem since the last decade. Peat fire is a major cause of peatland degradation that leads to loss of biodiversity and carbon stock in peat swamp forests. Analysis using Satellite Pour I'Observation de la Terre (SPOT) image clarified that less than 4 % of peatland areas remain covered by intact peat swamp forests (PSFs), while 37 % are covered by PSFs with varying degree of degradation, and over 20 % is considered to be a un-managed degraded landscape, occupied by ferns, shrubs and secondary growth in Sumatra and Kalimantan (Miettinen *et al*. 2010). Peat swamp forests are sustained in the sensitive balance among deep water tables, canopy cover and leaf litter inputs (Yule 2010), causing difficulties in forest recovery after fire.

In other words, this type of landscape is highly susceptible to further degradation and very difficult to regenerate into forest (Page *et al*. 2009, Shiodera *et al*. 2016). In this study, the impact of fire disturbance to peatlands was evaluated The various grassland communities which developed after peat fire, and the relationships between species composition and some environmental characteristics were compared.

METHODS

Research sites

This study was conducted in Riau Province, Sumatra, Indonesia. In this area, repeated occurrence of peat fire changed peat swamp forest to degraded bare land. Degraded peatlands which experienced peat fire around there (35° N, 136° E; 190–255 m above sea level). The study site has rainy and dry seasons affected by the inter-tropical convergence zone, which usually results in a rainy season (November - December) and two dry seasons (January - May and June - September) (Baum *et al*. 2007) in a year in the area.

Vegetational research on the burnt sites

The research period was from October, 2014 to March, 2015. To understand the relationship between vegetational types and environment factors, field observations were conducted in Tanjung Leban and some neighboring villages. Fifty-one 2 × 2 m plots in the various grassland communities were set-up which spent several years after peat fire disturbance. Species components and coverage rates of all species in each plot were checked. The species identification was conducted by researchers and engineering officials in the Research Center for Biology, Indonesian institute of Science (RCB-LIPI), by comparing the samples in the herbarium one by one.

Measurement of soil water contents and analysis of groundwater samples

The ground water levels were measured manually using water-level indicator in December 2014 (wet season) and February 2015 (dry season). Piezometer was inserted in the soil for 1.0 m depth to measure subsurface groundwater levels and collect the groundwater samples at each plot. In situ Ph and electrical conductivity (EC) were measured using a compact pH meter (LAQUA, Twin pH; HORIBA, Kyoto, Japan) and EC meter (LAQUA, Twin Cond, HORIBA, Kyoto Japan), respectively. Then, water samples were filtered, through glass-fiber filters (GF/F; nominal particle retention, 0.7 µm; Whatman, UK). In the laboratory, dissolved organic carbon (DOC) concentrations and total dissolved nitrogen (TDN) concentrations were determined using a total organic carbon (TOC) analyzer (TOC-V; Shimadzu, Japan).

RESULTS AND DISCUSSION

Forty five (45) plant species were found from the study plots (total 204 m2). Four (4) types of vegetations were identified namely *Pennisetum*, *Blechnum*, *Scleria* and *Stenochlaena* (Figure 1). However,there were only a few tree species, but many kinds of forb and grass species were found in sites that experienced fire . There were seventeen (17) forbs and eight (8) grasses, nine (9) ferns, nine (9) shrubs and two (2) trees. Dominant families were Asteraceae (seven species), Cyperaceae (four species) and Poaceae (four species). Two (2) tree species, *Elaeis guineensis* Jacq (oil palm) and *Acacia crassicarpa* A.Cunn ex Benth, were planted by local people for commercial use or natural regeneration after seed dispersal by birds. Seedlings or saplings of other tree species were not found. There were only four (4) shrub species, which were light-demanded species. Many *Asteraceae* species were found, however the coverage was less than 0.01 % in each plot. In contrast, the coverage of some Cyperaceae and Poaceae species were very high. Fern species also separated into higher and lower coverage species. The higher coverage fern species were *Stenochlaena* sp. (Blechnaceae), *Pteridium* sp. (Dennstaedtiaceae) and *Blechnum orientale L.* (Blechnaceae). As for the grass species, *Pennisetum polystachyum* (L.) Schult. (Poaceae) and *Imperata cylindrica* (L.) Rausch. (Poaceae) also showed higher coverage in the sites. The groundwater depth and quality were different with each vegetational type (Table 1).

CONCLUSION

Species composition seems to be influenced by the level of the groundwater table and water quality in the burnt grassland in peatlands in Indonesia.

ACKNOWLEDGEMENTS

We are grateful to the Research Center for Biology, Indonesian institute of Science (RCB-LIPI) for the permission to conduct our research. We also thank Mr. Ahmad Muhammad, Dr. Haris Gunawan, Riau univercity; Mr. and Mrs. Nur for supporting our research. This work was supported by the Institutional Collaboration Feasibility Studies

"Toward the Regeneration of Tropical Peat Land Societies: Establishment of an International Research Network and Proposal of its Future", Research Institute for Humanity and Nature (RIHN), Japan.

Figure 1: Various vegetation after peat fire (left; *Blechnum orientale L. (Blechnaceae),* center, *Cyperaceae,* right; *Pennisetum polystachyum (L.) Schult.(Poaceae)).*

Table 1. The environmental factors of each vegetational site. The values in parenthesis are standard deviation in each site.

Site name (Dominant species)	Ground water level (cm)	Soil water contents (%)	pH	EC (µS/cm)	TOC (mg/l)	TDN (mg/l)
***Pennisetum* sites**	-74.86 (22.9)	5.48 (3.3)	4.16 (0.4)	90.9 (14.7)	27.98 (3.1)	0.38 (0.1)
***Blechnum* sites**	-27.64 (12.7)	9.98 (3.7)	3.95 (0.4)	96.5 (18.1)	26.45 (2.8)	0.38 (0.0)
***Scleria* sites**	-33.24 (24.8)	32.21 (14.5)	3.84 (0.3)	111.2 (26.2)	23.90 (4.0)	2.97 (3.8)
***Stenochlaena* sites**	-60.16 (13.5)	3.1 (1.9)	3.8 (0.1)	86.2 (9.8)	33.43 (1.2)	0.40 (0.0)

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