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Plants diversity of the deforested peat-swamp forest of Tripa, Indonesia

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Abstract. *Djufri, Wardiah, Muchlisin ZA. 2016. Plants diversity of the deforested peat-swamp forest of Tripa, Indonesia. Biodiversitas 17: 372-376.* Tripa peat swamp forest has been degraded due to human perturbation and resulted in decreasing the plant diversity. Currently, no report on plant diversity from this region in another hand the degradation is occurring continuously. Hence, the purpose of the present study was to evaluate the plants diversity of the Tripa peat swamp forest in Aceh Barat District, Indonesia. A quadratic method was employed in this study. Determination of the square area was carried out based on the curve of minimum area. The result showed that there were 41 species of herbs with diversity index ranging from 1.8785 to 2.4180 classified as low to moderate categories. A total of seven species of shrubs and 24 species of trees were found at the locations with diversity index (H') ranging from 1.5186 to 1.7496 and 2.1713 to 2.9133 respectively, indicating the diversity of shrubs was in a low category, while the diversity of tress was in the moderate level. It is concluded that the diversity index of herbs and shrubs were in a low category while the tree groups were in the medium category. According to the diversity index and direct observation of the Tripa peat swamp forest, this area had been degraded due to land conversion.

Keywords: Deforestation, flora, peat swamp forest, Nagan Raya, Aceh Barat Daya

INTRODUCTION

Peat swamp forest plays a significant role in protecting the land from the intrusion of sea water, abrasion and tsunami (Djufri 2004); this area prevents floods during rainy seasons and supply fresh water for agriculture and aquacultural activities and settlements. The peat swamp has an important role as water storages and important habitat for various species of flora and fauna. Tropical peat swamps typically contain a high biodiversity of plants and animals (Muchlisin et al. 2015). However, slight changes in the environmental circumstances of peat swamp have strong effects on both forest structure and species diversity (Eijk and Leenman 2004).

Tripa peat swamp is one of the wetland forests in Indonesia. This ecosystem is covered approximately 61,000 ha and about 75% of this area had been deforested intensively (PIU-SERT 2013; Muchlisin et al. 2015). This area is situated approximately 100-300 m from sea level. In addition, the average rainy days per month are 16 days with an average monthly rainfall reaching of 300.27 mm. The Tripa peat swamp forest is a unique habitat for Sumatran Orangutans (*Pongo abelii* Lesson), the endangered and prior to extinction animal; Sumatran Tigers (*Panthera tigris sumatrae* Linnaeus), Bears (*Helarctos malayanus* Raffles), and Crocodiles (*Crocodylus porosus* Schneider) (YLI-AFEP 2008). It is also an important habitat for many species of plants.

Peat swamp has been known as a hostile and unsuitable area for agriculture with low economic value. However, the increase in human population and economic development lead to utilize and cultivate this area. Conversion of the forest into oil palm plantation or plantation of commercial timber species and other cultivated plants contribute not only in reducing plant and animal diversities, but also leading to decrease in water flows and influences susceptibility to fires during the dry season (Eijk and Leenman 2004; Posa et al. 2011). According to Setiadi (1998), the opening of peat swamp for palm oil plantations, settlements, and other purposes affected on the reduction of vegetation, animals, genetic diversity, disruption of aquatic habitat, deterioration of water quality due to the rise of pyrite level. Furthermore, the irresponsible utilization of peat swamp also generated negative impacts on the global warming and provides access to illegal logging.

Similar to other peat swamp areas in Indonesia, the peat swamp of Tripa is also threatened by land conversion for palm oil plantations, and settlements (Task Force REDD 2012), which potentially degrades the flora species in this important ecosystem. However, there is no information on the plant diversity of Tripa peat swamp forest. Information on the composition of vegetation is crucial to arrange a better conservation strategy. Hence, the paper presented the plant diversity of the Tripa peat swamp forest as a baseline data to plan a better conservation and monitoring strategies.

MATERIALS AND METHODS

The Tripa peat swamp is situated in Nagan Raya and Aceh Barat Daya Districts, Aceh Province, Indonesia. The sampling was focused in the peat swamp area at Pulo Kruet Village, Nagan Raya District (Figure 1). The study area was divided into five different stations with the total areas

of 4.2 ha (or 10% from the total peat-swamp areas), namely: Western Peat-swamp Forest (WPSF), Eastern Peat-swamp Forest (EPSF), Northern Peat-swamp Forest (NPSF), Southern Peat-swamp Forest (SPSF), and Local Beaches (LB). Ten sampling points which covered approximately 50 m^2 were determined randomly on each sampling station (with a total of 500 m^2 on each sampling station). Determination of the number of squares was carried out using three series techniques while the squares area determination of the sample was based on the technique of minimum curve area (Barbour et al. 1999).

The transect techniques were utilized in the study to examine the changes in vegetation stratification according to the topography and elevation. The values of the Absolute Density (AD), Absolute Frequency (AF) and Absolute Dominancy (ADM) were examined following Ludwig and Reynold (1988). The introduced species of plants were identified according to Backer and Bakhuizen van den Brink (1968); and Soerjani et al. (1987).

The importance value (IV) of each species was calculated according to Cox (2001), while the Index of Shannon-Wiever's Species Diversity (H') was examined using the criteria according to Barbour et al. (1999) and Djufri (2002). The H' value was typically ranged from 0 to 7, where H'≤ 1 is for very low category, H'≥ 1-2 is for low category, H' ≥ 2-3 is for medium category, H'≥ 3-4 is for high category, and H' ≥ 4 is for very high category. In addition, the Species Evenness Index (e) was examined using the formula as described by Barbour et al. (1999), Djufri (2004), and Djufri et al. (2005).

RESULTS AND DISCUSSION

The herbaceous plants dominated the deforested peat swamp of Tripa. A total of 41 species of herbs belonging to 39 genera were found in the study area (Table 1). Generally, the species composition in this area was higher compared to other stations.

The average diversity indices (H') of herbaceous species observed in five locations in the area of palm oil plantations was ranged from 1.88 to 2.42. This indicates that the important value was in the low to medium categories.

The dominant shrub species at WPSF were *Cassia siamea* (IV = 90.79%) and *Vernonia cinerea* (IV = 95.60%), while EPSF was dominated by *C. siamea* (IV = 99.19%) and *Mimosa pigra* (IV = 62.06%). The *C. Casia siamea* (IV= 84.25%) and *V. cinerea* (IV = 87.65%) were also the predominant species at NPSF (Table 2). In addition, at SPSF and LB, *C. siamea* (IV = 95.87%), *Lantana camara* (IV = 64.36%), *Bixa orellana* (78.10%), and *M. pigra* (IV = 60.69%) were the most predominant species, respectively. The diversity indices of tree species in the forest ranged from 2.17 to 2.91 with an average of 2.40 indicating a moderate category.

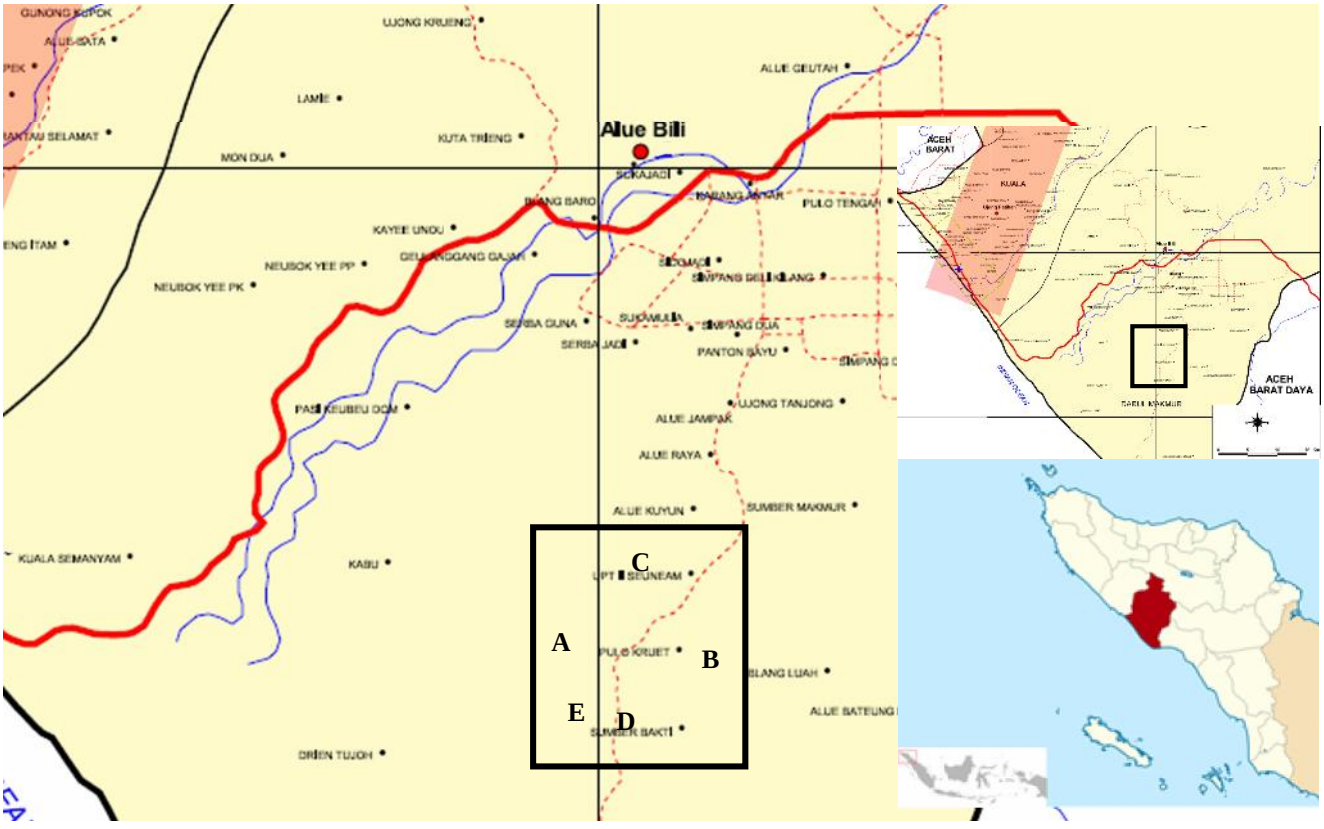

Figure 1. The study area (in red cycle): A. Western Peat swamp forest (WPSF), B. Eastern Peat Swamp Forest (EPSF), C. Northern Peat swamp forest (NPSF), D. Southern Peat swamp forest (SPSF), E. Local Beaches (LB)

The species of trees varied in the forest. There were 24 species of tree groups found in the study area (Table 3). In general, the compositions of Peat swamp forest in the village of Pulo Kruet were relatively similar to the peat swamp forests in other parts of Indonesia. The main tree species on site of WPSF were *Eugenia polyantha* (IV = 99.10%) and *Alstonia villosa* (IV= 90.60%). Whereas at EPSF, they were *E. polyantha* (IV = 79.07%) and *Acronychia porteri* (IV = 59.10%). At NPSF, they were *E. polyantha* (IV = 79.34%) and *Litsea cassiaefolia* (IV = 56.88%). Moreover, SPSF and LB were occupied by *Eugenia polyantha* (IV = 80.42%), *Litsea cassiaefolia* (IV = 55.13%), *Eugenia polyantha* (86.53%) and *Calophyllum spectabile* (IV = 54.66%) (Table 1). It is known that the environment plays an important role in vegetation diversity. Thus, this factor can change due to human activities, for example deforestation, open drainage, and fires that disturb the environmental condition (Hirano et al. 2007).

Table 1. Species composition, importance value (IV) and diversity index (H') of herbaceous stratification at deforested peat swamp forest of Tripa in the village of Pulo Kruet, Aceh, Indonesia

Species	Sampling location									
	WPSF		EPSF		NPSF		SPSF		LB	
	IV	H'	IV	H'	IV	H'	IV	H'	IV	H'
Eichhornia crassipes (Mart.) Solms	20.80	-0.19	79.19	-0.35	98.62	0.37	95.87	-0.36	44.24	-0.28
Panicum repens L.	24.20	-0.20	42.06	-0.28	-	-	-	-	60.69	-0.32
Hyptis capitata Jacq.	2.80	-0.04	3.19	-0.05	-	-	-	-	13.55	-0.14
Ipomoea aquatica Forsk.	95.60	-0.36	3.40	-0.05	-	-	-	-	-	-
Mimosa púdica L.	1.98	-0.03	4.76	-0.07	-	-	-	-	5.41	-0.07
Ageratum conyzoides L.	1.76	-0.03	6.13	-0.08	-	-	-	-	-	-
Cyperus pygmaeus Rottb.	5.44	-0.07	4.36	-0.07	2.20	-0.04	14.36	-0.15	30.24	-0.23
Desmodium heterophyllum Willd.	1.78	-0.03	1.80	-0.03	-	-	-	-	-	-
Desmodium triflorum (L.) DC	2.53	-0.04	2.95	-0.05	-	-	-	-	-	-
Coix lacrima-joby L.	0.76	-0.02	0.17	-0.01	-	-	-	-	-	-
Clitoria ternatea L.	3.07	-0.05	5.12	-0.07	-	-	-	-	-	-
Calopogonium muconoides Desv.	86.38	-0.36	49.77	-0.29	96.77	-0.37	97.55	-0.37	-	-
Emilia sonchifolia (L.) DC	4.24	-0.06	3.36	-0.05	-	-	-	-	9.57	-0.11
Eclipta prostrata (L.) L.	13.64	-0.14	7.49	-0.09	3.34	-0.05	21.56	-0.19	-	-
Passiflora foetida L.	9.22	-0.11	3.65	-0.05	-	-	-	-	-	-
Colocasia esculenta (L.) Schott	10.35	-0.12	37.65	-0.26	33.15	-0.24	-	-	-	-
Salvia splendens Sello	8.78	-0.10	7.07	-0.09	-	-	4.17	-0.06	-	-
Dactyloctenium aegyptium Richt.	5.43	-0.07	9.74	-0.11	-	-	-	-	-	-
Phyllanthus niruri L.	1.28	-0.02	1.54	-0.03	-	-	7.54	-0.09	-	-
Bidens pilosa L.	-	-	2.48	-0.04	-	-	4.48	-0.06	-	-
Leucas lavandulaefolia J.E. Smith	-	-	8.34	-0.10	4.61		7.29	-0.09	-	-
Euphorbia hirta L.	-	-	0.24	-0.01	-	-	-	-	-	-
Saccharum spontaneum L.	-	-	3.75	-0.05	21.44	-0.06	-	-	-	-
Sida rhombifolia L.	-	-	8.78	-0.10	-	-	8.66	-0.10	6.02	-0.08
Tridax procumbens L.	-	-	2.46	-0.04	-	-	-	-	-	-
Axonopus compressus Swartz.	-	-	0.55	-0.01	-	-	-	-	25.24	-0.21
Richardia brasiliensis Gomez.	-	-	-	-	0.53	-0.01	5.42	-0.07	-	-
Cyperus rotundus L.	-	-	-	-	3.29	-0.05	5.30	-0.07	-	-
Crotalaria striata L.	-	-	-	-	6.27	-0.08	-	-	-	-
Cyperus bulbosus Vahl.	-	-	-	-	0.47	-0.01	2.82	-0.04	-	-
Cleome rutidosperma DC.	-	-	-	-	0.09	-0.00	-	-	-	-
Physalis angulata L.	-	-	-	-	7.49	-0.09	7.82	-0.10	-	-
Synedrella nodiflora (L.) Gaertn	-	-	-	-	2.47	-0.04	1.99	-0.03	-	-
Commelina benghalensis L.	-	-	-	-	6.73	-0.09	3.36	-0.05	-	-
Solanum melongena L.	-	-	-	-	4.25	-0.06	3.71	-0.05	-	-
Urena lobata L.	-	-	-	-	0.88	-0.02	3.80	-0.05	-	-
Borreria laevis (Lamk) Griseb.	-	-	-	-	3.45	-0.05	-	-	-	-
Eleusine indica L.Gaertn.	-	-	-	-	1.62	-0.03	-	-	-	-
Dactyloctenium aegyptium Richt.	-	-	-	-	1.62	-0.03	-	-	-	-
Stachytarpheta indica (l..) Vahl.	-	-	-	-	-	-	4.30	-0.06	16.44	-0.16
Nephrolepis exaltata Schott	-	-	-	-	-	-	-	-	88.60	-0.36
Total	300	-2.05	300	-2.42	300	-1.88	300	-2.01	300	-1.97
Total	300	2.05	300	2.42	300	1.88	300	2.01	300	1.97

Note: WPSF = West of Peat swamp Forest, EPSF = Eastside Peat swamp Forest, NPSF = North side Peat swamp Forest, SPSF = Southern Peat swamp Forest, LB = Local Beach

Table 2. Species composition, importance value (IV) and diversity index (H') of shrub stratification at the Tripa peat swamp forest which was converted to oil palm plantations in the village of Pulo Kruet, Aceh, Indonesia

Species	Sampling location									
	WPSF		EPSF		NPSF		SPSF		LB	
	IV	H'	IV	H'	IV	H'	IV	H'	IV	H'
Cassia siamea Lmk	90.79	-0.36	99.19	-0.37	84.25	-0.36	95.87	-0.36	44.24	-0.28
Mimosa pigra L.	34.17	-0.25	62.06	-0.33	65.44	-0.33	43.12	-0.28	60.69	-0.32
Bixa orellana L.	12.80	-0.13	23.19	-0.20	-	-	23.44	-0.20	78.10	-0.35
Vernonia cinerea (L.) Less.	95.60	-0.36	33.40	-0.24	87.65	-0.36	41.31	-0.27	-	-
Melastoma malabatricum L.	21.98	-0.19	24.76	-0.21	27.46	-0.22	-	-	35.41	-0.25
Elaeocarpus edulis T. & B.	21.76	-0.19	23.04	-0.20	-	-	31.90	-0.24	44.32	-0.28
Lantana camara L.	22.90	-0.20	34.36	-0.25	35.20	-0.25	64.36	-0.33	37.24	-0.26
Total	300	-1.69	300	-1.79	300	-1.52	300	-1.68	300	-1.75
Total	300	1.69	300	1.79	300	1.52	300	1.68	300	1.75

Table 3. Species composition, importance value (IV) and diversity index (H') of tree stratification at the Tripa peat swamp forest in the village of Pulo Kruet, Aceh, Indonesia

Species	Sampling location									
	WPSF		EPSF		NPSF		SPSF		LB	
	IV	H'	IV	H'	IV	H'	IV	H'	IV	H'
Acronychia trifoliata Zoll.	30.79	-0.23	59.1	-0.32	24.53	-0.20	14.33	-0.20	24.35	-0.20
Adina polycephala Benth.	24.72	-0.21	42.06	-0.28	12.88	-0.14	22.08	-0.04	2.77	-0.04
Aglaia odorata Lour.	2.80	-0.04	3.19	-0.05	5.87	-0.08	9.77	-0.18	19.46	-0.18
Alstonia villosa Bl.	90.60	-0.36	3.4	-0.05	12.66	-0.13	4.07	-	-	-
Alstonia spatulata Bl.	11.98	-0.12	4.76	-0.07	20.35	-0.18	22.5	-	-	-
Anisoptera costata Korth.	1.76	-0.03	6.13	-0.08	0.77	-0.02	4.79	-	-	-
Antidesma bunius (L.) Spreng.	8.42	-0.10	4.36	-0.06	10.75	-0.12	10.51	-0.25	33.57	-0.25
Blumeodendron tokbrai (Bl.) Kurtz.	11.72	-0.13	1.8	-0.03	20.35	-0.18	23.35	-0.05	3.56	-0.05
Calophyllum inophyllum L.	12.50	-0.13	2.95	-0.05	10.2	-0.12	12.24	-0.19	22.29	-0.19
Calophyllum spectabile Willd.	4.66	-0.06	00.17	-0.01	14.71	-0.15	14.11	-0.31	54.66	-0.31
Campanumoea celebica Bl.	3.07	-0.05	5,12	-0.04	2.87	-0.10	8.87	-0.17	18.05	
Cinnamomum iners Reinw. ex. Bl.	6.38	-0.08	9.77	-0.11	3.66	-0.05	4.66	-0.15	14.92	-0.15
Cryptocarya costata Bl.	14.24	-0.14	3.36	-0.05	4.77	-0.07	4.12	-0.06	4.27	-0.06
Cryptocarya griffithiana Wight.	33.64	-0.25	7.49	-0.09	3.97	-0.06	5.71	-0.07	5.10	-0.07
Diospyros hasseltii Zoll.	29.22	-0.23	3.65	-0.05	-	-	-	-	-	-
Durio kutejensis (Hassk.) Becc.	30.35	-0.23	34.65	-0.25	-	-	-	-	-	-
Eugenia polyantha Wight.	99.10	-0.37	79.07	-0.35	79.34	-0.35	80.42	-0.36	86.53	-0.36
Hopea celebica Burck.	13.94	-0.14	9.04	-0.11	-	-	-	-	-	-
Knema cinerea (Poir.) Warb.	-	-	1.54	-0.03	-	-	-	-	-	-
Litsea angulata Bl.	-	-	2.4	-0.04	-	-	-	-	-	-
Litsea cassiaefolia Bl.	-	-	8.34	-0.10	56.88	-0.32	55.13	-0.09	7.13	-0.09
Macaranga semiglobosa J.J.S.	-	-	00.24	-0.01	-	-0.15	-	-	-	-
Palaquium javense Burck.	-	-	3.75	-0.06	15.44	-	3.34	-0.05	3.34	-0.05
Tristania conferta R. Br.	-	-	8.78	-0.10	-	-	-	-	-	-
Total	300	-2.91	300	-2.39	300	-2.35	300	-2.17	300	-2.17
Total	300	2.91	300	2.39	300	2.35	300	2.17	300	2.17

There were five predominant species found at the study locations, i.e. *Ipomoea aquatica, Eichhornia crassipes, Calopogonium muconoides, Panicum repens* and *Nephrolepis exaltata.* The first two species have grown rapidly in wet and humid areas while the last three species grow better in drier areas. Different kinds of forest provide markedly different habitat and support different species of wildlife. Moreover, different species have different responses to environmental factors that determine the survival and thriven species on certain regions (Nebel and Wright 1993).

The most of Tripa peat swamp forest areas have been converted to palm oil plantations. Conversion of the forest to oil palm plantations would alter its ecological functions for example, the increased frequency and severity of floods and forest fires during the last decade (Muchlisin et al. 2015). In addition, according to Wahyunto et al. (2005) the conversion of Tripa peat swamp forest to oil palm

plantations has insignificant positive economic benefit for local people.

The peat swamp forest mainly functions in regulating the water flows and water storages. The peat area has an important function for water storage. These are because the peat swamp forest has the capability to absorb the water rapidly during the rainy season and discharge the water slowly during the dry season and therefore the forest guarantees water sustainability (Eijk and Leenman 2004).

The study revealed that *C. siamea* was a predominant species in all locations except at LB. Seven species of shrubs have been found in the post deforested peat swamp (Table 2). These species were invasive into the peat swamp forests of this region, for example, Eijk and Leenman (2004) reported that those species were not commonly found in the virgin peat swamp in Indonesia.

The ecology of peat swamp forest which was converted to palm oil plantations were dominated by shrub group. The value of diversity indices (H') of shrub species in five locations in the area of palm oil plantations (converted peat swamp) had the average Diversity Index values that ranged from 1.5186 to 1.7496, with the importance value at the low category. The average value of the species in the five locations was 1.6848 indicating low category (Table 2). It indicates that the value of the shrub species diversity in oil palm plantation area was low. Posa et al. (2011) stated that the majority of trees of peat swamp forest in the Southeast Asia are dipterocarp, with species composition of *Shorea albida* and *Shorea balangeran*. However, these species were not recorded during the study, probably due to the deforestation which are occurring in this area.

It is concluded that the diversity index of herbs and shrubs were in a low category, while the tree groups was in the medium category. According to the diversity index and direct observation of the Tripa peat swamp forest, this area has been degraded due to land conversion.

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REFERENCES

Backer CA, Bakhuizen v.d. Brink Jr. RC. 1968. Flora of Java (Spermatophyte Only) Vol. III. Nordhoff, Groningen.

Barbour MG, Burk JH, Pitts WD, Gilliam FS, Schwartz MW. 1999. Terrestrial Plant Ecology. 3rd ed. Benjamin Cummings, Menlo Park, CA.

Cox GW. 2002 Laboratory Manual of General Ecology. WM.C. Brown, New York.

Djufri. 2002. Determination of distribution pattern, association, and interaction of plant species in grassland of Baluran National Park, East Java. Biodiversitas 3 (1): 181-188 [Indonesian].

Djufri. 2004 Review: The effect of conversion of peatswamp forest into agriculture land. Enviro 4: 34-43 [Indonesian].

Djufri, Setiadi D, Guhardja E, Qayim I. 2005 Effect of stand density Acacia (*Acacia nilotica*) (L.) Willd. Del ex. Composition and diversity of lower plants in Savannah Baluran National Park East Java. J Environ Anal 2 (1): 135-145 [Indonesian].

Eijk PV, Leenman P. 2004 Regeneration of Fire Degraded Peatswamp Forest in Berbak National Park and Implementation in Replanting Programmes. Water for Food and Ecosystems Programme Project on Promoting the River Basin and Ecosystem Approach for Sustainable Management of SE Asian Lowland Peatswamp Forest, Case Study on Air Hitam Laut River Basin, Jambi Province, Indonesia. Alterra Green World Research, Wageningen.

Hirano H, Segah H, Harada T, Limin S, June T, Hirata R, Osaki M. 2007 Carbon Dioxide Balance of A Tropical Peat Swamp Forest in Kalimantan, Indonesia. Global Change Biology 13: 412-425.

Ludwig JA, Reynolds JF. 1988 Statistical Ecology. John Wiley and Sons Inc., New York.

Muchlisin ZA, Akyun Q, Rizka S, Fadli N, Sugianto S, Halim A, Siti-Azizah MN. 2015. Ichthyofauna of Tripa Peat Swamp Forest, Aceh province, Indonesia. Check List 11 (2): 1560

Nebel BJ, Wright RT. 1993. Environmental Science Fourth Edition. Prentice-Hall. Inc. Englewood Cliffs, New Jersey.

PIU SERT. 2013. A Scientific Study for Rehabilitation and Management of Tripa Peat Swamp Forest. Research Note of Stakeholders Workshop of Tripa Peat Swamp Forest Management, Banda Aceh February 19–20, 2013. Unsyiah – Satgas Redd/UKP4, Banda Aceh.

Posa, MRC, Wijedasa LS, Corlett LT. 2011 Biodiversity and conservation of tropical peatswamp forest. J BioScience 61 (1): 49-57.

Soerjani M, Koestarman AJGH, Tjitrosoepomo G. 1987. Weeds of Rice in Indonesia. Balai Pustaka. Jakarta.

Task Force REDD. 2012. Vision and missions of the Tripa peatswamp rehabilitation program. Initial Report of Satgas REDD/UKP4, Jakarta. [Indonesian].

Wahyunto, Ritung S, Suparto, Subagyo H. 2005. Distribution of Peat Swampt and Carbon Content in Sumatra and Kalimantan. Project of Climate Change, Forests and Peatlands in Indonesia. Wetlands International-Indonesia Programme and Wildlife Habitat Canada. Bogor. 21 pp

YLI-AFEP. 2008. Monitoring Report on Current Condition of Tripa Peat Swamp Forest, the Leuser Ecosystem. Program of Aceh Forest and Environment Project, Yayasan Leuser Internasional, Banda Aceh. [Indonesian]