Biomass and tree diversity in a fragmented secondary forest in Tanah Laut Regency, South Kalimantan Province, Indonesia

by Kehutanan turnitin

Submission date: 19-Jun-2024 02:20PM (UTC+0700)
Submission ID: 2405211524
File name: ree_diversity_in_a_fragmented_secondary_forest_in_Tanah_Laut.pdf (2.89M)
Word count: 4272
Character count: 20630

ISSN : 0917-415X DOI:10.3759/tropics.MS21-01

TROPICS Vol. 30 (3) 31-39 Issued December 1, 2021

FIELD NOTE

Biomass and tree diversity in a fragmented secondary forest in Tanah Laut Regency, South Kalimantan Province, Indonesia

Kazuo Tanaka[1,2], Yasushi Morikawa[2], Yuji Nagai[3], Trisnu Satriadi[4], Hamdani Fauzi[4], Mahrus Aryadi[4,5] and Motoshi Hiratsuka[2*]

[1] Green Business Promotion Department (Forest and Agriculture), Construction Equipment Solution Division, Komatsu Ltd., 2-3-6 Akasaka, Minato-ku, Tokyo 107-8414, JAPAN
[2] Faculty of Human Sciences, Waseda University, 2-579-15 Mikajima, Tokorozawa, Saitama 359-1192, JAPAN
[3] Environmental Research Institute, Waseda University, 1-6-1 Nishiwaseda, Shinjuku-ku, Tokyo 169-8050, JAPAN
[4] Faculty of Forestry, Lambung Mangkurat University, Jl. A. Yani KM 36 Banjarbaru, South Kalimantan 70714, INDONESIA
[5] Agency of Conservation on Natural Resources South Kalimantan, JL. Sungai Ulin No. 28 A Banjarbaru 70714, INDONESIA
* Corresponding author: hiratsuka@waseda.jp

Received: May 10, 2021 Accepted: September 7, 2021 J-STAGE Advance published date: November 2, 2021

ABSTRACT In the tropics, the area covered by degraded and fragmented secondary forests has expanded following forest fires and intensive land-use. We studied a fragmented secondary forest in South Kalimantan Province, Indonesia, to gain ecological information and to quantify the effect of human activities on accumulated biomass and tree composition. A fragmented secondary forest of about 0.5 ha was divided into 27 edge and 18 inside plots with size of 10 m × 10 m and the stand biomass, tree composition and human activities were analyzed. Mean aboveground biomass (AGB) in edge and inside plots were 63.2 and 71.2 Mg ha^{-1}, respectively and the difference was insignificant (*t*-test: $p > 0.1$), while the Shannon–Wiener index (H') value of the later tended larger than former (*t*-test: $p < 0.1$). Native trees tended to be more in inside plots comparing with edge plots, and human planted trees were identified in mainly edge plots. There were also large differences in biomass (wood) removal by rural people (1.350 and 0.248 Mg ha^{-1} year^{-1}, respectively). The characteristics of each type of fragmented secondary forest were influenced by the human activity of wood collection: small-diameter trees, which should have been successors to the existing canopy, were frequently removed.

Key words: secondary forests, aboveground biomass, human activities, forest rehabilitation

INTRODUCTION

Continuous forest fires and intensive land-use, such as slash-and-burn agriculture, have resulted in the conversion of considerable areas of natural forests into grassland and/or fragmented secondary forests in the tropics (e.g., Toma et al. 2000, Thiam and Yoneda 2012). In South Kalimantan Province, Indonesia, these secondary forests are often found in humid areas, near streams or where the land is steep, because such areas are not suitable for agriculture or other rural activities. As a result these areas of secondary forest often remain, even after severe forest fires have occurred, and become isolated or fragmented secondary forests (Fig. 1). Such isolated or fragmented secondary forests have roles to keep carbon stock (Qirom 2021) and in supplying habitats for wild animals (Higashide et al. 2018) and wood for rural people.

Isolated or fragmented secondary forests experience the negative effects of strong light and high temperatures (known as direct and indirect edge effects) (Murcia 1995). These result in relatively low air humidity and soil water content (Matlack 1993), and it is estimated that most of the area affected by the edge effect extends to about 50 m into a forest (Ries et al. 2004). Such edge effects also lower a tree's survival rate (Phillips et al. 1998, Laurance et al. 2000) and have negative impacts on biomass stabilization (Laurance et al. 1997). In addition, the light conditions at the forest edge frequently invite new or exotic trees (Brothers and Spingarn 1992).

We aimed to gather ecological information on fragmented secondary forests in South Kalimantan Province, Indonesia, where wildfires frequently occur, and to quantify the effect of human activities on the accumulation of biomass and on tree composition.

MATERIALS AND METHODS

Study site

The study was carried out in Tebing Siring Village (3° 41′ S, 114° 49′ E, ca. 30 m a.s.l.) in the lowlands of Tanah Laut Regency (*kabupaten*), South Kalimantan Province, Indonesia (Fig. 2). The entire regency is predominantly lowland. It has a typical tropical rainforest climate, and covers ca. 363,000 ha, of which ca. 128,000 ha was forest (about 35 % of the total land area) in 2016. The area has been severely degraded. For example, 86,370 ha (67 % of the total forest area) of conservation forest (hutan konservasi in Indonesian) had been replaced by *Imperata cylindrica* (alang-alang) grassland as a result of severe forest fires. Tebing Siring Village (desa) is separated into four sub-villages (dusun) and had a total population of 2,668 (879 households) in 2017. The village community comprised two distinct groups of people. About half of one sub-village was inhabited by an immigrant population from Java Island, occupying about 2.0 ha per household, while the rest of the community was mostly from the Banjar indigenous group. The latter had limited land available for cultivation and found difficulty in accessing and collecting wood.

Traditionally, rural people used firewood collected from nearby natural secondary forest. In 2007, the Indonesian Government introduced a household fuel conversion program for cooking with liquefied propane gas (LPG) (Thoday et al. 2018, Pandyaswargo et al. 2020), and following its introduction people did not use firewood intensively and had not collected it in recent decades. Rural people mainly used wood from the secondary forest for construction and handicrafts, usually targeting species of high density because of their hardness.

Data collection and analysis

To evaluate stand biomass and tree composition in

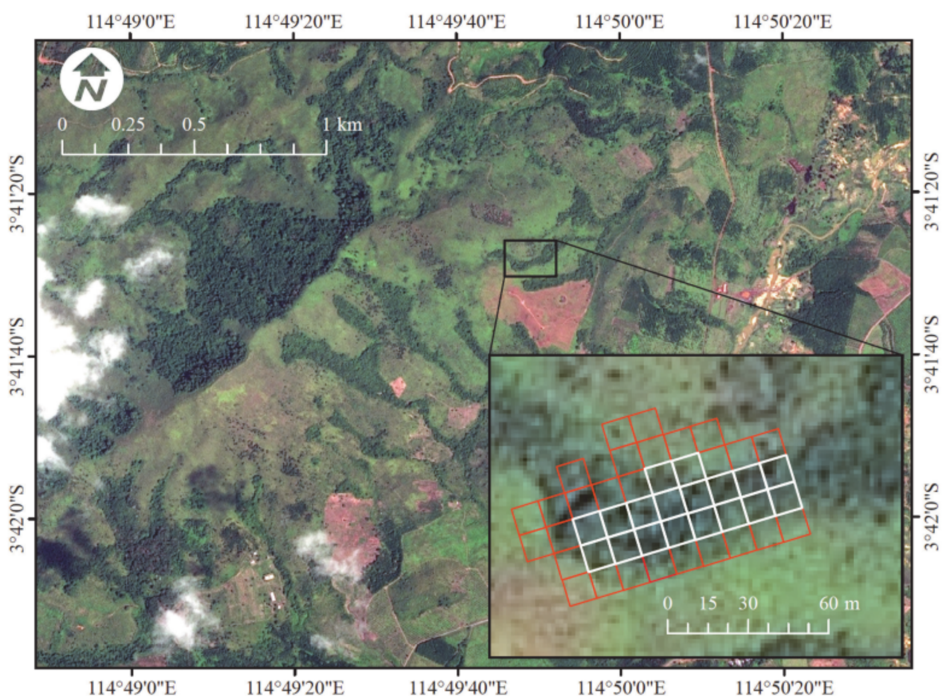

Fig. 1. Overview of typical fragmented secondary forests surrounded by degraded land, mainly *Imperata cylindrica* (alang-alang) grassland after wildfires in South Kalimantan Province, Indonesia.

Note: the land-cover is derived from SPOT6 satellite imagery, 2013; white squares ($n = 18$) and red squares ($n = 27$) indicate inside and edge plots of zonal research plot in this study; and most degraded land without canopy in this figure was part of the W-BRIDGE Project.

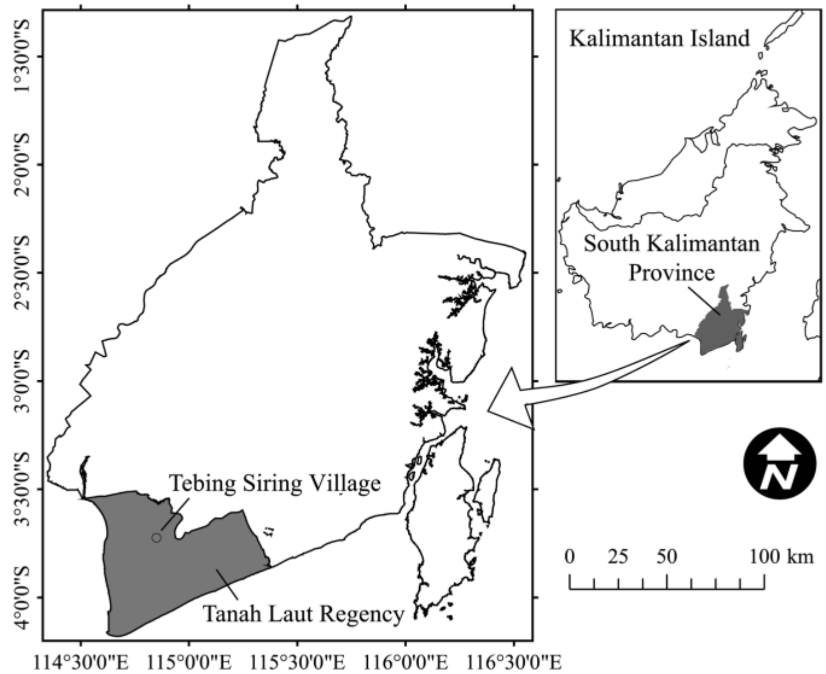

Fig. 2. Location of the study site: Tebing Siring Village, Bajuin district, Tanah Laut Regency, South Kalimantan Province, Indonesia.

both at the edge and inside the secondary forests, we developed a zonal research plot around 140 m long and 20 to 60 m wide (Figs. 1 and 2) near to a forest rehabilitation site by W-BRIDGE Project (details in Hiratsuka et al. 2019). The study site was on both slopes of the V-shaped valley. There was a small stream at the bottom of the valley, which was divided into small ponds during the dry season. We then established 45 plots with size of 10 m × 10 m and carried out a tree census in each plot. Edge plots were 27 in total and faced the W-BRIDGE site (i.e., burned and opened forest and under rehabilitation activities). Inside plots were 18 in total and located in at least 7 m interior to the W-BRIDGE site (Fig. 1). We measured the diameter at breast height (DBH) of trees with a diameter of 3 cm or more. In Tebing Siring Village, we also had interviewed rural people (especially the farmers) to identify their objectives for collecting wood in secondary forests. The first survey was conducted in September 2013 and the second in May 2014.

The data collected were analyzed to estimate aboveground biomass (AGB) and tree composition in each plot. AGB was estimated by using an allometric equation ($\ln (AGB) = 2.44 \times \ln (DBH) - 2.51$) developed in secondary forests in East Kalimantan (Hashimoto et al. 2004), and tree diversity was analyzed by the Shannon–Wiener index (H') with tree number. Statistical analyses of *t*-tests for comparison of edge and inside plots were performed by the IBM SPSS statistics package (version 25).

RESULTS AND DISCUSSION

The first tree census survey indicated that the plots were dominated by trees of less than 3–5 cm DBH, and the distribution showed a typical L-shape both at the edge and inside the secondary forests (Fig. 3). There were small differences in DBH distribution: the kurtosis at the edge and inside the secondary forests was 3.58 and 1.50, respectively, showing a remarkable L-shape at the forest edge.

We confirmed the identification of 51 tree species in fragmented secondary forest (Table 1). The most common species was *Peronema canescens* (sungkai), which was categorized as human planted tree species (i.e., not native to South Kalimantan Province), but was introduced as for timber harvest and other human uses and mainly recorded in edge plots, and was accounted for about 18.2 % of the total population. Also the third common species was *Pithecellobium jiringa* (jengkol), which was also

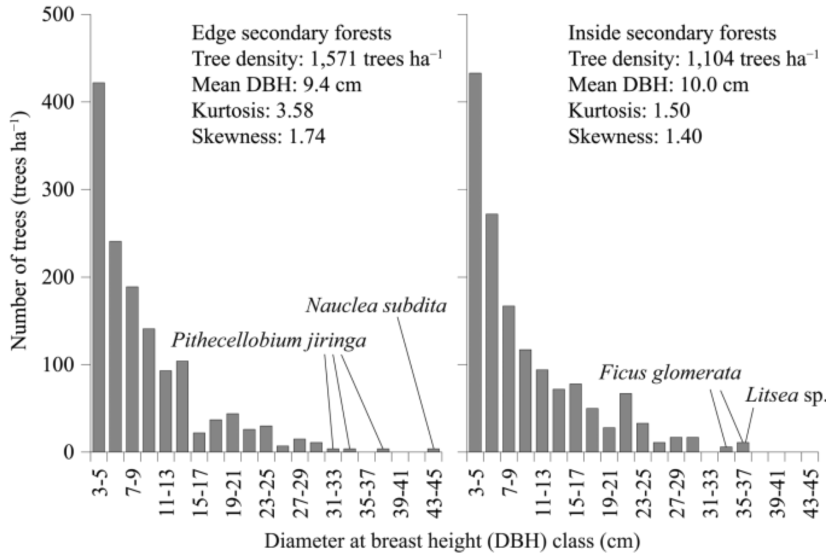

Fig. 3. Distributions of diameter at breast height (DBH) in the edge secondary forests (left) and inside secondary forests (right).

categorized as human planted tree species and mainly recorded in edge plots, at about 12.2%. *P. canescens* and *P. jiringa* are known to be very useful in providing wood and fruits for the inhabitants, respectively, and it is possible that people planted the seeds and also transplanted seedlings from natural forests. Such planted tree species showed tendency to regenerated in edge plots and some individuals with large DBH (*see* following Fig. 3) would be kept by rural people.

The second common species was *Macaranga* sp. (mahang), which are categorized as naive tree species (i.e., native to South Kalimantan Province) with adopted with fire events and mainly recorded in inside plots, and was accounted for about 16.0 %. Native tree species including *Macaranga* sp. (mahang) tended to be more in inside plots comparing with edge plots.

The second plot survey revealed that some of the standing trees measured in the first census were living, but that others were dead, felled or had disappeared. Some of the felled individuals had stumps and marking tapes left on them and, since they had been felled with a sharp knife, it was presumed that they were felled by rural people for their own use. The number of individual trees confirmed as having been felled was 33, and the species concerned were *P. canescens* and *P. jiringa* categorized as human planted tree species and *Macaranga* sp. categorized as naive tree species, in that order. The mean DBH of the felled individuals was 5.3 cm, and we estimated that they were mainly used as stakes for agriculture and around houses. In interviews with rural people, *P. canescens* was said to be of particular use as a stake (Table 2).

There was limited biomass lost due to felling, and felled and collected trees were clearly removed from the forest edge (1.350 Mg ha^{-1} year^{-1}) compared with the interior of the secondary forest (0.248 Mg ha^{-1} year^{-1}) (Table 3).

The AGB values at the edge of and inside the secondary forest were 63.2 Mg ha^{-1} and 71.2 Mg ha^{-1}, respectively, and the difference was insignificant ($p > 0.1$) (Fig. 4). The tree diversity showed marked differences in both types of secondary forests ($p = 0.07$) (Fig. 5). These findings might have been the result of rural people collecting wood, especially at forest edges (Table 2).

The increment in AGB at the edge and inside secondary forests was 6.30 and 4.09 Mg^{-1} ha^{-1} year^{-1}, respectively. We estimated this using the data from two tree censuses carried out 8 months apart, and found that the values did not differ greatly from those of a secondary forest 5-12 years old in East Kalimantan (Hashimoto et al. 2004, Hiratsuka et al. 2006). Evaluating biomass increase in such forests can take some time, because most trees were small or of medium size. Our survey also revealed that in the fragmented forests in this area, which are closely related to the livelihoods of rural people, large-diameter trees did not disappear. However, small-diameter trees of specific 10 species (less than 20 % to the total species) (Table 3) were

Table 1. Tree density and basal area of 3 typed recorded tree species in edge and inside plots.

Type of tree species	Tree species	Local name	Edge plots		Inside plots		References
			Tree density (trees ha^{-1})	Basal area (m^2 ha^{-1})	Tree density (trees ha^{-1})	Basal area (m^2 ha^{-1})	
Native species	*Adinandra subunguiculata*	Kayu Beranakan	3.7	0.03	0.0	0.00	3
	Antiaris toxicaria	Upas	0.0	0.00	22.2	0.66	1, 2 and 3
	Bridelia glauca	Kanidai Bini	55.6	0.56	0.0	0.00	3
	Bridelia sp.	Kanidai Laki	3.7	0.00	16.7	0.02	3
	Celtis sp.	Bati-bati Menjangan	59.3	0.61	33.3	0.05	3
	Clausena excavata	Jawaling	11.1	0.01	0.0	0.00	1, 2 and 3
	Croton sp.	Ketupuk	3.7	0.02	11.1	0.28	3
	Crypteronia paniculata	Kayu Habu	7.4	0.11	0.0	0.00	1, 2 and 3
	Diospyros macrophylla	Mahirangan	3.7	0.02	0.0	0.00	2 and 3
	Dracontomelon mangiferum	Singkuang	0.0	0.00	5.6	0.01	1 and 3
	Dysoxylum sp.	Surian	7.4	0.05	0.0	0.00	3
	Elaeocarpus stipularis	Bangkinang	7.4	0.46	0.0	0.00	3
	Ficus glomerata	Lua	100.0	2.05	133.3	3.83	1 and 3
	Ficus obscura	Dandali	11.1	0.06	16.7	0.02	2 and 3
	Glochidion arborescens	Palir Warik	3.7	0.00	22.2	0.02	2
	Garcinia parvifolia	Kumanjing	0.0	0.00	5.6	0.01	1, 2 and 3
	Glochidion capitatum	Katu gunung	3.7	0.00	5.6	0.00	3
	Glochidion sp.	Tiwangau	0.0	0.00	5.6	0.09	3
	Homalium foetidum	Tampang Kerbau	22.2	0.37	44.4	0.49	1, 2 and 3
	Leucosyke sp.	Kajajahe	14.8	0.08	11.1	0.20	3
	Litsea sp.	Kayu Lapar and Kayu Sia-sia	85.2	0.40	138.9	0.83	3
	Macaranga sp.	Mahang	151.9	0.71	300.0	1.91	3
	Mangifera caesia	Binjai Gunung	0.0	0.00	5.6	0.09	1, 2 and 3
	Nauclea subdita	Bangkal Gunung	40.7	1.25	5.6	0.14	1 and 3
	Pternandra rostrata	Jamai	25.9	0.27	11.1	0.01	2 and 3
	Pterospermum diversifolium	Bayur Laki	0.0	0.00	11.1	0.11	1 and 3
	Pterospermum javanicum	Bayur	0.0	0.00	5.6	0.03	1 and 3
	Sterculia rubiginosa	Limpasu Alang Gunung	0.0	0.00	5.6	0.00	3
	Strombosia javanica	Pohon Kacang	0.0	0.00	5.6	0.06	1, 2 and 3
	Vernonia arborea	Merambung	11.1	0.18	5.6	0.01	3
	sub-total		633.3	7.26	827.8	8.88	
	(Percentage of the total)		41.8%	41.6%	63.1%	52.4%	
Human planted species	*Peronema canescens*	Sungkai	359.3	3.18	155.6	2.12	2 and 3
	Phyllanthus emblica	Kamalaka	70.4	0.49	0.0	0.00	1, 2 and 3
	Pithecellobium jiringa	Jengkol	266.7	5.12	77.8	2.75	2 and 3
	Pithecollobium sp.	Jengkol Hantu	25.9	0.23	22.2	0.10	3
	Swietenia mahagony	Mahoni	3.7	0.04	0.0	0.00	2 and 3
	sub-total		725.9	9.04	255.6	4.97	
	(Percentage of the total)		47.9%	51.8%	19.5%	29.3%	

Table 1. *Continued*.

Type of tree species	Tree species	Local name	Edge plots: Tree density (trees ha^{-1})	Edge plots: Basal area ($m^2 ha^{-1}$)	Inside plots: Tree density (trees ha^{-1})	Inside plots: Basal area ($m^2 ha^{-1}$)	References
Alien species	*Albizia procera*	Birik	0.0	0.00	5.6	0.03	1, 2 and 3
	Alstonia scholaris	Pulai	0.0	0.00	11.1	0.29	1, 2 and 3
	Artocarpus elasticus	Tarap	40.7	0.73	66.7	1.84	2 and 3
	Cinnamomum glanduliferum	Rawali	0.0	0.00	5.6	0.03	2 and 3
	Cratoxylon formosum	Mampat	7.4	0.02	5.6	0.01	1 and 3
	Cryptocarya sp.	Tengkook Ayam	40.7	0.14	5.6	0.01	3
	Eugenia sp.	Jambu Burung	11.1	0.01	11.1	0.02	3
	Fagraea resinosa	Mengkudu Hutan	11.1	0.01	0.0	0.00	2 and 3
	Hibiscus macrophyllus	Waru	0.0	0.00	5.6	0.15	2 and 3
	Leea aculeata	Mali-mali	11.1	0.04	11.1	0.03	2 and 3
	Morinda citrifolia	Mengkudu laki	3.7	0.01	5.6	0.00	2 and 3
	Quercus cyclophora	Paning-paning	3.7	0.00	44.4	0.43	3
	Vitex sp.	*Alaban Tulang*	14.8	0.18	5.6	0.18	3
	Whiteodendron sp.	Waring	11.1	0.02	11.1	0.01	3
	sub-total		155.6	1.16	194.4	3.01	
	(Percentage of the total)		10.3%	6.6%	14.8%	17.8%	
Others	*Unidentified*	Kayu Sia-sia and Sapit undang	0.0	0.00	33.3	0.09	–
	(Percentage of the total)		0.0%	0.0%	2.5%	0.6%	

Note: Native species means native tree to South Kalimantan Province; human planted species means not native tree to South Kalimantan Province, but was introduced for fruits collection, timber harvest and other human uses; and alien species mean not native tree to South Kalimantan Province, but was invaded accidentally. Reference number 1 is Kitano et al. (1984), number 2 is GBIF (2021), and number 3 is personal communication with researchers of Lambung Mangkurat University, respectively.

Table 2. Typical uses of tree material identified by interviewees in Tebing Siring Village, Tanah Laut Regency, South Kalimantan Province, Indonesia.

Tree species	Local name	Objectives: Fruits	Objectives: Timber	Objectives: Stakes	Objectives: Charcoal
Albizia procera	Birik	NA	A	NA	NA
Cinnamomum glanduliferum	Rawali	NA	A	NA	NA
Cratoxylon formosum	Mampat	NA	A	NA	A
Dracontomelon mangiferum	Singkuang	A	NA	NA	NA
Elaeocarpus stipularis	Bangkinang	A	NA	NA	NA
Garcinia parvifolia	Kumanjing	A	NA	NA	NA
Peronema canescens	Sungkai	NA	A	A	NA
Phyllanthus emblica	Kamalaka	NA	A	NA	NA
Pithecellobium jiringa	Jengkol	A	NA	NA	NA
Pithecollobium sp.	Jengkol Hantu	A	A	NA	NA
Pternandra rostrata	Jamai	NA	A	NA	NA
Sterculia rubiginosa	Limpasu Alang Gunung	NA	A	NA	NA
Swietenia mahagony	Mahoni	NA	A	NA	NA
Vitex sp.	Alaban Tulang	NA	A	NA	NA
Unidentified	Kayu Sia-sia	NA	A	NA	NA
Unidentified	Kayu Beranakan	A	A	NA	NA

Note: A and NA mean "applicable" and "not applicable", respectively.

Table 3. Felled and removed trees and their aboveground biomass (AGB) at each edge and inside the plots.

Tree species	Local name	Felled and removed			
		Tree number (trees ha^{-1} year^{-1})		Aboveground biomass (AGB) (Mg ha^{-1} year^{-1})	
		Edge plots	Inside plots	Edge plots	Inside plots
Alstonia scholaris	Pulai	0.0	1.5	0.000	0.043
Celtis sp.	Bati-bati Menjangan	1.5	1.5	0.013	0.015
Ficus glomerata	Lua	1.5	1.5	0.008	0.010
Litsea sp.	Kayu Lapar and Kayu Sia-sia	1.5	1.5	0.010	0.077
Macaranga sp.	Mahang	9.0	1.5	0.064	0.011
Morinda citrifolia	Mengkudu Laki	0.0	1.5	0.000	0.000
Peronema canescens	Sungkai	10.5	1.5	0.382	0.024
Phyllanthus emblica	Kamalaka	1.5	0.0	0.032	0.000
Pithecellobium jiringa	Jengkol	7.5	0.0	0.841	0.000
Sterculia rubiginosa	Limpasu Alang Gunung	0.0	1.5	0.000	0.068
Total		33.0	12.0	1.350	0.248

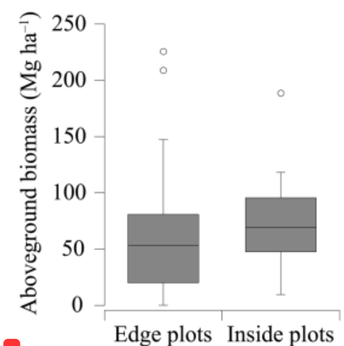

Fig. 4. Aboveground biomass (AGB) in edge plots (n = 27) and inside plots (n = 18).

Note: the top and bottom of the box represent the 75th and 25th percentiles, respectively, and the line in the middle represents the median. The whiskers represent extrema, and circles beyond the whiskers represent outliers and extreme values.

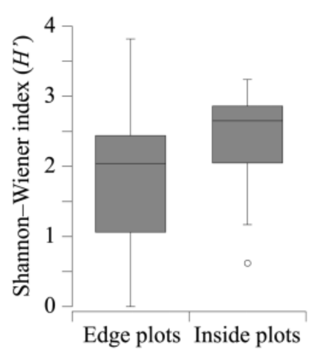

Fig. 5. Shannon–Wiener index (H') values in edge plots (n = 27) and inside plots (n = 18).

Note: the top and bottom of the box represent the 75th and 25th percentiles, respectively, and the line in the middle represents the median. The whiskers represent extrema, and circles beyond the whiskers represent outliers and extreme values.

frequently removed for use as stakes and for other human activities. In other words, removal of small-diameter trees – which should be future successors to the canopy trees (i.e., *P. jiringa* and *Litsea* sp. shown in Fig. 3) – is likely to make it difficult for fragmented forests to regenerate naturally.

Finally, secondary forests with huge area in the tropics are very important because they account for swathes of tropical forest landscapes that have lost their capacity to provide a high level of goods and services (Bieng et al. 2021). Even in the fragmented secondary forests we surveyed, from viewpoints of biodiversity conservation, efforts for conservation are required which is following the new discovery of the presence of *Mydaus javanensis* (Sunda stink-badger) at study site (Higashide et al. 2018). Furthermore, rehabilitation of degraded land around the secondary forest (such as the W-BRIDGE Project) where the rehabilitated forest had increased (Fig. 6) by around 33 % from 2013 to 2017 (Hiratsuka et al. 2019), will play a role in creating a corridor connecting fragmented forests: an important measure for the maintenance of existing forests, and for reforestation.

Fig. 6. The rehabilitated site by the W-BRIDGE Project in September 2012 (above) and July 2016 (below).
Note: area surrounded by white line in each figure indicates the plot study site.

ACKNOWLEDGEMENTS This study was financially supported by the W-BRIDGE Project. We received valuable comments from Mr. Eiichiro Nakama (Japan International Forestry Promotion and Cooperation Center), and the field survey was supported by members of Waseda University and Lambung Mangkurat University. We also had valuable support from Mr. Hisanori Okada and Dr. Daishi Higashide.

REFERENCE

Bieng MAN, Oliveira MS, Roda J-M, Boissière M, Hérault B, Guizol P, Villalobos R, Sist P. 2021. Relevance of secondary tropical forest for landscape restoration. *Forest Ecology and Management* 493: 119265.

Brothers TS, Spingarn A. 1992. Forest fragmentation and alien plant invasion of central Indiana old-growth forests. *Conservation Biology* 6: 91-100.

[GBIF] Global Biodiversity Information Facility. 2021. *Free and open access to biodiversity data*. GBIF Web site. https://www.gbif.org/. (cited August 10, 2021).

Hashimoto T, Tange T, Masumori M, Yagi H, Sasaki S, Kojima K. 2004. Allometric equations for pioneer tree species and estimation of the aboveground biomass of a tropical secondary forest in East Kalimantan. *Tropics* 14: 123-130.

Higashide D, Tanaka K, Nakama E, Faudi H, Satriadi T, Aryadi M. 2018. Camera-trap records of Sunda stink-badger *Mydaus javanensis* and other small carnivores in South Kalimantan, Indonesia. *Small Carnivore Conservation* 56: 54-59.

Hiratsuka M, Nakama E, Satriadi T, Fauzi H, Aryadi M, Morikawa Y. 2019. An approach to achieve sustainable development goals through participatory land and forest conservation: a case study in South Kalimantan Province, Indonesia. *Journal of Sustainable Forestry* 38: 558-571.

Hiratsuka M, Toma T, Diana R, Hadriyanto D, Morikawa Y. 2006. Biomass recovery of naturally regenerated vegetation after the 1998 forest fire in East Kalimantan, Indonesia. *Japan Agricultural Research Quarterly*: *JARQ* 40: 277-282.

Kitano S, Iwasa T, Kigata Y, Sasaki H, Suzuki K, Hara K. 1984. *Handbook of tropical plants and trees*. Yokendo, Tokyo.

Laurance WF, Delamônica P, Laurance SG, Vasconcelos HL, Lovejoy TE. 2000. Rainforest fragmentation kills big trees. *Nature* 404: 836-836.

Laurance WF, Laurance SG, Ferreira LV, Rankin-de Merona JM, Gascon C, Lovejoy TE. 1997. Biomass collapse in Amazonian forest fragments. *Science* 278: 1117-1118.

Matlack GR. 1993. Microenvironment variation within and among forest edge sites in the eastern United States. *Biological Conservation* 66: 185-194.

Murcia C. 1995. Edge effects in fragmented forests: implications for conservation. *Trends in Ecology & Evolution* 10: 58-62.

Pandyaswargo AH, Ruan M, Htwe E, Hiratsuka M, Wibowo AD, Nagai Y, Onoda H. 2020. Estimating the energy demand and growth in off-grid villages: Case studies from Myanmar, Indonesia, and Laos. *Energies* 13: 5313.

Phillips OL, Malhi Y, Higuchi N, Laurance WF, Núnez PV, Vásquez RM, Laurance SG, Ferreira LV, Stern M, Brown S. 1998. Changes in the carbon balance of tropical forests: evidence from long-term plots. *Science* 282: 439-442.

Qirom MA. 2021. The impact of land covers on carbon stock potential Rantau Research Forest in South Kalimantan. *IOP*

Conference Series: Earth and Environmental Science 739: 012010.

Ries L, Fletcher Jr RJ, Battin J, Sisk TD. 2004. Ecological responses to habitat edges: mechanisms, models, and variability explained. *Annual Review of Ecology, Evolution, and Systematics* 35: 491–522.

Thiam E, Yoneda T. 2012. Recent degradation process of a tropical secondary forest in West Sumatra. *Tropics* 21: 11–20.

Thoday K, Benjamin P, Gan M, Puzzolo E. 2018. The Mega Conversion Program from kerosene to LPG in Indonesia: Lessons learned and recommendations for future clean cooking energy expansion. *Energy for Sustainable Development* 46: 71–81.

Toma T, Matius P, Kiyono Y, Watanabe R, Okimori Y. 2000. Dynamics of burned lowland dipterocarp forest stands in Bukit Soeharto, East Kalimantan. In: Guhardja E, Fatawi M, Sutisna M, Mori T, Ohta S. (eds) *Rainforest Ecosystems of East Kalimantan*. *Ecological Studies* (*Analysis and Synthesis*), 140: 107–119.

Biomass and tree diversity in a fragmented secondary forest in Tanah Laut Regency, South Kalimantan Province, Indonesia

ORIGINALITY REPORT

19%	19%	12%	%
SIMILARITY INDEX	INTERNET SOURCES	PUBLICATIONS	STUDENT PAPERS

MATCH ALL SOURCES (ONLY SELECTED SOURCE PRINTED)

10%

★ www.scilit.net

Internet Source

Exclude quotes	On	Exclude matches	< 1%
Exclude bibliography	On		