INTERNATIONAL JOURNAL of OIL PALM

ISSN: 2599-3496 print
ISSN: 2614-2376 online

Volume 3, Number 1, January 2020
Page 1-10
DOI: https://doi.org/10.35876/ijop.v3i1.37

Is it True that Oil Palm Plantations are the Main Driver of Indonesia's Tropical Forest Deforestation?

Yanto Santosa[1]*, Arzyana Sunkar[1], Rozza Tri Kwatrina[2]

[1]IPB University, Bogor 16680, Indonesia.
[2]Forestry Research and Development Center, Bogor 16610, Indonesia.

ABSTRACT

The extent to which oil palm has contributed to deforestation of primary forests is still an intensive debate in public space. Even though the term deforestation and the results of the study are still "debatable" and have not been scientifically valid, they have had a very debilitating effect and detrimental to Indonesia's position in global trade because it is considered responsible for the destruction of primary natural forests in the Southeast Asia region. Therefore, since 2015, research has been carried out on the origin of status, history of land use, land-cover and biodiversity in 23 large scale plantations in 6 provinces (Riau, North Sumatra, South Sumatra, Central Kalimantan, West Kalimantan and West Sulawesi). The results of the search for the origins of the status of oil palm plantations (according to the provincial spatial plan) show that 98.56% of the candidates for oil palm plantation areas are "not forested", namely: other land use area (54.93%), plantation and agriculture (42.19%). Furthermore, the results of interpretation of Landsat imagery on the condition of vegetation cover at 1 year before being made into oil palm plantations indicate that the type of land cover is no longer in the form of primary forest, but already in the form of shrubs and bare-land or rubber-plantation (68,91%). Likewise with the results of the search history of land use where 71.29% of the land under study is the land of ex-community gardens, fields, transmigration land, or ex cultivation right of other companies. While the rest (28.71%) is ex- Forest Concession Right Land. Referring to the juridical definition of "deforestation", this data shows that oil palm plantation land which is the location of the study "is not the result of deforestation". Referring to both the juridical definition and the FAO/World Bank definition of "deforestation", this data shows that oil palm plantation land which is the location of the study "is not a direct cause of primary deforestation".

Keywords: deforestation, primary tropical forest, land sat imagery, land use change

INTRODUCTION

Indonesia's success as the largest palm oil producer in the world (Feintrenie *et al*. 2010) has had various positive impacts: the country's foreign exchange reached Rp. 200 trillion year^{-1} (Pardamean 2017; World Growth 2011), overcoming the problem of poverty in rural areas (Wigena *et al*. 2009), opening up employment opportunities so

*Corresponding author:
Department of Conservation of Natural Resource and Ecosystem, Faculty of Forestry,
IPB University, Bogor 16680, Indonesia.
Email: yantohaurjaya@yahoo.co.id

as to absorb around 21.49 million people (Directorate General of Plantations 2015; WWF 2008) and various positive effects the other. Even in 2017-2018 managed to make a real contribution as the largest contributor of foreign exchange with a value of 22.97 billion US dollars (Oil Palm Fund Management Agency 2019).

However, this success has reaped negative allegations (since 1980 until now) so that it becomes polemic in the public sphere. The negative allegations stated that oil palm originates from primary or secondary forest has caused deforestation (Thiollay 1999; Donald 2004; Dumbrell & Hill 2005; Vijay *et al*. 2016; Sawit Watch 2017) and resulting in decreased plant diversity (Benayas *et al*. 2007; Stevenson & Aldana 2008; Paciencia & Prado 2005). Koh and Wilcove (2008) who conducted an analysis of land cover for forest and agricultural land mentioned that the conversion of oil palm plantations established in primary and secondary forest areas reached 56% or equivalent to 1.7 million hectares without differentiating between primary and secondary forests. Wicke *et al*. (2008) reported that of the 9.7 million deforestations that occurred during the 1997-2003 period, 27% (2.6 million ha) had been converted to oil palm.

Although the results of these studies and studies are still "debatable" and not yet scientifically valid, they have had a very debilitating and detrimental impact on Indonesia's position in global trade because it has been held responsible for the destruction of primary natural forests in the Southeast Asian region. That is why this article was prepared in the hope that it will be able to provide valid and scientific explanations for these negative allegations.

MATERIALS AND METHODS

Study Area

This study was conducted in 23 large oil palm plantations spread across 6 provinces in Indonesia: North Sumatra, Riau, South Sumatra, West Kalimantan, Central Kalimantan and West Sulawesi. The location of each research site were displayed in Figure 1.

Methods and Research Procedure

This study was consist of several approaches, i.e. literature review, interview,

Figure 1 The location of each research site.

spatial analysis and ground checking. The data and information were obtained through the literature review related to some research on the topic "oil palm and deforestation". We browsed the scientific articles and other relevant publications. Interviews are used to get information about the origin of land status, history of land use before the existence of oil palm plantation, and development of land. We interview key persons including various community leaders both formal and informal by using the snowball technique.

Spatial analysis was used to determine the history of the origin of the status and the development of changes in land cover for the oil palm plantation concession area. We use the interpretation of Landsat 8 image maps. With the overlay technique, the cultivation rights of estate areas overlay with forest use agreement and provincial spatial plan including all maps and permit files. This analysis used for land satellite imagery 3 years before the establishment of the oil palm plantation and 2 years after the establishment of oil palm plantations. All of the collected data were tabulated, analyzed and presented descriptively.

RESULTS AND DISCUSSION

Bias From Different Definitions of Deforestation

The extent to which oil palm has contributed to deforestation in primary forests is still an intense debate in the public sphere. The different perceptions regarding the term deforestation used lead to different conclusions about the impact of oil palm plantations on deforestation (Gunarso *et al.* 2013). This not only creates confusion in the estimated area of deforestation but also identifies the perpetrators of deforestation (Sunderlin & Resosudarmo 1996). Three world institution defines deforestation in the diverse definition. The World Bank defines deforestation as permanent or temporary loss of forest cover, or loss of forest cover that does not produce wood. The united nations framework convention on climate change (UNFCCC) in 2001 defines deforestation as human-induced forest conversion directly to non-forest land. Whereas FAO in 2001 defines deforestation as the conversion of forests to other land uses or the reduction of long-term tree canopy cover below the minimum threshold of 10 percent.

Indonesia also have own definition, ministry of environment and forestry defines deforestation as a change or reduction of land cover conditions from forested categories over a certain period of time. This change including plantations, settlements, industrial estates, etc. Referring to minister of forestry regulation P.30/Menhut-II/2009 concerning procedures for reducing emissions from deforestation and forest degradation, then deforestation is a permanent change from forested to non-forested areas due to human activities. This definition means, an area can be said to be deforested if the forest is permanently lost and turned into a non-forested area. Another logical consequence of the meaning of deforestation is that "forest area" and "forest cover" are two different terms. The difference between the two terms is very important for a better understanding of "deforestation".

These different interpretations of deforestation lead to diverse perceptions and prolonged debate. Sawit Watch accused that the development of oil palm plantations carried out in the area of forest that was converted or in forested other land use areas was the practice of deforestation, regardless of whether the existing forest was primary forest or logged-over secondary forest. In the scientific version, Wilcove and Koh in 2008 conducted an analysis of land cover on forest areas and agricultural land. The results mention the

conversion of oil palm plantations established in primary and secondary forest areas to reach 56% or equivalent to 1.7 million hectares without differentiating between primary and secondary forests. Still in 2008, Fitzherdbert *et al*. (2008) state that if all existing oil palm land is planted from forest land, deforestation due to conversion of forests to oil palm is estimated at 16%. Another data by Wicke *et al*. (2011) reported that of the 9.7 million deforestations that occurred during the 1997-2003 period, 27% (2.6 million ha) had been converted to oil palm, but this report did not clearly state what the percentage of forest cover converted because it is assumed that the percentage of deforestation tends to be lower because there is other land cover that has been converted to oil palm, such as degraded land and plantations (Pagiola 2000, Gunarso *et al.* 2013).

In 2014, nature climate change published an article from the analysis of Margono and a team from the university of Maryland and the world resouce institute who claimed the first publication to contain maps and annual loss of primary forests in Indonesia. In the article mentioned that from 2000 to 2012, Indonesia lost more than 6 million hectares of primary forest - an area of half the size of Britain. It also said that in recent years, Indonesia even surpassed Brazil in deforestation, losing nearly twice the primary forest area in Brazil in 2012. They are also concerned about new data that shows the loss of Indonesia's primary forests increases by an average of 47 600 hectares per year. It is stated that the development of agricultural industrial land is the main cause of the loss of primary forest and is carried out mainly in production forests. International non govermental organization, greenpeace, accused many national companies of being responsible for deforestation in Indonesia. In its latest report released on September 19, 2018, the organization said there were 25 palm oil producers destroying more than 130 000 hectares of natural forest since 2015 in Indonesia. The area of cleared forest is claimed to be more than double the area of Singapore.

History of Deforestation of Indonesia's Primary Tropical Forests

History shows that Indonesia's tropical forests have been shifted to the function of "transmigration policy" (1905-1940/during the dutch colonial era and 1969-present) where around 8.94 million ha of land (most of the forest) has been converted to food crops, especially to increase rice production. Furthermore, starting from the early 1970s, the Indonesian government issued forest concession rights (HPH) licenses with systematic logging (peak in 1985-1997) with a rate of forest degradation of around 1.26 million year^{-1}. This has become the main cause of the acceleration of forest destruction so that it becomes access for migrants. In connection with the destruction of the forest, then in the late 1980s, the government launched a program to increase the productivity of degraded forest land by allowing investors to clear land (mainly on degraded forests) for oil palm plantations and industrial plantation forests (HTI).

In addition to these three things, forest degradation also occurs as a result of fires. Land and forest fires in Indonesia have occurred since 1877, following later in the 1880s, 1915s, 1930s, 1958, 1982-1983, 1991, 1994, 1997-1998 (Vayda 1999; Barber & Schweithelm 2000). The most devastating fires in Indonesia occurred in 1982-1983 in East Kalimantan which destroyed around 3.6 million ha of forests with an estimated loss of US $ 9 billion. Fires that occurred in Indonesia continued to increase, in 2011 the area of fires reached 2 612.09 ha and increased until 2015 with burning land reaching 2

610 060.44 ha (Ministry of Environment and Forestry 2016) with losses estimated at Rp 221 trillion (The World Bank 2016).

When compared to the development of forest area change data, the area of deforestation, with the development of oil palm expansion in Indonesia in the period between 1950 and 2017 (as presented in Table 1), it seems clear that the rate of deforestation has declined with the decrease in forest area. The proportion of deforestation area to forest area was 26.2% in the period 1950-1985, 13.6% in 1985-2000, 13.5% in 2000-2013. The development of oil palm plantations is actually very significant starting in 1990 and the peak occurred in the decade 2000-2010. In the 1950-1985 and 1985-2000 periods where the deforestation rate peaked (42 589 500 ha and 16 371 133 ha), the expansion of oil palm plantations was only around 1 126 677 ha and 3 769 609 ha. These figures clearly prove that the expansion of oil palm plantations in Indonesia is not a "direct cause" of deforestation in Indonesia's tropical forests.

Origins of Status, Type of Land-Cover and History of Land Use of Oil Palm Plantations

The results of tracing the origin of oil palm land status (according to the provincial spatial plan) as presented in Table 2 shows that 98.56% of prospective oil palm land status are "no longer forest area", namely: other land use area (54.93%), plantation (37.25%) and agriculture (4.94%). Referring to the juridical definition of "deforestation", this data shows that the oil palm plantation land that is the location of the study "is not the result of deforestation". Furthermore, the results of the interpretation of Landsat imagery to the condition of vegetation cover 3 year

Table 1 Changes in forest extent, deforestation and oil palm plantations in Indonesia 1950-2017

	Sumatra	Kalimantan	Sulawesi	Maluku	Papua	Jawa	Bali/Nusa Tenggara	Indonesia
Forest area (ha)								
1950	37 370 000	51 400 000	17 050 000	7 300 000	40 700 000	5 070 000	3 400 000	162 290 000
1985	23 323 500	39 986 000	11 269 400	6 348 000	34 958 300	1 345 900	2 469 400	119 700 500
2000	15 516 959	32 856 107	10 707 186	5 015 207	34 767 891	2 281 184	2 184 833	103 329 367
2013	12 856 700	25 910 400	9 188 900	5 121 600	32 137 900	2 227 300	1 610 200	89 053 000
2017	12 122 000	24 427 400	8 398 600	4 771 000	32 243 600	2 182 700	1 704 600	85 849 900
Deforestation (ha)*								
1950-1985	14 046 500	11 414 000	5 780 600	952 000	5 741 700	3 724 100	930 600	42 589 500
1985-2000	7 806 541	7 129 893	562 214	1 332 793	190 409	935 284	284 567	16 371 133
2000-2013	2 660 259	6 945 707	1 518 286	106 393	2 629 991	53 884	574 633	14 276 367
2013-2017	734 700	1 483 000	790 300	350 600	105 700	44 600	-94 400	3 203 100
1950-2017	25 248 000	26 972 600	8 651 400	2 529 000	8 456 400	2 887 300	1 695 400	76 440 100
Oil palm plantation area								
1950	105 000	-	-	-	-	-	-	105 000
1985	550 056	42 006	-	-	-	-	-	597 352
1990	984 267	71 314	15 718	-	29 000	4 000	-	1 126 677
2000	2 743 779	844 389	107 927	-	52 392	21 122	-	3 769 609
2010	4 743 000	2 897 000	293 000	-	84 000	58 000	-	8 075 000
2013	6 682 228	3 306 523	318 880	33 981	89 696	33 712	-	10 465 020
2017	7 400 353	4 340 060	404 060	11 063	115 546	36 597	-	12 307 679

*Deforestation is conversion from forest to nonforest

and 1 year before becoming an oil palm plantation (Table 3 and Table 4) show that the type of land cover is no longer in the form of primary forest, but already in the form of shrubs (24.88%), open land (24.68%), secondary forests (21.91%), rubber plantations (12.93%) and oil palm plantations (6.42%).

Likewise, the results of tracing the history of land use (Table 5) where 71.29% of the land surveyed was ex-community land, fields and transmigration lands or ex-cultivation rights of other companies. While the rest (28.71%) is ex-forest concession right land. Thus it can be concluded that "the oil palm plantations under study are not a direct cause of primary forest deforestation". This is in line with the results of research by Gaveau *et al*. (2016), Austin *et al*. (2017), Meijaard *et al*. (2018), Kwatrina *et al*. (2019) which show that most of the oil palm plantations in Indonesia are built on lands that have been completely degraded and/or on burnt land.

Other historical evidence that shows that oil palm plantations are not directly the result of deforestation of tropical primary forests is the following historical record, "the beginning of the opening of plantation lands in East Sumatra (now North Sumatra) pioneered by Nienhuys in 1863, not for planting oil palm but for the planting of tobacco which was then the main commodity traded on the European market". The dutch colonial occupation of the Labuhan Batu region began in 1862, and Kampuhan Labuhan Batu became the center of the dutch colonial government for this region (Harahap 2017).

Table 2 Status of the observed land-based on TGHK and RTRWP before it was made as an oil palm plantation

Land status before becoming an oil palm plantation		Land Type	South Sumatera	West Kalimantan	West Sulawesi	Central Kalimantan	North Sumatera	Riau	Total	Persentage (%)
	Forest use agreement/TGHK (ha)	APL	9 632.22	21 608.94	626.91	-	12 481.86	31 429.25	75 779.18	40.46
		HPK	85.78	9 020.3	33 638.98	8 458.16	-	11.487 37	62 690.59	33.47
		HPT	-	3 601.07	-	-	128.01	14 071.56	17 800.64	9.51
		HP	-	7 272.61	-	14 703.30	622.28	919.07	23 517.26	12.58
		HL	-	-	475.05	-	-	-	475.05	0.25
		KSA/KPA	-	-	-	7 020.31	-	-	7 020.31	3.75
	Subtotal		9.72	41 502.92	34 740.94	30 181.77	13 232.15	57 907.25	187 283.03	100.00
	Provincial spatial plan/RTRWP 2014 (ha)	HPK	-	-	151.61	-	-	155.77	307.38	0.20
		HPT	-	-	53.84	-	145.53	-	199.37	0.13
		HP	-	-	0.19	-	34.25	1 555.91	1 590.35	1.01
		HR	-	-	972.94	-	-	-	972.94	-
		HL	-	-	161.01	-	-	-	161.01	0.10
		APL	-	41 502.92	-	-	-	44 784.12	86 287.04	54.93
		Peat	455.62	-	-	-	-	-	455.62	0.29
		Plantation	4 303.53	-	30 494.11	-	12 971.51	10 751.13	58 520.28	37.25
		Agricultural	4 958.85	-	2 136.87	-	-	663.32	7 759.04	4.94
		Settlement	-	-	772.33	-	71.86	-	844.19	0.54
	Subtotal		9 718	41 502.92	34 742.90	-	13 223.15	57 910.25	157 097.22	100.00

References: Santosa *et al.* (2016); Santosa *et al.* (2017); Santosa *et al*. (2018). APL is another land use, HPK is conversion production forest, HPT is limited production forest, HP is production forest, HL is protected forest, HR is community forest, KSA is nature reserve, KPA is protected area

Several kingdoms in Labuhan Batu such as the panai sultanate, the kualuh sultanate and the bilah sultanate one by one slowly but surely subject to the authority of the dutch colonial. While the sultanate of Pinang City had already been controlled by the dutch in 1837. Only in 1915 was the opening of an oil palm plantation spearheaded by the Padang halaban plantagen AG zurich plantations company in 1915 in the Padang halaban plantation village. In 1911, oil palm trees were introduced in East Sumatra (now North Sumatra). Tanah itam hulu and pulau raja in Asahan afdeling was the location of the first oil palm plantation opened by oliepalmen cultuur and huileries de Sumatra companies. In 1934 a new export commodity emerged from the Labuhan Batu afdeling namely palm-olie, the number of which increased dramatically from year to year (Harahap 2017).

Some previous studies related to deforestation in Indonesia have produced various conclusions. Some conclude that deforestation in Indonesia does not originate entirely from primary forests. As revealed by Roda (2019) that as the world's largest palm producing country, the value of deforestation in Indonesia actually reached its peak in the past few decades when oil palm plantations have not yet begun to develop rapidly. In Indonesia, the peak of deforestation actually occurred in 2000-2008 and currently has decreased to 5%. Overall, the results of this study reveal scientifically by combining spatial approaches, site-level data, and interviews to obtain a comprehensive answer to the certainty of various allegations related to deforestation in Indonesia.

Table 3 History of land cover development 3 years before it was made as an oil palm plantation

Province	Development of land cover area 3 years or >3 years before the palm plantation (ha)														
	TT	SB	BR	R	HRS	HS	PK	PS	PL	PLK-BS	Mining	Settle-ment	Water body	Cover by clouds	Total area
North Sumatra	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
South Sumatra	72.88	103.03	803.56	218.75	-	132.81	3 259.69	-	-	-	-	-	-	5 127.27	9 717.99
Riau	237.10	1 431.61	-	-	-	14 532.48	5 898.40	-	-	390.01	-	-	-	405.78	22 895.38
Central Kalimantan	497.37	3 201.98	417.67	72.49	603.06	21 068.65	-	-	3 018.81	-	-	389.53	312.53	-	29 582.09
West Kalimantan	1 072.74	2 307.68	1 534.73	-	4 893.53	-	-	-	-	-	-	-	-	580.78	10 389.46
West Sulawesi	-	8 638.99	-	-	-	-	-	-	-	-	-	-	-	-	8 638.99
Total	1 880.09	15 683.29	2 755.96	291.24	5 496.59	35 733.94	9 158.09	-	3 018.81	390.01	-	389.53	312.53	6 113.83	81 223.91
Persentage (%)	2.31	19.31	3.39	0.36	6.77	43.99	11.28	0.00	3.72	0.48	0.00	0.48	0.38	7.53	100.00

References: Santosa *et al.* (2016); Santosa *et al.* (2017); Santosa *et al.* (2018). TT is open land, SB is shrub, BR is swamp shrub, R is swamp, HRS is secondary swamp forest, HS is secondary forest, PK is fiber plantation, PS is oil palm plantation, Pl is other plantations, PLKBS is dry mixed farming with shrubs

Table 4 History of land cover development 1 year before it was made as an oil palm plantation

Province	Development of land cover area 1 year before the palm plantation (ha)														
	TT	SB	BR	R	HRS	HS	PK	PS	PL	PLK-BS	Mining	Settle-ment	Water body	Cover by clouds	Total area
North Sumatra	1 886.83	154.75	-	-	-	-	-	11 190.57	-	-	-	-	-	-	13 232.15
South Sumatra	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Riau	32 760.94	7 814.83	-	-	-	21 117.76	22 530.36	-	-	390.01	-	-	-	638.16	85 252.06
Central Kalimantan	1 025.24	3 441.41	399.79	240.60	2 479.43	17 054.27	-	-	3 820.86	-	-	416.00	303.91	-	29 181.51
West Kalimantan	6 486.53	23 541.13	1 615.76	-	5 313.82	-	-	-	-	-	-	-	-	-	36 957.24
West Sulawesi	842.70	8 403.97	-	-	-	-	-	-	-	-	-	-	-	372.70	9 619.37
Total	43 002.24	43 356.09	2 015.55	240.60	7 793.25	38 172.03	22 530.36	11 190.57	3 820.86	390.01	-	416.00	303.91	1 010.86	174 242.33
Persentage (%)	24.68	24.88	1.16	0.14	4.47	21.91	12.93	6.42	2.19	0.22	0.00	0.24	0.17	0.58	100.00

References: Santosa *et al.* (2016); Santosa *et al.* (2017); Santosa *et al.* (2018). TT is open land, SB is shrub, BR is swamp shrub, R is swamp, HRS is secondary swamp forest, HS is secondary forest, PK is fiber plantation, PS is oil palm plantation, Pl is other plantations, PLKBS is dry mixed farming with shrubs

Table 5 History of land use studied before becoming an oil palm plantation

Province	History of land use before becoming an oil palm plantation (ha)			Total (ha)
	Ex another company's HGU	Ex HPH	Ex community filed/ garden/agriculture/ transmigration	
South Sumatra	-	-	9 718	9 718
West Kalimantan	13 469.68	-	28 032.94	41 502.62
West Sulawesi	1 029.80	-	33 711.14	34 740.94
Central Kalimantan	-	15 448.84	14 732.93	30 181.77
North Sumatera	7 647.95	5 584.20	-	13 232.15
Riau	15 844.18	37 860.56	22 029.49	75 734.23
Total	37 991.61	58 893.60	108 224.50	205 109.71
Persentage (%)	18.523	28.713	52.764	100

References: Santosa *et al*. (2016); Santosa *et al*. (2017); Santosa *et al.* (2018). HGU is Cultivation rights, HPH is forest concessions

CONCLUSIONS

The oil palm plantations studied were not the result of tropical primary forest deforestation, both in terms of status, type of land cover before being turned into oil palm plantations and the history of land use. If the conversion of secondary forests into oil palm plantations is categorized as deforestation, then only 25% of

the oil palm plantations studied are the result of deforestation. 75% of oil palm plantations (originating from the type of land cover in the form of shrubs, vacant land, community fields/gardens) can be categorized as a "reforestation", or "reforestation" or "rehabilitation" of degraded land as a result deforestation and b officially / legally oil palm plantations are programs implemented by the government to increase the productivity of "critical land" or degraded as a result of deforestation.

REFERENCES

Austin KG, Mosnier A, Pirker J, McCallum I, Fritz S, Kasibhatla PS. 2017. Shifting patterns of oil palm driven deforestation in Indonesia and implications for zero-deforestation commitments. Land Use Policy. 69:41-48.

Barber CV, Schweithelm J. 2000. Trial by fire. Forest fires and forestry policy in Indonesia's era of crisis and reform. Washington DC (US): World Resources Institute.

Benayas JMS, Martins A, Nicolau JM, Schulz JJ. 2007. Abandonment of agricultural land: an over view of drivers and consequences. CAB Rev: Perspective in Agriculture, Veterinary Science Nutrition and Natural Resources. 2(57):129-143. DOI: 10.1079/PAVSNNR20072057.

Oil Palm Fund Management Agency. 2019. Prospek ekspor produk kelapa sawit tetap cerah di 2019 [online]. Available: https://www.bpdp.or.id/id/berita/prospek-ekspor-produk-kelapa-sawit-tetap-cerah-di-2019/.

Directorate General of Plantations. 2015. Rencana strategis direktorat jenderal perkebunan tahun 2015-2019. Jakarta. (ID): Kementerian Pertanian.

Donald PF. 2004. Biodiversity impact of some agricultural commodity production systems. Biol Conserv. 18(1):17-38.

Dumbrell AJ, Hill Jane. 2005. Impact of selective logging on canopy and ground assemblages of tropical forest butterflies: implication for sampling. Biol Conserv. 125(1):123-131.

Feintrenie L, Chong WK, Levang P. 2010. Why do farmers prefer oil palm? Lessons learnt from Bungo district, Indonesia. Small-Scale For. 9(3):379-396.

Gunarso P, Hartoyo ME, Agus F, Killeen T. 2013. Oil palm and land use change in Indonesia, Malaysia and Papua New Guinea. Reports from the Technical panels of the 2nd Greenhouse Gas Working Group of Roundtable on Sustainable Palm Oil (RSPO).

Harahap HW. 2017. Sejarah awal pembukaan perkebunan kelapa sawit di Desa Perkebunan Padang Halaban, Kabupaten Labuhan Batu [Skripsi]. Medan (ID): Universitas Negeri Medan.

Koh LP, Wilcove DS. 2008. Is oil palm agriculture really destroying tropical biodiversity?. Conserv Lett. 1(2):60-64.

Kwatrina RT, Santosa Y, Sunkar A. 2019. 2019. The use spatial analysis in confirming the environmenla issu on oil palm and biodiversity. AIP Conference Proceedings 2120. 040006. DOI: http://doi.org/10.1063/1.5115644.

Meijaard E, Garcia-Ulloa J, Sheil D, Wich SA, Carlson KM, Juffie-Bignoli D, IM Brooks (eds). 2018. Oil palm and biodiversity. A situation analysis by the IUCN oil palm task force. Switzerland (CH): IUCN Oil Palm Task Force Gland. pp 116.

Paciencia MLB, Prado J, 2005. Effects of forest fragmentation on pteridophyte diversity in a tropical rain forest in Brazil. Plant Ecol. 180:87-104.

Pagiola S. 2000. Land use change in Indonesia. A background paper for Indonesia: environment and natural resource

management in a time of transition. World Bank.

Pardamean M. 2017. Kupas tuntas agribisnis kelapa sawit mengelola kebun dan pabrik kelapa sawit secara efektif dan efisien. Jakarta (ID): Penebar Swadaya.

Roda JM. 2019. The geopolitics of palm oil and deforestation [online]. Available: https://www.thejakartapost.com/academia/2019/07/08/the-geopolitics-of-palm-oil-and-eforestation.html.

Santosa Y, Sunkar A, Purnamasari I, Yohana. 2016. Sejarah perkembangan status, penggunaan lahan dan keanekaragaman hayati kebun kelapa sawit Indonesia. Laporan Hasil Penelitian. Bogor (ID): Badan Pengelola Dana Perkebunan Kelapa Sawit & Lembaga Penelitian dan Pengabdian Kepada Masyarakat.

Santosa Y, Sunkar A, Purnamasari I, Yohana. 2017. Sejarah asal usul status, riwayat penggunaan lahan, kanekaragaman hayati kebun kelapa sawit di Kalimantan Tengah. Bogor (ID): GAPKI.

Santosa Y, Sunkar A, Purnamasari I, Yohana. 2018. Sejarah asal usul status, riwayat penggunaan lahan, keanekaragaman hayati kebun kelapa sawit di Sulawesi Barat dan Kalimantan Barat. Bogor (ID): GAPKI.

Sawit Watch. 2017. Benar, sawit melanggar HAM. Press release Sawit Watch [online]. Available: http://sawitwatch.or.id/2017/03/press-release-sawit-watch-17-maret-2017-benar-sawit-melanggar-ham/. accessed 17 Mar 2017.

Stevenson PR, Aldana AM. 2008. Potential effects of ateline extinction and forest fragmentation on plant diversity and composition in the western orinoco basin, Colombia. Int J Primatol. 29:365-377. DOI: 10.1007/s10764-007-9177-x.

Sunderlin WD, Resosudarmo IAP. 1996. Laju dan penyebab deforestasi di Indonesia: penelaahan kerancuan dan penyelesaiannya. Occational Paper No. 9. Bogor (ID): Center for Forestry International Forestry Research.

Thiollay JM. 1999. Responses of an avian community to rain forest degradation. Biodivers Conserv. 8(4):513-534.

Vayda AP. 1999. Finding causes of the 1997-1998 Indonesian forest fires: problems and possibilities. WWF Indonesia forest fires project. Jakarta (ID): WWF Indonesia.

Vijay V, Pimm LS, Jenkins CN, Smith SJ. 2016. The impacts of oil palm on recent deforestation and biodiversity loss. Plos One. 11(7):1-19. DOI: https://doi.org/10.1371/journal.pone.0159668.

Wicke B, Sikkema R, Dornburg V, Junginger M, Faaij A. 2008. Drivers of land use change and the role of palm oil production in Indonesia and Malaysia overview of past developments and future projections final report. Science, Technology and Society Copernicus Institute for Sustainable Development and Innovation Utrecht University.

Wicke B, Sikkema R, Dornburg V, Faaij A. 2011. Exploring land use changes and the role of palm oil production in Indonesia and Malaysia. Land Use Policy 28(1):193-206.

Wigena IGP, Siregar H, Sudrajat, Sitorus SRP. 2009. Desain model pengelolaan kebun kelapa sawit plasma berkelanjutan berbasis sistem pendekatan dinamis (Studi kasus kebun kelapa sawit plasma PTPN V Sei Pagar, Kabupaten Kampar, Provinsi Riau). JAE. 27(1):81-108.

World Bank. 2016. The cost of fire. An economic analysis of Indonesia's Fire Crisis. Jakarta (ID): The Word Bank.

[WWF] Wold Wildlife Fund. 2008. Oil palm. Position paper [online]. Available: https://d2ouvy59p0dg6k.cloudfront.net/downloads/wwf_position_paper_on_palm_oil.pdf.