LETTER

Environmental impacts of large-scale oil palm enterprises exceed that of smallholdings in Indonesia

Janice Ser Huay Lee[1], Sinan Abood[1], Jaboury Ghazoul[1], Baba Barus[2], Krystof Obidzinski[3], & Lian Pin Koh[1]

[1] Department of Environmental Systems Science, ETH Zürich, CHN G 73.1, Universitätstrasse 16 CH-8092, Zürich, Switzerland
[2] Center for Regional System Analysis, Planning and Development, Bogor Agricultural University, Jalan Raya Pajajaran, Baranangsiang, Bogor 16153, Indonesia
[3] Center for International Forestry Research, Jalan CIFOR, Situ Gede, Bogor Barat 16115, Indonesia

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Correspondence
Janice Ser Huay Lee, ETH Zürich, ITES–Ecosystem Management, CHN H71, Universitaetsstrasse 16, 8092 Zürich, Switzerland. Tel: +41-44-632-7559; fax: +41-44-632-1575.
E-mail: janice.lee@env.ethz.ch

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Abstract

The expansion of large-scale oil palm plantations in Indonesia has taken a heavy toll on forests, biodiversity, and carbon stocks but little is known about the environmental impacts from the smallholder sector. Here, we compare the magnitude of forest and carbon loss attributable to smallholdings, private enterprises, and state-owned oil palm plantations in Sumatra. During 2000–2010, oil palm development accounted for the loss of 4,744 ha of mangrove, 383,518 ha of peat swamp forest, 289, 406 ha of lowland forest, and 1,000 ha of lower montane forest. Much of this deforestation was driven by private enterprises (88.3%) followed by smallholdings (10.7%) and state-owned plantations (0.9%). Oil palm-driven deforestation in Sumatra resulted in 756–1,043 Mt of total gross carbon dioxide emissions, of which ~90% and ~9% can be attributed to private enterprises and smallholdings, respectively. While private enterprises are responsible for the bulk of environmental impacts, the smallholder oil palm sector exhibits higher annual rates of expansion (11%) compared to private enterprises (5%). Both sectors will need careful monitoring and engagement to develop successful strategies for mitigating future environmental impacts of oil palm expansion.

Introduction

Rising global demand for food, better nutrition, and crop-based alternatives to fossil fuel are rapidly transforming natural landscapes, leading to agricultural intensification and expansion (Gibbs *et al.* 2010; Foley *et al.* 2011). In the tropics, where several key agricultural commodities are produced, industrial-scale agricultural development has contributed to deforestation (Morton *et al.* 2006; Butler & Laurance 2008; Hansen *et al.* 2009), biodiversity loss (Fitzherbert *et al.* 2008; Koh & Wilcove 2008), and greenhouse gas emissions (Nepstad *et al.* 2008; Koh *et al.* 2011). A case in point is Indonesia, where oil palm agriculture expanded from ~100,000 ha in 1967 to ~8.4 million ha in 2010 (8,300%; Indonesian Ministry of Agriculture 2011). While this has led to Indonesia being the world's top palm oil producer and exporter (World Bank 2011), it has also led to widespread conversion of lowland forests and peat swamp forests (Miettinen *et al.* 2012; Carlson *et al.* 2013).

Based on 2012 figures from the Indonesian Ministry of Agriculture, Sumatra accounts for approximately 67% of Indonesia's total planted oil palm area (9.2 million ha), and 74% of its national crude palm oil production (23.6 million tons) (Indonesian Ministry of Agriculture 2011). Over the last three decades, expansion of oil palm plantations in Southeast Asia has taken a huge toll on the environment and led to significant impacts on forest cover, biodiversity, and carbon emissions (World Wildlife Fund [WWF] Indonesia 2010; Azhar *et al.* 2011; Margono *et al.* 2012). During this period, oil palm development had been driven by both large-scale plantations and smallholders (Indonesian Palm Oil Council 2010; World Bank 2011). Large-scale plantations are either state-owned or private enterprises, which can be up to 20,000 ha or 40,000 ha depending on the province (Casson 2000;

Caroko *et al.* 2011). Smallholder oil palm plantations, hereafter also known as smallholdings, are on average 2 ha in size but can range up to 50 ha in Indonesia (Vermeulen & Goad 2006; World Bank 2010). Oil palm smallholdings can be managed either independently by the farmer (independent smallholders) or in association with an oil palm company (scheme smallholders) where farmers receive technical assistance and agricultural inputs for their plantations (Vermeulen & Goad 2006). Whereas the environmental impacts of large-scale plantations have been well documented (Carlson *et al.* 2012; Miettinen *et al.* 2012; Obidzinski *et al.* 2012; Carlson *et al.* 2013), relatively little is known about the impacts of oil palm smallholdings in Indonesia [but see Uryu *et al.* (2008)].

According to the Indonesian Ministry of Agriculture, Indonesia's smallholder oil palm sector grew from 1,166,758 ha to 3,387,257 ha (190%) over the last decade, surpassing state-owned plantations (588,125–631,520 ha; 7%) and private enterprises (2,403,194–4,366,617 ha; 82%) (Indonesian Ministry of Agriculture 2002, 2011). Smallholder expansion had been concentrated in Sumatra, increasing from ~891,000 ha in 2000 to ~2.7 million ha in 2010 (207%). In comparison, private enterprises increased by 68% from ~1.4 million ha in 2000 to ~2.4 million ha in 2010 (Indonesian Ministry of Agriculture 2002, 2011). As large contiguous land becomes increasingly scarce in Sumatra, the rapid pace of smallholder oil palm expansion may suggest an increasingly important contribution to future land cover changes through small to medium size land conversion.

Here, we investigate the historical impacts of Indonesia's smallholder oil palm on the environment. Specifically, by performing a land cover change analysis we quantify forest loss and associated carbon emissions attributable to smallholder oil palm development in Sumatra between 2000 and 2010. We also compare these environmental impacts among three main oil palm sectors on the island: smallholders, private enterprises, and state-owned plantations.

Methods

Land cover maps

We extracted land cover data for Sumatra at two time periods (2000 and 2010) from 250 m × 250 m spatial resolution land cover classification maps (Miettinen *et al.* 2011). These maps were produced based on Moderate Resolution Imaging Spectroradiometer images and Daichi-Advanced Land Observing Satellite data. The overall accuracy of the land cover maps reported by Miettinen *et al.* (2011) is 85.3%. The land cover map for 2000 comprises 12 classes of land cover (including water, mangrove, peat swamp forest, lowland forest, lower montane forest, upper montane forest, plantation/regrowth, lowland mosaic, montane mosaic, lowland open, montane open, urban); the map for 2010 includes an additional class for large-scale palm plantation (Miettinen *et al.* 2011; see Supporting Information for description of each land cover class).

Oil palm sectorial boundaries

We obtained sectorial boundaries of oil palm plantations in Sumatra from Greenpeace and the Center for Regional Systems Analysis, Planning and Development (*Pusat Pengkajian Perencanaan dan Pengembangan Wilayah*, P4W). These sectorial boundaries were provided in the form of vector layers within a geographic information systems framework, in which individual polygons represent the boundaries of smallholdings, private enterprises, and state-owned plantations. We treat these data sets as the two best available data sources on sectorial boundaries of the oil palm industry in Indonesia (see Supporting Information for more details on data sets).

We merged the Greenpeace and P4W data sets to obtain a combined vector layer for each of the three oil palm sectors. We identified areas of overlap between layers (298,760 ha), and excluded them from subsequent analyses since we were unable to ascertain their sectorial ownership. Furthermore, we also excluded areas of overlap between oil palm plantations and industrial timber plantation concessions or *Hutan Tananman Industri* (920,212 ha), which we obtained from the Indonesian Atlas (Minnemeyer *et al.* 2009) and the Indonesian Ministry of Forestry (Indonesian Ministry of Forestry 2011) (Supporting Information). The resultant total areas of private enterprise, state-owned, and smallholdings were 4,556,600, 511,647, and 798,815 ha, respectively. Since our data represent mostly scheme smallholders and independent smallholders with >25 ha plantations, we were not able to capture smaller plantations (<25 ha) owned by many unregistered independent smallholders. Hence, we acknowledge here that the results from our land cover analysis from oil palm smallholdings are conservative.

Land cover change analysis

From the 2000 and 2010 land cover classification maps (see above), we extracted land cover information for each of the three oil palm sectors. This analysis produced three pairs of raster layers: private enterprise between 2000 and 2010, state-owned between 2000 and 2010, and smallholding between 2000 and 2010. We then carried out a change analysis on each pair of raster layers using the matrix algorithm under ERDAS IMAGINE V 2011. This

change analysis tabulates land cover between the two time periods, and calculates net transitions between different categories of land cover. Since we are mainly interested in assessing the environmental impacts of different oil palm sectors, we focused our analysis on forest habitat changes within sectorial boundaries between 2000 and 2010. These habitats are represented by the land cover classes of mangrove, peat swamp forest, lowland forest (<750 m above sea level or a.s.l.) and lower montane forest (750–1500 m a.s.l.).

We quantified forest cover loss instead of forest conversion into large-scale palm plantations to represent the environmental impacts, which occurred within our oil palm sectorial boundaries. The large-scale palm plantation land cover class described by Miettinen *et al.* (2011) captured only contiguous (>2 km^2) and mature oil palm (>8 years) plantations. Therefore, quantifying only forest conversion into large-scale palm plantations might underestimate recent forest cover transitions to immature oil palm (<8 years), which are classified under lowland open, lowland mosaic, and plantation/regrowth land cover classes (J. Miettinen, personal communication). Hence, we assume here that all deforestation within the oil palm sectorial boundaries is related to land transitions toward oil palm plantations. The geospatial data on oil palm sectorial boundaries and land cover change are available upon request from the authors.

Estimating gross carbon dioxide emissions from forest loss

We calculated gross carbon dioxide emissions resulting from the loss of biomass carbon stocks in mangrove, peat swamp forests, lowland forests, and lower montane forests within each oil palm sectorial boundary from 2000 to 2010. As illegal burning of land prior to oil palm cultivation is a common practice in Sumatra (Suyanto *et al.* 2004; Uryu *et al.* 2008), we calculated carbon emissions for scenarios either with or without burning for land clearance (Germer & Sauerborn 2008; Uryu *et al.* 2008; Carlson *et al.* 2013) (see Supporting Information for more details).

Results

Forest loss within oil palm sectorial boundaries

Between 2000 and 2010, Sumatra lost 3,508,938 ha of forest habitats (mangrove, peat swamp forest, lowland forest, and lower montane forest), of which 19.3% occurred within oil palm sectorial boundaries (Figure 1). Oil palm development was responsible for the loss of 4,744 ha of mangrove, 383,518 ha of peat swamp forest, 289,406 ha of lowland forest, and 1,000 ha of lower montane forest (Table 1). A large proportion of this deforestation within the oil palm sector was caused by private enterprises (599,281 ha; 88.3%) followed by smallholders (72,725 ha; 10.7%) and state-owned plantations (6,662 ha; 0.9%) (Table 1). Private enterprises developed more on peat swamp forests (361,831 ha; 60.4%) than lowland forests (234,250 ha; 39.1%), while smallholders converted more lowland forests (48,525 ha; 66.7%) than peat swamp forests (21,656 ha; 29.8%). Peat swamp forest loss within private enterprises was 16.7 times higher than that in smallholdings (361,831 ha vs. 21,656 ha), and lowland forest loss within private enterprises was 4.8 times higher than that in smallholdings (234,250 ha vs. 48,525 ha) (Table 1). Only a small percentage of total deforestation from oil palm development occurred in protected areas (6,412 ha; 0.94%).

The highest levels of deforestation within oil palm sectorial boundaries occurred in Riau, which accounted for 70% (266,212 ha) of peat swamp forest loss and 52% (148,987 ha) of lowland forest loss. Private enterprises were the main causes of deforestation across provinces, accounting for at least 80% of peat swamp forest loss and at least 60% of lowland forest loss in each province (Figure 2). Smallholder oil palm activity accounted for relatively higher levels of peat swamp deforestation in South Sumatra (3,362 ha; 19%), and lowland deforestation in Bengkulu (10,475 ha; 39%) and West Sumatra (6,750 ha; 28%) (Figure 2). State-owned plantations accounted for relatively higher levels of lowland deforestation in Jambi (3,637 ha; 14%) and North Sumatra (1,962 ha; 8%) but close to zero levels of peat swamp deforestation across all provinces (Figure 2).

The largest land cover converted within both private enterprise and smallholder oil palm sectorial boundaries came from the lowland mosaic land cover class, which consisted of small plantations, agricultural fields, and fragmented forest patches (Miettinen *et al.* 2011). Within private enterprises, lowland mosaic loss was more than 4.4 times higher than that in smallholdings (460,824 ha vs. 104,575 ha). However, the proportion of lowland mosaic loss accounted for a higher proportion of total land cover losses within smallholdings (59%) compared to private enterprises (43%).

Our analysis presents three key findings on forest cover losses within oil palm sectorial boundaries in Sumatra: (1) private enterprises were the overwhelmingly dominant causes of the loss of both lowland and peat swamp forests; (2) smallholders were culpable of more lowland forest loss than peat swamp forest loss; and (3) lowland mosaic losses accounted for a higher proportion of total land cover losses within smallholdings compared to private enterprises.

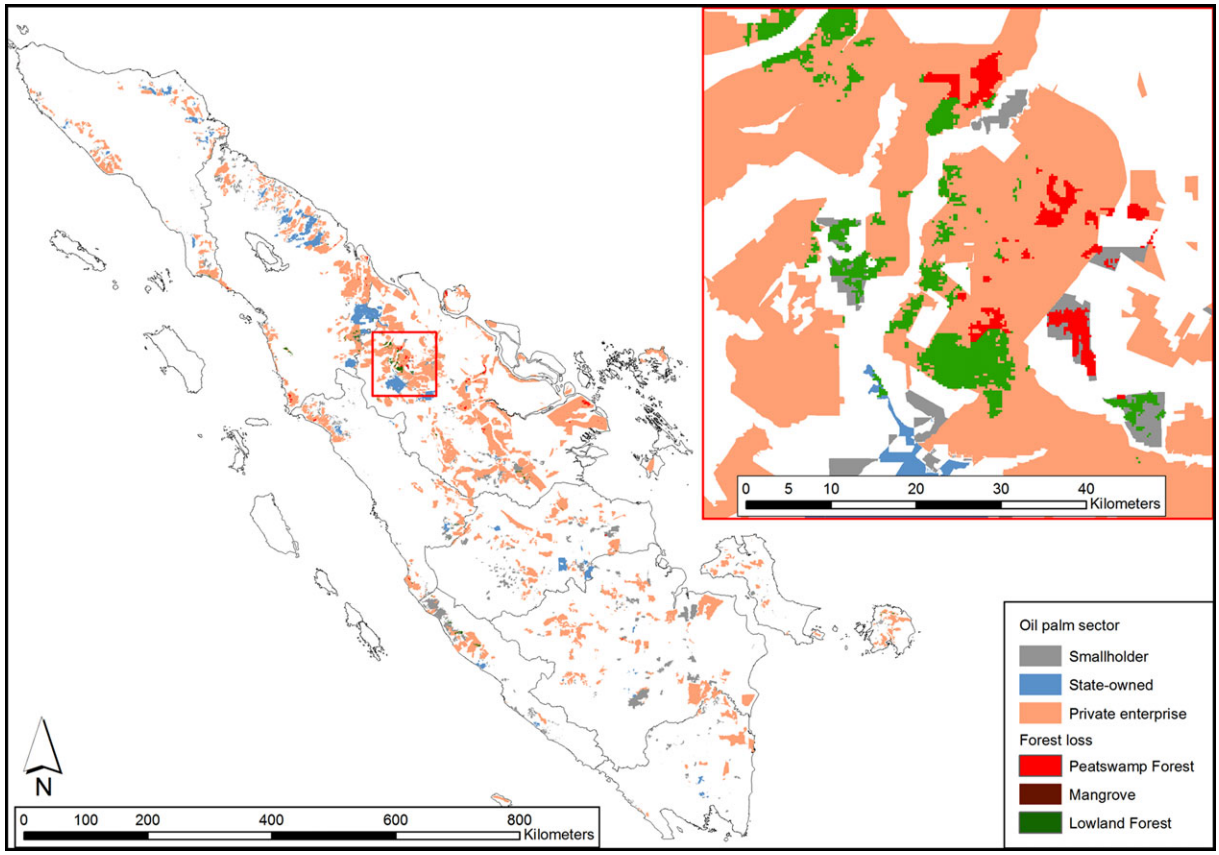

Figure 1 Forest loss (mangrove, peat swamp forest, lowland forest) within oil palm sectorial boundaries (smallholder, state-owned, private enterprise) in Sumatra from 2000 to 2010. The area of lower montane forest losses are small (1,000 ha) compared to other natural habitat losses (up to 380,000 ha) and are not displayed here.

Table 1 Forest loss (ha) in Sumatra and within each oil palm sector of private enterprises, smallholdings, and state-owned plantations for the period 2000–2010. Values in parentheses represent percentage forest loss within each sectorial boundary relative to forest loss within all oil palm sectorial boundaries

		Oil palm sectorial boundaries			
	Sumatra	Total	Private enterprise	Smallholding	State-owned
Mangrove	58,413	4,744	3,050	1,694	–
			(64.3)	(35.7)	
Peat swamp forest	1,301,181	383,518	361,831	21,656	31
			(94.3)	(5.6)	(<0.1)
Lowland forest	1,999,931	289,406	234,250	48,525	6,631
			(80.9)	(16.8)	(2.3)
Lower montane forest	149,413	1,000	150	850	–
			(15.0)	(85.0)	
Total	3,508,938	678,668	599,283	72,725	6,662
			(88.3)	(10.7)	(1.0)

Gross carbon dioxide emissions from forest loss

Between 2000 and 2010, deforestation in Sumatra resulted in an estimated 3,526–4,502 Mt of mean gross carbon dioxide emissions, of which 21–23% (756–1,043 Mt) was due to the conversion of forests within oil palm sectorial boundaries (range reflects scenarios without and with burning for land clearance) (Table 2). The loss of peat swamp forests to oil palm contributed the largest amount of carbon dioxide emissions (564–851 Mt;

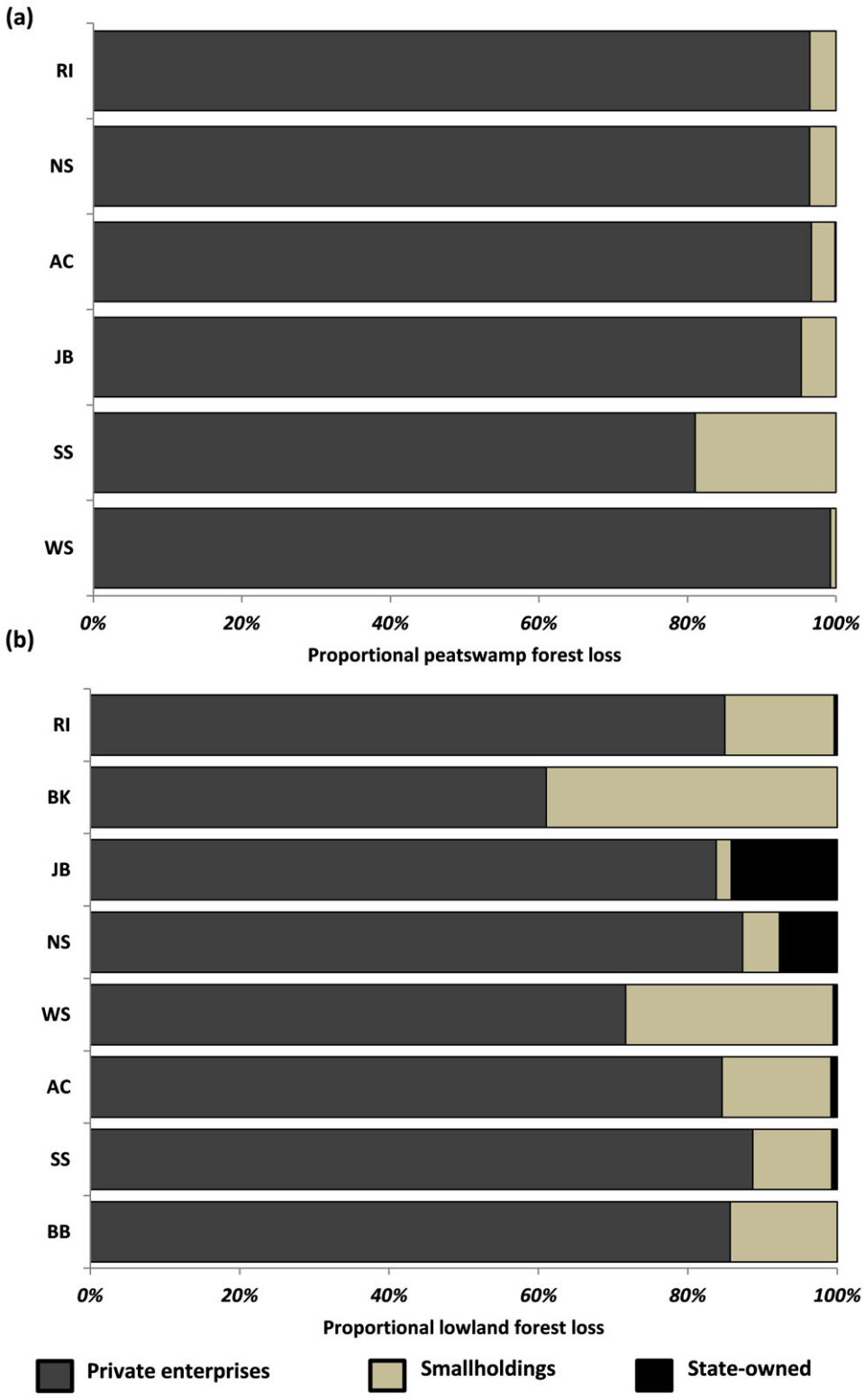

Figure 2 Percentage contribution to deforestation in (a) peat swamp forests, and (b) lowland forests from private enterprises, smallholder, and state-owned oil palm plantations at a provincial level. Ninety-nine percent of deforestation occurred within oil palm sectorial boundaries of provinces presented on the *y*-axis and provinces are arranged according to decreasing total area of deforestation from top to bottom. NS = North Sumatra; SS = South Sumatra; WS = West Sumatra; RI = Riau; AC = Aceh; JB = Jambi; BK = Bengkulu; BB = Bangka Belitung.

Table 2 Mean, low, and high estimates of gross carbon dioxide emissions in megatonne (Mt) from deforestation in Sumatra and within each oil palm sectorial boundary of private enterprises, smallholdings, and state-owned plantations for the period 2000–2010 (range of numbers indicates scenarios without and with burning for land clearance). Values in parentheses represent percentage carbon dioxide emissions within each sectorial boundary relative to total carbon dioxide emissions within all oil palm sectorial boundaries

Gross carbon dioxide emissions	Sumatra	Oil palm sectorial boundaries			
		Total	Private enterprise	Smallholding	State-owned
Mean	3,526–4,502	756–1,043	685–956	67–83	4.19–4.21
			(90.6–91.7)	(8.9–8.0)	(0.6–0.4)
Low	2,747–3,090	599–700	543–638	52–58	3.49–3.50
			(90.7–91.1)	(8.7–8.3)	(0.6–0.5)
High	4,387–6,231	919–1,462	830–1,342	84–115	4.89–4.93
			(90.3–91.8)	(9.1–7.9)	(0.5–0.3)

75–82%), with peat land burning accounting for 51% more carbon dioxide emissions compared to a scenario with no peat land burning. This was followed by the loss of lowland forests (180 Mt; 17–24%), mangroves (9 Mt; 0.9–1.3%), and lower montane forests (1.6 Mt; 0.16–0.22%). Of the total amount of carbon dioxide emissions released by the oil palm industry, 70–77% was a result of peat swamp forest loss within private enterprises.

An overwhelmingly large proportion of carbon dioxide emissions can be attributed to the private enterprise oil palm sector (685–956 Mt; 90–91%), followed by smallholders (67–83 Mt; 9–8%) and state-owned plantations (4.18–4.21 Mt; 0.5–0.4%). Under the scenario of burning for land clearing, gross carbon dioxide emissions increased by 40% for private enterprises and 24% for smallholders. Carbon dioxide emissions from private enterprises were ~10 times greater than that from smallholders, reflecting the magnitude of peat swamp deforestation by private enterprises (361,831 ha) compared to smallholders (21,656 ha).

Discussion

Forest clearing activities by smallholders in Indonesia were more prominent up to the 1990s where transmigration programs and smallholder tree crop development projects facilitated forest access to both local and migrant smallholders (Holmes 2000; Rudel *et al.* 2009). After the 1990s, private agricultural enterprises led most of tropical deforestation due to increased demand for agricultural commodities on the global market (Margono *et al.* 2012). As shown from our study on the oil palm sector, the impact of private enterprises on tropical deforestation in Indonesia continues to outweigh that of smallholders. Rather than clearing new land, smallholder oil palm expansion could have occurred over other forms of agriculture, such as rubber plantations, rattan gardens, and rice fields, all of which have been demonstrated to be less profitable for farmers in the short term compared to oil palm (Belcher *et al.* 2005; Feintrenie *et al.* 2010). Indeed as indicated by our results, lowland mosaic losses accounted for a higher proportion of total land cover losses within oil palm smallholdings as compared to private enterprises. Previous research also show that forested lands are favored by oil palm private enterprises due to timber revenues which help offset the costs of establishing a large-scale oil palm plantation (Casson 2000).

Between 2000 and 2010, Margono *et al.* (2012) identified oil palm and industrial timber plantation expansion as primary driving forces and transmigration activities and fires as secondary driving forces of forest cover loss in Sumatra. We show here that within the same timeframe, ~20% of forest loss occurred within oil palm sectorial boundaries. While the smallholder oil palm sector expanded faster than private enterprises in Sumatra (207% compared to 68%) between 2000 and 2010, the environmental impacts derived from the smallholder oil palm sector were lower compared to private enterprises. In terms of total forest losses in Sumatra, oil palm smallholdings accounted for 2.1%, while private enterprises accounted for 17.1% or eight times the impact relative to smallholders. State-owned plantations accounted for minimal deforestation (<1%) since recent expansion of Sumatra's oil palm industry was driven largely by private enterprises and smallholders. This is not the first study that has looked into the environmental impacts of oil palm private enterprises and smallholdings. Uryu *et al.* (2008) looked into deforestation rates in Riau from 1982 to 2007 and reported higher deforestation from oil palm private enterprises (28.7%) than oil palm smallholdings (7.2%).

Deforestation by the smallholder oil palm sector was twice as high in lowland forests compared to peat swamp forests, while within private enterprises, peat swamp forest loss was a third higher than lowland forests. This may

be related to higher establishment costs of developing oil palm on peat compared to mineral soils and lower competition for land use rights in peat swamp forests. The profitability of oil palm over peat is 35% lower than on mineral soils due to larger establishment costs from draining peat swamps and higher labor requirements (Budidarsono *et al.* 2012). Without the capital and expertise on establishing oil palm over peat, smallholders may avoid peatland areas unless they are associated with an oil palm company and receive financial and technical assistance. However, in some instances, peatlands are the only lands available to independent smallholders, and are cultivated without proper drainage and plantation management (J.S.H. Lee, personal observation). Population densities around peat swamp forests tend to be lower due to the difficulties involved in developing peat swamp forests for communal agriculture [but see Chokkalingam *et al.* (2007) for exceptions]. This has, therefore, led to large areas of peat swamp forests being allocated by the government for large-scale oil palm development, especially in the province of Riau (Anderson & Bowen 2000; Margono *et al.* 2012). Avoiding disputes with local communities over land tenure rights has been cited as an important consideration for private enterprise investment in Indonesia (Elson 2009) as well as industrial oil palm development in Peru (Gutiérrez-Vélez *et al.* 2011).

The pressure is mounting on the oil palm industry in Indonesia to lower carbon dioxide emissions as Indonesia strives to achieve 26% reductions in national carbon dioxide emissions by 2020 (Simamora 2010), and as developed nations consider the potential of palm oil as a substitute fuel (Gilbert 2012). Associated with the level of deforestation, our results indicate that 70–77% of gross carbon dioxide emissions from 2000 to 2010 released by the oil palm industry in Sumatra occurred through the conversion of peat swamp forests within private enterprises. Carlson *et al.* (2013) showed increasing oil palm development over peatlands in Kalimantan from 1990 to 2010 but demonstrated that 61–73% of carbon emissions from oil palm development came from forest conversion on mineral soils. Considering that oil palm plantations on Sumatra and Kalimantan account for >95% of Indonesia's total oil palm planted area (Indonesian Ministry of Agriculture 2011), mitigating carbon emissions from Indonesia's oil palm industry requires engagement with oil palm private enterprises to address the bulk of carbon dioxide emissions from oil palm development.

Halting the expansion of oil palm private enterprises over peat swamp forests and lowland forests is a crucial first step to mitigate carbon dioxide emissions from Indonesia's oil palm industry. Currently, there are more economic incentives for provincial and district level authorities to allocate forested lands rather than nonforested lands to private enterprises for oil palm plantation establishment (Irawan *et al.* 2013). These incentives are in the form of timber revenues that are institutionalized in various taxes and fees related to logging in the allocated concessions. Instead of distributing the economic returns from oil palm development through extractive land uses, the Indonesian government could consider restructuring the distribution of revenues from oil palm development based on crude palm oil production. Beneficial policies such as tax reductions or subsidies to oil palm producers could also be provided when oil palm is developed over nonforested lands such as *Imperata* grasslands. Such policy adjustments can help spur provincial and district level authorities to prioritize improving oil palm agricultural yields and diverting oil palm expansion away from forested lands.

Understanding the relative contributions to deforestation from various sectors of the oil palm industry enables the development of appropriate strategies for reducing conversion of Indonesia's forests into oil palm. In Sumatra, private enterprises show the largest environmental impacts within the oil palm industry although higher growth has been reported within the smallholder oil palm sector. Targeting oil palm private enterprises through publicity campaigns and market incentives is undoubtedly an easier task than influencing thousands of oil palm smallholders to reduce forest conversion to oil palm (Butler & Laurance 2008). Such efforts have already pressured some of the biggest oil palm producers to account for deforestation activities within their allocated concessions (Khor 2011) and consumer firms to be more proactive in reducing environmental impacts from their supply chains (Tabacek 2010). Within Sumatra's smallholder oil palm sector, it is also important to distinguish environmental impacts derived from smallholders of varying socioeconomic backgrounds. Based on field experiences in South Sumatra, the lead author observed large parcels of agroforests cleared and transformed into oil palm plantations by wealthy transmigrant oil palm smallholders. While private enterprises represent the bulk of the last decade's forest loss from the oil palm industry, we need to also anticipate future agents of land cover change especially within a forest landscape like Sumatra that is increasingly fragmented and accessible to smallholder agricultural conversion.

We attempted to quantify the environmental impacts from different sectors of the Indonesian oil palm industry in Sumatra using best available information on oil palm sectorial boundaries. Our study attempted to quantify the environmental impact of oil palm smallholdings in Sumatra but did not manage to capture the extent of impact

by independent smallholdings, which were <25 ha. Although we show that oil palm smallholders are responsible for less deforestation than private enterprises, our estimates are conservative and require further investigation especially since annual expansion rates of the smallholder oil palm sector is higher (11%) than that of private enterprises (5%) (Indonesian Palm Oil Council 2010). Given the smallholder oil palm sector is expected to expand (Bahroeny 2009; McCarthy 2010) and that smallholder tree crops have in the past contributed significantly to Indonesia's deforestation (Tomich & van Noorwijk 1995; Holmes 2000), we recommend careful monitoring and engagement with both oil palm smallholders and private enterprises to manage the environmental impacts derived from oil palm expansion in Indonesia.

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Supporting Information

Additional Supporting information may be found in the online version of this article at the publisher's web site:

Table S1. Distribution of land cover classes within different oil palm sectorial boundaries in 2010. Figures under Total Area (raster) are slightly higher that Total Area (vector) as a result of a vector to raster conversion.

Table S2. Carbon content values for above- and below-ground biomass for different land cover classes. Values in parentheses represent a 60% biomass loss when forest classes have been logged and/or degraded and were used in calculating gross carbon emissions from forest cover losses.

Table S3. Peat soil carbon estimates used to calculate carbon emissions from peat burning and peat oxidation.

Figure S1. Land cover class large-scale palm plantation which lie outside the oil palm sectorial boundaries are largely located along the North East (Inset A) and Central East side (Inset B) of Sumatra. They fall within the administrative districts of Asahan, Labuhan Batu, and Simalungan in North Sumatra, Indragiri Hilir from Riau, and Tanjung Jabung Barat and Tanjung Jabung Timur from Jambi.

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