

The Threat of Industrial Oil Palm Expansion to Primates and Their Habitats

Joshua M. Linder and Rachel E. Palkovitz

Introduction

Over the last few decades, agro-industrial enterprises have replaced small-scale farming and shifting cultivation as a leading driver of deforestation in many parts of the humid tropics (Butler and Laurance 2008; Gibbs et al. 2010). Of all the industrially produced crops, it is the relatively recent and rapid expansion of large-scale oil palm plantations that is among the greatest concern to tropical forest conservation. We review the history of large-scale, industrial oil palm expansion in the humid tropics and examine its ecological and social impacts to inform biodiversity conservation and human development strategies. We also assess global efforts to sustainably produce palm oil and offer recommendations on how to reduce the environmental footprint and improve the social benefits of producing palm oil.

The Rise of Industrially Produced Palm Oil

The African oil palm (*Elaeis guineensis* Jacq.) originated in Africa, where archaeological evidence suggests people have been cooking with palm oil for up to 6000 years in the tropical forest zones of West and Central Africa (Hartley 1988; Lynn 2002). A pioneer species, this member of the palm family (Palmae) thrives in tropical lowland areas with high rainfall and extensive sunlight. It begins to produce clusters of fruits 3–4 years after planting and can bear fruit for up to 60 years (Lynn 2002). Palm oil is extracted from the fruit pulp, while palm kernel oil (similar to coconut oil) is obtained from the hard seed embedded within the pulp. Per unit

J.M. Linder, Ph.D. (✉) • R.E. Palkovitz

Department of Sociology and Anthropology, James Madison University,
MSC 7501 Sheldon Hall, 71 Alumnae Dr., Harrisonburg, VA 22807, USA
e-mail: linderjm@jmu.edu

area, the African oil palm produces the highest oil yields and maintains the lowest production costs of any industrially derived vegetable oil (Rival and Levang 2014). Together, palm oil and palm kernel oil are used worldwide for cooking oil and as ingredients in soaps, cosmetics, detergents, lubricants, fertilizers, feedstuff, and biodiesel (Sheil et al. 2009).

The inter-continental trade in palm oil began as far back as the fifteenth century when European traders bought it from West Africans who extracted it from natural and sub-spontaneous groves (Lynn 2002). Palm oil became an important component of the transatlantic slave trade when it was used as a provision on slave ships and as a rub to enhance the marketability of slaves entering the New World (Watkins 2015). However, it was toward the end of the slave trade in the eighteenth and nineteenth centuries that brought about the more systematic and formalized export of palm oil from West African oil palm groves. By the late 1700s, the British began a sustained and extensive trade in palm oil and palm kernel oil from smallholder farmers in Africa's Upper Guinea and Gulf of Guinea regions as raw materials to help fuel an increasingly industrialized economy (Lynn 2002; Law et al. 2013). The development by the early twentieth century of large-scale industrial oil palm plantations started in Africa and Southeast Asia and stemmed from the inability of traditional palm oil extraction methods to meet a growing demand for the commodity. Large-scale, private enterprise-led oil palm plantations, compared with smallholder plots, would lead to greater yields, higher quality of palm oil, and lower production costs (Corley and Tinker 2003).

In Africa, the origins of large-scale, oil palm plantations can be traced to colonial Cameroon and the Congo (now the Democratic Republic of the Congo). By the late nineteenth century, the Germans were among the first colonial rulers in Africa to convert rain forest areas into plantation agriculture (Lanz 2000). In German-controlled Cameroon, cocoa plantations dominated at first, but were soon replaced in the early twentieth century by oil palm and rubber plantation crops (Gockowski and Dury 1999). Foreshadowing later agro-industrial developments in the tropics, early German plantation agriculture necessitated the expulsion and relocation of the indigenous people living in the concession area and led to a large influx of migrant workers living in company towns with poor living conditions (Konings 1993; Njoh 2002).

Around the same time, in the Belgian Congo, Sir William Lever (of the British soap manufacturing company, Lever Brothers) entered into a treaty with the Belgian colonial government in 1911 that eventually secured 750,000 ha of land, appropriated from the local population, on which his private company Huileries du Congo Belge would build modern processing facilities and monoculture plantations of oil palms to produce and export vast quantities of palm oil (Duignan and Gann 1975). Controlling the manufacturing, marketing, and distribution of palm oil along with the growing of oil palms revolutionized palm oil production (and industrial agricultural development, in general) and would temporarily vault the Congo into one of the top global producers of palm oil by 1935 (Dinham and Hines 1984). In 1930, Lever Brothers merged with the Dutch company Margarine Unie to form Unilever, now the world's largest buyer of palm oil (Oosterveer 2015), thus forming one of

the first large-scale, industrial, multinational oil palm enterprises. Despite the African origin of palm oil and some of the earliest experiments with large-scale cultivation of oil palms, palm oil production in Africa remained primarily controlled by smallholder farmers for much of the nineteenth and early twentieth centuries and even today much of the palm oil production is in the hands of small- to medium-scale farmers (Poku 2002; Corley and Tinker 2003; Rudel 2013; Wich et al. 2014). As such, Africa was the largest producer of palm oil until 1972, when Asia emerged as the leading global palm oil producer (FAO 2015).

The first African oil palms made their way to Asia when the Dutch planted four seedlings of African oil palm in Java's Buitenzorg (now, Bogor) Botanical Gardens in 1848. In 1875, the progeny of these plants would be planted in Sumatra and by 1914 these palms would be developed into a 2600 ha commercial oil palm plantation. Similarly, in 1911 and 1912 these palms were also planted in Malaysia, which by 1917 developed its own commercial oil palm plantations (Hartley 1988). The African oil palm and its varieties were found to thrive in Southeast Asia due to favorable soil and rainfall conditions and the absence of pests and diseases that afflicted it in Africa, resulting in higher yields. The oil palm industry would, thus, expand quickly in Indonesia and Malaysia.

In contrast to the smallholder dominance of palm oil production in Africa, large-scale, industrial cultivation of oil palms in Malaysia rapidly increased starting in the 1960s when the government introduced schemes to reduce the country's dependence on rubber and diversify its agricultural production (Teoh 2002). As a result, by 1975 Malaysia was producing more palm oil than all of Africa, with 60% of its oil palm hectareage in the hands of private enterprises and 10% managed by smallholder farmers as of 2000 (Teoh 2002). Similarly in Indonesia, government initiatives from the 1960s through the 1980s increased palm oil production from plantations, 50% of which is controlled by private enterprises (Colchester et al. 2006; Sheil et al. 2009). By 2013, Malaysia and Indonesia were responsible for over 85% of the world's palm oil production, whereas the proportion of the world's palm oil produced in all of Africa and the Americas was 4.1% and 5.5%, respectively (FAO 2015). Despite the early introduction and extensive use of the African oil palm in South America and the establishment of semi-wild populations in Brazil during the slave trade, large-scale cultivation did not really take hold until the 1960s (Hartley 1988). Since then, Columbia has seen the greatest growth of oil palm plantations in Latin America and is now the region's largest producer of palm oil and the fourth largest producer worldwide (FAO 2015; USDA 2015).

Impacts of Industrial Oil Palm Plantations on Biodiversity and Human Livelihoods

Global production of palm oil has increased exponentially over the past 50 years, driven by increasing consumption from a rapidly growing human population and use as a raw material (Fitzherbert et al. 2008). Today, the top importers of palm oil

are India, the European Union, and China, respectively (FAO 2015). Between 1961 and 2013, the average annual growth rate of the world's palm oil production was 7.4%, with production more than doubling every 10 years, making oil palm one of the most rapidly expanding crops in the tropics (Koh and Wilcove 2008; FAO 2015). At the same time, the total land devoted to oil palms more than quadrupled from 3.6 million ha in 1961 to over 17 million ha, distributed across 43 countries, in 2013 (Koh and Wilcove 2008; FAO 2015). Palm oil consumption and use as a raw material, especially for the production of biofuel, are expected to increase considerably by 2025 (Kongsager and Reenberg 2012). While Indonesia and Malaysia are predicted to maintain their dominance in palm oil production, land-use policy changes in these countries (Varkkey 2012; Feintrenie 2013) have contributed to an increase in land acquisitions and prospecting by agribusinesses for the development of oil palm plantations in other suitable regions, especially the tropical forest zones of Africa and Latin America (Schoneveld 2011; Greenpeace 2012; Sayer et al. 2012).

The lucrative palm oil industry and the need for economic development have motivated countries in these emerging palm oil producing regions to offer attractive land acquisition terms, including low rental fees, taxation, and duties and rights to water, minerals, and/or timber in the oil palm concession area (Hawkins and Chen 2011; Nguiffo and Schwartz 2012). In the African tropical forest zone, these factors are contributing to a "new wave" of palm oil production (Linder 2013). An estimated 2.6 million ha of land, the majority of which is forested, has already been allocated or is expected to be allocated to industrial oil palm developments in west and central Africa (Greenpeace 2012). These and other non-protected forests suitable for oil palm expansion overlap extensively with the geographic ranges of apes and other primate species (Wich et al. 2014). Similarly, the tropical forest zones of Central and South America are considered to be prime areas for large-scale oil palm cultivation (Corley and Tinker 2003). Almost half of Brazilian Amazonia, for example, holds some of the greatest biophysical potential for growing oil palms (Butler and Laurance 2009) and Brazil has recently increased its investment in the palm oil industry (Villela et al. 2014, Monteiro de Carvalho et al. 2015). Meanwhile, in Asia, large-scale oil palm developments are expected to expand quickly in Thailand (Saswattecha et al. 2015), Papua New Guinea (Nelson et al. 2014), and Myanmar (Donald et al. 2015).

Forest Loss and Fragmentation

Although oil palms require less land to produce the same amount of oil as other vegetable crops, and despite claims by some authors that the environmental damage from oil palm development has been exaggerated (Lam et al. 2009; Tan et al. 2009; Boyfield and Ali 2011; Roberts 2011), evidence indicates that industrial oil palm expansion can lead to extensive deforestation. Wicke and colleagues (2011) examined land use changes in Indonesia and Malaysia from 1975 through 2005, relying on data gathered from various kinds of publicly available national and international

statistics. They found that in Indonesia forested land experienced the largest changes, declining in extent by 30% over the 30-year period as agricultural land expanded by over 25% during the same period. Palm oil production accounted for approximately half of this expansion, but was largely concentrated in Sumatra and Kalimantan. Malaysian forests were reduced by 20% as land use for oil palm cultivation increased nearly sixfold. Although the impact of oil palm expansion varied across different scales and regions, the authors concluded that it played a significant role in reducing forest cover.

Based on nationally reported statistics of cropland and forest area, Koh and Wilcove (2008) also assessed the extent to which oil palm plantations are destroying forests (including primary, secondary, and plantation forests, but excluding rubber plantations) in Malaysia and Indonesia. They found that between 1990 and 2005, between 55 and 59% of oil palm expansion in Malaysia resulted in secondary forest (selectively logged) and plantation forest clearance. At least 56% of oil palm expansion in Indonesia during this same time period resulted in forest loss. Although the data did not permit the authors to discern between primary, secondary, and plantation forest loss due to oil palm developments, subsequent analysis showed that almost 60% of new plantations (oil palm and rubber) created in Southeast Asia between 1980 and 2000 occurred at the expense of intact forests (Gibbs et al. 2010).

Based on remotely sensed time series data and socioeconomic surveys in West Kalimantan in the Indonesian part of Borneo, Carlson and colleagues (2012) found that from 1989 to 2008, nearly half of all oil palm plantations were developed on intact, secondary, and logged forests, leading to a decline in forest cover outside of protected areas from 59 to 22%. The great majority of the forest loss during this 19 year period was attributed to fires that were exacerbated by deforestation (Curran et al. 2004). However, by 2008, 27% of deforestation (and 40% of all peatland loss) was directly attributed to oil palm plantation expansion. This is likely an underestimate of forest loss because in many instances logging conducted or contracted by oil palm companies was responsible for the deforestation and this was not attributed to oil palm expansion in the analysis. While many oil palm plantations in Southeast Asia have been established on selectively logged timber concessions (Curran et al. 2004; Hansen 2005), there is also a more direct link between palm oil production and logging. Timber production commonly precedes forest conversion to oil palm monoculture as timber revenues can help offset the costs of establishing a large-scale oil palm plantation (Hansen 2005; Sandker et al. 2007; Obidzinski et al. 2012; Hewitt 2013; Greenpeace 2014; Lee et al. 2014). However, these logging operations are often illegal or are conducted without intention of converting the area into an oil palm plantation (Sandker et al. 2007; Greenpeace 2014).

Considering forest loss across the entire island of Borneo, Gaveau and colleagues (2014) found that between 1973 and 2010, Borneo lost over 30% of its forests, with 33% converted to oil palm and rubber plantations. By 2010, industrial oil palm plantations covered almost 9% of Borneo. Along with rubber plantations, the authors concluded that oil palm expansion represents the primary driver of forest loss in Borneo.

Margono and colleagues (2012) quantified using remotely sensed time series data the loss of primary, intact, lowland forest in Sumatra between 1990 and 2010. Results show that primary forest extent was nearly halved over the 20-year study period with most of this loss occurring in the first decade as there was simply less intact forest remaining in the 2000s. Over two-thirds of Sumatra's primary intact forest loss was located in the province of Riau and mostly attributed to the establishment of oil palm plantations along with timber and pulp concessions.

Similarly, Lee and colleagues (2014) examined forest loss (mangrove, peatland, lowland, lower montane) in Sumatra from 2000 through 2010 from smallholdings, private enterprises, and state-owned oil palm plantations. They found that large-scale oil palm developments were responsible for almost 20 % of Sumatra's total forest losses over the 10-year study period—eight times the impact of smallholders. Private enterprise-managed plantations were responsible for over 88 % of the deforestation.

Large-scale oil palm plantations in Southeast Asia have, in general, expanded at the expense of peatland forests, unique ecosystems that harbor high concentrations of endemic plant and animal species and serve as important refuges for orangutans and other primate species (Yule 2010). From analysis of remote sensing data, Koh and colleagues (2011) found that by the early 2000s a large proportion of peatland forests were converted to oil palm plantations in Peninsular Malaysia and certain regions of Sumatra. Miettinen and colleagues (2012) also came to a similar conclusion examining peatland deforestation in Southeast Asia from 1990 to 2010. They determined that due to logging and plantation development (including the burning and draining of forests), Sumatra experienced the greatest loss of peatland compared with Peninsular Malaysia and Borneo. The total study area lost over half of its peatland over a 20 year period. Focussing just on Indonesia, Lee and colleagues (2014) found that peatlands lost the greatest absolute and relative amount of forest due to oil palm development (especially private enterprise-managed) from 2000 through 2010. In the state of Selangor, Malaysia, Abdullah and Nakagoshi (2007) using time series data from land use/cover maps found that between 1966 and 1995, peatland and mangroves became increasingly more fragmented than other forest landscapes due primarily to the expansion of oil palm plantations.

Although deforestation from oil palm development is not as well studied in Latin America as it is in Southeast Asia, the available evidence indicates a similar trend. From remotely sensed and field data, Gutierrez-Velez and colleagues (2011) assessed forest loss due to large-scale, industrial and small-scale, low-yield oil palm plantations in the Peruvian Amazon from 2000 to 2010. They found that 72 % of large-scale oil palm expansion occurred at the expense of forests, representing 1.3 % of total deforestation in Peru during that time period. In contrast to small-scale plantations, the large-scale, industrial developments tended to expand mostly into old-growth forests. In Costa Rica, Broadbent and colleagues (2012), using remote sensing and socioeconomic surveys, examined changes to forest cover around Manuel Antonio National Park from 1985 to 2008. They found that large-scale oil palm plantations expanded from 19 to 31 % of the surrounding study area on an increasing proportion of natural forests, including in the buffer zone of the

park. In Columbia oil palm expansion has become one of the principle drivers of deforestation and forest fragmentation, especially of gallery forests (Carretero-Pinzón et al. 2009), with the land devoted to oil palm increasing from 157,000 ha in 2000 to 404,000 ha in 2010 (Marin-Burgos et al. 2015). In the Brazilian State of Pará, the country's largest palm oil producer, 20 % of all oil palm expansion led to deforestation including of primary forest between 1985 and 2008 (Villela et al. 2014). Total area of oil palm plantations in Ecuador increased from 72,210 to 207,285 ha from 1998 to 2008, replacing over 22,000 ha of Ecuador's coastal Chocó rainforest (Hazlewood 2012).

The literature indicates that industrial oil palm plantations have expanded at the expense of tropical forests including primary, secondary, peatland, and mangrove forests. Especially salient is the link between industrial oil palm development and selective logging, a subject we explore in more detail below (see "Sustainability" and Industrially Produced Palm Oil).

Effects on Animal Communities

Turner et al. (2011) summarized much of the literature on the impact of oil palm development on species richness and abundance. Not surprisingly, conversion of forest to oil palm plantation results in simplification of the vegetation and extreme losses of biodiversity across taxonomic groups. Compared with intact primary, secondary, and/or selectively logged forest, industrial oil palm plantations are species-poor and/or exhibit substantially lower diversity. Specifically, research from Asia, Latin America, and Africa document the negative effects of large-scale oil palm plantations on mammals (Danielsen and Heegaard 1995; Maddox et al. 2007; Bernard et al. 2009; Swarna Nantha and Tisdell 2009; Struebig et al. 2011; Wich et al. 2012), birds (Danielsen and Heegaard 1995; Waltert et al. 2005; Aratrakorn et al. 2006; Koh and Wilcove 2008; Edwards et al. 2010; Azhar et al. 2011; Lees et al. 2015), reptiles (Glor et al. 2001; Gallmetzer and Schulze 2015), amphibians (Iskandar and Erdelen 2006; Gallmetzer and Schulze 2015), ants (Room 1975; Brühl and Eltz 2010; Lucey and Hill 2012), beetles (Chung et al. 2000; Davis and Philips 2005), orchid bees (Livingston et al. 2013), aquatic "true bugs" (Cunha et al. 2015), butterflies (Koh and Wilcove 2008; Lucey and Hill 2012), and fish (Giam et al. 2015).

Generalist, invasive, non-forest species tend to dominate oil palm plantations while species lost due to forest conversion are typically specialists and/or of highest conservation concern (Fitzherbert et al. 2008; Foster et al. 2011; Gallmetzer and Schulze 2015). Forest-dwelling primates are particularly affected by forest conversion to oil palm plantations. While some primate species can exploit the oil palm for food or shelter, few species can permanently live in such a monoculture (Humble and Matsuzawa 2004; Marchal and Hill 2009; Estrada et al. 2012; Azhar et al. 2013; Ancrenaz et al. 2014).

Related Ecological Effects

The ecological effects of large-scale oil palm development extend far beyond the direct loss of forest, subsequent dramatic declines in local biodiversity, and significant changes to animal assemblages. Large-scale oil palm developments result in local increases in human population density, primarily due to the mass migration of laborers into the project area, and investments in infrastructure, including roads and facilities to house and care for plantation workers (Susanti and Burgers 2013; Schoneveld 2014). In many tropical areas this results in increased hunting intensity for wild meat in adjacent forests and forest patches located within the plantation as migrant workers bring with them a preference for wild meat over other protein sources (Butynski and McCullough 2007; Maddox et al. 2007; Rist et al. 2010; Cramb and Curry 2012; Norwana et al. 2012; Azhar et al. 2013; Dewi et al. 2013; Luskin et al. 2014). The roads allow easier access to adjacent forests and markets, while reducing transport costs of wild meat (Laurance et al. 2014). Finally, the influx of laborers leads to further deforestation as these migrants clear forest for farmland (Laurance et al. 2009; Susanti and Burgers 2013; Schoneveld 2014).

Oil palm plantations are often established beside (and sometimes within) protected areas (PAs) including national parks (Curran et al. 2004; Broadbent et al. 2012; Azhar et al. 2013; Linder 2013; Susanti and Burgers 2013; Schoneveld 2014, Friends of the Earth 2015). As oil palm plantations have expanded (combined with their demographic, agricultural, and infrastructure correlates), PAs have become increasingly isolated (Broadbent et al. 2012; Carlson et al. 2012; Rival and Levang 2014). Forest loss and degradation surrounding PAs not only limit dispersal of non-flying mammals between remaining forest blocks (Bernard et al. 2009), but also threaten the ecological integrity of the PA itself through increased edge effects, hunting, encroachment, and pollution (Harvey et al. 2008; Laurance et al. 2012). Consequently, expansion of large-scale oil palm plantations near to PAs will likely result in increased rates of population extinction within the PA for many animal species. Primates are especially vulnerable to the synergistic interaction of inhospitable matrices and increased hunting intensity (Brashares et al. 2001; Gonedele Bi et al. 2012; Benchimol and Peres 2013).

Livelihood Impacts of Industrial Oil Palm Developments

Industrial oil palm development has been heralded as an effective strategy to improve rural development and alleviate poverty in developing countries (Hårdter et al. 1997; Susila 2004; Basiron 2007; Lam et al. 2009; Tan et al. 2009; Deininger and Byerlee 2011; Roberts 2011; World Growth 2011). Some have suggested that NGOs have exaggerated the negative socioeconomic impacts of large-scale, industrial oil palm development (Tan et al. 2009; World Growth 2011) and overstated the conflicts that arise between agribusiness, government, and local communities (Rival

and Levang 2014). A deeper consideration of the literature, however, indicates that oil palm development may have serious negative social, economic, and health consequences for local, especially indigenous, populations.

Rural and indigenous communities across Asian, Latin American, and African tropical forest zones exercise customary land tenure, but such rights are often unrecognized or ineffectively secured and protected (McCarthy and Cramb 2009; Colchester et al. 2011; Gerber 2011; Schoneveld 2014; Brad et al. 2015; Friends of the Earth 2015). Agribusinesses and national governments exploit this uncertain legal framework to gain control over forested lands, laying the foundation for the expansion of agro-industrial development throughout the tropics (Friends of the Earth 2008; McCarthy and Cramb 2009; Côté and Cliche 2011; Hazlewood 2012; Obidzinski et al. 2014; Brad et al. 2015; Rein 2015). This leads to the failure of many agribusiness to effectively follow national and international laws that give rights to affected communities to obtain free, prior, and informed consent (FPIC) in all phases of plantation development (Vermeulen and Cotula 2010; Hazlewood 2012; Colchester and Chao 2013; Nelson and Lomax 2013; Larsen et al. 2014; Friends of the Earth 2015; Global Witness 2015). Such large-scale land deals often suffer from lack of transparency regarding land allocation, resource rights, and contract details (Rosenkrantz et al. 2003; Friends of the Earth 2008; McCarthy and Cramb 2009; Rist et al. 2010; Vermeulen and Cotula 2010; Colchester et al. 2011; Hoyle and Levang 2012; Assembe-Mvondo et al. 2013; Schoneveld 2014). Consequently, without independent counsel and other experts advocating on their behalf, local community members (usually with only modest education levels) report confusion over rights, responsibilities, and obligations of stakeholders (Rosenkrantz et al. 2003; Rist et al. 2010; Vermeulen and Cotula 2010; Greenpeace 2013a; Nguiffo 2013; Brad et al. 2015; Friends of the Earth 2015). Local resistance, opposition, and other forms of conflict over land use, resource claims, and contractual obligations often follow (Ashley 1987; Mingorance 2006; Acciaioli 2008; Friends of the Earth 2008; McCarthy and Cramb 2009; Sirait 2009; Rist et al. 2010; Côté and Cliche 2011; Gerber 2011; Li 2011; Obidzinski et al. 2012; Väh 2012; Greenpeace 2013a; Schoneveld 2014; Castiblanco et al. 2015; Global Witness 2015; Marin-Burgos et al. 2015). Conflict occurs between local communities and the agribusiness and/or the government, among local communities that vary in acceptance of the plantation, among members within local communities, and between migrant workers and people native to the area (Colchester et al. 2011).

In addition to the links between industrial oil palm and human rights issues, claims that industrial oil palm development is a boon to local and national economies and livelihoods may have been exaggerated in some cases. Economic analysis suggests that the heyday of industrially produced palm oil profitability witnessed in the last decade may be coming to an end. Increasing production costs (especially labor costs), a declining global market price of crude palm oil, and overall declining cost competitiveness compared with other vegetable oils indicate that investments in large-scale oil palm ventures may not be as profitable in the near future as they were in the past (Rein 2015). While the industrial oil palm sector is an important source of employment, its proponents may be overestimating the number and quality of local jobs it generates

(Li 2011). Oil palm plantations profit by employing cheap, abundant labor. In Malaysia and Indonesia, this was largely accomplished through massive transmigration programs, moving mostly poor Javanese smallholders to oil palm plantation sites, marginalizing customary landholders (McCarthy and Cramb 2009). A similar strategy has been implemented in the Nigerian palm oil industry (Schoneveld 2014). Furthermore, oil palm development creates mostly seasonal and casual employment (Li 2011; Schoneveld 2014; Rein 2015). Converting forests and farmland to large-scale oil palm monocultures can also reduce income diversity, increase income inequality, and expose rural farmers to global commodity market volatility (Belcher et al. 2004; Dewi et al. 2005; McCarthy and Cramb 2009; Dauvergne and Neville 2010; Balachandaran et al. 2013; Elmhirst et al. 2015; Rein 2015). While the overall health impacts of industrial oil palm development on affected local communities are understudied, research shows that loss of forest and farmland to an export commodity threatens local food security and dietary quality, especially among women (Elmhirst et al. 2015), through declining access to non-timber forest products, reduced production of subsistence crops, and increased daily expenses on food (Norwana et al. 2012; Våth 2012; Balachandaran et al. 2013; Ickowitz et al. 2014; Schoneveld 2014; Sneyd 2014). In fact, Indonesia's rise to the world's top producer of palm oil came at the expense of its domestic food production; since 2011 the country has spent more money on importing food than it earned from exporting palm oil and rubber (Rein 2015). Finally, local populations can be affected by water contamination from plantation agrochemicals (Rosenkrantz et al. 2003; Hazlewood 2012; Marin-Burgos et al. 2015) and are at a high risk of malaria infection in plantation landscapes (Pluess et al. 2009).

This is not to say that industrial oil palm development always leads to adverse social and economic outcomes, nor is it the case that every agribusiness violates procedures of FPIC or causes social conflict (Susila 2004; McCarthy and Cramb 2009; Feintrenie et al. 2010; McCarthy 2010; Rist et al. 2010; Feintrenie 2012; Norwana et al. 2012; Obidzinski et al. 2012; Våth 2012; Beggs and Moore 2013). Indeed, economic benefits can be significant, particularly at the national level. Socioeconomic impacts of large-scale, industrial oil palm expansion are, however, highly variable (Zen et al. 2005; Sandker et al. 2007; McCarthy 2010; Rival and Levang 2014) and the socioeconomic risks involved with large-scale oil palm ventures are rarely, if ever, communicated to local people. The research cited above points to many detrimental social and economic consequences of industrial oil palm plantations that cut across time periods and all tropical regions where industrial oil palm is expanding. So, while there may be "winners" in the palm oil "sweepstakes," notably governments, agribusinesses, and elites, the "losers" stand to lose a lot (Belcher et al. 2004).

“Sustainability” and Industrially Produced Palm Oil

We have relied on peer-reviewed sources and the gray literature to illustrate that across regions where palm oil is produced, industrial oil palm development has been and continues to be a leading driver of tropical deforestation and biodiversity

loss, threatens the integrity of protected areas, and can lead to significant social, economic, and health costs for local populations. Combined with overhunting and the activities of other agricultural and extractive industries, the rapid expansion of industrial oil palm plantations in the Neotropics and African tropical forest zones, assuming a “Business As Usual” (BAU) approach, is a harbinger of significant declines in tropical forest biodiversity.

In response to the problems associated with the palm oil industry, the World Wide Fund for Nature (WWF) conceived of and initiated the Roundtable on Sustainable Palm Oil (RSPO), a voluntary, multi-stakeholder effort formally established in 2004 to improve through independent certification the environmental and social impacts of the palm oil industry (Schouten and Glasbergen 2011). As national governments were largely unwilling or unable to forestall deforestation from industrial oil palm development, an alternative strategy of “partnered governance” was established whereby the palm oil industry from across the “supply chain” (e.g., palm oil producers, buyers, retailer, traders) collaborates with civil society organizations, which represent ecological and social interests, to implement minimum standards for “sustainable” palm oil (Nikoloyuk et al. 2010). Through the application of a set of principles and criteria (P&C), the RSPO certifies that palm oil is produced by “legal, economically viable, environmentally appropriate, and socially beneficial management and operations” (Roundtable on Sustainable Palm Oil 2013). From the ecological perspective, the RSPO has focussed on compelling palm oil producing members to establish plantations on “degraded land” and to protect areas of “High Conservation Value” (HCV), defined on the basis of species diversity, ecosystem services, the presence of rare, endemic, flagship, or threatened ecosystems or species, community needs, and cultural values (Roundtable on Sustainable Palm Oil 2013). As of April 2016, 3.66 million ha across eleven countries have been certified by the RSPO resulting in the production of over 13.7 million tones of certified sustainable palm oil, representing 21 % of global production (www.rspo.org).

The apparent success of the RSPO to shift the palm oil industry from a BAU approach to one of “sustainability,” however, has been tempered by its critics. It has been argued that values held by palm oil producers, buyers, and traders dominate the RSPO system at the expense of environmental protection and local community rights (Laurance et al. 2010; Nikoloyuk et al. 2010; Paoli et al. 2010; von Geibler 2013) and that membership in the RSPO is too easy to acquire (Laurance et al. 2010). Critics have also cited the lack of effective oversight and enforcement of P&C as a major weakness of the RSPO (Siagian 2008; Laurance et al. 2010; Yaap et al. 2010; Schouten and Glasbergen 2011). There are many instances of members violating RSPO P&C including Herakles Farms/SG Sustainable Oils (Linder 2013), First Resources (Environmental Investigation Agency 2012; Parker 2013), Sinar Mas (Greenpeace 2009), United Plantations (Greenpeace 2008), Kuala Lumpur Kepong (Rainforest Action Network 2014), and the Wilmar Group (Friends of the Earth 2007; Greenpeace 2013c), challenging the credibility of the RSPO. Although the RSPO has established a formal grievance process to address complaints against RSPO members, this system has its limitations. To be

successful, grievances require extensive evidence of violation, which require substantial resources and may involve entering the concession illegally (Pesqueira and Glasbergen 2013; Ruyschaert and Salles 2014; Marin-Burgos et al. 2015). In practice, grievances are typically filed by large NGOs often acting on behalf of local affected populations who may lack the capacity to do it themselves, and resolution can take up to 36 months (Ruyschaert and Salles 2014). Local community members and independent researchers who attempt to “blow the whistle” on powerful agribusinesses, which are often backed by national governments, risk intimidation, harassment, imprisonment, and death (Bird 2013; GRAIN 2014; Rainforest Action Network 2014). Without such NGO oversight, violation of P&C by RSPO members would likely go undetected by the RSPO.

Many have argued that weak and imprecise P&C allow national governments and palm oil producers to interpret the guidelines in ways that allow deforestation; including and especially of peatland and high carbon stock forests (Laurance et al. 2010; Nikoloyuk et al. 2010; Edwards et al. 2012; Greenpeace 2013a; Ruyschaert and Salles 2014). Among the most confusing yet critical concepts central to the RSPO sustainability approach is that of “degraded” land, on which members are encouraged to establish plantations so long as HCV is not present or is identified and protected. To date, the RSPO has not defined “degraded,” despite calls to do so in 2010 (Roundtable on Sustainable Palm Oil 2010), in part because degradation is a value judgement and, as such, there is no widely accepted definition of or method for delineating degraded land (McCormick et al. 2014). The P&C, however, imply that an area of land is either degraded or not degraded. In other words, the RSPO presents the process as a binary decision and that growers should select one over the other. In reality, degradation is a far more complex concept that is site specific and that falls along a continuum in terms of degree (e.g., lightly vs. severely) and scale (e.g., land/soil, habitat, ecosystem) (McCormick et al. 2014). Furthermore, protecting fragments of HCV forest within presumed “degraded” landscapes, as required by the RSPO, contributes little to broader biodiversity conservation efforts (Wilcove and Koh 2010). This RSPO conservation strategy also fails to account for delayed extinctions following forest loss and fragmentation (Kuussaari et al. 2009). As a result, biodiversity loss from conversion of land to industrial agriculture is likely being underestimated. A focus on identifying HCV and degraded land also ignores the importance of overall landscape heterogeneity in promoting biodiversity (Azhar et al. 2015).

Actors in the Malaysian and Indonesia palm oil industry have argued that industrial oil palm expansion has occurred primarily in previously logged, degraded land and, therefore, has not lead to the extensive deforestation and biodiversity losses suggested by environmental NGOs (Koh and Wilcove 2008). Selectively logged forests, however, have been found to retain relatively high levels of biodiversity, especially for primates (Meijaard et al. 2005; Berry et al. 2010; Putz and Redford 2010; Didham 2011; Gibson et al. 2011; Edwards and Laurance 2013; Ramage et al. 2013) and can become floristically similar to surrounding intact forest blocks within a few decades (Van Gemerden et al. 2003). Thus, logged forests are degraded relative to unlogged forests but still retain important conservation value and should

be protected from conversion to industrial agriculture (Gaveau et al. 2014). With over 30% of Central Africa's dense, humid forests under logging concessions (Laporte et al. 2007), Africa would stand to lose a significant proportion of forest biodiversity if it were to follow the Malaysian and Indonesia model of converting logged forests to oil palm plantations.

To further illustrate how the interpretation of the RSPO's "degraded" land and HCV approach can lead to forest loss and social conflict, we turn to the case of American agribusiness Herakles Farms (HF) and its subsidiary SG Sustainable Oils, which in 2009 signed an agreement with the government of Cameroon to establish an industrial oil palm plantation on over 73,000 ha adjacent to four protected areas including two national parks. HF, a member of the RSPO at the time of starting its development, claimed that the concession area was degraded because it had been heavily fragmented from years of commercial logging and slash and burn agriculture and was, therefore dominated by secondary forest of low biodiversity value (Asamoah 2011; Herakles Farms 2012). The HF formal assessment of HCV, submitted to the RSPO and Cameroon government, indicated that within this degraded landscape only small (mostly <25 ha), isolated patches of HCV forest primarily restricted to hilltops and steep-sided ridges would be spared from conversion (Asamoah 2011). The relevant Cameroon ministries generally concurred with this evaluation and management plan. HF further argued that they secured the support of local communities in the form of signed Memorandums of Understanding. The HF development may have been given permission to clear forest by the RSPO had it not been for the efforts of local community members and Cameroonian and foreign NGOs and scientists who brought the HF issue to international attention and filed an official grievance with the RSPO. Years of data gathering by this group (including interviews, ecological surveys, remote sensing, and investigations into HF) indicated that the concession area primarily consisted of dense, intact, high canopy forest with carbon stocks higher than the regional average and contained many kinds of threatened and/or narrowly endemic plant and animal species distributed throughout the planned plantation area (Maschler 2012; Greenpeace 2013b; Kupsch et al. 2014). Furthermore, HF allegedly failed to obtain the FPIC of local communities, resulting in extensive conflicts with (and among) local stakeholders (Nelson and Lomax 2013). Thus, contrary to claims made by HF and the Cameroon government, critics argued that the proposed plantation area was composed almost entirely of HCV forest and not suitable for conversion, local communities were not given the opportunity to give their informed consent, and the process by which HF obtained the land lease would not meet RSPO standards. In response to the grievance file, the RSPO asked HF to engage in bilateral discussions with only one of the dozens of complainants (WWF-Cameroon) to resolve issues related to HCV areas, FPIC, and legal compliance (Roundtable on Sustainable Palm Oil 2012). In other words, despite the depth and breadth of violations allegedly committed by one of its members, the RSPO was evidently still willing to certify as sustainable the palm oil produced by HF so long as the company could resolve its issues with only one of the complainants. In spite of these outstanding issues, the sustained campaign against HF would lead the company to withdraw from the RSPO and abandon some of its

oil palm nurseries, while the Cameroon government reduced the concession area to 20,000 ha. This example lends strong support to many of the accusations leveled by critics of the RSPO and illustrates how RSPO weaknesses can be easily exploited by agribusiness members, who use their membership to greenwash their activities (McCarthy and Zen 2010).

In view of the problems with the RSPO, it could be argued that ecologically sustainable palm oil has yet to be produced on an industrial scale. Rather, in its present form, the RSPO provides minimum standards for palm oil production that improve upon BAU approaches but fall short of eliminating (or, significantly reducing) deforestation, biodiversity loss, and social and economic risks associated with the industrial palm oil industry. As such, if the RSPO “sustainability” approach were to rapidly expand in emerging palm oil producing regions (e.g., African tropical forest zones and Latin America) we can continue to expect large-scale losses in forest cover, biodiversity, and ecosystem services as well as increased social conflict.

Palm Oil Is Not Bad, It Is Just Produced That Way

While the industrial production of palm oil on large plantations has greatly contributed to the biodiversity crisis (Laurance 2007), the African oil palm and its varieties are not inherently damaging to biodiversity (Colchester et al. 2006). Given the global demand for palm oil, the immense productivity of the oil palm, and its near ubiquity in tropical forest regions, the oil palm holds a unique opportunity to help bridge the divide between local and national aspirations for economic development and global concerns for biodiversity. Many of the authors cited in this chapter have offered solutions to the environmental and social challenges of producing palm oil on an industrial scale and we encourage readers to refer to their suggestions. Here, we aim to supplement those recommendations with a few of our own.

The evidence presented in this chapter indicates that those concerned with biodiversity conservation, human rights, and socioeconomic development should be wary of industrial oil palm developments (even RSPO certified ones) as a means of rural development, poverty alleviation, and as a “win–win” for people and the environment. Most worrisome is that industrial oil palm plantations are rapidly expanding in areas of high conservation concern including biodiversity hotspots (Myers et al. 2000; Mittermeier et al. 2004), threatened ecoregions (Olson and Dinerstein 1998), and regions characterized by exceptionally high plant and animal endemic species richness (Fa and Funk 2007; Kier et al. 2009). Conservation, development, and human rights NGOs should collaborate with local actors to invest resources in oversight of industrial oil palm developments and in providing legal counsel to locally affected communities. Such expansive coalitions are especially necessary to investigate RSPO members and file grievances when appropriate. Results from well-researched, scientifically grounded studies can also be used successfully to influence agribusiness activity and government support of agribusinesses that violate national and international

agreements and laws (Ongolo 2015). As in the case with Herakles Farms, such research can be elevated to the international stage to overcome agribusiness greenwashing and public relations campaigns. To maintain credibility, NGOs must present to the public factual information about the environmental, socioeconomic, and legal issues surrounding industrial oil palm developments without inflating claims or resorting to scare tactics (Koh et al. 2010).

While the negative effects on the environment are clear, there remain many unanswered questions regarding the socioeconomic and local human health impacts of large-scale, industrial oil palm plantations. A deeper understanding of the factors that influence social and economic effects is desperately needed. For example, will the variables that make industrial oil palm “good for some” (Rival and Levang 2014) in Malaysia and Indonesia also apply to other regions of the world? How will the concerns over the social and economic risks of industrial oil palm development, presented by many of the authors cited above, be incorporated in national land use and agricultural policies and legal responsibilities of agribusinesses? How will the diets and health of local community members living in and around oil palm plantations change through time as landscape heterogeneity declines?

As governments in the tropics look to bolster their economy and invest in the agricultural sector, alternative strategies for producing palm oil besides on large-scale plantations need to be investigated. This is especially salient for the African tropical forest zones where smallholders control up to 80% of planted oil palm areas (Wich et al. 2014). What role can smallholders and their agroecological systems play in expanding production of palm oil? With proper technical and financial capacity building, can investments in smallholder agriculture improve palm oil productivity to the extent that large-scale monocultures are unnecessary while maintaining some degree of habitat heterogeneity through agroforestry techniques?

Tropical forest conservation, including and especially primate conservation, in the 21st century will require innovative strategies for conserving biodiversity not only in protected areas but also in human modified landscapes where palm oil and other agricultural commodities are produced (Chazdon et al. 2009). In his critique of large-scale land acquisitions for farming, De Schutter (2011) argues that we need to examine whether land leased to agribusinesses for large, monoculture plantations could, instead, be used more productively, in ways that reduce environmental impacts and socioeconomic risks. Toward this end, the conservation, development, and human rights communities should work in concert to influence land use policies in regions where industrially produced palm oil is expanding.

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