



## Review

## Towards sustainable palm oil production: The positive and negative impacts on ecosystem services and human wellbeing

Lacour M. Ayompe<sup>a, b, \*</sup>, M. Schaafsma<sup>c, d</sup>, Benis N. Egoh<sup>a, b</sup><sup>a</sup> Department of Earth System Science, University of California Irvine, California, USA<sup>b</sup> International Institute for Tropical Agriculture (IITA) Cameroon, Yaoundé, Cameroon<sup>c</sup> School of Geography & Environmental Science, University of Southampton, UK<sup>d</sup> Environmental Economics, Institute for Environmental Studies, VU University Amsterdam, the Netherlands

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## ABSTRACT

Palm oil is an important commodity contributing to livelihoods of many communities, GDP of governments and the achievement of several sustainable development goals (SDG) including no poverty, zero hunger, and decent work and economic growth. However, its cultivation and continuous expansion due to high and increasing demand has led to many negative effects and subsequent calls to make production sustainable. To this end, information is needed to understand the negative and positive impacts on both the environment and human wellbeing to respond appropriately. Sustainability in palm oil trade entails having a global supply chain based on environmentally friendly and socially acceptable production and sourcing. Much has been done in understanding and responding to impacts on the environment but not so much on social impacts partly due to a lack of information. The direct (socio-economic) and indirect (through ecosystem services) impacts of palm oil trade were reviewed using peer-reviewed literature and the Environmental Justice Atlas (EJA). Our results show that most of the 57 case studies were conducted in Indonesia and Malaysia where 85% of global production of palm oil occurs. The results show both negative (109) and positive (99) direct impacts on humans. Indirect impacts through ecosystems services were predominantly negative (116) as were the direct negative impacts. The most frequently studied direct negative impacts were conflicts (25%), housing conditions (18%) and land grabbing (16%) while the most frequently studied direct positive impacts were income generation (33%) and employment (19%). Ongoing initiatives to make the palm oil sector sustainable such as the RSPO are focused on the environment but need to pay more attention to (related) social impacts. To make palm oil production sustainable and to meet SDGs such as ensuring healthy lives and promoting wellbeing as well as responsible consumption and production, negative social impacts of palm oil trade need to be addressed.

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\* Corresponding author. Department of Earth System Science, 3200 Croul Hall St, Irvine, CA 92697, USA.

E-mail address: [mlacour@uci.edu](mailto:mlacour@uci.edu) (L.M. Ayompe).

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## 1. Introduction

Palm oil is a valuable product used all over the world as part of a vast number of products used daily in the biofuels, agri-food and body care sectors (Mutsaers, 2019). It is the major source of vegetable oil produced mainly in Indonesia and Malaysia (Villela et al., 2014). Palm oil is also the most widely traded vegetable oil globally accounting for nearly 60% of global oilseed exports (Carter et al., 2007) with demand projected to increase substantially in the future (Vijay et al., 2016). The main advantage of oil palm in comparison to other oil crops is the significantly higher production per hectare leading to higher income (Khatun et al., 2017). As the trade in palm oil grows due to increasing global demand, there has also been a rapid increase in the amount of oil produced and the total area cultivated in regions where oil palms are grown (Sayer et al., 2012). For example, between 1974 and 2007, global crude palm oil output increased from less than 3 million tonnes to almost 40 million tonnes, representing an average annual growth rate of more than 8% (Carter et al., 2007). Following this trend, the oil palm area cultivated worldwide also increased from 3.6 million ha in 1961 to 21.4 million ha in 2017. The growing global demand for palm oil is likely to drive further expansion of this strategic commodity in producer countries (Yaap et al., 2010) with consequences for the environment and human wellbeing. Growth of commercial plantations in Southeast Asia and recent expansions in Africa and Latin America have led to a growing call for sustainable production of palm oil, driven to a large extent by concerns over the associated impacts of deforestation and biodiversity losses (Hansen et al., 2015).

Palm oil production (cultivating and milling) has become highly controversial because it leads to serious and often intertwined environmental and social problems such as destruction of tropical forests, climate change and threats to livelihoods (Oosterveer, 2015). The palm oil industry has received criticism from various parties on the issue of sustainability and greenhouse gases (GHG) emissions (Jamaludin et al., 2019). In Thailand, for example, the expansion of oil palm plantations has been associated with several environmental impacts (Saswattecha et al., 2016) and concerns about the environmental sustainability of oil palm cultivation especially in regions where land and climate are less suitable for oil palm (Silalertruksa et al., 2017). Oil palm plantations have been associated with multiple negative impacts, including deforestation, habitat and biodiversity loss (Teoh, 2010), forest fragmentation, disruption of food chains, air and water pollution, soil erosion (Szulczyk and Khan, 2018), and hydrological changes due to alteration in precipitation (Obidzinski et al., 2012). In addition, some negative impacts are associated with crude palm oil production activities, such as the use of fertilizers, wastewater and empty fruit bunch disposal, gasoline use in weed cutters, and glyphosate use for weed control (Saswattecha et al., 2015). These activities have negative impacts on the environment and humans, and in turn have led to calls for more responsible production and consumption of palm oil to meet the objectives of Sustainable Development Goal 12 which deals with responsible production and consumption.

To respond to the demand to make palm oil production sustainable, several efforts are underway. For example, the implementation of integrated strategies aimed at expanding oil palm plantations in areas with low carbon stock (Permpool et al., 2016), avoiding deforestation of natural forests, increasing crop yield to minimize land use (Gérard et al., 2017). Other measures include increasing the use of organic fertilizers, using biodiesel as a substitute for fossil fuels, and producing biochar at the time of replanting (Rivera-Méndez et al., 2017). Some of these efforts are yielding results. For example, in Indonesia, new oil palm plantations have increasingly been developed on non-forested land (Austin et al., 2017). In addition, according to Leijten et al. (2020) over 470 companies involved in the production, processing or distribution of major commodities such as palm oil, soy, beef and timber have committed to eliminate or reduce deforestation from their supply chains. Donofrio et al. (2017) also report that at least 477 companies in forest risk-commodity supply chains have made “zero-deforestation commitments” (ZDC). In the specific case of palm oil, Schröder et al. (2019; pp 401); reports that some major traders and corporate groups producing palm oil (e.g. Wilmar, Musim Mas Group, Golden Agri Resources, Cargill) in Malaysia and Indonesia, which are the main producer countries, have adopted No Deforestation, No Peat and No Exploitation policies. However, the effectiveness of these commitments needs to be tested as there are always challenges in monitoring deforestation. The Roundtable on Sustainable Palm Oil (RSPO) certified producers in Colombia were also found to cause the lowest environmental impacts due to better management practices (Saswattecha et al., 2015). However, these efforts are mainly focused on the environment and not so much on the social aspects. Sustainability in palm oil trade entails having a global supply chain based on socially acceptable and environmentally friendly production. Indeed, to achieve SDG 3 “to ensure healthy lives and promote wellbeing for all at all ages”, sustainability efforts must also be geared towards reducing the negative impacts on people. An important aspect in addressing both SDG 3 and 12 is to collate information on the positive and negative impacts of palm oil trade on human wellbeing and find ways to minimize negative impacts while promoting positive contributions to livelihoods. However, information on the impacts of palm oil trade on humans is often lacking.

All palm oil producing countries are classified as developing or least developed economies with about 38% as least developed countries where most of the people are poor (UNCTAD, 2019). In these countries, palm oil production contributes positively to GDP and (income) poverty alleviation. For example, in Malaysia, earnings from palm oil, palm kernel oil and its products in 1998 amounted to almost US\$5.6 billion, equivalent to 5.6% of GDP (Yusoff, 2006). In addition, in many developing nations, including countries in Asia, oil palm plantations are established by large agro-industrial corporations that provide access to education to several children who would otherwise be at home, therefore contributing to SDG 4 (quality education) (Bennett et al., 2018). A few studies have reported positive impacts of palm oil trade such as improvement in farmer income, economic benefit for smallholders,

opportunities for employment in rural areas (McCarthy, 2010), improved livelihoods, and improvement in economic growth and GDP (Li, 2015). However, palm oil production also has direct negative social impacts. For example, where local communities who are custodian or owners of land suffer loss of livelihood when such land is converted to oil palm plantations, as they can no longer cultivate crops on the land, or collect wild foods (Santika et al., 2019b). Also, negative environmental impacts such as air and water pollution negatively affect human wellbeing. These social aspects need to be considered and accounted for when designing sustainability strategies.

Apart from the direct negative and positive social impacts of palm oil trade on human wellbeing, many people rely on ecosystems for their wellbeing (e.g. medicinal plants, water and timber). Cultivation of oil palm sometimes has indirect negative effects on human wellbeing via ecosystem services, defined as the benefits from the natural environment and ecosystems to people. For example, establishment of oil palm plantations next to water bodies causes eutrophication and siltation, impacting on local water purification and supply services (Igwe and Onyegbado, 2007). Some ecosystem services such as pollination, which is impacted negatively by deforestation from palm oil, is very important in productivity on landscapes and in particular on crops which humans depend on. In fact, oil palm plantations rely on ecosystem functions such as pollination for their continuity. For example, Li et al. (2019) showed that known oil palm pollinators with fluctuating populations have led to concerns about yield and resilience. To the best of our knowledge, no study has synthesized these positive and negative social impacts of palm oil trade.

The overall objective of this review is to understand palm oil trade impacts on human wellbeing across the world. We do this by assessing (1) the direct socio-economic impacts of palm oil trade such as social and financial benefits and costs, (2) the indirect impacts of palm oil trade through ecosystem services such as food provision and water purification. Since most impacts are attributed to large-scale plantations in public discourses, we seek to understand how these impacts are distributed between smallholders and agro-industrial plantations. Lastly, in order to understand the extent to which negative impacts recorded in the peer-reviewed literature and how representative our sample is, we look at which impacts are reported in grey literature, specifically in the Environmental Justice Atlas.

## 2. Methods

Two sources of information were used in this review to understand palm oil trade impacts on human wellbeing through case studies of direct (socio-economic) and indirect (through ecosystem services). Our first source of information was from peer-reviewed literature (Web of Science) to look for papers that used primary data to assess the impacts of palm oil trade on human wellbeing. Although many studies on palm oil trade are conducted by NGOs such as the Center for International Forestry Research (CIFOR) and World Wildlife Fund (WWF), we did not include all grey literature but used only the Environmental Justice Atlas (<https://ejatlas.org/>), a source of grey literature to compare our results on the negative impacts of palm oil trade on human wellbeing. A limitation of Environmental Justice Atlas (EJA) is that it only reports negative impacts.

In our analysis, we distinguish between smallholders and agro-industrial oil palm plantations. Smallholders are considered as growers that are not agro-industries with average planted area of 50 ha or less and if stated in the study as smallholders. This is a shallow way of assessing smallholders compared to the definition by the Roundtable on Sustainable Palm Oil (RSPO) where the farm

provides the majority of income to the family and, in turn, the family provides the majority of labor on the farm ([www.rspo.org](http://www.rspo.org)). Independent smallholders were not distinguished from those in partnership schemes with agro-industrial companies. It should also be noted that the definition of smallholders may differ from country to country depending on different schemes of ownership and management.

### 2.1. Peer-reviewed literature

ISI Web of Knowledge's database was selected as the only search engine and database to conduct a comprehensive search of the academic, peer-reviewed literature. A search was conducted in October 2019 (without specifying an initial or end year but included studies in 2019) using the following search terms: "palm oil" or "oil palm" AND "wellbeing" or "well-being" or "well being" or "income" or "poverty" or "nutrition" or "livelihood" or "security" or "vulnerable" or "human capital" or "social impact" or "economic impact" or "welfare". A second search was conducted with the terms "palm oil" or "oil palm" AND "ecosystem services" or "provisioning services" or "regulating services" or "habitat" or "supporting services" or "cultural services". The outcomes of the two searches were combined and duplicates removed. We deliberately excluded 'biodiversity' from these terms.

These search terms resulted in a total of 924 papers which were narrowed down to 357 papers after scrutinising the titles and abstracts (Fig. 1). We read through the abstracts in detail, and selected only those papers that reported direct and/or indirect impacts on human wellbeing of palm oil trade in field case studies. 68 papers that met these criteria were selected and read in full. Out of the 68, only 44 papers were eligible to be included in the study. Subsequently, snowballing was used to find more studies from the references of papers read and 13 more relevant case studies were found that met the selection criteria of our study making a total of 57 case studies included in this review.

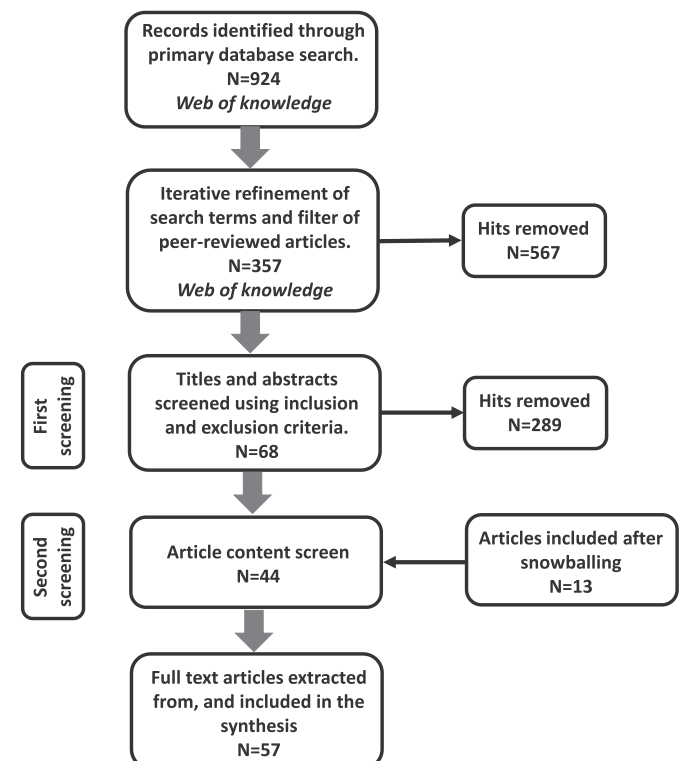


Fig. 1. Flowchart of peer-review procedure.

## 2.2. Grey literature

To understand the extent to which the results reported in the peer-reviewed literature are consistent with those reported in the grey literature, we look for direct and indirect impacts as reported in the Environmental Justice Atlas (EJA). The EJA website was searched for cases that have reported impact of palm oil trade on human wellbeing. The EJA is a global database containing more than 3000 reported cases of environmental conflicts arising due to the exploitation of natural resources, generation of waste, and the degradation and commodification or privatization of environmental goods. The EJA is a collaborative effort, where anyone can contribute to the database and may vary in quality, but entries are checked by the editorial team. It is an online platform that allows searching and filtering across several fields, as well as browsing by commodity, company, and type of conflict. Two searches of the database were carried out using the terms “palm oil” and “oil palm” respectively. 62 cases were obtained for the first search and 77 cases in the second search. After excluding duplicates, we retained 85 reported cases. The EJA only reports negative impacts. The database was only used for comparison purposes to find out the extent to which negative impacts captured in peer-reviewed literature are reported or absent in this database as well as to understand the response of impacts reported in peer-reviewed literature.

## 2.3. Data extraction

Information was extracted from the 57 case studies selected from peer-reviewed literature and 85 from EJA. Examples of information gathered include: country of data collection; type of evidence (qualitative/quantitative); type of palm oil plantation (smallholder, agro-industrial); type of impact (direct, indirect). For direct impacts, information such as income, employment, house condition, infrastructure such as schools or roads or hospitals were extracted. Direct impacts were therefore defined as aspects of livelihoods directly related to wellbeing indicators such as income, education or infrastructure. For the indirect impacts through ecosystem services, the categories outlined by The Economics of Ecosystems and Biodiversity were used (Sukhdev and Kumar, 2008) which include: provisioning services (e.g. raw materials, water, food and medicines); regulating services (e.g. air purification, carbon sequestration and water regulation); habitat and supporting services (e.g. habitat for species); and cultural services (e.g. aesthetic value or spiritual value). Indirect impacts were therefore defined as aspects that were related to loss of nature that would benefit humans and contribute to their wellbeing. We only reported the frequency at which the impacts were reported in the case studies without distinguishing who the affected stakeholders were or which parts of the supply chain the impacts are attributed to.

## 3. Results

### 3.1. Distribution of studies

Most of the 57 case studies reported in the peer-reviewed literature were conducted in Asia (78%), primarily in Indonesia (46%) and Malaysia (27%) as shown in Fig. 2. Some of the case studies (12%) were reported in Latin America with Colombia and Costa Rica each reported in 3% of the studies while Guatemala, Nicaragua and Peru were each reported in only 2% of all studies. Africa the origin of oil palms had 8% of the case studies with Cameroon, Gabon, Ghana and Nigeria each reported in only 2% of the studies. There was an increase in studies from 2004 to 2010 and from 2016 to 2019 with most published in 2019 (Fig. 3).

### 3.2. Direct and indirect impacts of palm oil trade

The selected case studies reported negative and positive impacts for both direct (socio-economic) and indirect (through ecosystem services) impacts of palm oil trade on human wellbeing. Table A1 in the Appendix details the source of information, country where impact was recorded, continent and type of evidence for the direct and indirect impacts of palm oil trade reported in the peer-reviewed literature.

#### 3.2.1. Direct impacts

The 57 peer-reviewed studies more often reported negative (109) than positive (99) direct impacts of palm oil trade on human wellbeing. The three most frequently reported negative impacts include conflicts (25%), housing condition (18%) and land grabbing (16%). These direct negative impacts reported in the peer-reviewed literature were compared against those reported in grey literature (EJA) (Fig. 4(a)). The EJA also reported land grabbing impacts with a high frequency (in 89% of cases), but impacts on livelihoods in general were reported in even more cases (92%). Direct negative impacts reported in the peer-reviewed literature under the “Others” category include access to education, harassment, inequality, job quality, security, social equity, social networks and solidarity. Some of the negative impacts extracted from the peer-reviewed literature that were not reported in EJA include housing condition, provision of hospitals, and increase in suicide rate. All impacts included in the EJA are also reported in at least one peer-reviewed case study. This tells us that the peer-reviewed literature captured the breadth of potential negative impacts.

In terms of positive impacts, income generation (33%) and employment (19%) were reported most often in the peer-reviewed studies (Fig. 4(b)). Direct positive impacts reported in the peer-reviewed literature under the “Others” category include credit facilities, improved housing condition, landscaping, market infrastructure, migration, religious centers, rural development, and urbanization. Several of the same indicators used for direct and indirect impacts were reported as positive and negative impacts depending on the context. For example, income, working condition, hospitals were all reported as both negative and positive impacts.

#### 3.2.2. Indirect impacts

Negative (116) indirect impacts of palm oil trade on human wellbeing were reported more frequently than positive indirect impacts (13) in the studies from the peer-reviewed literature. In the case studies from the peer-reviewed literature the highest negative impact was on food provision (28%) followed by carbon sequestration and storage (21%) and climate regulation (18%) (Fig. 5). However, this was not necessarily reflected in the EJA where negative impacts on erosion prevention (100%) was the highest that was reported in all records. Top negative indirect impacts from EJA were erosion prevention, carbon sequestration, and habitat provision. Carbon sequestration and storage (96%) was one of the top 3 most often reported services for negative impacts both from peer reviewed literature and EJA. Some of the impacts identified in the peer-reviewed literature that were not reported in the EJA as indirect negative impacts include pollination, recreation, and tourism. All impacts included in the EJA are also reported in at least one peer-reviewed study. Only 16% of peer-reviewed studies reported positive impacts of palm oil trade on ecosystems services and includes aesthetic appreciation (4%), climate regulation (4%), provision of raw materials (4%), erosion prevention (2%) and food provision (2%). Interestingly, climate regulation and erosion prevention both came up as negative and positive impacts.

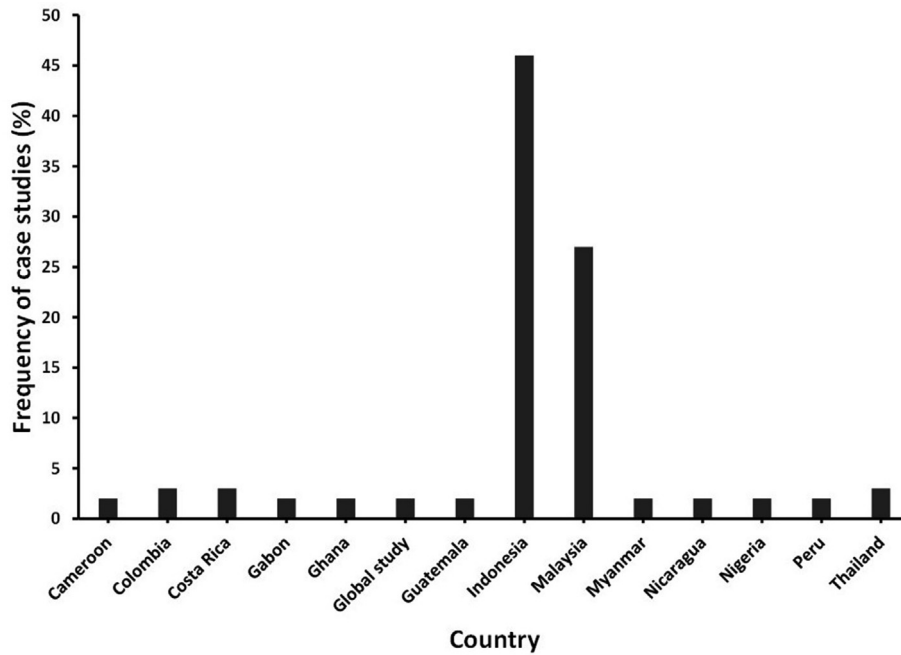


Fig. 2. Distribution of peer-reviewed case studies across countries.

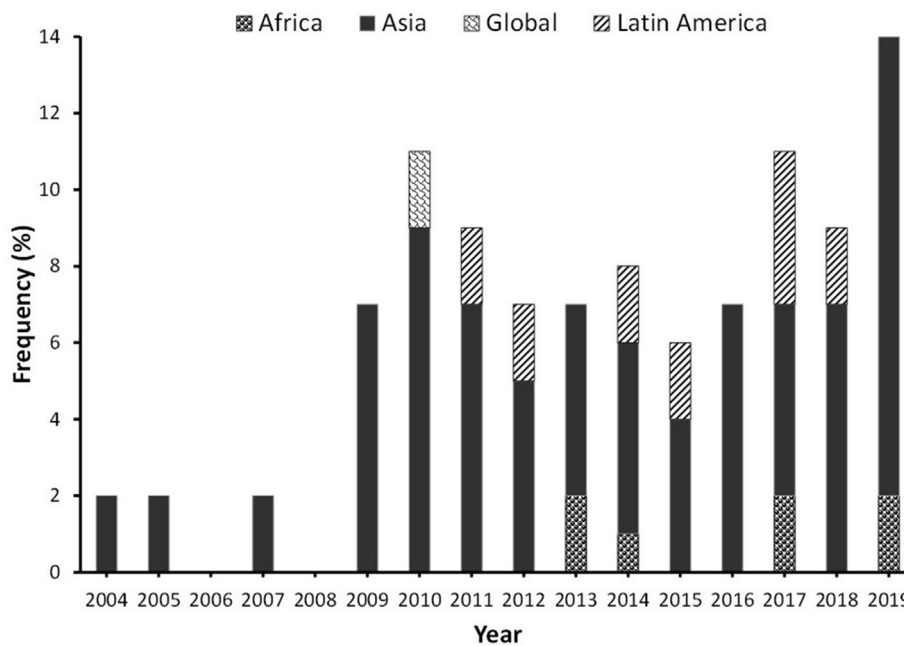


Fig. 3. Number of peer-reviewed case studies reporting direct or indirect impact of palm oil trade per year of publication.

### 3.2.3. Impacts of smallholder vs agro-industrial plantations

In distinguishing between smallholder and agro-industrial oil palm plantations, both direct and indirect impacts were considered. In the peer-reviewed literature, 31 case studies reported impacts by smallholders while 46 reported impacts by agro-industrial oil palm plantations. Among the direct impacts reported in the peer-reviewed literature, there are both negative and positive impacts. Agro-industrial oil plantations were highlighted for negative impacts such as conflicts (20%), worsening housing conditions (11%) and land grabbing (11%), while smallholder oil palm plantations were reported to have negative impacts such as land conflicts

(16%) and land grabbing (13%) (Fig. 6(a)). Negative impacts that were reported to be caused by only agro-industrial oil palm plantations include solidarity, security, schools, job security, job quality, housing condition and hospitals. Negative impact on social networks was reported to be caused by only smallholder oil palm plantations. Both agro-industrial oil palm plantations and smallholders were highlighted for positive impacts such as income (30%; 29%) and employment (20%; 13%) respectively (Fig. 6(b)). Some positive impacts reported to be generated by only agro-industrial plantations include access to education, provision of hospitals, housing condition, the establishment of religious centers and tax

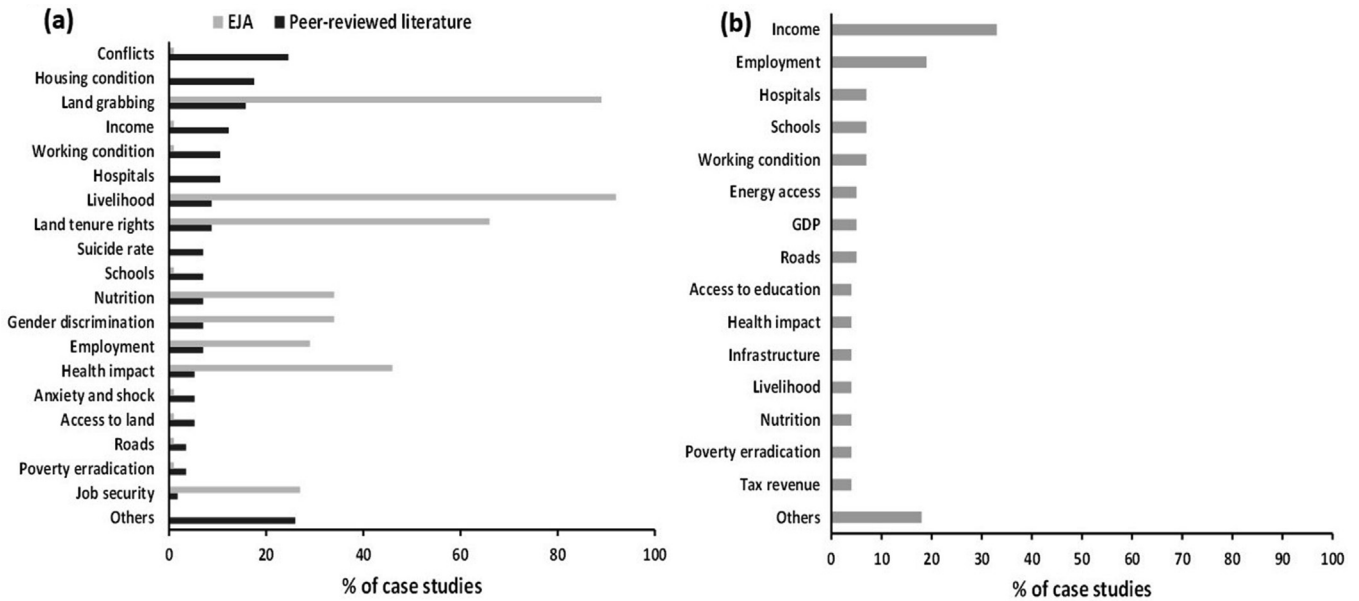


Fig. 4. (a) Direct negative impacts of palm oil trade on human wellbeing from peer-reviewed literature vs EJA and (b) direct positive impacts from peer-reviewed literature.

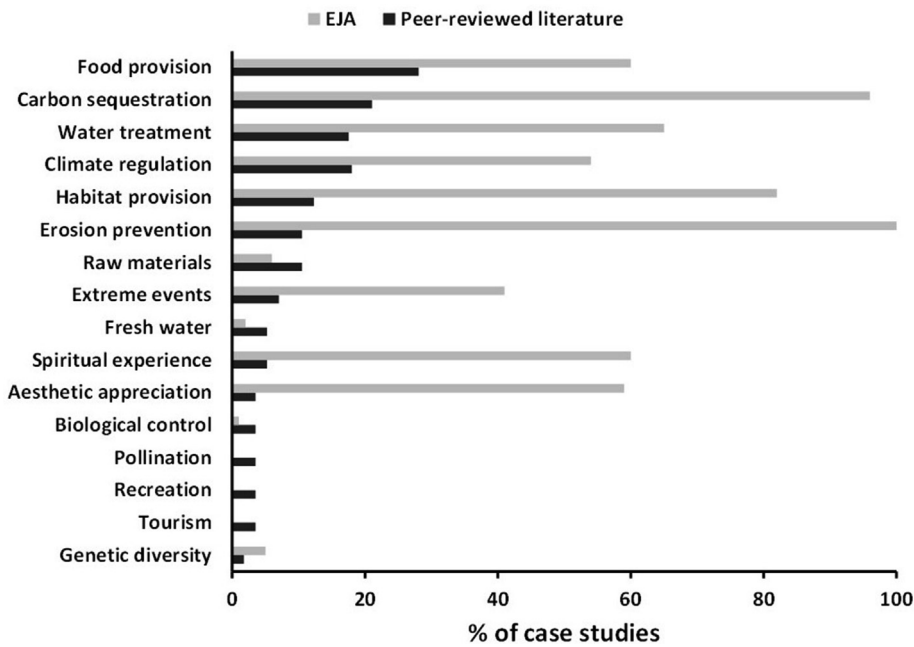


Fig. 5. Indirect negative impacts of palm oil trade on human wellbeing from peer-reviewed literature compared to those from EJA.

revenue. Some direct positive impacts in both agro-industrial and smallholder oil palm plantations include poverty eradication and working condition. Positive impact on livelihood was reported to be provided by only smallholder oil palm plantations.

Indirect impacts associated with changes in ecosystem services were recorded for both smallholder and agro-industrial oil palm plantations. Although negative impacts on ecosystem services such as food provision, and carbon sequestration and storage were highlighted in both agro-industrial and smallholder oil palm plantations, the (absolute) percentage frequency with which they were recorded was higher in agro-industrial plantations (35%, 24% respectively) than smallholders (26%, and 13% respectively) as

shown in Fig. 7. However, tourism, recreation, genetic diversity, water treatment and aesthetic appreciation are indirect positive impacts associated with only agro-industrial plantations.

The same types of indirect positive impacts were reported for both smallholder and agro-industrial oil palm plantations. Agro-industrial plantations had slightly higher frequency of direct positive impacts, 4% for raw materials, air quality, and aesthetic appreciation than smallholder plantations (3%). Smallholder plantations were reported to positively impact on food provision, and erosion prevention in 3% of the case studies while agro-industrial plantations were reported in only 2% of the case studies.

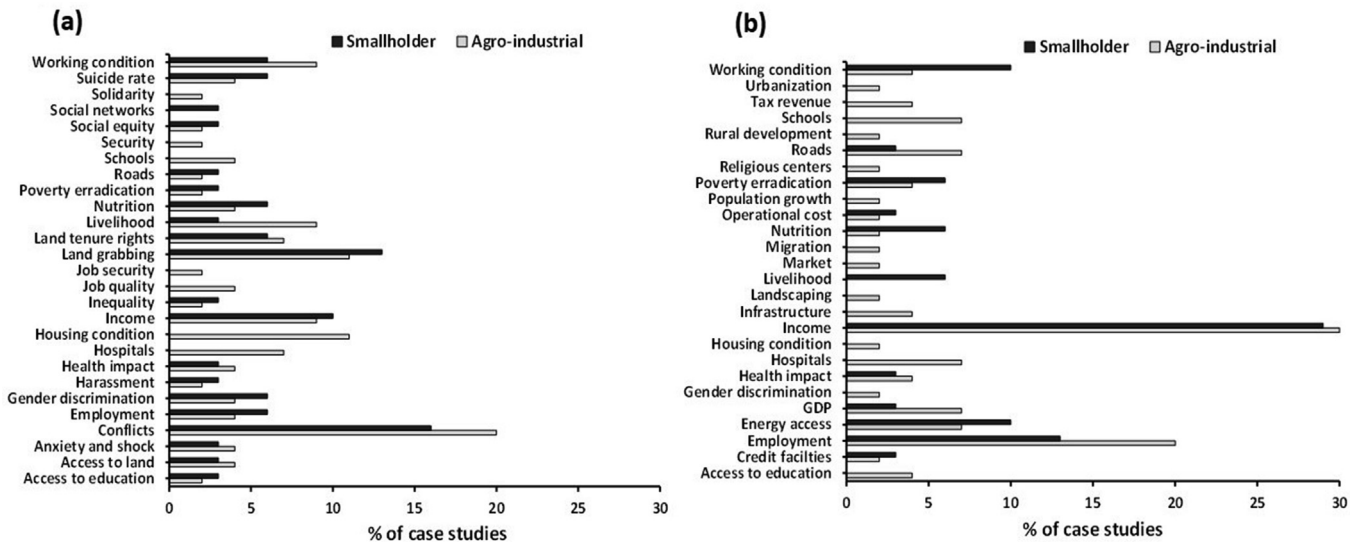


Fig. 6. Impacts of smallholder Vs agro-industrial oil palm plantations on human wellbeing from peer-reviewed literature (a) direct negative (b) direct positive.

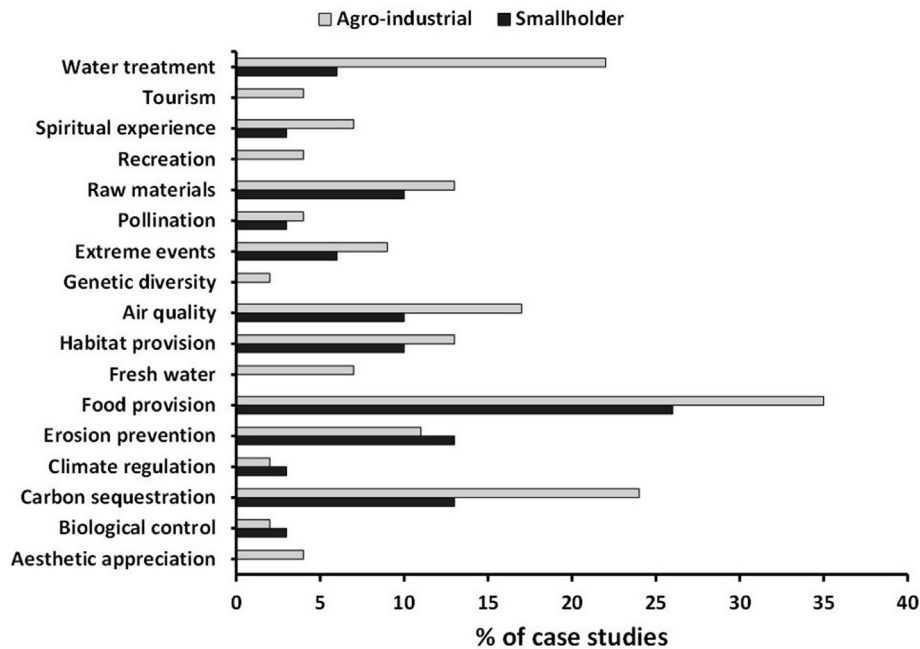


Fig. 7. Indirect negative impacts of smallholder Vs agro-industrial oil palm plantations on human wellbeing from peer-reviewed literature.

#### 4. Discussion

Oil palm is an important commodity contributing to livelihoods of many communities and governments around the world. However, its cultivation and continuous expansion due to high and increasing demand has led to many negative effects leading to a call to make production sustainable. To this end, information is needed to understand the negative and positive impacts on both the environment and on human wellbeing. This study aimed to inventorize the direct and indirect impacts of palm oil trade on humans. Most of the studies were carried out in Indonesia and Malaysia. This is not surprising because, as of 2006, Indonesia became the largest producer of crude palm oil in the world, a result of decades of favorable government incentives to expand production (Khatiwada et al., 2018). In 2013 Indonesia alone produced

about 50% of global palm oil (FAO, 2019) in mostly large state plantations (Li, 2018). In contrast, few case studies were found in Africa despite the continent being the origin of palm oil cultivation. The low number of case studies in Africa could result from a combination of low yield in palm oil and lack of capacity in researching and reporting on impact. Africa has a long history of palm oil production (Onwueme, 1979), longer than Malaysia and Indonesia, but most African farmers have focused on other cash crops such as coffee and cocoa and food crops instead of palm oil. It is not exactly clear why African farmers have focused on other cash crops in the past but it is foreseen that this may change in the future.

Most of the studies reviewed were carried out from 2009 to 2019 (Fig. 2). While there are some successes to reduce impacts on the environment in certain countries, there continues to be

negative impacts on people around the world. Examples of initiatives to reduce negative impacts on the environment include the launch of new national standards in Indonesia and Brazil (Hospes, 2014) and the temporal moratorium by the governments of Indonesia and Malaysia placed on granting new concessions for oil palm plantations in primary forests and peatlands (Busch et al., 2015). These responses have also made Africa and some parts of Latin America become new targets for oil palm expansion in primary forest. Nevertheless, recent efforts to expand palm oil trade, for example in Cameroon, have been met with strong opposition from both local and international environmental NGOs such as Greenpeace and conservation scientists. Herakles Farms, an American company obtained 73,086 ha from the government of Cameroon in 2009 to develop a large-scale oil palm plantation. The project was stalled following widespread local opposition, international campaigns, media coverage and several reports. In 2013, the government reduced the lease term from 99 years to a three-year probationary lease for just 19,843 ha (Fraser and Mousseau, 2016). This is only one case showing some of the obstacles in establishing large-scale oil palm plantations in Africa. Similar patterns of land grabbing and conflicts were found in Colombia (Grajales, 2011).

There are now some initiatives that address negative environmental impacts but not much has been done to reduce the negative impact on humans. This study found that the peer-reviewed literature reported more frequently on negative direct impacts than on positive impacts. Conflicts and land grabbing were the most frequently reported impacts. According to Li (2018), oil palm plantations in Indonesia were intended to transform underutilized land held by villagers under customary forms of tenure, into more productive lands yielding them higher revenues. However, there have been over 600 land disputes in Indonesia between local communities and palm oil companies (Colchester, 2010). We continue to find this trend in our study where 25% of negative impacts were studies carried out in 2019. It is likely that conflicts between agro-industrial companies and communities in Indonesia will increase over the coming years due to the increasing cultivation of oil palms (Abram et al., 2017). About a third of Indonesia's reported land conflicts concern large-scale oil palm plantations, and many of these conflicts are decades old (Li, 2018). This is related to the loss of land tenure rights. Some of the conflicts arise as a result of unfulfilled promises to provide essential infrastructure to the local communities (Ruthean et al., 2017). Patterns of land grabbing for oil palm plantations described above in the case of Cameroon and Indonesia may partly explain why land grabbing and conflicts were found as the most frequently reported negative impacts in both peer-reviewed literature and EJA. Our study has shown that negative impacts on people are widespread and ongoing. An important tool which has had some success in addressing the current negative impacts is through certification standards both globally and nationally (Santika et al., 2020).

Indirect impacts of palm oil trade are also being increasingly reported reflecting that the livelihood of local and indigenous people depends to a large extent on land that is used for activities such as cropping and collection of wild foods. This study found that in the peer-reviewed literature 92% of the reported indirect impacts were negative with only 8% being positive. The most frequently reported indirect negative impacts in both peer-reviewed literature and EJA were food provision, carbon sequestration and storage, climate regulation and habitat provision. These findings were similar to Dislich et al. (2015) who identified several ecosystem functions (pollination, waste treatment, food and raw materials and disturbance prevention) impacted by oil palm plantations which are linked to human wellbeing. Surprisingly, water was not one of the most often reported affected ecosystem services, despite

knowledge on how cultivated land next to water bodies impacts on water quality and quantity through siltation (Silalertruksa et al., 2017). However, Córdoba et al. (2019) found that water availability, air and water quality were perceived to be the most heavily impacted ecosystem services by oil palms in the Brazilian Amazon. Carbon sequestration and storage are important ecosystem services since deforestation of peatlands, home to globally significant carbon reserves, result in an increase in GHG emissions (Zakaria et al., 2007). In addition to impacts on carbon sequestration, storage and climate regulation, habitat for species are destroyed due to land conversion.

Despite the negative impacts, palm oil trade contributes to economic growth in many countries where it is grown but particularly in Southeast Asia (Aubert et al., 2017). Where large plantations are established by agro-industrial companies, they can provide jobs through employment of local communities and improve income. For example, in Indonesia, agro-industrial oil palm plantations are an important driver of economic development since they provide employment in rural areas and contribute to state revenues (Basiron, 2007). Agro-industrial oil palm plantations can also positively contribute towards increasing farmers' incomes (Bunyamin, 2008) because in many cases, locals combine a job in these oil palm plantations with peasant farming to increase their income and sustain their livelihoods. In addition, oil palm cultivation presents entrepreneurial opportunities for rural communities (Asmit and Koesrindartoto, 2015). This study found many positive impacts reported including income generation (33%) and employment (19%). As many as 700 million people around the world live on less than \$1.90/day mostly in developing countries (World Bank, 2018) that include palm oil producing countries. Palm oil trade is generating jobs in these low-income countries and contributing to education and health through schools and hospitals as recorded in this study. Palm oil demand is projected to increase substantially in the future (Vijay et al., 2016) with no shortage of markets. In addition, palm oil is the most sustainable commodity in meeting the world's need for vegetable oils while contributing to state coffers, meeting equitable development goals, alleviating poverty and meeting nutritional needs of many communities which is important in achieving SDG 2 (food security), 3 and 8. These positive impacts suggest that the commodity should be made sustainable by limiting negative impacts and enhancing positive contributions to livelihoods.

This study shows that the impacts of palm oil trade on human wellbeing are both positive and negative for both smallholders and agro-industrial oil palm plantations. Out of the 57 peer-reviewed papers considered in this study, 81% reported impacts caused by agro-industrial oil palm plantations while only 54% reported impacts by smallholder plantations. Agro-industrial companies have been held responsible for causing negative impacts on humans and the environment. However, we found that although there were more direct negative impacts (64) caused by agro-industrial compared to smallholder plantations (45), both are implicated. This result is similar to those in Dislich et al. (2017) who found both smallholder and agro-industrial plantations having negative impacts on ecosystem functions. There is a wide debate in the literature and palm oil industry about the social and environmental performance of smallholders versus agro-industrial oil palm plantations. Proponents of smallholders argue that they engage less in environmentally degrading practices and contribute more to rural food security and livelihoods (Azhar et al., 2017). In addition, there is some evidence that biodiversity is higher in smallholder than in large-scale plantations, at least for birds (Azhar et al., 2011). Opponents of agro-industrial plantations argue that large-scale oil palm plantations are shrouded in controversies related to being responsible for deforestation, greenhouse gas emissions and



human rights abuses (Corciolani et al., 2019). Counterarguments include that smallholders, who contribute close to 50% of the palm oil traded worldwide (Mutsaers, 2019), have lower production yields (Euler et al., 2016) and therefore use more land to produce the same volume of palm oil than agro-industrial oil palm plantations. Indeed, expansion among smallholder oil palm plantations may be larger in some areas (Lee et al., 2014). Other studies point out that uptake of “good” agricultural practices among smallholders is low, threatening the sustainability of palm oil production (Donough et al., 2009). This study has shown that both smallholders and agro-industries have negative impacts that should be acted upon. Indeed, the indirect impacts are similar for both smallholders and agro-industries (Dislich et al., 2017).

The importance of palm oil trade in poverty alleviation, nutritional benefits and in supporting livelihoods and contributing to several SDGs suggest that increasing the sustainability of palm oil production and trade should be encouraged. Several of the studies in the peer-reviewed literature reported both negative and positive impacts for the same indicator. For example, both negative and positive impacts on income generation have been reported in the peer-reviewed literature. Similarly, carbon sequestration and storage, was listed as both negative and positive impact. However, the positive impacts need to be weighed against the negative impacts. For example, the conversion of forest on mineral soil to oil palm plantation has been estimated to result in mean carbon losses of about 702 Mg CO<sub>2</sub> ha<sup>-1</sup> over 30 years, while conversions on peatlands lead to carbon losses ranging from 1486 to 4746 Mg CO<sub>2</sub> ha<sup>-1</sup> over 30 years (Fargione et al., 2010). These losses are enormous compared to any carbon that might be stored in an oil palm plantation. To enhance environmental sustainability, policy incentives are required to persuade growers to establish oil palm plantations on already-cleared lands instead of biodiverse, high carbon primary rainforests and invest in better environmental practices (Glinskis and Gutiérrez-Vélez, 2019). Another example of negative and positive impact was in soil erosion where all studies in the EJA reported negative impacts of oil palm cultivation on soil erosion. Several studies have found that soil loss from oil palm plantations is about 50 times greater than in natural forests (see Dislich et al., 2017). However, while clearing of land for oil palm plantations impacts negatively on soil erosion, recent studies have shown that the use of crop residue (empty fruit bunches) application has a high potential to enhance soil biota and functions, and soil fertility in oil palm plantations (Tao et al., 2018). Therefore, some of the positive or negative impacts reported here must be interpreted with care as they depend on the context and the type of oil palm plantation as well as the particular wellbeing indicator considered. Many of the negative impacts can be avoided or minimized through good practices included in certification standards.

Efforts to enhance sustainable oil palm cultivation and competitiveness of the palm oil industry have to be vigorously pursued in order to mitigate the negative impacts on humans and the environment. Some of the measures suggested to reduce impacts on the environment include improving productivity through best management practices and using high quality seeds (Purba, 2019), mulching empty fruit bunches, and planting cover crops (Saswattecha et al., 2016). The greening of palm oil production through the use of by-products such as biomass to produce bio-based products (Ng et al., 2012), biogas capture to reduce methane emissions (Ramirez-Contreras et al., 2020) and palm oil processing wastes for energy generation is encouraged (Zahraee et al., 2019). Several certification initiatives exist at the global and national level and include the Roundtable on Sustainable Palm Oil (RSPO), which provides incentives for reducing environmental impacts of palm oil production, and the Indonesian Sustainable Palm Oil (ISPO), the Malaysian Sustainable Palm Oil Certification

(MSPO) and the European Sustainable Palm Oil (ESPO) initiatives. There is some progress in reducing negative impacts on the environment by these initiatives with notable results. For example, RSPO certified producers in Colombia were found to cause lower environmental impacts than their non-certified counterparts due to better management practices (Saswattecha et al., 2015). Furumo et al. (2020) argue, however, that despite the progress achieved through certification schemes, new strategies should be sought in tandem with certification to capture more value in sustainable palm oil supply chains. Both RSPO (principle 6) and ISPO (principles 5 and 6), for example, have principles aimed at reducing negative social impacts, but they were more frequently reported including in recent studies (e.g. at least 25% of all impacts reported in publications from 2019). These findings suggest that the certification principles aimed at social impacts may not be enough. In fact, only one of 8 principles in the RSPO initiative is aimed at social aspects (Suharto et al., 2015). This is compounded by the fact that many palm oil producers are not certified, and those that are certified do not necessarily comply with these principles. Strategies need to be put in place to increase the visibility and implementation of social impacts in certification schemes and to engage actors in the palm oil production value chain to reduce their social impacts as described in this study.

Ideally, one would see an increase in positive impacts relative to negative impacts over time as sustainability initiatives take effect. However, our data from the peer-reviewed literature does not show such discernible trend. Superficially, there seems to be a slight decline in the number of reported palm-oil cases in the EJA (grey literature) over time, but it is not known whether this relates to an overall decline in cases reported to EJA (palm oil or otherwise), less attention to palm oil irrespective of the direction of impact, or indeed reflects a decline in negative impacts of palm oil trade. In order to detect changes in the direction of impacts (net impacts) of palm oil over time, longitudinal studies, ideally on specific initiatives in order to inform policy makers on which policy instruments contribute to achieving the SDGs (e.g. Santika et al., 2020), would be necessary. Nevertheless, there is a need to enforce existing policies, including increasing emphasis on accountability of private sector actors and their corporate sustainable production and sourcing policies. This includes the importance of increasing efforts towards the development of an enabling environment as well as enforcement of sustainable development initiatives for smallholders through increased monitoring.

## 5. Conclusion

Despite ongoing efforts to limit or eliminate negative impacts of palm oil trade, widespread negative impacts on humans both directly such as land grabbing, conflicts, low income and poor housing conditions or lack of housing and indirect through ecosystem services were found. Most studies were in Indonesia and Malaysia with very few from other parts of the world where palm oil is cultivated. More studies need to be carried out in these places including in Africa to understand the impacts in other parts of the world compared to Asian countries such as Indonesia and Malaysia. Palm oil trade also impacts humans indirectly through various ecosystem services. Although large scale agro-industries have for long been incriminated for negative impacts of palm oil trade, smallholders also had negative impacts that must be addressed. Nevertheless, the establishment of oil palm plantations have several positive impacts especially on poor people including income generation and job creation and has the potential to contribute to several sustainable development goals. Several initiatives (e.g. RSPO, ISPO and ESPO) are in place to limit the negative impacts of palm oil trade through certification standards. While

much has been achieved for the environment, more needs to be done to include social impacts in certification standards and to implement them. Our results show ongoing negative social impacts that must be addressed but more information is needed to completely understand the severity of these impacts.

This study focused on peer-reviewed literature and cases recorded in the EJA. While all negative impacts recorded in the EJA were also captured in the peer-reviewed literature making our study robust in that sense they should be interpreted with care for the following reasons. Firstly, these results are just an overview from a representative sample since not all studies on social impacts in the scientific literature were included. Secondly, much of the research in the palm oil sector is conducted by NGOs such as WWF and CIFOR. These NGOs do not necessarily publish their work in the scientific literature but in grey literature The EJA which represents our grey literature does not contain reports on positive impacts, making it hard to weigh both sides of the story from grey literature. Lastly, the majority of the studies were from Asia with higher percentages in Indonesia and Malaysia, which means that our results may not necessarily reflect the situation in most other countries. However, the continued high frequency of reported negative impacts in these countries in recent years is worrisome. The magnitude of these impacts needs further investigation.

#### Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper

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#### Appendix A. Supplementary data

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