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Cerulogy

Driving deforestation

The impact of expanding palm oil demand through biofuel policy

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Executive summary

In 2015, about 35 billion litres of biofuel (biodiesel and renewable diesel) was produced from fats and vegetable oils, consumed primarily in the EU, U.S., Brazil and Indonesia. This created an estimated 8.2 million tonnes of demand for palm oil as biofuel feedstock (mostly for use in Indonesia and the EU), and a further indirect demand of at least 2.5 million tonnes of palm oil to replace other biodiesel feedstocks in existing uses (considering only indirect demand from the EU and U.S. mandates, not from biodiesel mandates elsewhere in Asia and Latin America). In total, those 10.7 million tonnes represent nearly a fifth of global palm oil production, which the FAO reported as 57 million tonnes in 2014 and was expected to reach 65 million tonnes in 2017. Globally, average palm oil yields have been more or less stagnant for the last 20 years, so the required increase in palm oil production to meet this growing demand has come from expanding the cultivated palm area, with profound impacts on biodiversity and carbon storage. Increasing demand for palm oil is a problem because palm oil expansion in Indonesia and Malaysia is currently endemically associated with deforestation and peat destruction. Without fundamental changes in governance, we can expect at least a third of new palm oil area to require peat drainage, and a half to result in deforestation.

Approaching 2020, the future of biofuel policy is at a potential inflection point. Targets have been set by several countries, and by the aviation industry, that could lead to a significant increase in palm oil demand in the decade from 2020 to 2030. Given current biofuel consumption targets, by 2030 Indonesia alone could consume 19 million tonnes of palm oil as biodiesel feedstock. That is double total current global production of palm oil biofuels. In parallel, the aviation industry has ambitious alternative fuel consumption goals but currently no limits on the feedstocks that are eligible. Palm oil is the world's cheapest plant oil and well suited to hydrotreating for renewable jet fuel production, and therefore if nothing changes is likely to play a major role. If 25% of aviation biofuels required to deliver on stated 2030 aspirations came from palm oil, this would add a further 12 million tonnes of demand.

The EU, which has been the main driver of increased palm oil demand due to biofuel policy to date is currently negotiating its 2030 renewables policy. Depending on how that negotiation is resolved, the EU could be responsible for driving even more deforestation in the coming decade. Alternatively, the EU could build on the precedent set in 2014 when the 'ILUC Directive' limited the use of crop-based first generation biofuels by creating a policy that reduces pressure on vegetable oil demand, and in particular that reduces demand for palm oil production. Such a policy would set a positive example that would be considered carefully by countries around the world as they consider how to develop their own renewable fuel policies.

High demand, high impact:

Currently, biofuel policy results in 10.7 million tonnes of palm oil demand, just under a fifth of global production.

The scenario in this report for high 2030 palm oil consumption due to biofuel policy would result in*:

- 67 million tonnes palm oil demand due to biofuel policy.
- 4.5 million hectares deforestation.
- 2.9 million hectares peat loss.
- 7 billion tonnes of CO2 emissions over 20 years, more than total annual U.S. GHG emissions.

*(when compared to eliminating palm oil demand due to biofuel policy, based on current land use change trends)

This report looks at the current demand and potential 2030 demand for palm oil from biofuel policies in key countries and in the aviation industry. It presents low, medium and high scenarios for the role of 2030 biofuel production in increasing demand for palm oil, and based on these scenarios presents estimates of the likely impact of this biofuel demand on palm-oil related tropical deforestation and destruction of peatlands. Palm oil demand due to biofuel policy in the three scenarios is illustrated in Figure 1, alongside projected consumption of palm oil for food and other uses.

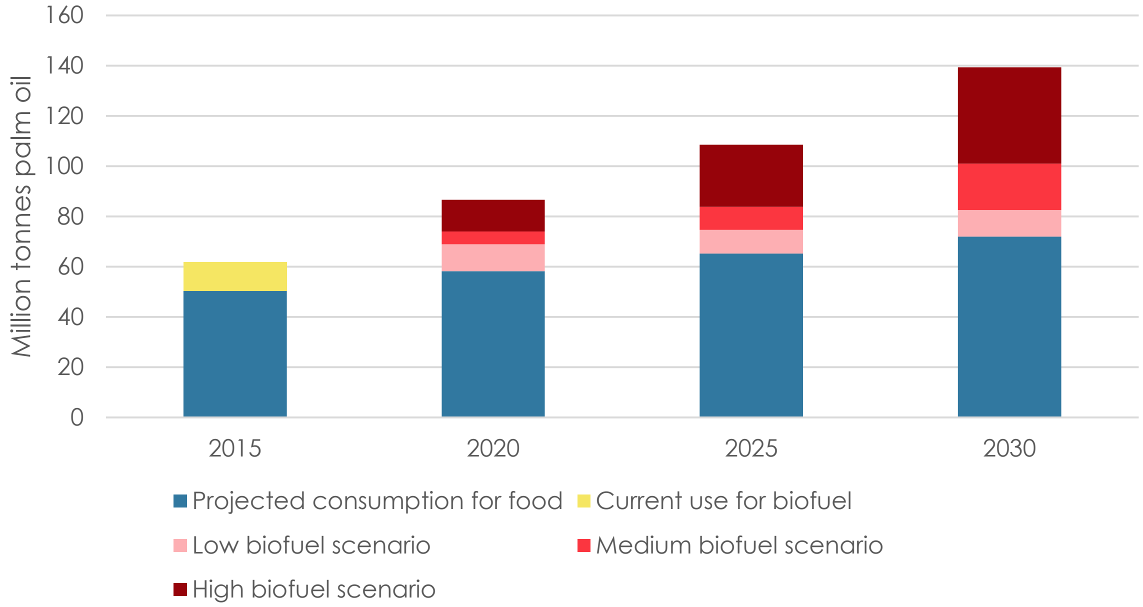


Figure 1. Scenarios for demand for palm oil from biofuels compared to projected palm oil consumption for food and other uses

Data on projected consumption for food from OECD and FAO (2017)

In the high scenario, global demand for palm oil from biofuel policies would be 67 million tonnes in 2030. That is a six-fold increase from today, and is greater than today's total global production of palm oil. The demand increases in this high scenario are not based on extravagant assumptions about dramatic future ramping up of targets – they come from assuming that existing biofuel targets for Indonesia would be met and that targets in China and for aviation will be met with significant contributions from palm oil, along with modest increases in demand from the EU and U.S. markets. Alternatively, if targets are reduced or measures are taken to move to more sustainable feedstocks such as agricultural residues and biomass energy crops, demand from the global biofuel industry could remain relatively stable.

Delivering the volumes of palm oil required in the high demand scenario would be expected to result in world vegetable oil prices in 2030 26% higher than if incentives to turn virgin vegetable oils into biodiesel were eliminated. If current deforestation patterns continue, it would result in 4.5 million hectares of additional forest loss, including 2.9 million hectares of peat forest, compared to a case with frozen palm oil demand due to the biofuel industry. That is an area larger than the size of Switzerland or the Netherlands. Over a 20-year period these land use changes would result in an additional 7 billion tonnes of CO_2 emissions compared to a case where palm oil demand due to biofuel policy was completely eliminated (Figure 2) – more than the total annual greenhouse gas emissions of the USA. It is clear that CO_2 emissions of that magnitude are profoundly inconsistent with attempts to limit global warming to the levels set out in the Paris Agreement, and would in all likelihood more than eliminate any benefit from reducing the use of fossil diesel or jet fuels. Indeed, the best available evidence suggests that using palm oil for biodiesel is significantly worse for the climate than continuing to consume fossil diesel, perhaps as much as three times as bad (Malins 2017a).

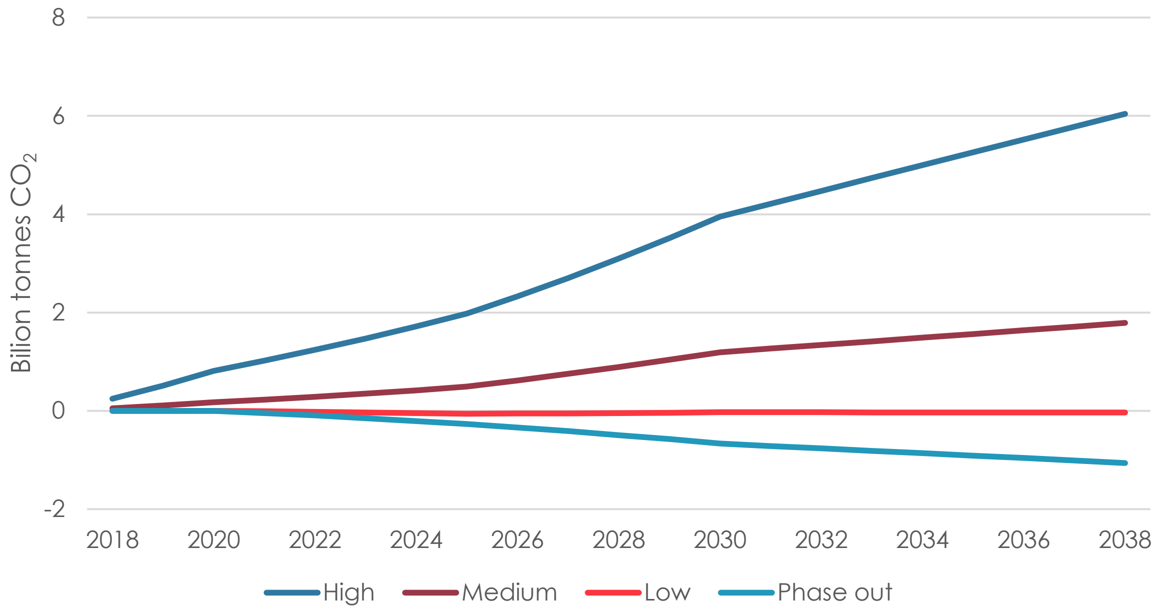


Figure 2. Cumulative land use change emissions (or avoided emissions) for the high, medium and low palm oil demand cases and for a total demand phase out, compared to frozen demand

Assuming a steady rate of additional deforestation and peat loss through the period

Beyond the climate impact of this scale of land use change, palm oil expansion is disastrous for biodiversity, and increases susceptibility of tropical landscapes to forest fires that are responsible through air pollution for enormous additional CO_2 emissions and for tens of thousands of annual deaths. There are also serious social issues associated with the palm oil industry, including poor working conditions and repeated conflicts with indigenous communities over land rights.

In the long term, the best and only solution to deforestation and peat drainage in Southeast Asia will be a paradigm shift in the regulation of the palm oil industry and enforcement of anti-deforestation policy by the countries involved. Until that happens, it is vital that well-meaning biofuel policies should not needlessly inflate demand for palm oil, and thereby increase pressure for environmental destruction. For existing programmes in the EU and U.S. this means phasing out support for the production of biodiesel from vegetable oils, and in particular phasing out support for biofuels produced with palm oil or PFAD as a feedstock. For the embryonic aviation biofuel industry, the simplest answer to guarantee long-term sustainability and public acceptance would be to focus solely on biojet produced using biomass to liquids technologies such as gasification and Fischer-Tropsch synthesis that allow the use of low-value feedstocks instead of valuable vegetable oils.

Some commentators argue that reducing the market for palm oil in Europe will reduce the pressure on government and industry for better forest governance in Southeast Asia, or that it is unfair to discount hypothetical future reductions in deforestation when assessing the environmental performance of biofuel policy. On the contrary, we believe that the recognition that the growth of palm oil demand is jeopardised by poor sustainability governance is much more likely to spur action than hinder it, and that reductions in deforestation rates must be demonstrated in reality before they can be assumed in modelling.

The governments of Indonesia and Malaysia have been active in opposing any limits on the use of palm oil for biofuel. This has included promoting misleading claims to undermine scientific consensus on the harm associated with the destruction of peat landscapes (Wijedasa et al. 2017), and criticising attempts by the EU and other countries to improve the environmental performance of their biofuel support regimes by differentiating between feedstocks[1]. While it is not surprising that the governments of these countries would seek to protect export revenue, it must always be remembered that the primary purpose of biofuel policy in the EU and many other countries is climate change mitigation. Fuel consumers in the European Union, Norway and elsewhere cannot be asked to continue indefinitely to pay to support vegetable oil based alternative fuels that exacerbate rather than mitigate climate change.

Recommendations

In order to reduce pressure for deforestation in highly biodiverse habitats in Southeast Asia, existing mandates for biodiesel from vegetable oils should be reduced or eliminated, and new biofuel policies should avoid these resources.

- Palm oil and PFAD are unsuitable as biofuel feedstocks. Due to land use change associated with expanding palm oil production, palm-oil based biofuels increase GHG emissions and drive biodiversity loss. The use of palm oil-based biofuel should be reduced and ideally phased out entirely.
- In Europe, the use of biodiesel other than that produced from approved waste or by-product feedstocks should be reduced or eliminated.
- In the United States, palm oil biodiesel should continue to be restricted from generating advanced RINs under the Renewable Fuel Standard.
- Indonesia should reassess the relationship between biofuel mandate, and its international climate commitments, and refocus its biofuel programme on advanced biofuels from wastes and residues.
- Other countries should avoid creating new renewable energy incentives without strong environmental criteria to ensure that genuine emissions savings are delivered.

1 See e.g. https://asia.nikkei.com/Politics-Economy/Economy/EU-asking-for-trade-war-with-palm-oil-curbs-Indonesian-minister

- The aviation industry should focus on the development of advanced aviation biofuels from wastes and residues, rather than hydrotreated fats and oils.
- Sustainability initiatives for oil palm agriculture should be supported for food and oleochemical applications, but must not be used as an excuse for driving further demand growth from biofuels.
- The governments of Indonesia and Malaysia should be supported to overhaul forest governance and break the link between palm oil production and environmental destruction.

Contents

Introduction

Since the year 2000, global biodiesel demand has increased dramatically, as illustrated in Figure 3. In 2015, global biodiesel production was about 30 billion litres, with a further 5 billion litres of hydrotreated vegetable oil (HVO) being produced from a similar set of feedstocks (Sawin, Seyboth, and Sverrisson 2016). Biofuel production consumed around 20% of global vegetable oil production in 2014, and has absorbed about 40% of global vegetable oil production growth since 2000 (UN Food and Agriculture Organisation 2017).

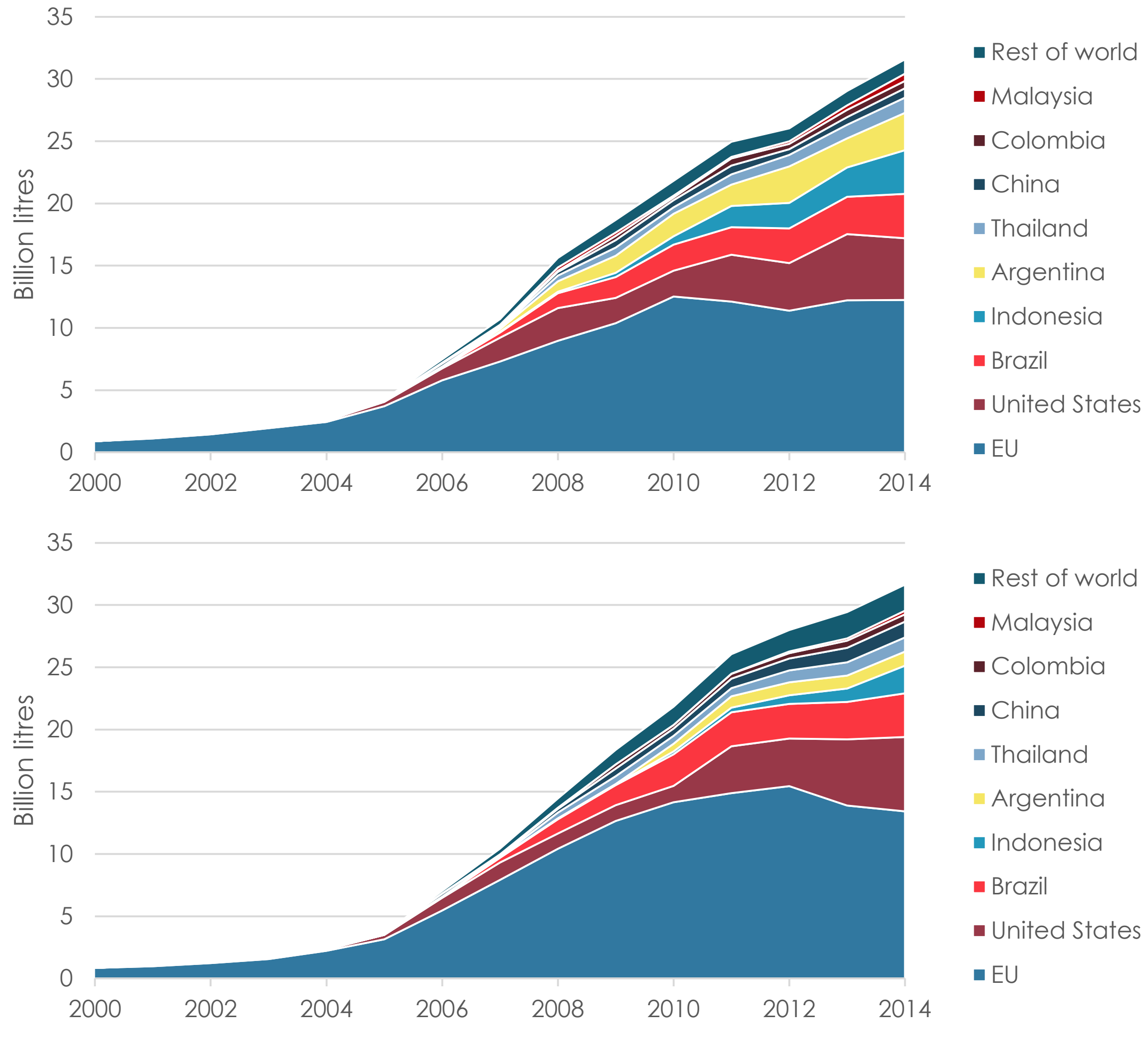


Figure 3. Global biodiesel production (above) and consumption (below)

Source: https://www.eia.gov/beta/international/data/browser/. Note that The EIA production data show a production drop in 2010 in several countries, which is not reflected in other sources. This likely is a data-handling artefact, and the 2010 production has hence been adjusted to reflect the longer term trend.

This increase in global biodiesel demand since the year 2000, alongside increasing demand for vegetable oils for other food and non-food applications, has put considerable stress on vegetable oil markets. The average inflation-adjusted index price (2010 $) for vegetable oils and fats from 1990 to 2004 was $63 per tonne; from 2005 to July 2017 the average was $95 per tonne, 50% higher (see Figure 4). It is widely accepted that biofuel demand was one of the factors that contributed to food price spikes in 2006-08 and again in 2011-12 (Malins 2017b), and will have caused a longer term increase in equilibrium prices, though it is difficult to exactly isolate the specific contribution of biofuels to the price increases in the last decade.

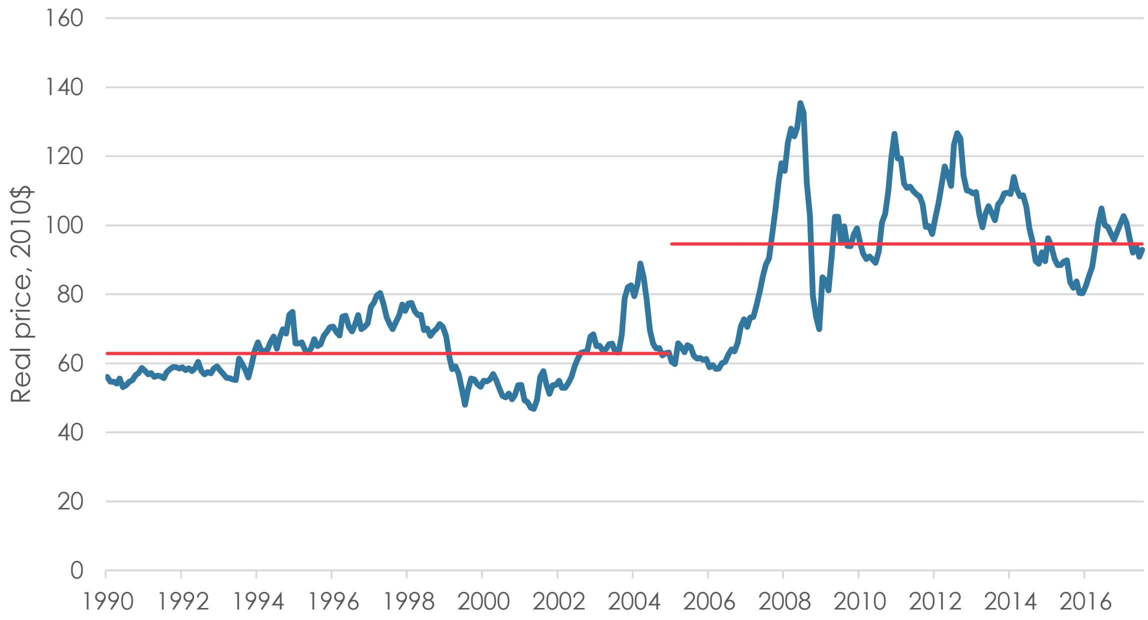


Figure 4. Inflation adjusted price index for fats and oils, 1990-2017, with average before and after January 2005 marked in red

Source: World Bank Global Economic Monitor Commodities http://databank.worldbank.org/data/reports.aspx?source=global-economic-monitor-commodities

Biodiesel demand has been policy-driven – biodiesel producers are generally not able to compete with fossil fuel producers on price, and thus the market for biodiesel only exists at its current size because of government action. The largest producers of biodiesel are generally the countries with the strongest biofuel incentives or mandates, and hence also the largest consumers. The European Union, U.S., Brazil, Argentina and Indonesia, among others, have all set mandates and/or incentives to significantly increase biodiesel consumption since 2000. Biodiesel can be blended with standard fossil diesel and delivered to normal vehicles, but due to differences in chemical properties and stability between fossil diesel and biodiesel this blending is generally limited in fuel quality specifications. Most countries limit biodiesel blending to between 5% and 10% which places practical limits on the volumes of biodiesel that can be consumed. Vegetable oils can also be treated with hydrogen to produce hydrotreated vegetable oil (referred to as HVO or renewable diesel), which is not subject to any limitation on maximum rates of blending, but which more complex and expensive facilities are required to produce.

The two largest biodiesel mandates in the world are provided by the EU Renewable Energy Directive and the United States Renewable Fuel Standard. While both policies were conceived partly with a view to supporting domestic vegetable oil producers, in both regions biodiesel demand has grown far more quickly than vegetable oil production, as illustrated in Figure 5.

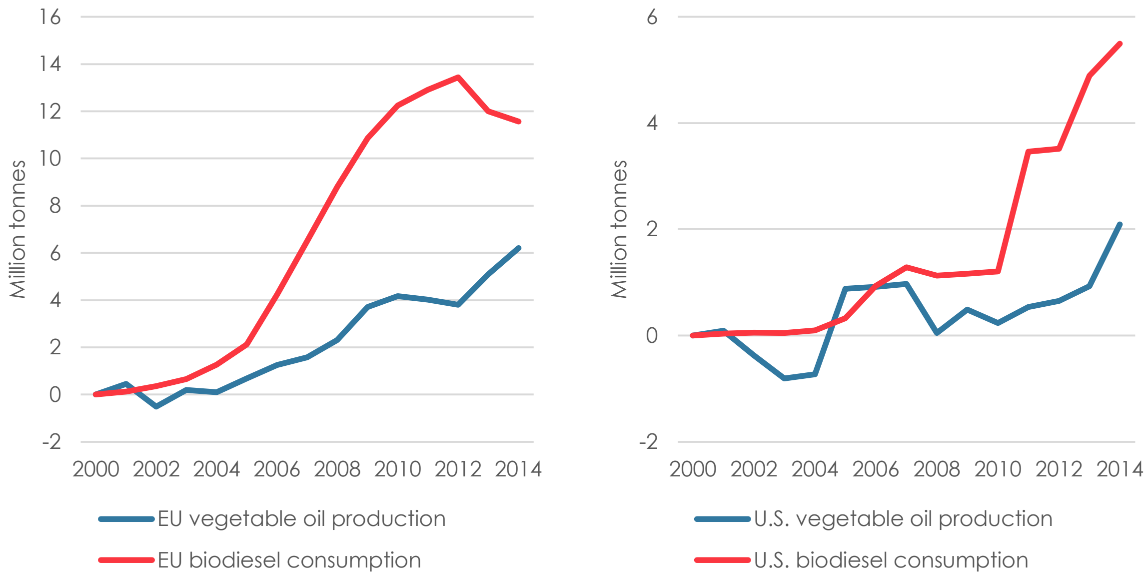


Figure 5. Biodiesel consumption compared to vegetable oil production in the U.S. and EU, compared to year 2000 levels

Source: FAOstat and U.S. EIA

One result of this rapid increase in biodiesel consumption has been increased vegetable oil imports to these regions. As shown in Figure 6, between 2000 and 2013 EU vegetable oil imports increased by 5.7 million tonnes per year (more than half of the increase in biodiesel production over the same period) while U.S. vegetable oil imports increased by about 2.4 million tonnes (a bit under half of the increase in biodiesel consumption in the period). Clearly, growing biodiesel consumption has affected patterns of vegetable oil use globally.

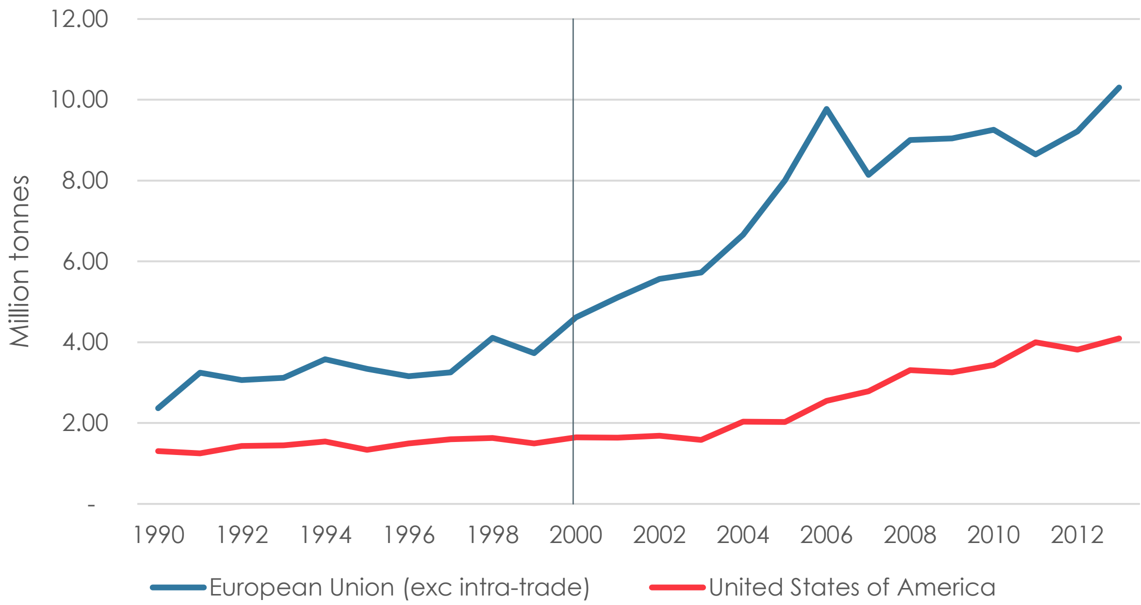


Figure 6. Vegetable oil imports for the EU and U.S., 1990-2013

Source: FAOstat

Increasing demand and increased prices have been accompanied by increasing production. According to FAOstat (UN Food and Agriculture Organisation 2017), global vegetable oil production increased by 80 million tonnes from 2000-2014. Of this, about half (39 million tonnes) came from additional palm oil production. During the same period, biofuel production from vegetable oils increased by about 36 million tonnes.

Palm oil is the world's most produced and traded vegetable oil, and is the cheapest of the virgin[2] vegetable oils. The international palm oil market is dominated by Indonesia and Malaysia, accounting for 85% of palm oil production globally, and nearly 90% of the increase in palm oil production from 2000 to 2014. During this period, reported global average yields actually fell slightly (by 4%[3]), so the whole of the increase in palm oil production over the period effectively came from area expansion[4]. Palm oil plantations in Indonesia expanded by 5.4 million hectares, quadrupling in overall extent, and plantations in Malaysia expanded by 1.6 million hectares (UN Food and Agriculture Organisation 2017). This is a combined area of palm oil expansion the size of Ireland.

This expansion of palm oil plantations has been associated in many cases with the loss of

2 In this report, we use the term 'virgin vegetable oil' to refer to unused vegetable oils, as opposed to used cooking oils collected from restaurants etc.

3 Malaysian and Indonesian yields performed even worse, falling on average by 26% and 6% respectively. This was likely primarily related to a changing age profile of the palm oil estate, but may also have been related to expansion into less productive peat soils (Malins 2012).

4 Note that this does not necessarily mean that demand for palm oil for biodiesel had no impact on yield. It is at least possible that without this demand increase, yields could have fallen still further.

carbon and biodiversity rich primary or secondary tropical forest, including swamp forest on peatland (Miettinen, Aljosja Hooijer, et al. 2012). As reported by Malins (2017a), the use of palm oil as a biodiesel feedstock has almost certainly resulted in significantly higher net greenhouse gas emissions than simply continuing to burn fossil diesel would have caused. Mandates that support the expansion of palm oil biodiesel use are not only ineffective climate change mitigation policies, but are actively counter-productive. This report considers the potential for continued increases in palm oil demand driven directly and indirectly by biofuel policy, and the potential impacts such further demand increases could be expected to have.

Demand for palm oil for biodiesel

In this chapter, we review current and potential future demand for palm oil for use as a biodiesel (or HVO) feedstock, and present low, medium and high scenarios for palm oil biodiesel demand for each region considered. The high scenario assumes that ambitious existing biofuel consumption targets in Southeast Asia, China and the aviation industry are met in 2030, and that where targets are not yet agreed (e.g. the EU and U.S.) there are modest increases in use of palm oil for biofuel. The low scenarios assume that Southeast Asian countries fall well short of stated targets while demand from the rest of the world is reduced. The medium scenarios assume a middle ground in which demand growth in Southeast Asia and the aviation industry is significant but falls short of targets, and demand in the EU and U.S. reduces slowly.

Indonesia

Indonesia's domestic biofuel blending market is (assuming targets can be met) one of the world's fastest growing markets for palm oil. In the past, Indonesia's main role in the biofuel market has been as an exporter of palm oil for feedstock or to replace other vegetable oils that are used for biodiesel. As shown in Figure 7, unlike the EU and U.S. Indonesia's vegetable oil production (the vast majority of which is palm oil) has grown far faster than its developing domestic biodiesel industry.

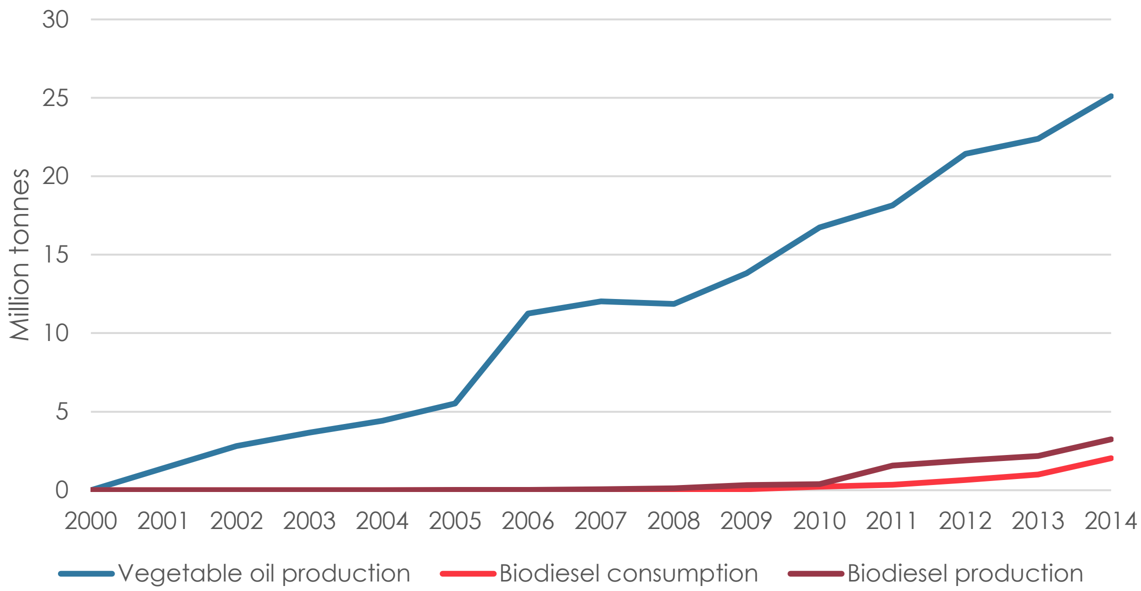


Figure 7. Growth in Indonesian vegetable oil production, and biodiesel production and consumption, 2000-2014

Source: FAOstat, EIA

The government plans to change this picture somewhat, through the adoption of biodiesel

blending targets that are some of the most ambitious in the world (Kharina, Malins, and Searle 2016). In 2015, the Indonesian government adopted targets to increase biodiesel blending rates to 30% by 2020 (Ministerial regulation No. 12/2015). The targets are shown in Table 1.

Table 1. Indonesian biofuel blending targets

Sector	April 2015	January 2016	January 2020	January 2025
Micro-business, fisheries, agriculture, and public service (subsidized)	15%	20%	30%	30%
Transportation	15%	20%	30%	30%
Industry and commercial	15%	20%	30%	30%
Electricity	25%	30%	30%	30%

Source: Kharina et al. (2016)

The supply of biofuels to meet the blending targets is to be financed through an export levy on palm oil exports (Presidential Regulation No 61/2015 on collection and use of palm oil funds), which is to be used to subsidise domestic biodiesel production. In this way, the proceeds of palm oil exports are directly used by the Indonesian government to encourage additional domestic palm oil demand, and even more oil palm expansion and subsequent deforestation.

The implementation of the biofuel targets has been partial in the past, with relatively high compliance by Pertamina, the state fuel supplier, but much lower compliance with blending targets by other fuel suppliers. Kharina et al. (2016) report that in 2014, 73% of the biofuel blending target was achieved for subsidised fuel from Pertamina, but only 35% for other fuel companies. Figure 8 shows the persistent gap between the 'mandatory' blending targets and the actual level of biodiesel blending in Indonesia.

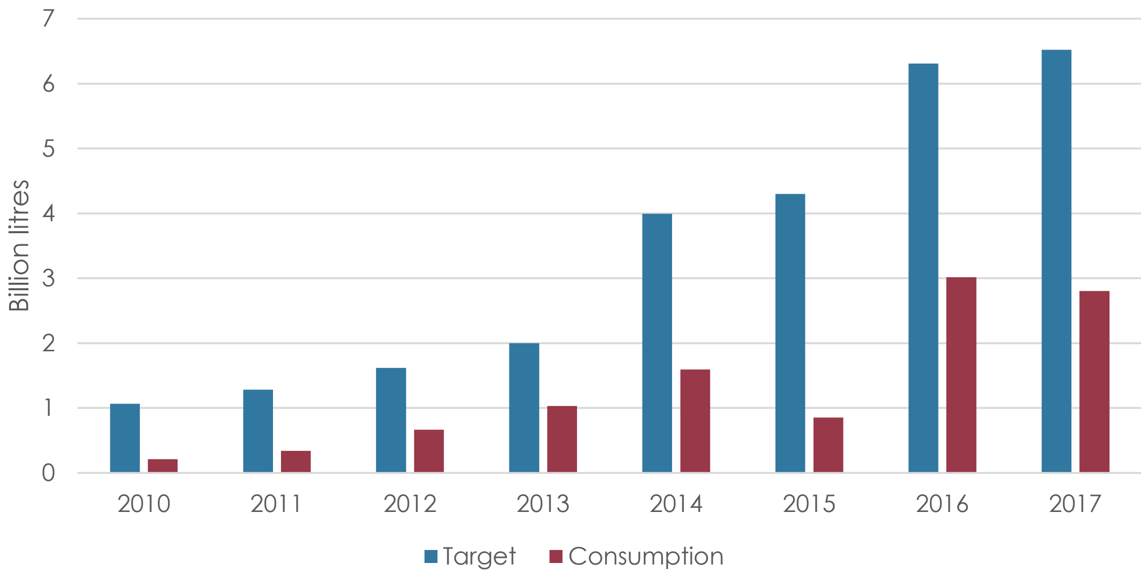


Figure 8. Indonesian biodiesel blending target vs. consumption

Source: Wright and Rahmanulloh (2017)

By 2016, Indonesian biodiesel production had grown to 3.7 billion litres (Wright and Rahmanulloh 2017). This is up by 300 million litres on 2014, but not consistent with the strong growth that would be required to meet government targets. Wright and Rahmanulloh (2017) report that the Indonesian Ministry of Energy and Mineral Resources in fact expects reductions in both biodiesel production and consumption in 2017. Given the current system of subsidisation, the rate of biodiesel blending is likely to be limited by the revenue from the export levy. Currently, the Indonesian biodiesel market index price is 60% higher than the Indonesian diesel price (Wright and Rahmanulloh 2017).

Delivering compliance with published biodiesel targets would require a dramatic increase in both production and consumption of palm oil biodiesel in Indonesia. By 2030, it is estimated that 19 billion litres of biodiesel would be required for published road and industrial biodiesel targets. Meeting aviation targets would require still more palm oil (see below). This would raise Indonesian consumption of biodiesel above current EU consumption, making the Indonesian programme potentially the largest biodiesel programme in the world. While the regulatory framework currently in place seems unlikely to be able to drive this rate of increase in biofuel consumption, it should be noted that there is considerable spare capacity in the Indonesian biodiesel industry. Wright and Rahmanulloh (2017) estimate that only 35% of existing biodiesel production capacity is being utilised, and so in principle production could be increased by a factor of nearly three without a need to invest in any new production installations.

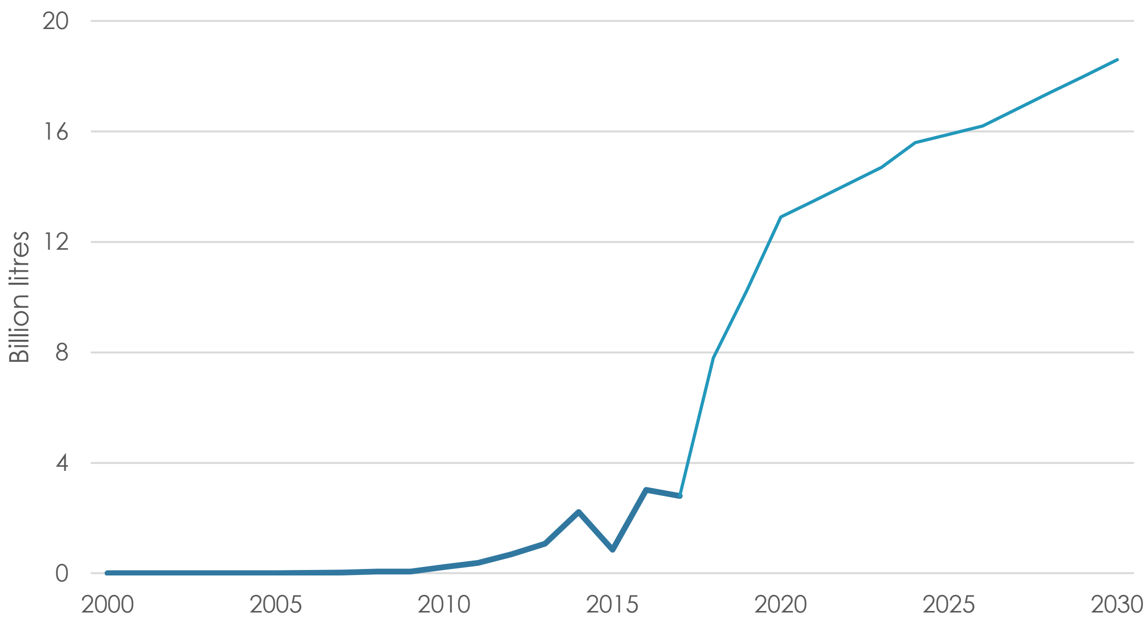


Figure 9. Required biodiesel consumption to meet Indonesian blending targets

Table 3 details scenarios for Indonesian demand for palm oil as biodiesel feedstock for the period 2020 to 2030. The high scenario reflects a case in which current targets are achieved in 2030. Given the persistent gap in the past between targets and delivered volumes of fuel consumption, we have not included a scenario in which volumes of biodiesel consumption are even higher than current targets.

Table 2. Potential direct palm oil demand for Indonesian biodiesel consumption (2020-2030)

Scenario	Description	Palm oil demand (million tonnes)		
		2020	2025	2030
High	Stated targets fully met	12.9	15.9	18.6
Medium	Stated targets partly met	4.0	6.9	12.2
Low	Modest growth after 2020	2.5	4.0	5.5

Malaysia

Malaysia has not got much history of domestic biodiesel consumption, but since the start of 2015, Malaysia has implemented 7% biodiesel blending, using domestic palm oil as feedstock. The Government of Malaysia had initially scheduled introduction of a higher 10% biodiesel blend for October 2015, but at the time of writing this had been delayed (Wahab 2016), although the government asserts that it remains committed in principle[5].

As is the case for Indonesia, in Malaysia biodiesel consumption has absorbed only a fraction of the increase in palm oil production since the year 2000 (Figure 10). Even from 2014, domestic biofuel consumption absorbed only 3% of the increase in domestic palm oil consumption. In 2017, palm oil biodiesel consumption reached 800 million litres, with a further 250 million litres being exported (Wahab 2016), but this remains a modest contributor to domestic demand. Malaysia has a target to introduce 15% biodiesel blending by 2020, which would require about 2 billion litres of palm oil. The Malaysian biodiesel industry is reportedly running at about 33% of capacity, so this level of increase in production would be potentially achievable given an appropriate set of incentives, and if any blending limitations could be overcome.

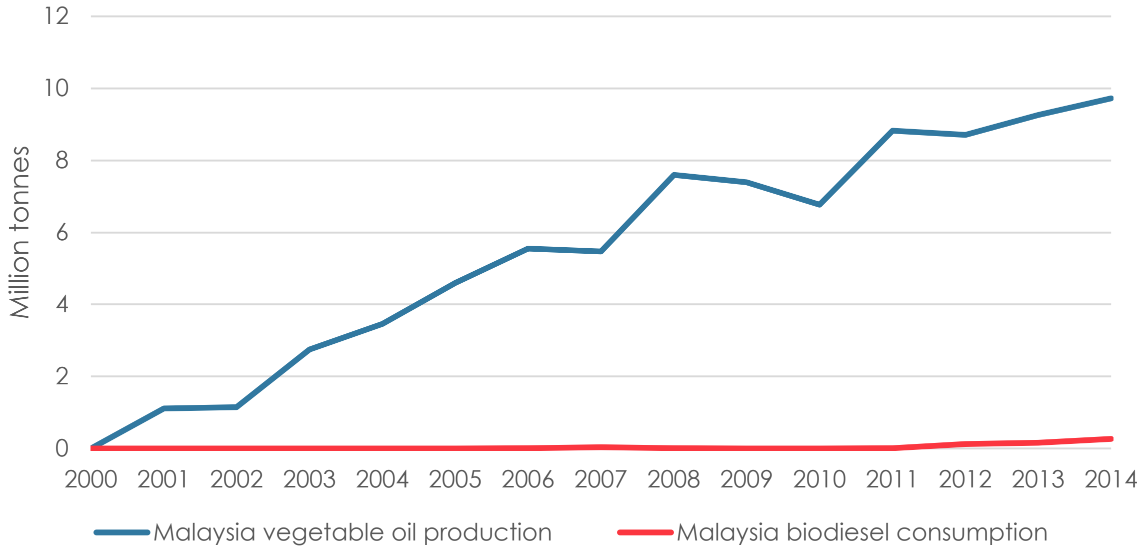


Figure 10. Growth in Malaysian vegetable oil production and biodiesel consumption 2000-14

Table 4 details scenarios for Malaysian demand for palm oil as biodiesel feedstock for the period 2020 to 2030.

5 https://www.platts.com/latest-news/agriculture/singapore/malaysian-b10-mandate-implementation-is-when-26784012

Table 3. Potential direct palm oil demand for Malaysian biodiesel consumption (2020-2030)

Scenario	Description	Palm oil demand (million tonnes)		
		2020	2025	2030
High	Stated 2020 targets met, consumption doubles between 2020 and 2030	1.8	2.4	3.6
Medium	Stated 2020 target partially met, 50% growth 2020 to 2030	1.2	1.5	1.8
Low	Modest growth after 2020	0.7	0.9	1

Thailand

Thailand has ambitious biofuel consumption targets under its Alternative Energy Development Plan 2015, aiming to increase biofuel use in transport energy from 7% in 2015 to 25% by 2036, which would require 5 billion litres of palm oil (Preechajarn and Prasertsri 2017). The Thai government has reportedly acknowledged that the 2036 targets may be unattainable without allowing reliance on imports, and the policy may be re-examined, with a reduced 2036 target of 2.6 billion litres (Preechajarn and Prasertsri 2017). Figure 11 shows that since 2006 increasing biodiesel blending has used up more than the increase in Thai vegetable oil production. In 2017, biodiesel consumption was expected to reach 1.4 billion litres (Preechajarn and Prasertsri 2017).

Palm oil is the primary feedstock for Thai biodiesel, and the Thai government is targeting a 0.9 million hectare expansion in the Thai palm estate by 2036 in order to meet demand for biodiesel, with the energy plan requiring biodiesel to use domestically sourced feedstock. The Thai biodiesel market is therefore potentially different in its environmental impact than other palm oil biodiesel markets, because of the focus on domestic production in Thailand, which is not so severely associated with ecological damage as palm oil expansion in Indonesia and Malaysia currently is. That said, the same issues do apply to some extent, and both peat loss and deforestation have been documented as resulting from palm oil expansion.[6] However, given that the extent of Thai peatlands is only about 70 thousand hectares, compared to 15.5 million hectares in Malaysian and Indonesia together, the potential impact of peat loss is not on the same scale.

6 E.g. https://news.mongabay.com/2017/03/as-thailand-ramps-up-its-palm-oil-sector-peat-forests-feel-the-pressure/

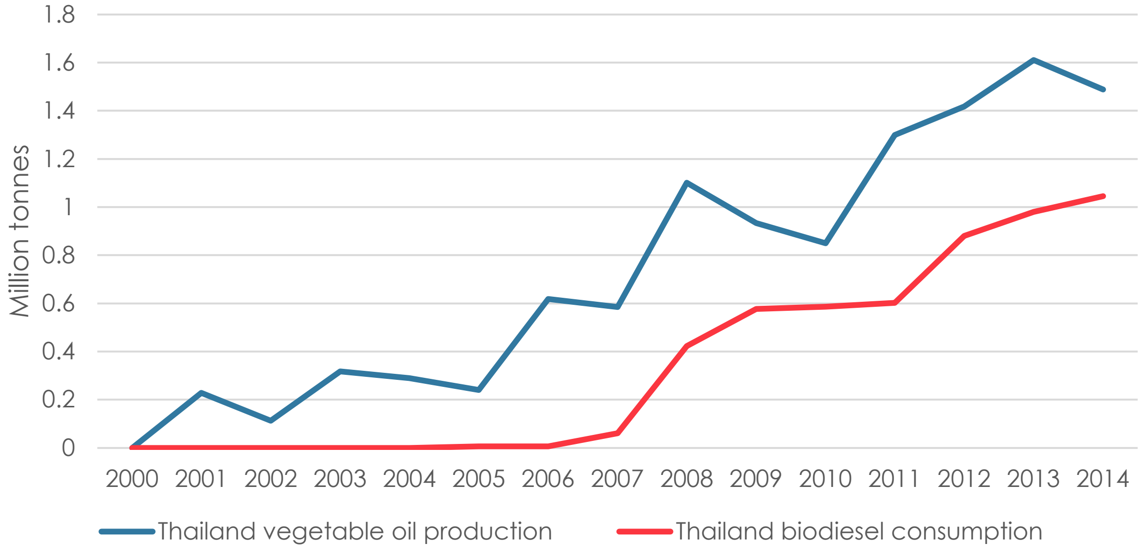


Figure 11. Growth in Thai vegetable oil production and biodiesel consumption, 2000-14

Source: FAOstat, EIA

Table 5 details scenarios for Thai demand for palm oil as biodiesel feedstock for the period 2020 to 2030.

Table 4. Potential direct palm oil demand for Thai biodiesel consumption (2020-2030)

Scenario	Description	Palm oil demand (million tonnes)		
		2020	2025	2030
High	Stated 2036 target met by 2030	2.5	3.3	4.3
Medium	Consistent with meeting expected revised 2036 target	1.3	1.6	1.9
Low	Modest growth after 2020	1.2	1.3	1.5

European Union

Based on statistics for EU biodiesel feedstocks collated by the USDA (Flach, Lieberz, and Rossetti 2017), the EU represents a similar size market for palm oil biofuel (biodiesel and HVO) to Indonesia. Nearly 3 billion litres of palm oil based biodiesel and HVO are expected to be supplied in 2017 (Figure 12). The share of palm oil in the market is not expected to change significantly in the near term (DG Agri and Joint Research Centre 2016). Palm oil use in Europe has increased partly due to the expansion of HVO production capacity, for which palm oil is a favoured feedstock. For instance, Flach et al. (2017) report that Eni's HVO plant in Venice currently runs entirely on palm oil, while Neste use a feedstock mix that includes 19% palm oil and a significant fraction of palm fatty acid distillates (PFADs), which are associated with similar environmental issues to the direct use of palm oil (Malins 2017c). The waste-oil broker GreenEA reports that of the 'other' oils used in Europe in 2016, about 500 thousand tonnes came from 'acid oil, PFAD and POME' (Hillairet, Allemandou, and Golab 2016). We expect that the substantial majority of this material is PFAD, given that oil recovery from POME is not yet widely implemented, and production of acid oils from other virgin oils is very low in comparison to production of acid oils from PFAD (Malins 2017c). Based on analysis presented in Malins (2017c), it is assumed that using 1 tonne of PFAD for biofuel results in 0.64 tonnes of additional palm oil demand, meaning that EU use of PFAD as biofuel feedstock in 2016 was associated with approximately 290 thousand tonne of additional palm oil demand.

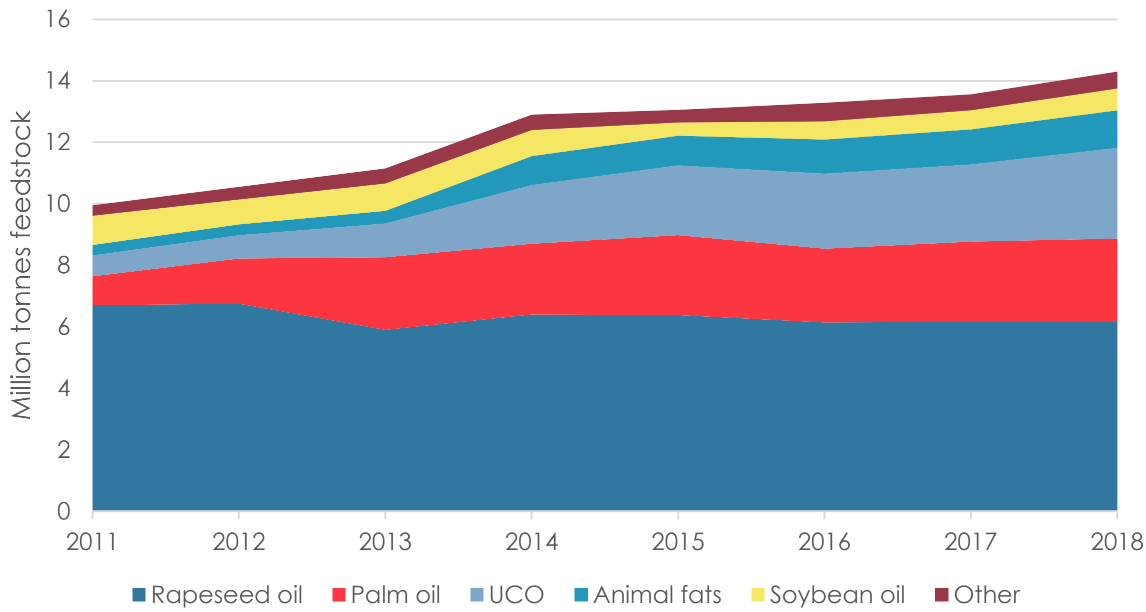


Figure 12. Biodiesel feedstock use in the EU

Source: Flach et al. (2017)

In 2013, the EU introduced anti-dumping duties on imports of processed Indonesian palm oil, which suppressed imports of Indonesian biodiesel (Wright and Rahmanulloh 2017). These duties do not, however, affect EU processing of Indonesian palm oil exports, and do not appear to have significantly reduced overall use of palm oil as biodiesel feedstock for EU consumption.

The future of EU consumption of palm oil-based biodiesel is currently in flux, due to the ongoing process of adopting a revised Renewable Energy Directive to take effect in the period from 2020-2030. The Commission's initial proposal (European Commission 2016) would curtail the role of food-based biofuel in the EU, including palm oil, by reducing the maximum incentivised fraction of food-based biofuels in transport energy from 7% to 3.8%, and creating a basis for Member States to apply further restrictions on fuels with high ILUC emissions (cf. Malins, Searle, and Baral 2014). DG Agri and Joint Research Centre (2016) anticipate that this reduction in incentives would reduce EU palm oil imports by 15-20%, i.e. between 1.5 and 2 million tonnes. However, farmer's organisations and the food-based biofuel industry oppose these reductions, and it is unclear what the end result of the negotiation between the European Commission, Parliament and Council will be[7]. A Council position published in December 2017 proposed maintaining the cap on the use of food-based biofuels at 7% rather than reducing it (Permanent Representatives Committee of the Council of the European Union 2017).

Scenarios for potential palm oil feedstock demand from EU biofuel are shown in Table 5.

Table 5. Potential direct palm oil demand for EU biodiesel (2020-2030)

Scenario	Description	Palm oil demand (million tonnes)		
		2020	2025	2030
High	Growth in share of palm oil biodiesel under a 7% cap on food-based fuels	3.3	3.7	4.1
Medium	Use of food-based fuels reduced to 3.8% by 2030	3.1	2.5	1.8
Low	Support for palm oil for biodiesel phased out from 2021 (some PFAD use continues)	2.9	0.3	0.3

Norway

While Norway is not a member of the European Union, it also implements the Renewable Energy Directive as a member of the EEA (Norwegian Ministry of Petroleum and Energy 2012). In addition, the consumption of biofuels in Norway is impacted by further two incentive mechanisms within road transportation. One is the so-called 'escalation plan' announced by the Norwegian Government in 2016, which goes beyond the requirements of the RED by stipulating that the biofuel volume blending mandate for road transport shall increase from 7 percent as of 1 January 2017 to 20 percent as of 1 January 2020 (the blending mandate at the time of publication in January 2018 is 10 percent). The other is that biofuel supplied above the blending mandate threshold shall be exempt from road tax. [8]

In 2016, the Norwegian Government reported that 423 million litres of biofuel were supplied to the Norwegian fuel market (Miljødirektoratet 2017). This represented a more than doubling compared to 2015, when only 188 million litres of biofuel were supplied (Miljødirektoratet 2017). Accompanying this rapid increase in biofuel use was a dramatic expansion in the role of palm oil and palm oil derivatives in the Norwegian market. Whereas the government reported that in 2015 palm oil was not used as feedstock for Norwegian fuels, and that PFADs accounted for only 1% of biofuel feedstock, most of the volume growth from 2015 to 2016 was delivered from palm oil and PFADs. Based on the data presented by Miljødirektoratet (2017), we estimate that

7 https://www.euractiv.com/section/agriculture-food/news/biofuel-debate-a-political-hot-potato-as-renewable-energy-debate-nears-the-home-straight/

8 http://www.miljodirektoratet.no/no/Nyheter/Nyheter/2017/Februar-2017/Fakta-om-biodrivstoff1/

about 90 million litres of PFAD and 60 million litres of palm oil were consumed in 2016, resulting in about 100 thousand tonnes of total palm oil feedstock demand.

The Norwegian Environment Agency reclassified PFAD in 2016 from 'waste/residue' to 'by-product' and thereby disqualified PFAD derived biodiesel from receiving double counting incentives feedstock with effect from 1 January 2017.[9] This is expected to result in a dramatic reduction in the volumes of PFAD used for the Norwegian market (as there are other EU markets where it is still eligible for additional support). However, preliminary data for 2017 from the Norwegian Tax Administration show that biofuel sales in Norway from January to September 2017 totalled 538 million litres (including 482 million litres of biodiesel). This is already over 100 million litres above total biofuel sales in 2016, on which basis it seems likely that 2017 saw a further increase in the overall use of palm oil biodiesel in Norway. Market research undertaken by Rainforest Foundation Norway[10] suggests that the reduction in use of PFAD compared to 2016 has been more than compensated by a significant increase in the supply of palm oil biodiesel.

U.S.

In the U.S., palm oil based biodiesel is not an approved pathway to supply biofuels eligible to meet the biomass based diesel mandate of the Renewable Fuel Standard, but several facilities processing palm oil are eligible to supply palm oil based biodiesel as 'renewable fuel'[11]. The ICCT estimates (Searle 2017) that in 2016 there were about 400 million litres of palm oil biodiesel imported to the U.S. from Indonesia, and notes an additional ~800 million litres of biodiesel imports from Singapore and Finland, which could include a significant amount of palm oil derived HVO from facilities operated by Neste.[12]

The commencement of palm oil biodiesel imports to the United States for compliance with the Renewable Fuel Standard coincided with a significant uptick in the price of 'D6 RINs', the certificates awarded for the supply of 'renewable fuels' in the U.S. As of August 2017, the D6 RIN had a value of about 40 cents per litre, which the ICCT believe is "highly likely to incentivize continued imports of [biomass based diesel] from Indonesia" (Searle 2017).

It is difficult to predict the potential future role of palm oil based biodiesel in the Renewable Fuel Standard. Given the weight of lifecycle analysis evidence that palm oil biodiesel drives very large indirect land use change emissions (Malins 2012, 2017a), it is considered unlikely that palm oil biodiesel will ever be made eligible for biomass based diesel or advanced biofuel RINs under the RFS (assuming that the eligibility rules are not changed). The grandfathering that has allowed imports to date to count towards the renewable fuel mandate, however, will continue until 2022. The situation is further complicated by the potential application of countervailing

9 https://www.platts.com/latest-news/agriculture/london/norway-tightens-regulations-on-use-of-pfad-for-26427825

10 Private communication with Rainforest Foundation Norway.

11 This is the same category as corn ethanol is supplied in, but the credits available for supplying bio-fuel categorised as 'renewable fuel' are less valuable than those for biomass-based diesel.

12 Cf. https://www.theicct.org/blogs/staff/unexpected-tax-bill-for-imported-palm-oil-biodiesel

tariffs on Indonesian biodiesel by the U.S. Government, which accuses Indonesia of dumping unfairly subsidised product.[13]

Table 7 details scenarios for U.S. demand for palm oil as biodiesel feedstock for the period 2020 to 2030.

Table 6. Potential direct palm oil demand for U.S. biodiesel (2020-2030)

Scenario	Description	Palm oil demand (million tonnes)		
		2020	2025	2030
High	Palm oil and/or PFAD biodiesel use grows under revised rules	1.5	1.8	2.1
Medium	Use of palm oil remains steady to 2030	0.7	0.7	0.7
Low	Grandfathering removed, no support in 2030	0.7	0	0

China

In 2014, China imported about 900 million litres of Indonesian biodiesel, contextualised by high fossil diesel prices (Anderson-Sprecher and Ji 2015; Kim and Anderson 2017). This appears however to have been a temporary phenomenon, and no significant imports are reported for 2015 and 2016. In the longer term, there remains interest on the Indonesian and Malaysian side in providing palm oil as feedstock to support growth in Chinese biodiesel use.[14] China's 13th Five year Plan sets a goal of 2 million tonnes of biodiesel consumption in China by 2020, which (if domestically produced) would require a fourfold increase compared to 2017 production (Kim and Anderson 2017). China's national biodiesel/diesel standard is B5, and full supply of B5 in China would require about 9 million tonnes of biodiesel (Palm Oil Agribusiness Strategic Policy Institute 2017). While an increase in palm oil imports to support a growing biodiesel sector is possible, it is not clear at this time whether the Chinese Government is seriously interested in pursuing that avenue. We therefore assume no demand from China for palm oil for biodiesel in the low scenario, but in the high scenario take the case that China delivers full B5 biodiesel supply based on palm oil by 2030 (Table 7).

13 https://www.commerce.gov/news/press-releases/2017/08/us-department-commerce-issues-affirmative-preliminary-countervailing

14 https://www.nst.com.my/business/2017/08/271666/malaysia-indonesia-talks-china-b5-biodiesel-programme?lipi=urn%3Ali%3Apage%3Ad_flagship3_pulse_read%3BBpzwq1s6R6CAwlhJgrFheg%3D%3D, http://www.en.netralnews.com/news/business/read/5759/indonesia.set.to.increase.cpo.export.to.china, http://palmoilmagazine.com/index.php/news/detail/the-government-will-boost-the-cpo-export-to-china

Table 7. Potential direct palm oil demand for Chinese biodiesel (2020-2030)

Scenario	Description	Palm oil demand (million tonnes)		
		2020	2025	2030
High	50% palm oil in 2020 biodiesel target, B5 from 100% palm oil by 2030	1	4	9
Medium	50% palm oil in 2020 biodiesel target, no further growth	1	1	1
Low	No palm oil for biodiesel	0	0	0

Japan

Japan has only a limited programme of support for the use of transport biofuels, and this is expected to be met in 2017 more or less entirely through the supply of ETBE (ethyl tert-butyl ether) (Iijima and Paulson 2017), which does not use vegetable oils as feedstock. Currently, demand for palm oil is more likely to come from Japan's support for stationary renewable power generation. It has been reported[15] that the Japanese Government has provided approval for up to 5 gigawatts of palm oil fired renewable power generation. According to calculations by the Japanese Biomass Power Association, operating those facilities would consume about 9 million tonnes of palm oil annually.

This would be a large additional source of palm oil demand, but it remains unclear whether these facilities will actually all be built and operated. We understand that current capacity is only 40 megawatts, and Bloomberg report that currently power plants use an oil that is "a byproduct from refining the edible kind", likely PFAD, and that the Biomass Power Association anticipates that at most 20-30% of the approved facilities will be built. This would require a more modest 2-3 million tonnes of palm oil imports.

There is still considerable uncertainty about how the Japanese renewable power programme will develop, whether approved palm oil power plants will in fact be built, and whether the Japanese government will further regulate the use of palm oil to ensure sustainability of the programme. The Bloomberg article notes that, "the official in charge of the incentive program at the Ministry of Economy, Trade and Industry, said it plans to have more discussions with the government-appointed tariff-setting committee to ensure the program remains 'sustainable.'" Given these uncertainties, and the small size of the existing market, we have not included significant growth in demand from Japan in the analysis in this paper. It is to be hoped that given that the goals of the Japanese renewable power programme are environmental, limits will be placed on the combustion of palm oil that will prevent it from turning into a major market.

15 https://www.bloomberg.com/news/articles/2017-11-07/where-green-incentives-chop-down-palm-trees-in-search-for-fuel

Aviation

The aviation industry is potentially a large user of biofuels. Alternative fuel scenarios presented at the 2017 International Civil Aviation Organisation (ICAO) Conference on Aviation and Alternative Fuels (CAAF2) have biofuels meeting 4% to 100% of aviation fuel demand in 2050. As illustrated in Figure 13, ICAO has considered scenarios in which aviation alternative fuel demand ranges from 9 to 69 million tonnes in 2030, and from 20 to 570 million tonnes by 2050. A scenario with 50% eventual substitution of aviation fuel by renewable jet fuel is identified as the "inspirational ICAO Vision 2050" (ICAO Secretariat 2017b). This scenario requires 46 million tonnes of alternative aviation fuel by 2030.

There are two main families of production processes to produce drop-in aviation biofuel – the process of hydrotreating vegetable oils or fats, which is already commercially operational, and various processes able to convert generic biomass into fuel through thermochemical and biochemical processing, which are not yet operational at commercial scale. The availability of the hydrotreating process means that aviation biofuel production could potentially be a large consumer of vegetable oils.

ICAO note that short term growth could be achieved by directing "large quantities of HEFA[16]-diesel" to aviation (ICAO Secretariat 2017c), which could include palm oil based fuels. As noted above, palm oil is currently a favoured feedstock for many producers of HEFA/HVO diesel. It is generally the lowest priced virgin vegetable oil available, making it appealing on financial grounds as a HVO feedstock, and therefore in the absence of any regulatory barriers[17] might be likely to make a substantial contribution to the 2030 aviation biofuel supply.

16 Hydro-processed esters and fatty acids (HEFA) is another term for HVO diesel.

17 The difficulty of imposing strong sustainability governance on aviation biofuels is illustrated by reports that proposed rules are likely to be dramatically weakened due to opposition from some ICAO member nations: https://www.reuters.com/article/us-climatechange-aviation/u-n-aviation-agency-recommends-weaker-rules-for-biofuels-sources-idUSKBN1DA2JT

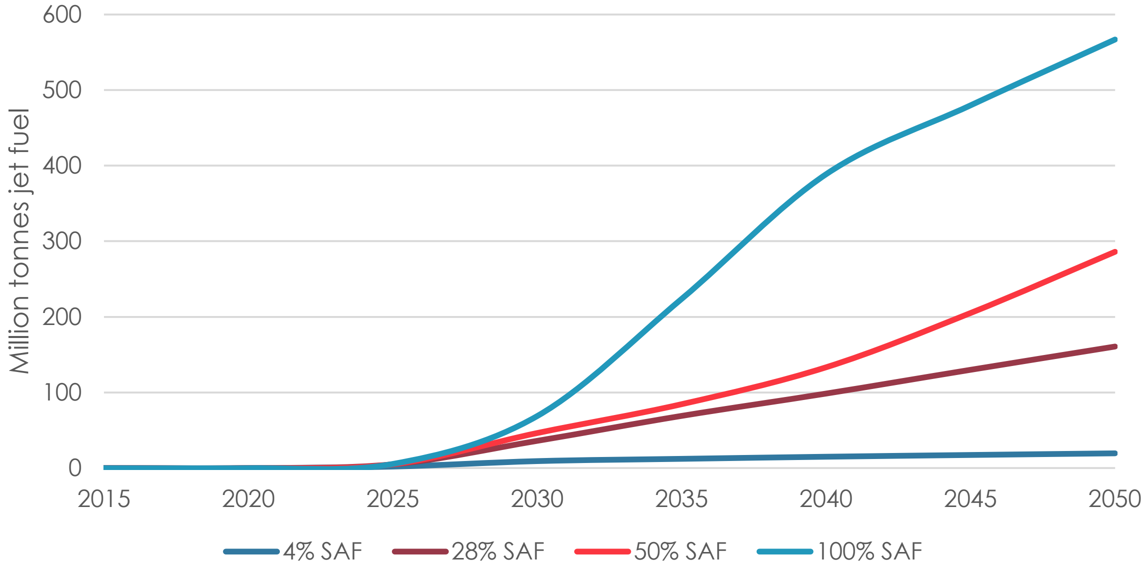


Figure 13. Aviation alternative fuel demand scenarios

Source: ICAO Secretariat (2017c)

The Government of Indonesia has already set targets for the use of alternative fuels in domestic aviation, rising to 5% by 2025 (Government of Indonesia 2015), although it has noted that "the industry is very reluctant to its implementation" (Government of Indonesia 2017). This target, if met, will almost certainly be met with hydrotreated palm oil, requiring 320 million litres of renewable jet fuel by 2025 (Widiyanto 2017).

It is exceedingly difficult at this time to make any convincing prediction about how the aviation alternative fuel market may develop. The level of aspiration for alternative fuel volumes espoused by ICAO and the aviation industry is huge, but to date there has been only very limited success in deploying alternative aviation fuel at scale. The European Advanced Biofuels Flightpath[18] called for 2 million tonnes of alternative jet fuel by 2020, a target that will be missed by an order of magnitude, and U.S. initiatives such as the 'farm to fly' target for a billion gallons of aviation biofuel by 2018 are falling similarly short. Identifying likely feedstocks is also challenging. While the aviation industry consistently refers to 'sustainable' alternative fuels, it is unclear what sustainability requirements might be imposed, and the current proposal would set a minimum carbon saving of only 10% (ICAO Secretariat 2017a). Such modest climate benefits fall well short of what is required by most existing sustainability standards for alternative fuels. It is also unclear whether the policy frameworks that are currently in prospect (such as "CORSIA", ICAO Secretariat 2017a) will be adequate to bring alternative fuels into the jet fuel market.

If the aviation industry moves ahead with ambitious volume targets for biofuel deployment, there is currently considerable risk that this will include a very large increase in palm oil demand. On the other hand it seems perfectly plausible that deployment will stall, with very

18 https://ec.europa.eu/energy/en/topics/biofuels/biofuels-aviation

little demand being generated, and that the high aspirations for the use of alternative fuels in aviation in 2030 will fail to materialise. Table 8 provides illustrative scenarios for potential palm oil demand for aviation fuel.

Table 8. Potential direct palm oil demand from alternative aviation fuels (2020-2030)

Scenario	Description	Palm oil demand (million tonnes)		
		2020	2025	2030
High	Alternative jet deployment based on 'Inspirational ICAO Vision 2050', palm oil as 25% of feedstock	0.4	1.3	11.6
Medium	ICAO 28% jet fuel scenario, 15% from palm oil	0.2	0.8	5.4
Indonesia only	Indonesia meets 2025 target, no other palm oil based jet	0.2	0.3	0.3
Low	Indonesia achieves 50% of 2025 target	0.1	0.1	0.1

Overview of direct demand

Table 9 and Figure 14 provide an overview of potential palm oil demand for biofuel feedstock between 2020 and 2030. If demand declines in the EU and U.S., and other programmes fail to meet their targets, overall demand could remain static. If, on the other hand, U.S. and EU demand fails to reduce, and programmes in Southeast Asia and in aviation expand rapidly, demand could rise dramatically. The 'high' scenario involves a more than 500% increase on current palm oil consumption for biofuels, driven mainly by Indonesia, China and the aviation sector. Of course, in reality it may be that some programmes drive increased consumption while others shrink, resulting in an intermediate outcome.

Table 9. Scenarios for direct palm oil demand for biofuel feedstock

Demand in million tonnes	2020			2025			2030		
	Low*	Medium	High	Low	Medium	High	Low	Medium	High
Indonesia	2.5	4	12.9	4	6.9	15.9	5.5	12.2	18.6
Malaysia	0.7	1.2	1.8	0.9	1.5	2.4	1.0	1.8	3.6
Thailand	1.2	1.3	2.5	1.3	1.6	3.3	1.5	1.9	4.3
EU	2.9	3.1	3.3	1.3	2.5	3.7	0.9	2.2	4.1
Norway	0.1	0.1	0.2	0	0.1	0.2	0	0.1	0.3
U.S.	0.7	1.0	1.5	0	0.7	1.4	0	0.7	2.1
China	0	0	1.0	0	0	4.0	0	0	9.0
Aviation	0.1	0.2	0.4	0.1	0.8	1.3	0.1	5.4	11.6
Total	**8.2**	**10.9**	**23.6**	**7.6**	**14.1**	**32.2**	**9**	**24.3**	**53.6**

**In all cases, the 'low' case for 2020 reflects estimated current consumption.*

Scenarios are based on information documented above and author's expert judgement.

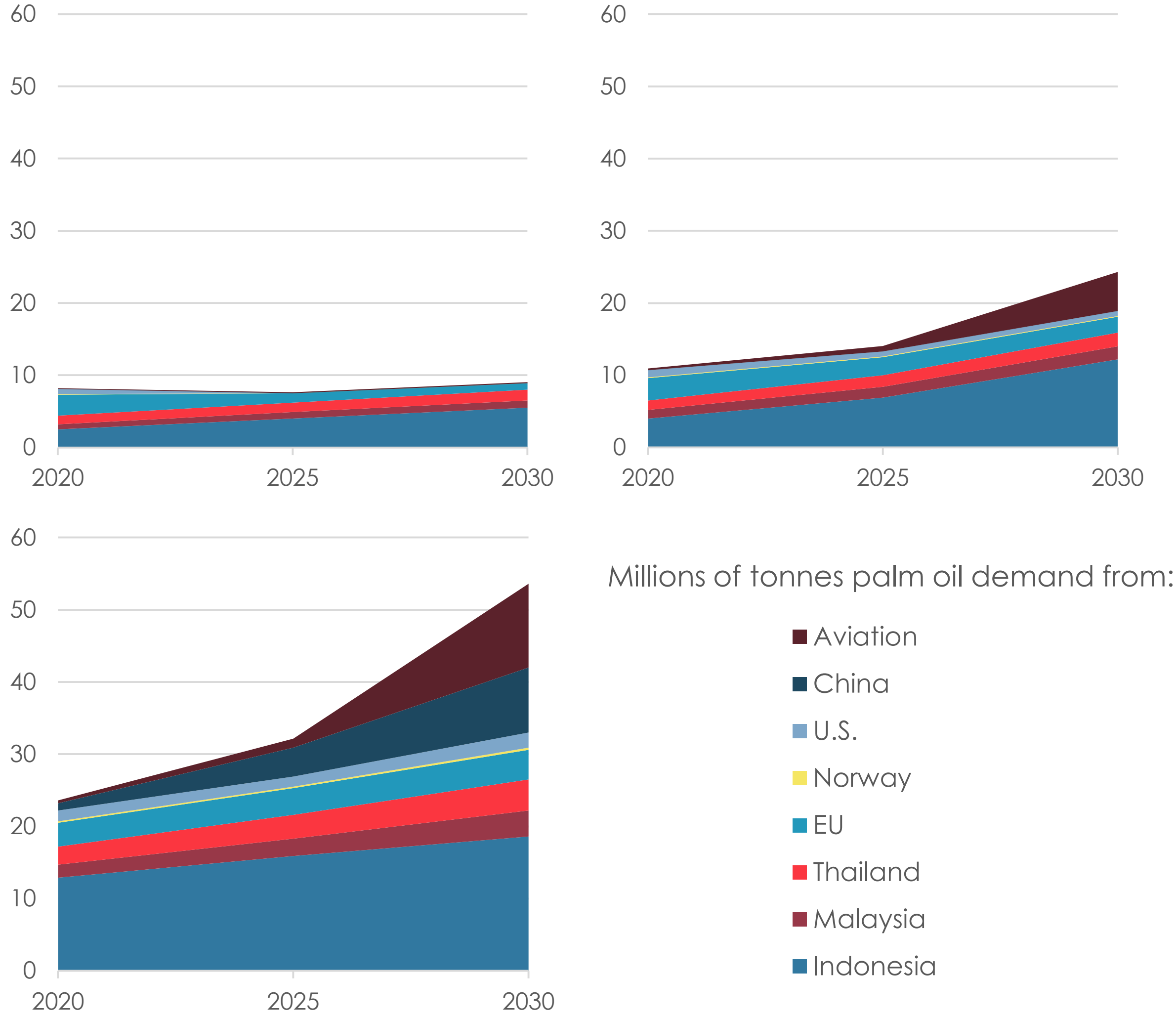


Figure 14. Low, medium and high (clockwise from top left) scenarios for increase in direct demand for palm oil as biofuel feedstock from 2020 to 2030

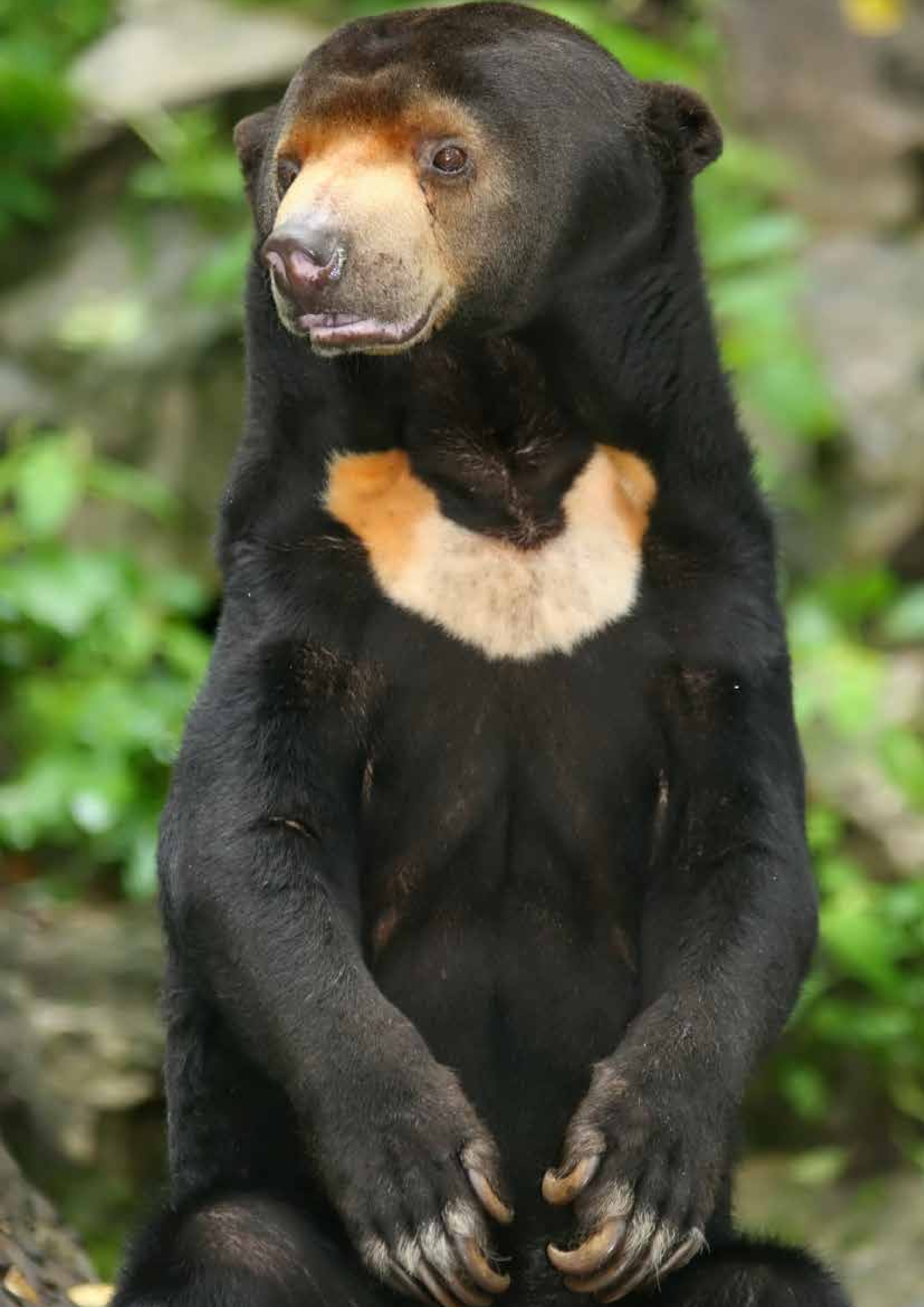
Indirect palm oil demand to due to consumption of other vegetable oil biodiesel

Palm oil demand is not only increased by the direct use of palm oil as a biodiesel feedstock, but can also be driven up by the increased vegetable oil demand that results when biofuel programmes use other oils, such as rapeseed and soy (Malins 2013). Future palm oil demand will therefore be dependent on not only direct demand from biodiesel processors, but also on indirect demand increases if other oils are displaced out of the food, feed and pharmaceuticals sectors and into the fuel sector.

European Union

In the EU, analysis of indirect land use change expected from increased biofuel demand provides predictions of the impact of demand for other biodiesel feedstocks on palm oil demand. As noted by Malins (2013), modelling by the International Food Policy Research Institute using the MIRAGE model (Laborde 2011) finds that palm oil can also account for as much as 48% of additional global vegetable oil production when use of other feedstocks for biodiesel production increases. Similarly, modelling with GLOBIOM (Valin et al. 2015) suggests that palm oil can constitute up to 40% of additional vegetable oil production when demand for other feedstocks increases. The mix of additional production resulting from biodiesel demand increases for the MIRAGE and GLOBIOM modelling exercise respectively is illustrated in Figure 15 and Figure 16.[19]

19 This analysis is based on additional data kindly shared by the two modelling teams.



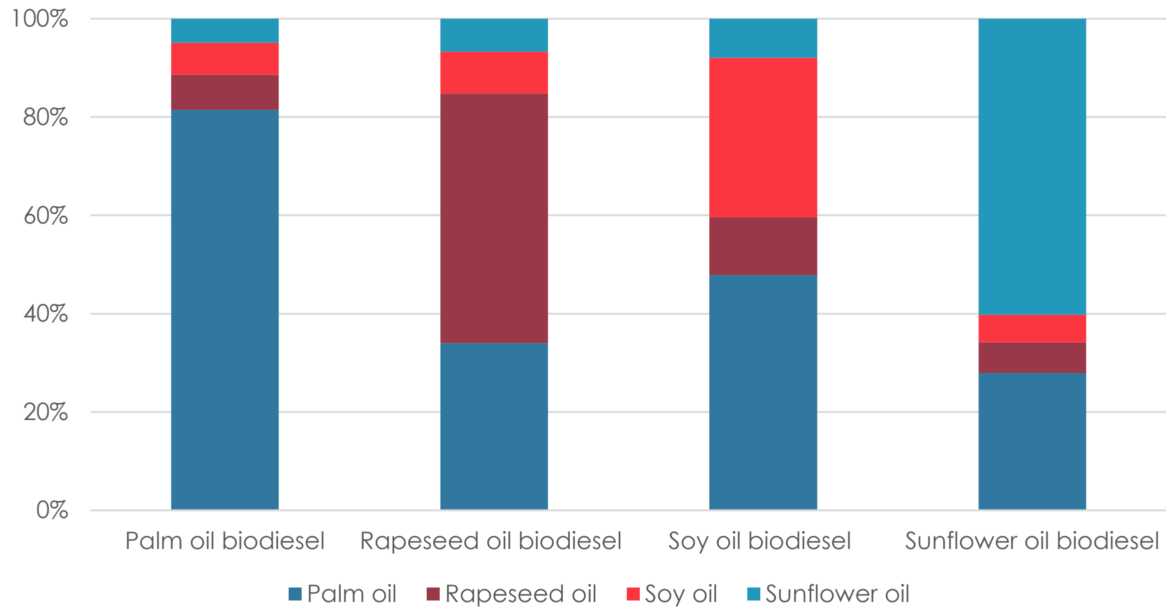


Figure 15. Increases in vegetable oil production in response to demand for different biodiesel feedstocks in MIRAGE (Laborde 2011)

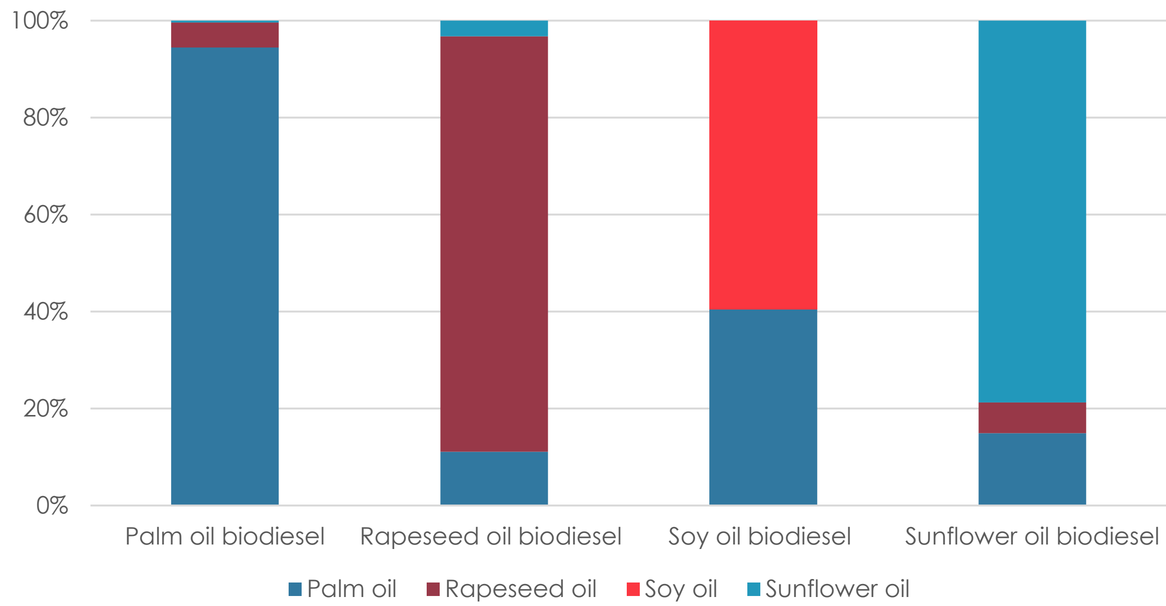


Figure 16. Increases in vegetable oil production in response to demand for different biodiesel feedstocks in GLOBIOM (Valin et al. 2015)

These results suggest that if EU demand for biodiesel from vegetable oils is maintained at current levels instead of being phased out, this will result in not only direct palm oil demand for use as feedstock but also indirect demand to replace other vegetable oils taken out of the food market to produce biodiesel. In 2030, assuming a continued 7% limit on the use of food-based biofuels in the EU transport energy mix, EU demand for virgin vegetable oil for biodiesel production is expected to be 16 million tonnes, split as shown in Figure 17 (Malins 2017b).

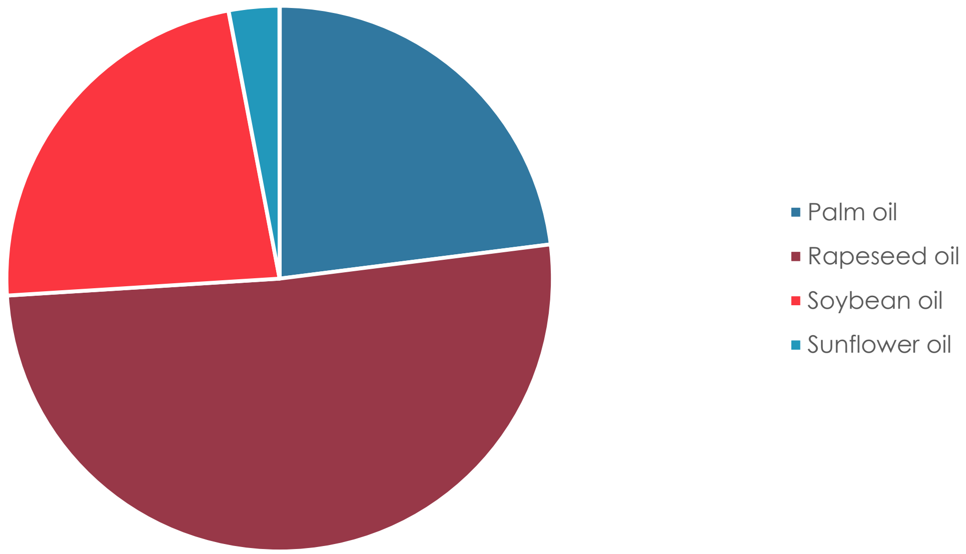


Figure 17. Expected feedstock split for EU biodiesel, 2030

Feedstock split based on GLOBIOM modelling for 2020

Combining the expected 2030 vegetable oil demand in the case of continuing a 7% cap in EU policy with the values from MIRAGE and GLOBIOM for the effect of increased use of soy/rapeseed/sunflower oil on palm oil demand, and an assumption about the fraction of demand that might be met through some combination of yield improvement and reduced food consumption[20], it is possible to get a first order estimate of potential indirect palm oil demand in 2030. Indirect demand for palm oil due to continued EU biodiesel production is anticipated to be 1.2-2.3 million tonnes.

An alternative way to consider this question is by looking at EU vegetable oil import data. As established above in Figure 5 and Figure 6, domestic EU vegetable oil production has not kept up with biodiesel demand, and imports have risen to fill part of the gap. Figure 18 shows that most of this growth in vegetable oil imports, 4.5 out of 6.9 million tonnes from 2000 to 2013, has come from palm (and palm kernel) oil. This is similar to the sum of the direct palm oil demand for biodiesel in the EU identified in the previous chapter (about 2.5 million tonnes) with the 1.2-2.3 million tonnes of indirect demand estimated above.

20 We assume that 50% of increased vegetable oil demand from biodiesel producers comes from a combination of these two effects.

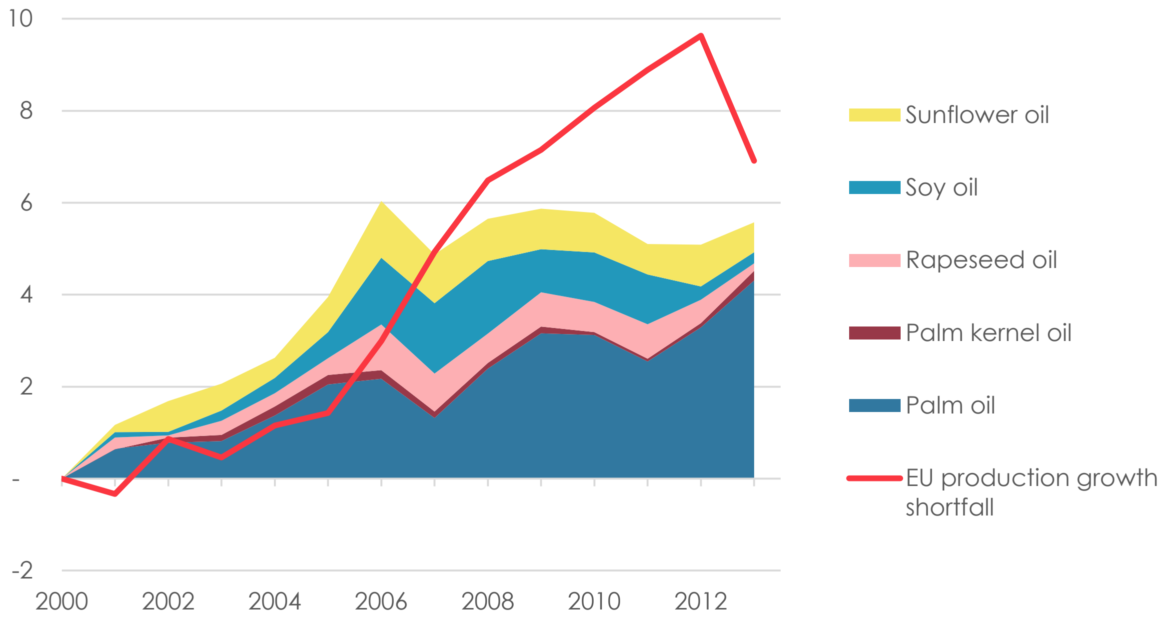


Figure 18. EU growth in net imports of major vegetable oils against shortfall between biodiesel demand and vegetable oil production growth, 2000-2013

Scenarios for indirect palm oil demand due to EU biofuel policy are given in Table 11.

Table 10. Potential indirect palm oil demand from EU biofuel policy (2020-2030)

Scenario	Description	Palm oil demand (million tonnes)		
		2020	2025	2030
High	High estimate of current indirect demand, consumption of food-based biodiesel increases	2.3	2.8	3.2
Medium	Central estimate of current indirect demand, consumption of food-based biodiesel remains constant	1.7	1.7	1.7
Low	Low estimate for current indirect demand, production of food-based biodiesel is phased out	1.2	0.6	0.3

U.S.

The U.S. is not a large direct consumer of palm oil for biodiesel, but U.S. biodiesel programmes may still be driving overall demand. As was shown in Figure 5, U.S. biodiesel consumption has significantly outpaced increases in U.S. vegetable oil production since 2000. During this period, as shown in Figure 6, U.S. vegetable oil imports have risen to meet some of this excess demand, although it should also be noted that during this period soy oil exports actually increased from 600,000 tonnes in 2000 to 1.7 million tonnes in 2010, before falling back to 800,000 tonnes by 2013. Over half of the growth in net imports has come from palm oil and palm kernel oil. Figure 19 shows that a growing shortfall in U.S. vegetable oil production due to biodiesel demand growth has been partly met by increased imports of palm (and palm kernel) oil and rapeseed oil. It is reasonable to conclude that had there not been a 4.9 million tonne growth in biodiesel consumption in the U.S. from 2000 to 2013, the parallel 1.3 million tonne increase in palm oil imports would not have been necessary.

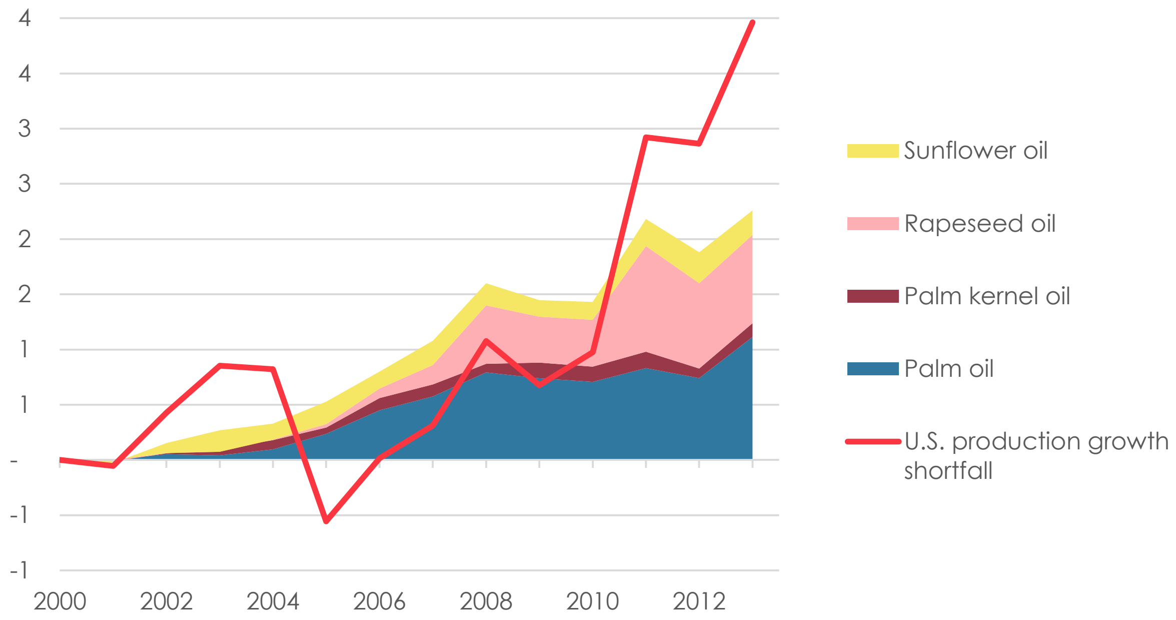


Figure 19. U.S. growth in net imports of major non-soy vegetable oils against shortfall between biodiesel demand and vegetable oil production growth, 2000-2013

Table 11. Potential indirect palm oil demand from U.S. biofuel policy (2020-2030)

Scenario	Description	Palm oil demand (million tonnes)		
		2020	2025	2030
High	High estimate of current indirect demand, consumption of food-based biodiesel increases rapidly	2.5	3.0	3.6
Medium	Central estimate of current indirect demand, consumption of food-based biodiesel increases	1.9	2.1	2.3
Low	Low estimate for current indirect demand, production of food-based biodiesel remains constant	1.3	1.3	1.3

The U.S. biomass based diesel mandate has continued to grow since 2014, and is set at about 7 million tonnes for 2018[21]. Assuming that the contribution of imported palm oil to meeting this demand remains roughly constant, this suggests that palm oil imports to the U.S. are likely about 1.9 million tonnes higher than they would be in the absence of a biodiesel mandate.

Brazil and Argentina

Brazil consumes 3 million tonnes of biodiesel per year, the largest programme in the world behind the U.S. and EU. Unlike these two regions, domestic vegetable oil production growth in Brazil has more or less kept up with biodiesel demand growth (Figure 20), and palm oil imports are relatively small (about 430 thousand tonnes in 2013). While Brazilian biodiesel demand will certainly have had some transmitted impact on palm oil demand by reducing availability of soy oil for other purposes, it is likely modest compared to the other markets discussed here. The situation is similar for Argentina.

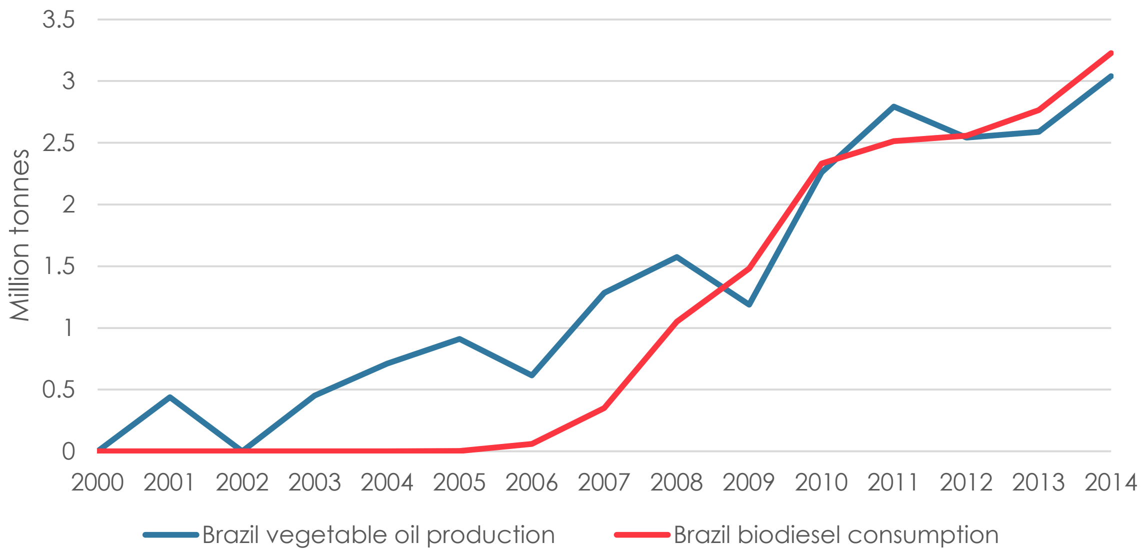


Figure 20. Growth in Brazilian vegetable oil production and biodiesel consumption, 2000-14

Aviation

As well as the direct impact of aviation through increasing palm oil demand as feedstock, aviation could increase palm oil demand indirectly if it uses large volumes of other vegetable oils, or indeed if it uses large volumes of by-product oils (Malins 2017c). The actual impact on palm oil markets will depend heavily on the level of use of hydrotreated alternative jet as opposed to other biomass to liquids technologies. Table 12 presents scenarios for potential indirect palm oil demand from aviation biofuel.

21 https://www.epa.gov/renewable-fuel-standard-program/final-renewable-fuel-standards-2017-and-biomass-based-diesel-volume

Table 12. Potential indirect palm oil demand from alternative aviation fuels (2020-2030)

Scenario	Description	Palm oil demand (million tonnes)		
		2020	2025	2030
High	Alternative jet deployment based on 'Inspirational ICAO Vision 2050', palm indirectly meets additional 15% of feedstock production demand	0	0.8	7.0
Medium	ICAO 28% jet fuel scenario, palm indirectly meets additional 15% of feedstock production demand	0	0.8	5.4
Low	No HVO jet fuel outside Indonesia	0	0	0

Overview of indirect demand

Table 13 provides an overview of potential indirect palm oil demand to compensate use of other vegetable oils for biofuel feedstock between 2020 and 2030. The assessment of indirect demand potential is limited to the EU, U.S. and the aviation sector. Other nations' biodiesel programmes are also likely to cause indirect increases in palm oil demand, but these three markets are considered likely to be the largest. If the EU phases out biodiesel demand based on concerns about ILUC and the aviation industry pursues advanced technologies for biomass to liquids rather than vegetable oil hydrotreating, indirect demand could be reduced. If instead programmes for vegetable oil biofuel are maintained or expanded, indirect palm oil demand could increase considerably by 2030.

Table 13. Scenarios for indirect palm oil demand to replace biofuel feedstock

Demand in million tonnes	2020			2025			2030		
	Low	Medium	High	Low	Medium	High	Low	Medium	High
EU	1.2	1.7	2.3	0.6	1.7	2.8	0.3	1.7	3.2
U.S.	1.3	1.9	2.5	1.3	2.1	3.0	1.3	2.3	3.6
Aviation	0.0	0.0	0.0	0.0	0.8	0.8	0.0	5.4	7.0
Total	**2.5**	**3.6**	**4.8**	**1.9**	**4.6**	**6.6**	**1.6**	**9.4**	**13.8**

Overall demand scenarios

Table 14 and Figure 21 details the overall demand implications of combined direct and indirect palm oil demand in the three scenarios.

Table 14. Scenarios for total demand for palm oil due to biofuel consumption, 2020-2030

Demand in million tonnes	2020			2025			2030		
	Low*	Medium	High	Low	Medium	High	Low	Medium	High
Indonesia	2.5	4	12.9	4	6.9	15.9	5.5	12.2	18.6
Malaysia	0.7	1.2	1.8	0.9	1.5	2.4	1	1.8	3.6
Thailand	1.2	1.3	2.5	1.3	1.6	3.3	1.5	1.9	4.3
EU	4.1	4.8	5.6	1.9	4.2	6.5	1.2	3.9	7.3
Norway	0.1	0.1	0.2	0	0.1	0.2	0	0.1	0.3
U.S.	2	2.9	4	1.3	2.8	4.4	1.3	3	5.7
China	0	0	1	0	0	4	0	0	9
Aviation	0.1	0.2	0.4	0.1	1.5	2	0.1	10.8	18.6
Total	**10.7**	**14.5**	**28.4**	**9.5**	**18.6**	**38.7**	**10.6**	**33.7**	**67.4**

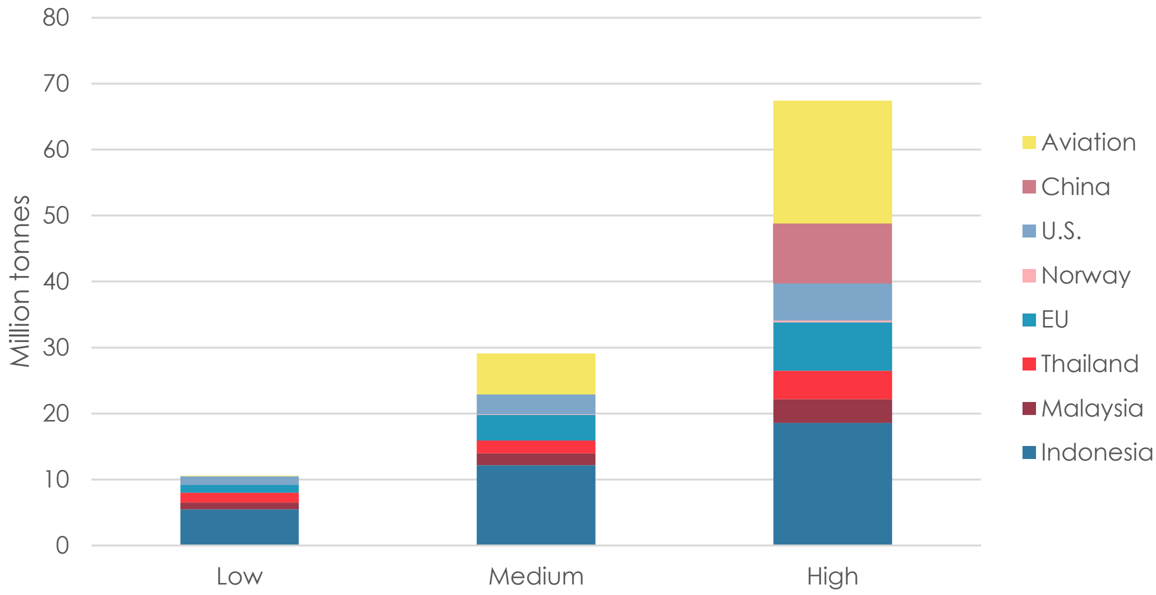


Figure 21. Total palm oil demand due to biofuel policy in 2030 by scenario

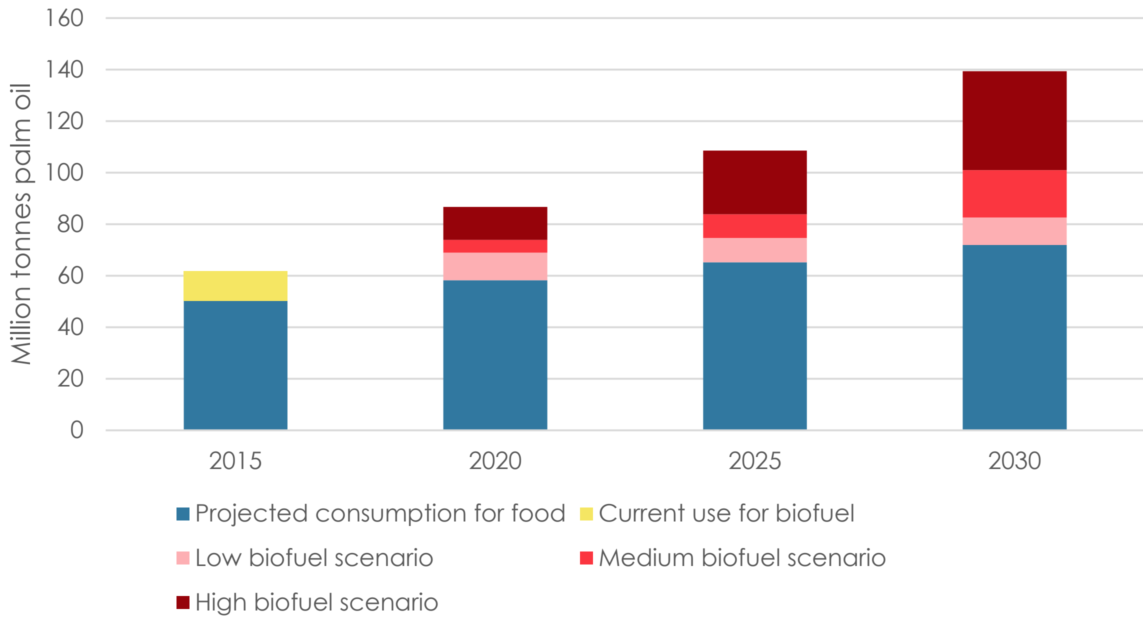


Figure 22. Scenarios for demand for palm oil from biofuels compared to projected palm oil consumption for food and other uses

Data on projected consumption for food from (OECD and FAO 2017)

It is important to note that we have not applied any feedback on projected demand for palm oil for food in Figure 22, and that in reality such a large increase in palm oil demand from the biofuel sector (and accompanying price increases) would be expected to suppress demand for palm oil from other sectors significantly (Malins 2017b).

Impact on forest and peat

There is a long history of competition in Southeast Asia between expanding agriculture and tropical forests. Oil palm plantations thrive in the climate required for tropical rainforest growth, and the rapid expansion of the oil palm estate over recent decades has been strongly linked to deforestation.

Deforestation and peat destruction are major CO_2 emissions sources, and therefore a biofuel programme that leads to deforestation and peat drainage may undermine its own climate protection goals (Malins 2017a). Destruction of above and below ground biomass on a hectare of tropical forest results on average in 500 - 1000 tonnes of CO_2 emissions per hectare (Malins 2010; Petrenko, Paltseva, and Searle 2016; Plevin et al. 2014). Soil carbon is also likely to be reduced by conversion to oil palm. For plantations on mineral soils, this could result in an additional 150 tonnes CO_2 emissions (Germer and Sauerborn 2008). For plantations on peat soils, the emissions consequences are even larger, on average about 106 tonnes of CO_2 emissions per year for decades following drainage (Page et al. 2011).

Indonesia

Abood et al. (2015) provides an indication of the extent to which palm oil plantation expansion was associated with forest loss in Indonesia in the decade from 2000 to 2010, as total harvested palm area in Indonesia rose dramatically from 2 million hectares to 6 million hectares. They used satellite images to assess the rate of forest loss observed within identified industrial palm oil concessions. In that decade, there was one million hectares of observed lowland deforestation in palm oil concessions, and a further 500 thousand hectares of peat swamp deforestation, a loss of nearly 2% of Indonesian forested area. This rate of deforestation for palm oil expansion in Indonesia is similar to the total rate of annual deforestation in Argentina or Cambodia (Mongabay 2005). Over the period, 23% of forest loss in Kalimantan occurred in palm oil concessions. Deforestation in palm oil concessions, and associated peat decomposition, is estimated to have resulted in the release of 1.3 to 2.3 billion tonnes of CO_2 over the decade. This is roughly equal to a whole year's CO_2 emissions from Russia, and makes Indonesian palm oil concessions roughly comparable to the whole economy of Venezuela, Pakistan or the Netherlands in terms of annual climate pollution.[22]

Carlson et al. (2013) provides an even higher estimate of forest loss in this period, a total of at least 1.6 million hectares in Kalimantan (Indonesian Borneo) alone, of which 400 thousand hectares occurred on peat soils (Figure 23). This suggests that at least 70% of new oil palm plantations developed in Kalimantan were developed at the expense of primary or secondary (logged) forest, or of agro-forestry plantations. The difference in forest loss estimates between Carlson et al. (2013) and Abood et al. (2015) may reflect different categorisation of agro-forest or degraded forest areas, and the fact that Abood et al. (2015) considers only deforestation in government registered concessions. Gaveau et al. (2016), assessing land use changes in the period 1973 to 2015, argue that Carlson et al. (2013) may have overstated the role of plantation development in driving deforestation due to failing to control for the length of the period between deforestation and plantation development, arguing that in some cases

22 National CO2 emissions data from (Joint Research Centre 2017).

deforestation was likely the responsibility of the timber industry, and plantations were only established later, but notes that this type of delay before plantation establishment has been much less prevalent since 2005 than in the earlier period of oil palm expansion, and finds that more than 50% of new industrial plantations in Borneo in the period 2005-2015 were planted within 5 years of deforestation occurring.

Vijay et al. (2016) provides a similar picture. Based on studying satellite images for a sample of palm oil plantations in 20 countries, they conclude that approximately 54% of palm oil area in Indonesia came through deforestation in the period 1989-2013 (based on sampling 3% of palm oil area). Whereas in some countries (including Thailand and Colombia) oil palm plantation establishment generally followed several years after deforestation had occurred, for Malaysian and Indonesia “deforestation in sample sites mirrors oil palm plantation expansion.”

Satellite mapping of palm plantations in Indonesia (Miettinen, Al Hooijer, et al. 2012; Miettinen, Aljosja Hooijer, et al. 2012) shows that from 2000 to 2010 a total of 770 thousand hectares of new oil palm was planted on drained peat soils in Indonesia, of which 350 thousand hectares of land use change occurred in the period 2007-2010. Comparing to FAOstat data for increase in harvested palm oil area, they find that 28% of palm expansion in the period 2007-2010 was on peatland. Comparing instead to Indonesian national statistics for planted palm area (Indonesian Central Bureau of Statistics 2017) suggests a slightly lower fraction (19%) of new plantations requiring peat drainage in that same period. A review of expectations for rate of expansion of palm plantations onto peat for indirect land use change modelling for the European Commission with the GLOBIOM model (Valin et al. 2015) anticipated that 32% of new oil palm plantations in Indonesia would require peat drainage.

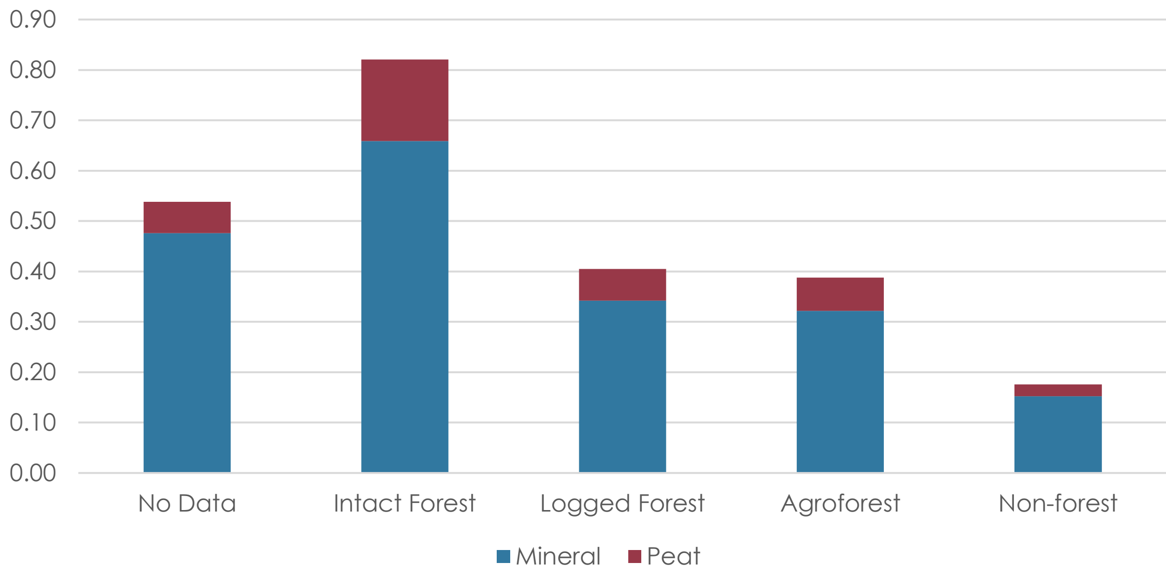


Figure 23. Land types cleared for oil palm plantations in Kalimantan, 2000-2010

Source: Carlson et al. (2013)

Malaysia

There is a similarly strong link between oil palm expansion and deforestation in Malaysia. Since 2000, the palm oil estate in Malaysia has expanded by 2.4 million hectares, half of this in the Bornean province of Sarawak (Figure 24). Peat destruction and deforestation associated with palm expansion is endemic to Sarawak. SARVision (2011) document 900 thousand hectares of deforestation in Sarawak from 2005-2010, including at least 230 thousand hectares of peat forest lost to oil palm plantations. Miettinen, Al Hooijer, et al. (2012) estimate that over 80% of palm oil expansion in Sarawak occurred on peat soils in the period 2007-2010. Vijay et al. (2016) find that 40% of palm oil area in Malaysia came through deforestation in the period 1989-2013 (based on sampling 5% of the area). A review of expectations for rate of expansion of palm plantations onto peat for indirect land use change modelling for the European Commission with the GLOBIOM model (Valin et al. 2015) anticipated that 34% of new oil palm plantations in Malaysia would require peat drainage.

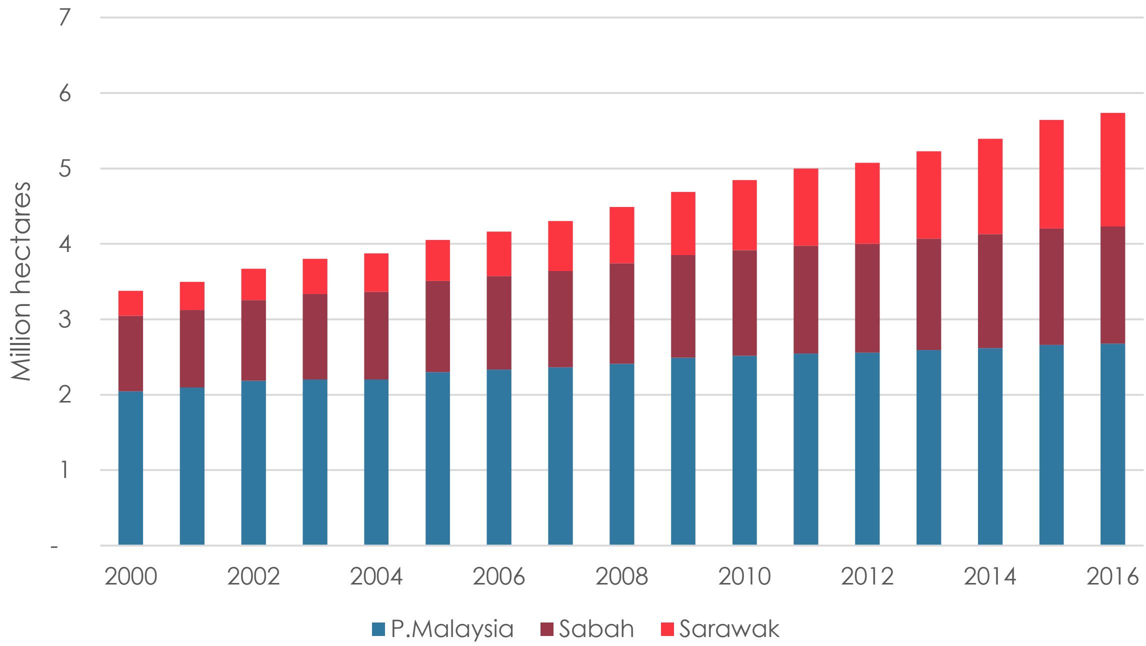


Figure 24. Planted palm oil area in Malaysia, 2000 – 2016

Source: MPOB

Expected rate of future encroachment on forest and peatland

Using data from the literature indicating the fraction of new palm plantations established at the expense of deforestation and peat drainage, and national statistics regarding planted area of oil palm plantations, it is possible to provide an indication of the rate of deforestation and peat drainage that might be expected due to future palm oil expansion. This is provided in Table 15.

Table 15. Potential fraction of future palm oil expansion associated with deforestation and peat loss

	% deforestation for new plantations (author's estimate*)	% peat loss for new plantations (Valin et al. 2015)	% of new plantation area in each country, 2010-2015 (Indonesian Central Bureau of Statistics 2017; MPOB 2017)
Indonesia	50%	32%	78%
Malaysia	50%	34%**	22%

** To the best of our knowledge, there is a paucity of overall estimates in the literature for this value (available studies tend to be limited to a single region). Valin et al. (2015) predict 60% of land use change caused by palm expansion in Southeast Asia results in deforestation.*

*** This figure may fail to account for the high fraction of expansion occurring in Sarawak (66% of new area 2011-2016), where about 80% of recent expansion required peat drainage.*

The values given in Table 15 are based on the assumption that past land use change trends are a reasonable guide to future trends. There are still extensive areas of peat and forest within existing palm concessions (Carlson et al. 2013; Miettinen, Al Hooijer, et al. 2012), and there is no effective regulation in place at this time that would result in a fundamental change in land use change patterns, in either Malaysia or Indonesia. While a 'moratorium' has been placed on some aspects of peat and forest destruction in Indonesia, this has had limited impact on overall land use change patterns to date (Austin et al. 2014; Wijaya, Juliane, et al. 2017). It has been estimated that continuing the moratorium to 2020 in its current form would reduce deforestation by only 10% compared to business as usual palm expansion. (Wijaya, Chrysolite, et al. 2017) outline measures that could be taken to make the moratorium significantly more effective in reducing deforestation, but there is no guarantee at this time that any such measures will be implemented. Similarly, a public pledge to introduce a moratorium on new palm oil concessions, made by the President of Indonesia following forest fires in 2015, has not yet been actioned and seems likely to be forgotten.[23]

While many of the larger palm oil companies have made nominal commitments to reduce or eliminate deforestation in their supply chains, (Greenpeace 2017) note that a major initiative to reduce deforestation, the 'Indonesian Palm Oil Pledge' (IPOP) was disbanded in 2016 following adverse pressure from the Indonesian Government, and that there are multiple weaknesses in the systems that companies have put in place to manage deforestation risk.

Without robust measures that apply across the industry as a whole, it is difficult to see any fundamental change to land use change patterns occurring in the near future. Until such actions have been taken, it remains grossly environmentally irresponsible to continue to add pressure for more deforestation through government policy that drives ever increasing demand for palm oil consumption.

23 http://www.thejakartapost.com/news/2017/05/12/ngo-urges-jokowi-to-issue-moratorium-on-oil-palm-plantations.html

Land use change impact of palm oil demand scenarios and related CO_2 emissions

Oil palm plantations are expanding in both Indonesia and Malaysia. If demand for palm oil due to biofuel policy decreases, this expansion would be slowed. If, however, biofuel-related palm oil demand continues to increase, this will put a great deal of extra pressure on forest and peatlands, with potentially disastrous ecological consequences. Above, scenarios are drawn up for low, medium and high rates of direct and indirect palm oil demand due to biofuel policy. Delivering these volumes of palm oil will cause increased deforestation and increased peat drainage, unless there is a fundamental change in land use governance in both Malaysia and Indonesia. By combining the deforestation and peat loss fractions in Table 15 with the demand scenarios laid out in Table 9 and Table 13, it is possible to estimate the deforestation and peat loss impact that can be expected due to ongoing biofuel policies to 2030.

It is important to recognise that not all additional palm oil demand associated with biofuel policy will be met by expanding palm area. Just as when modelling indirect land use change, it is appropriate to recognise that some additional demand can be met by yield increase, and some by reducing demand in other sectors (Malins et al. 2014). Palm oil yields have been relatively stable for the last 20 years, especially in Indonesia (Figure 25). This may be partly explained by the increased use of peat soils, which are less agriculturally suitable (but have been favoured due to availability and lack of competition from other land users). It may also be a result of aging plantations going beyond their productive peak.

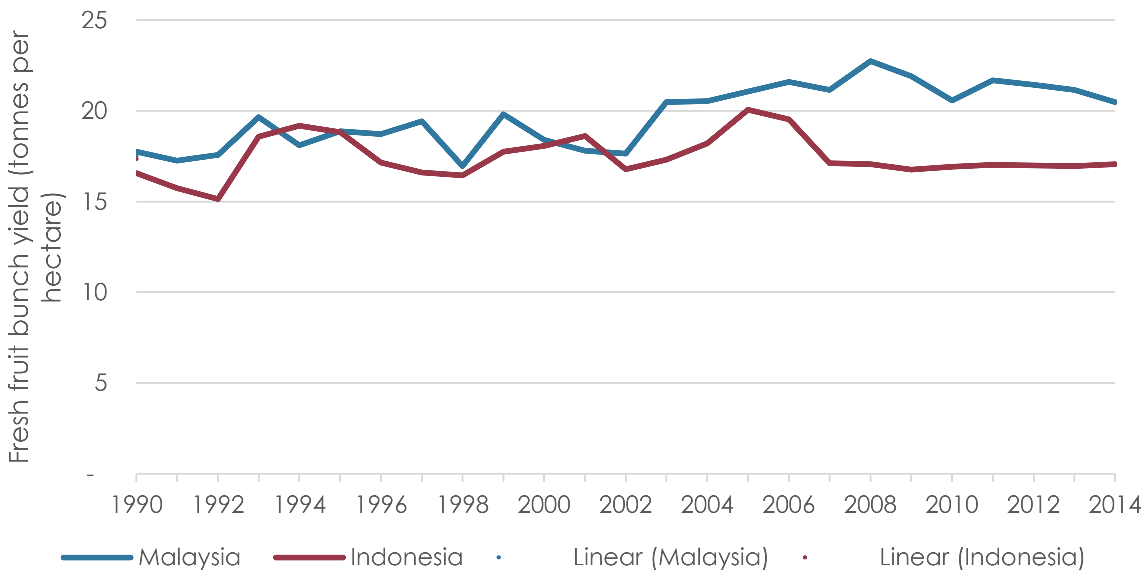


Figure 25. Palm oil yields in Indonesia and Malaysia

Given this persistent weakness of yields, it is assumed that only 10% of required palm oil comes from yield increases. It is assumed here that a further 33% of required palm oil is made available by reduced consumption in other sectors, primarily food (cf. Malins 2017b). The remaining 57%

is assumed to be met by area expansion at trend national yields[24], assuming 0.23 tonnes oil per tonne palm fruit, and split based on recent rates of area expansion in each country. Using these simple fractions for feedstock from additional area lacks the sophistication and detail of full ILUC modelling, but provides an indication of the likely scale of impact.

The resulting areas of potential additional deforestation and peat loss (compared to a case with no biofuel-induced demand for palm oil) are shown in Table 16. In total, in the highest scenario biofuel demand could drive 4.5 million hectares of additional deforestation by 2030, including 2.9 million hectares of additional peat loss, as compared to a scenario in which the use of palm oil for biodiesel feedstock is eliminated. This is an area similar to the size of the Netherlands or Switzerland. Of that, 3.1 million hectares and 2.1 million hectares respectively are associated with potential growth in biofuel demand between now and 2030.

Table 16. Scenarios for additional deforestation and peat loss due to palm oil demand from biofuel policy, against a case with no biofuel demand

Million hectares		2020			2025			2030		
		Low	Medium	High	Low	Medium	High	Low	Medium	High
Forest loss	Direct demand	0.6	0.7	1.6	0.5	0.9	2.2	0.6	1.6	3.6
	Indirect demand	0.2	0.2	0.3	0.1	0.3	0.8	0.1	0.3	0.9
	Total	**0.8**	**1.0**	**1.9**	**0.7**	**1.2**	**2.9**	**0.7**	**1.9**	**4.5**
Peat loss	Direct demand	0.4	0.5	1.0	0.4	0.6	1.4	0.4	1.1	2.3
	Indirect demand	0.1	0.2	0.2	0.1	0.2	0.5	0.1	0.2	0.6
	Total	**0.5**	**0.6**	**1.2**	**0.4**	**0.8**	**1.9**	**0.5**	**1.3**	**2.9**

Assuming 150 tonnes per hectare of biomass carbon stocks lost on forest conversion, these amounts of deforestation would result in between 400 million and 2 billion tonnes of carbon dioxide emissions (low vs. high scenarios). At 106 tonnes CO_2 emission per hectare per year, this amount of additional peat drainage would result in annual emissions of 50 to 270 million tonnes of carbon dioxide. Over twenty years of peat subsidence, that's between 1 billion and 5 billion tonnes of carbon dioxide emitted, equivalent in the worst case to a whole additional year of greenhouse gas emissions by the United States of America (Joint Research Centre 2017). Peat subsidence can continue for decades after land conversion (Page, S.E., Morrison, R., Malins, C., Hooijer, A., Rieley, J.O. Jaujiainen 2011).

Figure 26 shows an estimate of cumulative CO_2 emissions due to palm oil linked land use

24 22 tonnes FFB per hectare in Malaysia, 17.5 tonne FFB per hectare in Indonesia.

change for the high demand scenario, assuming that land use change occurred at a steady rate. In the short term, emissions from deforestation and biomass carbon loss (treated here as instantaneous) are largest, but over time ongoing peat degradation becomes the dominant source of CO_2 emissions. By 2038, 6 billion tonnes of additional CO_2 emissions are expected. Figure 27 compares the land use change emissions in the three cases, and a case in which palm oil demand for biodiesel was gradually phased out by 2030. The cumulative emissions by 2038 in the medium scenario are 1.4 billion tonnes. In the low demand scenario, a reduction in palm oil demand from 2020 to 2025 avoids deforestation and peat loss, resulting in slightly negative emissions compared to freezing demand at the current level. In the case of a full phase out of demand by 2030, 1.2 billion tonnes of land use change emissions could be avoided compared to a case with frozen demand. In total, in the high scenario cumulative emissions are 7 billion tonnes of CO_2 higher by 2038 than in the scenario with a phase out of palm oil demand from biofuel policy by 2030. Land use change emissions in the medium demand scenario are 2.6 billion tonnes of CO_2 higher than in the phase out scenario.

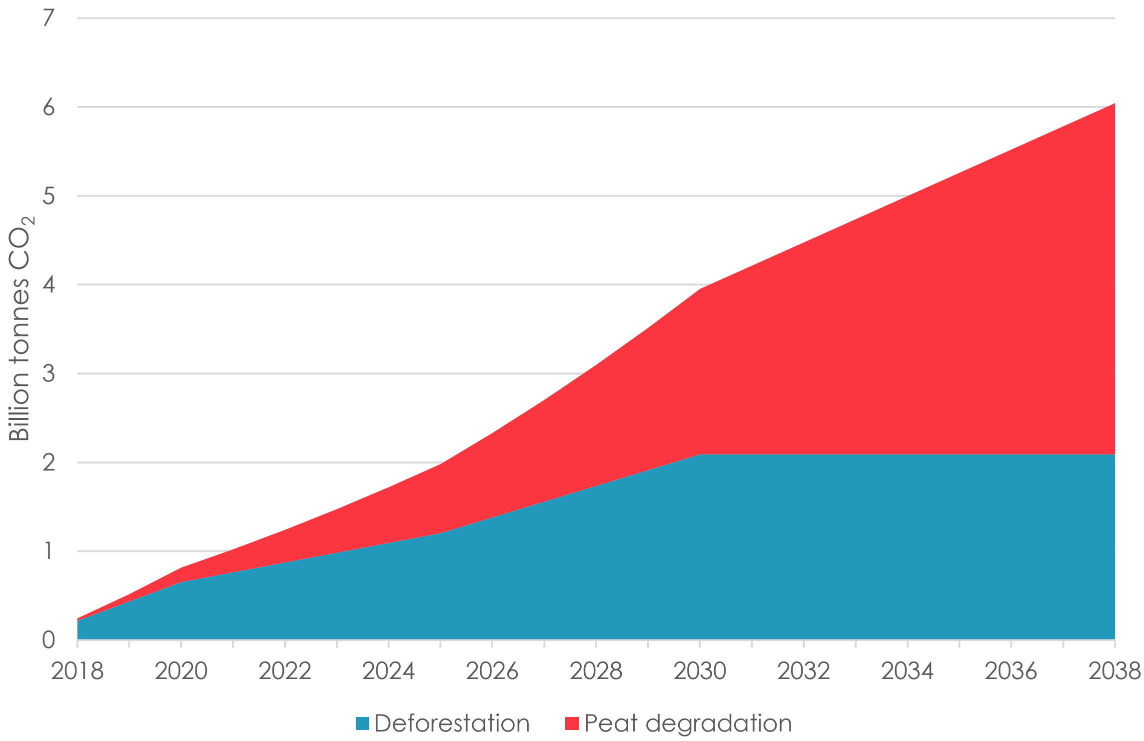


Figure 26. Cumulative CO_2 emissions due to palm oil related land use change in the high demand scenario

Assuming a steady rate of additional deforestation and peat loss through the period

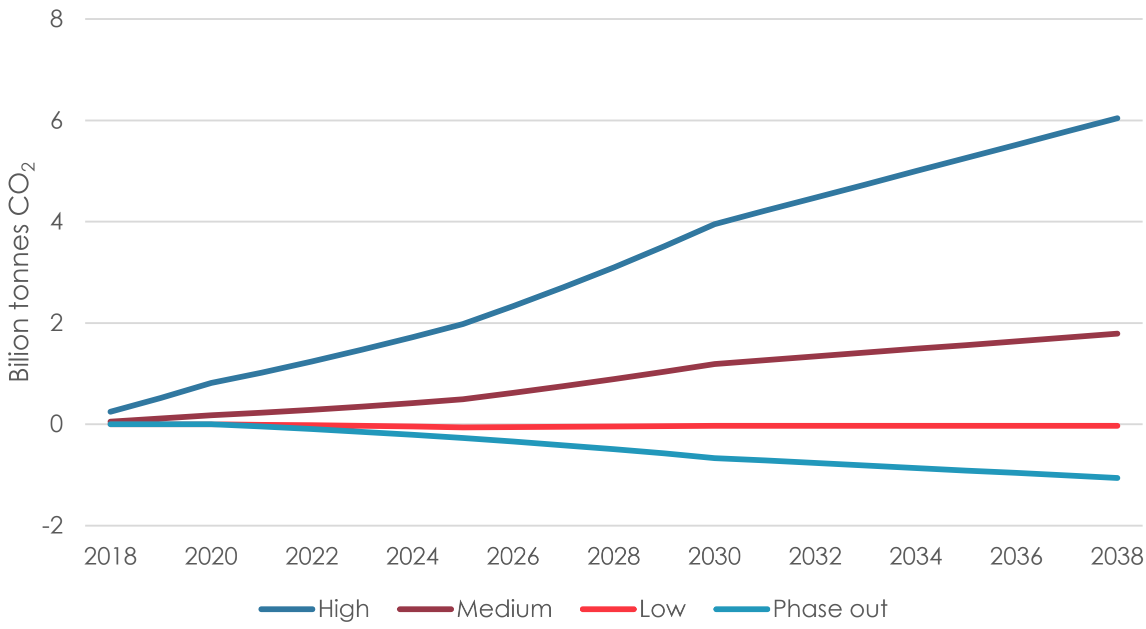


Figure 27. Cumulative emissions (or avoided emissions) for the high, medium and low demand cases and for a total demand phase out, compared to frozen demand

Assuming a steady rate of additional deforestation and peat loss through the period

Other impacts

Impact on biodiversity

Forests in Southeast Asia are highly biodiverse. Threatened species in areas that will be affected by palm oil expansion include the Sumatran tiger, orangutan, Sumatran rhinoceros and elephant, as well as over a hundred bird species and numerous reptiles, amphibians, fish, insects and plants, many of which exist only in the region.[25]

Replacing both primary and secondary forest with oil palm plantations results in a dramatic reduction in biodiversity (Petrenko et al. 2016). Palm plantations, "support few species of conservation importance" and can impact adjacent habitat negatively "through fragmentation, edge effects and pollution" (Fitzherbert et al. 2008). Vijay et al. (2016) identify that many areas in Indonesia and Malaysia that are at risk from palm expansion, including large areas of Borneo, are within the 10% of richest global land for threatened species. Only 4.4% of forests in Southeast Asia that are considered vulnerable to palm development are protected by IUCN category I and II protected areas.

The highest deforestation scenario detailed above, 4.5 million hectares of forest loss, would be equal to about eight years of Indonesian forest loss at historical rates 2000-2012 detailed by (Margono et al. 2014). The lower level would represent more than a year of average forest loss.

Impact on food markets

Using the methodology described in (Malins 2017b), it is also possible to make a first order estimate of the potential impact on food prices that could be caused by palm oil demand on this scale. For the high demand scenario, we estimate that average ***global vegetable oil prices would be about 26% higher*** in the short to medium term than in a case with no demand for palm oil due to biofuels. That would imply a $50 billion additional annual cost to other vegetable oil consumers. For the low demand scenario, global vegetable oil prices would be only 4% higher than without biofuel linked palm oil demand.

Forest fire

Drainage of peat and fragmentation of forest increase vulnerability to fire, and the use of fire for land clearance can increase incidence of forest fires. Marlier et al. (2015) found that in 2006, fires in palm oil and logging concessions were responsible for 41% of total fire related emissions in Sumatra and 27% in Kalimantan. Forest fires cause additional carbon dioxide emissions and pose an obvious threat to biodiversity. They are also a major contributor to air pollution in Southeast Asia. Koplitz et al. (2016) estimates that in 2015 air pollution, largely caused by fires in degraded peatland in Sumatra and Kalimantan, was responsible for around 100,000 excess mortalities. They note that peat drainage for agriculture "may have made the peat more vulnerable to fires" and therefore have contributed to a dramatic increase in peatland related fire activity between 2006 and 2015. As noted by Malins (2017a), greenhouse gas emissions from Indonesian forest fires in 2015 are estimated to have been larger than total

25 https://www.ran.org/indonesia_s_rainforests_biodiversity_and_endangered_species

annual Japanese national greenhouse gas emissions from fossil fuel combustion, and several times larger than Indonesia's own fossil fuel related greenhouse gas emissions (Global Fire Emissions Database 2015).

While it is difficult to accurately quantify the contribution of palm plantation expansion to the fire problem, it is clear that it is a contributing factor, and that greenhouse gas emissions from forest fire linked to oil palm plantation expansion further undermine the climate performance of palm oil biodiesel support policies.

Is there a role for certification?

One approach that has been widely advocated to reduce the negative environmental impact of palm oil production is the use of sustainability certification. Initiatives include the multi-stakeholder Roundtable on Sustainable Palm Oil (RSPO), the EU policy based International Sustainability and Carbon Certification (ISCC) and the Indonesian Government's Indonesian Sustainable Palm Oil System (ISPO) and Malaysian Government's Malaysian Sustainable Palm Oil Standard (MSPO). These standards apply sets of minimum criteria and suggested good practices, and are intended to provide assurance that materials are being produced in a responsible way, as well as driving improvements in practices on the ground. This is not the place to attempt a full review or comparison of the standards available, an extensive task in itself. Voluntary standards currently only cover a small fraction of global agricultural production, but the rate of adoption has been relatively high for the palm oil industry (Tayleur et al. 2017 report 2 million hectares certified as of 2012), and it is clear that certification can deliver improvements in environmental and social outcomes (Malins 2010). National schemes may achieve greater coverage (although currently only 12% of Indonesian palm oil has met the ISPO standard[26]), but are expected to set weaker standards in the first instance (EFECA 2016).

While the benefits of certification are real, the serious limitations must also be recognised. The RSPO standard, for instance, restricts only some deforestation (although a zero-deforestation compatible version, 'RSPO NEXT', is available[27]), while ISPO and MSPO largely rely on inadequate existing legal requirements to protect forest and biodiversity (EFECA 2016). ISCC follows European biofuel legislation in restricting planting on peat, but RSPO only asks for voluntary commitments to avoid peatland; ISPO only prohibits planting on peat where it is more than 3 metres deep[28] across over 70% of a concession, and MSPO sets only best practices for peat management (EFECA 2016). Even when applying best practice for peat management, degradation can only be reduced, not prevented, and in climate impact terms any peat drainage is clearly unsustainable. Under the existing standards, even 100% certification would therefore not necessarily resolve the problem of CO_2 emissions from land use change due to palm oil expansion – and 100% certification remains far off.

Certification has value as a way to improve environmental and social performance in agricultural, but supporting certification is not mutually exclusive with understanding that the best way to reduce the impact of the palm oil industry at the current time is to reduce demand for palm oil. In particular, until certification approaches 100% of production, certification is not able to or designed to deal with indirect land use change effects. Even if the RSPO standard were strengthened to ban deforestation and peat conversion, and if half of the oil palm plantations in the world were RSPO certified, that would still leave enormous scope for deforestation and peat destruction in the other half.

26 http://www.thejakartapost.com/news/2017/04/12/only-12-of-indonesias-oil-palm-plantations-ispo-certified.html

27 https://rspo.org/certification/rspo-next

28 Even for a peat depth of 'only' 3 metres, degradation and associated carbon emissions can continue for many decades (Page, S.E., Morrison, R., Malins, C., Hooijer, A., Rieley, J.O. Jaujiainen 2011).

Conclusions

Since 2000, global biofuel consumption has expanded dramatically, and that has created a very large increase in demand for vegetable oils. Much of that supply gap has been filled either directly or indirectly by increased palm oil production. The global palm oil market is dominated by Indonesia and Malaysia, and in both of those countries palm oil expansion is chronically associated with deforestation and peat destruction, in some of the most biodiverse habitats in the world.

Following the 'food vs. fuel' controversy sparked by the food price crisis of 2008, and parallel concerns about indirect land use change, many countries backed away from implementing biofuel targets, or reduce the rate of increase in biofuel consumption. Nevertheless, there is still considerable support for the expansion of biofuel mandates, in particular in Indonesia and for aviation. The Indonesian government has set very ambitious targets for domestic conversion of palm oil to biodiesel and biojet fuel. While global ambition for the use of biofuels as road fuel has been dampened, the aviation industry has set 'inspirational' targets for an enormous expansion of biojet production, with hydrotreated palm oil one of the most technically and financially viable options to meet these targets in the short to medium term. In Europe, while the Commission has proposed a gradual reduction to 2030 in the use of biofuel from virgin vegetable oils, this proposal remains controversial, and some industry stakeholders would still like to see the market expand.

If targets set by Indonesia and the aviation industry are met, coupled with demand increases from policies in other countries, global palm oil demand due to biofuels could rise to as much as 67 million tonnes. That is about the same as current total global palm oil production. Given current forest governance in Indonesia and Malaysia, that level of demand increase would be expected to cause about 4.5 million hectares of additional deforestation, including about 2.9 million hectares of additional peat drainage. On the other side, eliminating demand for palm oil due to biofuels could save about 700 thousand hectares of forest by 2030 (compared to allowing demand to continue at current levels).

Many studies that consider the land use change implications of biodiesel policies have concluded that they do not offer any net climate benefits, in large part due to the high emissions associated with increased pressure for palm oil expansion (Malins 2017a). In climate policy terms continuing palm oil biodiesel mandates without a step change in global land use governance is not simply shuffling deck chairs on the Titanic, it's setting fire to the deck chairs and throwing them into the lifeboats.

In the long term, the only real solution to deforestation and peat drainage will come from a fundamental adjustment in attitude and aspiration by the governments of Indonesia and Malaysia. In the short term, however, much can be done to prevent irreversible harm to tropical rainforests simply by reducing mandates for food-based biodiesel use, and especially palm biodiesel, and by avoiding creating new mandates that allow vegetable oil based fuels to be used, such as the proposed mandate for aviation.

Recommendations

In order to reduce pressure for deforestation in highly biodiverse habitats in Southeast Asia, existing mandates for biodiesel from vegetable oils should be reduced or eliminated, and new biofuel policies should avoid these resources.

- Palm oil and PFAD are unsuitable as biofuel feedstocks. Due to land use change associated with expanding palm oil production, palm-oil based biofuels increase GHG emissions and drive biodiversity loss. The use of palm oil-based biofuel should be reduced and ideally phased out entirely.
- In Europe, the use of biodiesel other than that produced from approved waste or by-product feedstocks should be reduced. The European Commission's proposal to gradually reduce the contribution of first generation biofuels while allowing Member States to favour ethanol over biodiesel is a good basis for this.
- In the United States, palm oil biodiesel should continue to be restricted from generating advanced RINs under the Renewable Fuel Standard, due to its poor GHG performance.
- Indonesia should reassess the relationship between its rapidly increasing biofuel mandate, expansion in its palm oil industry and its international climate commitments, and refocus its biofuel programme on advanced biofuels from wastes and residues, including those produced by the palm oil industry (Paltseva, Searle, and Malins 2016).
- Other countries such as China and Japan should avoid creating new renewable energy incentives without strong environmental criteria to ensure that genuine emissions savings are delivered.
- The aviation industry should focus on the development of advanced aviation biofuels from wastes and residues, rather than hydrotreated fats and oils. These advanced fuels from wastes have dramatically better environmental performance, and have the potential to be cheaper than hydrotreated biofuels in the longer term (Peters et al. 2016).
- Sustainability initiatives for oil palm agriculture should be supported for food and oleochemical applications, but must not be used as an excuse for driving further demand growth in the biofuel sector.
- The governments of Indonesia and Malaysia should be supported to overhaul forest governance and break the link between palm oil production and environmental destruction.

About this report

This report was commissioned from Cerulogy by Rainforest Foundation Norway (Regnskogfondet). The views expressed are those of Cerulogy. Errors and omissions excepted, the content of the report is consistent with the best understanding of Cerulogy at the time of writing, however Cerulogy makes no representations, warranties, undertakings or guarantees relating to the content of report, and accepts no liability in respect of any losses arising related to the use of any information contained or omitted from the report. Cover image by Jane Robertson Design.

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