



Beyond Oil Palm: Perceptions of Local Communities of Environmental Change

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Involving local communities in ecosystem service research can improve the relevance, quality and, ultimately, the outcomes of natural resource management. Local engagement can also contribute to solutions to ecosystem management challenges by diversifying the range of options and contextualizing their applicability. The benefits to local communities of ecosystem service-based policies relative to other interventions, such as oil palm development, are, therefore, best understood from the perspectives of the local communities themselves. We used observations, focus group discussions, and interviews in four villages along the Belayan River, East Kalimantan, Indonesia, to explore how local communities in different oil palm development contexts perceive Ecosystem Services (ES). The main livelihood activity differed across these villages, which were either fishing, oil palm smallholder communities, or forest-dependent communities. Perceptions about ES varied across villages, though three services were perceived to be crucial in all four villages, namely fish provision, water quality, and land availability. These services can be a common concern entry point for discussions on landscape management. Despite common recognition of the negative impacts of oil palm development on these crucial services, all communities are nevertheless choosing to expand oil palm. Communities identified a wide array of direct and indirect drivers underlying this trend, including social influence, financial capital, ecological factors, and subsidies from local government. Early engagement of local policymakers, oil palm companies, and local communities is essential to the maintenance of crucial and widely recognized ecosystem services in oil palm landscapes.

Keywords: ecosystem services, Indonesia, Kalimantan, landscape, livelihood, participation, values

INTRODUCTION

Local communities should be included in ecosystem services (ES) assessments, as they are the primary users and beneficiaries of many ecosystem services and have direct access to local resources provided by the ecosystems of which they are a part (Folke et al., 2005). Involving local communities in ES assessments facilitates more accurate evaluations of the importance of the ecosystem services and the factors that determine social preferences and trade-offs associated with land use change and decision-making (MEA, 2005). The value and needs of local users should, therefore, guide any ecosystem assessment process (Menzel and Teng, 2010).

Integrating socio-political aspects into ES will deepen the conceptual understanding of how land use decision-making takes account of and affects the services provided by ecosystems to humans (Andersson et al., 2007; Abson et al., 2014; Albert et al., 2014). Issues of social impacts, governance, legal rights, and justice all play a role in shaping decision-making by local land users (Chaudhary et al., 2015). Local participation during the process will, therefore, increase the quality of decision-making (Sayer et al., 2013). Such integrative collaboration provides a better understanding of the role of societal and cultural processes on ecosystem changes (van Oudenhoven et al., 2018) and the ways in which ES are supplied and distributed (Bennett et al., 2015).

International trade often detrimentally affects local ecosystems and communities who depend on them (Aggarwal, 2006; Chang et al., 2016). The growing global demand for palm oil, for example, has driven large-scale land use changes in Southeast Asia and elsewhere. This has resulted in the transformation of often formerly forested landscapes into extensive areas of oil palm plantation. The development of oil palm in Indonesia, for example, has increased at a rate of around 10.99% per year; what was only 294.56 ha in 1980 reached to 11.2 million ha in 2016 (Indonesian-Agricultural-Ministry, 2016). The production increase has amounted to 11.50% per year, from 721.17 tons in 1980 to 31.7 million tons of crude palm oil in 2016. This rapid and extensive development has caused adverse effects on both the environment and society (Sayer et al., 2012), one of which has been declining food security (Sinaga, 2013). While the production of marketable goods may increase as a result of oil palm plantations (Dislich et al., 2017), extensive development of this commodities generally reduce ecosystem service provision (Fitzherbert et al., 2008) and can cause growing economic inequities that lead to social conflict and poverty (MEA, 2005). Different scenarios for oil palm expansion are possible, which would give opportunities for enhancing carbon stock, water yield and habitat quality (Sharma et al., 2018).

Such outcomes are, however, contested. In Kutai Kartanegara, a district in East Kalimantan, the development of oil palm has been dramatic since 2011, and the district government has promoted oil palm development to enhance local government income and improve the wealth of local communities (Syahrumsyah-perscom, 2016). The ambition to further expand oil palm plantations has been part of the East Kalimantan government's "1 million hectares palm oil plantation" target that covers across the entire province (Risal, 2015). Subsidies and support have been put in place for oil palm cultivation, including the provision of seedlings, pesticides, and fertilizers for local communities. The lucrative crop, along with provided support and processing infrastructure, has encouraged local communities to plant palm oil, often at the expense of traditional livelihoods (e.g., fishing and paddy farming) or to become laborers on palm oil plantations. As shown elsewhere, expansion of oil palm has also accelerated the transfer of lands to palm oil companies (Semedi and Bakker, 2014).

There have been policy efforts issued by the government at different levels to ensure that adverse impacts arising from oil palm development are avoided and those green growth principles

through the use of low carbon emission are adopted. The President issued a national policy to put a halt the issuance of new oil palm permits on primary forests and peatlands. To further follow up the policy, the Governor of East Kalimantan issued a regulation specifying the postponement of the issuance of licenses for land-based investment including oil palm plantations across the province. Particularly, a province regulation stipulates the need for oil palm companies to set aside and protect high-conservation areas. The Head of the district in Kutai Kartanegara issued a policy to protect peatlands and ensure that the policy is not benefiting only the environment, but also local communities.

Despite massive efforts to adopt the practices, adverse impacts of the oil palm development continue to occur. How such social and economic changes affect the traditional fishing and forest-dependent communities, many of which source a variety of resources and services from natural and semi-natural ecosystems, remains unclear. Also poorly understood is how local communities perceive these changes and are responding to opportunities, and how vulnerable they are considering their physical, social, economic, and environmental limits and capacities. Understanding them is essential if the future development of oil palm is to effectively respond to community needs and aspirations.

Direct community involvement in ecosystem service research can contribute to improved natural resource management by acknowledging and responding to locally perceived trade-offs (Tadesse et al., 2014). The direct involvement of local communities in research can also promote local engagement in finding solutions to ecosystem management challenges (Menzel and Teng, 2010; Meijaard et al., 2013). Yet there are few investigations of the benefits to local communities of ecosystem service-based policies relative to other interventions, such as oil palm development (Goldman et al., 2008; Bennett et al., 2015). With these considerations, we aim to explore the condition of the ecosystems in Kutai Kartanegara as perceived by local communities living in different contexts of oil palm development. Specifically, we address the following questions: (1) How important are various ES to local communities? (2) How do local communities perceive the current ES conditions? (3) What is the impact of changes in ES to the community? (4) What are the drivers of ES change?

METHODS

The Study Area

The district of Kutai Kartanegara is located in East Kalimantan Province, Indonesia, covering a land area of 27,263 km². The climate is a seasonal humid (tropical forest) one, with an annual rainfall of between 2,000 and 4,000 mm/year with an average temperature of 26°C. The district has 10 rivers, which are used as main transportation routes besides roads. Villages are consequently concentrated on riverbanks, and the hinterland is thinly populated. The population of the district was estimated to be 717,789 in 2015 (BPS, 2016), consisting of the native tribes Kutai and Dayak (Benuaq, Tunjung, Modang, Bahau, Kenyah, Punan, and Kayan) as well as settlers such as Javanese, Bugis, Banjar, and Madura. The Dayak tend to inhabit villages close to or

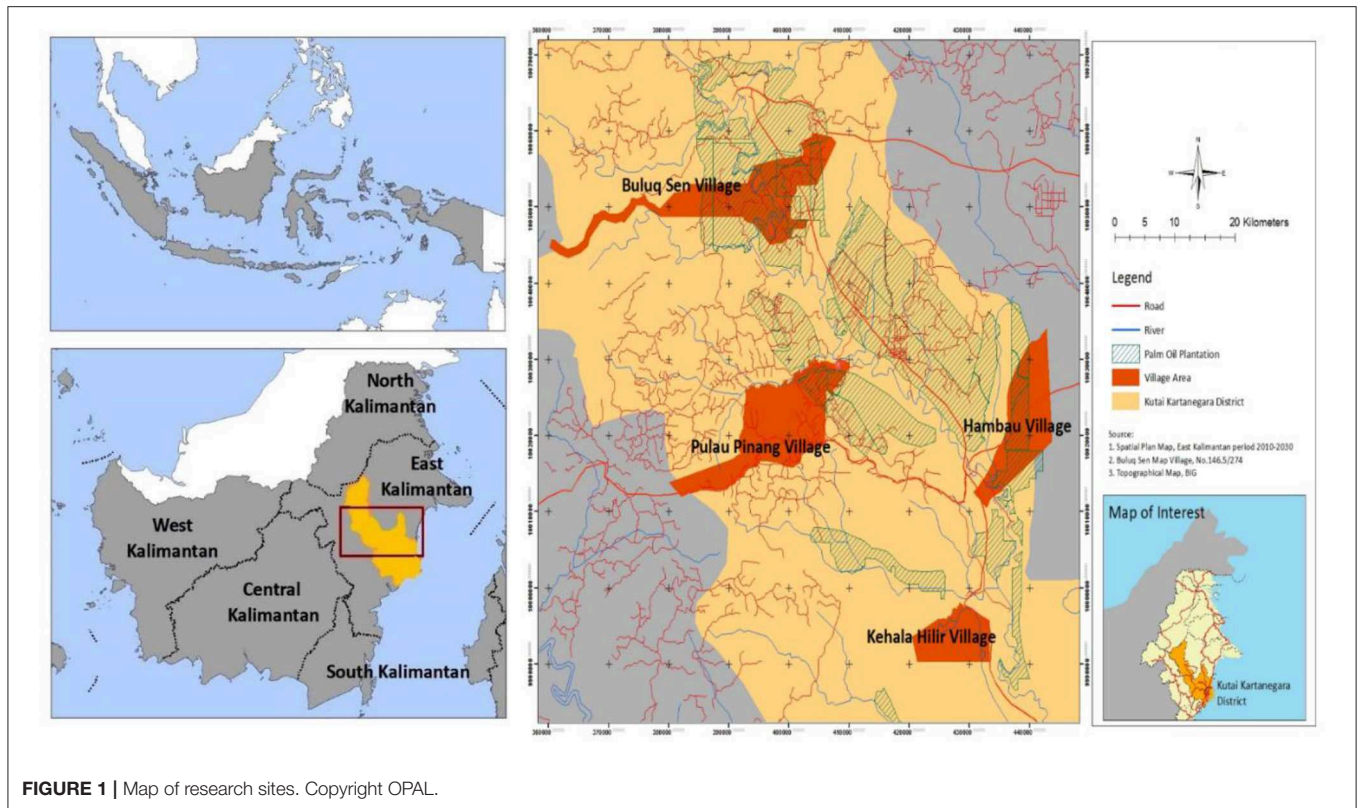


FIGURE 1 | Map of research sites. Copyright OPAL.

within forested areas and depend mostly on shifting agriculture and the collection of products from the forest. Revenue of the district derives from oil, gas, coal, and other mining products, forestry, fisheries, and livestock. Mining contributes to 69.6% of the total economy, followed by the agriculture sector (10.3%) (BPS, 2016). Besides mining, palm oil is the main export commodity. Other agriculture products, upland rain-feed, and wetland paddy, for example, are only sold in local markets (BPS, 2016).

Our research took place at four villages along the Balayan River (Figure 1), a region that has experienced a recent expansion of oil palm development. The four villages were selected according to their main livelihood activity, with one being a fishing community, two are primarily dependent on oil palm smallholder production, and the fourth village is mainly a forest-dependent community (Table 1).

We selected the Balayan riverbank as our entry point, based on the following considerations: (1) The riverbank is the only watershed that flows to three major rivers in Kutai Kartanegara; (2) the most prominent and oldest palm oil company is located here; (3) both RSPO and non-RSPO companies occur nearby; (4) two different ethnic groups inhabit along the river, and these might have different perceptions on ecosystem services and the development of oil palm; (5) oil palm smallholders and paddy farmers, as well as fishers, occur in this region; (6) companies rely on the river for their oil palm processes, and local communities use it for drinking, showering and cooking; (7) the region was until 2015 only accessible by river. It takes 2 days to reach the

district capital by the river, and the upstream location in this district was electrified only in 2016.

There are several large companies active near the settlements and the Balayan River, including industrial forest plantations for commercial timber, oil palm plantation, and mining. A new road had been built along the river in 2015, making these rural areas much more accessible. One head of the village, for example, mentioned that it is now much easier and cheaper to travel to Samarinda, the capital city Kutai Kartanegara (head village of Hambau).

Kehala Ilir Village/Fishing Community

Kehala Ilir is a village in Kenohan sub-district. The population of the village is 1,090, with 97.5% of households being fishermen. The village is surrounded by peatland and lies next to Lake Semayang and the Kenohan River, where fishing takes place. The local community, dominated by ethnic Kutai, mostly also own land for wetland paddy farming or vegetable production, usually for subsistence. These local communities maintain their traditional livelihoods because their lands are not suitable for growing palm oil, or it is not permitted to do so owing to a moratorium on oil palm expansion in wetlands. Before the opening of the new Tabang road in 2015, income was also derived from water transportation, delivering passengers between villages and even from and to Samarinda (the capital city of East Kalimantan). The head of the Kehala Ilir village, for example, said *“We used to have 100 water taxis, generating an income of around 7–9 million per month, but at certain times, they could bring in 25*

TABLE 1 | Typology of communities along Belayan River, Kutai Kartanegara.

Community	Ethnic group	Location along Belayan	Start planting OP ^b	Involvement of communities in the palm oil business
Kehala Ilir (fishing community)	Kutai	Downstream	None	2.5% of population (1,090) work in palm oil commodity
Hambau (oil palm stakeholders)	Kutai	Midstream	2010	60% of population (3,367) work in the palm oil business (workers and smallholders)
Pulau Pinang (oil palm smallholders)	Dayak Tunjung	Midstream	2007	90% of villagers (1,783) depend on palm oil
Buluq Sen (paddy farmers)	Dayak Kenyah	Upstream	2016	20% of work/have palm oil plantation. Six hundred eighty-six individuals (in 2017), in 164 families. Only four individuals are non-Dayak

Source: *Villages Monographie, observation, interview, 2016.*

^bOP: Oil palm.

million. Usually, staff from the palm oil companies used our service. This job would become an alternative livelihood after fishing.” Currently, many local communities, who have financial capital, are establishing Edible swiftlet-nests businesses as an alternative income. Two companies are located near to the village. An oil palm company has operated since 2007, and a timber company.

Local community from Kehala Ilir reported that in early 2016 the village suffered from water pollution resulting in fish kills and bad odors from the river. According to the local community, the pollution was attributed to waste from the mill of an upstream oil palm company. Local communities reported that such events did not occur before the mill was built in 2015. They additionally complained about the Tabang road infrastructure as being a contributing factor to pollution as barriers reduced or blocked the flow of Belayan river tributaries. The local communities claimed that the only water flow now came from the stream where the mill located. Since then, they reported that fish continue to decline, and this has affected the livelihoods in the village.

Hambau Village/Oil Palm Smallholders

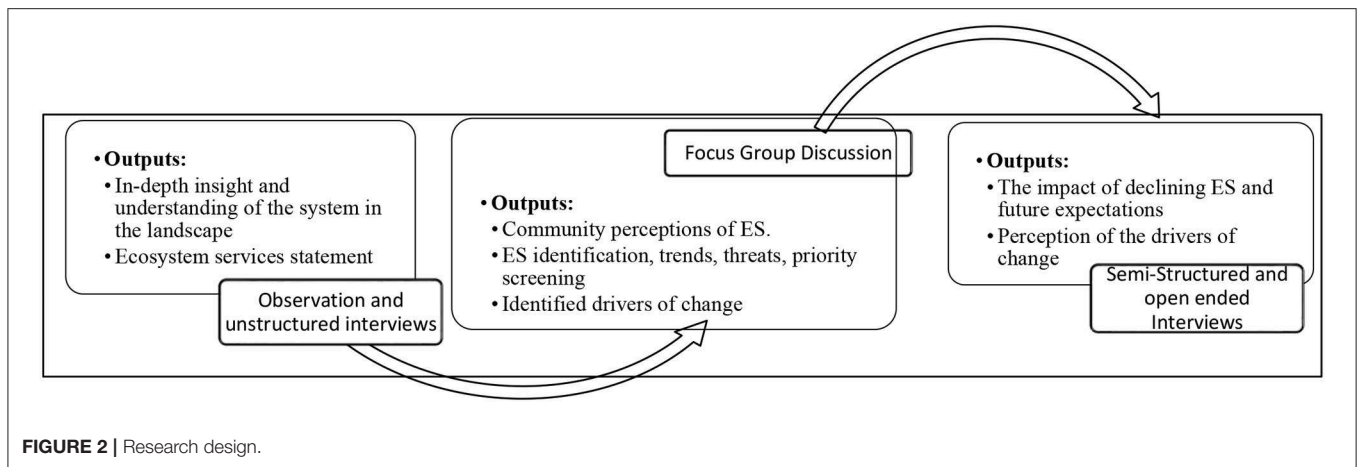
This village is located mid-stream of the Belayan River, Kembang Janggut sub-district, the surrounded landscape is a mix of drylands and wetlands, and large palm oil plantations are located within 10 km of the village. The population is 866 families (3,367 individuals). Before the development of oil palm, the local communities engaged in paddy farming, vegetable gardening, and fishing. Since the local establishment of the oil palm plantations by two companies in 1992 and later in 2007, many local communities gave up fishing and paddy farming and started to work in the palm oil business. In 2016, the head of the village reported that 60 percent of households were working in the oil palm business as employees and independent smallholders. In 2015, 600 households were engaged in plasma schemes that are linked to the oil palm companies. In the plasma, scheme community land is planted with oil palm using capital loaned by the company. To repay the loan, the company directly deducts a certain amount of the income derived from the harvest. The process is managed by

a cooperative (Koperasi), consisting of village representatives and officers, and company staff. The main sources of conflicts between local communities and cooperative concerned the lack of transparency of the cooperative and the small income that the plasma generates. “Koperasi gives us only IDR 150,000 every 3 months because we have to pay the loan to the company” (oil palm smallholder). Local communities also mentioned high pest pressure by rodents leading to harvest failure as a contributing factor to seeking employment in the oil palm sector.

Pulau Pinang Village/Oil Palm Smallholders

This village is located in the Kembang Janggut sub-district. The local communities are mainly independent oil palm smallholders, with 147 families having around 5 ha of oil palm plantation, 23 families around 10–50 ha, and 5 families between 50 and 100 ha. While total plasma was 1,215 ha in 2016. The production is around 3 tons of FFB oil palm per ha. Of the 460 families in the village, 250 were directly dependent on water sourced from the Belayan River in 2016 (refer to the Monograph data of Pulau Pinang village, 2016). Other families relied on water sourced from wells or bought water from Perusahaan Daerah Air Minum, a municipal water-works company. The company itself draws water resources from the Belayan River and filters it before distribution to the householders.

The local communities are recognized as being owners of their land, which is passed on within families through the generations. The land certificate (SKT/*surat keterangan tanah*) issued by the village official, certifying who is controlling the land, the size of the land and show how the land is obtained. While the letter is not proof of land ownership as recognized by law, the land can be sold and the letter can be transferred to other parties (e.g., company, migrants). Thus, decisions related to their lands are made by each family (not by village). Before the arrival of an oil palm company in 1992, forest clearance required permission from ethnic group leaders, mainly where this was carried out close to ancestral graves and other sacred sites (Colchester et al., 2013). Local communities reported that they sold their lands



because they were not aware of its value, and only later did they realize the potential that the land has when planted with oil palm.

The first oil palm nurseries near to the village were established in 1992 by the oil palm company following permission granted by the provincial government (Colchester et al., 2013). This led to increased migration rate into the village. Around 40% of the populations are now non-native, and either bought lands from local communities or later married into local communities' households. Since 2007, the government requires companies to create plasma schemes on at least 20% of their concession. Consequently, the company bought community-owned lands and created benefit-sharing agreements. In August 2016, it was apparent that land claim conflicts remain.

Buluq Sen Village/ Forest Community

This village is located in the Tabang sub-district in the upper Balyan river watershed. Six hundred eighty-six individuals (in 2017), distributed across 164 families of the Dayak Kenyah ethnic group inhabit it (only four individuals are non-Dayak). The village area is 18,103 ha. This village has been accessible by road since 2015. Electricity was provided by the oil palm company PT REA from April 2016. Unlike Dayak Tunjung in Pulau Pinang village, the local communities have legal land tenure, but decisions on land sales to outside agencies or actors are agreed communally across the village. Decisions relating to village lands are discussed among them, with leadership being provided by the village head and ethnic leader. Until August 2016, the majority of the population (80%) took basic needs from forest and field (*Ladang*). They practiced swidden agricultural relying on local knowledge. Rice and vegetables are planted, and after harvest, the land is left to fallow, with a new 2 ha area of land being cleared and planted. Rotation periods are 5–6 years. Farming is conducted communally with relatives or neighbors (*gotong-royong*) and no pesticides or fertilizers are used. The village suffered a harvest failure in 2015 due to drought and pests. In 2016 only 20% of the village, labor force works in the palm oil sector. The younger members of the labor force (25 people) tend to either work as laborers in oil palm company estates or have their oil palm plantations, while older village members prefer

paddy farming. A subsequent visit in 2017 revealed that within 1 year 90% of local communities had started to plant oil palm, and around 5,000 young oil palm trees had been planted.

There are three palm oil concessions around the village, as well as the mining company. The companies provide jobs to the local communities. According to the head of the village, a proposal for a water tank aid submitted to an oil palm company resulted in uneven water distribution to the village, which created tensions among local communities and village officers in 2016. Some household did not receive access to water from the tank, while others gained good access. The tank itself provided filtered water from the Balyan River. Other conflicts between local communities and companies have arisen about access to land and cultivation rights. Continued expansion of company plantations has led to the development of oil palm even up to local communities' houses.

Research Design and Data Collection

We used three methods to collect data: observations, focus group discussions (FGD), and interviews. The combination of these methods provided integrative results to address our research questions (Figure 2).

An ethics approval was not required as per applicable institutional and national guidelines and regulations and oral informed consent were obtained from all participants. Specifically, in all cases full information was given about the work and what it entails to each participant in the study (Annex 1. Ethical Statement). As most participants were illiterate, this information was given verbally, and informed consent to participate was provided verbally by all those interviewed for the study. We did not ask participants for written confirmation of their agreement, as would be the norm, on account of illiteracy levels. The village head was given written documentation explaining the project (Annex 2, in Indonesian), and the work could only proceed with his permission.

Participant-Observation and Unstructured Interviews

We started by collecting data through observation and 9 unstructured interviews from 20 to 26 May 2016, aiming to get more insight into tangible aspects such as the physical context

TABLE 2 | Respondents of interviews in four villages.

Village	N	%	Age (yo)				Main livelihood					
			<30	31–40	41–50	>50	Paddy farmer	OP ^b smallholder	Fishers	Officers	OP ^b labor	Other ^a
Kahala Ilir	26	35	1	9	11	5	9	0	14	0	1	2
Hambau	15	20	2	6	5	5	1	6	7	0	1	0
Pulau Pinang	14	19	0	6	2	6	2	10	0	1	0	1
Buluq Sen	19	26	1	6	6	6	14	4	0	0	0	1

^aOther: business, freelance.

^bOP: Oil palm.

of villages and intangible elements such as culture, stakeholders, and social organization. We also explored villages, observed people, and their activities, and took notes and pictures. Doing observation help us gain a better understanding of the context and phenomenon under study, that is not mentioned or is perhaps misrepresented by interview or group discussion (Scott and Garner, 2013). We stayed in a guesthouse, in a village near the oldest oil palm company in the areas. This allowed us to engage in conversation with, and listen to the life stories of, the hosts as well as neighbors (one male and two females). In the following days, we had, separately, other unstructured interviews with the heads of the four villages, and one ethnic group to get more understanding from the key decision-makers' perspective on oil palm development. We also reviewed village monographs, consisting of demographic data village profile.

Forum Group Discussions

We conducted Focus Group Discussions (FGD) between 24 June and 01 July 2016 in selected four villages, aiming to identify ecosystem services and explore communities' perception of ES current condition and drivers of change. The events were organized together with the village officers at the Balai Desa (village office) and were attended by 6–10 people in each village.

Using a matrix, we encouraged participants to write down the ES they know about, using the agreed term of ES (MEA, 2005), that is “benefits from ecosystem to a human being.” Participants were then asked to value each ES based on a Likert scale, an ordinal score from 1 to 10, where “10” is the highest value that indicates an ES is essential, while “1” reflects no perceived value or benefit. Moreover, to investigate the condition of the ES compared to 5–10 years ago, we asked the participants to allocate a symbol (1), (2), (3) to each ES, representing “decrease,” “no change,” and “increase,” respectively, in the condition of each ecosystem service. Based on this information provided by local communities, we were able to identify ecosystem services of the highest value as well as the greatest vulnerability.

Semi-structured Interviews

Following up FGDs, in August 2016, we undertook semi-structured interviews with 74 local communities (Fisher, oil palm smallholders, and farmers) in four different villages, selected using stratified purposeful sampling (Table 2), and excluded local communities who already attended the FGDs. The interviews

aimed to gain in-depth knowledge of the local communities' perceptions of the priority ecosystem services, their change, and the impact of and perceptions about oil palm.

We prepared questions that cover the basic topics, but not limited to encourage respondents in expanding their answer (Scott and Garner, 2013). The interviews focused on the following topics: (i) demographic, cultural and economic characteristics (e.g., name, age, gender, education, occupation, and income); (ii) usage and the current conditions of ecosystem services (e.g., river); (iii) the perspectives of oil palm development. We additionally asked open-ended questions, for example, on their opinion of the palm oil companies nearby and their expectations and plans for the future, assuming access to sufficient capital. We categorized answers as being: “positive,” “negative,” and “neutral.” We defined a negative view as one where palm oil was said to provide not profits or other benefits, and when people were unwilling to plant oil palm. A neutral view was when informants said they had no particular opinion or did not know. A positive perception was when participants expressed interest and willingness to expand oil palm, and/or mentioned that palm oil is more beneficial than other livelihoods and crops.

Data Analysis

Quantitative data came from FGD, consisting the score of the importance value of ecosystem services were compared across villages using Kruskal-Wallis and Pearson tests, using statistical software GraphPad Prism version 7.4. In addition, the importance and current condition of ES in each village were visualized, where Y-axis is the Importance score, and X-axis is the Current Condition score. Whist, qualitative data from semi-structured interview and observation were analyzed by categorizing the information obtained.

RESULTS

Ecosystem Services (ES) Perceptions by Local Communities

Categorizing ES into provisioning, cultural, supporting regulating services according to 2005 Millenium Ecosystem Assessment (MEA) framework yields 29 different ES, as shown in Table 3, which shows that every village has various numbers of identified ES. The local community in Kehala Ilir village listed

TABLE 3 | Ecosystem services perceived by local communities.

ES	No	ES	Code	Kehala Ilir		Hambau		Pulau Pinang		Buluq Sen		Total I- score
				I	C	I	C	I	C	I	C	
Provisioning services	1	Fish	PS1	10	1	10	1	10	1	8	1	38
	2	Water	PS2	10	1	10	1	10	1	10	1	40
	3	Swiftlet bird nest	PS3	10	3	8	2	8	3			26
	4	Vegetable	PS4	10	1	9	2			7	2	26
	5	Deer	PS5	10	1							10
	6	Land	PS6	10	1	10	1	10	1	10	1	40
	7	Timber	PS7			8	1	10	1	10	1	28
	8	Pig	PS8					10	1			10
	9	Banana plantation	PS9	8	2	7	1			7	1	22
	10	Coconut plantation	PS10			7	1					7
	11	Ratan	PS11			6	1	10	1	10	1	26
	12	Rabbits	PS12	5	1							5
	13	Honey	PS13					8	2	5	2	13
	14	Fruit forest	PS14					9	1	7	1	16
	15	Firewood	PS15			7	1					7
	16	Bamboo	PS16			1	2	10	1			11
	17	Gold	PS17							9	2	9
	18	Rice	PS18							10	1	10
Regulating services	19	Peat forest for flood mitigation	RS19	10	1							10
	20	Fresh air	RS20							10	1	10
	21	Primate	RS21	10	1							10
Cultural services	22	Ecotourism	CS22	10	2							10
	23	Teamwork (Gotong Royong)	CS23			6	1					6
	24	Traditional medicine	CS24					10	1	9	1	19
	25	Traditional ritual "Kwangkey"	CS25					10	1			10
	26	Sacred tree	CS26					10	1	10	1	20
	27	Biruuq leaf	CS27					10	1	8	2	18
	28	Traditional farming system (shifting cultivation)	CS28					9	1			9
Supporting services	29	Soil fertility	SS29							10	1	10
Average				9.36	1.35	7.42	1.25	9.6	1.2	8.64	1.21	

I, importance score; C, current condition; PS, provisioning services; RS, regulating services; CS, cultural services; SS, supporting services (source: 4 FGDs, 2016). The bold values indicate the highest importance score listed by communities.

a total of 11 ES, including 8 provisioning services, 2 regulating services, and 1 cultural service, while in Buluq Sen cited 16 ES, including 12 provisioning services, 1 regulating services, 3 cultural services, and 1 supporting service.

The villagers used a variety of ES, the most important of which were those that the community was able to access directly and from which they could derive immediate benefits (Bhatta et al., 2016; Sinare et al., 2016). Thus, provisioning services accounted for 62% of the total recognized, while cultural services were mentioned primarily by participants in

Pulau Pinang and Buluq Sen. The only supporting service mentioned was soil fertility, and only by villagers from Buluq Sen as they did not use fertilizer on their agriculture. Thus, the villagers from this village recognize easily the change of soil fertility.

Almost all the ES were given low situation metric scores, with the exception of swiftlet nests, the importance of which has increased because communities have invested capital in building nesting houses to attract the birds.

TABLE 4 | Statements of local communities on the driver of ES change.

- (1) "Penyebab utama menurutnya ikan juga karena bertambahnya migrasi pendatang dengan pihak terkaitnya yaitu perusahaan sawit mendatangkan karyawan karyawan" (Oil palm smallholder, Pulau Pinang village)
 – The main cause of declining fish stocks is the increasing number of migrants who come as workers in the oil palm company; the migrants use electricity to catch fish.
- (2) "Ikan tergantung dari masyarakat itu sendiri karena pengambilan yang salah dengan cara diracun atau di setrum, maka dampaknya juga sangat berkurang, belum lagi masalah dengan tahun 70'an kayu tidak ada dampaknya, namun kemudian pada dampak dari palm oil mulai terlihat walaupun dari segi ekonomi mulai membaik" (oil palm smallholders, Pulau Pinang village),
 – Fish stocks depend on how people catch fish; they decrease if we use poison and electricity. In the 1970s, when logging was common, there was no impact on fish, but now we have started to see the impact of palm production affecting fish numbers, even though our economy is better.
- (3) "Sejak adanya sawit, memang produksi ikan menurun, Ikan tiba tiba mati, diare. Kejadian ini terjadi sejak tahun 2010. Hal ini dikarenakan pupuk dan pestisida dari kebun sawit di hulu dan mengalir ke anak sungai dan akhirnya mengalir ke sungai besar" (oil palm smallholder, Hambau village)
 – Since palm oil has existed, fish production has decreased; fish die suddenly because of fertilizer and pesticide from the upstream palm oil plantations that dump them into the river. This has been happening since around 2010.
- (4) "Adanya limbah dari oil palm, tambang batubara yang ada di hulu (oil palm smallholder, Hambau village)"
 – There is waste coming from palm oil production and coal mining upstream.
- (5) "Banyak perubahannya sekarang membeli ikan makin sering, dulu sesekali bisa mencari sendiri untuk dimakan sekarang ikan sudah jarang jadi kebanyakan membeli (oil palm smallholder, Hambau village).
 – There is a lot of change now. We buy fish more often than to 5 years ago when we could go fishing and get fish for own consumption.
- (6) "Dulu bisa menggunakan air sungai untuk minum, namun sejak banyak limbah mengalir di sungai tidak bisa lagi digunakan air tersebut untuk minum." (Fishers, Kehala Ilir village)
 – We used to drink the water from the river, but since it has been polluted by waste (from an oil palm mill), we do not do so anymore.
- (7) "Lalu penggunaan air sungai semakin jarang, dibandingkan dengan air ledeng, air sungai sangat keruh, jernihnya air sungai pada saat ketika surut saja baru bisa digunakan. Sedangkan ketika banjir air sangat keruh dan sama sekali tidak bisa digunakan. Sudah jarang mencari ikan dan juga mengambil/ menggunakan air minum sungai belayan. (oil palm smallholder, Hambau village)"
 – I now barely use water from the river; I prefer to buy from the Water Company, as the colour [of water from the river] is murky. However, I sometimes use it when the river is at low tide. I also barely catch fish or use the water to drink from Balayan River anymore.
- (8) "Air juga menjadi sangat penting saat ini, dan kondisinya buruk karena sangat kotor tetapi tetap digunakan karena hanya itulah saja sumber airnya" (oil palm smallholder, Pulau Pinang village)
 – Water [from the Belayan River] has become crucial; the quality is worse, and it is dirty, but we still use it as it the only water resource we have.
- (9) "Dulu bisa menggunakan air sungai untuk minum, namun sejak banyak limbah mengalir di sungai tidak bisa lagi digunakan air tersebut untuk minum. Sekarang jangan harap bisa mencari hutan bahkan didaerah pegunungan pun telah berubah menjadi kelapa sawit (fisher, Kehala Ilir village)."
 – Previously, we drank water from the river, but since a lot of waste (from palm oil production) flows into the river, it is not drinkable anymore. Today, we do not expect to find forest areas; even the mountain areas have been converted for palm oil production.
- (10) "Jangka panjang ni sarang wallet, kalo beli mobil nanti rusak" (oil palm smallholder, Hambau village)
 – Swiftlet bird nests are for long-term investment, rather than buying a car that can be broken.
- (11) "Masalah dari pembukaan lahan untuk sawit ini memang cukup banyak, salah satunya jarang ditemui rotan yang biasa buat bangunan, walaupun ada, lokasinya jauh sekali dari desa." (Farmer, Buluq Sen village)
 – Land clearing for palm oil caused some problems, one of them is the difficulty to find rattan that usually we used it for building (house, and other infrastructures).
- (12) "Kayu ulin ini kayu emasnya kami, karena penting untuk bangun rumah dan bikin peti mati adat, namun susah sekarang sejak sawit ini, mau beli mahal sekali, jadi ya pakai kayu biasa saja, ga pakai cara adat lagi sekarang." (Pulau Pinang village).
 – Ironwood is a gold wood for us, as it important to build house and lungun. But it is difficult now since palm oil come. The wood is expensive to buy, so the traditional death ritual is not practiced anymore.
- (13) "Keberadaan rotan sangat penting sebelum adanya paku karena untuk mengikat kayu kayu untuk keperluan bangunan dan juga berbagai upacara adat, kondisinya sekarang buruk karena jarang dijumpai karena hutan sudah sawit semua, jadi ya mesti beli paku" (farmer, Buluq Sen village).
 – Rattan is important before we used nails to tie wood for housing and traditional ceremony. The current conditions is worse as we barely see find it because of palm oil, so we need to buy nails.

Distribution Pattern of ES by Local Communities in Each Village (Source: FGD)

Participants from four villages agreed that the ES they listed were the most important. A total of 20 out of 29 ESs are considered crucial, being given a maximal score of 10 (Figure 3). Three ES were considered unimportant (scores of 1–5). There were, however, many variations in the degree of importance attached to ES by each community. Pulau Pinang listed the highest number of ESs (9.6 ± 0.7) followed by Kehala Ilir village (9.4 ± 1.6), Buluq Sen (8.75 ± 1.6), while participants in Hambau village listed the fewest ES (7.4 ± 2.5). Using the Kruskal-Wallis non-parametric test to compare ES importance scores as given by the four villages,

we found significant differences in the reported values of ESs ($H: 11.52, p = 0.0092$). Pulau Pinang and Buluq Sen village reported broadly similar responses ($r = 0.880, p = 0.011$), despite the fact that 90% of local communities in Pulau Pinang are palm oil smallholders, while the local community in Buluq Sen are mostly paddy farmers.

The majority of ES were scored high important, but that the state of that service was poor (Figure 4). The four villages had broadly similar responses concerning ecosystem services. While most ES reported by participants from Kehala Ilir and Pulau Pinang were scored high but low condition, local communities from Hambau and Buluq Sen allocated several ES to medium

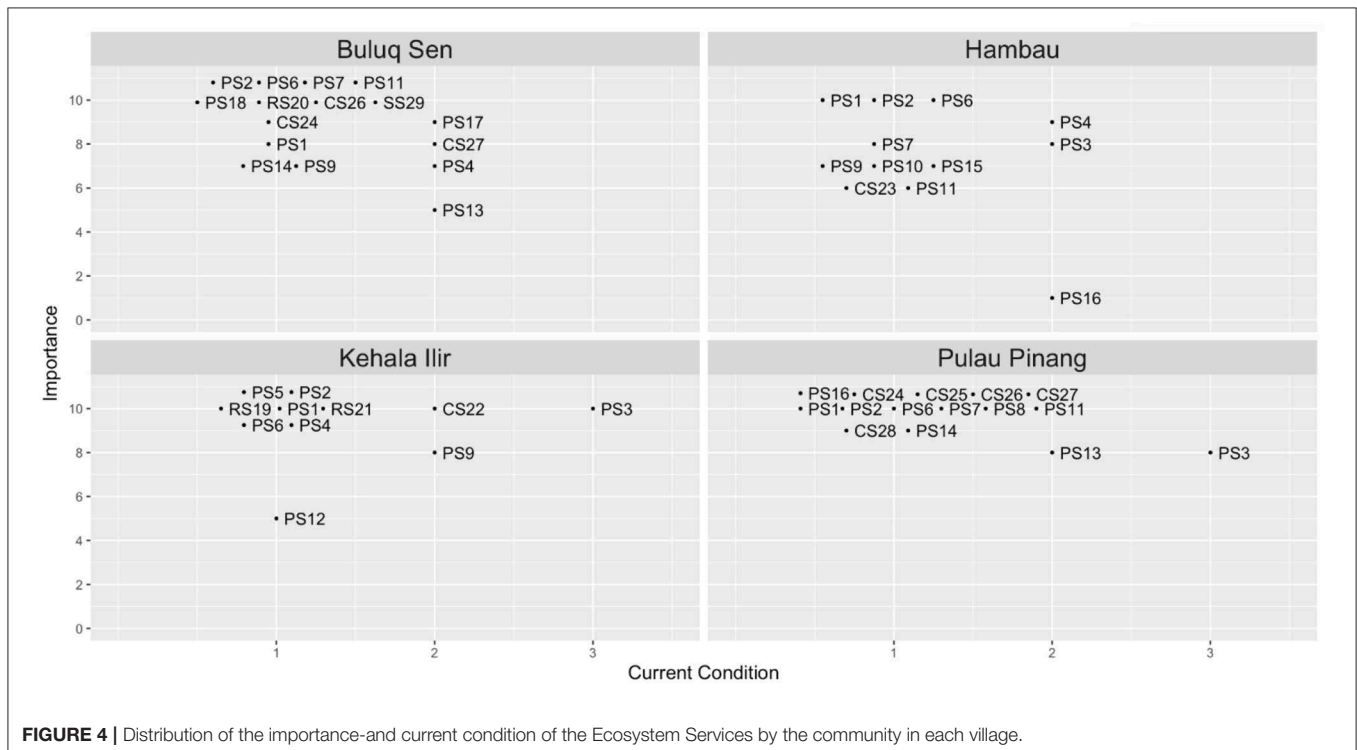
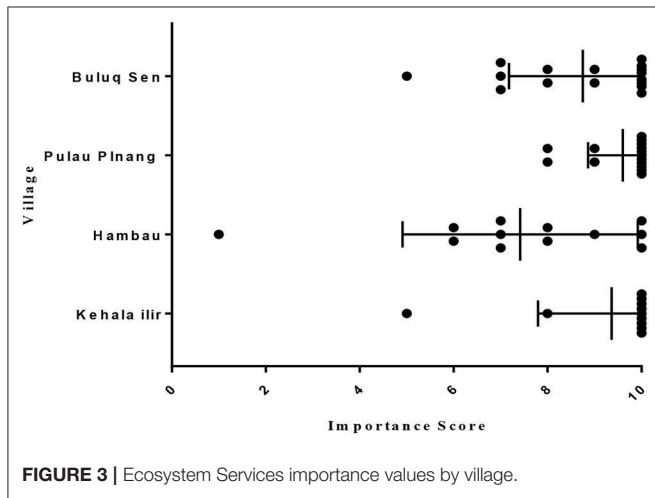
score but low condition (bottom left), indicating recognition of the decline of these services, but attaching little importance or value to them.

Cultural services were given recognition by all villages, although reporting of these services was highly uneven. For instance, the indigenous Dayak of Pulau Pinang and Buluq Sen villages recognized a large number of cultural services, particularly related to their cultural heritage and traditional social practices. Many goods, valued by the local communities, were also related to cultural purposes (Daniel et al., 2012; Meijaard et al., 2013). These include the harvesting of Ulin

timber/Ironwood (*Eusideroxylon zwageri*) for traditional Dayak coffins (called Lungun), herbs for medicines, rattan to build houses and furniture, and Biruq leaves (*Johannestijmania altifrons*) to make caps (called *Seraung*) to block the sun, all of which are synonymous with Dayak identity. Indigenous Kutai inhabitants in the Hambau also listed cultural services, teamwork/community self-help (called “*Gotong-Royong*”).

Only participants from Buluq Sen recognized the importance of Supporting Service (e.g., soil fertility). Members of this community, which still practices traditional farming, determine soil fertility by observing a variety of rattan and other plants, including those from the families *Zingiberaceae* and *Euphorbiaceae*, and employ *Myrtaceae* as an indicator of soil infertility (Siahaya et al., 2016). These indicators are used to plan rotational fallow periods. Thus, Dayak communities employ rattan not only for building but also to indicate the soil’s need for shifts in cultivation (Siahaya et al., 2016).

Regulating services were recognized only by participants in Buluq Sen and Kehala Ilir– peat forests for flood mitigation, fresh air, and pollinators (from the peat-forest). The participants from Kehala Ilir were unique in identifying the importance of peat forests for the mitigation of floods and water pollution (RS19). They ranked peat forests highly because they reduced water pollution by filtering waste. These also act as a natural buffer to the nearby environment and aid in flood mitigation. Consequently, these villagers supported the moratorium on oil palm expansion on peatland (Daemeter, 2016). Swiftlet nest (PS3) as an ES that was increasing, but attached different degrees of value to this service. For example, the fishing community, Kehala Ilir, recognized it as a highly important ES (10), but it was deemed



less so by palm oil smallholders from Hambau village (score 8). During the FGD, only participants in the Buluq Sen did not list it, as it had not been started in 2016.

The Drivers and Impact of Changes in ES to Communities

The four communities that reported the resources were identified as having been subject to decline or degradation. The drivers of change were attributed by local communities to water pollution (Allen, 2013), as well as the fishing behavior of migrants—who use poison and electric fishing, upstream mining, and palm plantations, which the local communities claim cause water pollution (Table 4, statements 1–4). Despite the perceived decline in fish stocks, the local communities acknowledged that their household economies had improved (Table 4, statement 2).

Declining incomes from fishing are perceived to have been caused by water pollution that has caused reputedly caused substantial declines in fish stocks. Typically, local communities reported fish catches to have dropped from around 15 kg per day 5 years previously, to only 5–6 kg per day at the time of the study in 2016. One species, Betutu (*Oxyeleotris marmorata*), was considered to now be rare in the wild and may have become locally extinct. Other fish such as Puyau (*Osteochilus hasselti*), Lais (*Cyptopterus* sp.), Baung (*Macrones* sp.), and Pahat (*Osteochilus repang*) are reported to be rare.

Decreasing the provisioning services has caused crime and unemployment to increase (Table 5, statement 25 and 26). As reported by local communities in Kehala Ilir, who depend on the river (97% of populations are fishing), they now store fish collected from the river in their house (rather than in front of it as before) for security. The perceived decline in fish populations was also claimed to affect employment. Mr. H, a fish distributor, said that he used to employ five workers, but is now no longer able to do so due to insufficient fish catches. Both undermine the fabric of a community and can lead to tensions within and among communities.

Local communities also expressed concerns about the quality of the river water used for drinking and washing, as well as for mill operation (Table 4, statements 4–9). All stakeholders living in the area draw water for daily requirements, either directly or indirectly, from the Belayan River. They were also concerned over increased living costs, is now compelled to buy drinking water (and even water for cooking) from the water company (statements 1–3). They dated these changes to the establishment of the upstream palm oil mill and its waste flowing into the river.

In addition, the expansion of oil palm has led to the adoption of more intensive farming systems as opposed to the more traditional shifting cultivation practices of the past. Oil palm cultivation undermines the shifting cultivation system by committing a parcel of land to continuous agricultural use for 25 years, and thus requires fertilizer to maintain soil fertility. Buluq Sen and Pulau Pinang Dayak communities had, for example, never used synthetic chemicals on their paddy and banana farms, but this changed following the adoption of oil palm. Pulau Pinang local communities reported that each oil palm tree needs 3 kg of fertilizer every 3 months, and in at least one case in Buluq Sen it

was reported that the oil palm trees died because they were given too much fertilizer.

Meanwhile, local communities from Buluq Sen reported a decline in soil fertility, which they attributed to nearby palm oil plantations, which used pesticide sprays. While we cannot verify the validity of this statement, it seems possible that frequent use of pesticides might cause pest agents to move from the treated fields to adjacent untreated lands, as detailed by Arias-Estévez et al. (2008).

Majority Informants Desire to Grow Palm Oil

Despite local communities mentioning that deforestation due to palm oil plantations is a primary driver for declining ES, the majority of informants (81% of total 74) were positively disposed to palm oil development (Table 6). There was widespread agreement that the development of palm oil in their areas had improved household and community economic conditions (Table 5). The informants across all four villages stated their intentions to continue to expand palm oil production by replacing existing farms with palm plants if suitable land and capital were available. Some interviewees expressed uncertainty about palm oil, but this, they acknowledged, was due to their lack of knowledge on expected revenues.

Reasons for Growing Oil Palm

While understanding the likely linkage between decreased ES and oil palm development around them, local communities still like growing such a lucrative crop. Aware of the dilemma, they still favor palm oil development mostly because of the benefits of high revenue (Feintrenie et al., 2010; Pfund et al., 2011; Saswattecha et al., 2016), yet losses from forest income, other crops, and fish might be higher than previously assumed (Angelsen et al., 2014). We found that local communities motivated by several reasons other than the economy for planting palm, such as unpredictable weather, governmental policies, government incentives (Rist et al., 2010), as well as influencing from neighbors (Figure 5).

Oil palm is also perceived as being more tolerant to drought (Table 7, statements 49–50) and unpredictable weather events (Masato Kawanishi, 2013) than rice. To adapt to uncertainty, farmers switched from paddy farms to oil palm plantation (Masato Kawanishi, 2013). Indeed, on several occasions, entire rice crops had been lost to rats and root-eating insects. Recent extended dry seasons, occurring most recently in 2015, had affected upland paddies, particularly in Buluq Sen village, causing rice crop failure. These collective experiences have driven communities to convert or consider converting, their lands to oil palm plantations.

Growing and maintaining oil palm was reported to be easier than rice. Planting oil palm seedlings is done once with no need to replant for 25 years. Paddy, by contrast, needs to be replanted after harvest (once a year for upland rice at Buluq Sen and Pulau Pinang, and twice a year for wetland rice at Kehala Ilir and Hambau). Rice farming is a strong part of the cultural heritage of Buluq Sen and Pulau Pinang local communities, yet considering

TABLE 5 | Statements of community as the indicators and the impacts of decreasing Ecosystem Services by the community.**Fishermen catch a small number of fish**

- (14) "Dulu hasil tangkapan bisa diprediksi namun saat ini sulit sekali disebabkan karena menurunnya jumlah ikan serta limbah yang jatuh ke sungai" (Fisher, Kehala Ilir village)
 – We used to be able to estimate how many fishes we would get, but now it is difficult to predict, as the fish numbers are declining and because of the existence of pollutants in the river.
- (15) "Keramba berisi ikan haruan sekitar 1-ton jika ditotalkan sekitar 25 juta. Ikan Haruan yang hari ini didapat sekitar 2 kg saja, karena tidak banyak sehingga untuk konsumsi sendiri saja tidak dijual apa bila dijual sekilo hanya Rp. 13.000, - sedangkan modalnya sekitar Rp.19.000" (Fisher, Kehala Ilir village)
 – (Our) Keramba (fish's cultivation ponds) contained 1 ton of fish (Haruan), which were valued at Rp. 25 million. However, today, we catch around 2 kg., only enough for own consumption. Even if we wanted to sell, there would be less or no profit, as per kilo the price is Rp. 13.000, while the operational cost is 19.000 Rupiah.
- (16) "Membeli ikan makin sering, dulu sesekali bisa mencari sendiri untuk dimakan." (oil palm smallholder, Hambau village)
 – We are now buying fish more, whereas previously, we could catch it in the river if we wanted to consume it.
- (17) "Biasanya kami mendapatkan tangkapan ikan 10 kg dalam waktu 2-3 days, tetapi sekarang hanya 5 kg saja yang bisa ditangkap saat ini." (fisher, Kehala Ilir village)
 – We used to get 10 kg within 2-3 days, but lately only 5 kg.
- (18) "Sekali jalan untuk mencari ikan bisa dapat sampai to ½ pikul (25 Kg) menggunakan ringgi. Apabila hasilnya banyak maka biasanya dijual, dan dikonsumsi sendiri sekitar ½–1 Kg saja" (fisher, Kehala Ilir village)
 – We used to get 25 kg per fishing activity using Ringgi. So we would able to sell it and retain 1 kg for our own consumption, but now we get less, only enough for our own consumption.
- (19) Banyak sekali kesulitannya, saat ini ikan sangat sulit dicari sekitar seminggu ini hanya mendapatkan ikan sekitar 10 kg ikan haruan dan sepat siam sekitar 4 kg (fisher, Kehala Ilir village)
 – We have a lot of difficulty; nowadays, fish is very difficult to find. This week we only got about 10 kg of Haruan and about 4 kg of Sepat Siam fish.

Decreasing size of fish

- (20) "Bukan hanya hasil tangkapannya yang berkurang, tetapi juga ikan yang didapatkan banyak ikan kecil."
 – We wandered around the village; now the size of the fish are smaller.

Difficulty getting certain fishes that existed before

- (21) "Sekarang beberapa ikan sudah tidak ada ataupun jarang ditemukan seperti ikan puyau, lais, baung, pahat dan betutu."
 – Nowadays, some fish cannot be found or are hard to find, fish such as puyau, Lais, baung, pahat, and betutu (*Oxyeleotris marmorata*).
- (22) "Sebenarnya ikan betutu ini bukannya tidak tahan, namun apabila dipelihara disungai memang tidak cocok karena ikan betutu sendiri asalnya dari danau rawa-rawa, sehingga bila dipindahkan tempat hidupnya akan sulit sekali untuk dapat hidup Sedangkan ikan yang memang masih tahan dengan bangar (air berbau) yaitu biawan, sepat siam, haruan, patin, dan toman, ikan Kendia, Tebal Dada, Merah Mata, Repang." (Fisher, Kehala Ilir)
 – This Betutu fish (*Oxyeleotris marmorata*) is not an endurance fish because it comes from the swamp, so it will not be fit to live in the river; therefore, if it is moved it cannot easily adapt. Fish that survive from Bangar (in stinky water) are biawan (*Helostoma temminchii*), sepat siam (*Trichogaster petroralis*), haruan, patin (*Pangasius sp*) and toman (*Orheichepalus micropeltes*), ikan Kendia, Tebal Dada, Merah Mata, Repang (*Ostheocillus repang*)

River became murky

- (23) "Sungai untuk air minum biasanya mereka mengambil air di sungai dan dimasak, tetapi sejak tahun 2012, air dari sungai harus direbus terlebih dahulu setelah diendapkan" (Fisher, Kehala Ilir village)
 – Drinking water or water for cooking was generally taken from river, but since 2012, we have needed to let it be for a while before consumption. (11)
- (24) "Beberapa masyarakat juga mereka membeli isi ulang seharga Rp. 50000-60000, - perbulan."
 – Some people buy a refill drinking water bottle for 50.000 – 60.000 per month.

More fishermen are unemployed, and crime is increasing

- (25) "Dulu pegawai saya sekitar lima orang, karena dulu ikan sangat banyak bila nelayan sekali panen. Namun saat ini hanya tersisa satu orang saja dengan sistem upah perkilonya Rp. 250" (Fishes distributor, Kehala Ilir village).
 – I used to have five staff members because there were plenty of fish at one time for harvesting, but now I only have one staff member with the salary of Rp. 250/ kilogram
- (26) "Sekarang ikan juga ada yang nyuri, saya taro di didepan rumah ilang dicuri orang, padahal dulu tidak pernah, ini karena ikan makin menurun, ndak ada lagi sumber penghasilan." (Fisher, Kehala Ilir village)
 – Now event fish can be stolen. I put fish in front of my house, and someone took it; this had never happened before. This is because the number of fish is getting smaller and smaller, and there is no more income.

Harvest paddy failed

- (27) "Kita nanam padi dekat kelapa sawit, tapi tidak bisa, mati. Karena sawit pake semprotan (pestisida)" (Oil palm smallholder, Pulau Pinang village)
 – We plant rice near palm oil production sites, but it keeps dying, maybe because the palm oil plantations are using sprays (pesticide).
- (28) "Gagal padi kayaknya karena perusahaan kelapa sawit Makai pestisida, jadi hama nya kesini" (farmer, Buluq Sen village)
 – Rice crop failures may have occurred because the Palm Oil Company uses pesticide that causes pests to come here (to our fields) instead.

Difficult to find raw materials

- (29) Sekarang susah dapat rotan karena sudah ndak ada hutan lagi" (farmer, Buluq Sen village)
 – Now, it is difficult to find rattan because of deforestation.

Source: FGD and interview, 2016.

the effort required, it is becoming less attractive than oil palm. This also relates to local communities' age and health concerns, with a few villagers stating that as they get older they have reduced the ability to farm paddies and work in fisheries, whereas oil palm

remains productive for 25 years with little management input (Rist et al., 2010).

Local communities' motivation to invest in oil palm is further fueled by local government policies at different levels affecting

TABLE 6 | Perceptions of communities in Kutai Kertanegara on palm oil development (n: 74).

Neutral (n: 14 or 19%)	Positive (n: 60 or 81%)
<p>(30) "Tidak ada lahan lagi untuk menanam sawit. Jadi menanam padi saja" (fisher, Kehala Ilir village) – I only plant rice because there is no land to plant palm oil.</p> <p>(31) "Biasa saja. Tidak punya lahan untuk menanam" (fisher, Kehala Ilir village) – Nothing special. I don't have land to plant oil palm.</p> <p>(32) "Tidak tahu, karena baru menanam" (farmer, Buluq Sen village) – Do not know—we just started planting.</p> <p>(33) "Kalau ada modal mau menanam" (farmer, Buluq Sen village) – If I have financial capital, I will plant.</p> <p>(34) "Tidak begitu menguntungkan hanya karena terpengaruh tetangga jadinya ikut menanam" (palm oil smallholder, Pulau Pinang village) – Not that profitable. I only planted it because I was influenced by my neighbours to plant it.</p>	<p>(35) "Kita akan nanam sawit lagi ke depannya, walaupun tidak ada lahan lagi untuk rumah, ya kita bangun rumah diantara pohon sawit itu, kan kosong sekitar 9 m jaraknya." (oil palm smallholders, Pulau Pinang village) – We will expand palm oil in the future; if we do not have lands available for settlement, we intend to use the nine-meter empty land area to build houses between one palm tree and another.</p> <p>(36) "Kurang lebih sama dengan yang lain kalau punya modal dan lahan lebih pasti ingin menanam Sawit apalagi Pabrik juga dekat" (fisher, Kehala Ilir villager) – More or less the same as others (people). If I have financial capital and lands, for sure I will plant palm oil, not to mention the mills are located nearby.</p> <p>(37) "Ada rencana memperluas kebunkelapa sawit." (oil palm smallholder, Pulau Pinang village) – I plan to expand my palm oil plantation.</p> <p>(38) "Kalau ada modal mau menanam" (Farmer, Buluq Sen village) – I want to plant if I have capital.</p> <p>(39) "Lebih menguntungkan dibanding pekerjaan sebelumnya" – More profit than previous job (palm oil smallholder, Pulau Pinang village)</p> <p>(40) "Lebih menguntungkan menanam sawit bila memang ada dipupuk secara rutin" – Planting palm oil is more profitable than other crops if we use fertilizer routinely (farmer, Buluq Sen villager).</p>

decisions among farmer to grow oil palm (Rist et al., 2010). In one of the study areas in Buluq Sen village, farmers became encouraged to plant oil palm once the village government decided to allocate some of the village budget allocations (*Alokasi Dana Desa* or ADD) to provide village farmers with subsidies to cover 80% of initial planting cost, including seedlings and nurseries. ADD is sourced from the local government budget, and is allocated to villages across the country. However, the ways in which the budget is allocated depends on the village authority, which has discretion in proposing budgets and potential programs that would increase the wealth of their own village, making the use of ADD vary from one village to another (Magdalena et al., 2013). Across four different village sites, the use of ADD to promote the planting of oil palm was only found in Buluq Sen village.

In Pulau Pinang village, the central governments' decision to stop issuing permits for logging in 2011 has forced local villagers (many former loggers) to grow oil palm or become laborers in oil palm companies, though a palm oil company had been present in the region since 1992. Since then, increasing numbers of oil palm processing mills and the construction of roads and other facilities, which have been promoted by the government, have encouraged other local actors to invest in oil palm businesses, further driving oil palm expansion. In addition, the government's policy of nucleus and smallholder scheme requires that companies enter into an agreement with local communities and facilitate the establishment of a plantation. In so doing, the government provides a favorable scheme for local communities to engage in this business, start to plant and influence each other to plant oil palm. One of the local communities said that he saw his neighbors achieve economic success after harvesting palm oil (Table 7, statement 47–48).

Finally, the existence and proliferation of mills have tempted communities to plant oil palm through the availability of a readily accessible market [see also (Masato Kawanishi, 2013)]. The readily available market makes oil palm more attractive than other crops (e.g., bananas). Local communities also frequently mentioned the crucial role of middlemen in facilitating ES and land cover change. As a market intermediary, middlemen facilitate trade between suppliers (farmers) and buyers (mills), making FFB trading accessible across the region, and thereby promoting the adoption of oil palm cultivation. While middlemen are not a direct driver of ES degradation, they have information and capacity (e.g., they know the location of the smallholder plantations and have vehicles for transportation of the FFB to the mills) which is crucial to the expansion of smallholder oil palm systems. Moreover, middlemen can buy from and sell to whomever they want, and they often prefer to sell FFB to non-RSPO companies, as the FFB quality screening is not as strict. This results in lower incentives to adopt certification standards by producers and undermines the competitiveness of RSPO certified mills.

Community Perceptions of Oil Palm Companies

Despite enthusiasm for palm as a crop, as shown in Table 6, there was a mixed response across communities regarding nearby oil palm companies. As shown in Table 8, over half of respondents expressed unhappiness about the various impacts derived from company operations. Company practices that clear forests and how the processing mills operated were believed to have affected environmental services. There was also concern about the operation of the plasma system, as

TABLE 7 | Reasons of local communities in Kutai Kartanegara to expand oil palm plantations.**Financial- Easier market access**

- (41) "Karena pabrik juga dekat jadi lebih mudah untuk menjual hasil dari sawit ini (farmer, Buluq Sen village)
 – Because the mills are close by, it is easy to sell the palm oil.
- (42) "Biasanya ada tengkulak yang datang untuk mengambil buah sawit dikebun langsung. Banyak tengkulak, dan ada juga koperasi disini, jadi kalau mau menjual pasti sangat mudah sekarang" (oil palm smallholder, Hambau village).
 – There are middlemen picking up our harvested FFB directly from the plantation. The selling process is much easier now because of high number of the middlemen as well as the existence of cooperatives (Koperasi).
- (43) "Belum ada kesulitan untuk menjual, banyak tengkulak yang mau menerima hasil sawit ini." (oil palm smallholder, Hambau village)
 – There is no difficulty yet in selling (FFB) because many middlemen want to buy.

Financial- The high production raises high revenue than other crops

- (44) "Harga sawit kan makin tua makin naik" (oil palm smallholder, Pulau Pinang village)
 – The older the plantation is, the higher the price of FFB will be.
- (45) "Mulai tahun 2013, sudah mulai kredit motor hasil dari sawit ini dengan panen dua kali satu bulannya" (oil palm smallholder, Pulau Pinang village)
 – Since 2013, I have started motor credits using two months of revenue from this palm.

Financial- Growing and maintaining the palm is simpler than other crops

- (46) "Ada Menanam dan tidak terlalu rumit"(oil palm smallholder, Hambau village)
 – I planted palm oil, and it is not complicated (compared to other crops).

Social- desire to imitate

- (47) "...Pada tahun 2013, karena banyak tetangga nanam sawit, dan untung, jadi ya kita ikutin aja"(oil palm smallholder, Hambau village)
 – In 2013, [I planted] because many neighbours were planting palm oil, and it is profitable, so we followed suit.
- (48) "Karena banyak dilingkungan sekitar yang menanam sawit jadi ikut menanam sawit sebelum terlambat" (farmer, Buluq sen village)
 – Because our neighbours have planted palm oil, we followed and planted before it was too late.

Ecology- Climate change

- (49) "Sekarang cuaca ndak nentu, biasanya bulan bulan Agustus itu hujan, jadi nanam padi, tapi kemarin kemarau panjang, jadi daripada gagal panen, nanam sawit saja" (Farmer, Buluq Sen village)
 – Currently, the weather is indeterminate. Usually August is the rainy season and time to plant paddies, but last year included a long drought time, so rather than crop failure, we planted oil palm instead.
- (50) "Paling banyak sekitar satu kaleng saja namun terakhir hanya menghasilkan 8 kg saja karena gagal panen" (Farmer, Buluq sen village)
 – I usually plant as much as 1 can of paddy, but the last harvest only produced 8 kg (instead of 24 kg).

Ecology- Existence of pests

- (51) "Ya sekarang padi ada hama, ga pernah sebelumnya, ini gagal panen, makanya saya nanam sawit saja"
 – Now, there are pests that destroy our paddy, something that never happened before, so I had better plant palm oil.
- (52) "Sekarang banyak yang beralih menanam sawit karena ada pabrik dekat walaupun menanam padi pada kena hama" (oil palm smallholders, Pulau Pinang village)
 – There are pests in the paddy, so we switched to palm oil. Even the mills are closing.

Policy- government support (subsidies and training)

- (53) "...Ya sama desa diberi bibit, ya saya terima saja" (Farmer, BuluqSen village)
 – Yeah, the village gave us seeds, so I accepted them.
- (1) "Bibit dulu ada bantuan juga dari Disbun 300 pohon..... bahwa bibit diberi bantuan dari Disbun, ada juga bibit yang dari PPMD sebanyak 286 bibit total keseluruhannya..... juga pupuk sekitar 6 bulan sekali diberikan.dari Disbun.....herbisida 6 liter, dan juga racun tikus Kelerat." (Oil palm smallholder, Hambau village)
 – The Plantation Office subsidized 300 seedlings and the Village Community Empowerment Office provided them with 286 seedlings. Also, they provided fertilizer about once every six months, as well as six liters of herbicide and rodenticide.
- (2) "Selama ia menjabat saya akan terus masukkan program penanam sawit pada ADD" (The head of the village of Buluq Sen village)
 – During my tenure, I will continue to include a palm oil plantation program in the village budget.
- (3) "Saya dorong kepada masyarakat supaya tinggal ladang berpindah, sudah ganti sawit saja lebih mudah, desa lain sudah mulai, kita baru akan mulai." (officer in Buluq Sen village)
 – I encourage villagers to stop swifiting cultivation to plant palm oil, because it is easier. Other villages has already started.

Source: interviews in 2016.

well as negative impacts due to the influx of migrants in the region.

The central issue was a lack of transparency on the part of the companies and cooperatives with respect to reporting information regarding costs and revenues from the *plasma* scheme to local communities. As a result, local communities do not know whether the profit-sharing agreement is being met. This situation has often led local communities to engage in street protests against the oil palm company (Chao, 2013). In Pulau Pinang, local communities claimed that they had not received revenues from the oil palm company for their *plasma* for 2

years. They, therefore, started to harvest the FFB themselves in 2016 and were consequently accused by the company of stealing. Based on these events, the military was deployed to prevent the smallholders from further harvesting FFB. This conflict within the *plasma* scheme at Pulau Pinang was ongoing during our study in 2016, and almost all interviewees from Pulau Pinang identified this as an issue of immediate concern. Such negative perceptions contrast with the views of villagers in earlier years. In Hambau village, for example, before one of oil palm companies near their village opened in 2007, the majority (97% of 185 respondents) of local communities gave positive responses

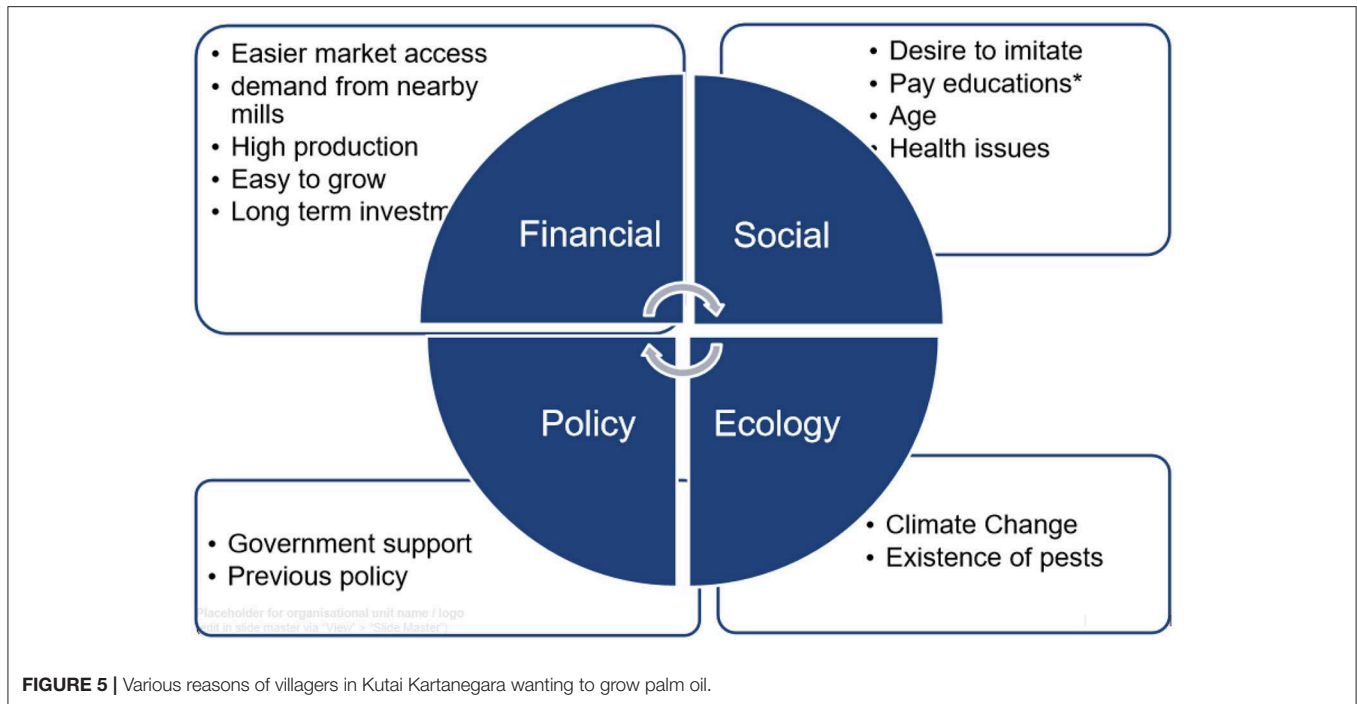


FIGURE 5 | Various reasons of villagers in Kutai Kartanegara wanting to grow palm oil.

about oil palm companies, as they expected that the plantation’s existence would provide benefits, including job opportunities (PT-TPS, Unpublished).

However, several respondents from Kehala Ilir, Buluq Sen, and Hambau said that they did not think that the presence of companies was detrimental. Around 23% of respondents said they did not know whether the existence of those companies was good or bad, or they simply did not want to judge the companies or express a negative opinion. This was a personal opinion of a villager expressed without fear. Most of the villagers were quite willing to talk about the company, and a majority of them openly voiced their negative opinions surrounding oil palm. Some positive views on palm oil companies were shared by about 30% informants. The presence of companies was recognized as being necessary to ensure the viability of palm oil business in the region, and to provide benefits beyond palm oil. The increase in migrant employees had created new business opportunities for local people, including the provision of transportation services and restaurant businesses. Company employees often bought local fish, giving local people a chance to earn cash. Another benefit acknowledged by the head of the Hambau village included *Rumah Belajar* (“A House of Learning”), established by companies. The local communities use this house as a place to learn English and computer skills. Trainers were provided by companies to help local communities to enhance their knowledge-based skills.

Conflict around ecosystem services related to oil palm arose in the downstream fishing community of Kehala Ilir, due to water pollution and reportedly declining fish stocks. The people of Kehala Ilir village blamed plasma oil palm development by the upstream villages of Buluq Sen and Pulau Pinang for these impacts. Within Kehala Ilir village, declining ecosystem services

affected food security, which in turn was attributed to conflicts within the community as unemployment and crime rose. Conflicts in the upstream villages (Buluq sen and Pulau Pinang) mostly concerned the social interactions these communities had with the oil palm company. While in Hambau village, the conflict occurred within the community, due to the lack of transparency of the Cooperative (*koperasi*) in sharing revenue resulted from plasma lands.

The Roundtable on Sustainable Palm Oil (RSPO) has created a set of social requirements that RSPO certified companies must meet, and which are designed to minimize or avoid conflicts. Implementation has not always been successful. Improving on this might require that the RSPO monitoring and evaluation process should follow a bottom-up approach, namely by directly involving local communities. The RSPO does not, however, include areas beyond oil palm concessions. To resolve this, RSPO could be integrated with other existing site level instruments such as Environmental Impact Assessments (EIA).

The companies are individually given the mandate to do the EIA before starting operating to anticipate a negative impact on the environment. From the public sector, local governments at all levels are required to do Strategic Environmental Assessments (SEA) before any district-wide policies or permits related to land use and land allocation are issued. The assessment will ensure that all potential impacts arising from the adoption of policies (e.g., land use) can be identified and adverse impacts could later be avoided. In addition, in 2014 the district head of Kutai Kartanegara issued a regulation No. 5 aiming to protect and manage the environment and No. 48 on guidelines for maintaining environment and preventing environmental destruction and water pollution while developing oil palm plantations and processing mills. They stipulate that those in

TABLE 8 | Perceptions of the communities of Palm Oil Company.**Negative (N:38, 51% of total 74 respondents)**

- (4) "Perusahaan bisa lebih memperhatikan lingkungan atau masyarakat kalau bisa diganti rugi dari ikan-ikan yang telah mati dikeramba masyarakat karena limbah yang meluap ke sungai." (Fisher, Kehala Ilir Village)
 – The company could pay more attention to the environment or community and if possible, pay for the loss of fishes on people's keramba caused by a pollutant in the river.
- (5) "Yang Pasti limbah dari pabrik ikut turun ke sungai sehingga saat mencari ikan pasti jarang dapat, sedangkan kebutuhan utama itu ikan" (Fisher, Kehala Ilir)
 – The waste from mill flows downstream to the river, so it is difficult to get fish, a fundamental daily need.
- (6) "Perusahaan tidak ada sama sekali campur tangan untuk masalah yang ada desa termasuk menyangkut Ikan di sungai sebagai salah satu mata pencaharian" (Fisher, Kehala Ilir village)
 – The company did not care about our village's problems, including the problems with the fish in the river [caused by water pollution], which is our livelihood source.
- (7) "Perusahaan ga mau ngasi status pekerja kita" (Palm oil labourer, Hambau village).
 – The company did not give me status as a worker.
- (8) "Perusahaan hanya mempekerjakan masyarakat yang pendidikannya tinggi (oil palm smallholder, Pulau Pinang village)
 – Employment is only for villagers who have high educational qualifications.
- (9) "Banyak yang tidak bagus tentang Perusahaan, untuk karyawan sendiri kurang ada pengangkatan status kerja" (Oil palm smallholder, Hambau village)
 – One thing that is not good about the company is that for the workers, there are no permanent contracts.
- (10) "Perusahaan tidak transparan soal hasil plasma ini" (Cooperative staff, Hambau village)
 – The company is not transparent with the results from plasma land.
- (11) "Pembagian hasil dari lahan plasma yang tidak jelas" (Farmer, Hambau village)
 – Profit sharing from plasma land unclear.
- (12) "PT TPS dulu perizinannya hanya untuk nursery saja, bahkan warga/masyarakat tidak ada yang tahu menahu bagaimana bisa ada pabrik disana" (Fisher, Kehala Ilir village)
 – PT TPS in the past, the permit was only for the nursery. The villagers did not know that they would build a mill there.

Positive (N: 19, 26% of 74 respondents)

- (13) "Pabrik dekat, jadi gampang jual sawit"(farmer, Buluq Sen village)
 – Mill access is easy because it is close to the village.
- (14) "Perusahaan kasi kita bibit, jadi ya bisa nanam" (oil palm smallholder, Hambau village)
 – The company gives seeds to the community.
- (15) "Perusahaan sebenarnya sudah berusaha memberikan yang terbaik yang mereka bisa, salah satunya listrik yang bisa dirasakan oleh masyarakat" (oil palm smallholder, Pulau Pinang villager)
 – Actually, the company is trying to do as well as they can, for example, by providing electricity to the villagers.
- (16) "Staf nya perusahaan suka beli ikan, jadi menguntungkan juga" (fisher, Kehala Ilir village)
 – Company staff often buys fish.
- (17) "Adanya perusahaan ini, jadinya bisa buat bisnis travel sama ada banyak restoran" (fisher, Hambau village)
 – Because the company existed, there is other business, such as travel agencies and restaurants.

Neutral (N:17, 23% of 74 respondents)

- (18) "Kehadiran perusahaan tidak mempengaruhi masyarakat" (farmer, Buluq Sen village)
 – The company's existence has not affected people.
- (19) "tidak tahu"(oil palm smallholder, Hambau village)
 – Do not know.
- (20) "Tidak mau berpikiran negative dengan perusahaan" (Oil palm smallholder, Hambau village)
 – Do not want to judge the company.

disputes can go through formal court (which is the last resort) or alternative forms of dispute resolutions through negotiation, mediation and engaging a third party to arbitrate the dispute. Depending on the case, the solution can take the form of compensation, agreements on shared roles to take responsibility for restoring the polluted or damaged environment, and/or to gain benefits from the resources under dispute.

DISCUSSIONS

Common Agreed Upon ES to Manage the Oil Palm Landscape

Our assessment process allows better assessment of the importance of ES to the socioeconomic conditions of local communities, particularly in the context of oil palm expansion as a new economic opportunity (Davies et al., 2015). It incorporated local perceptions and valuations, which we expect to increase local awareness and participation, and reinforce the legitimacy

of regional assessment and planning, for the management of ecosystem services (Ramirez-Gomez et al., 2015).

Through direct local community involvement on our ES assessment process, we found out that a number of ES underpin food security, employment, and sociological benefits, even though, most commonly recognized provisioning services related to basic needs and immediate benefits, especially those that generate income. This result is reflected by other studies of landscapes undergoing transformation (Akwetaireho and Getzner, 2010; Tadesse et al., 2014; Bhatta et al., 2016; Sinare et al., 2016; Mensah et al., 2017). In our oil palm landscapes, ES remained important to local communities for at least one decade following the expansion of oil palm in the region. Any changes in the condition of these services are, therefore, likely to affect the economy of local communities, particularly in remote rural regions where local communities tend to be more dependent on natural resources (Akwetaireho and Getzner, 2010; Suich et al., 2015; Bhatta et al., 2016).

It is clear that the Balayan river serves a crucial role in providing several benefits to the local communities in Kutai Kartanegara. Rivers and their resources are widely recognized to provide a variety of important services on which many rural communities across the world depend. Yet freshwater resources globally are subject to much degradation resulting from upstream development (Carlson et al., 2014; Merten et al., 2016). Communities are often acutely vulnerable to such degradation on account of high dependencies on river systems for food, drinking water, and transport. These recent and ongoing losses of ES, as well as the socio-political drivers of such ES degradation, were recognized by local communities. Despite this, our results showed that many villagers from the four communities expressed interest in developing their own oil palm plantations not only one, but because of several reasons, in view of the income (Feintrenie et al., 2010; Rist et al., 2010; Pfund et al., 2011; Sayer et al., 2012) and other benefits that oil palm offers. These benefits include being highly tolerant to natural hazards, avoiding the pests that affected rice (Rist et al., 2010; Saswattecha et al., 2016), withstanding unpredictable weather events (Masato Kawanishi, 2013), and government policies (Rist et al., 2010). The loss of traditional forms of employment can be offset by new employment opportunities in the oil palm sector; this change in livelihoods can affect the relationship that people have with their natural resources and services which underpins their cultural identities. Furthermore, indigenous people tend to attach more value to Cultural services than immigrants and settlers, who value Provisioning services more (Tadesse et al., 2014). This was also reflected in our results. Nonetheless, about 80% of informants regardless of ethnicity still wanted to plant oil palm if they had the capital to do so. Among indigenous Dayaks, forest conversion and shifting cultivation to oil palm plantations might, therefore, be disconnecting people from their forests and cultural foundations. Thus, our results showed the communities are making decisions to expand oil palm, fully recognizing the impact on ES, yet also acknowledging the diversity of direct and indirect drivers.

Solutions to problems facing complex landscapes, such as Kutai Kartanegara's oil palm landscapes, need to be built on shared negotiation processes based on trust, but trust will only emerge when objectives and values are shared (Sayer et al., 2013). Given the fact that actors across different villages and landscapes under study have different values, beliefs, and motivations, it is important to identify a common concern entry point. The three ES deemed highly important by all villages are fish provision, water quality, and land availability. These shared perceptions can be a common concern entry point to engage communities in discussions about improved landscape management regardless of local livelihood strategies. In this case, ES framework is a potential tool to manage more sustainable oil palm landscape, where inhabit various actors, cultures, and local knowledge, connecting scientists and non-scientists, but it will have an impact when it matched with policy (Abson et al., 2014; Albert et al., 2014). In addition, mechanisms are needed to collate such information more widely and integrate it into policy and land management and planning processes, as well as certification schemes.

The Need for Stakeholder Engagement to Manage ES in Oil Palm Landscape

To support natural resources management, stakeholder engagement during ES assessment is recommended (Menzel and Teng, 2010; Mascarenhas et al., 2016). In our oil palm landscape, plantations are located along the river, mostly upstream, and their management will determine the quality of river ES. The river provides benefits, not only to local communities, but also to companies. A big oil palm company in the area, for example, needs 210,000 liters a day to meet operational needs (Environmental Agency of Kutai Kartanegara, Unpublished), and local communities use the river for basic needs, such as drinking water and cooking. Meanwhile, the community members to whom we spoke were aware of the ES flows, the threats to these flows from various interests and drivers and the power of key stakeholders, from village heads to higher-level policymakers, to influence landscape change that affected ES provision (Fisher et al., 2009; Termorshuizen and Opdam, 2009; Suich et al., 2015). Collaborations with oil palm companies are crucial to ensure that water in oil palm landscapes are not polluted and conflicts between companies and cooperatives are avoided. This could be achieved through a stakeholder platform that empowers a range of actors to share concerns and develop solutions. Local government has a role to play in facilitating the emergence of such a platform, and in monitoring, supervising, and charging sanctions to those failing to comply with existing regulations.

The Indonesia oil palm sector is shaped by public and private standards and its policy regime complex is challenged by disconnects and antagonisms (Pacheco et al., 2018), which undermine stakeholder efforts to conserve ecosystem services and ensure its benefit for all. Enforcing and harmonizing existing policies are essential so that companies and other actors adhere to relevant legal, environmental, and management standards. Through such a platform, various actors, including local communities, policymakers, shall engage from the design stage of environmental impact assessment plans to the monitoring of companies' operations (Ruckelshaus et al., 2015).

In the oil palm sector, the goals of protecting and maintaining environmental goods and services are continuously constrained by high global demand for vegetable oil. This places pressure on more land to be made available for developing lucrative vegetable oil crops such as oil palm. Despite existing public and private policies and instruments (e.g., EIA) prohibiting the conversion of forested lands into the plantation, undesirable effects from oil palm concession operations persist.

Some palm oil companies in the area have acceded to voluntary sustainability standards such as Roundtable Sustainable Oil Palm (RSPO), which requires them to comply with environmental criteria and indicators. They are, for instance, required to identify soil and water sources, air quality, preserve valuable biodiversity and ecosystems, and to mitigate negative effects arising from their operations. When developing new plantings, they are also required to conduct high conservation values (HCV) assessment through consultation with affected stakeholders so that harmful social and physical impacts can be avoided (Lyons-White et al., 2017). In our study,

local communities provided us with information on the critical role of three commonly agreed ES and described the relevance of these ES to livelihoods, culture, welfare, and income. Mechanisms are needed to collate such information more widely and integrate it into policy and land management and planning processes, as well as certification schemes.

Involving local communities using the ES framework is already acknowledged as good practice by the RSPO certification's instrument (HCV criteria 4–6), for improving the sustainability of palm oil landscape. Criteria 4–6 focus on ES and the protection of indigenous people, but companies are only responsible for their concession areas. Yet the impacts of palm oil development extend well beyond the concession area and affect, for example, water quality, widely attributed to pollution from an upstream mill (Carlson et al., 2014; Dislich et al., 2017). The fishing village, Kehala Ilir, tried to negotiate compensation for damaging to water and fisheries but, because the village is not included within the company's concession, requests from local communities were rejected. The head of the village said *"We have informed to district government (about water pollution), but this village is not included in their (companies) concession. We do not want to have conflicts, so we only accepted. We only asked to open the water flow from Balayan River (not only coming from the stream where the company located)."*

Indonesian on Sustainable oil palm (ISPO) does not cover all categories of ecosystem services refer to MEA (2005) framework. ISPO require growers to identify and maintain protected areas such as water sources, for example, they are not allowed to clear within a certain radius of the concerned objects (e.g., 200 m from a water source, 100 m along the river path). Oil palm growers should also make efforts to prevent erosion, maintain soil fertility, prevent fire and conserve rare wildlife. ISPO is required for all types of oil palm production system in Indonesia (including companies and smallholders), its implementation faces challenges, not least owing to the high cost too, and the limited capacity of, smallholders. While the ISPO itself requires smallholders to plant oil palm from certified seedlings, not all smallholders have been planting the certified seedlings. Thus, RSPO and ISPO will not be sufficient to resolve such conflicts so long as the guidelines are confined only to the area of the concession. These conflicts could become exacerbated if not addressed, as many important resources and services identified by communities are also perceived to be highly vulnerable to continuing the land transformation.

In addition, stakeholders such as oil palm smallholders, government, companies, and local communities need to establish a more effective and equitable mechanism to reduce or resolve conflicts. The majority of informants are unhappy with the oil palm industry, and conflicts continue, particularly around the lack of transparency and agreements related to plasma (Rist et al., 2010). This conflict within the plasma scheme at Pulau Pinang was ongoing during our study in 2016, and almost all interviewees from Pulau Pinang identified this as an issue of immediate concern. Such negative perceptions contrast with the views of villagers in earlier years. In Hambau village, for example, before PT TPS opened in 2007 the majority (97% of 185 respondents) of local communities gave positive responses about the companies, as they expected that the plantation's

existence would provide benefits, including job opportunities (PT-TPS, Unpublished). This is challenging as the incentive structures all point toward continued oil palm development even by smallholders who recognize the negative impacts that such development is having on a variety of ES, which they value.

CONCLUSIONS AND RECOMMENDATIONS

A shared community understanding of the value of ES and their degradation by both direct and indirect pathways allows for a bottom-up approach to ecosystem management. Engaging policymakers is essential to success, but success is only likely when communities feel empowered by their own knowledge, particularly in socially hierarchical settings.

As some resources and services are being lost, other alternative livelihood opportunities are being developed. If these bring new economic benefits that improve livelihoods, the loss of ecosystem and cultural services might be regretted but also accepted as part of the trajectory of change. A difficulty is that economic benefits and environmental costs are not distributed equally across the population, resulting in winners and often marginalized losers. In Kutai Kartanegara, for example, restoring river water quality and fish stocks would be a more equitable response by revitalizing the traditional fishing livelihoods and rehabilitating the various ES from which the whole community benefits. Yet this requires coordinated and agreed action across multiple stakeholders and scales, which is challenging on account of the profitability of both palm oil and Swiftlet nests available to those with the capital to invest. RSPO certification is not sufficient to achieve sustainable palm oil in the landscape, and it seems unlikely that the Indonesian Sustainable Palm Oil standard (ISPO), which is due to be mandatory for all producers, will help either. There is a need for a coordinated and equitable negotiation platform, and a recognition that impacts of oil palm plantations extend far beyond the plantation boundaries. The responsibility lies with the more powerful actors in these landscapes, namely the companies and the district government, to establish a cross-sectoral and regional management and planning approach in the Balayan River region. Such an approach must engage with local stakeholders and communities and acknowledge not only their economic needs and aspirations but also the values they attach to a wide variety of ecosystem services.

AUTHOR CONTRIBUTIONS

NH carried out the data collection, data analysis, drafting the manuscript, editing, and revisions. JG supervised the project, contributed critical revisions, editing, and drafting the manuscript. HK contributed critical revisions and editorial comments. AD contributed editorial comments.

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SUPPLEMENTARY MATERIAL

The Supplementary Material for this article can be found online at: <https://www.frontiersin.org/articles/10.3389/ffgc.2019.00041/full#supplementary-material>

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Conflict of Interest Statement: The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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