Why is tropical peatland conservation so challenging? Findings from a livelihood assessment in Sumatra, Indonesia

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SUMMARY

In recent years, widespread peatland degradation has occurred in Indonesia as a result of both natural events and human activities. Although there is a strong push for restoration from national and international stakeholders, at the local level, farmers and communities are still widely managing peatlands with unsustainable practices including their conversion into agricultural land. To understand the causes of such a challenging situation, we carried out a survey to investigate the drivers of local livelihoods in the typical peatland village community of Kayu Labu in South Sumatra Province. Our findings showed that while the unsustainable practices adopted do not align with either the long-term interests of this community or the wider public interest, they do align with the best socioeconomic interests of the farmers. A preliminary examination of the livelihood options chosen illustrates the strong contrast between public and private interests. In particular, in local communities like Kayu Labu, the profit margins for oil palm and rubber are higher than those for sustainable alternatives. We conclude that, to address the problem of peatland degradation and to design successful and sustainable peatland restoration initiatives, decision-makers need to understand the local socioeconomic situation, people's livelihoods, and their expectations. A key option is to increase the roles and responsibilities of local communities in determining the rules that relate to land management. Only then are regulatory and policy interventions likely to improve peatland conservation and restoration outcomes.

KEY WORDS: ecosystem services, Kayu Labu, livelihood options, restoration, tragedy of the commons

INTRODUCTION

As the fourth most populous country in the world (World Bank 2020), Indonesia has a pressing need for food security. Extensive areas of peatland (Figure 1) are perceived by government as having capability to support this requirement. However, pertinent properties of peatland soils differ from those of other (mineral) soils and not all peatland can be used for agricultural crops (Nursyamsi *et al*. 2016). Although utilising peatlands for rice farming, oil palm and rubber plantations has been shown to improve the livelihoods and welfare of some rural communities (Surahman *et al.* 2017), at the same time oil palm plantations have negatively affected the subsistence-based livelihoods of village communities in remote areas with high forest cover (Santika *et al*. 2019). Uncontrolled development within this ecosystem has also resulted in negative outcomes for biodiversity, including threatened extinctions linked to loss of habitat for endangered species (Rydin & Jeglum 2015).

The conversion of peatland from natural forest to other land uses generally requires the construction of drainage canals that promote surface and subsurface runoff and reduced soil water holding capacity (Holden *et al.* 2006, Hooijer *et al.* 2012, Ritzema *et al.* 2014), along with drying of the soil leading to its oxidation, consolidation and shrinkage that results in subsidence and carbon emissions (Parish *et al.* 2008, Hooijer *et al.* 2012, Schrier-Uijl *et al.* 2013). Drained and degraded peatland is also prone to increased flooding and fire (Dohong *et al.* 2017).

One of the mandates of the Peatland Restoration Agency (*Badan Restorasi Gambut*; BRG), established by the Indonesian Government in 2016, was to revitalise the livelihoods of people living in communities that are dependent on peatland (Ward *et al*. 2021). The BRG (BRGM from 2021) came with a commitment to restore > 2 Mha of degraded peatland by the end of 2020, an ambitious target (Ward *et al.* 2021) that remains largely un-met owing to complexity of the problem, lack of knowledge about the rewetting process, and disagreements amongst stakeholders with differing needs and goals (Fleming *et al.* 2021). At community level there is general agreement about the need to protect forested peatland and restore degraded areas by rewetting, but

awareness about the likely extent of change in livelihoods that this will require is lacking (Fleming *et al.* 2021). Consequently, a major challenge faced by the Indonesian government and its international supporters in their efforts to restore peatlands is the provision of sustainable alternative livelihood options for local people. This raises the question of whether it is possible to sustain and improve community livelihoods whilst restoring and protecting peatlands (Sakuntaladewi *et al.* 2022).

To address this question in general, our project team undertook extensive surveys and interviews of local residents, local government authorities and businesses in the peatland-dependent village of Kayu Labu in South Sumatra Province. One previous analysis of our data investigated how the development of degraded peatland areas could help to support food self-sufficiency and thus improve the food security of local communities (Winarno *et al.* 2022); while another aimed to understand the challenges limiting peatland restoration efforts by studying local livelihoods, and concluded that "… capacity building, communication and knowledge enhancement, and partnerships are needed for the success of land use-based peatland restoration in Kayu Labu" (Lestari *et al*. 2021). The further analysis reported here assesses the causes of those challenges in terms of reasons for the local community to avoid pursuing peatland restoration. The objectives of this study are to:

a) consider the main livelihood options that are currently available to the residents of Kayu Labu in terms of their advantages and disadvantages for local people;

b) understand the rationale behind the behaviours of local people that result in them continuing to seek livelihood support through unsustainable practices (Thornton *et al.* 2020, Widyatmanti *et al.* 2022);

c) suggest alternative strategies for encouraging the sustainable use of peatland that take into account the socioeconomic and physical factors affecting the local community; and

d) consider the policy implications and directions for future research required to promote the adoption of sustainable peatland management practices.

METHODS

Study area

Kayu Labu is one of seven villages located in the Pedamaran Timur sub-district of the Ogan Komering Ilir Regency in South Sumatra. The village extends to approximately 171 km^2 and comprises five hamlets housing people of three origins, namely: Pedamaran, eastern Pedamaran (orang Ogan), and Javanese through transmigration. Villagers originally supported themselves by fishing and rubber tapping, and when natural resources became depleted through over-exploitation of the peatland forest and accidental fires, they increasingly cultivated rubber. Migrants from Java and the neighbouring province of Lampung have been attracted to Kayu Labu by logging activities in the 1980s, the establishment of oil palm plantations in the early 1990s, and opportunities to purchase land from local residents since 2004 (Winarno *et al.* 2022; see later). The population of Kayu Labu is currently 2,931 (BPS

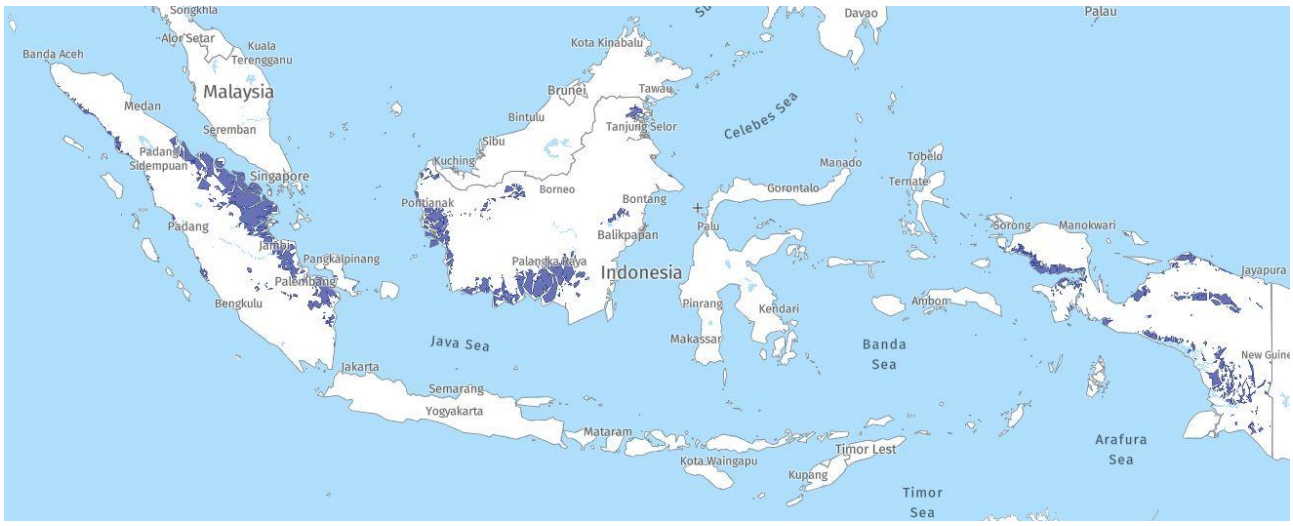

Figure 1. The extent of Indonesian peatlands in 2012 (dark blue shading). The map was developed using a tool and data available from Global Forest Watch (Grantham *et al*. 2020).

Kabupaten Ogan Komering Ilir 2021). All residents are, or aspire to be, landowners. Newcomers live rent free on other people's land until they can accumulate sufficient savings to purchase their own land.

The topography generally consists of lowland and slightly hilly terrain that drains into rivers and swamps. The main wild plant species are paperbark gelam (*Melaleuca cajuputi* subsp. *cumingiana*), mangrove apple (*Sonneratia caseolaris*) and the grass purun (*Lepironia articulata*) (BRG 2019). Purun is a wetland plant species that grows naturally in acidic, inundated areas (Junaidah *et al*. 2020).

There are two broad land types, namely dry land and swamp (mostly peatland) (Figure 2), and four predominant soil types (white clay, red clay, sandy, humus and peat). Clay soils generally occur on riverbanks and are used to grow rice, vegetables and fruit. Sandy soils are associated with housing and plantations of oil palm, rubber, coconut and fruit. Peat soils of shallow (0.5 m) to moderate (2.0 m) depth occupy the largest area (60–70 % of total) and are mostly planted with oil palm, the remainder being unmanaged. The peatland areas are inundated during the rainy season and vulnerable to fires during the dry season (BRG 2019), which usually result from intentional and unintentional human actions.

Peatlands in Indonesia are generally owned by the state or publicly held according to the Basic Agrarian Law of 1960. This means that the state has legal authority over management and use of this land, and may allocate it to private companies or individuals for commercial uses such as oil palm plantation and other types of agricultural production. Land allocations are typically made through government licensing processes and are subject to regulations and environmental assessments. Two palm oil companies operate under concession permits in Kayu Labu. Their corporate social responsibility (CSR) contributions to the community include infrastructure, educational programmes and establishment of a community fire brigade.

In 2004 the national Ministry of Forestry accepted a proposal from local stakeholders (including a palm oil company) to release peatland within the village boundary from the state forest. Local families subsequently (re)claimed ownership of areas previously used by their ancestors with authorisation by letter from the Village Head, but the possibility

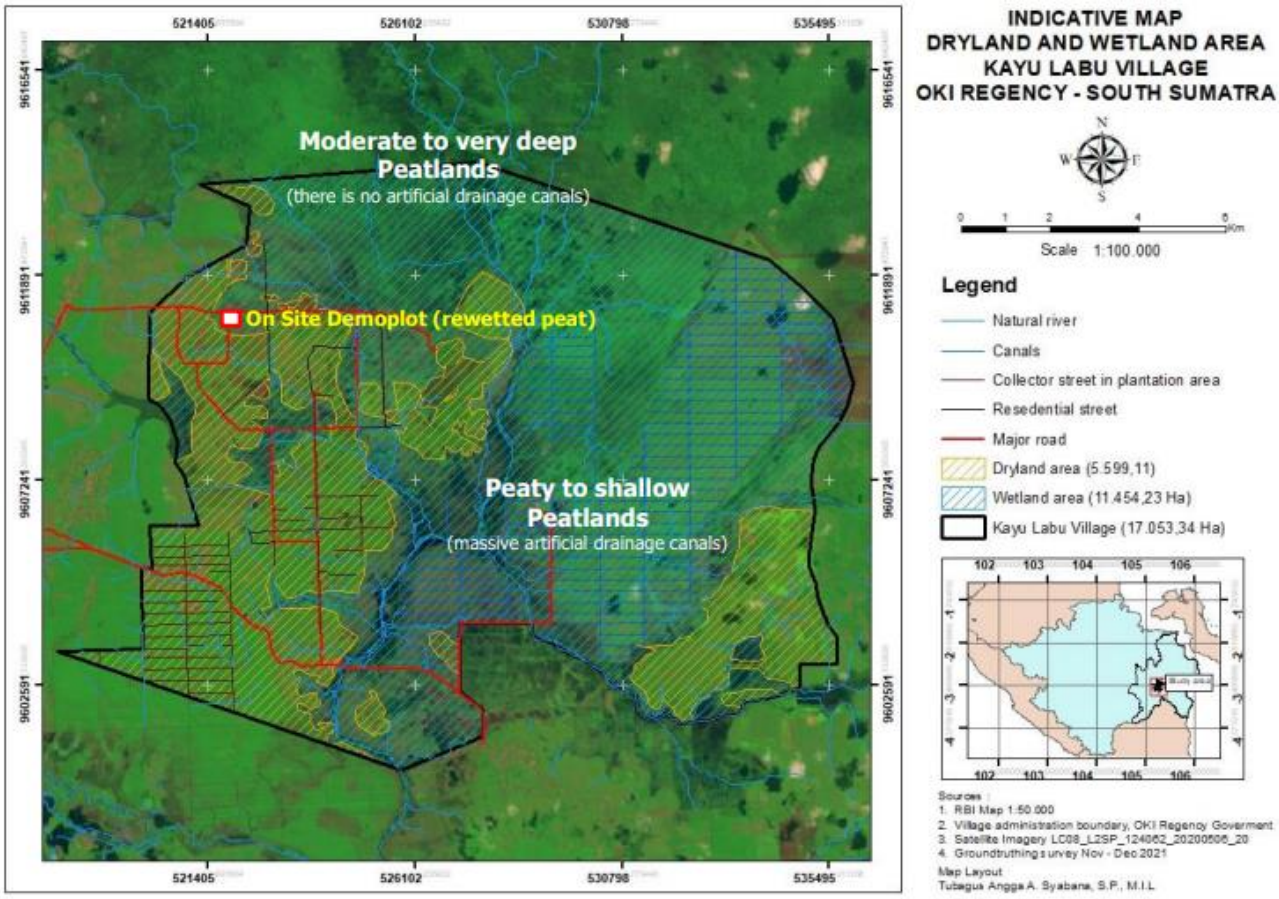

Figure 2. Indicative map of Kayu Labu.

of certification by the National Agrarian Agency must await the establishment of effective lines of communication between different Ministries of the national government (Winarno *et al.* 2022).

As a community that is highly dependent on peatland, Kayu Labu is one of the 'peat care villages' (*desa peduli gambut*) selected by BRG to participate in their '3Rs' (Rewetting, Revegetation, Revitalisation) programme. There have been two canal blocking projects, funded by BRG through the provincial government's Environment and Land Agency. Both included training and field schools for farmers, aiming to improve the community's knowledge and networks around sustainable peatland management. In 2019, 36 canal blocks were built and a one-year livelihood programme focusing on cattle production was conducted. This was followed in 2022 by a second one-year programme involving the construction of 16 additional canal blocks and livelihood training on water buffalo husbandry (DLHDP 2022).

Data collection and analysis

To create a profile of the residents of Kayu Labu, and to understand their livelihood options and how they utilise peatlands, data were collected between March and November 2021 using the following methods:

- In-depth interviews with 18 key informants (local farmers and other residents) who are familiar with the local situation and whose livelihoods depend on the peatland. Key informants were chosen purposively based on initial advice from the Village Head followed by snowball sampling using information received from village elders and previous respondents. Interviewers used open-ended and multiple-choice questions (see Appendix).
- Direct observation of the social conditions, public facilities and interactions within the community. The first in-depth interviews took place during a ten-day visit by project staff in March, after which a research assistant continued to live in the village observing its everyday life and conducting further interviews.
- Three Focus Group Discussions (FGDs) with community representatives, conducted at village and hamlet levels in October 2021. These were facilitated by the authors and involved a total of 22 (5–12 per FGD) participants of both genders including government employees; community, religious and traditional leaders; and young people (aged 18–30 years). FGD participants were chosen, in consultation with village authorities, as established (> 5 years) residents with typical employment, familiar with the village dynamic, and willing to participate actively in FGD proceedings with anonymity in reporting assured. The topics discussed included historical and current settlement around the peatland as well as peatland uses, fires and floods.
- Literature review to obtain additional data regarding conditions in Kayu Labu. Sources included the government's medium-term development plan and population data for the village and other literature identified by searching databases such as Scopus and Google Scholar (search terms, e.g., 'tropical peatland restoration', 'Indonesia', 'Sumatra', 'livelihood').

The data were analysed using qualitative and descriptive methods.

RESULTS

The current livelihood options: costs and benefits

Oil palm

Oil palm (OP) is the most popular agricultural commodity and the main source of livelihood for most villagers who own their own land. Several OP companies operating under concession permits run a 'plasma system' to support community outgrowers (Rahman 2016), and cooperation in OP development between companies and the transmigrant population also contributes to the success of OP plantations. Moreover, the infrastructure for OP production is already established in the sub-district and the Village Unit Cooperative (Koperasi Unit Desa, KUD) supports OP plantations locally. The KUD was established in 2002 by villagers who already owned OP plantations with help from agriculture extension officers at sub-district or village level, and plays an important role in the establishment and maintenance of plantations as well as in harvesting and marketing of the product. Thus, the KUD increases the chance of a successful outcome for the farmer and improves the bargaining power of OP farmers in the market.

OP has a high entry cost compared to rubber, vegetables or horticultural crops, so plantations are usually established by communities like Kayu Labu that have regular incomes from a range of different sources. The high entry cost is related to: (1) the requirement for large areas of land (minimum 2.4 ha) to justify the investment; (2) the need for canal construction to drain water from the peatland; (3) the cost of oil palm seedlings, typically more than IDR 50,000 (in local currency: Indonesian rupiah) or US$ 4 per stem for one-year-old seedlings; (4) the cost of fertilising and maintenance for the first 3.5–4

years before the plantation starts to return an income; and (5) the need for road access to facilitate the transportation of harvested oil palm bunches, which must be processed 1–2 days after harvesting. The high economic value, well-known cultivation system, easy marketing, support from OP companies, and suitability for marginal land such as peatland make oil palm the clear favourite amongst crop choices in the village. In June 2021, the payment received per kilogram of harvested fruit was IDR 1,800–2,000 (US$ 0.12–0.14).

Rubber

Rubber is the second most important livelihood option. Daily tapping of the plants is carried out by landowners or by hired labour through a production sharing system (Lestari *et al*. 2021). Once a week, the rubber is sold to buyers located in the village or transported and sold elsewhere; the option taken depends on price and weather conditions. In the rainy season, when roads are impassable, urgent needs for cash flow make selling at lower prices to buyers in the village the more usual practice.

Rubber was initially cultivated on mineral land by the local community and has been an important commodity crop in Kayu Labu for many (> 40) years. Transmigrants have also been attracted to rubber cultivation because it is affordable and relatively easy to learn, the latex can be stored for up to six months, and there are established markets. Community rubber plantations have become characteristic of lowland rural areas and have proved successful in enhancing the welfare of local people in Kayu Labu, in part because the rubber market functions well at village and district levels. The price of rubber is volatile and can fall to a level at which it is not worth tapping, but the higher prices of the last 2–3 years have motivated the community to expand their rubber plantations. Using traditional methods, tapping can commence about six years after planting. The important considerations in choosing land for rubber plantations are access to market, production cost and ease of transportation. In June 2021, latex could be sold at IDR 9,000–9,500 kg^{-1} (US$ 0.61–0.64 kg^{-1}).

Vegetables

The vegetable crops grown by the community are eggplant (*Solanum melongena*), chilli (*Capsicum annuum*), long bean (*Vigna unguiculata* ssp. *sesquipedalis*), kale (*Ipomoea aquatica*), spinach (*Amaranthus tricolor*), Chinese okra (*Luffa acutangula*), cucumber (*Cucumis sativus*) and chayote (*Sechium edule*). For easy maintenance, vegetables are grown on small areas, typically about 0.25 ha, as they are quite labour intensive and it can be difficult to sell the products. Some farmers grow vegetables amongst young OP trees on their own land, or on other people's land at no cost as the landowner's OP benefits indirectly from the fertiliser applied to the vegetable crops.

The growing season for vegetables is relatively short, with harvesting typically after 1–3 months. The domestic market includes neighbouring villages, subject to good transportation and access. For transmigrant households, vegetables are an important source of cash income to help provide the financial capital for another agricultural activity such as buying land to grow OP or rubber. The challenges of cultivating vegetables include: (1) price fluctuations (the best prices can usually be secured during the dry season because of limited supply); (2) vulnerability to pests and diseases; (3) short shelf life; and (4) limited markets.

Oranges

The land used for orange cultivation was formerly used for growing vegetables or has just been cleared of shrubs. Trees can be planted in mineral or shallow (< 50 cm) peat soil and the first fruit harvested three years later. Key benefits of cultivating oranges are: (1) relatively easy to learn; (2) fruit harvested in a short time; (3) easy access to markets - fruits keep well at ambient temperature and can be transported over long distances. The challenges, which mean that few people are orange farmers, are: (1) higher capital requirement than rubber because seedlings are very expensive; (2) risk of pests and diseases; (3) limited availability of good seedlings; and (4) price fluctuations. The 2021 market price for one kilogram of oranges was IDR 8,000 (US$ 0.54).

Orange growers need to be aware that fruit production is seasonally variable, with highest yields just after the dry season. Fruit can be harvested 2–3 times per year depending on the cultivar, and the economic life of a tree is 20–25 years. Orange production is regarded as high risk although the returns are potentially lucrative. Therefore, oranges are typically grown by farmers who have substantial capital and sufficient land to allow them to diversify their crops. Those who succeed usually have previous experience in cultivating oranges, sufficient capital, and knowledge of how to manage the risks. Most of them are transmigrants from East Java.

Rice

In 2018 the development of around 1,136 ha of rice fields in Kayu Labu through a government supported programme attracted additional transmigrants to the village. Most of the rice fields are on mineral soil and a few are on shallow (< 1.0 m) peat. Cultivating rice

is a symbol of food security for Javanese households. However, significant inputs were required from the farmers to prepare the land for planting and establish irrigation, and the rice fields are difficult to manage because the infrastructure needs continuous maintenance. The availability of only simple equipment and technology for these tasks is associated with frequent crop failure due to pests and floods. Land under rice production is also used for growing horticultural and vegetable crops at the beginning of the dry season.

Gelam

Gelam wood is strong and durable, and is used for piles, construction, firewood and briquettes. Collectors generally search for gelam when there is an order from a buyer or from a middleman in the village. The collectors receive initial capital in the form of a loan from the middleman, which is used to purchase provisions whilst working and to support the households involved during the expedition. An expedition generally takes 2–5 days, depending on the number of orders and the travel distance required to find gelam. Currently, large gelam trees are scarce, and collectors are able to meet the demand for medium and small logs only. The travel distance is also increasing because OP plantations are encroaching on the traditional collecting areas. In other words, this activity is becoming an insecure source of income owing to resource depletion.

Fishing

Fish populations have decreased significantly since the widespread establishment of OP plantations. This is attributed to contamination of the river water associated with the use of fertilisers (Holden *et al*. 2006). Canal construction causes fish to move from the river into the canals, facilitating unscrupulous fishing using illegal nets or explosives which reduces fish stocks. The diversity of fish has also decreased. In the past, up to eight species were caught in local rivers, namely: baung (*Mystus sabanus*), beringit (*Mystus singaringan*), betok (*Anabas testudineus*), gabus (*Channa striata*), lais (*Kryptopterus bicirrhis*), selincah (*Belontia hasselti*), tapa (*Wallago leeri*) and toman (*Channa micropeltes*). Currently the only three types of fish that are routinely caught are beringit, gabus and selincah.

Purun

This grass grows in swamp and peat swamp areas and is processed by the community to make mats and other household items. Several varieties of purun are used. In the past, almost all women and girls from the age of ten years were engaged in purun mat weaving. Purun handicraft production is still practised by the community, but mainly by women with small children and by the elderly who do not have the strength to work as waged labour for the OP companies. It also serves as a social activity and is used to produce additional income.

Paid employment and labouring

Although hunting and gathering activities (fishing or the collection and trading of gelam and purun) are declining and most local people farm their own land (for oil palm, rubber, vegetables, fruit and rice), some others work as traders or are employed as civil servants and plantation company workers. This is reflected in the diversity of origins, education and income levels of the people who participated in our survey (Table 1). Additionally, it is quite usual for the livelihoods of villagers to be supplemented by paid labouring in the local rubber and OP plantations, and the household incomes of most people in the village are derived from a combination of farming activities and paid labour. Paid labourers are generally from

Table 1. Basic demographic and farming data for the survey respondents in Kayu Labu.

Descriptors	Categories	%
Age	< 21	0.0
	22–44	45.5
	45–64	54.5
	>65	0.0
Gender	female	9.0
	male	91.0
Education	no school	18.2
	primary school	45.5
	secondary school	27.3
	high school	9.0
	other	0.0
Origin	local	27.0
	transmigrant	73.0
Job (farming being the primary one)	one job	28.0
	more than one job	72.0
Main job	farmer	82.0
	purun craftsman	9.0
	labourer	9.0
Weekly income	< IDR 2M	90.0
	IDR 5–10M	10.0

younger households without owned land (e.g. couples who married within the last five years) and others whose incomes from vegetable farming and rubber tapping are insufficient to meet household needs.

Currently, labouring is the main choice for most people who need to earn cash income in the short term. In general, farm labouring does not require specific skills so is an option for most community members. Some labouring activities do not require a full-time allocation every day and are undertaken by farmers who set aside part of their income from labouring as capital for vegetable farming and planting rubber, whilst still having time for their own farming activities. The high demand for farming labour throughout the year helps to provide income certainty, particularly when income from rubber and oil palm products declines due to unfavourable seasonal factors or falling commodity prices.

Income from farming labour is taken either in the form of cash or as part of a profit-sharing model. In the cash income model, the labourer receives income based on an agreement regarding the frequency of wage payments (weekly, fortnightly or monthly) and activity targets. The work carried out is land clearing, planting, manual and chemical weed control, fertiliser application, pruning and harvesting. The profit-sharing model usually applies to rubber tapping. The cost of maintaining the trees is borne by the owner and the profit based on total sales over a set period of time is shared 50/50. For the profit-sharing arrangement to be successful, it is fundamental that a trusting cooperation can be built between the plantation owner and the labourer.

Motivations of local people

Drawbacks and advantages of the main sources of livelihood identified above are summarised in Table 2. In general, the knowledge of the (originally transmigrant) farming community in Kayu Labu is based on mineral-soil agriculture, and people generally understand that peatland comes with an opportunity cost because it is a barrier to cultivation of the most profitable crops. Indeed, the complete loss of shallow peat layers is perceived as a good outcome for the community, allowing cultivation of the underlying mineral soil which provides more livelihood options.

Table 2. The main drawbacks and advantages of commodity-based livelihood options available in Kayu Labu.

Commodity	Main drawbacks	Main advantages
Oil palm	Large land area required Need to construct drainage canals Cost of seedlings Fertilisers and maintenance Road access	High economic value Well-known cultivation system Easy marketing Support from OP companies Suitability for marginal lands
Rubber	Price fluctuation Road access	High economic value Easy marketing
Vegetables (various)	Road access Price fluctuation Vulnerability to pest and diseases Short shelf life Limited markets Labour intensive	Short growing season Important for cash income Can serve to accumulate capital for another agricultural activity
Fruits (oranges)	High entry costs Vulnerability to pest and diseases Price fluctuation	Easy to learn growing technique Harvest in short time Easy marketing Easy transportation
Rice	Not well suited to peatland Susceptible to pests	Maintains food security
Gelam	Need to secure purchase order Long travel time to find it	
Fishing	Fish population decreased	Diet diversification
Purun		Social activity

Against this background, oil palm and rubber are rational crop choices for villagers who own land, as low-risk and high-income commodities whose cultivation and marketing are supported by the respective industries. For those who do not own land or whose land does not provide sufficient income, plantation work can provide supplementary income in exchange for labour. As one respondent noted:

> "*Oil palm plantations require various kinds of labour, and this opportunity is available all year around for all the people*".

Income from labouring can also be saved towards buying land to establish the labourers' own oil palm and rubber plantations:

> "*The majority of the people in this hamlet (Senasi Mulya) depend on farming labour as a source of daily income because they have no land and/or no capital to cultivate their land. This is regarded as a way of raising the capital to buy land or establish rubber or oil palm cultivation on their land*."

'Peat-friendly' crops (that do not disturb the peatland environment) are not yet widely accepted. In fact, the community is reluctant to restore peatland owing to lack of knowledge, as revealed by the respondent who said:

> *"Currently, we have no option for profitable commodities from peatland other than oil palm and rubber, which have already been proven to increase the welfare of the community; we do not have knowledge and skill to cultivate other prospective commodities. Up to now, we have received no information about this from the government or other stakeholders".*

In this context it is notable that participation in both of the BRG programmes to introduce livestock husbandry (cattle, water buffalo) as an alternative source of livelihood was low, as was the subsequent uptake of these activities. This is attributed to poor local communication about the programmes, as well as the lack of local follow-up and support for participants after each of the one-year BRG initiatives ended.

DISCUSSION AND POLICY IMPLICATIONS

Current situation and new opportunities

We acknowledge that the circumstances of different villages on peatland in Indonesia are highly variable but consider that the findings of our study provide insights that are relevant to many of them, and this is indeed reflective of our observations on other villages in which we have worked.

This study has shown that people living in Kayu Labu are reliant on oil palm and rubber agriculture, which requires the conversion and development of natural forested peatland. Indonesia is the world's largest producer of palm oil, and the palm oil industry has been credited with generating significant economic benefits for the country including employment opportunities and export revenues (e.g. Obidinski *et al*. 2012, Sari *et al*. 2017). The rubber industry has been a similarly important source of income for many smallholder farmers. However, there are also concerns about the social and environmental impacts of these industries (e.g. land grabbing, deforestation, biodiversity loss, labour exploitation) which can disproportionately affect marginalised communities including indigenous peoples and smallholder farmers, and thus exacerbate poverty and inequality.

The main reasons given by local people for their reluctance to grow crops other than oil palm and rubber are poor market access, price fluctuations, transportation difficulties and the need for significant capital inputs. Thus, improved transportation infrastructure, communications and financial services for alternative commodities may help to promote change. However, an underlying impediment is poverty. In 2021, the poverty level in Sumatra (12.8 %) was higher than the national average of 9.7 % (Indonesia Expat 2022, ADB 2023). Under these circumstances, earning sufficient income to meet the daily needs of a family becomes a major concern. In rural areas, the cultivation of oil palm and rubber offers a pathway out of poverty (Sayer *et al.* 2012, Langston *et al*. 2017, Indonesia Expat 2022). Alternative livelihood options based on sustaining the inherent values of peatland have not been proven to avert poverty, and incentives to transition are often rejected for this reason Mendham *et al*. 2024).

On the other hand, it has been confirmed that developing degraded peatland areas for 'more sustainable' agriculture can improve self-sufficiency in food, and thus improve food security for local communities (Winarno *et al*. 2022). There are also ways to increase the commercial value of horticultural crops; for example, processing activities such as fruit-drying, product standardisation and packaging can increase product value and expand the range of marketing opportunities. Additional options for 'peatland-friendly' land use include agroforestry and sustainable forestry. Also, peatland restoration can provide employment, stimulate the recovery of

fisheries and non-timber forest products, and create potential for eco-tourism. However, the suitability of each alternative livelihood strategy can be expected to vary with physical and socioeconomic factors that specifically affect the individual community. Therefore, a participatory approach that involves engagement with local communities and other stakeholders is crucial. This approach should take into account the needs and aspirations of local people and the characteristics of the ecosystem, alongside the availability of resources and markets.

It is clearly important to enable local people to improve their knowledge of such alternative livelihood options but, in light of the outcomes of previous BRG initiatives, there is also a need to better publicise training opportunities and effectively support those wishing to transition beyond the period of training. More fundamentally, a new framework for the valuation of goods and services is needed.

Suggested theoretical framework for change

Indonesian peatlands present the classical problem of market failure in public goods and ecosystem services (ES). The ES framework provides a basis for understanding the benefits that humans derive from natural ecosystems. It recognises that ecosystems provide a wide range of services that are crucial to human wellbeing such as food production, water purification and carbon sequestration, along with cultural and recreational benefits, which helps us to place value on these services and thus to make informed decisions about how to manage and protect natural ecosystems. The ES framework can be used to identify and quantify the full range of benefits derived by different stakeholders including local communities, indigenous peoples and other groups that depend on ecosystem services for their livelihoods. This information can then be used to develop inclusive management strategies that take into account all stakeholder needs and perspectives.

While much of the value attached to landscapes such as peatlands is external benefit to the general public (Bullock & Collier 2011), market failure occurs in the sense that this value is not taken into account by the existing economic system. Landscape and habitat protection are generally regarded as an opportunity cost to communities, especially where agricultural or land-use policies provide incentives for intensifying production (de Groot 2006). Because these costs are typically borne by a separate set of stakeholders, they can be seen as both a restriction on freedom to manage land and a loss of monetary income. Therefore, environmental policy in rural areas often faces opposition from those who derive their livelihoods from the land, which is at odds with the protection of natural habitats (de Groot 2006).

There are published studies on non-market valuation of the carbon sequestration, biodiversity, flood risk mitigation and water quality services that peatlands provide. For example, Moxey & Moran (2014) employed an abatement costs method to quantify carbon emission reductions, while other authors have used stated preference techniques to estimate non-market benefits and trade-offs (Bullock & Collier 2011, Tolvanen *et al.* 2013, Glenk & Martin-Ortega 2018). These studies focus primarily on the economic efficiency of restoring degraded peatlands by looking at whether potential investments are socially desirable. This means a monetary value must be assigned to goods and services that are not traded.

There are challenges in this approach. It is not always the case that an individual understands the functions of ES sufficiently to assign a value (Johnston *et al.* 2017); for example, data on downstream flood risk mitigation and water quality are often not available and the spatially explicit character of many ecosystem services complicates the analysis (Glenk *et al.* 2014). Currently, the best basis for valuation of peatland restoration is the reduction of carbon emissions (Evans *et al.* 2014) but, as the benefits are ultimately spread globally, a local resident may not see any benefit. This is a well-known phenomenon called distance decay of benefit estimates, where the value assessment of an environmental good by an individual diminishes with increasing distance of the individual from the site receiving benefit (Bateman *et al.* 2006).

Although the ES framework is used widely to assess the value of ecosystem services, a major criticism is that it is anthropocentric, meaning that it places human interests at the centre of the analysis and does not fully consider the intrinsic value of nature or the complex relationships between humans and nature. However, it can be used in conjunction with other approaches, such as theories of the commons, to develop more comprehensive analyses of human–nature relationships and to promote more sustainable land use practices.

Indonesian peatlands are particularly important for their ability to store carbon, regulate water flows and provide habitats that support biodiversity, as well as for their cultural value, and can be regarded as a common pool resource because they are typically not owned by any individual or group and are available for use by multiple stakeholders. The characteristic feature of a common pool resource is joint utilisation by a group of appropriators with subtractability, which means that withdrawal by one user reduces its availability to others (Ostrom 1990).

An extensive literature discusses the issue of 'free rider' activities eventually ending in a common pool resource collapsing (Bednarik *et al.* 2019). Competition for a common pool resource of land undergoing transformation to agricultural use creates an example of the 'tragedy of the commons' (Hardin 1968). Tragedy of the commons occurs when individual users have unrestricted access to the resource and, although they act rationally in their own self-interest (by maximising their own utilisation), the resource becomes degraded or depleted through overuse. If individual users continue to prioritise their own short-term interests over maintaining the long-term health of the ecosystem and the services it provides, conflicts between different user groups will arise. The resource must now be protected by shared social structures or formal rules that govern access and use. Effective governance arrangements will ensure the sustainable use and management of the resource, whilst balancing the interests of different stakeholders.

Specific suggestions for Indonesian peatlands

In the context of this study, a Kayu Labu villager has access to the common pool resource of peatland but does not contribute fully to its maintenance. Being a rational actor, the villager pursues their own short-term interests (e.g. feed the family today) at the expense of longer-term public benefits. As a result, and generally in Indonesia, the development of peatland is strongly associated with its degradation. Transparently enforced rights of access and use could help to sustain peatland resources by increasing the revenues derived from them and raising the opportunity cost of their degradation. However, before engaging in peatland restoration and peat conservation activities, there is a need to understand how local people might behave in response to such measures given their socioeconomic situation, their way of living and their expectations.

Three solutions to the problem have been suggested, namely: centralised governmental laws or regulations; privatisation (fees/permits); and cooperative institutions formed and managed by the resource users themselves (Ostrom 1990). In the absence of properly functioning government regulation, and understanding that privatisation of peatlands may not be feasible, we suggest a version of the third option based on the principles that Ostrom (1990) suggested will play decisive roles in the design and implementation of cooperative institutions. A successful application of these principles to the management of Indonesian peatlands might incorporate the following elements:

- Clear delimitation of physical boundaries and identification of all affected communities or members of the user pool that collectively establish the rules of appropriation and provision. Importantly, users must have recognition of their own rights to organise institutions.
- Coordination of actions governing these rules i.e. timing, location, technology to be used, and quantity of peatland being transformed.
- Assignment of a party responsible for monitoring compliance with collective decisions. This party could be either the users themselves or persons with specific responsibility for monitoring who are accountable to the appropriators.
- Establishment of an enforcement mechanism that is expressed in sanctions/penalties for violation of collectively adopted rules. Low-cost and readily available conflict resolution mechanisms must exist to mediate conflicts amongst appropriators and between appropriators and officials.
- Nested enterprises, i.e. sets of rules established within a hierarchy of appropriator institutions must be established for common pool resources that sit within larger resource systems and political jurisdictions.

Other considerations

In addition to the creation of institutions that will establish laws and regulations to prevent individual stakeholders from maximising private gains at the expense of community interests, policies to simultaneously increase both community wellbeing and peatland restoration are needed so the changes result in outcomes that are likely to be acceptable to (and consequently adopted by) local communities. Such policies will require substantial scientific, engineering and technical support.

Ignoring long-term cost for the sake of short-term profit maximisation results in further peatland degradation along with more fires and GHG emissions. However, the substitution of regenerative or conservation agriculture is unlikely to meet with success unless the improvement of peatland condition can be linked to community wellbeing. More sustainable options may include mixed-use agricultural systems that combine commercial cropping of native plant species in marginal areas and strict protection of undisturbed peatland (Giesen 2021, Yuwati *et al.* 2021, Sakuntaladewi *et al.* 2022). The implementation of such measures could increase people's prosperity whilst conserving biodiversity and environmental assets, and would thus be more likely to forge a path forward by promoting both community wellbeing and peatland restoration.

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AUTHOR CONTRIBUTIONS

DM, NS, SMJ and TWY initiated the study and analysed the data. SL and BW designed the sampling and collected the data. All authors contributed to the interpretation of results and writing of the final manuscript.

ETHICS

The activities reported herein have been conducted in accordance with CSIRO Social Science Human Research Ethics approval.

REFERENCES

ADB (2023) Poverty Data: Indonesia. Asian Development Bank, Manila. Online at: https://www.adb.org/countries/indonesia/poverty, accessed 20 Mar 2023.

Bateman, I.J., Day, B.H., Georgiou, S., Lake, I. (2006) The aggregation of environmental benefit values: Welfare measures, distance decay and total WTP. *Ecological Economics*, 60(2), 450–460.

Bednarik, P., Linnerooth-Bayer, J., Magnuszewski, P., Dieckmann, U. (2019) A game of common-pool resource management: Effects of communication, risky environment and worldviews. *Ecological Economics*, 156, 287–292.

BPS Kabupaten Ogan Komering Ilir (2021) Kecamatan Pedamaran Timur Dalam Angka (Pedamaran Timur Subdistrict in Figures). BPS Kabupaten Ogan Komering Ilir (BPS Statistics of Ogan Komering Ilir Regency), 147 pp. (in Indonesian). ISBN: 978-623-98094-5-4

BRG (2019) Profil Desa Peduli Gambut: Desa Tumbang Nusa (Peat Care Village Profile: Tumbang Nusa Village). Report, Peatland Restoration Agency of the Republic of Indonesia (BRG), Jakarta, 82 pp. (in Indonesian).

Bullock, C.H., Collier, M. (2011) When the public good conflicts with an apparent preference for unsustainable behaviour. *Ecological Economics*, 70(5), 971–77.

de Groot, W.T. (2006) From friend to enemy and onwards: An evolutionary perspective on the people–nature relationship. In: van den Born, R.J.G., Lenders, R.H.J., de Groot W.T. (eds.) *Visions of Nature*, LIT Verlag, Berlin, 19–40.

DLHDP (2022) Rekapitulasi kegiatan pembasahan, revegetasi dan revitalisasi (3R), tugas pembantuan restorasi gambut di Provinsi Sumatera Selatan 2018–2022 (Recap of rewetting, revegetation and revitalization (3R) activities, co-administration tasks for peat restoration in South Sumatra Province 2018–2022). Pemerintah Provinsi Sumatera Selatan Dinas Lingkungan Hidup Dan Pertanahan (Environment and Land Agency of South Sumatra Provincial Government), Palembang, 10 pp. (in Indonesian).

Dohong, A., Aziz, A.A., Dargusch, P. (2017) A review of the drivers of tropical peatland degradation in South-East Asia. *Land Use Policy*, 69, 349–360.

Evans, C.D., Bonn, A., Holden, J., Reed, M.S., Evans, M.G., Worrall, F., Couwenberg, J. Parnell, M. (2014) Relationships between anthropogenic pressures and ecosystem functions in UK blanket bogs: Linking process understanding to ecosystem service valuation. *Ecosystem Services*, 9, 5–19.

Fleming, A., Agrawal, S., Dinomika, Fransisca, Y., Graham, L., Lestari, S., Mendham, D., O'Connell, D., Paul, B., Po, M., Rawluk, A., Sakuntaladewi, N., Winarno, B., Yuwati, T.W. (2021) Reflections on integrated research from community engagement in peatland restoration. *Humanities and Social Sciences Communications*, 8, 199, 11 pp.

Giesen, W. (2021) Tropical peatland restoration in Indonesia by replanting with useful indigenous peat swamp species: Paludiculture. In: Osaki, M., Tsuji, N., Foead, N., Rieley, J. (eds.) *Tropical Peatland Eco-Management*, Springer, Singapore, 411–441.

Glenk, K., Martin-Ortega, J. (2018) The economics of peatland restoration. *Journal of Environmental Economics and Policy*, 7(4), 345–362.

Glenk, K., Schaafsma, M., Moxey, A., Martin-Ortega, J., Hanley, N. (2014) A framework for valuing spatially targeted peatland restoration. *Ecosystem Services*, 9, 20–33.

Grantham, H.S., Duncan, A., Evans, T.D., Jones, K. R., Beyer, H.L., Schuster, R., Walston, J., Ray, J.C., Robinson, J.G., Callow, M., Clements, T., Costa, H.M., DeGemmis, A., Elsen, P.R., Ervin, J., Franco, P., Goldman, E., Goetz, S., Hansen, A.,

Watson, J.E.M. (2020) Interactive World Forest Map & Tree Cover Change Data. Global Forest Watch (GFW), Washington DC. Online at https://www.globalforestwatch.org/map/, accessed 10 Jun 2022.

Hardin, G. (1968) The tragedy of the commons. *Science*, 162(3859), 1243–1248.

Holden, J., Chapman, P.J., Lane, S.N., Brookes, C. (2006) Impacts of artificial drainage of peatlands on runoff production and water quality. Chapter 22 in: Martini, I.P., Martinez Cortizas, A., Chesworth, W. (eds.) *Peatlands: Evolution and Records of Environmental and Climate Changes*, Developments in Earth Surface Processes 9, Elsevier, Amsterdam, 501–528.

Hooijer, A., Page, S., Jauhiainen, J., Lee, W.A., Lu, X.X., Idris, A., Anshari, G. (2012) Subsidence and carbon loss in drained tropical peatlands. *Biogeosciences*, 9(3), 1053–1071.

Indonesia Expat (2022) Indonesia's provinces with most poverty population. *Indonesia Expat*, 18 Jan 2022. Online at: https://indonesiaexpat.id/amp/featured/indonesias-provinces-with-most-poverty-population/, accessed 16 Jun 2022.

Johnston, R.J., Schultz, E.T. Segerson, K. Besedin, E.Y., Ramachandran, M. (2017) Biophysical causality and environmental preference elicitation: Evaluating the validity of welfare analysis over intermediate outcomes. *American Journal of Agricultural Economics*, 99(1), 163–85.

Junaidah, Alimah, D., Ardhana, A. (2020) Purun, jenis asli rawa gambut yang sangat bermanfaat (Purun, a very beneficial type of peat swamp). In: Kurnain, A., Hadi, T.S. (eds.) *Komoditas Paludikultur di Kalimantan* (*Paludiculture Commodities in Kalimantan*). IPB Press, Bogor, 154 pp. (in Indonesian). ISBN: 978-623-256-065-9

Langston, J.D., Riggs, R.A., Sururi, Y., Sunderland, T.C.H., Munawir, M. (2017) Estate crops more attractive than community forests in West Kalimantan, Indonesia. *Land*, 6, 12, 14 pp.

Lestari, S., Winarno, B., Premono, B.T., Syabana, T.A.A., Sakuntaladewi, N., Mendham, D., Jalilov, S. (2021) Opportunities and challenges for land use-based peatland restoration in Kayu Labu Village, South Sumatra. *IOP Conference Series: Earth and Environmental Science*, 917, 012021, 10 pp.

Mendham, D.S., Sakuntaladewi, N., Ramawati, Yuwati, T.W., Budiningsih, K., Prasetyo, B.D., Handoyo (2024) Facilitating new livelihoods to promote peatland restoration in Indonesia - what are the challenges for ensuring sustainable and equitable livelihood transitions? *Mires and Peat*, 30, 04, 14 pp.

Moxey, A., Moran, D. (2014) UK peatland restoration: Some economic arithmetic. *Science of the Total Environment*, 484(1), 114–120.

Nursyamsi, D., Noor, M., Maftu'ah, E. (2016) Peatland management for sustainable agriculture. In: Osaki, M., Tsuji, N. (eds.) *Tropical Peatland Ecosystems*, Springer, Tokyo, 493–511.

Obidinski, K., Andriani, R., Komarudin, H., Andrianto, A. (2012) Environmental and social impacts of oil palm plantations and their implications for biofuel production in Indonesia. *Ecology and Society*, 17(1), 25, 19 pp.

Ostrom, E. (1990) *Governing the Commons: The Evolution of Institutions for Collective Action*. Cambridge University Press, New York, 280 pp.

Parish, F., Sirin, A., Charman, D., Joosten, H., Minayeva, T., Silvius, M., Stringer, L. (2008) *Assessment on Peatlands, Biodiversity and Climate Change: Main Report*. Global Environment Centre, Kuala Lumpur and Wetlands International, Wageningen, 179 pp.

Rahman, B.N. (2016) Indonesia: "Plasma obligation" for oil palm plantation business established prior to the issuance of Regulation of the Indonesian Minister of Agriculture No.26/2007. *Mondaq* article dated 17 Feb 2016. Online at: https://www.mondaq.com/inward-foreign-investment/467128/plasma-obligation-for-oil-palm-plantation-business-established-prior-to-the-issuance-of-regulation-of-the-indonesian-minister-of-agriculture-no262007, accessed 29 May 2022.

Ritzema, H., Limin, S., Kusin, K., Jauhiainen, J., Wösten, H. (2014) Canal blocking strategies for hydrological restoration of degraded tropical peatlands in Central Kalimantan, Indonesia. *Catena*, 114, 11–20.

Rydin, H., Jeglum, J.K. (2015) Peatlands and climate change. In: Rydin, H., Jeglum, J.K. *The Biology of Peatlands*, Second edition, Oxford University Press, Oxford UK, 296–316.

Sakuntaladewi, N., Rachmanadi, D., Mendham, D., Yuwati, T.W., Winarno, B., Premono, B.T., Lestari, S., Ardhana, A., Ramawati, Budiningsih, K., Hidayat, D.C., Iqbal, M. (2022) Can we simultaneously restore peatlands and improve livelihoods? Exploring community home yard innovations in utilizing degraded peatland. *Land*, 11(2), 150, 22 pp.

Santika, T., Wilson, K.A., Budiharta, S., Law, E.A., Poh, T.M., Ancrenaz, M., Struebig, M.J., Meijaard, E. (2019) Does oil palm agriculture help alleviate poverty? A multidimensional counterfactual assessment of oil palm development in Indonesia. *World Development*, 120, 105–117.

Sari, S.R., Hadiyanto, H., Pramono, A., Saefulkakim, S. (2017) Impact of rubber plantation on household income and expenditure in Jambi Province, Indonesia. *Journal of Tropical Agriculture*, 55(1), 60–68.

Sayer, J., Ghazoul, J., Nelson, P., Boedhihartono, A.K. (2012) Oil palm expansion transforms tropical landscapes and livelihoods. *Global Food Security*, 1(2), 114–119.

Schrier-Uijl, A.P., Silvius, M., Parish, F., Lim, K.H., Rosediana, S., Anshari, G. (2013) *Environmental and Social Impacts of Oil Palm Cultivation on Tropical Peat: A Scientific Review*. Reports from the Technical Panels of the 2nd Greenhouse Gas Working Group of the Roundtable for Sustainable Palm Oil (RSPO), RSPO, Kuala Lumpur, 40 pp.

Surahman, A., Shivakoti, G., Soni, P. (2017) Prospect of sustainable peatland agriculture for supporting food security and mitigating green house gas emission in Central Kalimantan, Indonesia. Chapter 15 in: Shivakoti, G.P., Pradhan, U., Helmi (eds.) *Redefining Diversity and Dynamics of Natural Resources Management in Asia: Sustainable Natural Resources Management in Dynamic Asia*, Volume 1, Elsevier, Amsterdam, 291–303.

Thornton, A.S., Setiana, E., Yoyo, K., Dudin, Yulintine, Harrison, M.E., Page, S.E., Upton, C. (2020) Towards biocultural approaches to peatland conservation: The case for fish and livelihoods in Indonesia. *Environmental Science and Policy*, 114, 341–351.

Tolvanen, A., Juutinen, A., Svento, R. (2013) Preferences of local people for the use of peatlands: The case of the richest peatland region in Finland. *Ecology and Society*, 18(2), 19, 12 pp.

Ward, C., Stringer, L.C., Warren-Thomas, E., Agus, F., Crowson, M., Hamer, K., Hariyadi, B., Kartika, W.D., Lucey, J., McClean, C., Nurida, N.L., Petorelli, N., Pratiwi, E., Saad, A., Andriyani, R., Ariani, T., Sriwahyuni, H., Hill, J.K. (2021) Smallholder perceptions of land restoration activities: Rewetting tropical peatland oil palm areas in Sumatra, Indonesia. *Regional Environmental Change*, 21, 1, 17 pp.

World Bank (2020) Databank: World Development Indicators. The World Bank, Washington DC. Online at: https://databank.worldbank.org/source/world-development-indicators/preview/on, accessed 25 May 2022.

Widyatmanti, W., Minasny, B., Awanda, D., Umarhadi, D.A., Fatma, Z.S.N., Mahendra, W.K., Field, D.J. (2022) Codification to secure Indonesian peatlands: From policy to practices as revealed by remote sensing analysis. *Soil Security*, 9, 100080, 11 pp.

Winarno, B., Lestari, S., Ramawati, Syabana, T.A.A. (2022) Food security prospects of rural community in the change and degraded peatland landscape of South Sumatra. *IOP Conference Series: Earth & Environmental Science*, 1107, 012037, 8 pp.

Yuwati, T.W., Rachmanadi, D., Pratiwi, Turjaman, M., Indrajaya, Y., Nugroho, H.Y.S.H., Qirom, M.A., Narendra, B.H., Winarno, B., Lestari, S., Santosa, P.B., Adi, R.N., Savitri, E., Putra, P.B., Wahyuningtyas, R.S., Prayudyaningsih, R., Halwany, W., Nasrul, B., Bastoni, Mendham, D. (2021) Restoration of degraded tropical peatland in Indonesia: A review. *Land*, 10, 1170, 31 pp.

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Appendix

Questionnaire on socioeconomics of peatlands

Village : …….
Hamelet : ……
Time of survey : …….

CURRENT STATE

Characteristics of respondents

1. Name : .....
2. Age : ☐ <21 ☐ 22-44 ☐ 45-64 ☐ >65
3. Gender : ☐ Male ☐ Female ☐ Don't want to disclose
4. Education : ☐ No formal education ☐ Primary school ☐ Secondary school ☐ High school ☐ Other
5. Wife education: ☐ No formal education ☐ Primary school ☐ Secondary school ☐ High school ☐ Other ____
6. Origin : ☐ Native ☐ Migrant
7. Job : ☐ Employed (one job) ☐ Employed (more than one job) ☐ Other _____
8. Current occupation/s (if employed): _____
9. Side job (if employed): _____
10. Number of family members : male :……..., female:…….....
11. Number of familiy members more than 15 years old :.....persons
12. Number of family members who have jobs : …….....Income .....
13. The number of children who are still in school :.....persons
14. Farming experience? ☐ <5 years ☐ 5–10 years ☐ >10 years
15. Average income in a week(for main job) : IDR.....
    ☐ Less than 2 Million ☐ 2–5 Million ☐ 5–10 Million ☐ More than 10 Million
16. Average income in a week(for side job) : IDR.....
    ☐ Less than 2 Million ☐ 2–5 Million ☐ 5–10 Million ☐ More than 10 Million
17. Average expenditure in a week: IDR.....
18. Your current income compared with previous (5-10 years): ☐ Improved ☐ Worsened ☐ No change
19. How much time do you need to travel from the house to the field?..... (minutes or hours) (on foot/motorcycle)
20. Land holding : …….. ha

No.	Cultivation system and types of plants	Alluvial/peatland (depth (m))	Land area (ha)	Status (own/rent)	Distance from home	Technology applied (irrigation/canal/burn)

PREVIOUS STATE / CONDITIONS

1. Are you: ☐ Native to this area ☐ Moved in last 15–20 years ☐ Moved in last 5–10 years ☐ Moved recently (<5 yrs)
2. Has your (or your family's) economic situation changed in last 5–10 years: ☐ Yes ☐ No ☐ Prefer not to say
3. What has changed in your life in last 5–10 years (more than one answer allowed):
   ☐ Relationship (married/divorced) ☐ Family size (increased/decreased) ☐ Have job/lost job
   ☐ Migration ☐ Education ☐ Other ……
4. Previous business/es you were engaged in: ……..……
5. Were you satisfied with your previous economic situation: ☐ Yes ☐ No ☐ Don't know
6. If not, please state the main reasons (may be multiple): ……

7. How would you rate your previous economic situation, compared with the current one, on a 5-point scale (1=worst, 5=best): _____
8. Average income in a week (5–10 years ago): IDR.....
9. Average expenditure in a week (5–10 years ago): IDR.....
10. Did transformation to current state happen under: ☐ Family support/influence
    ☐ State/government support ☐ Example of friends or other people ☐ My decision
11. Drastic changes that have occurred in the last 5–10 years:
    ☐ Crop failure due to pests and diseases ☐ Drought or fire ☐ Flood
    ☐ The price of the harvest plummeted ☐ Drastic increase in the price of foodstuffs
    ☐ Lost job / business / land ☐ Getting better in life ☐ Nothing
12. What did you do to address the change:
    ☐ Looked for work outside the village ☐ Looked for side job in the village : waged labour or other
    ☐ Opened new cultivated land ☐ Financial debt ☐ Looked for natural resources: wood, fish, others
    ☐ Nothing
13. Do you have savings? ☐ Yes ☐ No What form of savings? Money / gold / land / others .....
14. Do you have debt? ☐ Yes ☐ No To whom?..... What is it used for? .....
15. Are you a member of an organisation in the community? ☐ Yes ☐ No If so, what are the benefits? .....
16. Have you ever experienced a famine? ☐ Yes ☐ No If yes, when? .....
    What was your strategy to survive ? .....

BUSINESS OF PURUN COLLECTING AND PROCESSING

1. Where did you get purun grass?
2. How many times a week did you go looking for purun?
3. How is the availability of purun grass now compared to some years ago?
4. How many types of purun that could you find in the field?
5. What kinds of handicrafts could you make from purun as raw materials?
6. In general, who does purun craft activities in this village? and why?
7. What is the important role of purun craft product for the community?
8. What are your hopes for the future regarding this purun craft business?

BUSINESS FOR COLLECTING GELAM WOOD

Job description	Family members (persons)	Apart from family members (persons)	Cost per person (IDR)

1. The price of gelam per unit? .....
2. The results obtained from looking for gelam once? .....
3. Cost incurred to collect gelam.....
4. Collection period (how many times a month)? .....
5. Sales system? .....

FISHING

Job description	Family members (persons)	Apart from family members (persons)	Cost per person (IDR)

1. Is fishing done all the time? ..... Or is there a certain time?.....
2. How many results are obtained? .....
3. How do you collect fish? .....
4. How much is consumed by the family? .....
5. What is the selling price? .....

BUSINESS OF PADDY (RICE FIELD)

1. Land area : .....ha
2. How many times a year do you cultivate your rice fields: a. Once b. Twice
3. The use of production factors:

Production factor per hectare	**Number of units**	**Unit price**
Seeds (kg)		
Fertiliser		
a. Urea		
b. TSP		
c. NPK		
Herbicide (litres)		
Pesticide (litres)		
Others		
Dolomite		
The cost of milled grain		

4. Labour required:

Job description	**Family members (persons)**	**Apart from family members (persons)**	**Cost per person per ha (IDR ha^{-1})**
Land clearing - Slash - Burn - Others			
Land preparation			
Planting			
Maintenance (weeding, pests and diseases, etc.)			
Fertilisation			
Harvesting			
Post-harvest			

5. Rice field production
   a. PP (Planting period) 1:.....ton
   b. PP (Planting period) 2:.....ton
   c. Sold in what form: a. Dry grain b. Wet grain c. Rice
6. How much of the rice harvest is consumed by family members per planting season.....kg per person
7. Daily wages of work : .....(IDR day^{-1})

OIL PALM BUSINESS

1. Land area : .....ha
2. Spacing : ..... .

Production factor per hectare	**Number of units**	**Unit price**
Seedlings		
Fertiliser		
a. Urea		
b. TSP		
c. NPK		
Herbicide (litres)		
Pesticide (litres)		
Dolomite		
Fruit stimulant		
Others		

3. Labour required:

Job description	**Family members (persons)**	**Apart from family members (persons)**	**Cost per person per ha (IDR ha^{-1})**
Land clearing - Slash - Burn - Others			
Land preparation			
Planting			
Maintenance (Weeding, pests and diseases, etc.)			
Fertilisation			
Fruit stimulant spray			
Harvesting			
Post-harvest			
Others			

4. Year and number of productions:.....
5. How many times harvested in a year: .....
6. Selling price : Rp.....
7. Sales system:
   a. The nearest industry
   b. Brokers who come to the village
   c. Sold directly to the industry that offered the higest price
8. Sales mechanism:
   a. Without agreement
   b. By agreement (please give explanations)

RUBBER BUSINESS

1. Land area: .....ha
2. The use of production factors:

Production factor per hectare	**Number of units**	**Unit price**
Seeds (kg)		
Fertiliser		
a. Urea		
b. TSP		
c. NPK		
Herbicide (litres)		
Pesticide (litres)		
Others		
Dolomite		

3. Labour required:

Job description	**Family members (persons)**	**Apart from family members (persons)**	**Cost per person per ha (IDR ha^{-1})**
Land clearing - Slash - Burn - Others			
Land preparation			
Planting			
Maintenance (Weeding, pests and diseases, etc.)			
Fertilisation			
Harvesting			
Post-harvest			

4. Production/yield of rubber per week/month:.....(kg) per .....

HORTICULTURAL BUSINESS

1. Land area: .....ha
2. The use of production factors:

Production factor per hectare	**Number of units**	**Unit price**
Seeds (kg)		
Fertiliser		
a. Urea		
b. TSP		
c. NPK		
Herbicide (litres)		
Pesticide (litres)		
Others		
Dolomite		

3. Labour required:

Job description	**Family members (persons)**	**Apart from family members (persons)**	**Cost per person per ha (IDR ha^{-1})**
Land clearing - Slash - Burn - Others			
Land preparation			
Planting			
Maintenance (Weeding, pests and diseases, etc.)			
Fertilisation			
Harvesting			
Post-harvest			

4. Production / results of horticultural cultivation :.....(kg)
5. Selling price : IDR.....
6. Sales system: 1. Nearest market 2. Brokers who come to the village 3. Directly to market in the city

FRUIT BUSINESS

1. Land area: .....ha
2. Spacing: .....
3. The use of production factors:

Production factor per hectare	**Number of units**	**Unit price**
Seeds (kg)		
Fertiliser		
d. Urea		
e. TSP		
f. NPK		
Herbicide (litres)		
Pesticide (litres)		
Others		
Dolomite		
Fruit stimulant		

4. Labour required:

Job description	**Family members (persons)**	**Apart from family members (persons)**	**Cost per person per ha (IDR ha^{-1})**
Land clearing - Slash - Burn - Others			
Land preparation			
Planting			
Maintenance (Weeding, pests and diseases, etc.)			
Fertilisation			
Fruit stimulant spray			
Harvesting			
Post-harvest			

5. Production results in one harvest period:.....
6. Number of harvests in a year: .....
7. Selling price : IDR.....
8. Sales system: 1. Nearest market 2. Brokers who come to the village 3. Directly to market in the city