Opportunities and challenges for land use-based peatland restoration in Kayu Labu Village, South Sumatra, Indonesia

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Abstract. Restoration of degraded peatland has proven to be complex and many activities that have been initiated in recent years have not had a significant impact on restoring peatland condition. Revitalization activities that have been carried out in several locations have not been effective. Likewise, rewetting actions were often poorly understood by the community. This research aimed to analyze land use-based peatland restoration opportunities and challenges in Kayu Labu village, South Sumatra. Survey methods and interviews with the stakeholders were applied to collect primary data in the field. The results showed that although Kayu Labu has been designated as one of the focus villages for restoration by the Peatland Restoration Agency, the restoration efforts to date have not significantly impacted on people’s lives. The community has not widely known the implementation of the programs, and only those who were directly involved in the activities were aware of the peatland restoration program. Several opportunities are available to support the implementation of land use-based peatland restoration in Kayu Labu: the community has a strong willingness and commitment to restore their peatlands because they have suffered badly from peatland fires in the past. The community also acknowledges the loss of their livelihoods due to peatland degradation, especially for purun craftsmen, gelam collectors, and fishers. There are also opportunities from government and research programs to be implemented in this area to support peatland restoration. However, there are still challenges that must be faced: the increasingly massive expansion of oil palm plantations by clearing the peatlands, the lack of knowledge about peatland, and there is a general feeling from the community that without peatland their lives would be better off because they could grow diverse crops with higher yields. Therefore, capacity building, communication and knowledge enhancement, and partnerships are needed for the success of land use-based peatland restoration in Kayu Labu.

1. Introduction
Indonesia has the second largest area of tropical peatlands in the world after Brazil, with an area of 14.85 million hectares (Mha), mainly in Sumatra, Kalimantan, and Papua [1]. Approximately 7.7 Mha
of peatland is forested (mangrove, swamp forest, and plantation forest), another 3.23 Mha with shrubs, and the rest of the area is under agriculture and under settlement [1]. Peatland in its natural state can provide important ecological and economic benefits [2][3][4], and the conversion to agricultural land can cause environmental, social, and economic damage [5]. Therefore, communities in degraded areas have to adapt to environmental changes, landscape changes and to the decline of previously abundant natural resources.

A range of factors are impacting on the condition of peatlands, including direct factors (logging, agriculture and industrial plantations, drainage canals, fires, poverty and traditional farming system) and indirect factors (climate change, land use policy and governance) [6] [7] [8][9]. Peatlands are fragile, relatively infertile, and can be irreversibly dried if not managed appropriately [10] [11]. Degradation of peatlands can cause considerable losses of biological and economic function, including loss of soil carbon storage [12][9][13], biodiversity loss and greenhouse gas emission [14][3], and smoke haze from burning peat causes a loss of economic activity and extensive human health problems [15][16].

It is obvious that human activities are the main cause of tropical peatland degradation. With increasing population and various interests in the peatland, the pressure to the peatland and the risk of degradation are getting higher. Conflict of interest among stakeholders with high political economy tension in lowland area of Indonesia, including peatland, affect the livelihood and sustainability [17]. Recurrent fires in peatland also one of the key challenges in peatland management and have contributed significantly to the degradation and the loss of livelihoods of the people [6,18–20]. Understanding more comprehensive factors causing peatland degradation are important to design integrated approaches toward sustainable peatland management. Local biophysical, ecosystem and social economic characteristics of the peatland call more appropriate and adaptive approaches in peatland management.

In South Sumatra, the largest peatland area is located in Ogan Komering Ilir (OKI regency). Traditionally, fisheries were the main livelihoods of the local people around the peatland in OKI [21]. Logging activity in the early 1970s and following with the transmigration program were the beginning of peatland changing landscape in OKI regency [21,22]. Along with the development activities, peatlands in OKI regency have been largely degraded due to installation of drainage canals, illegal logging, conversion to industrial timber and agriculture, and recurrent fires. In the long term, this has resulted in a decrease in natural resources which are a source of livelihood for communities around OKI's peatlands. Poor management on peatland brings some problems including flooding, drought, livelihood and social change, climate change, and peatland fires [3]. Fires on peatland are the cause of much of the smoke haze that is a national and international disaster in many years, and once the fire enters the peat they become very difficult to extinguish [16] [23]. Human activities such as developing canal for drainage, land preparation by using fires, and also the condition of dry climatic conditions increase the risk of fire and smoke haze [16]. In some cases, people only consider the advantages and low costs of land preparation without considering the impact on peatland degradation. These lead to select OKI as one of the priorities area for peatland restoration program from Peatland Restoration Agency (BRG). Larger area of peatland and the extensive degraded peatland in OKI show the importance of immediate actions to halt the degradation and to secure the livelihoods of the people.

Various programs have been implemented in OKI’s peatlands by government, NGO and other parties through national and international projects. Peatland Restoration Agency (BRG) implemented several programs to restore the condition of peatlands through the 3R’s: Rewetting, Revegetation, and Revitalization. Based on the information from the Environmental and Agrarian Service of South Sumatra, there were 297 canal blockings were built as part of rewetting, 50 ha area of revegetation and, 21 revitalization programs implemented in OKI regency as peatland restoration programs funded by BRG. However, peatland restoration efforts in recent years have not yet had a significant impact on restoring the condition of degraded peatlands. Revitalization activities that were carried out in several locations still have not been effective. Likewise, rewetting actions were often poorly understood by the community. This is not only due to the nature of the peatland which is fragile and
difficult to restore its function, but also due to social and cultural factors of the community, as well as other inhibiting factors. This research aims to analyze land use-based peatland restoration opportunities and challenges in Kayu Labu village, South Sumatra.

2. Research method

2.1. Research location

This research was located in Kayu Labu village – Ogan Komering Ilir Regency, South Sumatra. Kayu Labu is located between 3°28’10.36” and 3°36’51.31” South Latitude and between 105°11’53.28” and 105°21’52.27” East Longitude. This village is included in the East Pedamaran sub-district which is bordered by several villages: Pulau Geronggang, Gading Rejo, Pancawarna, Cengal, Talang Jaya, and Sidomulyo villages (see Fig. 1). Peatland utilization in Kayu Labu is mainly dominated by oil palm and rubber. There is also 1,100 hectare of rice field which was established 2018. Unfortunately, rice cultivation has not been successfully carried out by many of the growers, so only a few people are still growing rice. Kayu Labu was designated as a Desa Peduli Gambut (Peat Care Village) by BRG in 2019. After it was assigned this status, several peat restoration activities began to be carried out in this village, including the construction of blocking canals, drilling of wells, and several other programs.

2.2. Data collection and analysis

The types of data collected in this study include primary data and secondary data. Surveys and interviews with the stakeholders were applied to collect primary data in the field. The survey activity was intended to determine the socio-economic status of the community as well as the types of land use being carried out by the community, especially on peat. Observations were also made on the types of plants cultivated by the community in pursuit of their livelihoods. Stakeholders interviewed at the village level included the village head, other village officials, community leaders, and farmers with different types of land use and types of plants on their land. In addition to primary data, secondary data was also obtained from various reports and scientific publications to complement the information and strengthen the results. The data that has been collected was analyzed descriptively.

3. Results and discussion

3.1 Descriptions of the research area
Kayu Labu Village has a total area of 17,444 ha, of which 4,470 ha (25%) are peatland [24]. In the past, the peatlands supported peat swamp forest with large trees such as perepat (Sonneratia alba), tembesu (Fagraea fragrans), and meranti (Shorea spp). At that time, the population of large diameter gelam trees (Melaleuca leucadendron L.) and purun grass as raw materials for handicrafts was abundant and easy to obtain. However, most of these areas have now been converted into oil palm and rubber plantations, an additionally some of the area has been abandoned. Kayu Labu village has five hamlets, Dusun I and Dusun II are located in the main village area, Dusun III (Sentul Jaya), Dusun IV (Pondok Duku), and Dusun V (Senasi Mulya). The total population of Kayu Labu Village is 2,744 people, 53% male and 47% female [24]. Most of the community has attained a primary school level of education, and their livelihoods are typically based on plantations and agriculture. They work as farmers, wage laborers, fisheries and purun craftsmen.

Access to Kayu Labu Village was initially via the river. The first residents began to build settlements along the river. The main livelihoods at that time were fishing and shifting cultivation. At first, there were few people and a large area of land, so shifting cultivation was the main form of agriculture. They cleared an area of land, planted their crops and then moved to a new place to repeat the process. They continued clearing and planting different areas until returning to harvest their crops.

Intensive development of Kayu Labu village began with the construction of a village road in 1980 by oil palm plantation company, PT Duara, which was then followed by a transmigration program by the government in 1983. This was the starting point for the intensive development of Kayu Labu village, when the number of residents from surrounding villages and migrants from outside Sumatra increased significantly. They began to build houses to live on either side of the road. Furthermore, in 2002 the village administration which was originally part of Pulau Geronggang Village began to separate itself into an independent village with the name Kayu Labu. Kayu Labu continues to grow and electricity has been available in the main village since 2014.

Since being designated as a Peat Care Village by BRG in 2019, many programs and activities have been initiated by BRG to be implemented in this village. Among them are rewetting activities (rewetting peatlands so that the peatland are not easily burned, by constructing canal blocking and deep wells along with the fulfillment of equipment needs), revegetation (replanting endemic peat plant species), and revitalization (increasing sources of community income to improve the economic conditions of the communities around peatlands). Unfortunately, there is still some community members who are not aware of the activities carried out by BRG. Some of them also do not understand the purpose of these programs, probably due to the short time given for program implementation and large areas needing to be restored.

3.2 Land use and community livelihood

Kayu Labu Village is a lowland area consisting of mineral soil, peat swamp and lebak swamp. Peatlands in Kayu Labu Village are located in Dusun V Senasi Mulya and a small part in Dusun II. The average peat depth in Senasi Mulya hamlet is less than 2 meters. Therefore, the community can utilize it for intensive agricultural and plantation activities. Deeper peat (4 meters) tends to be unmanaged and is vegetated with shrubs. These unmanaged peatlands usually burn during the long dry season and the fires spread to the community plantations. The fires in 2015 destroyed several community-owned oil palm and rubber plantations, causing enormous economic and environmental losses. The main land-uses in Kayu Labu Village include the following:

1. Oil palm and rubber plantation
Figure 2. Oil palm plantation

Oil palm plantations dominate the land use system in Kayu Labu Village (Figure 2). Oil palm was introduced by a company, and it has been well received by the community since its inception. Oil palm has been a source of livelihood for most people even today. Some of the reasons why oil palm is widely adopted in Kayu Labu include: high economic returns, easy management (the cultivation system is sufficiently controlled by the community), easy and open marketing, support provided by oil palm companies around the village, and oil palm is able to grow on marginal land such as peatlands. The area of oil palm is growing rapidly in Kayu Labu after several companies have obtained concession permits. The support offered by the companies was well received by the community because they provide share-farming arrangements where they supply the capital that farmers need to get started.

The community perceives that oil palm companies bring both positives and negatives. Some people noted that road construction in the village was better when there is an oil palm company. Therefore, transportation becomes easier, which can significantly improve the community’s economy, especially for the marketing of agricultural and plantation products [25]. Meanwhile, those who oppose the existence of oil palm companies highlight several negative impacts. Oil palm expansion has a large negative impact on the environment and causes deforestation [25]. Among the environmental impacts they noted were decreasing fish production around the village area, decreasing purun stocks, and decreasing availability of natural gelam wood. Moreover, the construction of canals in oil palm plantations changes the physical, chemical, and biological properties of peatland and increases CO₂ emissions [26]. Extensive canalization has resulted in over-drainage and increases the vulnerability of peatlands to fires, especially in the dry season [27] [28].

As well as oil palm, the people in Kayu Labu also tap rubber as a source of their livelihood (Figure 3). Rubber in this area is mostly already in production and being harvested every day. Local villagers who have small areas of rubber will manage their own land. However, those who have larger areas of rubber will pay for the labor to harvest their rubber using a profit sharing system. There are several rubber traders in Kayu Labu Village, and traders from outside the village will also come to buy rubber latex from the community. In addition, they can also sell their rubber latex to collectors who live outside the village and who offer higher prices.
2. Fruits  
Some members of the community are growing oranges (Figure 4), as well as pineapples and bananas. Some other fruit trees that also planted by the community but for subsistence rather than for income include mango, guava, and papaya. Oranges were chosen because the farmer had previous experience with the crop, and the prices were good. However, because orange production is variable and seasonally dependent (the peak in production occurs after the dry season), not many in the community are involved in orange production.

The price of orange seed can be prohibitively expensive, which is also an obstacle for some farmers who would otherwise want to grow this fruit crop. Therefore, oranges tend to be developed by farmers who have sufficient capital and larger areas of land, so that they can diversify their livelihoods away from rubber and oil palm. When the oranges grow well, they can provide a high return. Conversely, the losses from a failed crop are also very high. Therefore, oranges are a high-risk investment.

3. Horticulture
Horticultural cropping is another land-use option employed by some farmers in Kayu Labu Village. The cultivation of this type of plant requires intensive maintenance, but they have a short time to harvest so they can provide relatively quick cash income. The types of vegetable crops grown by the community include eggplant (Figure 5), chillies and long beans. These three types are grown because they are easy to plant and maintain, and the product prices are quite stable. The community grows these vegetables between the young oil palm trees, either on their own land or in oil palm plantations owned by others. Oil palm landowners are happy to freely allow anyone who wishes to grow vegetables among their oil palm crops, as their oil palm crop will benefit from the fertilizer that is applied to the vegetables.

Prior to the establishment of oil palm plantations in 1980 large diameter trees such as meranti and perapat were common in the peat areas, as well as natural jelutung, gelam and purun grass. Community members were able to easily obtain or collect these natural resources as a source of their livelihood. The natural conditions also supported an abundance of fish, with Kayu Labu well known for its salted-fish production.

Natural resources in Kayu Labu village are still a source of livelihood for some of the villagers with Gelam collecting, fishing, as well as purun collecting and purun crafting being key livelihood options. The income obtained from purun is relatively small but it can be used as an additional source of income to meet the needs of the family. Girls from the age of 10 will learn to make purun mat crafts. Making this mat can be done in their spare time, or when they gather with relatives and neighbors while chatting or caring for their children. However, over time, the expansion of oil palm plantations has resulted in a decline of trees and purun stocks in Kayu Labu Village, and collection of large quantities of gelam, fish, and purun has become difficult, requiring covering of longer distances and taking much more time than before. The fish population is decreasing because fish are impacted by the application of toxic fertilizers and pesticides/herbicides to oil palm plantations. Some fish have also moved from rivers into canals built by oil palm companies.

3.3 Opportunities and challenges for land use-based peatland restoration

Land-use in Kayu Labu is heavily influenced by government policies and changes in natural conditions. The government policy regarding the granting of concession permits to oil palm plantations as well as the transmigration program, has brought many changes to the condition of the land and the availability of natural resources in Kayu Labu. There are no more large trees, and while some of the area has been converted to oil palm and rubber, the rest has been abandoned, which is now overgrown with shrubs, and is very prone to fire during the long dry season.
There are several opportunities for land-use-based peatland restoration in Kayu Labu. Based on interview results with several stakeholders such as the village head and village officials as well as farmers in Kayu Labu, the community has a strong willingness and commitment to restore their peatlands because of their bad experiences due to peatland fires. Some people suffered substantial losses in the fires of 2015, when their oil palm and rubber plantations were burned. Therefore, they have a strong willingness to restore the condition of peatlands, especially the deep peat. They hope that large trees can once again grow in that area, and that peatlands can function properly. When peatlands are damaged and degraded, the community is concerned about the loss of trees, purun, and fish as well as the risk of fire.

Several government programs have been implemented since 2019 to improve the condition of peatlands in Kayu Labu. Additionally, some research activities also have been implemented in this location. These programs are expected to be able to provide the best support and options to restore the sustainability of peatlands and improve people's livelihoods and incomes. The community is looking for profitable land use options that can support the sustainability of peatlands. Investment opportunities or funding for land cultivation are urgently needed by the community. Currently, there is an area of 1,100 hectares of rice field that has not been optimally utilized due to limited land processing equipment. According to the community members, this area could be better managed to improve the welfare of the community. Although some of the owners of this area come from outside the village, the community will still benefit from the availability of new, more profitable jobs.

In addition to the existing opportunities, there are also several challenges in land-use based restoration in Kayu Labu. One of the challenges is the continued expansion of oil palm plantations, with abandoned peatlands a target for several oil palm companies to expand their plantation areas. The community has an expectation that this peatland can be restored with plant species that can also support their livelihoods. Establishment of monoculture plantations is not going to support this aim. For this reason, some of the people are quite interested in agroforestry: combining trees and agricultural crops in one landscape. Environmental protection by planting trees is something that must be realized for sustainable development of Kayu Labu village [29]. It is hoped that by applying this land use system, the community can earn income in the short, medium and long term. However, further information are still needed to support this system including the types of plants that suitable with the land condition, the market system (value chain), the feasibility of the system, and also the support from government regulations.

Lack of knowledge about peatland is also one of the big challenges for peatland restoration in Kayu Labu. In particular, the understanding in the community that peat is a barrier to achieving optimal land use is also of concern, because they will try to remove the peat from their land in various ways. To help them to recognize the value of their peat, capacity building, communication and knowledge enhancement, and partnerships are needed for the success of land use-based peatland restoration in Kayu Labu. Socialization with the community about the importance of peatlands is needed. They need support to recognize the benefits that peat can convey so that they can be instrumental in protecting peatland from further damage.

4. Conclusions
There are several types of land use being employed for livelihoods of the Kayu Labu community, including oil palm, rubber, fruit trees, and horticulture. Since being designated as a Peat Care Village by BRG in 2019, many programs and activities have been initiated by BRG to be implemented in this village. Unfortunately these programs do not appear to have significantly impacted people’s lives, or resulted in an improvement of the condition of the peatlands in this village. The community has not widely been engaged in the implementation of these programs, and only those who were directly involved in the activities are aware of the peatland restoration program. Several opportunities are in place to support the implementation of land use-based peatland restoration in Kayu Labu. The community has a strong willingness and commitment to restore their peatlands because of their previous experiences with peatland fires. Some members of the community suffered substantial losses
in the peatland fires of 2015, because they lost significant areas of oil palm and rubber plantations. The community also acknowledges the loss of their livelihoods due to peatland degradation, especially for purun craftsmen, gelam collectors, and fishers. They are also concerned about the reduced availability of the natural resources that supported their earlier livelihood options, such as trees, purun grass, and fish. Several government programs to improve the condition of peatlands in have been running in Kayu Labu village, and some research activities from a range of research institutions have also started to provide the best support and options to restore the sustainability of peatlands and improve people's livelihoods and incomes. There are also several challenges in land-use based restoration in Kayu Labu, including the increasing expansion of oil palm plantations. This expansion can be very detrimental to the sustainability of peatlands because it requires the peatlands be cleared and drained. Limited information and knowledge of the community regarding peatland has also becomes apparent as a challenge for restoration. Application of agroforestry, combining trees and agricultural crops in one landscape, is likely to be one of the best solutions, because it provides for a transition from current livelihoods to future livelihoods that can be conducted on peat that has been fully rewet. By applying this land use system, the community can earn income in the short, medium and long term while the sustainability of peatlands can be maintained. Capacity building, communication and knowledge enhancement, and partnerships are needed for the success of land use-based peatland restoration in Kayu Labu.

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