Alternative natural capital-based livelihoods in facing peatland degradation in Rengas Merah hamlet, Ogan Komering Ilir Regency, Indonesia: a financial analysis approach

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Abstract. Peat swamp forests in Ogan Komering Ilir (OKI) Regency have been experiencing dramatic changes caused by timber extraction and fire. These changes are now increasing ecological vulnerability and threatening the livelihoods of communities living in rural areas around these forests. This study investigated the diversity of natural capital-based livelihood strategies for sustainable livelihood in Rengas Merah hamlet, OKI Regency, South Sumatra Province, Indonesia, with a financial analysis approach. A combination of qualitative and quantitative methods is used for data analysis. Data were collected using questionnaires, in-depth interviews, and focus group discussions. A benefit-cost analysis analyzed the choice of various livelihoods. The result showed that gelam wood harvesting and developing edible bird nests while cultivating rice paddy are feasible as a sustainable livelihood. Natural capital is still a significant asset for the community to achieve sustainable livelihood. The natural capital-based livelihood strategy by directly exploiting natural resources combined with agricultural cultivation is the primary strategy chosen by the community for livelihoods sustainability.

1. Introduction
In recent years, peat swamp forests across Indonesia, and neighboring countries such as Malaysia, Singapore, the Philippines, and Thailand have been experiencing dramatic change due to exploitation that impacts the health and livelihoods of local people[1–3]. Until the 1970s, peatlands in the Ogan Komering Ilir (OKI) Regency were in the form of peat swamp forests. The condition of the peat swamp forest in OKI began to change as timber exploitation of peat swamp natural forests started with the Forest Concession Rights (Hak Pengusahaan Hutan /HPH) concession system in the 1970s[4–6]. Large scale timber exploitation and land fires that repeatedly occur with increasing frequency and magnitude damaged peat swamp forest. Uncontrolled fires on peatland pose severe risks to the economy, health, and conservation efforts contributing significantly to climate change[7–11].

There are social and ecological impacts caused by the changes in natural peat swamp forests. The peat swamp forest offers ecosystem services as a water absorber in the rainy season, storing and releasing it in the dry season, which is important for local livelihoods because water is a basic need for human life [12–14]. Tropical peatland, composed of organic material, also has the function of storing carbon (C) with C deposits around 17% to 19% of the world’s carbon stocks, which, when released into
the atmosphere, will have significant impacts on climate change[7–9,11,15,16]. Those ecosystem services or functions would be lost by damaging the biophysical composition of the peat swamp forest. Serious environmental problems following peat swamp forest damage are drought in the dry season and floods in the rainy season [7]. These environmental changes increase ecological vulnerability and threaten community’s livelihoods living in rural areas around peat swamp forests. Households make a variety of efforts and strategies to gain sustainable livelihoods and address its vulnerability related to changes in the condition of peat swamp forests[4].

Referring to the livelihood framework proposed by Scoones and Ellis [17,18], disasters that occur as a result of changing the natural conditions of peat swamp forests into pressures and shocks that increase ecological vulnerability and threaten community livelihoods who live in rural areas around peat swamp forests. This threat mainly occurs in households that depend on peat swamp forests for their livelihood strategies. As a response to this threat, households are trying to make adjustments in order to overcome vulnerabilities and maintain sustainable livelihoods.

Livelihood strategies are an effort made by the community to obtain an adequate life [18]. Although there is little research with Indonesian communities, previous studies in sub-Saharan Africa[17,19], rural Africa[20], and Brazilian Amazon [21,22] have identified that livelihood strategies are closely related to the way a community manages and combines the livelihood assets that are owned or available around them, which influences how community members can respond to economic changes. Each household may have a different livelihood strategy, depending on the available assets and the vulnerabilities faced, however, there remains little knowledge of these livelihood strategies in peatland swamp areas. Salazar in 2018 [23] added that livelihood strategies can be included in policies to improve the lives of farmers without damaging the environment.

This study investigated the range of diverse livelihood options and financial viability in a high fire-risk village in Ogan Komering Ilir (OKI) Regency, South Sumatra Province, Indonesia. The results of this study are expected to provide information to the government to improve policies aimed at preventing fire while simultaneously improving livelihoods.

2. Materials and methods
2.1. Conceptual framework
Sustainable livelihood according to Chambers and Conway [24] from the Institute of Development Studies (IDS) is:

"A livelihood comprises the capabilities, assets (stores, resources, claims, and access), and activities requires for means of living; a livelihood is sustainable which can cope with and recover from stress and shocks, maintain or enhance its capabilities and assets, and provide sustainable livelihood opportunities for the next generation; and which contributes net benefits to other livelihoods at the local and global levels and in the short and long term"

The definition above states that people who experience shocks try to maintain the sustainability of livelihoods with livelihood strategies. According to [17,18], livelihood strategies are assets or capital (natural capital, human capital, economic/financial capital, physical capital, and social capital), activities and access with institutional mediation and social relations that collectively determine life community, both individuals and households.

Rural livelihood strategies are generally very dependent on natural resource-based activities. The livelihood portfolio of rural communities is influenced by the abundance of natural resources, risks, and uncertainties. Socio-economic conditions also have a large influence on the choice of livelihood portfolios [18]. Ellis in 1998 classifies livelihood strategies based on activity base categories, which are separated into two groups, namely based on natural resources and non-natural resources[19]. Furthermore, [18] state that there are three groups of livelihood strategies that may be done by farmers (communities) under the changes (shocks) that affect their livelihoods are:

a. Agricultural intensification/extensification. Agricultural intensification strategies are carried out by increasing capital (external inputs such as technology and policy) and labor, while agricultural extensification is carried out by expanding land arable or business.
b. Livelihood diversification. This strategy is carried out by applying a variety of livelihood patterns. Diversification is done by looking for jobs other than agriculture to increase income or mobilize family workers to work outside the agricultural sector to earn income.

c. Migration. The strategy is carried out by carrying out mobility activities to other areas outside the village, both permanently and circularly to obtain income.

2.2. Research location
The research was conducted in the Rengas Merah hamlet of Riding Village, Ogan Komering Ilir Regency, South Sumatra Province, Indonesia. Riding Village is at coordinates 3°10' 24.3" NL and 105°10' 56.6" EL [25]. Rengas Merah hamlet is located on peatland, directly adjacent to the production forest area (already managed as a forest plantation company) and the Padang Sugihan Wildlife Sanctuary.

2.3. Data collection and analysis
This research is a case study research, focusing on the Rengas Merah hamlet. The reason for choosing Rengas Merah as a focus is that the community living in the research location has been affected by the sustainability of their livelihoods caused by shock and stress. The shocks are caused by changes in the condition of natural resources (peat swamp forest).

Data collection was collected through household surveys using questionnaires, in-depth interviews, focus group discussions (FGD), and direct field observations. Research respondents were determined by the purposive sampling method [26]. Data extracted from respondents include social and economic characteristics of the community, such as age, education, occupation, income, number of family members, and land area. In addition, various information related to village history, peat swamp forest management development, natural resource conditions, and various livelihood strategies adopted by the community to maintain economic sustainability through in-depth interviews and focus group discussions.

Data were analyzed by a combination of qualitative and quantitative methods. Community livelihood strategies at the study site were studied using the theory of livelihood strategies [18]. The choice of various farms was carried out by the community as part of the livelihood strategy was analyzed with a financial analysis framework. The criteria used in the business analysis are the Net Present Value (NPV), the comparison between the value of costs and benefits (Benefit Cost Ratio/BCR), and the discount rate of the net present value of investment (Internal Rate of Return/IRR) [27,28].

3. Results and discussions
3.1. The development of peat swamp forest conditions as natural capital for the livelihood of the people in OKI
Forests in Tulung Selapan Subdistrict in the 1950s and 1960s were still very dense. Mangosteen tree (Koompassia malaccensis), medang (Litsea spp), merawan (Hopea mengarawan), and tembesu (Fragraea fragrans) which are very large in diameter are found in the forest. As an illustration of the size of trees in the OKI forest, after being cut down and processed, if a boat is made, there are seven pieces of length up to 12 meters each [4–6,29]. Interviews with one of the timber business leaders in OKI and [6] obtained information that the extraction of timber from the forest before 1967 was carried out with permission and following the applicable rules of the local clan. Timber from forests is traded only for domestic use and is used by the community to build houses and furniture. Timber extraction from production forests in OKI was carried out on a large scale starting around the 1970s with the issuance of about 10 of HPH. In its journey, forest exploitation in OKI cannot be carried out sustainably, peat swamp forests in OKI experience deforestation and degradation.

Natural forest cover in Air Sugihan OKI around 1978 still reached 37% with tree species including meranti (Shore sp.), tembesu (Fragraea fragrans), and pulai (Alstonia sp.). However, this natural forest was reduced to 17% in 1986, to 6% in 1993 and then disappeared completely in 1998. Natural forest
stands are decreasing over time both due to timber extraction and illegal logging and the conversion of forest areas into plantations and transmigration areas [6,30].

This was compounded by repeated forest and land fires throughout the 1980s to the 1990s with the peak in 1997/1998. The condition of the severely damaged peat swamp forest encouraged the government to revoke concession permits. Revocation and return of HPH licenses make the production forest area in OKI, such as unoccupied, without being burdened with concession permits for a period of about 5 years (1999 - 2003). At this time the condition of the land became unmanaged and abandoned. There were many forest disturbances, such as illegal logging, forest encroachment, and forest and land fires. As a result, the forest area became increasingly damaged and the land cover expanded in the form of scrub [6].

One of the informants in the study provided information that in order to prevent more severe forest destruction due to the absence of area managers in the ex-HPH area, the local government encouraged the issuance of IUPHHKHT (Business Permit for Timber Forest Plantation Product Collection) in OKI Regency. According to the Minister of Forestry Decree Number 10.1/Kpts-II/2000, in CHAPTER III Article 4, vegetation cover on land permitted for plantation forest permits is in the form of forests (bushes, reeds, and empty land). The IUPHHKHT is given by the Regent if the area requested is in the Regency. Based on these rules, since 2004 several forest plantation company (Hutan TanamanIndustri/HTI) operations in OKI Regency have been operated as holders of management permits in production forest areas.

3.2. The livelihoods of the community around the peat swamp forest in OKI Regency
The community in the research locations has strong interactions with the wetland ecosystem. Rivers and waters play an important position in people's lives. Livelihoods, transportation, settlements are influenced by rivers and streams. Discussions with community leaders at the research area provided information that transportation in South Sumatra until the 1950s and 1960s was river-based. Diem [29] tells that the journey from Kayuara in OKI to Palembang was carried out by following the river. The most common means of transportation until 1961 was a kajang (a traditional boat that is also a house). After that period, the more common means of transportation was boats with outboard engines (ketek) replaced by speedboats. When the river water is high, the trip can be reached by boat, ketek, or speedboat, however, when the river water recedes, some parts of the river that become shallow and impassable by river vehicles.

The source of livelihood for the community in the research location is extractive in the peat swamp forests and cultivation activities on mineral soils. The extractive activities carried out in the peat swamp forests include logging, fishing, and hunting animals. Cultivation activities carried out on dry land are planting paddy fields, secondary crops, and rubber. The cultivation patterns used are the same as those commonly practiced by people in South Sumatra. When a new rubber plantation was opened, the community also planted upland rice and secondary crops in the garden. Rice and secondary crops are planted until the rubber plants are 3-4 years old when the canopy is closed so that no agricultural crops can be cultivated. The people of Riding Village are also familiar with sonor rice cultivation on peatlands.

The results obtained from capture fisheries (bekarang) activities in peat swamp forests are only to fulfill daily needs. Capture fishery yields in peat swamp forests began to decline when there was massive logging of natural forests starting in the 1980s. Timber extraction and forest fires caused forest cover in the wetland forest area around Riding Village to become more open. The water condition also receded. Rivers and streams (tulung) began to narrow their flow and reduce their discharge significantly starting in the 1980s. However, when there was continuous heavy rain, there was a big flood (in 1990). The impact of this condition is that capture fisheries products have decreased from time to time, even now it can be said that the people of Riding Village, especially those in the main village, no longer rely on wetland forest areas to catch fish. For people in hamlets such as Rengas Merah, capture fisheries can still be relied on to meet daily needs, as well as for sale under the lebak lebung auction scheme The lebak lebung auction system. In this system, the community is permitted to catch fish for consumption without making payment to the winner of the lebak lebung auction. If fishing is carried out for
commercial purposes, the fisherman must pay the fishing permit to the winner of the *lebak lebung* auction.

### 3.3. Natural capital based livelihood strategies in Rengas Merah as an adaptation to peatland degradation

The community at the research location tried to carry out various livelihood strategies based on natural capital for livelihood sustainability. The chosen livelihood strategy is a combination of extractive and cultivation activities. Extractive activities carried out by the community cannot be separated from the habits of the past, such as *bekarang* and timber extraction. Rice cultivation is carried out on burnt peatlands. In addition, there is also the development of edible bird nests.

#### 3.3.1. Gelam wood harvesting

Some people still carry out Gelam wood harvesting activities at the research location. The location for gelam wood harvesting when it is farther away from the settlement. Gelam seekers at the research location generally take gelam after obtaining loan money from gelam collectors. The loan amount is equal to the price of gelam wood obtained in one harvesting period. Gelam wood wholesale value in the study location ranged between 200,000 IDR to 250,000 IDR for one period of gelam wood harvesting. In general, there are two kinds of patterns for collecting wood from the location of the study based on the length of the harvest period and the price of wood. Gelam wood harvesting activities are only carried out for approximately six months in one year, ie when the water is high enough to help transport the wood. The first pattern (Pattern I), gelam wood harvesting wood is done for a period of 1 week (7 days), with a frequency of 4 times per month. Activities are carried out from 8 am to 5 pm by 2 people using a machete as the only tool. On the first day, the liberation activities were carried out. On the 2nd to 6th day logging, cutting, and collecting activities are carried out on the edge of the trench. On the 7th day the wood is collected on the side of the road with a shouldered. Gelam wood obtained is 100 stems per period with a wholesale price of 200,000 IDR.

**Table 1.** Cost of gelam wood harvesting using Pattern I for one harvesting period.

| No. | Description  | Total Cost (IDR) |
|-----|--------------|-----------------|
| 1.  | Equipment    | 110,000         |
| 2.  | Labor        | 1,050,000       |

Source: Primary data analysis

Pattern I in one year gives total revenue to the timber collector for 4,800,000 IDR. The total cost issued in one year to collect gelam wood is 25,227,500 IDR. The ratio between revenue and costs in one year (R/C ratio) is 0.19. Analysis of gelam wood harvesting business with Pattern I for a period of 10 years, the interest rate of 12%, giving NPV value - 115,314,624 IDR, BCR 0.19 and IRR 14%.

The second pattern (Pattern II), gelam wood harvesting wood is carried out for a period of 4 days, with the frequency of harvesting 4 times a month. Like Pattern I, the activity of gelam wood harvesting is carried out from 8 am to 5 pm, using machetes and canoes as harvesting equipment. Every day they could harvest about 40 gelam logs, or 200 logs per period. They obtained 250,000 IDR per period.

**Table 2.** Cost of gelam wood harvesting using Pattern II for one harvesting period.

| No. | Description  | Total Cost (IDR) |
|-----|--------------|-----------------|
| 1.  | Equipment    | 1,690,000       |
| 2.  | Labor        | 75,000          |

Source: Primary data analysis

The total revenue obtained by Pattern II in one year is 22,812,500 IDR. The total cost issued in one year to harvest gelam wood is 8,492,500 IDR. The ratio between revenues and costs in one year (R/C
ratio) is 2.69. Analysis of gelam wood harvesting activity with Pattern I for a period of 10 years, an interest rate of 12%, giving an NPV value of 80,938,810 IDR, BCR 2.68, and IRR 3%. The financial analysis results provide information that Pattern I is not feasible, because the NPV value is negative, BCR is less than 1 even though the IRR is greater than the interest rate of the analysis. While Pattern II is feasible because it gives a positive NPV value, BCR is more than 1 even though the IRR is less than the interest rate of the analysis. The use of canoe as a tool for transporting wood makes the transport of gelam wood in Pattern II easier to do when compared to Pattern I which relies on human labor to transport gelam wood to the roadside. The use of canoes can lift more wood than using human power and reduce the amount of labor used so that there is an increase in yield and reduced costs.

3.3.2. Paddy rice cultivation. Agricultural cultivation activities carried out by the community at the research location are paddy rice. Rice cultivation is done once a year. Rice fields are carried out when there is a puddle. The community began to cultivate paddy rice in the shallow peat in 2011. Initially, the varieties of rice cultivated were local rice varieties with a planting period of 5 months and 10 days. Starting in 2013 the farmer cultivate new rice varieties (Ciliwung) with a planting period of 4 months and 10 days. The yield obtained is 3 tons of grain per hectare which is sold at 8,500 IDR/kg.

| No. | Description                      | Total Cost (IDR) |
|-----|----------------------------------|------------------|
| A.  | Land preparation                 | 3,835,000        |
| B.  | Planting                         | 985,000          |
| C.  | Maintenance                       | 1,125,000        |
| D.  | Harvesting                        | 5,400,000        |

Source: Primary data analysis

The amount of income obtained by farmers from the cultivation of lowland rice in tidal peatland in one year is 25,500,000 IDR. The total cost issued by farmers for one year is 10,745,000 IDR. Comparison between revenues and costs (R/C ratio) for lowland rice farming on peatland with one planting season at the study site was 2.37. Analysis of paddy field cultivation on peatland for a period of 10 years, an interest rate of 12%, gives an NPV value of 87,775,850 IDR, BCR 2.56 and IRR 3%. The results of the analysis show that lowland rice farming in the research location is feasible to be cultivated and used as an alternative sustainable livelihood.

3.3.3. Edible bird nest development. Some community members at the research location began to undertake the development of edible bird nest. The community develops an edible bird’s nest on a small scale, after knowing and exploring the business of edible birds in several locations with similar biophysical characteristics. Some residents of Riding Village, Lebung Gajah Village, and several other villages in TulungSelapan and Sungai Lumpur Sub Regency which have similar environmental conditions have success stories from edible bird nest business.

The edible bird nest developed at the research site is still a small scale. One of the farmers developed a swallow house with a length of 5 meters, a width of 5 meters and a height of 8 meters. The swallow bird as the producer of edible bird nests starts living in the swallow house about 5 months after the completion of the construction of the ‘house’. Until the second year, the results have not reached 1 kg of bird nests per year.

| No. | Description                     | Total Cost (IDR) |
|-----|---------------------------------|------------------|
| A.  | Preparation and development     | 50,000,000       |
| B.  | Maintenance                     | 1,225,000        |
| C.  | Harvesting                      | 24,375           |

Source: Primary data analysis
The R/C ratio in the first and second year of swallow house development is less than 1 (0.604 and 0.905) because the yield of edible bird nests is still small so that the total revenue in the first and second year is lower than total cost in one year. In the third year and then the total revenue value is greater, the total cost value tends to be fixed so that the R/C ratio is more than 1. The RC ratio tends to increase from the first to the tenth year (Figure 1). The results of the financial analysis of the development of edible bird nests for a period of 10 years with an interest rate of 12%, gave an NPV value of 47,495,072 IDR, BCR 1.74 and an IRR of 11%. The results of the R/C ratio analysis and financial analysis indicate that edible bird nest development was an alternative livelihood that might be developed.

![Figure 1. The R/C ratio value of the edible bird nest development for 10 years](image)

The community implements a livelihood strategy in the form of a combination of various farming as a source of income for sustainable livelihoods. Concerning [17,19] the activities carried out by the community are still based on natural resources (natural capital). Shocks in the form of changes in the condition of natural resources as natural capital encourage people to make adjustments so that their livelihoods can be sustainable. When the peat swamp forest has experienced degradation and deforestation, people no longer rely on logging as their main livelihood. Gelam wood harvesting activities are still being carried out, although the results of the financial analysis show that some of the methods of gelam wood harvesting (Pattern I) are not feasible to operate, the income obtained from gelam wood harvesting is used to buy daily necessities such as buying rice, oil, and vegetables. Rice is sometimes obtained from sonor activity during the long dry season. Fish obtained from bekarang activities are used for daily needs. The community carried out their activities for gelam wood harvesting and bekarang by an extensive extraction pattern, there is no agricultural intensification effort related to gelam wood and fishing activities.

Permanent agricultural cultivation began to be carried out on shallow peatlands which in the past were natural forests. This permanent lowland rice cultivation began to be carried out by the community in 2011. At the time of this research, agricultural intensification began to be carried out by the farmers. The farmers initially used local seeds with a harvest period of 5 months and 10 days, but starting in 2013 the farming community started using rice seeds with a shorter harvest period (4 months and 10 days). Land preparation no longer fully relies on human labor. Some farmers are starting to use the hand tractor. Some farmers also started planting corn when the land was not flooded. Around the yard and rice field embankments, several community members also started planting timber plants such as jabon (**Antocephalus cadamba**) and developing edible bird nests. The community understands that the agricultural intensification strategy is capable of providing greater additional yields when compared to
increasing inputs. The agricultural intensification strategy is expected to be able to encourage the revitalization of community livelihoods so that sustainable livelihoods can be achieved.

Even though intensification efforts have started, the community is also trying to extend it by expanding agricultural land. The background of the extensification was the assumption that there was still a lot of empty and abandoned land in their surroundings. This land is actually part of Areas of Other Use or Non-Forestry Cultivation Areas (Areal Penggunaan Lain/APL) and the living plant area which is part of the IUPHHK-HTI concession. In addition, the community expects an increase in income and welfare with an increase in the area of arable land.

4. Conclusion
Natural capital is still a significant asset for the community to achieve sustainable livelihoods. Natural capital-based livelihood strategies by extracting natural resources directly combined with agricultural cultivation are the main strategies chosen by the community for sustainable livelihoods. Financial analysis results provide information that gelam wood harvesting with Pattern II, developing edible bird nests, and lowland rice cultivation is feasible to be cultivated to be used as an alternative livelihood strategy for sustainable livelihoods. Agricultural intensification and extensification are carried out jointly by the community. Agricultural intensification is carried out by improving the quality of farm inputs. Extensification is carried out because of the community’s perception that there is still a large amount of abandoned land around them. More efforts should be made to encourage the community to undertake an agricultural intensification strategy because, in the framework of peatland extension, extensification of agriculture has the potential to be a source of peatland degradation.

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