The Covid-19 pandemic impact on indigenous people livelihoods in the peat swamp forest ecosystem in Central Kalimantan Indonesia

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Abstract. Global tropical peat swamp forest ecosystems mostly are found in Indonesia. However, these unique yet fragile ecosystems are subject to deforestation and degradation due to forest fires and land conversion. Peat swamp forests are well known for their ecosystem services related to global climate mitigation because they store carbon inside and are very vulnerable to forest fires. Another direct function is providing various needs for the indigenous people livelihoods who live close to and in the areas. This study was conducted qualitatively to assess the forest utilization and the impact of the COVID-19 pandemic on the livelihoods of indigenous people. The study results show that the Dayak Ngaju Communities utilize the forest for timber, non-timbers, medicinal plants, foods, and religious culture. There is no significant impact of COVID-19 on forest product collection activities, but the pandemic impacts the marketing and sales of forest products. The marketing of fish and other non-timber forest products has been negatively affected due to decreased demand and limited transportation. On the contrary, the use, need, and demand for medicinal plants for the traditional medicine of COVID-19 is increasing significantly and improving local livelihoods.

1. Introduction

Indonesia has the most extensive tropical peatland globally, around 21 million hectares or 47% of the total global peatland area [1]. However, based on Ritung et al. measurements, mapped peatlands in Indonesia are 15.4 million hectares, covering Sumatra, Kalimantan, and Papua [2,3]. The existence of this massive peatland makes Indonesia play a crucial role in peatland management on a global scale for various purposes, such as reducing carbon emissions and mitigating global climate change [4].

In Indonesia, the largest peatland is in Riau province, with 3,867,413 or 60% of the total peatland on Sumatra Island. At the same time, on Kalimantan Island, Central Kalimantan has the largest peatland with an area of 2,659,234 or 56% of the total land area. Peat on the island of Borneo. However, what is distinctive in that the peatlands in Central Kalimantan are mostly peat swamp forests. The part of peatland that is still a stretch of land dominated by trees is called Peat Swamp Forests (PSFs). Peat swamp forest in Southeast Asia, including Indonesia, is a lowland ecosystem with a critical role in biodiversity, carbon storage, and a resource used for human life [5,6].

Peat swamp forest part of peatland has a vital role in human life with various ecological and economic benefits [7,8,9,10]. Specifically, peat swamp forests are of global importance because of their high
carbon stores [11], which means they are associated with global carbon emissions when burned [12,13,14]. In addition, these ecosystems also have high biodiversity, including various endemic, rare and endangered species [15,12,16,6] and a source of livelihood for local communities [17,18,19].

In Central Kalimantan, the reduction of peat swamp forest started with the project of clearing 1 million hectares of peatland to pursue food self-sufficiency in the 1990s by clearing forests into agricultural land through the transmigration program. This land-use conversion then causes several aftershocks such as drought and land conversion to various utilization and fires. The leading causes consist of extensive land transformation to plantations and sizeable industrial-scale agriculture [20,21,22], massive canal/drainage building activities [23,11,24], and land and forest fires [25,26,11].

Land and forest fires are among the leading causes of peat swamp forest deforestation and peatland degradation in Central Kalimantan. Most fires are used to clear land for conversion to other uses, especially for large-scale agriculture and pulp and paper plantations or HTI [27,28,29]. However, a forest fire is not a single factor but is related to other factors such as drought, drainage opening, land conversion, and other human activities [30,31].

Peatland and Peat Swamp Forests have many functions on local, regional, and global scales. The first function of the peat swamp forest ecosystem is to store carbon and is linked to climate change. Although tropical peatlands, especially peat swamp forests dominated by trees, are essential for biodiversity, carbon, and water protection [23,32]), peat swamp forest differs from other peatlands in the form of organic matter. Although tropical Peat Swamp Forest mainly in the state of decomposition from tree roots, stems, and branches, peat swamp forest is of concern to scientists because of its high carbon stock and its strong influence on global climate change [31,7]. The second function is a habitat of conservation and habitat for biodiversity. Peatlands, especially peat swamp forests, have high conservation value and biodiversity [6]. The existence of peat swamp forests supports many high conservation value organisms, including endemic animals such as orangutans and tigers [34]. Peat swamp forest is the essential habitat for protected primates in Indonesia, such as forest orangutans (Pongo Pigmus) and probosci's monkeys (Nasalis lavartus) [35]. Peat swamp forest is also a habitat for several types of small and rare vertebrates [7,14].

In addition to supporting animal diversity, peat swamp forest also has endemic flora species such as Meranti Rawa or Shorea Balangeran. Furthermore, several protected woody species such as jelutung and ramin[36] and various types of giant fungi, mammals, birds, fish, and invertebrates are also found in peat swamp forests [37,38,39]. The ecosystem also supports the biodiversity of grass and ferns that grow as pioneers in forest fires, including rare kantong semar (Nephentes Sp.) species [13].

The third function of peat swamp forest is hydrological benefits. Peat swamp forest is a unique ecosystem with black water so that it becomes the primary water source (aquifer) for river water flow during the dry season [40,41,2]. In addition, peatland is a freshwater source, wherein 1 million hectares of peatland with an average depth of 2 meters stores 1.2 million m3 of freshwater [11,42,44,29].

Peat swamp forest is a water regulator because, in the rainy season, water is absorbed into the peat soil, which functions like a sponge that absorbs moisture and holds water to keep it wet in the dry season if the hydrological balance is good [41, 42,] In addition, peat swamp forest also functions as a barrier to seawater intrusion, especially in coastal peat swamp forests [43,44]

In terms of economic function, peat swamp forest has high economic value in terms of goods and services. Peat swamp forest is an ecosystem where people depend on their livelihoods by collecting forest products in the form of wood, rattan, latex, game animals, fish, and mushrooms as their source of livelihood [17, 32,8].

Peat swamp forests provide extraordinary natural resources, including various types of woody plants that have high economic value, such as ramin (Gonystylus bancanus), jelutung (Dyera costulata), and meranti (Shorea spp). Several socio-economic studies show that the dependence of local communities on peat swamp forests can reach up to 80% (eighty per cent), which is higher than their dependence on agriculture [45,46,9,47,48].

The most important and often under-appreciated part globally is the economic benefits of peat swamp forests for local communities. Local communities live, utilize, and depend on the peat swamp forest
ecosystem to meet their daily need [9]. With high biodiversity and various ecosystem services [34], peat swamp forests are closely linked to the livelihoods of local communities.

This complexity is also related to various social and cultural aspects in the community that depend on forest products and ecosystem services from forest areas, thus requiring more equitable and acceptable policies [10].

The Covid-19 pandemic condition from the beginning of 2020 had a terrible impact on local communities due to restrictions on many social activities and limited distribution of goods and services. We study qualitatively the uses of forest areas and ecosystem services and how this covid-19 pandemic affects their livelihoods, especially the local Dayak Ngaju people who have traditionally depended on tropical peat swamp forests.

2. Methodology

The research was conducted in 3 villages around the peat forest, namely Katunjung, Tumbang Mangkatup and Tuanan Village, Kapuas District, Kapuas Regency, Central Kalimantan. The study was carried out from June 2020-January 2021 in three villages near the Kapuas Kahayan Protected Forest Area, where local communities primarily depend on the tropical peat swamp forest for their livelihoods.

This research was the qualitative-exploratory approach with multi-stakeholders as the sources of information. Our source of information was all communities who use forests and forest areas, village officials, traditional leaders, buyers of forest products at the village level, and buyers of forest products from outside the region. The research was conducted using the method of extracting information through in-depth interviews. The study would be terminated if no new or different information was found.

With limitations due to the Pandemic period, few interviews used Whatsapp media, while direct interviews were conducted in person by observing the health protocol. We also checked information by participating with the community in the forest to take photos and see firsthand.

The information collected is then interpreted because there is much information in the local area (Dayak Ngaju), then triangulated with different data by different sources of information, then grouped according to research categories. The categories of data include Forms of use, types of forest products used, types of ecosystem services utilized, types and forms of utilization of medicinal plants, and the impacts of the COVID-19 pandemic on the livelihoods of those who use forests and forest products. The tools used are writing instruments, laptops, calculators, cameras, and recorders during our study.

3. Result and discussion

3.1. The utilization of forest product from peat swamp forest ecosystem

We listed some forest product that utilized by local people in the Table 1.

| Forest Products Utilized | Part collected | Usage |
|--------------------------|----------------|-------|
| Timber Products (Shorea balangeran, Shorea Sp, Litsea Sp.) | log | Meubel, family use, building material for wooden house |
| Rattan | Rattan stick | for trade |
| Bamboo | Bambo bar | Meubel, for husbandry purposes |
| Bambang (Donax canniformis) and Purun (Lepironia articulata) | Stem, Stick, bar | For handicrafts, personal tools |
| Latek (Dyera Lowii dan Hevea brasiliensis) | Latex (liquid and solid) | for trade |

Local communities around peat swamp forests, Dayak Ngaju, have been living and depending on forests and forest products for generations. Hunting and gathering are among the local tradition of the Ngaju Dayak people around the peat swamp forest. In addition, various forest products are used and utilized by the community, both timber and non-timber forest products.
Previously, the collection of timber forest products was the most valuable product of high economic value and was mainly carried out by local communities in the rural areas of Central Kalimantan. However, timber harvesting activities are currently rare because wood/timber harvesting must be carried out with complex permits, management, and technologies. Local people only collect and use timber products for their own needs or villages, such as building a wooden house as their residency. Almost all rural homes of local communities living in areas bordering peat swamp forests use wood as the primary material for their houses, with simple processing into boards and blocks.

Rattan (*Calamus trachycoleus*) is the most important non-timber forest product for local communities. The best-selling type of rattan is economical rattan (which can be sold at the village level for 200,000 IDR/1 quintal or 20 USD/100 kgs. One family can collect up to 200 kilograms of rattan per day with a workforce of 2 people, and the production costs are about of the total income. However, rattan collection cannot be carried out throughout the year because it takes time to regenerate. Usually, they move to the location of the rattan harvest every two years of harvest. Therefore, one family needs a large area of forest area to collect rattan. Rattan is the most critical non-timber forest product for local people in the area [17] and should be the part of forest area management, as it has a strong relationship with local communities [9].

In addition to rattan, non-timber forest products collected are bamboo. Bamboo in Kalimantan is not a commercial product but is collected for various local community needs, namely to make chicken drums, ducks, pigs, and fish cages. Therefore, bamboo is never sold. The bamboo primarily consists of small and thin species, which is not suitable for constructing large buildings like on the island of Java. In addition, there are not many bamboos in the peat swamp forest area.

Another non-timber forest product is latex. The latex collected consists of two types, namely rubber latex and jelutong latex. Rubber latex is very common and is sold in solid form for 8000-10000 IDR/kg or 80 cent-1 USD/kg and is an essential forest product for community livelihoods. On the other hand,
Jelutung (*Dyera lowii*) latex is much more expensive but difficult to market because it is usually only for handicrafts and industry.

3.2. The utilization of ecosystem services

Besides direct forest products, we also listed any ecosystem service and products for ecosystem service utilized by local people of Dayak Ngaju as listed in the Table 2.

**Table 2.** Forest product from ecosystem service and ecosystem service used by local people.

| Forest Products Utilized | Part collected       | Usage                                                                 |
|--------------------------|----------------------|----------------------------------------------------------------------|
| Water                    | water                | Household usage                                                       |
| Habitat for fish         | fish                 | More than 30 species, including nine main species with the highest production and economic value |
| Habitat for medicinal plants | Leaves, roots, fruit, bark, or bar | More than ten species, including six main species using for Covid-19 treatment and medicine |
| Religious Places for local believe | River creeks | The socio-cultural and religious functions |
| Habitat for Plant-based foods | Fruit, seedling | There are more than ten species, including three main species using for daily consumption. |

Tropical peat swamp forests are known for their outstanding ecosystem services and are much higher in value than timber forest products. The most well-known ecosystem service and has always been the concern of various parties at the global level is the ability of ecosystems to store carbon and the function of these ecosystems in mitigating global climate change. Still, on the other hand, these indirect benefits are not felt economically at the household scale for local communities.

Peat swamp forest is a water storage aquifer. Peat water is usually red and black but is clear and with high acidity. However, many local communities use clean water because peat water is relatively clean compared to the ample river water that flows around community villages. Large river water can be contaminated with mercury from traditional gold mining, *e-coli* bacteria mixed with mud. Still, water from rivers in peat colour is usually free from pollution.

Peat swamp forest is a unique ecosystem because it is a swamp that is inundated during the rainy season and partially inundated throughout the year. Swamp with water plants rasau (*Pandanus helicopus*) is a habitat for more than 30 endemic species of peat swamp forest. 6 main species are used by the community, namely *papuyu, kakapar, patung, mehau, haruan, tauman, tempahas, sapat, and lais*. These nine species have high economic value, which is traditionally processed and marketed to local markets.
Figure 3. Swamp with water plants rasau (*Pandanus helicopus*) is a habitat for more than 30 endemic fish species of peat swamp forest.

Fish is a by-product of peat swamp forest, which is very important for the livelihood of local communities. However, fish harvest is usually in the dry season, where fish are collected in lakes where the water is receding or in artificial ponds called "beje."

In addition, the peat swamp forest and peatland ecosystems also provide various medicinal plants (See Figure 3). The use of these medicinal plants is done traditionally with local knowledge passed down across generations. There are more than 17 species they use from peat swamp forests, and nine species of which are medicinal plants used during the COVID-19 pandemic and have high economic value.

The peat swamp forest ecosystem is also connected with local beliefs. The Ngaju Dayak people believe that particular places at the river creeks are sacred places associated with the local religion, namely the Kaharingan. The Kaharingan religion is closely connected with the use of the surrounding forest, and they always protect the forest.

Peat swamp forest is a unique ecosystem and can provide a variety of vegetables for local communities. More than 13 peat swamp forest plants are commonly used as vegetables, such as *kalakai*, ferns, rattan grass, lilies, and various types of mushrooms. Mushrooms play a crucial role for livelihood as they are sold with high economic value, such as bantilung mushrooms, which sell for 50,000/kg (4 USD/KG).

3.3. High economic value of medicinal plant for covid-19 treatment
We also identified and listed every medicinal plant used by indigenous people of Dayak Ngaju for the treatment and medicine for Covid-19, as presented in the Table 3.

| Species (Orig.) | Part collected | Usage |
|----------------|----------------|-------|
| Bajakah (*Spatholobus littoralis*), and various unidentified species | Stem, log | For various cancer treatment, For traditional medicinal covid-19 with cancer |
| Asam Limpasu (*Baccaurea lanceolata*) | Fruit | For hypertension (high blood pressure), For covid-19 with blood pressure problems |
| Asam Ramania (*Bouea Marophylla*) | | |

Table 3. Medicinal plants for Covid-19 by indigenous knowledge of Dayak Ngaju.
### Table

| Species                  | Part collected          | Usage                                                                 |
|--------------------------|-------------------------|----------------------------------------------------------------------|
| Kayu Daha (Corymbia gummifera) | Root                   | For Covid-19 with breathing Problems                                 |
| Akar Kuning (Arcangelisia flava) | Stem, log             | For Covid-19 with lungs and liver problems                            |
| Bamban (Donax canniformis)       | Bark and root          | For mother post-natal or a mother who had just delivered a baby To maintain the health and immunity during covid-19 |
| Daun Sungkai (Peronema canescens Jack) | Leaves                | For covid treatment, it is believed as an anti-virus, the most famous traditional plant during pandemic covid-19. |
| Tatunjuk Langit (Helminthostachys zeylanica) | Leaves and Stem       | For mother post-natal or just delivery baby To maintain the health and immunity during covid-19. |
| Pohon Taya (Nauclea orientalis) | Flower and young leaves | For mother post-natal To maintain health and immunity during covid-19. |

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**Figure 4.** Sungkai, *Peronema canescens Jack*, the most famous and widely used medicinal plant for covid-19 by indigenous people of Dayak Ngaju.

**Figure 5.** Pohon Taya, *Nauclea orientalis*, is used both as a medicinal plant and consumed as a vegetable.

The medicinal plants from peat swamp forests are products with a high economic value during the Covid-19 Pandemic. The selection of medicinal plants is made with local wisdom from village elders. This study explored what medicinal plants are traditionally used by local communities, especially during the COVID-19 pandemic, and are used to treat COVID-19.

The first medicinal is the "bajakah," a climbing and twining plant consisting of many unnamed/unidentified species. Bajakah was viral some time ago because it is believed to treat cancer. The local government of Central Kalimantan had banned the collection of pirates because of over-exploitation and forest destruction. Local people usually collect a small amount according to their needs.
Bajakah decoction is an anti-virus for patients with covid and is still used as a cancer drug. Currently, the demand for bajakah from outside the region is also high.

Asam Limpasu is a fruit plant that grows in peat areas that are not flooded or parts that are not swampy. The fruit of this plant has recently been used in patients with COVID-19 because it can cure ammonia or loss of sense of smell. On the other hand, it is also used to prevent covid 19 because it contains high vitamin C, increasing endurance. Limpasu fruit is also used as a traditional medicine for high blood pressure.

Daha wood is a type of wood whose roots are used by the community to treat respiratory disorders in asthma and COVID-19. This wood has a red sap, just like fresh blood in humans. The part used is the root, and it is boiled with hot water low heat method until turn on a red liquid similar to tea, to be consumed by COVID-19 sufferers.

Akar Kuning (Arcangelisia flava) has been used for a long time in patients with impaired liver function and bile disorders. However, during a pandemic, this wood is also used to treat COVID-19 symptoms by boiling, and the water is used for bathing or boiled for traditional saunas, and it can also be drunk if you have liver problems. In addition, this plant is believed to be anti-virus.

Bamban root (Donax canniformis) is a root taken from the roots of a shrub that grows on the edge of a river or the edge of a swamp. The stems and bark of this plant are used for making various household items and handicrafts, while the roots are used for postpartum mothers after giving birth. In addition, the roots of this plant can be used to prevent viruses and increase the body's resistance to viruses. Sometimes the root of bamban is used together with the root of Tunjuk Langit (Helminthostachys zeylanica) by boiling and drinking the boiled water.

Sungkai (Peronema canescens Jack) is increasingly being used to treat covid-19 by various indigenous tribes of Kalimantan (See Figure 4). If other plants are used as prevention, then sungkai leaves are often used as an ingredient for saunas to expel sweat and kill the virus. In addition, some drink the stew of sungkai leaves. This species is the most famous medicinal plant for covid treatment and medicine. However, the effectiveness of this medicine is still in indigenous knowledge, not yet verified by pharmacology research. The sungkai leaves are also sold and trade-in a reasonable price and blessing in disguise for local people.

The next tree is the Taya tree (Nauclea orientalis). This riverside tree has corona-shaped flowers and looks like the coronavirus when enlarged (See Figure 5). The Ngaju Dayak people use young leaves as vegetables for a mixture of fish and meat. The flower and old leaves are used for medicine, while the young leaves are used for vegetables served with local fish in local food.

### 3.4. Pandemic Covid-19 impacts on local livelihoods

We also assessed any impacts of pandemic covid-10 on local people's livelihood, as they depend on peat swamp forest products and ecosystem service. The summary result can be seen in the Table 4.

| Activities                      | Impacts of Covid-19 Pandemic | Additional information                        |
|---------------------------------|-----------------------------|-----------------------------------------------|
| Timber Forest harvesting        | Less Impacted               | Rare activities due to forest status and legal requirement |
| Non-Timber Forest Harvesting    | Less Impacted               | Harvesting based on demand and reasonable price |
| Medicinal plants harvesting and | Less Impacted               | Harvesting based on demand and reasonable price |

Table 4. Pandemic Covid-19 impacts on local livelihood.
We also interviewed local people to get firsthand information on how the COVID-19 pandemic is affecting their livelihoods. In general, the pandemic does not directly impact their activities in and out of the peat swamp forest. Still, it has a significant impact when they market and distribute products outside the village due to many restrictions on community activities.

The collection of forest products, both timber, and non-timber forest products, does not significantly impact the COVID-19 pandemic. Local people usually enter the forest area independently and independently by using a *kelotok* or water boat. There are two types: large water boats to transport forest products and small water boats for hunting and fishing. Some communities also have cottages categorized as temporary houses for staying and working for a few days. This halfway house is usually a 4x5 meter hut and can be used for cooking, eating, and resting. Activities that take days, such as harvesting rattan and collecting fish, are carried out by staying at a halfway house; the goal is to save fuel oil for their *kelotok*.

Capture fisheries and fish processing activities are also not affected by Covid-19, where they have no difficulty getting into the forest because existing regulations require restrictions on social activities. At the same time, they usually go to the forest areas in a small group of people in one household.

The most significant impact is marketing difficulties due to restrictions on activities; usually, they market forest products or processed fish and fish to sub-districts or districts 2-3 times a week, now usually only once a week. However, for villages that are far apart, the number of confirmed COVID-19 is deficient.

Another impact is the decline in people's purchasing power, for example, products that are not primary needs, such as handicrafts, fashionable rattan bags, and various other village products.

While fish and processed fish products and people's purchasing power are not affected by the pandemic, there is a slight decline in prices in June-August due to abundant fish production, but returns to normal in another month. Sales of rattan and rubber also experienced a decrease in prices at the beginning of the pandemic, but moving back to normal now, it is just that buyers come with a lower frequency due to social restrictions.

Some communities enjoy increasing demand and prices for traditional medicinal plants, where they sell medicinal plants at reasonable prices and increase their income.

In general, the Covid-19 pandemic affected people's livelihoods due to limited sales and distribution difficulties. However, most of them agreed that the pandemic had no significant impact as long as rubber, rattan, and fish buyers could come to buy their products at standard prices.

### 4. Conclusion

Our study concludes that The Ngaju Dayak people depend on forests and forest products for their livelihoods from tropical peat swamp forests. The community utilizes timber forest products, non-timber forest products, and ecosystem services. Rattan and rubber are the two non-timber forest products that provide the most economic benefits to local communities. Peat swamp forest also provides ecosystem services for various biodiversity habitats. However, the essential products for local people's livelihoods are fish habitat, forest food habitat, and habitat for rattan.

Although community activities utilizing peat swamp forests during the pandemic were not affected due to the COVID-19 pandemic. Still, the real impact was felt on the marketing of forest products, fish, craft materials, which experienced a decline in demand and fluctuating prices. On the other hand, the COVID-19 pandemic has also triggered local people to utilize medicinal plants with high demand and
price. The two most frequently used species are *sungkai* and *limpasu* fruit. In addition, the pandemic condition has also created much demand for traditional medicines that are purchased at reasonable prices.

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