Peat swamp forest-fires impacts on local livelihoods: a case study in Kapuas Kahayan Protected Forest Management Unit, Central Kalimantan, Indonesia

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Abstract. Peat swamp forests have received great global attention in the last few decades because of their carbon stock, which is closely related to climate change and global warming. In addition to the global role of peat swamp forests in climate change and carbon storage, peat swamp forests also have some social and economic functions because of their great contribution to the livelihoods of local people. In Central Kalimantan, peat swamp forests have been experiencing a massive degradation mainly due to fires. This study aims to describe the utilization of peat swamp forests and the impacts of peat-swamp-forest fires on local people’s livelihoods in Central Kalimantan. The research was conducted by interviewing local communities around the area, then the data were analyzed qualitatively. The study result shows that there are 8 utilization activities related to livelihoods by local people on peat swamp forest i.e. logging; gathering rattan, orchid, medicinal plants, grasses and epiphytes, damar, gemor (tree bark); fishing and hunting; freshwater utilization, foods gathering, sacred spots for local belief, and traditional agriculture. Overall, forest fires have significantly negative impacts on local livelihoods as fires cause the loss of biodiversity and decrease the quality of ecosystem services. These losses lead to the disappearance of income and food sources for local people. However, there are also some small advantages or positive impacts of forest fires i.e higher production of fish after forest fires, and more jobs in forest rangers and land rehabilitation from both government and non-government organizations.

1. Introduction, problem statement, and study purpose
In Indonesia, the largest peatland is in Riau province with an area of 3,867,413 or 60% of total peatland on Sumatra Island, while on Kalimantan Island, the largest peatland is located in Central Kalimantan with an area of 2,659,234 or 56% of the total area of peatlands in Borneo Island [1] while in central Kalimantan, peatland can be found mostly as peat swamp forest [2]. During the two last decades, there is an significant increase of forest fire frequency because of rapid-land use change and climatic condition and the remaining peat swamp forests are also under pressure from land
conversion, illegal logging and traditional agriculture [1,3]. Peat swamp forests have some vital roles for human life with various benefits on ecological, economic, and socio-cultural aspects. Specifically, peat swamp forests are becoming very important globally because of the high content of carbon deposits [4] which means they are related to global carbon emissions if burned [5], as well as high biodiversity of flora and fauna including various endemic, rare and endangered species [6], and as a source of livelihoods for local communities [7] because they produce a variety of forest-ecosystem services, timber products, and non-timber forest products [8,9]. Kapuas Kahayan Protected Forest Management Unit is located in Central Kalimantan that covers an area of 105,372 ha of which is 95% is peatland and swamp forest [10]. This location includes a forest area that was a failed 1 million mega-rice project in 1995.

Although forest degradation and deforestation have been the main problems in this area, at the same time, the forest area is also a vital ecosystem for local people as their livelihoods mostly depend on peat swamp forest. Local people, known as Dayak Ngaju tribe, are native people who utilize peat swamp forests to fulfill their daily needs as well as a source of income. Even though peat swamp forests provide benefits in the form of forest products and ecosystem services, for the local people, forest products are more important because of their benefit directly into their livelihoods. In global scope, forest have a strong relationship with local people livelihood, especially in developing countries because forests support livelihoods of a vast number of people through subsistence use of products such as food, fooders, and medicinal plants [11]. The utilization of forest has been the essential part of humankind as they have a strong dependent on forest product such as flora (leaves, fruits, roots, and resins) and fauna to fulfill their needs [12]. However, these livelihoods are under the threats because of forest fires as there is about 2,2% rate of deforestation because of forest fires in peat swamp forest ecosystems [13].

Recently, most of the studies on peatland forest and peat-swamp forest aimed to describe the fire’s impacts on carbon stock [2], gas emission [1,2,5,9], water and hydrology [24,25], degradation [3,20], and biodiversity [16,18], while forest fire’s impacts on local livelihoods are very less in number especially for Dayak Ngaju, indigenous ethnic group who live in and close to the area of peat-swamp forests and utilize the forest products and ecosystem services for generations.

This study aims to: 1. Describe the utilization of peat swamp forest. 2. Compare the livelihood-related activities by local people in primary forest and burned forest areas. The study is important for the peat swamp forest management, as the local people is the integrated part of it.

2. Research Location

The study was conducted in the Kapuas Kahayan Protected Forest Management Unit in Kapuas Regency, Central Kalimantan Indonesia. This protected forest is one of unique ecosystem of peat swamp forest in Indonesia, which consists of 80,374.55 ha of very deep peatland or 76% of total 103,572 hectares area.

In another side, this protected forest have been experiencing several forest fires since the 1990-s until now. These fires, alongside with other causes such as land conversions and drought, have been degrading the area to an awful ecosystem quality with more than 84,742.01 critically-degraded land. The location can be found at figure 1 below.
For the data and information of this study, we have interviewed local people from 9 villages close to the area who have been utilizing forest and forest products for their livelihoods. The census method was used to pick every villager who entered the locations, as there were only two water-entrances to this area: the Mantangai river and the MuaraMangkutup river.

3. Method and Data Analysis

This study is a qualitative study, where the data and information were collected by a deep interview with villagers who have been working in the area for their livelihoods. As the ‘entry point’ to the area only in 4 spots: Mantangai River and MuaraMangkutup. We focused on these spots where census method was carried out for everyone who passed the spots to the Kapuas Kahayan Protected FMU. For triangulation purposes, we also had a deep interview with head of Kapuas Kahayan Forest Management unit and his staffs, BOS Foundation staff and two customary leaders of Dayak Ngaju from Mantangai Hulu and Katunjung.

Data and information were analyzed by these steps: prepare a list of questions, conduct a deep interview with information sources and an observation, data and information triangulation, categorize the data and information, identify the patterns of utilization and make connections between forest fires and livelihood, interpret the data and explain findings.

4. Result and Discussion

4.1. The utilization of peat swamp forest by local people

Based on our findings, the areas of protected forest management unit are utilized not only by local people who live in 9 villages closed to the area but there are also some people live far away from location, especially for collection some non-timber forest products.

For the first step, the list of utilization by local people was made from the study result in the table 1 below:
The utilization of peat swamp forest has been the part of local livelihoods for generations. They utilize both forest products and ecosystem services. Although the forest products can be categorized as the sources of direct income for local people, the ecosystem services are also important things for their daily lives. Silvius and Diemont [7] have also stated that peatland forest is essential for local livelihoods, while Suwarno [14] suggested that ecosystem service is the factor that should be considered carefully in the management of peat swamp forest as conservation/protected area. In general, forests have been supporting local livelihoods for the generations through subsistence use of forest products [11] and everything to fulfill local people’s need in any aspect [12, 28]. However, our research has found that local people utilized both forest products and ecosystem services in almost equal proportion, a bit contrast with the utilization of another forest in Indonesia, where the forest products in main sources for local livelihoods.

Logging or timber harvesting was the main source of income for the local people until the 1990-s, this timber collecting activity is one of major drivers of peatland degradation and deforestation in the area [2]. In fact, since the 2000-s, logging is forbidden activity by Indonesia law as the area is reserved for conservation purposes and protected area. However, community logging on a small scale is still found in this area although it was not the main source for their livelihoods anymore.

The biggest income for local people, known as Dayak Ngajuethnic group, is obtained from the collection of non-timber forest products. Tropical peat swamp forest has lower biodiversity than any tropical forest types, but it has the richest biodiversity among the peatland forest types in the world as the location of areas is in tropical regions [15,16]. The biodiversity of non-timber forest products of peat swamp forests is a blessing for local livelihoods because of its huge contribution to their total income. The collection of non-timber forest products does not get legal constraints, because it is permitted by the government even in protected forests, as long as it does not damage the ecosystem as a whole. Rattan is a high economic value forest product. This type of swampy peat forest is a fertile growing-habitat for rattan and becomes the most important non-timber forest product [17].

Important ecosystem services from peat swamp forests is habitat for various types of freshwater fish. Fishing is one of the biggest sources of income for Dayak people around and within the Kapuas Kahayan FMU area. Apart from being a source of income, fishing is also an effort to fulfill household needs, especially as a source of protein for families that can be consumed fresh or traditionally preserved [1]. Fish is not categorized as a “forest products”, but it is a products of forest ecosystem services as a habitat for wildlife including fish and other water-animals.

Large-animal hunting is also still carried out by the community to fulfill their family needs. There are animals which are important for local people’s hunting i.e. wild boar, deer, freshwater turtles and various types of birds. Animals from hunting are used more for family consumption, but it is very useful to reduce family expenses to buy meat and other food ingredients. In peat swamp forest,

Table 1. Several forms of utilization of forest products and ecosystem services

| No | Utilizations related to livelihoods | Categories |
|----|-----------------------------------|------------|
| 1  | Logging (forest timber)           | Forest product |
| 2  | Gathering rattan, orchid, medicinal plants, grasses and epiphytes, damar, and gemor (tree bark) | Forest product |
| 3  | Fishing and Hunting               | Forest products and Ecosystem services |
| 4  | Freshwater collection             | Ecosystem services |
| 5  | Foods gathering                   | Fruits, vegetables, and mushroom |
| 7  | Sacred sport for local believe    | Ecosystem services |
| 8  | Traditional agriculture           | Ecosystem services |

Source: Primary data from research
avifauna is more familiar to be found and consumed by local people because of their high biodiversity [18].

Freshwater is also a product used by the community, especially in the dry season. Some main rivers as the main resources for freshwater for local community are on lowest water quality during the dry season, and rivers on peat swamp forest would be the alternative for water sources. Although freshwater is not for sale and influences local people’s income, water availability is an essential thing to avoid more expenses for freshwater.

Peat swamp forests are also the habitat various types of vegetables, fruits and mushrooms. The most important vegetable in peat swamp forest is kalakai, a species of red fern, which is available everyday. Local people collect this vegetable both for their consumption and for sale. Green fern and red rattan are the other vegetables could be found in the peat swamp forests. Unfortunately, peat swamp forest is not a habitat with a rich variety of fruit-tree species. There are only limited species of fruits in peatland forest such as wild mangosteen, wild lyceee, swamp berries and many more, which are mostly for family-consumption only. Utilization of forest as the food source is a common thing in developing country, especially for the local people who live close to the forest areas. For millennia, forests have provided humankind with a wide variety of crucial goods and ecosystem services: as traditionally agricultural land, global climate regulator, timber forest products, sacred grove, and the primary raw materials used in local households. Although timber has assumed a dominant position among forest resources over the last century and for most of human history [19] Globally, forest ecosystems provide some forest products other than timber products as it fed, clothed, and sheltered the ancestors. These included aromatic spices, fruits, roots, seeds, nuts, barks, fungi, resins, feathers, bushmeat, fibers, and leaves [12] however, in peatland forest the biodiversity is lower than in other types of other forests [16] but peat swamp forest areas are still the crucial part for local livelihoods.

The Dayak Ngaju community, as the local people, has a local religion, namely Hindu Kaharingan. The community believe that certain places have to be reserved for sacred places, usually at the meeting point of two tributaries or in the largest and deepest lakes in peat swamp forest areas. Although this aspect has no direct impact on their livelihoods, local people will take care the area in more sustainable ways where the sacred spots are located. This condition lead peat swamp forest to be a low degradation rate with high-quality forest products.

Farming is a traditional agricultural practiced by the Dayak Ngaju people from generation to generation, most of them make some traditional garden, tana, close to their settlements or in the border with protected forest areas, but quite a lot are located in protected forests. Their traditional agriculture has been practicing since hundreds of years ago, when the area was not categorized as protected forest by government. In some cases, traditional agriculture practice or slash-burn method is one of the causes of peatland degradation in the location [20].

4.2. Comparison of Activities before and after forest fires on local livelihoods
We have analyzed the comparison activities between before and post peat swamp forest fires which can be seen on table 2.

**Table 2. Comparison of Activities before and after forest fires on local livelihoods**

| No | Utilizations of Peat swamp forest related | Primary Peatland Forest post fires | Degraded Peatland Forest post fires |
|----|------------------------------------------|-----------------------------------|-----------------------------------|
| 1  | Traditional Agriculture                   | - Slash-Burn Method               | - Slash-burn method               |
|    |                                          | - Small scale because of limited access | - Semi-modern agriculture (paddy field) |
|    |                                          | - Traditional method              | - Open access more extensive      |
|    |                                          |                                   | - Lead to many conflicts          |
|    |                                          |                                   | because of conservation area status |
| 2  | Logging                                  | - Mostly illegal logging          | - Open access to the new area of primary forest |
|    |                                          | - Small volume with traditional logging method | - Loss of timber products          |
|    |                                          | - For household need               |                                   |
|    |                                          | - For trading for local timber factory |                                   |
| 3  | Collecting Non-timber Forest Products   | - Rattan                          | bushes and grasses for            |
|    |                                          | - Damar                           | handicrafts                       |
|    |                                          | - Jelutung                        |                                   |
|    |                                          | - Eaglewood                       |                                   |
|    |                                          | - *Kakitau*                       |                                   |
|    |                                          | - *Kalanis*                       |                                   |
| 4  | Foods                                    | - Umbut                           | *Kalakai*                        |
|    |                                          | - Kalakai                         | *Pakis*                          |
|    |                                          | - Pakis                           | *Less mushroom*                   |
|    |                                          | - Mushroom                        |                                   |
| 5  | Fishing and traditional fishery         | - Mostly in the dry season        | - More locations to be accessed because of forest fires |
|    |                                          | - Main sources of local income    | - Higher-income                   |
|    |                                          | - For household consumption food in long term period | - Low income in flooding season |
| 6  | Hunting                                  | Deer                              | No more animal in burned area     |
|    |                                          | Boar                              |                                   |
|    |                                          | Birds                             |                                   |
|    |                                          | Mammals                           |                                   |
| 7  | Medicinal Plants                        | More than 10 species of medicinal plants | Less than 4 species of medicinal plants in degraded-burned areas |
| 8  | Freshwater                               | Good quality                      | Low quality during the dry season |
| 9  | Rehabilitation job                      | No Job                            | Some jobs from government         |
and some NGOs

Our research is to explore how changes in community activity relate to their livelihoods when utilizing primary peat swamp forests and burned peat swamp forests, as well as describing how they impact livelihoods.

Peat swamp forests and peatlands have long been used by local communities to make ends meet by doing traditional farming. This traditional agriculture is known as slash-and-burn farming [20] and has been known as one of the drivers for the degradation of peatlands. Of course, local people will choose the area which is suitable for the local crops, for example the thin-peatland to grow local rice. In addition to self-consumption, these agricultural products are also sold as a source of income, however, the main objective is to fulfill their own needs. In the 2nd and 3rd year when the land is infertile for seasonal crops, the local people plant annual crops such as rubber trees, jelutung and sengon. Most of local people who utilize peat swamp forest and its products are the poor segment of the community. Angelsen [21] stated that the poor rely more heavily on subsistence products such as wood fuels and wild food.

Forest and land fires on the one hand also have a positive impact on the community because they can conduct traditional farming without having to cut and burn themselves, but on the other hand the forest and land fires on peatlands are very feared by the community because the fires are very difficult to extinguish, so they will burn their gardens which have been kept for years, for example, rubber trees plantation, sengon gardens and rattan plantation.

Logging or timber collection is usually done by local communities, usually with small scale and simple equipment. Logging is usually carried out in the rainy season when the water is deep so that the felling wood can be carried by being pulled floating above the water surface. Wood is usually collected in small quantities and for its own purposes, however wood is still found illegally collected. Forest fires have a negative impact, namely the loss of timber that should be cut down, including the death of young trees, which stops the natural regeneration process in the peat swamp forest. On the other hand, forest fires also increase people's access to the forest in search of large trees with high economic value, but now the community is also limited by rules regarding the status of the area included in protected forests. The lack of socialization of law and regulations on peatland forest, including timber regulation, is one of Indonesia weaknesses on peatland forest management [22]. In the same time, it is undoubtable that forest products are more important for poorer segment of local people [23].

The most important part is the collection of non-timber forest products. Non-timber forest products are forest products that make the most contribution to the income of local communities. The collection of non-timber forest products is the most favored by the community because it is not legally prohibited for the use of block areas in protected forests. There are several types of non-timber forest products that have high economic value, namely rattan, resin, gemor, jelutung latex, eagle wood, Katiau and Kalanis. The type most often collected by local people is gemor, rattan and jelutung sap. Forest fire is feared by the community because it has a very negative impact, considering that this type of non-timber forest product is very prone to death when a fire occurs. The impact is economically very detrimental because it removes a very important source of income for the local community. Rattan is the most important non-timber forest products (NTFP) in Indonesia [17], and this forest product also recommended as a form of economic development for local people in Kapuas Kahayan because of its high economic value and ecological suitability [14].

Peat swamp forest ecosystems are very unique ecosystems. When in the rainy season, the forest floor is always flooded with black water, so it is often called a swamp, while in the dry season, the forest floor becomes dry and puddles are concentrated at certain points. Fish in peat swamp forests can
indeed be collected throughout the year, but fish production will greatly increase during the dry season. Many local people depend their livelihood on selling fish, shrimp and other aquatic animals.

The price of fish is indeed cheaper in the dry season because the supplies are abundant in the market, but local people use their local wisdom such as raising fish in cages until fish prices improve, or processing fish into salted fish, crackers, and various processed foods that are durable for longer period.

On one side, forest fires are very detrimental, but in certain year, peat swamp forest fires actually increase fish production in the dry season, because of the access to get a pool where more fish are collected due to open space. But this increase of fish production does not always occur, in certain year fish production also decreases because the forest is burned down and less fish breed in the rainy season

Hunting is also an activity that has a direct negative impact from the forest fires. Fires cause some damages and habitat loss of animal and lead to a great decrease of animal population in the area. There are some species of animal which are categorized as animal for hunting by local people i.e. wild boar, deer, various species of birds, water turtles, snakes, monitor lizards and various species of primates and water animal. Although it does not have a large contribution to the total income of the community, hunting activities are very important for household needs in terms of meeting the need for protein sources. The fauna biodiversity has been a source for many purposes such as protein sources and income for local people close to the area of peat swamp forest [7, 16, 21]

One characteristic of Dayak Ngajuas local people is that they use forests as the main source for medicinal plants. There are more than 10 species of medicinal plants used, to threat various types of diseases. Fire events eliminate many species of medicinal plants that can only grow in forested areas, which are only 3 species left, namely karamunting, hiring, and tatunjuklangit. Medicinal plants are one source of community income because of high demand for medicinal plants from the nearest city. Collection and processing of medicinal plants is usually done by women, and it is very important to be preserved. In many developing countries of many regions in the world, forests are always related to family income in the areas. There is some empirical and quantitative knowledge of study on forest-livelihood relationship [11].

Forest fires also harm the quality of peat water in the dry season, even though the water in peat swamp forests is used by the community as drinking water because it is much larger than the river near the house. Residues from the litters that is burned and carried by air into the water will reduce the quality of drinking water, and at certain times are also not suitable for consumption. In peat swamps forest, hydrology and ecology have a strong relationship with each other [24,25], and both influence the economic value of forest products and ecosystem services. Forest fires also hurt the quality of peat water in the dry season as water in peat swamp forests is consumed by the local people for drink-water because it is far better than water from the main river near their house. Residues from litter that are burned and carried by air into the water will reduce the quality of drinking water, and at certain times are also not suitable for consumption. Water is a product from ecosystem services of peatland forest, these ecosystem services is important part of conservation planning for peat swamp forest especially for conservation areas [14]. When the quality of water is low, local people will have to allocate additional costs to obtain freshwater for their daily lives. This expenditure will reduce the amount of money in each family and influence their livelihoods as well.

Forest and peatland fires are occurrences that continue to occur from the 1990s, when the biggest fire incident in the area in 1997 and continues to this day in the long dry season. As the area is bordering the ex-one million hectares mega rice-project, the potential for fires is even greater because canals have been built in the areas and reduce the peat water level and water table [20]. The occurrence of repeated fires and a large number of abandoned ex-forest fires has made the world's attention through NGOs and the government even greater. Many programs and projects carried out mainly related to fire prevention and control as well as rehabilitation for burned-critical land. These programs give more job opportunities for the local people, for example: job small dams construction,
seedling production, planting, forest ranger, fire patrol. Unfortunately, these jobs are limited in number, and do not accommodate all local people in the areas who need work as a source of income [28]. It is not a surprising thing that forest landscape restoration is linking to livelihood and well-being income [26], however, in this area the number of people participating in these restoration and fire-protection is not significant to the total number of households. The lack of clarity about ‘fire problems’ led to the adoption of policies that may have negative impacts on local livelihoods, the regional environment, and the economy [27].

5. Conclusion
There are some conclusions of the study:
1. The local people of Kapuas Kahayan Forest Management unit di Kapuas Regency, known as Dayak Ngaju, have been utilizing both forest products and ecosystem service of peat swamp forest for generations. Mostly local people live in 8 villages close to the area, but there some small group of people from farther villages who also have some livelihood-related activities in Kapuas Kahayan FMU area. There are 8 utilization activities related to livelihoods by local people on peat swamp forest in Kapuas Kahayan FMU i.e. 
   - Logging (forest timber);
   - Gathering rattan, orchid, medicinal plants, grass and epiphytes, damar, gemor (tree bark), and grass;
   - Fishing and hunting, freshwater collection, sacred spot, and traditional agriculture.
2. Overall, forest fires have significantly negative impacts in local livelihoods as fires cause the loss of biodiversity both timber and non-timber forest products and decrease the quality of ecosystem services. This loss lead to the disappearance of income and food sources for local people. Forest fire is also the biggest threat for their traditional agriculture system. There are also some small advantages or positive impacts of forest fires in peat swamp forest i.e. higher production of fish post forest-fires, and more jobs in forest ranger and land rehabilitation from both government and non-governmental organization. However, these advantages in total do not raise all local people income significantly.

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