Out of fire disaster: dynamics of livelihood strategies of rural community on peatland use and management

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Abstract. Rural community in peatland is less concerned actor during the recurrent fire disaster. This disaster has already diminished the source of livelihoods. There is limited information about the dynamics of the livelihoods related to the use of fire in peatland. This paper examines the dynamics of rural livelihoods and the adaptation livelihoods strategies in degraded peatland. Data are collected by field survey, in-depth interview, focus group discussion in three villages at Riau Province and they are analyzed descriptively. Peatland is the only remaining important resource for the rural people after fire disaster. They will select prospective commodities based on their capabilities and access to market. Rural community are more intensive in using the resource of peatland for their livelihoods with the growing interest to several commodities. Recent community livelihoods depend on some certain commodities (palm oil, areca nut, rubber) and tend to conduct expansive and monoculture land use strategy rather than polyculture strategy. Diversification livelihood with adaptive and valuable commodities through trainings, continuous coaching and building business.

1. Introduction

Recurrent forest and land fire in Indonesia has become one of the main challenges in sustainable forest and land management. In many cases, extensive fires turn to be disaster that causes negative impact to human and ecosystem. The last big fires incident in 2015 caused problem of health, economy and environmental [1–3]. Estimated carbon emission from 2015 fires in Indonesia were 0.89 gigatons carbon dioxide equivalents (Gt CO_2e) [4]. Economic loss from this fire were around US$ 16,1 million dollar and affected various sector such as agriculture, forestry, transportation, tourism, trading, health, education and also the expense for fire suppression and rehabilitation [1]. Big forest fire has occurred in at least 8 provinces in 3 islands, Sumatra, Kalimantan and Papua but the haze affects regional areas in South East Asia [2] . Fires have become trans-boundary haze problem in this region and Indonesia has facing internal and external problems to deal with.

Fires occurs not only in mineral soil but also in peatland. Estimated burnt areas in 2015 reached 2.6 million hectares and 33% of the areas were in peatland [1]. Tropical peatland in Indonesia has become the main contributor for the carbon emission from fires [2–4] . Fires in the peatland can cause severer damage to the ecosystem and loss livelihood of the people. Fire in the peatland is one of some causes of tropical peatland degradation and deforestation [3,5,6]. The use of fire for land preparation in peatland is the common and cheapest way for all land users. Fire in land preparation is the effective way for crop management [7,8]. This way is followed by building canals for drying the peatland and directly will increase the susceptibility of peatland to fires. Peatland conversion into other land use also can trigger fires in the area and contributes to the degradation and deforestation [5,9]. This is justified that human activities are the dominant cause of fire disaster in Indonesia [1,3,10].

For rural community, peatland and mineral land are important resources for their livelihoods. The commodities are already cultivated in the mineral land that will be adopted in the peatland to increase the benefits of the land for better livelihoods. In case of peatland, rural smallholders are key stakeholders with high dependency to the peatland ecosystem but the improvement of their sustainable livelihood has less attention [11]. Therefore, this paper highlights the livelihood of rural people in peatland and its dynamic. Hopefully this paper can enrich information in providing various livelihood strategies and potential alternative livelihoods to minimize peatland fires.

2. Methodology

2.1. Research sites

This research is conducted in 4 villages at 3 districts which have extensive peatland in Riau Province. Riau is one of the provinces in Indonesia that have large peatland and experienced big fire in 2015. Indragiri Hilir, Indragiri Hulu and Pelalawan are the districts that have extensive peatland in Riau, more than 200,000 ha for each district [12]. Selected villages for this research are Teluk Meranti (Pelalawan district), Tanjung Sari (Indragiri Hulu district), Bayas Jaya and Simpang Gaung (Indragiri Hilir district). All of the villages area are dominated by peatland and there are more intensive use of peatland by community.

2.2. Data collection and analysis

Concept of rural livelihood [13,14] is applied in this research to investigate the dynamic of the rural livelihood in peat land, livelihood of people related with their resource and capabilities. Dynamic of their livelihood and their available assets are affected trends, shocks and seasonality [14]. To response to these situations, people will implement possible livelihood strategies to survive and to continue their livelihood under certain circumstances [13].

We conducted three activities for collecting data in this research during the year of 2016-2017. First, we collected supporting documents from each village related with demography, general description of land use, overview of public facilities, information of local economic activities, access to the village and general description of development program. Group discussion with representative village administrative staffs and local actors was then also conducted to find out more deep information. This event is also a part of building network and communication with the representative stakeholders in each village. In the discussion, appropriate representative local actors for more in-depth interview are also conducted. The second step, key informants interview to the 6-10 persons in each village from various background is also implemented. These key informants are representatives of the village administrative staffs, religious leaders, farmer groups, businessmen, women groups and, youth activists. Third step, household survey in each village is conducted to find more information related with the livelihood. Finally, data and information are analyzed descriptively and qualitatively.

3. Result and Discussion

3.1. Sites characteristic

This research takes place on 4 villages around the peat land area in Riau province. The type of the village is divided into local and transmigration village based on the initial development of the

settlement. The local village belongs to the community that has already existed for generations in the area and is usually dominated by *Melayu* ethnic. Transmigration village defines to the village developed by the government transmigration program in 1980-1990 and usually is dominated by *Java* ethnic. Those villages have both mineral and peatland as resources for their livelihood activities. Previously, all area in the transmigrant villages, Tanjung Sari and Bayas Jaya, were peatland [15]. Agricultural activities that are applied on shallow peat land by building canals have slowly eroded and depleted the peat layer in these villages. In Teluk Meranti and Simpang Gaung, the small area of mineral land is located in the edge of the river. Public facilities in local and transmigrant village are relatively similar in general. The position of Teluk Meranti as sub-district area makes this village has more public facilities and service compared to other villages. General description of the sites [15] is summarized in the following table.

Table 1. General description of the sites

No.	Site characteristic	Teluk Meranti	Tanjung Sari	Bayas Jaya	Simpang Gaung
1.	Type of village	Local	Transmigration	Transmigration	Local
2.	Accessibility	Difficult	Relatively easy	Easy	Difficult
3.	Main access of transportation	Car	Car and crossing raft	Car	Boat
4.	Distant to capital district (km)	140	25	70	85
5.	Population in 2016	3,363	1,543	2,704	6,551
6.	Number of households	1,027	437	887	1528
7.	Public facilities	Schools, health service, traditional market, mosque, agricultural service office, police & army service, sub-district administrative office & service	Schools (elementary), heath service, mosque	Schools, health service, traditional market, mosque, bank, police service	Schools, health service, traditional market, mosque

Accessibility to each site is categorized by availability of facilities to reach the village and the distant to the main road. Teluk Meranti village is located around 100 km from the main road of trans Sumatra and some parts of the road have not been paved, difficult to access. To reach Tanjung Sari village, it is around 2 km away from the main provincial road Rengat-Tembilahan and continue crossing a river by a craft. There is no bridges to connect the road. This craft has limited the mobility of the people to the village. Bayas Jaya village is on the edge of the main road of Rengat-Tembilahan and the easiest site to access among other villages. The most difficult site to access is Simpang Gaung village. It needs 2.5 hours travel by boat from Tembilahan. Alternative access to this village is using motorcycle to pass palm oil plantation, dirty and muddy road for about 2.5-3 hours.

3.2. Livelihood of respondents

There are 129 respondents from 4 villages in this research. Number of respondents in each village is presented in the following table. Age of respondents in average is in productive age, between 15-64 years old. There are only 8 respondents in 3 villages exceed the productive age. Even all of respondents in Simpang Gaung village are in productive age. Majority respondents in this research

(65%) are in the age between 35-54 years and 94% of respondents in productive age. Their level of education is majority elementary school respondents (52%).

Table 2. Characteristic of respondents

No.	Respondents characteristic	Teluk Meranti	Tanjung Sari	Bayas Jaya	Simpang Gaung
1.	Number of respondents (head of household/HH)	32	31	32	34
2.	Age (years)				
	- Average	50.1	43.7	46.5	43.6
	- minimum	33	29	27	27
	- maximum	72	87	79	63
3.	Level of education (persons)				
	- no school	2	5	3	3
	- elementary	18	16	17	17
	- junior high	2	3	8	11
	- senior	9	6	3	2
	- college	1	1	1	1
4.	Average number of family member	4	3	4	5
5.	Source of livelihood (persons)				
	- off-farm	4	0	4	3
	- on-farm	9	15	15	14
	- on & off-farm	19	16	13	17

In all villages, majority respondents depend on both on-farm and off-farm as source of livelihood. The on-farm activities of the respondents are related with cultivating agricultural commodities, cultivating plantation crops, labor farm, and few of them are fishermen and cattlemen. While the off-farm activities are trading, grocery stalls, employee (civil service, company employee), service worker (driver, teacher, tailor, mechanic). Availability of the land is relatively sufficient for respondents to choose their livelihoods from on-farm activities compared to off-farm activities. On-farm activity is the basic livelihood activities of majority villagers in all sites. There are less respondents (8.5%) who depend their livelihood only from off-farm activities, such as trader and working in service sector that earn regular monthly income. Because of the limited resource, these respondents focused on their off-farm activities for their livelihood recently. In the future, these respondents can possibly change their livelihood to both on-farm and off-farm because of the dynamic of the ability to access the resource.

Dual source or multiple source of income is general condition to obtain better livelihoods. Conducting off-farm and on-farm activities are parts of livelihood strategy for diversification source of income [13] [16] for rural people. Availability of time and capability of the resource allow people to conduct dual sources of livelihood. It also depends on the discussion at household level based on respondents' argument. Dual source of income is also carried out by respondents because income from single source is not sufficient for their living needs and as a response in the face of stress and shock condition. Frequently, off farm activities are also carried out to finance on-farm activities that are being carried out.

3.3. Land holding and land use

In general, land holding of respondents vary from zero (in Teluk Meranti and Bayas Jaya) until 33 ha/household (in Tanjung Sari). The largest land holding in average occurs in Tanjung Sari village and

the smallest is in Bayas Jaya. Both are transmigration village but they have different land holding in average. Land expansion done by people in Bayas Jaya is limited by the narrow area of the village which is also surrounded by other village areas. Whereas in Tanjung Sari, there are production forest areas which are targeted by the people for land expansion. In those two transmigration villages, there are more parcels land already have certificate of ownership fom The National Land Agency, respectively, 70% in Tanjung Sari and 26.67% in Bayas Jaya. Whereas in local villages, there are only 18% parcels land in Teluk Meranti who has been stated as certificate of land ownership from The National Land Agency but none in Simpang Gaung. The rest of the parcels of the land have land information letter from sub-district head, village head, hamlet head or other kind of statement letter. These kind of legality are still questioned because the land, including the smallholder plantations, potentially in state forest area which can raise conflict. These situation can be found in Teluk Meranti, Tanjung Sari and Simpang Gaung which are directly adjacent to state forest area. Although the people's livelihoods are dominated by on-farm activity, there are some people who do not have land to cultivate but they are still conducting on-farm activities in the other land which belong to other people. They have the access to the land through an agreement to utilize the land with the land owner by land rent agreement, land pawn, or share cropping scheme. In cultivating the land, respondents in average cultivate around 2 to 3 plots with commercial commodities. The wider span plot of land that is cultivated, from minimum to maximum, found in Tanjung Sari and Simpang Gaung. Land is an important asset for rural people livelihood in the area, and the more land they owned the more livelihood security they will obtain. It also shows the dynamic of peatland as more important target for land expansion and investment.

Table 3. Land holding and land use for livelihoods

No.	Items	Teluk Meranti	Tanjung Sari	Bayas Jaya	Simpang Gaung
1.	Land holding (ha/HH)				
	- average	3.75	5.18	2.08	2.64
	- minimum	0	0.25	0	0
	- maximum	14	33	5.5	29
2.	No have land holding (respondent)	5	0	6	11
3.	Plot of land cultivated				
	- Average	2	3	2	2
	- minimum	1	1	1	1
	- maximum	4	11	4	11
4.	Land use type (%)				
	- home yard	0	12	13	8
	- agriculture	2	32	32	2
	- fish pond	0	1	0	0
	- shrub	2	3	0	5
	- timber crops	0	0	2	0
	- plantation crops	96	52	53	85

Land use in all villages is dominated by plantation crops. In Riau, plantation is a dominant land use on peatland [17]. Palm oil (*Elaeis guineensis*) is dominant plantation crop that could be found in all sites. Teluk Meranti and Tanjung Sari started to develop palm oil in the late 1990's. In Bayas Jaya, palm oil began to cultivate by the villager in 2004/2005 and in Simpang Gaung it just cultivated in

2012/2013. Relatively, palm oil is a new commodity in all villages but in a short time this commodity is adopted widely by rural people for peatland use.

In transmigrant village, land use for agriculture activities are the second importand land use after plantation. Paddy field is the important agriculture activity in transmigrant village and it was initial peatland use developed by government with the transmigration program. Majority of transmigrants had already practiced paddy field activity as a part of their livelihood previously in Java before coming the the transmigrant area. Developing paddy field in their new area of transmigration become a part of approaches to make them able to continue paddy farming as a part of livelihood strategies in a new place.

3.4. Use of fire in crop management

Use of fire in land management relates to the dynamic of rural community livelihood in Indonesia. Fire usually connects to the history and dynamic of small-scale farming in Indonesia [18]. It has already known that fire is the main tool for land clearing by various stakeholders [7,8]. In these research sites, fire is the main way for the community in land clearing because it is considered an effective and efficient way of land clearing. Social community can lower their cost of crop management with the use of fire in land clearing both in mineral land and peatland. All of the communities believe that burning the land at the initial process of crop management can improve the soil nutrient. People in Teluk Meranti community are accustomed to burning the land before growing maize because this can reduce the use of fertilizer. Burning land also can reduce the risk of pest and disease in growing the crops. For the community in all research sites, burning the land is one of the important factors in the success of growing crops in peatland. Without burning the land, they believe the risk of failure will be greater.

At the field level, the communities have already knowledgeable the technique of burning land for land clearing. They have already been practicing it for years with carefull technique and strict control. To avoid spreading fire, the communities are burning the land in group with clear firebreaks surrounding the land. They know the appropriate situation to ignite the fire and control the fire in the land. In local village, there is a set of sanctions for people who can not control the fire and cause fire disaster surrounding the land. This rule is a kind of convention in the village which has a long history in crop management, such as in Teluk Meranti and Simpang Gaung. In both villages, fire disaster caused by burning land rarely occur when there exist more forested area and peatland is relatively wet in dry season. In transmigration village, comunity learn and adopt burning land technique from the local people. The condition of land in this village is degraded from the initial process of building canals for the drainage of the land for crop management. The canals make the land drying and it is susceptible to fire in dry season. The use of fire is an ultimate choice for transmigrants in land clearing but unfortunately this increases the risk of recurrent fire disaster with more extensive peatland use.

Local knowledge in control land burning has not been working well with the recurrent fire disaster occurs in all research sites and it is related with the change in peatland condition. Recurrent peatland and forest fire disasters occur in all research sites along with the peatland degradation and the extensive and intensive uses of peatland. In 2015, all of the research sites were experienced big fire disaster that loss the people's livelihoods, including their plantation. Massive illegal logging in peatland forest around the research sites has contributed to the peatland degradation and land cover change from forested area into shrub area which is more susceptible to fire. Road development at Teluk Meranti in 2004 encourage more local people and migrants to use fire for land clearing for growing palm oil in peatland. Not only in Teluk Meranti, degraded peatland is also the main target for extensive plantation by smallholder and corporation in the rest research sites. Drainage of the peatland through building canals cause the change of peatland ecosystem from naturally wet into dry and degraded peatland. This situation is corroborated with more people use of fire for land clearing in larger area and fire disaster has been inevitable in all research sites.

Fire is still the main problem for peatland management during dry season at field level. Although the fire disaster has caused losses of assets to the people, the use of fire is still the main tool in land

clearing. The comunity in all research sites may potentially continue burning the land as they have no better alternatives in effective and efficient land clearing. This is the rational choice for them despite fire ban regulation has been implemented since the end of 2015. Beyond this, fire is not only a technical matter but also relates to social, economy and political circumstances of the peatland. Fire is a part of processes in land tenure conflict, added value of the land transactions and it is involving many interests and stakeholders [19]. The community realize and agree that fire suppression, especially in peatland, is not effective in combating fire. In this situation, fire prevention policy and program will be more appropriate to deal with the fire. These include in dealing with the effective and efficient zero burning techniques for land clearing.

3.5. Dynamic rural livelihoods: variation of commodities

Palm oil has become a main commodity from the peatland in Teluk Meranti, Bayas Jaya and Tanjung Sari. In Teluk Meranti, palm oil is one of the important commodities for the livelihood and even it surpasses the popularity of rubber. Businesses related to palm oil, from seeds trading to marketing the palm oil fruit, are growing in Bayas Jaya. The growing interest in planting palm oil also occurs in Tanjung Sari village. The existence of some processed palm oil factory around the villages affect relatively stable price, the growing of market and less intensive crop management. These all encourage more people to grow palm oil as lucrative commodity.

Rubber (*Hevea brasiliensis*) is another plantation crop that is traditionally planted by smallholder farmer. It has become important commodity in Teluk Meranti, Tanjung Sari and Bayas Jaya. Usually, rubber is planted in mineral soil but more people also adopt and grow this commodity in the peatland [22]. This commodity is usually cultivated monoculture in peatland which is preceded with digging ditch to build drainage cannal for the peatland. In Teluk Meranti, rubber has already been known more than 40 years and initially it was planted at mineral land, near the river. Limited available mineral land encourage villager to plant rubber in peatland and it has grown well recently. Because of the fluctuation price of the rubber sap, the interest of people to grow rubber decreases and they are looking for other prospective commodities and livelihood in peatland. In Tanjung Sari and Bayas Jaya, rubber is introduced in the late 1990s and it was planted at home yard initially. Then some of the people tried to plant rubber near their paddy field at that time. The good growth of rubber plants makes people increasingly attracted to develop rubber plants on the land they manage. Ruber starts to produce sap at the age 5-6 years and the farmer can sell the product weekly, twice a month or monthly, depend on their needs. Even some of the less productive rice fields are converted into rubber plantation. However, the fluctuations in rubber latex prices in the past 5 years have reduced people's interest in cultivating rubber. Recently, the existing rubber plants are retained by the community and the sap is still being tapped. In fact, some people still plant rubber in the hope that prospective latex prices will increaase and only requires small amount of cost if it is compared to planting oil palm.

Different with other villages, commercial commodities from land use in Simpang Gaung are coconut (*Cocos nucifera*), betel nut (*Areca catechu*), and sago (*Metroxylon* sago). The largest of coconut plantation in Riau is located in Indragiri Hilir regency and most of them belong to smallholder plantation [23]. Coconut has long history for the livelihood of people in Indragiri Hilir, including in Simpang Gaung, which was introduced to plantation in 1970's. Most of the households in Simpang Gaung depend on coconut as source of livelihood. coconut is planted in both mineral land and peatland areas. Usually, building canal and ditch are the requirement in planting coconut for water drainage and transportation, because most of the location are swamp area. It takes 4-6 years of coconut to start producing the fruit, it depends on the variety of the tree. The harvest period of coconut is usually once in 2.5-3. Betel nut is usually planted as inter-crop plant and hedgerow in coconut area. This plant starts to produce at the age of 4-5 years with harvesting period every two weeks or twice a month. Sago has already known by people in Simpang Gaung for generations as staple food, combined with rice. Naturally, sago grows in mineral land at the edge of the river and close to community settlement. Their Ancestor in Simpang Gaung planted this commodity close to the river as part of food security as well as commercial purposes. However, sago did not provide prospective commercial

benefit with long period of harvest, it was harvested only once in a year, and the price was relatively cheap. That time, people then cut down sago and replaced with coconut and betel nut which were more prospective for their livelihood. This Conversion of sago into coconut and betel nut was conducted massively by people in the decade of 2000s. Currently sago plants are still found in small amounts in various people land.

Table 4. Priority of variation commodities at research sites

No.	Commodities	Teluk Meranti	Tanjung Sari	Bayas Jaya	Simpang Gaung
1.	Palm oil	1	2	1	3
2.	Rubber	2	2	2	
3.	Coconut	3			1
4.	Betel nut	3	2	3	2
5.	Sago				
6.	Paddy	1	1	2	
7.	Corn	1	1		
8.	Vegetables	3	3		
9.	Pineapple	4	3	2	
10.	Capture fish	1			2
11.	Aquaculture		4		
12.	Swift nest	1			
13.	Honey				4

Notes: (1) very important; (2) important; (3) quite important; (4) supporting commodity

4. Conclusion

The dynamic livelihoods of rural community around peatland occurs following the changes around them, including changes in the conditions of peatland use and cover, changes in commodity trends, and changes in environmental around the peatland areas. Rural community will adapt to the situation based on their resource and their socio-cultural conditions of the community. Fire is still the main tool for land clearing by the community as long as no alternative which is considered a cheaper way. Land use patterns that tend to be extensive on peatland, especially for expansion plantation crops, are still the current community livelihood main strategy at the research site. This strategy will continue as long as peatland is still available and this will trigger more fire accident in the peatland.

The community will continue to look for and to adopt commodities that can be cultivated on peatland which can provide benefits in a short time. Consideration of ease of cultivation with low costs, sustainable production results, prospective economic values supported by markets at the local level are important considerations for the community in determining the commodities to be cultivated on peatland. This is currently the case with oil palm monoculture that continue to grow on peatland. In addition, the environmental aspects of peatland management have not been considered by most community because they prioritize the economic financial benefits in growing monoculture crops.

In dealing with this situation, diversification of livelihoods and product diversification to increase the added value of a commodity is one of the important considerations in supporting sustainable rural livelihood. Diversification of commodities growing on peatland is already practiced by some rural people. However, more implementation programs are still needed by considering community rationality in determining the commodities to be cultivated and and by considering peatland-friendly management. Adaptive and applicable techniques need to be continuously introduced and practiced by various stakeholders in cooperation with the community. This is also part of efforts to reduce the risk of land and forest fires from the use of fire in land clearing. Providing more peatland-friendly livelihood options is an initial step to deal with the issue of sustainable livelihoods and sustainable peatland management.

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