ENVIRONMENTAL BEHAVIOUR OF COMMUNITIES AROUND PEATLAND AREA OF PULANG PISAU, CENTRAL KALIMANTAN

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ENVIRONMENTAL BEHAVIOUR OF COMMUNITIES AROUND PEATLAND AREA OF PULANG PISAU, CENTRAL KALIMANTAN. Sustainable peatland management must consider the social, economic, and environmental conditions of surrounding communities. Balancing these three pillars is essential for preserving the peatland's functions, which support the lives of various organisms dependent on the ecosystem. This research focuses on the behaviours of communities around peatlands in the Block C Peatland Management Unit (PMU) in Pulang Pisau Regency, Central Kalimantan. It investigates the social and economic variables influencing environmental behaviour in peatland management and utilization. Employing two methods-Participatory Rural Appraisal (PRA) and survey – this research aims to collect comprehensive data. Data processing is conducted by using tabulation and statistical inference. The PRA includes tools like village historical timelines, transects, seasonal calendars, and livelihood preferences, while the survey uses semi-structured interviews to assess individuals' characteristics, perceptions, and participation in peatland management. The study reveals that villages encounter several challenges, including insufficient agricultural support, susceptibility to flooding, restricted access to clean water, and poorly functioning irrigation systems. Climate change has disrupted the dry season, resulting in lower rubber sap production. The limited availability of land for rice farming and a decreasing interest in forestry products are also significant concerns. The communities must shift their agricultural practice to adapt to climate change. While most respondents acknowledge the ecological importance of peatlands, greater involvement in their management is still needed. This underscores the need to enhance community capacity for peatland restoration and conservation. In conclusion, the findings stress the importance of incorporating social factors into peatland preservation efforts to foster environmental sustainability.

Keywords: Behavior, Central Kalimantan, environment, peatland, Pulang Pisau, and PRA

PERILAKU LINGKUNGAN MASYARAKAT DI SEKITAR KAWASAN GAMBUT PULANG PISAU KALIMANTAN TENGAH. Pengelolaan gambut yang lestari perlu mempertimbangkan keadaan sosial, ekonomi dan lingkungan masyarakat sekitar. Keseimbangan tiga pilar konsep pengelolaan seharusnya diperhatikan, sehingga fungsi lahan gambut dapat bertahan, menjadi pendukung kehidupan beragam organisme yang tergantung pada ekosistem. Penelitian ini bertujuan mendeskripsikan perilaku masyarakat di sekitar lahan gambut pada kesatuan pengelolaan gambut Blok C di Kabupaten Pulang Pisau, Kalimantan Tengah, dengan fokus pada variabel sosial dan ekonomi masyarakat yang membentuk perilaku lingkungan dalam pengelolaan dan pemanfaatan lahan gambut. Penelitian menggunakan dua metode,

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yaitu participatory rural appraisal (PRA) dan survei untuk pengumpulan data. Pendekatan PRA meliputi sejarah desa, transek, kalender musim, dan preferensi mata pencaharian, sedangkan survei menggunakan wawancara semi terstruktur untuk mengukur karakteristik, persepsi, dan partisipasi individu terhadap pengelolaan lahan gambut. Hasil penelitian menunjukkan bahwa semua desa menghadapi kurangnya dukungan pertanian, kerentanan terhadap banjir, kekurangan air bersih dan saluran air yang tidak berfungsi dengan baik. Mereka juga menghadapi keterbatasan lahan untuk mengembangkan pertanian padi, serta semakin berkurangnya produksi atau minat petani terhadap produk-produk kehutanan. Masyarakat harus melakukan adaptasi terhadap perubahan iklim. Walaupun mayoritas responden memahami fungsi ekologis gambut, namun partisipasi dalam pengelolaan lahan gambut masih rendah. Penelitian ini juga mengindikasikan kebutuhan peningkatan kapasitas masyarakat dalam restorasi dan konservasi lahan gambut. Implikasi dari temuan ini menggarisbawahi pentingnya integrasi aspek sosial dalam upaya pelestarian lahan gambut untuk mencapai keberlanjutan lingkungan.

Kata kunci: Gambut, Kalimantan Tengah, lingkungan, perilaku, PRA, and Pulang Pisau

I. INTRODUCTION

Indonesia has the largest peatland area among tropical countries in the world, covering approximately 13.43 million hectares, dispersed on Sumatra Island (5.58), Kalimantan (4.54), Papua (3.01), and Sulawesi (0.024) (Anda et al., 2021; BBSDLP, 2011). Pulang Pisau Regency in Central Kalimantan Province covers 924,520.7 ha Peat Hydrological Area (*Kesatuan Hidrologis Gambut-KHG*), or 94.6% of the regency's total area (Aguswan, 2019). Based on the Decree of the Minister of Environment and Forestry Nomor Sk.129/Menlhk/Setjen/Pkl.0/2/2017, the peat area divided into three Peatland Management Unit (PMU), namely the Kahayan–Kapuas, the Kahayan–Sebangau, and the Kapuas–Mangkutup. However, deforestation has occurred in those areas, for example, it is estimated to reach an average of 2-3% per year in Kahayan-Sebangau PMU. The deforestation rate in the Kahayan–Sebangau KHG in 2016-2017 reached 1,459.5 ha, making it imperative to restore because of their function as sources and purifiers of water (if undisturbed, peatlands can store water up to 0.8-0.9 m^3 per m^3 of peat), coastal protectors, and also the largest carbon storage on earth (Husain & Korbaffo, 2024; Maas et al., 2020). Deforestation and forest degradation are suspected to contribute to an increase in greenhouse gas emissions by about 18% of total overall emissions (Purba et al., 2014). Disasters such as prolonged droughts, forest fires, and floods occur. Prolonged droughts have caused damage to residents' plantation crops (rubber). Fires have led to respiratory health problems and limited transportation modes due to reduced visibility during the haze, which also impacts the economy and the distribution of goods. The area of forest fires in 2019 was 6.604,39 ha (Putri, 2022).

The peat dome restoration and rehabilitation program requires the involvement of social and economic elements (Fadmastuti et al., 2018). The objective is to preserve the health of the peat ecosystem, which requires taking into account any factors that may lead to environmental pollution. Community assessment of environmental quality is a crucial aspect of developing natural resources. Understanding environmental sustainability can become social capital, which, if well-managed, will be a critical factor in the success of planned programs. For sustainability, a structure and natural environmental aspects need to be understood, saved, and preserved, which can be built through the positive attitudes of the individuals living within it (Aladağ et al., 2016). Local wisdom in the form of the community's views, values, and practices correlated to the ecological role of peat (Harrison et al., 2020; Padur et al., 2017) along with the potential pollution, and environmental harm, should be studied and considered carefully.

The assessment of the local community is important because they are not just participants, but the key actors in implementing the restoration activities, which in this study are identified in Pulang Pisau Regency, Central Kalimantan. This research investigates the social and economic variables regarding environmental behaviour in peatland management and utilization using Participatory Rural Appraisal (PRA) and survey methods in local communities. The value system that applies to environmental management can be a supporting or inhibiting factor in management, especially when external influences are introduced that could affect the value system (Ibrahim et al., 2019). This underscores the importance of empowering the local community and making them feel responsible for the success of the restoration activities.

II. MATERIAL AND METHOD

A. Study Site, Location and Materials

This research was done in PMU Blok C Pulang Pisau Regency, part of the Kahayan-Sebangau peatland area of Central Kalimantan Province in 2020 (Figure 1). We chose that area since first, it has a large area of peatland, reaching 94.6% of its total area, and is home to a peat dome, the largest carbon storage area within the ecosystem (Julzarika et al., 2020). The second is that at the time of the research, Pulang Pisau was one of the national targets of the national economic empowerment program due to Covid-19 recovery. For this study, we select four villages, namely Buntoi, Mentaren I, and Kalawa in Kahayan Hilir district, and Pilang in Jabiren Raya district where the community's relationship with the peatland ecosystem is deeply intertwined with their daily lives and cultural practices, using PRA techniques. The use of tools helps capture traditional knowledge and land-use practices, which are crucial for maintaining sustainable management. For instance, indigenous practices like observing the water levels in peatlands during the rainy season are often used to determine the best time for agriculture, and these insights are valuable for restoration efforts.

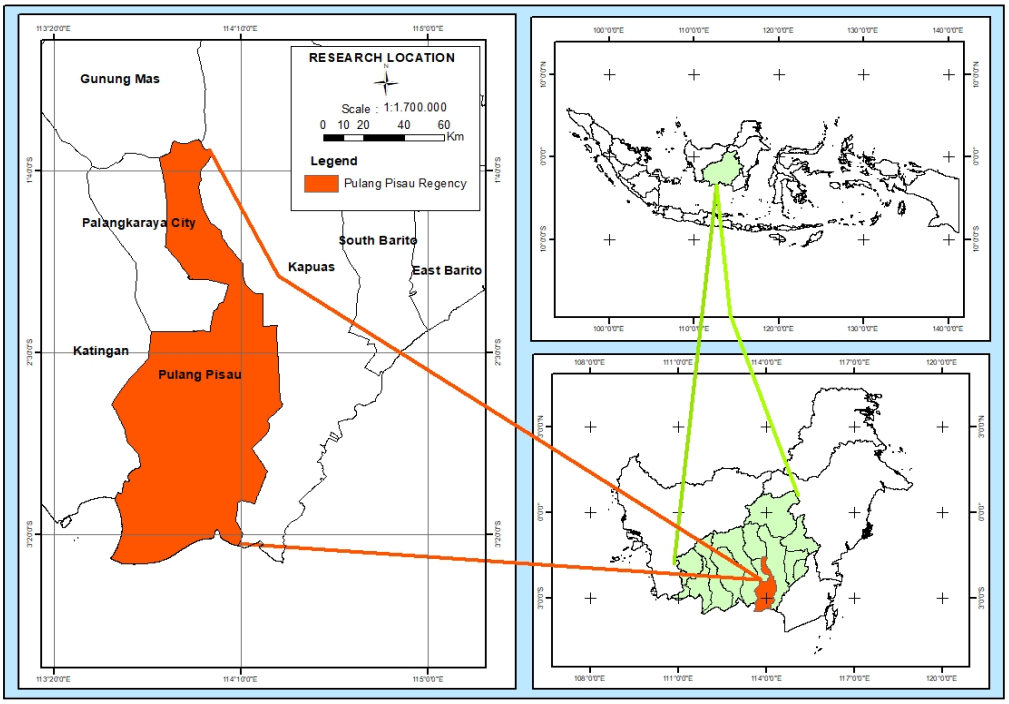


Figure 1. Map of Palangka Raya

We used research materials for conducting PRA, including stationery, cameras, drawing tools, drawing paper, and recording devices. Meanwhile, for the survey, we employed a structured interview set, which included sections on biodata, environmental sanitation, knowledge of peatlands, perceptions of the environmental benefits of peatland, participation in peatland management, and consent to participate in the research).

B. Methods and Analysis

This research applies, first, PRA for the environmental behaviour of communities, after studying its advantages and suitability in revealing environmental management, as it can capture community participation in the research (Berardi, 1998; Mueller et al., 2010). The research employs several data collection techniques, including village historical timeline (Ahmed et al., 2019), walking transect lines (Nyaligwa et al., 2017), seasonal calendar (Shamsuddin et al., 2007), and matrix ranking (Chakraborty et al., 2023; Sanudin et al., 2020).

The second method, the survey, was conducted online. The detailed questions were presented on the Google Forms platform. The respondents were assisted by enumerators to fill out the form using their smartphones. The form was divided into four sections: respondent biodata, knowledge, involvement, and participation in the management and utilization of peatlands. The PRA and survey were conducted in four villages, namely Buntoi, Mentaren I, Pilang, and Kalawa, each characterized by communities that have or are currently relying on peatlands for their livelihoods. The participants of PRA and survey are listed in Table 1):

C. Analysis

The research involved synthesizing quantitative and qualitative information to analyse data collected from PRA and surveys. The specific analysis for each method was conducted because each tool has different processes and objectives (Table 1).

Table 1. Data collection and analyses methods

No	Methods	Objective	How to	Analysis	Number of participants	Reference
1.	PRA					
1.1	Historical timeline	Understand historical context and significant events	Records major historical events in the community that have had significant impacts, such as natural disasters, changes in land use, development projects, or shifts in economic activities.	- Review and categorize events. - Identify trends and correlations. - Create visual representation of events.	18	(Ahmed et al., 2019)
1.2	Walking transect line.	Assess land use patterns and environmental conditions	Gather detailed information about the landscape, environmental conditions, and land use in a specific area by walking through it with community members.	- Review observations and map findings. - Evaluate land use and identify issues. - Integrate community feedback.	17	(Nyaligwa et al., 2017; Yusuf, 2014)
1.3	Seasonal calendar	Investigate seasonal patterns affecting livelihoods and environment	Identify the timing or cycles of various activities, events, and ecological changes throughout the year.	- Examine timing of activities and events. - Identify seasonal challenges and opportunities. - Cross-reference with other data	20	(Shamsuddin et al., 2007)

No	Methods	Objective	How to	Analysis	Number of participants	Reference
1.4	Matrix ranking	Prioritize livelihood options based on community preferences	Record the community preferences regarding livelihood choices for agricultural crops or livestock.	- Compile rankings and identify priorities. - Analyse justifications for scores. - Present findings visually and discuss implications	20	(Chakraborty et al., 2023; Sanudin et al., 2020)
2.	Survey					
2.1	Structured interview	Explore respondent socio-economic characteristics and behaviour.	Online survey using Google platform to assess respondent biodata, knowledge, involvement, and participation in the management and utilization of peatlands.	- Using statistic inference to classify demographic characteristics. - Analyse behaviours on sanitation and waste management. - Using Likert scale to categorize perception towards environmental benefit of peatland and participation on peatland management.	211	(Fauzi et al., 2019; Lutpi, 2016; Salam, 2010; Sugiyono, 2012)

Meanwhile, this research employs a Likert scale to measure public perception and uses a scoring approach to assess community participation. The Likert analysis is used to gauge respondents' perceptions of peatland management and utilisation from an environmental perspective. This analysis involves creating structured and semi-closed questionnaires. These questionnaires are distributed to respondents who meet the criteria of being heads of households and residing in four designated villages. Responses to the questionnaires are recorded on a form that assigns weights to answers, ranging from high to low, or vice versa (Sugiyono, 2012).

Respondent participation in peatland management is measured quantitatively using the same questionnaire employed to assess perceptions. The sample size for measuring respondents' perceptions and participation in peatland management was determined using Slovin's formula. Based on this formula, a minimum target of 204 respondents was set; however, this study successfully gathered information from 211 respondents. The number of respondents exceeded the target due to the use of an online questionnaire via Google Forms, which was distributed for six days by enumerators across four villages. The respondents included farmers, entrepreneurs, private employees, civil servants, students, labours, fishermen, merchants, pensionaries, and part-time teachers (Figure 2). The level of participation in this study is assessed by evaluating the knowledge of the respondents, who are the research subjects, regarding the research topic (Salam, 2010). The participation level analysis uses a scoring approach applied to the questionnaire items. The highest score of 5 indicates high involvement, while the lowest score of 1 indicates low involvement. The data from the questionnaire scoring are summarized in tabular form. To analyse this data, the range value must be calculated by first determining the maximum and minimum values from the questionnaire, followed by calculating the interval value, which is obtained by subtracting the minimum value from the maximum value and dividing the result by three (Fauzi et al., 2019; Lutpi, 2016).

III. RESULT AND DISCUSSION

A. Result

1) PRA

1.1). Village historical timeline

The formation of some villages in Pulang Pisau Regency was started far before the Indonesian independence. In this study, two villages, namely Buntoi and Pilang, were established before 1900. Mentaren I village was established in 1920, Kalawa as the youngest of the fourth villages/Sub-districts, was established in 1958.

Chronologically, the progress of community development in the villages of Buntoi, Mentaren I, Pilang, and the Kalawa Sub-district after their formation can be summarized from the historical timeline in Table 2. From 1970 to 2000, new economic activities like rattan weaving (1970), rubber farming (1978), and efforts to reduce shifting agriculture (1997) were introduced. In the 2000s, canal construction (2006) and bans on slash-and-burn farming (2008) were initiated to improve agriculture and land management. In the last period, 2010-2020, Government aid and infrastructure projects (e.g., rubber, rice, aquaculture) were introduced. Special tourism such as orangutan conservation area, river tracing, *purun* (*Cyperaceae* sp.), and *mandau* crafts were created. It can be highlighted that the

Table 2. Village historical timeline

Year	Events	Challenges
18th century – 20th century	The formation of Buntoi (1700), Pilang (1890), Mentaren I (1920), and Kalawa (1958)	Settlement system that keeps the population from dispersing across the entire village area.
1970	Introduction of rattan weaving in Kalawa	Marketing and the low exchange value of woven products.
1978	Establishment of a joint rubber business group in Kalawa	Stabilizing rubber sap price for farmers' benefit.
1980	Establishment of farmers group	Lack of agricultural support from government.
1990-1991	Severe forest fires that is recurrence in 2014-2015 in Kalawa, 2007, 1997 and 2015 in Pilang, 1997 and 2015 in Mentaren, and 2015 and 2018 in Buntoi.	Eradicate slash-and-burn in land clearing for the agricultural purpose.
1997	The reduction of shifting agriculture practices in Mentaren I	The increasing demand of agricultural lands and input for permanent agriculture system.
2006-2007	Canal construction	Maintenance and upkeep of the canals are required to ensure they work properly.
2008	The governments ban the slash-and-burn practices in Buntoi.	This regulation was reinforced in 2015 and extended to other villages, including Kalawa and Pilang.
2013	Government assistance for providing rubber plant seedling in Mentaren	The governments providing supports for the farmers and the residents in the form of: rubber plant seeds in Mentaren (2013), rice field development in Pilang (2014 and 2017), hand tractor in 2015, fishery in 2017, fruit plant seedlings in 2019 and rice paddy seedlings in 2020.
2014	Rice field development in Pilang, which is reinforced in 2017	The new seedlings were not suitable for the swampy site, and the maintenance techniques were not appropriate.
2015	Hand tractor introduction in Pilang	The farmers must be trained to operate the machines.
2016	Clean water supply and agricultural partnership for rubber sap marketing development in Mentaren I. The establishment of *orang utan* tourism destination in Pilang and *Mandau* art work in Kalawa	The clean water supply system only reaches a small population. The partnership of rubber sap marketing unable to increase the price. *Orang utan* tourism is only open to special interest groups. The *Mandau* crafts only reach a few people because they are produced individually.
2017	Initiation of aquaculture in Mentaren I.	Most of the fish seedlings died or suffered from a lack of food.
2018	The last ritual of traditional dryland paddy plantation ritual in Mentaren I and the introduction of river tourism in Pilang.	The diminishing indigenous agricultural practices. The new form of tourism needs different form of tourism marketing
2019	Government aid for fruit plants seedlings in Mentaren I	The limited parcel of land to accommodate all the new seedling provided.
2020	Government aid for seedlings and other inputs of rice paddy farming in Mentaren I	The irrigation system is not well-organized, making the water supply difficult to manage.

worst situation was happening at the time of the land and forest fire, which occurred in 1990-2019. During that period, the biggest forest and land fires were in 2015 and 2019, which caused a large scale of economic loss and degraded the peatland of Pulang Pisau (Astuti, 2020; Kanyama et al., 2023; Saharjo & Novita, 2022). The best situation occurred in 2010-2020, a period when increasing number of government aid was disbursed for infrastructures, crafts, and tourism.

1.2). Walking transect line

The walking transects conducted across the four villages/urban areas produced types of land use every 100 m and the challenges faced by the communities. The synthesis of land use and the resulting challenges are presented in Table 3. To summarize, the communities face infrastructure limitations for agriculture, such as land shortages and limited knowledge and technology. They also face environmental problems, such as poor sanitation and a lack of clean water, and environmental hazards, such as forest and land fires, flooding, and waste management.

Transect analysis reveals that the community adapts land use to meet their needs. They clustered housing in the village center, developed home gardens near the residential areas, and located community forests farther from the settlement. However, supporting technology for each land use—whether in residential areas, farming, gardens, forests, or fisheries—remains limited and does not function effectively to support environmental sustainability, health, and community welfare.

1.3). Seasonal calendar

The results of the seasonal calendar in the four villages indicate common activities related to the two main seasons, the rainy season and the dry season, as well as the transitions between them. These activities are presented in Table 4. The key events associated with the seasons in the four villages include floods, land and forest fires, and the harvest of crops, dryland paddy, and home garden produce.

The high frequency of forest and land fires has led to climate change in Central Kalimantan. This climate change forces farmers to access productive land that is increasingly farther from residential areas and further into the forest (Marlina et al., 2021). It also shifts the planting pattern such as dryland paddy, and decreases the harvest of commodities such as rubber sap.

1.4). Matrix ranking

The matrix ranking is the process in which the respondents valued the commodities in the everyday livelihood developed in their villages. The preference score is based on respondents' valuation of four aspects: seedlings availability, maintenance easiness, water (irrigation)

Table 3. Walking transect line

Length (m)	Land use	Challenges
0-100	Jetty (Buntoi), housing, livestock (goat) pen, home yard garden mixed with NTFPs.	Population density, limited source of clean water, plastic waste, poor sanitation, seasonal floods, toilet facilities, and waste management are insufficient.
100-400	Housing mixed with NTFPs garden such as rubber plant and fruit plants, and fish ponds.	Population density, plastic waste, poor sanitation, lack of waste collection facilities, seasonal floods, and limited clean water sources. There is some bare land in all villages.
400-800	Dryland farming or garden, rice paddy farming, chicken farm, NTFPs, private rubber forest, shrubs, bare lands, and farmhouse.	Lack of irrigation facilities, irregular plant spacing on garden or private rubber forests, prone to seasonal floods or forest/land fire, dysfunctional canal system, and plastic waste.
800-1.200	Private rubber forest, NTFPs, chicken and swiftlet nest farming mixed with a small housing area.	Lack of irrigation facilities, irregular plant spacing on garden or private rubber forests, prone to seasonal floods or forest/land fire, dysfunctional canal system, poor sanitation and the absence of waste and sewage disposal facilities.

Table 4. Seasonal calendar

Month	Activities or season	Challenges
January - March	Rainy season and the harvesting time of some fruits, such as *durian* and *rambutan*. March is also the last month of rice paddy planting season and usually the harvesting time for dryland paddy.	The residential areas are prone to flooding and facing waste problem.
April-September	Dry season in which the preparation of rubber plantation such as land clearing, bed preparation, and seedling planting are carried out. August is also the harvesting time of rice paddy farming and September is for mango.	The slash-and-burn system for land preparation poses a high risk of causing land and forest fires.
October	Transition of dry season into the rainy season. Usually, this is the seedling time of the rice paddy and the beginning of the planting time for the dryland paddy.	The slash-and-burn system of land preparation for dryland paddy farming increases the risk of farmland fire.
November-December	The beginning and the second month of rainy season. The canal must be cleared in early November to prevent flooding.	Harvesting time of some fruit plants such as *rambutan*, *durian,* and *cempedak* (jack fruit).

Table 5. Matrix ranking

No	Agricultural commodity	Preference score				Challenges
		V.1	V.2	V.3	V.4	
1	Seasonal crops					
1.1	Rice paddy	14	20	16		Irrigation, pest control, and cyclical floods
1.2	Dryland rice		17			Declining interest of farmers
1.3	Cassava		20			Crop failure during dry season
1.4	Vegetable plants				17	Pest control
2	Timber-producing plants					
2.1	Albizia	15	20			Long harvesting age and pest control
3	Non-timber-producing plants					
3.1	Rubber tree (*Hevea brasiliensis*)	14	19	15	20	Cyclical floods and unstable price
3.2	*Rambutan* (*Nephelium lappaceum*)	14			18	Unstable price in harvest season
3.3	*Durian* (*Durio zibethinus*)	16			18	Pest control
3.4	Mango (*Mangifera indica*)	13				Unstable price in harvest season
3.5	*Petai* (*Parkia speciosa*)		20		17	Long dry season
3.6	Rattan (Calamoideae)		20	17		Declining interest of farmers
3.7	Bamboo (Bambusoideae)		20			Unsustainable harvesting
3.8	Palms		20			Declining production
4	Fishery					
4.1	*Patin* fish (Pangasius)	12				Water pollution and marketing
4.2	*Nila* fish (Tilapia)	13				Water pollution and marketing

Remark: V.1 = Buntoi, V.2 = Mentaren I, V.3 = Pilang and V.4 = Kalawa.

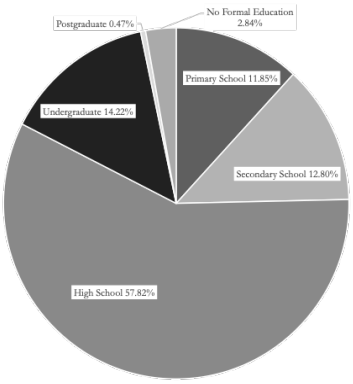
availability, and marketing easiness. Each aspect referred to the easiness or availability, ranging from 1 (very difficult) to 5 (very easy). The sum of preference scores across all commodities for each village is presented in Table 5. The highest score in Buntoi village is the durian home garden. Several commodities score highly in Mentaren I, i.e., rice paddy and cassava farming, albizia, rattan, bamboo, palm forest, and petai home garden. The most preferable commodity in Pilang is rattan. In Kalawa, several commodities are preferred, and the rubber tree achieves the highest score. Aquaculture is only preferable in Buntoi.

2) Survey

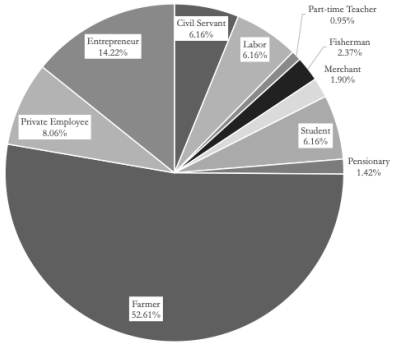
This study successfully gathered data from 211 respondents across four areas: Pilang Village, Mantaren I Village, Buntoi Village, and Kalawa Subdistrict. The distribution of respondents is as follows: 57 in Pilang Village, 52 in Mantaren I Village, 53 in Buntoi Village, and 49 in Kalawa Subdistrict. Most respondents were male, with 118 (55.92%) participants. The majority were within the productive age range (15–64 years), accounting for 205 respondents (97.16%), while the rest (2.84%) were classified as non-productive age. Most of the households had four family members (31.28%). Additionally, food needs were primarily met by purchasing from markets (79.15%), while 18.48% of respondents sourced food from their gardens or fields, and only 2.37% from home yards.

According to the education level, most of the respondents' highest education is high school, with a total of 122 respondents (87.82%), followed by undergraduate and secondary school. There are only 2.84% of the respondents that have not experienced formal education. Based on their livelihood, most of the respondents are farmers, 111 individuals (52.61%). Most residents of the four villages are the indigenous people (Dayak) and engage in similar, often hereditary, livelihoods. The most common income level among respondents is less than USD 31.85 (1 USD = Rp.15,700.00), with 68 respondents (32.23%) falling into this category.

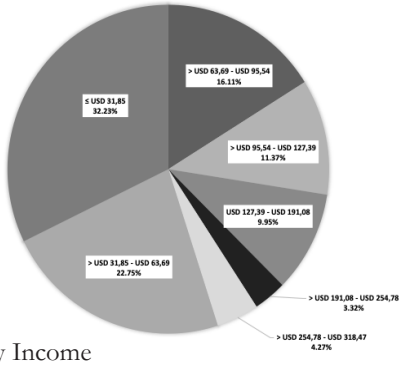
Most of the respondents' residences are more than 3 km from peatlands where they find their livelihoods. Some respondents have huts/shelters in the garden that are used during their farming activities and are also used to protect plants from pests when the plants enter the harvest age. The community has a place to live next to rivers and roads. Some people also live close to the cultivated peatlands. So houses on peatland that have a high thickness have a unique house design, with piles in the foundation (Wardani et al., 2017).



a. Education



b. Occupation



c. Monthly Income

Figure 2. Socio-economic characteristics of the respondents

B. Discussion

1) Lesson learnt form PRA

Currently, most residents live clustered in the center of the villages. Historically, the clustering of the population has occurred in the early formation of villages, at the time, the population was still small, and for security reasons, they lived in groups based on tribe or kinship in the center of the village. Large families initially lived together in one house, called a 'betang'. When the house could no longer accommodate all the family members, they built new houses for each nuclear family, which generally consisted of the father, mother, and their children. This pattern causes people live far apart from their fields, gardens, or forests and causes difficulties in handling emergency hazards such as land and forest fires.

Population growth not only changes the pattern of residence that separates one nuclear family from another nuclear family but also causes expansion of agricultural land to meet their increasing needs. Meanwhile, government assistance to increase farmer capacity and agricultural intensification efforts as an alternative source of income for the communities did not work effectively. This situation encouraged residents to expand land as a new source of income. The expansion of agricultural land contributed to the reduction of peatlands and forest fires.

The severe forest and land fires cause air pollution in the form of fog, threaten community health, and cause significant economic losses in all villages. Although the government has made efforts to encourage community participation in the prevention and management of forest and land fires, low levels of knowledge and limited experience become the major barriers to successful implementation (Fleming et al., 2024). Agricultural extension officers have not yet provided intensive support to farmer groups. Agricultural yields have started to increase since the canals were built. The historical timeline of the villages showed that all villages facing insufficient agricultural support such as infrastructure and advisories, market access, and diminishing indigenous practices such in farming.

From the transect conducted in the four villages, the area from the starting point up to 100 m from the village center is relatively densely populated. Environmental infrastructure issues pose common challenges in the residential area. Residents face limitations in access to clean water, sanitation facilities, and the absence of waste management systems for both household and communal needs. At a medium distance of about 100-400 m from the village center, the land is used for mixed gardens and increasingly sparse residential areas, facing similar environmental problems as those in the village center. The next space consists of agricultural land, plantations, and private forests, with the main issue being the lack of irrigation. In the furthest area, which can extend more than 1,200 m from the village center, there are smallholder rubber forests occasionally mixed with dryland rice fields. Overall, all locations are vulnerable to flooding, lack of clean water, poorly functioning canals, and the absence of waste management systems. Supporting technology for each land use such as residential areas, farming, gardens, forests, and fisheries remains limited and does not work effectively to support environmental sustainability, health, and community welfare. The environmental conditions result in diverse and high levels of pollution, particularly related to water quality, due to their activities as well as activities upstream of rivers (de Jong et al., 2015).

The seasonal calendar depicted challenges related to the cyclical dry season, and rainy season, and the transition between them. The people adapted to the cycle, but nowadays they also face irregularities due to climate change, which is further exacerbating around peatlands (Leng et al., 2019; Marlina et al., 2021). One of the impacts is flooding, which swamps farmland and leads to the risk of crop failure as the canal cannot hold excess water. The price of harvested fruit such as durian, rambutan, kelengkeng, and cempedak tends to

decrease during harvesting time. On the other hand, durian production tends to decrease over time as there is no crop rejuvenation system. The fruit harvest season also increases the risk of the attack of monkeys. Another challenge faced by people is the difficulty of irrigation for annual crops during the prolonged dry season due to climate change. The impact is the decreasing harvest of rubber sap. In addition, the prolonged dry season has also resulted in low water levels in the canals which disrupts transportation and delays the movement of goods. Fisheries resources are also threatened as fish that are cultivated in the cage are at risk of dying. This condition shows that climate change makes people difficult to carry out their agricultural activities.

The matrix ranking showed that rice paddy farming was started to be more favored than the old dryland paddy farming. The consequence is that the more demand for rice paddy farmland, the more intensive the technology used and larger the inputs needed such as seedlings, manure, pest controller, and water provided by a proper irrigation system. The irrigation system is also needed for other commodities such as cassava and vegetable plants. The analyses also portray that some forestry commodities such as bamboo, rattan, and palms have faced the problem of diminishing production or declining interest of farmers. A similar phenomenon was also reported by another study, highlighting that the expansion of intensive agriculture such as palm oil plantations reduces the dependency of villagers on forestry-related products (Afentina et al., 2020). The other persistent challenge that was also identified in other analyses is the recurrence of cyclical floods in the rainy season and forest-and-land fires in the dry season.

2) Peatland use and impacts

A total of 127 respondents or 60.19% knew about peatlands and how to use them. In addition, as many as 54% of the respondents stated that they benefited directly from the peatland ecosystem, from agricultural products to handicraft materials. The three largest benefits obtained from peatland are agricultural products, forestry/timber, and fisheries (Figure 3). Agricultural expansion has contributed to the increasing utilization of land surrounding peatlands. Although categorized as marginal land, peatland has the potential to be used for agricultural purposes (Arief et al., 2018). Along with the growth in population around peatlands, the use of peatlands for life fulfillment has increased. In this research, some respondents use peatland to develop agricultural commodities such as rice paddy or dryland paddy fields, seasonal crops, and other root crops. Peatlands used for agricultural and plantation cultivation are generally at depths of less than 300 cm. Peat depths greater than 300 cm are not recommended for cultivation and are better suited for conservation purposes due to the soil's structural instability and low

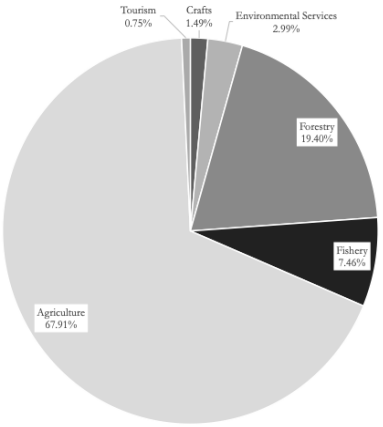


Figure 3. Local benefit from peatland ecosystem

nutrient content (Nasrul, 2010; Wösten et al., 2008; Zamaya et al., 2021).

However, the use of peatland for agriculture and other needs must certainly be approached with caution, as its environmental functions can change. Studies have warned that more intensive, frequent, and large-scale changes in peatland use have occurred over the past hundreds of years (Cole et al., 2022). This survey tried to measure communities' concerns about the environmental impacts of peatland disturbances. Most respondents (71%) perceive that there will be environmental degradation if peatland is damaged. The management of peatland into productive land must pay attention to the condition of peat water management. Poor water management in peatland management to be more productive can result in the oxidation of pyrite (Soewandita, 2018) This oxidation of pyrite results in a further drop in the pH level so it will be very detrimental. Changing the function of peatlands to more productive land without paying attention to peatland characteristics has an impact on environmental quality (Irma et al., 2018; Nugraha et al., 2019). Peatland cultivation must pay attention to the conservation chemistry carried out and is suitable for peatlands. As many as 53% of respondents still do not know how or how to protect, rehabilitate techniques, and peatland restoration techniques so that they are maintained. Some respondents believe that preventing burning is one way not to damage peatlands.

A significant portion of the respondents have already used bottled or gallon water to meet their drinking water needs. A total of 162 respondents (76.78%) reported that they use bottled or gallon water for drinking, as it is easier to obtain and ensures better water quality. Meanwhile, for their bathing, washing, and sanitation (MCK) needs, water is supplied by the local PDAM, as stated by 55 respondents (26.07%). As many as 136 respondents (64.45%) mentioned that the water they use is of good quality, being clear, colourless, and odourless. However, based on the questionnaires distributed to 211 respondents, there is still evidence of the use of river toilets by 70 respondents (33.18%). This condition requires special attention as it can lead to river pollution from domestic waste (de Jong et al., 2015; Fitriansyah et al., 2018).

3) Efforts to achieve peatland sustainable management

This research manages to describe the potential of community engagement in preserving peatland and measure their potential participation in the future (Table 6). The first step is the community acknowledges the importance of peatland in their livelihood. They tend to strongly agree that peatlands serve as carbon storage/absorption areas. The second step is maintaining peatlands functioning for water availability. Most respondents share the same perception regarding the function of peatlands in maintaining water availability, as water will be preserved as long as the peatland remains intact and undamaged.

The third step is keeping peatlands as habitats for various types of plants and specific animals. The fourth step is managing peatlands function as a source of livelihood. The fifth step is the opening of peatlands to make them more productive with zero burning. The community perceives that peatlands have largely been left unused. Regarding the utilization of peatlands, the use of peatlands for timber crops (forestry). They tend to strongly agree with using peatlands for timber crops. Other utilizations are rubber plantations, nature tourism, dryland rice, wetland rice, and lastly, oil palm plantations. The utilization of peatlands for oil palm plantations received the lowest option compared to the other five uses.

The community is aware that the overall condition of peatlands in Central Kalimantan has deteriorated due to converting peatlands into agricultural land by burning. This indicates that some respondents are hesitant about burning peatlands to clear the land. This hesitation is due to the prohibition on burning land for clearing purposes, as well as the sanctions imposed on those who burn

peatlands. The community tends to agree that one of the causes of peatland degradation is the construction of poorly designed canals that fail to consider the water table of the peatland. Similarly, the conversion of land use is a cause of peatland damage. The community strongly agrees to conduct conservation/restoration/ rehabilitation activities for maintaining the existence of peatlands.

The second part is the assessment of respondent's participation in managing peatland. The involvement of respondents in peatland management activities is one form of community participation, whether active or passive, as a manifestation of their engagement. Community participation in land and forest management plays a crucial role in providing added value to the community (Gunawan &

Table 6. The estimation results of respondents' perceptions using a Likert scale

No.	Question	Likert Index	Category
1	Peatlands act as carbon sinks/stores	83,89	Strongly Agree
2	Peatlands function to maintain water availability	83,70	Strongly Agree
3	Peatlands are habitats for various types of plants and specific animals	85,21	Strongly Agree
4	Peatlands are a source of livelihood/income for the local community	81,90	Strongly Agree
5	Peatlands are opened up for productive activities	80,95	Strongly Agree
6	Peatlands are cleared for paddy farming (wetland rice)	78,10	Agree
7	Peatlands are cleared for dryland rice farming	79,05	Agree
8	Peatlands are cleared for oil palm plantations	57,06	Uncertain
9	Peatlands are cleared for rubber plantations	80,66	Strongly Agree
10	Peatlands are planted with forestry crops (timber)	83,70	Strongly Agree
11	Peatlands are utilized for ecotourism	79,05	Agree
12	Peatlands in Central Kalimantan Province have been damaged	72,80	Agree
13	Peatlands are cleared for farming through burning	53,18	Uncertain
14	Uncontrolled canal construction leads to peatland degradation	76,11	Agree
15	Land use changes are a cause of peatland destruction	74,60	Agree
16	Peatland conservation/restoration efforts are being carried out in this village/ area	82,27	Strongly Agree

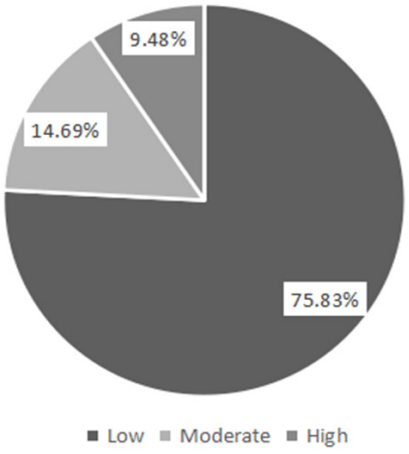


Figure 4. Community participation in peatland management activities

Afriyanti, 2019). Such participation can take the form of labour, ideas, or other resources (Fauzi et al., 2019; Lutpi, 2016; Suhesti & Hadinoto, 2019). A study of the environmental aspects of peat dome restoration and rehabilitation was conducted to assess the level of participation up to the time of this survey. Participation was measured through a survey and then analysed quantitatively.

Based on the figure 4, it is evident that the level of respondent participation in peatland management activities remains low, with 76%, or 160 respondents, not participating. This indicates that most respondents are not involved in peatland management, whether in planning, implementation, utilization, or evaluation. The low level of community participation could suggest that the community is still not engaged in major government programs, particularly those related to peatland management. This result agrees with the low involvement of communities in the peatland rewetting program conducted in Tumbang Nusa Village, Central Kalimantan (Fleming et al., 2024). Research suggested social psychology intervention to increase collaboration and integration between community members in restoration efforts (Brotosuilo et al., 2021). It also stated that peatland restoration actions have to be developed based on ecological, social, and economic principles rather than just limited community knowledge.

Respondents' perception of the role of peatlands as environmental guardians (carbon storage, water, biodiversity) is almost as high as its role as a source of livelihood. Utilization of peatlands also needs to be done more optimally. Although respondents agree that peatlands should be used for cultivating wood and need to be conserved, but they do not participate in managing the peatland. The conversion of peatland to agricultural land still increases. They admit that peatlands are in a damaged condition due to the conversion of peatlands into agricultural land and the construction of canals. Uniquely, this perception is not in line with their involvement in peatland management. It is strongly suspected that the low participation is influenced by economic vulnerability and their capacity to manage peatlands. Vulnerability makes people prioritize the economy over environmental sustainability.

IV. CONCLUSION

This research described the challenges and potential for community participation, both as individuals and groups, in managing the environment around peatlands using PRA (Participatory Rural Appraisal) and socio-economic surveys. This study showed that land use for settlement, agriculture, fisheries, and forestry has been actively passed down through generations. Shifting cultivation, initially practiced with the slash-and-burn technique for land clearing, was phased out in the 2000s due to the recurring forest and land fires that occurred in the 1990s and 2000s. As a result, farming practices turned toward settled agriculture around residential areas, with land being used for farming, home gardens, dryland crops, and forestry, particularly for albazia and rubber trees. However, the insufficient infrastructure and lack of community education on behavioral changes have led to significant environmental pollution around residence areas and agricultural zones, with the risk of contamination spreading to downstream villages. Climate change has altered the timing of, and challenges associated with, the rainy and dry seasons, as well as their transitions. The farmers must modify their planting and harvesting schedules, cope with lower yields, and manage the risk of crop failure from floods or droughts. However, the growing diversity in crops and livelihoods reflects the farmers' ability to adapt to both climate change and the surrounding peatland conditions.

This study also revealed that most respondents rely on market purchases for food, while farming serves as the main occupation, particularly among the indigenous Dayak community. Despite recognizing peatlands' role in carbon storage, water regulation, habitat provision, and livelihood support, community

involvement in peatland management remains low, with 76% not participating. This indicates a lack of community integration in government programs for peatland conservation. Enhancing community engagement in peatland restoration may require integrating ecological, social, and economic principles, as well as psychological interventions to strengthen collaboration among community members in this area.

This research has recorded the chronologic history, land use pattern, adaptation to respond to climate change, and livelihood preferences that encompass society behaviour nowadays. However, the research that was done during the prevalence of the Covid-19 pandemic faced the limited participation of informants on PRA. Fortunately, the online survey successfully gathered data and insights from many respondents, providing valuable information that enhanced the analysis. This study directs further research, including strategies to increase community participation in peatland management, environmental quality concerning potential pollution spread along river flows, and water supply technology for household and agricultural irrigation needss.

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