RT5ELinkages of peatland degradation and rural poverty in development scenarios of peatland restoration

Bella Syakina[1], Radieah Mohd Nor[1], M. Edi Armanto[2]

[1]Centre for Global Sustainability Studies, Universiti Sains Malaysia, 11800 Penang, Malaysia.
[2]Faculty of Agriculture, Sriwijaya University, South Sumatra 30820, Indonesia.

Correspondence: M. Edi Armanto (email: mediarmanto@unsri.ac.id)

Received: 7 November 2023; Accepted: 4 January 2024; Published: 29 February 2024

Abstract

Currently, peatland degradation continues due to drainage for industrial plants (Oil palm and Acacia), so their productivity continues to decline and rural communities are very dependent on peatlands, hence the poverty problem in rural areas remains unresolved. Due to a lack of government policies that adequately recognize the benefits and functions of peatland ecosystems, it seems that the government is adopting a hierarchical and structured approach to planning and permitting peatland degradation, which is contingent upon the growth of rural economic development within these communities. This research aims to analyze the relationship between peatland degradation and rural poverty in peatland restoration development scenarios. This research was conducted between 2020 and 2023 in South Sumatra, Indonesia and the data collected was analyzed using qualitative methods. The real facts indicated that government policies were more in favor of large investors (not rural communities). In these circumstances, rural communities typically operated by the tenet of "first come, first served," making illicit logging and slash-and-burn farming acceptable forms of livelihood. Therefore, in this research compiling concepts and linkages of agricultural land degradation and rural poverty is the way to solve the problems. The government needs to restore them utilizing three key development scenarios, namely revegetation; revitalization; and empowering local farmers.

Keywords: Degradation, local wisdom, native species, restoration, scenarios, triggers

Introduction

Theoretically, the ecosystem of peatlands is naturally stable and tends to get thicker with more peat; nevertheless, if the natural conditions are disturbed, the peatlands are readily damaged and eventually disappear (Byg et al., 2023; FAO, 2022). Most peatlands have been drained for plantation industry (Oil palm, Acacia) and agricultural purposes in a broad sense. Peatlands are extremely sensitive to hydrological changes due to changes in land use, and climate, as well as ignoring conservation principles (BRGM, 2022). Peatlands provide habitats for a variety of unique species of plants and animals, store a lot of carbon, and have a great capacity to hold water, which makes them hydrological buffering zones for the surrounding area (IPS, 2023; Holidi et al., 2019).

Peatlands are often sparsely populated, making them a preferred choice for plantation companies to minimize conflicts among peatland users. Large concession areas have been awarded since the 1980s, converting peatland ecosystems into drained and canalized landscapes (Parish et al., 2021). Numerous peatlands have been drained and degraded as a result of ongoing, heavy drainage for logging, plantations, and regional agriculture (Armanto et al., 2023a, 2023b). Peat fires are seen as a systemic danger that demonstrates how several hazards to the environment, human health, climate, and socio-economic outcomes are interconnected (Ribeiro et al., 2021). These systemic risks are situated at the nexus of environmental phenomena (El Niño), socio-economic development (agricultural), and policy-driven activities (plantations). Thus, peatland fires pose serious systemic dangers to the entire world as well as local and national concerns to the environment, economy, and humanity (Lourenco et al., 2022; Armanto et al., 2022).

Rewetting activities, building canal blocks, and filling canals, the most crucial components from a hydrological perspective are the first steps in the restoration of peatlands. The water level might rise when channels are properly blocked (Armanto, 2019a; 2019b). To purposefully rewet the peatlands, these actions must be taken throughout the ecosystem of the Peat Hydrological Unit (PHU) as an integrated water management system. Peatlands will be less vulnerable to fire risk by decreasing drying. Revegetation is required to finish the biophysical regeneration of the peatlands after rewetting. The next step is to restore rural livelihoods to lessen community strain on rewetted peatlands (Wildayana & Armanto, 2021).

Even though numerous attempts have been made to address the issue of peatland restoration, the results have not been satisfactory, and peatland degradation has persisted ever since (Wildayana et al., 2019). In connection with the problems above, this research aims to analyze the relationship between peatland degradation and rural poverty in peatland restoration development scenarios.

Method and study area

Time and sites of research

The research was carried out from 2020 to 2023 and was conducted in South Sumatra Province, Indonesia which is geographically located between 1-4º South Latitude and 102-106º East Longitude (Figure 1).

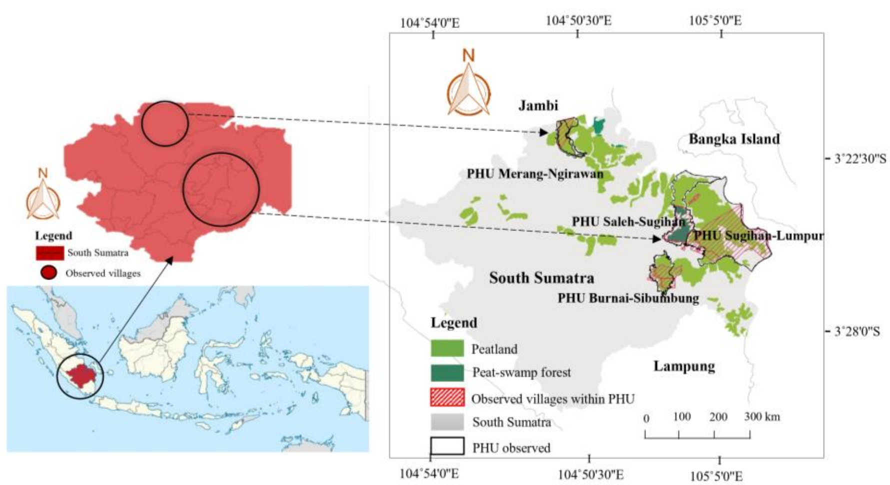


Figure 1. Research location in South Sumatra Province, Indonesia

Interview of respondents

Four PHU plots were purposefully sampled for collecting biophysical, socioeconomic, and cultural data, as well as spatial, qualitative, and quantitative data, then examined, synthesized, and cross-checked with stakeholders. A total of 525 households were interviewed, which represents 15% of the entire 3,500 population of peatland households. The respondents were drawn from three villages chosen for each PHU, resulting in a total of 12 selected villages. The interview scope was on questions about linkages of peatland degradation and rural poverty in development scenarios of peatland restoration. Key informants from important institutions involved in the governance cycle (planning, implementation, monitoring, and evaluation) of peat restoration and related stakeholders were chosen through interviews using purposive and snowball sampling strategies. The interview subjects were derived from the conceptual framework list.

Data collection method

The summary of data collection methods can be seen in Figure 2, both primary and secondary information will be used for this research. Primary information will be collected during the field study, applying qualitative research methods. For secondary information, scientific articles, reports, and documentation of the government will be used. The qualitative method seeks to learn about the conditions of a specific degradation caused by the use of peatlands, as well as thoughts and opinions regarding degradation that has occurred in peatlands.

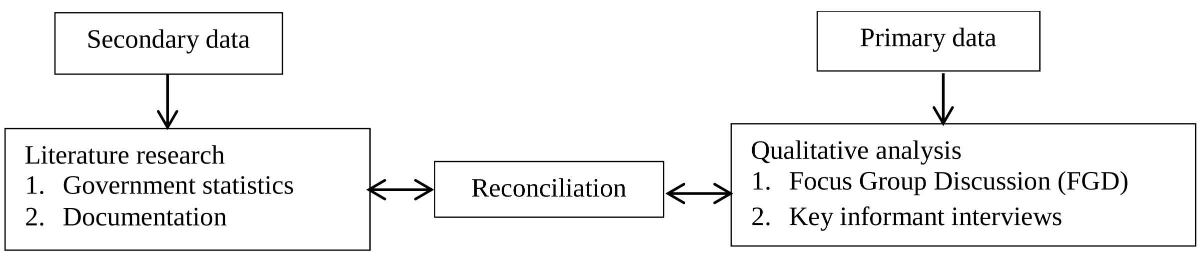


Figure 2. Diagram of data collection method

Data analysis

This research used descriptive analysis. All information gathered was typed (other field notes), scanned (examination of printed papers), or included in questionnaires, for example, including interview findings. Excel software was then utilized to give a more thorough content analysis once the data had been coded according to various parts of the conceptual framework. The SPSS program was used to digitally gather, process, and assess data. Tables, graphs, descriptions, and narratives are used to show the results.

Transcripts from interviews, policy papers, and reports were all used in the first coding session. Vulnerabilities in the governance cycle of peatlands management, particularly in restoration, were examined. The risk governance phases of the peat restoration governance cycle were examined in the second coding session. The governance mechanisms of peatlands were next examined in the third coding session. The outcomes of the geographical analysis and field measurements were integrated with this analysis. The interrelationships among the various parts were thoroughly examined and cross-checked using program reports, policy documents, transcripts from interviews, and geographic data.

Results and discussion

Economics and spatial planning triggering degradation of peatlands

Aspects of economics triggering the degradation of peatlands are divided into two categories, namely microeconomics and macroeconomics. Microeconomics is based on the local economy of farmers (subsistence) and has direct contact with peatland degradation. This means that all agricultural activities were carried out by farmers on peatlands and had a direct impact on peatland degradation (Table 1). Important variables influencing peatland degradation are education level; income of farmers; prices of agricultural inputs; land tenure; prices of agricultural products; and wages of off-farm. Subsistence farmers did not only act as microeconomic actors but also as holders of peatlands management. This result was also stated by other workers (Wildayana & Armanto, 2018b, 2018c).

Table 1. The scope of micro economy triggering degradation of peatlands

Variable	Variable increase impacts		Specific descriptions
	Real facts	Analyses	
Education	Lower	Lower	By mastering science and technology, farmers can increase their awareness of managing their peatlands better.
Income of Farmers	Intensify	Indeterminate	Farmers' incomes briefly rise as a result of a general increase in agricultural activity on peatlands (e.g., the sonor system).
Prices of agricultural inputs	Mixed	Indeterminate	Rising prices of pesticides and fertilizers can trigger a decline in farmers' interest in farming, and trigger peatland degradation because farmers take other alternatives by burning crop residues to make fertilizer. Burning crop residues is dangerous for the environment.
Land tenure	Small evidence	Intensify	Claiming land rent in the future can provide additional income for farmers to clear land.
Prices of agricultural products	Intensify	Intensify	Increasing or stable prices of agricultural products can trigger farmers to do more farming.
Wages of off-farm	Lower	Lower	Generally, farmers do not have enough free time to carry out activities outside of farming.

Source: Results of field survey analyses, 2023

Macroeconomics covers activities on a large scale, including industrial activities, infrastructure, agriculture, and large-scale plantations. Due to the large scale, the main macroeconomic actors are the government and large investors because the government makes regulations and policies to implement activities on all peatlands, and large investors have strong capital to manage peatlands. The macroeconomic impact on peatland degradation was categorized as slow, but influential, had a broad, global impact, and was difficult to manage unless the macroeconomic actors themselves created policies that support the environment. This means that when these activities are carried out, the impact of degradation little by little has a global effect. Long-term effects on the degradation of peatlands at the in-situ level up to the national level will come from an increase in macroeconomic activity. This is related to the work results of Zahri et al. (2018; 2019). The degrading of peatlands is influenced by several macroeconomic factors, including population pressure, industry and housing, employment possibilities, economic growth, and government laws (Table 2).

Table 2. The scope of the macro economy triggering degradation of peatlands

Variables	Variable increase impacts		Specific descriptions
	Real facts	Analyses	
Rules of Governments	Lower	Lower	Peatlands conservation zones with a depth of > 3 m must be provided by investors.
Industry and housing	Intensify	Intensify	Impermeable layers are caused by compaction and subsidence of the land surface due to land conversion to non-agricultural use.
Work opportunity	Lower	Lower	Increasing work opportunities outside of agriculture could reduce farmers' interest in cultivating peatlands.
Economic growth	Mixed	Indeterminate	Increased income will be followed by increased demand for agricultural products, market access, and employment outside of agriculture.
Innovation & technology in agriculture	Mixed	Indeterminate	Technology and innovation can lower the cost of agricultural products, raise farmer incomes, and lower bank interest rates, that is, if they don't also lower the labor and/or capital intensity of the improvements.
Pressure of population	Increase	Increase	The dense population harms pressure and degradation of peatlands, especially in rural areas.

Note: */ It is based on secondary data and may be changed temporally
Source: Results of field survey analyses, 2023

Complex regional planning has a direct impact on the degradation of peatlands because it requires an enormous amount of labor in these areas, which is closely related to macroeconomics. Development that is not in line with the area's spatial designation for example, peatlands with a depth of more than 3 m should only be designated as a protected area, not as an industrial plantation concession is the primary cause of peatland degradation as seen from the perspective of spatial planning (Oil palm and Acacia). Dryland plant species like Oil palm and Acacia are not suitable for peatlands; if they are planted there, drainage measures must be taken to lower the Groundwater Table (GWT), which will lower Oil palm plant productivity and degrade the peatlands (Table 3).

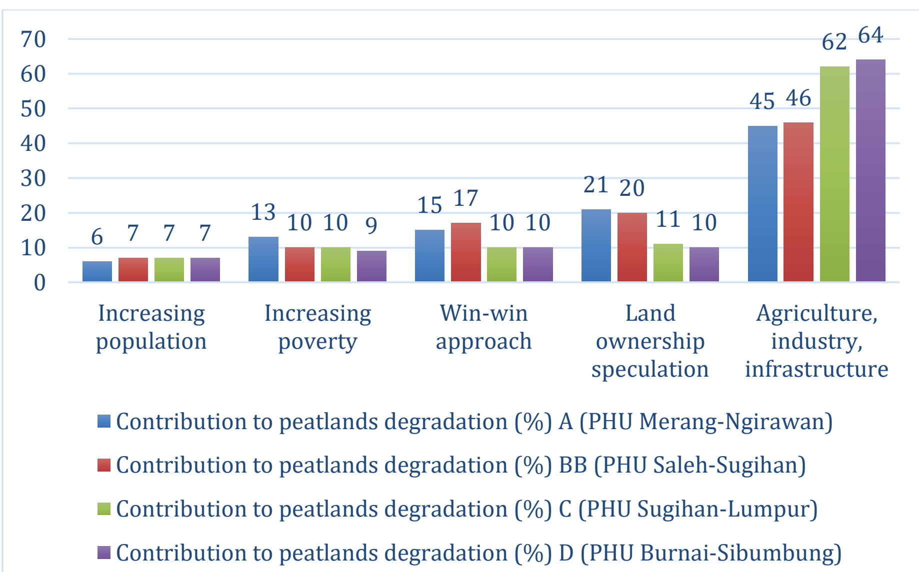
The central government created regional spatial planning regulations, which are then carried out by regional governments through regional regulations (Perda). Communal areas and investors frequently disregard agreed-upon spatial plans. Finding out in the field that previous spatial planning is frequently updated in the event of a violation was an intriguing discovery. This is obviously at odds with the fundamental idea of spatial, which states that each construct must adhere to the area that it is designated for. The actual data demonstrated that development decisions were made after considering spatial planning. These factors regional planning and economics were intricately linked and had a significant impact on the degradation of peatlands. The above statements are integrated into Sjarkowi's work (2007).

Table 3. The scope of regional planning triggering degradation of peatlands

Variables	Variable increase impacts		Specific descriptions
	Real facts	Analyses	
Agricultural expansion	Intensify	Intensify	Agricultural expansion triggers continuous clearing of peatlands.
Transmigration	Intensify	Intensify	The transmigration program requires clearing land for housing and agricultural land.
Acacia	Mixed	Indeterminate	Acacia can reduce peatland degradation through replanting systems, but Acacia can increase greenhouse gases (ecosystem degradation) through monoculture species.
Oil palm	Intensify	Intensify	Oil palm can trigger CO_2 gas emissions and due to excessive drainage can lower groundwater levels.
Rubber	Intensify	Intensify	Rubber cultivation on peatlands causes groundwater levels to drop, making the soil dry and flammable.
Infrastructure (roads, bridges)	Intensify	Intensify	Roads and bridges facilitate easy access, thereby motivating everyone to enter and welcome peatlands.

Source: Results of field survey analyses, 2023

A conceptual classification of the reasons behind the degradation of peatlands was done, taking into account the proportion of the peatlands area impacted by development. Because each component has an integrated influence and is related to every other component, this clustering is required. The preparation seeks to make it easier to comprehend the factors that lead to the degradation of peatlands. The primary factors contributing to the degradation of peatlands are population growth, rising rates of poverty, win-win strategies, security of land ownership, infrastructure development, and agricultural expansion, according to data from field surveys that were analyzed by FGD and interviewed respondents (Figure 3).



Source: Field survey results analysis, 2023

Figure 3. Clustering contributions of peatland degradation

Increasing population was found to be the factor with the least influence on peatland degradation with a contribution of around 6-7%. The small contribution of this factor was because peat areas were isolated areas and part of the workforce left the village (migration) in search of a more decent life. Currently, the majority of the population (> 67%) in peat areas is inhabited by women, children, and elderly people aged over 60 years.

Increasing poverty's contribution was also relatively small (around 9-13%). The poverty factor made it relatively difficult for local communities to gain access to work, so they cultivated peatlands as their main source of livelihood. However, for the last 30 years, the poverty factor has not changed and remains poor, so this factor was less dominant in contributing to peatland degradation.

The win-win approach played a role of around 10-17%, this factor was played by government policies, village officials, and large-scale investors in determining development priorities on peatlands. The win-win approach also occurred because of social jealousy between local communities and large investors who use peatlands for industrial plantations (Oil palm, Acacia), so they used the sonor system to get food. Most social jealousies triggered forest fires, which caused total peatland degradation.

Land ownership speculation played a relatively high role, ranging from 10-21%, the perpetrators of this factor were dominated by immigrants from outside the peat area and village leaders who tried to speculate on peatlands. Any operation on peatlands to demonstrate to others that the land is theirs is considered speculation (security of peatlands ownership). Sometimes their activities were not aimed at producing agricultural products, but simply marking the peatlands they own. These peatlands were frequently claimed as owned without any supporting documentation, such as a land certificate. Land speculators purchase land solely to maintain control over the peatlands; afterward, the area will be made available to major investors, who will establish plantation enterprises and sell them at a higher price.

The most dominant factors influencing peatland degradation were Agriculture in the broadest sense (plantations and forestry), industry, and infrastructure development which played a role of 45-64%. The closer to the district capital (such as PHU Burnai-Sibumbung), the more dominant this factor played a role. Moreover, there was now an increase in the need for housing and expansion of agricultural land to meet the need for food and wood for industry, infrastructure, and housing. The government's initiative to advance regional planning gave rise to agricultural infrastructure and expansion. Degradation of peatlands can result from this activity in the form of soil compaction, peat sinking, and decreased water-holding capacity. Before infrastructure was constructed, clearing land by burning peatlands was the simplest method. This result is relevant to the works of Armanto & Wildayana (2022, 2023) there's no doubt that this might degrade peatlands.

Scenarios and linkages of peatland degradation and rural welfare

There are nine scenarios for peatland restoration with rural welfare (Sjarkowi, 2007), which can be grouped based on the peatlands resource phenomenon (Table 4), namely: (1) Damaging peatlands resources (S1, disaster; S2, useless; S3, tactic); (2) Does not damage peatlands (S4, septic; S5, static; S6, strategic); and (3) Improving the quality of peatlands (S7, volunteer; S8, happy; and S9, dream). Table 5 explains examples of species recommended in this scenario which were aimed at achieving peatland restoration scenarios (dream, strategic, or happy) as priority 1, 2, and 3 respectively.

Cage Fish Farming was one of the local wisdoms of the community in the field of fisheries resources through an auction system and fish cultivation which has been inherited from generation to generation and has been proven to be able to contribute to the sustainable use of fisheries resources. The results of identifying potential threats show that river waters that have auction status have relatively tolerable potential threats compared to non-auction-status water areas.

Table 4. Scenarios between peatland restoration and rural welfare

Scenarios	Description
S1 (disaster) FW (-) PR (-)	It is a form of interaction between environmental changes in peatlands (PR) and rural welfare (FW), where the use of peatlands has the impact of reducing rural welfare (FW-) and causing damage to the quality of peatlands (PR-).
S2 (useless) FW (0) PR (-)	A form of interaction where rural welfare remains relatively unchanged (FW0), but on the other hand there is damage to the peatlands (PR-).
S3 (tactic) FW (+) PR (-)	An interaction where the use of peatlands has a positive impact on rural welfare (FW+), but has a negative impact on reducing the quality of peatlands (PR-).
S4 (sceptic) FW (-) PR (0)	Interaction conditions where the use of peatlands has a negative impact on reducing rural welfare (FW-), but is unable to improve the quality of peatlands (PR0).
S5 (static) FW (0) PR (0)	This is a form of interaction where the use of peatlands has proven to be relatively unsuccessful in improving rural welfare (FW0) and does not reduce the quality of peatlands (PR0).
S6 (strategic) FW (+) PR (0)	This is a form of interaction where the use of peatlands can improve rural welfare (FW+), but these efforts are not able to improve the quality of peatlands (PR0).
S7 (volunteer) FW (-) PR (+)	Description of the interaction where the use of peatlands has an impact on reducing the quality of rural welfare (FW-), even though this use has an impact on improving the quality of peatlands (PR+).
S8 (happy) FW (0) PR (+)	The form of interaction where the use of peatlands is proven to be unable to improve rural welfare (FW0), even though this use has an impact on improving the condition of peatlands quality (PR+).
S9 (dream) FW (+) PR (+)	A form of interaction where the use of peatlands is proven to be able to improve rural welfare (FW+), and on the other hand can improve the quality of peatlands (PR+).

Note: FW (Rural welfare); PR (Peatland degradation). The shadowed box indicates the presence of local wisdom

Honey bees are one of the local wisdoms of the community in the field of honey bee farming, which is a legacy passed down from generation to generation and has been proven to be able to contribute to the sustainable use of peatland resources. This Honey bee cultivation was also discovered by Wildayana et al. (2019). The results of identifying potential threats show that honey bee farming has relatively tolerable potential threats compared to other commodities.

Sago cultivation is one of the local wisdoms of the food sector because the consumption of sago flour is the second highest after wheat. Sago flour is also a substitute for the staple food rice, has been passed down from generation to generation, and has been proven to be able to contribute to the sustainable use of food resources. Sago cultivation also has a low potential threat of crop failure. This was also found by other workers (Alikhani et al., 2021).

Table 5. Recommended species for each scenario of peatland restoration

PR/FW	FW (-)	FW (0)	FW (+)
PR (-)	S1 (disaster); Fishing with batteries and poison, burning	S2 (useless); Illegal logging	S3 (tactic); Oil Palm and Acacia cultivation
PR (0)	S4 (sceptic); Sonor system	S5 (static); Purun moven, wild animal hunting	S6 (strategic); Tapping Jelotong, sap, resin, Gaharu, and fish auction
PR (+)	S7 (volunteer); Protected forest, wildlife preservation	S8 (happy); Pineapple and Aloe vera cultivation	S9 (dream); Honey bee, Sago cultivation, cage fish farming

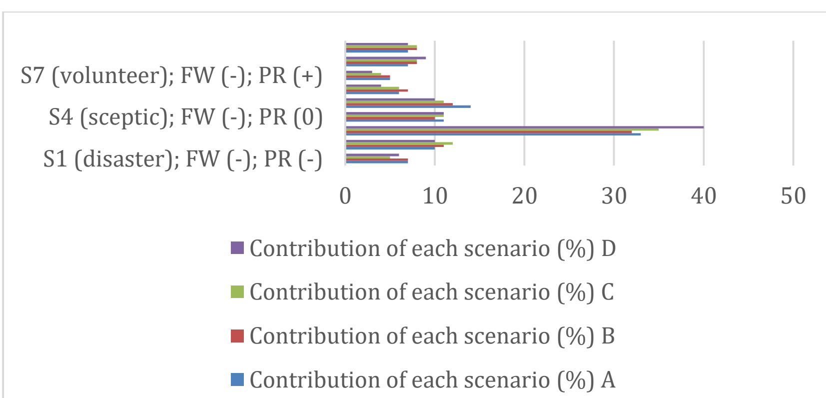
Note: FW (Rural welfare); PR (Peatland restoration). The shadowed box indicates the presence of local wisdom

Environmental engineering maintains the existence of this system through the social development of the community to maintain traditions passed down from generation to generation as ancestral heritage full of wisdom. The existence of this tradition will continue to contribute to the sustainable use of fisheries resources in the peatlands area. Environmental Engineering to change the pattern of using mobile fishing gear to permanent aquaculture can be done by imposing taxes on catches, so it is hoped that farmers will slowly switch to a fixed aquaculture pattern to avoid additional fishing costs.

Developing scenarios of peatland restoration

There are nine possible peatland restoration scenarios with rural poverty, so the research results can be concluded in Figure 4. It turns out that all research locations are dominated by the tactical scenario (S3), with the main commodities being Oil Palm and Acacia.

Even though plantation industries were able to improve rural welfare (FW+), these efforts were unable to improve the quality of peatlands (PR0) because these two commodities were not native peat swamp commodities (peat native plants), because both commodities require continuous drainage (drying). so that the groundwater level drops by less than – 50 cm). This drainage action was the forerunner to continuous peatland degradation. Therefore, there was no other way, if peatlands were to be saved, then the expansion of plantation industries must be reduced. Table 6 outlines several scenarios efforts to achieve the peatland restoration scenarios and is expected to achieve dreams of dream (S9), strategic (S6), or happy (S8) respectively as priorities 1, 2, and 3.



Note: A (PHU Merang-Ngirawan); B (PHU Saleh-Sugihan); C (PHU Sugihan-Lumpur) D (PHU Burnai-Sibumbung). The shadowed box indicates the presence of local wisdom.
Source: Field survey results analysis, 2023

Figure 4. Nine possible peatland restoration scenarios

Table 6. Some efforts to achieve the peatland restoration scenarios

Scenarios	Some efforts to achieve the peatland restoration scenarios
S9 (dream)	1) Management with non-attenuated property rights
	2) Development of existing community-based activities supported by clear peatlands zoning
	3) Fostering the restoration of traditions as a legacy for generations of local communities
	4) Maintaining the sustainability of peatland areas
S6 (strategic)	1) Fostering the local farmers' livelihood businesses.
	2) Cultivating cage fish farming and indigenous species
	3) Maintaining the existence of farmers, so that they do not switch to clearing peatlands
	4) Empowering the local communities in the field of education
S8 (happy)	1) Cultivating cage fish farming and indigenous species
	2) Socializing the function of peatland areas for the production of honey, sago, and fisheries
	3) Maintaining the capacity of existing peatlands
	4) Empowering the local communities in the field of education

Source: Field survey results analysis, 2023

In peatlands forest agroecosystems that are isolated and have relatively closed socio-economic conditions, rural poverty, and peat degradation, it is tended to be factors that were closely interconnected and influenced each other. From the standpoint of poverty, hard times and low family incomes drove more people to participate in large-scale illicit logging, which can ultimately disrupt a variety of ecological functions and increase the susceptibility of agricultural ecosystems to fire. It can be shown that the scenario places more emphasis on destroying or destroying peatland resources (S1, disaster; S2, useless) and it is similar to Sjarkowi (2006).

The interplay of four primary elements: hydrological conditions, plant and animal life, peat properties, and C-peat deposits defines the ecosystems of peatlands. The opening of peat dome vegetation damages the peat hydrology, which in turn causes a decrease in the peat soil's surface and an increase in peat breakdown and C loss in the peat dome. Peatland fires are occurring more frequently as a result of all of these variables combined with the climatic changes they bring about.

However, when they spread throughout the ecosystem, big peatlands and forest fires would negatively affect communities and agricultural land, increasing the likelihood of drought and flooding. Investigating the socio-economic response to programs based on agriculture or non-agriculture to reduce poverty is therefore urgently needed. Furthermore, the management of peat restoration needs to be planned properly to accommodate the zoning of the peatlands as well as the availability of domestic manpower.

Peatland restoration based on rural phenomena

In peatlands (< 1.0 m depth, and hemic and sapric maturity), various agricultural plants can grow productively as long as appropriate and appropriate water management is carried out. However, empirical data shows that the income earned from agricultural land is rarely enough to support the family's growing needs and expenses. There are three reasons underlying this, namely: (1) Low agricultural productivity which tends to be unresponsive to current peatlands agronomic developments; (2) Agricultural commodity prices are unstable and unresponsive to the market with limited demand from small regional populations and agro-industry; and (3) Poor transportation infrastructure to generate income for small farmers but unresponsive to changes in transactional prices and it is also in line with Sjarkowi (2006).

A common query is whether small farmers can effectively engage in peatland restoration management programs to combat rural poverty and lessen social unrest. The attainment of technical and social goals centered around peatlands is undoubtedly challenging. There exist five primary barriers that prevent small farmers from participating in peatland restoration mechanisms: (1) insufficient knowledge about the instability of peatland agroecosystems; (2) unclear tenure; (3) absence of commercial economies of scale; (4) insufficient institutional capacity; (5) lack of access to rural infrastructure; and (7) lack of medium-term credit.

The following will eventually become evident: (1) Seasonal mixed farming can reduce risks and boost farmers' income sources; and (2) Seasonal and annual crops, including tree cultivation, can isolate the negative effects of increased land conversion brought on by boomerang land expansion. Other employees likewise demonstrated this outcome (Wildayana & Armanto, 2018a).

Restoration of peatlands for agricultural purposes implies that any agricultural activity on peatlands must not be aimed solely at agricultural production; but rather for various purposes in the production of food and non-food products. This is so that ecosystem recovery will probably be aided by the increases in forest cover brought about by these actions. Three operational assumptions need to be taken into consideration when designing an ecosystem engineering strategy for degraded peatlands:

1) It is necessary to focus agricultural efforts on planting paludiculture and food production on shallow peatlands that are situated at the peatlands' margin. In addition to taking into account the requirement to enhance soil structure, ecology, and function, the combination of agronomic and silvicultural treatments should aim to optimize the advantages of the chosen crop mix.
2) Only naturally occurring plants that thrive in that environment should be used to revegetate peat domes in degraded environments. In addition to sago, peatlands support the healthy growth of *Shorea balangeran*, Honey bees, fisheries, and Tumeh (*Combretocarpus rotundatus*).
3) The application of tree plants for peat dome revegetation is done gradually, beginning at the dome's edge and working your way inward. Rubber plantations can be used to substitute hard crop cultivation to reduce poverty (*Hevea brasiliensis*).

At the moment, pressures for regional development that aim to exploit these ecosystems more profitably constitute a constant threat to the lives of local communities that live in and around peatlands ecosystems. Existing peatlands are frequently viewed as a supply of land for the next generation to cultivate by small, disorganized farmers who reside in rural locations with poor market accessibility and a dearth of creative agribusiness. If this occurs, there will probably be disagreements among stakeholders over who has access to natural or planted wood so it can be used for agricultural purposes. People typically work on a "first come, first served" basis in circumstances such as these, making illicit logging and slash-and-burn farming which includes sonor rice farming seem like legitimate sources of income. This result was indicated by other workers (He et al., 2023; Armanto et al., 2013).

Conclusion

Government policies and economic changes influence the development of peatlands, thus any decisions made on how to use them must come from the government. Because of insufficient government policies addressing the benefits and functions of peatland ecosystems, it appears that the government has a hierarchical and structured approach to planning and programming peatland degradation, depending heavily on the growth of rural communities' economies. At the moment, peatlands require restoration by the government for them to be sustainable indefinitely. Three important conclusions regarding the linkages of peatland degradation and rural poverty in development scenarios of peatland restoration, namely:

1) The vicious cycle of poverty in rural areas and peat degradation is common in degraded peatland ecosystems. To promote tree crop farming intended to create revenue and restore peatlands, food crops, and tree crop farming are necessary on a socio-economic level.
2) To encourage local institutions to restore the ecosystems of peatlands to conserve a variety of traditional but sustainable livelihoods and simultaneously enhance agroecological conditions for the benefit of non-tree crop farming, a socio-economic approach is crucial.
3) Agricultural systems based on pastures need to be planned for both socio-ecological and socio-economic factors. The development of small-scale agroforestry systems necessitates the ability of small-scale market-based agroindustry to offer value addition and contribute to more equitable and stable product prices.

Acknowledgement

The authors would like to express their thanks to colleagues and students who have helped with this research. Thanks are also addressed to local people who have facilitated research in the field.

References

Alikhani, S., Nummi, P., & Ojala, A. (2021). Urban wetlands: A review on ecological and cultural values. *Water, 13*(22), 1-47.

Armanto, M. E. (2019a). Comparison of chemical properties of peats under different land uses in South Sumatra, Indonesia. *Journal of Ecological Engineering, 20*(5), 184-192.

Armanto, M. E. (2019b). Improving rice yield and income of farmers by managing the soil organic carbon in South Sumatra Landscape, Indonesia. *Iraqi Journal of Agricultural Sciences, 50*(2), 653-661.

Armanto, M. E., & Wildayana, E. (2022). Accessibility impact to government programs on the household income contribution at the various livelihood sources of farmers. *Agriekonomika Journal*, *11*(1), 62-75.

Armanto, M. E., & Wildayana, E. (2023). Predictive mapping for soil pH and Phosphate based on kriging interpolation. *International Conference on Sustainable Environment, Agriculture and Tourism (ICOSEAT), Advances in Biological Sciences Research 26*, 254–262.

Armanto, M. E., Adzemi, M. A., Wildayana, E., & Imanudin, M. S. (2013). Land evaluation for paddy cultivation in the reclaimed tidal lowland in Delta Saleh, South Sumatra, Indonesia. *Journal of Sustainability Science and Management*, *8*(1), 32-42.

Armanto, M. E., Hermawan, A., Imanudin, M. S., Wildayana, E., Sukardi, & Triana, A. N. (2023a). Biomass and soil nutrients turnover affected by different peat vegetation. *Journal of Wetlands Environmental Management, 11*(1), 31-42.

Armanto, M. E., Wildayana, E., & Syakina, B. (2023b). Deciphering the anthropogenic challenges of peat swamp forest degradation to improve awareness and emphasis on restoration in South Sumatra. *Forestry Ideas, 29*(2), 207–215.

Armanto, M. E., Zuhdi, Mohd., Setiabudidaya, D., Ngudiantoro, Wildayana, E., Hermawan, A., & Imanudin, M. S. (2022). Deciphering spatial variability and kriging mapping for Soil pH and groundwater levels. *Journal of Suboptimal Lands (JLSO), 11*(2), 187-196.

BRGM (Badan Restorasi Gambut dan Mangrove). (2022). Laporan Kinerja Badan Restorasi Gambut dan Mangrove 2022.

Byg, A., Novo, P., & Kyle, C. (2023). Caring for cinderella - Perceptions and experiences of peatland restoration in Scotland. *People Nature, 5*(2,) 302–312.

FAO. (2022). Peatlands and climate planning – Part 1: Peatlands and climate commitments. Rome.

He, N., Yan, P., Liu, C., Xu, L., Li, M., Van Meerbeek, K., Zhou, G., Zhou, G., Liu, S., Zhou, X., Li, S., Niu, S., Han, X., Buckley, T. N., Sack, L., & Yu, G. (2023). Predicting ecosystem productivity based on plant community traits. *Trends in Plant Science*, *28*(1), 43–53.

Holidi, Armanto, M. E., Damiri, N., & Putranto, D. D. A. (2019). Characteristics of selected peatland uses and soil moistures based on TVDI. *Journal of Ecological Engineering, 20*(4), 194-200.

IPS (International Peatland Society). (2023). In what is peat? International Peatland Society: Jyväskylä, Finland. https://peatlands.org/peat/peat (accessed on 14 March 2023).

Lourenco, M., Fitchett, J. M., & Woodborne, S. (2022). Peat definitions: A critical review. *Progress in Physical Geography*, *47*, 506–520.

Parish, F., Lew, S. Y., & Hassan, A. H. M. (2021). National strategies on responsible management of tropical peatland in Malaysia. In Osaki, M., Tsuji, N., Foead, N., Rieley, J. (Eds) *Tropical Peatland Eco-Management* (pp. 677–723). Springer.

Ribeiro, K., Pacheco, F. S., Ferreira, J. W., de Sousa-Neto, E. R., Hastie, A., Krieger Filho, G. C. K., Alvalá, P. C., Forti, M. C., & Ometto, J. P. (2021). Tropical peatlands and their contribution to the global carbon cycle and climate change. *Global Change Biology, 27*(3), 489–505.

Sjarkowi, F. (2006). Is Poverty Eradication Possible in Peatland Areas of Central Kalimantan? Proceedings of the International Symposium on Peatland Development, September, Central Kalimantan, Palangkaraya.

Sjarkowi, F. (2007). Conceptual framework towards social forestry management unit (SFMU). Jurnal SUPK (Satuan Usaha Perhutanan Kerakyatan). Edisi Khusus Agustus, Jaringan Komunikasi PASAKBUMI, Palembang, Indonesia.

Wildayana, E., & Armanto, M. E. (2018a). Dynamics of landuse changes and general perception of farmers on South Sumatra Wetlands. *Bulgarian Journal of Agricultural Science*, *24*(2), 180-188.

Wildayana, E., & Armanto, M. E. (2018b). Formulating popular policies for peat restoration based on livelihoods of local farmers. *Journal of Sustainable Development*, *11*(3), 85-95.

Wildayana, E., & Armanto, M. E. (2018c). Utilizing non-timber extraction of swamp forests over time for rural livelihoods. *Journal of Sustainable Development, 11*(2), 52-62.

Wildayana, E., & Armanto, M. E. (2021). Empowering indigenous farmers with fish farming on South Sumatra Peatlands. *Jurnal HABITAT, 32*(1), 1–10.

Wildayana, E., & Armanto, M. E., Zahri I., Adriani, D., & Syakina, B. (2019). Socio-economic factors causing rapid peatland degradation in South Sumatra. *Sriwijaya Journal of Environment*, *3*(3), 87-95.

Wildayana, E., Armanto, M. E., Idrus, Z., Radiatmoko, I. A., Umar, S. A., Syakina, B., Oktavia, R., & Sari, E. (2018). Surviving strategies of rural livelihoods in South Sumatra farming system, Indonesia. *The 1st Sriwijaya International Conference on Environmental Issues 2018(1 st SRICOENV 2018), E3S Web of Conferences, 68*, 02001.

Zahri, I., Wildayana, E., Thony Ak, A., Adriani, D., & Harun M. U. (2019). Impact of conversion from rice farms to oil palm plantations on socio-economic aspects of ex-migrants in Indonesia. *Agricultural Economics-Czech, 65*(12), 579–586.

Zahri, I., Adriani, D., Wildayana, E., Sabaruddin., & Harun, M. U. (2018). Comparing rice farming appearance of different agroecosystem in South Sumatra, Indonesia. *Bulgarian Journal of Agricultural Science, 24*(4), 189-198.