Improved Peatlands Potential for Agricultural Purposes to Support Sustainable Development in Bengkalis District, Riau Province, Indonesia

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Abstracts: Bengkalis District in Riau Province, Indonesia, has potential peatlands covering 647,962.26 ha or 76.05% of its total land area. Peatlands not only have a function as direct life support, especially by providing area for agricultural purposes, but also ecological functions, such as flood and global climate control. Peatland areas will be arduous to restore if damaged. This condition certainly has negative impacts on the socio-economic aspects of the people living in the surrounding areas in particular. Sustaining the function of peatlands for the ecosystems essentially requires a detailed review of spatial feasibility and socio-economic impacts of peat swamp reclamation. Plants that have been cultivated on peatlands by the community are palm oil, rubber, coconut, coffee, and areca catechu (pinang). On wetlands, in particular, people do sago farming. One of the problems encountered in the utilization of peatlands is the low level of community participation in the development of peatland management policies. As a result, the implementation of these policies is still conflicting, prone to dispute and hard to do.

Keywords: peatland, pre-eminent commodity, sustainable, ecological services

1. Introduction

Bengkalis District located in Riau Province, Indonesia, has potential peatlands covering 647,962.26 ha or 76.05% of its total land area. Utilizing peatlands that have specific and fragile characteristics has now become a necessity because of several reasons, including: 1) the community need for land is increasing in line with the population growth and changes in its life patterns; 2) Peatland has the potential to be developed into agricultural land for several commodities; and 3) Appropriate technology to be applied in the peatland development is available, which considers the socio-economic aspects as well, although sometimes it still requires high-tech input and quite considerable investment.

On the other hand, peatlands not only have function as direct life support, especially by providing areas for agricultural purposes, but also ecological functions, such as flood and global climate control. Peatland areas will be arduous to restore if damaged, and this condition will inevitably have negative impacts on the socio-economic aspects of people living in the surrounding areas in particular. Thus, to sustain the function of peatlands for the ecosystem, the Government of Bengkalis District should necessarily conduct a detailed review of spatial feasibility and socio-economic impacts of peat swamp reclamation (depth <300 cm). Studies related to the use of peatlands have been carried out by among
Considering these reasons, the agricultural development on peatlands in Bengkalis District should definitely be based on land suitability or its typology. In addition, introduction of new technology should be supported by appropriate socio-economic and institutional conditions. In fact, agricultural activities on peatlands are not supported by appropriate institutions, and adequate facilities and infrastructure. Therefore, successful development of agricultural business in peatlands should begin with identification and characterization of the area that will be cultivated in order to obtain thorough information about the biophysical condition of the land, level of farming technology, socio-economic and institutional conditions as well as obstacles in the land development encountered in each region. This knowledge will be used for directing the development of farming technology in peatlands, which is expected to be based on sustainable development.

Every development conducted in Bengkalis District should refer to the Riau development program, because regional development is determined considerably by the potential of an area. Policies established by the local government should take into account the local potential that can be developed, especially in the agricultural sector. The potential includes: 1) horticultural crops; 2) plantation crops; 3) fisheries; 4) animal husbandry; 5) mining; 6) industrial sector; and 7) tourism. Development of the agricultural sector should be largely led to the agrobusiness and agro-industry systems that are based on sustainable development. This approach will be able to increase the added value of the agricultural sector, which may essentially increase the income of the local agrobusiness and agro-industry actors.

This study was carried out to prepare a meticulous planning on agricultural management in peatlands, especially management of food crops, vegetable and fruit horticulture, so it was expected to result in, among others: 1) An increase in production and productivity of peatlands which is ultimately increase peatland farmers’ income; 2) Creation of environment-based agricultural business along with the improved welfare of rural society living in peatlands. Studies on commodities suitable to grow on peatlands were, among others, conducted by: Asmit et al (2015), Syahza et al (2017, 2018), Syahza (2019), Michler et al(2019), Prastyaningsih et al (2019). According to Yanti et al (2018), to maintain the ecosystem balance in peatlands, it is necessary to establish communication among the stakeholders. Glenk et al (2018), suggested that peatland restoration offered an opportunity to secure and improve services for the critical ecosystem provided by peatlands, such as carbon storage, water retention and maintenance of water quality, as well as support for biodiversity and wild animals.

2. Research Method
The study was focused on management and improvement of peatland potential based on sustainable agricultural development. It was conducted through surveys using the Developmental Research method in a coastal area of Bengkalis District in Riau Province, Indonesia. The district has a fairly wide area of peatlands, covering 76.05% of its land area. Most people in the rural areas work in farming business in peatlands to earn their livelihood.

This research required primary and secondary data. Primary data was collected using the Rapid Rural Appraisal (RRA) method, a participatory approach to obtain data/information and make a general assessment in the field in a relatively short time. This approach has the advantage of being able to cover a wider area in a relatively short time in order to gain general and broad information (Alam et al, 2012, and McCracken et al, 1988). Other specific characteristic of the RRA is that the survey to collect information is carried out by researchers from multidisciplinary fields, or researchers who are able to look at problems from multidisciplinary point of views.

Secondary data collection was also required from relevant offices and agencies, including: agricultural office, regional planning agency, industry and trade office and population data as well. The secondary data would be validated by primary data information obtained in the field. Data collection was followed by tabulation of data according to the needs of the study, and continued with descriptive analysis. A quantitative analysis was also made using a regional spatial development
concept that was evaluated from various aspects, and adjusted to the physical and economic conditions, government policies, land carrying capacity, and socio-cultural aspects of the society.

3. Results and Analysis

a. Agricultural Condition in Peatland

Bengkalis District is an area that has flat topography (with a slope of 0-3%) and most of its area are adjacent to the sea. The agricultural lands in the study area consist of yards and fields, with average ownership of 0.45 hectares, ranging from 0.1 to 4.5 hectares. Almost all farmers in the location of the study did not do specific activities, such as fertilizing, weeding and controlling pests and diseases, to maintain their plants cultivated both on alluvial soil, which is known by the society as clay, and on peat soils. They only did it if assisted by the government. When the assistance was completed, they returned to the farming system known as 3T (tanam/planting, tinggal/letting the plants grow naturally, tuai/harvesting).

Figure 1 shows that most peatlands in Bengkalis District are located in the seaside/riverside. According to Wahyunto et al (2014) in Sumatra, peatlands that were still covered with forests (mangroves, peat swamps, plants/industrial plantations) and shrubs were spread over an area of 2,352,342 ha (32.6%) and 1,526,825 ha (23.7%) respectively. Mangrove swamp forest, peat swamp forest, and some lands have been utilized for industrial and palm oil plantations, especially in the east coast of Sumatra. The land utilized for plantations, agricultural purposes (cultivating food crops and horticulture), and rice fields respectively covers the area of 1,262,530 ha (19.6%), 499,819 ha (7.4%), and 212,690 ha (3.3%). It is also used for human settlements covering an area of 40,199 ha (0.6%). As peatlands and land suitability were developed, the community's economy was also flourishing, which was in accordance with the level of community growth as well.

![Image](source: Food, Horticulture and Plantation Office of Riau Province, 2017)

**Figure 1.** Map of Peat and Non-Peatland Distribution in Riau Province

The plantation sector in Bengkalis District is dominated by palm oil, rubber, coconut and sago plantations. Commodities developed in peatlands, especially in Bengkalis District, are presented in Table 1. Not only in the plantation sector, Bengkalis District also has quite good potential in the marine fisheries sector, where in 2015 its production reached 7,580 tons.
Table 1. Area of Plantation Commodity (ha) in Bengkalis District.

| Sub-District | Rubber | Palm Oil | Coconut | Sago | Coffee | Pinang |
|--------------|--------|----------|---------|------|--------|--------|
| 1. Mandau    | 2,006.0| 51,682.0 | 140.0   | -    | -      | -      |
| 2. Pinggir   | 1,434.0| 65,073.0 | 395.0   | -    | -      | 204.0  |
| 3. Bukit Batu| 4,059.0| 7,281.0  | 479.0   | 20.0 | -      | 29.0   |
| 4. Siak Kecil| 2,006.5| 12,352.0 | 275.6   | -    | -      | 70.0   |
| 5. Rupat     | 5,106.0| 3,338.0  | 591.0   | 57.0 | 67.0   | 65.0   |
| 6. North Rupat| 3,808.0| 753.0    | 100.0   | -    | -      | 80.0   |
| 7. Bengkalis | 4,803.0| 396.0    | 756.9   | 2,452.0| 6.0   | 149.0  |
| 8. Bantan    | 7,447.0| 4,371.0  | 7,283.0 | 341.0| 28.4   | 355.0  |

Bengkalis District 30,669.5 145,246.0 10,020.5 2,870.0 180.0 952.0

Source: Plantation and Forestry Office of Bengkalis District, 2016

Table 2 presents the amount of production of plantation commodities in Bengkalis District which include palm oil (1,660,975.3 tons), rubber (45,672.6 tons), sago (15,124.3 tons), pinang/areca catechu (2,160.4 tons) and coffee (28.4 tons). Looking at from the economic perspective, rubber farming and other commodities have been shifted to palm oil business. This is due to the fact that the palm oil market is more secure than rubber market. On the other hand, rubber farming is heavily dependent on the nature/climate condition. Conversion of land that was used to grow rubber and other crops to palm oil estate occurred almost evenly in all peatland areas. Figure 2 depicts rubber forest that remains intact on peatlands.

Table 2. Amount of Plantation Commodities Production (ton) in Bengkalis District

| Sub-District | Rubber | Palm Oil | Coconut | Sago | Coffee | Pinang |
|--------------|--------|----------|---------|------|--------|--------|
| 1. Mandau    | 7,266.1| 812,927.8| 0.0     | -    | -      | -      |
| 2. Pinggir   | 370.0  | 585,400.0| 0.0     | -    | -      | 192.0  |
| 3. Bukit Batu| 6,186.6| 55,670.4 | 0.0     | 84.0 | -      | 88.0   |
| 4. Siak Kecil| 1,305.7| 89,116.7 | 0.0     | -    | -      | 115.7  |
| 5. Rupat     | 10,127.0| 44,499.9 | 0.0     | 175.8| 4.4    | 91.4   |
| 6. North Rupat| 6,155.0| 7,211.1  | 0.0     | -    | -      | 25.4   |
| 7. Bengkalis | 4,297.2| 3,082.7  | 0.0     | 9,254.5| 24.0  | 1,528.0|
| 8. Bantan    | 9,965.0| 63,066.7 | 0.0     | 5,610.0| 24.0  | 1,528.0|

Bengkalis District 45,672.6 1,660,975.3 0.0 15,124.3| 28.4 2,160.4

Source: Plantation and Forestry Office of Bengkalis District, 2016

In addition to palm oil, the community also planted pineapple on peatlands. Pineapple is a pre-eminent peatland commodity that has a high economic value. Pineapple farming on peatlands improved peatland management, which will be able to reduce the risk of fire in the dry season. Pineapple crop makes a reasonable contribution to the household economy for people living in peatland areas. Figure 3 shows pineapple farming activities on peatlands.
In addition, findings in the field indicate that most of the people used peatlands for coconut farming. Coconut is also a promising commodity. But under certain conditions the price of coconuts also fluctuates. Farmers sell coconuts to collectors to be processed into copra. Figure 4 shows the utilized peatlands for coconut and oil palm commodities.

In addition to palm oil, other commodity that was widely cultivated by farmers was rubber, particularly in community-based plantation. Growing rubber on peatlands or peat soil is financially viable. From the economic point of view, using peatlands for agricultural purposes or plantation is promising and can improve community’s welfare if the farming activities pay attention to the principles of environmental sustainability.

On wetlands, particularly, the community worked in sago farming. Although sago is not the staple food of local people in Bengkalis District, this crop was widely cultivated and became the source of additional income. They worked in sago farming where the sago trees were inherited by their parents. Sago crops were cultivated on flooded lands or lands that are always inundated by tide. Sago crops were maintained only by clearing the land where they were growing from shrubs or ferns, which was done once a year or when the sago stems were ready to harvest. Sago farmers never cut down population of sago plants to provide rooms for the remaining plants to grow nor controlled the amount of the growing pups. Because of this condition, sago plants growth was relatively slow and their harvest time was long (around 12-14 years). Figure 5 presents the peat wetlands utilized for growing sago trees in Bengkalis District.
b. Obstacles to Agricultural Development on Peatlands
Peatland is an ecological unity that should be managed according to its ecosystem ecosystem; although they cross the administrative boundaries or the authority of a particular agency. The implementation of peatland management referring to the ecosystem boundaries is getting harder without any institutions that fully coordinate and take responsibility for this activity. Until now, there is no institution either at the national or sub-national level that has full responsibility and authority to undertake or coordinate peatland management activities.

Principal, peatlands stakeholders consist of many parties. Unfortunately, adequate mechanisms applicable for cross-sectoral coordination are not yet available. The absence of a specialized institution and lack of communication and coordination between cross sectoral agencies of the local government, or between the local government and the central government made peatland management activities prone to conflict. Even in some places, these disadvantages have threatened the natural resources preservation. Peatland management requires policies that are binding on all stakeholders and all parties responsible for implementing the management activities. Peatland management requires strong institutions in terms of area control and responsibility, organizational aspect, institutional capacity, and financing aspect.

Another problem that is also significant is the low level of community participation in the establishment of peatland management policies, making their implementation conflicting, prone to dispute and hard to do. This problem became more complicated due to institutional shortcomings and weak regulations/laws and policies which make it hard to enforce the law and policies on peatland management. The effectiveness of law enforcement and policy implementation is largely determined by the community’s understanding and legal awareness, including their compliance to the laws and policies on peatland management.
The obstacles to peatlands management in Bengkalis District can be grouped as follows:

**Damage to the Water System.** Damage to the water system in peatlands is often caused by uncontrolled community activities, such as construction of ditches and canals, logging activities, land clearing, etc. Construction of ditches and open canals on peatlands was done without maintaining the level of water in the ditches. The ditches were also used to transport timber (produced from legal or illegal logging activities) in the forest or to supply water for agricultural lands and plantation. This condition drained the peatlands, so they became dry and got burned easily in the dry season. Drained peat may cause damage to the peat structure and lower its surface as well, so changes in the function of the existing waterways potentially lead to flooding. It has proven in Bengkalis District that peatlands caught by fire are located near ditches and canals or residential areas near river and sea flood plains. Another impact of the construction of ditches is the release of basil materials (litter, mud and peat masses) into the river, which can cause changes in the river morphology and quality of its water. If this condition continues, it may give negative impacts on the aquatic biota.

**Illegal Logging.** Lack of the government’s supervision towards holders of forest management concession that have expired while the lands have not been returned to the government lead to uncertain situation as who is responsible for managing these lands. As a result, forest products, such as timber and others, are exploited and transported using the existing canals. Thus, the utilization of peatland forests in Bengkalis District and Riau Province in general has proven to be unsustainable. Forests that have been cut down were left damaged and turned into unproductive fern swamps and grass swamps.

**Biodiversity Loss, Carbon and Climate Change.** Peat swamp forests are rich in biodiversity and become the habitat for certain animals. Land clearing as well as forest and land fires have caused degradation of and damage to peat swamp forest biodiversity. One of the vital functions of peat swamps relates to their ability to store a huge amount of carbon, which is released as CO2 after reclamation, draining or burning process. The rise of the CO2 level in the air will add to the global greenhouse effect indicated by a gradual increase in temperature giving a negative impact on the earth's climate system. Carbon loss of carbon in a quite large amount is the result of land clearing activities.

**Community Involvement.** Another serious problem is lack of community involvement in peatland management. This problem may reduce people’s interest in managing their land by ignoring the aspects of conservation. The assessment of peatland has only focused so far on the timber standing on it. A comprehensive assessment, covering social, economic, and cultural values, biodiversity and environmental services that can be provided by peatlands, has not been carried out yet, while exploitation of timber in particular tends to ignore other values.

The low level of community participation in the establishment of peatland management plans also results in program activities that are less sensitive to local culture. Peatland management plans and implementation of planned activities are not often adapted to local conditions. Appreciation and application of traditional wisdom that should become the basis for peatland management at the local level are still inadequate or even neglected.

**Limited Data.** Accurate data and information on the condition and status of peatlands in Bengkalis District are still limited. They are only available in few locations where agro-forestry industry, plantation, or transmigration exist, and with related agencies handling peat issues.

**Institutions with Authority and Responsibility.** Many problems arising mainly from the degraded quality of peat swamps in Bengkalis District and Riau Province in general are caused by various interests, especially in promoting the economic growth. Exploitation of natural resources does not take into account their conservation and sustainability due to lack of attention to the importance of peatlands in supporting sustainable development and the absence of institution with responsibility for managing and protecting the existence of peatlands in Bengkalis District.

**Special Policy on Peat Management.** Until today, policies or regulations that specifically govern sustainable peatland management are still limited, both at the national and the sub-national levels. Peatland management is only governed under a regulation on more general issues. A problem
identified at the location of the study that is related to biophysics of lands is the increasingly limited area that can be utilized by farmers for agricultural purposes, leading to changes in the farming behavior. The land is used in various agricultural subsectors developed by farmers, especially for palm oil, rubber and coconut plantations.

4. Conclusion
A problem related to agricultural activities on peatlands that is also significant is the low level of community participation in the making of peatland management policies. Thus, the implementation of these policies is still conflicting, prone to dispute and hard to do. On the other hand, there are weaknesses relating to institution and regulation/law, that make it hard to enforce the law on peatland management.

Community-based peatland management is practiced without adequate technical guidance from relevant agencies. The practice of using fires to clear the land adopted by the community and excessive drainage tend to cause peatland damage. Failures arising from these activities cause farmers to leave these lands in a damaged condition. To prevent peatland fires, dissemination of information on peatland management is urgently needed.

To maintain the level of surface water in peatlands, it is necessary to build flexible canal blockings in the areas assigned for agricultural purposes. In certain conditions, canal blocking may increase the water retention in the body of the canal and its surroundings and prevent decrease in water surface in peatlands. On the other hand, canal can be piled up with materials to increase sedimentation and the body of the canal can be silted up to reduce its drainage power and maintain the level of water surface.

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