Efforts to Prevent Land Fires through the Use of Potential Peatlands in Coastal Areas

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Abstract. The development of the agricultural sector for coastal communities, especially on peatland plays an important role in the structure of the regional economy. In Riau province, there are potential peatlands of approximately 64% of the total land area, that support the local people’s lives, especially for agriculture. These peatlands also have various ecological functions such as flood and global climate controls. Therefore, this study aims to determine efforts to prevent land fires through the development of superior commodities in potential peatlands. This study was carried out through a survey using the developmental research method and the data were collected with a participatory rural appraisal (PRA) approach. The food crops cultivated on the peatland were rice, corn, and cassava, and were carried out for the first 2-3 years. Furthermore, long-term crops such as rubber, sago, and coffee were also planted. The results showed that the use of peatland with an economic value has a positive impact on its management. Therefore, this effort is capable of preventing the occurrence of land fires.

1. Introduction

The development of the agricultural sector in coastal areas plays an important role in the structure of the regional and national economy. This is because it accommodates economic growth through the application of populist, sustainable, and equitable principles between individuals and regions. One of the coastal areas that become the study survey is Bengkalis Regency. The government of this Regency has made efforts to explore new sources of growth on the available peatlands and to improve their designation and use. Moreover, the area of Bengkalis Regency has a potential peatland of 840,328.00 ha or 66.50% of the total land area. Therefore, efforts to use these peatlands with specific and fragile characteristics have now become a necessity for several reasons, such as 1) The need for land by the community is increasing in line with population growth and lifestyle changes. 2) Peatlands have significant potential to be developed into agricultural land for several commodities. 3) Availability of appropriate land management technology, which includes considerations from a socio-economic perspective that occasionally requires high technology input and substantial investment.
Peatlands provide direct life support, especially for agricultural use, and also have various ecological functions such as flood and global climate controls. When these peatlands are damaged, the condition is difficult to be restored. This certainly has harms socio-economic aspects, especially for the surrounding community. To preserve the function of the peatland ecosystem, the Bengkalis Regency Government needs to conduct a detailed review of the spatial feasibility and socio-economic impact of peat swamp reclamation (depth < 300 cm).

Therefore, agricultural development on peatlands in Bengkalis Regency needs to be strictly based on land suitability or typology. The introduction of new technology needs to be supported by adequate socio-economic and institutional conditions. Although the peatlands are used for agricultural purposes, the existence of supporting institutions and the availability of infrastructural facilities are still limited. Therefore, for the successful development of agricultural businesses, identification and characterization of the area to be developed are required. This is conducted to obtain detailed information such as the biophysical condition of the land, the level of agricultural technology, socio-economic and institutional conditions, as well as development constraints in each region. This information is used for the development of agricultural technology.

Every development carried out in coastal areas, especially peatlands, is referred to as the Riau Regional development program [1]. Regional development is majorly determined by the potential possessed by a region. Also, the policies made by the government need to be in line with the potential of the region to be developed, especially the agricultural sector. Similarly, the development of the agricultural sector is to be directed to the agro-industry systems to increase the value-added, especially in small-scale farming.

Agricultural development in coastal areas based on agribusiness is capable of reducing inequality between rural and urban areas. Meanwhile, Friedmann and Douglass had an agropolitan development concept that aimed to accelerate the rural economy based on its potentials. One of these is changing rural areas with urban lifestyles that have been adapted to certain communities and have reduced the level of urbanization. Furthermore, investment in rural areas is another method to suppress urbanization and transform rural settlements into a mixed form called agropolitan (a city in the village) [2]. According to Syahza and Asmit, agropolitan is achieved by using the existing workforce more effectively through targeted resource development efforts in each district and increasing agricultural yields. In addition, it can also be carried out through the provision of financial resources by diverting development funds from urban centers and special industrial areas for agropolitan [3].

A previous study has shown that the development of the agricultural sector, especially plantations in rural areas, has an impact on the regional economy in creating job opportunities. This development has provided a trickle-down effect, which has expanded the power of dispersion in the surrounding community [4]. The bigger the development, the more impact on the workforce in the rural economic sector and its derivatives. This impact is shown in the increase in the farming community's income, which has a positive influence on their purchasing power for primary and secondary needs [5]. Meanwhile, the impact on communities around agricultural development is shown in the creation of employment opportunities. This eventually leads to the emergence of traditional markets in residential as well as rural areas and also causes consumption patterns and public education to increase [1]. Furthermore, plantation activities have made the community's livelihoods not to be limited to the primary sector in fulfilling families' needs, but have expanded their business space in the tertiary sector [6]. Agricultural development has created entrepreneurial abilities for farmers that captured the business opportunities, especially in the plantation sub-sector. Recently, the character of modern entrepreneurs that can read future opportunities is being seen in farmers in coastal areas [7].

Therefore, this study aims to prepare adequate planning for agricultural management on peatlands to prevent land fires, especially on food crops, vegetable, and fruit horticulture, in Bengkalis Regency, Riau Province. This management aims to increase the income of coastal communities and change their mindset to open land without burning. Furthermore, it also provides input in the management and improvement of peatland potential through the development of superior commodities in line with regional conditions.
2. Research Methods

The study on the management and improvement of peatland potential in efforts to prevent fires in the coastal areas of Riau Province is exploratory, which aims to investigate the pattern and sequence of growth or changes in formulating policy strategies. It was conducted through a survey using developmental research methods in Bengkalis Regency. The target area was the rural communities with agriculture as a source of livelihood. Meanwhile, the observations made on superior commodities in terms of agribusiness include the provision of added value to the community’s incomes in coastal areas, which is still being maintained from an environmental perspective.

In this study, the primary and secondary data used were collected using a participatory rural appraisal (PRA) approach. According to Chambers and Preece, PRA describes a group approach for obtaining local community information. This approach has participatory resources related to field research on agricultural systems and rural assessment in a short time.[8], [9]. This PRA has been widely used in various countries, especially in the agriculture and forestry sectors [10], [11], [12].

3. Results and Discussion

The function of peat as a reservoir plays an important role in accommodating and controlling rainwater together with surface runoff to minimize the risk of flooding around peatland areas during the rainy season. The water in this reservoir is slowly released for the availability of enough water for agricultural purposes and other daily needs during the dry season. Figure 1 showed the area of peatlands in Bengkalis Regency in 2019 and the data is supported by field checks. The potential of this peatland can be used by local communities to improve the family economy. Meanwhile, the area of peatlands was calculated to be 558,848.96 ha or 66.50% of the total area of the Regency, which was divided into shallow, middle, deep, and very deep with a thickness of 50-100 cm, 100-200 cm, 200-300, and over 300 cm, respectively. The remaining 349,979.13 ha or 41.65% was in form of peatlands with a thickness of 0-50 cm and mineral soil.

Due to population growth and prevalence of peatlands in the Bengkalis Regency, development options need to be directed to these lands for agriculture and related businesses benefits. In Bengkalis Regency, various crops such as food, vegetables, and fruits are commonly cultivated by farmers as an indicator of the presence of peatlands.

![Figure 1. Peatland Map of Bengkalis Regency, Riau Province](image-url)
For agricultural development on peatlands, the resource potential is determined by the similarities between the characteristics of the land and the growing requirements of the commodity being evaluated. This provides information that the land has the potential for agricultural development purposes on peatlands. The peatland is used for agricultural purposes by considering the required inputs that can provide the expected outputs. Furthermore, the potential for agricultural development on peatlands is also determined by the level of farm management that is being applied. Meanwhile, peatland management at the farmer level from low to medium inputs is different from land productivity with high management by the private sector or large companies. Medium management is soil improvement using affordable inputs for farmers such as tillage, micro water, fertilization, liming, pest, and disease eradication.

With the development of the Bengkalis Regency area, the use of peatlands for agriculture and related businesses is growing rapidly. Several perennial and annual crops are being cultivated on the peatlands, moreover, food crops, vegetables, and fruits are the most successful or promising that have economic value in the study area. The land suitability analysis showed that food crops thrive and are suitable for peatlands with a thickness of 0-50 cm, mineral soils on thin peatlands (50-100 cm), food and horticulture crops on medium peatlands (100-200 cm), horticulture and plantation crops on deep peatlands (200-300 cm), plantation crops on very deep peatlands (300-500 cm), and forest crops are suitable for very extreme peatlands (>500 cm).

Moreover, farming on peatlands is very different from other types of land. Although the local community is very familiar with peatland management, there is a need for technical guidance to cultivate crops by clearing the land without burning. According to Syahza et al, clearing land without burning on peatlands costs approximately IDR 3,000,000 to IDR 3,600,000 per hectare. However, clearing land by burning requires a cheaper cost ranging from IDR 700,000 to IDR 900,000 per hectare [13]. The community is expected to be careful in using the peatland ecosystem in form of non-timber value from peat forests, flood control, water supply, tourism potential, local community livelihoods (fishing, agriculture, plantations), climate stabilization, maintaining biodiversity, education, and socio-economic benefits.

3.1 Farming System in Peatlands
Bengkalis Regency has a flat topography (slope 0-3%) and most of the area is adjacent to the sea, which makes this regency to be affected by tides. This condition affects the agricultural sector in terms of patterns, distribution, infrastructural support, and others [14]. Farmers in this area apply monoculture cropping patterns in the cultivation of rice, secondary crops, vegetables, and fruits, which also include biennial (two-year) crops such as bananas and pineapples. Meanwhile, the cultivation of perennial fruit crops such as rambutan, mangosteen, mango, and durian is conducted with a mixed cropping pattern with plantation crops. This pattern is usually applied in fields or yards.

Crops cultivated on peatlands or which is also called red soil by the people of Bengkalis Regency include rice, corn, cassava, eggplant, chili, cucumber, mustard greens, lettuce, kale, and long beans. These crops are cultivated in the first 2-3 years only and rubber or oil palm is planted later because the land is no longer fertile, while sago commodities are cultivated on wetlands.

Almost all the farmers in this regency are not practicing plant maintenance activities in form of fertilizing, weeding, controlling pests, and diseases. This condition is present in plant cultivation on alluvial soil or known by the community as clay and on peatlands. Maintenance is only carried out when there is government assistance and farmers return to a 3T (planting, living, reaping) system after the activity ends. The main pests that become enemies of farmers are birds for rice crops, while pigs, cows, and civets are for other crops.

3.2. Farming of Food and Horticulture Crops on Peatlands

a. Corn (Zea mays)
In Bengkalis Regency, corn farming activities on peatlands are in every sub-district surveyed, namely Rupat, Bukit Batu, Siak Kecil, Bantan, and Bengkalis. The pattern of farming in these locations differs
slightly different based on the local community by using superior seeds, fertilization, and crop maintenance. Meanwhile, corn farming activities are carried out on the peatlands around the community to maintain the lands and prevent fires, especially during the dry season.

Corn farming in this area is usually an intercrop and garden which is carried out on vacant land, especially around the house (Figure 2a), without any obstacle. Moreover, corn crop yields are in form of fresh fruit for consumption (boiled and baked) or vegetables with a price of IDR 6,000-IDR 8,000 per kg.

b. Cassava (Manihot esculenta)
Cassava farming activities are carried out in all sub-districts in Bengkalis Regency on alluvial and peat soils. This farming activity is usually practiced as yard crops on vacant land around the house, which require no external inputs such as seeds, fertilizers, and pesticides. Cassavas used as a source of vegetables are planted by farmers at a close distance, while those used for harvesting tubers are cultivated at a less frequent distance (Figure 2b). The yield of tubers from cassava crops ranges from 0.5 to 1.0 kg per clump or the equivalent of 5-10 tons per hectare with a selling price of IDR 1,200-2,000 per kilogram excluding the harvest costs. Cassava farming that is being carried out by local communities aims to maintain the balance of peatlands to avoid being burned easily.

c. Pineapple (Ananas comosus (L.) MERR.)
The main centers for pineapple development in Bengkalis Regency are spread over three sub-districts, which are Bengkalis, Bantan, and Bukit Batu. Moreover, this crop is also developed in other sub-
districts with relatively low productivity. Based on the latest data, the production is approximately 893.60 tons, or an average of more than 74.47 tons per month. Furthermore, a total of 500 tons or 55.95 percent is from pineapple plantation centers in Bengkalis Regency and 347.30 tons or 38.87 percent from the Bantan sub-district, while the remaining 46.30 tons is from six other sub-districts.

As a community crop, pineapple cultivation in Bengkalis Regency is carried out around the house yard, between rubber, areca nut, or other crops. Moreover, the use of technological inputs such as local seeds is very limited (Figure 2c), This farming activity is usually carried out without fertilization and prevention of pests as well as diseases. In almost all areas, pig pests are the main enemy of farmers. Furthermore, the type of soil in this area is acidic and poor in nutrients, which leads to low productivity of pineapples, which are sold in local markets and home industries. However, marketing problems are the main obstacles encountered in all study locations. Since pineapple is very suitable to be planted on peatlands, farming development has the potential to prevent land fires because this crop requires moist and slightly wetland conditions.

3.3. Plantation Crops on Peatlands

a. Sago (Metroxylon sagus/rumphii)

Although sago crops are not used as the main source of food for Bengkalis Regency residents, the crops are widely planted and have become an additional source of income. The farming activity is still in form of sago forest, which is carried out by planting parent crops. Meanwhile, sago crops are cultivated on land that is always flooded by tides (Figure 3a). The maintenance is only in form of clearing the land by slashing bushes or ferns once a year or when harvesting the stems. Since farmers have never performed thinning or regulating the number of tillers that grow, hence the growth of sago crops is relatively slow with a long harvest period of approximately 12-14 years. Sago cultivation is a very effective land fire prevention strategy because the crop requires adequate water to keep the land wet. A previous study stated that peatland management is carried out with wetland crops such as sago, especially at a depth of more than 2 meters [15]. This showed that sago is a wetland crop that is capable of preventing land fires in coastal areas [16].

b. Natural Rubber (Metroxylon sagus/rumphii) and Rubber Tree (Hevea brasiliensis)

Natural rubber is a crop that has long been cultivated by coastal communities and is suitable for peatlands. In Bengkalis Regency, efforts to improve the quality of rubber are continually carried out with the establishment of seed breeders in several sub-districts. With the maintenance of natural rubber plantations, the community has automatically monitored the potential of land fires by using the peatlands. This is because natural rubber that grows on peatlands requires soil moisture on average in line with the management system (Figure 3b). Syahza et al stated that after oil palm, natural rubber is the main plantation commodity and source of livelihood for rural communities in coastal areas [13].
Related studies on the use of peatlands have been widely carried out, especially on the efforts to prevent land fires. Meanwhile, Irianti et al. stated that most of the peatlands have the potential to be used by local communities by considering the principles of environmental balance [17]. Along with the peatland development and suitability, the community's economy also develops. Similarly, this is also consistent with the rate of population growth in peatland areas. According to Asmit et al, the potential of peatlands is a source of income when tourist areas are well managed and developed to pay attention to environmental balance [18]. This is in line with a study by Pieter et al. which stated that non-market environmental service factors for peatland resources have a significant effect on individual willingness to pay for the environment [19]. Policy development has a positive impact on environmental management and the willingness to pay for ecosystem benefits is the preferred option [20]. Therefore, strategies for managing mangrove forests on peatlands, which increases carbon sequestration, storage, and prevents illegal logging needs to be carried out with community involvement [21]. Furthermore, conserving mangroves and restoring degraded ones is a necessity to support biodiversity and the functions of most tropical ecosystems [22].

4. Conclusion
The problem with peatlands farming is the low level of community participation in land management, which causes the implementation of various policies to be difficult. Hence, the use of peatlands by the community is carried out without adequate technical guidance from the relevant agencies. Furthermore, the culture of fire techniques applied by the community in land clearing and drainage destroys peatlands. The failures from this activity make farmers leave these lands in a state of disrepair. Therefore, to prevent land fires, counseling on peatland management for agriculture without burning is very important.

In several peatland development locations, macro water systems built by the government or independent farmers generally do not consider typology. Therefore, the tidal water dynamics that characterized peatlands are not exploited by farmers. The attention of the government and private sector is needed to fix the water system. Furthermore, it is necessary to provide production facilities, infrastructure, and empower farmers to improve the balance of peatland use.

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