Managing mangrove forest in Bintan Island: socio-economic benefits of climate change mitigation and adaptation

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Abstract. In climate change mitigation, mangroves have an important role as one of the most effective and economic methods of offsetting carbon emissions and protecting shoreline erosion. Mangroves in Indonesia have a total area of 2.9 million hectares, 52 thousand hectares of them disappear every year and aquaculture is responsible for 40 percent. In contrast, with the level of mangroves damage threats is high, the level of sustainable ecosystem awareness is low. In accordance with previous studies, mangroves forests in Bintan Island have been cut down to supply combustion and ended up into charcoal. However, it can be minimized by enabling the local communities to avail themselves of carbon offset/conservation payments under approved climate change mitigation strategic-plans. The law enforcement of Law no 32 Year 2009 and the PERDA No. 14/2007 about neighboring Bintan Island Regional Coastal Planning were designed to support the Mangroves Conservation in Bintan Island. This paper aimed to examine mangrove ecosystem management through the collection of data and information on the socio-economic in 8 potential villages in Bintan; Busung, Kuala Sempang, Penaga, Pengujan, Bintan Buyu, Tembeling, Mantang Baru and Sebong Lagoi. This study found Busung, Kuala Sempang, Penaga and Pengujan as 4 potential Villages to be seriously developed and recommends the government to gain more partnerships in arranging and solving mangroves conservation problems.

1. Background
Mangroves, in Climate Change mitigation, remain the most effective and economical methods of offsetting carbon emissions and also have an important role in protecting shoreline erosion. Mangroves, as stated by Santos et al [1], are connected to ecosystems adjacent to seagrass beds and coral reefs to reduce negative impacts of climate change and are precious for aquaculture, agriculture, forestry and tourism [2]. It is also necessary to understand, even the substantial part, the management and policy of sustainable mangrove ecosystems. Furthermore, mangroves have several interesting facts, such as if it stores more than five times of carbon uplands forests, it will reduce 3 billion tons of carbon. Approximately 52,000 hectares disappear per year. Aquaculture is responsible for 40% of them, and stopping mangrove destruction means 26% emission reduced or equal to 40 million fewer cars on the
road. Therefore, mangrove is one of the important components of coastal ecosystem sustainable development.

Sustainable development is defined as fulfilling the people's needs in the modern world and not posing any threats to future generations' needs. Ecologically sustainable development means the coordinating development between economy, society, resources and environmental protection [3]. Furthermore, the sustainable development of region is based on economic growth of labor and capital productivity, including cross-border area [4].

Mangrove conservation, which is caused by deforestation, under suitable mechanism needs to be mapped. The main problems of mangroves conservation in Bintan Island are, the level of mangroves damage threats is high, and the level of awareness of the sustainable ecosystem is low. In accordance with some previous studies, mangroves forests in Bintan Island have been cut down to supply combustion ended up into charcoal. However, the damage may be reduced by enabling local communities to mitigate and adapt strategic plans.

The International Ecotourism Society (TIES) defined ecotourism as responsible travel to natural areas that conserves sustainable environment [5]. The mangrove ecosystem area has a potential for tourism destination by adding value to the beautiful scenery of mangrove forest, in combination with beach and coral reefs. Mangrove tourism also provides educational and ecological aspects and has direct impact on alternative livelihood of surrounding community. In addition, ecotourism is a part of sustainable tourism that can help increase the local community's earning and conserve the ecosystem [6].

Mangrove ecosystems uptake CO₂ to carbon burial and sediment accretion and stabilization, trap particles to deposition carbon supported by reef formation to get opportunity for expansion or conservation and contain high economic value [7]. The lack of appropriate institutions, coordination mandates, political and government structures will make the task difficult. This study aimed to contribute to the policy and lawmakers in Kepulauan Riau Province to keep mangrove sustainability so that it provides an added value to the local community's income in Bintan Island, Kepulauan Riau Province. Therefore, what policy is suitable for managing mangroves forests and climate change mitigation and adaptation in Bintan Island?

2. Methods
This study was conducted from April to July 2020 on people living around the forested areas in 8 potential villages in Bintan Regency, namely Sebong Lagoi, Bintan Buyu, Tembeling, Penaga, Penganan, Kuala Sempang, Busung, and Mantang Baru island.

Materials used in this study include interview questions for informants to strengthen the answer to the research question. The key answers to interview were written in notebook and recorded in a voice recorder. All of data were divided into several groups, classified, and analyzed descriptively. The additional information was collected from the experts, local communities, government agencies and other stakeholders. This paper examines the mangrove ecosystem management through the collection of data and information on the socio-economic in 8 potential villages in Bintan, as follow in Table 1:

| No | Village         | Location                  | Mangrove Potential Area |
|----|-----------------|----------------------------|-------------------------|
| 1  | Sebong Lagoi    | 1°10′07″N 104°22′24″E      | 89.9 ha                 |
| 2  | Bintan Buyu     | 1°04′31″N 104°30′34″E      | 242 ha                  |
| 3  | Tembeling       | 1°03′10″N 104°30′34″E      | 478 ha                  |
| 4  | Penaga          | 1°03′45″N 104°24′38″E      | 398 ha                  |
| 5  | Penganan        | 1°01′12″N 104°22′17″E      | 184 ha                  |
| 6  | Kuala Sempang   | 1°03′21″N 104°19′20″E      | 261 ha                  |
| 7  | Busung          | 1°00′48″N 104°12′20″E      | 173 ha                  |
| 8  | Mantang Baru    | 0°45′36″N 104°30′49″E      | 36.4 ha                 |

Source: Field research on August 2020
3. Results and discussions

As stated by Idajati and Widiyahwati [6], mangrove management strategy’s main keys must be implemented in several aspects of conservation area, law enforcement, quality of ecotourism, and collaboration between all stakeholders. Mangroves area in Bintan Island are divided into 3 zones, namely; core area (conservation area) is area not to be used for any reason, except for sustainable mangrove activity in Bintan; supporting area is allowed area to be used in less than half of entire area; utilization area is area with direct and indirect economic value for all local communities.

The development of mangrove ecotourism has to be innovated based on decentralized approaches focusing on non-governmental actors and at the bottom-up levels with 3 premises; first, activities of human effects on the climate system; second, attractive measurement of critical mass of actors for mitigation, for example reducing local pollution for better health; and third, bottom-up initiatives can take advantage of existing institutional capacity [8]. Sebong Lagoi has a small mangrove potential area with the most progressive development in mangrove tourism because of awareness of the local community to reduce the effect of climate change by taking care of the environment with the high economic potential. There are several tourism sites and attractions, namely Bintan Mangrove QIU & LI, Bintan Mangrove and Fireflies Tour, and cottages and restaurants. Kuala Sempang, Busung, Pengujan and Penaga are neighboring villages with high potential in developing ecotourism. Busung, so far, provides a well-known beautiful scenery of post-mining area for tourist, and it should be an advantage to attract more tourist with alternative tourism site and attraction.

There are five aspects that need to be explored, namely knowledge, accessibility, activity, awareness and participation. One of the main keys is to assess the community knowledge and the role to support sustainable development of mangroves [9]. In economic aspect includes the total economic value of

![Figure 1. Bintan island map with 8 potential villages (Source: Field research 2020)](image_url)
mangrove potential area is needed to be measured. Mangroves in Bintan Island have potential in tourism and economic potential in biota, for example mud crab. However, based on the field research, they also have vulnerability based on local communities’ residence and other potential threats (Table 2).

The law enforcement No 32 Year 2009 regarding the Protection and Management of Environment, is about criterion on fixing the damage of the environmental ecosystem and climate change. One of the protection is mangrove ecosystem and the Local Regulation (PERDA) No. 14/2007 about neighboring Bintan Island and regional coastal planning. In order to support mangrove conservation in Bintan, the government needs to apply the Zonation Planning of Coastal Area and Small Islands (RZWP3K) by synchronizing map, Provincial Regulation Planning (RAPENDA), the appendices of area measurement and numbering the zones and naming the sub-zone of tourism site by, obviously, along with the Mangrove Ecosystem Conservation and Sustainable Use in the ASEAN (MECS). Also, having technical cooperation with country that may be concerned with mangrove planning and policy can be adopted and implemented effectively. Even in applied social science, diagnosing a problem logically precedes prescribing a cure, as in medicine, by building a basic understanding for constructing successful and efficient return plan of action and calculation [8]. Observing may be held through routine agenda or based on mechanisms for stakeholders of sustainable mangrove management [10].

**Table 2.** Socio-Economic measurement of mangroves in Bintan Island

| Economy | Social |
|---------|--------|
| 1 Contribution in increasing income of the community livelihood | 1 Knowledge of the local community |
| 2 Types of Direct Value of Mangrove | 2 Access to community to utilize mangrove ecosystem |
| 3 Mangrove utilization zone | 3 Mangrove community-caused damage |
| 4 Contribution to increase employment | 4 Community awareness |
| 5 Total economic value of the entire mangrove ecosystem | 5 Community participation |

Source: Field research on August 2020

![Figure 2. Stakeholders and The Zonation Planning of Coastal Area and Small Islands (RZWP3K) Kepulauan Riau Province (Field research. 2020).](image-url)
4. Conclusion
Mangroves in Busung, Kuala Sempang, Penaga and Pengujan have the biggest potential for ecotourism in Bintan Island, since they have the largest potential mangrove with the lowest risk of climate change effect, strategic area, and availability of human resources. The rapid development of mangrove ecotourism is in Sebong Lagoi with several tourist attractions such as mangrove tours and restaurants. However, the development of the mangroves also needs a strategic plan with suitable policy. In RZWP3K, hopefully, the plan of climate change effect prevention and mangroves' ecotourism directly impact the socio-economic aspect to the local communities. This study recommends the government gain more partnership in arranging and solving the problems of mangroves conservation. Managing mangrove needs more political potential, smart political plan, support by civil society, and more feasible solutions by making criteria. There is also the importance of ecological sustainability, basic needs fulfillment, cost-effectiveness and political feasibility. The next research needed is about observing and measuring Mangrove's socio-economic potential in eight potential villages mentioned above.

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