Developing community-based mangrove management through eco-tourism in North Sumatra, Indonesia

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Abstract. Mangrove forests in North Sumatera, Indonesia existed in the east coast of Sumatera Island and commonly thrived in Langkat, Deli Serdang, Batubara, Tanjung Balai, Asahan, Labuhanbatu until Serdang Bedagai. The present study describes the developing community-based mangrove management (CBMM) through eco-tourism in two locations, Lubuk Kertang (LK) of Langkat and Sei Nagalawan (SN) of Serdang Bedagai, North Sumatra, Indonesia. Mangrove ecosystem, coastal villagers and visitors, and related stakeholder were analyzed to present the potential of mangrove ecosystem, the ecological suitability, and the carrying capacity then continued with SWOT (Strengths, Weaknesses, Opportunities, and Threats) analysis. Results showed that mangrove diversity in LK consist of fifteen species which Rhizophora apiculata and Avicennia lanata dominated the area, where mangroves in SN found seven species dominated by R. apiculata and A. officinalis. Based on the suitability level of mangrove ecosystem for ecotourism development, LK and SN were categorized as suitable and conditionally suitable, respectively. The carrying capacity of mangrove ecotourism for LK and SN were 36 and 36 people/day respectively. SWOT analysis revealed that both locations of eco-tourism have a potential eco-tourism attraction, high mangrove biodiversity, possible human resources, and real people's perception on the importance of mangrove conservation, and relatively easy access. The study present suggested that mangrove ecotourism is a sustainable form of land use, to contributing the environmental protection and providing socio-economic benefits to the local people through indirect values of the natural resources.

1. Introduction
Mangroves as among the most threatened global ecosystems, especially in Southeast Asia, including Indonesia [1]. Indonesia has 22.6% of the world's mangroves. However, that area has been degraded from 4.2 million in 1980 to 3.1 million in 2011 [2]. Mangrove plants comprise a heterogeneous group of independently derived lineages that are defined ecologically by their location in inter-tidal zones of tropical and sub-tropical climates and physiologically by their ability to survive high salinity concentration or low levels of soil aeration [3]. Mangrove forests in North Sumatera, Indonesia covered approximately 50,369.8 ha and existed in the eastern coast of Sumatra Island and commonly distributed in Langkat, Deli Serdang, Batubara, Tanjung Balai, Asahan, Labuhanbatu until Serdang Bedagai [3-4].
Because of its position along the land-sea interface, mangroves have high potency to promote ecotourism. Many studies have reported that mangrove and coastal environment to be an appropriate place for the sustainable development of ecotourism [5-6] such as in Peninsular Malaysia [7], Surat Thani, Thailand [8], and the northwest Black Sea coast of Turkey [9]. Therefore the development of mangrove ecotourism is important as a part of community-based mangrove management (CBMM) [6]. CBMM primarily denotes to the centralization of rights and responsibility from government to local communities for natural resources management [6]. Furthermore, the involvement of the local community is noteworthy to implement sustainable mangrove management practice. The present study aimed to describe the developing community-based mangrove management through ecotourism activity in two locations, Lubuk Kertang of Langkat and Sei Nagalawan of Serdang Bedagai, North Sumatra, Indonesia.

2. Materials and Method

2.1. Study area

We performed the study in Lubuk Kertang (LK) village and Sei Nagalawan (SN) village, North Sumatra, Indonesia, covering an area about 1200 ha. The Lubuk Kertang village is situated between at 04º 02’ 34.25” - 04º 05’ 27.11” North latitudes, and between at 98º 14’ 57.92” - 98º 18’ 37.87” - East longitudes (Figure 1). Regionally, Lubuk Kertang village resides in Langkat regency and district of Brandan Barat. The Sei Nagalawan village is located between at 03º 35’ 29.52” - 03º 35’ 24.46” North latitudes, and between at 98º 5’ 18.59” - 99º 5’ 39.09” East longitudes, Perbaungan district, Serdang Bedagai Regency (Figure 1).

![Figure 1. Study site of two eco-tourists in North Sumatra, Indonesia](image)

2.2. Analysis of mangrove eco-tourism

To review the more suitability of mangrove ecotourism, we used five parameters used as shown in Figure 2, a namely perspective of community and visitor, analysis of mangrove potency, determination of ecological suitability, analysis of carrying capacity of mangrove ecotourism, and SWOT analysis as previously reported [5,8]. SWOT matrix introduced the strengths-weaknesses as the situation of the area regarding internal; on the other hand, the opportunities-threats was as an external basis out deeply. Analysis of mangrove flora and fauna was conducted using a combination between transect and line compartment method [3]. To produce eco-tourism development strategies [9], we used the Internal strategic factor analysis summary (IFAS) and external strategic factor analysis summary (EFAS) matrix.
The perspective of community and eco-tourism visitors on the existence of mangrove forests, mangrove ecotourism, mangrove utilization, and involvement on mangrove and eco-tourism were analyzed by questionnaires [10]. Fifty head of household from Lubuk Kertang and 90 visitors in Lubuk Kertang eco-tourism, while 52 head of the family and 361 visitors to Sei Nagalawan eco-tourism were collected to answer closed-ended questions as previously described [10]. The respondents are given a list of fixed responses from that to select their available answer.

3. Results and Discussion
The results discussed in 4 subsections; they are the perspective of coastal community and visitor on ecotourism activity, analysis of mangrove ecosystem, ecological suitability and carrying capacity analysis, and SWOT analysis and proposed development strategy on eco-tourism.

3.1. Perspective of coastal community and visitor on eco-tourism activity
The present study described the character and perspective of local community knowledge on mangrove ecotourism, mangrove existence and visitor's perspective on eco-tourism and mangrove ecosystems. As depicted in Figure 3, the aspect of community on job/live hood of both communities (A), education (B), utilization of mangrove product (C), and the existence of mangrove condition (D), respectively. Community in LK as fisherman used mangrove for their food, contrasting to SN where they utilized mangrove fruits and leaves as mangrove product. More than 50% of both communities agreed well the condition of mangroves (Figure 3B).

Figure 2. Schematic method to determine mangrove ecotourism in Lubuk Kertang and Sei Nagalawan

Figure 3. Characteristic and perspective of community on the job or live hood (A), education (B), utilization of mangrove product (C), and the existence mangrove (D).
3.2. Analysis of mangrove ecosystem
Vegetation analysis of LK eco-tourism consists of 15 species; more diverse than in SN that found seven species mangrove flora (Table 1). It has reported that ten mangrove species found at Karang Gading Langkat Timur Laut [3]. Moreover, 14 species thrived naturally in Pulau Sembilan, Langkat, Indonesia [4], and ten mangrove species existed in Iriomote Island, Okinawa Japan [11]. As shown in Table 2, we noted the diversity of mangrove fauna in both eco-tourism locations. The high diversity of mangrove flora and fauna contributed to the suitability of mangrove ecotourism. The cultures fauna such as Aves, fish, mollusk, the mammal is compatible with mangroves.

![Image of bar charts]

**Figure 4.** Characteristics and perspective of visitors on mangrove ecotourism.

**Table 1.** Diversity of mangrove flora at eco-tourism locations

| No | Species                  | Ecotourism |
|----|--------------------------|------------|
| 1  | *Acanthus ilicifolius*   | + +        |
| 2  | *Avicennia marina*       | + +        |
| 3  | *A. lanata*              | + -        |
| 4  | *A. officinalis*         | + +        |
| 5  | *B. gymnorrhiza*         | + +        |
| 6  | *B. cylindrica*          | - +        |
| 7  | *B. sexangula*           | + -        |
| 8  | *Ceriops tagal*          | + -        |
| 9  | *Excoecaria agallocha*   | + -        |
| 10 | *Lumnitzera racemosa*    | + -        |
| 11 | *R. apiculata*           | + +        |
| 12 | *R. mucronata*           | + -        |
| 13 | *Scyphiphora hydrophyllacea* | + -     |
| 14 | *Sonneratia alba*        | + -        |
| 15 | *S. caseolaris*          | + +        |
| 16 | *X. granatum*            | + -        |
Table 2. Diversity of mangrove fauna in eco-tourism locations

| No | Fauna     | Species                                      | Ecotourism |
|----|-----------|----------------------------------------------|------------|
|    |           |                                              | LK         | SN         |
| 1  | Aves      | Edible-nest Swiftlet (*Collacalia fuciphaga*) | +          | -          |
|    |           | White-bellied sea eagle (*Haliaetus leucogaster*) | +          | -          |
|    |           | Cattle Egret/Bangau Putih (*Bubulcus ibis*)   | +          | +          |
| 2  | Reptilia  | Water monitor (*Varanus salvator*)           | +          | +          |
|    | Squamata  | Mangrove snake (*Boiga dendriphila*)         | +          | -          |
|    |           | Common skink (*Mabouya multifasciata*)       | +          | +          |
|    |           | Keel back (*Natrix stolata*)                 | -          | +          |
| 3  | Mammal    | Crab-eating macaque (*Macaca fascicularis*)  | +          | -          |
|    |           | Common treeshrew (*Tupaia glis*)             | +          | -          |
|    |           | Yellow-throated marten (*Martes flavigula*)  | +          | -          |
| 4  | Fish      | Eeltail catfish (*Plotosus canius*)          | +          | -          |
|    |           | Mudskipper (*Periophthalmus sp.*)            | +          | +          |
|    |           | Giant grouper (*Epinephelus lanceolatus*)    | +          | -          |
|    |           | Porcupinefishes (*Diodon sp.*)               | -          | +          |
|    |           | Flathead gray mullet (*Mugil cephalus*)      | -          | +          |
| 5  | Mollusc   | Girdled horn shell (*Cerithidea cingulata*)  | +          | -          |
|    |           | Horn snail (*Telescopium telescopium*)       | +          | +          |
|    |           | Quadrade horn shell (*Cerithidea quadrata*)  | +          | -          |
|    |           | Rare-spined Murex (*Murex trapa*)            | +          | +          |
|    |           | freshwater snail (*Melanoides punctata*)     | -          | +          |
|    |           | Fiddler Crab (*Uca sp.*)                     | -          | +          |
|    |           | Mangrove crab (*Polymesoda bengalensis*)     | +          | +          |
|    |           | Celtic Sea (*Corbicula javanica*)            | -          | +          |
|    |           | Teritip (*Belanus sp.*)                      | -          | +          |
| 6  | Crustacean| Giant mud crab (*Scylla serrata*)            | +          | +          |
|    |           | Purple Climber Crab (*Metapograpsus sp.*)    | +          | -          |
|    |           | Giant tiger prawn (*Penaeus monodon*)        | +          | -          |
|    |           | Banana prawn (*Penaeus merguensis*)          | -          | +          |
|    |           | Speckled shrimp (*Metapenaeus monoceros*)     | -          | +          |

3.3. Ecological suitability and carrying capacity analysis

Environmental suitability and carry capacity for two mangrove eco-tourism displayed in Table 3. In the case of LK eco-tourism was suitable for ecotourism (84.6%), the higher value than in SN with conditionally suitable status (53.6%). The carrying capacity both locations are similar to 36 people/day. These results suggest that the maximal number of visitors physically fit in the area without disturbing to mangroves and other visitors as well. It has established that ecotourism is not mass tourism; therefore guest space is limited [8], indicated that determination of carrying capacity and ecological suitability might consider the sustainability of environmental aspects.

3.4. SWOT analysis and proposed development strategy

Based on the internal and external factors analyzed, SWOT results led to several considerations. They are both locations of mangrove ecotourism have a potential eco-tourism attraction and facility such as tracking, lodgement, toilet, cafeteria, praying place, home stay and gallery (SN only), parking lot, simple cottage, the souvenir of mangrove products. Both eco-tourism sites have high mangrove biodiversity
(Table 1-2), and potential human resources for both locations as well. Furthermore, real people’s perception on the importance of mangrove conservation supported both areas (Figures 3-4). Also, both mangrove eco-tourism spots have relatively easy access to be visited.

**Table 3.** Ecological suitability and carrying capacity for mangrove eco-tourism

| Parameters                                             | LK         | SN         |
|--------------------------------------------------------|------------|------------|
| Relevance level of mangrove ecosystem for ecotourism   | 84.6 %     | 53.6 %     |
| development                                            |            |            |
| Carrying capacity for mangrove eco-tourism             | 36 people/day | 36 people/day |

We, therefore, proposed three eco-tourism development strategies as follows, firstly, to increase the efforts to manage the mangrove ecosystem through eco-tourism activities. The second strategy is to maintain both mangrove eco-tourism according to the carrying capacity area. The third approach was proposed to promote the mangrove eco-tourism using internet or mass media to attract a large number of tourists. Implementation of eco-tourism in mangrove ecosystem indicated as a sustainable development approach to increasing local income, reducing fishing pressure, and mangrove conservation. The study present suggested that mangrove ecotourism is a viable form of land use, to contributing the environmental protection and providing socio-economic benefits to the local people through indirect values of the natural resources [8-9].

4. Conclusions

Varying characteristic of mangrove eco-tourism suggested the critical study on difference type mangrove ecotourism. Ecotourism potential of the mangrove ecosystem in SN and LK produced mangrove product from mangrove resources. The existence of community groups supported both locations. An alternative strategy for prioritized mangrove ecotourism management in SN and LK by increasing efforts to manage the mangrove ecosystem as CBMM through ecotourism activities, keeping the mangrove about the carrying capacity of the region and use the internet and social media to attract tourists to visit mangroves eco-tourism. Further research on the landscape on mangrove eco-tourism will deepen our knowledge of community-based mangrove management.

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