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Suitability of Mangrove Forests for Sustainable Tourism

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Abstract. The Pantai Indah Kapuk (PIK) Mangrove Ecotourism is in DKI Jakarta Province. It can develop into sustainable tourism because it has good natural conditions and an easy-to-reach location. This research aims to determine the suitability index of mangrove forest tourism for sustainable tourism development. This research was conducted from February to March 2023. The method used in this research is a quantitative descriptive method. This study has two observation points to determine the thickness, density, type of vegetation, and biota objects. The results showed that this location has the potential to be used as a tourist attraction. It is supported by the value of the tourism suitability index for each research station of 68.7% at the first observation station and 62.5% at the second observation station. *Rhizphora apiculata* species dominate the composition of the mangrove vegetation in this location, with a density of 850 trees/ha. The thickness of the mangrove at this location is 60.4 m at the first station and 64.1 m at the second station. The biota objects found at the observation point were fish, mollusks, reptiles, and mammals. Overall, this research location is suitable for tourist attractions and can be developed to become more sustainable tourism. However, several efforts are needed to improve this suitability, such as mangrove forest rehabilitation and cooperation from various stakeholders.

Keywords: Jakarta, Mangroves, Sustainability, Tourism suitability index

I. INTRODUCTION

Sustainability is the capacity of natural systems that support life and human social systems to survive or adapt to changing environmental conditions indefinitely [1]. Three main components of environmental science are needed to realize sustainability: economic, environmental, and social [2]. Socially sustainable means that it can maintain social and system stability. It can preserve the resilience of the system and the physical environment and is economically sustainable to maximize income while maintaining natural capital [3].

Economic prosperity and welfare in a region are supported by its natural capital. From this natural capital, humans can obtain various ecosystem services, such as preventing natural disasters, climate regulation, and nature-based recreation [4]. In simple terms, ecosystem services can be interpreted as the benefits of everything that humans can utilize from the ecosystem they are located in [5-29]. The benefits obtained are tangible or intangible products, such as wood products, food, and freshwater. In contrast, intangible products such as habitats are used for conserving biological resources, preventing erosion, balancing air quality, and recreational and aesthetic facilities [6]. Each ecosystem provides different ecosystem services with other functions.

Mangrove ecosystems are ecosystems located in coastal areas that are affected by tides. This ecosystem is essential in providing ecosystem services for living things around it. Mangrove ecosystem functions can be categorized into biological or ecological, physical, and socio-economic [7]. Some of the parts and ecosystem services produced by mangroves are: as a habitat for aquatic biota (fish, shrimp, crabs), shelter and search for some waterbirds, serves as a damper for waves from the sea, as a protector to avoid absorption, prevents water intrusion. The ocean produces oxygen and absorbs carbon and can be used as a tourist attraction [8, 9].

Globally, the mangrove area is estimated at around 14.8 million ha [10]. The extent of this mangrove is scattered in various countries around the world. Problems arise when the human population has increased and the mangrove area has decreased. The world population in 2020 was 7,761,620,146 people, which increased by 78,247,887 people from 2019 [11]. Globally, the mangrove area has reduced by 1.04 million hectares between 1990 and 2020 [10]. The increase in population has an impact on increasing the need for land for

settlements, thus causing the conversion of mangrove forest areas. This decrease in mangrove areas will cause negative effects on the environment, such as habitat loss, biodiversity, and ecosystem services [12, 13].

Indonesia has the largest mangrove ecosystem in the world at 3,364,080 Ha [14]. However, the existence of this mangrove ecosystem has the potential to experience a decline or damage caused by the conversion of mangrove forest land. One of the drivers of increasing the function of mangrove forest land is the increase in population in Indonesia. The total population of Indonesia in 2020 is 270.20 million, an increase of 32.56 million from the previous census results [15]. In line with the rise in population, it will increase the demand for land resources in Indonesia [16].

The mangrove ecosystems in Indonesia are spread across various provinces, one of which is in DKI Jakarta. In the coastal area of DKI Jakarta, mangrove forest lands are used as tourism objects. However, currently, the environment can be ruined due to the conversion of functions into residences, fish ponds, industry buildings, infrastructure development, and ports [17]. The mangrove ecosystem at Pantai Indah Kapuk (PIK) was damaged by 272.79 ha due to land conversion [18]. Currently, to control the damage and maintain the existence of mangroves, the local government is developing the area as a tourist attraction. Utilizing this ecosystem as a tourist attraction can benefit ecosystem sustainability and increase the economy for regional income [19].

Increasing the number of visitors to tourist attractions can have economic benefits. On the other hand, it has the potential to be harmful to the environment. As a result, the principle of sustainability must be followed to avoid harming natural ecosystems. Given this situation, innovation and evaluation are required to ensure the long-term viability of the mangrove tourism object at PIK.

The tourism suitability index (TSI) is one of the efforts that can be made to maintain the sustainability of this tourist attraction [32]. This analysis has been used in several previous studies to determine whether mangrove ecosystems are suitable for use as tourist attractions. Similar studies have been conducted in several Indonesian mangrove ecosystems, including Mangrove Ecotourism in Siahoni Village, North East Buru Regency; Kelapan Island, South Bangka Regency; and Mangrove Ecotourism in Taddan Village, Sampang Regency [20-22]. This research, however, has never been conducted at PIK Mangrove Ecotourism, furthermore, this study is different from previous research in that it was conducted following the COVID-19 pandemic. As a result, this research is critical to provide information about the potential and suitability of tourism in PIK Mangrove Ecotourism. This study aims to determine whether mangrove forests are suitable for sustainable tourism.

II. METHOD

Study Area and Data Collection

This research was conducted at the Mangrove Nature Tourism Park, Pantai Indah Kapuk, North Jakarta City, DKI Jakarta Province, Indonesia. Research data collection was carried out from February to March 2023. The research location was divided into two research stations, the first station has coordinates of 6°07'20.3"S 106°45'21.8"E, and the second station has coordinates of 6°07'20.5"S 106 °45'26.5"E. Determining location points or data collection is carried out using a purposive sampling technique, by determining specific criteria. The specified criteria are that the selected location generalizes the overall condition of the area and is located along the tourist route visitors use. The tools used in this research are the Global Positioning System (GPS), the Rollmeter, the Laser Distance Meter (LDM), the camera, and writing tools.

Data Analysis

In this study, the analysis of suitability data focused on putting mangrove tourism areas in the recreational category. The suitability of mangrove tourism in this location considers four main parameters: mangrove thickness, mangrove density, type of vegetation, and biota objects. The density parameter is obtained by plotting the sample using the transect quadrat method. The thickness of the mangroves is obtained by using a rolling meter to measure the distance between the last mangrove vegetation in the research location and the final boundary for the area of the tourist attraction. At the same time, the type of vegetation and biota objects were obtained through direct field observations. The selection of these parameters is based on has been conducted by several studies [21, 23-24, 31], which were adjusted to the field conditions at the research location. The mangrove tourism suitability index used in this study refers to the suitability matrix used in research [20-25], which can be seen in Table 1.

The matrix is used as a reference in the weighting and scoring of the indicators used in the research parameters. The weighting for each indicator is determined based on the score obtained from field research on ecosystem conditions [30]. Furthermore, all the data collected related to the state of the mangrove ecosystem is analyzed to determine its suitability to be used as a tourist attraction. Tourism suitability is investigated using the formulation of the mangrove tourism suitability index as follows [25]:

$$TSI = \sum \left(\frac{Ni}{Nmax}\right) \times 100\%$$

where,
TSI = Tourism suitability index
Ni = Value of parameter i (weight × score)
Nmaks= The maximum value of a tourism category

After the calculations are done, a suitability value will be made up of information that can be categorized as follows:
S1 = Very suitable, TSI > 75–100%
S2 = Suitable, TSI > 50–75%
S3 = Conditionally/ Least suitable, TSI > 25–50%
N = Not Appropriate, TSI < 25%.

TABLE 1.
SUITABILITY INDEX FOR MANGROVE TOURISM

No.	Parameters	Weight	Category 1 (S1)	Score	Category 2 (S2)	Score	Category 3 (S3)	Score	Category N	Score
1.	Mangrove thickness (m)	5	> 500	4	> 200 – 500	3	> 50-200	2	< 50	1
2.	Mangrove Density (100 m^2)	4	> 15-25	4	> 10 – 15	3	> 5 – 10	2	< 5	1
3.	Types of Mangrove Vegetation	4	> 5	4	> 3 – 5	3	> 1 – 2	2	0	1
4.	Biota Object	3	> 5	4	> 3 - 5	3	> 1 – 3	2	0	1

TABLE 2.
RESULTS OF SUITABILITY INDEX FOR MANGROVE TOURISM

No.	Parameters	Weight (W)	Point 1			Point 2		
			Score (S)	Category	Ni= W × S	Score (S)	Category	Ni= W × S
1.	Mangrove thickness (m)	5	2	3	10	2	3	10
2.	Mangrove Density (100 m^2)	4	4	1	16	3	2	12
3.	Types of Mangrove Vegetation	4	3	2	12	3	2	12
4.	Biota Object	3	2	3	6	2	3	6
	Total				44			40
	Suitability Indeks				68,7%			62,5%
	Suitability Category				Suitable (S2)			Suitable (S2)

III. RESULTS AND DISCUSSION

Composition, Density, and Thickness of Mangrove in PIK Mangrove Ecotourism

There are three types of mangroves found in two research stations. The species that dominated both stations were Rhizophora, both *Rhizophora apiculata* and *Rhizophora mucronata*. In addition, another species found at the two research stations was *Avicenna marina*. The type of *Rhizophora apiculata* dominates the composition of the mangrove vegetation for the tree level at 850 trees/ha. This number is higher than in [21], with a 429 trees/ha density. At the sapling level, it was dominated by the same species, namely *Rhizophora apiculata*, at 550 trees/ha. It was the same with the tree and sapling level; at the seedling level, it was dominated by *Rhizophora apiculata* at 900 trees/ha.

The high index species of *Rhizophora apiculata* in this place is due to the characteristics of the place where it grows according to this type. The characteristics of this species can grow well in deep and muddy substrates, with root morphology that rises to the surface of the water. This statement follows [26] which states that mangroves of the *Rhizophora apiculata* type can grow in muddy

substrates. In addition, the high number of *Rhizophora apiculata* species in this location is also because this species is the result of planting and growing into mature trees.

Based on a report from the DKI Jakarta Provincial Forestry Service, the Mangrove Ecotourism area has an area of 16.03 ha [27]. The thickness of the mangrove obtained through observation equals 60.4 m at the first station and 64.1 m at the second station. Within this area, there is a rehabilitation monitoring route that can also be used as a tracking route or a photo spot, one of the main attractions. In addition, several other facilities are provided, such as toilets, information boards, prayer rooms, gazebos, and some simple seats. However, the condition of this facility needs to be given even better attention because of its poorly maintained condition.

Biota Objects in PIK Mangrove Ecotourism

In addition to the mangroves themselves, several faunas live at the study site. Based on the results of field observations, several faunas were found at research stations one and two, namely fish, reptiles, mollusks, and mammals. The biota found were identified by comparing the species found with the fauna introduction book based on the characteristics and morphology of the biota. In addition, several types of biota that are difficult to identify can be identified by asking the expert/tourist manager.

At station one, several types of water snails (*Pomacea canaliculata*), monitor lizards (*Varanus salvator*), and various kinds of fish were found. At the second station, the fauna found were water snails (*Pomacea canaliculata*), several species of fish, and long-tailed monkeys (*Macaca fascicularis*).

This type of fauna is essential for the ecosystem because it interacts with all biotic and abiotic components, resulting in an interdependent relationship. The number of fauna found at this location is less when compared to the fauna found in [21] where there are four types of fauna at the research location. However, there are as many as the number of biotas found in [24] as many as three types of fauna species at the study site.

Suitability of Mangrove Tourism in PIK Mangrove Ecotourism

The tourism suitability index (TSI) of mangroves at the study site can be seen in Table 2. Tourism suitability in this study was seen at two observation stations. The TSI value at the first observation station was 68.7%, and at the second observation, the station was 62.5%. The TSI values obtained at all observation stations are included in the S2 category or suitable to be used as a mangrove tourism object. The results of this study are not much different from the research of [20] in the Mangrove Ecotourism Area in Siahoni Village, Maluku Province, which obtained an TSI score of 65% at station 1 in the S3 category (suitable), an TSI value of 72.5% at station second with category S2 (suitable) and other stations that also have category S2 (suitable). The results of this study are even higher when compared to [22] on Mangrove Ecotourism in Taddan Village, Sampang Regency, which obtained a TSI score of 59% at the first station in the S3 category (suitable with conditions), a TSI score of 54% at the second station in the S3 category (conditionally/least suitable), and other stations with S3 category (conditionally/least suitable).

Based on the assessment at the two observation stations, the Mangrove Ecotourism area, PIK is feasible to be used as a tourist attraction because the calculated parameters fulfill the requirements and are suitable for use as tourism. This location has the potential that can be developed and utilized for sustainable mangrove tourism. However, further efforts are needed to increase the suitability score in this area. One of the efforts that can be made is to carry out rehabilitation and reforestation of mangroves at the research location by holding planting events, which can involve many parties in its implementation. Ecologically, this effort can be carried out to improve the quality of mangroves as a habitat and the main attraction of this area so that the suitability value can be achieved by increasing the area and the density of the mangrove area. In addition, government support and attention are needed in developing facilities and infrastructure to support the development of mangrove ecotourism activities. There needs to be integration between the government and tourism object managers, communities, and third parties from both the private sector and related NGOs to encourage sustainable mangrove tourism development. This opinion is also reinforced by the research of [28] which suggests that one of the strategies for sustainable tourism development is to develop ecotourism-based tour packages involving elements of the population, agencies, academics, and non-governmental organizations.

IV. CONCLUSION

The PIK Mangrove Ecotourism Area has environmental conditions that have the potential to be developed into a sustainable tourism object. The tourism suitability index (TSI) obtained at this location was 68.7% at the first observation station and 62.5% at the second. The TSI value obtained is included in the S3 category or suitable to be used as a mangrove tourism object. However, this

condition can be improved by making several improvement efforts. Some of the efforts that can be made include rehabilitation and planting of mangroves, monitoring the condition of mangrove ecosystems, and maintaining the natural environment around tourist objects so that the attractiveness and ecological functions in this area can continue to increase. As well as the involvement of stakeholders, it is crucial to improve the process of developing this area to become a sustainable tourist attraction.

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