The Sustainability Analysis of Mangrove Ecosystem for Mangrove Ecotourism in Pandansari Hamlet, Kaliwlingi Village, Brebes District

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Abstract:- This paper describes the role of the mangrove forest ecosystem as a habitat for marine organisms by using quantitative and qualitative analysis. The data are taken from related literature which is then described further. The data obtained show that mangrove forests in Indonesia are estimated to cover an area of 4.25 million hectares, only about 2% of the total land area, but their economic and environmental values should not be underestimated, therefore their presence must be maintained. As a transition zone between terrestrial and marine ecosystems, mangrove ecosystems have long been known to have many functions and are an important link in maintaining the biological balance of coastal ecosystems. The mangrove forest ecosystem is an important habitat for marine organisms. Generally dominated by molluscs and crustaceans. These mollusks consist mainly of Gastropods and are further dominated by two families, namely Potamidae and Ellobiidae. As for crustaceans, it mainly consists of Brachyura. Some mangrove fauna is also known as consumables and is economically important such as Terebralia palustris, Telescopium telescopium (Gastropoda), ancient Anadara, Coaxans polymesoda, Ostrea cucullata (Bivalvia), and Scylla serrate, S. olivacea, Portunus pelagicus, Epixanthus dentatus, Labnanium polytum (crustaceans).

Keywords:- *Mangrove Forest, Mangrove Ecotourism, Mangrove Ecosystem, Molluscs.*

I. INTRODUCTION

Kaliwlingi Village is one of the villages in the northern coastal area of Java, precisely in Brebes District, Brebes Regency, Central Java. In 1983 the coastal area of Brebes Regency, Central Java Province was 65.48 km long, overgrown with 2,372 ha of mangroves. However, in 2013 the mangrove area was only 243.20 ha [1]. Mangrove ecosystem is a typical coastal ecosystem that is a place for reciprocal relationships between abiotic components such as inorganic compounds, organic, tidal, salinity, and biotic components such as producers (vegetation and plankton), macro consumers (insects, fish, birds, and crocodiles) take place [2]. Some mangrove species can grow and develop in muddy coastal tidal areas [3,4]. Mangrove ecosystems are natural resources in the tropics that have multiple benefits, both ecological and socio-economic aspects [5]. The magnitude of the role of mangrove ecosystems for life can be seen from the many types of animals, both those that live in waters, on land, and in tree crowns and human dependence on them [6,7].

The muddy coastal area is the main habitat of the mangrove ecosystem in Indonesia. This region is full of interests, so the region faces various threats caused by humans [8]. On the other hand, mangrove stands can store carbon stocks of 18.53 tons/ha [9]. Tourism is the main service industry that generates employment and economic development so that its development innovation must consider the environmental paradigm [10]. In recent years, the paradigm of tourism activities has changed along with the application of the concept of global sustainable development, namely mass tourism to nature and culture-based tourism. Research by Akhil and Kurniawan in Pandansari mangrove forest tourism objects shows that the ecosystem in the area is suitable to be developed as an educational tour [11,12]. The equitable distribution of income in rural communities around the location is a major issue in tourism development [13].

This area has become one of the tourist destinations for tourists every vacation, from visitor data in 2018 it is estimated that more than 500 people visited the mangrove ecotourism. Mangrove ecotourism in Pandansari Hamlet is also supported by the beauty of its natural scenery where you can see the waves of the Java Sea on the north side, the beautiful view of Mount Ciremai on the southwest side, and Mount Slamet that extends on the other side. In addition, the beauty of the sand island in the middle of the sea, as well as swimming, snorkeling, mangrove trekking tours that are offered make mangrove ecotourism in Pandansari Hamlet much in demand as a tourist destination. Dukuh Pandansari is the closest point to the location of mangrove ecotourism so that the community will receive a positive impact due to tourism development in this area. Some of the supporting facilities and infrastructure are already available, such as paving 5 km of roads, directions, parking lots, secretarial offices, docks, public toilets, prayer rooms, gazebos, IPAS (Well Water Treatment Plant), viewing towers, and mangrove tracking. The availability of information centers and tour guides are important for visitors who are visiting tourist sites for the first time [14]. The variable cost added to the entrance ticket price is not a problem for most visitors because the information obtained becomes visitor satisfaction [15].

Conservation activities in the Pandansari Mangrove area have the potential to be used as a natural tourism area to increase the income of the surrounding community so that people are motivated to conserve mangroves. In the initial step, further analysis is needed regarding whether the condition of the Pandansari mangrove ecosystem can be used as a sustainable mangrove ecotourism area? Ecotourism is an approach in managing coastal resources as a marine tourism object, as a guarantee of resource sustainability and ecosystem health in the environment (Center for Research and Development of Environmental and Coastal Resources, 2012). Ecotourism activities that can be carried out include observing birds and animals around the ecosystem, planting mangroves, fishing, photography, and other natural tourism activities. The purpose of this study was to analyze and evaluate the condition of the Pandansari Mangrove Ecosystem to determine its feasibility as support for mangrove ecotourism. A similar study was carried out by Fahrian et al in the mangrove area of Monorejo Village, Kendal Regency, and it was found that this area is included in the conditionally appropriate category and needs to be started by opening a conservation area and birdwatching [16].

II. RESEARCH METHOD

A. Research Time and Location

This research was conducted for fourteen months between March 2020 and May 2021 in Pandansari Hamlet, Kaliwlingi Village, Brebes District, Brebes Regency, Central Java.

B. Village Selection Criteria, Respondents, and Research Data Collection.

Pandansari hamlet was chosen as the research location because in that hamlet there is a mangrove ecosystem. Research is generally carried out using a quantitative approach, namely to obtain data in the form of values of measured variables. The research method used is a combination of quantitative and qualitative research methods. Quantitative methods are carried out by analyzing aerial photos using drones and ArcGIS programs, image analysis using overlays and field measurements, while qualitative methods are carried out by collecting data in the form of interviews (depth interviews), observation, and documentation. The shooting system with unmanned aerial vehicles (drones) has a higher level of portability than the use of standard aircraft [17]. This is considered very effective for aerial photography on land under 100 ha [18].

The bird observation method uses the Encounter Rates (meeting rate) method, namely direct observation by exploring and counting every bird encountered [19]. Exploration was carried out 1 time with 1 group of observers, namely from 08:00 to 16:45, with the identification of local names from local sources who like chirping birds [19].

In-depth interviews were conducted by elements of the government and community leaders who handle the mangrove ecosystem in Pandansari Hamlet. Respondents who were interviewed (deep interview) were 3 people consisting of community leaders who are also members of Commission II

DRPD Brebes Regency, Head of Tourism Destination Development Section of the Brebes Regency Tourism Office, and the Head of Kaliwlingi Village.

The data needed are primary data obtained through field measurements, observation, documentation, and interviews (depth interviews) and secondary data obtained through relevant agencies and library materials (literature). As the population in this study are 1). Mangrove ecosystem in Pandansari Hamlet, with a sampling plot measuring 10 m x 10 m as many as 8 plots, 2). Elements of government in charge of mangrove ecosystems in Pandansari Hamlet (Brebes Regency Tourism Office, and Head of Kaliwlingi Village), 3). Community elements who handle mangrove ecosystems in Pandansari Hamlet (Pokdarwis, and Pandansari Community Leaders). Supporting data for this research is the search for village documents, laws and regulations, and archives of documents in the Pandansari mangrove area.

C. Determination of Mangrove Ecosystem Conditions

The condition of the mangrove ecosystem was analyzed by analyzing parameters such as thickness, density, number of species, ecological functions, and types of animals referring to Mulyo and Murni as shown in Table 1 [8,20].

TABLE I. WEIGHT OF MANGROVE ECOSYSTEM CONDITION ASSESSMENT.

Rating Parameters	Scale/Score	Damage Weight
Mangrove thickness	Mangrove green strip thickness >90%	5
	Mangrove green strip thickness 60%–90%	10
	Mangrove green strip thickness 30%–60%	15
	Mangrove green strip thickness <30%	20
Mangrove density	If there are >15 mangrove trees per 100 m^2	5
	If there are 15-10 mangrove trees per 100 m^2	10
	If there are 9-5 mangrove species per 100 m^2	15
	If there are <5 mangrove species per 100 m2	20
Number of mangrove species	If there are > 6 types of mangrove	5
	If there are 5-6 types of mangrove	10
	If there are 3-4 types of mangrove	15
	If there are 1-2 types of mangrove	20
Ecological Function	If it becomes a place for Spawning, Enlargement, and wildlife habitat	5
	If there are only 2 (two) ecological functions among the ecological functions as a place for Spawning, Enlargement, and wildlife habitat	10
	If there is only 1 (one) ecological function among the ecological functions as a place for Spawning, Enlargement, and wildlife habitat	15

Animal Type	If there are 4 (four) types of animals among the types of mammals, birds, reptiles, and marine biota	5
	If there are 3 (three) types of animals among the types of mammals, birds, reptiles, and marine biota	10
	If there are 2 (two) types of animals among the types of mammals, birds, reptiles, and marine biota	15
	If there is only 1 (one) type of animal among the types of mammals, birds, reptiles, and marine biota	20

The Formula

$$KL = \frac{X_t - X_r}{k} \qquad (1)$$

Description:
KL : Interval Class
Xt : highest value
Xr : lowest value
k : number of desired classes

Based on this formula, the interval class calculation is carried out as follows:

$$KL = \frac{100 - 25}{3}$$
$$KL = \frac{75}{3}$$
$$KL = 25$$

Based on these calculations, the value of the interval class is 25 and the class division is 25 to 50 into the good classification, 51 to 75 into the medium classification, and 76 to 100 into the bad classification.

D. Aerial Photo Analysis

The scale of shooting using aerial photography produces a mapping above a scale of 1:10,000 for an area under 500 ha (Rokhmana, 2015). An aerial photo of the Pandansari Mangrove area was taken using a DJI Phantom 4 Pro V.2.0 type drone at an altitude of 100 meters. The mapping of the Pandansari mangroves was carried out at a photo scale of 1:900 so it can be concluded that this mapping is very accurate.

Details in aerial photographs can make it easier to analyze objects, according to Rokhmana in analyzing vegetation such as the textured appearance of the canopy cover combined with hues/colors and shadows for the impression of altitude, which are the main elements of recognizing vegetation types [18].

III. RESULT AND DISCUSSION

A. Mangrove Ecosystem Condition

Based on the data obtained with 8 sample plots which were divided into areas A and B, there were 2 types/species of mangrove plants in the research location, namely: Rhizophora Mucronata and Avicennia Marina. Previous research by Hakim, et.al., the majority of mangrove species that grow in Kaliwlingi Village are Rhizophora apiculata and Rhizophora mucronata (mangroves) [21]. Each research transect consisted

on average of 2 mangrove species with an average weight of 18.99 (Figure 2). The dominant mangrove species in the Pandansari Mangrove Area are Avicennia marina and Rhizophora Murcronata.

The mangrove vegetation density level has a high value with an average weight of 5, and the level of damage as measured by the thickness level has an average weight value of 9 (Figures 1 and 2). The level of density and thickness of mangroves can affect the ecological function of mangrove vegetation. Ecological functions include spawning, rearing, and animal habitats with an average weight value of 8.89 (Figure 2).

The mangrove ecosystem is an ecosystem rich in fish (golodok fish, mullet fish, milkfish, and white snapper), shrimp (tiger shrimp, jerbung shrimp, and werus shrimp), and crabs (violin crab and mangrove crab), which attracts several birds. water. Habitats can include various types of ecosystems, ranging from natural ecosystems to artificial ecosystems. The results of bird observations in the Pandansari Mangrove area, Kaliwlingi Village, showed that 26 species of birds were identified (Table 2).

Other types of animals found in the Pandansari mangrove area are gelodok fish, crabs, and mussels. Based on these data, it can be determined that the average weight value for each animal species in the research transect in the Pulau Lumpur area is 11.88 (Figure 2).
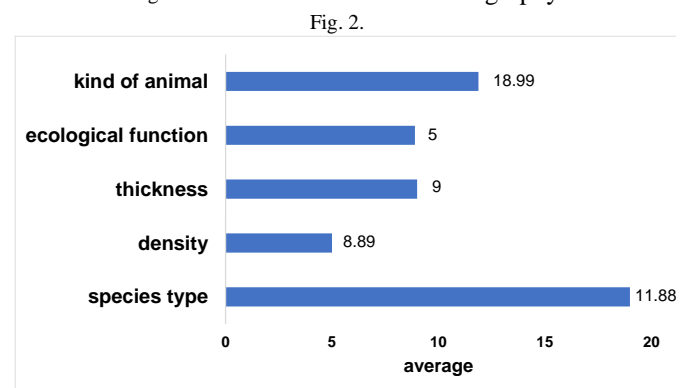

Fig. 1. Transect Plot Aerial Photography

Fig. 2.

Fig. 3. Parameter measurement results

TABLE II.   BIRD DIVERSITY IN THE PANDANSARI MANGROVE AREA, KALIWLINGI DESA VILLAGE

No	Family	Species	Local Name
1	*Ardeidae*	*Egretta alba*	Kuntul Besar
2	*Ardeidae*	*Egretta garzela*	Kuntuk Kecil
3	*Ardeidae*	*Ardea Cinerea*	Cangak Abu
4	*Ardeidae*	*Ardeola speciosa*	Blekok Sawah
5	*Ardeidae*	*Butorides striatus*	Kokokan laut
6	*Artamidae*	*Artamus leucorhynchus*	Kekep Babi
7	*Acanthizidae*	*Gerygone sulphurea*	Remetuk Laut
8	*Alcedinidae*	*Todirhamphus sanctus*	Cekakak Suci
9	*Alcedinidae*	*Alcedo coerulescens*	Raja Udang Biru
10	*Anatidae*	*Dendrocygna javanica*	Belibis Batu
11	*Apodidae*	*Collocalia linchi*	Walet Linci
12	*Threskiornithidae*	*Plegadis falcinellus*	Ibis Rokoroko
13	*Sternidae*	*Sterna bergii*	Dara Laut Jambul
14	*Sternidae*	*Sterna Hirundo*	Dara Laut Biasa
15	*Charadriidae*	*Charadrius javanicus*	Cerek Jawa
16	*Columbidae*	*Streptopelia bitorquata*	Dederuk Jawa
17	*Rhipiduridae*	*Rhipidura javanica*	Kipasan Belang
18	*Sturnidae*	*Acridotheres javanicus*	Kerak Kerbau
19	*Passeridae*	*Passer montanus*	Burung Gereja Erasia
20	*Hirundinidae*	*Hirundo tahitica*	Layang-layang Batu
21	*Cuculidae*	*Centropus nigrorufus*	Bubut Jawa
22	*Estrildidae*	*Lonchura punctulata*	Bondol Peking
23	*Pycnonotidae*	*Pycnonotus aurigaster*	Kutilang
24	*Columbidae*	*Streptopelia chinensis*	Burung Tekukur Biasa
25	*Scolopacidae*	*Numenius phaeopus*	Gajahan Pengala
26	*Cisticolidae*	*Prinia flaviventris*	Perenjak Rawa

The diversity of animals in the Pandansari mangrove ecotourism area can provide its charms, such as the behavior of gelodok fish, the unique behavior of birds, the distinctive sound of each bird species, and the beauty of the color of bird feathers. Based on the results of the assessment of some of these parameters, it can be seen how the condition of the Pandansari mangrove ecosystem by adding up the overall average weight value of the parameters in Figure 2 obtained a value of 53.76 which belongs to the interval class 51 to 75 with the classification "medium".

The accuracy value of Mosaic and DSM UAV based on NMAS (National Map Accuracy Standard) meets the accuracy tolerance according to scale so that it can be used for large-scale mapping (up to 1:1000) [17]. Based on the results of topographic measurements and aerial photographs with drones (UAV) (Figure 3), it is known the following data: the Pandansari mangrove area is about 2.47 ha. Based on the boards installed at the location, it shows that the Pandansari mangrove ecosystem area has an area of about 430 ha. The difference in value is because the analysis carried out by researchers only focuses on the Tourism Zone, not comprehensively with the Conservation Zone in the Pandansari Mangrove Ecosystem Area, Kaliwlingi Village, Brebes District, Brebes Regency, Central Java Province.

The visual preferences of tourists' landscapes for tourist objects vary based on aesthetic qualities, tidiness, and cleanliness [22]. In making a master plan for the development of Pandansari mangrove ecotourism, it is necessary to consider these three things, namely aesthetic quality, tidiness, and cleanliness to increase tourist visits. According to Kurniawan et al., the strategy of developing marine tourism potential in the ecological dimension by applying the concept of ecotourism in the use of tourism activities can maintain the sustainability and preservation of existing resources [23]. One of the sustainable tourism development strategies is to develop ecotourism-based tour packages by involving elements of the population, agencies, universities, and NGOs [24].

The location of mangrove ecotourism which is in a stable tidal area and sloping contours strongly supports mangrove vegetation to live well. Differences in the surface character of the area in the Pandansari mangrove area can be used as part of the land suitability reference to make a master plan based on the carrying capacity of the environment so that in the management and development of ecotourism it does not cause damage to mangroves and reduce tourist satisfaction.

Fig. 4. Map of Land Use in Pandansari Mangrove Ecotourism

IV. CONCLUSION

The condition of the mangrove ecosystem in Dukuh Pandansari is currently suitable to be used as a sustainable mangrove ecotourism area, but there is still a need for additional parameters such as adding mangrove diversity and animal breeding to make the ecosystem better.

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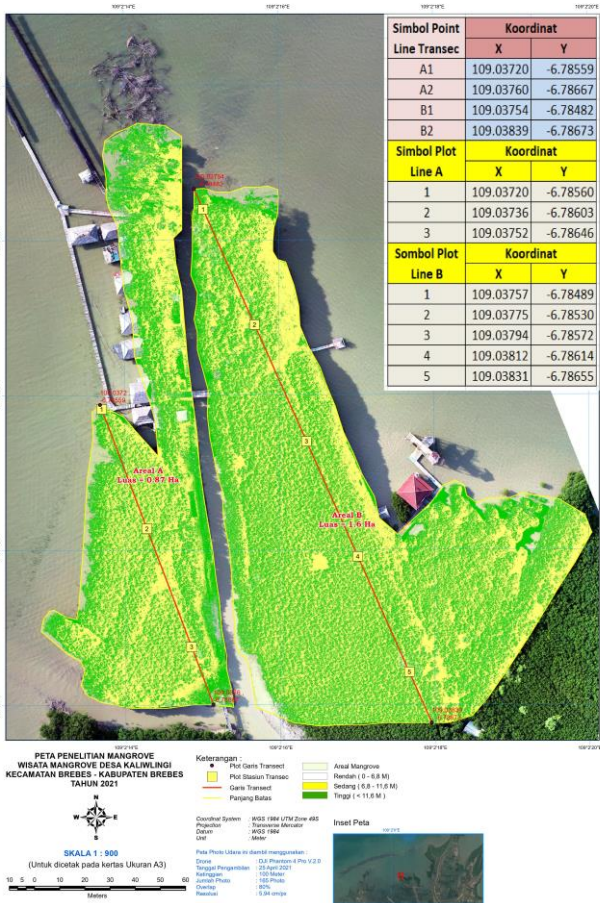
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