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Potential of Mangrove Ecotourism in Pangandaran, West Java Indonesia Case Study: Bulaksetra, Bojongsalawe, Batukaras

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ABSTRACT

Pangandaran is a district in the province of West Java with great potential for tourism. The attractions are not limited to the coastal areas but also include other natural resources, one of which is the mangrove ecosystem. The objective of this research was to measure the suitability index for mangrove tourism in Bulaksetra, Bojong Salawe, and Batukaras. The research used a survey method with direct field observations and satellite imagery analysis of mangrove areas, followed by descriptive analysis. The potential of these areas is calculated using the tourism suitability index. The results show that the mangrove area at Station 1 (Bulaksetra) is 6.6 hectares, Station 2 (Bojong Salawe) has 3.4 hectares, and Station 3 (Batukaras) covers 16.7 hectares. The tourism suitability index analysis at the three stations reveals that Bulaksetra falls into the "very suitable" category (S1) with a suitability value of 76%; Bojong Salawe is classified as "suitable" (S2) with a value of 63.5%, and Batukaras is also in the "suitable" (S2) category with a value of 74%

INTRODUCTION

Mangrove is the most productive ecosystem, providing many benefits in the form of ecosystem services that greatly determine the sustainability of coastal communities. Some of the benefits of the mangrove ecosystem include regulatory services such as protecting coastal areas from disasters, storing carbon, mitigating climate change, and serving as a tourist attraction **(Rihardi, 2016)**. One of the mangrove ecosystem services is an ecotourism attraction that is unique and has a special value. The special value of mangrove ecosystem services includes recreation, aesthetics, education, cultural heritage **(Blanton *et al.*, 2024)**. Aesthetically, mangroves attract tourists and generate income for many countries. Globally, mangroves area known for the benefits they provide to communities ranging from providing food to protection from strom, as well as their importance to local culture, economics and social value. Thus, the services provided by the mangrove ecosystem offer many opportunities for sustainable ecotourism; however, mangrove ecotourism has not been well developed or managed **(Nelly *et al.*, 2020)**.

Pangandaran is a district in West Java with significant tourism potential. Several areas within Pangandaran have great potential for development as tourist destinations, particularly in coastal tourism and other natural resources. Beyond mass tourism, Pangandaran also offers high potential for ecotourism. According to **Surjati (2020)**, ecotourism is nature-based tourism that contributes to social and environmental benefits. Additionally, ecotourism plays an important role in local and regional economic growth. The marine ecotourism potential in Pangandaran extends beyond the coastal areas to include the mangrove ecosystems, which could be valuable if developed into a marine ecotourism attraction. The mangrove ecosystem in Pangandaran serves as an example of community-based management, where success is largely dependent on local community involvement. According to data from Pusluh KP (August, 2018), the mangrove area in Pangandaran spans approximately 237.59 hectares **(Mulyani, 2023)**.

After the tsunami wave occurred in 2006, intensive mangrove rehabilitations efforts in Pangandaran were carried out with the result that several mangrove areas in Pangandaran showed signs of significant recovery. The conditions of mangrove Pangandaran has changed in recent years. One area that has a fairly extensive mangrove ecosystem is Cijulang. The mangrove ecosystem in Cijulang is divided into several areas including Nusawiru, Bojongsalawe and Batukaras. According to **Astuty (2019)**, the mangroves in Batukaras exhibit natural characteristics and consist of three types: *Rhizophora*, *Bruguiera*, and *Avicennia*. The most common mangrove species found in Pangandaran include *Avicennia alba*, *Rhizophora apiculata*, *Nypa fruticans*, and *Sonneratia alba*. The distribution of mangrove vegetation in the Pangandaran area is generally random. Rehabilitation efforts, such as mangrove replanting and community-based ecotourism development, have been implemented to preserve this area.

The mangrove ecosystem in Pangandaran presents a significant opportunity to be developed into an alternative tourist attraction that offers recreational, conservation, and educational tourism services while incorporating local cultural values and prioritizing sustainability. In the future, the development of mangrove ecotourism in Pangandaran is expected to yield positive outcomes and contribute to increasing the income of the surrounding community. The objective of this research was to measure the suitability index of the mangrove ecosystem for development into mangrove ecotourism in Pangandaran.

MATERIALS AND METHODS

1. Reasearch methods

This research used quantitative methods with descriptive analysis. To collect data on mangroves, the line transect method was employed. Data were collected from plots measuring 10m x 10m and 5m x 5m, where trees, stakes, and seedlings were observed. The criteria for classification were: trees with a diameter at breast height (DBH) greater than 20cm, stakes with a DBH between 10-20cm, and seedlings or saplings with a DBH less than 10cm. Line transect installation was conducted perpendicular to the coastline, extending 150m into the sea. A total of three transects were made, with a 50-meter distance between each.

Aquatic fauna were observed using line transects. Aquatic life observations were conducted using 1m x 1m quadrat transects placed randomly within the 10m x 10m plots. Other fauna, such as birds and reptiles, were recorded based on their presence around the transect lines. The mangrove area was observed using the NDVI (Normalized Difference Vegetation Index) method, an indicator of vegetation density, greenness, and condition. NDVI calculations are based on the principle that green plants absorb visible light (PAR or Photosynthetically Active Radiation) and reflect infrared radiation. This spectral pattern is analyzed using red band images with the following formula: :

$$NDVI = (NIR - Red) / (NIR + Red)$$

NDVI : Normalize difference index vegetation
NIR : Near infrared radiation from pixels
Red : Infrared radiation from pixels

In this study, NDVI was used to assess changes in the mangrove area across three stations: Bulaksetra, Bojongsalawe, and Batukaras. Satellite images from Landsat 8 composite bands 5, 6, and 4 (bands 564) spanning the last 10 years (including 2014, 2019, and 2024) were used for analysis. Water quality measurements, including potential hydrogen (pH), temperature, salinity, and dissolved oxygen (DO), were taken directly in the field, with three repetitions for each measurement.

2. Analysis

Analysis of the potential for mangrove ecotourism uses the tourism suitability index (TSI) across three research stations, considering parameters such as aquatic conditions, biota associations, mangrove cover, and density. The data, collected through field measurements, were then analyzed, and weighting was applied to categorize the suitability into the following categories: very suitable (S1), suitable (S2), conditionally suitable (S3), and not suitable (N). The formula used to calculate the mangrove tourism suitability index was adapted from **Yulianda (2007)** and is as follows:

$$TSI = \sum \left(\frac{Ni}{N\ maks} \right) x\ 100\%$$

TSI : Tourism suitability index
Ni : Value of the parameter *i*
Nmax : Maximum value of tourism category

Table 1. Mangrove tourism suitability matrix, adopted from **Yulianda (2007)**

No	Parameter	Quality	Category S1	Score	Category S2	Score	Category S3	Score	Category N	Score
1.	Mangrove Cover Area	5	>500	4	>200-500	3	50-200	2	<50	1
2.	Mangrove Density	4	>15 - 25	4	>10-15	3	5-10	2	<5	1
3.	Mangrove Varians	4	>5	4	3-5	3	1-2	2	0	1
4.	Tidal	3	0 – 1	4	>1-2	3	>2-5	2	>5	1
5.	Biota Object	3	Fish, Benthos, Shrimp, crab, molusca, reptile, aves	4	Fish, Shrimp, crab, molusca	3	Fish, Molusca	2	One of the aquatic biota	1

3. Study area

The research was conducted in Pangandaran Regency, West Java Province, across three sub-districts. Station 1 is located in the Bulaksetra mangrove area in Babakan Village, Pangandaran District. Station 2 is in the Bojongsalawe mangrove area in Karang Jaldri Village, Parigi District. Station 3 is situated in the Batukaras mangrove area in Batukaras Village, Cijulang District.

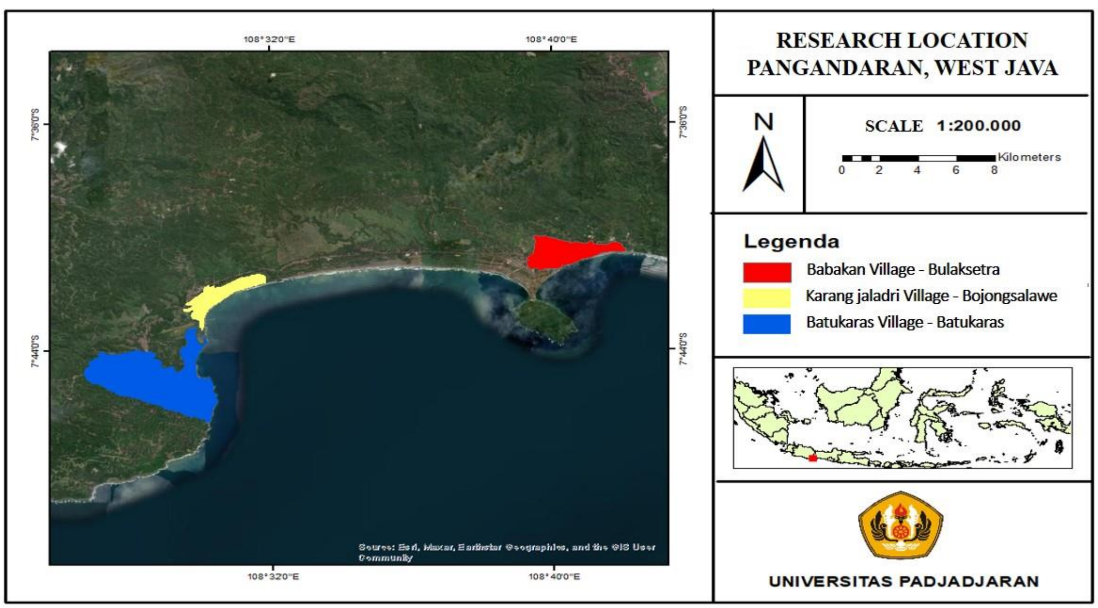

Fig. 1. Reaserach location

Station 1 is located in the Bulaksetra mangrove area. Plot 1 is at coordinates 7°40'49.05" S and 108°40'55.53" E; Plot 2 is at 7°40'49.06" S and 108°40'55.55" E; and Plot 3 is at 7°40'49.06" S and 108°40'45.25" E. Station 2, located in the Bojong Salawe mangrove area, has two plots: Plot 1 is at 7°42'53.24" S and 108°29'57.04" E, and Plot 2 is at 7°24'49.07" S and 108°29'57.36" E. Station 3 is in the Batukaras mangrove area, where three plots were used for data collection: Plot 1 is at 7°48'19.58" S and 108°22'10.99" E, Plot 2 is at 7°43'44.86" S and 108°29'32.80" E, and Plot 3 is at 7°43'46.58" S and 108°30'26.14" E.

RESULTS

1. Mangrove

1.1 Mangrove cover area and density

The data analysis from Landsat 8 satellite images for 2024 shows that the mangrove cover area at Station 1 (Bulaksetra) is 6.65 hectares. At Station 2 (Bojongsalawe), the mangrove cover area is 3.41 hectares, and at Station 3 (Batukaras), the mangrove cover area is 16.57 hectares. Based on observations at the three research stations, Batukaras has the largest area because it is a previous mangrove conservation area, and a significant amount of natural mangrove vegetation remains. The mangrove cover area is an important metric in mangrove ecosystem management, as it provides insight into the extent of mangrove presence and its potential to offer environmental benefits, such as coastal protection, biodiversity enhancement, and carbon dioxide sequestration.

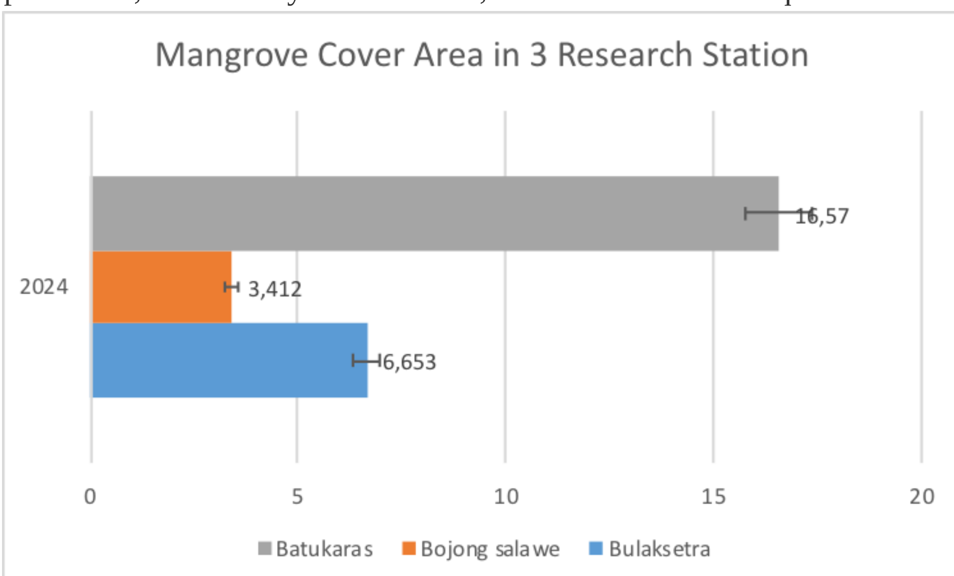

Fig. 2. Chart of mangrove area in 3 research locations

Observations of mangrove cover using NDVI analysis were conducted to determine the density range based on the color variations in the NDVI data visualization. The change in color trends in NDVI indicates the mangrove cover category: red represents the rare category, with a range of 0-0.32; yellow represents the medium category, with a range of 0.33-0.42; and green represents the dense category, with a range of 0.43-1. The observation results for the mangrove cover area at the three research stations showed that Station 1 (Bulaksetra) had a range value of 0.196-0.479, placing it in the medium category; Station 2 (Bojongsalawe) had a range value of 0.111-0.399, placing it in the rare to medium category; and Station 3 (Batukaras) had a range value of 0.076-0.512, placing it in the rare to dense category.

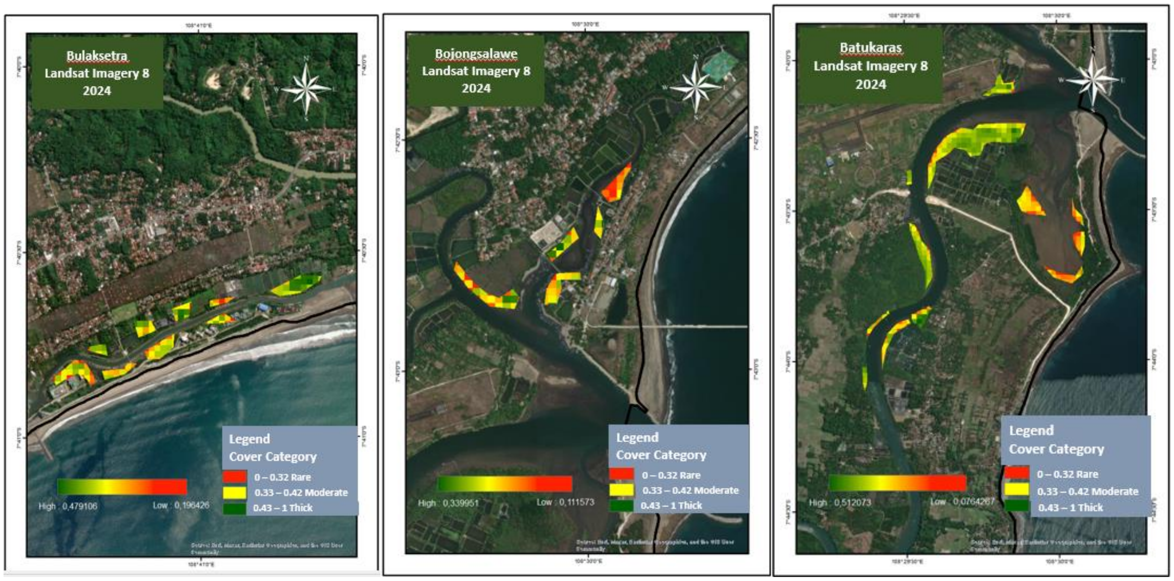

Fig. 3. Visualization of NDVI In 3 research location

1.2 Variations of mangrove

The results of field observations identified nine types of mangroves. At the Bulaksetra station, the mangrove species found include *Rhizophora mucronata*, *Sonneratia alba*, *Casuarina equisetifolia*, and *Nypa fruticans*, with *Rhizophora mucronata* being the dominant species. At the Bojongsalawe station, the species identified were *Avicennia marina*, *Rhizophora apiculata*, *Rhizophora mucronata*, *Sonneratia alba*, and *Nypa fruticans*, with *Rhizophora mucronata* predominating at the seedling level. At the Batukaras station, the species found include *Avicennia alba*, *Avicennia mucronata*, *Rhizophora mucronata*, *Sonneratia alba*, *Nypa fruticans*, and *Hibiscus tiliaceus.*

At each station, a large number of mangrove species were found in the seedling category, as planting activities are frequently conducted in these locations as part of rehabilitation programs sponsored by corporate social responsibility (CSR) initiatives or educational programs from academic institutions. In addition to seedlings, a significant number of mangroves in the stake category were also found at all three research stations.

Table 2. Variations of mangrove at 3 observations stations

No.	Species	Family	Observation station		
			Bulaksetra	**Bojongsalawe**	**Batukaras**
	Avicenia alba	*Avicenniaceae*	-	-	+
2.	*Avicenia marina*	*Avicenniaceae*	-	+	+
3.	*Rhizopora apiculata*	*Rhizophoraceae*	-	+	-
4.	*Rhizopora mucronata*	*Rhizophoraceae*	+	+	+
5.	*Soneratia Alba*	*Rhizophoraceae*	+	+	+
6.	*Nypa fruticans*	*Arecaceae*	+	+	+
7.	*Terminalia catappa*	*Combretaceae*	-	-	+
8.	*Hibiscus tiliaceus*	*Malvaceae*	-	-	+
9.	*Casuarina equisetifolia*	*Casuarinaceae*	+	-	-

Note : + = Found , -= Not Found

2. Water parameter

The water parameters were measured at three research stations, with three data collection plots at each station. The measurements were taken in the morning, before the tide occurred at the research sites. The results showed that the pH value at all three stations ranged from 5.8 to 6.8, which is within the normal limits. The pH levels at Bulaksetra, Bojongsalawe, and Batukaras did not show significant differences, as the measurements were taken at the lowest tide. A pH value of <7 is considered acidic, and since the research locations are in a watershed, the measurements were conducted at the lowest tide, which means there was no influence from seawater.

The temperature ranged from 25°C to 32°C. Weather conditions during the measurement period were somewhat humid, as it was the transition season between the western monsoon. The salinity ranged from 15 to 26 ppt at the three stations. Salinity in brackish water ecosystems typically ranges from 5 to 30ppt. Temperature variations can be influenced by factors such as tides, rainfall, evaporation, and freshwater flow from nearby rivers.

The dissolved oxygen (DO) value, based on direct measurements in the field, ranged from 4 to 7.6mg/ L. In general, DO values in mangrove ecosystems range from 2 to 8mg/ L. The DO levels at the research sites fall within the acceptable range for mangrove habitats. DO can be influenced by factors such as temperature, salinity, the presence of organic material, and biological activities in the surrounding environment.

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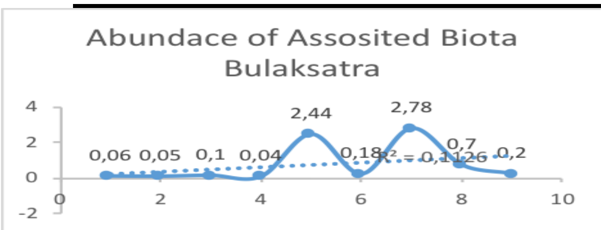
Based on direct field measurements, the dissolved oxygen (DO) value ranged from 4 to 7.6mg/ L. Generally, DO values in mangrove ecosystems range from 2 to 8mg/ L. In this case, the DO value at the research locations remains within the acceptable range for mangrove habitats. DO levels can be influenced by temperature, salinity, the presence of organic materials, and biological activities in the surrounding environment.

Table 3. Water parameters

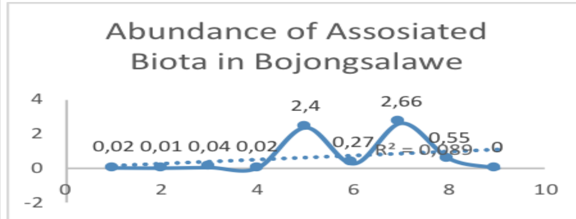
Parameter	Station			
	Bulak Setra	**Bojong Salawe**	**Batu Karas**	**Water quality standards, Ministry of Forestry and Environment**
pH	6,3 – 6,7	6,2 – 6,5	5,8 – 6,4	6,5 -8,5
Temperature	28 – 32	25 – 28	27 – 31	28-32
Salinity	18 – 25	21 – 26	15 – 25	Natural -34
DO	4 – 5,8	4 – 5,8	4,2 – 7,6	4-6

3. Biota assosiation

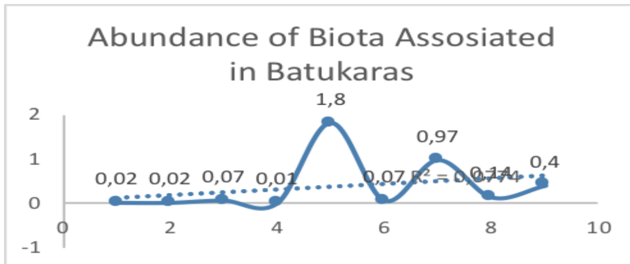
The associated biota found at the research stations were predominantly gastropods, though other organisms such as crabs, fish, and birds were also present. Associated biota play a crucial role in the ecosystem, particularly in terms of the food chain, as the mangrove ecosystem supports various trophic levels, ranging from primary producers to apex consumers. In the nutritional cycle, gastropods contribute to the decomposition of organic material and the recycling of soil nutrients back into the water. Furthermore, the mangrove ecosystem serves as an important spawning ground for many species of biota.



(a)



(b)



(c)

Fig. 4. (a) Abundance Of assosiated biota in Bulaksetra; (b) Abundance of assosiated biota in Bojongsalawe; (c) Abundance of assosiated biota in Batukaras

The analysis results show that Bulaksetra station has an R^2 value of 0.11, Bojongsalawe station has an R^2 value of 0.089, and Batukaras station has an R^2 value of 0.077. These values indicate that the regression model used is not strong enough to explain the variations in biota abundance in the research locations. The abundance of associated biota at all three stations was dominated by gastropods. The dominance of gastropods can provide several indications about the health and quality of the aquatic ecosystem. Generally, this may suggest that the water body has a high nutrient content, a suitable substrate, and could be experiencing organic pollution or water quality degradation. It may also indicate an imbalance in the ecosystem or a shift in predator-prey dynamics and food chain systems.

4. Tourism suitability index

Analysis of the mangrove tourism suitability index category involves evaluating several environmental and ecological factors that influence the potential of a mangrove area to be developed as a tourist attraction. The aim was to assess the extent to which a mangrove area is suitable for tourism activities, such as ecotourism, environmental education, or nature-based recreation. Several factors are measured in calculating the tourism suitability index, including the area of mangrove cover, mangrove density, mangrove species, water parameters, and biota.

Based on the results of measurements and calculations at three observation stations, Station 1 (Bulaksetra) falls into the very suitable category (S1) with a suitability value of 76%. Mangrove areas in the S1 category have all parameters that support tourism activities. This area features good vegetation density, biodiversity, and satisfactory infrastructure access. The tourism potential in this area is very high and requires only minimal management interventions.

Station 2 (Bojongsalawe) falls into the suitable category (S2) with a suitability value of 63.5%, and Station 3 (Batukaras) is also in the suitable category (S2) with a suitability value of 74%. Mangrove areas in the S2 category are quite supportive of tourism activities, although several aspects may require improvement. For example, the water depth or pathway width may be less than ideal, and tourist facilities are still limited. With proper management, these areas can be further optimized for ecotourism.

Table. 4. Tourism sustainability index at 3 research stations

Parameter	Quantity	Value	Grade	Score
Station 1 Bulaksetra				
Mangrove cover (Ha)	6,65	4	0,35	0,35
Mangrove density (/ 100m^2)	16,715	4	0,25	0,25
Mangrove type	3	3	0.17	0,1275
Biota object	1	1	0,13	0,0325
Total value				**0,76**
IKW				**76%**
Category				**Very Suitable**

Parameter	Quantity	Value	Grade	Score
Station 2 Bojongsalawe				
Mangrove cover (Ha)	3,4	4	0,35	0,35
Mangrove density (/ 100m^2)	6,75	2	0,25	0,125
Mangrove type	4	3	0.17	0,1275
Biota object	1	1	0,13	0,0325
Total value				**0,635**
IKW				**63%**
Category				**Suitable**

Parameter	Quantity	Value	Grade	Score
Station 3 Batukaras				
Mangrove cover (Ha)	16,57	4	0,35	0,35
mangrove density (/ 100m^2)	13,243	3	0,25	0,1875
Mangrove type	9	4	0.17	0,17
Biota object	1	1	0,13	0,0325
Total value				**0,74**
IKW				**74%**
Category				**Suitable**

DISCUSSION

Ecotourism functions as both a local development tool and a conservation tool by meeting the socio-economic needs of the region and preserving its natural and cultural values and historical heritage **(Tajer, 2022)**. Mangrove ecotourism is a form of ecotourism that can help preserve the environment. Mangroves have great potential for ecotourism development due to their unique ecosystem and the possibility of creating tourist facilities while maintaining the authenticity of the forest and the organisms that live within it. According to **GKJ (2022)**, factors influencing the development of mangrove ecotourism include the diversity of mangrove species, the quality of human resources for handling tourists, the availability of high-quality natural resources for conservation-based ecotourism, local government policies and regulations related to ecotourism, the socio-economic conditions of the community, and supporting infrastructure.

The potential for developing ecotourism is divided into three main categories: abiotic potential, biotic potential, and socio-economic and cultural potential **(Antara, 2017)**. Similarly, mangrove ecotourism offers not only natural beauty as a tourist attraction but also opportunities for cultivating plants by local communities. According to **Mulyani *et al.* (2023)**, mangrove ecotourism has high potential for development due to its natural scenery as well as its socio-economic potential. This potential can be leveraged both from natural and human resources to create economic value. The economic benefits of mangrove forests include being a source of fuel for aquaculture, a place for salt production, food, medicine, drinks, fisheries, aquaculture, animal feed, fertilizer, paper, land, and more. There are many advantages to mangrove forests, and efforts to protect them are vital.

Kusmana (2011) states that mangrove ecotourism can generate income for local communities while also promoting the protection of natural resources. Ecotourism activities, such as bird watching, boat tours, and environmental education, can help raise environmental awareness among visitors. Sustainable mangrove tourism requires well-planned visitor management, infrastructure development, and community engagement to minimize impacts on the delicate ecosystem. Mangrove ecotourism not only boosts conservation efforts but also creates economic opportunities for local populations through employment and business activities. However, challenges such as habitat degradation, inadequate infrastructure, and overtourism must be addressed through sustainable practices, including environmental education and enforcing regulations to manage tourist numbers.

CONCLUSION

The mangrove ecosystem in Pangandaran has significant potential to be developed as an ecotourism destination. While some facilities need improvement, the area is quite suitable for further development into a nature-based tourism destination, with a sustainable conservation approach. The results of the research show that the tourism suitability index value for mangrove tourism in the three research locations falls within the very suitable (S1) and suitable (S2) categories. This indicates that the Bulaksetra, Bojongsalawe, and Batukaras stations all have promising potential to be developed into ecotourism areas. However, to fully develop mangrove ecotourism, it is necessary to conduct a study on the carrying capacity of these areas. This will provide a data foundation for the development and formulation of strategies to ensure the sustainable development of mangrove ecotourism in Pangandaran.

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REFERENCES

Agussalim, A. (2014). Potential suitability of mangroves as an ecotourism area on the Musi River Estuary Coast, Banyuasin Regency. Maspari Journal: Marine Science Research, 6(2), 148-156. https://doi.org/10.56064/maspari.v6i2.3037

Antara, M. (2017). Subak Ecotourism, Jatiluwih, Tabanan, Bali. Denpasar: Pelawa Sari.

Bai'un, N. H.; Riyantini, I.; Mulyani, Y. and Zallesa, S. (2021). Macrozoobenthic diversity as an Indicator of Water Conditions in the Mangrove Ecosystem of Pari Island, Seribu Island. JFMR (Journal of Fisheries and Marine Research), 5(2), 227-238. https://doi.org/10.21776/ub.jfmr.2021.005.02.7

Blanton, A. (2024). Ecotourism and mangrove conservation in Southeast Asia: Current trends and perspectives. Journal of Environmental Manajemen 365 (2024) 121529. https://doi.org/10.1016/j.jenvman.2024.121529

Ewaldo. K.; Kairuniasa. M. and Takarina, N.D. (2023). Carrying capacity of mangrove ecotourism area in Pantai Indah Kapuk, North Jakarta, Indonesia. Biodiversitas. Vol 24. Number 10. http://dx.doi.org/10.13057/biodiv/d241063

GKJ, J. (2019). Study of the Potential for Developing Ecotourism as a Mangrove Conservation Effort in Pasar Bangi Village, Rembang District. *Journal of marine research* , 117-126.

Julaikha, S. (2017). Ecologycal Value of Mangrove Ecosystem. *Jurnal Biologi Tropis*.

Kanjin, K. and Alam, B.M. (2024)). Assessing changes in land cover, NDVI, and LST in the Sundarbans mangrove forest in Bangladesh and India: A GIS and remote sensing approach. Remote Sensing Applications: Society and Environment. Vol 36. 101289. https://doi.org/10.1016/j.rsase.2024.101289

Kusmana, C. (2011). Forest resources and forestry in Indonesia. *Forest Science and Technology*, *7*(4), 155-160.

Kusmana, C. (2017). Suitability of mangrove Tree Species in Bulaksetra, Pangandaran District, West Java. *Jurnal Silvikultur Tropika*, 48-54.

Mulyanie, E.; Maryani, E. and Ningrum, E. (2023). Development of Nusawiru Mangrove Forest Ecotourism Through Local Community Empowerment. Jurnal Geografi Geografi dan Pengajarannya, 21(1), 35-46.

Nelly, C.; Rasnovi, S. and Zumaidar, Z., 2020. Mangrove ecosystem suitability for ecotourism management recommendation in iboih village – sabang. E3S Web of Conferences 151, 01060. https://doi:10.1051/e3sconf/202015101060

Nugroho, F.A. (2019). Analysis of land Suitability and Carrying Capacity of Ecotourism Areas in Sanghiang Mangrove Lestari, Cijulang, Pangandaran, West Java (Doctoral dissertation, Universitas Brawijaya).

Nurdiana, R.; Pribadi, T.D.K. and Ihsan, Y. N. (2020). Estmated Primary Productivity of Phytoplankton In The Batukaras Mangrove Forest Area of Pangandaran, West java. JFMR (Journal of Fisheries and Marine Research), 4(2), 274-280. https://doi.org/10.21776/ub.jfmr.2020.004.02.11

NURFAJRIN, A.R. and ROSADA, K.K. (2018, December). Biodiversity of macrozoobenthos in the Bulaksetra and Batukaras mangrove area, Pangandaran, West Java. In Prosiding Seminar Nasional Masyarakat Biodiversitas Indonesia (Vol. 4, No. 2, pp. 248-253). https://doi.org/10.13057/psnmbi/m040226

Nurlistianto, R.A. (2019). Analysis of Changes in Mangrove Cover in 1998 – 2018 Using Landsat Satellite Imagery on the Batukaras Coast, Pangandaran West Java. Universitas Brawijaya .

Nybakken. (1992). Marine Biology : An Ecological. Jakarta: Gramedia .

Republic of Indonesia Government Regulation Number 22 of 2021 Concerning Implementation of Environmental Protection and Management, Appendix VI

P.35/MENHUT-II, P. M. (2010). Concerning Produres for Preparing Technical Plans for Forest and Watershed Land Rehabilitation. *(RTKRHL-DAS).*

Piawai, F.P. (2022). Utilization of Landsat 8 Imagery for Mapping the Distribution and Density of Mangrove Ecosystems in Cijulang District, Pangandaran Regency. *Jurnal Geografi* , 53-64.

Rai, N. and Thapa, B. (2015). A study on purposive sampling method in research. Kathmandu: Kathmandu School of Law, 5(1), 8-15.

Riana, A.P. (2020). Potential of Mangrove Forests as Ecotourism for Bengkulu Coastal Communities. *Indonesian Science Education Journal (ISEJ)*, 210-215.

Saputra, S.E. (2014). Ecotourism potential of mangrove forests in Merak Belantung village, Kalianda subdistrict, South Lampung regency. *Jurnal Sylva Lestari* , 49-60.

Surjanti. J.; Soejoto. A.; Seno, D.N. and Waspodo. (2020). Mangrove forest ecotourism: Participatory ecological learning and sustainability of students' behavior through self-efficacy and self-concept. Sosial Sciences & Humanities Open 2, 100009. https://doi.org/10.1016/j.ssaho.2019.100009

Tajer, S.D. (2022). Ecotourism strategy of UNESCO city in Iran: Applying a new quantitative method integrated with BWM. *Journal of Cleaner Production*, Vol 376.

Yanto, R.; Pratomo, A. and Irawan, H. (2016). Gastropod Diversity in the Mangrove Ecosystem of Masiran Beach, Bintan Regency. Repository Umrah, 1-10.

Yulianda. (2007). Marine Ecotourism as an Alternative to Conservation-Based Coastal Resource Utilization. *Seminar Sains 21 Februari 2007*. Bogor: Departemen M FPIK IPB.

Yulianda, F. (2007). Marine Ecotourism as an Alternative to Conservation- Based Coastal Resource Utilization. Bogor: IPB.

Yustisia, K. (2019). Ecotourism Studies Textbook. Deepublish.