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Spatial assessment of ecotourism potential in the mangrove area of Ujungalang Village, Cilacap District, Central Java, Indonesia

YOUHANA ELI SANTIKA[1], VIDDA ARLYSIA[1], ANGELA REGINA ASTUTI[1], DINDA SYAFIRA PUTRI[1], ANGGITA PUSPITOSARI[2], SUGENG BUDIHARTA[3], CHEE KONG YAP[4], AHMAD DWI SETYAWAN[1,5,♥]

[1]Department of Environmental Science, Faculty of Mathematics and Natural Sciences, Universitas Sebelas Maret. Jl. Ir. Sutami 36A Surakarta 57126, Central Java, Indonesia. Tel./fax.: +62-271-663375, ♥email: volatileoils@gmail.com
[2]Department of Environment Science, Graduate School, Universitas Sebelas Maret. Jl. Ir. Sutami 36A Surakarta 57126, Central Java, Indonesia
[3]Purwodadi Botanic Gardens, Research Center for Ecology and Ethnobiology, National Research and Innovation Agency. Jl. Surabaya-Malang Km.65, Pasuruan 67163, East Java, Indonesia
[4]Department of Biology, Faculty of Science, Universiti Putra Malaysia. 43400 UPM Serdang, Selangor, Malaysia
[5]Biodiversity Research Group, Universitas Sebelas Maret. Jl. Ir. Sutami 36A, Surakarta 57126, Central Java, Indonesia

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Abstract. *Santika YE, Arlysia V, Astuti AR, Putri DS, Puspitosari A, Budiharta S, Yap CK, Setyawan AD. 2025. Spatial assessment of ecotourism potential in the mangrove area of Ujungalang Village, Cilacap District, Central Java, Indonesia. Intl J Bonorowo Wetlands 15: 7-19.* Mangrove ecosystem, with its diverse ecological and economic functions, is a vital provider of ecosystem services that benefit coastal communities, including the potential for ecotourism development, which is considered as win-win solution for conservation and sustainable utilization of natural resources. Ujungalang Village, located in Kampung Laut Sub-district, Cilacap District, Central Java, is one area with significant mangrove potential that can be developed as an ecotourism destination. This study aims to identify potential mangrove ecotourism locations in Ujungalang Village and analyze the physical and social conditions that support the development of mangrove ecotourism in the region. The research was conducted using a quantitative method with a spatial approach, employing Geographic Information System tools and remote sensing data. The spatial analysis technique utilized is overlay, involving scoring and weighting several factors influencing ecotourism potential including slope, temperature, land use, conservation status, population density, elevation, as well as facilities and infrastructure. The study results show that the Ecotourism Potential Index of Ujungalang Village ranges from 3.03 to 156.16, which can be divided into three categories: non-potential, with values of 3.03-33.66 (174.02 ha); low potential, with values of 33.67-64.30 (1,292.52 ha); and highly potential, with values of 125.59-156.16 (5,290.43 ha). The findings of this study can assist tourism planners and government authorities in identifying appropriate locations for ecotourism development, instilling a sense of optimism and hope.

Keywords: Ecotourism, GIS, mangrove, overlay, potential mapping

INTRODUCTION

Ecotourism is a form of nature-based tourism where economic activities can be aligned with the conservation of species and habitats, both directly and indirectly, benefiting local communities through empowerment as well as protecting biodiversity (Saeroji 2020). In many cases, ecotourism aims to promote environmental conservation practices in protected natural areas, which involves local communities as a form of sustainable tourism (Çetinkaya et al. 2018). This is achieved by educating visitors and local communities to protect nature while enjoying the ecosystem services the nature provided as well as gaining economic benefits for regional development (Gigović et al. 2016).

In Indonesia, ecotourism has been increasing and developing in various regions, attracting international and domestic tourists. There are several well-known ecotourism destinations in Indonesia, for example Kuala Langsa Mangrove Forest Ecotourism in Aceh, Tangkahan Ecotourism and Gunung Leuser National Park in North Sumatra, Way Kambas National Park in Lampung, Bunaken National Park in North Sulawesi, Komodo National Park in East Nusa Tenggara, Raja Ampat in West Papua and others (Yusnikusumah and Sulystiawati 2016; Safuridar and Andiny 2020; Mu'tashim and Indahsari 2021; Yunanda and Chair 2022).

Mangrove areas have a great potential to be developed into environmentally-based tourism destinations (Erlinda et al. 2022). The presence of mangroves in coastal areas offers natural beauty and unique experiences to visitors, for example through bird watching. Additionally, educational activities focused on biodiversity, ecological functions, and conservation efforts also have the potential to attract tourists (Mulyadi et al. 2021).

Indonesia has the largest mangrove area in the world, covering 3,112,989 ha, which is equivalent to 22.6% of the world's mangrove area (Febrianto et al. 2024). One of the mangrove areas in Java Island that is still in its natural state is located in Segara Anakan, Cilacap District, Central Java Province. Kampung Laut Sub-district, one of the sub-districts located in the Segara Anakan lagoon, is situated on the edge of the lagoon and is surrounded by water, making its location relatively isolated (Qomariyah and Kiat 2024).

Kampung Laut Sub-district has the potential to be developed for mangrove ecotourism. Various species of

mangroves grow in this area might be used for education purposes as well as research activities. Kampung Laut Sub-district has a tourist attraction called Kolak Sekancil, a mangrove arboretum area that was abandoned during the COVID-19 pandemic. The main issues in developing this area to be attractive as tourism spot are the lack of supporting infrastructure and limited education of the local community. This has resulted in suboptimal management, which hinders the development of ecotourism and educational activities (Dian et al. 2024).

Suboptimal management of mangrove ecotourism can lead to a decline in the value of resources, including mangroves (Liu et al. 2021). Therefore, it is important to study on the potential of mangroves, one of which can be done using remote sensing methods (Abidin et al. 2023). The combination of remote sensing and Geographic Information Systems (GIS) is considered an efficient method for tourism planning, development and management by handling the large volume of spatial data, and analyzing the relationship between spatial data and various tourism aspects, such as location (Sahani 2019; Pathmanandakumar et al. 2023).

Literature analysis reveals that various spatial variables (factors and criteria) have been employed to determine potential ecotourism locations using GIS. Chaudhary et al. (2022) used GIS and remote sensing to identify potential ecotourism locations in Garhwal, Uttarakhand, India, based on vegetation, biodiversity, slope, and elevation. Pathmanandakumar et al. (2023) used Analytical Hierarchy Process (AHP) and GIS to identify suitable zones for ecotourism development in Batticaloa District, Sri Lanka, based on landscape, conservation areas, elevation, accessibility, and population density. This study aims to identify potential locations for ecotourism development in Ujungalang Village by systematically integrating approaches used in the three previous studies in term of geographical aspects (slope, elevation, and land use), ecological aspects (conservation status), physical aspects (temperature), and socio-economic aspects (population density and infrastructure). The scoring and weighting were applied to factors such as slope, temperature, land use, conservation status, population density, elevation, and infrastructure to achieve the GIS combination. Therefore, the findings of this study can assist tourism planners and the government in determining appropriate locations and further developing ecotourism activities.

MATERIALS AND METHODS

Study area and period

This research was conducted in the mangrove ecosystem area in Ujungalang Village in October 2024. The mangrove ecosystem is within the Segara Anakan Lagoon area, which is administratively part of Kampung Laut Sub-district, Cilacap District. Ujungalang Village covers an area of 6,756.97 ha and consists of four hamlets: Lempong Pucung, Motean, Paniten, and Bondan (Figure 1).

Ujungalang Village is located at an elevation of 1-40 meters above sea level (masl), with a slopes ranging from less than 5° (very gentle) to more than 35° (very steep). The temperature in Ujungalang Village ranges from 22-30.6°C, predominantly falling within temperature factor class IV (28-30°C). The area of Ujungalang Village is primarily dominated by mangrove forests, covering 5,474.59 ha or 81.02% of the total land cover. The mangrove vegetation in Ujungalang Village includes species such as *Avicennia alba*, *Ceriops tagal*, *Ceriops decandra*, *Aegiceras floridum*, *Aegiceras corniculatum*, *Sonneratia caseolaris*, *Bruguiera sexangula*, nipa palm, and various minor mangroves and associated species (Hariyadi 2018).

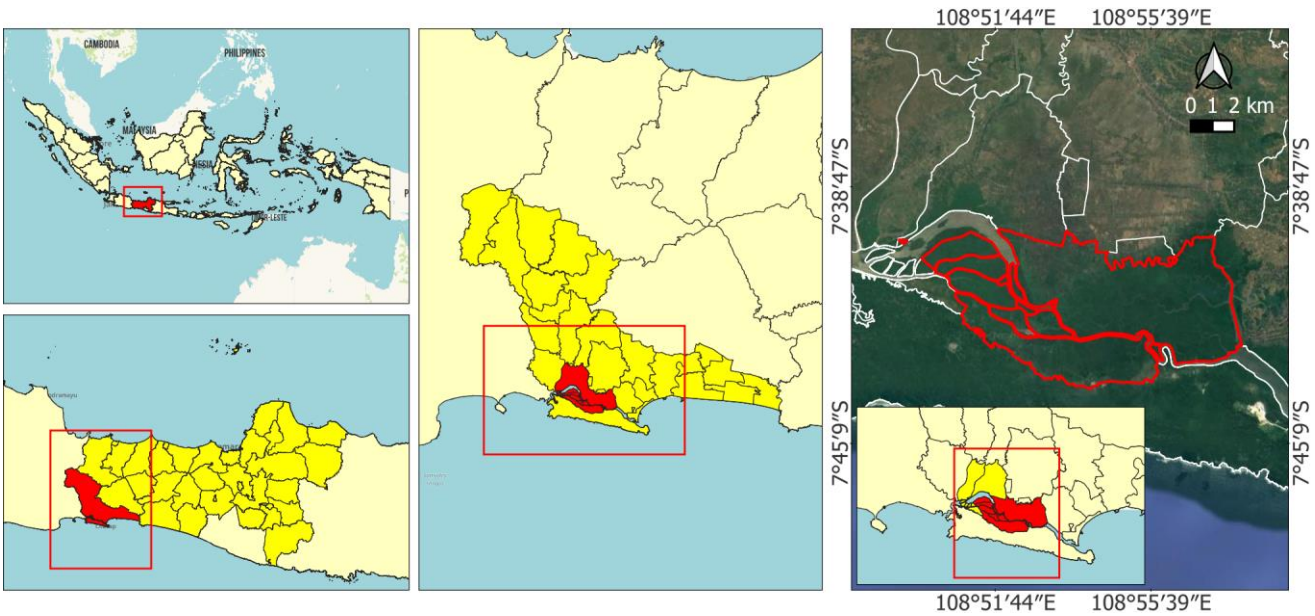

Figure 1. Location of Ujungalang Village, Kampung Laut Sub-district, Cilacap District, Central Java, Indonesia

According to data from the BPS-Statistics of Kampung Laut Sub-district (2024), the population of Ujungalang Village is 4,265 people, with a population density of 65.87 people/km². The male population consists of 2,271 people, or 53.25%, while the female population consists of 1,994 people or 46.75%. Based on the data from the BPS-Statistics of Kampung Laut Sub-district (2020), the residents of Ujungalang Village include 900 fishermen and 458 farmers.

Data collection

This research used both primary and secondary data. Primary data was obtained through field observations at the research site, including information about the facilities and infrastructure supporting tourism activities. Information about these facilities and infrastructure was also verified through map analysis sourced from Google Maps. Meanwhile, the secondary data used in this study is presented in Table 1.

Land use

In addition to vegetation cover, various natural landscapes and areas with cultural value are also key factors in the development of ecotourism (Chaudhary et al. 2022). Land use information was obtained using Google Earth imagery. The Google Earth imagery, adjusted for coordinates and administrative boundaries, was manually delineated for land use classification. The boundary data was obtained from the Geospatial Information Agency website (https://tanahair.indonesia.go.id/), which contains the boundary of Ujungalang Village. In this study, land use is categorized into five types: agriculture, open land (unused vacant land), settlement, mangrove forest, and water bodies.

Slope

The Digital Elevation Model Shuttle Radar Topographic Mission (DEM SRTM) was used to determine the slope. After calculating the slope from the DEM, the slope values were then reclassified into categories that are suitable for supporting the development of ecotourism. Chaudhary et al. (2022) classified the slopes as follows: very suitable (<5.0°), suitable (5.1°-15.0°), moderate (15.1°-25.0°), low suitable (25.1°-35.0°), and unsuitable (>35.0°).

Elevation

DEM SRTM can be used to extract topographic features, such as slope, and generate surface elevation maps. For this purpose, the DEM was reclassified to represent elevation zones ranging from unsuitable to very suitable based on accessibility levels and climate feasibility. Fu et al. (2018) classified suitable elevations as follows: very suitable (<100 masl), suitable (100-500 masl), moderate (500-1,000 masl), low suitable (1,000-1,500 masl), and unsuitable (>1,500 masl).

Temperature

The temperature data used in this study were extracted from the spatial (raster) Land Surface Temperature (LST) data obtained from the Moderate Resolution Imaging Spectroradiometer (MODIS) MOD11A2 V6.1 imagery. The imagery was downloaded and processed using the Google Earth Engine (GEE) platform. Data processing techniques included image composition, data extraction based on the study area, and area calculation based on temperature factor classes. The temperature related to ecotourism activities were categorized into five classes: very suitable (20-21°C), suitable (22-24°C/17-19°C), moderate (25-27°C/14-16°C), low suitable (28-30°C/11-13°C), and unsuitable (>30°C/<10°C) (Department of Forestry Republic of Indonesia 2003).

Population

Demographic data were obtained from the publication of BPS-Statistics of Kampung Laut Sub-district. The demographic data used in this study include total population, population distribution by gender, population density, and primary occupations.

Facilities and infrastructure

Information about facilities and infrastructure was obtained through field observations and interpretation of Google Maps. Facilities included various amenities and infrastructure needed by tourists in a destination area, such as accommodations, restaurants, transportation, and travel agency services (Amerta et al. 2024).

Table 1. Secondary data and data sources used in this study in Ujungalang Village, Kampung Laut Sub-district, Cilacap District, Central Java, Indonesia

Data	Years	Type of data	Sources
Administrative boundary	2024	Vector	Shapefile of Administrative Boundary (https://tanahair.indonesia.go.id/)
Land use	2024	Raster (30m resolution)	Image from Google Earth (https://earth.google.com/)
Slope	2024	Raster (30m resolution)	DEM SRTM 30m (https://earthexplorer.usgs.gov/)
Elevation	2024	Raster (30m resolution)	DEM SRTM 30m (https://earthexplorer.usgs.gov/)
Temperature	2024	Raster (30m resolution)	MODIS Imagery from Google Earth Engine (https://earthengine.google.com/)
Population	2024	Vector	BPS-Statistics Cilacap District (https://cilacapkab.bps.go.id/id)
Facilities and infrastructure	2024	Vector	Map from Google Maps (https://www.google.com/maps)
Road network	2024	Vector	Shapefile of Road Network (https://tanahair.indonesia.go.id/)
Conservation	-	Vector	Peraturan Daerah Kabupaten Cilacap Nomor 17 Tahun 2001 (Regulation of Cilacap District Number 17 of 2001) (https://jdih.cilacapkab.go.id/v2/)

Road network

The road network data was obtained from the Geospatial Information Agency website (https://tanahair.indonesia.go.id/) and adjusted to the study area. Road network information was used to evaluate the accessibility of the study area, which is planned to be developed into an ecotourism destination. Tourism destinations should be easily accessible, with necessary facilities readily available for tourists, such as transportation to the destination, as well as safe and comfortable roads.

Conservation

To preserve the beauty of nature, nature reserves and protected areas play a crucial role in supporting the development of ecotourism activities (Gigović et al. 2016). In this study, conservation status is ranked based on the opportunities available for ecotourism activities. Conservation forests are ranked as having a high potential for ecotourism. Coastal buffer zones are categorized as having fair potential for ecotourism. Wildlife sanctuaries, nature reserves, and national parks are categorized as having moderate potential for ecotourism, while other conservation areas are considered to have low potential for ecotourism. However, areas outside protected zones, or unprotected areas, are considered to be non-potential for ecotourism. According to Regional Regulation of Cilacap District Number 17 of 2001, the mangrove forest in the Segara Anakan area is a protected forest area.

Data analysis

The analysis method used in this study is a quantitative method with a spatial approach through the use of Remote Sensing (RS) and Geographic Information System (GIS). The spatial analysis technique employed was overlay, which involved the process of assigning scores and weights to each factor affecting ecotourism (Waspodo et al. 2024). The overlay is a spatial analysis technique that involves combining multiple spatial elements or geographic layers to generate new elements or information (Hafidz et al. 2023). The spatial data in this study was analyzed and processed using ArcGIS 10.8 software. Figure 2 presents a flowchart that systematically depicts the stages and methods of this research.

Scoring

The first step in analyzing the potential of ecotourism is to assign scores to each criterion of the factors used. The factors considered in this study include slope, temperature, land use, conservation status, population density, elevation, and facilities and infrastructure. The determination of factors and criteria is based on a literature review, taking into account the physical conditions of the research location (Table 2).

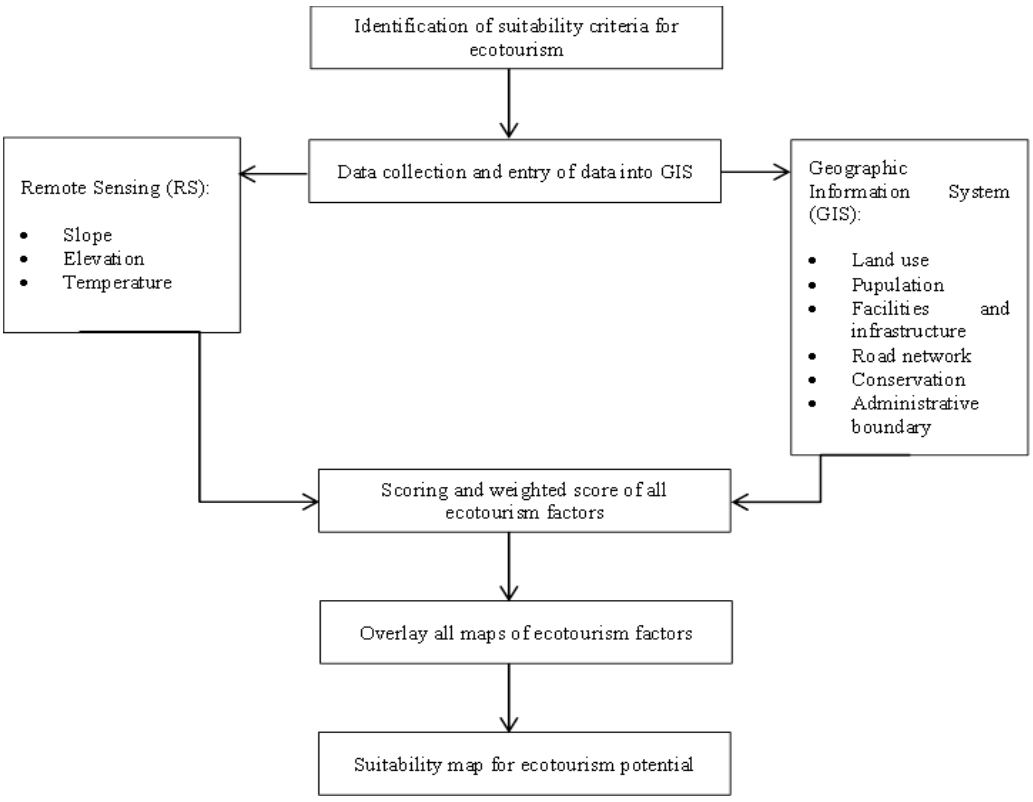

Figure 2. Flowchart of the research

Table 2. Factors and criteria scores used in the research and related references

Factors	Criteria scores/factor class					References
	1	2	3	4	5	
Land use	Mangrove forest	Water bodies (lakes, swamps, rivers, etc.)	Agricultural areas (rice fields, farms, gardens)	Open land	Settlement	Pathmanandakumar et al. (2023)
Slope (°)	<5	5.1-15	15.1-25	25.1-35	>35	Chaudhary et al. (2022); Yasin and Woldemariam (2023)
Elevation (meters above sea level/masl)	<100	100-500	500-1000	1000-1500	>1500	Fu et al. (2018)
Temperature (°C)	20-21	22-24/17-19	25-27/14-16	28-30/11-13	>30/<10	Department of Forestry Republic of Indonesia (2003)
Population density (people/km^2)	0-50	51-150	151-250	251-400	>400	National Standardization Agency of Indonesia (2004); Samanta and Baitalik (2015)
Facilities and infrastructure	≥4 types	3 types	2 types	1 type	None	Department of Forestry Republic of Indonesia (2003); Sisriany (2021)
Conservation status	Conservation forest/protected forest	Coastal buffer zone	Wildlife sanctuary, nature reserve, national park	Other conservation areas	Unprotected	Gigović et al. (2016); Sahani (2019)

Table 3. Position of the factor ranking

Data	Ranking
Land use	1
Conservation status	2
Elevation (meters above sea level/masl)	3
Facilities and infrastructure	4
Slope (°)	5
Temperature (°C)	6
Population density (people/km^2)	7

Weighted score

Scores are used to differentiate the extent of the influence of each assessment criterion for each factor used, while the weight values serve to distinguish the impact between factors. Weighting for each factor is used to measure the development of natural tourism potential, a practical application of our methodology. Factors with high carrying capacity are given high weights. In contrast, factors with low carrying capacity are given low weights (Selamat 2015). Weighting is performed using the ranking method from Selamat (2015), with the rankings shown in Table 3 and the following formula:

$$Wj = n - rj + 1 / \Sigma(n - rp + 1)$$

Where: Wj = Normal weight of factor j (j = 1,2,3,.....n); n = Number of factors being studied; rj = Position of the factor ranking; rp = Factor (p = 1,2,3,.....n).

Ecotourism potential index

The ecotourism potential index was obtained by overlaying all the maps that have been weighted. The weight value of each factor is multiplied by the amount of spatial data or the number of polygons representing land availability in each map to produce the final value. This final value is then used to determine the classification of ecotourism potential using the following formula:

$$I : \frac{a-b}{n}$$

Where: I: Class interval; a: Highest score; b: Lowest score; n (number of classes): 5.

RESULTS AND DISCUSSION

Potential index of ecotourism based on remote sensing and GIS

Land use

Land uses in Ujungalang Village are classified into mangrove forests, water bodies (rivers), rice fields, and settlements (Figure 3.A). The largest extent of land use is mangrove forest with 5,474.59 ha, followed by rice fields with 929.42 ha. Meanwhile, settlements, which serve as residential areas and spaces for community activities, cover an area of 57.4 ha. Other land uses include rivers, covering 295.56 ha. Based on these land uses, Ujungalang Village falls into land use factor classes I, II, III, and V (Table 2).

Conservation status

According to the Regional Regulation of Cilacap District Number 17 of 2001, the mangrove forest in the Segara Anakan area is designated as a protected forest area (Figure 3.B). Kampung Laut Sub-district is located in the middle of the Segara Anakan area, which consists of four villages: Klaces, Panikel, Ujungalang, and Ujunggagak. Therefore, the mangrove forest in Ujungalang Village is part of the Segara Anakan conservation area. Protected areas play a crucial role in supporting ecotourism due to their function in conservation and the preservation of natural beauty that can serve as tourist attractions (Chaudhary et al. 2022). Implementing ecotourism activities in protected areas ensures that conservation involves not only the preservation of biodiversity but also the overall environment (Ahmadi et al. 2017). The ideal areas for

ecotourism development are those located closest to protected areas (Chaudhary et al. 2022).

Conservation efforts through mangrove reforestation have also been carried out in Ujungalang Village. The concern of a local resident regarding mangrove degradation that occurred in 1998 marked the beginning of attention to this issue, as that year saw a significant conversion of mangrove land into shrimp ponds. This land conversion disrupted the breeding and spawning cycles of fish, leading to a decline in fish production (Gustami et al. 2023). The wastewater produced by the shrimp ponds also impacted the quality of the mangrove ecosystem. After the shrimp ponds went bankrupt and were abandoned by investors, the deforestation that occurred caused significant damage to the mangrove forest in Kampung Laut Sub-district, as well as a considerable reduction in land area.

In 2005, Patra Krida Wana Lestari Group was formed, focusing on mangrove conservation, under the guidance of Pertamina and DKP2SKSA (Ratini et al. 2016). This group focuses on developing nurseries to produce seedlings and the restoration of mangrove forest to recover its functions as a coastal protector. Since 2009, Patra Krida Wana Lestari Group and Pertamina have successfully planted over 1.5 million mangrove trees, covering an area of approximately 160 ha in the Segara Anakan conservation area (Environmental Agency of Cilacap District 2019). This mangrove conservation area was later named Kolak Sekancil, and it was established in 2016 with support from Pertamina.

Elevation

Ujungalang Village is located at an elevation of 1-40 meters above sea level (masl), which falls into factor class I (Figure 3.C). The analysis results show that the village has the potential to be developed as a water tourism destination. Still, efforts to mitigate potential disasters, such as floods and tsunamis, must be considered.

Facilities and infrastructure

Ujungalang Village has various facilities and infrastructure that support the community's needs (Table 4), although there are still some deficiencies that need to be addressed for further development. Based on this table, the availability of facilities and infrastructure is classified as "very good" because more than four types of facilities are available (Figure 3.D). Basic facilities such as clean water are available through wells and the Regional Drinking Water Company (PDAM) network, ensuring that the community's water needs are met. Religious facilities are also adequate, with a mosque, prayer room, and church. In terms of electricity, the village is served by a Hybrid Power Plant (HPT), which provides energy needs in the area. However, the communication and internet network in the village is only available through the support of two providers, which offer communication access to the residents.

Several other important facilities in Ujungalang Village have yet to be available or are still limited. Parking areas and public sanitation facilities are completely absent, which poses a barrier to the development of the tourism sector as well as to activities that require high mobility from the community. Trash bins and accommodations are also very limited, and the village does not have an adequate waste management system, so environmental cleanliness issues need to be addressed promptly. Facilities such as food stalls are still limited to small convenience stores, while souvenir shops are already available to support visiting tourists. Souvenirs are made by the local community, such as the Women's Farmer Group, which demonstrates community initiative, although further support is still needed.

In terms of tourism management, there is an information board that serves as a tourist guide, but a management office still needs to be made available. The local government primarily carries out tourism management, but it is not yet optimal and still lacks involvement from the local community. Additionally, a security post is also unavailable, which is a concern to ensure the comfort and safety of both residents and visitors.

Slope

The slope is one of the main criteria for identifying potential ecotourism locations (Yasin and Woldemariam 2023). Landscape with flat topography or gentle slope is preferable for developing an ecotourism site, while steeper slopes reduce the potential for developing the site (Sahani 2019). Extremely steep slopes can increase the risk of erosion, excessive sedimentation, and potential hazards for tourists. Ujungalang Village has a relatively safe slope, with the majority of the area, approximately 5,290 ha or 79.50%, classified as having gentle slopes (5-15°) (Figure 3.E). Therefore, the slope in Ujungalang Village indicates good safety factors and potential for ecotourism development.

Table 4. Facilities and infrastructure in Ujungalang Village, Cilacap District, Central Java, Indonesia

Facilities and infrastructure	Availability	Description
Clean water	Available	Water spring cave and *Perusahaan Daerah Air Minum* (PDAM) or regional drinking water company
Places of worship	Available	Mosque/prayer room, church
Electricity	Available	Hybrid Power Plant (HPT)
Communication network	Available	2 providers
Parking area	Not available/ None	-
Public sanitation facilities	Not available/ None	-
Trash bins	Rarely	No waste collection
Food stalls or restaurants	Rarely	Convenience store
Accommodation	Rarely	Homestay
Souvenir shop	Available	Made by women's farming group (kelompok tani wanita)
Management office	Not available/ None	-
Information boards	Available	Tourist signage
Tourism management	Available	The local government manages it, but it is not yet optimal
Security post	Not available/ None	-

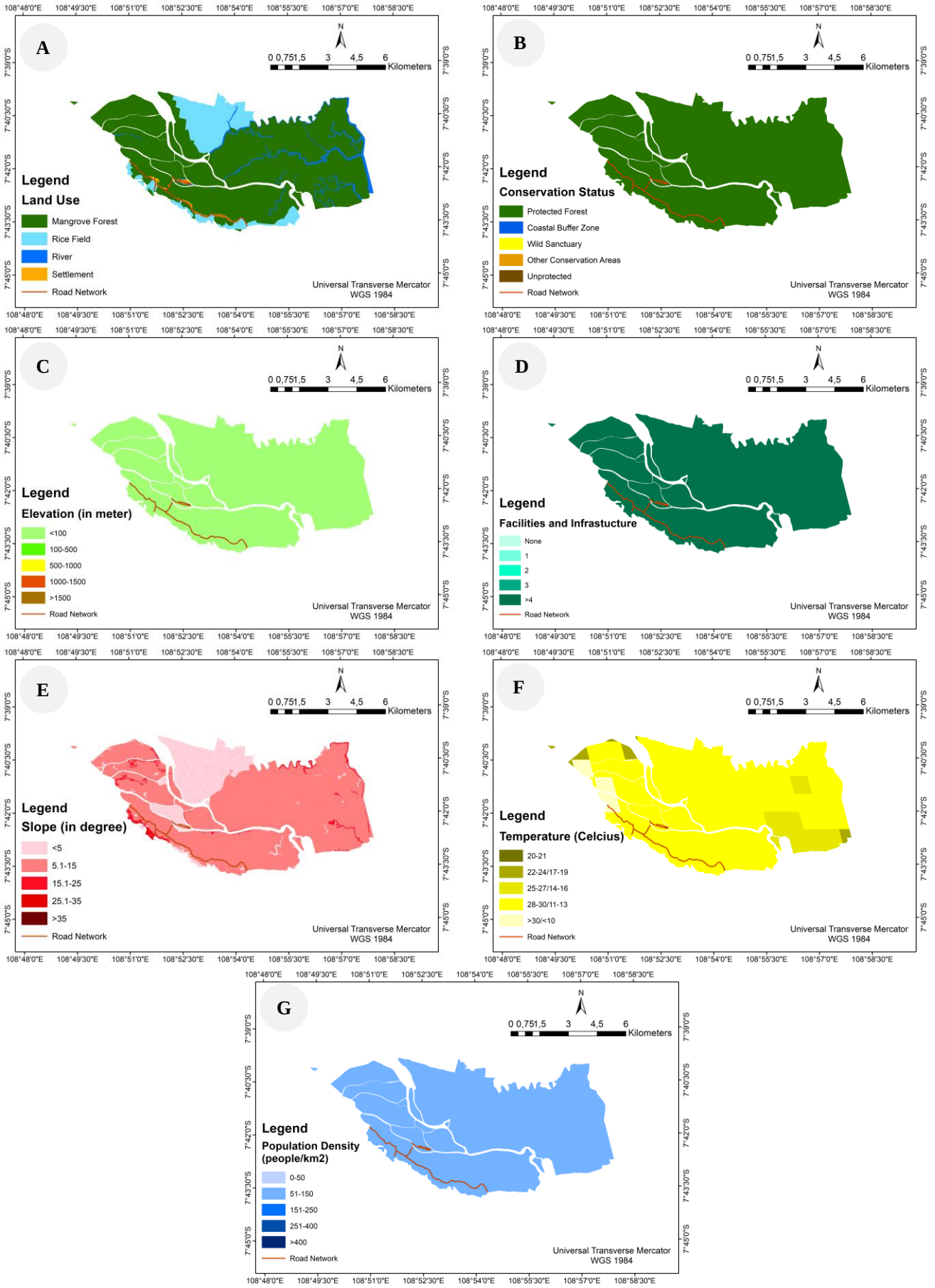

Figure 3. Spatial classification of each factor related to ecotourism in Ujungalang Village, Cilacap District, Central Java, Indonesia: A. Land use; B. Conservation status; C. Elevation; D. Facilities and infrastructure; E. Slope; F. Temperature; G. Population density

Temperature

The temperature in Ujungalang Village ranges from 22-30.6°C. This indicates that the village falls into factor classes II (110.25 ha), III (602.29 ha), IV (5,817.03 ha), and V (219.39 ha) for mangrove ecotourism development based on its temperature range. According to Figure 3.F, Ujungalang Village is dominated by factor class IV, with a temperature range of 28-30°C. This relatively high temperature is due to the village's location in the coastal area, which tends to have hotter or higher temperatures. In terms of temperature, Ujungalang Village is less suitable for tourism because of its hot climate. According to Yasin and Woldemariam (2023), lower temperature ranges are recommended for tourism, as most people tend to be more comfortable in cooler environments when vacationing.

Population density

Ujungalang Village is one of the villages with a relatively large population in the Kampung Laut Sub-district; data from the BPS-Statistics of Kampung Laut Sub-district (2024), the population of Ujungalang Village is 4,265 people, which occupy an area of 67.56 km². Therefore, the population density in this village is 65.87 people/km². According to the Analysis of Operational Areas of Natural Tourism Objects and Attractions book (*Analisis Daerah Operasi Objek dan Daya Tarik Wisata Alam/ADO-ODTWA)* by the Department of Forestry Republic of Indonesia (2003), this population density is categorized as low (Figure 3.G). However, the population and population density are expected to increase over time, which will result in a growing demand for land for housing. This increase in population density has the potential to cause negative impacts, as it could lead to a reduction in the area of mangrove forests (Ernawati 2016). In line with the findings of Ismail et al. (2019), the reduction in the mangrove area can decrease economic activities in the Segara Anakan area, which will ultimately have a negative impact on the local community's livelihood.

Accessibility

The journey to reach Ujungalang Village is approximately 8 km from the city center of Kampung Laut Sub-district, Klaces Village, or about 23 km from the city center of Cilacap District. This area can be accessed by both land and sea routes, using either a ship or a boat, with a travel time of 1.5 to 2 hours from the port in Cilacap, depending on the condition of the boat and the currents in Segara Anakan. Along the way, visitors can see the Cilacap port, the coastline of Nusakambangan, and the vast mangrove forests. According to data from the BPS-Statistics of Kampung Laut Sub-district (2024), public transportation is available in Ujungalang Village, though it only follows a fixed route.

Accessibility to Ujungalang Village can be categorized as limited, as the frequency of public boat transportation from Sleko Port is very restricted, with departures only available at 09:00 and 16:00 WIB. In addition, the cost of renting a boat is relatively high. For land access, the journey can be made via Tanjung Intan Ferry Port or Batre Port to Nusakambangan Island, with a travel time of about 1 hour. This land route can be traveled by motorcycle, although the road conditions are still unpaved (Sanjatmiko 2016).

Ecotourism potential index

The ecotourism potential index assesses an area's suitability for development as an ecotourism destination (Manurung et al. 2022). Table 5 presents the assessment results for each ecotourism potential factor in Ujungalang Village, while Table 7 and Figure 4 show the ecotourism potential classification.

The final values in Table 5 are used as the final weights for each factor. Then, the maps of each factor, which have been weighted, are overlaid, and the summed weights of each factor are used to obtain the ecotourism potential value (Table 6).

The analysis results show that the mangrove ecotourism potential in Ujungalang Village falls into three categories: non-potential (174.02 ha), low potential (1,292.52 ha), and high potential (5,290.43 ha). This indicates that most of Ujungalang Village has a very high potential to be developed as a mangrove ecotourism destination. Ujungalang Village is located in Kampung Laut Sub-district, which is known for its vast and fertile mangrove areas. The existence of mangroves is due to their location at the mouth of several rivers, such as the Citanduy, Cimeneng, Cibeureum, Sapu Regel, and Donan rivers. The meeting of fresh water from these rivers with the salty water from the Indian Ocean creates brackish water areas that support the growth of mangrove vegetation and the formation of mangrove forests (Ratnasari and Romansyah 2022).

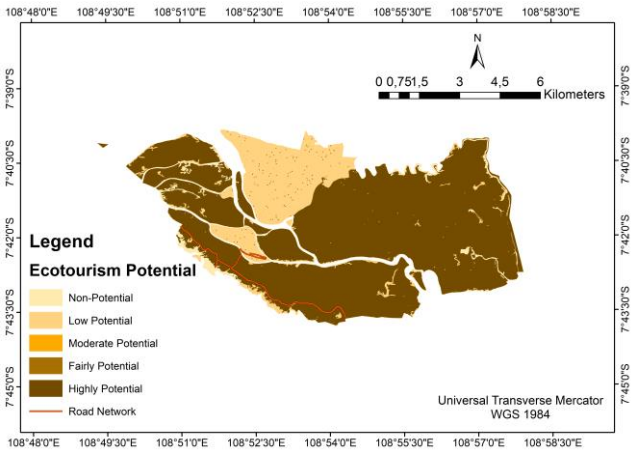

Figure 4. Ecotourism potential map in Ujungalang Village, Cilacap District, Central Java, Indonesia

Table 5. Assessment result of each ecotourism potential factor in Ujungalang Village, Cilacap District, Central Java, Indonesia

Factors	Description	Amount of availability	n*)	rj*)	wj*)	Final value
Land use	Rice fields	29	7	1	0.25	7.25
	Mangrove forest	7				1.75
	Settlement	8				2.00
	Rivers	13				3.25
Conservation status	Conservation forest	1	7	2	0.21	0.21
Elevation (masl)	<100	1	7	3	0.18	0.18
Facilities and infrastructure	>4 types	1	7	4	0.14	0.14
Slope (°)	<5	421	7	5	0.11	45.11
	5.1-15	1,384				148.29
	15.1-25	166				17.79
	25.1-35	35				3.75
	>35	5				0.54
Temperature (°C)	22-24/17-19	2	7	6	0.07	0.14
	25-27/16-16	2				0.14
	28-30/11-13	1				0.07
	>30/<10	2				0.14
Population density (people/km^2)	65.87	1	7	7	0.11	0.11

Note: *)n = Number of factors being studied; rj = Position of the factor ranking; rp = Factor (p=1,2,3,.....n)

Table 6. Index value of ecotourism potential in Ujungalang Village, Cilacap District, Central Java, Indonesia

Land use	Conservation status	Elevation	Facilities and infrastructure	Slope	Temperature	Population density	Index value
1.75	0.21	0.18	0.14	0.54	0.14	0.11	3.03
2.00	0.21	0.18	0.14	0.54	0.07	0.11	3.21
2.00	0.21	0.18	0.14	0.54	0.14	0.11	3.28
1.75	0.21	0.18	0.14	3.75	0.14	0.11	6.23
2.00	0.21	0.18	0.14	3.75	0.07	0.11	6.41
3.25	0.21	0.18	0.14	3.75	0.07	0.11	7.66
3.25	0.21	0.18	0.14	3.75	0.14	0.11	7.73
7.25	0.21	0.18	0.14	0.54	0.07	0.11	8.46
7.25	0.21	0.18	0.14	3.75	0.07	0.11	11.66
1.75	0.21	0.18	0.14	17.79	0.07	0.11	20.16
1.75	0.21	0.18	0.14	17.79	0.14	0.11	20.23
2.0	0.21	0.18	0.14	17.79	0.07	0.11	20.41
2.0	0.21	0.18	0.14	17.79	0.14	0.11	20.48
3.25	0.21	0.18	0.14	17.79	0.07	0.11	21.66
3.25	0.21	0.18	0.14	17.79	0.14	0.11	21.73
7.25	0.21	0.18	0.14	17.79	0.07	0.11	25.66
7.25	0.21	0.18	0.14	17.79	0.14	0.11	25.73
1.75	0.21	0.18	0.14	45.11	0.07	0.11	47.56
1.75	0.21	0.18	0.14	45.11	0.14	0.11	47.63
2.00	0.21	0,18	0.14	45.11	0.07	0.11	47.81
2.00	0.21	0.18	0.14	45.11	0.14	0.11	47.88
3.25	0.21	0.18	0.14	45.11	0.07	0.11	49.06
3.25	0.21	0.18	0.14	45.11	0.14	0.11	49.13
7.25	0.21	0.18	0.14	45.11	0.07	0.11	53.06
7.25	0.21	0.18	0.14	45.11	0.14	0.11	53.13
1.75	0.21	0.18	0.14	148.29	0.07	0.11	150.66
1.75	0.21	0.18	0.14	148.29	0.14	0.11	150.73
2.00	0.21	0.18	0.14	148.29	0.07	0.11	150.91
2.00	0.21	0.18	0.14	148.29	0.14	0.11	150.98
3.25	0.21	0.18	0.14	148.29	0.07	0.11	152.16
3.25	0.21	0.18	0.14	148.29	0.14	0.11	152.23
7.25	0.21	0.18	0.14	148.29	0.07	0.11	156.16

Table 7. Ecotourism potential classification in Ujungalang Village, Cilacap District, Central Java, Indonesia

Index value	Potential ecotourism class	Total area (Ha)
3.03-33.66	Non-potential	174.02
33.67-64.30	Low potential	1,292.52
64.31-94.94	Moderate potential	-
94.95-125.59	Fairly potential	-
125.59-156.16	Highly potential	5,290.43

Ujungalang Village is a place of immense potential, with a diverse ecotourism index that ranges from high (125.59-156.16) to non-potential (3.03-33.66). Several factors, including land use, conservation status, elevation, facilities and infrastructure, slope, temperature, and population density, influence this variation and contribute to this potential. The primary factor influencing ecotourism potential is land use change, as it significantly impacts the determination of ecotourism potential, particularly in the case of the Mangrove Forest in Ujungalang Village. The conservation status of Ujungalang Village as a Conservation Forest enhances its protected status, thereby increasing its ecotourism potential. Facilities and infrastructure are also key to boosting ecotourism potential. The variety of facilities and infrastructure, with more than four types of infrastructure, have positively influenced its ecotourism development. However, the low population density in the Ujungalang Village limits community involvement in environmental preservation efforts, a challenge that can be overcome with the right strategies.

Discussion

The mangrove ecotourism potential in Ujungalang Village is classified into three categories: non-potential, covering 174.02 ha; low potential, covering 1,292.52 ha; and high potential, covering 5,290.43 ha. Of the total area, approximately 78.29% in Ujungalang Village has a very high potential for the development of mangrove ecotourism. This potential is supported by the presence of thriving mangrove forests in the area. As an ecosystem, mangrove forests offer natural beauty and environmental value, including vegetation, marine life, wildlife, and the surrounding environment, all of which can support the development of ecotourism activities (Joandani et al. 2019).

Most of the mangrove area in Ujungalang Village is classified as having high ecotourism potential with extent of 5290.43 ha and an index range of 125.59-156.16. The condition of the mangrove forest in Ujungalang Village is considered good, making it highly potential to be developed as an ecotourism destination. Additionally, the availability of supporting facilities and infrastructure is also an important factor. The location already has facilities such as clean water, places of worship, information boards, and souvenir shops, which further enhance the potential of Ujungalang Village as a mangrove ecotourism destination. According to Joandani et al. (2019), the presence of local souvenirs not only attracts tourists but also contributes to the improvement of the local economy. Moreover, the area's status as a conservation zone further supports the development of ecotourism activities.

The locations with low ecotourism potential index typically have limited natural attractions or are not yet optimal for sustainable tourism development. Ecotourism is a concept that integrates environmental conservation, sustainable tourism development, and local community empowerment (Afif and Aisyianita 2023). Approximately 21.71% of the total area in Ujungalang Village is considered less suitable for ecotourism due to its geographical conditions, which require many adjustments to ensure the safety and comfort of tourists. These geographical conditions include agricultural areas, residential zones, and regions prone to disasters such as tsunamis and floods. According to Chaudhary et al. (2022), areas classified as unsuitable for ecotourism development include lowland regions, which are predominantly used for intensive agriculture and densely populated urban centers. The development of this area requires additional infrastructure, such as flood-resistant drainage systems, observation posts, information boards, and an early warning system. Furthermore, disaster mitigation training for the management team needs to be conducted before the ecotourism area is opened to the public. In the development plan, inclusivity in tourism development is a key consideration, ensuring that all visitors, including those with disabilities, feel valued and considered. This is in line with the ecotourism potential of Ujungalang Village, which focuses on conservation and water activities. According to Sica et al. (2021), responsible and inclusive tourism management not only supports sustainability but also opens up new opportunities in areas previously considered less suitable through innovative attractions that can attract tourists' interest.

Mangrove-based ecotourism is a form of ecotourism that can preserve the environment. Mangroves have great potential to be developed as ecotourism destinations due to their unique characteristics and the ability of these areas to be used as tourist locations while maintaining the originality of the forest and the preservation of the organisms that live within it (Pellokila and Sagala 2019). Utilizing the mangrove ecosystem for ecotourism is also a strategic step in improving the welfare of local communities. The distinctiveness of mangroves, such as their root structures and the diversity of fauna associated with this ecosystem, makes them highly potential for development as an alternative tourism destination (Hadinata et al. 2020). Sustainable mangrove ecotourism development can be carried out with an integrated approach involving the active participation of coastal communities around the mangrove areas. This approach not only raises awareness about the importance of mangrove conservation for the sustainability of local communities but also ensures that development strategies align with the needs and interests of local people. Intensive consultation and coordination with coastal communities are key to achieving sustainable and inclusive management.

Furthermore, Qomariah (2009) stated that community involvement in ecotourism management includes two main aspects: the ability to be a good host and openness to

visitors. The principles of ecotourism are not only focused on economic benefits but also aim to raise tourists awareness and sensitivity about the local social and cultural aspects, which can be gained through interactions with local communities (Dian et al. 2024). Therefore, education and socialization about the importance of mangrove conservation for the sustainability of coastal communities livelihoods are essential.

Sustainable mangrove ecotourism development also requires awareness of conservation aspects, mangrove preservation, and the enhancement of supporting tourism infrastructure (Dian et al. 2024). One step that can be taken is the development of supporting facilities such as public sanitation facilities and proper waste management. In Ujungalang Village, the lack of such facilities poses an obstacle to realizing sustainable mangrove ecotourism. According to Joandani (2019), the availability of facilities and infrastructure plays a crucial role in the success of ecotourism, as it supports the comfort and convenience of visitors. Furthermore, improving these facilities can stimulate economic growth within the community by increasing the number of tourists (Handayani and Harlina 2021).

One important form of collaboration is with local government institutions, such as the Cilacap District Tourism Office (*Dinas Pariwisata Kabupaten Cilacap*). This collaboration can cover various aspects, including the development of tourism infrastructure, promotion of tourist destinations, environmental management, and the formulation of regulations that support sustainable tourism development (Amerta et al. 2024). Government institutions can also provide support in the form of funding and supervision to ensure that tourism activities comply with established standards. Collaboration with the private sector also plays a crucial role in supporting the development of mangrove ecotourism in Ujungalang Village. Local and national companies can contribute by investing in tourism infrastructure, developing tour packages, conducting promotional and marketing activities, and providing accommodation services and other supporting facilities (Sartika et al. 2024). Collaboration with the private sector can also bring innovation and valuable expertise to enhance the tourist experience and strengthen competitiveness.

Collaboration with academics and mangrove experts is also necessary for ecotourism management, both for managing mangrove areas, utilizing mangroves to create value-added products, and ensuring the sustainability of mangrove ecotourism by considering the carrying capacity of the area (Millenia et al. 2021). Assessment of environmental carrying capacity assessment is crucial in determining the area of mangroves that can be utilized for tourism, as well as the safe and comfortable duration of visits for tourists (Hadinata et al. 2020). This aspect is a key factor in ensuring the sustainability of mangrove ecotourism management.

In conclusion, around 78.29% of the area in Ujungalang Village has a great potential to be developed as mangrove ecotourism, mainly due to the lush mangrove forest in the area. Meanwhile, 21.71% of the area is considered unsuitable for ecotourism due to its geographic conditions, which require significant modifications to meet safety and comfort standards for tourists. These geographic conditions include agricultural areas, settlements, and areas that are prone to natural disasters such as tsunamis and floods. Therefore, it is necessary to build flood-resistant infrastructure development, as well as the provision of observation posts, informational boards, and an early warning system. The development of sustainable mangrove ecotourism can be more integrated by involving the local coastal community, which in turn will raise their awareness of the importance of mangrove conservation for the community's livelihood. Additionally, mangrove ecotourism development can be carried out through collaboration with local government institutions, the private sector, academics, and mangrove experts for the management and development of mangrove ecotourism. This research contributes to identifying ecotourism indicators and helps develop a methodology for analyzing ecotourism potential. Mapping potential ecotourism locations is a valuable tool for policymakers and decision-makers in planning sustainable tourism development that benefits local communities while protecting biodiversity. The findings of this study provide information that can guide regional investments by identifying suitable areas for ecotourism development. Ultimately, this can encourage job creation opportunities, improve the economic welfare of local communities, and preserve natural resources.

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