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The Potential Of The Mangrove Forest Ecosystem As A Conservation-Based Educational Tourism Attraction In Tuwed Village, Jembrana Regency

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ABSTRACT
The mangrove forest ecosystem in Tuwed Village, Jembrana Regency, has significant ecological and educational potential to be developed into a conservation-based educational tourism destination. This study aims to analyze the physical and ecological potential of the mangrove forest in Tuwed Village, identify management constraints, and formulate a strategy for developing mangrove educational tourism based on Community-Based Tourism (CBT). A descriptive-exploratory qualitative method was used, employing the interactive analysis technique of Miles and Huberman (2015), triangulated through a survey of 33 local community respondents. The results show that the mangrove forest in Tuwed Village covers an area of 44.50 hectares, with the potential to expand to 67 hectares due to land accretion, and a Normalized Difference Vegetation Index (NDVI) ranging from 0.6128 to 0.7093, which is classified as healthy. Community awareness (100%) and perceptions of feasibility (100%) are very high. Nevertheless, development is hampered by a lack of infrastructure (boardwalks and sanitation), coastal litter, uncertainty regarding land legality, and the limited capacity of the Tanjung Pasir Forest Farmers' Group (KTH). The strategies formulated include zoning the area (conservation, educational tourism, and research), capacity building for the KTH, and collaborative pentahelix governance.

Keywords: Mangrove Forests, Educational Tourism, Coastal Conservation, Community-Based Tourism, Tuwed Villag

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INTRODUCTION
Mangrove forest ecosystems play a vital role as ecological buffers for coastal areas by protecting against erosion, absorbing carbon emissions, and providing spawning grounds for aquatic organisms (Dahuri et al., 2013; Pramudji, 2018). Beyond these basic environmental functions, integrating mangrove ecosystems into educational ecotourism serves as an effective tool for aligning environmental conservation efforts with improvements in the economic well-being of local communities (Bhuiyan et al., 2010; Permatasari & Suryawan, 2020). Mangrove educational tourism offers interactive learning about coastal ecological functions, vegetation rehabilitation techniques, and biodiversity conservation (Karampotsis et al., 2024; Samal & Dash, 2023).

The village of Tuwed in Melaya Subdistrict, Jembrana Regency, has a coastal mangrove forest area with great potential for development. Geographically, the village is located 12 km from Negara City and 107 km from Denpasar City, making it a strategic hub for environmental educational tourism in the West Bali region. The coastal area of Tuwed Village is also undergoing physical changes in the form of sediment accumulation (land uplift), which offers natural prospects for the expansion of the mangrove "green barrier" (Dahuri et al., 2013).

Although the mangrove vegetation cover in Tuwed Village is relatively dense and healthy, with a Normalized Difference Vegetation Index (NDVI) ranging from 0.6128 to 0.7093, its management as a conservation-based educational tourism attraction has not yet been optimized (Fattah et al., 2022). On-the-ground challenges include a lack of physical infrastructure for accessing

the mangroves, the prevalence of marine debris, unclear ownership status of coastal land, and limited governance capacity of the Tanjung Pasir Forest Farmers' Group (Kitole & Sesabo, 2024).

The development of mangrove educational tourism in Tuwed Village is relevant to the achievement of the Sustainable Development Goals (SDGs), particularly SDG 13 (Climate Action) and SDG 14 (Life Below Water) (Yang & Duan, 2020). The novelty of this study lies in its focus on analyzing the spatial-ecological conditions of the mangroves, combined with the community's social readiness, to formulate a mangrove ecotourism model based on Community-Based Tourism (CBT) (Gili & Widiastuti, 2021).

The objectives of this study are, to analyze the physical and ecological potential of the mangrove forest in Tuwed Village as a key asset for educational tourism, to identify physical, environmental, and institutional constraints in the management of the mangrove forest in Tuwed Village and to formulate a strategy for the development of mangrove educational tourism based on conservation and community empowerment.

METHOD

This study employs a descriptive-exploratory qualitative approach (Miles & Huberman, 2015). The study was conducted in the mangrove forest area of Tuwed Village, Melaya Subdistrict, Jembrana Regency, Bali, which is located at the coordinates 8°20'28.0" S and 114°39'48.0" E. Research data were collected using a combination of several methods: field Observations: Observing the physical condition of mangrove cover, density levels, and the availability of coastal infrastructure, in-Depth Interviews: Conducted with key informants from the Tanjung Pasir Community Forest Management Group, the Tuwed Village Government, coastal community leaders, and the Village-Owned Enterprise, with informants selected using purposive sampling, questionnaire Survey: Distributed to 33 local residents of Tuwed Village to measure the level of community understanding and support for participation, with respondents selected using purposive accidental sampling, document Review: Utilizing NDVI imagery, coastal area maps, and village planning documents. Qualitative data were analyzed using the interactive model proposed by Miles and Huberman (2015), following the stages of data reduction, thematic data presentation, and the drawing and verification of conclusions through data triangulation.

FINDING AND DISCUSSION

Social Profile and Community Readiness

Community empowerment is a key pillar of the success of educational tourism based on Community-Based Tourism (CBT).

Table 1. Sociodemographic Profile of Respondents from Tuwed Village (N=33)

Variable	Category	Frequency (n)	Percentage (%)
Gender	Men	18	54,5%
	Women	15	45,5%
Occupation	Village Officials	9	27,3%
	Farmers / Fishermen	5	15,2%
Education Level	High School / Vocational High School	11	33,3%
	Bachelor's Degree / Diploma	14	42,4%
Estimated Income	Rp 1,000,000 – Rp 2,000,000	16	48,5%
	Rp 2,000,000 – Rp 3,000,000	10	30,3%

The respondents educational background which was dominated by high school and vocational school graduates and college graduates (75.7%) reflects the high capacity of human resources to embrace education and innovation in tourism governance.

Table 2. Community Perceptions and Readiness for Mangrove Ecotourism (N=33)

Evaluation	Indicators Category	Category Frequency (n)	Percentage (%)
Understanding the Potential of Mangroves	Understand	33	100%
Feasibility as an Educational Tourism Destination	Eligible	33	100%
Support for Local Involvement	Willing	27	81,8%
Availability of Management Groups	Available (Tanjung Pasir Forest Farmers' Group)	31	93,9%

The data in Table 2 confirm that there is absolute (100%) social support from local residents for the use of mangrove forests for educational tourism, with 81.8% of the community stating that they are ready to actively participate in environmental tourism activities,

Analysis of the Ecological Potential of the Mangrove Forest in Tuwed Village

The mangrove forest ecosystem in Tuwed Village has significant ecological benefits:

1. Area and Growth Dynamics of the Region: Currently, the area of mangrove forest cover in Tuwed Village is 44.50 hectares. The accumulation of coastal sediment deposits (land accretion) has the potential to expand this green cover to 67 hectares. This dynamic provides an ideal setting for educational tourism activities, such as mangrove planting and seedling adoption programs.
2. Mangrove Vegetation Density (NDVI): The Normalized Difference Vegetation Index (NDVI) values for the mangrove ecosystem at the study site range from 0.6128 to 0.7093. This range indicates that the vegetation is in moderate to very healthy condition, capable of optimally performing its functions of erosion control and carbon sequestration.
3. Coastal Biodiversity: The mangrove forest in Tuwed Village serves as a habitat for various aquatic species (such as mangrove crabs and coastal fish) as well as a nesting area for coastal birds, which has the potential to be developed as a bird-watching attraction.

Constraints and Challenges in Mangrove Forest Management

Based on a qualitative thematic analysis, mangrove management in Tuwed Village is still limited by several major constraints,.

Table 3. Matrix of Constraints on Mangrove Forest Management in Tuwed Village

Challenges	**Field Findings**	**Impact on Educational Tourism**
Physical Infrastructure	There are currently no boardwalks, elevated bridges, or sanitation facilities.	Tourist access is very limited and has the potential to damage young vegetation.
Environmental Conditions	Marine plastic waste has accumulated around the mangrove roots.	It reduces the area's aesthetic value and disrupts vegetation growth.
Land Tenure	The ownership status and boundaries of the coastal land reclamation area remain unclear.	It hinders investment certainty and the processing of tourism business permits.
Institutional Capacity	The Tanjung Pasir Forest Farmers' Group has not yet received training in eco-tourism guiding and marketing.	Mangrove management is still limited to passive conservation.

Discussion

Strategies for Developing Community-Based Tourism (CBT)-Based Mangrove Ecotourism

To achieve sustainable mangrove educational tourism, an integrated strategy that combines area zoning and pentahelix governance is recommended (Tola et al., 2024; Tomasi et al., 2020).

1. Mangrove Management Zoning

   The mangrove area, spanning 44.50–67 hectares, is divided into three operational zones (Yang & Duan, 2020),

   a. Core Conservation Zone

      The Core Conservation Area is designed as the primary bastion for protecting ecosystems that have high vegetation density with NDVI values ranging from 0.6128 to 0.7093 and the highest level of ecological vulnerability. Focused on the absolute protection of biodiversity, this zone serves as a spawning and nursery ground for aquatic biota such as fish and mangrove crabs, while also providing a nesting habitat for various species of coastal birds. This area is exclusively designated as a natural laboratory for scientific research activities, such as coastal ecology studies, carbon stock analysis, and climate change monitoring. To prevent habitat fragmentation, this zone enforces a policy prohibiting permanent infrastructure, including boardwalks, with physical access limited solely to the installation of ecological monitoring instruments. Access to this zone is strictly regulated (strict protection) and closed to general tourism activities, so that only researchers, academics, or conservation officers with special permits are allowed entry in limited numbers.

   b. Limited Eco-Tourism Zone

      The Limited Ecotourism Zone serves as a space for controlled interaction between visitors and the mangrove ecosystem, prioritizing hands-on learning experiences without compromising environmental sustainability. This area is equipped with eco-friendly infrastructure in the form of a boardwalk elevated to avoid damaging the mangrove root system or disrupting tidal currents. Within this zone, visitors can actively participate in interactive conservation activities through the mangrove adoption project at designated nursery and planting sites. Additionally, exploration activities are conducted in an environmentally friendly manner via canal trails using rowboats or non-motorized kayaks to prevent noise and fuel pollution, and wooden observation towers are provided for bird watching. Use of this zone is subject to strict carrying capacity limits to control visitor numbers and requires accompaniment by local guides from the Tanjung Pasir Forest Farmers' Group to ensure compliance with conservation principles.

   c. Buffer and Service Zone

      The Buffer and Service Zones are located on the mainland outside the mangrove forest barrier and serve to mitigate the impact of human activities before they enter the conservation area, while also acting as centers for community economic development. All public facilities and public gatherings are concentrated in this zone to preserve the tranquility of the core ecosystem. Key infrastructure includes the Mangrove Information Center a facility for visitor reception and audio-visual educational exhibits as well as a small and medium-sized enterprise (SME) hub and a local products market to promote the community's coastal-based processed goods, along with parking lots and eco-sanitation facilities that prevent wastewater pollution of coastal waters. This zone is open to the public and managed comprehensively through a Community-Based Tourism (CBT) program that fosters collaboration among the local community, the Tanjung Pasir Forest Farmers' Group, the Village-Owned Enterprise, and the Tuwed Village Government.

2. Pentahelix Partnership Synergy

   a. Academics

      Academics play a strategic role as facilitators of knowledge and scientific monitors in the development of mangrove educational tourism in Tuwed Village. This role is realized through ongoing guidance in the development of an ecology-based tourism management framework, the establishment of standard operating procedures for educational tourism, and the implementation of ecoguiding training for local residents. Academics equip managers with materials on environmental interpretation, coastal biodiversity, and public communication techniques to ensure that interactions with tourists are both educational and memorable. In addition, academics conduct periodic monitoring research on the health of mangrove vegetation, such as mapping density levels using the NDVI index and measuring environmental carrying capacity, to ensure that tourism activities do not interfere with the area's conservation functions.

   b. Community

      Local communities (the Tanjung Pasir Forest Farmers' Group and the Tourism Awareness Group) serve as the main actors and driving forces in community-based ecotourism management. The Tanjung Pasir Forest Farmers' Group and Pokdarwis are fully responsible for daily operations, ranging from managing tourist flow, providing on-site guiding services, managing the nursery facilities for the mangrove adoption program, to

maintaining the eco-tourism trails and keeping the coastal environment clean. This direct involvement ensures that the community is not merely a bystander but an active participant in the process, reaping direct economic benefits through the creation of new job opportunities, the management of canal boat rentals, and the marketing of local culinary specialties and coastal handicrafts.

c. Businesses & Media

The business and media sectors play a crucial role as catalysts for infrastructure funding and digital market expansion. The business sector (the private sector, as well as tourism industry players) contributes through the allocation of Corporate Social Responsibility (CSR) funds and green investments to finance environmentally friendly physical facilities that require significant initial capital, such as the construction of wooden boardwalks, bird-watching towers, and eco-sanitation facilities. Meanwhile, the media sector and digital platform advocates are tasked with crafting conservation narratives and widely promoting the mangrove ecotourism potential of Tuwed Village through digital marketing campaigns, the creation of engaging audio visual content, and mass media publications to raise public awareness and attract tourists.

CONCLUSIONS

The mangrove forest ecosystem in Tuwed Village, Jembrana Regency, has extremely high ecological potential and great prospects for development as a conservation-based educational tourism destination. This area currently has 44.50 hectares of vegetation cover, with the potential for the green belt to expand to 67 hectares due to coastal sedimentation (land accretion). The vegetation density, which falls into the moderate to very healthy category as evidenced by a Normalized Difference Vegetation Index (NDVI) range of 0.6128 to 0.7093 underscores the ecosystem's vital role in absorbing carbon emissions, mitigating coastal erosion, and providing breeding grounds for aquatic life and coastal birds. These natural physical and spatial conditions serve as a strong foundation for offering eco-tourism packages with high educational value.

From a social perspective, the local community demonstrates full awareness and a 100% consensus on the feasibility of developing the mangrove area as an educational tourism site, with the majority of residents expressing their willingness to actively participate in educational tourism activities. However, the full realization of this ecological potential remains hindered by various fundamental challenges on the ground. These constraints include a lack of supporting physical infrastructure such as wooden boardwalks and sanitation facilities, the widespread accumulation of marine debris, the unresolved legal status of coastal land, and the limited institutional capacity of the Tanjung Pasir Forest Farmers' Group to manage tourism professionally.

To address these challenges and ensure the area's long-term sustainability, the development strategy focuses on a structured zoning plan for the mangrove area, dividing it into a Core Conservation Zone, a Limited Ecotourism Zone, and a Buffer & Service Zone. This strategy is combined with the development of environmentally friendly access infrastructure and the implementation of collaborative governance based on Community-Based Tourism (CBT). Through pentahelix institutional synergy involving the village government, academics, the Tanjung Pasir Forest Farmers' Group/Tourism Awareness Group, the business sector through corporate social responsibility (CSR), and digital media activists, the mangrove educational tourism program in Tuwed Village is projected to successfully align coastal environmental conservation efforts with the sustainable improvement of the local community's economic well-being.

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