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Sustainable Ecotourism Infrastructure Spatial Planning (Site Plan) Integrated with the Mangrove Forest Ecosystem of Kuala Bubon, West Aceh, Indonesia

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ABSTRACT

The issue of developing the Kuala Bubon mangrove forest in West Aceh as an ecotourism destination has emerged and is widely discussed in the public sphere, gaining much sympathy and support from the community, considering the forest's high biodiversity of flora and fauna. However, ecotourism activities, if not properly managed, can pose a serious threat to the sustainability of the ecosystem, such as unplanned infrastructure development that damages the habitats of various flora and fauna. Therefore, ecotourism needs to be managed effectively through pre-ecotourism studies, particularly the design of sustainable infrastructure spatial planning. The goal of this research is to create a site plan for sustainable ecotourism infrastructure integrated with the mangrove ecosystem. This design ensures that the negative impacts of infrastructure development in ecotourism areas can be minimized through the application of sustainable strategies and practices. The stages of this research include: 1. Documenting the potential of natural resources as ecotourism attractions and ecological conditions, 2. Mapping spatial data on ecotourism potential using GIS applications, 3. Designing spatial infrastructure for supporting ecotourism by considering the needs of ecotourism and selecting areas that do not harm the habitats of flora and fauna using AutoCAD. The research was conducted in the Kuala Bubon mangrove forest, West Aceh, from July to August 2024. The results of the research identified six ecotourism potential points, including: 1) Ecotourism boat tours for flora and fauna observation, 2) Open-air camping ecotourism, 3) Fishing ecotourism, 4) Birdwatching ecotourism, 5) Recreational boating ecotourism, and 6) Sunset ecotourism with a coffee shop and heron watching. The spatial planning of ecotourism infrastructure becomes crucial as the foundation for sustainable ecotourism development.

I. Introduction

The background of this research is the plan of the West Aceh Regency government and the Ministry of Tourism and Creative Economy of the Republic of Indonesia to designate the Kuala Bubon mangrove forest in West Aceh as an ecotourism area [1]. Ecotourism activities, if not properly managed, can pose a serious threat to the sustainability of ecosystems [2], [3]. For instance, unplanned infrastructure development can damage the habitats of various flora and fauna. On the other hand, the lack of ecotourism infrastructure, such as transportation facilities, tourism amenities, and waste management systems, can become obstacles to sustainable ecotourism [4], [5]. In this context, sustainable ecotourism becomes crucial in efforts to preserve ecosystems and advance the local economy. Therefore, ecotourism needs to be effectively managed through pre-ecotourism studies, specifically the design of infrastructure planning that is friendly to the mangrove ecosystem.

The design of spatial infrastructure planning is a development planning process that takes into account building layouts, placement, and land use in an effort to meet needs [6], [7]. The development

is required to be environmentally friendly and not to harm ecosystems that serve as habitats for flora and fauna. Before designing the construction of ecotourism facilities, an analysis of ecotourism potential is conducted first, focusing on both biodiversity and natural beauty as tourist attractions, so that the areas and proper infrastructure placement can be determined. Furthermore, it also involves selecting construction methods that prioritize sustainable development (sustainable infrastructure) [8]–[12].

The issues to be studied are: 1) the potential tourist attractions of the mangrove forest in Kuala Bubon, West Aceh, and 2) the design of sustainable ecotourism infrastructure based on its ecotourism potential and ecological structure. The specific aim of this research is to create a site plan for the sustainable ecotourism infrastructure that integrates with the mangrove forest ecosystem. This design ensures that the negative impacts of infrastructure development in the ecotourism area can be minimized through the application of sustainable practices and strategies, as has been implemented in ecotourism areas such as Graha Indah in Balikpapan, Rowo Jombor in Klaten, Batu Katak in Langkat, Likupang, and in the West Azerbaijan Province [8].

Research on sustainable infrastructure design in the Kuala Bubon mangrove forest has never been conducted, making it a valuable and high-priority pre-ecotourism study as a reference for ecotourism development. This is particularly significant given the interdisciplinary collaboration between biological sciences, information technology, and civil engineering, which will address challenges in sustainable ecotourism management. Examples of sustainable strategies that must be implemented include the placement and construction of environmentally friendly infrastructure, ecotourism trails that do not damage habitats, and parking areas. These strategies will serve as a model for future ecotourism area development.

This research, which will examine ecological conditions, will also identify ecotourism potentials such as birdwatching, hiking, fishing, kayaking, and natural scenery. By doing so, the infrastructure developed will be well-organized and tailored to the specific needs of the ecotourism attractions, which will be reflected in the site plan for the spatial layout of the infrastructure.

II. Method

The approach in this research involves both qualitative and quantitative methods. The qualitative approach is used to gather data on ecotourism potential, while the quantitative approach is applied in the spatial planning of infrastructure (site plan). This research is categorized as fundamental research, aimed at revealing ecotourism potential and developing a site plan for sustainable ecotourism infrastructure. The research will be conducted in the Kuala Bubon Mangrove Forest, West Aceh, during July-August 2024.

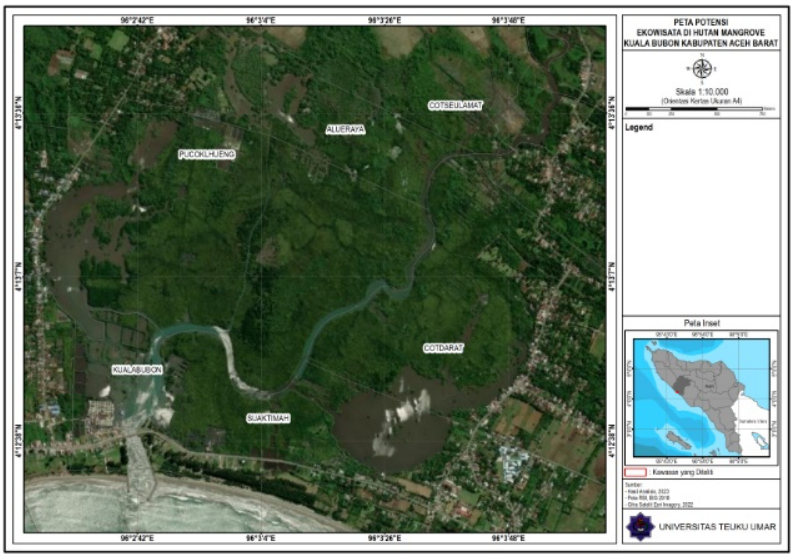


Fig 1. The study area at Kuala Bubon mangrove forest, West Aceh, Indonesia

Data collection on ecotourism potential and ecological conditions is carried out through exploratory surveys, with coordinates recorded using GPS [12], [13]. This ecotourism potential data is primary data, and secondary data regarding ecological conditions is also collected. The tools used in data collection include a digital camera, binoculars, observation sheets, GPS, and writing instruments. The data on ecotourism potential will be analyzed using Quantum GIS software to generate visual mapping data of the ecotourism potential [12]. Additionally, space requirements, physical ecosystem carrying capacity, and site analysis will be conducted to determine the size of the area needed (numerical). Subsequently, a site plan for the infrastructure will be designed using AutoCAD for 2D visualization and SketchUp for 2D and 3D visualization to provide a more detailed site plan.

III. Results and Discussion

A. Ecotourism Potential

The Kuala Bubon Mangrove Forest in West Aceh is one of the areas with high ecotourism potential, characterized by a rich biodiversity of flora and fauna and adequate travel access. The vegetation of the Kuala Bubon mangrove forest is composed of mangrove species such as Rhizophora apiculata, Rhizophora mucronata, Rhizophora stylosa, Sonneratia alba, and Nypa fruticans. These plants provide food and nesting sites for various fauna, while the pristine condition of the mangrove waters supports a complex and interconnected ecosystem chain.

Exploration of tourism potential is conducted based on current trends in sustainable ecotourism across various regions in Indonesia, resulting in six ecotourism potentials, including: 1) Ecotourism boat tours for flora and fauna observation, 2) Open-air camping ecotourism, 3) Fishing ecotourism, 4) Birdwatching ecotourism, 5) Recreational boating ecotourism, and 6) Sunset ecotourism with a coffee shop and birdwatching. These activities can be developed in the Kuala Bubon Mangrove Forest in West Aceh. The coordinates of the ecotourism potential points are recorded, followed by mapping.

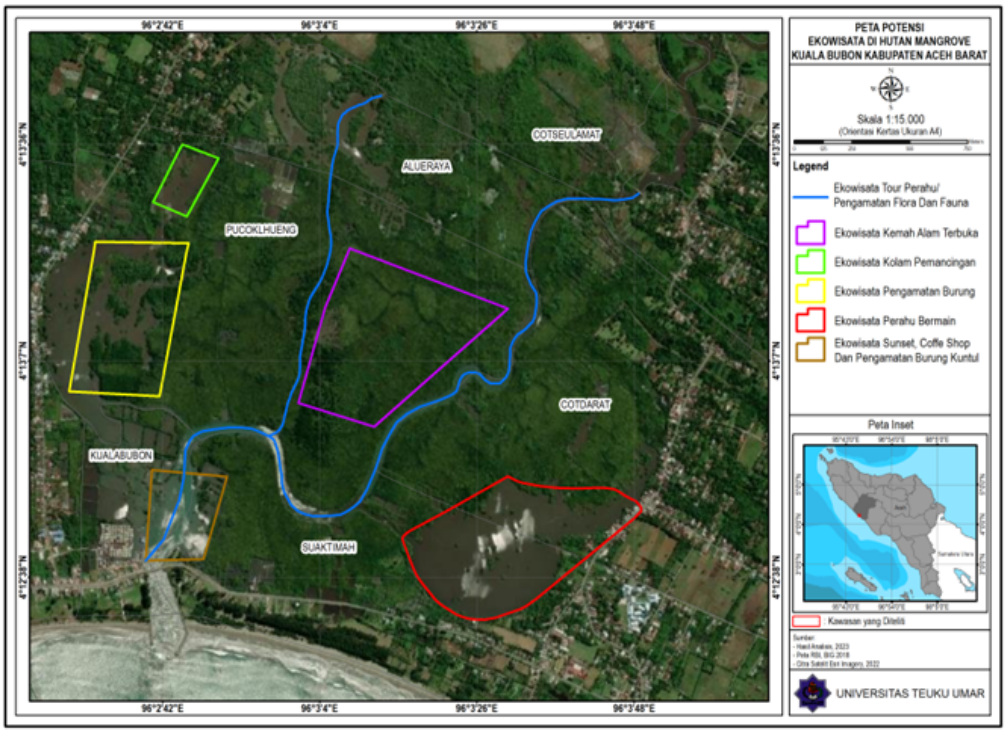


Fig 2. Mapping of Ecotourism Potential

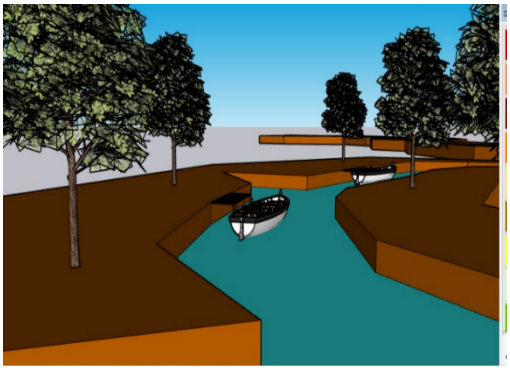
B. Site Plan for Sustainable Ecotourism Spatial Planning

The design of the site plan for ecotourism spatial planning uses AutoCAD for 2D visualization and SketchUp for both 2D and 3D visualization. The planning of the site plan for infrastructure that is integrated with the ecosystem is an effort to maintain the sustainability of both ecotourism and ecology simultaneously.

Fig 3. Site Plan for Ecotourism Infrastructure

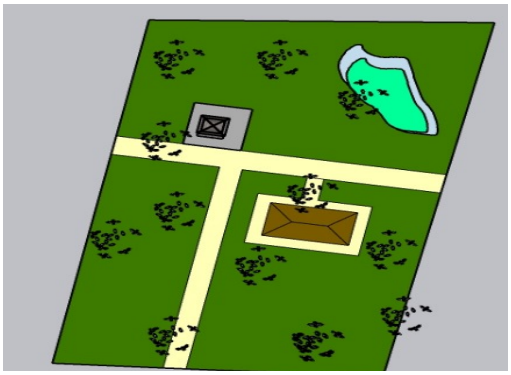
The utilization and management of ecotourism must be based on a balance of natural resource use. Therefore, it is necessary to map the development needs of the literature study based on the potential attractions of ecotourism itself. The Kuala Bubon Mangrove Forest in West Aceh has very high attraction potential, making this site plan a necessity for the development of sustainable ecotourism.

The developed site plan includes six ecotourism potentials, namely: 1) Ecotourism boat tours for flora and fauna observation, 2) Open-air camping ecotourism, 3) Fishing ecotourism, 4) Birdwatching ecotourism, 5) Recreational boating ecotourism, and 6) Sunset ecotourism with a coffee shop and heron watching.

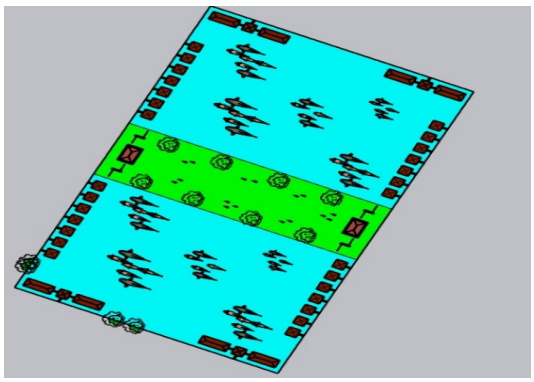


Ecotourism boat tours for flora and fauna observation

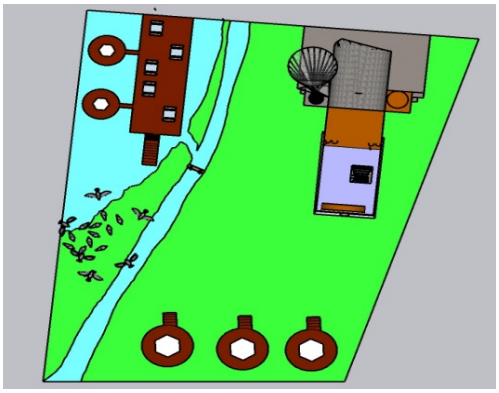
Open-air camping ecotourism



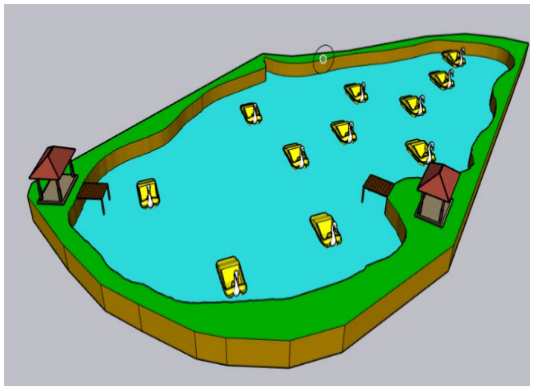
Birdwatching ecotourism



Fishing ecotourism



Recreational boating ecotourism, and



Sunset ecotourism with a coffee shop and heron watching.

Fig 4. Site Plan for Ecotourism Infrastructure Spatial Planning

The planning of development in ecotourism areas is inseparable from innovations developed to preserve the ecosystem itself [14]. Development should not only focus on the provision of facility buildings but also on the design of environmentally friendly structures, the selection of appropriate areas without harming habitats, and the construction of ecotourism facilities based on the potential attractions for tourists in building supporting infrastructure for ecotourism activities.

The spatial planning of ecotourism infrastructure requires a balance between development and conservation [15], [16]. On one hand, development is necessary for the needs of ecotourism expansion. On the other hand, conservation must be a top priority in maintaining the sustainability of ecotourism [17]. Without conservation, biodiversity will be lost, thereby hindering the sustainability of ecotourism

IV. Conclusion

The research identified six ecotourism potentials, which consist of: 1) Ecotourism boat tours for flora and fauna observation, 2) Open-air camping ecotourism, 3) Fishing ecotourism, 4) Birdwatching ecotourism, 5) Recreational boating ecotourism, and 6) Sunset ecotourism with a coffee shop and heron watching. The site plan for ecotourism spatial planning in the Kuala Bubon mangrove forest, West Aceh, becomes crucial as a foundation for the development of sustainable ecotourism.

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