Development of an Environmentally Friendly Tourism City in the Protected Forest of Lombok Using Integrated Geospatial Analysis

(Case study: Batu Putih, Sekotong, West Lombok, Indonesia)

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Key words: Tourism city, Environmentally Friendly, Protected Forest, Integrated Geospatial

SUMMARY

Batu Putih, Sekotong, West Nusa Tenggara is a region that required the public's attention. This region is a part of a conservation area according to Ministry of Forestry Decree No. 664/Kpts-II/92/76 on July 1st, 1992. Batu Putih is a habitat for protected floras and faunas such as brahminy kites (Haliastur indus), kingfishers (Halcyon chloris), swifts (Collocalia sp), kelicung (Diospyros malabarica), rosewoods (Dalbergia latifolia), and waru (Hibiscus tiliaceus). This habitat is threatened to be disturbed by local agricultural activities. Land use changes that occur in forest areas that are transformed into agricultural areas can disturb local ecosystems' sustainability.

This condition calls for an approach to conserve local sustainability while fulfilling local economic needs at the same time. Tourism development is an approach that is possible to be done in this hamlet. Beautiful scenery and ocean waves on the beach nearby are tourist attraction potentials that can be used as assets for the development. This development is also expected to trigger a partnership between local residents, government, and business entities.

This study aims to recommend land plots that are possible to be developed as a tourism city in Batu Putih. Geospatial approaches such as field surveys, topography analysis, and land use classification will be used in this research. The result of this research in the form of tourism city development location recommendation is aimed at the betterment of local social, economic, and environmental conditions. This research is also aimed to trigger a partnership between local residents, government, and business entities.

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1. INTRODUCTION

Nature conservation is a complex task that mostly falls under the government's jurisdiction (Booth et al., 2022; Kurniawan et al., 2016). The complex task is often followed by funding and capability inadequacies (Bates & Hersey, 2016). This condition often hinders conservation efforts. To tackle this limitation, the government should collaborate with local business entities and residents (Wan et al., 2022; Zhang & Kumaraswamy, 2012). Business entities are often driven by profits to be able to operate. This requirement drove business entities to operate as efficiently as possible (Bates & Hersey, 2016).

Commercial approaches in nature conservation have been tried and proven to be working well (Bates & Hersey, 2016; Chidakel & Child, 2022; Shine & Somaweera, 2019). This conservation approach is proven to be able to generate revenues and improve local employment while conserving natural ecosystems. The government also gets benefit from reduced management load (Wan et al., 2022). Commercial nature conservation can be the alternative to regions that have inadequate funding and capabilities to maintain their conservation efforts.

A similar case is happening in Batu Putih Village, Sekotong, West Lombok. The village has a conservation area called Taman Wisata Alam (TWA) Bangko-Bangko that is settled by the Decree of Minister of Forestry No. 664/Kpts -II/92/76 on July 1st, 1992. The area is a habitat for protected floras and faunas such as brahminy kites (Haliastur indus), kingfishers (Halcyon chloris), swifts (Collocalia sp), kelicung (Diospyros malabarica), rosewoods (Dalbergia latifolia), and waru (Hibiscus tiliaceus). Despite that, the conservation status is constantly ignored by local residents. The locals are clearing the forest to develop agricultural lands. Corn is the crop the locals commonly plant on this plot of land (BKSDA NTB, 2018; Rakhman, 2019).

Local government's efforts to educate the locals about the conservation area are futile (BKSDA NTB, 2018). The forest lands are still cleared to make place for corn. While the conservation area is owned by the Ministry of Forestry, the management now is done by a local business entity named PT Bangko-Bangko Sejati. This made more flexible conservation approaches possible.

National regulations regarding the utilization of state-owned property enable business entities to develop government properties under certain periods and conditions (Kementerian

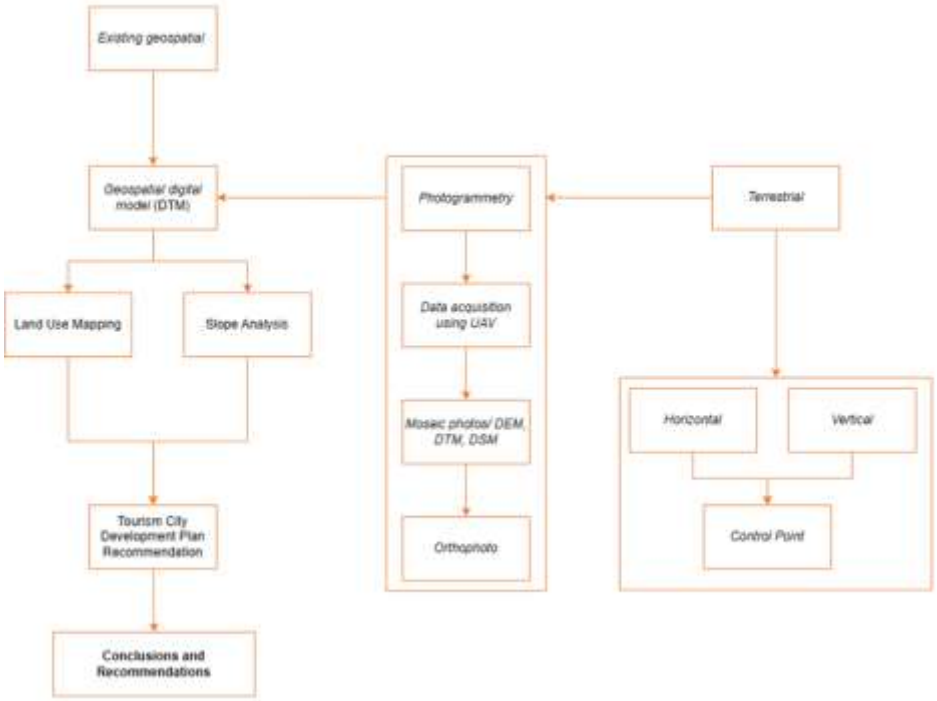
Keuangan, 2020). This means conservation areas that are managed by private business entities can be developed to generate revenue while still maintaining their conservation functions. To be able to generate revenues, a business entity should operate as efficiently as possible. A study of efficient private development should be done to understand the most effective approach to develop the conservation area.

Tourism is one of the most successful commercial conservation approaches (Kowalczyk-Anioł, 2023; Wang et al., 2022; Xu et al., 2022). This development approach is also possible to be practiced in Batu Putih since it has beautiful coastal scenery. The development should be done effectively and efficiently by addressing local complex socio-economic conditions and understanding local geographical terrain. This study is aimed to generate a recommendation for efficient tourism hub development using integrated geospatial analysis approaches.

2. GEOSPATIAL ANALYSIS APPROACHES

Geospatial analysis is an approach to study real earth geographic information using geographical information systems, remote sensing, and other geographical instruments (Singh et al., 2021). Spatial data availability has been limiting development efforts, especially in developing countries (Domínguez-Tejo et al., 2016; Nha, 2017; Schwartz-Belkin & Portman, 2023). The usage of integrated geospatial analysis is crucial to tackle this problem. It enables the users to extract as much information about a location as much as possible. The usage of this approach is hoped to improve the integrity of the data and the quality of the analysis (Esmaiel et al., 2022; van Heerden et al., 2022).

The usage of geospatial analysis in this study is aimed to acquire information regarding land use types and slopes. Because nature conservation is the main concern of this development, the non-forest lands (agricultural lands, barren lands, etc.) will be the only land use types directed for development. Profits and efficiency should also come to mind since the development will mostly be done by private business entities. Therefore, lands with flatter topography should be prioritized for tourism development. This is due to lands with flatter topography tend to be easier to develop. The topography analysis will be done using the guideline of Kementerian Pekerjaan Umum dan Perumahan Rakyat (2007). Lands with ≤15% slopes will be prioritized as development locations.

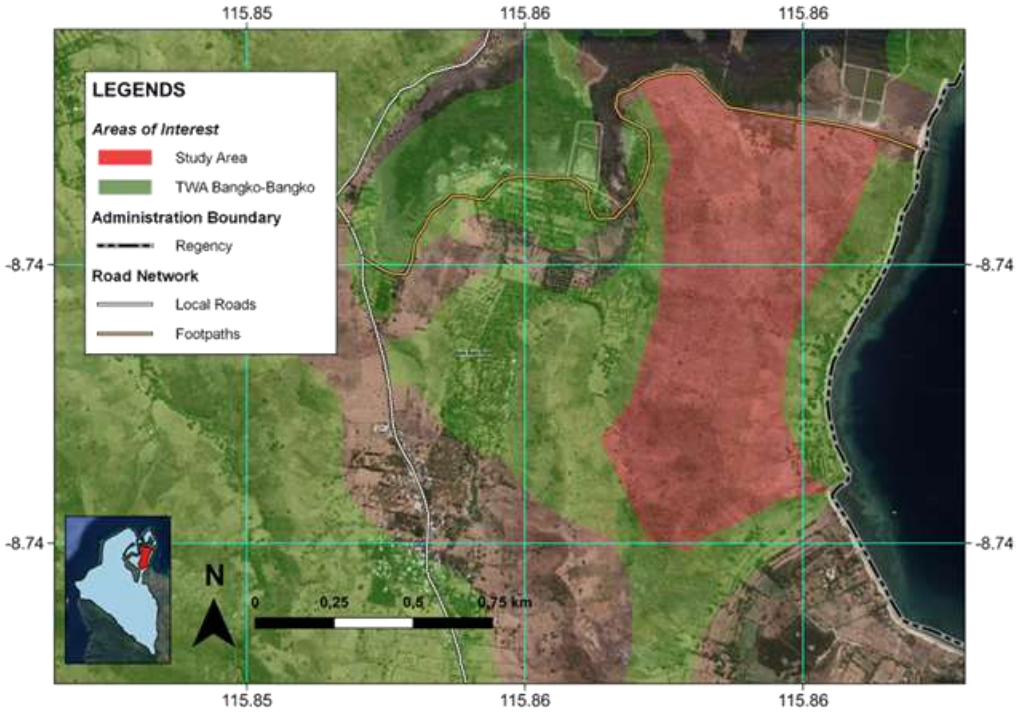


The analysis will be done using an *unmanned aerial vehicle* and a mirrorless camera. This analysis will generate point clouds and orthophotos data. That output will then be used to generate spatial models in the form of terrain models and high-resolution imagery (Caroti et al., 2015; Iheaturu et al., 2022). The specifications of the tools used in this analysis are stated in the table below. The tools are capable to generate 4 cm/pixel imageries and 15 cm/pixel terrain models.

Product	Specifications
Foxtech Loong 2160 VTOL (V – Tail)	Wingspan 2160nm
	Max Takeoff Weight 8kg
	Material EPO, Plastic Film, PVC
	800kg max payload weight (excluding batteries)
	Up to 95 minutes flight time (without camera payload)
	Up to 10km control distance
	Stall speed 50 km/h
	Service Celling 3000m AMSL
	Wind resistance 28 km/h
	68-72 km/h Cruising Speed
Sony Cyber-Shot DSC-RX1 RII	42.4 MP Full-frame back-illuminated Exmor R CMOS sensor
	35mm F2.0 ZEISS Sonnar T lens with macro capability
	World's first user-selectable optical variable low-pass filter
	Fast Hybrid AF with 399 focal plane phase-detection AF points
	Retractable 2.4-million dot XGA OLED Tru-Finder w/ ZEISS T coating
	DIOPTRE ADJUSTMENT: -4.0 to +3.0m 1

3. STUDY AREA

The study area is a plot of land managed by PT Bangko-Bangko Sejati. The land is located within a conservation area called Taman Wisata Alam (TWA) Bangko-Bangko. Although it is privately managed, the land should be managed according to certain management guidelines signed with the Ministry of Forestry. Limitations such as building restrictions and activity continence are common to the private land managers within TWA Bangko-Bangko.



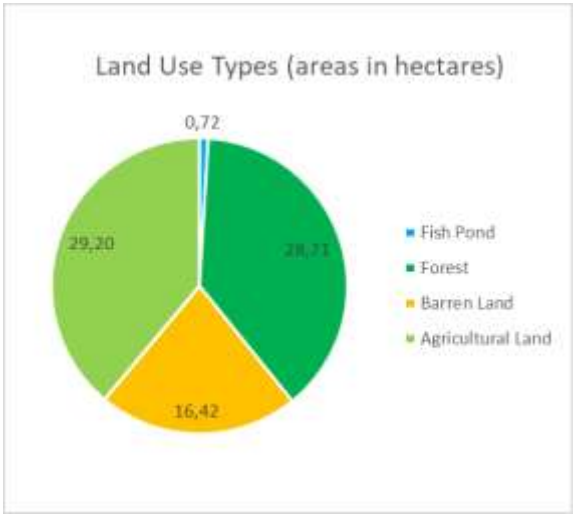
The land is located by the coast of Lombok Strait. The location can be reached via local roads continued with paths made of dirt. This road material made the use of offroad vehicles necessary as conventional vehicles tend to be obsolete facing rough terrain. This location can also be reached from the sea using rented boats. The boats are rented by local fishermen that usually finished fishing that day.

The locations tend to be hilly in the middle and flat on the periphery. The hills near the coast are covered with dense vegetation. Indigenous fauna such as long-tailed monkeys (Macaca fascicularis) are commonly found nearby those hills. The coast itself is flat which made traveling on foot feasible.

4. RESULTS AND FINDINGS

Terrain models made by utilizing point clouds taken by the UAV show that the land plot is separated into three zones by a hill in the middle. The skirt areas tend to be flatter compared to areas in the middle. This condition made the development in the skirt areas possibly easier compared to the middle parts of the land. At the same time, the hills can provide a natural barrier to noise and natural hazards such as strong winds and sea waves.

The land use model generated from a high-resolution orthophoto of the study area shows that most of the land plot area is being used as agricultural land. The land use type area is almost proportional to the forest area. Agricultural lands tend to be located around the periphery areas. This is possibly due to the hilly terrain in the middle of the land plot making tilling the land in the middle harder compare to the peripheries.



Barren land is the second largest non-forest land use type in the study area. Its development is closely related to the agricultural activities. Orthophotos taken in the area show that the barren lands were made from forest clearings. The cleared lands are then utilized as agricultural lands to plant food crops such as corn. This founding also proves the behavior of agricultural activity in the area that tends to utilize the outermost flat area first then developing inward to the more contoured areas.

A slope model of the land plot is also made to determine which location is the most suitable to be developed as a tourism hub. The slope classes are made according to a guideline developed by Kementerian Pekerjaan Umum dan Perumahan Rakyat (2007). According to the guideline, a plot of land can be considered to be easy to develop when it has a ≤ 15% slope. The analysis output shows that most lands in the area have more than 40% slopes. This is contributed by the hilly landscape the area has. Several flat areas can be identified in some parts of the north and south of the land.

Even though it complicates development efforts, natural barrier properties given by the hilly terrain in the areas should be put into mind when developing the area. Lombok is known to be prone to natural disasters such as earthquakes. The location that is nearby the sea will become vulnerable if an earthquake and tsunami happen simultaneously. An evacuation point in the form of higher terrain can help mitigate natural disaster hazards.

Recommendation of tourism city development location is then made by overlaying the land use data with slope classifications data. Areas that are considered to be suitable should have non-forest land uses and have ≤ 15% slope. The overlaid informations show the spread of the most suitable locations for the development. By the stated standard, around 3,7 hectares out of 75 hectares of land can be prioritized to develop. The lands with said classification tend to be located in the periphery areas behind the cover of the hills surrounding them.

5. CONCLUSIONS AND RECOMMENDATIONS

The development of a new tourism city is a joint effort mainly done by local business entities and governments. The development should be done with nature conservation in mind while not forgetting the importance of generating revenues. These approaches are required to reduce government management loads and conserve the environment. Therefore, a recommendation regarding an efficient development strategy is vital to be conducted.
conserve
The study findings stated that the development should be done in the periphery areas first. The flatter topography will contribute to the ease the development planned in the area. This will also decrease the operational budget needed to develop the area. Because most of the periphery areas are already becoming agricultural lands, the developers can develop tourism activities without worrying that they would disturb the ecosystem's sustainability. The hilly terrain itself can be utilized as an evacuation point if natural disasters occur.

UAV utilization in this research is proven fruitful. The tool can be used to generate high-quality information regarding the development area. Besides identifying geographic phenomena, it can also identify contributing factors surrounding it such as deforestation processes and agricultural activity development. This is due to the high-resolution image acquisition and terrain modeling capabilities the tool has.

This study has identified and given recommendations regarding local conservation efforts considering socio-economic and physical factors. Further studies such as local natural disaster mitigation efforts can be helpful for the development of the area. The proven usage of UAVs as monitoring tools might indicate that local governments' conservation efforts can be helped by their utilization.

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BIOGRAPHICAL NOTES

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