

# GIS-Based Evaluation of Site Suitability for Eco-Tourism Development in the Batticaloa District: A Geospatial Assessment

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## Abstract

*Tourism is an important economic sector in Sri Lanka, contributing over 12% to the country's GDP and representing the third largest source of foreign exchange. However, the Batticaloa district in the east of Sri Lanka is a tourist destination that is rapidly expanding. Accordingly, the purpose of the study is to explore the suitability of the region to promote sustainable eco-tourism in the Batticaloa District. Data was gathered from multiple sources. Primary data was collected through interviews to identify the factors important for ecotourism in the Batticaloa district. Global Positioning System (GPS) field survey was conducted as the sample location to verify the location information. Using secondary source, spatial analysis was conducted with the help of Geographic Information System (GIS) using the Multi-criteria decision-making analysis and Weighted Overlay Analysis technique to identify ecotourism zones. This study employs an integrated approach to ecotourism development, identifying ecotourism sites and creating a model to evaluate ecotourism sustainability by combining regional criteria with the sub-criteria that are most conducive to ecotourism. The study found that the ecotourism potential of the Batticaloa district was to be the most suitable at 27.42 % of the total area, the moderate suitable at 59.37 %, suitable at 8.14 % and less suitable at 3.43%. But the area that not suitable for eco-tourism is only 1.64 % of the total area. Finally, this study recommends the adoption of ecotourism strategies to promote sustainable ecotourism development in the study area.*

**Keywords:** *Ecotourism, Economic Sector, Sustainable Development, GIS, Spatial Analysis, Batticaloa*

## Introduction

The tourism industry is a significant part of the worldwide economy, and as the industry with the highest growth rate it has expanded and diversified throughout the years (World Tourism Organization, 2021). Though underrated Sri Lanka's tourism sector may support economic stability by fostering intercultural understanding, generating income, safeguarding the environment, and creating employment (Ranasinghe & Sugandhika, 2018). While the long-term relationship between tourism and employment creation is not clear, there is a short-term causality between the two (Ganeshamoorthy, 2019). The industry's significance in the economy is further emphasized by its role in macroeconomic stability and the need for a stable political environment (Ranasinghe & Deyshappriya, 2010). However, the potential for nature tourism in Sri Lanka is also highlighted, with its ability to generate income and employment while safeguarding the environment (Nuskiya, 2022).

Tourism, Sri Lanka's second-largest industry after textiles and apparel, represents revenue and job-generating opportunities. Sri Lanka is becoming a popular destination for international travellers as well as expatriates going home to see friends and family, indicating that the country is transitioning from the periphery of global tourism to a key destination. Since tourism is a main economic generator, Sri Lanka's contribution to Gross Domestic Product (GDP) was 12.6 % in 2019 and the country has the third biggest foreign exchange reserves (SLTDA, 2019). The contribution of tourism to Sri Lanka's GDP increased from 6% in 2000 to 12.6% in 2019, growing at a 4.28 % yearly rate. The direct contribution of travel and tourism to the country's GDP would expand at a rate of 5.7 % each year between 2018 and 2028, according to the World Travel and Tourism Council (WTTC), reaching LKR 1.26 trillion (\$7.9 billion) in 2028, or 5.7% of GDP (WTTC, 2019; Fernando, 2020).

Ecotourism and sustainable tourism are closely linked, with both aiming to protect the environment and benefit local communities (Ali *et al.*, 2017). Sustainable tourism development, including ecotourism, requires a balance between economic progress, social justice, and environmental protection (Azmaiparashvili, 2023). Sustainability of tourism depends on its interaction with the environment. As the fastest-growing sector of one of the largest industries in the world, tourism, ecotourism is seen as a long-term development plan for localities with a wealth of tourism resources (Zhang & Lei, 2012).

Geographical Information Systems (GIS) is a tool for determining location suitability and resource inventories that are environmentally friendly. GIS may be quite useful in identifying unexplored regions. As a result, this study used

the GIS approach to expose the event prospects and constraints of Sustainable Eco-tourism, as well as to select the appropriate eco-tourism sites in the study area. The land suitability process for eco-tourism is increasingly supported by more advanced spatial analysis and modelling due to the advancement of GIS (Pham *et al.*, 2021). The merging of Weighted Overlay Analysis (WOA) methodologies with GIS, on the other hand, has significantly improved traditional map overlay approaches for land-use suitability assessments. The integration of WOA with GIS has significantly enhanced traditional map overlay methods for land-use suitability assessments. Zhang *et al.* (2013) developed a comprehensive model for urban construction land suitability, addressing the limitations of traditional GIS-based methods. Ghahroudi Tali *et al.* (2012) applied Multi-Criteria Evaluation (MCE) techniques to land suitability analysis, demonstrating the rational and objective approach of integrating GIS and MCE.

The Batticaloa region in the eastern Sri Lanka has seen remarkable growth in tourism potential. The region exhibits favourable conditions and abundant natural resources, making it highly favourable for tourism development. In response to this situation, the objective of this study is to identify suitable sustainable ecotourism sites in the study area. The results may contribute to the development of a natural access policy for sustainable tourism in the region. The paper consists of an introduction, literature of past studies, methodology, identification of ecotourism zones, evaluation of sustainability, findings on suitability, and recommendations for promoting sustainable ecotourism in the Batticaloa District.

### **Literature review**

The ecotourism-related literature makes it evident that ecotourism is defined by different interests and ownership. As a result, there is no simple understanding as to what ecotourism is. As tourism rises to become the world's largest industry, eco-tourism has emerged the fastest-growing segment of this diverse global industry. Eco-tourism has grown in importance in both developed and developing countries around the world (Fennell, 1999).

In concept, ecotourism appears to have a lot of potential as a tool for conservation and sustainable growth, which can be done by shifting human social behaviour toward environmental conservation (Buckley, 2003). In reality, however, the label's uncertainty can make it difficult to follow ecotourism management activities. It is hard to tell this practice apart from other forms of tourism growth and there is no consensus on how ecotourism should

be implemented in terms of planning and management (Hawkins & Lamoureux, 2001).

This substantial overlap between the main concepts of ecotourism and sustainable development, on the other hand, is evident. In ecotourism literature, sustainability is a common term. The World Tourism Organization (WTO) described sustainable tourism as "development that meets the needs of current tourists and host regions while preserving and enhancing opportunities for the future" in Agenda 21 for the Travel and Tourism Industry (1995). It is envisioned as contributing to the management of all resources in such a way that economic, social, and aesthetic needs can all be met while maintaining the environment (Sirakaya *et al.*, 2001).

There are several empirical studies conducted related to Sri Lanka's ecotourism, Gunasinghe (2011) used descriptive research and secondary sources to determine the importance of biodiversity conservation and the sustainability of Sri Lanka's tourism industry. He found that the future of Sri Lankan tourism, as well as its contribution to the livelihood of a large number of people engaging in tourism, is dependent on the protection and wise management of the country's biodiversity is its most valuable asset. He also concluded that tourism should be regarded as a natural resource-dependent industry and that poorly controlled tourism contributes to the loss of biodiversity, which affects the tourism industry.

A Geographical Information System (GIS) is a technology that allows you to visualize and analyze geographically referenced data. It comes with a powerful set of tools for collecting, storing, retrieving, manipulating, and displaying spatial data about a specific feature when working with multiple datasets (Olafsdottir & Runnstrom, 2009; Khaemba & Stein, 2000). This practice has expanded in recent years, even though it is a complex process involving vast datasets, species geographical extents, and data quality. GIS is widely acknowledged as a useful method for managing, analyzing, and viewing a large amount of data relevant to planning activities with the ability to handle multiple spatial criteria and provide tools to aid in the allocation of resources between conflicting demands, consequently help plan decision makers' decisions (Olafsdottir & Runnstrom, 2009).

According to the literature, there is strong evidence from the empirical survey through past studies. The present study is guided by new approaches revealed in the literature.

## **Material and methods**

### **Study area**

The Batticaloa district is located at North latitude  $7^{\circ} 42' 36.72''$  and East longitude  $81^{\circ} 41' 32.64''$ , which is the central part of Eastern province. The figure 1 shows the location information of the study area. The study area is around 2,633 square kilometres in extent, accounting for about 3.8 per cent of Sri Lanka's total land area. Batticaloa has been one of the most popular destinations for tourism since the early centuries. Its locational, environmental and cultural diversity attracts both foreign and local guests

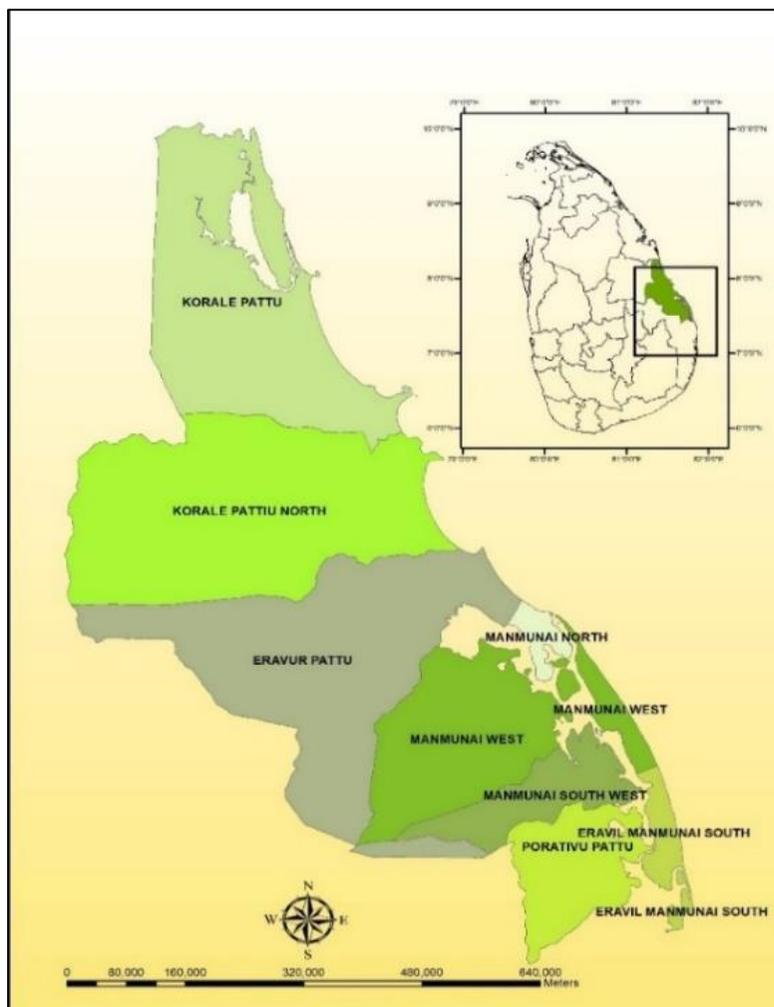


Figure 1: Location of Study area

## Research design and conceptual model

This paper evaluates the capacities and suitability of tourism as well as nature tourism in the Batticaloa district using GIS. The present research employs an applied approach, utilizing a spatial-analytical method through Weighted Overlay Analysis and mapping techniques. Figure 2 shows the conceptual model that depicts the total research design.

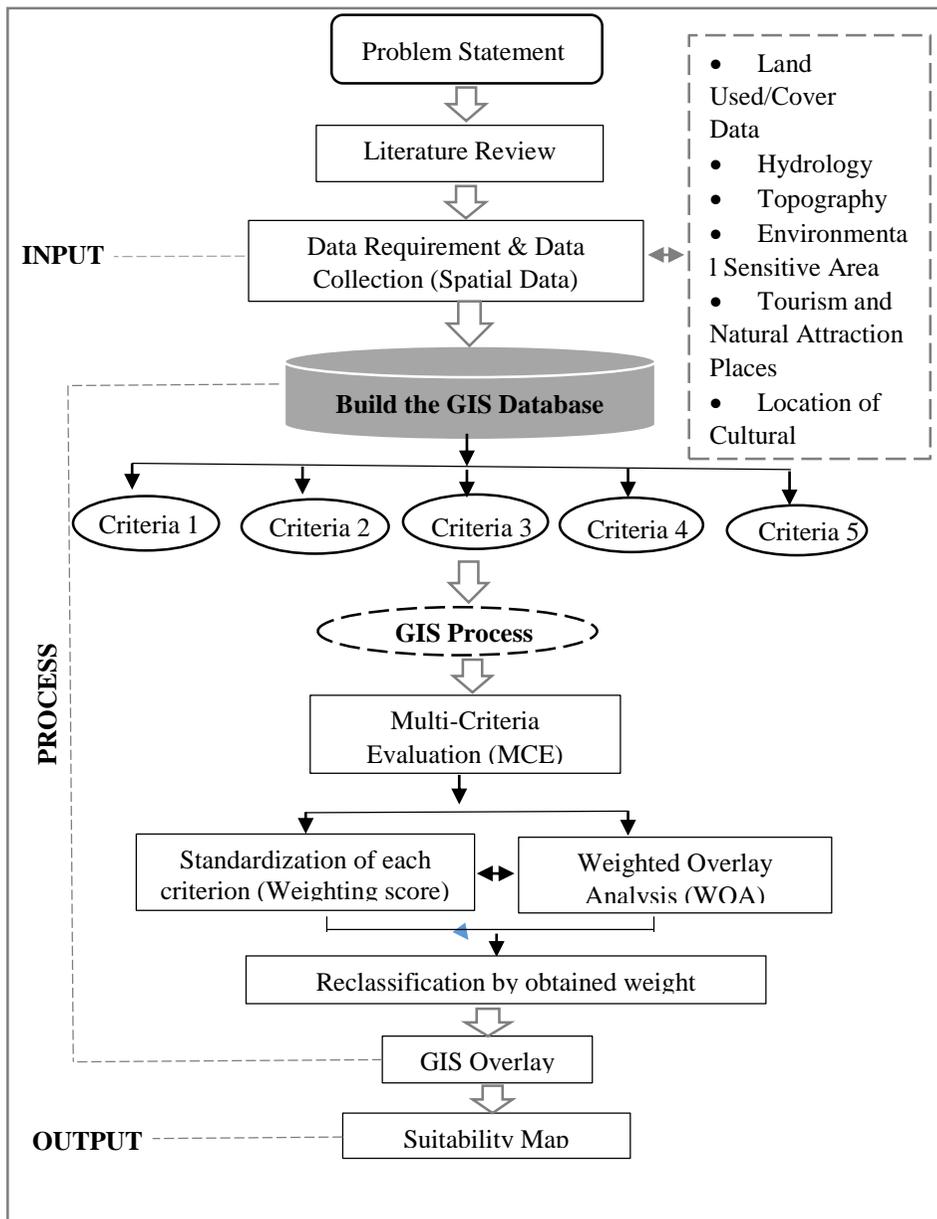


Figure 2: The Conceptual Framework of the Research Process

### **Data collection**

The study collected data from various sources, including socioeconomic data and primary data obtained through field surveys. These surveys involved interviews with selected individuals closely associated with the research, aimed at identifying key elements pertinent to ecotourism in the Batticaloa region. Field survey data was obtained from the Global Positioning System (GPS) and other GIS datasets. The secondary sources were used to compile the data for this study as summarised in Table 1 to discern characteristics that are crucial for ecotourism in the Batticaloa area, and other GIS datasets. There are several contexts in which the GIS-based land suitability analysis has been applied, including sites and administrative borders.

Table 1: List of collected secondary data and their sources

<b>Data</b>	<b>Source</b>
Land Use/Cover Data	Department of Land Use, Batticaloa
Hydrology	LANDSAT - 7 ETM+ Satellite Imagery, USGS (U.S. Geological Survey)
Topography (Elevation, Slope, Contour Line)	USGS (U.S. Geological Survey)
Environmental Sensitive Area	LANDSAT - 7 ETM+ Satellite Imagery, Reports
Tourism-related data	Tourism Authority of Sri Lanka, Other secondary sources
Tourism and Natural Attraction Places	Field Survey with GPS and secondary sources
Location of Cultural attractions	Secondary source and Google Earth pro/street view
Road network	Base Map (Road Layer-ESRI)
Settlement and Recreational activity data	UDA, Batticaloa
Boundary data and layer	DIVA-GIS

### **Determination of criteria and sub-criteria**

A set of criteria must be created to evaluate and allocate suitable regions for diverse uses of tourism destinations (Mahdavi *et al.*, 2015). As a result, the most relevant criteria and sub-criteria that influence site selection for ecotourism sites were determined in the first step (Table 2). Multi-Criteria Evaluation (MCE) is an effective method for resolving multi-criteria issues. The WOA

assigns weights to the items of each level based on the comparison. Table 2 outlines the criteria and sub-criteria used in the evaluation of land suitability for ecotourism development. The goal is to assess different aspects related to topography, hydrology/water resources, naturalness, accessibility, and recreational tourism attractions. The suitability rating is categorized into five classes (Class 1 to Class 5) for each sub-criterion based on specified thresholds.

Table 2: Criteria for land suitability analysis for ecotourism

Goal	Criteria	Sub-Criteria	Suitability Rating				
			Class 1	Class 2	Class 3	Class 4	Class 5
Suitability Evaluation for Ecotourism Development	Topography	Slope (%)	>5	5-10	10-15	15-20	20<
	Hydrology/water resource	Ocean, Tank, River, Lake (m)	>300	300 - 600	600 - 900	900 - 1200	1200<
	Naturalness	Land Use (LU)	Near range	Middle range	Far range	Not visible	Near range
	Accessibility	Road	>5000	5000 - 10,00	10,00 - 15,00	15,00 - 20,00	20,00
		Railway Airport Network (m)		10,00 - 0	0 - 15,00	0 - 20,00	0<
Recreational Tourism Attractions	Nature (m) And other type	>3000	3000 - 6000	6000 - 9000	9000 - 12000	12000 <	

Expert judgments were used to calculate the weight of the criteria and sub-criteria (Saaty, 1980). The criteria and sub-criteria for this study were chosen based on similar studies, natural conditions in the study location, and expert opinions. The final weight was established for each sub-criteria of evaluation by the factor suitability rating considering the expert opinions by averaging the weights of the layers. Table 3 provides a classification of Suitability Rating Classes, each denoted by a specific class code (C1 to C5), along with corresponding descriptions of the level of suitability. The classes range from Class 1 (C1) to Class 5 (C5), and each class is associated with a distinct level of suitability for a given purpose or context.

Table 3: Description of Suitability Rating Classes

Classes	Class 1 (C1)	Class 2 (C2)	Class 3 (C3)	Class 4 (C4)	Class 5 (C5)
Description	Highly suitable	Moderately suitable	Suitable	Slightly suitable	Less suitable

**Weighted value to the selected criteria**

Table 4 presents the scoring system for weighting values and the influencing weight assigned to different criteria and sub-criteria in the context of land suitability analysis for ecotourism. The criteria include topography, hydrology/water resource, naturalness, accessibility, and recreational tourism attractions.

Table 4: Selected factor's score for weighting value and influencing weight

Criteria	Sub-criteria	Rating Classes	The score for weighting value	Influencing weight (%)
Topography	Slope (%)	>5	1	<b>5%</b>
		5-10	2	
		10-15	3	
		15-20	4	
		20<	5	
Hydrology/ water resource	Ocean (m)	>300	5	<b>15%</b>
		300-600	4	
	River (m)	600-900	1	
		900-1200	2	
Lake (m)	1200<	3		
Naturalness	Land Use (LU)	Near range	5	<b>20%</b>
		Middle range	1	
		Far range	2	
		Far range	3	
		Not visible	4	
Accessibility	Road Network (m)	>5000	1	<b>15%</b>
		5000-10,000	2	
		10,000-	3	
	Railway Network (m)	15,000	4	
		15,000-	5	
		20,000		
Airport (m)	20,000<			

Recreational	Nature (m)	>3000	1	<b>28%</b>
Tourism	Cultural	3000-6000	2	<b>5%</b>
Attractions	Historical &	6000-9000	3	<b>5%</b>
	Archaeological	9000-12000	4	<b>7%</b>
	Entertainment	12000<	5	

According to the current study to find out the tourism destination in the Batticaloa District, especially using WOA is the most important practice to identify suitability by various criteria. With the base criteria divided into five main components, within this factor, 5 types of criteria were selected to connect the suitability value to achieving the study objective. In this study, weight value was chosen to effectively to obtain the overall rating factors by getting expert perception (Saaty, 1980; Ozdemir, 2003; de FSM Russo & Camanho, 2015). Table 4 shows the selected criteria score for weighting value and influencing weight percentage.

During the Classification and Standardization of the Criterion stage, relative weights of decision elements were aggregated to obtain an overall grade for the alternatives as classified and according to experts and studies, and a numerical value was assigned to criteria and land use. Different evaluation criteria were used to evaluate the suitability of the study area as an eco-tourism site.

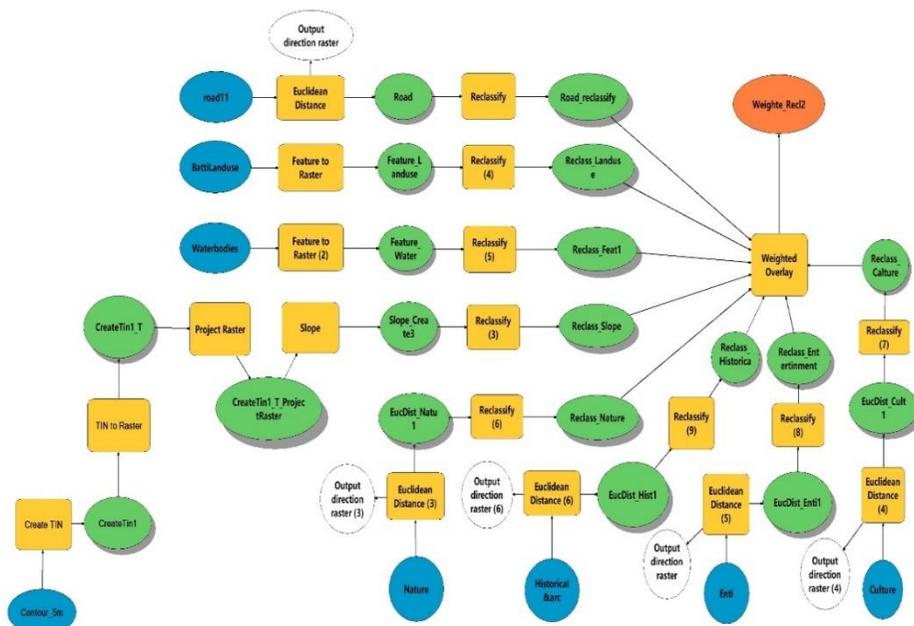


Figure 3: Ecotourism site suitability analysis model in ArcGIS 10.8

### **Data presenting model**

Figure 3 shows the structure of presenting data and the final output generated by the ArcGIS 10.8. The criteria for site selection are investigated to assign relative range and individual feature weights based on the appropriateness type considered. The criteria under consideration in this study activity have been organized to maintain the validity of the analysis. Accordingly, each criterion has a strong influence on the final output.

### **Data analysis and findings**

#### **Classification and evaluation of criteria**

Ecotourism land use requires gradually good connectivity and accessibility to each criterion such as water bodies, Land Use (LU), roads, slope, recreational and tourism attractions. The criteria for evaluating ecotourism land-use suitability are listed in the table no 4. This collection of criteria was used to assess the region's main appropriateness of suitability. The scale used to evaluate and rank from 1 to 5, with 1 denoting the most important aspect and 5 the least. Figure 4 shows the evaluation of the land-use appropriateness requirements for ecotourism based on a thorough analysis of important variables. A region's suitability for ecotourism development is determined in large part by its road network (D), water bodies (C), slope (A), land use (B), tourism recreations & attractions (E), and road network (D).

Aspects are ranked and evaluated on a scale of 1 to 5, where 1 denotes the most important factor and 5 the least. Regarding these parameters, the evaluation offers insightful information on the region's accessibility and connectedness. This figure helps identify places with great potential for ecotourism by providing a visual depiction of the weight attributed to each criterion. A thorough examination of each criterion and an explanation of how it affects the suitability of land use for ecotourism will be provided in the sections that follow. This comprehensive evaluation contributes to a nuanced understanding of the ecological and recreational potential of the region, facilitating informed decision-making in ecotourism development.

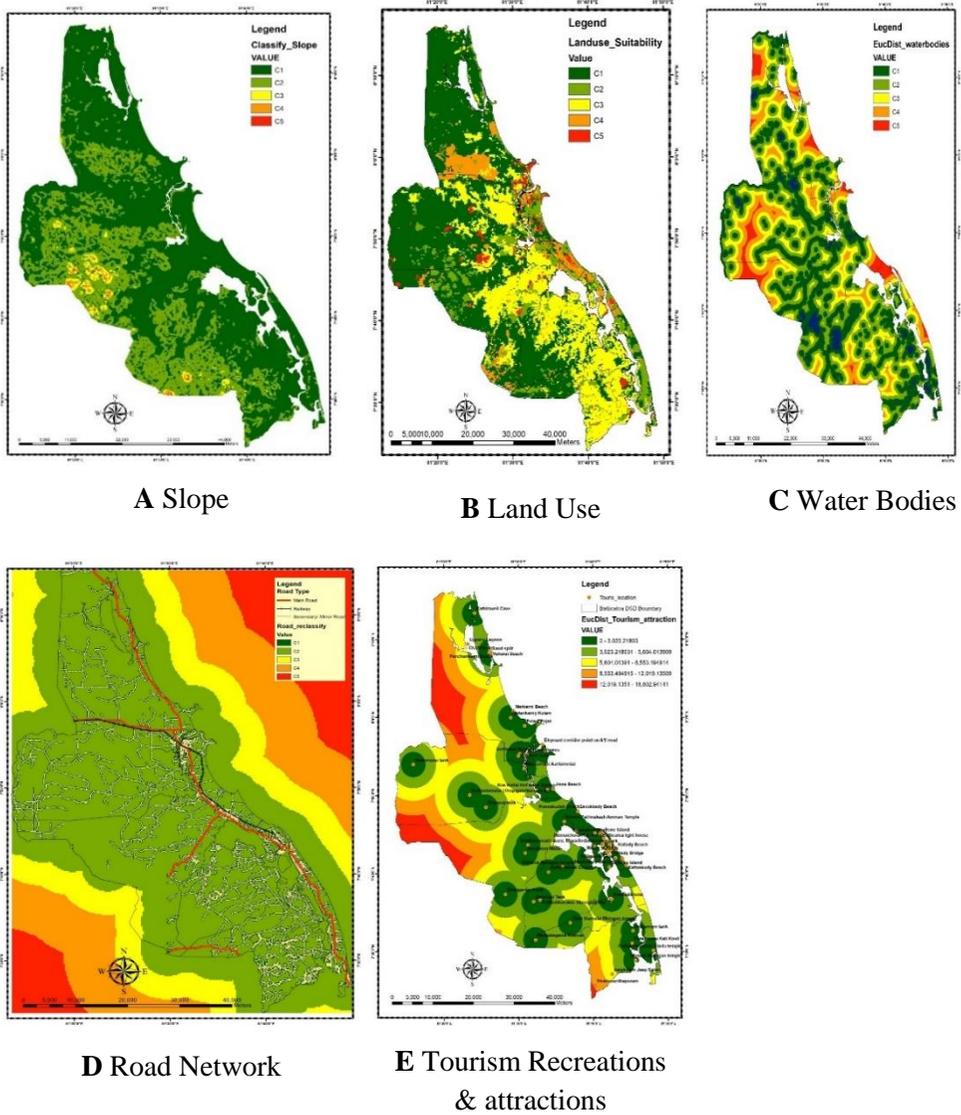


Figure 4: Evaluation Criteria for Ecotourism Suitability

### **A. Slope (topography)**

The slope is a criterion to identify the ecotourism suitability regions within the study area. The study area is generally a low-lying plain and only about 5 percent of the land rises above 30 meters. Accordingly, the study area was reclassified as 5 suitability rating classes accordingly highly suitable, moderately suitable, suitable, slightly suitable, not suitable to identify the most suitable region to develop ecotourism in the region. There are a lot of recreational and tourist attractions operating within the 5% of the slope region, if there are additional requirements inside this slope defined zone.

### **A. Land use**

Land use patterns exert a significant influence on the physical, social, and economic fabric of regions, illustrating the intricate interplay between human activities and the natural environment. Within the context of the Batticaloa district, various land use categories impact the potential for ecotourism development. Eco-tourism sites, ranked from 1 to 3, emerging as favorable locations interconnected with land utilization, presenting prime opportunities for tourism growth. Conversely, built-up areas, essential for tourism infrastructure, are deemed moderately suitable (ranging from 4 to 6) for ecotourism, with potential for enhancement through strategic recreational development. Furthermore, the assessment extends to forest and wetlands, with a suitability ranking of 1 to 3, based on proximity. Regions falling within near, middle, or far ranges are identified as conducive to ecotourism development. Nature-related abandoned land, when situated near existing tourism sites, holds potential for transformation into captivating eco-tourism attractions.

### **B. Hydrology (water bodies)**

Water bodies are ideal recreational and ecotourism destinations, and with the right distance, they may be transformed into high-value ecotourism destinations. The evaluation framework encompasses the criterion of hydrology/water resources, delineated into three distinct sub-criteria: Ocean (m), River (m), and Lake (m). Each sub-criterion is associated with specific rating classes, determined by measured values in meters. For the Ocean (m), the rating classes include greater than 300 (Rating: 5), 300-600 (Rating: 4), 600-900 (Rating: 1), 900-1200 (Rating: 2), and 1200 or less (Rating: 3). The corresponding scores for weighting values are 5 for Ocean (m), 4 for River (m), and 1, 2, 3 for Lake (m). The influencing weight, set at 15%, signifies the relative importance of hydrology/water resources in the overall evaluation. This structured approach allows for a nuanced assessment of different water bodies

based on specific measurement ranges, providing a comprehensive understanding of the hydrological features and their significance in the broader context of the evaluation.

### **C. Road network**

Road Network has assessed under three different modes of transportation, road transportation, railway transportation and air transportation. The region's road network connects important tourist destinations with the rest of the country. It allows for more convenient and speedier movement. The road is the most convenient mode of transportation in terrain where another mode of transportation cannot be developed. Since the road is a basic requirement regarding accessibility, it has been assigned a rank from 1 to 3. The railway station serves as a link between the settlement and the city. With railway connectivity, a tourism prospective location has a better chance of becoming a larger tourism centre with railway connectivity, this region has a better chance of becoming a larger tourism centre. Therefore, railway stations are assigned a value from 1 to 3 Air connectivity is critical for the development of tourism. Tourists may arrive by domestic and international flights. Air travel is the quickest and most convenient mode of transportation, making it easier for travellers.

### **D. Tourism recreations & attractions**

The tourism sector demands recreational and leisure-related activities. It is important to make such tourist attractions which plays an important role in developing tourism regions. According to the current study, the criterion ranks from 1 to 2. There are 73 places of interest to tourists in the Batticaloa district and they are categorized as archaeological, historical, and cultural and entertainment places. Out of these 73 places, 27 are in the Manmunai North Divisional Secretariat (DS) Division and 13 are in the Eravurpattu DS Division. These two divisions account for more than half of the place of interest. Figure 5 shows the location of the main tourist attractions in the Batticaloa district, grouped according to the type of the site as nature, entertainment, historical, cultural, and archaeological. It is obvious that the Batticaloa district is endowed with a wide range of attractions for domestic and international tourists.

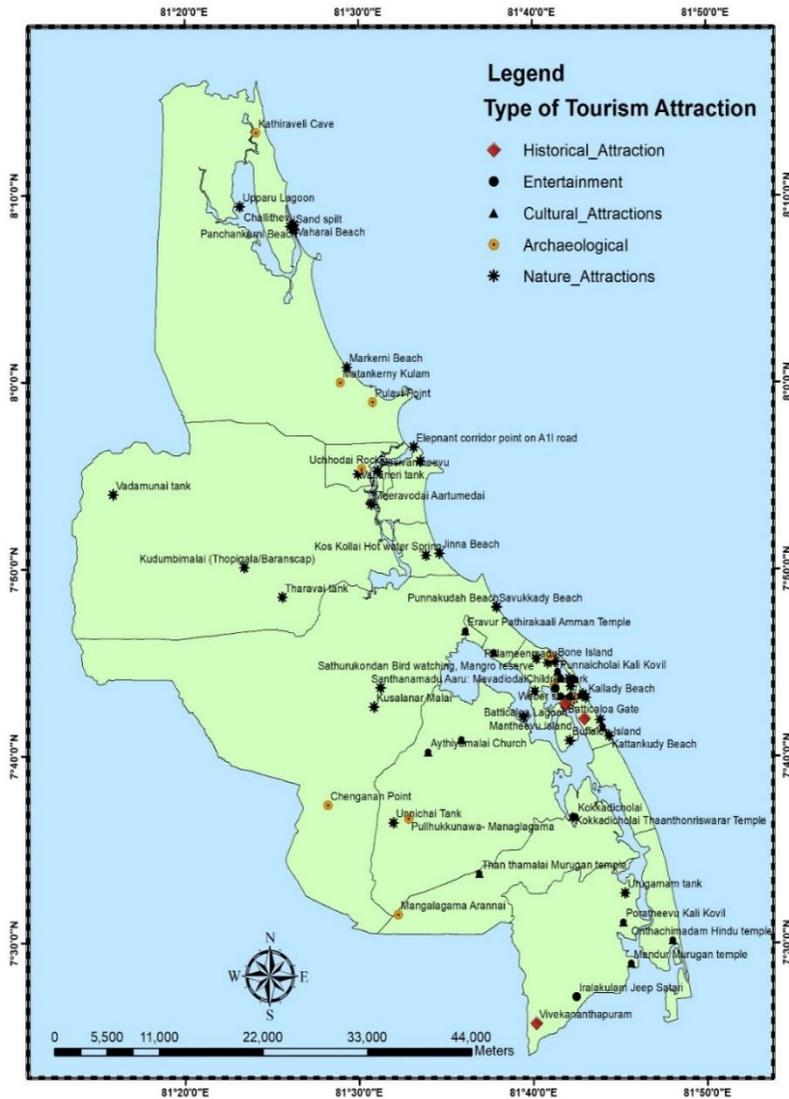


Figure 5: Types of tourism attractions

### Evaluating the suitability of the study area for ecotourism

The final stage in this analysis is to determine the relative weights of the decision-making factors to arrive at the following overall rating for the above options (Saaty, 1980).

$$W_i^S = \sum_{j=1}^{j=m} w_{ij}^S w_j^a, \quad i = 1, 2 \dots n$$

Where:

$W_i^s$ : Total weight of the site

$w_{ij}^s$ : Weight layer of all criteria associated with factor

$w_j^a$ : Weight of criteria

$m$ : Number of criteria

$n$ : Number of sites

$j$ : Specific criterion within a particular factor

$i$ : each individual site that is being evaluated for its suitability

The Weight Standardization Measure is then applied within the ArcGIS 10.8 environment, where the model is executed. In order to take this measure, each criterion's standardized weights must be evaluated while considering related criteria and factors during the decision-making process. A uniform map of the research area is produced using the outcome of this standardization procedure. Based on the provided weight ratios and categorizations, this map depicts the regional distribution of appropriateness for the development of ecotourism.

The visual representation of the standardized map, Figure 6, is cited as offering a clear illustration of the relative importance of various places within the study region. Decision-makers may make better decisions by using the standardized map, which provides information on the best places to promote ecotourism based on the weighted criteria and characteristics identified by the WOA technique. The application of a rigorous analytical methodology improves accuracy and impartiality of the decision-making process with regard to choosing appropriate locations for ecotourism land use.

According to ArcGIS 10.8, 94.93 % of the land area is a suitable region for developing ecotourism in the research area, based on the rating class or parameters used for each criterion to assess the potential for ecotourism development in the study area. However, each criterion in the final layer was assigned to one of five suitability classes, with suitability scores ranging from highly suitable, moderately suitable, suitable, slightly suitable, and not suitable.



Table 5: Weighted percentage for suitability score

Suitability score	Weighted percentage of the total land area
Most suitable	27.42 %
Moderate Suitable	59.37%
Suitable	8.14%
Slightly suitable	3.43%
Less suitable	1.64%
<b>Total</b>	<b>100%</b>

Figure 7 shows the proposed suitable ecotourism sites in the Batticaloa District. According to the study following 38 tourism attractions can be recommended for the ecotourism development site.

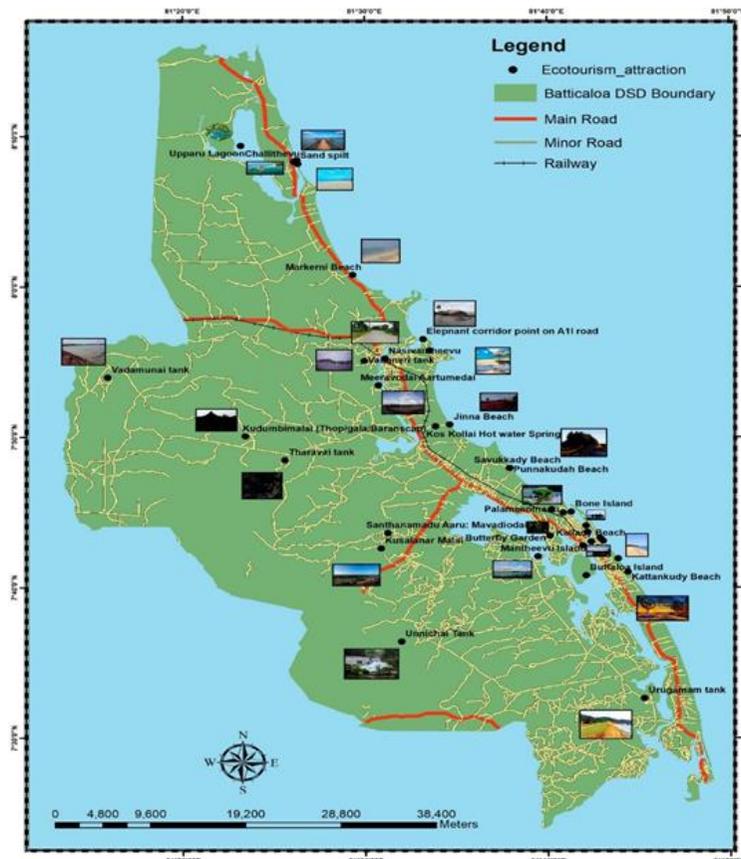


Figure 7: Ecotourism potential in Batticaloa District

Several tourism sites in the Batticaloa region welcome both domestic and foreign visitors (Figure 7). In addition to addressing the urgent needs of visitors and host communities, sustainable tourism development safeguards and improves Batticaloa's long-term prospects. Thus, the core principles that guide both pure sustainable tourism and sustainable development also guide ecotourism. It is crucial to acknowledge sustainability both as a core objective of ecotourism and a tool for achieving it.

## **Conclusion**

The study conducted a comprehensive GIS-based evaluation of site suitability for eco-tourism development in Batticaloa District, Sri Lanka. The analysis incorporated multiple criteria, including topography, land use, hydrology, road accessibility, and tourist attractions, to assess the ecological and recreational potential of the region. The findings provide valuable insights into the suitability of different areas for sustainable eco-tourism development. The study identified that approximately 94.93% of the land area in the Batticaloa District is suitable for ecotourism development. This suitability is distributed across various levels, with 27.42% considered most suitable, 59.37% moderately suitable, and 8.14% suitable. All the criteria were important in assessing the region's overall appropriateness, but topography and accessibility were major factors. In order to encourage sustainable development in the designated eligible locations, the research suggests implementing ecotourism tactics. The suggested ecotourism locations have a variety of attractions, including historical monuments, cultural landmarks, beaches, and lagoons. The results underscore the significance of incorporating sustainability concepts into the process of developing ecotourism.

Moving forward, prioritizing local stakeholder participation and community involvement will be imperative for the success of ecotourism development. Incorporating local viewpoints and expertise can enhance the authenticity and sustainability of ecotourism experiences. A robust marketing plan is essential to promote Batticaloa District as a premier ecotourism destination, requiring collaborative efforts between local communities, government bodies, and corporations. Thoughtful infrastructure development, including transportation hubs and road networks, will enhance accessibility to ecotourism sites, fostering overall prosperity in eco-friendly travel. Ongoing monitoring and conservation initiatives are vital for preserving natural ecosystems and biodiversity within ecotourism zones, necessitating responsible tourist practices to minimize the environmental impact.

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