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Establishing a GIS-SMCDA model of sustainable eco-tourism development in Pahang, Malaysia

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(Received: November 20, 2021; Revised accepted: September 29, 2022)

https://doi.org/10.18814/epiiugs/2022/022037

In this study on dynamic, complex, and spatial decision-making situations, the geographic information system (GIS) based spatial multi-criteria decision analysis (SMCDA) is used as a tool for sustainable environmental planning and ecotourism spot study. GIS is used to identify and study the morphological zones of coastal resorts and ecotourism sustainability in Sungai Karang sub-district in Kuantan, Pahang. To evaluate the geographic information of the state, the development of geodatabase and spatial modeling were used as one of the most appropriate GIS-SMCDA models to create new dimensions for understanding the current situation in the identification of ecotourism-sensitive areas (ESA). The results in the final ESA map show that the size of the zones for the built-up area: 4,500.25 ha, agricultural area: 3,635.87 ha, coastline: 2,109.67 ha, road: 3,518.72 ha, and water bodies: 8,899.37 ha. The study suggests that the GIS-SMCDA model can be a quite effective method for dealing with different parameters of site attractiveness for ecotourism sustainability. The results show that the area of a suitable site for ecotourism in Sungai Karang Sub-district is 248.87 ha, compared to an unsuitable site of 29,104.44 ha. This shows that a minimum area can be selected for the construction of an ecotourism center in this area.

Introduction

Urbanization is one of the most critical processes shaping land use and has attracted considerable attention worldwide (Daba and You, 2022). It is estimated that the urban population will increase from 3.57 billion in 2010 to 6.34 billion in 2050, with nearly 70 percent of the world's population living in cities (DOE et al., 2022). Although the number of people living in coastal cities is gradually increasing, about 70 percent of the world's beaches are declining, about 20 percent are healthy, while the remaining 10 percent are increasing (Kingdon and Grey, 2022).

Coastal areas are an important center for travel, recreation, tourism, commercial fishing and other productive activities in some regions of the world. The natural and economic attractions of coastal areas thus attract large numbers of people to coastal areas (Neumann and Kenchington, 2017). Coastal changes have drastic impacts on different regions of the world (Daramola et al., 2022). With about two-thirds of the world's population living on coasts, there is growing uncertainty about the ability of coastal habitats to adequately cope with the stresses resulting from increased growth (Drammeh, 2013). The coastal zone is a diverse and complex environment where human activities and the natural beach overlap (Dada et al., 2021). Coastal areas provide ecological services that support the economic development of the state and country (Zong et al., 2021). Therefore, the critical challenge for the protection and growth of the coastal zone is to strike a balance between human use, biodiversity conservation, and the environment (Mendelssohn et al., 2017).

Changes in the study area are reflected in the perception of coastal shifts, building practices, resort development, and economisation. Urbanisation is one of the most important mechanisms influencing land-use practices and has attracted much interest globally (Zhou et al., 2017). Malaysia has an extensive coastal area and is an ideal tourist destination (Bagheri et al., 2021b). The east coast of Malaysia is comparatively dotted with gently banging, shallow beaches. The beaches that exist in this region are mainly based on ecotourism, such as Cahaya Bulan Beach, Cherating Beach, Rantau Abang, etc. (Anuar et al., 2018). Threats facing the region include land use, climate, natural resource management, and protection, especially in ecologically vulnerable areas due to increasing land use, special consideration and regulation of ESAs that need to be put in place so that sustainable urbanisation can minimise impacts on the ecosystem and reduce the risk of disasters (Nor Hidayah, 2012). Recently, various threats have emerged from human activities, natural processes, and climate change, as described in Table 1.

The South China Sea is bordered by ESA Peninsular Malaysia to the east and the Strait of Melaka to the west. The coastal areas of Malaysia consist of alluvial land that is easily eroded and at risk of disasters

Table 1. Threats to coastal, sensitivity levels and ranking and criteria for eco-tourism sensitive areas

Coastal tourism and ESA			
Coastal interest			
Heritage Value	Worth Living Support	Disaster Risky	
Having high value & importance to marine ecosystems with the formation of sand plywood as a wave buffer and protection to marine habitats.	Having high value & importance to marine ecosystems with the formation of sand plywood as a wave buffer and protection to marine habitats. In terms of coastal ecosystems such as mangrove forest resources, coral reefs, and marine habitats.	Development on the shores negatively impacts on coastal processes as well as sediment transport such as erosion.	
Coastal threats			
Coastal Development	Redeem Land Use	Mining Outdoor Sand Beach	Climate Change
The coastline is subject to coastal erosion which may result in loss of land area and habitat loss. Furthermore, this natural process can be further aggravated by human activity.	Redeeming land without good planning will harm coastal processes and sediment transport which may result in erosion or growth of accretion. This will pollute seawater and kill the diversity of marine habitats	Reclamation materials required for land reclamation projects will be derived from offshore sand production. This activity will change the bathymetric floor of the sea. Impacts such as sand degradation, large waves, and high tides will result in erosion, deposition, and loss of marine ecosystems.	Global warming is expected to impact humans including the rising sea level between 18 and 59 cm where this increase will threaten coastal areas and low-lying islands as well as extreme climate phenomena.
Sensitivity Level			
Level 1	Level 2	Level 3	
No development, agriculture, or logging is permitted except for low-impact nature eco-tourism activities, research, and education.	No development or agriculture. Sustainable logging and low-impact nature eco-tourism are allowed depending on local barriers.	Controlled development where the type and intensity of development is controlled depending on the barrier characteristics	

(Source: PLANMalaysia, 2017).

(Islam et al., 2016). The coastal area in the east of Peninsular Malaysia covers 860 km of sandy passage, while the west coast is composed of silt and clay and covers an area of 1,110 km (Ismail et al., 2018). As the physical, geological, biological, and chemical characteristics of beaches in Malaysia vary, more thorough planning by area is required (Abdullah et al., 2016).

Environmental Sensitive Areas

The Planning Guidelines for the Conservation and Development of Environmentally Sensitive Areas (ESAs) are intended to assist the State Government and local authorities in determining the type of land use that may be developed in ESAs.

An environmentally sensitive area is defined as an area that is vulnerable to changes in its ecosystems due to natural processes or activities in or around it, either directly or indirectly, with the degree of sensitivity determined based on the integration of the characterisation of the disaster risk function elements, the livelihood value and the treasure and heritage value of the area" (PLANMalaysia, 2017). In Malaysia, Environmentally Sensitive Areas (ESAs) are designated under Section 51B of the Environmental Protection Act 1986 (EP Act) and gazetted on 8 April 2005.

Meanwhile, the sensitivity level was applied based on the three rungs of the PLAN Malaysia of the indicator of physical activities allowed on the site, namely:

1. No development, agriculture, or logging is allowed, except for nature-based ecotourism, research, and education.

2. No development or agriculture. Sustainable logging and nature-compatible ecotourism are allowed depending on local conditions.

3. Controlled development, where the type and intensity of development are controlled depending on the barrier characteristics.

Coastal Morphology and Eco-Tourism Development

In recent years, researchers have begun to look at how local communities can direct and benefit from tourism activities (Asadzadeh and Mousavi, 2017). In the 1980s, new forms of tourism began to attract the attention of states, societies, and scholars. They were given a range of names, such as nature tourism, soft tourism, conscious tourism, green tourism, and ecotourism, but all were seen as alternatives to mass tourism (Ei and Karamanis, 2017). The term ecotourism has gained acceptance among these different brands, but there is by no means a clear concept, even among scholars. However, most meanings include principles related to sustainable development and growth (Kiper, 2013; Font and McCabe, 2017). In Sustainable Growth Addressing the inconsistencies, some researchers and planners attempted to link economic development with environmental sustainability, and his thesis served as a methodological basis for ecotourism researchers (Anup, 2016). As a comparatively young site, ecotourism is perceived as only one aspect of the overall tourism industry system (Tang, 2022). This type of tourism is designed to provide recreational opportunities to broadly explore the natural attractions of host communities in the wild (Leung, 2018). Exploring their myriad wonders and impacts to derive pleasure from diverse natural experiences can be combined with cultural and moral collateral gain made possible when focused on a seamless, guided host destination (Hitchcock, 2009).

Coastal ecotourism is a global phenomenon synonymous with water, sun, and resorts (Mendoza-González et al., 2018), and when considering ecotourism, the issue of sustainability is quite essential (Şalvarachi, 2021). Today, the issue of ecotourism has led many countries to devote a large amount of money to this sector due to its high income-generating property (Kiper, 2013). Ecotourism aims to generate revenue from nature-based attractions, support protected areas and local communities, and provide rewarding, educational experiences for tourists (Stronza et al., 2019). The overall value of ecosystem services and ecotourism is made up of the importance of direct benefits, indirect benefits, choices, and livelihoods, and depends on the views and needs of stakeholders (Goessling, 1999; Matthew et al., 2019).

The benefit of ecotourism is that it comes from voluntary performance (Al-Halbouni et al., 2022). Businesses and academics seek to create volunteer resources that are marketed as 'good tourism' or 'conservation holidays' (Novelli et al., 2016). Through this approach, tourism will tap into financial and human resources for environmental science (Tanova and Bayighomog, 2022; Alemu, 2022). Determining the monetary importance of ecosystem services to society and the economy through a spatial economic valuation of different ecosystem resources offers essential insights for regional environmental protection and sustainable growth (De Groot et al., 2012).

Spatial Multi-Criteria Decision Analysis (SMCDA)

Different models are used to describe the transition and development of a place (Slaev, 2022). Travel and morphological components are complementary components of considerable importance (Schmuck et al., 2022). A new approach to overall engagement in all areas should be created or adopted (Prizant, 2022). In recent years, comprehensive ecosystem service valuation techniques and methodologies have been developed in case studies that illustrate a variety of spatial scales and locations (Dunford et al., 2018; Hermes et al., 2018). The Spatial Decision Analysis (SDA) approach refers to a collection of structured methods used to analyse dynamic spatial decision problems and help decision-makers solve challenges, complexities, and risks associated with land use management issues (Wiebe, 2018). The SDA technique is commonly used for environmental impact assessment (EIA) and coastal mitigation over time (Della Spina, 2019). Multi-criteria decision analysis (MCDA) is a method of SDA used to support complex decision-making, especially in difficult situations where there is a limited number of possible alternatives, and to select the best alternative based on the scores of multiple attributes of the multi-attribute decision-making problem (Baloyi, 2019). MCDA provides more supported approaches for evaluating alternatives to projects that focus on decision matrices (Cole et al., 2018).

It also provides organised methods for integrating the viewpoints of project stakeholders when ordering or evaluating alternatives (Huang et al., 2020). MCDA has been extended to many areas of environmental policy and stakeholder engagement (Lienert and Linkov, 2019). One of the main advantages of MCDA is its willingness to draw out the parallels and future areas of tension between members of a decision-making community that promote a comprehensive understanding of the values of others (Petchrompo and Parlikad, 2019). Since the 1990s, urban planners in coastal regions have increasingly focused their attention on incorporating a multi-criteria decision-making approach with GIS to solve spatial planning problems (Bagheri et al., 2021a,b). The AHP followed by Analytic Network Mechanism (ANP), Technique for Order Choice by Resemblance to an Ideal Solution (TOPSIS) and Basic Additive Weighting is the most widely used MCDA method (Chen, 2021). Pawluszek and Borkowski (2017) stated that AHP remains one of the most widely used strategies in the MCDA environment. This viewpoint was supported by Bello-Dambatta et al. (2009), who argued that AHP is the most widely used and fastest evolving approach to decision analysis in various fields, including environmental and resource planning, coastal management and others.

AHP has been used in various complex environmental assessments, including the complexity of Integrated Coastal Zone Management (ICZM) (Orencio and Fujii, 2013), environmental issues (Kablan, 2004; Hill et al, 2005), social sciences and technology (Fong and Choi, 2000; Altuzarra et al., 2007; Azadeh et al, 2008), economic studies (Bhutta and Huq, 2002), environmental issues (Kablan, 2004; Hill et al, 2005), social sciences and technology (Fong and Choi, 2000; Altuzarra et al, 2007; Azadeh et al., 2008), economic studies (Bhutta and Huq, 2002), risk management (Dey et al., 1994), land use planning (Bello-Dambatta et al., 2009), urban planning (Benzerra et al., 2012), economics (Chen et al., 2012) and tourism (Gigović et al., 2016; Wanyonyi et al., 2016; Zabihi et al., 2020; Mansour et al., 2020; Asadpourian et al., 2020; Bianco and Marcian, 2018; Sadeghi and Behzad, 2019).

The GIS-SMCDA method helps decision-makers determine the relative targets of parameters for decision-making based on a selection of expectations and metrics that are not inherently of the same type (de Almeida et al., 2018; Greene et al., 2011; Karleuša et al., 2019; Atici et al., 2015; Ghorbanzadeh et al., 2018).

The outcome of the decision depends not only on the spatial distribution of events but also on the value judgments that enter the decision-making process. Two GIS-SMCDA considerations, then:

- Acquisition, collection, extraction, use, and analysis of GIS data,
- SMCDM, aggregation of decision makers' priorities for spatial data.

Decision-making issues that arise:

- A significant range of considerations appropriate for detection and assessment,
- The extensiveness of the interrelationships between these factors
- Processing of data to generate information for decision making.

Decisions can be divided into three levels by using GIS-SMCDM techniques to support decision-makers:

- Intelligence: problem or probability of change,
- Design: what are the alternatives?
- Choice: Is this the right alternative?

The purpose of this research is threefold:

- Mapping ecotourism attractions using the GIS-MCDM model.
- To assess and define future and suitable ESA implementation sites using the GIS-MCDM model.
- Elaboration of the requirements for the development of ESA as an acceptable site design.

Investigating Using the GIS-SMCDA Model

Applications of MCA in combination with GIS (Pataki and Kitsiou, 2022) can be found in the literature. Sharma et al. (2018) used MCA to conduct a risk analysis in the 'Ebro Delta' in Spain by considering different risk perceptions of a citizen within a given social system. Malczewski (2006) provided a holistic overview of spatial multi-criteria decision analysis. MCDAs are widely used for sustainable environmental planning, strategic environmental assessments, and the study of tourist sites (Khalid, 2013). In this study, GIS and SMCDA were used to identify potential sites for ESA. The sites were assumed to be areas where critical infrastructure is likely to be present (Mahlaba, 2022). There are five steps in this approach: Defining the objectives, identifying the criteria, determining the weighting of the factors, standardising and mapping the criteria, and combining all the criteria based on decision rules (Ali et al., 2020; Alwan et al., 2019). These steps are used to map the ecotourism site soon. The SMCDA approach allows various stakeholders to be involved in decision-making (Seddiki and Bennadji, 2019). Affected residents, planners, experts, or decision-makers could thus contribute, give opinions, and influence decision-making.

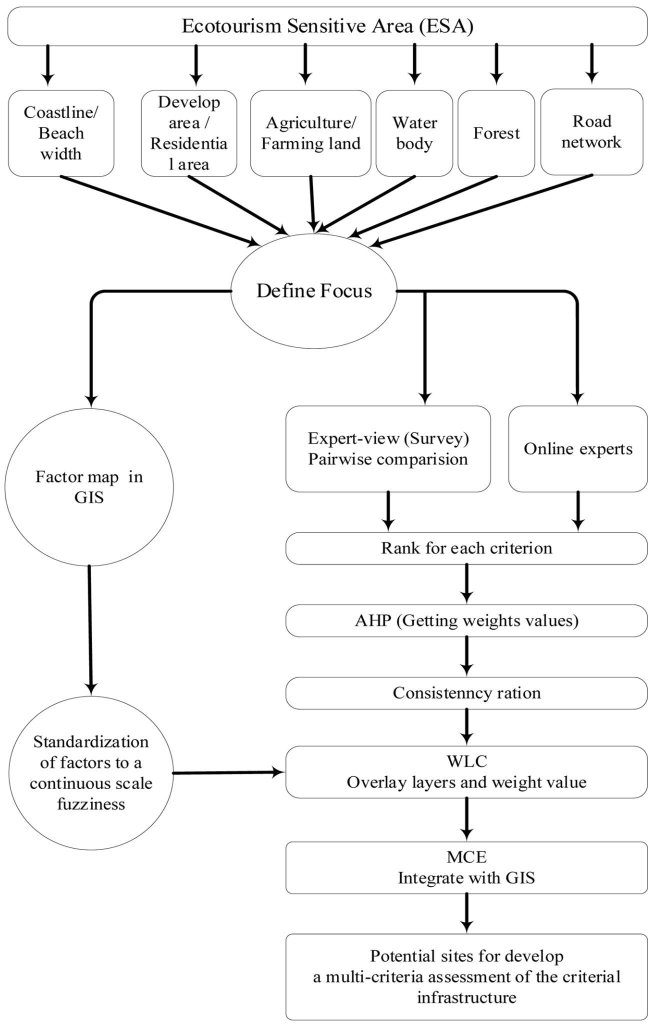

Figure 1. GIS-SMCDM framework for identifying eco-tourism spot areas.

Figure 1 shows the GIS-SMCDA framework used in this study, in which six criteria were included and an expert survey was conducted to derive the weighting for each criterion. As mentioned earlier, the objective of this analysis was to identify potential sites or areas suitable for ecotourism in Kuantan. The weights were derived from the expert survey and calculated using pairwise comparison. The score for each criterion was standardised using an analytical hierarchy approach available in the Expert Choice software environment used to run the GIS-SMCDA model. The weighted linear summation approach combined all criteria (Khalid, 2013).

Study Area

The monsoon winds and tides are essentially fundamental natural forces that promote the shaping of the Pahang coastline. Since most of the activities in the area are concentrated in the coastal area, monitoring is essential to identify the areas within the coastal city that are highly affected by erosion/accretion. For this study, Pahang was selected as the study area because it is an active tourist gateway to the East Coast Economic Region (ECER) (Fig. 2).

It has several distinct tourism attractions, mainly mainland coastal tourism and sustainable island tourism, ecotourism, urban tourism, and typical cultural tourism and heritage (Camilleri, 2018). ECER Malaysia was established as an economic corridor to create a socio-economic transformation of the east coast of Peninsular Malaysia.

Therefore, ECER includes the states of Terengganu, Kelantan, Pahang, and the districts of Johor and Mersing (Bhuiyan and Siwar 2011; Alam et al. 2012; Latip et al., 2020). Sungai Karang sub-district is a MUKIM located in Kuantan, Pahang, Malaysia. Its geographical coordinates are 3°54'0" North, 103°22'0" East, and its original name (with diacritical marks) in Kampung Sungai Karang. It is one of the most attractive beaches in Malaysia for ecotourism.

The coast is the beach that is connected to the mainland. It is a narrow body of sediment and runs parallel to the coastline. It is composed of sediment formed by wave action. Over time, this sediment is above sea level, exposed to the wind, and forms a low dune. The Ministry of Natural Resources and Environment (NRE) defines the shoreline zone as a land area within 5 km and the marine area within 200 nautical miles of the great tide. The shoreline zone also includes the river and its tidally influenced reserves.

Spatial Data for Eco-Tourism Sustainability Development

The data required for the study's ESA are reanalyses, and primary and secondary data were obtained from various websites and government agencies. Data needed for the ESA assessment includes a map, imagery data, and numerous technical reports. This data/information is available from various government agencies in paper and soft copy formats. These data are generally divided into two major categories: primary and secondary.

Primary Data

Two types of data are collected in the study, primary and secondary

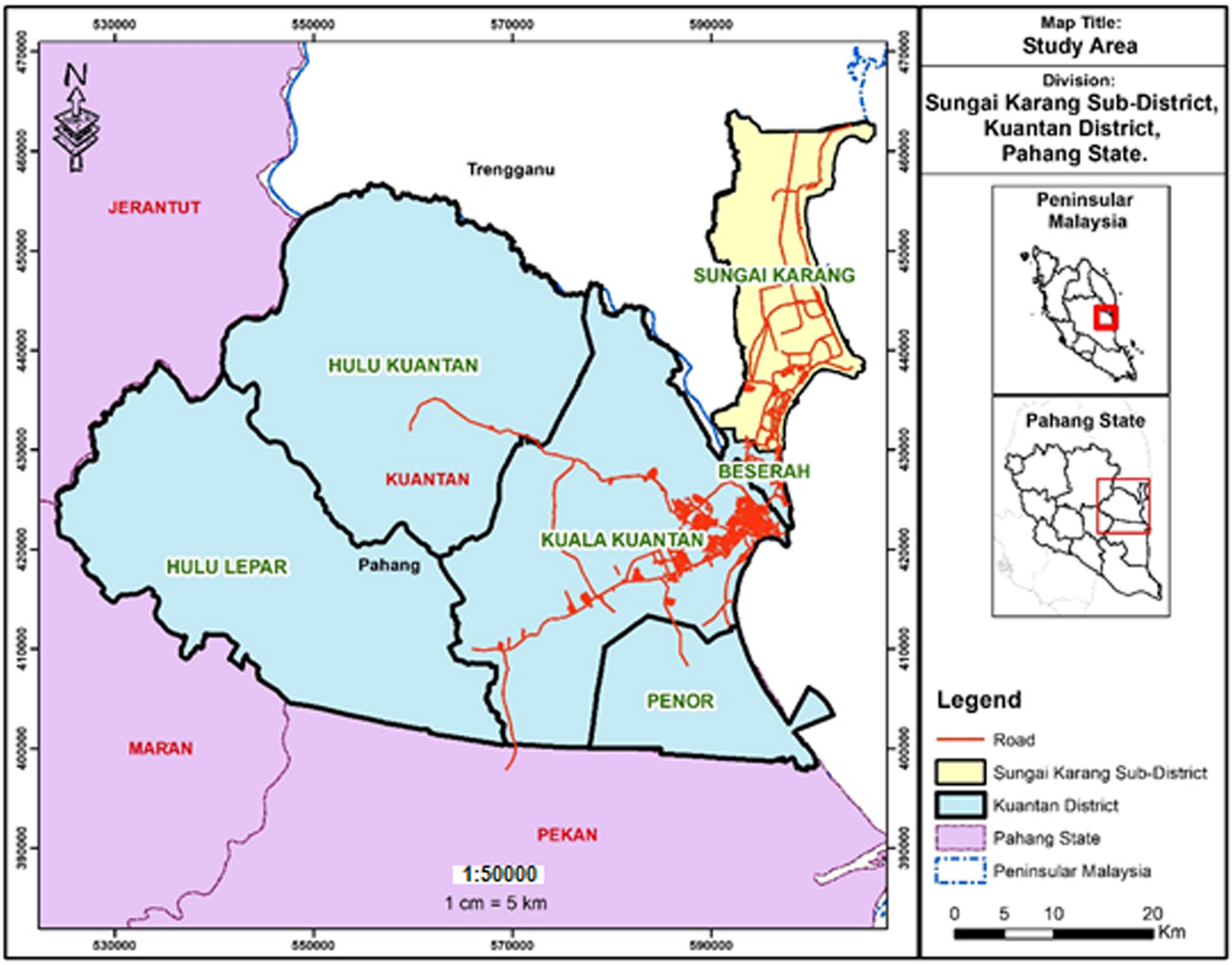

Figure 2. Sungai Karang Sub District, Kuantan, Pahang, Malaysia.

data for the model GIS-SMCDA. The primary data for this study was collected by interviewing the experts. The primary data for the AHP model was obtained through the expert selection matrix and provided to 12 experts from different agencies or departments in Malaysia (DID, JUPEM, NAHRIM).

Secondary Data

JUPEM's Land Use Map (2013), Topographic Map (2013), and Mukim Map (2010), as well as other information from various departments and agencies, were used in this work as prospective sources of secondary spatial data for mapping at GIS for ESA.

Identifying the Criteria

Based on the above objective, criteria or factors affecting ecotourism sites in Kuantan could be identified based on a multi-criteria assessment of critical infrastructure based on existing literature, analyst definition, or expert opinion. In this study, expert opinions were used to obtain input criteria from stakeholders familiar with the study area. Criteria that influence ecotourism sites can be divided into local and global factors and constraints (Khalid, 2013).

Defining Weights for Siting Factors

In this study, the Analytic Hierarchy Process (AHP) method is used to determine the weighting. It is based on creating a matrix of pairwise comparisons. In this technique, the weighting can be defined using the basic eigenvectors of a quadratic reciprocal matrix of pairwise comparisons between criteria (Malczewski, 2004). These comparisons consider the relative importance of two criteria used to determine the suitability of a particular target. Thus, an attempt is made to evaluate the pair of criteria while using the nine-point (degree) scale from 1/9 to 9, as shown in Table 2.

The continuous rating scale is used for the pairwise comparison of factors in multi-criteria evaluation. In this research, the weighting of criteria collected by pairwise comparison is presented in the following procedures. The pairwise comparison method was chosen to calculate the weights of the drivers because this approach is a popular method for analysing the Likert scale questionnaire (Beynon, 2002). In this study, it is assumed that the areas with the highest population density also have the associated physical structures and livelihood options (Sharma et al., 2018).

Table 2. Continuous rating scale used for the pairwise comparison of factors in AHP Numerical Scale

j is important than i				Equal	i is important than j			
1/9	1/7	1/5	1/3	1	3	5	7	9
Extremely	Very	Strongly	Moderate	Equally Important	Moderately	Strongly	Very	Extremely

(Source: Khalid, 2013; Udie et al., 2018)

Weights Assignment Procedure

There are several techniques for assigning criterion weights. The most common methods include ranking, rating, and pairwise comparison (Malczewski, 2004). However, in this study, the pairwise comparison method was used due to the nature of the problem at hand. Accordingly, the researcher collected the data for pairwise comparison by distributing questionnaires to managers (experts) of relevant government agencies, academicians, and university researchers. The weights of the factors were calculated according to their importance for urban development in the study area. In this process, the criteria must be compared with each other (Khalid, 2013). The method of pairwise comparison is particularly suitable for this task because it allows the comparison of two criteria at the same time. Similarly, the pairwise comparison method is more suitable than the other methods when accuracy and theoretical basis are the main concern. A series of questions are asked between pairs of criteria within clusters at each level of the hierarchy to determine the relative importance of the criteria. The study applied the principle of AHP, which is based on this pairwise comparison and is performed on a scale of 1 to 9 as follows.

Mapping the Criteria

In the study, ArcMap software was used to create maps by generating a layer for each criterion. The factors are usually measured and geographically represented on a continuous scale. The constraints are always Boolean layers (a map layer with only two categories, usually with values of one and zero), where the areas to be excluded from the analysis must have a value of zero and the areas to be included must have a value of one. Using GIS, the researcher created five vector layers (shapefile) representing the elevation constraint and five factors for the MCD analysis mentioned above. The layers were created for the entire study area. ArcMap vector and raster layers were used for all five variables listed: Proximity to Water Bodies, Proximity to Populated Areas, Proximity to Developed Areas, Current Land Value, and Proximity to Road Networks. Using spatial analysis in ArcMap applications, all vector layers are translated into a raster format.

Combining Criteria Using Decision Rules

Weighted Linear Combination (WLC) allows each criterion to perform to its potential based on the criterion weights. Criterion weights are important in WLC because they determine how each criterion is combined. Factors and constraints were combined with WLC. In WLC, continuous criteria are normalised to a typical range of numbers and combined with a weighted average to produce a continuous suitability mapping. The WLC approach involves standardising the suitability maps, assigning relative weights to the suitability maps, and then combining the weights and standardised suitability maps to obtain an overall suitability score (Moeinaddini et al., 2010). The suitability index for a site is the sum of the products of the standardised score for each criterion multiplied by the weight of each criterion. Equation 1 is WLC:

$$Sij = \sum xi.Wi\pi Ci \quad (1)$$

Where,

S = Suitability index of location ij
Xi = Standardized score for value of criteria i
Wi = Weight of criteria
Ci = Constraint of i

The result is a continuous map of suitability (Drobne and Lisec, 2009). In this study, the initial map from the MCE analysis was used to identify areas suitable for tourist sites in Kuantan, Pahang. These areas were expected to have critical infrastructure in the next few years.

Sensitivity Analysis

The spatial criterion levels and judgments must be integrated to obtain an overall evaluation of the alternatives. Appropriate decision rules or aggregation functions can accomplish this. Decision rules are a procedure that allows the alternatives to be ranked according to their performance. They determine how best to rank the alternatives or which alternative is preferable to another. The role of GIS and SMCDA techniques can support the following:

- The decision-maker in achieving greater effectiveness and efficiency in decision-making, Solving spatial decision problems.

The last step deals with the sensitivity analysis of the AHP model. The last step of the decision-making process, sensitivity analysis, refers to the slight change in the input data to determine the impact on the results. The results are considered stable if there is no change in the ranking. The main objective of sensitivity analysis is to determine how sensitive the decisions are to changes in the criteria weights (Ishizaka and Labib 2009). The sensitivity analysis in this study shows the sensitivity of the alternatives for the different criteria in the model to the choice of the critical ESA criteria in the Kuantan coastal ecotourism area (Fig. 3). The sensitivity analysis was applied only to the qualitative data because the experts evaluated and weighted the qualitative data and their results could be used to decide on the semi-quantitative data.

This study attempts to identify suitable and unsuitable areas for the development of sustainable ecotourism in Pahang, Kuantan. First, the relative importance is calculated based on the Likert scale ratings, and then a proposal matrix is constructed to calculate the weights using

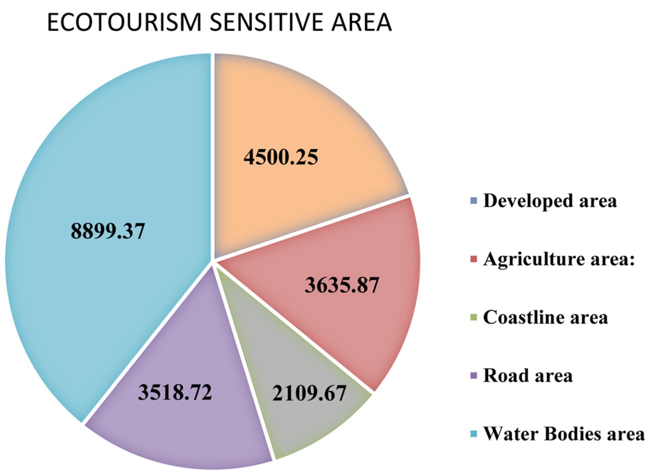

Figure 3. The importance of ESA criteria for Pahang, Kuantan.

Table 3. Continuous rating scale for the pairwise comparison of factors in multi-criteria evaluation

Factors	1	2	3	4	5	6
Agriculture	1	1	3	5	7	9
Developed Area	1	1	1	3	5	7
Water Bodies	1/3	1	1	1	3	5
Forest	1/5	1/3	1	1	1	3
Road	1/7	1/5	1/3	1	1	1
Coastlines	1/9	1/7	1/5	1/3	1	1

(Source: Ahris Yaakup et al., 2004; JPBD, 2005; Ahris Yaakup et al., 2006; Dawod, 2013; Mehdi Ahmadi et al., 2014; Norhidayah Harun and Narimah Samat, 2016; PLANMalaysia, 2017; Çetinkaya et al., 2018).

the pairwise comparison method. The suggestion matrix to determine the weights of the factors is shown below (Tables 3 and 4).

Table 4. Weighted of the study and amount of influence in weighted overlay

No.	Criteria	Weighted	% Influence
1	Agriculture Area	0.371	37
2	Developed Area	0.261	26
3	Water Bodies	0.162	16
4	Forest	0.111	11
5	Road	0.055	6
6	Coastlines	0.037	4
	Total	Consistency Ratio: 0.06	100

(Source: Ahris Yaakup et al., 2004; JPBD, 2005; Ahris Yaakup et al., 2006; Dawod, 2013; Mehdi Ahmadi et al., 2014; Norhidayah Harun and Narimah Samat, 2016; PLANMalaysia, 2017; Çetinkaya et al., 2018)

The weighted ArcGIS overlay (Spatial Analyst Tools) was applied to each criterion individually. In this way, six different suitability criteria were identified in the AHP model, one for each specified constraint. The only exceptions are terrain slope and vacant land-use models, which are divided into two categories: suitable or unsuitable. The data are run with a weighted overlay. These results are shown in Fig. 4.

The database was influenced by the criteria used. Overlay multiple grids using a standard measurement scale and weighted each according to its importance. The weighted overlay tool applies one of the most commonly used approaches to overlay analysis to solve multi-criteria problems such as site selection and suitability criteria. Each of the general overlay analysis steps is followed in a weighted overlay analysis. As with any overlay analysis, in weighted overlay analysis you must define the problem, divide the criteria into sub-criteria, and identify the input layers. An assigned preference on the standard scale implies the preference of the phenomenon for the criterion. For example, in a simple site selection model, there are six input criteria: Water bodies, coastlines, roads, forests, developed areas, and agricultural land.

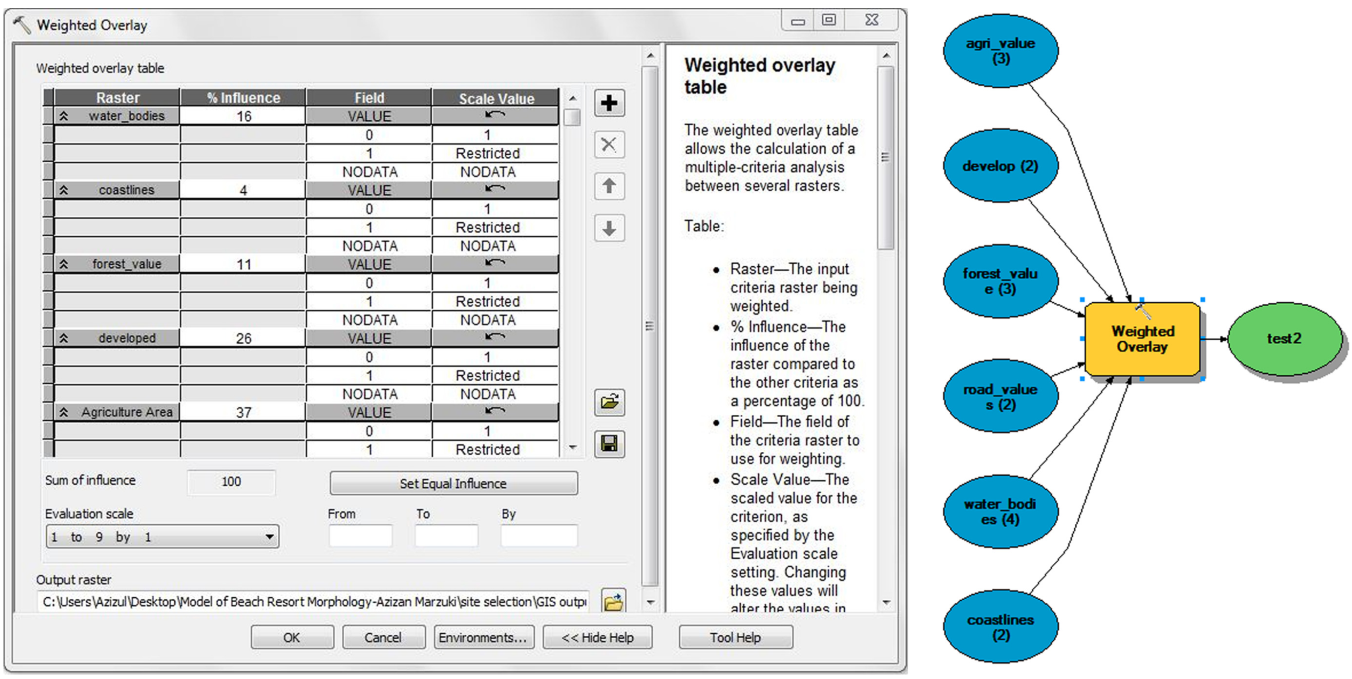

Figure 4. AHP weights and overlay model builder in a GIS environment.

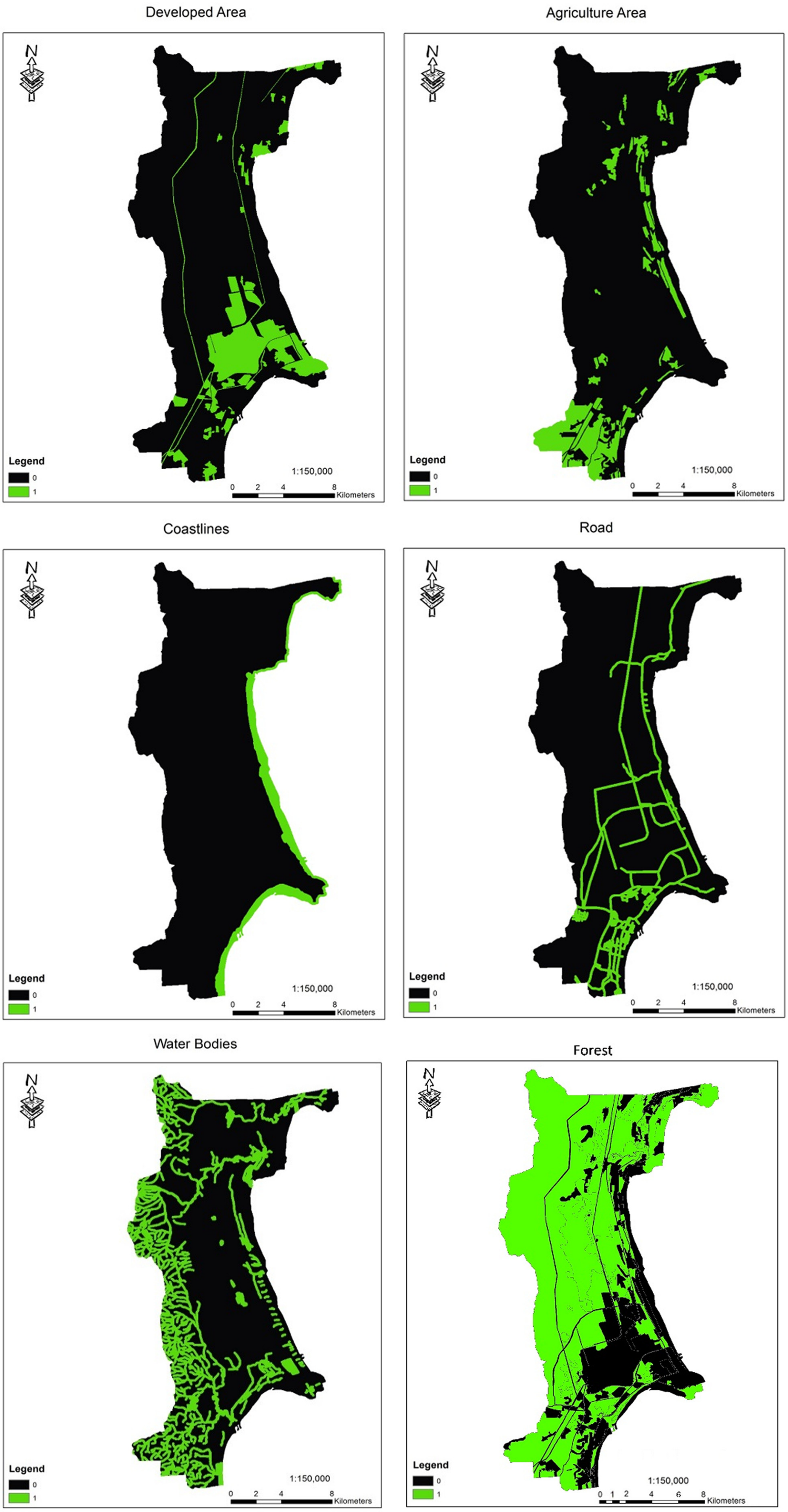

Figure 5. GIS raster layers of ESA after calculating with AHP weights.

The final step in the overlay analysis is to validate the criteria to ensure that what the criterion indicates is present at a site. Once the model is validated, a site is selected for the ecotourism spot. The result shows that the built-up area is 4,500.25 ha, agricultural area: 3,635.87 ha, coastal area: 2,109.67ha, roads: 35,187.24 ha, and water bodies: 8,899.37 ha (Fig. 5).

The results show that the area for a suitable site for a tourist resort in Sungai Karang sub-district is 248.878 ha, while the area for an unsuitable site is 29,104,45 ha (Fig. 4). This shows that there is a minimal area in this area that can be considered for the construction of a tourist attraction. These areas are either ESA areas that may not be developed or already developed areas (Nor Hidayah and Narimah, 2016).

As shown in the area classification maps, the most attractive sites in the region are located in the southern and southeastern parts of the Sungai Karang sub-district, which are highlighted in red (Fig. 6). These areas are also located near the main roads and built-up areas. Areas with average ecotourism potential are located in the north, center, and southeast of the sub-district. These areas are a sufficient distance from the main roads in the region. The areas with low ecotourism potential are widely scattered in the northwest and west of the region. The low elevation is not a barrier to development in the study area. The rivers that flow through the mountainous regions of the province cross these areas. The best places with high eco-tourism attractions are highlighted in green color on the map.

The results of this study can be useful for ecotourism planning, as governments are investing too much in ecotourism despite having scarce resources. Further research can be conducted to identify the optimal locations for different types of ecotourism such as religion, hunting, and golf tourism to enable effective ecotourism planning. Another extension may be to study destination management in specific ESAs. Finally, various SMCDA techniques can be applied under uncertainty to deal with the indeterminacy of comparison matrices (Çetinkaya et al., 2018).

The study aims to establish a set of criteria for the development of ESA and ecotourism for all agencies in the region (area) or in the planning phase. It aims to propose areas for ecotourism development without compromising ESA using the combined methods of GIS and SMCDA. A sensitivity analysis was also carried out to study the impact of the different weighting on the results generated by the decision-makers using heuristic analysis methods. The objective is to find out the extent to which the views and opinions of the different experts in the planning authority have similarities and differences in evaluating the criteria that determine the ESA and identify a potential area for ecotourism development in Sungai Karang.

In this study, ESA and ecotourism development were determined using the WLC method in MCD. In this process, the criteria are divided into two parts. The first criterion consists of 6 ESA criteria to create a composite map of constraints, and the second is the development of ecotourism criteria consisting of one criterion used for site selection analysis. The weighting was based on previous studies. The analysis shows which eco-tourism activities can be developed in Sungai Karang. The site selection equation analysis shows that the results are influenced by the criteria set and less by the weighting of the decision-makers, which differ from the opinion of the previous study.

The sites identified by Mukim Sungai Karang also show the potential for ecotourism development. The sites are identified within the objectives of the study in environmentally sensitive areas to avoid impacting the ESA. The sites that are located within the environmental zone are also approved for development. Overall, this study has demonstrated the potential of integrating GIS and MCE methods in determining ESA and ecotourism development to preserve and maintain the environment to remain natural. ESA planning and suitability ecotourism development can be carried out more systematically using the criteria that influence it uniformly for all planning stages. This method allows taking into account the views of experts or parties involved in the planning of development within the same district, territory, area, or region.

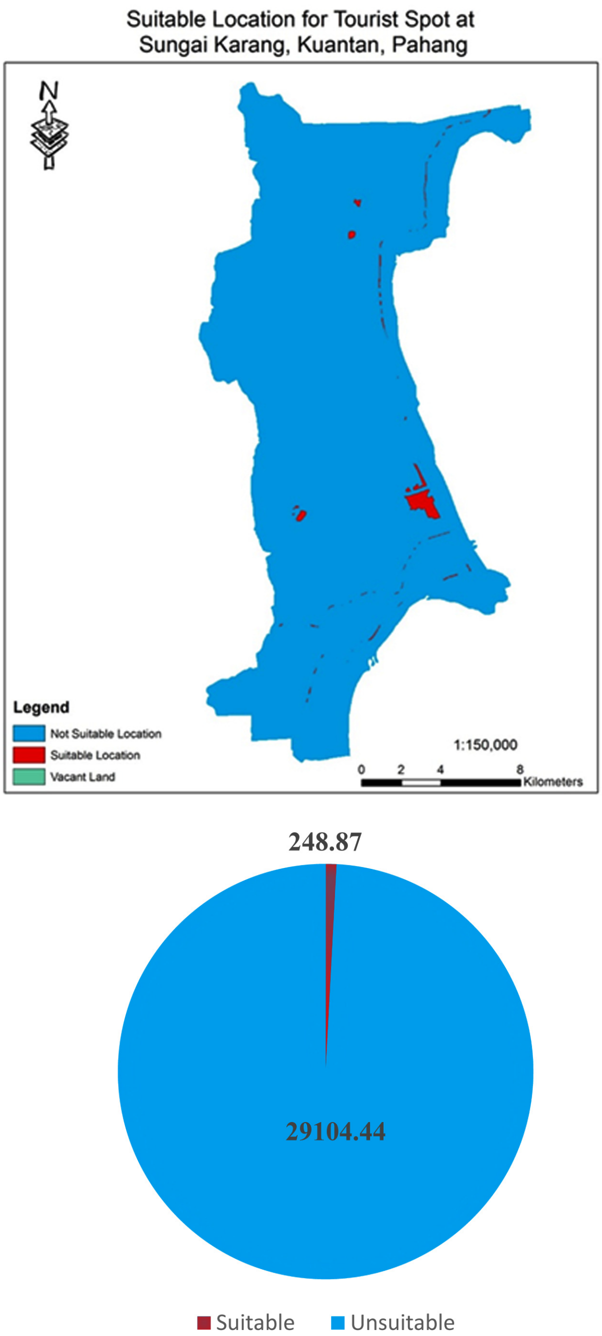

Figure 6. Final ESA map and suitable and unsuitable zones.

Therefore, this study aims to standardize the criteria used in determining the ESA and development of coordinated ecotourism for all agencies such as DOE, DID, JKR, MPK, and JPBD of Kuantan Pahang since these agencies are directly and indirectly involved in the development of Mukim Sungai Karang, Pahang. In addition, the availability of this method in the GIS and ArcGIS MCE software facilitates the MCE technique as the information or data from GIS is still entered and the output is explicitly displayed in the same software. This process saves time and makes it easier for responsible planners to use GIS and MCE methods as a reference in all phases of planning (Nor Hidayah, 2012).

Conclusion

First of all, an appropriate criterion for determining the position of ecotourism should be established. These different comparisons of parameters are beneficial to make decisions that can be made with some systems other than the AHP approach with the tools of GIS. MCD is also the best dynamic case where a lot of thinking is required. The selection criteria need to be standardised and weighted to get the best position for the field of ecotourism and effectively implemented by several researchers.

This research aimed to examine which combinations of GIS and SMCDA can be used in recognising attractiveness to help ecotourism authorities and managers decide on new ecotourism destinations to be built. The research procedure shows that decision-making based on the GIS multi-criteria can be able to manage a set of criteria related to location attractiveness for ecotourism production. GIS can quickly determine the location of attractions, ecotourism hotels, route collection, nearest services, cultural, historical, and natural monuments, and their suitability degree for spatial comparison of ecotourism attraction sites. The importance of this system to the success of the ecotourism sector is unprecedented.

The ecotourism sector has contributed significantly to the economy and socioeconomic growth of Sungai Karang. At the same time, however, this behavior can have harmful effects on the environment. Research conducted in Sungai Karang found that although the government has developed various strategies to promote ecotourism, it has succeeded in protecting the environment despite taking numerous measures to protect regional land-use changes. This may be due to the success of protection policies on the mainland to manage economic growth and urban sprawl.

Further analysis is needed to determine the impacts of land-use change at the local level.

This study illustrates the potential use of a GIS-based SMCDA approach that provides a basis for considering hard and soft knowledge in planning and creating land in Sungai Karang for ecotourism activities. The viewpoints, interests, and expertise of professionals should be incorporated and utilised in the decision-making process. It will also enable the conservation and security of the ESA. Urban development is a process that contributes greatly to the national economy. However, sustainable planning requires safeguards to ensure that it does not adversely affect the environment. GIS ESA regulation applications, especially in urban construction areas, will help control environmental degradation and ensure sustainable growth for future generations. Therefore, guidance on controlling ESA should be made explicit for urban growth areas to ensure that construction in required areas is sustainable and does not have a detrimental impact on the environment.

Suggestion

Any recommendations can be considered for further research following the same approach. A GIS-MCDM model and framework for ecotourism can be built and designed to achieve a faster and more structured solution. It should be user-friendly and can be updated in a short time. The data and details of ESA and ecotourism can be updated at different planning levels according to the current situation. A special debate and meeting can also be held simultaneously to clarify the different views and opinions of the decision-makers. The data and details on ESA and ecotourism can be updated at different planning levels according to the current situation. A particular debate and meeting can also be held at the same time to resolve the differences of opinion among the decision-makers. This approach will lead to unifying the decision-makers with the weighting factor. However, it is not very easy as it requires the commitment of time and cost of the decision-makers. Other suggestions are to strengthen the standards followed by the existing ESA conditions and specifications for land use and ecotourism.

According to a report, the parameters can be applied and reduced. This is because the MCE approach makes it possible to continuously assess the number of parameters at any given time. It is also possible to study parameters such as psychological, physical, and economic parameters. This would generate a commodity that is simpler, more reliable, and can be changed quickly, either spatially or non-spatially, depending on the current situation. In addition, decision-makers or planners influence decision-making.

Thus, policymakers may abandon or overlook the requirements for a thesis. For example, in the construction of coastal zones, decision-makers do not take into account the requirements of the coast and overlook certain requirements to meet the purpose of construction, which in turn affects the product. To avoid details and inconsistencies, each planning organisation should jointly prepare a precise guideline based on the type of construction project. For example, for each category of compliant production, the classification criteria and details should be changed to keep the results consistent. This simplifies the process of reviewing and accepting an application so that excessive detail is not required.

Acknowledgments

The authors would like to thank Universiti Sains Malaysia for funding the Research University Grant entitled Establishing a New Model of Beach Resort Morphology in Coastal Eco-tourism Destination [Grant No. 1001/PPBGN/816230], which made this study and article possible.

Reference

Abdullah, N.H., Mohamed, N., Sulaiman, L.H., Zakaria, T.A., and Rahim, D.A., 2016, Potential health impacts of bauxite mining in Kuantan. The Malaysian Journal of Medical Sciences, v. 23, pp.1.

Ahris, Y., Foziah, J., Siti, Z.A.B., and Haibenarisal, B., 2006, Pendekatan Penilaian Kawasan Sensitif Alam Sekitar Menggunakan Analisis Multi-Kriteria. Malaysian Journal of Environmental Management, v. 7, pp. 43–57.

Ahris, Y., Susilawati, S., and Siti, Z.A.B., 2004, Integrated Land Use Assessment (ILA) Model. "What if" Approach. Malaysian Townplan, v. 2, pp. 5–14.

Alam, M., Morshed, M.D., Siwar, C., and Murad, M.W., 2012, Initiatives and challenges of agricultural crop sector in East Coast Economic Region (ECER) development projects in Malaysia. American-Eurasian Journal of Agricultural and Environmental Sciences, v. 12, pp. 922–931.

Alemu, M.M., 2022, Way forward for the Sustainable Development of Protected Areas: Integrated Strategic Development Approaches. In Human Activity, Biodiversity and Ecosystem Services in Protected Areas (pp. 143–159). Springer, Cham.

Ali, U., Shamsi, M.H., Bohacek, M., Purcell, K., Hoare, C., Mangina, E., and O'Donnell, J., 2020, A data-driven approach for multi-scale GIS-based building energy modeling for analysis, planning and support decision making. Applied Energy, v. 279, pp. 115834.

Alwan, I.A., Karim, H.H., and Aziz, N.A., 2019, Groundwater aquifer suitability for irrigation purposes using multi-criteria decision approach in Salah Al-Din Governorate/Iraq. AgriEngineering, v. 1, pp. 303–323.

Al-Halbouni, D., AlRabayah, O., and Rüpke, L., 2022, A Vision on a UNESCO Global Geopark at the Southeastern Dead Sea in Jordan-Geosites and Conceptual Approach. Land, v. 11, pp. 549.

Altuzarra, A., Moreno-Jiménez, J.M., and Salvador, M., 2007, A Bayesian priorization procedure for AHP-group decision making. European Journal of Operational Research, v. 182, pp. 367–382.

Anuar, A.N.A., Jaini, N., Robat, M., and Jamaluddin, E.R., 2018, The identification of criteria for ecotourism practice in Peninsular Malaysia. J Hotel Bus Manage, v. 8, pp. 2169–0286.

Anup, K.C., 2016, Ecotourism and its role in sustainable development of Nepal. INTECH Open Science, pp. 31–59.

Asadpourian, Z., Rahimian, M., and Gholamrezai, S., 2020, SWOT-AHP-TOWS Analysis for Sustainable Ecotourism Development in the Best Area in Lorestan Province, Iran. Social Indicators Research, pp. 1–27.

Asadzadeh, A., and Mousavi, M.S.S., 2017, The role of tourism on the environment and its governing law. Electronic Journal of Biology, v. 13, pp. 152–158.

Atici, K.B., Simsek, A.B., Ulucan, A., and Tosun, M.U., 2015, A GIS-based Multiple Criteria Decision Analysis approach for wind power plant site selection. Utilities Policy, v. 37, pp. 86–96.

Azadeh, A., Ghaderi, S.F., and Izadbakhsh, H., 2008, Integration of DEA and AHP with computer simulation for railway system improvement and optimization. Applied Mathematics and Computation, v. 195, pp. 775–785.

Bagheri, M., Zaiton, I.Z., Akhir, M.F., Talaat, W.I.A.W., Oryani, B., Rezania, S., and Pour, A.B., 2021a, Developing a Climate Change Vulnerability Index for Coastal City Sustainability, Mitigation, and Adaptation: A Case Study of Kuala Terengganu, Malaysia. Land, v. 10, pp. 1271.

Bagheri, M., Zaiton, I.Z., Mansor, S., Manaf, L.A., Akhir, M.F., Talaat, W.I.A.W., and Beiranvand, P.A. 2021b, Land-Use Suitability Assessment Using Delphi and Analytical Hierarchy Process (D-AHP) Hybrid Model for Coastal City Management: Kuala Terengganu, Peninsular Malaysia. ISPRS International Journal of Geo-Information, v. 10, pp. 621.

Baloyi, E., 2019, Evaluating the Location of Fire Stations Using Geographic Information Systems GIS-Based Accessibility Analysis: A Case Study in Ekurhuleni (Doctoral dissertation, University of Johannesburg (South Africa).

Bello-Dambatta, A., Farmani, R., Javadi, A.A., and Evans, B.M., 2009, The Analytical Hierarchy Process for contaminated land management. Journal of Advanced Engineering Informatics, v. 23, pp. 433–441.

Benzerra, A., Cherrared, M., Chocat, B., Cherqui, F., and Zekiouk, T., 2012, Decision support for sustainable urban drainage system management: A case study of Jijel, Algeria. Journal of Environmental Management, v. 101, pp. 46–53.

Beynon, M., 2002, DS/AHP method: A mathematical analysis, including an understanding of uncertainty. European Journal of Operational Research, v. 140, pp. 148–164.

Bhuiyan, M.A.H., and Siwar, C., 2011, Tourism for Economic Development in East Coast Economic Region (ECER), Malaysia. Institute for Environment and Development, University Kebangsaan Malaysia.

Bhutta, K.S., and Huq, F., 2002, Supplier selection problem: a comparison of the total cost of ownership and analytic hierarchy process approaches. Supply Chain Management: An International Journal, vol. 7, pp. 126–135.

Bianco, S., and Marcianò, C., 2018, Using a Hybrid AHP-SWOT Method to Build Participatory Ecotourism Development Strategies: The Case Study of the Cupe Valley Natural Reserve in Southern Italy. In International Symposium on New Metropolitan Perspectives (pp. 327–336). Springer, Cham.

Camilleri, M.A., 2018, The tourism industry: An overview. In Travel marketing, tourism economics and the airline product (pp. 3–27). Springer, Cham.

Çetinkaya, C., Kabak, M., Erbaş, M., and Özceylan, E., 2018, Evaluation of ecotourism sites: a GIS-based multi-criteria decision analysis. Kybernetes, v. 47, pp. 1664–1686.

Chen, C.H., 2021, A Hybrid Multi-Criteria Decision-Making Approach Based on ANP-Entropy TOPSIS for Building Materials Supplier Selection. Entropy, v. 23, pp. 1597.

Chen, S., Jiang, Y., Liu, Y., and Diao, C., 2012, Cost constrained mediation model for analytic hierarchy process negotiated decision making. Journal of Multi?Criteria Decision Analysis, v. 19, pp. 3–13.

Cole, J., Sharvelle, S., Grigg, N., Pivo, G., and Haukaas, J., 2018, Collaborative, risk-informed, triple bottom line, multi-criteria decision analysis planning framework for Integrated Urban Water Management. Water, v. 10, pp. 1722.

Daba, M.H., and You, S., 2022, Quantitatively assessing the future land-use/land-cover changes and their driving factors in the upper stream of the Awash River based on the CA–markov model and their implications for water resources management. Sustainability, v. 14, pp. 1538.

Dada, O., Almar, R., Morand, P., and Ménard, F., 2021, Towards West African coastal social-ecosystems sustainability: Interdisciplinary approaches. Ocean and Coastal Management, v. 211, pp. 105746.

Daramola, S., Li, H., Omonigbehin, O., Faruwa, A., and Gong, Z., 2022, Recent retreat and flood dominant areas along the muddy Mahin coastline of Ilaje, Nigeria. Regional Studies in Marine Science, v. 52, pp. 102272.

Dawod, G.M., 2013, Suitability analysis for tourist infrastructures utilizing multicriteria GIS: A case study in Al-Hada city, Saudi Arabia. International Journal of Geomatics and Geosciences, v. 4, pp. 313–324.

De Almeida, A.T., Ekenberg, L., Lopez, J.C.L., and Morais, D.C., 2018, Building Mathematical Models for Multicriteria and Multiobjective Applications 2017.

De Groot, R., Brander, L., Van Der Ploeg, S., Costanza, R., Bernard, F., Braat, L., and Hussain, S., 2012, Global estimates of the value of ecosystems and their services in monetary units. Ecosystem services, v. 1, pp. 50–61.

Della, S.L., 2019, Multidimensional assessment for "culture-led" and "community-driven" urban regeneration as driver for trigger economic vitality in urban historic centers. Sustainability, v. 11, pp. 7237.

Dey, P., Tabucanon, M.T., and Ogunlana, S.O., 1994, Planning for project control through risk analysis: a petroleum pipeline-laying project. International Journal of Project Management, v. 12, pp. 23–33.

Doe, B., Amoako, C., and Adamtey, R., 2022, Spatial expansion and patterns of land use/land cover changes around Accra, Ghana–Emerging insights from Awutu Senya East Municipal Area. Land Use Policy, v. 112, pp. 105796.

Drammeh, F., 2013, Assessing and adapting to climate-change induced sea level rise on the southern coastline of the Gambia. UN Oceans and Law of the Sea. pp. 47–51.

Dunford, R., Harrison, P., Smith, A., Dick, J., Barton, D.N., Martin-Lopez, B., and Verheyden, W., 2018, Integrating methods for ecosystem service assessment: Experiences from real-world situations. Ecosystem Services, v. 29, pp. 499–514.

Ei, T., and Karamanis, K., 2017, The evolution of alternative forms of Tourism: a theoretical background. Business & Entrepreneurship Journal, v. 6, pp. 1–4.

Fong, P.S.W., and Choi, S.K.Y., 2000, Final contractor selection using the analytical hierarchy process. Construction Management and Economics, v. 18, pp. 547–557.

Font, X., and McCabe, S., 2017, Sustainability and marketing in tourism: Its contexts, paradoxes, approaches, challenges and potential. Journal of Sustainable Tourism, v. 25, pp. 869–883.

Ghorbanzadeh, O., Feizizadeh, B., and Blaschke, T., 2018, Multi-criteria risk evaluation by integrating an analytical network process approach into GIS-based sensitivity and uncertainty analyses. Geomatics, Natural Hazards and Risk, v. 9, pp. 127–151.

Gigović, L., Pamučar, D., Lukić, D., and Marković, S., 2016, GIS-Fuzzy DEMATEL MCDA model for the evaluation of the sites for ecotourism development: A case study of "Dunavski ključ" region, Serbia. Land Use Policy, v. 58, pp. 348–365.

Greene, R., Devillers, R., Luther, J. E., and Eddy, B.G., 2011, GIS-based multiple-criteria decision analysis. Geography compass, v. 5, pp. 412–432.

Hermes, J., Van Berkel, D., Burkhard, B., Plieninger, T., Fagerholm, N., von Haaren, C., and Albert, C., 2018, Assessment and valuation of recreational ecosystem services of landscapes.

Hill, M.J., Braaten, R., Veitch, S.M., Lees, B.G., and Sharma, S., 2005, Multi-criteria decision analysis in spatial decision support: the ASSESS analytic hierarchy process and the role of quantitative methods and spatially explicit analysis. Environmental modelling and software, v. 20, pp. 955–976.

Hitchcock, M. (Ed.). 2009, Tourism in Southeast Asia: challenges and new directions. Nias Press.

Huang, H., Lebeau, P., and Macharis, C., 2020, The multi-actor multi-criteria analysis (MAMCA): new software and new visualizations. In International Conference on Decision Support System Technology (pp. 43–56). Springer, Cham.

Ishizaka, A., and Labib, A., 2009, Analytic hierarchy process and expert choice: Benefits and limitations. Or Insight, v. 22, pp. 201–220.

Islam, R., Kamaruddin, R., Ahmad, S.A., Jan, S.J., and Anuar, A.R., 2016, A Review on Mechanism of Flood Disaster Management in Asiaf. International Review of Management and Marketing, v. 6.

Ismail, I., Abdullah, W.S.W., and Zakaria, S.M.M.R., 2018, Physical Impact of Sea Level Rise to The Coastal Zone Along the East Coast of Peninsular Malaysia. Marang, v. 5, pp. 12–82.

JPBD, 2005, Draf Rancangan Struktur Negeri Kedah 2002-2020. Kedah: Town and Country Planning Department.

Kablan, M.M., 2004, Decision support for energy conservation promotion: an analytic hierarchy process approach. Energy policy, v. 32, pp. 1151–1158.

Karleuša, B., Hajdinger, A., and Tadić, L., 2019, The application of multi-criteria analysis methods for the determination of priorities in the implementation of irrigation plans. Water, v. 11, pp. 501.

Khalid, S.M., 2013, Urban Expansion, Development Pressure and The Perception Of The Local Communities: The Application Of Geographic Information System (GIS) And Remote Sensing (RS). School of Humanities, Geography Section. Penang: Universiti Sains Malaysia (Unpublished PhD Thesis).

Kingdon, A., and Gray, B., 2022, The Class Conflict Rises When You Turn up the Heat: An Interdisciplinary Examination of the Relationship between Climate Change and Left-Wing Terrorist Recruitment. Terrorism and Political Violence, pp. 1–16.

Kiper, T., 2013, Role of ecotourism in sustainable development. InTech.

Leung, Y.F., 2018, Tourism and visitor management in protected areas: Guidelines for sustainability. A. Spenceley, G., Hvenegaard, R. Buckley, and C. Groves (Eds.). Gland: IUCN.

Lienert, J., and Linkov, I., 2019, Editorial featured papers on environmental decisions. EURO Journal on Decision Processes, v. 7, pp. 151–157.

Mahlaba, B., 2022, The assessment of degradation state in Ecological Infrastructure and prioritisation for rehabilitation and drought mitigation in the Tsitsa River Catchment.

Malczewski, J., 2004, GIS-based land-use suitability analysis: a critical overview. Progress in Planning, v. 62, pp. 3–65.

Malczewski, J., 2006, GIS-based multicriteria decision analysis: a survey of the literature. International Journal of Geographical Information Science, v. 20, pp. 703–726.

Mansour, S., Al-Awhadi, T., and Al-Hatrushi, S., 2020, Geospatial based multi-criteria analysis for ecotourism land suitability using GIS & AHP: a case study of Masirah Island, Oman. Journal of Ecotourism, v. 19, pp. 148–167.

Matthew, N.K., Shuib, A., Ramachandran, S., and Afandi, S.H.M., 2019, Total Economic Value of Ecosystem Services in Malaysia: A Review. Journal of Sustainability Science and Management, v. 14, pp. 148–163.

Mehdi, A., Mohammad, F.D., and Ezatollah, G., 2014, A GIS-based Multi-criteria Decision-making Approach to Identify Site Attraction for Ecotourism Development in Ilam Province, Iran. Tourism Planning & Development, pp. 1–14.

Mendelssohn, I.A., Byrnes, M.R., Kneib, R.T., and Vittor, B.A., 2017, Coastal habitats of the Gulf of Mexico. In Habitats and biota of the Gulf of Mexico: Before the Deepwater Horizon oil spill (pp. 359–640). Springer, New York, NY.

Mendoza-González, G., Martínez, M.L., Guevara, R., Pérez-Maqueo, O., Garza-Lagler, M.C., and Howard, A., 2018, Towards a sustainable sun, sea, and sand tourism: The value of ocean view and proximity to the coast. Sustainability, v. 10, pp. 1012.

Moeinaddini, M., Khorasani, N., Danehkar, A., Darvishsefat, A.A., and Zienalyan, M., 2010, Siting MSW landfill using weighted linear combination and analytical hierarchy process (AHP) methodology in GIS environment (case study: Karaj). Waste Management, v. 30, pp. 912–920.

Neumann, B., Ott, K., and Kenchington, R., 2017, Strong sustainability in coastal areas: a conceptual interpretation of SDG 14. Sustainability science, v. 12, pp. 1019–1035.

Nor Hidayah, B.H., and Narimah, S., 2016, GIS-Based Multicriteria Evaluation Approach in Planning Tourism Development Sites in Environmentally Sensitive Areas. PSU-USM-NSTRU 2014 International Conference on Arts and Sciences 2014 "Arts and Sciences Research 2014: Spot of Change for Tomorrow". 23, 02001, hlm. 16. EDP Sciences, SHS Web of Conferences.

Nor Hidayah, B.H., 2012, Aplikasi Sistem Maklumat Geografi Dan Penilaian Pelbagai Kriteria Bagi Menentukan Kawasan Sensitif Alam Sekitar Dalam Pembangunan Kawasan Pelancongan Di Pulau Langkawi. School of Humanities, Geography Section. Penang: Universiti Sains Malaysia (Unpublished MA Thesis).

Novelli, M., Morgan, N., Mitchell, G., and Ivanov, K., 2016, Travel philanthropy and sustainable development: the case of the Plymouth–Banjul Challenge. Journal of Sustainable Tourism, v. 24, pp. 824–845.

Orencio, P.M., and Fujii, M., 2013, A localized disaster-resilience index to assess coastal communities based on an analytic hierarchy process (AHP). International Journal of Disaster Risk Reduction, v. 3, pp. 62–75.

Pataki, Z., and Kitsiou, D., 2022, Marine Spatial Planning: Assessment of the intensity of conflicting activities in the marine environment of the Aegean Sea. Ocean & Coastal Management, v. 220, pp. 106079.

Pawluszek, K., and Borkowski, A., 2017, Impact of DEM-derived factors and analytical hierarchy process on landslide susceptibility mapping in the region of Rożnów Lake, Poland. Natural Hazards, v. 86, pp. 919–952.

Petchrompo, S., and Parlikad, A.K., 2019, A review of asset management literature on multi-asset systems. Reliability Engineering & System Safety, v. 181, pp. 181–201.

PLANMalaysia. 2017, Garis Panduan Perancangan (GP007-A (1)) Pemuliharaan Dan Pembangunan (GPPPP) Kawasan Sensitif Alam Sekitar (KSAS). Putrajaya: PLANMalaysia (Jabatan Perancangan Bandar dan Desa), Kementerian Perumahan dan KerajaanTempatan.

Prizant, B.M., 2022, Uniquely Human: Updated and Expanded: A Different Way of Seeing Autism. Simon and Schuster.

Sadeghi, T., and Behzad, A., 2019, The Role of Eco geomorphology in ecotourism expansion using AHP and VIKOR method (Case study Ardebil City).

Schmuck, N., Carlson, R.J., Reuther, J., Baichtal, J.F., Butler, D.H., Carlson, E., and Rasic, J.T., 2022, Obsidian source classification and defining "local" in early Holocene Southeast Alaska. Geoarchaeology.

Seddiki, M., and Bennadji, A., 2019, Multi-criteria evaluation of renewable energy alternatives for electricity generation in a residential building. Renewable and sustainable energy reviews, v. 110, pp. 101–117.

Sharma, S.S., Parth, S.R., Chakravarthi, V., and Srinivasa, R.G., 2018, Flood risk assessment using multi-criteria analysis: a case study from Kopili River Basin, Assam, India. Journal Geomatics, Natural Hazards and Risk, v. 9, pp. 79–93.

Stronza, A.L., Hunt, C.A., and Fitzgerald, L.A., 2019, Ecotourism for conservation? Annual Review of Environment and Resources, v. 44, pp. 229–253.

Tang, S., 2022, Research on the Development of Eco-Health Tourism Products Based on IPA Model in Internet Plus. Mobile Information Systems, 2022.

Tanova, C., and Bayighomog, S.W., 2022, Green human resource management in service industries: the construct, antecedents, consequences, and outlook. The Service Industries Journal, v. 42, pp. 412–452.

Udie, J., Bhattacharyya, S., and Ozawa-Meida, L., 2018, Review-A Conceptual Framework for Vulnerability Assessment of Climate Change Impact on Critical Oil and Gas Infrastructure in the Niger Delta. Climate, v. 6.

Wanyonyi, J.W., Imwati, A., and Boitt, M., 2016, GIS in analysis of potential sites for ecotourism-a case study of Kwale County. J Environ Sci Toxicol Food Technol, v. 10, pp. 43–49.

Wiebe, K., Zurek, M., Lord, S., Brzezina, N., Gabrielyan, G., Libertini, J., and Westhoek, H., 2018, Scenario development and foresight analysis: exploring options to inform choices. Annual Review of Environment and Resources, pp. 545–570.

Zabihi, H., Alizadeh, M., Wolf, I.D., Karami, M., Ahmad, A., and Salamian, H., 2020, A GIS-based fuzzy-analytic hierarchy process (F-AHP) for ecotourism suitability decision making: A case study of Babol in Iran. Tourism Management Perspectives, v. 36, pp. 100726.

Zhou, D., Yu, J., Li, Y., and Zhan, C., 2017, Effects of Urbanization Expansion on Landscape Pattern and Region Ecological Risk in Chinese Coastal City: A Case Study of Yantai City. AGUFM, 2017, GC21H-1032.

Zong, S., Hu, Y., Zhang, Y., and Wang, W., 2021, Identification of land use conflicts in China's coastal zones: From the perspective of ecological security. Ocean & Coastal Management, v. 213, pp. 105841.