GIS based Analytical Hierarchy Process (AHP) for Ecotourism Site Suitability in South Kelantan, Malaysia

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Abstract. Ecotourism is an important part of sustainable tourism. Thus, the selection of the suitable sites is important in the development of ecotourism site. The objective of this study are to identify the criteria of the potential area for ecotourism and to develop a model to map the potential area of ecotourism and to map the suitable location of the ecotourism in South Kelantan. The criteria such as Land use, slope, elevation and proximity to road were selected following the guidelines and also from the previous study. The method used is Analytical Hierarchy Process (AHP) and GIS. AHP technique were used to calculate the weightage for each of the criteria. At the end of this steps, the model of Site Suitable Area for Ecotourism Model (SSME) was produced. In this study, map of the site suitability area for ecotourism in South Kelantan were process and displayed in ArcGIS. Keyword: Ecotourism, AHP, MDCM, GIS

1. Introduction
For more decades ago, tourism industries especially in ecotourism activities have shown an increasing all over the world including Malaysia. Nowadays, the tourists are most likely willing to pay higher prices for environmental with less damaging products [1]. In fact, tourism Malaysia has become the second largest contributors in economy for the past 20 years ago. This is due to the diversity of the cultural, heritage, races and religions. Malaysia is also known as a truly a treasure trove for who’s that love natural. Malaysia is very full of the flora and fauna itself and has 54 protected areas of more than 1000 hectares, totally 1483 million hectares or about 45% of the land surface of the country [2].

There are many definitions on ecotourism. The most common used definition is from the International Ecotourism Society (TIES) (previously known as The Ecotourism Society (TES)) it defined eco-tourism as “responsible travel to natural areas that conserves the environment, sustains the lives of local people, and involves all about interpretation and education” [3]. There are many definitions that describe how the ecotourism is with their perspective and paradigm. According to the [4] it gives the idea on ecotourism as the tourism and recreation that is both nature-based and sustainable. This idea is contradicted with the idea by [5] which mentioned that ecotourism can be sources for creating employments for local communities and offer environment education,[6] except the definition of the ecotourism is important for planning development and can be proceeding. Also, the definition of
Ecotourism is varying and must be suited with the development of each country. It is a must for each ecotourism site to follow the definition of their government in each country as the meaning of ecotourism basically have their purposes.

2. Methodology
The methodology can be divided into three phases, namely Phase 1, Phase 2 and Phase 3. Phase 1 describes the preparation stage which includes selection of the study area and selection criteria refer to previous study and guidelines. Phase 2 refer to the process of the calculation of weightage using AHP and LST method while Phase 3 is a process of development a model named Site Suitability for Ecotourism Model (SSEM). At the end, the map of site suitability area for ecotourism in South Kelantan is formed. Figure 1 illustrates research methodology for this study.

![Flow of Methodology](image_url)

**Figure 1. Flow of Methodology**

2.1 Site Study
The site of the study is located at South Kelantan. South Kelantan having 3 districts namely Kuala Krai, Gua Musang and Jeli. The study area is mostly covered with the forest and a few developments area. The reason of this study area was chosen because the study area had untouched nature and the deforestation occurs within the lines. This location also selected for ecotourism site as it can replaced the deforestation that may occurs in future developments. Figure 2 shows the location of the study area in Kelantan.
2.2 Criteria Used

The criteria used in this research are land use, slope, elevation and proximity to road. These criteria were referred to the previous study. The decision and criteria and factor are evaluated based on the past research and studies. As refer to [7] the research used 5 criteria as indicator of suitability within the land ecosystem of Surat Thani Province, Thailand. These criteria are landscape/naturalness, wildlife, topography, accessibility, and community. In other research done by [8], the criteria used such as water resources, terrain, land use, biodiversity, transport, and settlement.

Each criterion is divided into sub criteria. The range and weight of each sub criteria also evaluated from the previous research. In the previous research, the sub criteria were chosen based on the suitable place of the study area. For elevation, the sub criteria are divided into 4 classes which from 0-150m, 151-300m, 301-1000m and 1000-2180m and the highest elevation in South Kelantan 2180m from sea level. This range were referred to the Environmental Impact Assessment (EIA) that were established by the Department of Environment (DOE) [9].

The aim of this guidelines is to guide the project proponent and qualified person (registered consultants by Department of Environment, DOE) in the preparation of the EIA reports and projects deliverable. For the criteria such as slope, it was based on the High Land Development Guidelines that were produced by Ministry of Natural Resources and Environment. In this guideline, the development is categorized into 4 classes namely Class 1 and 2 are slope from 0-25 degree and Class 3 are slope from 25-35 degree and the rest are class 4. Thus, these slope classifications were adopted from this guideline. The sub criteria such as road are referred to the Environmental Impact Assessment (EIA) that were established by the Department of Environment (DOE) [9].

For land use, it were divided into 7 criteria and each sub criteria had its own weight. All types of land use in South Kelantan are compress into 7 types of sub criteria and it were distributed into attribute table in ArcGIS. These classes are based on the previous study and also refer to the location of the existing tourism site. The types of land use were forest (Hutan Simpan Negeri), forest (Hutan Simpan Kekal), forest (others), water bodies, vegetation, urban, and bare land. Besides, it also refers to the government in each district by using their online e-portal. These sub criteria were gathered for calculating the weightage value using AHP and LST.

2.3 Weightage using AHP and LST

Analytical hierarchy process (AHP) is used for calculated the weightage of the criteria. At first the intensity or scale preference are being assigned to each criteria in order to control the consistency of the result obtain. The scale preference is referred to the parameters by [10]. This scale is being given by the respondents and for this study, it based on the previous research.
AHP is only used for calculating the weightage for criteria and basically refer to the previous study in ecotourism. There were about 10 previous study on site suitability for ecotourism in other country were studied to gather the weight of each criteria. Besides, the guidelines to differentiate the weight for each criterion are also used to support the decisions. For the sub criteria, the calculation of weightage process is done by using Linear Scale Transformation (LST) technique. The normal weight is assigned to each sub criteria based on the preferable one.

After the calculation process, the weight for each criterion were multiple by each weight of sub criteria. The value produced are then being added in new field of attribute table. The product of the multiplication then were total up and forms the site suitability area equation. The higher the value of the standardized score, the higher classes of the suitability area for ecotourism.

Site Suitability for Ecotourism Model (SSEM) = \( (\text{Land use})(0.476) + (\text{Slope})(0.2884) + (\text{Elevation})(0.1545) + (\text{Proximity to road})(0.0812) \) (1)

The equation above shows The Model of Site Suitability Area for Ecotourism (SSEM) produced from the calculation of AHP and LST techniques. From the above result, we can conclude that the land use criteria gave the highest effect to the selection of the site suitability area for ecotourism. The highest the value of the weightage means the stronger of the criteria in selection the potential area.

3. RESULT AND ANALYSIS

3.1 Site Suitability Area for Ecotourism Map

The data were then processed using the calculation using AHP and LST techniques. The zonation of site suitability area of ecotourism in South Kelantan were obtained and analysed based on the classification from the developed model.

Figure 3 shows the site suitability map area for ecotourism after applying the equation. In this map, it covers 3 districts in South Kelantan such as Kuala Krai, Gua Musang and Jeli. As refer to the map, it contains the legend consists of water bodies, boundary of each district and sub district. The classification of the suitability area is differentiate using different colour symbol which represents different classes.

For this study, 5 classes namely very high suitable, very suitable, moderate suitable, low suitable and not suitable were used. These five classes to show the potential area for site suitability and the analysis will focuses in certain area. As refer to the map, it shows that Gua Musang District which cover Chiku, Bertam, Galas and Tenggara are mostly located at the very high suitable. Regardless to the existing site, this place is where the Taman Negara Kuala Koh are located. This national park is one of the forest reserved area that are very famous for nature ecotourism. Located near to road and the river made this area more preferred for new ecotourism site. Gua Musang district are also have more area covered with high and very high classes rather than the other area. Kuala Krai district consists of 3 sub districts, such as Batu Mengkebang, Olak Jeram, and Dabong. From the map, it shows that a very high suitable are mostly located at Dabong. Dabong is a place which famous with theGunung Stong State Park. It is a pristine forest reserve covering 21,950 hectares near to small town of Dabong.

Jeli district is also located at South Kelantan. It consists of Jeli, Batu Melintang and Kuala Balah. A very high suitable area for ecotourism area mostly located in Batu Melintang. The area of Batu Melintang is about 311.623 kilometre square and mostly covered with the very high suitable area and high suitable area for ecotourism. Meanwhile in Jeli, mostly this area is located in moderate suitable rather than very high suitable. The classes such as moderate suitable, low suitable and not suitable mostly located at Batu Mengkebang in Kuala Krai district. Weightage and the criteria used are the main factor contributes in developing the map. The criteria were selected according to the availability of data and previous study.
4. CONCLUSION
The ecotourism is an important economical income to each country and not too mentioned, Malaysia. Besides, it also can reduce the unwanted pressure to nature of the environment. For example, the activities like cutting trees, deforestation and cleaning the forest for the development or other purpose without proper planning can destroy the area such as the environment and native inhabitants, indigenous people, flora and fauna. With this study, the location of the suitable potential area for ecotourism can be identify and a proper planning can be implemented without harmful the natural habitat and environment. Despite reduce effect to the surrounding, the nature of the area can be preserved.

Other than that, the map can be used for future research and also for prediction in ecotourism site for other area. South Kelantan mostly covered by the forest area and this area are suitable to be selected as a study area because of its nature and can be a potential area for increasing the profit especially in tourism of Malaysia.

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Figure 3. Map of Site Suitability area for Ecotourism in South Kelantan
References

[1] Goodrich, J.N. and Goodrich, G.E, “Health-care tourism – An exploratory study”. *Tourism Management*, 217-222 1987

[2] Norizan 2000. Malaysia set to lose biodiversity as species go extinct.Retrieved from: https://www.star2.com/living/2019/01/22/malaysia-extinct-bees/

[3] The International Ecotourism Society (TIES) (1990). Retrieved from: https://bsc.smebg.net/ecotourguide/best_practices/articles/files/ TIES.pdf and https://ecotourism.org/

[4] Lindberg, K, “Policies for maximizing nature tourism's ecological and economic benefits”. *World Resources Institute*, Washington D.C.1991

[5] Boo, E, “Ecotourism: potentials and pitfalls: country case studies.” *WWF-US, Washington D.C.* Volume 2 ISBN 0942635140 9780942635140 0942635159 9780942635157.1990

[6] Bjork P., “Ecotourism from a Conceptual Perspective, an Extended Definition of a Unique Tourism Form.” *International journal of tourism research* 2, 189±202,1965

[7] Khwanruthai,B, Yuji. M, 2012. “Land Use and Natural Resources Planning for Sustainable Ecotourism Using GIS in Surat Thani, Thailand” *Procedia - Social and Behavioral Sciences* 2011, 21, 269 -278.

[8] S. L. J. Fernandoa, Noresah Mohd Shariff, 2017, “Site Suitability Analysis for Ecotourism Development at the Kirala Kele Partial-Nature-Based Wetland of Southern Sri Lanka.” *International Journal of Sciences: Basic and Applied Research (IJSBAR) (2017) Volume 32, No 3, pp 89-104*

[9] Slope Engineering Branch, Jabatan Kerja Raya Malaysia 2010. “Guidelines for Slope Design. Slope Engineering Branch, Jabatan Kerja Raya Malaysia.”

[10] Saaty, T.L. “The Analytic Hierarchy Process,” *New York: McGraw Hill. International,Translated to Russian, Portuguese, and Chinese, Revised editions, Paperback (1996, 2000), Pittsburgh: RWS Publications*. 1980.