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LAND SUITABILITY EVALUATION OF RECREATION ACTIVITIES USING MULTI-CRITERIA EVALUATION PROCESS: A CASE STUDY OF ASWAN CITY, EGYPT

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Abstract

Land suitability analysis for recreation and ecotourism is the process of predicting the potential use of land on the basis of its attributes. The planning decisions making on land use have been one of the essential parts of the human society. The integration of this GIS using a multi-criteria decision analysis approach provides an environment for decision-makers in citing areas using land suitability analysis procedures. The present study aims to evaluate the land use suitability for recreation and ecotourism development in Aswan city, Egypt. This is achieved by using the GIS-based Multi-Criteria Decision Analysis (GIS-MCDA) on twelve various economic, environmental and social criteria. The present study was concentrated on the utilization of Analytic Hierarchy Process (AHP) framework as a multi-criteria evaluation approach by integrating it with the Geographic Information System (GIS). Our results indicate that Aswan city has good natural and cultural resources for developing and supporting recreation and ecotourism in the future, because more than half of the study area is considered as suitable for these activities. The investigation of the present study shows that Aswan city has a great potential for successful and sustainable urban planning, and improvement of current and future areas for various types of recreational and tourism activities. Moreover, Aswan has some sites which locate on the Nile banks, which are considered as tourist attraction sites, and here visitors could practice the hobby of swimming and sailing. Results can be useful in the practical planning of public facilities of recreation activities, and future land use planning in Aswan city.

Keywords: recreation and ecotourism, MCDA, land suitability evaluation, evaluation criteria, spatial criteria

INTRODUCTION

Cultural Ecosystem Services (CES) are the 'the non-material benefits people obtain from ecosystems through spiritual enrichment, cognitive development, reflection, recreation and aesthetic experiences' (Tratalos et al., 2016; Stålhammar and Pedersen, 2017). The categories of CES have evolved significantly from the original idea: at first it recognized merely recreation and culture, but now its meaning broadened in the consolidated framework developed by the Millennium Ecosystem Assessment (MA) in 2008 (Fisher and Turner, 2008). CES categories are spiritual and religious, recreation and ecotourism, aesthetic, inspirational, sense of place, cultural heritage and educational (Tratalos et al., 2016; Ament et al., 2017). Recreation and ecotourism can be defined as the practicing of leisure activities during one's spare time: if people participate in activity near their home or community, it is considered recreation, such as hunting, fishing, riding bikes, mountain climbing etc. However, if these activities are further away, and people must travel some distance to participate in them, they are often described as ecotourism such as visiting historical areas to study, admire and enjoy scenery, plants, animals, and cultural attractions. Participating in recreational activities is of great importance for maintaining mental and physical health of individuals, families and communities (Tratalos et al., 2016; Stålhammar and Pedersen, 2017). A positive relationship was found between human health and green areas in recent studies, supporting the idea that parks, green areas, and their facilities affect public health positively (Schneider and Lorencová, 2015; Doğu and Çamaşırcıoğlu, 2016).

Sustainable planning represents the idea that local people should live within the capacity of their environment to support them, which becomes essential, especially in the planning process for new services. (Senes and Toccolini, 1998). The high population density living and working in the same area leads to the degradation of the ecosystem environment and the surrounding area (Fung and Wong, 2007). High recreational use on the land can significantly affect the natural and cultural value of the land and surrounding area. As a result, environmental and social values can be degraded in some areas, especially where there are limited appropriate natural and cultural areas near urban or areas with high population density (Manning et al., 2011). According to the sustainability of the environment, different kinds of concepts have to be considered, such as carrying capacity, landscape scenery, sensitivity to natural and cultural values, and regular maintenance. For achieving the sustainability of recreation benefits for present and future generations, it is necessary to address and work toward a sustainable balance between environmental, social, and economic conditions.

Sustainable land-use planning requires an in-depth analysis of the existing resources' localization, features, sensitivity to development, and an understanding of development characteristics and resource needs (Senes and Toccolini, 1998; Leung et al., 2008; McCool, 1994).

There are different kind of spatial and non-spatial criteria utilized in the evaluation process of different kind of CES, especially recreation services. For example, Dağıstanlı et al. (2018) addressed criteria, namely land-use type, distance from water surface, natural and cultural areas, distance from residential areas, distance from transportation or roads, flora cover density, erosion, slope, and their sub-criteria and weightings, which are typically employed in the evaluation of land for recreational suitability, in the compilation of information on the study area. Nahuelhual et al. (2013) utilized all of the singular natural resources, scenic beauty, accessibility, tourism attraction capacity, and tourism use aptitude, as land evaluation criteria for recreation service. Bunruamkaew and Murayama (2011) determined criteria for selecting a region as a tourism area. These criteria at the macro-level include two main categories, environmental and socioeconomic features. Each of the mentioned categories consists of many sub-criteria that have significant importance in tourism land capability evaluation of the land (Bunruamkaew and Murayama, 2011; Dağıstanlı, et al., 2018). Environmental features include physical and biological criteria. Physical criteria, including climate, topography, geology, and pedology, are placed at the fourth level (Zarkesh et al., 2011). Biological criteria in the fourth level contain fauna and flora, and two sub-criteria land cover density and animal distribution. There are several factors in the economic and social characteristics including land uses buffers and distances. Carrying capacity of the landscape also include as a social-economic criterion in the proposed evaluation criteria of recreation activities: how much use can be accommodated in the recreational site before the quality of the visitor experience is degraded to an unacceptable degree? So, the carrying capacity is an indicator/criterion which evaluate the quality or the efficiency of the recreation services. For example, Cupul-Magana and Rodriguez-Troncoso (2017) argue that using the carrying capacity concept in a recreation area may generate a satisfactory experience for the recreation with an acceptable or minimum impact on the resource of the natural and cultural area. Atanga (2019) proposed a method to calculate the recreational carrying capacity by calculating the number of visitors per day in a recreational area or recreational facility for a certain period of time. Some of mentioned criteria defined in the articles are considered for my study.

Land suitability analysis is the process of predicting the potential use of land on the basis of its attributes. Decisions on land use have always been part of the evolution of human society. In our crowded and complex world, the decisions on land use are frequently brought about by the process of land use planning by the land evaluation (Dağıstanlı et al., 2018). Such planning takes place in all parts of the world, including the Middle East countries such as Egypt (Bunruamkaew and Murayama, 2011). As GIS-based Multi-Criteria Decision Analysis (MCDA) became one of the most useful methods for spatial planning and management (Dağıstanlı et al., 2018), thus combining GIS and MCDA is a powerful approach for land suitability assessments. GIS techniques and procedures have an important role to play in analyzing spatial decision problems (Lee et al., 2010). Indeed, GIS is often recognized as a spatial decision support system. On the other hand, the Analytic Hierarchy Process (AHP), introduced by Saaty and Vargas (1980), is an effective tool for dealing with complex decision making, and may aid the decision maker to set priorities and make the best decision. In addition, the AHP incorporates a useful technique for checking the consistency of the decision maker's evaluations, thus reducing the bias in the decision-making process (Ahmed et al., 2016). There are many studies in the literature that integrates the GIS applications and MCDA models. One of the most remarkable features of the GIS-MCDA method is the wide range of decision and management situations in which they have been applied. Major application areas include: environmental planning and management (e.g. Conroy and Peterson, 2013; Mosadeghi et al., 2013; Mustajoki and Marttunen, 2017), recreational and ecotourism planning and management (e.g. Olaniyi et al., 2018; Zabihi et al., 2020), urban and regional planning (e.g. Mosadeghi et al., 2015; Simwanda et al., 2020), waste management (e.g. Coban et al., 2018), outdoor recreation planning (e.g. Chow et al., 2014; Dağıstanlı et al., 2018), agriculture and forestry (Colantoni et al., 2016).

This research attempts to evaluate environmental and recreational capabilities in Aswan city (Egypt) as a case study- using a MCDA which includes Weighted Linear Combination (WLC), and The Analytic Hierarchy Process (AHP). For scrutinizing the criteria selected from the literature, we used weighted pairwise comparisons.

DATA

Study Area

Aswan is located at the southern tip of Egypt and is the state capital of the Aswan Governorate (Fig. 1), and the city is considered as the southern gate to Africa. Aswan's population is almost about 900,000, and its area about 35,7 km^2. Aswan is considered as one of the best tourist destinations around the world, because of its tourist distinctive features, especially in winter. In addition, the moderate and dry climate is the most important feature of Aswan city, because of its location on the Nile east bank. During the summer, average temperature is above 23°C, while in the winter it remains above 8°C. So, Aswan city is considered an international winter resort. Moreover, it has many different archaeological and historical attractive sites, so, it is known as one of the best open museums that date back to various ages and spread all over the city.

Aswan is a busy market and tourist center, and it is considered beside Luxor city as a vast tourism source in Egypt. Furthermore, the city has many natural and cultural attractions and ancient pharaonic civilizations, including Pharaonic, Islamic, and Nubian. The most important natural and cultural attraction sites are the Upper Dam, the

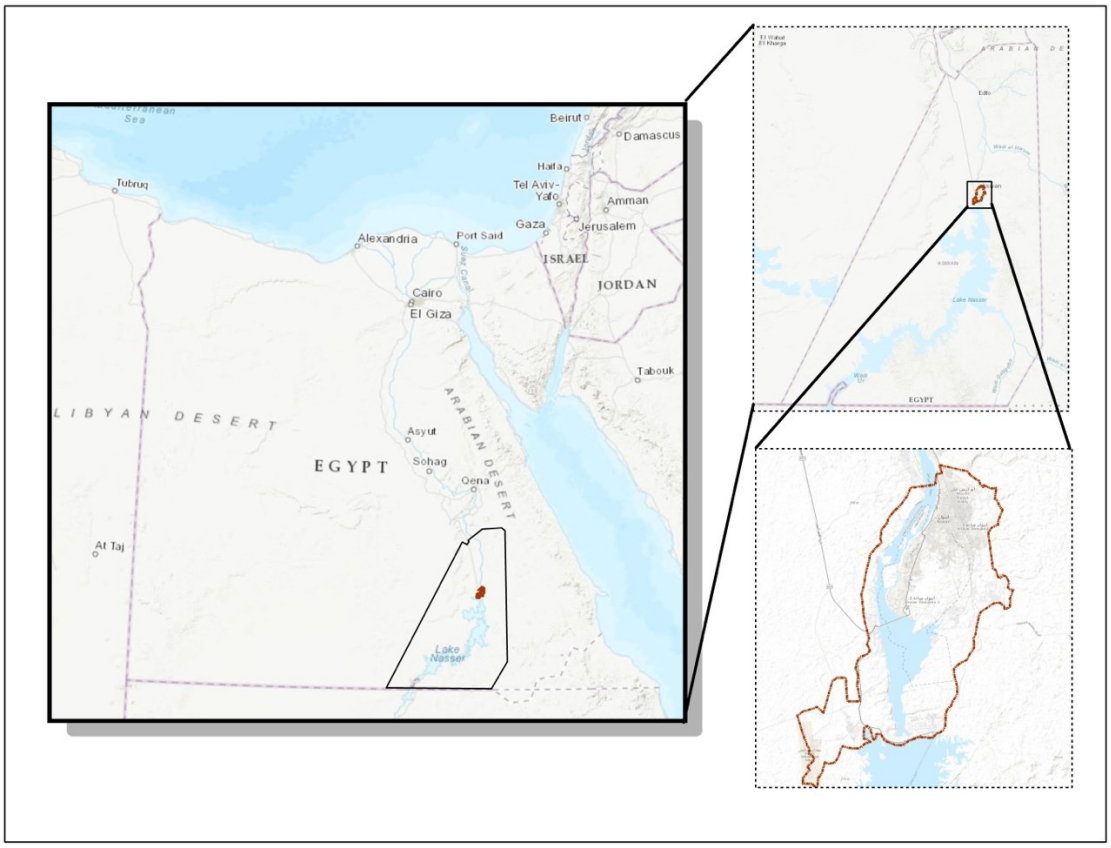

Fig. 1 Location of the study area

Tabiya Mosque, the Nile Museum, the Princess Ferial Park, the West Suhail area, the Nile Islands, and the twin temple of Abu Simbel (Fig. 2). Moreover, Aswan has some tourist attraction sites located on the Nile banks, and they are considered as appropriate sites where visitors can practice the hobby of swimming and sailing boats.

Data Sources

Different type of data sources was utilized in the present study (Table 1). Firstly, the primary data have been assembled through online questionnaires answered by experts in the related fields of study to identify criteria/indicators that are important for land evaluating of recreation service along with statistical data. Secondary, layers displaying land use/cover and vegetation density have been created utilizing a Landsat satellite image (Landsat 8 ETM+2011), and the road layer has been downloaded from ESRI. Finally, other data such as attractive sites and current recreation and tourism sites have been collected by using field survey data applying Global Positioning System (GPS).

An online questionnaire has been established to order the chosen RES evaluation sub-criteria based on their importance. Only experts in urban planning, recreation, and tourism have been involved in this questionnaire. Altogether 200 questionnaire forms had been sent to experts, and all criteria gave a rating value from 1 “Least important” to 9 “Extremely important”. The obtained sub-criteria were classified into three main criteria: environmental, social, and economic criteria. A total of 53 respondents ranging from decision-makers,

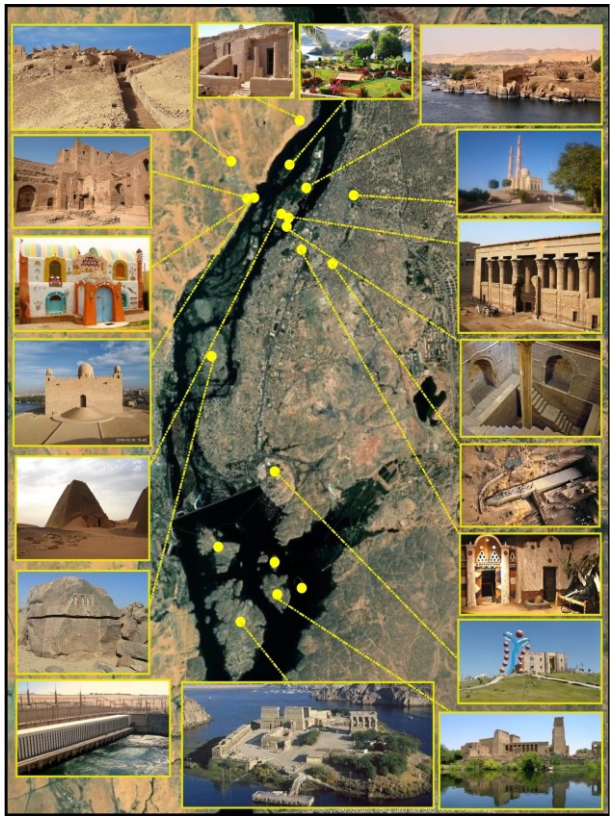

Fig. 2 Natural and cultural attraction sites at Aswan city

Table 1 List of collected data and their source

Data	Type of data	Utilized for creating	Source
Aswan boundary file	Vector	Clip indicators maps	GAUP - Egypt
Landsat satellite image	Raster	Land cover/use	Landsat8 (bands 2,3,4,5,6,7) ETM+ 2011
Digital elevation model (DEM)	Raster	Slope	USGS
Natural and cultural attractions	Vector	Distance from attractive sites	Field Survey with GPS
Road map	Vector	Distance from road and transportation	Road Layer, ESRI
Water bodies map	Vector	Distance from water bodies	GAUP - Egypt
Pollution map	Vector	Distance from active pollution points	GAUP - Egypt
Vegetation cover	Raster	Vegetation density	NDVI Index
World Soil map	Vector	Soil erosion/loss	FAO DSMW
Current recreation and tourism site	Vector	To evaluate current RTS	Field Survey with GPS

Abbreviations:
GAUP (General Authority for Urban Planning); USGS (U.S. Geological Survey); DSMW (Digital Soil Map of the World)

academicians, landscape and urban planners with 5–15 years in landscape and urban planning experience were involved in this survey. The stratified random sampling method was chosen, which comprises landscape experts, academicians, urban planning and design experts, architectures, and others. To ensure a better response, the survey forms were distributed by e-mail for 200 people. Moreover, part of the questionnaire was also sent by google accounts. Altogether, 41 questionnaires were completed by 11 landscape experts, 10 architects, 15 urban planners and designers, and the remained number classified as others. The number of participants who started with the assessment and ranking of the evaluation criteria was just 53, but only 41 evaluated the complete set of 12 criteria questions. The participation/response rate was approximately 26% (the number of people who assessed at least one question compared to the total number of people received the online surveys).

METHODS

Procedure

The technical procedure of the Multi-Criteria Evaluation (MCE) model of land evaluating of current recreation service in Aswan City is illustrated on Figure 3. GIS database development of this study was made by using recreation service spatial evaluating indicators/criteria and display each spatial indicator in maps. However, AHP is a methodical method helping decision-makers and urban planners in making better decisions to solve urban planning problems based on different priorities. Thus, in this study, AHP was used to calculate land evaluation indicators' weight. In order to produce a land evaluation model of recreation service four main steps was followed (Fig. 3). First, based on the literature review, spatial land evaluation indicators were collected for the assessment process. They were transferred based on their type to main indicators/criteria and factors which can be used as input layer in the MCE model. In the second step land evaluation indicators/criteria priority were determined by considering expert opinion and calculate indicators/criteria weights by using the AHP method to be involved in the evaluation process. Thirdly, indicators/criteria maps were created using proper spatial analysis techniques in ArcGIS environment such as Distance, Reclassify, and Raster calculation for applying NDVI analysis. Then a land evaluation map was produced by overlaying all indicators/criteria maps and weights by using the weighted indicators overlay tool in ArcGIS environment. Finally, after producing a land evaluation map for recreation service, the current state of recreation service in Aswan city was evaluated based on the produced map.

Utilized land evaluation criteria

According to the literature review, different kind of spatial and non-spatial criteria have been collected to achieve the sustainable planning of recreation service (Table 2). However, only spatial criteria should be considered when conducting a land evaluation of recreation service (Table 3). The recreation service land evaluation criteria may differ from one region to another based on circumstances and local conditions (Zoderer et al., 2016; Clemente et al., 2019). In the present study, a various criterion has been analyzed to conduct a land evaluation of recreation service in the study area. Therefore, a number of studies were reviewed to gather the related evaluation criteria (Casado-Arzuaga et al., 2014; Sun et al., 2019). The utilized criteria in the land evaluation of recreation service were (1) type of land cover/use; (2) distance from water bodies; (3) distance from attractive sites; (4) distance from current residential area; (5) distance from roads; (6) vegetation density; (7)

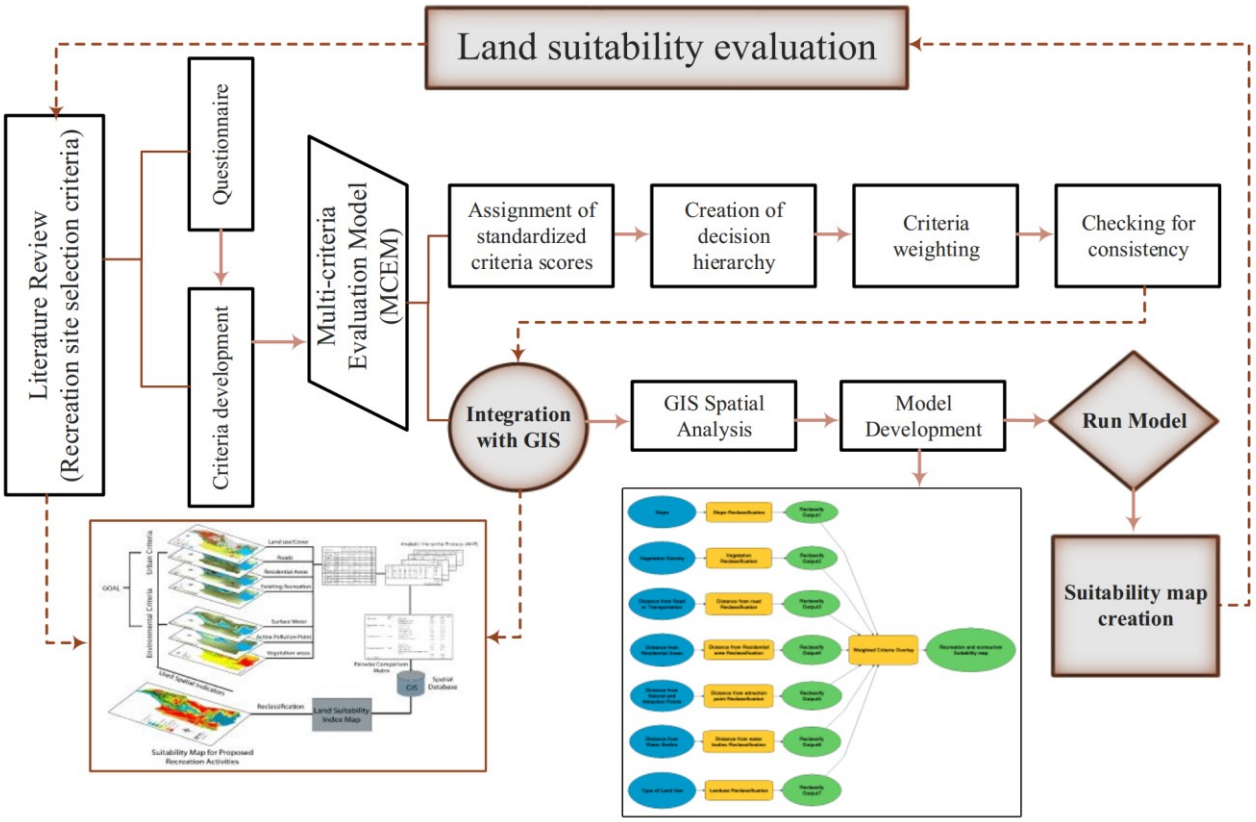

Fig. 3 Recreation and tourism services land evaluation process

Table 2 Recreation service evaluation criteria classification

Evaluation criteria		Sub-criteria	Spatial sub-criteria	Non-spatial sub-criteria	Utilized sub-criteria
Environmental Criteria	Biodiversity	Vegetation	√	-	√
	Availability	Soil erosion	√	-	√
	Comfort	Water bodies	√	-	√
	Pollution	Active pollution points	√	-	√
	Topography	Elevation	√	-	√
Social Criteria	Accessibility	Distance from residential areas	√	-	√
		Distance from attractive sites	√	-	√
		Distance from road	√	-	√
	Security	Number of threats	-	√	
	Compatibility	Sense of satisfaction	-	√	
		Sense of happiness	-	√	
		Sense of care with the place	-	√	
Economic Criteria	Utility	Travel costs	√	-	
		Willingness to pay (WTP)	-	√	
	Efficiency	Landscape settings	√	-	
		Photographs	-	√	
		Accommodation	-	√	
		Carrying capacity	-	√	
		Population density	-	√	
	Site's price	Site location	√	-	
	Surrounding area	Land cover/use	√	-	√
		Viewpoint	√	-	
		Landscape Aesthetics	√	-	

Table 3 Recreation and tourism services site evaluation criteria/indicators details and data types

Criteria/Indicators	Layer type	Spatial analysis
Vegetation density	Raster Layer	NDVI analysis (band 4,5)
Elevation	Raster Layer	Slope tool
Land cover/use	Raster Layer	Composite (band 2-7)-classification tool
Water bodies	Shape file-polygon-converted to raster	Distance tool (cell 30)
Attractive sites	Shape file-Points- converted to raster	Distance tool (cell 30)
Residential areas	Shape file-polygon- converted to raster	Distance tool (cell 30)
Road or transportation	Shape file-polyline- converted to raster	Distance tool (cell 30)
Pollution Points	Shape file-Points- converted to raster	Distance tool (cell 30)
Soil Erosion/Loss	Vector Layer - Using Land use and Slope	Raster calculator

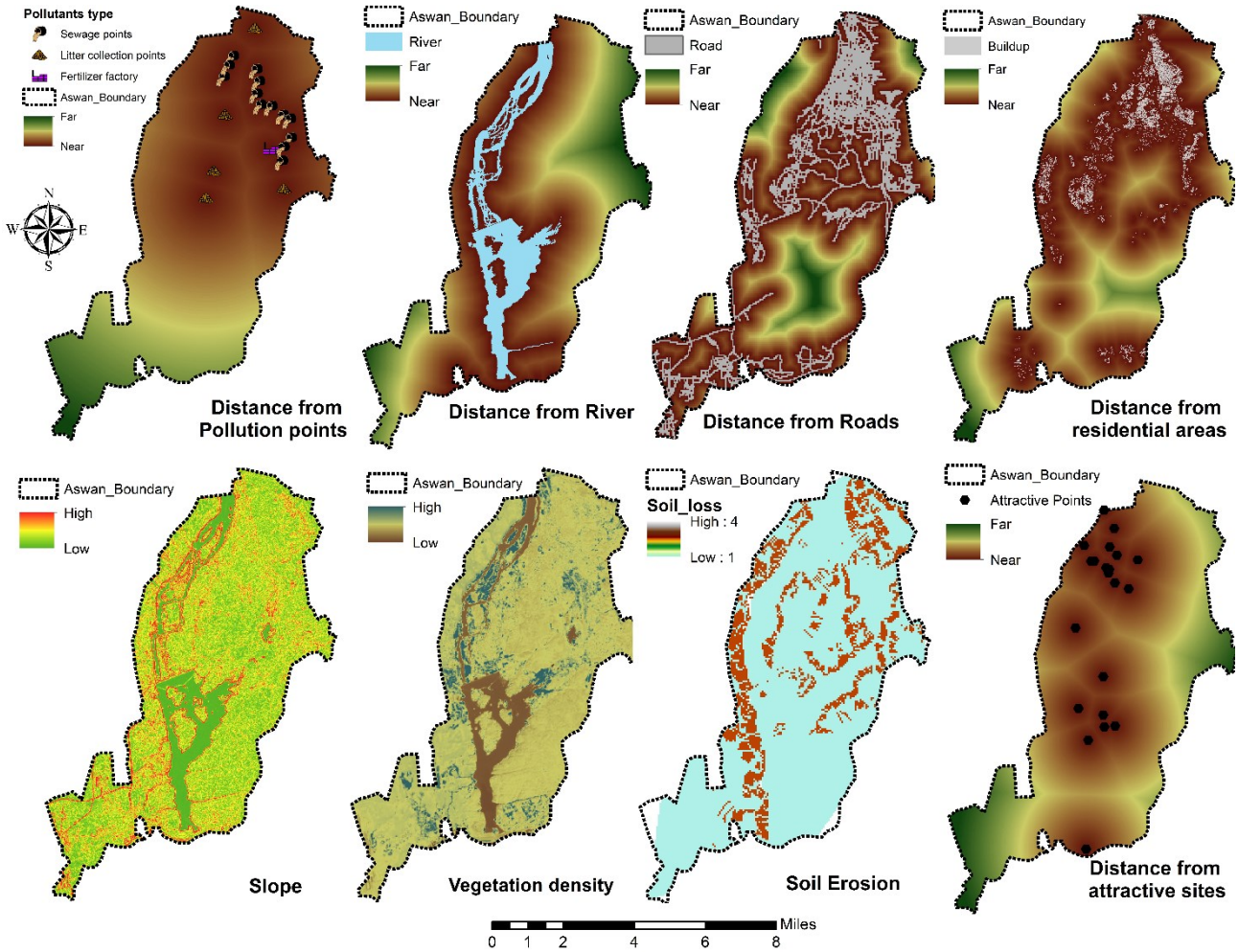

Fig.4 Recreation and tourism services land evaluation indicators maps

slope; (8) distance from active pollution points; and (9) soil erosion/loss. The criteria and sub-criteria importance were chosen and ordered according to the literature review and experts' opinions. Collected criteria for the land evaluation process should be comprehensive and measurable (Zarkesh et al., 2011). In this process, data of all selected criteria were displayed and analyzed individually. Finally, all criteria displayed on maps were overlaid to produce the recreation service land evaluation map. Thus, to produce a land evaluation map, the collected evaluation criteria can be integrated into the MCE model, and these criteria have to be transferred to layers on ArcGIS environment to converted to maps (Table 3, Fig. 4).

Evaluation Criteria Weight Calculation

The AHP is one of the most extended MCE techniques. This method provides a structural basis for quantifying the comparison of decision elements and criteria in a pair-wise technique (Chandio et al., 2013; Li et al., 2018). Therefore, in the present study, we asked experts about their opinion to rate land evaluation criteria of recreation

service based on their importance. And then each criteria weight was calculated by considering the priority suggestions from experts by using the AHP method. Based on the properties of reciprocal matrices, the Consistency Ratio (*CR*) index can be calculated to ensure the credibility of the relative significance used.

$$CR = CI/RI \quad (1)$$

Where *CI* is Consistency Index and *RI* is Random Inconsistency index. In general, if the CR index is ≤10%, then the degree of consistency is considered constant and acceptable. But if CR is larger than 10%, then there are inconsistencies in the assessment process, and the results should not be used in the evaluation process and not acceptable, and the evaluation process has to be revised (Bunruamkaew and Murayama, 2011).

Land evaluation criteria weights have been calculated by using a pairwise comparison matrix. For every two criteria, the pair-wise comparison matrix was applied by utilizing a nine-point scale. The nine-point scale includes 9, 8, 7, ..., 1/7, 1/8, 1/9, where 9 means extreme preference, 7 means very strong preference, 5 means strong preference, and so on down to 1, which means no preference (Table 4).

The pairwise comparison matrix allows the evaluation of the contribution of every criterion, therefore it simplifies the process of decision-making. The consistency index (*CI*) of the matrix was calculated as:

$$CI = (\lambda max - n)/(n - 1) \quad (2)$$

Where *CI* is the consistency index, λmax is the largest eigenvalue of the matrix, and *n* is the number of criteria.

Land Evaluation Map Creation

In the present study, the recreation and tourism land evaluation map were produced, based on the Weighted Linear Combination (WLC) of each selected indicator's suitability score by using Equation 3. To calculate the recreation and tourism land evaluation indicator weights and identify the importance rate for all indicators, the AHP method has been applied. The land suitability score "*SE*" for each site in the study area was calculated from the WLC of the land suitability score gained from each involved indicator. By using the WLC procedure and raster calculator tool in ArcGIS, the recreation service land suitability evaluation model has been established by using the following equation:

$$SE = \sum_{i-1}^{n} WiXi \quad (3)$$

Where *SE* is the value of the recreation service suitability evaluation; *n* is the total criteria number; *Wi* is the weight result of each indicator *i*, and *Xi* is the suitability map for each involved indicator in our analysis.

Like the indicator map, the land evaluation map of recreation service was also divided into four classes and these classes were given the numerical values (1-4), which represent Most-suitable (S1), Suitable (S2), Low-suitability (S3), and Not-suitable (N), respectively.

Table 4 The comparison scale in the AHP method (Saaty and Vargas 1980)

Scale of importance	Definition
1	Equal importance
3	Slight importance
5	Strong importance
7	Demostrated importance
9	Absolute importance
2, 4, 6, 8	Intermediate values

RESULTS

Criteria Order and Weights

Based on the expert's questionnaire analysis, first of all, experts have scored both the distance from attractive points and distance from residential areas criteria as the most important factors to evaluate recreation service, followed by distance from water bodies. In the contrast, all the remained indicators were received the lowest importance compared to previous indicators. The previous results ensure the rank of the land evaluation criteria of recreation service from the most important to the least important, as it follows: distance from attractive points; distance from residential areas; distance from water bodies; soil erosion; distance from active pollution point; distance from road and transportation; vegetation density; slope; and type of land use/cover (Table 5).

Based on the expert order of recreation and tourism land evaluation criteria, these criteria' weights have been calculated by using the AHP method. Table 5 shows the importance and weights of recreation and tourism land evaluation criteria. Based on the AHP result, the criterion distance from attractive points received the highest weight (34.00%) with a consistency ratio (CR) of 0.78, followed by distance from residential areas and distance from water bodies criterion (23.20% and 14.10% respectively) with CR of 1.19 and 1.45, while all the remained land evaluation criterion received the least weight (range from 7.10% to 2.70%). Table 5 presents the attribute of recreation service land evaluation criteria in Aswan city and indicate the percentage of its weight with Consistency Ratio (CR) for each evaluation criterion. The consistency ratio of the evaluation process was calculated for recreation service evaluation criteria. It was found less than 0.1 (0.077), which means our evaluation process is constant and acceptable to can be used in the suitability evaluation process in Aswan city. The pair-wise comparison matrix for every two indicators and computation of CR are given in Table 5.
Evaluation Criteria Classification

The specified land evaluation system was used to reclassify recreation service land evaluation criteria in line with the degree of effect on the land evaluation

Table 5 Evaluation indicators weight and ranks by using pair-wise comparison.
CI: consistency index; RI: random consistency index; CR: consistency ratio.

Criteria	Dist. WB	Dist. AP	Dist. CPP	Dist. R$T	Dist. RA	LU type	Slope	Veg. density	Soil erosion	Weight (%)	Consistency Index	Priority
Dist. water bodies (WB)	1.00	3.00	5.00	7.00	5.00	0.20	3.00	9.00	0.33	14.10%	1.45	3
Dist. attractive points (AP)	0.33	1.00	3.00	5.00	0.33	0.11	3.00	0.33	0.14	5.20%	1.39	6
Dist. active pollution points (CPP)	0.20	0.33	1.00	3.00	0.33	0.14	5.00	0.20	0.11	4.20%	1.42	7
Dist. road and transportation (R$T)	0.14	0.20	0.33	1.00	0.20	0.14	3.00	0.20	0.11	2.70%	1.13	9
Dist. residential area (RA)	0.20	3.00	3.00	5.00	1.00	0.11	3.00	0.33	0.14	6.10%	1.61	5
Land use (LU) type	5.00	9.00	7.00	7.00	9.00	1.00	9.00	7.00	3.00	34.00%	0.78	1
Slope	0.33	0.33	0.20	0.33	0.33	0.11	1.00	3.67	0.14	3.40%	1.16	8
Vegetation density	0.11	3.00	5.00	5.00	3.00	0.14	0.27	1.00	0.14	7.10%	2.03	4
Soil erosion	3.00	7.00	9.00	9.00	7.00	0.33	7.00	7.00	1.00	23.20%	1.19	2

CI= 11.04, RI = 1.45

CR = 7.70% <10% acceptable

Table 6 Site evaluation criteria reclassification

Dist. from water bodies (m)		**Dist. from attractive points (m)**		**Dist. from active pollution points (m)**	
Classes	LER	Classes	LER	Classes	LER
0-300	MS (4)	0-250	MS (4)	0-700	NS (1)
301-700	S (3)	251-500	S (3)		
701-1000	LS (2)	501-700	LS (2)	>700	MS (4)
>1001	NS (1)	>701	NS (1)		
Dist. road and transportation (m)		**Dist. residential area (m)**		**Land use type**	
Classes	LER	Classes	LER	Classes	LER
0-500	MS (4)	0-500	MS (4)	Grassland	MS (4)
501-1000	S (3)	501-1000	S (3)	Bare Land	S (3)
1001-2000	LS (2)	1001-2000	LS (2)	Sand Land	LS (2)
>2001	NS (1)	>2001	NS (1)	built-in	NS (1)
Slope (%)		**Vegetation density (%)**		**Soil erosion**	
Classes	LER	Classes	LER	Classes	LER
0-6	MS (4)	0-10	NS (1)	High	NS (1)
7-20	S (3)	11-40	LS (2)	Moderate	LS (2)
21-30	LS (2)	41-70	S (3)	Low	S (3)
>30	NS (1)	>71	MS (4)	Very low	MS (4)

LER: Land Evaluation Rate

process. Each criterion was categorized, and their land evaluation scores were presented in the standardized map format. The land use/cover classes in the study area were categorized into these four evaluation classes. They are as follows: Most-suitable (Grassland), suitable (Bare Land), low-suitable (Sand Land), and not suitable (built-in) for recreation service (Table 6, Fig. 5). Table 7 illustrates that both bare land area and built-in area cover more than half of the total area of the case study (35.12% and 27.54% respectively), while sand land area covers around a fifth of Aswan city accounting for 17.55% of the total area. However, both grassland and water bodies cover almost the same area, 9.92% and 9.87% respectively.

Consequently, the total land evaluation score from each factor was pulled together to calculate the land evaluation map for recreation service by using Equation 3. The evaluation classes are defined as:

(1) Most-suitable (MS) class: it indicates a land parcel of high suitable that is located a considerable distance from natural and culture attractive sites which is close to residential areas and water sources and easy access to from the towns and that is

Table 7 Type of Land use/cover areas

Type of Land use/cover	Area (ha)	Area (%)
Grassland	1161.9	9.9%
Bare land	4113.0	35.1%
Sandy surface	2054.7	17.5%
Built-in	3224.6	27.5%
River (Water)	1155.8	9.8%
Total	11710.3	100%

suitable for developing recreation service in Aswan city.

(2) Suitable (S) class: it indicates a land parcel that fulfills many land evaluation criteria that may optimize the existing recreation and tourism resources to properly develop and promote a mass kind of recreation service and that could provide various opportunities for creating recreation service services in these sites with some modification.

(3) Low-suitable (LS) class: it is an intermediate level between the unsuitable and suitable classes.

(4) Not-suitable (NS) class: it indicates a land parcel that relatively not fulfills many land evaluation criteria that is not suitable for developing recreation services in the study area which requires strict urban regulations.

Land Evaluation Map

We performed the land evaluation of recreation services by utilizing the spatial analysis tools and a comprehensive overlay analysis of ArcGIS on each evaluation criteria to obtain the final evaluation value. Like land evaluation criteria, the values of the land evaluation map were divided into four classes: not-suitable (N), low-suitable (S3), suitable (S2), and most-suitable (S1) (Fig. 5). Overall, the results indicate that the spatial distribution of recreation and tourism services in Aswan city is high in the middle of the area, especially along the Nile River, and low in the east and southwest. Based on the land evaluation map, the most-suitable (S1) area is located in the middle of the study area and about 2892.2 ha, accounting for 25% of the study area. Most of these areas are water bodies like lakes and rivers, and areas with high green coverage. While the suitable area (S2) is 4523.5 ha large, accounting for 39% of the case study area. It contains built-in areas and urban areas surrounding by green space. The less-suitable (S3) area is 3029.0 ha large, accounting for 26% of the study area, and most of these areas are characterized by low-density urban construction land with serious ecological and environmental problems, like areas close to active pollution sites. The not-suitable area has a size of 1200.6 ha, accounting for 10 % of the study area. It is mainly the area that has a low density of built-in and urban construction and population, such as desert and sand lands. Therefore, it is necessary to create new recreation service for all un-covered spaces with recreation sites as far as possible, to improve the

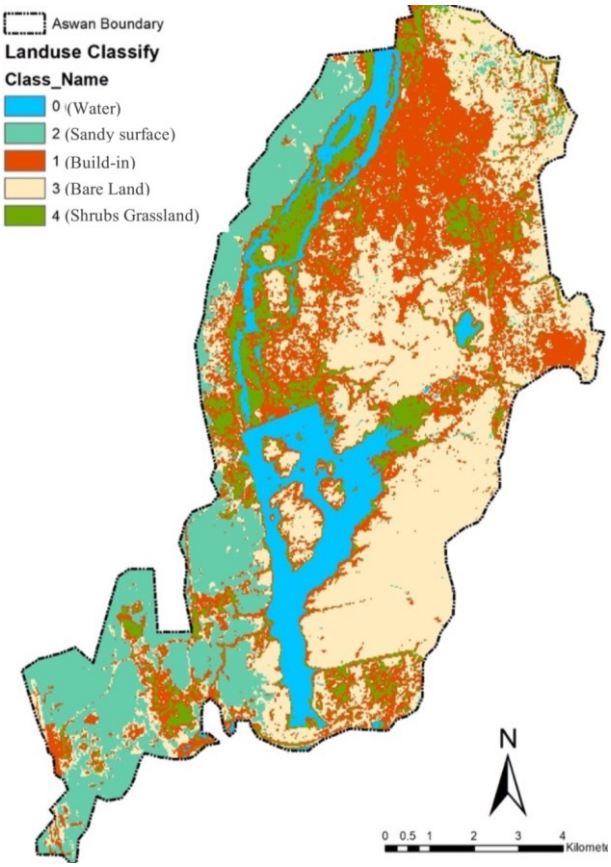

Fig. 5 Land use classification map

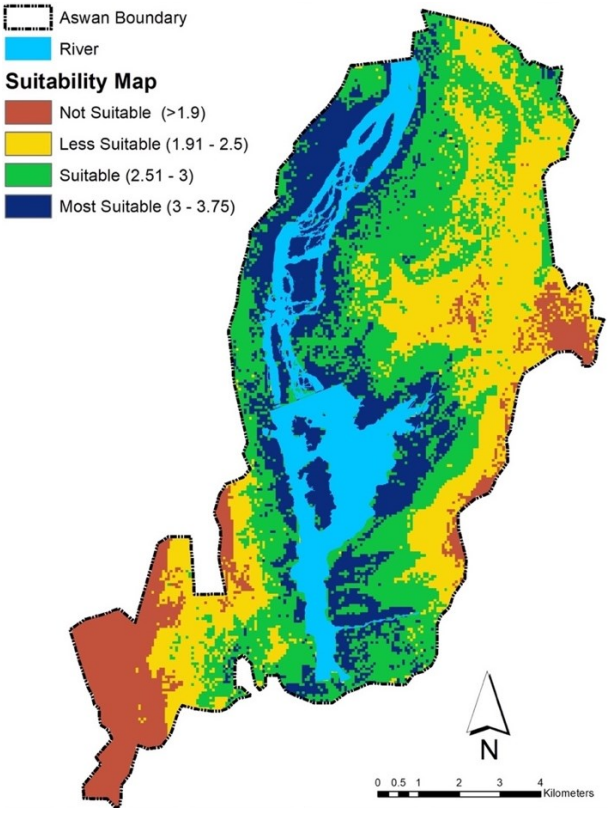

Fig. 6 Recreation and tourism services land evaluation map

Table 8 Utilized classification index for land evaluation map

Definition	Classes	Index Value	Area (ha)	Area (%)
Not Suitable	N	<1.9	1200.7	10 %
Less Suitable	S3	1.9-2.5	3029.0	26%
Suitable	S2	2.5-3	4523.5	39%
Most Suitable	S1	>3	2892.2	25%
		Total	11645.4	100%

distribution of these kinds of services in the sand and bare land areas and motivating the urban planning extension in those areas. Based on our evaluation of the study area, we concluded that the most suitable lands for recreation service planning are the sites where the environmental and ecological problems, like pollution, are not appropriate, but high vegetation density and green space is urgently needed. With regards to the analyzed results of the land evaluation process, the most suitable lands for recreation service are mainly distributed in the areas which are along both banks of the Nile River. Table 8 indicates and compares the land suitability classes of recreation service in Aswan city in terms of index value and area. Whenever the land suitability index value increases, the potential land suitability for developing recreation service raise.

DISCUSSION

Land evaluation of recreational facilities is the most effective approach before we began the planning and outlining process (Li et al., 2018). Hence, it is necessary to consider many spatial criteria for evaluating the suitability of study area land for creating and assessing the current recreation and tourism facilities before considering public opinions and demands, and also planning needs in the recreation and tourism planning process (Ebrahimi et al., 2019). Land suitability evaluation of recreational and tourism services is essential when planning and developing any region effectively. Moreover, the land evaluation before the planning process will serve to prevent wastage of financial and human resources. In this study, questionnaires were used to rank and weight the recreational and tourism evaluation criteria based on their importance in the planning process, and then the integration between GIS and MCE method was used for land evaluation of current recreation and tourism services and indicate the suitable lands for potential services. Through this GIS-MCE approach, an effective framework for land evaluation of this kind of services was presented, the selection of evaluation indicators, and the determination of a suitable weight for each indicator had a direct influence on the final land evaluation map results (Ebrahimi et al., 2019).

The results revealed that there are five categories of land evaluation maps of recreation and tourism including areas with very high spatial suitability, areas with high spatial suitability, areas with moderate spatial suitability, areas with low spatial suitability, and areas with very low spatial suitability. And these suitability categories were utilized in the evaluation of the current state of existing recreation and tourism sites which is called land evaluation in Aswan city. Moreover, this study also supports the recommendations of establishing other recreation and tourism activities in order to allow expansion of the urban masses of Aswan city and ensuring all study area covered with recreation and tourism facilities and motivate the urban planning development of these kinds of services. In our study, distance from residential areas, water bodies, road and transportation, and natural and cultural attractions were determined with distance analysis in GIS and all of the mentioned criteria are classified to four grads based on their importance, and slope classification was obtained from the digital elevation model (DEM). Furthermore, soil loss/erosion indicator was created by classes were taken from World Digital Soil Map (WDSM). Distance from natural and cultural attractive sites is an important factor in land suitability evaluation of recreation and tourism services because it plays an essential role in how the public preferences are interacting with the natural and cultural attractive sites. Moreover, type of land use/cover and vegetation density are necessary as well for urban development of current and future recreation activities. Besides, some studies have addressed the connection between the distance to water sources criterion and how often locals use recreation service services. Due to reach the recreation service services area that has natural and culture attractive sites, easy access should be taken into our consideration. In addition, for different recreational activities such as swimming, walking, and running, there are many important indicators that have to be used to identify the suitable sites for creating new recreation activities such as soil loss/erosion, slope, and distance to roads.

The benefits of using the AHP method in solving site suitability decision problems which is a multi-criteria decision process integrated into GIS which used in the land suitability evaluation process and it was expressed by Chandio et al. (2013). Moreover, according to many studies, such as Aklıbaşında and Bulut (2014), this methodological approach has other advantages like increasing the accuracy of used data and contributing to the planning process efficiency and allowing a quick process of a large amount of spatial information particularly for analyzing a large area. In our study, the AHP method was utilized to conduct the pair-wise comparisons for many different factors by applying AHP method equations (e.g. Equations 1-3)

in Excel sheets. The normalized weights for each recreation service land evaluation criterion were calculated by utilizing a pair-wise comparison matrix (Table 5). By asking experts to order the land evaluation criteria based on their importance for producing recreation and ecotourism services suitability map, the pair-wise comparison matrix was calculated. Furthermore, a standardized weight of each criterion was calculated from the pair-wise comparison matrix, allowing the assignment of weighting to each criterion by using Equation 3. The highest value was for distance from attractive natural and cultural sites and the lowest was for the type of land use/cover criterion. The land evaluation of the study area determined that sites located around water bodies and have natural and cultural attractive points are the most.

Therefore, Aswan city has a great opportunity for developing suitable lands for recreation and tourism activities. However, land that is not close to both water bodies or roads and transportation and that has just a few attractive sites been mainly not suitable for recreation and ecotourism activities. Furthermore, there are some sites within our study area that are close to active pollution points and located on steep slopes and thus are also not suitable for recreation and ecotourism sites. In general, our results indicate that Aswan city has good natural and cultural resources for developing and supporting recreation and ecotourism services in the future. Because more than half of the study area consider suitable and most suitable areas and most of these areas include sites that have distance from active pollution points more than 700 m, distance from all of the residential area, water bodies, attractive points, and public transportation less than 1000, 700, 500, and 100 m respectively, with a slope less than 20% and lands with low and very low soil erosion. The investigation of the present study shows that Aswan city has a great potential opportunity for successful urban planning and improvement of current and future areas for many different types of recreational and ectourism activities. Moreover, Aswan has some site which locates on the Nile banks, which is considered as tourist attraction sites, and it considers appropriate site where tourist can practice the hobby of swimming and sailing boats also. In addition to natural and cultural attraction destinations, tourist travel to Aswan to visit the islands of plants like El-Nabatat Island, museums like the Nile Museum and Nubian Museum, and temples on the islands of the middle of the river like the Temple of Philae, and other areas suitable for walking, jogging and running, around the River.

CONCLUSION

The recreation and ecotourism land evaluation process used in this study demonstrated how MCE approaches can be incorporated into the GIS planning and decision process to evaluate the current state of recreation and ecotourism facilities based on spatial criteria. Additionally, combining MCE and GIS contributed to a more robust understanding of current recreation site distribution patterns and suitable areas for potential recreation and ecotourism activities in the future. Moreover, this study provides a foundation for planners and decision-makers to continually develop and improve the urban planning approaches for future recreation and ecotourism facilities sites. Furthermore, this study was able to identify, weigh, and rank the evaluation spatial criteria of land evaluation for recreation and ecotourism services in Aswan city based on different kinds of site evaluation criteria. Land use/land cover and visibility are considered to be the highest-ranked indicators, respectively.

Our study area constitutes one of the main recreations and ecotourism destinations around the world. Thus, land evaluation of recreation and ecotourism services is a multi-criteria decision problem, which needs to meet the functional planning requirements and indicators. The evaluation methodology utilized in this study that is conducted for land evaluation of recreation and ecotourism services can also be applied to other land evaluation process. GIS-based AHP as an MCE approach is applied in this evaluation study. The main benefit of this evaluation approach is that it can be applied quickly using the data processing in ArcGIS environment. Thus, the concluded results of the present study will be useful with GIS-based land evaluation and suitability analysis modeling in land-use development and assessment plans. of recreation and ecotourism sites in the future. Moreover, this study also supports the recommendations of establishing other recreation and tourism activities in order to allow expansion of the urban masses of Aswan city and ensuring all study area covered with recreation and ecotourism facilities and motivate the urban planning development of these kinds of services. Therefore, for future planning, it is important to make an ecological and environmental connection between both current recreation and ecotourism sites and potential sites and cultural and natural attraction sites in the study area. On the other hand, planner and decision-makers could be better consider these mapping indicators/criteria when planning for new sites for recreation and ecotourism activities in Aswan city. it would be better to integrate the natural and cultural attractive sites in Aswan city and the suggested or potential recreation and tourism sites and consider the land evaluation criteria/indicators which effect on the suitability of the planned sites.

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