Research Paper

Evaluating Land Use and Natural Resources for Sustainable Ecotourism Site Development and Its Contribution to Urban Economy

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Abstract

The complex characteristics of tourism require effective tools to incorporate tourism development in decision making, which will help to meet the economic, social, and environmental demands of future sustainable development. There is ample opportunity to develop ecotourism in Rajshahi city and its neighbourhood that would generate both employment and income of people and foster development in the area. This study aims to evaluate the land use and natural resources for future sustainable ecotourism site development using Geographic information system (GIS). Land use/land cover (LULC) data estimated from satellite image for the year 2018 and Analytical Hierarchical Process (AHP) data collected from expert opinion was integrated with GIS to evaluate the best-suited ecotourism suitability zones. AHP is an expert opinion based approach and helps to identify the suitable ecotourism zone in Rajshahi. This study selected five criteria and four GIS-based layers in determining what areas are best suited for ecotourism development. These are physical (land use/cover), topography (elevation, slope), accessibility (proximity to open space and water bodies, distance from roads) and environmental characteristics (NDVI). The output of the study is effective for tourism facilities development, ecotourism resource utilization, and identifying the suitable ecotourism site where ecotourism could be more developed. Moreover, the results can be helpful for environmental managers and planners working in local, central governments and non-governmental organizations. These integrated approaches help to solve the complex and universal issues regarding the sustainable development of ecotourism, biodiversity conservation and improve the urban economy of any countries.

Keywords:

GIS; Ecotourism; Analytical Hierarchical Process; LULC.

1. Introduction

Ecotourism is increasing its attention not only as a substitute to mass tourism but also as a resource to promote a country's economic development and environmental conservation(Tewodros, 2010, Kafy et al., 2018c). Ecotourism means a sustainable form of natural environment based tourism which combines environment and economy to minimize harmful impacts and focuses on local culture and wilderness adventures (Reza et al., 2009). Ecotourism defined by McCormick (1994) "purposeful travel to natural areas to understand the culture and natural history of the environment, taking care not to alter the integrity of the ecotourism. Ecotourism creates economic opportunities that make the conservation of natural resources beneficial to local people" (Hossen et al., 2014). Ecotourism is focused on the natural environment and relies on natural and cultural heritage (Bunruamkaew and Murayama, 2012, Kafy et al., 2018b). Compared to other consumptive economic uses, there is no doubt that ecotourism represents more friendly alternatives for economic use of natural resources (Randolph, 2004).

Since the late 20th century, there has been a growing trend towards ecotourism in both the developed and developing world (Wanyonyi et al., 2016). The concept of ecotourism is now a common issue for the developed countries whereas it is still a new area for the tourism industry in Bangladesh as a 'gold mine' for her unparalleled bio-diversified natural habitats, wildlife and ancient heritages (Ahsan, 2008). Bangladesh has an appealing natural environment and numerous historical and cultural sites that can be used for tourism growth (Rahman et al., 2010, Rahman, 2010). Rajshahi district is decorated with a number of cultural heritage sites and land diversity full of natural resources. That is why the study aims to evaluate and monitor the natural resources used for ecotourism site selection on the land ecosystem in Rajshahi City and its neighbourhood areas. The methodology is to generate land use/land cover (LULC) map for ecotourism and present a suitable space for ecotourism development.

The use of Information Technology in tourism has been an issue of growing importance during the last years (Farsari, 2016). Geographic Information System (GIS) can be used in tourism as a decision-supporting tool for sustainable tourism planning, impact assessment, visitor flow management, and tourism site selection (Rahman et al., 2010). To form the base of a decision support system for policy and decision making in sustainable tourism GIS is helpful (Wanyonyi et al., 2016, Farsari, 2016). A GIS helps to classify the Landsat Imagery to evaluate the land use and natural resource distribution and also for suitability analysis. The integration of the AHP with GIS combines decision support methodology with powerful visualisation and mapping capabilities which in turn facilitates the creation of land use suitability map (Bunruamkaewa and Murayamaa, 2011, Kafy et al., 2019). These two methods together help to define the suitable zone for ecotourism development, considering the ground information and expert opinion.

Some operations can degrade natural resources due to the fast development of mass tourism, particularly when confronted with poor management and moving towards ecotourism can be a solution to this (Tewodros, 2010, Hossen et al., 2014, Wanyonyi et al., 2016). If proper steps can be taken to protect the ecotourism spots along with adequate measures to make the destinations as eco-tourist-friendly with appropriate policy to allow ecotourism, it will also improve the socio-economic condition of remote local people and Bangladesh will be able to earn a considerable amount of foreign exchange through it.

Ecotourism has a chain of impacts. It has a multiplier effect in an economy, which is very much rewarding for the growth of a country (Ahsan, 2008, Kafy et al., 2018c).

Ecotourism's is a useful tool for sustainable development, which is the main reason why developing countries adopt conservation strategies resulting in economic development. The area appropriate for ecotourism must be identified to assist in the decision-making of the concerned authorities and to conserve the environment of these attractions. This study aims to evaluate the land use and natural resources for future sustainable ecotourism site development in Rajshahi city using Geographic information system (GIS) and AHP methods and analyse how it impacts the urban economy.

2. Materials and Methods

2.1. Study area

Rajshahi city is situated in the ancient Barind area. Rajshahi is the most significant metropolitan city in the northern part of Bangladesh. It lies between 24°07' to 24°43' north latitudes and between 88°17' to 88°58'east longitudes (Figure 1). The total area of the Rajshahi district is 2,425.37 sq.km. Rajshahi District was bounded by Naogaon District on the north, West Bengal of India, the Padma and Kushtia District on the south, Natore District on the east and Chapainawabganj District on the west. The region consists of Barind tract, Diara and Char lands. Rajshahi Development Authority (RDA) stands on the bank of the river Padma. The total area of the RDA is 364 Km^2(Kafy et al., 2018d, Clemett et al., 2006). The RDA is bounded in the east, north and west by Paba thana and in the south by the Padma river and the shape of the city is as like an inverted "T". The maximum length along the east-west direction is about 13 km and along north-south is 8 km (Rahman, 2004, Kafy et al., 2018c).

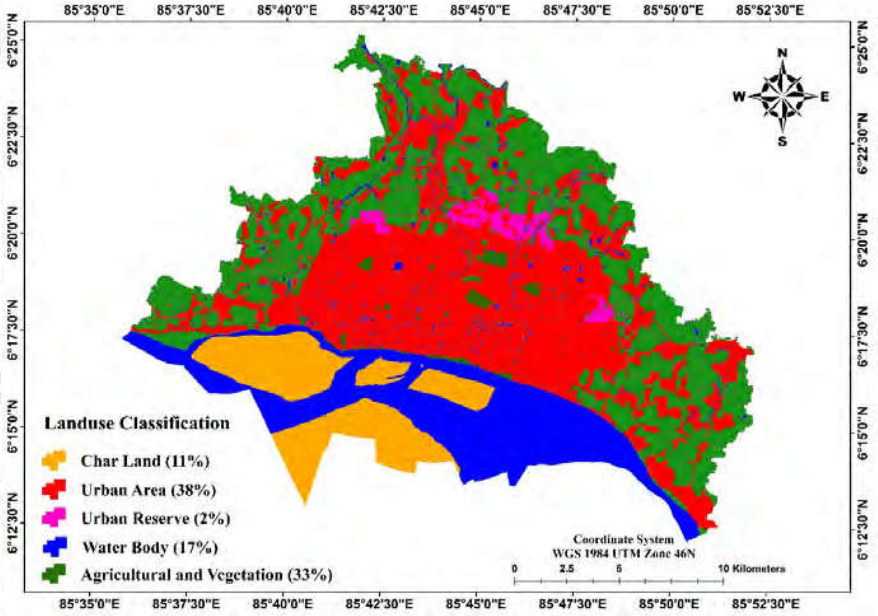

Figure 1 Classified LULC map of Rajshahi City, 2018

Rajshahi City has many tourist attraction places which are noticeable. First of all, Padma River, which itself is a source of beauty and a favourite place for river lovers. Rajshahi is

called as the 'City of Silk' because of flourishing silk industry. Rajshahi starts its journey as an urban centre by driving the business of 'Blue' and 'Silk'. Shaheb Bazar is the Central Business District (CBD) of the town where all traditional matters can be found. At present, a Mazar which is known as Hazrat Shah Mokhdum Ruposh (ra), is the most remarkable tourist spot of the city.

Additionally, Rajshahi Collegiate School, previously known as the first modern educational institute Boalia English School, is situated in the year 1828. It is believed that the institution is the first modern institution of Bangladesh. Now, Rajshahi city has several renewed institutes such as Rajshahi University of Engineering and Technology (RUET), Rajshahi University, Rajshahi Medical College, Rajshahi College and so on. That is why the city is called the 'City of Education'. Besides, Shahar Rakkha Badh, T-badh, I-badh, National Zoo, Varndra museum (the first museum of the country established in 1910), Zia Park, Lalon Shah Park and so on which are the most popular tourist attractive places in the city (Kafy et al., 2018c, Kafy et al., 2018a, Clemett et al., 2006, Rahman et al., 2010).

2.2. Materials and Method

2.2.1 Data Collection

Two types of data were used for this study; primary and secondary. Expert opinion and interview were one of the crucial primary data collection methods in this study. At the inauguration of the study, they were interviewed for selection of the suitability criteria. The experts were interviewed for one last time to determine the relative weight of the selected suitability criteria. For this purpose, evaluation forms were prepared. Twenty experts were interviewed for specifying the criteria weight. A various literature review was conducted in order to identify the criteria for suitability analysis for eco-tourism site.

Table 1 List of data and sources

Data	Scale	Source
Boundary Map	1:10,000	Rajshahi Development authority, Rajshahi, Bangladesh.
Land Used/Cover Map 2004	1:10,000	Rajshahi Development authority, Rajshahi, Bangladesh.
ASTER DEM (View-shed Map)	1:10,000	U.S. Geological Survey (USGS).
Tourist Map	1:50,000	Bangladesh Parjatan Corporation
Natural Attraction Places		Field Survey.
Protected Areas	1:10,000	Department of Land Record and Survey, Bangladesh.
Location of Park		Rajshahi Development Authority, Rajshahi, Bangladesh.
Road Map	1:50,000	Rajshahi Development Authority, Rajshahi, Bangladesh.
Population Data 2011		Bangladesh bureau of statistics, Bangladesh

To have an overview of the various multi-criteria decision-making tools and to identify the method for suitability analysis, guidelines for land use planning of other countries etc**.** All the secondary data related to the recent development plan of Rajshahi district and GIS database for Rajshahi city were collected from different organizations like RDA, UDD, DDC, BBS etc. (Table 1).

2.2.2 Selection of Criteria and spatial database preparation

The criterion is a general category of information by which the site being evaluated. To find out the suitable location for ecotourism is often consider some aspects such as physical factor like LULC, topography factors like slope and elevation, accessibility factor-like

accessibility to roads and open space and environmental factors like availability of park, open space and vegetation cover. By synthesising literature reviews, local contexts, expert opinions and available data six criteria were selected for this study. Twenty expert's opinion was undertaken for this study. Among them, eight experts ware urban planner, six experts were environmentalist, three experts were engineers, and other three experts were geographers.

Table 2 Factors and criteria in site suitability analysis for ecotourism

Factors	Criteria	Unit	Factor Suitability Rating			
			High	Moderate	Marginal	Not suitable
Physical	Land use/Land Cover	class	High	Moderate	Marginal	Not
Topography	Elevation	meter	300-400 m	100-300 m	> 400 m	0-100 m
	Slope	degree	0-5°	5-25 °	25-35 °	> 35 °
Accessibility	Proximity to open space and water bodies	meter	<500 m	500-1000 m	1000-2000 m	>2000 m
	Distance from roads	meter	<50 m	50-100 m	100-200 m	>200 m
Environmental	NDVI	Range	NDVI< 0	NDVI> 0.3	0.1 <NDVI< 0.3	0 < NDVI< 0.1

The evaluation of ecotourism site development was based on the six chosen criteria demonstrate in table 2. Criteria and criteria range were selected according to experience, expert opinion, and information gathered from literature review. Table 1 is given below showing the parameters with their suitability ranges from ecotourism site development perspective. Each of the sub-parameter is divided into Four ranges: S1 (Highly suitable), S2 (Moderately Suitable) S3 (marginal Suitable), N0 (Not Suitable) on the basis of FAO framework (Çetinkaya et al., 2018, Šiljeg et al., 2019, Bunruamkaew and Murayama, 2012)and expert opinion.

2.2.3 Determining Weight Values in AHP

Once the criteria for ecotourism site analysis were fixed, the relative weights of the parameters were determined using the AHP technique. At first, individual experts' opinions were undertaken. Experts were asked to score their preference values over the criteria using Saaty's 1–9 ratio scale (Wind and Saaty, 1980, Saaty, 2008). Saaty's 9-degree scale for qualitative judgment based on experiments (table 3). Many authors criticised Saaty's this scale and some authors tried to improve this scale but still no unique scale has been suggested other than Saaty's scale (Cengiz and Akbulak, 2009, Saaty, 2008). Besides, Saaty's scale is simple and easy to understand. To make the pair-wise comparison between two factors or criteria under 9-degree preferences scale following table 4 was used.

Table 3 Saaty's Scale for Pairwise Comparison

Preferences expressed in numeric variables	Preferences expressed in linguistic variables
1	Equal importance
3	Moderate importance
5	Strong importance
7	Very strong importance
9	Extreme importance
2,4,6,8	Intermediate value between the two adjacent judgments

Table 4 Factor preference by expert

Criteria	Importance (or preference) of one criterion over another																	Criteria
	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	
Slope													√					Elevation

Table 4 shows the diagram to choose a preference level between Land-use and Physical/Geological. At first an expert fixes his stance, either both criteria are equally important or not. If they are equally important, then the value is 1. If they are not, then the expert takes his position where he prefers. For example, in Table, an expert prefers Elevation over slope. So, he takes right side positions of 1. Finally, according to 9 degree preferences scale (Table 3) he marks his actual value of preference. In this diagram, the elevation got strong importance over the slope. So, the value of 5 on the right side of 1 was highlighted. Thus pair-wise comparisons were made for all the factors.

2.2.4 Land Suitability Assessment

In this process, the land suitability map for ecotourism site has been created, based on the linear combination of each used factor's suitability score, as shown in Equation (1). The AHP technique was used to determine the comparative significance of all the selected variables. The total suitability score "Si" for each land unit was calculated from the linear combination of suitability score obtained for each factor and criteria involved.

$$Si = \sum_{i=1}^{n} (WiXRi) \qquad (1)$$

where "n" is the number of factors, "Wi" is the multiplication of all associated weights in the hierarchy of "i^{th}" factor (as seen in Table 7) and "Ri" is a rating given for the defined class of the "i^{th}" factor found on the assessed land unit. In this process, after getting experts' opinions, the pairwise matrix was formed to calculate the relative importance of the factors and criteria involved. The calculations of the pair wise comparison matrix are given in Table 5.

2.2.5 Evaluation of Land Suitability in GIS

After finishing all the above steps, the GIS Model builder (Geo-processing tool) in ArcGIS (version 10.6.1) was used to develop a model for analysing the ecotourism site suitability based on different criteria and their weight. Initially different raster files for each parameter: Slope (degree) Elevation (m), Proximity to existing road (km), Proximity to open space and water bodies (km), and NDVI were prepared from the existing Geodatabase (. gdb) files. These raster files were then reclassified according to the suitability ranges. For calculating the suitability ranges Euclidian distance was followed. A '0-3' scale was used for reclassifying suitability ranges: '0' is not suitable, '1' being marginally suitable area, '2'being moderately suitable area and '3' is the highly suitable area. Finally, when all the layers were reclassified, these were overlaid following "weighted overlay method" to get the final suitability map. Based on the properties of pairwise comparison matrices, the consistency ratio index (CR) as shown in Equation (2) can be calculated. Saaty suggests that if CR is <0.10, then degree of consistency is fairly acceptable. But if it's >0.10, then there are inconsistencies in the evaluation process, and the AHP method may not yield meaningful results.

$$CR = \frac{CI}{RI} \quad (2)$$

Table 5 Establishment of the pairwise comparison matrix

Factor	C1	C2	C3	C4	C5	C6
Land use/Land Cover (C1)	1	1.02	2.05	4.23	5.52	4.2
Elevation (C2)	0.19	1	2.3	0.23	1.73	2.03
Slope (C3)	1	3	1	4.57	3.1	0.63
Proximity to open space (C4)	0.18	0.49	0.22	1	0.9	5.62
Distance from roads (C5)	0.25	0.58	0.32	1.11	1	1.74
NDVI (C6)	4.75	0.23	0.32	5.06	1.56	1

3. Result and discussion

3.1. Influencing factors in ecotourism suitability.

In Table 7 Factors and criteria selected for ecotourism, suitability analysis was ranked high (rank 1) to low (rank 6) to identify the most influential factors contributing to ecotourism site development. The ranking evaluated using the weighted sum approach in Arc GIS 10.6. From Table 7 it's noticeable that LULC was the highest rank criteria with total suitability 0.32. On the other hand green open space and water/riverside places along with dense vegetation cover area placed at 2nd and 3rd rank respectively with suitability value of 0.29 and 0.27. Hardly few places have higher topography because flat topography present in Rajshahi. People also pay less attention to those places of, and these places receive lower rank with slope and elevation receive 0.20 and 0.06 suitability respectively. Road accessibility creates positive impact on eco-tourism suitability and rank 4th with 0.22 suitability value.

Table 6 Factors and criteria ranking for ecotourism site suitability analysis

Factors	Criteria	Weight	Total Suitability	Ranking
Physical	Land use/Land Cover	0.46	0.32	1
Topography	Elevation	0.12	0.06	6
	Slope	0.1	0.20	5
Accessibility	Proximity to open space and water bodies	0.35	0.29	2
	Distance from roads	0.36	0.22	4
Environmental	NDVI	0.42	0.27	3

3.2. Identification of Ecotourism suitable site in Rajshahi City

Figure 2 describes the suitability map for ecotourism site in Rajshahi city. Four suitability classes were used (Table 6) to describe the data in maps, namely not suitable (0.0-0.2), marginally suitable (0.2-0.4), moderately suitable (0.4-0.8) and highly suitable (0.8-1.0). The suitability map illustrates that maxima area (218.4 km^2) in Rajshahi city is marginally suitable (S3) and located in outside the central part of the city. The significant amount of open space, greenery and good accessibility in those part create attraction and make those part marginally suitable for ecotourism. The area of moderately suitable (S2) is about 22%, and these are in the north-eastern and southern parts of the city. Only a few percentages (7% and 11%) of the area were classified as highly suitable (S1) and not suitable (N), respectively.

Table 7 Area coverage for ecotourism suitability classes

	Area Coverage		
Suitability Class	Score Range	Km^2	%
Highly suitable (S1)	0.75–1.00	25.48	7
Moderately suitable (S2)	0.50–0.75	80.08	22
Marginally suitable (S3)	0.25–0.50	218.40	60
Not suitable (N)	0.00–0.25	40.04	11
Total area		364.00	100

The high suitable ecotourism site mainly the Padma riverside places T badh, I badh, shimanto nongor and some museum-like Barandra museum and Kamrruzzamn park in Rajshahi city. If these places were equipped with more tourist attraction elements and maintain properly the local government can earn huge money and contribute to the development of local and national economy.

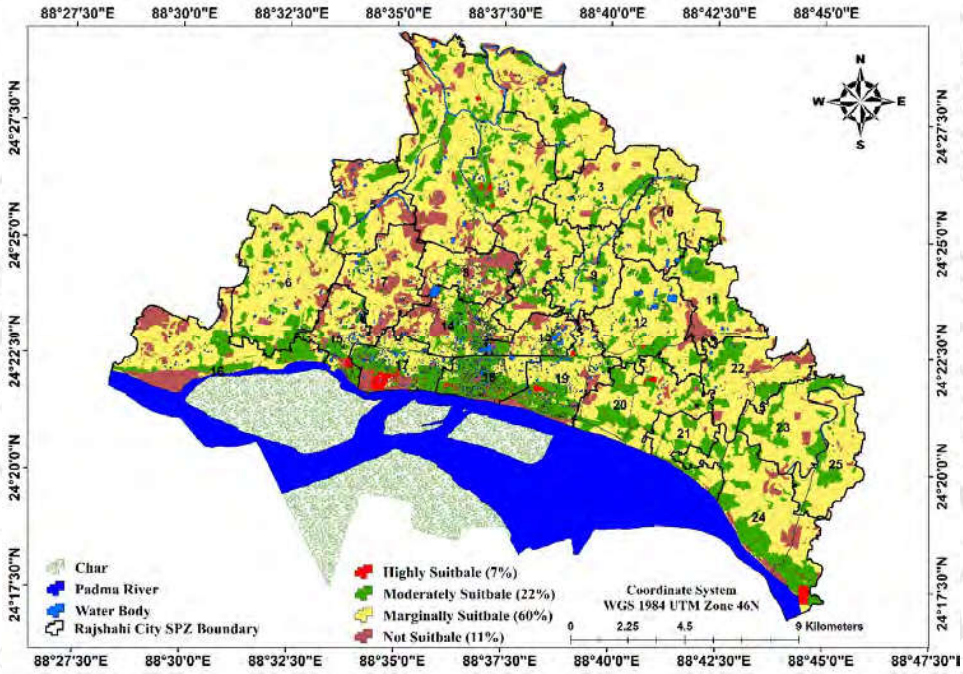

Figure 2 Suitability map for ecotourism in Rajshahi, Bangladesh

4. Conclusion

This research represents an integrated strategy to the development of ecotourism via the identification of ecotourism sites and the formation of methods to assess the ecotourism sustainability, by adapting the characteristics of the location. This method has been proven advantageous for assistant decision-making for tourism facilities planning and ecotourism resource utilization for sustainable development. The eco-tourism suitable map prepared using weight-based approach (i.e. AHP) in the current study and is the outcome of a combination of various factors responsible for eco-tourism suitability, in which each factor has relative significance. The availability of up to date data, higher-resolution satellite

images, better base maps will assist in producing high accuracy eco-tourism suitable maps. The research outcome will help the local community, urban planner and engineers to improve the facilities in high eco-tourism suitability locations and develop strategies which will contribute to the local and national economy.

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