Available online at http://www.journalcra.com

International Journal of Current Research
Vol. 7, Issue, 03, pp.14212-14217, March, 2015

INTERNATIONAL JOURNAL OF CURRENT RESEARCH

ISSN: 0975-833X

RESEARCH ARTICLE

USE OF REMOTE SENSING, GIS AND ANALYTICAL HIERARCHY PROCESS (AHP) IN SELECTION OF SUITABLE SITES FOR WILDLIFE HABITAT

***Gavade Vaishali and Dr. Patil, R. R.**

Department of Geoinformatics, School of Earth Sciences, Solapur University, Solapur 413255

ARTICLE INFO

Article History:
Received 19th December, 2014
Received in revised form
30th January, 2015
Accepted 19th February, 2015
Published online 31st March, 2015

Key words:

Site suitability,
Wildlife habitat,
Remote Sensing, GIS and AHP

ABSTRACT

The improvements in technology and procedures of data acquirement have been responsible for more faith in remote sensing and GIS application by researchers for site suitability studies. Study was conducted in Western part of Kolhapur District, Maharashtra to identify suitable sites for wildlife habitat. Habitats were evaluated using analytic hierarchy process (AHP) integrated with remote sensing and geographic information system. The evaluation process for wildlife habitat site was conducted based on 7 important factors viz. NDVI, River, Slope, Aspect, Elevation, Roads and Settlement. Each factor received a weight and a score which represented its relative importance in the suitability evaluation. The overall results recorded were in form of a pair wise comparison matrix. Thematic maps for each factor were created in ArcGIS 9.3 environment according to their score value. Result showed that out of total area 10.68% area was found very highly suitable, 14.76% as highly suitable, 20.72% as moderately suitable, 32.97 as less suitable and 20.85% as unsuitable.

INTRODUCTION

The term wildlife applied to all biotic elements that comprised every species of plant and animal in the world, excluding man and his domesticated pets. Modern civilization, by clearing the forests for settlements, agriculture and communication purposes, and by setting up large hydroelectric projects and industries has done irreparable damage to the natural system which directly effect not only surface water hydrology but also has threatened the wildlife habitat as well. Elephants, in search of food and water tend to enter human habitations and in the process, often came into direct conflicts to humans by destroying crops, live-stock or property and sometimes by even killing people (Kushwaha and Hazarika 2004; Sukumar, 1994). Human - Elephant conflict (HEC) had emerged as a major issue in the field of wildlife management in India (Easa, 2002; Kushwaha and Hazarika 2004; Singh *et al*., 2002; Sukumar, 1994). Asian Elephant (Elephas maximus), once widely distributed in Indian sub-continent, has now been categorized as "endangered" species as per IUCN red list. Conversion of forested land into settlements, agriculture, other infrastructure such as dams had led to fragmentation, shrinkage and degradation of elephant habitat as well as loss of traditional migratory paths results in increased HEC (Singh, 2002; Sukumar, 1994; Singh *et al*., 2002). The process of site suitability required the identification of the appropriate locations for a particular land use activity by considering physical resources (Laurin and Ongaro, 2006) (elevation, slope, aspect, climate), natural resources (soils, geology, hydrology, flora and fauna habitat, and environmentally sensitive areas), and existing land use and development (manmade facilities such as transportation systems, existing urban areas, and utility networks). These different types of information constituted the "criteria" based on which the area under consideration was evaluated (Keeney and Raiffa, 1993).

****Corresponding author: Gavade Vaishali***
Department of Geoinformatics, School of Earth Sciences, Solapur University, Solapur 413255.

Study Region

The area selected for the study covers Western part of Kolhapur district and incorporate western part of Chandgad, Ajra, Bhudargad, Radhanagri, Gaganbawada, Panhala, Shahuwadi tahsil. It is located between 15^0 72' to 17^0 12' North latitude and 73^0 64' to 74^0 28' East longitude covering an area of 1657 sq. kms. This area represents diversified physiography, its western part is covered by hills while the eastern part is represented by plateau area. Through the western part of study area Tamraparni, Hiranyakeshi, Vedganga, Dudhaganga, Bhogawati, Tulshi, Kumbhi and Kasari river are drained. Western part of study area exibited redish soil where as eastern part is covered by black soil. Seasonal rainfall ranges between 6000 mm in the West to 1150 mm in the East. Average temperature lies above 20^0C in winter and 35^0C summer respectively. The temperature fluctuation exibited by daily minimum temperature in night and maximum temp in noon is large.

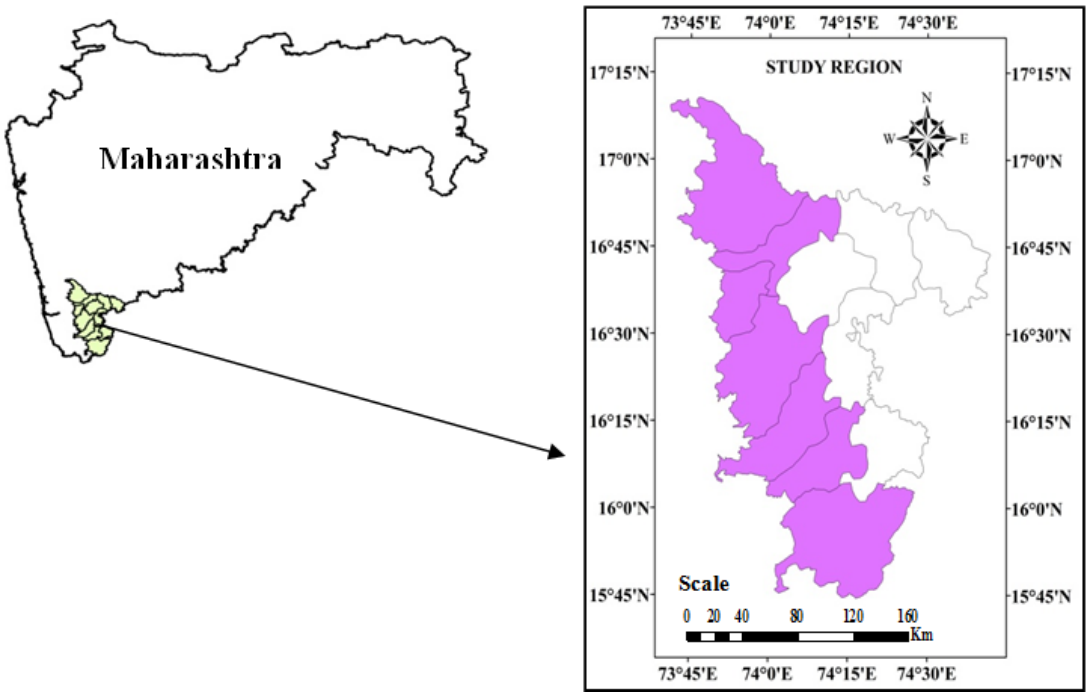

Figure 1. Location map of study region

Table 1. Description about data used for site suitability for wildlife habitat management and their source

S.No.	Input Data Layer/ Map	Source
1	Slope	DEM created from SRTM WRS 2 Tiles, Global Land Cover Facility (GLCF) http://glcfapp.glcf.umd.edu
2	Aspect	
3	LULC	IRS LISS III, January 2012, National Remote Sensing Centre (NRSA),Hyderabad
4	NDVI	
5	River	Survey of India Toposheets, Scale – 1:50000
6	Road	
7	Settlement	

Data Sources

This study focused on site suitability for wildlife habitat, based on some previous analysis of wildlife habitat for site suitability some of the environmental and demographical factors considered were slope, aspect, elevation, NDVI, river, road and settlement. All the maps were geometrically corrected and digitised using ERDAS IMAGINE 9.1 and ArcGIS 9.3 version respectively. The description about various data used for site suitability and their source are tabulated in Table 1.

Methodology

To suggest suitable site for wildlife habitat Analytical Hierarchy Process (AHP) (Saaty, 1977 and 1980) method was used. This method was attempted using an extension of AHP for ArcGIS 9.3 software.

Analytical Hierarchy Process (AHP) Procedure

Saaty's (1977 and 1980) used Analytical Hierarchy Process as a popular means to determine the weights which was one of the classical problems in multi-criteria decision analysis. AHP is considered as a mathematical method of analysing complex decisions problem with multiple criteria.

It was used with three principles: decomposition, comparative judgment and synthesis of priorities. The method used is indicated below with flow chart. The decision criteria and factors were evaluated based on Natural factors and anthropogenic factor of the land suitability evaluation for wildlife habitat management site suitability. The evaluation process for wildlife habitat site was conducted based on 7 important factors, namely: Land use/ Land cover, River, Slope, NDVI, Elevation, Roads and Settlement. Each factor received a weight and a score which represented its relative importance in the suitability evaluation. The overall results recorded were put in form of a pair wise comparison matrix.

Calculation of Score Value

Before any site suitability could be calculated, each raster layer of habitat variables ware reclassified into several suitability classes to input the score value. The habitat variables data had to be translated into numerical data, and all the data was standardized with same scoring systems. In the scoring techniques, the expected consequence of each option were assigned a numerical score on the strength of preference scale for each criteria with more preferred option having higher scores and lower option having lower scores as per the procedure suggested by Malczewski,1999.

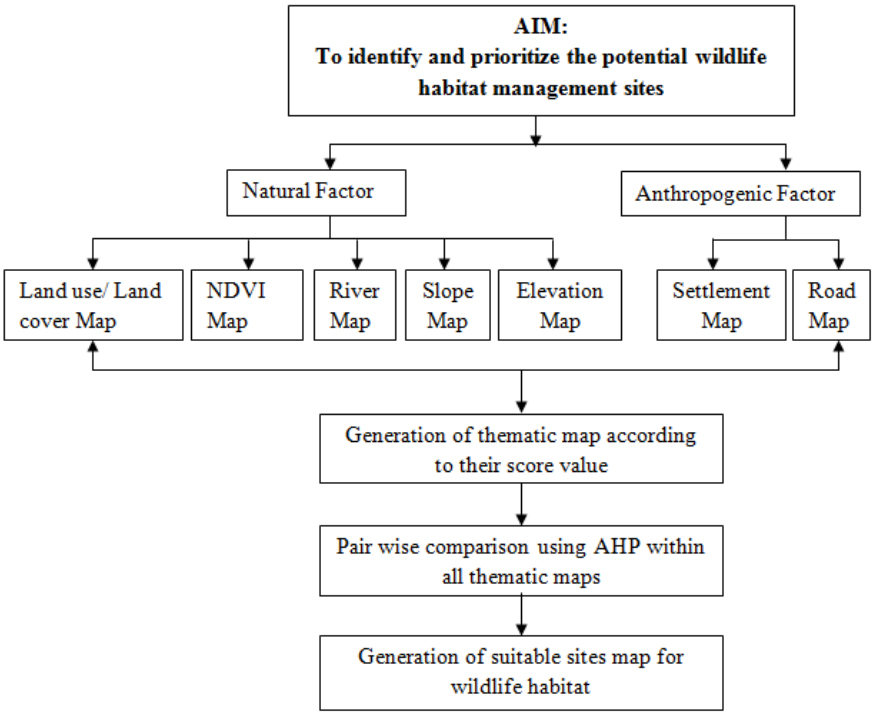

Figure 2. Flow chart of methodology

Table 2. Score value for wildlife habitat site suitability

Criteria/ Variables	Very High Suitability	High Suitability	Moderate Suitability	Less Suitability	Unsuitable
River buffer in meter	500	1000	1500	2000	Rest of study region
Slope in degree	0-5	5-10	10-15	15-30	30-49
Elevation in meter	800-1052	660-800	500-660	250-500	38-250
NDVI	0.50 to 0.86	0-34 to 0.50	0.18 to 0.34	-0.43 to 0.18	-1 to -0.43
Land use /land cover	Very dense forest, water	Moderately dense forest	Open forest, Grassland	Barren land	Agriculture, Fallow land
Road buffer in meter	Rest of study region	2000	1500	1000	500
Settlement buffer in meter	Rest of study region	3000	2500	2000	1500

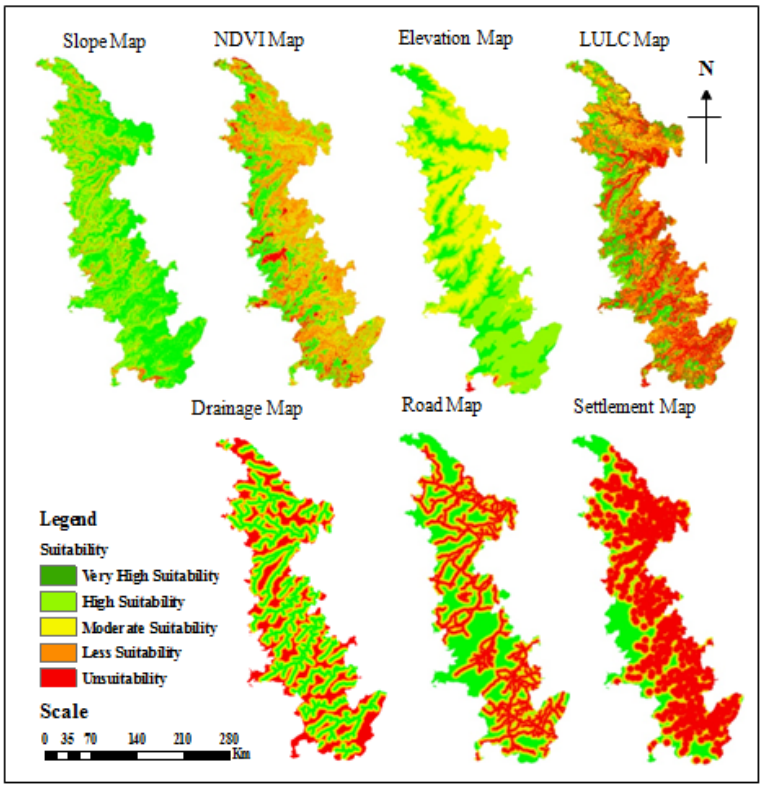

Figure 3. Thematic maps used for Wildlife Habitat site suitability

Table 3. Wildlife Habitat Pair wise comparison matrix

Criteria Maps	A	B	C	D	E	F	G	Criteria Weight
NDVI (A)	1	1	5	7	5	9	9	0.3771
LULC (B)	1	1	3	3	3	7	5	0.2498
River (C)	0.2	0.33	1	3	3	3	5	0.1359
Elevation (D)	0.14	0.33	0.33	1	3	3	5	0.0966
Slope (E)	0.2	0.33	0.33	0.33	1	5	5	0.0798
Road (F)	0.11	0.14	0.33	0.33	0.2	1	3	0.0362
Settlement (G)	0.11	0.2	0.2	0.2	0.2	0.33	1	0.0246

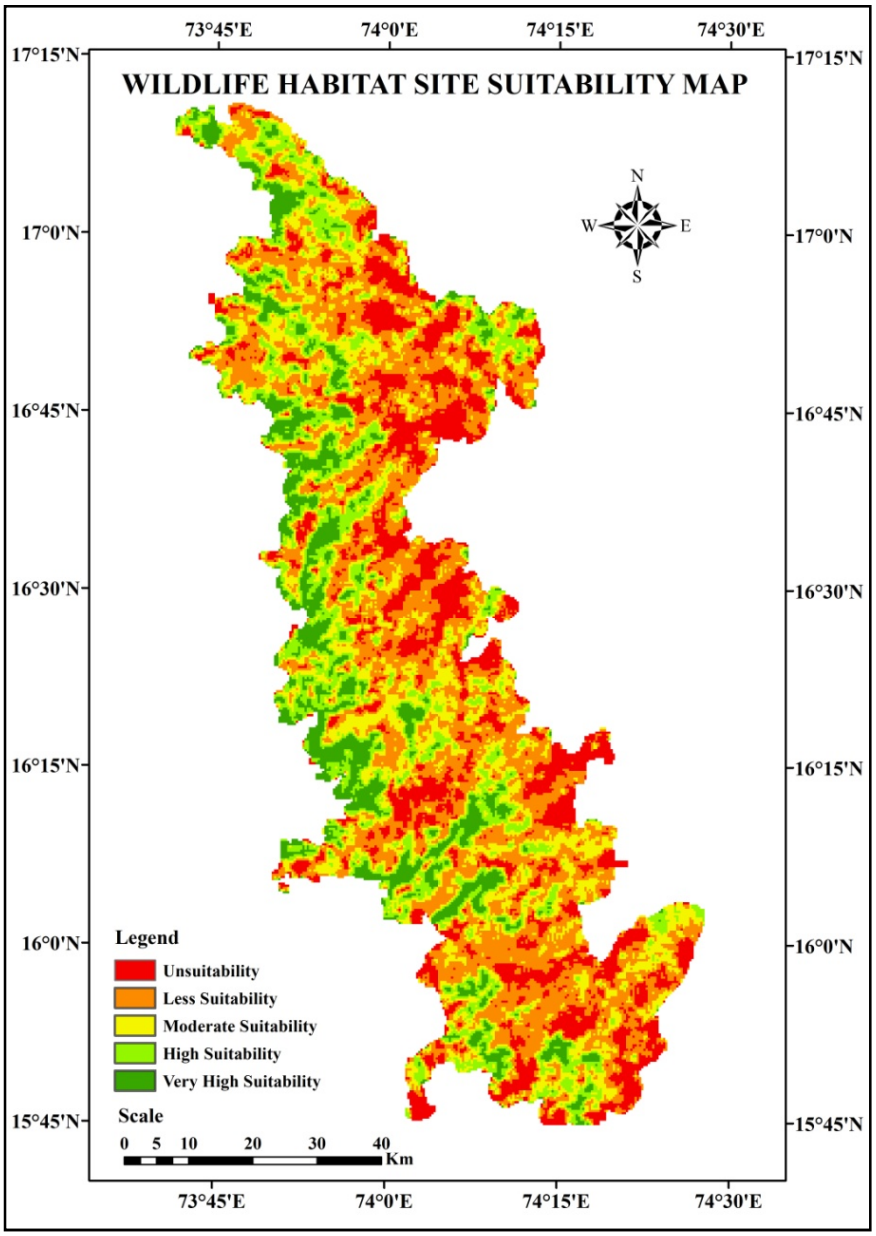

Figure 4. Site suitability map for wildlife habitat

Table 4. Area Estimated for wildlife habitat Site Suitability

Suitability Class	Wildlife Habitat Management Sites Suitability Area	% of Area
Very High Suitability	52554.9	10.68
High Suitability	72625.8	14.76
Moderate Suitability	101901	20.72
Less Suitability	162169	32.97
Unsuitability	102560	20.85
Total	491810.7	100

In this study, suitability criteria were developed based on previous study on habitat selection of elephant and Bison. The region of wildlife habitat site suitability variables were classified into five suitability type, with score value ranging from 1 to 9. Those were 1, 2, 3, 4 and 5 for unsuitable, less suitability, moderately suitability, high suitability and very high suitability respectively. Each variable layer was reclassified into five suitability classes to input score values using reclassify tool in spatial analyst ArcGIS 9.3 software. For some variables, raster data were reclassified using Jenks natural break. The Jenks' natural breaks classification scheme determines the best arrangement of values into classes by iteractively comparing sums of the squared difference between observed values within each class and class means. The best classification identified breaks in the ordered distribution of values that minimizes within-class sum of squared differences as per the procedure suggested by Jenks, 1967. Following Table 2 shows the criteria used for wildlife habitat.

Calculation of Weight Value

In this study the Analytic Hierarchy Process (AHP) was adopted to determine an objective and reliable weight value for wildlife habitat management variable. This analysis was done using an extension of AHP for ArcGIS 9.3 software. The analysis consisted of two steps; the first was defining the site suitability variables and second was determining the preference value of one variable against another.

Results

Generation of Thematic Map for Wildlife Habitat Site Suitability

By applying Table 2 score value following reclassified map were generated for wildlife habitat site suitability.

Pair wise Comparison

Weights obtained from pair wise comparison for each criterion are shown in Table 3 for wildlife habitat. NDVI received the highest weight (0.3425) whereas settlement received the lowest weight (0.0235) for wildlife habitat management. The Consistency Ratio obtained through AHP tool of AcGIS software for pair wise comparison was 0.1 for wildlife habitat site suitability.

Wildlife Habitat Site Suitability Map

The study carried out help to generate map given in Figure 4. Wildlife habitat site suitability found in some part of western side of study region was dependent on criteria where dense forest cover, good water facility and area represents gental slope with elevation above 800 mts.

In order to analyze the habitat suitability map of wildlife habitat management, the results were classified into five suitability classes (Figure 6.14). The classified wildlife habitat suitability map showed that very high and high suitability were located at west, north and south part of study region. This region was composed by Very dense forest cover, availability of water, away from settlement and road, accompanied with suitable slope and elevation for wildlife. The map delineated areal extent of each suitability type. 10.68% area was found very highly suitable, 14.76% as highly suitable, 20.72% as moderately suitable, 32.97 as less suitable and 20.85% as unsuitable.

Conclusion

To understand the environmental suitability of an animal, it is essential to understand those geographical factors that directly influence and are essential to them. From this study it could be eniciated that choice of habitat type for animals depends not only on food and water but also on other factors like elevation, slope, vegetation coverage, distance from road, settlement, river and existence of water bodies. It was noteworthy that species behaviour differed according to gender and its changing in psychology with season. Mapping the habitat suitability of the animal helped to find areas possible for the animals to live in, thereby helped in planning conservation practices to be adopted for endangered species.

This study was very helpful for decision making and expected to provide vital data useful in the wildlife management and conservation of elephant and bison. With the availability of satellite imagery data that covers almost all area in the world and combined with the powerful tools of GIS, this study is very useful and would also serve as path way and can be applied to other region for another species. The study would definitely help the planners from government and non-government agencies to increase employability and thereby to irradiate the poverty of these poor in habitants staying in villages along the forest border.

REFERENCES

Easa, P. S. 2002. Asian Elephants in India: A review.. In: V. Menon, S. K. Tiwari, P. S. Easa and R. Sukumar (eds.) Right of Passage: Elephant Corridors of India. Conservation Reference Series No. 3. Wildlife Trust of India, New Delhi, pp. 14-22.

Jenks, G. F. 1967. The Data Model Concept in Statistical Mapping. Int Yearb Cartogr 7, pp. 186–190.

Keeney, R. L., and Raiffa, H. 1993. Decisions with Multiple Objectives: Preferences and Value Trade-Offs, Cambridge: Cambridge University Press, 569 p.

Kushwaha, S. P. S. and Hazarika, R. 2004. Assessment of Habitat Loss in Kameng and Sonitpur Elephant Reserves. Current Science, 87, pp. 1447-1453.

Laurin, G. V., and Ongaro, L. 2006. Mapping the Suitability of Potential Conservation Sites: A Case Study in Northern Tunisia, *Journal of Agricultural and Environment for International Development*, 100 (1/2), pp. 3 – 28.

Malczewski, J. 1999. GIS and Multicriteria Decision Analysis. Wiley & Sons Inc., New York. 392 p.

Saaty, T. L. 1977. A Scaling Method for Priorities in Hierarchical Structures. *Journal of Mathematical Psychology*, 15, pp. 231-281.

Saaty, T. L. 1980. The Analytic Hierarchy Process: Planning, Priority Setting, Resource Allocation. McGraw-Hill, New York, NY, 437 p.

Singh, A. K., Singh, R. R. and Chowdhury, S. 2002. Human - Elephant Conflicts in Changed Landscapes of South West Bengal, India. *Indian Forester,* 128, pp. 1119-1132.

Singh, R. K. 2002. Elephants in exile: A Rapid Assessment of the Human-Elephant Conflict in Chhattisgarh. An Occasional Report of a Rapid Action Project as part of the Elephant Conservation Project. Occasional Report No.5, Wildlife Trust of India, New Delhi.

Sukumar, R. 1994. Wildlife-human Conflict in India: An Ecological and Social Perspective. In: R. Guha (ed.) Social Ecology. *Oxford University Press, New Delhi*, pp. 303-317.

****