Remote Sensing Techniques and GIS Applications in Earth and Environmental Studies

Abhisek Santra
Haldia Institute of Technology, India

Shreyashi Santra Mitra
Haldia Institute of Technology, India

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Chapter 13
Wildlife Habitat Evaluation

Peeyush Gupta
Intergraph SG & I India Pvt. Ltd., India

Swati Goyal
Guru Jambheshwar University of Science & Technology, India

ABSTRACT

Before an individual can evaluate wildlife habitat and make management recommendations, some basic concepts about habitat and its relationships to different wildlife species should be understood. In this chapter, some of the basic concepts will be described; mainly analyzing of habitat alterations, landscape analysis, networking and creation of corridor between protected areas, wildlife habitat suitability analysis using Remote Sensing & GIS. Since most of the contest will be based on these concepts. Like other natural resource fields, wildlife management is both an art and science that deals with complex interactions in the environment. This means that management includes art or judgment based on experience as well as sound factual information based on scientific studies.

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INTRODUCTION

The worldwide destruction of natural environment is reducing the number of species and the amount of genetic variation within the individual species. There are two principal approaches for protecting and managing nature:

1. To ensure survival of population of a given species abundantly.
2. Conservation of natural community in their original habitats.

During early seventies the 'Protected Area' concept obtained wider acceptability to check the process of depleting biodiversity. In India, this diversity is reflected in the fact that as many as 10 biogeographical regions representing three basic biomes and two natural realms are met (Champion et al., 1968). Major threats to biodiversity include habitat alteration, overharvesting, pollution, climatic change, introduced species and population increase. Of these, habitat alterations due to deforestation, habitat loss, fragmentation and degradation are primarily responsible (McNeely et al., 1990).

ANALYSING HABITAT ALTERATIONS

Tropical forests are facing disturbance of varying magnitudes in the different regions. The disturbances are leading to the following changes in the habitats:

- Loss of particular species and change in cover characteristic.
- Degradation due to reduction in canopy density.
- Changes in understory vegetation and invasion of exotic species.
- Fragmentation of forest areas leading to the loss of corridors, depletion of minimum habitat areas and reduction of home range.
- Habitats are often very susceptible to degradation viz., fire, overgrazing and cultivation. These factors make it difficult for original vegetation to reestablish (Gupta, 1991).

Above situation justifies the need of well- structured information system, which can allow access to the stored data and monitoring at very short time space. The continuous monitoring and habitat inventory should permit detection of changes related to the both, the habitat components and the immediate population for the analysis of their interrelationship and cause of change.

LANDSCAPE ANALYSIS

Evaluation of landscapes has emerged as an important branch to study structure and function and changes in the landscapes. Remote sensing provides information with respect to the homogeneous spatial units. The interrelationships of these units can be best evaluated through landscape analysis. Each landscape is formed of several landscape elements, which appear as patches and vary markedly in size, shape, type, and heterogeneity and boundary characteristics. Analysis of these parameters brings out the disturbance gradient in various habitats (Gupta et al., 2014). The remote sensing derived vegetation maps provide perspective horizontal view and helps in delineating different landscape elements and their spatial characteristics. (Gupta 2014) used satellite derived vegetation map for analyzing landscape elements of TehriGarhwal region. The analysis brings out structural and quantitative landscape perspective in the three management zones of the national park. The patch characteristics of vegetation units viz., size, shape, porosity and patch density has been studied. Medium patch size and porosity have been found to be the most important parameter to discriminate differences in the ecological status of three different zone of the park. The patchiness and shape of different vegetation types also provide valuable information and characteristics of the native, seral and retrogressive vegetation forms (MadhvanUnni, et al., 1990).

NETWORKING AND CREATION OF CORRIDOR BETWEEN PROTECTED AREAS

Forest area managed for wildlife should have a network of patches of old growth forest joined by dispersed corridors of similar structures and composition. Such corridors are multipurpose:

- They ensure that sub-populations are interconnected into demographically functioned unit.
- They offer some protection to surrounding agricultural lands.
- They decrease dispersal morality and release pressure on destination areas.

The demarcation of corridor should be based on an evaluation of land resources and it can be done using GIS using existing land use map and physical set up of the landscape. It is also important to incorporate social and economic data to check land utilization type and description of its key attributes. Such land mapping unit characteristics can be translated into qualities related to networking and corridor requirement using GIS (Jain et al., 1996).

WILDLIFE HABITAT SUITABILITY ANALYSIS

Habitat analysis is considered most important for management and planning of national parks. Wildlife habitat includes wide variety of factors viz., vegetation; cover characterization including human influence on all these, soil, topography and water availability. Since each species required a particular habitat to meet the requirement of space, food, cover and other needs of survival. The database with respect to above parameter can be used to identify the specific needs for particular wildlife for habitat suitability area analysis. Besides, other analysis like home range, tourist route planning and carrying capacity analysis can also be made using GIS (Maslekar, 1974).

AN EXAMPLE

Siwalik Himalayas are considered fragile ecosystem. The proposed Rajaji National Park (UP) located in the foothills of Himalaya represents typical Siwalik landscape. It is known for diverse vegetation types and potential habitat of many wildlife including Elephasmaximus (Asian elephant) and Nemorhaedus goral (goral). The GIS data base consisting of present and historical forest type maps, physiographic map, drainage, road/communications, settlement maps and their attributes have been used for deriving critical habitat management information in the areas of habitat changes, fire risk and habitat suitability.

Dhaulkhand range within proposed Rajaji National Park constitutes representative ecosystem comprising of all the key habitat elements of the Siwalik landscape. The area lies within 29°59’45” to 30°08’48” N latitudes; 70°55’5” to 78°04’42”E longitude. Topography of the area varies with altitude ranging from 320 m above msl in submontane area to 800 m above in Siwalik ranges. In the submontane area the ground is apparently levelled but slopes gently towards south-west. Climate of the area is subtropical. Rainy season commences from late June and continues up to mid-September with the heaviest rainfall recorded in August (range 1200-1500 m). The average temperature in the area varies from 13.1°C in January to 38.9°C in May/June.

Vegetation of the area mainly belongs to northern tropical dry deciduous forest and subtropical forest. Among the tropical dry deciduous forests, main types are dry Siwalik Sal (Shorearobusta) forests, while subtropical forest consists mainly of Chir pine (Pinusroxburhii) forest. Sal forest occurs on the higher slopes of Siwalik as well as on the Bhabhar belt. The area is also rich in wildlife. Elephants are present in good number. There are large carnivores like, tiger and leopards. Herbivorous animals are; Axis axis (cheetal), Axis parcinus (hog deer); Muntiacusverginalis (barking deer). Mountain goat (Nemorhaedus goral) is an endangered species found in the specific habitats of this region.

The following study presents results of GIS applications in conservation area management using vegetation type map, physiographic map, digital elevation model, road/communication network, settlements, fuel value in vegetation types and related socioeconomic data.

HABITAT SUITABILITY ANALYSIS FOR NEMORHAEDUS GORAL

Habitat is a place occupied by a specific population within the community of population and habitat selection is an important part of an organism's life history patterns. The colonization pattern of animals is related to parameters viz., cover, physical set-up and land use, which can be studied using aerospace remote sensing. There is a loss of natural habitat for animals in Rajaji National Park due to the biotic interference in forest ecosystem. The study is an attempt to evaluate habitat of goral (Nemorhaedus goral) using remote sensing derived vegetation map integrated with other parameters like, juxtaposition, interspersion and the restrictive factors in the GIS domain. The habitat of the animal under study requires the very specific habitat like, habitat with good grass cover away from human habitation, high slope areas i.e., $>30^{o}$ as escape terrain and areas with less extensive shrub cover. These habitats are becoming narrower due to deforestation, fragmentation and human influences. It would be of interest to estimate suitable habitat of the endangered mountain goat.

The habitat suitability is derived based on spatial information viz., interspersion, juxtaposition and restrictive factors for goral population. The vegetation type map was derived by visual interpretation of IRS 1B LISS-II data and was used to analyse the spatial pattern of the vegetation. In addition, the terrain features viz., slope, drainage, water bodies, settlements and roads were also used to derive habitat parameters (Gupta et al. 2014).

Interspersion (Is) is defined as a measurement of the spatial intermixing of the vegetation types and was calculated in non-species specific manner. Juxtaposition (Jx) is defined as a measure of the proximity of the vegetation. Its measurement mostly includes relative weightage assigned by the importance of the adjacency of two cover types for the species in question. Therefore, Jx is a species-specific measurement. This was accomplished by defining a grid, which was placed on the forest type map covering 149 sq.km. area. The grid size was 20" * 20" i.e., 533.33 * 533.33 m. In all 511 cells covered the whole area. Grid size selection was based on the size of the 'goral' territory i.e. about 300 m radius circle.

Thus, in present study the Is and Jx were calculated as:

Is = arrangement of land cover types around grid

Jx = the mathematical approximation to juxtaposition is the quality of edge

(1 for diagonal and 2 for horizontal and vertical edge)

The edge effect is defined as the tendency for an increase in variety and density at community junction. The weightage factors were assigned to edges based on the order of preference by 'goral'.

Based on habitat used by goral, three restrictive factors were determined:

1. Availability of water within 1 km (Rfw)
2. Steep slope (Rfs)
3. Area devoid of human habitation (Rfh)

Presence of a restrictive was given a value of one and it has impact on habitat quality, otherwise a factor of zero was assigned which resulted in the habitat quality value being zero. Intermediate values were also assigned based on field conditions and habitat requirement of 'goral'. Habitat quality was determined based on the above parameters with different weightages assigned to each parameters.

All parameters for each grid were determined and maps showing interspersion and juxtaposition were prepared. Restrictive factors were assigned using the slope map, drainage map and human habitation map. The following equation was used for habitat quality calculation:

$$HQ = (0.2 * Is/8 + 0.8 * Jx/12) * Rfw * Rfs * Rfh$$

Thus each cell was assigned certain habitat quality value. A threshold value was set to group the entire area into different habitat quality zones viz., highly suitable, moderately suitable, less suitable and not suitable.

The suitable locations listed down during the field visits were compared by overlaying them on the final map of habitat quality prepared through this model. It was observed that out of total 10 location sited, 4 feel in most suitable areas, 4 fell in moderately suitable areas, 2 fell in less suitable areas whereas none fell in unsuitable areas. The results were also compared with census records of the forest department carried out in May, 1993. During census actual sighting method was used.

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