Habitat Suitability Modeling For Great Indian Bustard (GIB) In Solapur District; A Geoinformatics Approach

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Abstract:

Clearing of forests for settlements, agriculture, industries and for communication purposes has done irreparable damage to the natural system. In particular, many wild species including birds are adversely affected by human induced changes in land use. Even though wildlife conservation is practiced according to Wild Animals Protection Act, 1953, Great Indian Bustard (GIB) has been hunted indiscriminately for years. It is reported that the population of GIB at GIB Sanctuary / Jawaharlal Nehru Bustard Sanctuary (Nannaj) was 40 in 1989, whereas it is 9 in 2010. Declining population of GIB the "globally endangered" species is because of hunting, continuing agricultural development and loss of habitats. The paper presents application of remote sensing and GIS technique for Habitat Suitability Modeling for the GIB in Solapur District. Four tehsils viz. Karmala, Madha, Mohol and N.Solapur are considered in this study. Locations for habitats of GIB are located using GPS points. Landuse/land cover, soil, altitude and distance of habitat from road are mapped using ERDAS IMAGINE 9.1 and Arc GIS 9.3. AND Boolean operator is used in this Multi-Criteria Decision Making (MCDM) problem to map suitable habitat for GIB.

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Introduction

Many wild species are adversely affected by human induced changes in land use that operate over very large spatial scales. For example, in Europe, agricultural policy change and its consequent effects on farming practice have profoundly influenced many bird species (O'Connor & Shrubb 1986; Pain & Pienkowski 1997). The great bustard *Otis tarda,* a globally threatened species has suffered dramatic decline in their number (Collar & Andrew 1988; Heredia, Rose & Painter 1996). Although the reasons for such decline are not completely understood, it seems agriculture intensification and habitat fragmentation due to human activities, have played a decisive role. The population was probably declining until hunting was outlawed in Spain in 1980 and is now thought to be stable at best. Its conservation is still threatened by habitat fragmentation over most of the Iberian peninsula. Recent dispersal studies using individual marking and radio tracking techniques have shown that although the species is capable of performing considerable seasonal migration, individuals display a marked site fidelity to their breeding areas (Alonso, Morales & Alonso 2000; Morales *et al* . 2000). Once traditional sites are lost, this behaviour may restrict the potential to establish new populations elsewhere. Monitoring national or regional changes in great bustard distributions and numbers through field surveys cannot realistically keep pace with the rate of agricultural and infrastructure development. This is equally true for large numbers of other species that require assessments of the reasons for population decline. Such knowledge is essential for compiling conservation management action plans under international conventions and legislation such as the Biodiversity Convention and the Birds Directive. There is an urgent need to develop ways for mapping threatened species at large spatial scales with reduced field effort (Gaston & Blackburn 1995; Williams *et al* . 1997). In this paper we present the results from a pilot study that attempted to model the breeding distribution of great bustards in south Maharashtra from remotely sensed data and digitally mapped data layers. Large-scale studies continue to pose major challenges in applied ecology and model development may provide ecological insight at scales where manipulation is not possible (Ormerod, Pienkowski & Watkinson 1999; Caldow & Racey 2000). Both bustard sexes are highly aggregated in early spring, when the surveys were conducted (males usually in a single flock and females in just a few flocks). Until recently great bustards in Iberia were considered sedentary in the vicinity of breeding leks (areas for male sexual exhibition and copulation). However, work on radio-marked birds has demonstrated that both sexes behave as partial migrants between the lek site and post breeding or wintering areas (Alonso, Morales & Alonso 2000; Morales *et al* . 2000) and generally show strong interannual fidelity to lek sites in spring. Females nest close to the lek where they copulate, and take over all brood caring duties. Thus surveys conducted in spring are likely to reveal consistent breeding distributions, but these may differ from wintering sites which are not addressed here. Data availability is a constraint in building large-scale models of species' distributions, and two basic approaches seem to be emerging to make best use of available resources. Interpolation methods, ranging from simple linear interpolation (Farina 1997) to kriging (Palma, Beja & Rodrigues 1999), estimate species' occurrences.

Habitat:

The Indian Bustard is a bird of sparse grassland with scattered low scrub, bushes and cultivation in open, stony and frequently slightly rolling semi-desert country. In some parts of the bird's range, the habitat is entirely dry and it is assumed that they obtain moisture from food. Maximum sightings of bustards are seen at pure grassland areas, and no bird is recorded in dense woodlots. Bustards prefer wide open short grass plains and open scrubland with scattered trees. (Manakadan, R and Rahmani, A. R. 1986, Rahamani, A. R. 1989).

Conservation status:

Globally endangered "because of its very small, declining population, a result of hunting and continuing agricultural development". As these birds do not live in nests, there is greater risk of their eggs destruction. The largest protected area of the Great Indian Bustard is the Desert National Park in India.

Conservation measures:

The species is protected under Schedule I of the Wildlife (Protection) Act 1972, and its hunting or trapping is prohibited in India. There are Indian sanctuaries in Rajasthan (Desert National Park, Sonkhaliya and Sarson); Gujarat (Bhatiya, Naliya); Madhya Pradesh (Ghatigaon, Karera); Maharashtra (Bustard Sanctuary); Karnataka (Rannibennur) and Andhra Pradesh (Rollapadu).

Occurrence of GIB in India:

Previously widespread and regular across most of the dry western plains of the Indian subcontinent, the Indian Bustard is now restricted to small breeding patches in Gujarat, Rajasthan, Maharashtra, Uttar Pradesh, Madhya Pradesh, Andhra Pradesh and Karnataka in India. Some may still survive in Sind, Pakistan. Rajasthan, with over 50% of the entire global population, is the stronghold of the species. Due to hunting and greater use of pesticides, the population of Great Indian Bustard is continuously declining. We must protect and conserve this endangered species by using various techniques. Remote sensing and geographic information system (GIS) technologies have been used for gathering the information on physical parameters of the wildlife habitats and geospatial modeling for Great Indian bustard habitat management. This study reviews the developments on wildlife habitat evaluation and management employing remote sensing and GIS tools.

Aim and Objectives:

The aim of this study is to use of remote sensing and GIS technique for Habitat Suitability Modeling for the Great Indian Bustard.

Objectives:

The following specific objectives pursued in order to achieve the aim above.

- To create a Habitat Suitability area map for Great Indian Bustard using GIS & Remote Sensing technique.
- To use Physical parameters for Habitat Suitability analysis this includes suitable slope, suitable altitude, suitable landuse, & suitable soil.
- To create various map of study area and show physically suitable area for GIB.
- Work for Great Indian Bustard conservation & monitoring with the help of GIS & Remote Sensing.

Study area:

Karamala, Madha, Mohol, and N.Solapur tahashils located in Solapur District has been selected as the study area for the present research work because these Tahshils had been demarcated by Government of India as a GIB conservation area under Great Indian Bustard Sanctuary / Jawaharlal Nehru Bustard Sanctuary (Nannaj). The Geographic location of study area is 74077’1’’E to 75096’3’’E Latitude and 17057’00’’N to 18054’00’’N longitude.

DATA AND SOFTWARE:

Spatial data including Satellite images, soil map, and forest plan map was used.

Sr.No	DATA TYPE	SCALE	SOURCE OF DATA
1	Forest Management map of Solapur division	1:250000	Forest department of solapur
2	SRTM Data - Landsat-7 ETM+	30 m resolution	GLCF SITE
3	GPS	GPS point	Garmin
5	Soil Map	1:50000	MRSAC

Table 1: Data source and type used

Software Used for Present work:

- ArcGIS 9.3 – It was used analysis to compliment the display and processing of the data
- ERDAS 9.1- It was also used to processing the data.
- Microsoft word – It was used basically for the presentation of the research.
- Microsoft Excel- It was used in producing the chart.

Georeferencing of map: The Forest Management map of Solapur forest division were Georeferenced in the ArcGIS with projection type Geographic (Lat/Long), spheroid name Everest definition 1975 and datum name Everest definition 1975.

Extraction of the Study area: The study area was extracted from Georeferenced management map of solapur forest division by using extract by mask tool from extraction toolset, which is in spatial analyst toolbox. Above processes are done by using Arc GIS 9.3.

RESEARCH METHODOLOGY:

Geographic information systems have become the promising tool for an effective analysis associated with the study of gathering the information on physical parameters of the wildlife habitats and geospatial modeling for Great Indian bustard habitat Suitability management. In the present study, a series of systematic field surveys have been conducted with aim of locating the habitat of Great Indian Bustard. Location is highlighted using the Global Positioning System. The SRTM image was used to generate the terrain elevation and slope map. The SRTM image was downloaded from GLCF site.

Soil map is used to show soil types (based on dept of soil layer) of study area, i.e. extremely shallow, very shallow, shallow, moderately shallow & deep. The Landsat 7 ETM+ image was used to generate the land use /land cover of study area. The Management map of solapur forest division was used to show road and railway coverage of study area. The SRTM image was used to generate the terrain elevation and slope map. In the present study, analysis were derived from the management map of Solapur forest division (scale 1:250,000) prepared by the Forest Survey of India (FSI) and field survey.

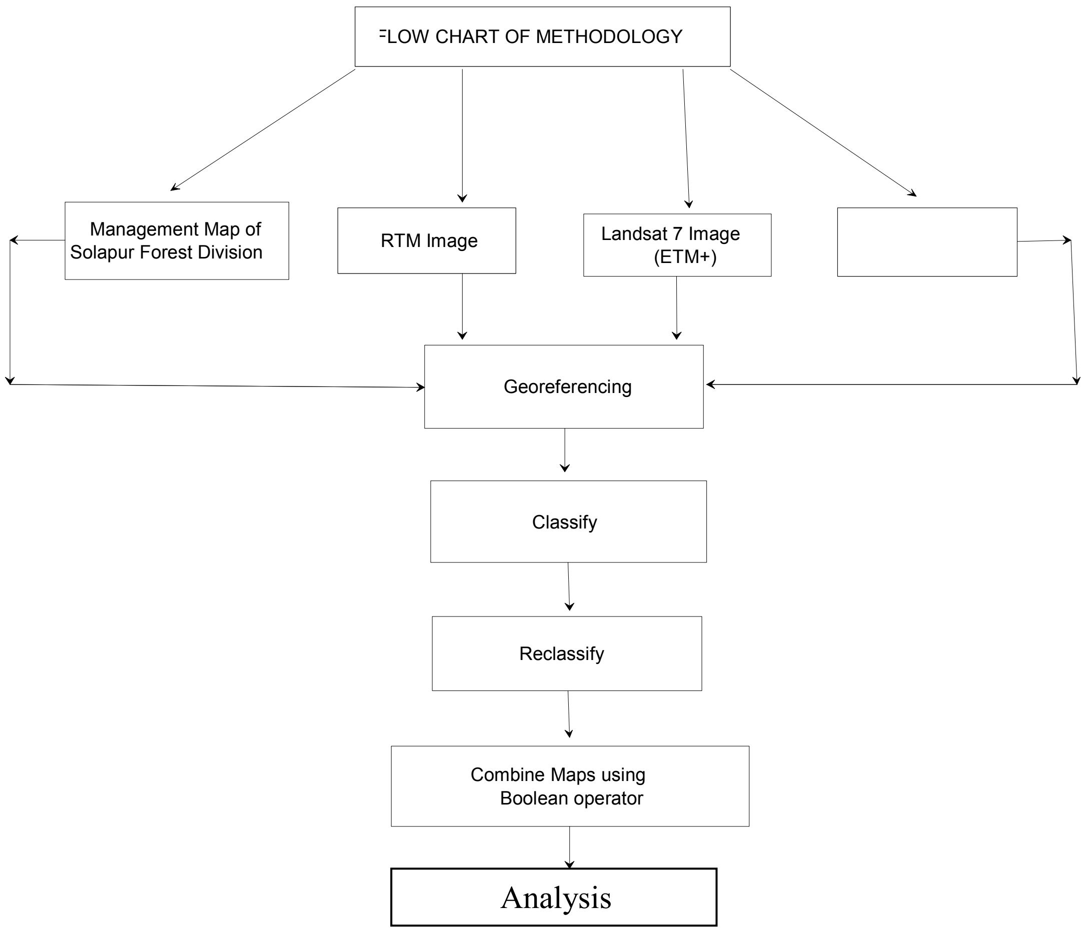

Fig: 1 – Flow Chart

DATA ANALYSIS:

Introduction

The results are presented in the form of various maps. To prepare a map of suitable area the following criteria was decided, which is based particular Habit on that birds ongoing field work collected GPS point where the Great Indian Bustard was found.

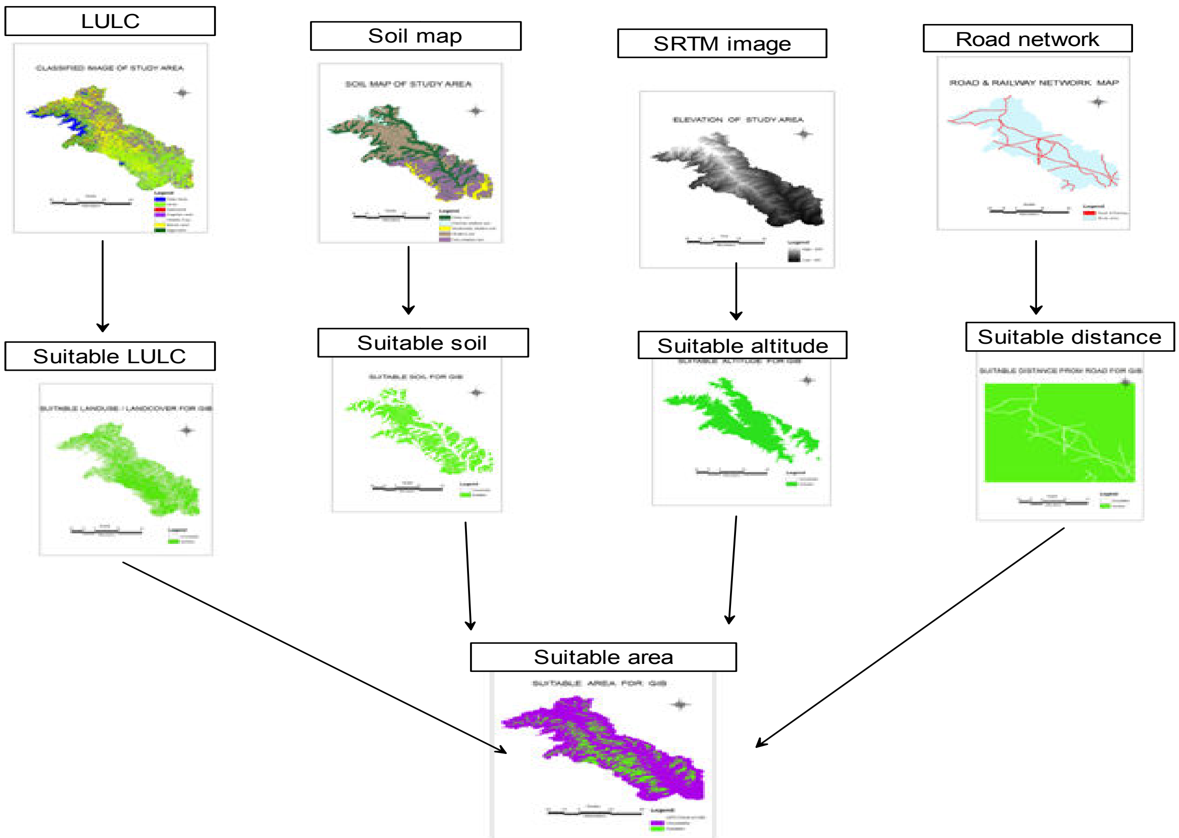

Fig:2 –Suitable land use/land cover, Suitable soil, Suitable altitude, and Suitable distance from road.

MAP OF SUITABLE LANDUSE/LANDCOVER FOR GIB

Land use is the manner in which human beings employ the land and its resources. Land cover deals with physical or natural state of the Earth's surface. The FCC image of study area is classified by image processing software then shrub & barren land is reclassified as suitable land for Great Indian Bustard by using ArcGIS

MAP OF SUITABLE SOIL FOR GIB

Soil map of study area was obtained from Agricultural department of Solapur division, which is having soil type based on depth of soil i.e. extremely shallow, moderately shallow, very shallow, shallow, deep. Shallow & very shallow soil classes are reclassifying as suitable soil for Great Indian Bustard.

SRTM IMAGE

Shuttle Radar Topographic Mission image is downloaded from GLCF site. It is used to generate contour map, altitude map as well as suitable altitude map.

Map of Suitable Altitude for GIB:

The height or vertical elevation of a point above a reference surface. Altitude measurements are usually based on a given reference datum, such as mean sea level. The height above the horizon, measured in degrees, from which a light source illuminates a surface. Altitude is used when calculating a hill shade, or for controlling the position of a light source in a scene. The SRTM image was classified by using unsupervised classification method in ERDAS IMAGIN. The classes of altitude where GIB had found were reclassified as suitable altitude for Great Indian Bustard. Road network map was created from management map of Solapur forest division. The Great Indian Bustard prefer those areas which are least affected by human disturbance. The Great Indian Bustard had found at which locations, the average distance of those locations is 500 meter from the road. So the area which have less than 500 meter from the road was classified as unsuitable area and remaining area is suitable for Great Indian bustard.

Map of Suitable Area for GIB:

A model that weights locations relative to each other based on given criteria. Suitability models might aid in finding a favorable location for a new facility, road, or habitat for a species of bird. The map of suitable area map includes a suitability of soil, slope, land use/land cover, and distance from road. These suitability maps are combined by using “AND” Boolean operator in ArcGIS software.

Conclusion:

Global habitat loss, and human disruptions, such as pollution and deforestation, climate change, can cause wildlife fragmentation and extinction and threaten the biodiversity of the earth. GIS technology is an effective tool for managing, analyzing, and mapping wildlife data such as population size and distribution, habitat use and preference, changes in habitats, and regional biodiversity. The ability to overlay such data makes GIS instrumental in delineating relationships between wildlife and outside forces, enabling the visualization of both where conservation practices need to be implemented and what current protection plans are effective These preliminary results suggest that it should be possible to use satellite data to map the spatial and temporal distribution of potential habitat for this species at regional to continental scales. Wildlife distribution and abundance patterns depend on many environmental factors. This study was a simplification of the process of habitat selection, and identifying the most affecting factors in habitat preference by the GIB. The study clearly showed that specific vegetation patterns were playing the most important role for this species. This could be a shortcut for habitat managers in terms of saving time and cost, and also a big help for nature conservation. GIS was used to produce the data needed in the models, as a platform to execute the models and in presenting the results of the analysis. However, the suitability models for the case study species were constructed outside the GIS This approach is likely to advance the understanding of the habitat requirements of a species but, due to the time and cost involved in measuring finer scale variables, This approach is most likely to be used for conservation planning in developed countries..

Remote sensing and GIS are the modern tools/technique which helps in analyzing the biodiversity change. Remote Sensing has the capacity to provide synoptic coverage over wildlife management, thereby enabling us to get information/ image rapidly & accurately. GIS has the capability to hold large database that can be observed easily & update quickly. Thus Remote Sensing & GIS technique provide creation of habitat suitability map for birds.

A predictive distribution model, or habitat suitability model, usually consists of a probability map depicting the likelihood of occurrence of a species (Pereira & Itami 1991; Store & Kangas 2001). The categorization of habitat quality displayed in the spatial model can be used to prioritize areas requiring protection based on their value. This statement is made on the premise that the probability of species presence is positively correlated with the quality of the habitat.

Suggestions:

1. Scientific management of GIB habitat areas.
2. Find out the new areas which are favorable for GIB & protect these areas.
3. To give a protection for GIB breeding area.
4. Create awareness of people about GIB conservation.

5. Generate GIB conservation area such as Nannaj.

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