

GIS Applications in habitat conservation for migratory birds in Uttar Pradesh (India)

Meena Kumari Yadav¹ and Surendra Kumar Yadav²

¹Research Scholar

²Associate Professor (Environmental Sciences), University Department of Engineering & Technology (SCRIET),
CCS University, Meerut-250004 (UP), INDIA.

ABSTRACT

Geographical information systems (GIS) allow researchers to visualize and investigate relationships between various geographic features, such as land, elevation, and vegetation cover. In avian research and conservation, GIS is a powerful tool for studying bird distributions, population densities, home range characteristics, and habitat quality. With GIS we can map where birds are most active, home range sizes and overlap, and where birds build nests. We can better visualize the types of habitat where birds are most successful and locations of food sources and endangered and rare plants used by native birds. Our habitat management efforts also incorporate GIS techniques to map fences, and habitat threats such as the appearance of new invasive species.

Keywords-GIS; birds, migration, habitat, conservation, management.

1. INTRODUCTION

Western Uttar Pradesh region has some demographic, economic and cultural patterns which are distinct from other parts of Uttar Pradesh, and more closely resemble those of Haryana and Rajasthan states [1-2], and has experienced rapid economic growth, in a fashion similar to Haryana and Punjab, due to the successes of the Green Revolution [3-5]. Western Uttar Pradesh's soil and relief has marked differences from that of the eastern part of the state [6]. The soil tends to be lighter-textured loam, with some occurrences of sandy soil [7]. Some loess soil is continuously deposited by winds blowing eastwards from Rajasthan's Thar Desert [8]. The Monsoon carries moisture northwards from the Indian Ocean, occurs in late summer and is important to the Kharif or autumn harvest [9-10]. Western Disturbances, on the other hand, are an extratropical weather phenomenon that carry moisture eastwards from the Mediterranean Sea, the Caspian Sea and the Atlantic Ocean [11-14].

The contribution of birds to maintain the ecological balance is immense. India has approximately 1250 species of birds among which about 300 species of birds migrate across Himalayas from Tibet, China, Europe and Siberia during winters. Some of these birds fly over 5000 km and above 8500 metres high to reach India. The arrival of migratory birds starts from the month of November. The lake is in its behest during the month of December and January. By the end of February these migratory birds gradually start leaving for their respective destinations. Some resident birds stay here round the year, do nesting and lay eggs. Migratory Birds, such as, Greylag Goose, Pintail, Common teal, Cotton teal, Red Crested pochard, Brahmini duck, Gadwall, Shoveller, Wigeon, Coot and Mallard etc. are to be found in the Nawabganj Bird Sanctuary. Besides these Spotwill, Sarus crane, Painted Stork, White Ibis, Black Ibis, Dabchick, Whistling teal, Open billed stork, White necked stork, Black necked stork, Spoon bill, Pheasant tailed jacana, Broze winged Jacana, Purple moorhen, White breasted water hen, Indian Moorhen, Grebe, Cormorant Darter, Lapwing, Egret, Purple heron, Pond heron, Stone curlew, King fisher, Night jar, Tern vulture, Kite, Partridge, Hawk, Koel, Dove, Pigeon, King crow, Baya, Munia, Golden oriole, Barbet, Babbler, Indian roller, Bee eater, Parakeet, Drongo, Hoopoe, Finch, Peacock, Brain fever bird, Comb duck etc. are the local birds.

The adaptive value of migration with fluctuating food sources has earlier been well documented [15-16]. Survival challenges encountered on these journeys may be responsible for a majority of annual adult mortality in land birds [17]. There was increased mortality during long migrations of avifauna [18]. Bird's sensitivity varies towards temperature and other environmental conditions. There is indication that a following wind is of major importance. A clear sky also helps, but is of secondary importance. Birds will take flight in overcast days if the wind is good. For hawks and other soaring birds, updrafts are of extreme importance. They can't go very far flapping those heavy, wind-resistant wings. That's why they usually fly parallel to north-south mountain ridges that will produce updrafts with the wind. According to BBC news South East Wales (July 12, 2012) unpredictable weather had altered bird migration patterns. Avian migration is a natural process, whereby different birds fly over distances of hundreds and thousands of kilometers in order to find the best ecological conditions and habitats for feeding, breeding and raising their young. Due to changing crop pattern and environmental pollution, the number of cranes coming to India over the years has reduced by as much as 75 per cent. As many as 4,000-5,000 bar-headed geese were sighted in the past. But in the last two years, flocks of only 40-50 of these birds were seen at one time. The number of geese has definitely reduced by 50 per cent [19].

2. GIS APPLICATIONS IN MIGRATORY BIRDS STUDIES

Point count survey data was coupled with the GIS variables to predict the probability of occurrence for each species of birds. Problems begin with the intensive data collection methods required to tailor a management practice for a particular species and area. The technological advances within the areas of remotely sensed and other spatial data, increased computing power for large datasets, and geographical information systems (GIS) may provide us with a means to develop solutions to balance our management goals. Geographic Information Systems (GIS) are computer systems used for storing, analyzing, and displaying spatial data. GIS is very helpful for creating colorful and clear visual illustrations of our work for seminars, posters, and public outreach programs. It is a big improvement in clarity and accuracy over hand drawn maps, which prior to GIS were the norm. GIS also makes it easier for us to share data with other scientists in order to collaborate on various conservation efforts and evaluations. Modern tools for habitat management of migratory birds include models describing habitat-population relationships, coupled with remote sensing and geographic information systems (GIS). These approaches implicitly assume some degree of underlying understanding about the functioning of bird populations and communities in response to habitat modifications.

Migratory birds/ wildlife models that use satellite imagery and other types of data that can be manipulated in a GIS may eliminate the need for costly and time-consuming measurements that are not used migratory birds' conservators. Understanding which images or GIS variables correlate with biological variables for a particular species still needs exploration; as well as the development of methods that allow a model to be applicable across a theme by theme basis. There is also a question of which types of models and statistics are best able to predict the occurrence of a species across a landscape, species diversity, or identify critical habitats. The objectives of this research was to investigate which GIS variables are associated with biological variables for different species of migratory birds, to use a Bayesian statistics model within a GIS to map potential habitat for the birds, to assess model performance using raw reflectance signatures of Landsat (30-m) imagery/ data, and to compare the applicability and cost factors of migratory birds/ wildlife and forestry measurements to the use of GIS variables for land management plans. Selecting those habitat manipulations that alone or in combination will have the desired effect on a population is a difficult procedure because of the number of variables involved and the complex biological interactions between species biology and habitat. The same advances in computer technology that have led to recent developments in the use of GISs have led to increases in the use of simulation models that attempt to portray the population biology of waterfowl species. Population data required by these simulation models usually are difficult and expensive to obtain. For many species, habitat availability and quality and various population parameters are correlated. Fortunately, recent advances in remote sensing have made inexpensive estimates of the availability of habitat over vast areas available to waterfowl managers. A marriage between GIS and simulation modeling is the logical outcome of these technological developments.

The simulation models also can be combined with economic models to produce a planning tool. The system demonstrated here combines GIS and simulation modeling. It cannot tell the manager what management should be applied, but it is a tool to assist evaluation of the outcome of various alternatives. The software has the advantage of allowing this to be done by modifying the habitat displayed on the computer monitor. For illustration, we used the editing functions of the GIS to simulate three management techniques. These techniques were represented by three different land use and land cover data files. Furthermore, shrike habitat suitability indices were calculated based on the amount of potential and usable foraging habitat, and the number of potential nesting sites within a specified area. Interpretation of high quality digital photographs was used to delineate land cover classes, hedgerows and tree counts. These data were entered into a geographic information system (GIS) as individual data sets. The shrike habitat model was then employed to produce a GIS database predicting low, moderate, and high quality shrike habitat.

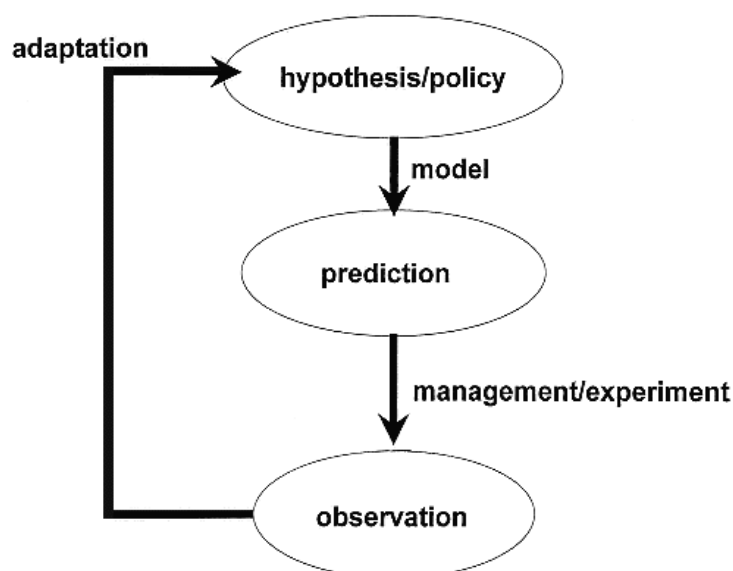
3. INDUSTRIAL POLLUTION PROBLEM

Environmental pollution is major cause for endangering birds. Bio-accumulation of chemical fertilizers, pesticides, insecticides, herbicides etc., which are being increasingly and indiscriminately used, affects birds. Studies have shown that 65 percent of bird's extinctions are due to destruction and alteration of habitats in which birds live. Uttar Pradesh pollution control board has closed down 65 tanneries in Kanpur for polluting the river Ganga by discharging wastes into it without treatment and asked the administration to issue notices to seven more such tanneries. Eight factories involved in dyeing were already shut down to contain pollution at Farrukhabad. The Environment Ministry has also ordered the Central Pollution Control Board to immediately shut down nearly 170 factories and tanneries located between Kannauj and Varanasi covering an area of 450 km that were found responsible for polluting the river by discharging wastes into it without treatment. Most of the 7000-odd industrial units spread in about 2,000 hectares of land in Noida are least bothered about pollution concerns or public safety. In an Application (No. 36 of 2012) Rajiv Narayan Vs. Union of India & Ors before National Green Tribunal, Uttar Pradesh Pollution Control Board, in an affidavit has stated that there are 9 industries operating in spite of action initiated against them. These are the units which are 'red category water polluting industries'. There are 15 industries which are not complying with the prescribed norms. These are the industries which fall in the 'red category air polluting industries'. These industries are also operating without complying with the terms and conditions of the consent order and initiation of action by the Board has failed to yield any results. The state has two

major production centres of leather and leather products, with over 11,500 units; Agra and Kanpur are the key centres. About 200 tanneries are located in Kanpur.

The Comprehensive Environment Pollution Index (CEPI) scores of Ghaziabad for the year 2009 and 2011 is 87.37 and 81.14 respectively which both show a red zone situation. Beside coal, kerosene, wood and LPG are other domestic fuels that emit hazardous gases in the atmosphere in the State of UP. What further worsens the situation is the dug up roads that permit dust particles to mix in the air, adding to air pollution. Vehicles emanating gases like sulphur dioxide (SO₂), particulate matter, hydrocarbons, nitrogen dioxide and carbon monoxide are main contributors to air pollution. Higher concentration of sulphur has a laxative effect and causes gastro-intestinal irritation, while high level of nitrogen is harmful for cattle and infants. The quantity of fossil fuel burnt in boilers and emissions from industries were affecting the air content in the city to a large extent. Concentration of SO₂ and nitrogen dioxide were found to be well within limits, but SPM was noticed to be exceeding the prescribed norms at all locations. High levels of arsenic, cadmium, mercury, nickel and chrome VI released from the tanneries has increased pollution level in the Ganga. This way, the entire environment is affected by high pollution level. Therefore, the need of the hour is to curb the alarming situation for which every individual has to understand his/her responsibility. Otherwise, too much of human interference would leave a negative impact on the present civilization, which may be a sign of disaster.

Diagram of adaptive learning process showing the roles of GIS modeling, research and monitoring, and management.



4. CONCLUSIONS

GIS Modeling of bird population dynamics, habitat management and movements can be a useful component of management, research, and monitoring programs. Model users (and modelers) must recognize that models are vast simplifications of the real world. Models can be useful in summarizing extant knowledge, providing testable predictions based on underlying assumptions, and directing future research efforts, for example, toward understanding key parameters or functional relationships. By simplifying a system to a few key components and predictions, models sometimes can crystallize a problem in a way not possible by other methods. Since habitat analysis is crucial to understanding changes in a species' demographics, the ability of GIS technology to handle the various data of a habitat and create visual depictions gives the user the ability to monitor change and discover important relationships. Understanding threatened species is important in preventing their extinction and revitalizing their populations. By integrating research and monitoring with management, information gathered is relevant to decision making, and can discriminate between information that is essential for reaching resource management goal, versus that which would simply be nice to have. Likewise, conservation decisions should continually be reevaluated in the light of new information, and modified as old assumptions change in the light of new data. Actions connected to birds' habitats include conservation and restoration of habitats for birds; identification and designation of special protection areas (SPAs); management of SPAs so as to avoid deterioration of habitats and maintenance or restoration of endangered bird populations, including the drafting and implementation of management plans; monitoring and research, including monitoring bird population trends; public consultation on projects and action plans and in the drafting and adoption of

management plans; design, proposal and adoption of agri-environmental schemes beneficial for managing birds habitats; and training stakeholders such as hunters and farmers, thereby raising awareness of management best practices.

5. REFERENCES

- 1 A special report on India: Ruled by Lakshmi. *The Economist*, 11 December 2008.
- 2 Alfred De Souza, *Urban growth and urban planning: political context and people's priorities*, Indian Social Institute, 1983.
- 3 Mohamad Riad El Ghonemy, "The Dynamics of Rural Poverty", Food and Agriculture Organization of the United Nations, 1986.
- 4 V. G. Rastyannikov, "Agrarian Evolution in a Multiform Structure Society: Experience of Independent India", Routledge & Kegan Paul, 1981, ISBN 0710007558.
- 5 M. Bhatia, "Food Security in South Asia", Oxford & IHB Pub. Co., 1985.
- 6 Aijazuddin Ahmad, *Geography of the South Asian subcontinent: a critical approach*, Concept Publishing Company, 2009, ISBN 9788180695681.
- 7 A.K. Kolay, *Soil Genesis, Classification Survey And Evaluation, Volume 2*, Atlantic Publishers & Distributors, 2007, ISBN 9788126908035.
- 8 M. Hanif, *Encyclopaedia of Agricultural Geography*, Anmol Publications Private Limited, 2005, ISBN 9788126124824.
- 9 Vidya Sagar Katiyar, "Indian Monsoon and Its Frontiers", Inter-India Publications, 1990, ISBN 81-210-0245-1.
- 10 Ajit Prasad Jain and Shiba Prasad Chatterjee, "Report of the Irrigation Commission, 1972", Ministry of Irrigation and Power, Government of India, 1972.
- 11 "Western disturbances herald winter in Northern India". The Hindu Business Line. 2005-11-17. Retrieved 2008-10-20.
- 12 Bin Wang, "The Asian Monsoon", Springer, 2006, ISBN 3-540-40610-7.
- 13 R.K. Datta (Meteorological Office, Dum Dum) and M.G. Gupta (Meteorological Office, Delhi), "Synoptic study of the formation and movements of Western Depressions", Indian Journal of Meteorology & Geophysics, India Meteorological Department, 1968.
- 14 A.P. Dimri, "Models to improve winter minimum surface temperature forecasts, Delhi, India", Meteorological Applications, 11, pp 129-139, Royal Meteorological Society, Cambridge University Press, 2004.
- 15 Lack D. (1968). Bird migration and natural selection. *Oikos* 19: 1-9.
- 16 Alerstam T., Hedenström, A. and Åkesson, S. (2003). Long-distance migration: evolution and determinants. *Oikos* 103: 247-260.
- 17 Sillett, T. S. and Holmes, R. T. (2002). Variation in survivorship of a migratory songbird throughout its annual cycle. *Journal of Animal Ecology* 71: 296-308.
- 18 Newton, I. (2008). *Migration ecology of birds*, Academic Press, London, UK.
- 19 Agarwal, M. (2011). Migratory birds in India: Migratory birds dwindling, New Global Indian (<http://newglobalindian.com/nature>).