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Spatial analysis to assess industrial pollution risk for migratory birds in western Uttar Pradesh (India)

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ABSTRACT

Geographical information system (GIS), remote sensing (RS) and global positioning system (GPS) are components of spatial technology which is extremely important for studies to assess industrial pollution risk for migratory birds. The flights of many migrating birds follow specific routes, sometimes quite well-defined, over long distances. Environmental conditions in terms of geographic factors, ecological conditions and meteorological conditions determine such routes. Industrial pollution has impact on migratory birds because it affects ecological conditions and habitats for feeding, breeding and raising their young. There is need for further research for formulation of policy for protection and conservation of migratory birds.

Keywords-Spatial analysis, GIS, industrial pollution, migratory birds, policy.

1. INTRODUCTION

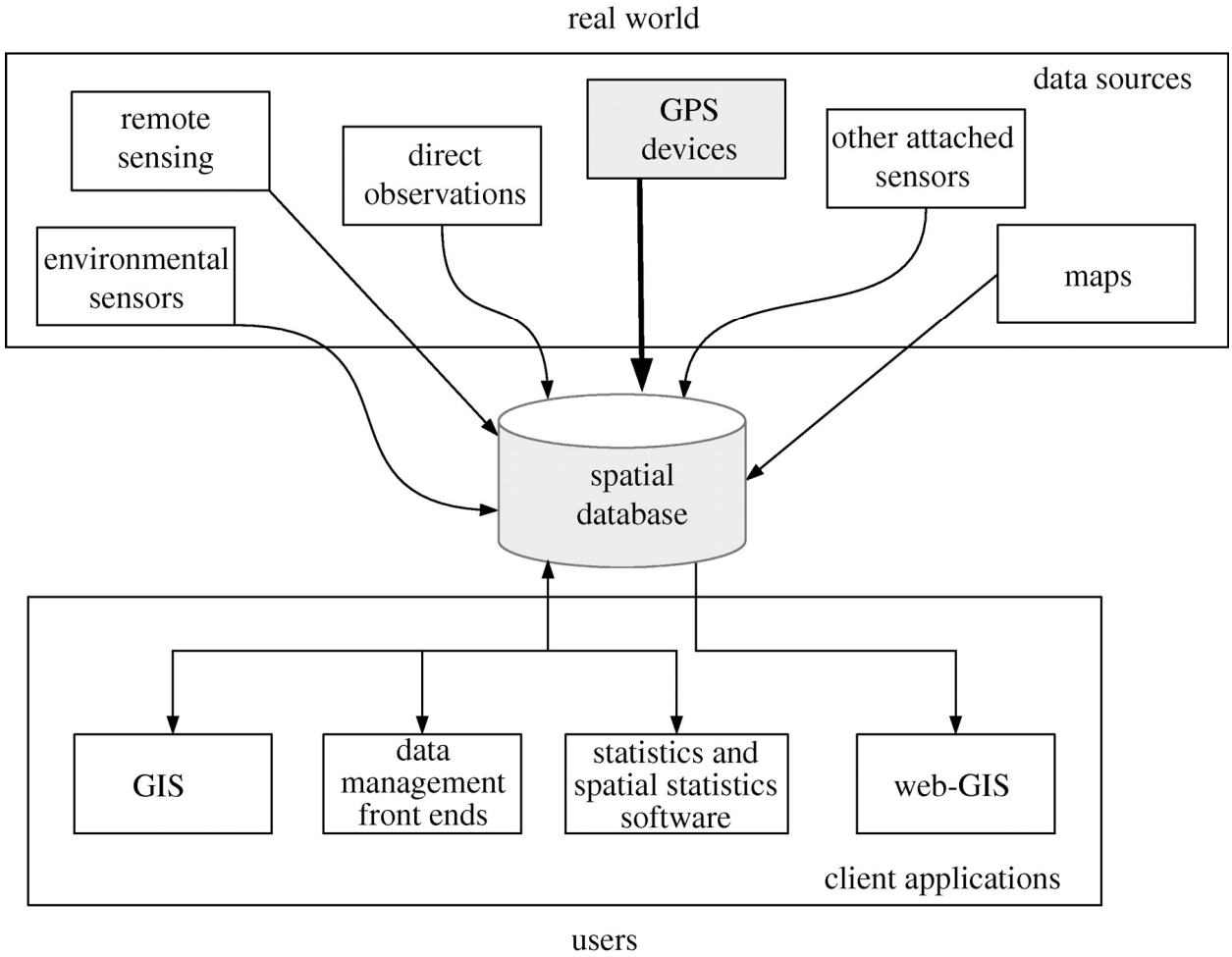
Uttar Pradesh is bounded by Uttaranchal and Nepal on the north, by Madhya Pradesh and Chhattisgarh on the south, Rajasthan, Haryana and Delhi on the west, and Bihar and Jharkhand on the east. It has a geographical area of 24,092,800 ha, about 7.3% of the land area of the country (Ministry of Environment and Forests 2001). Despite its bifurcation in November 2000 into Uttaranchal and Uttar Pradesh, it is still one of the largest and most densely populated states in India. It has been divided into 70 administrative districts. Uttar Pradesh comprises three physiographic regions namely, the submontane region lying between the Himalayas and the plains, the vast alluvial Gangetic plains and the southern hills and plateau. All the rivers except the Gomati and the Chambal emerge from the Himalayas. The State is fed by five major rivers, the Ganga, the Yamuna, the Ramganga, the Gomati and the Ghaghra which drain into the Bay of Bengal. More than one-fourth of Uttar Pradesh lies within the Gangetic plains consisting of alluvial deposits brought down from the Himalayas by the Ganga, Yamuna and their tributaries. The southern hills form part of the Vindhya range whose elevation rarely exceeds 300 m. Uttar Pradesh has been categorized into three major eco-zones on the basis of forest and vegetation types. These three zones are: the *Terai* region; the Gangetic plains (West and East Uttar Pradesh); the Bundelkhand of Uttar Pradesh including the Vindhya ranges. The *terai* region of Uttar Pradesh is a very important ecosystem for many threatened species of tall wet grasslands and swamps (Rahmani 1987, 1988, 1992, 1996, Javed 1996) and is the topmost priority for conservation (Rahmani and Islam 2000). It supports many threatened bird species such as the Swamp Francolin *Francolinus gularis* (Javed *et al.* 1999, Iqubal *et al*. 2003) and Bengal Florican *Houbaropsis bengalensis* (Rahmani *et al*. 1991).

The bird life of Uttar Pradesh is rich and varied. More than 500 species are found, including some extremely rare ones. Among the Critically Endangered species, Oriental White-backed Vulture *Gyps bengalensis*, Long-billed Vulture *G. indicus* and Slender-billed Vulture *G. tenuirostris* are found in this State. Bird Life International (2001) has listed ten Endangered species, of which, the Bengal Florican has been definitely recorded in four IBAs, the White-headed Duck *Oxyura leucocephala* and Lesser Florican *Sypheotides indica* are occasionally seen, and the Greater Adjutant *Leptoptilos dubius* has not been recorded recently (Rahmani *et al.* 1990). In this State, on record are 20 of the 57 vulnerable species listed for India by Bird Life International (2001). For six species, the IBAs and protected areas of Uttar Pradesh are extremely important. Bird Life International (2001) has listed 52 Near Threatened bird species of India, 14 of which occur in Uttar Pradesh. For two species, the Black-necked Stork and Rufous-rumped Grassbird *Graminicola bengalensis* (earlier known as Large Grass Warbler), the wetlands and tall grasslands of Uttar Pradesh are very important for survival. Earlier, Rahmani (1989), and recently Gopi Sunder and Kaur (2001) have shown that the wetlands of Uttar Pradesh are the major strongholds of the Black-necked Stork. A species that needs special attention is the Hodgson's Bushchat *Saxicola insignis*. It is also known as the White-throated Bushchat or Hodgson's Stonechat. It has a much localized breeding range in the mountains of Mongolia where it is difficult to study. Its winter range is the northern Gangetic plains and the duars of northern India and the *terai* of Nepal. From the comparatively little information available it is probably the scarcest species in its genus (Urquhart 2002). In northern India, it has been reported from Ambala in the west to northern Bengal in the east (Ali and Ripley 1987). It is found in heavy grassland, reeds and tamarisks along river beds and cane fields. Earlier it was recorded in Kanpur, Gonda, Faizabad, Basti, and Gorakhpur (BirdLife International 2001, Urquhart 2002) but there is a recent record only from Corbett (Bose *et al*. 1989). Javed and Rahmani (1998) did not record it in Dudwa. However, looking at the paucity of reliable birdwatchers in Uttar Pradesh,

development of tall grasslands and marshes on seepages of the vast canal systems of the State, and extant tall grasslands along major rivers, this species is likely to be present in many areas. Soil management and ecosystem management are helpful for sustainable development (Yadav, 2007) and creation of favourable habitat for migratory bird.

2. METHODOLOGY

Spatial technology, comprising of geographical information system (GIS), remote sensing (RS) and global positioning system (GPS), play vital role for studies related to migratory birds to assemble and document bird population and habitat data maintained by these agencies at their finest levels of spatial and temporal resolution; assure that databases remain current through periodic update; and provide web-based access to the data by researchers and managers for strategic planning and evaluation of avian conservation strategies. GIS integrate spatial data and non-spatial data, as it analyze huge and complex data to provide output in understandable manner to simplify the problem for better planning, conservation and management in migratory studies. Remote sensing and GPS are data sources along with other data sources and all data is entered into GIS system for modeling and analysis from real world and provide solutions to users in desired manner and combinations. GIS was used as the primary tool for data integration, geospatial display, and analysis of multidimensional data. The associated biological and environmental databases (attribute data) were queried using GIS and statistical tools. The consolidation of the digital database for importation into a GIS is being performed using Microsoft applications, particularly Excel, Access and text editors. Digital sources of historic avian data, including stork migration routes obtained through satellite telemetry and the autumn migration survey were collected and reformatted for compatibility with GIS data types. Indian Remote Sensing (IRS) data and Geomedia Intergraph GIS was used for analysis.



3. THREATS AND CONSERVATION ISSUES

Uttar Pradesh is famous for its flood-plain wetlands – results of copious rainfall in the Gangetic Plain and also in the Himalayas from where most of the rivers originates. Large areas are annually flooded, and when the flood recedes, it leaves low-lying areas under water. These wetlands are extremely productive in terms of vegetation biomass and avian diversity (Howes 1995). Some of the most important wetland are found in this regions with significant populations of waterfowl. Patna *jheel* in Etah, Lakh-Bahosi in Farrukhabad, Saman in Mainpuri, and Nawabganj in Unnao are some of

the more spectacular wetlands for migratory waterfowl in winter. The marshes and wetlands of the Gangetic drainage system show a long history of stability in geological sense, thus many marsh- dependent species are found such as Striated Marsh Warbler or Grassbird *Megalurus palustris*, Bristled Grassbird *Chaetornis striatus*, Rufous-rumpled Grassbird *Graminicola bengalensis*, Yellow-bellied Prinia *Prinia flaviventris*, Swamp Francolin *Francolinus gularis*, Bengal Florican *Houbaropsis bengalensis* and various ducks. Unfortunately, one of the species, the Pinkheaded Duck *Rhodonessa caryophyllacea*, has become extinct, not due to any geological upheaval but due to human-related activities.

A variety of management issues are involved in the conservation of migratory bird stopover habitats. Some conservation issues concerning the integrity and/or suitability of stopover habitat in the southeastern United States include global/climate change, conversion of natural habitats, coastal erosion, bird collisions with communications towers, the role of fire in managing landscapes, livestock grazing and white-tailed deer over browsing, the suitability of man-made habitats, invasive exotic plants, and forest management practices. This study was helpful in gaining a deeper understanding of the behavior, ecology and ecophysiology of migratory birds during the study. That understanding, in combination with the recent accessibility of remote-sensing and GIS technology and the scale-dependent approach outlined here, provided a framework or perspective to identify those issues most-relevant to the development of successful conservation initiatives and management plans that are focused explicitly on migration and the stopover biology of migratory birds.

Many hundreds of various types of industries are operational in western UP. Major industrial cities and towns viz.
Moradabad, Ghaziabad, Meerut, Hapur, Saharanpur, Aligarh, Muzaffarnagar, Rampur, Shahjahanpur, Etah, Firozabad, M ainpuri, Bareilly, Agra, Noida and Greater Noida and Etawah have polluting industries. The proposed monitoring of environmental pollution and actions against industries only is not enough. The situation here is rather more grave because beside making the life of all inmates in surroundings a hell, it is perpetually posing immediate dangers to the health of old and children living in its close proximity along with impacts on migratory birds. It can really be real relief to the people in general, if authorities take cognizance of this and strictly implements pollution control rules here too. U.P Pollution Control Board is a statutory organization entrusted to implement Environmental Laws and rules within the jurisdiction of the state of Uttar Pradesh, India. U.P. Water Pollution Prevention and Control Board, constituted on February 3, 1975, initially under the Water (Prevention and Control of Pollution) Act., 1974, was consequently rechristened as U.P. Pollution Control Board on 13th July,1982, subsequent to the enactment of the Air (Prevention and Control of Pollution) Act, 1981. The Board was also entrusted with the powers and functions under the Water (Prevention and Control of Pollution) Cess Act, 1977 along with other responsibilities under the Environmental Protection Act, 1986.

4. CONCLUSIONS

Geographic Information System (GIS) tools are being used for data integration, analysis and geospatial display of historic bird migration data, environmental and land use data, and near real-time migration data, to create a dynamic model of soaring bird migration. Industrial development in last 2-3 decades in western Uttar Pradesh (India) has changed the pattern of bird migration in the study area. Migratory birds changed their earlier route/ path due to industrial pollution. Further, migration of birds in the region has also declined, as different pollutants created disturbances for birds in many ways. The majority of migrants travel along broad airways within these flyways with minor changing their flight direction in response to the direction and force of the wind. It has been estimated that birds generally fly at heights varying from 500 to 900 m, at speed ranging between 30 and 100km/h, and often fly continuously for 6 to 11 hours/day with an average of 240 to 970 km, before stopping to eat or rest. Various migratory birds, having native places throughout the Europe, Asia, Africa, Arctic region etc., arrive through different migratory routes in India. 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. The reproductive success in the heronry colonies can be improved if industrial pollution is controlled. There is a strong need for research on ecosystem management. This relates primarily to increasing our knowledge of the relationships between colonial water birds and their environments, especially with respect to the availability of adequate food supplies and habitat. The use of GIS and remote sensing technology can be used as an integral part to trace the migrating location of these birds from field mapping to reporting of the location. One tip to find the birds of migration is to identify their food habit. This would give an idea of their prospective migrating location with regard to the availability of the specific food. Further research is required to provide information on the reproductive strategies and environmental factors affecting reproductive success. Variables that are worthy of monitoring in case of subsequent population decline are environmental contaminants in food sources, movement patterns and foraging habitat by nesting and wintering birds.

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