International Journal of Research in Advent Technology, Vol.6, No.5, May 2018
E-ISSN: 2321-9637
Available online at www.ijrat.org

Correlating Climatic Shifts and Land Use Land Cover Change Impacts on Wetland Ecosystems Using Remote Sensing: A Case Study of Nalsarovar Bird Sanctuary

*Nirmal Desai[1], Anurag Bhatu[2] and Archana Mankad[3]
Department of Botany, Bioinformatics and Climate Change Impacts Management [1, 2, 3]
Gujarat University, Ahmedabad, Gujarat, India.
*Email: *nirmaldesai329@yahoo.com* [1]

Abstract- Wetlands are considered as the lifelines of any country as they cover both geographically and ecologically important habitats and thus are rightly called biodiversity hotspots. They provide a variety of ecological and economical services and products such as water, food, regulation of local climate, regulation of flooding events, protection of coastal areas etc. Wetland mainly depend on rainfall for its water level and thus any changes in the regional climate are bound to affect the water quality and quantity of the wetlands. The wetland degradation is one of the main issues that is responsible for the drop in the quality of wetlands. Both climatic and non-climatic drivers are responsible for these issues. The anthropogenic activities like dumping of sewage, exploitation of water from the wetlands for agriculture, habitat fragmentation etc. have been mainly responsible for the direct negative impacts on wetlands. The aggregate impacts on the wetlands will be a result of the magnitude of human interference and climatic change, which is predicted to rise in the near future. In terms of predicting the changes in an ecosystem, they are more individualistic than monotonic in nature and thus they remain complex for us to comprehend the impacts. The application of remote sensing and geospatial techniques would thus become more relevant and accurate due to the advancement in the satellite and software sectors. This study aids future researches carried out in the field of wetland and avifaunal conservation, providing detailed changes observed and probable mitigations steps to reduce future hazards.

Index Terms- Wetlands; Remote sensing; Geospatial; Anthropogenic; Climate; Avifaunal.

1. INTRODUCTION

Wetland is a collective term for ecosystems whose formation has been dominated by water and whose process and characteristic are largely govern by water (Maltby's definition). The Ramsar conservation 1971 defines 'Wetlands' as the area of marsh, fens, peat land or water whether natural or artificial, permanent or temporary, with water that is static or flowing, fresh, brackish or salt, including area of marine water, the depth of which at low tides dose not exceeds six meters [1]. Wetlands are the places on earth where land meets the water. They act as a buffer between various terrestrial and aquatic ecosystems, responsible for the conducive environs for biodiversity to flourish and thus are rightly called the "Kidneys" of the Earth. Wetlands according to UNEP (2000) [2] are considered to be the land areas that are partially or permanently covered with water during some months or all the months of the year. Wetlands in India occupy 58.2 million hectares (18.4% of the country area), of which 70% are under wet paddy cultivation [3]. India is known as the land of wetlands as it has a total of 27, 403 wetlands out of which 23,444 are inland wetlands and 3,959 are coastal wetlands. Most of the inland wetlands are dependent upon the major rivers like Ganga, Brahmaputra, Narmada, Godavari, Krishna, Tapi etc. In India, out of an estimated 4.1 mha (million hectares) of wetlands (excluding irrigated agricultural lands, rivers, and streams), 1.5 mha are natural, while 2.6 mha are manmade. India has totally 67,429 wetlands, covering an area of about 4.1 million hectares [4]. Out of these, 2,175 are natural and 65,254, artificial. Wetlands of India (not rivers) cover a total of 18.4% of the total land area of the country out of which 70% is under rice cultivation.

1.1 Objectives

(1) To monitor the Land Use, Land Cover change for the year 1984 and 2016 using high resolution satellite imagery.
(2) To analyze the changes in precipitation and correlating it with the avifaunal population.

2. MATERIAL & METHODS

2.1 Study Area

Nalsarovar is a natural, shallow, inland fresh water lake which sprawls at the junction of mainland of Gujarat and Saurashtra. It is located in Gujarat State (India) between 71°92' E & 72°08' E and 22°40' N and 22°55' N (Figure-1). It falls in two districts of Gujarat State, viz, Ahmedabad and Surendranagar. The depth of Water in the Nal seldom exceeds 3 meters [5-6].

Nalsarovar Bird Sanctuary is a Ramsar site from 26 Ramsar Sites recognized in India and it is the only one from Gujarat. The lake has 36 islets that are relatively large. The area has an ecosystem that provides foraging, roosting, nesting and breeding sites for 216 species of birds. The wetland mainly receives its waters from rivers, viz. the Brahmini and the Bhagavo. It also receives water from the surrounding catchment in north, west and east which have gradual elevated lands. The natural shallowness of the lake sustains numerous types of habitats, which in turn, harbors a diversity of resident and migratory water birds. Thousands of migratory water birds gather at the Nal from early winter to early summer every year.

2.2 Applying remote sensing and GIS techniques for mapping LULC (Land Use Land Cover) of the study area.

(1) Remote sensing imagery of very high resolution from Google Earth Pro was used to carry out historical and recent past land use land cover mapping.
(2) The imagery used were for the years 1984 (pre Ramsar site) and 2016 (post Ramsar site).
(3) Land use Land cover mapping was carried out using ArcGIS 10.4
(4) Land use Land cover maps were generated, apt legends and scales were provided to the maps generated.
(5) Unsupervised classification was carried out using ArcMAP and it was correlated with ground surveys to remove any software-based errors or improper classification of various land use land cover classes.

2.3 Ground based surveys for Avifaunal diversity

(1) Multiple and periodic surveys were carried out in the winter mornings to record the avifaunal biodiversity
(2) Canon DSLR 7 D MK II was used to take the photographs of the bird species
(3) 300 mm (Tamron Telephoto) and 500 mm (Sigma Telephoto) lenses were used during the avifaunal surveys.
(4) Bird census data for various years was gathered from the Forest Dept. (Govt. of Gujarat)
(5) Weather data was gathered from the Water Data Center, Gandhinagar.

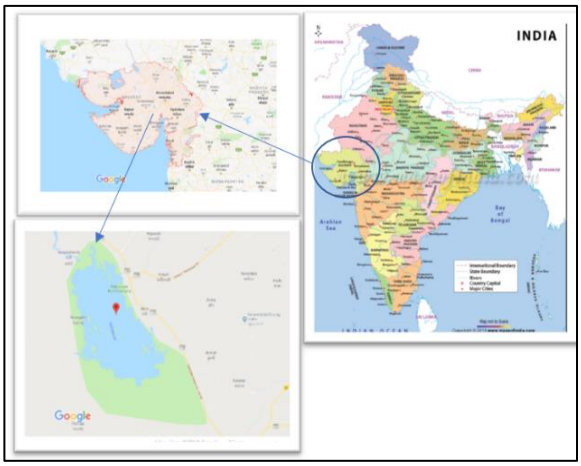

Figure-1: Nalsarovar wetland and its location.

3. RESULTS AND DISCUSSION

Wetland ecosystems depend on water levels and therefore, climate trend (especially trend of precipitation) is likely to have a significant impact on their aquatic habitat components (e.g., open water habitat, emergent vegetation) and associated species [7]. Gujarat Forest Department has been conducting water bird census at Nalsarovar wetland since 1992 at an interval of every 2 years. As per these censuses, the total population of the water birds using open water area (which is the predominant aquatic habitat area for food resource harnessing) and other aquatic habitat areas has been derived. In other words, there has been increase by 1,79,999 individuals (137.52 %) increase in population of water birds using Aquatic Habitat Area. Thus, an increasing population trend has been observed between the winter 2002 and winter 2016 for the water birds using all the Aquatic Habitat Areas. One of the factors affecting water bird population at any wetland is water availability, or in other words, water-level that is manifested as Open Water-spread area. Thus, Stewart [8] has stated that the availability of water is a very important wetland feature to birds of wetlands Bancroft [9] and Kushlan [10] too have emphasized the importance of water availability in wetland for water birds by stating “water bird populations are directly influenced by the amount of available foraging habitat (besides its quality)” and in case of water birds, this foraging habitat is undoubtedly Open Water in association with other aquatic habitats like Emergent Vegetation Cover, Muddy areas of Shore etc. A positive correlation was established between the availability of open water habitat and the water bird population. An increasing trend has been observed from 2002 to 2016 (Figure-2). However, rainfall-water amount and the population links cannot be established accurately due to multiple factors. For example, the region received good amount of rainfall in 2001 but the population of water birds

was still comparatively low thus making climate-wetland interrelationship a very complex one. Nalsarovar is heavily used for irrigation purpose by surrounding community and it is likely that this activity can extract large quantities of waters of the lake for irrigating cropland in the surrounding landscape. The increasing trend of rainfall (Figure-3) was also responsible for the increased open water areas within the wetland. With the increasing trend of rainfall, from the monsoon 2001 to monsoon 2015, the area of the cropland has not consistently increased till winter 2015.

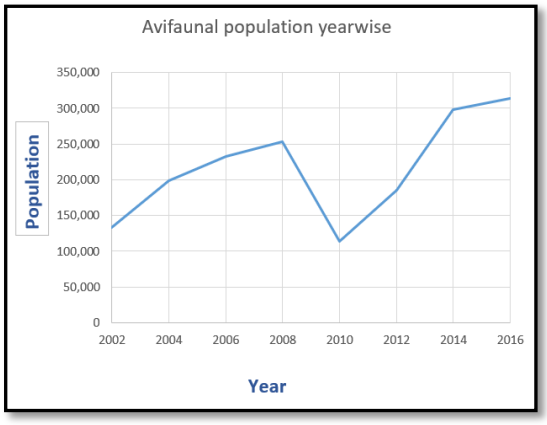

Figure-2: Graphical representation of the bird population years (Incremental trend)

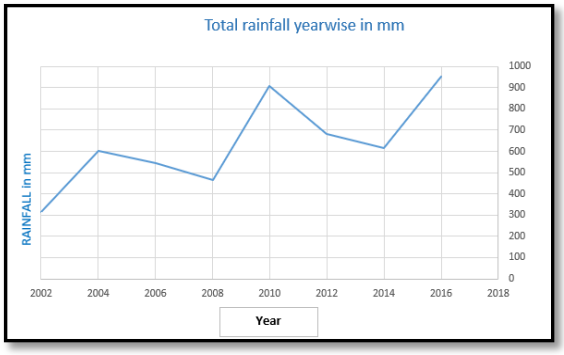

Figure-3: Total rainfall in the study area year wise in mm

Land use Land cover has drastically changed from the year 1984 and 2016 (Figure-4a and 4b). A total increase of cultivated land and agricultural fallow land was very high in the year 2016 in comparison to 1984.

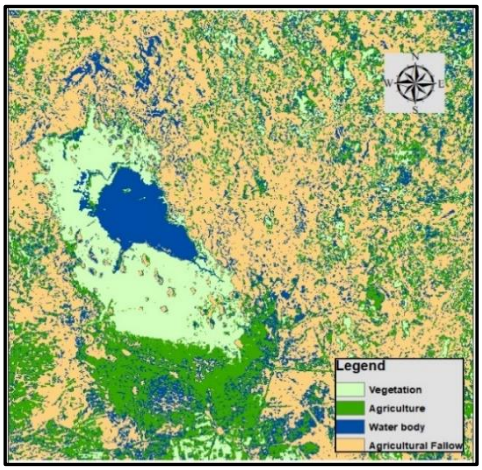

Figure-4a: Land Use Land Cover of the study area (1984, S: 1:50000).

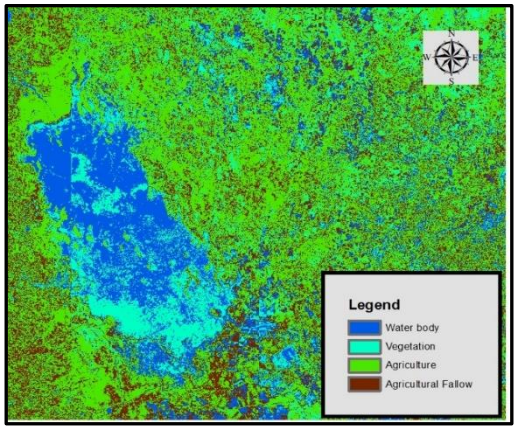

Figure-4b: Land Use Land Cover of the study area (2016, S: 1:50000).

4. CONCLUSION

The total increment in the agricultural land in the surrounding area was computed at around 87%, which in itself has been responsible for the reduction of the total open water habitat within the study area. Such a trend points out to an undesirable condition for the health of the Nalsarovar ecosystem. This is because though the trend of increasing rainfall from 2002 to 2015 might have benefitted Nalsarovar wetland from the view-point of surface water input to the wetland, an increase in both the agricultural activities as well the developmental projects might affect the input of water into the wetland despite increasing trend of precipitation. Both, the exploitation of wetland water for irrigation purposes and the developmental activities will hinder the availability of water to the wetland. Increase in residential and/or industrial area from 2000-2016 infers an increased chance of contaminations through sewage and various other pollutants. From climatic point-of-view Nalsarovar

has had an incremental trend of precipitation and inflow of water birds. Due to the complexities of the human activities involved, the direct connections towards the correlation of climate and waterfowls tends to be inaccurate but certainly a positive one.

4.1 Recommendations

- Monitoring of rainfall (an important climatic parameter) must be an innate feature for all the future studies.
- Other physico-chemical parameters such as pH, Turbidity, heavy metals etc. must be carried out for periodic checks of the quality of the wetland water.
- The study establishes a direct relationship between the open water habitats and population, thus in order to improve the quality of the wetland continuous monitoring must be carried out.
- Proper care must be taken to avoid any habitat destruction, fragmentation and other related disturbances.
- Reducing the exploitation of water from the wetlands by providing riverine waters through canals and creating smaller lakes within the farms for harvesting and storing rainwater for longer periods.

Acknowledgements: The author would like to express sincerest gratitude towards the co-authors and the Department of Botany, Bioinformatics and Climate Change Impacts Management, Gujarat University.

REFERENCES

[1] Wetlands International Annual Review 2003.
[2] UNEP ANNUAL REPORT 2000.
[3] Directory of Indian Wetlands, (1993), World Wide Fund for Nature, India in association with Asian Wetland Bureau.
[4] Wetlands of India: A Directory, MOEF, INDIA (1990)
[5] Acharya, H.G. 1965. A Note on the Nal. 'Prakriti'-*Journal of Gujarat Natural History Society*, Vol.12, No.3 & 4 pp. 1-16.
[6] Johri, A., Ramani, K.R., Suthar, D.C. and Patel, G.A. (1990). Management plan for NalSarovar Bird Sanctuary, 1990-2000. Gujarat State Forest Department, Gandhinagar.
[7] Dawson TP, Berry PM, Kampa E. CLIMATE CHANGE IMPACTS ON FRESHWATER WETLAND HABITAT. *J. NAT. CONSERV.* 2003; 11:25-30.
[8] Stewart, R. (2016). Technical Aspects of Wetlands, Wetlands as Bird Habitats, U.S. Geological Survey https://water.usgs.gov/nwsum/WSP2425/birdhabitat.html
[9] Bancroft, G. T. (1989). Status and conservation of wading birds in the Everglades. American Birds 43:1258-1265
[10] Kushlan, J. A. 1978. Feeding ecology of wading birds. In A. Sprunt, IV, J. C. Ogden, and S. Winckler (Eds.) Wading Birds: 249-297. National Audubon Society. Research Report No. 7. New York, New York.)
[11] Satellite image courtesy: Google Earth Pro and Software courtesy: ARCGIS 10.4.