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Monitoring of Okhla Bird Sanctuary using Temporal Satellite Data: A case study

RAJ SINGH[1,2*] and VARA SARITHA[1]

[1]*Department of Environmental Science, GITAM (Deemed to be University), Visakhapatnam- 530045,*
[2]*Department of Applied Science, Dr. K. N. Modi University, Newai- 304021*
[*]*Corresponding author's email id: rajsinghiirs1996@gmail.com*

ABSTRACT: New trends in wetland management, analysis, and conservation are based on remote sensing techniques and geographical information systems (GIS). Present study investigates the LULC (land use land cover) analysis of Okhla Bird Sanctuary, with the help of LISS III (2008) and Sentinel-2 (2021) satellite data. A comparison study involving all three categories (water, barren land, and vegetation) has been carried out as part of the process of monitoring the change in land use and land cover. From 2008 to 2021, there were big changes in the barren land, which grew by 50.77%, and in the amount of vegetation cover, which went down by 36.87%. The results of regression analysis indicate that LULC classes was influenced by precipitation, 88.7% in 2008 and 64.9% in 2021.Wetlands are one ecosystem where governments around the world should focus their attention to help recharge groundwater and control the amount of water, which will also help solve the problem of drinking water scarcity.

Key words: Land use, land cover, remote sensing, wetland

Wetlands are one of the most important ecosystems on earth that support large and unique biodiversity (Zhang *et al*., 2010; Sandilyan *et al*., 2009; Guo *et al*., 2017; Huang *et al*., 2014). By using space-borne acquired data, researchers are able to identify different types of wetland.They are using remote sensing and GIS technique for wetland classification, inventory, location, determination of area extension, and to know their current status on earth (Hu *et al*., 2018; Cozar *et al*., 2005). During water saturation time and growing season, wetland area covered by much divers' active plants and the plants often found near the ground surface of wetland and commonly identified in low water level area (Barducci *et al*., 2009). Although urbanization is an essential aspect of the new world, it also has a sideways effect on any country's economic growth but it'sreduce the infiltration capability and ground water recharge (Mishra *et al*., 2013). Drinking water is a problem that affects people all around the world, and wetlands can help to solve this problem. Wetlands can help to improve water quality as well as recharge groundwater (Singh and Mishra, 2019). Apart from that, wetlands will be helpful to protect shorelines, provide severity during the flood and drought (Zhang *et al*., 2010; Fickas *et al*., 2016). Even though wetlands are very important for our ecosystem from the beginning of the 20th century but more than 50 percent of wetlands have been lost (Nicholls, 2004). Wetlands are a key component in mitigating climate change, thus investigating how they are changing is a hot topic of study. For retrieving the information related to the earth's surface one of the important sources of the data collection is remote sensing. The required data is collected through relevant sensors in the remote sensing technique, and the scientist and field experts monitor the collected data on a regular basis to draw spatial information on various types of earth resources (Park *et al*., 2003). Remote sensing data are helpful for identification of carbon emission by peatland fires (Van der Werf *et al*., 2006; Rappold *et al*., 2011), identification of changes in land use land cover area of wetland (Adam, 2010 and Yuan, 2005) and spatial analysis of water quality using interpolation techniques (Mishra *et al*., 2021). This research deals with the temporal basis spatial analysis of Okhla Bird Sanctuary wetland using optical satellite data.

MATERIALS AND METHOS

Study Area: Okhla Bird Sanctuary (OBS) Wetland (Fig.1) located between latitudes 28°32'44"N and 28°34'18"N and longitudes 77°17'41"E and 77°19'12"E in Delhi NCR region at GautamBudh Nagar District, Noida. It is a man-made floodplain wetland with high anthropogenic pressure. In 1990,

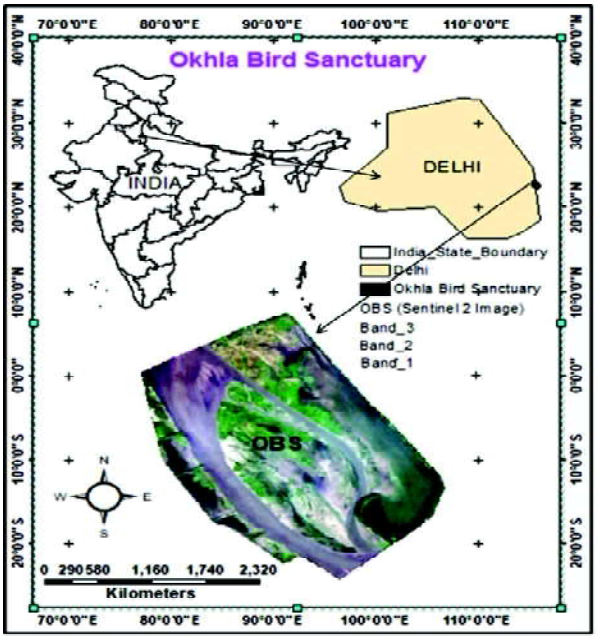

Fig. 1: Study area

the Uttar Pradesh government designated this area as a sanctuary. The roughly covered area of wetland is 4 km sq. It is located where the Yamuna River enters the state of Uttar Pradesh. Due to its unique location of surrounded urban area, the wetland attracts a variety of migratory birds as well as local migratory birds. The construction of the Okhla Barrage resulted in the formation of this wetland.

Table 1: Specification of LISS III data

Acquisition Date	Band	Description	Resolution (meters)
23 October 2008	2	Green	23.5
	3	Red	
	4	NIR	
	5	SWIR	

Table 2: Specification of Sentinel-2 Imagery

Acquisition Date	Band	Description	Resolution (meters)
26 October 2021	1	Coastal Aerosol	60
	2	Blue	10
	3	Green	10
	4	Red	10
	5	Vegetation Red Edge	20
	6	Vegetation Red Edge	20
	7	Vegetation Red Edge	20
	8	NIR	10
	8A	Vegetation Red Edge	20
	10	Water Vapor	60
	11	SWIR- cirrus	60
	12	SWIR	20
	13	SWIR	20

Methods: The extensive work based on the reflectance characteristic of the object was carried out with LISS III and Sentinel-2 imageries (Table 1 and 2). The Resources at LISS III and Sentinel 2 data was downloaded from Bhuvan Geoportal and USGS Earth Explorer respectively. The data pre-processing done in QGIS. Area of interest (AOI) masked out for further processing. Number of training samples was collected for representative classes viz., water, barren land and vegetation. Based on the collected training samples supervised classification technique was executedwith a

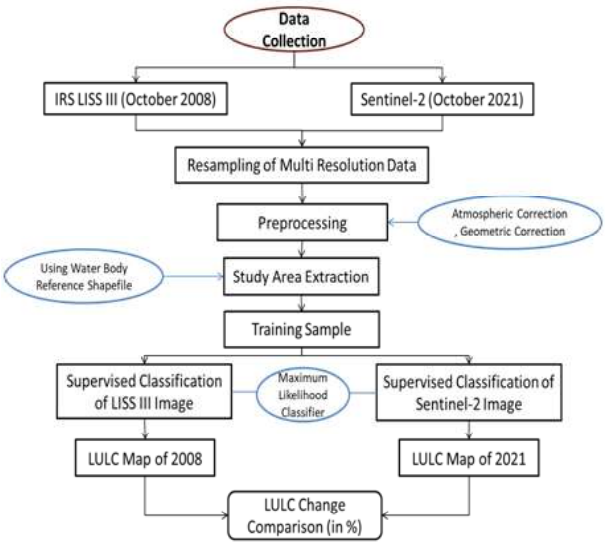

Fig. 2: Flow chart of methodology

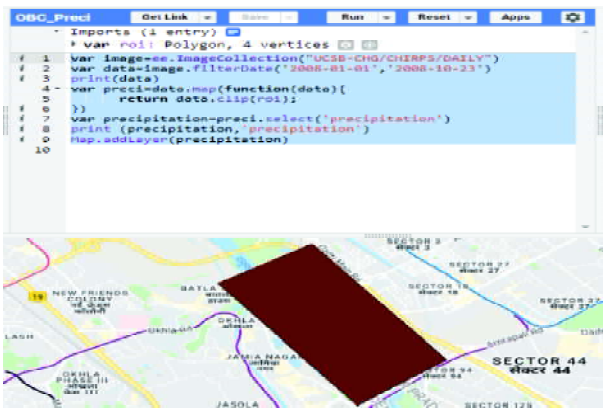

Fig. 3: Precipitation data extraction using Google Earth Engine

maximum likelihood classifieron both satellite images i.e., LISS III (2008) and Sentinel 2 (2021) (Fig.2). Earth Engine platform was used for compilation of precipitation data (Fig.3).

RESULTS AND DISCUSSION

The Yamuna River passage in Delhi is under anthropogenic load, resulting in worsening water quality and a shifting water regime. LULC maps were created using supervised classification technique with LISS III and Sentinel 2 image (Fig.4 and Fig.5). According to fig. 4 and fig.5 classified image the following changes was recorded, the special distribution of vegetation was covered much large area of wetland in October 2008 comparison to October 2021. The few region of Okhla wetland covered with massive silt (Manral *et al*., 2012). The vegetation density and their diversity are playing very important role in wetland ecosystem. Due to industrialization and urbanization at Delhi NCR and Uttar Pradesh Noida sector, the natural vegetation cover areas are continuously degraded. In India, the lacking of strict rules and regulation and policy implementation is one of the responsible factorsfor loss of biodiversity in city area (Sharma *et al*.,2015). Due to the decrease in vegetation cover area in 2021, the barren land areas sharply increased. The water cover area also decreased from 2008 to 2021. Much of the standing wetland water was covered with surface-level green algae, which are easily interpretive in False Color Composite (FCC) of Sentinel-2 2021 data.The high algae species and water hyacinth distribution on top of the water surface is an indication of nutrient enrichment and water pollution of a wetland ecosystem.The discharge of untreated sewage water and industrial rubbish into the Yamuna River in the Delhi NCR area, which is kept and standing at Okhla Bird Sanctuary, endangers its biodiversity and water quality. OBC water quality is rated "C", referred to "moderately polluted" (CPCB, 2011). In October 2008, the water cover 43.17% but in same month 2021 their coverage area was decreased and it's showing 39.25% of total wetland area. Sometimes this type of deference was showing due to rate of

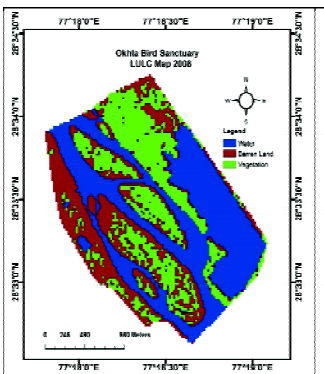

Fig. 4:LISS III classified map (2008)

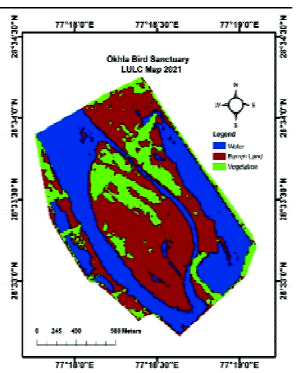

Fig. 5:Sentinel 2 classified map (2021)

Table 3: Area statistics of LULC map 2008 and 2021

LULC Classes	2008 (Area in %)	2021 (Area in %)
Water	43.17	39.25
Barren Land	28.38	42.79
Vegetation	28.45	17.96

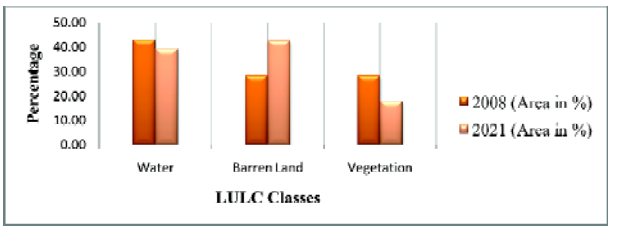

Fig. 6:Changes aspect in percentage of all three classes in 2008 and 2021

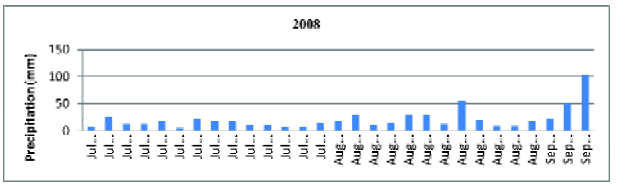

Fig. 7: Average precipitation trend of monsoon session 2008 (OBS surrounding area)

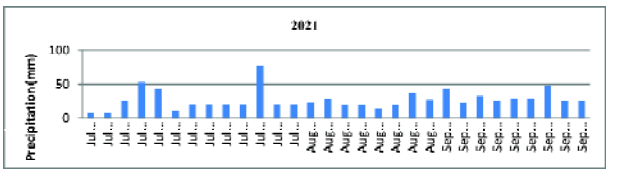

Fig. 8:Average precipitation trend of mansoon session 2021 (OBS surrounding area)

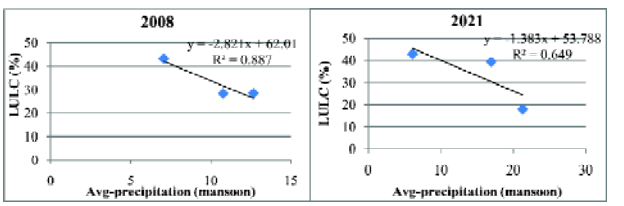

Fig. 9:The result of regression analysis between LULC and average precipitation.

precipitation in that particular year or outflow rate of water from barrage. But at Okhla Bird Sanctuary region, previous research literature highlighted that the urbanization and other human activities are responsible for degradation (TNN, 2014; Mamgain, 2014; Singh, 2013). The barren land covered area was increased 28.38% to 42.79% from 2008 to 2021 respectively in October month. The vegetation distribution was 28.45% in 2008 and its continuously decreased and showing only 17.96% total coverage area of wetland in 2021 (Table 3 and Fig. 6). Fig. 7 and Fig. 8 representing the precipitation trend of monsoon in 2008 and 2021. The LULC study have done with post-monsoon satellite imagery so only monsoon precipitation data have been used of the same year to find relationship. Fig. 9 reveals the influence of precipitation on the LULC classes. Changes in land use, land cover, and the climate all affect each other (Thapa, 2020). The LULC result is interrelated with Indian summer monsoon rainfall trends (Paul *et al.,* 2016). The results of the regression analysis revealed that the coefficient of multiple determination (R^2) was 0.887 in 2008 and 0.649 in 2021, indicating that in 2008, 88.7% of total variation in the LULC class was due to precipitation while in 2021, 64.9% of total variation in the LULC classes was explained by precipitation.

CONCLUSION

The current study presents the three major classes distribution and their land cover changes, and effecting climate variable (precipitation) in month of October 2008 and 2021.In thestudyarea, a dramatic increase in barren land and a reduction in green cover observed.We find the remote sensing and GIS technique is very effective tools for water bodies monitoring and change detection analysis. Sedimentation is a major contributor to the severe pollution and wetland degradation. However, from last few decades the Okhla Bird Sanctuary are highly threatened due to urbanization. OBS surrounded area is highly populated. The urban wetlands areprovided habitat for many migratory birds and animal so its management and function awareness are very important. The well drainage system, prohibited industrial activity, settlement restriction, maintenance of noise pollution and silt removal from OBS area is essential requirement for protection and management of this precious recourse.

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