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Spatio-Temporal Changes of Vegetation (Phumdi) in Loktak Lake of Manipur with Remote Sensing and GIS

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ABSTRACT: The wetlands of Manipur River Basin are essentially floodplain wetlands. This study is about Loktak Lake which is the largest freshwater lake in Northeast India. Due to high rate of population growth in the Manipur River Basin, it leads to deterioration of the Loktak Lake by disturbing its ecosystem. Continue process of deterioration will reduce the storage capacity and the life span of the Lake. Therefore, it is necessary to study the changing environment condition of the Loktak Lake. In this study the data of 1989 and 2002 are obtained from the Atlas of Loktak Lake (Trisal, C.L. and Manihar, Th. 2004). For the comparative analysis, 2016 data are obtained by using 2016 image of Google earth. For the changes in the vegetation characteristics of Loktak Lake, the normalized difference vegetation index (NDVI) is done for the time period of 2001 and 2016 with the help of GIS.

KEYWORDS: Manipur, Loktak Lake, Normalized Difference Vegetation Index (NDVI), Phumdi.

I. INTRODUCTION

The vegetation plays an important role in governing the wetland process and its function of lake ecosystem. Loktak Lake is covered with vegetation locally called phumdi. These phumdis have thickness ranging from 0.2 to 1 m. The Loktak Lake is further classified into three zones namely northern, central and southern zones in terms of biodiversity and pressure of human activities as per the Atlas of Loktak Lake (Trisal, C.L. and Manihar, Th. 2004). The central zone is mainly covered with phumdis, which is thick in outside edges but hollow inside. They are mainly used for fish farms which is locally known as athaphum. These phumdis can lead to threat the survival of the lake ecosystem. If it is not properly managed, rapid growth of phumdis will retard the flow of water and promote water logging and reduce the water holding capacity by accelerating sedimentation.

II. RELATED WORK

Ningthoujam Talini et.al (2018) this paper deals with the temporal study of changing dynamics of Loktak Lake. This paper describes about the various reasons for deterioration of Loktak Lake such as siltation, deforestation, soil erosion, etc. This paper describes about the use of NDVI index in evaluating the changing dynamics of the lake, land use, land cover and vegetation cover using Google Image by visual interpretation of different time period 2001, 2015, 2011 and 2017. The results of this research show variation in land use land cover as well as vegetation cover.

Trisal C.L. and Manihar Th. (2004) in "The Atlas of Loktak Lake", the lake area during the period of 1989 and 2002 are analysed in three zones namely northern, central and southern zones according to the classes of phumdi, open water, fish farm-cum-agriculture and changes in the lake area had been observed. The phumdi area is significantly increased from 116.4 sq. km. to 134.6 sq. km. with a decrease of open water area from 84.6 sq. km. to 43.9 sq. km. Moreover, fish farm-cum-agriculture area has significantly increase from 84 sq. km. to 106.5 sq. km.

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Devi Rajkumari Sunita et.al (2008) in this paper the catchment area of Loktak lake had been studied using IRS-IC, IRS-ID, LISS-III&IV data, PAN data and IKONOS and prepared different thematic maps like hydrogeomorphology, contour, drainage, road network, settlement and land use are prepared at scale of 1:25000 by using merged data from PAN IRS- LISS-IV image. It also derives the temporal change in the Loktak lake and develop a digital elevation model of this catchment area.

III. STUDY AREA

Loktak Lake

The Loktak Lake is the largest freshwater lake in Northeast India, which is situated between 93°46' and 93°55' E longitude and 24°25' and 24°42' N latitude. It covers an area about 287 sq. km at an elevation of 768.5 m above MSL, which is the reservoir level for the operation of Loktak Hydroelectric scheme. The Loktak Lake is oval shaped with maximum length and width of 32 km and 13 km respectively. It is a shallow lake, with the depth of water varying between 0.5m and 4.6m and average depth of 2.7m.

Loktak Lake Zonation

The Loktak Lake is further classified into three zones (Fig. 1) viz, - northern, central and southern zones in terms of biodiversity and pressure of human activities.

The main features of the three zones are: -

Northern Zone - This zone extends from eastern side of Nambol River. Five main rivers namely Nambol, Merakhong, Ishok, Waishel and Nambol flows through the northern zone. This leads to inundation of the peripheral areas. The problem has been further compounded by choking of the drains by the proliferation of phumdis.

A large thick layer of phumdis extending from the northwest to the southeast separates this zone from the central zone. The thickness of the phumdis in this area ranges between 0.4 m and 2.5 m. Phumdis from this area are usually burnt annually during January to March for construction of fish cum paddy farms. Several large fish farms with raised embankments have been constructed in this area.

Central Zone - This zone extends from western side of Nambol River. The prominent islands of Thanga, Karang and Ithing are located in this zone. The central zone is the main open water zone in the lake. This zone was earlier relatively free from phumdis but over a period of time, it has been used by the neighbouring villagers for athaphum fishing. The number of athaphums in this zone has considerably increased during last decade choking the entire lake.

Southern Zone - This zone is located in the southernmost part of the lake, it includes Keibul Lamjao National Park. Ungamel channel links this zone with Khuga River. Similarly, Khordak channel links Imphal River with this zone.

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Fig. 1: - Zones of Loktak Lake. (Source LDA)

IV. RESULTS AND ANALYSIS

Changing Environment of The Loktak Lake.

For analysis of the changing environment in the Loktak Lake. In “The Atlas of Loktak Lake”, the Loktak Lake is further classified in three zones northern, central and southern zones in terms of biodiversity and pressure of human activities. In the below table 1, the data of 1989 and 2002 are obtained from Atlas of Loktak lake and those of 2016 are obtained using image of Google earth 2016.

From the comparative analysis of the year 1989 and 2002, overall phumdis (a floating bio-mass) have significantly increased throughout the lake from 116.4 to 134.6 sq. km. and the open water area is decreased from 84.6 sq.km to 43.9 sq. km as the phumdi area is increasing. The fish farm cum agriculture area has significantly increased from 84 sq. km to 106.5 sq. km.

In 2016, from the Google earth image, the overall phumdis are decreased to 97.6 sq. km as compared with 2002. As a result, the open water area is slightly increased to 47.8 sq. km. The fish farm cum agriculture is significantly increasing to 139.6 sq. km. continuously. The Fig.2 represents changing environment of the Loktak Lake in 2016.

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Year	Zone	Phumdi (sq. km)	Open water (sq. km)	Fish farm cum agriculture (sq. km)	Island (sq. km)	Total (sq. km)
1989	Northern Zone	55	-	67		122
	Central Zone	29	75.5	5.5	2.0	112
	Southern Zone	32.4	9.1	11.5		53
	Total	116.4	84.6	84	2.0	287
2002	Northern Zone	41.6	-	80.4		122
	Central Zone	59.6	37.5	12.9	2.0	112
	Southern Zone	33.4	6.4	13.2		53
	Total	134.6	43.9	106.5	2.0	287
2016	Northern Zone	34.6	-	88.1		122.7
	Central Zone	32.1	45.6	32.0	2.0	111.7
	Southern Zone	30.9	2.2	20.4		53.5
	Total	97.6	47.8	139.6	2.0	287

Table 1: - Change in Loktak Lake.

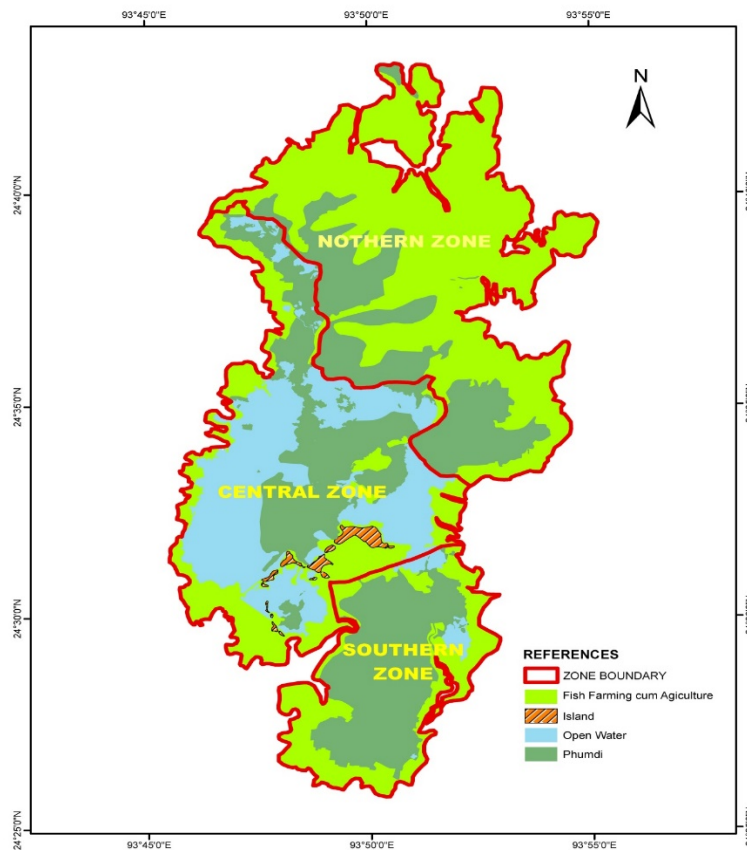


Fig. 2: - Changing Environment of The Loktak Lake in 2016.

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Changes in The Vegetation Characteristics of Loktak Lake.

The Normalized Difference Vegetation Index (NDVI) is a standardized index to generate an image displaying greenness (relative biomass) or density of vegetation by measuring the reflectance portion of spectrum in red and near infrared region. The NDVI index is calculated by near infrared radiation minus visible radiation divided by near infrared radiation plus visible radiation. The range of NDVI index is -1 to 1. No vegetated area is represented by the index value of -1 to 0 whereas vegetated area is represented by 0 to 1.

The satellite image of Landsat has been used for the analysis of NDVI index for the year 2001 and 2016. The value of NDVI index ranges from -0.616 to 0.611 for the year 2001 whereas for the year 2016 NDVI index ranges from -0.089 to 0.356 which conclude that the positive NDVI value above 0 is less as compared to 2001. The images of the NDVI index is shown below in the Fig. 3.

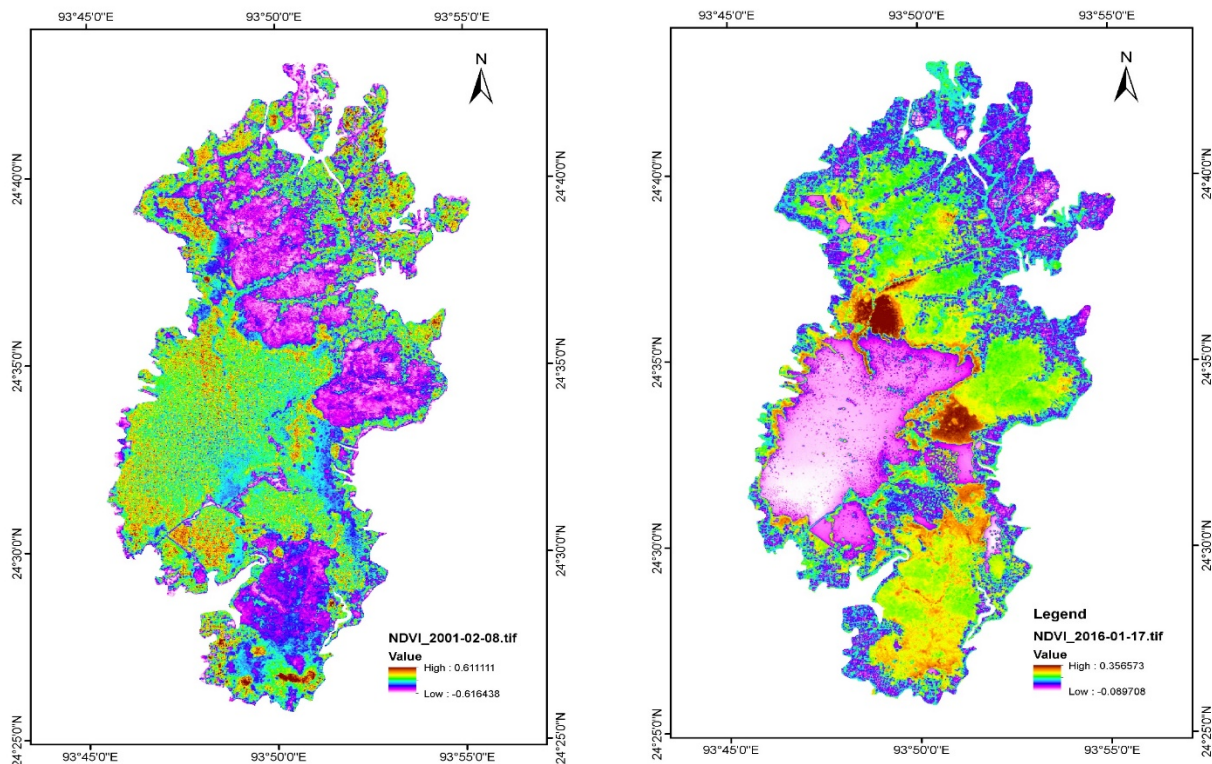


Fig.3: - NDVI index of 2001 and 2016 Landsat image of Loktak lake.

V. CONCLUSION

The study reveals that after comparative analysis of the year 2016, from the Google earth image, the overall phumdis are decreased to 97.6 sq. km as compared with 2002 due to the implementation process of cleaning phumdis by LDA under Conservation & management of Loktak & Associated Wetlands Integrating Manipur River Basin. As a result, the open water area is slightly increased to 47.8 sq. km. The fish farm cum agriculture is significantly increasing to 139.6 sq. km. For the Normalized Difference Vegetation Index (NDVI) the vegetation cover has decreased in 2016 as compared to 2001. Hence, both the studies are related to each other.

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