

“SPATIO-TEMPORAL ANALYSIS OF PHUMDI PROLIFERATION AROUND LOTAK LAKE OF MANIPUR USING GEOSPATIAL TECHNOLOGY”

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Abstract:

The floating mats of Loktak lake are also well-known by the name of Phumdis locally. The phumdis are a rare mass of floating entangled plant life, which is formed by the accumulation of organic debris and biomass with soil particles, which has been concentrated in solid form and it is also consist of matter which is organic and is at different stages of decomposition. The Phumdis play a vital role in the ecological processes and functioning of the Loktak lake's ecosystem. The existence of phumdi is one of the main unique traits of the Loktak lake, which is the largest freshwater lake of north-east India. It is around 38 kilometers away from Imphal the state's capital. The phumdi itself covers almost most of the parts of Loktak lake. In the present study, an effort has been made to study and estimate the changes taken place in the lake over the past few years using remotely sensed data of 2002 and 2017.

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Introduction

In northeast India, Loktak Lake comes as the largest freshwater lake, and it acts as a natural reservoir for the rivers and streams of the valley and hills in the state, and it has been identified as a major Indian wetland by the World Conservation Union (IUCN). The rich wildlife/biodiversity of this area had earned its position of Ramsar site of international importance in the year 1990. Loktak Lake also finds its mention in the Montreaux Record, which is a record of Ramsar sites where changes in ecological character have occurred, are occurring or are likely to occur. The ecosystem can also be described as a wetland with north-south elevation (Imphal 790 msl; Loktak lake surface at present level 768.5 msl). One of the main unique characterizations of Loktak lake is the presence of thick floating biomass known as phumdi. The 28896 ha Loktak lake area is not a single body but a composite of several separate wastelands, locally known as 'pats,' which could earlier be easily distinguished in the lean season before the Loktak hydel project was initiated. Loktak Lake is considered the lifeline of Manipur and is an integral part of the socioeconomic and cultural life of the people in the state (Singh and Shyamananda, 1994).

Lakes have got a great importance value in regards to physical, economic, ecological and social benefits . Bodily, they operate as the reservoirs for storing water and filtering it for recharging groundwater storage; ecologically they uphold a large range of life forms such as mammals, migratory birds, reptiles, amphibians, fish and many other plant species; economically they are endowed with a vast variety of valuable commodities, and socially a vast number of people carry on their livelihood by making use of them. But regardless of performing so many vital function lakes are under severe stress and are becoming ecologically dead. And Loktak Lake is also one of the lakes which are also going through such a problem. This lake plays an important role in the economy of Manipur. It serves not only as the source of water for drinking, power generation and irrigation but it is also a source of livelihood for the people living in the surrounding villages, islands and on the phumdis survived by engaging in different economic activities such as fishing, agriculture, fish farming, trading of lake products, traditional handicraft made of lake products such as mats, baskets, and other woven goods etc. So, keeping this aspect in mind, an attempt has been made to assess the causes for this stress and its resultant impact on the lake.

Various type of work has been performed by many researchers to explore the landscape on the earth surface by using remote sensing and Geographic information system (GIS). Many scholars now are putting more

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importance of the wetland studies to know its change origin stress and to conserve it from being exploited.

Remote sensing and GIS plays a very vital role in such kind of study.

Study Area

Loktak lake (24°25'N to 24°25'N latitude and 93°46'E to 93°55'E longitude) is situated in Bishnupur district approximately 38 kilometers away from south of Imphal which is the capital of Manipur. Loktak lake is the largest freshwater wetland of Manipur and declared a Ramsar Site in 1990 (LDA, 1996). The lake is oval with maximum length and width of 26 Km and 13 Km respectively (Environment Information Center Manipur). The depth of the lake varies between 0.5 to 4.58 m with average depth recorded at 2.7 m (Trisal and Manihar, 2004). Loktak Lake can be considered as a sub-basin of the Manipur River basin. It has a direct catchment area of 980 sq.km and indirect catchment area of 7157 sq.km. There are 55 rural and urban settlements around the lake with a total population of 100,000 (LDA and WISA, 1999). The lake provides livelihood to the settlements in the form of fishing, agriculture, a collection of vegetables, etc.

Methodology:

Remotely derived indices were used to study water and vegetation in the study. NDWI (normalized difference water index) helped in the identification of water and the changes in the water content of the lake. This is a very effective method to calculate the water content of the lake. The study also used NDVI (normalized difference vegetation index) to know the content of phumdi, and it changes over the time.

$$NDVI = \frac{NIR - R}{NIR + R}$$

$$NDWI = \frac{Green - NIR}{Green + NIR}$$

This study was carried out to detect the changes in the lake and the factors influencing it. Remote sensing and GIS played a very important role in this study. Remote sensing was used in the collection of the data and GIS was utilized for the preparation of the final maps of normalized difference vegetation index (NDVI) and normalized difference water index (NDWI).

Results and Discussion

In 2000 the water bodies were 55.88 Km² which increased to 133.03 Km² in 2017. One of the major reason for the increment of the water bodies was due to the phumdi clearance work taken up by the Loktak development authority and with the construction of barrage such as Ithai barrage dam (Figure 1).

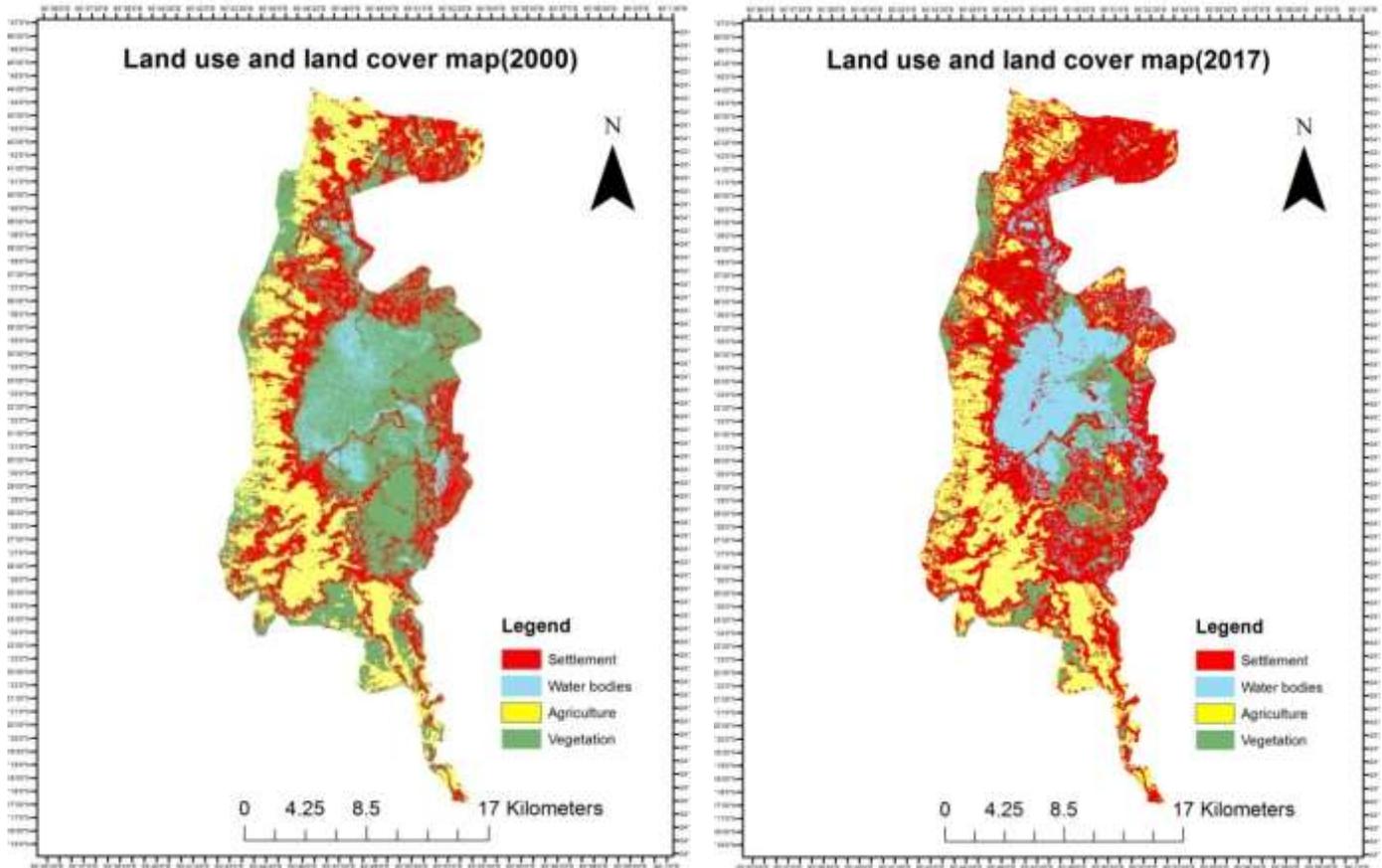


Fig 1: Land use and land cover Map (a) 2000 (b) 2017

Settlement in 2000 was 105.51 Km² increased to 157.37 Km² in 2017 with the increasing population density while agricultural land in 2000 was 200.06 Km² decreased to 121.81 Km² in 2017 (Table 1). The reason may be attributed to the hilly terrains which not fertile and unproductive due to their steep slope and undulating terrain (Banerjee et al., 1983). Vegetation in 2000 was 134.55 Km² decreased to 83.79 Km² in 2017 (Figure 2).

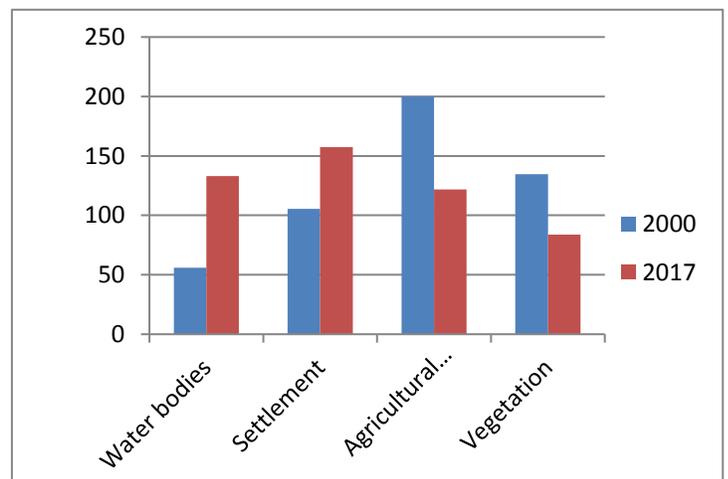


Fig 2: Area covered by LULC in 2000 & 2017

The transformation of adjacent lands into the settlement, agricultural land can be one of the reasons behind the decrease.

Table 1: LULC area in the Year 2000 and 2017

LULC	2000 (area in Km ²)	2017 (area in Km ²)
Water bodies	55.88	133.03
Settlement	105.51	157.37
Agricultural area	200.06	121.81
Vegetation	134.55	83.79
Total	496	496

Taothabi, a tall traditional variety of rice plant that thrives well in the swampy ecosystem is almost locally extinct. Encroachment is generally done on the peripheral areas of the lake primarily for expansion of human settlements and aquaculture (Kosygin and Dharmendra, 2009). Due to lack of agricultural land *athaphum* fishing (a method of fishing using the floating vegetative mat), a form of traditional fishing has been intensified in number and spaced occupied in the lake. Large areas of the lake have encroached for aquaculture practices.

Spatio-Temporal Analysis of Waterbodies

The NDWI image of 2000 and 2017 clearly shows the difference in water content. In the year 2000, the water content was very less compared to the year 2017, and the reason for it is the presence of phumdis as in 2000 the presence of loktak was very high, but in 2017 it was cleared. With the construction of barrage such as Ithai barrage dam, the high level of water in the lake is flooding the surrounding area. As a result, the rise and fall of the phumdis have been adversely affected by it (Figure 3).

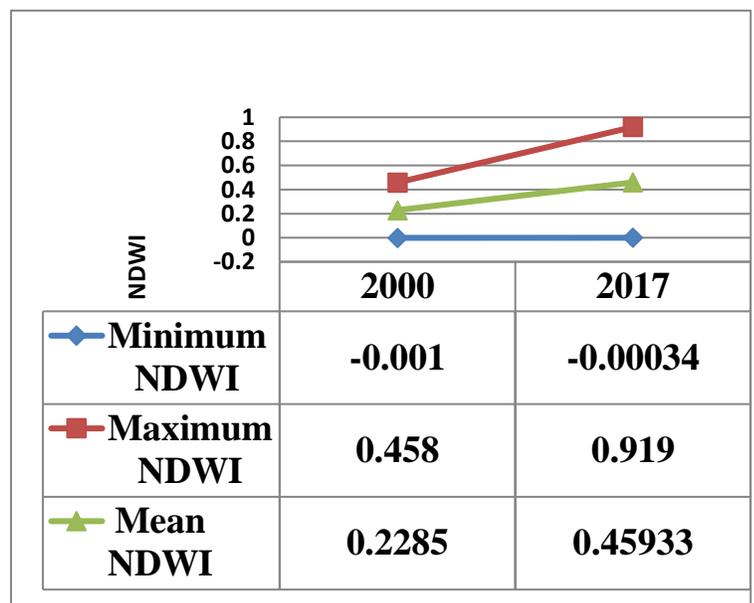


Fig 3: Statistics of NDWI for 2000 and 2017

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The phumdis no longer sink and are deprived of nutrients, so they are dying which has resulted in the practice of making artificial phumdis or floating mats also atthaphum (Laishram and Dey, 2014).

The significant increase in the practice of atthaphum which is the practice of making artificial floating mats and fishing has also led to an increase of phumdi area. The erection of Ithai barrage dam has brought a rise in the practice of athaphum fishing and phums culture. The proliferation of phumdis has led reduction of water holding capacity, deterioration of water quality. With the increase of phumdi covered region in the lake, the open water area of Loktak Lake has ultimately decreased (Figure 4).

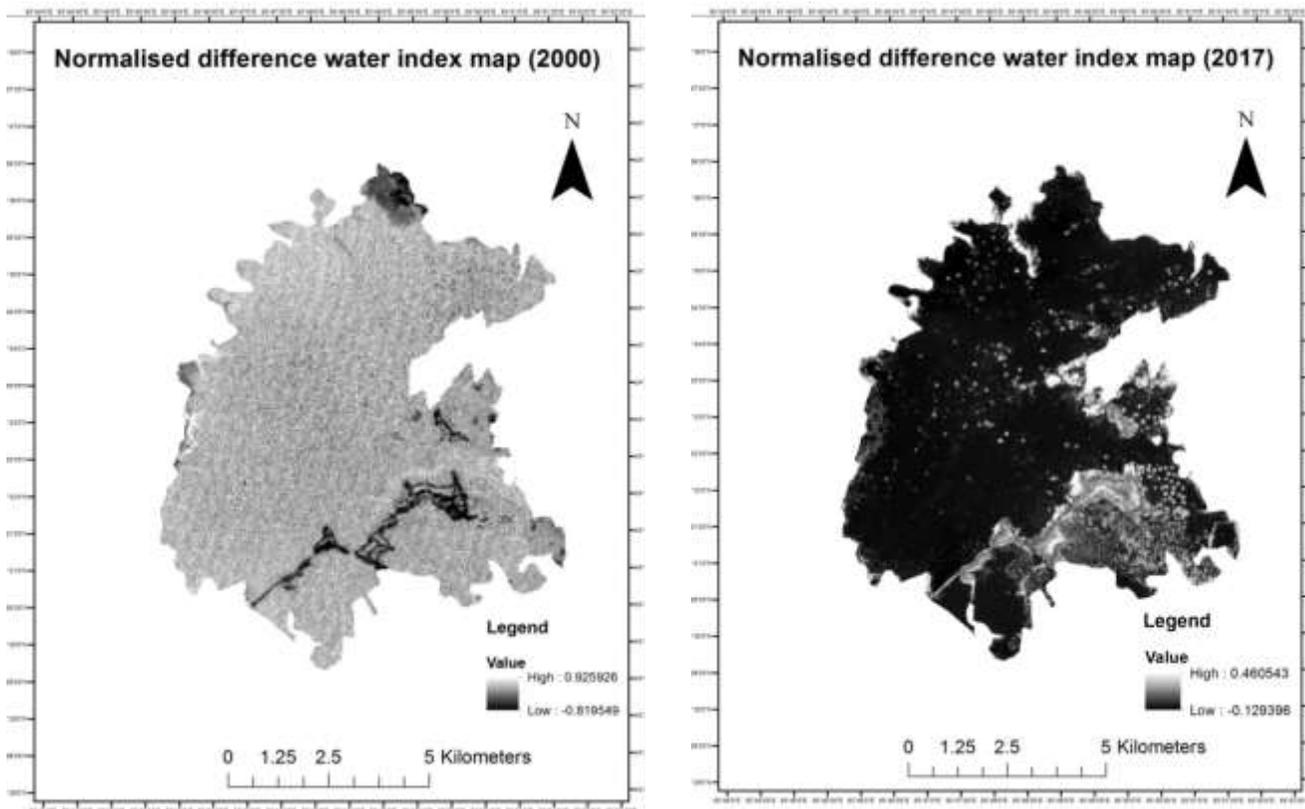


Fig 4: Spatio-Temporal Map of NDWI (a) 2000 (b) 2017

Spatio-Temporal Analysis of Vegetation

There is a major change in the NDVI image of 2000 and 2017 as in the 2000 image the lake area is mostly covered by vegetation which is the phumdis, and it was the year the phumdi population was very high.

In the year 2017, there was a drastic change in the NDVI image and one of the major reasons for it was due to the phumdi clearance work taken up by the Loktak development authority (Figure 5). The rapid proliferation of phumdi and aquatic weeds in the Loktak is a cause of concern for the lake management. S as it hampers fishing activities. Every year the fishermen community organized to cut the phumdis and release in the Khordak water channel and during the lean season they burnt down the dry vegetation in phumdis (Singh and Khundrakpam 2011).

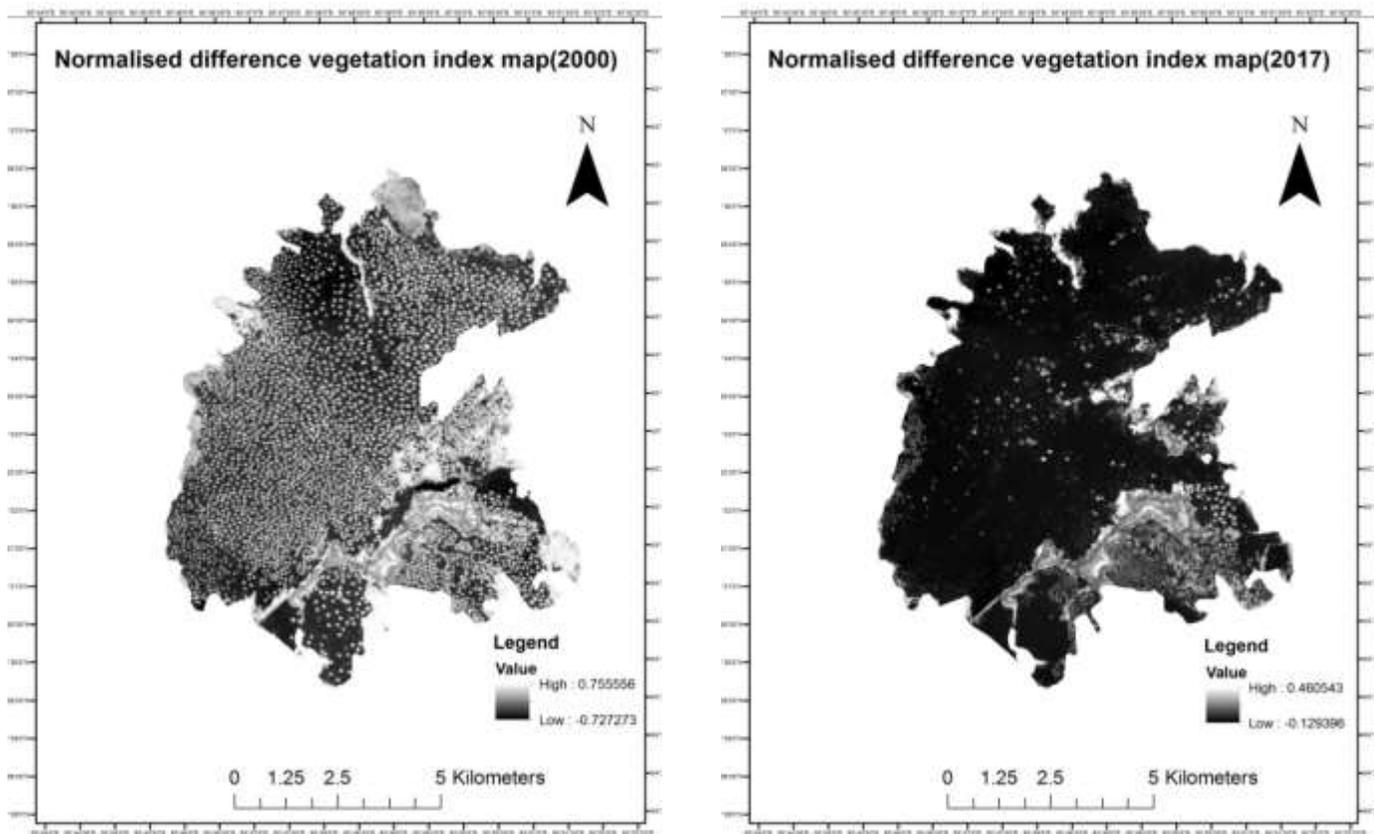


Fig 5: Spatio-Temporal Map of NDVI (a) 2000 (b) 2017

Conclusion

The study of land use pattern can be considered as one of the prime indicators of the relationship between man and natural environment. The study reveals that the land use and land cover-pattern of Loktak Lake changed during the last few decades. The vegetation has been converted into to settlement land represents the significant urbanization. Despite the impressive gains in aquacultural production, there are worries related

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to degradation in water quality in the lake due to increased use of feed and other chemicals. Anthropogenic factors are the major compelling factor underlying the change. Waterbodies and settlement showed an increasing trend, whereas a declining trend was found for agricultural land and vegetation. Such a change in the land use and land cover caused undesirable impacts on natural environment causing depletion of natural resources base. The livelihoods of the people have been considerably marginalized. There is a need for greater efforts and new methods to monitor and mediate the negative consequences and to sustain current and future human populations under desirable conditions. There is also a need for maintaining the well-being of Lake Ecosystem and the people depending upon its resources.

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