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Siltation In Loktak Lake: A Geographic Study

Dr. Kh. Pradipkumar Singh

Abstract

Land and Water are the most important resource of life in any environmental condition. By taking the advantage of achievement people have started exploiting the natural resources at an alarming rate. Loktak, the fresh water lake, is now under threat due to several integrated factors mainly caused by anthropogenic pressure. Large scale and rapid degradation of forests in the upper catchment area has led to the serious problems of siltation and reduction in water holding capacity of the lake. These problems are further enhanced by the construction of Ithai Dam across the Imphal river that has changed hydrological regime of the lake.

Introduction

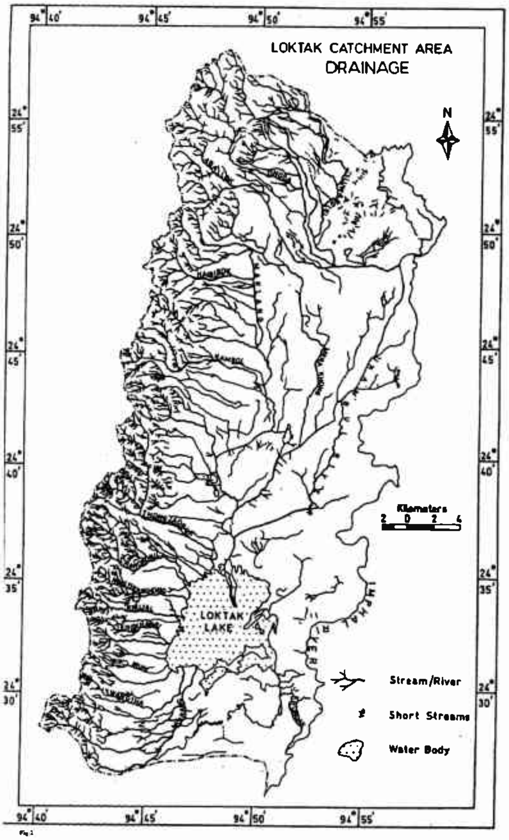
Loktak catchment area covers 969.01 km^2 and lies between 24^{0}57'56" and 24^0 25' 68" N latitude and between 93^0 40' 45" and 95^0 58' 37" E longitude (Fig. 1). Physiographically, the study area consists of four distinct units, viz. the hill, the foothill, the plain and the lake. The Hill area occupies the western margin of the study area. The foothill region lies between the first and third unit. The lake region is confined in the south-central part of the catchment area. Loktak lake, the largest natural fresh water lake in the North-Eastern region of India, covering an area of 286 km^2 at normal level of the water, is now highly endangered. The lake is rich in biodiversity and has been recognised as a wetland of International Importance under Ramsar Convention in1990.

The present status of the lake is now menaced by several integrated factors. There are fifteen streams of different orders which flow directly into the lake. The Nambul river, the longest river Draining into the lake brings down the sediment loads and lot of pollutant materials as it passes through the heart of the Imphal city. It is estimated that the annual sediment input into the lake by these rivers is 650,000 MT approximately (LDA report, 2004). This has been attributed to the degradation of the upper catchment area. Besides, there are other problems like, inundation of cultivable agricultural lands, changes in hydrologic regimes affecting the normal carrying capacity of the lake, loss of fish population and diversity etc.

The main thrust of the present study is to analyse the relationship between the amount of sediment discharge by the thirteen rivers into the lake and the problems associated with the siltation.

Methodology

The study is based on both primary and secondary data. Base map and other thematic maps are prepared from the topographical sheets-83H/9, 83H/ 10, 83H/13, 83H/14, and 83H/15. Necessary data and information such land use, discharge and sediment loads are collected



from the office of the Loktak Development Authority, Imphal. Intensive field work has been carried out to identify the geology, landforms and drainage networks in the upper catchment area. Field visits are also made in and around Loktak lake during pre-field and post-field seasons to collect the relevant data relating to saltation in the lake.

Land use and Soil Erosion

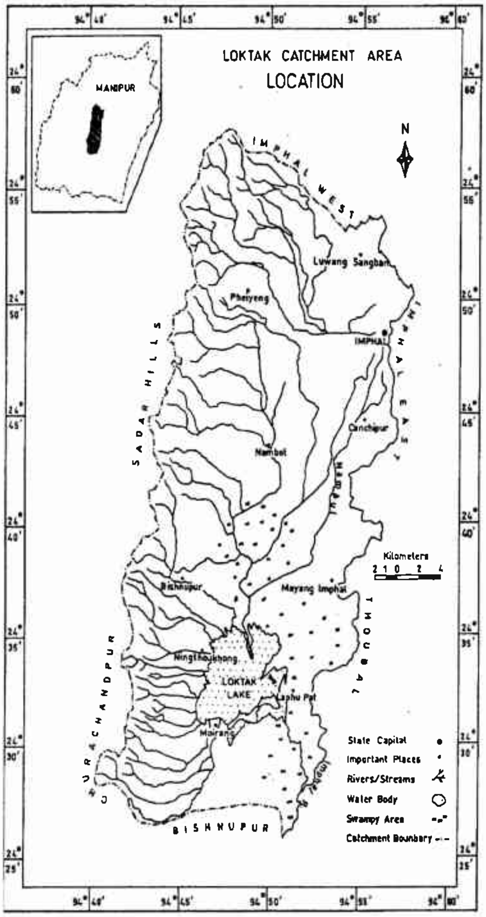
Changing a land use pattern is a reflection of the structural change of economic, social and cultural activities. Rapid advancement of technology has created new needs of the society and demand more land. At the same time soil erosion is an outcome of

Table1:MajorLanduse/Landcovercategories of Lokatak Catchment Area(Km^2)

Categories	Area in Km.^{2}	Percentage to the Total Area
Agriculture	342	32.57
Settlemet	133	12.67
Forest	266	35.33
Waterlogged	22	2.09
Lake area	287	27.34

Source: LDA

the changing land use system. Erosion is a complex phenomenon which includes the detachment and removal of soil and rock by different action. The web of relationship between the factors which influences the erosion is extremely complex (M.J. Selby, 1982).Thesefactorsareclimate,topography, vegetation and soil character. However, human factor is influencing the natural system of soil development to a great extent. By modifying the other factors such as they clear the forest, changing the topography for terrace and shifting cultivation. Since last five decades Loktak catchment area has experienced a significant change in its land use pattern both in hilly terrain and plain areas. For instance, the duration of cycle of jhuming that extended to 20-30 years in olden days has now been reduced to 2-3 years. This is mainly because of increased population pressure on land and decreasing productivity. This has also resulted in bringing more areas under this type of cultivation. Jhuming is done on sloppy land. It involves deforestation, burning and clearing of vegetation which give rise to a serious problem of soil erosion and soil wash. Through these process



soil materials, to the tune of 3.7 tone/hac. was reported to slide down (LDA report, 1993). Soil erosion studies confirmed that shifting cultivation is a hazardous farming system. In the absence of soil and water conservation measures, crop canopy is the only safeguard against direct impact of rain drops (Borthakur et. al, 1983).

It is also reported that the some part of the study area is having high erodibility of soil. The soil developed in the higher slopes of both high and medium hills are deep to very deep, well drained, fine loamy to fine texture. In coarse of fragments

Table 2: Stream order and area of streams directly draining to the Loktak Lake

Basin	Stream Order	Area (km²)
Nambul	6	582.33
Thongjaorok	5	32.09
Kongdun	3	5.65
Charoikhul	5	20.19
Ningthoukhong	4	11.36
Khujal	4	6.80
Thinungei	3	3.58
Lengkhanbi	4	11.22
Sunusiphai	3	4.59
Irum	3	6.04
Thingjin	3	6.02
Wangtha	4	14.91
Moirang	4	47.12

are present today become moderately to excessively erodible. About 5.9% of the Loktak catchment area falls under very severe erosion class, 14.6% under severe and 7.2% under moderately severe (LDA report, 2004).

Although there is lack of quantitative information on the loss of forest resources due to shifting cultivation in the upper catchment area, it generally conceived that the existing forest is substantially degraded. At present the forest occupying land is estimated to be 25.33% of the total study area consisting of dense forest, degraded forest, land with or without scrub and vegetation or plantation. Out of the total forest area occupied by dense forest area is limited and mainly confined to the north western corner of the study area. As the maximum forest area is under the sub-category of degraded forest land the present forest is in such a condition that it does not control the hydrological regime of the area. The catchment area is now considered as 'runoff exceeds regime' of the area, meaning the runoff exceeds infiltration, quick water discharge, frequent occurrence of flood in the plain and heavy soil erosion. This is the state of the natural ecosystem of Loktak lake.

Drainage

For the present study, thirteen streams that directly drain into the Loktak lake have been taken into consideration. These streams are Nambul, Thongjaorok, Kongdun, Charoikhul, Ningthoukhong, Khujal, Thinguei, Langkhanbi, Sanathoibi, Irum, Thingjin, Wabngtha and Moirang. Nambul river drains more than half of the study area i.e. 582.3 km² and drains to the lake at the northern side (Fig. 2). Those streams draining the Loktak catchment area originate from hilly region that stretch from north to south and to situated on the western margin of the study area. Some of these streams are perennial. Besides, there are many gullies development in degraded sloppy lands which are in the stream lengthening process.

Very high drainage density and very fine drainage texture occurre all along the western flank of the study area. Dendritic to sub-parallel dendritic drainage patterns are commonly found in the upper catchment area. The drainage characteristics, the present land use system and the prevailing topographic feature (i.e. abrupt change in slope with short distance) are some of the factors responsible for the higher rate of soil erosion.

What is indirect C.A.?

In addition to that so called indirect catchment area which is formed by five sub-basins viz, Imphal, Iril, Thoubal, Sekmai, and Khuga basin join together and flow towards the south direction and connected to Loktak lake through Ungamel land Khordak channels. Practically these two channels are having bidirectional flow of water depending upon the relative water level of Loktak lake and Imphal river.

Human Occupance in and around Loktak Lake

Loktak lake is situated in Imphal East, Thoubal and Bishnupur districts of Manipur. Altogether there are 53 settlements in an around Loktak lake with the total population of 279,935 (2001 Census). Out of this 33% is in the Western zone, 29% in Eastern zone and 10% in the Southern zone of the lake shore. Besides, 7% of the valley population lives in three islands of Loktak lake namely, Thanga, Karang and Ithing (LDA Report, 2004). The people living in and around this lake directly or indirectly depended on Loktak resources for their sustenance. Some of the important resources are fishes, aquatic vegetation and water. As per the survey report made by Loktak Development Authority, the sanitation facilities, in general, are inadequate in the entire settlements. Only 26% of the total population living in this region has access to proper sanitation system. The situation is more serious in the island villages, where 89% of the population has no sanitation facilities. They simply discharge human wastes directly into the lake and deteriorated the water quality of Loktak.

Table 3: Sediment Load Carried by Four Rivers (1999-2002)

Name of the River	Total Sediment	Total Sediment load in Kg.	Sediment load in million Kg.
1999-00			
Nambol	589.45	50928836.9	50.92
Potsangbam	222.82	19251684.6	19.25
Nambul	448.07	38713843.52	38.71
Thongjaorok	NA	NA	NA
2000-01			
Nambol	587.41	50752429.46	50.75
Potsangbam	262.93	22717787.01	22.71
Nambul	784.81	67808019.60	67.80
Thongjaorok	503.95	43541336.36	43.54
2001-02			
Nambol	1075.99	92965818.37	92.96
Potsangbam	1005.14	86844727.33	86.84
Nambul	1371.30	118481070.30	118.48
Thongjaorok	NA	NA	NA

According to Department of Fisheries, Manipur, Loktak lake is producing 1358 to 1685 tones every year. In this activity, altogether 50,400 fishers comprise of 40,500 from Lakeshore villages, 8,300 from island villages and 1,600 from Phum villages (living in floating huts) are engaged. In another wards, approximately 44% of the total households in and around the lake are directly engaged in this profession. Besides, there are 10,600 private fish firms located on the periphery of the lake. After the construction of the Ithai Dam most part of the outer limit of the lake, previously used as agricultural land has turned into fishery pond. This process involves huge amount of investment so many of the poor farmers could not afford the cost and their lands are lying unused. The water quality of Loktak lake is also deteriorating year after year as it receives the polluted water from many rivers like Nambul, Nambol and Moirang which pass through the urban areas. This level of populated water in the lake is one of the reason for declining the fish diversity and population in the lake. At the same time, before the construction of the Ithai Barrage, as many as 12 fish species used to migrate from Chindwin Irawadi river system, Myanmar to the upstream of Manipur river for breeding purposes (Fishery Department, Manipur 1981). These additional fish species have stopped to migrate after the construction of the Ithai Barrage as it blocked the migratory path ways. The increased number of population of the fisherman and unrestricted fishing activities in the Loktak lake have resulted to indiscriminate fishing without considering the regenerative cycle of fish stock. These are some of the factors for the significant decline in fish production from Loktak Lake.

Table 4: Phumdis Proliferation in Loktak Lake

(All figures in km²)

Zone	1980	2002
Northern Zone	55.0	41.6
Central Zone	29.0	59.6
Southern Zone	32.4	33.4
Total	**116.4**	**134.6**

Source : LDA Report, 2004

Loktak lake also provides diverse aquatic vegetation and plants which are used for different purposes such as vegetables, fodder, fuel, handicrafts etc. Many of households in and around the Loktak lake are harvesting these aquatic plants for their livelihood. Similarly water from the lake is also an important lake resource for domestic use. Unfortunately, the present status of water quality of the lake is highly deteriorated and lying beyond tolerable limit for domestic uses.

Siltation in Loktak Lake

The location of Loktak lake is such that it traps the sediment coming from the surrounding hills composed of mainly of non-resistant rocks like clay, shale and sandstones. However, the problem of siltation and degradation of the lake ecosystem are mainly caused by both natural and anthropogenic factors. Rapid and large scale deforestation in the upper catchment area for jhuming and mining activities are responsible for the exceeding run off rate infiltration rate. Altogether sixteen streams ranging from second ordered to six ordered drainages directly fall into the lake.

Except Nambul river, other streams are very short in length and they carry down both suspended and bed load and accumulate in the lake floor. Besides, tremendous amount of silt is also added by the inflows from the Imphal river through Khordak and Ungamel channels. These two channels connect the Imphal river and the Loktak lake during flood where water level in the lake is lower than the water level in the Imphal river. Subsequently, the Loktak lake receives substantial amount of silts both from direct catchment and indirect catchment area. The annual sediment input to the lake is estimated to be 650,000 Metric tons. Approximately 65% of the total amount has been contributed by the sixteen rivers originating from the western hills. While the remaining 35% is contributed by Imphal river through those two connecting channels. Loktak Development Authority has generated data on sediment load carried by four important rivers for three consecutive years (Table 3). The table depicts that the amount of sediment brought by all the rivers increasing in even within a span of three years. As Nambul river drains more than northern half of the Loktak catchment area its sediment load is comparatively very high. In 1999-2000 the Nambul river carries down 38.71 million kg. of sediment load in 2001-2002. The same picture is more or less similar to other rivers too. This adverse condition has been resulted mainly from the excessive large scale deforestation and increasing land under Jhuming cultivation. For instance, due to population pressure in the hilly region the jhuming cycle has been reduced to 2-3 years only. This is a very short period for the soil to get rejuvenated through the natural process. Accordingly the jhum cultivators expand their agricultural in order to meet the sustenance level. As a result, the lake is gradually silting up and getting shallower. Further, the lake is proliferated with floating weeds, called 'Phumdis". Table 4 reveals that the phumdis covered area in the lake has increased from 116.4 km² to 134.6 km² during 1989 to 2002. The central zone of the lake has the maximum areal unit under the coverage of phumdies i.e. 59.6 km² in 2002 from 29 km² in 1989 (Table 3). This is primarily because of preservation of phumdies by the fisherman for fishing purposes and also the fishing activities are mostly confined in the central zone.

This excessive growth of floating weeds is one of the factors for reduction of water holding capacity of the lake. As the channel capacity of Imphal river is very low due to existence of rocky barrier within the river valley itself at Sugnu village (down stream side), it has resulted sudden swelling of water in the lake during the monsoon. The above problems of Loktak ecosystem is further aggravated by the illegal encroachment in the lake side for construction of fishery ponds, roads and settlements. The number small lakes around the Loktak lake, locally known as "Pats" are united into a large sheet of water body. This scenario is more pronounced during wet season. As a matter of fact thousands of hectares of agricultural lands are partially or fully inundated under water.

Strategies

The present status of Loktak lake is really endangered and its life is shortened due to multifaceted problems. The overall ecosystem of Loktak lake is getting disturbed by heavy siltation, lowering of water holding capacity, frequent occurrence of flood, induscriminate fishing in the lake, sudden decline in fish stock, etc. In order to reduce the degree of these problems both long and short term measures should be taken up simultaneously. As a long term measure watershed management in the upper catchment area is a paramount importance. The following measures are suggested.

1. To control the soil erosion utmost care has to be taken up by afforestation programme in the sensitive upper catchment areas. This kind of social forestry programme should have the full participation from the villagers so as to make a mechanism which can create a self protecting system of the new forest. For this, social awareness campaign and motivation on sensitization of the villagers to these issues are highly essential.
2. To minimize the soil wash some of the existing jhuming areas which are having a viable slope should be altered to terrace cultivation.
3. Upper catchment area of the Loktak lake is having a great potential for the development of large scale horticulture. Since the farmers are growing some of the fruits species like, pineapple, banana, orange, lemon, yongchak (tree been), etc. it is necessary to encourage them and they may be given whatsoever possible incentives for large scale production of such fruits.

As a short term measures the following steps can be taken up.

1. To minimize the flood inundated areas and its hazard in and around the Loktak lake the inflow and the outflow mechanism of the lake should be checked at the right time.

2. To reduce the inflow rate from the Imphal river to the lake it is indispensable to construct the check dams across those channels.
3. Removal of Sugnu hump lying within the Manipur river valley will work in the enhancement of channel capacity of Imphal river.
4. Not only the phumdis in the lake are being used for fishing, construction of floating huts and other economic activities but also hampered in preserving the ecosystem of the lake. So, the need for controlling the proliferation of phumdis in the lake is also essential.
5. Land encroachment towards the lake side for construction of of number of private fishery pond and other activities should be strictly prohibited by preparing effective legislation.

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Dr. Kh. Pradipkumar Singh
Department of Geography
Manipur University, Imphal,
Manipur