

## CHANGING LANDSCAPE OF LOKTAK LAKE AND ITS IMPACTS ON LOCAL PEOPLE'S LIVELIHOOD

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### ABSTRACT

*Changes in landscape in wetland area of Loktak Lake have brought considerable impacts on the environment and livelihood of local community. The current study investigates the changes occurring in the livelihood of people in Loktak Lake in the aftermath of the commissioning of hydropower plant. The primary changes taking place in the area include inundation of agricultural land, frequent floods in the fringe lands, loss of biodiversity, occupational change, etc. Floods are associated with wide scale devastation in the agricultural fields, residential areas, home garden, and aquaculture lands. During the last 10 years majority of the houses in the study area experienced floods more than once. About 76% of the households experienced occurrence of floods with the magnitude and severity that submerged the basement of their houses. In the past, livestock have been an integral part of the rural livelihood and a source of household income. However, the number of livestock in the areas has shown a declining trend in the last few decades. Taothabi, a tall traditional variety of rice that thrives well in swampy ecosystem is almost locally extinct, while other traditional paddy varieties have been replaced to near total by improved varieties. Increasing costs incurred by the changing land use and livelihood opportunity lost due to resources degradation leads to increasing marginalization of the population.*

**Keywords:** Loktak Lake, Hydropower project, Landscape, land use changes, Livelihood of people.

## INTRODUCTION:

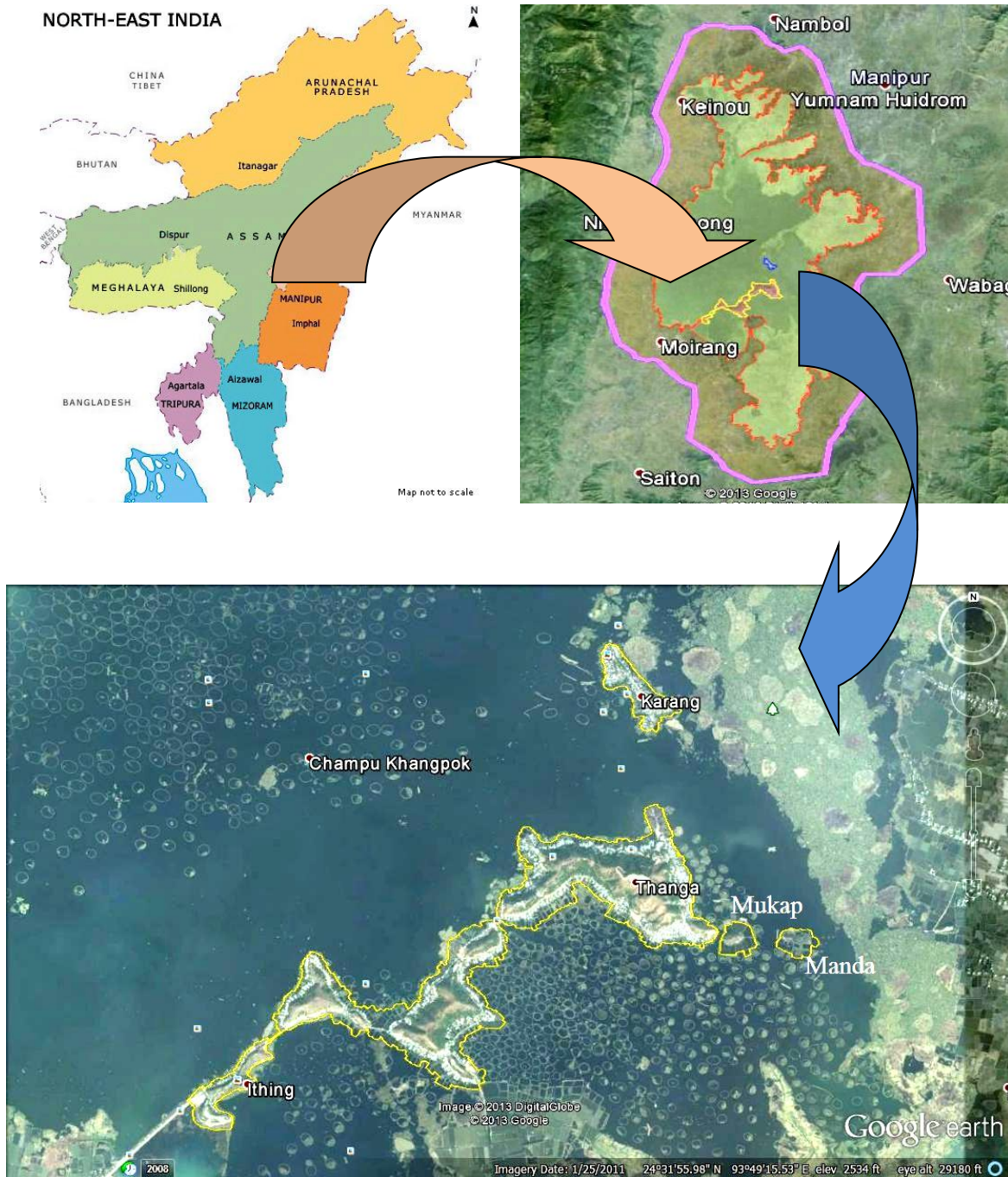
Land use and land cover changes vary in accordance with relief, climatic conditions and other socio-economic requirements of individuals. Land resources fulfil the primary and secondary human needs, *i.e.*, food, shelter, industries, recreation, communication and economic security (Stamp, 1960). Land use is a phenomenon which undergoes ever changing with the growing needs of human beings. These changes in land use patterns are more specific in the marginal and climatically severe regions. Rapid expansion of human populations in the recent decades coupled with widespread unscientific land use practices have resulted into decline in the land to man ratio and shifting from an extensive cultivation practices to intensive ones (Oinam *et al.*, 2005); (Kuniyal, 1996); (Ramakrishnan *et al.*, 2000); (Bilsborrow and Okoth-Ogendo, 1992). Therefore, sustainable utilisation of land resources becomes utmost important to achieve sustainable development and food security of the ever increasing human population (Oinam *et al.*, 2004-05).

The current study attempts to assess the land use land cover changes taking place in the catchments of Loktak Lake as a result of impoundment for hydropower generation. Literature pertaining to studies in land use and land cover changes for the area is scanty, even though many studies were conducted by different scholars on other important aspects. For instance, WAPCOS (1993) conducted an extensive study on Loktak Lake, focusing on issues and challenges pertaining wetland degradation. The report emphasises the need of multidisciplinary approaches to counter the problems of siltation, flood, watershed degradation, weed infestations, *etc.* Presence of *phumdis* (floating vegetative mats) is one of the natural features of Loktak Lake. In a series of studies conducted by the Loktak Development Authority (LDA, 1996); (LDA, 1999) in the lake, the urgent need for control and management of *phumdis* was highlighted. Singh and Moirangliema (2009<sup>a</sup>) had also studied on *phumdi* proliferation in Loktak Lake. Water quality status, water borne morbidities of the lake and its conservation measures were studied by other authors (Laishram and Dey, 2014); (Singh and Devi, 2006). Some other researchers also contributed their thought on watershed management and conservation of the Lake (Singh and Moirangleima, 2009<sup>b</sup>); (Shamungaou, 2007); (Singh and Moirangleima, 2009<sup>c</sup>); (Singh and Moirangleima, 2012). The results obtained in all these studies hinted that the ecosystem and environment in and around the Lake has been changing gradually due to anthropogenic activities.

## RESEARCH METHODS:

### Loktak Lake and the Study Sites:

Loktak Lake (24°25' N to 24°42' N and 93°46' E to 93°55'E) is spread over five valley districts of Manipur. It is the second largest freshwater in India covering an area of about 286 km<sup>2</sup> at the elevation of 768.5 m amsl. During the rainy season the Lake water swelled up to ~490 km<sup>2</sup>. The lake has direct catchment area of ~980 km<sup>2</sup> and indirect catchment area of ~7,157 km<sup>2</sup>. About 34 streams, coming from the western hills and the Imphal River drains into the lake. Loktak in actuality comprises of 20 water bodies of different sizes. The landscape becomes quite distinct during the dry season but the water bodies merged and forms single water spread during the rainy months. The current study area comprises of three hillocks within the lake area *viz.*, Thanga, Karang and Ithing (Fig. 1). The hillocks are situated around 50 km south (on road distance) from the capital city, Imphal. The villages in the hillocks truly represent lake settlement and are spread over 3.22 km<sup>2</sup>. Development of road network in the state has made inroads into some of the larger and populous hillocks like Thanga and Ithing half a century ago. The hillocks in Karang remain untouched by the expanding road network and still represent a typical island settlement. There are 2458, 299 and 297 households in Thanga, Ithing and Karang village (Census, 2011), inhabiting a total population of 14316, 1832 and 1859 individuals.



**Fig. 1: Map showing the study site**

The primary data were collected through direct interviewing of heads of the family with a well-structured questionnaire. After selecting three important villages; Thanga village, Ithing village and Karang Islands, random stratified samplings were carried out. The survey was devised to represent every category of economic status, and per capita land availability with the farmer has been considered a base to represent every group. Fifty houses were taken up for the surveyed. The village level questionnaires were filled by consulting the local elders. Secondary data were also collected from various offices in the area. The estimation of the current land use and land cover for the study area is done in a series of steps using Google Earth images. The satellite images were obtained from the Google Earth Image domain each covering a relatively small area of the study area. The different land use and land cover found in the study area were delineated using the measuring tools in Google Earth and subsequently converted to kml file formats. The individual areas were measured using the kml files with the help of the website of University of New Hampshire Cooperative extension (<https://extension.unh.edu/kmltools/>). Ground truth observations and field surveys were also repeatedly carried out.

**FINDINGS AND DISCUSSION:**

**Land use and land cover types:**

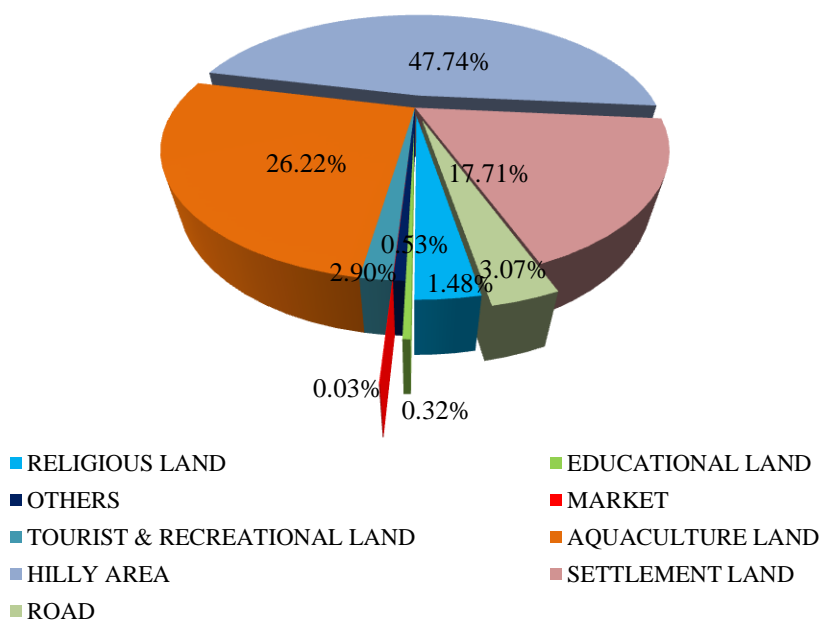
Land use pattern in a rural ecosystem is as old as the development of human civilization. In the catchment areas of Loktak, the commissioning of Hydro-electric project (HEP) in the mid-eighties have led to tremendous change in land use pattern particularly in those lands proximate to the lake shore. This change represents one of the important indicators of the socio-economic transformation taking place in the area. Major implications brought by these changes include changes in livelihood pattern, transformation in age-old traditional land use practice and last but not the least a gradually deterioration in ecosystem. Land use is a product of interactions between cultural backgrounds, state and physical needs of the society with the natural potential of land (Karwariya and Goyal, 2011). In India, land is a scarce resource, even though the country has a large land area of about 328 million hectares. The total geographical area of Manipur is 2.23 million hectares and the reported area has been for 1.97 million ha (Table 1). About 90% of the land in Manipur is make-up of hilly terrain and is primarily covered by forest. According to the land use data of the state, forest occupies 86.16% of the reported area, land not available for cultivation accounts to 1.37 %, land under net sown area is 12.01 %, culturable wasteland is 0.05%, and land under miscellaneous tree crops and groves covers 0.31%.

**Table 1: Land use Pattern in Manipur**

Land Use	Area In ‘000 ha	Percentage
Total geographical area	2,233	
Reporting area for land utilization	1,965	100.00
Forests	1,693	86.16
Not available for cultivation	27	1.37
Permanent pastures and other grazing lands	1	0.05
Land under misc. tree crops and groves	6	0.31
Culturable wasteland	1	0.05
Fallow lands other than current fallows	0	0.00
Current fallows	0	0.00
Net area sown	236	12.01

**Source:** Land Use Statistics, Ministry of Agriculture, GOI, 2008-09.

The patterns of land use/cover in the present study area can be classified into nine board categories, namely hilly terrain, aquaculture land, settlement area, road, religious land, playground/recreational land, educational land, market sites and others (Fig. 2). The last category of others includes land occupied by fishery office, army camps, hospital, water supply, water reservoirs and panchayat office (in Khunjem).

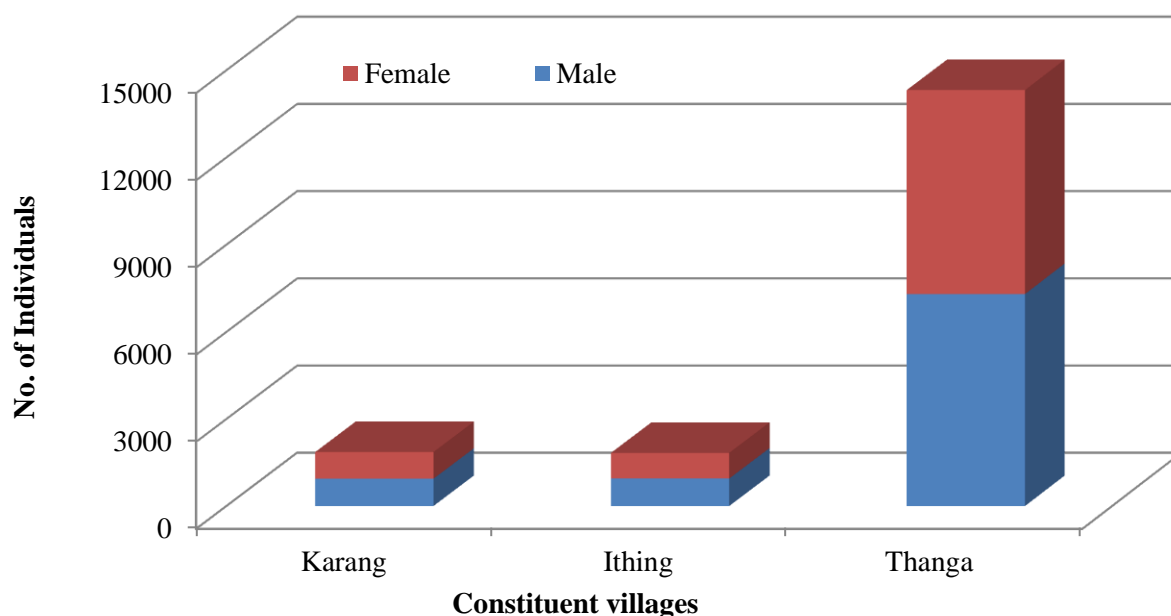


**Fig. 2: Land use and land cover types**

Hilly terrain accounts for the highest percentages of land cover with 153.97 ha, constituting 47.74 % of the total available land. The hilly terrains in Thanga are not fertile and unproductive due to their steep slope and undulating terrain. The areas under aquaculture represents the next important land use type covering 26.22%. The aquaculture land forms a concentric strip of land around the hillock beyond the foothill settlement area. Settlement area covers 17.71% of the land and is characterized by high population density. The average population density in Thanga is around 689 per km<sup>2</sup>, while the highest population density is around 1,465 per km<sup>2</sup>. Other land use such as land under road networks (3.07%), religious land (2.90%), playground/recreational land (1.48%), educational land (0.32%) and market sites (0.03%) even though significant from human, societal and cultural standpoints, make up only a small portion of the total land area. At present, the study area is devoid of any agricultural or cropping lands. Before the commissioning of the HEP, vast tracks of flood plains adjacent to the hillocks were cropped with tall traditional paddy varieties. Changes in land use in fact have led to rapid erosion of some of the important crop biodiversity and also the associated traditional cropping patterns prevalent in the area.

**Socio-economic Condition:**

In Thanga and Ithing, the communities mainly derived their livelihood from either the aquaculture or fishing activities in the lake. Most of the households were found to engaged in aquaculture and fishing in the lake. Unlike many other neighbouring villages, agriculture played a lesser role in Thanga. The reasons for this might be their affinity towards the lake, sticking to the traditional fishing occupation and last but not the least the location of the agricultural fields which are far off from Thanga. The other occupations widely prevalent in the area include embroidery, carpentry, tailoring, poultry farms, weaving, painting, plying private transport, masonry, daily wage labourers, teaching, watchman, shop keeper, vegetable vendor, rickshaw puller, cycle and motor vehicle repairing workshop, goldsmith, piggery farms and other livestock rearing, etc.



**Fig. 3: Population structure in the study villages (as per 2011 Census)**

**Flooding Problems:**

Floods during the monsoon have been the most devastating natural hazard faced by the people inhabiting the peripheral lands of Loktak. It is during the monsoon that the lake water often swells beyond the flooding danger mark. As a measure to avoid flooding, houses along the lake raised the basement of their living spaces. Houses commonly seen in the area have mud plastered walls, wooden framework and metal-sheet roofs. Around half of the money spent for constructing new houses in the area is incurred in earth filling and elevation of the basement. In the current survey, 22 % of the households have reported flooding. On an average an individual household spend around Rs. 19, 909 annually for either repairing their houses or earth filling lands or for both. Inundation of home garden were recorded in 26 % of the houses and the average monetary loss

incurred due to the inundation amounts to about Rs.2488 per household per year. In the advent of occurrence of flash floods some of the fishery farms are either submerged or flush off. Flooding of aquaculture was reported by 18 households. The average loss incurred by the individual owner of the affected farm due to decline in annual fish harvest plus for cleaning the aquaculture land and repairing the earthen bunds amounts to about Rs. 37,416. The data obtained convincingly revealed that the incidents of inundation of land and aquaculture are quite frequent and severe in the settlement located close to the lake.

**Changes in Occupational Structure:**

**Livestock rearing:** Rearing of livestock mainly, cows and buffaloes have been an integral part of the livelihood and a source of household income in Thanga. However, a declining trend in the number of these animals was observed in recent times. This is primarily attributed to the loss of open grazing lands due to HEP and partly due to the change in economic condition of the community. Forty-four per cent of the houses in Thanga were found to engage in rearing animals and fowls. These include, cows (13 animals reared in 02 households), pigs (54 animals in 10 households), and poultry animals (a total of 743 fowls in 32 households). It was observed that animals of fine breeds are in shortage in Thanga. For instance, the entire cow encountered in the present survey comprises of local breed with marginal financial remunerations.

**Extraction of Natural Resources:** The community in Thanga villages relies on the various natural resources for their sustenance. Wild edible plants from the lake is extracted mainly by the womenfolk whereas natural recourses for other uses are collected by males. Other than providing several items for domestic consumption, extraction pressures of some wild edible plants moved up from subsistence to market level in the past. However, population of most of these plants has currently declined because of changes in water level. As presented in table 2, a decline in the number of households engaged in extraction of natural resources from the lake was observed. At present an individual can earn around rupees 150 to 200 a day by selling the collected biomass.

**Table 2: Extraction of some Natural Resources**

Natural Resources	No. of Households engaged	
	30 years back	Present
Fish	34	23
Khajing	08	06
Tharoi	11	07
Heikak	12	03
Yena	12	03
Kambong	03	0
Pullei	09	04
Loklei	12	06
Tou	38	12
Khoimon	30	22
Komprek	12	8
Tharo mari	03	0

**Environmental Impacts:**

The changes in land use pattern in the peripheral land of the Loktak have brought considerable impacts on the ecological and environment set-up of the area. The area is currently in deep ecological crisis and the ecosystems are showing sign of near total collapse. In fact, Loktak Lake is currently a divided water body of two incompatible pursuits: biodiversity conservation and hydropower generation. There is merit in either allowing the lake to be used for hydropower generation or devoted fully to conserve its wilderness and associated cultural importance.

**Wildlife Habitat Degradation:**

Loktak Lake is a Ramsar Site. The lake supports important wintering ground for migratory birds arriving from the Trans Himalaya. The Keibul Lamjao National Park the only natural habitat of the highly endangered *Cervus eldi eldi* occupies the southern portion of the lake. Impoundment of water leads to steady degeneration of floating islands in KLNK on which the deer feed and thrives. The transformation of adjacent lands into settlement, agricultural, fishery land, etc., resulted into unwanted people-wildlife encounter.

### Loss of biodiversity:

In the past, fishes from Chidwin-Irrawady constitutes around 40 % of capture of the Lake. However, the commissioning of Ithai barrage across Manipur River for the operation of HEP has blocked the migratory pathways of a number of fish species leading to a decline in their population and ultimate disappearance. The fish varieties that are lost from the lake are Ngaten (*Ompok bimaculatus*), Khabak (*Bangana devdevi*), Ngaton (*Labeo bata*) and Ngaril (*Mastacembellus armatus*). Ngaril laina (*Anguilla bengalensis*) and Sareng (*Wallago attu*) are included in endangered category. Manipur's state fish *Osteobarma belangeri* was reported to regionally extinct in wild.

### Biodiversity Change:

*Taothabi*, a tall traditional variety of rice plant that thrives well in swampy ecosystem is almost locally extinct, while other traditional paddy varieties such as *Phouren*, *Changphai*, *Yenthit*, *Moirang phou*, *Tumai*, *Taothabi*, *Punsi*, etc., have been replaced to near total by improved varieties. *Heikak*, a local variety of trapa is also replaced by exotic counterparts. Increasing number of exotic plants invasion is a serious threat in Loktak. Paragrass is one such exotic species which comes to the attention of the experts in the recent time. It is learned that the grass has outcompeted and overgrown in KLNP leading to substitution of some indigenous plant species including *Koubru Yai* (local name) that forms the feed material of sangai causing potential problems for its survival.

### Deterioration in natural resources base:

Growth of economic species in the lake like Loklei (*Hedychium coronarium*), Pullei (*Alpinia galanga*) and Komprek (*Oenanthera javanica*), Heikak (*Trapa natans var. bispinosa* Linn.), Tharo (*Nymphaea pubescens*), rhizome of Thambal (*N. nucifera var. rubra* Roxb), Thangjing (*Euryale ferox* Salisb), etc. declined down considerably in the last three decades.

### Pollution:

Increasing dependence on chemicals fertilizers, pesticides, fish and animal feed have polluted the delicate ecosystem. The fate of the built-up chemicals could be traced back, in a wide scale of catchment erosion, agricultural runoffs, untreated sewage and disposal of wastes in the upstream urban centres. Besides, uncontrolled growth of aquatic weeds and their subsequent decay also attributed to the enrichment of nutrients in the water body.

### Marginalization of People:

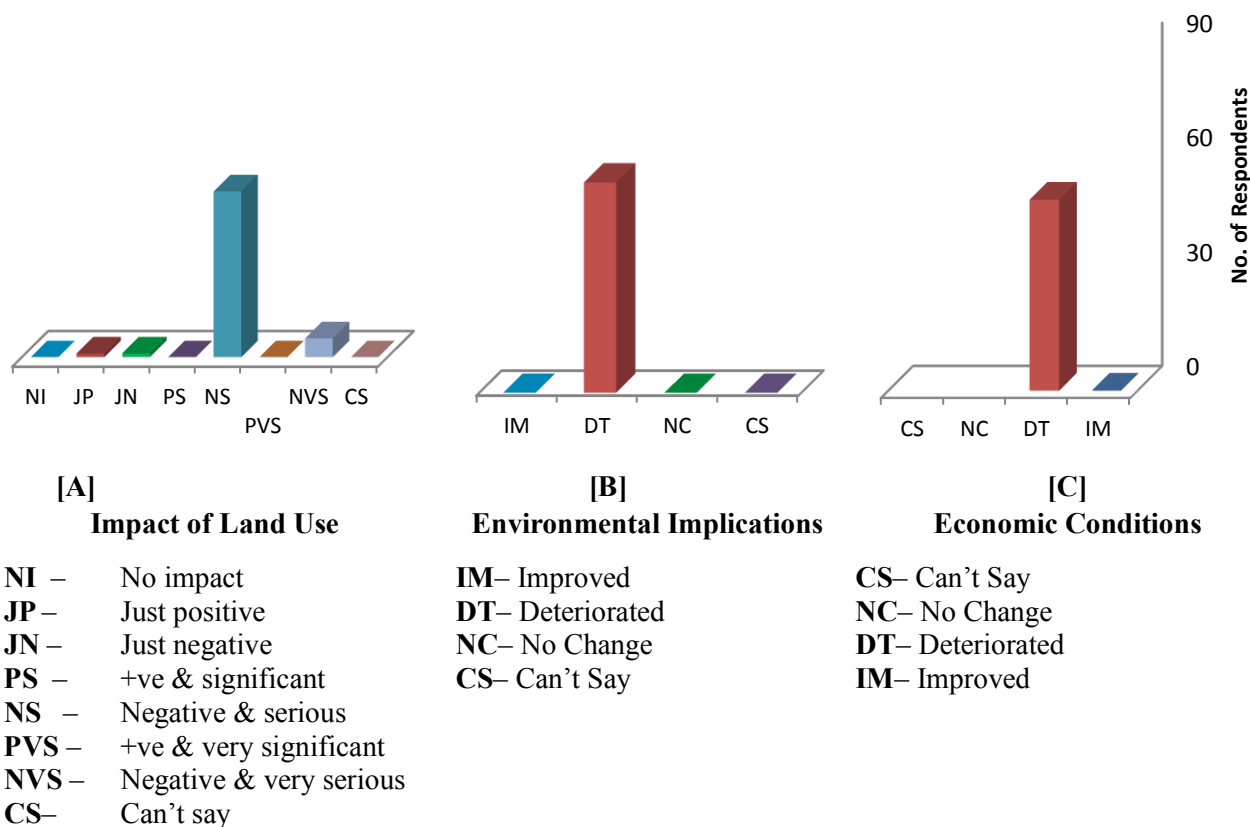
The above discussed environmental problems and resources degradation have caused devastating impacts on the poor, who often depend on natural resources for their income with few possibilities for substitution by other assets. The economic costs incurred by the changing land use and opportunity lost due to resources degradation leads to increasing marginalization of the population. In the absence of proper credit facilities, the poor people resorted to local moneylenders. Many a times, they fall in the debt trap as major portion of their earning is used in debt repayment.

### Proliferation of weeds:

The rapid proliferation of *phumdi* and aquatic weeds in the Loktak is a cause of concern for the lake management. The overall area of *phumdis* in the lake has increased from 116.4 km<sup>2</sup> to 134.6 km<sup>2</sup> during 1989 – 2002 (Singh and Moirangleima, 2009<sup>6</sup>). Anthropogenic activities have failed the century old, natural mechanism of aquatic weed control in the area with the advent of Ithai barrage in early eighties. Prior to that, free-floating aquatic weeds – precursor of *phumdi*, were seasonally flushed down by the natural water courses that drain into the Manipur River. Earlier, the *phumdis* were also managed by the local communities 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*.

### Encroachments:

Encroachment is generally done on the peripheral areas of the lake primarily for expansion of human settlements and aquaculture. Due to lack of agricultural land *athaphum* fishing (a method of fishing using the floating vegetative mat) a forms of traditional fishing has been intensified in number and spaced occupied in the lake. Large areas of the lake have been encroached for aquaculture practices. Large number of landless fishermen took refuge in floating huts in the lake. The number of floating huts in the lake crossed above 1200, which were latter evicted by the government a couple of years back.



**Fig. 4: Perception of the local people on the land use change**

**Perception of the Residents:**

Studies were also carried out to assess the local people’s perception on the trend and extent of land use change in the area. A few open and close ended questions were added to the household level questionnaire to facilitate the study. The perception of respondents and the observation of the researcher in the field have been shown in Fig. 4. The results revealed that the respondents strongly perceived that there are certain inter-linkages between land use change, environmental deterioration, natural resources depletion and marginalization of livelihood in the area. Forty-nine out of the 50 respondents felt that the existing land use system poses undesirable negative impacts on their livelihood and sustenance. However, there was wide variation among the respondents with regard to the perceived scale of impacts. One of the respondent viewed that the impact is just negative, 44 respondents claimed that it is a negative and serious issue, while 5 others considered it as a negative and very serious issue. On matters related to the dependence of local people on natural resources base, none of the respondents opined that their dependence on natural resources has been intensified after the commissioning of the Loktak Hydro-electric Project. With respect to environmental implications of the on-going land use change occurring in the area, all the respondents claimed that the conversion of agricultural land to aquaculture land have deteriorated the environment. All of them also expressed that the commissioning of LHEP have brought about deterioration in their general economic condition of the community.

**CONCLUSION:**

The study of land use pattern can be considered as one of the prime indicator of the relationship between man and natural environment. The study reveals that the land use and land cover-pattern of Thanga were changed during the last few decades. The conversion of agricultural land to aquaculture land represents the significant single land use change taking place in the area since the early eighties. Despite the impressive gains in aquacultural production there are worries related to degradation in water quality in lake due to increasingly use of feed and other chemicals. Anthropogenic factors especially the impoundment of lake water for hydro power generation in HEP is the major compelling factor underlying the change. Other important land use in the study area include settlement areas, religious site, educational purposes, mandap, market places, tourist and recreational areas, etc. Most of the land use type showed an increasing trend, whereas a declining trend was found and agricultural land. Such change in the land use and land cover caused undesirable impacts on the



natural environment causing depletion of natural resources base. The livelihoods of the people have been considerably marginalized. There is need for greater efforts and new methods to monitor and mediate the negative consequences of HEP, if we are 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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