

## **Wetlands in Loktak: Issues and challenges of merging Wildlife conservation and Hydropower generation – An Overview**

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### **Abstract**

Wetlands in Loktak, besides the ecological services, serve the dual pursuit of wildlife conservation and hydropower generation. Four decades-long experience has convincingly revealed that meticulously tailoring the two incompatible endeavour is not easy to attain. Himalayan wetlands are inherently sensitive ecosystems, and operating hydropower projects in these water bodies, exceptionally challenging. The ecological footprint of the Loktak hydropower project reflects a mixed blessing for the people and the environment. Impoundment of water jeopardised the natural hydrological regime, affecting the ecology and economy and altering the landscape. The water spread in Loktak falls in the Indo-Burma biodiversity hotspot and is gifted with rich biodiversity. The southern portion of the wetland harbours the Keibul Lamjao National Park (KLNP), devoted to conserving the highly endemic deer *Rucervus eldii eldii*. The operation of the hydropower plant in the lake has degraded the habitat and threatened the survival of wildlife in KLNP. The loss of people's livelihood due to the inundation of vast tracks of agricultural land, a decline in catch of fish outside the park, restrictions in entry into the park for sustenance needs have intensified the human-wildlife conflict. The present paper reviews the current status of the wetland, highlighting the environmental changes, emerging conflicts, threats, and challenges facing the wetland ecosystem.

**Keywords:** Loktak, hydropower, Keibul Lamjao, Protected area, *Rucervus eldii eldii*

## INTRODUCTION

Loktak is a wetland (93°46'E-93°55'E and 24°25'N-24°42'N) in the Barak-Chindwin river basin in the Indo-Burma Biodiversity hotspot. It is the largest freshwater lake in the eastern Indian Himalayas. The presence of the floating vegetative mat, locally called *phumdi* is the prominent feature of the lake (WAPCOS, 1988). Loktak was declared a wetland of international importance under the Ramsar Convention in 1990 (Bassi *et al.*, 2014; Garg, 2013) and is one of the 115 wetlands identified under the National Wetland Conservation Programme (Tuboi *et al.*, 2018). The lake has been gifted with rich biodiversity, including 233 macrophytes, 425 species of animals, including 249 vertebrates and 176 invertebrates (Trishal and Manihar, 2004). The lake also serves as the home for several birds belonging to 116 species, of which 21 species are migratory waterfowl (Singh, 1991). A stretch of 40 km<sup>2</sup> in the southeastern portion of the lake forms the last remaining habitat of the Eld's deer *sangai* (*Rucervus eldii eldii*) in India (Tuboi *et al.*, 2018). The pressing need for conservation *sangai* has led to the declaration of the area as a National Park in 1977. The Loktak Multipurpose Hydropower Project (LHP) was commissioned in 1983 (Trishal and Manihar, 2002). Ithai barrage was constructed to ensure sufficient water for power generation. With the advent of LHP, the then fluctuating floodplain-wetland where the *sangai* thrived is converted virtually into a man-manipulated reservoir (Khoiyangbam, 2011). Although the ecological ruins due to the LHP have grave long-range economic consequences, their immediate burn is borne by the marginalised community and the protected wildlife. Today, the wetland is a water body in conflict with two incompatible human pursuits: biodiversity conservation and hydropower generation. The much needed multiple-use conflict resolution and mediations to address the issues at hand have not yet been forthcoming. Four years ago, the state government approached the union government to review the Loktak Hydropower project and decommission the Ithai barrage. However, a detailed review of the LHP by the central government and the wetland's ultimate fate remains undecided until today.

## STATE OF ENVIRONMENT OF THE WETLANDS

Wetland in Loktak comprises a cluster of floodplain lakes of the Manipur River in the intermountain alluvial plain. The drainage of the catchment area has a centripetal pattern to the lake. Thirty-four streams from the western hills feed the lake directly and indirectly (Singh, 2010). However, discharge from nine major rivers significant impact the ecology of the lake (Khawairakpam *et al.*, 2019). The lake drains through the Manipur River that joins the Chindwin River in Myanmar, a tributary of the Irrawaddy. The Loktak basin and the Manipur basin are thus part of the larger Irrawaddy basin (Trishal *et al.*, 2008). The rivers carry a massive load of sediments, thereby shallowing the lake. The rate of siltation has increased due to *jhum* cultivation, deforestation and unscientific land use in the catchment areas (Thangjam, 2014). The annual sediment deposit is estimated to be around 6,50,000 metric tons (Trishal and Manihar, 2004), and the Nambul river contributes more than half. The

lake is shallow, with an average depth of around 2.7 m and a maximum of 4.6 m (Talini and Kalota, 2018). Loktak is experiencing severe degradation due to anthropogenic pressures (Tuboi *et al.*, 2018). Increasing deterioration in the lake water quality due to pollution is a cause of concern (Kangabam *et al.*, 2015; Kangabam *et al.*, 2017). The fate of the built-up chemicals could be traced back to a wide scale of catchment erosion, agricultural runoffs, untreated sewage and disposal of wastes in the upstream urban centres. The feeder streams meandering through the towns come along with a large volume of sewage and pollutants (Kosygin *et al.*, 2007). Analysis of water quality showed low dissolved oxygen content and high biochemical oxygen demand (Kiranbala and Gupta, 2015; Laishram and Dey, 2014). The bacteria count in some portions of the lake water ranged from 12,000 to 58,000 mL<sup>-1</sup> and the total coliform bacteria 8.8 – 25.6 mL<sup>-1</sup> (Singh and Khundrakpam, 2009). The lake water is hypertrophic (Tuboi *et al.*, 2018). Important feeder streams are contaminated with heavy metals, particularly the concentrations of lead (Pb), iron (Fe), mercury (Hg), were beyond the permissible level prescribed by BIS (IS 10500: 1991) (Chanu and Gupta, 2013; Singh *et al.*, 2013). The nitrite content in the lake water was beyond the WHO permissible limits and not fit for human consumption (Kangabam *et al.*, 2017). The Water Quality Index (WQI) ranged from 64 to 77 and poor. At present, around 5,000 households depend on lake water for domestic use. Safe drinking water facilities are available to only 51 % of the lake communities (WISA & LDA, 2004).

### FLOATING VEGETATIVE MATS (*PHUMDI*)

One of the salient features of the landscape of Loktak Lake is the presence of floating peats or '*Phumdi*'. Structurally, *phumdi* is composed of living and dead organic matter that can be distinguished into three distinct horizontal layers, the top zone, the mat zone and the bottom peat zone (Devi and Sharma, 2002). The higher proportion of spongy biomass results in their low specific gravity and high buoyancy. *Phumdi* is made up of organic carbon (36%), nitrogen (2.08%), organic matter (24.98%), and other residues, including mineral matter (37.94%) (Saratchandra, 1977). About one-fifth of the mass of the *phumdi* protrudes above the water surface. Generally, the thickness of individual *phumdi* varies considerably depending on its formation and developmental stage. *Phumdi* of the thickness reaching up to 8 ft was reported by Trishal and Manihar (2002). The plants on *phumdi* are mainly comprised of *Leersia hexandra*, *Zizania latifolia*, *Phragmites karka*, *Saccharum munja* and *Narenga porphyrochroms*. *Phumdi* supports specialised habitats for both aquatic and terrestrial biota.

Floating islands play a significant role in ecosystem services and processes (Kangabam *et al.*, 2018a). However, the rapid proliferation of *phumdi* became a cause of concern for both the Park authorities in the KLNP and the lake management (Santosh and Bidan, 2002; Sanjit *et al.*, 2005). The rapid vegetative growth in the lake may be linked with the anthropogenic activities in the catchment. Firstly, the growth is fueled by the enrichment of nutrients in the water body attributed to soil

erosion, agricultural runoffs, untreated sewage and disposal of wastes in the upstream urban centres. Secondly, human has failed the natural mechanism of weed control in the aftermath of the commissioning of LHP (Khoiyangbam, 2011). Prior to that, free-floating weeds – the precursor of *phumdi*, were seasonally flushed down by the natural watercourses during the rainy season, plus fishermen community periodically organised *phumdi* cleaning drives (Singh and Khundrakpam, 2011). The area under *phumdi* increased from 116.4 km<sup>2</sup> in 1989 to 134.6 km<sup>2</sup> in 2002 (Singh and Khundrakpam, 2009). Proper management of *phumdi* had become a vital task for maintaining the health of Loktak (Trishal and Manihar, 2002). The need for effective control and management of *phumdi* was highlighted in a series of studies conducted by the Loktak Development Authority (LDA, 1996; LDA, 1999). Management of *phumdi* in Loktak is not that easy; it has to establish twin goals, arresting unrestricted growth of *phumdi* in lake proper, while it is imperative to revive the degrading *phumdi* in KLN. For quite some time, the state government had been relentlessly searching for ideas and innovations to tackle the worsening nuisance before finally zeroing down on a company to take up the challenging task of cleaning the 132.94 lakh cubic meters of *phumdi* (Khoiyangbam, 2011). After that, the area under *phumdi* cover started declining (Talini and Kalota, 2018; Kangabam *et al.*, 2018a), increasing the open water spread from 55.88 km<sup>2</sup> in 2000 to 133.03 km<sup>2</sup> in 2017 (Kumari *et al.*, 2018).

The presence of vegetative mats is not uncommon in tropical wetlands (Gopal *et al.*, 2003), but in Loktak, it formed an integral part of the local culture, which is reflected in the ways how the resource is adeptly used for livelihood sustenance, floating settlement, fishing practice and growing crops (Singh, 1997). Using *phumdis* for fishing (locally known as *Athaphums*) and as the basement for constructing floating hut (locally known as *phumshang*) have evolved over generations. In the *athaphums*, narrow strips of cut-off *phumdi* (~1.5-2.3m wide and > 5.0m in length) are laid in a circular formation, with a circumference of 200–250 m and a diameter of around 72 m (Singh and Khundrakpam, 2009). The structure is used to attract fish with feeds and furnishing a safe refuge. Harvesting of *athaphum* is usually carried out twice a year, preferably during the drawdown of the water. However, with the increase in population, the number of *athaphums* in the lake increased considerably. Biaklun *et al.* (2009), through remote sensing, observed that the *athaphums* had increased in number from 217 (in 1990) to 3019 (in 1999). Lack of agricultural land and marginalisation of people had intensified the practice of *athaphum* fishing (Kumari *et al.*, 2018). Floating huts in the lake are constructed on *phumdi* (with bamboo and grass) and are generally found in cluster forming floating villages. There were only 28 floating huts in 1985, but these increased to 733 huts in 2001 (Census of India, 2001), reaching above 1200 at one point in time. The residents of *phumshangs* depend entirely on fishing for their sustenance. About 82 % of the family have no houses elsewhere and are permanent dwellers. The Loktak Development Authority (LDA) was formed in 1987 to oversee the management of the lake. The LDA, under the Manipur Loktak Lake (Protection) Act 2006, initiated drives in 2011 to forcibly evict the *phumshang* dwellers and eradicate *athaphums* giving monetary compensation. Around 500 huts were burnt down within five days, displacing more

than 2000 fishermen (Thangjam, 2014).

## KEIBUL LAMJAO NATIONAL PARK

The landmark of protected wildlife areas began with the establishment of the world's first National Park, Yellowstone, in the United States in 1872. This model was replicated in many countries, including India, to set up an exclusive network of Protected Areas. Decades back, the government designated the entire area of Loktak as a sanctuary. By 1954, the area was scaled down to 52 km<sup>2</sup> in the southern portion of the lake. The area was declared a protected forest in 1965, as reserved forest in 1974, and ultimately as a national park on 5<sup>th</sup> April 1977. Today, KLNP stretches over 40 km<sup>2</sup>, of which 26.41 km<sup>2</sup> is covered almost by a thick and contiguous mat of *phumdi* (Tuboi, 2013). The landscape of the park includes land, marshes, small hillocks and the lake itself. Eld's deer is a highly endangered Southeast Asian cervid (Balakrishnan *et al.*, 2003), persisting only in small, fragmented populations. The deer occurred in India (Manipur), Myanmar, Thailand, Lao, Cambodia, Vietnam to China (Lekagul and McNeely, 1977). The species is currently listed in Appendix I of the Convention on International Trade in Endangered Species (CITES) and is considered endangered by the World Conservation Union (Tabasum *et al.*, 2017). Eld's deer belongs to the subgenus *Rucervus*. The *sangai* in KLNP is a medium-sized deer, having the smallest antlers of the three subspecies (Geist, 1998). *Sangai* was first noticed by Lt. Percy Eld – a British officer in Assam, and in his honour, the animal was named *Cervus eldi eldi* in 1842 by John McClelland. *Sangai* was once thought to be extinct (Ranjitsinh, 1978). E.P. Gee, in 1953 rediscovered the animal in a survey conducted under IUCN in a small pocket of the floating islands in Keibul Lamjao. The number of the animal increased from 14 deer in 1975 to 180 deer in 2003. *Sangai* is currently held in captivity in 14 different locations in India. Other faunal species in the park include Hog deer (*Axis porcinus*), Wild boar (*Sus scrofa*), Common otter (*Lutra lutra*), India civet cat (*Viverricula indica*), Russell's viper (*Viper russelii*), Cobra (*Naja naja*), etc.

## LOKTAK HYDROPOWER PROJECT

Big dams started well but often ended badly – this is precisely what is happening with the Loktak. The price paid for these modern temples and the hydropower becomes truly staggering. The concept of the LHP was initially devised in the 1950s (Monica, 2014). The construction of the Loktak project started in 1971 under the Ministry of Irrigation and Power, Government of India, which was then later handed over to the National Hydropower Co-operation (NHPC) (Thangjam, 2014). The LHP was commissioned in 1983. The primary objectives of the LHP are to control floods, reclaim land, augment the water supply needs for various purposes, irrigate 24,000 hectares of land (Singh, 2017), and generate hydropower of 105MW (three units of 35 MW capacity each). Out of the 105 MW, 35 MW was allocated for use in Manipur state, and the rest have been sold to other neighbouring states (Singh, 2014). After

four decades of commissioning, the ambitious project failed to translate to the lines, and the expected benefits fell short of the planned targets. The Ithai Barrage was constructed downstream of Manipur River to impound sufficient water of 769.12 m *amsl* in the Loktak to ensure uninterrupted hydropower generation (Tuboi *et al.*, 2018). The Manipur River is connected to Loktak by Khordak River, and the water body act as both the inlet and outlet for the Loktak (Wangkheirakpam, 2014). The impounded lake water is siphoned through the penstocks embedded in the western mountain to propel the hydraulic turbines at Leimatak (312 m lower than the Loktak) before finally discharging it into Leimatak River.

### ENVIRONMENTAL IMPLICATIONS OF LHP

The prime environmental implications of the Ithai Barrage are (i) Alteration in the natural hydrology of the region, (ii) inundation of peripheral land and consequent changes in land use and land cover, (iii) loss of biodiversity and (iv) degradation of habitat of *sangai*. Land use and land cover change is another environmental change that influences biodiversity and livelihoods (Verburg *et al.*, 2000) and on a wide range of socio-economic and ecological processes (Desanker *et al.*, 1997). The catchment of Loktak covers about 22% of the total area of the Manipur state (Khwhairakpam *et al.*, 2019). Loktak Lake faces a significant issue of unplanned land-use practices (Kangabam *et al.*, 2018b). Comparing the remote sensing data in 1970 and 2002, Trishal and Manihar (2004) have concluded that the lake area increased from 207 km<sup>2</sup> to 287 km<sup>2</sup>. Since the late eighties, the conversion of agricultural land to aquaculture has been taking place in the immediate catchment of Loktak. The inundation of peripheral agricultural lands had compelled this change. The lake water has permanently flooded around 80,000 acres of land and devastated homesteads in the lake skirt areas, destroying livelihood (Singh, 2017). The land-use changes have led to impressive gains in aquacultural production, but there are worries of increasing water quality degradation due to the aquaculture (Kumari *et al.*, 2018). Changes in the landscape have brought considerable impacts on the environment and livelihood of the local community (Oinam and Khoiyangbam, 2017). As land becomes meagre, their dependence on the lake for subsistence have intensified. Inundation of cultivable land and decrease in the open water area of the lake uprooted and deprived about 25,000 lake dwellers of their livelihood (Trishal and Manihar, 2002). On the other hand, encroachments in the lake through the expansion of fishponds, roads and settlements have degraded the lake (Trishal and Manihar, 2004).

Challenges facing the protected areas in the country are much the same, but the KLNP stands out because it is different from the others in more than one. Firstly, KLNP has the uniqueness of being a floating wildlife reserve. Secondly, unlike many other National Parks, KLNP is bounded closely by human settlements on many sides except for the lake water bounded portion. Thirdly, Loktak and the KLNP, the then fluctuating floodplain-wetland until a few decades ago, is converted virtually into a man-manipulated artificial reservoir rather than a man-managed natural lake. The *sangai* habitable, thick *phumdis* in the KLNP are becoming thinner over the years,

and the thin *phumdis* cannot support the weight of *sangai* (Tuboi and Hussain, 2016). The increasing degeneration of the healthy *phumdi* on which the animal feeds and thrives posed a challenge and a question mark on the long-term sustenance of the park. As per the IUCN, habitat loss exceeds all other threats, including overexploitation. Prior to the commissioning of LHP, *phumdis* were rejuvenated by sinking on the lake bottom during the drawdown of lake water below the subsurface. At present, the *phumdis* are devoid of this natural regeneration cycle. The plant species composition in *phumdi* has been changing over the years (Tuboi and Hussain, 2018), primarily due to the change in the natural hydrologic regime plus the extraction of plant species (Tuboi, 2013; Tuboi *et al.*, 2015). There is a high probability of extinction of the *Sangai* if *phumdis* are not conserved (Kangabam *et al.*, 2018a). The hoofs of the limbs of *Sangai* get stuck in the thinner marsh, thereby resulting in their drowning (Singh, 2014).

The most glaring example of biodiversity loss occurring in the lake is the disappearance of the migratory fishes. In the past, fishes from Chindwin-Irrawaddy from Myanmar constitutes a sizeable amount of capture in the lake. However, the construction of the Ithai barrage blocked the migratory pathways of these fishes, leading to a decline in their population and ultimate disappearance (Singh, 1991 and 1993). The fishes that are known to have been lost from the lake are Ngaten (*Ompok bimaculatus*), Khabak (*Bangana devdevi*), Ngaton (*Labeo bata*) and Ngaril (*Mastacembelus armatus*). Ngaril laina (*Anguilla bengalensis*) and Sareng (*Wallago attu*). *Osteobrama belangeri*, locally known as “Pengba”, is a medium-sized carp of high food value. The species was classified as “Extinct in the Wild” in 1997 (CAMP Report, 1998) and as “Near threatened” (IUCN, 2010). Besides the fishes, many indigenous varieties of wild edible plants such as *Trapa natans*, *Ludwigia claveliana*, *Euryale ferox*, *etc.* have disappeared from the Lake (Oinam and Khoiyangbam, 2017). The migratory birds arriving in the lake from *Trans* Himalaya and resident waterfowl’s population have also dwindled. The most dangerous part is, in the KLNP, the exotic weed species like the para grass (*Brachiaria spp.*) has outcompeted the indigenous fodder plants of *Sangai*, thereby posing a potential threat for its survival. Many traditional crop species, particularly the paddy varieties like *Phouren*, *Changphai*, *Yenthit*, *Moirang phou*, *Tumai*, *Taothabi*, *Punsi*, *Taothabi*, *etc.*, once cultivated around Loktak are replaced by other high yielding varieties.

Conflicts between the local community and wildlife conservation are a common phenomenon worldwide. The genesis of the conflict between the local people and wildlife conservation in KLNP starts at the very inception of the park. The conflict stands unresolved till today. The park’s establishment has alienated the people from the land they have traditionally considered their own. Due to the wildlife protection regulations, their usual collection of fuelwood, fodder, vegetables, and building material is being stopped (Arunkumar *et al.*, 2002). There are 55 rural and urban settlements around the lake with a combined population of 100,000 (LDA and WISA, 1999). Communities around the lake shoreline depend on aquatic plants in *phumdi* for their livelihood (Devi *et al.*, 2010; Jain *et al.*, 2011). Twenty-seven edible species used for traditional food preparations have been identified in the *phumdi* (Meitei and

Prasad, 2015). The gathering of aquatic plants contributes as high as 89.7 % of the average annual household income, and fishing contributes as high as 67.2 % (Leima *et al.*, 2008). More than 85 % of the communities living around the lake depend on the lake (Singh and Khundrakpam, 2009). Human-wildlife conflict in the KLNP primarily arises from the dependence of the marginalised local population on the biotic resources in the park. Lack of sustainable livelihood due to loss of agricultural land to flood, a decline in catch of fish outside the park, restrictions in the entry to the park to access sustenance needs (Arunkumar *et al.*, 2002) have intensified the conflict. In due course of time, extraction pressures of some wild edible plants moved up from subsistence to market level (Khoiyangbam, 2011). The comparatively small size (~ 40 km<sup>2</sup>) plus the enclosure of the park by villages on many sides without a proper buffer zone make KLNP highly vulnerable to human and livestock interference. Rearing of livestock is an integral part of the rural livelihood. Animals from nearby villages regularly enter the parkland for grazing.

## CONCLUSION

Loktak lake is currently in a deep ecological crisis, and the water bodies are showing signs of near-total collapse. Unless remedial measures are taken straightaway, the whole ecosystem is headed for a major catastrophe. India is one of the top-ranking dam-building nations in the world. In the last few decades, the installation of hydropower plants has been pursued at an accelerating pace in the Indian Himalayas. The Himalayas is one of the most fragile ecosystems, and the mountain wetlands in its ranges are inherently sensitive. Most of the problems faced in Loktak is anthropogenic and centred around the shift in hydrological regime after the construction of the Ithai Barrage (Suresh, 2003). One of the notable changes is the loss of peripheral lands to water and the compensatory transformation of the then agricultural land to aquacultural land. The local people are compelled to change their age-old traditional livelihood pattern due to the loss of land. Worldwide, there has been a surge of attention for conserving wildlife. The lake's southern portion was declared a national park to conserve the highly endemic deer *Rucervus eldii eldii* and the wilderness. Degradation of the quality of the *phumdi* in KLNP and the resulting threat to the animal's survival is one of the significant impacts of the hydropower project. Nevertheless, highlighting the unwanted impacts of the LHP does not directly imply the decommissioning of the LHP. It seeks attention to the broader concerns that have been ignored so far. It calls for a look into aspects of the social and environmental cost of LHP, adapting to sustainable power generation practices, efficient regulation of the reservoir water, up-grading the efficiency of the hydraulic turbines, finding alternative energy sources and last but not the least, partitioning of KLNP from the lake proper for wildlife conservation. Failure to strike the right balance will undoubtedly harm the ecology and economy of the state. In its worst, this may result in complete degradation of the habitat of *sangai* and wipe out the wildlife from KLNP leading to severe social and ecological crises in the area.



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