Status Review Of Fish Fauna Of Loktak Wetland Complex With Reference To Changing Dynamics Of The Wetland Ecology.

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ABSTRACT
Loktak Lake – a Ramsar site of international importance – is a key biological diversity site in Manipur, India, being an important feature of wetland ecosystem within two significant global biodiversity hotspots, namely, the Eastern Himalaya and the Indo-Burma Biodiversity Hotspots. The Loktak Lake, a composition of several separate wetlands converged into a single spread of water by artificial regulation of Ithai Barrage for the 105 MW capacity Loktak Hydroelectric Power Project, is currently undergoing changes influenced by physical modifications, siltation, pollution, and eutrophication enhanced by inflow of chemical residue from nearby paddies and pollutant effluent discharge from urban and peri-urban areas. Extensive use of chemical fertilizers and pesticides by farmers in peripheral agricultural fields, and their runoff thereof, along with pollutant effluent feed from direct in-flowing rivers like Nambul, Nambol and Moirang has accentuated the pace of degradation of the wetland ecology. A visible example of physical changes taking place is the rapid spread of invasive aquatic plants and weeds which are overcrowding the water body of the lake and posing threat to native species of food and medicinal plants traditionally harvested by local people for food, and for their livelihoods. At the same time, it is observed that fish fauna population in the lake has declined considerably owing to these influences. The paper attempts at understanding the human induced impacts on the lake ecology, the plant and animal lives, and upon the local fishing community by the changes taking place since the commissioning of Ithai Barrage in 1983. The methodology is empirical in design being based primarily on observations in field and through interaction with local fishing families. The suggested pathway is for rapid assessment of the current status of Loktak wetland complex, and, thereto, in finding ways to minimize the changes taking place through scientific intervention and community participation.

Key words: Loktak wetland complex, Ithai Barrage, physical changes in wetland ecology, biodiversity loss, fish fauna population decline.

Objective: The paper attempts at an overview of the present status of Loktak wetland complex and how wetland ecology, biological diversity, species population and sustainable livelihoods of local communities are impacted by negative anthropogenic influences.

Theoretical Framework: The paper tries in understanding the issue wherein anthropogenic influences largely induced physical changes resulting in environmental and ecological degradation, biodiversity loss and species decline within the Loktak wetland complex, and subsequently leading to food and water insecurity for the wetland dependent local communities.

Methodology: The paper covers a period of near four decades of field-based observation on the status of Loktak Lake and its associated wetlands in Manipur State, with specific focus on anthropogenic-led influences inducing environmental and ecological degradation, biodiversity loss and species decline within the wetland complex, while impacting the sustainable livelihoods of local communities who largely depend on the wetland complex for their livelihoods and sustenance. The paper particularly looks at the impact of Ithai Barrage on the Loktak wetland ecology. The field study is supplemented with information from local informants and secondary literature sources.

Discussion and Results: The results of the study reveal a trend where state and central institutions, and responsible agencies, are lacking in addressing the concerns on ecological degradation, biodiversity loss and species decline impacted by anthropogenic interventions on the Loktak wetland ecosystem. The absence of monitoring and evaluation mechanism to assess the gaps in information and the lack of scientific input for conservation measures had led to the continued wetland ecosystem degradation and biodiversity loss during the past decades. Processes of unchecked siltation, pollution and eutrophication are observed as accelerating the degradation of the wetland ecology. This results in physical changes to the water body, such as decreasing the depth of the lake, increasing pollution level leading to contamination of the water, eutrophication and subsequent biodiversity loss including decline of aquatic plant and animal species, and rapid

proliferation of invasive weeds. Consequently, wetland degradation is seen as impacting the livelihoods of the wetland dependent communities, especially the local fishing community, primarily due to the absence of effective strategies and measures for minimizing and halting the process of ecological degradation, pollution of the freshwater water body, and biodiversity loss.

Research Implication: The finding of the study concludes that due to lack of effective strategic action plan on ground, there is visible lack of mechanism to check and halt the negative anthropogenic influences which are inducing physical modifications, ecological degradation and biodiversity loss. This significantly impacts the food and water security for the marginalized local fishing community. Unless the processes of siltation, pollution and nutrient enrichment issues in the freshwater wetland are not adequately addressed, it defeats the purpose of achieving the goals of the Sustainable Development Goals, namely, SDG1, SDG2, SDG3 and SDG13.

Introduction

Loktak Lake in Manipur by area size is the fourth largest inland freshwater lakes in India. It currently is a glaring example of traditional waters under tremendous stress, largely owing to anthropogenic pressures.

The stress is felt in the observed gradual ecological degradation, biodiversity loss and species decline, with considerable impact on the traditional livelihoods of local communities, in particular the Loktak wetland dependent fishing community.

Loktak Lake is one the largest Ramsar sites in India by area size, out of the 85 notified sites to date. Considering its surface area of 288.96 sq km at full pond level maintained by Ithai Barrage at an elevation of 768.5 meter above mean sea level (MSL) as suggested by Singh & Singh (1994), or 287 sq km according to Trisal and Manihar (2004), Loktak is the tenth largest Ramsar site in India.

Taking into consideration the status of inland freshwater wetlands in the country, as per their area coverage, Loktak at 288.96 (287) sq km is the fourth largest freshwater lake in India, after Vembanad-Kol wetland in Kerala at 1512.5 sq. km, Satkosia Gorge in Odisha at 982 sq. km, and Kolleru Lake in Andhra Pradesh at 901 sq km respectively.
Loktak Lake, located at the geographical coordinates of 24°25'48.12"N to 24°41'19.58"N Latitude and 93°45'32.41"E to 93°54'20.64"E Longitude, was identified by the International Union for Conservation of Nature (IUCN) as a major Indian wetland of significance being located within two highly biodiverse global hotspots, namely, the Eastern Himalaya Biodiversity Hotspot and the Indo-Burma Biodiversity Hotspot.

In 1990, Loktak was designated as a Ramsar site of International Importance, and subsequently was placed in the Monteux Record in 1993 as a Ramsar site 'where changes in the ecological character have occurred, are occurring, or likely to occur'.

The lake, moreover, is plagued by many ills including continued process of pollution, siltation, encroachment, physical modification, water body to land conversion, and nutrient enrichment from agricultural runoff and pollutant effluent discharges from polluting rivers like Naga Turel, Nambul Turel, Nambol Turel and Moirang Turel.

Literature review

The Ministry of Environment, Forest & Climate Change, Government of India (MoEF&CC, 2019), noted that most wetlands in India are under stress due to impacts of urbanization, and agricultural runoffs, which require specific management plans for their long-term conservation.

Wetlands in Manipur are in various stages of degradation and degeneration. Rajesh (2023) observed that most wetlands in the State had been partially or wholly reclaimed for agriculture, fish farms, settlement and other small scale commercial activities.

Wetlands International (2022) noted that wetlands [1] are disappearing three times faster than forests. Vishwanath (2000; 2017) identified pollution, habitat loss, damming, over-exploitation, besides species invasion, as major threats in Loktak wetland complex.

IPBES (2019) emphasized that freshwater ecosystems provide fundamental services to humans such as food, water, nutrient retention, recreation, and climate regulation. An estimated 129,000 species live in freshwater ecosystems, representing 8% of Earth's described species.

With reference to Loktak Lake, Wetlands International states that the onslaught of unsustainable developmental activities without understanding the nature of the wetland ecosystem had led to the degradation and loss of benefits accrued from them through their natural functioning (Trisal and Manihar, 2004).

Methodology

Multiple visits to Loktak wetland complex and field assessment form the basis upon which the authors define its present status. Interaction with local communities is basic to understanding the changes in the physical and ecological character during these past decades, which is supplemented by information available from secondary literature sources and government data. Physical observation concurrently for near four decades to date reveals the extent to which the freshwater wetland had been subjected to many forms of abuse that threaten the dynamics of this critical water body.

Results and Discussions

Studies and findings on the status of wetlands locally and globally indicate that wetlands are generally under tremendous stress, of which anthropogenic interference in nature reserves is clearly evident. Reclamation of wetlands for expansion of cities and towns, earth-filling for roads and rails, agriculture and industries are just a few of the several instances of human-influenced activities inducing wetlands loss.

Beginning 1980, the discussions on the Loktak wetland complex [2] has centered mainly on the impact of the Ithai Barrage [3], commissioned in mid 1983, on the hydrological and ecological regime of Loktak Lake and its associated wetlands, impacting large areas within the Manipur River Basin (Trisal and Manihar, 2002; 2004).

The major controversies within Loktak wetland complex began with the commissioning of the 5-sluice gate operated barrage at Ithai Khunou village in Bishnupur District which cut off the flow of Manipur River and Khuga River, and subsequently inducing stagnation of water in its upstream areas. Ithai Barrage converted several separate wetlands into one large water body to retain water for the hydro project.

It is roughly estimated that around 55,000 to 80,000 ha of agricultural lands were either permanently submerged or damaged by the Loktak hydro project.

Human settlements situated along the peripheral areas of the lake's shoreline experience frequent inundation when the level of water in the lake rises during the monsoons. When this occurs, houses are flooded and the fish culture ponds over-flow, resulting in outflow of the cultured fish and incurring huge economic losses for the marginal fish farmers in localities like Nongmaikhong, Khordak, Laphupat-Tera, Komlakhong, Wapokpi, Mayang Imphal, Toubul, Khoijuman, Ningthoukhong, Bishnupur, Nachou, Nambol, Oinam, and Keinou.

Trisal and Manihar (2002) maintained that the main changes to the water regime in Loktak Lake are those pertaining to the hydro-period, water spread area, residence and turnover time, and wave hydro-balance due to the construction of Ithai Barrage for the purpose of hydro-power generation and irrigation.

Trisal and Manihar (2004) further noted that the serious implication of Ithai barrage had led to: (a) Changes in the hydrological regime thereby affecting ecological processes and functions of the wetland complex; (b) Inundation of agricultural lands and displacement of people from flooded lands; (c) Loss of fish population and diversity; and (d) Decrease in the thickness of Phumdi [4] biomass in Keibul Lamjao National Park, thereto threatening the habitat of the endangered Manipur Brow-antlered Deer.

Kosygin (2002) noted that the main reasons for the rapid proliferation of Phumdi biomass in the Loktak wetland complex are: (i) Inflow of high amounts of nutrients in the lake from point to non-point sources, (ii) Phum fishing practice, and (iii) Construction of Ithai barrage and other hydraulic structures along the Manipur River which blocks the outflow of sediments and nutrients resulting in their deposition into the lake.

Stagnation of water in Loktak Lake had largely influenced the proliferation of Invasive Alien Species (IAS) [5] of aquatic and semi- aquatic plants. The entire Loktak wetland complex is dominated by IAS like *Brachiaria mutica*, *Pistia stratiotes*, *Alternanthera philoxeroides* and *Pontederia (Eichhornia) crassipes* while IAS like *Lantana camara*, *Parthenium hysterophorus*, *Mikania micrantha* and Vetiver grass are prominent on land. IPBES (2023) identified 3500 invasive species globally as severely harming biodiversity and human livelihoods.

Brachiaria mutica is considered nuisance plant in Loktak wetland complex as it had practically dominated over the native plants and the floating biomass with its tenacious spread.

Extensive growth of the IAS like *Brachiaria mutica*, *Pontederia crassipes*, *Pistia stratiotes*, *Alternanthera philoxeroides* and *Mikania micrantha* had caused the decline of edible aquatic plants like *Zizania latifolia*, *Ludwigia claveliana*, *Cyperus esculentus*, *Ipomoea aquatica*, *Oenanthe javanica*, *Hedychium coronarium*, *Alpinia galanga*, *Nelumbo nucifera*, *Polygonum barbatum*, *Euryale ferox* and *Trapa natans* that are harvested by the locals for food and fodder.

The uncontrolled spread of Paragrass (*Brachiaria mutica*) and other invasive species while reducing the open water body in Loktak Lake also blocks the waterways used by local fishers in their dugout canoes. This impacts the traditional capture fishery practice by local fishers, thus reducing their earning capability and defeating the objectivity of SDG1 and SDG3.

Water stagnation and resulting nutrient enrichment is observed to influence the rapid spread of submerged aquatic plants like hydrilla. Food plants like *Euryale ferox* and *Trapa natans* have declined due to the spread of the hydrilla species locally known as Charang-kokpha, thereby inducing loss of food supplements for the locals.

The wide spread of Charang-kokpha hydrilla is observed as impacting capture fishery as local fishers informed that this underwater plant discourages the congregation of the fish in those pockets of the water body dominated by this submerged plant.

Additionally, it was also observed that the winter migrating water birds do not congregate in those parts of the water body where this hydrilla dominates. The extensive growth of this underwater plant likely displaces the invertebrates and micro-organisms that the fish and the water birds feed upon.

The rapid spread of invasive aquatic weeds in the lake is reported to be influenced by nutrient enrichment induced by feed from chemical residue runoff from the adjoining agricultural fields, and the pollutant effluent discharge from the inflowing rivers.

Local farmers in peripheral villages in Bishnupur District are reported to be using fertilizers like urea and DAP (Di-ammonium phosphate) in considerable amount for nourishing their paddy crop and large swathes of agricultural land utilized for growing vegetable crops.

Di-ammonium phosphate is one of the widely used phosphate fertilizers globally as it has high nutrient contain. Combined with urea, the nitrogen and phosphorous residue runoff from use of high quantity of both urea and DAP reportedly influence nutrient enrichment in the lake, particularly in its shoreline and in the shallow depths.

DAP is a water soluble fertilizer containing high concentration of the primary plant nutrients phosphorous (46%) and nitrogen (18%). Excessive quantity of urea and DAP used in agricultural fields is reported to have potential for human health and environmental risks associated with their nano-particle concentration as in nano-DAP formulations.

The rapid and widespread intrusion of *Brachiaria mutica* in the lake water body is being attributed to the process of continued nutrient feed as runoff from the nearby agricultural fields that are treated with the nutrient-rich fertilizers. The gentle west-east inclined slope of the agricultural fields in Bishnupur District is ideal for agricultural residue runoff directly into the lake, in particular during the rainy season.

Trisal and Manihar (2004) noted that the annual fish yield in Loktak Lake had declined at an annual rate of 2.74 percent during the assessment years 1991 to 2001.

The obstruction by Ithai Barrage in free-flow of the Manipur River, a major tributary of the Chindwin-Irrawaddy river system in Myanmar, had halted the in-flow of migratory fish population coming upstream for spawning in water bodies within the Loktak wetland complex.
This had caused sharp decline in the population of many species of migratory fishes that were highly relished by the local people and which provided means of earning their livelihood through capture fishery.

The decline in the population of migratory fishes like *Cirrhinus reba*, *Osteobrama belangeri*, *Labeo bata* and *Wallago attu* considerably impacted the economy of the rural population while also bringing about a change in the species profile of the Loktak wetland complex with the introduction of carp species by the State Fisheries Department.

Loktak wetland complex is presently dominated by introduced species of fish like *Cyprinus carpio*, *Ctenopharyngodon idellus*, *Labeo rohita*, *Glossogbius giuris*, *Cirrhinus mrigala*, *Oreochromis mossambicus* [6], *Labeo gonius* and *Puntius javanicus*.

Singh & Singh (1994) noted that the fishery in Loktak Lake has traditionally been open water capture fishery which accounted for 60 percent of the total fish production of the State. Migratory fishes from the Chindwin-Irrawaddy river system in Burma used to contribute about 40 percent of the capture fishery of the lake.

Vishwanath (2017) observed that ‘Unlike Inle Lake in Myanmar, fish species in Loktak Lake are not specialized and restricted to the lake (Hora 1921), being also found in the nearby streams of the valley. Manipur Valley was very rich in its native species. Hora (1921) listed 56 species from the State and described six new species. However, many species have been lost from Loktak Lake as a result of the introduction since the 1980s by the State Government of Indian and Chinese carps for aquaculture, and by over-exploitation’.

The report of the National Biodiversity Authority of India on Invasive Alien Species of India (Sandilyan, S., 2018) includes two fish species found in the Loktak wetland complex, namely, the

Common carp and the Mozambique tilapia, wherein both the fish species *Cyprinus carpio* and *Oreochromis mossambicus* are included in the list of Inland Invasive Alien Species of Fishes as is the case for the country.

In the longer term, the domination of these invasive alien fish species is likely going to contribute to the decline and extinction of native fish species from within the Loktak wetland complex, enhancing biodiversity loss to a great extent.

Conclusion

Habitat loss and degradation driven by infrastructure development, water regulation, agricultural intensification and human disturbances are among the most frequent threats to key wetlands and their waterbird populations (Wetlands International, 2010). Dasgupta (2021) stressed that habitat fragmentation reduces biodiversity by impairing important ecosystem functions and altering nutrient cycles.

The continued and unchecked deposit of chemical residue from agricultural runoff in the lake peripheral areas and the pollutant effluent discharge from directly-inflowing polluting rivers are primary seen as influencing nutrient enrichment, and thereto eutrophication, leading to accelerated ecosystem degradation and decline, and subsequently leading to biodiversity loss.

Biodiversity loss and species decline impacts the sustainable livelihoods of local people (Millennium Ecosystem Assessment, 2005). Rapid decline in indigenous fish population and edible aquatic plant species due to ecosystem degradation impacts the food needs for the wetland dependent communities. This poses threat to sustainable living for the locals, defeating the goals of SDG1, SDG2 and SDG3.

IPBES (2019) suggests possible solutions for maintaining freshwater for nature and humanity, maintaining that pathways exist that can improve water use efficiency, increase storage and improve water quality while minimizing disruption of natural flow regimes.

Suggested Pathways

Multiple issues that are primarily human induced are impacting the wetland ecology of Loktak Lake and its associated wetlands negatively, consequently affecting both the human and the natural environments, and also leading to biodiversity loss and species decline.

Suggested pathways to achieve biodiversity recovery and rejuvenation of the health of the Loktak wetland complex could be as follows:

(a) Assess the current status of Loktak wetland complex, with particular reference to biodiversity loss and species decline;
(b) Formulate strategic action plans to monitor and evaluate the physical and morphological health of the wetland complex periodically;
(c) Formulate mechanism to control chemical residue runoff and pollutant effluent discharge into the wetland complex;
(d) Check and halt the uncontrolled spread of invasive alien species of terrestrial, semi-aquatic, and aquatic plants, with similar measures on introduced and invasive alien species of fish;
(e) Control land-fills and conversion of wetlands for agricultural activities, fish farms, and physical encroachments within the wetland complex.

Notes

1. Globally, the new terminology in use is ‘Wetlands and other Traditional Waters’ to indicate the differences in characteristics and physiology of wetlands like peat lands, bogs, marsh and swamps as compared to ‘traditional waters’ like lakes, rivers, streams, brooks, ponds, etc. Peats, bogs, and swamps have saturated lentic water while rivers, streams and lakes have running, flowing water.

2. The Loktak wetland complex comprises of several separate wetlands within the Manipur River Basin, such as, Loktak Pat, Pumlen Pat, Ungamen Pat, Laphupat, Kumbi Pat, Khoidum Lamjao Pat, Kharung Pat, Ikop Pat, Utra Pat, Sana Pat, etc.

3. This singular barrage, constructed over the Manipur River at its confluence with Khuga River near Ithai Khunou village in Bishnupur District, has been the nemesis for myriad problems faced by hundreds of fishers and farmer families both in the upstream and the downstream areas. Submergence of settlement and agricultural lands, loss of fish culture ponds, decline in migratory fish population, decline in edible aquatic plants and insects population, loss of livelihoods, etc. are some of the common issues plaguing the wetland complex since the past four decades and more.

4. Phumdi is a heterogeneous mass of living and decaying vegetation, in floating and rooted conditions. Phumdi forms a salient feature of Loktak and its associated wetlands. Locals utilize the phumdi for different purposes including for capture fishery, dwelling in shelter huts upon the phumdi during their period of fishing in the lake, and to shelter from sun and rain. The phumdi floats up and down with the varying seasons, such as, it floats up when the water level in the

lake increases with the arrival of heavy rains during the monsoons, while it floats down and rests upon the lake bed during the lean season when the level of the lake water recedes considerably.

5. Currently, there are several species of introduced and invasive alien species (IAS) of plants and weeds that have practically over-run the wetlands and other water bodies across the central Manipur valley areas, and in the uplands. The more troublesome IAS is Paragrass which is proving a nuisance plant dominating over the native plants which are sourced by the locals for food, medicine, and fodder. Water hyacinth is another problem IAS aquatic plant in the Loktak wetland complex.

6. Tilapia population in Loktak wetland complex is spreading rapidly with its introduction intentionally by local people without fully realizing its invasiveness nature and possible long-term impact on native fish species.

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