LOKTAK

NEWSLETTER

MARCH 2011, VOLUME VI

LDA

WETLANDS INTERNATIONAL

Loktak Development Authority

LDA is the nodal organization entrusted with management of Loktak Lake. It functions under the aegis of the Department of Forests and Environment, Government of Manipur. The authority draws its powers and functions from the Manipur Loktak Lake (Protection) Act, 2006. The Chief Minister is the Chairman of the Authority and Project Director its Member Secretary. The members of the authority include state ministers, members of legislative assembly, secretaries / heads of concerned state government departments and experts.

Wetlands International – South Asia

WISA is the South Asia Programme of Wetlands International, a global organization dedicated to conservation and wise use of wetlands. Its mission is to sustain and restore wetlands, their resources and biodiversity. WISA provides scientific and technical support to national governments, wetland authorities, non government organizations, and the private sector for wetland management planning and implementation in South Asia region. It is registered as a non government organization under the Societies Registration Act and steered by eminent conservation planners and wetland experts.

"LOKTAK" is the jointly published newsletter of the Loktak Development Authority and Wetlands International - South Asia

CONTENTS

EDITORIAL PANEL

Chief Editors : Wetlands International - South Asia : Ritesh Kumar
Loktak Development Authority : Th. Ibobi Singh

Editors : Loktak Development Authority : Ng. Sanajaoba Meitei
Wetlands International - South Asia : Pranati Patnaik

Design & Concept : Wetlands International - South Asia : Kamal Dalakoti and Satish Kumar

Print & Layout : The Printshop, New Delhi, India

Forests : for water and wetlands

World Wetland Day is celebrated each year on 2 February to mark the birth of Ramsar Convention in the city of Ramsar in Iran. On February 2, 2011 the Convention completed 40 years as an intergovernmental treaty solely focused on one ecosystem – wetlands. As on date, Ramsar Convention has 160 Contracting Parties and 1896 Ramsar sites covering 185 million hectares representing the largest protected area network of the world.

India joined the Ramsar Convention in 1981, initially designating 2 wetlands as Ramsar Sites, and subsequently adding 4, 13 and 6 sites in 1990, 2002 and 2005 respectively. As on February 2011, overall 25 wetlands have been desingated with total area of 0.67 million hectare. The year 2011 also marks 30 years of India's membership to Convention. Loktak was designated as a Ramsar Site in 1990 and also included in Montreaux Record (which is a list of sites wherein changes in ecological character have occurred and require priority attention by the national government).

The theme for World Wetland Day 2011 is Wetlands and Forest, considering the fact that the United Nations has declared 2011 as the International Year of Forests. It provides an ideal opportunity for the Convention to highlight the role of 'forested wetlands'. These include broadly, intertidal forested wetlands (mangrove swamps, and tidal freshwater swamps), freshwater tree dominated wetlands (freshwater swamp forests, seasonally flooded forests, wooded swamps) and forested peatlands.

Dense forests in and around the Loktak Wetlands

All these types can also be collectively termed as swamp forests, defined as any wetland with woody vegetation. These wetlands are important as sources of fish and other aquatic foods, and providing diverse range of habitats for animal and plant species. They are particularly important stores of carbon.

Beyond the forested wetlands, the wider relationship between forests, wetlands and water makes the World Wetland Day theme important. World over, water scarcity has emerged as one of the major challenges for sustainable development. Forests, in general, are known to use more water than woody vegetation due to high evaporation rates, but forest soils absorb and retain water easily and thereby affect runoff. Forests also reduce erosion, thereby reducing sedimentation in downstream wetlands. Terrestrial forests and forested wetlands have crucial role in global water cycle. Forests have significant impact on the levels of evaporation and evapotranspiration, which in turn affects rainfall. Within a given catchment, forests play a dual role, both as a vital part of water cycle and as a strong influence on how water is routed through the catchment and stored.

A third of the world's hundred largest cities draw a substantial proportion of their drinking water from forest protected areas. There are many examples of forests and wetlands with dedicated management actions having provided clean water at much lower costs than man-made substitutes like water treatment plants. Cities like Rio de Janeiro, Johannesburg, Tokyo, Melbourne, New York and Jakarta all rely on protected areas for supply of drinking water. In Catskill watershed, New York, an investment of US$ 1 billion in catchment conservation measures has led to avoidance of over US$ 4 – 6 billion on water treatment plants (plus annual maintenance costs). In Venezuela, the national protected area systems prevents sedimentation that if left unattended could reduce farm earnings by around US$ 3.5 million annually.

Conservation and sustainable management of Loktak wetland complex is critically hinged to management of forests within the Manipur River Basin. As per land use assessments carried out in 2005, forests constitute 73.6 % of the total basin area. However, a large part of these is barren and denuded, primarily due to large scale shifting cultivation practised in the hilly regions of the basin. Dense forests account for only 5% of the overall forest cover in the hill catchments. Vegetation is particularly sparse in the higher slopes (> 35%), where dense forest cover is less than 3%. Rapid deforestation has led to severe erosion problems as well as reduction in flood cycle and drying of streams. There has also been reduction in the availability of timber and non-timber forest products. Degrading catchments are one of the several sources of the 0.65 million metric tonnes of sediment input into Loktak Lake.

The Management Action Plan for Loktak and associated wetlands emphasizes on catchment conservation, and land and water management as crucial prerequisites for conservation and wise use of the wetland system. Specific interventions in the form of afforestation, aided regeneration and soil and moisture conservation techniques are being implemented. Measures for providing alternate and additional livelihood opportunities through sustainable micro enterprise development and enhanced access to social and economic infrastructure are being undertaken to reduce dependence on forests and improvising shifting cultivation. The Short Term Action Plan focuses on three catchments that yield maximum silt load to the wetland complex, namely the Loktak, Thoubal and Heirok.


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An aerial view of fish farms adjoining Loktak Lake

Shrinking natural regimes of Loktak wetland complex – challenges and management implications

Ng. Sanajaoba Meitei, Ritesh Kumar, Ch. Bidan Singh

The multifunctional Loktak Wetland Complex, ecosystem services of which play a vital role in sustaining the state of Manipur, is undergoing gradual land use transformation. Shrinkage of natural wetland regimes poses a grave threat to its ecological character as well as creates a distinct conservation-development tradeoff wherein long term societal benefits stand compromised by short term private gains.

Wetlands worldwide are being lost at rates faster than any other ecosystem types. The current trend of loss of natural wetlands and transformation of land use within the Loktak Wetland Complex is similar to changes observed in some other Ramsar sites of the country which have led to significant environmental as well as socioeconomic conflicts.

Loss of marshes within Loktak Wetland Complex

The Survey of India topographical maps of 1970 for Manipur Central and North districts provide a baseline scenario of the extent of Loktak Wetland Complex. These maps, prepared at a scale of 1: 50,000 using survey data of 1969-70 describe the wetland complex as a single connected regime girdled with settlements and agriculture (Map 1). Four large subsystems are discernible. On the west of the Manipur River lies Loktak Lake surrounded by Keibul Lamjao Games Sanctuary (presently Keibul Lamjao National Park) and Laphu pat in the south and several smaller waterbodies in the north.

Fish farms within Loktak Wetland Complex

In the east, between Manipur and Sekmai Rivers lies Pumlen and Lamjaokhong subsystem. Kharung , Ikop and Laushipat are wetland formations between Sekmai and Thoubal Rivers. A group of small wetlands are also formed between Iril and Thoubal Rivers of which Waithou and Punem are major. Each of these subsystems is presented as an open water formation surrounded by seasonally inundated marshy areas.

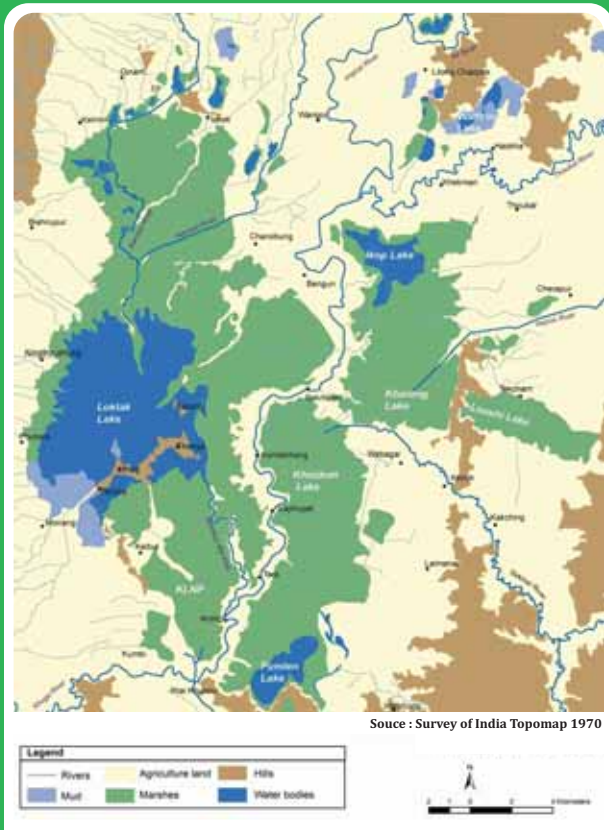
The map of 2009, prepared using Quickbird imagery (0.6 m resolution, date of pass 9 May) indicates that the marshes have shrunk considerably (Map 2). There has been a significant increase in open water area (which has been almost static since 1989) towards the marshes. Fish farms emerge as the predominant feature of the landscape encircling almost the entire complex margin as well as expanding into the nearby agricultural lands (Map 3 and Table 1). In 2009, their total area was assessed as 175.9 square kilometre of which 88.5 square kilometre (50.2%) are converted marsh areas.

Table 1: Land use change within Loktak wetland complex (all figures in square kilometre)

Land use category	1970	2009
Open water	67.96	117.12
Marshes	272.84	110.9*
Fish farms	Not Shown	88.5**
Agriculture	Not Shown	24.29

** Area under free floating phumdi have been excluded*
***Does not include area outside the 1970 wetland complex boundary*

A spatial pattern also emerges from the analysis of imageries. Most of the times, the conversion has started from the settlement fringes, along water channels or along elevated landforms, gradually moving into agricultural lands and finally into marshes.



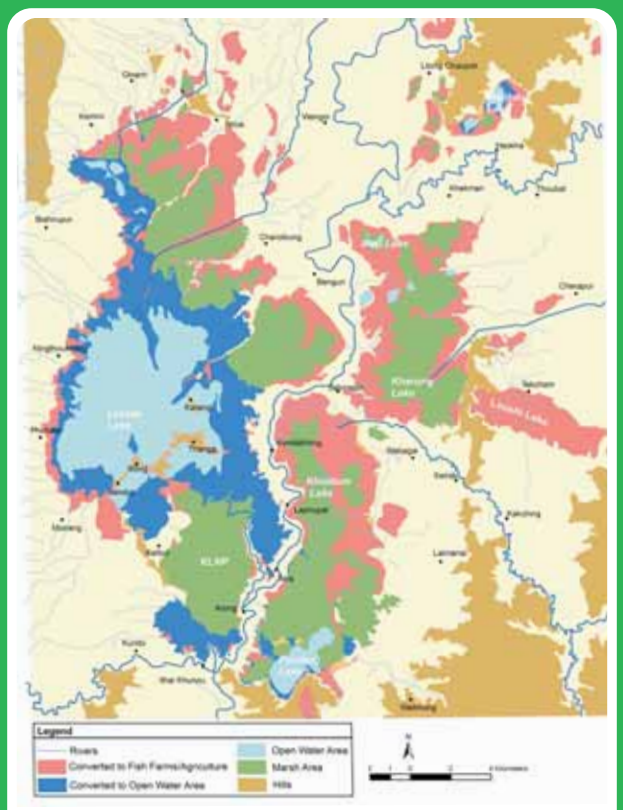
Souce : Survey of India Topomap 1970

Map 1 : Loktak Wetland Complex, 1970

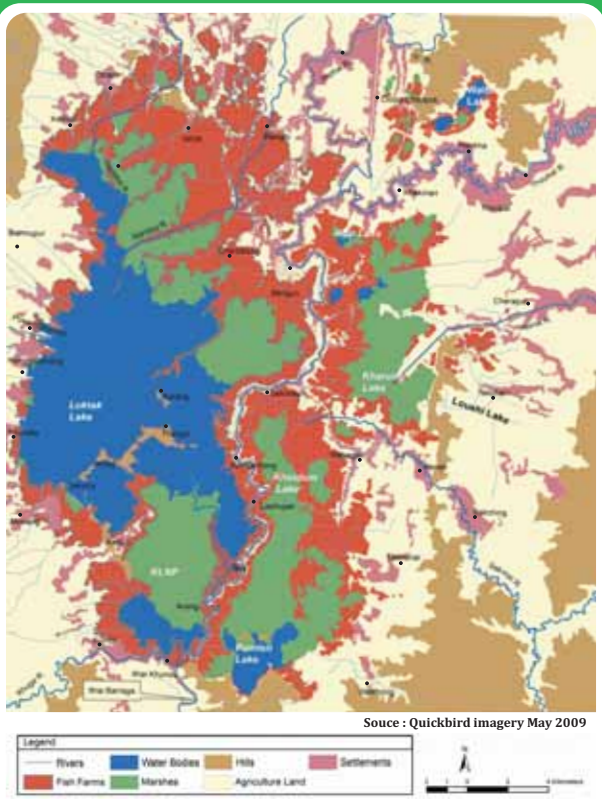
Proximate reasons

The Manipur valley with a population density of over 630 persons per square kilometre (as per 2001 census) has tremendous pressure on land and water resources. More than 60% of the state's population inhabits the 2238 square kilometre valley (equivalent to only 10% of state's geographical area). The total production of foodgrains and fish in the state has been less than the overall demand in the recent decades. As per the statistics of the Directorate of Economics and Statistics, the total foodgrain production ran short of the requirement by 21% on an average during 1999-2008, with progressive widening of gap. Thus, there has always been a policy stimulus to bring in additional areas under food production as well as intensify areas currently under use. The pressure for meeting food security is often through conversion of marginal lands as marshes. Shallow depths with periodic inundation make marshes more vulnerable to conversion.

The first major thrust to develop fish culture in Manipur was in the 1970s, primarily using Indian Major Carps (*Labeo rohita, Catla catla and Cirrhinus mrigala*) and common carp (*Cyprinus carpio*). Subsequently in the 1980s, exotic carps were introduced (*Ctenopharyngodon idella* and *Hypopthalmicthys molitrix*) in combination with the



Map 3 : Changes in marshes of the Loktak Wetland Complex, 1970 - 2009



Souce : Quickbird imagery May 2009

Map 2 : Loktak Wetland Complex, 2009

Indian Major Carps to enhance productivity and returns to the farmers. There was also a progressive increase in stocking density, leading to adoption of chemical fertilizers since mid 2000. As per the Statistics of the Fisheries Department, the overall waterlogged areas converted into agricultural land as on 2009-10 stood at 17.38 square kilometer. The same report mentions that the total water area in Manipur State has shrunk from 1,000 square kilometer in 1990 to 564.61 square kilometer. in 2007-08. About 150 square kilometer of water area has been brought under fish culture operations. The overall fish production has increased from 16.6 thousand tonnes in 2002-03 to 18.50 thousand tonnes in 2006-07, an enhancement largely possible through culture sources.

The commissioning of Ithai Barrage in 1984 brought in major changes in inundation pattern within the marsh areas. Seasonal inundation changed to near permanent waterloged conditions. This brought about a decline in natural fisheries productivity, particularly due to impacts on their breeding and spawning grounds of several indigenous fish species which preferred marshes as habitat (for example *Anabas testudineus, Channa punctatus* etc.). At the same time, waterlogging created more feasible conditions for developing culture fisheries by constructing dykes. Culture fisheries also provided

Marsh areas converted for permanent agriculture

opportunities of higher incomes and employment. At current prices, a hectare of fish farm generates on an average a net profit of Rs. 1,30,000 (with an investment of Rs. 1,10,000) as compared to Rs. 45,000 from paddy cultivation (with an investment of Rs. 16,000) . A converted fish farm also has a much higher economic asset value as compared to a marsh in its natural state, as much of the benefits derived from the later are non-marketed and accrue to society as a whole.

The institutional regime for land and water management, conventionally being revenue centric, favours productive uses. The range of economic values of wetlands were not considered into policy and decision making processes, as was globally, primarily being attributed to lack of awareness and comparable economic estimates for benefits from wetland ecosystem services. Thus, majority of marsh areas were surveyed by the Settlement Department and classified as agriculture or settlements areas with determined titles. Large parts of wetlands were left in the hands of private owners with flexibility to alter land use. Only deeper segments of wetland systems remained unsurveyed and thus escaped from being put to any conventional land use classification.

Implications for wetland management

Conversion of marshes within the Loktak wetland complex has several implications for management of the system. The key impact is on the natural wetland regime, which has shrunk by 33 % since 1970s.

Loktak and associated wetlands function as natural water storages, providing the much needed flood attenuation as well as water supply function for various human uses. Conversion of marshes reduces its effective water storage capacity. As per bathymetric survey made for Loktak Lake in 2000, of the total water holding capacity of 509 Mm^3 (at 768.5 m amsl, excluding islands), 28 Mm^3 is lost to conversion by fish farms. The impact is much more severe for other parts of wetland complex such as Kharung, Lamjaokhong and Laushi which have been almost completely converted into farms. Additionally, the overall wetland regime is fragmented.

The marshes also function as sinks for nutrients from the highly populated and intensively cultivated catchments. Assessments made under Sustainable Development and Water Resources Management project indicated that the *phumdi* in the northern sector of Loktak annually captured 478.6 tonnes of nitrogen, 39.6 tonnes of phosphorous and 157.2 tonnes of potassium , thereby playing a critical role in determining the water quality of wetland. Conversion of marshes therefore reduces the nutrient retention capacity of the wetland system. The impacts on biodiversity have not been fully assessed. However, fish farms have replaced the breeding and spawning grounds of several indigenous fish species which preferred marshes as habitat. The impact on bird habitats is currently being assessed by Wildlife Wing of Forest Department in collaboration with Bombay Natural History Society.

From the perspective of community livelihoods, there has been a loss of capture fishing grounds as well as community grazing areas. There was a gradual decline in appreciation of the values and functions of the marsh systems due to decline in resources, promoting further conversion. There has also been a change in power relations, with more affluent fish farmers getting higher share of benefits through wetland conversion as opposed to other livelihood systems and biodiversity benefits which are dependent on natural regimes of the lake.

Management efforts and gaps

Several attempts have been made in the past for demarcating Loktak Lake. During 1993-94, the State Government took an initiative of delineating the lake boundaries based on revenue records through a team of officers from Settlement Department attached to Loktak Development Authority. However, the work could not be completed due to various reasons. The issue of lake boundaries once again came to fore while drafting the Loktak Protection Act of 2006. The act notified an area of 230.6 square kilometer as the total area of Loktak Lake and defined a core and buffer area for the purpose of regulating detrimental activities. The core area, which is the main open waterbody mostly corresponds to the unsurveyed areas. The buffer areas, constituting mostly the marshes, are the areas surveyed and classified under Revenue administration. These include Keibul Lamjao National Park, Takmu Fisheries Reserve (under the jurisdiction of Fisheries Department) and private lands. This multiplicity of ownership is a complex management issue for conservation planning.

Other wetlands of the Loktak complex have been mapped by the Settlement Department and classified as various productive land use categories. With the institutional mandate of Loktak Development Authority limited to Loktak Lake, no effective arrangements currently exist for their management.

The first major attempt to address comprehensive land and water management for Loktak wetland complex was through the Planning Commission supported management planning at Manipur River basin level. The plan formulated by Wetlands International – South Asia jointly with Loktak Development Authority entailed identification of priority action for conservation and management of the wetland complex based on assessment of the extent of wetland regimes, their ecological, hydrological, socioeconomic and institutional features

Open water spread areas like the above are limited only to central sector of Loktak

Migratory birds congregate in marshes

and factors governing these features. Interventions within Loktak as well as Pumlen and Ikop systems including their catchments were suggested in the plan which was submitted in 2005 and subsequently approved by the Planning Commission as well Government of Manipur. The current Short Term Action Plan being implemented since 2008 forms an integral part of the management action plan, but is aimed at Loktak Lake alone.

However, the fact that several marsh areas have been lost is a clear indicator of lack of appreciation of benefits these marshes provide to the society as a whole. On an overall, baseline information on the wetland extent, biodiversity and ecosystem services remains limited except that for Loktak Lake. Sectoral approaches to land and water resources management makes the task of conserving the wetland complex for sustaining livelihoods of local communities difficult. Overall, limited efforts have been made till date for conservation and sustainable management of these marsh systems.

Way ahead

The current review clearly points out the urgent need to broadbase the management of Loktak Lake and focus on the entire wetland complex, in line with the objectives of the Comprehensive Management Action Plan for Loktak and associated wetlands integrating Manipur River Basin. A river basin level stakeholder led systematic land use planning process is required wherein conservation areas, as the wetland complex, are identified and requisite management practices are put in place to ensure that their ecological character as well as societal benefits are maintained. This should be based on a detailed survey and mapping of the wetland areas including defining their ownership and ecological, hydrological and socioeconomic values. Assessments would also need to be carried out to express the benefits derived from the wetland complex in concrete economic terms so that the

Productivity of wetlands and sustenance of livelihoods of communities is dependent on marshes

tradeoffs due to their conversion are rationally defined and integrated into decision making. The impact of current aquaculture practices would also need to be assessed in detail and measures taken to ensure that sustainable practices are promoted and complied with.

Given the fact that several conservation areas have private land titles, land use planing would need to account for genuine opportunity cost losses as well as providing incentives for natural resource stewardship. An intensive campaign focused on values and functions of the marsh systems at multiple levels would be required to augment these processes. An overarching institutional regime building on cross-sectoral cooperation and stakeholder participation needs to be put in place to sustain the management efforts and ultimately conserve the wetland complex.

The Ministry of Environment and Forests, Government of India has notified the Wetland (Conservation and Management) Rules in 2010 under the Environmental Protection Act which will apply to all Ramsar sites, wetlands within ecologically sensitive and important areas, UNESCO Heritage sites, high altitude wetlands with an area of 5 ha and above, and other wetlands having area of 500 ha and above. The rules prohibit reclamation of wetlands, dumping of solid wastes, discharge of untreated wastes as well as any construction of permanent nature except boat jetties. Permission for withdrawal and impoundment of water is granted only after approval from the Central Wetland Regulatory Authority. These Rules in conjunction with the Loktak (Protection) Act, 2006 provide the required regulatory framework for conserving the wetland complex. The need of the hour is to use this framework as a foundation to build appropriate management practices for the Loktak Wetland Complex.

A panoramic view of Loktak Lake

Paragrass invasion in Loktak

S. Shyamjai Singh

Rapid proliferation of Paragrass (*Brachiaria mutica),* a grass species of the Poaceae family, within Loktak Lake is posing a great threat to its ecological processes and biodiversity. It has invaded almost all parts of the wetland system. During 2000-02, its spread was confined to only northern and northwestern fringes and in small patches in Kumbi pat area (southern side) of the lake.

The rapid spread of paragrass is a concern for lake management primarily due to its role in *phumdi* proliferation. In the open water area, *Salvinia* and *Cyperus* species effectively associate with paragrass to form dense mats of vegetation which ultimately grows into *phumdi*. The species which used to be one of the several constituents of *phumdi* has become dominant. Its spread and rapid growth in the marsh areas is gradually changing the vegetation pattern with impacts on overall biodiversity. Its spread in the Keibul Lamjao National Park has the potential to alter the habitat, specially leading to reduction in food and shelter plants of Sangai deer (*Rucervus eldii eldii*).

Paragrass is a perennial grass species which can grow in terrestrial as well as in aquatic environments. It has hairy stem and leaves. The stem is up to 1-1.5 cm in diameter. The leaf can extend upto 75 cm at maturity. Vegetative propagation from the nodes makes its growth profuse which aids in invading new areas. The plant has been seen to grow beyond 2 meter and laterally to more than 5 meter through stolons. In the terrestrial areas, it dominates other grasses and leads to a monotypic stands.

Paragrass was introduced in Manipur by the Veterinary and Animal Husbandry Department (in consultation with National Seed Corporation of India, Guwahati) during 1972-1973 to support dairy development in the state.

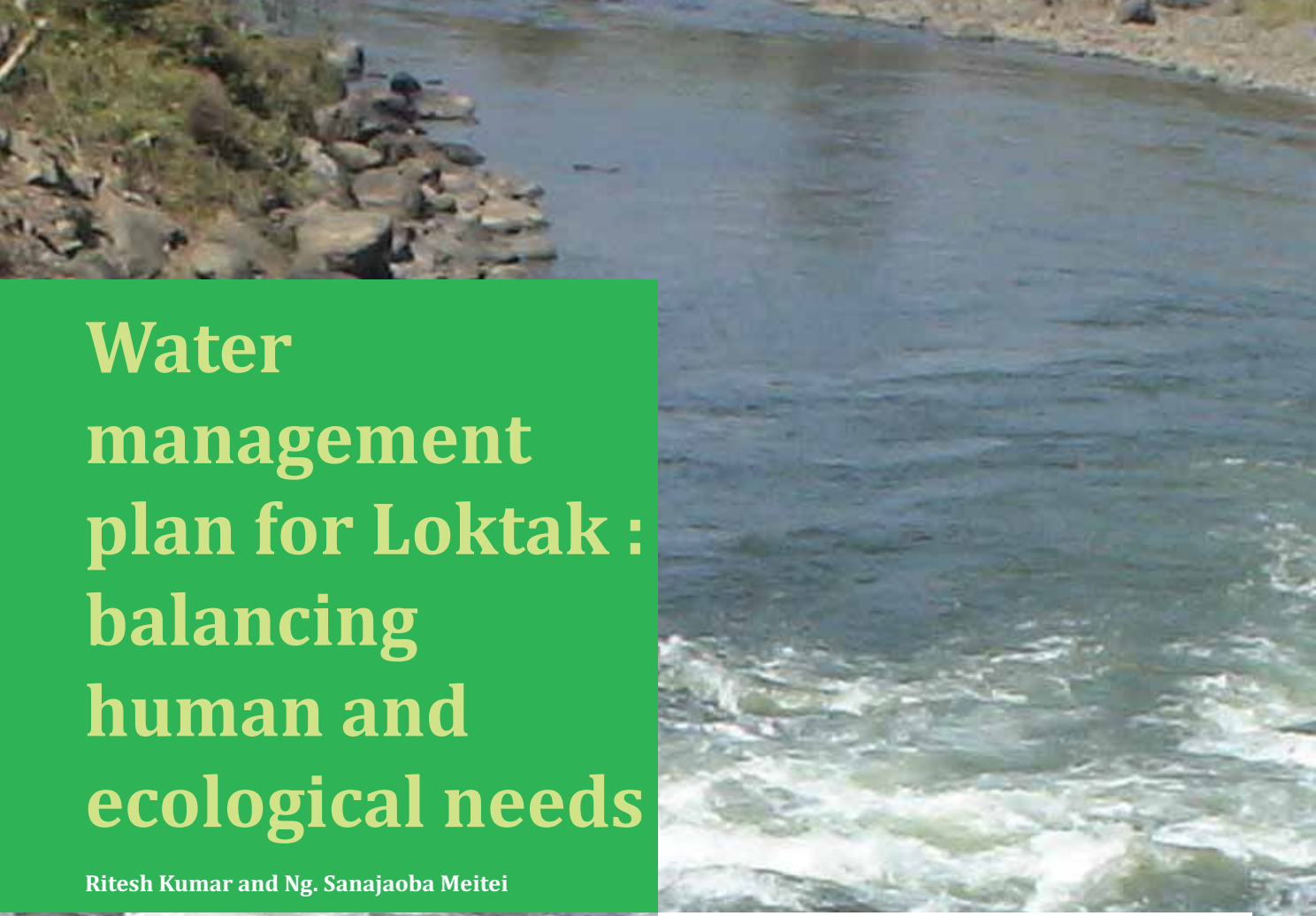
While paragrass poses a threat to the wetland, the communities have several beneficial uses and do not view it as a nuisance. Paragrass serves as a good feed for milch cattle as well for fish farming in the lakeshore and island villages. Communities report enhanced milk production from the cattle which use paragrass as feed. Some households even collect and sell paragrass to farmers as livelihood option. A small size boat can carry upto 15 bundles of the grass and is sold at Rs. 5 – 10 per bundle. *Athaphum* fishers also

Paragrass harvested for fooder

use this grass for strengthening the fishing enclosures. In certain pockets, the tender shoots are cut and stored for use in dry period as fodder.

Management of invasive species is a challenge for all wetlands. Within Loktak, the rapid spread of *Eichhornia crassipes* was successfully controlled in 1988-89 through biological methods (using two weevil species *Neochetina eichhorniae* and *N. bruchii*). However, the niche was occupied by *Salvinia* and paragrass. There has been a reduction in area under *Salvinia* due to *athaphum* removal and creation of large open water areas. This has to some extent suppressed the rapid expansion of paragrass in the central sector. However, the growth remains luxuriant in other parts.

Addressing the invasion of paragrass requires a mix of in-situ as well as catchment level interventions. While there are no known biological control agent for this species, a mix of manual, mechanical and controlled chemical methods need to be used after having assessed the impacts on other biota and ecological processes. The strengthening of dairy and fish farming within lakeshore villages provide opportunities of management of this invasion through economic uses. At the same time, a risk management strategy needs to be put in place which allows development of a system and early warning indicators to project the risk of invasion and ensure that immediate preventive management action is undertaken.



Water management plan for Loktak : balancing human and ecological needs

Ritesh Kumar and Ng. Sanajaoba Meitei

Loktak and associated wetlands are multifunctional systems providing the base of food and water security of the state of Manipur as well as the entire northeastern region of the country. Conservation and wise use of these wetlands is hinged on harmonizing water allocation for human purposes (i.e hydropower generation, agriculture and domestic use) with ecological demands for maintenance of wetland ecological character (maintenance of KLNP habitat, fish migration, lake water quality and overall ecosystem health).

Improving allocation of water to wetlands in water management decisions has received considerable focus within the last few decades and several guidelines have been evolved for securing environmental flows for wetlands. An environmental flow can be defined as "the water regime provided within a river, wetland or coastal zone to maintain ecosystems and their benefits where there are competing water uses and where flows are regulated". The "water regime" includes consideration of the volumes, timing and quality of flows, including periods of low or no flow and floods. Environmental flows have become increasingly widely accepted as an important component of integrated water resources management. The process of determining an environmental flow is commonly referred to as an environmental flow assessment. This article outlines the finding of environmental flow allocation process undertaken for Loktak.

The Ithai Barrage plays a major role in controlling lake levels

Assessing current water management

Loktak and associated lakes are essentially floodplain systems associated with Manipur River. The Manipur River forms a part of the drainage basin of Irrawaddy River, which has an international basin extending to 413,710 square kilometers, majority area being in Myanmar. Hydrological regimes of the Loktak are primarily defined by surface water flows received from the lake catchment of 4,947 square kilometers. The Manipur valley, extending to an area of 2,238 square kilometers and elevation between 760-800 m amsl forms a bowl like depression surrounded by mountainous ranges with steep slopes and incised drainage.

Inflows and outflows to Loktak wetlands are regulated by hydraulic structures both on the upstream as well as downstream rivers. All the major inflowing rivers are dammed for various purposes with the exception of western catchment which flows directly into the lake. Flows from the Heirok and Sekmai basins are largely diverted from the basin through irrigation schemes, limiting the effective catchment area to 4,241 square kilometers. The outflow of the lake is regulated by structure constructed under the Loktak Lake – multipurpose project aimed at controlling floods and reclaiming shallow areas of the lake for agriculture.

Water availability and lake capacity

Inflows to the Loktak are received through 34 streams from the western catchments and Manipur River (via the Khordak and Ungamel channels), whereas the outflows take place through the power channel (for hydropower generation) and releases through the barrage. Water balance of the lake for a full water year (2000 – 01) indicates an overall inflow of 1589 Mm^3, of which western catchment streams and Manipur River contribute 55% and 21% respectively, the rest being rainfall. The outflows were 1,156 Mm^3 of which water abstraction for hydropower and releases from Ithai barrage account for 67 % and 20% respectively. The balance 13% is on accounted of evaporation and evapotranspiration. During the period of May – October, the lake is a net store of water, which is then subsequently drained during the lean seasons. The control of Ithai Barrage on the overall outflows is apparent.

The lake levels play a crucial role in determining availability of water for hydropower generation, since theoretically, water can be taken for hydropower generation only when the lake levels are higher than that of the power channel. The lake is quite shallow at its margins, and at its deepest portion is only 4.5 meter deep. The KLNP, at an average elevation of 766 meter amsl is 2.5 meter higher than the central part of the lake. The power channel, through which water is abstracted for hydropower generation is located at 766.2 m amsl at the western margin of the lake. Overall, the lake level increases during the monsoon (May – July) and then gradually declines. The annual range though is a maximum of 2 meters as compared to 3 meters in pre – barrage situation. The decline in lake levels is however much more gradual than that observed before hydrological regulation, with the levels maintained above 768 m amsl for almost entire year. Also noticeable is the significant difference in the lake levels within the national park and power channel during the lean seasons (Fig 1).

Estimation of the water holding capacity of the lake was carried out in the year 2000. Accounting for the losses in capacity due to phumdi, islands and fish farms, the net capacity has been estimated to be

448 Mm^3 at 768.5 m amsl. Bathymetric surveys carried by WAPCOS in the 1980s indicated the capacity to be 600 Mm^3 at the same water level. There are two apparent reasons for this loss in water holding capacity, i.e siltation from the catchments and changes in land use, especially on the peripheral regions of the lake. The annual average sediment input into the lake has been estimated to be 650,000 MT, with the degraded hills of the western catchments accounting for 65% of the total yield. The natural profiles of the link channels have also undergone volumetric reduction. After the construction of Ithai barrage, the number of fish farms has increased tremendously in the peripheral regions of the lake. Raised earthen bunds of fish farms seclude 28 Mm^3 of water holding capacity.

The water quality of the Loktak Lake, in general, falls within class C to E as per the Central Pollution Control Board's designated best use criteria. The lake water is not fit for direct drinking without treatment but can be used for irrigation and ecological purposes. A large population of 0.28 million people living within Nambul catchment generates on daily basis 72.23 million tonnes of solid waste and 31,207 cum of sewage. Nambol also contributes 4.9 million tonnes of solid waste and 2,121 cum of sewage annually. All the wastes directly or indirectly find their way into Loktak Lake. In KLNP the pH value remains acidic, ranging from 4.5 – 8.5 at the surface and from 4.1 – 8.3 at the bottom. At some spots, its value remains below 6, which shows unhealthy nature. Higher values of free carbon dioxide and low values of DO show relatively high process of respiration and decomposition over photosynthesis of phytoplankton and aquatic vegetation.

Water use

Water abstraction for hydropower generation is the key water use. In absence of any competing claims, water quantity used for hydropower and hydropower generation have been on an increase. The average annual production from the hydropower unit which was designed at 448 MU, has been always above these targets for almost all the years since 1989. There is no specific allocation of water for other sectors, partly because the demand for industrial and domestic purposes is negligible and partly because the other activities, except incidence of surplus releases with consequent flooding, being located and executed within the lake itself are not expected to experience difficulties. The quantum of water used for lift irrigation directly from the lake is variable and not estimated.

Tradeoffs

It is evident that the current water use pattern does not recognize multiple values of the lake ecosystem. Most importantly, water abstraction for hydropower seems to have precedence overall all water management objectives. The gains achieved from this form of management are in the form of increased generation of hydropower, however, with the following implications :

- Reduction and degradation of critical habitat of Sangai deer (phumdi in KLNP with thickness > 1m) to 8 km^2 in 2004 due to changes in water circulation and accelerated acidification within KLNP. Changes in overall composition and proportion of cover and fodder plants preferred by the deer species, further aggravated by stunting of shelter plants.
- Loss of 63,500 ha of agricultural lands due to continuous inundation and flooding within the lake margins and surrounding areas
- Loss of fisheries due to blockages in migratory pathways of riverine species
- Decline in water quality of the lake due to poor circulation and flushing patterns leading to impacts on health of communities

A regulated regime has also promoted changes in livelihoods of the communities. There has been a shift from agriculture to fisheries. The fringe

Degraded catchments increase sediment loading in Loktak

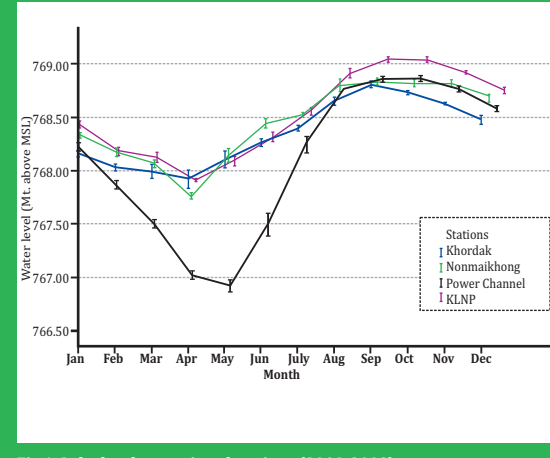


Fig 1: Lake levels at various locations (2000-2003)

agricultural lands have been gradually converted into fish farms, and the dykes used for the same isolate a significant area from the main lake. As the lake margins become shallower, it created conducive environment for encroachment. As per the remote sensing imageries of 2009, fish farms occupy 77 km^2 of the lake area. Similarly, there has been a rampant increase in the incidence of harmful fishing practices, particularly fishing using *phumdi* as enclosures.

The hydropower pricing mechanism in place at present does not recognize lake water as an input to production process. The actual costs of hydropower generation has phenomenally increased due to environmental damages in the form of degraded habitats of KLNP, loss of fisheries and agriculture and enhanced siltation within the lake. This is akin to subsidizing the overall hydropower generation costs, by shifting the impacts to communities through a gradual and continuous degradation of resources and livelihoods. As the upstream water abstractions for irrigation, domestic use and hydropower within Manipur River Basin would increase, the inflows to the Loktak and associated wetlands would gradually diminish, particularly during the lean seasons when water demands for all these purposes are the highest. Ultimately this would constrain the overall economic development of the entire basin, jeopardizing the regional ecological and economic security.

Water management objectives and scenarios

Water management objectives

Developing a water allocation plan for Loktak Lake needs to be referenced to the fact that the hydrological regimes of the wetland have already been modified, and the system no longer exists in its natural state. Several processes, including regulation of outflows, channelization, construction of fish farms, reduced connectivity with other wetlands within the complex, can be variably attributed as causative factors. Secondly, the demands from water management have also changed with changing societal needs and economic development. Water allocations process is therefore to be seen as a matter for societal choice, and to be achieved through participation of all stakeholders.

Loktak has tremendous potential for supporting ecotourism

KLNP is a natural habitat of Sangai Deer

In this light, a stakeholder workshop was convened on March 23, 2010 at Imphal, Manipur with the objective of reviewing the current water management planning and defining objectives for allocating water from Loktak Lake. The meeting was attended by representatives from National Hydro Power Corporation (NHPC); the state government departments of irrigation and flood control, public health engineering, forests and wildlife, rural development, planning, and LDA. During the meeting the following nine specific water management objectives were stated for each of which a required hydrological regime and lake condition were defined:

- Hydropower generation
- Maintenance of Keibul Lamjao National Park
- Flushing of sediments
- Providing water for irrigation
- Reduction in flooding in peripheral settlements and agricultural lands
- Management of *phumdi*
- Supporting capture fisheries
- Supporting culture fisheries
- Maintaining lake aesthetics for tourism and water sports

Water management scenarios

What can be easily observed that all the water management objectives stated above, expect 1 and 8 can be achieved by operationalizing a lake level management close to natural regime. However, the objectives related to hydropower generation and to certain degree maintenance of culture fisheries require stable and regulated lake level conditions, and are likely to be affected by a fluctuations. One way to seek the best combination of the two to explore a range of water management scenarios and evaluate their impacts on multiple criteria. The current water management regime, which is dictated by the needs of hydropower generation, and the baseline natural regime (which addresses ecological needs on a priority) can be taken as two extreme ends of scenario development. The following three scenarios were assessed to illustrate the options available for management of lake water resources:

Scenario 1: Mimicking natural regime – prioritizing biodiversity conservation

Scenario 2: Multiple objective – water allocation for hydropower generation, biodiversity conservation, fisheries and flood control

Scenario 3: Business as usual – prioritizing hydropower generation.

The projections for each of these scenarios was based on using an average lake level of 766.3 m amsl in June and thereafter using a balance model to consider the inflows and outflows. However, the lake levels at various points have been known to vary distinctly, especially during the lean season (October – February). Thereby, it would be important to first of all ascertain these changes in levels and subsequently: a) to agree on a single representative station which characterizes the lake regimes, in agreement with various user agencies, importantly NHPC, IFCD, LDA and Forest Department; b) to synchronize lean season level management for KLNP and hydropower by benchmarking these level differences.

Scenario evaluation

An evaluation of the scenarios was carried based on assessment of impacts on the water management objectives identified by the stakeholders. It was observed that Scenario 3 performed better in terms of objectives related to hydropower, but did not augur well for biodiversity and lake ecosystem processes related objectives. On the other hand, the Scenarios 1 and 2 provided for lake ecosystem processes at the cost of reduced hydropower generation. Under scenarios 1 and 2, the power production during lean seasons was affected, with the impacts higher in 1 than 2. Overall, it was possible to approximately maintain the design power production while providing for lake biodiversity and ecological processes under scenario 2.

Scenario recommendation

The overall scenario analysis clearly indicates the trade-off between hydropower generation and maintaining lake ecological character. There is a very narrow window of opportunity for achieving both the objective simultaneously under the current constrained situations. However, given the fact that Loktak is a Ramsar site, and the government is committed towards maintenance of ecological character of the wetland, scenario options which improve maintenance of ecological character are clearly preferred. Hence, of the options 1 and 2, a variant of 2 could be translated into a suitable barrage operation rule.

The present analysis still needs to address several sensitivities that could affect water availability within the basin. The important factor to consider is that of climate change. Since the General Circulation Models do not provide high resolution information for small regions, the impacts of climate change on the northeastern region of India are relatively unclear. However, several studies indicate a declining trend in summer monsoon rainfall and Manipur River Basin in particular. More recently, an analysis of the impacts of prescribed global warming on the lake regimes indicate that the current water management infrastructure might not be capable to handle projected rise in lake levels and the associated implications for land use in the lake periphery as well as lake biodiversity.

***Athaphum* fishing in Loktak Lake**

Fishing practices in Loktak have changed significantly

Next Steps

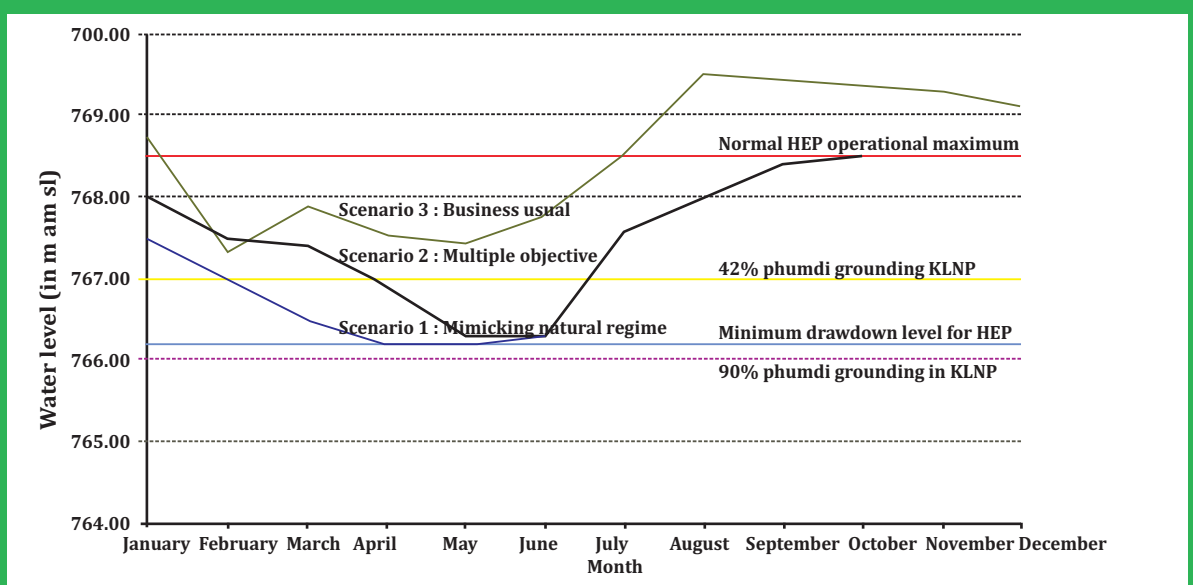
Reaching a decision

The current analysis suggests a mechanism for defining a barrage operation rule. The first and foremost step therefore is to agree to move to Scenario 2 led allocation mechanism, which would entail an understanding that the current levels of hydropower production cannot be retained. Based on the decision, collectively a barrage operation rule could be determined jointly by LDA and NHPC in consultation with all stakeholders. Critical to reaching to a decision on operating scenarios is agreeing on a representative lake level , or even multiple levels, which could be used to benchmark performance against various objectives.

Implementation

Demand and Supply side water management

It is amply clear that the current levels of water resources would be insufficient to meet all water management objectives, and that with each passing day, the scenario would get worse. Therefore, demand and supply management assume a critical role in determining availability of water. From the demand side, opportunities include enhancing efficiency of water use for hydropower generation, and managing phumdi to reduce water losses. The other major factor is controlling land use change in the margins of lake (for example controlling expansion of fish farms). Supply side options include enhancing connectivity between the wetland complex and optimizing water use upstream through better management of water storage structures.



Water level management scenarios for Loktak

Incentive systems to rationalize water allocation

It is high time that the incentive systems linked with water resources are rationalized. The first and foremost is to consider better accounting of waters of Loktak in hydropower pricing mechanism. Secondly, incentive systems should also be explored to ensure that revenue generation through sale of hydropower generated through Loktak contributes to resources required for lake management. Consideration should also be given to the fact that the pricing mechanism would also need to address downtime in hydropower production.

Monitoring ecological character

Since the water allocation plan is aimed at creating positive changes in ecological character, it is important to put in place a system for monitoring of ecological character – including components, processes and ecosystem services. This would require revitalization of monitoring infrastructure, creating adequate human resources, and developing decision support systems to inform changes in ecological character. Additional research is also required to inform lake management, key being the impacts of climate change. It is also pertinent to repeat hydrological assessments to understand the current baseline, for example, lake bathymetery, status of KLNP, water quality, fisheries and biodiversity.

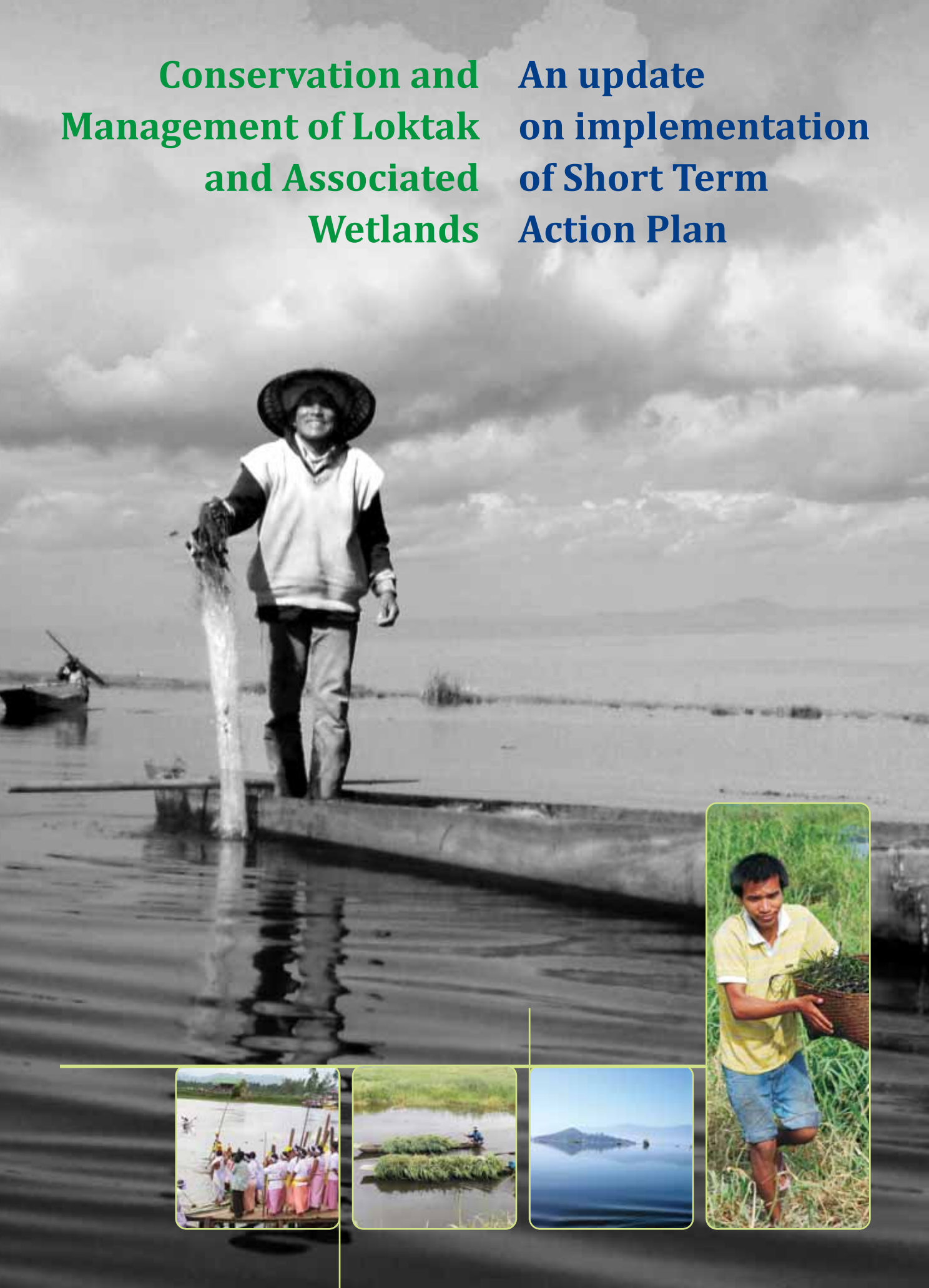
Review and adaptation

It is emphasised that the recommended scenario is the best of those assessed and not necessarily optimal. There remain many unknowns and uncertainties associated with the lake ecosystem and its responses to fresh water and sediment inflows. Equally, with changing upstream water use conditions there is likely to be scope for further refinement of the initial operating rule. Thus, a review of the barrage operation rules would be required based on monitoring information and further research findings.

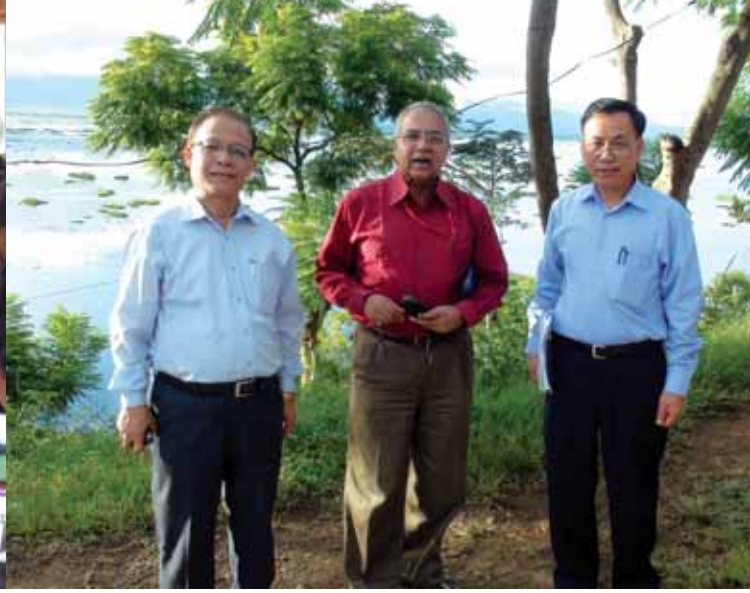
Floating *phum* huts in Loktak Lake

Conservation and Management of Loktak and Associated Wetlands

An update on implementation of Short Term Action Plan



Steering Committee meeting being chaired by Mr. D.S. Poonia, Chief Secretary, Manipur



Planning Commission team comprising Mr. Brohmo Choudhary (Left) Adviser (NE) and Mr. B.K. Chaturvedi (Centre), inspecting progress of implementation

The second year of the Short Term Action Plan (STAP) for conservation and management of Loktak Lake and associated wetlands is drawing to close. This section of the newsletter provides a brief account of achievements made under various components by the end of January 2011

Project Management

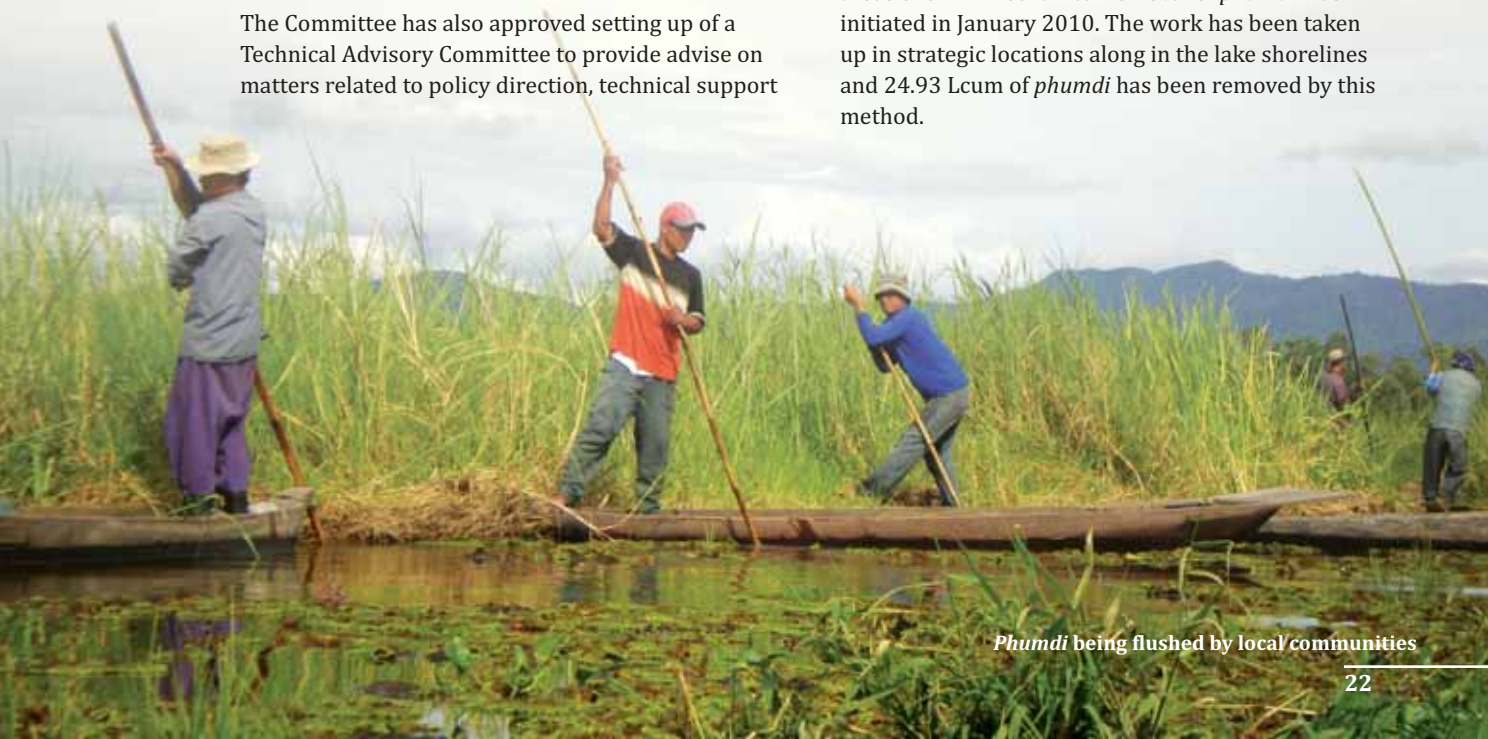
The Steering Committee of LDA provides the policy direction and maintains an overview of implementation of various STAP activities and coordination between line departments and agencies. The Committee chaired by the Chief Secretary, Government of Manipur, Mr. D.S. Poonia has introduced several measures for enhancing effectiveness of project implementation, key being streamlining of project fund flows, convergence of funds and schemes between line departments, establishment of a Project Management Unit within LDA, and implementation of the monitoring system recommended under the Monitoring and Evaluation Framework.

The Committee has also approved setting up of a Technical Advisory Committee to provide advise on matters related to policy direction, technical support for effective lake management and overseeing monitoring and evaluation of project implementation and lake ecology.

STAP is implemented by LDA in collaboration with Forest Department, Horticulture and Soil Conservation, Public Health Engineering and Fisheries Department. The Planning Department facilitates the fund flows, convergence and reporting activities for STAP. Based on recommendations of the LDA Steering Committee, a committee on convergence has been constituted under the Principal Secretary (Forests and Environment) focused on convergence between various schemes being implemented by line departments working under the project. An interdepartmental coordination committee on Nambul River has also been constituted.

Phumdi Management

Management of *phumdi* has been one of the focus areas of STAP. Mechanical removal of *phumdi* was initiated in January 2010. The work has been taken up in strategic locations along in the lake shorelines and 24.93 Lcum of *phumdi* has been removed by this method.



***Phumdi* being flushed by local communities**

Removed *Phumdi* transported by truck

Drainage channels to improve flow regime

A cost effective and eco-friendly method of managing *phumdi* is by manual flushing. Traditionally, communities managed *phumdi* by cutting them into small pieces and flushing through the Khordak and Ungamel channels down the Manipur River. LDA has successfully flushed 4.04 sq km of *phumdi* from Loktak in consultation with NHPC which regulates the gates of Ithai barrage. This has created employment opportunities for the local communities as well as contributed to lake improvement.

The removed *phumdi* are transported to identified disposal sites and composting yards at Ningthoukhong and Moirangkhunou. Steps have been initiated for seeking private sector and local farmer association led management of composting units. The Biotechnology Laboratory of LDA has been upgraded to support culture of microorganisms for composting purposes.

Water Management

Improvement of Drainage System

LDA has undertaken concerted efforts in improving the lake drainage through desiltation of areas impeding free flow of water. Around 2.8 Lcum of silt has been removed from 14 imflowing streams.

Desiltation of critical areas

Desiltation activities have been undertaken along the critical stretches near the out fall of the western streams. Currently 2.21 Lcum silt has been removed from the mouth areas. The dredged material is disposed in agricultural area for constructing embankment in low lying areas along the southern and western periphery.

Construction of regulator

Regulators have been constructed at 4 sites (Nausekpi Khong, Hiyangkhong, Naoremkhong and Keibul- Takmu Khong) to mitigate flooding and water logging in agricultural areas of the northern and southern zone of Loktak Lake.

Water Allocation Plan

The stakeholder endorsed Water Allocation Plan has been developed by Wetland International- South Asia. The initial assessments and evaluation of scenarios indicated trade-offs between hydropower generation and maintenance of lake ecological character. Base on the evaluation WI-SA has

recommended a barrage operation rule to the Steering Committee which will be jointly determined by LDA and NHPC in consultation with all stakeholders, and facilitated by WISA. Being a Ramsar site, maintenance of ecological character finds a significant place in water allocation plan. Monitoring of ecosystem components, processes and services will be conducted according to the Monitoring and Evaluation Framework developed by WI-SA, based on which the barrage operation rule will be reviewed by the Steering Committee.

Total Sanitation Campaign

The programme is being implemented in convergence with the flagship national programme under the Department of Drinking Water Supply of the Ministry of Rural Development. A total of 1234 community toilets have been constructed in identified locations through microplanning with the community groups. A similar number will also be completed by the end of March 2011 cumulating the total to 80% of the target intended. The Public Health Engineering Department is also organising awareness campaigns on safe sanitation through its Community Capacity Development Unit (CCDU).

Sanitation units constructed in Lakeshore areas

Catchment Conservation

The Forest Department has undertaken treatment of degraded forest through afforestation programme in 8564 ha and promoting agro-forestry in 3 priority watersheds (Loktak, Thoubal and Heirok). Regeneration of 9947 ha of degraded forest lands has also been carried under the STAP in collaboration with Forest Department. Small scale engineering works like counter trenching (in 50 ha), construction of Gabion check dams (in 300ha), bamboo spurs (1500 Rm), vegetative check dams (1500 Rm) and water harvesting structures (50 units) have also been taken up for control of soil erosion, landslides and arresting flow of silt from critical micro-watersheds.

An area of 150 ha under shifting cultivation has been converted to settled agriculture by the Soil Conservation Department and an equal area under homesteads have been improved by the Horticulture Department by promoting cultivation of species which would provide long term economic benefits to the communities. To reduce the pressure on forests, 1000 units of improved *chullas* have been installed in these 3 watersheds. Diversified livelihood options like

Afforestation activities in direct catchment of Loktak Lake

Check dam arresting flow of silt from watershed

weaving, bamboo and cane craft, integrated livestock, mushroom culture, apiculture, ginger dehydration and oleoresins, spices processing and preservation and processing of fruit and bamboo have also been initiated.

Biodiversity Conservation

The water bird migration studies have been initiated by Wildlife wing of Forest Department in collaboration with BNHS and local organisations. Assessments have been conducted for species distribution, composition, feeding and foraging habits in relation to the Lake environment. The bird census programme is under progress by laying transect lines, point counts at strategic locations and 'mist netting' methods. Capacity building programme on 'Monitoring of Water Birds and Wildlife Management' and 'Media sensitisation' have been organised for KLNP managers. Park management infrastructure has been enhanced through procurement of vehicles, motor bikes, dugout canoes, computers and WTI outfits.

Sustainable Resource Development and Livelihood Improvement

LDA in collaboration with Fishery Department has undertaken efforts to enhance the fisheries around Loktak Lake by upgrading and bringing into operation 12 non-functional hatcheries. The hatcheries are operated by Hatchery Management Committees formed by local community. The initial support in terms of seed money is provided through STAP subjected to a condition of stocking 50% of the fingerlings produced into Loktak Lake free of cost.

The Fishery Department has restocked the Lake with 27 lakh fingerlings to enhance the Lake fishery resources. Fingerlings of Indian Major Carps and Common Carps are mostly used for restocking. This is being undertaken through a convergence programme with the department.

Training on water birds monitoring

Monitoring & Evaluation team of Karunya University led by Prof. E. J. James in the field

Basket from bamboo an important livelihood option

Communication, Education, Participation and Awareness

LDA is making constant efforts for raising awareness of community by organising campaigns on ecosystem services of Loktak Lake. Events like Loktak Day (October 2010) and World Wetlands Day (February 2011) were celebrated involving school students, local youth clubs and community in catchment areas. Cultural shows and painting competition involving school children were organised and Ramsar masks distributed to the participants.

Monitoring and Evaluation

The Management Plan is monitored according to the Project Monitoring Framework developed by WI-SA following the Ramsar guidelines. The recommendation of Planning Commission for Third party Independent Monitoring has also been taken up involving Development Alternatives, New Delhi and Karunya University, Coimbatore who conducted the mid-term evaluation during November- December, 2010. Interdepartmental workshop were conducted in October 2010 in which the Management Action Plan was reviewed in relation to the 3-tier Monitoring and Evaluation Framework.

The Lake Monitoring Laboratory at Ningthoukhong monitors on a daily basis 17 water quality and 6 hydro-meteorological parameters. GIS based monitoring is also conducted by procuring NRSA imagery on land use and land cover, vegetation and *phumdi*. The establishment of Wetland Inventory, Assessment and Monitoring Systems (WIAMS) has been initiated with technical support of WI-SA.

Monitoring & Evaluation team of Development Alternatives with LDA staff

Celebrating World Wetlands Day

Building Livelihood Resilience in Changing Climate

Report of Asia Regional Conference, 3 – 5 March 2011, Kuala Lumpur, Malaysia

Asia, home to over 60% of human population presents a strikingly contrasting picture of economic growth and human development. The United Nations Millennium Development Goals report of 2010 highlights that the proportion of undernourished people in the region has swelled to levels last seen during the nineties. While already burdened with challenges of food and water security, Asia has also seen an unprecedented increase in the number of natural disasters which threaten to wipe out the development gains made so far. Their cumulative impact has been disproportionately higher on the poor and vulnerable sections of society. The vulnerability of the poor is further enhanced by the rapid degradation of environmental resources and biodiversity. Climate change and associated drivers and pressures are only likely to make the situation more unpredictable and vulnerable accentuating the burden on poor who often have little capacity to adapt and adjust in changing environments.

Increasing incidence of disasters and consequent stresses on livelihoods and efforts for poverty reduction has led to renewed interest in understanding and conceptualizing livelihood vulnerabilities and devising strategies and actions for creating resilient livelihoods. Several emerging paradigms from ecosystem management, livelihoods and disaster risk reduction sectors can be mapped in this direction. It is also evident that theories, approaches, policy frameworks and actions within these sectors differ on perceptions of livelihood resilience. Individually, none of these present a full-fledged pathway for achieving resilient livelihoods.

While an impressive body of knowledgebase, best practices and lessons learnt exist within individual sectors, there are still repeated calls for promoting and communicating an integrated livelihood resilience vision, approach, policy and practice.

In this backdrop, Wetlands International – South Asia in partnership with Cordaid and Ekgaon Technologies organized an Asia Regional Conference on 'Building Livelihood Resilience in Changing Climate' with an aim to provide an interdisciplinary platform to researchers, practitioners, and policy makers working within the domains of environmental management, development and disaster risk reduction for developing a shared vision of livelihood resilience in changing climate. Financial support for the conference was provided by International Development Research Center (IDRC), New Delhi, India and CDKN (Climate and Development Knowledge Network), United Kingdom. The conference was held from 3-5 March 2011 in Hotel AnCasa, Kuala Lumpur, Malaysia.

The conference was set up in the following sessions:

- **Exploring livelihood resilience** focused on approaches, frameworks and lessons from field implementation related to environmental management, development, disaster risk reduction
- **Pathways to livelihood resilience** focused on the role governance; information, communication and technology; markets and technical expertise play in building livelihood resilience

- **Livelihood resilience – the policy challenge** aimed at exploring the challenges and solutions in creating policy design for supporting livelihood resilience
- **Livelihood resilience – Institutional frameworks** aimed at analysing institutional arrangements with various domains and building a design framework in the context of livelihood resilience

Overall 54 participants from 14 Asian countries attended the conference. A live webcast was also organized. The three day conference included 7 keynote presentations, 23 case studies, 4 panel discussions and 6 sessions of group discussions. The case studies were selected from over 200 submissions.

Discussions on approaches and frameworks within ecosystem management, sustainable livelihoods and disaster risk reduction highlighted a distinct commonality of aims. However, there were differences in ways system boundaries as well as drivers for action were defined and identified. The case studies from India, Bagladesh, Vietnam, Indonesia and China indicated that local level adaptation to climate change was a continued process as it has imposed new dimensions to existing vulnerabilities due to poverty, sectoral planning, and degrading natural resources. However, their integration into policy making remained a challenge owing to scale and degree of replicability. Strengthening and empowering community institutions was identified as being fundamental to resilient livelihoods. Loktak Lake was one of the six case studies presented at the conference.

Inadequate interface between various governance mechanisms was identified as a major challenge that needs to be addressed in the context of livelihood resilience. The feedback mechanisms between the local scale (wherein management takes place) and national/provincial scales (which generally set the policy direction) are currently underdeveloped, creating information asymmetries at various levels, and thereby inefficiencies in policy making. The participants also felt that the role of corporate sector as a partner in livelihood resilience had not been recognized at its fullest extent. Additionally, it was stressed to include social and environmental benchmarks apart from the financial benchmarks within the performance standards of the corporate sector. Discussions on ICTs focused on information sharing as a two way process, and the need to innovatively use technology as a tool to empower communities.

The role of markets in creating resilient livelihoods was recognized, with a call for making these institutions more socially and environmentally responsible. There was also a call for creating adequate safeguards so that the poor and vulnerable sections of the society having proportionately high dependence on the ecosystem services realize equitable and just outcomes from markets.

The session on policy making for livelihood resilience focused on bridging the science –policy divide. Key recommendations that emerged included creation of enabling mechanisms for joint identification and prioritization of policy needs from research; communicating research in language and form understood by policy makers; and creating entrepreneurial capabilities in research agencies to integrate research into policy making domain.

In summary, the conference concluded that despite there being no universal agreement on the understanding of 'resilience', the challenges in lexicon need not limit convergence. The following attribution could help understanding livelihood resilience in changing climate in Asia:

a) Recognizing change as a fundamental property

b) Having adaptive capacity and transformability to new stability domains

c) Retaining ability to support livelihoods including equitable allocation and benefit sharing of livelihood resources

d) Recognizing urban rural continuum

e) Sustaining ecosystem services as the guiding principle

Development of an integrated framework for livelihood resilience that could address the objectives within the individual domains as well as enable cross sectoral communication was urged. While several successful models of creating resilience through ecosystem management, development and disaster risk reduction approaches existed, a pressing need to upscale these to influence the policy environment was identified which could be achieved through conducting research on scalability potential of the interventions on policy relevant parameters; cross sectoral linking and learning and creating knowledge networks which enable sharing of multiple knowledge systems.

Mission:

Restore and develop Loktak Lake resources and biodiversity for present and future generations through participatory processes, research and conservation activities.

To sustain and restore wetlands, their resources and biodiversity.

For further information

Ritesh Kumar
Conservation Programme Manager
Wetlands International-South Asia

A-25, (2nd Floor), Defence Colony
New Delhi - 110 024, India
Telefax: 011 - 24338906
URL: http://south-asia.wetlands.org

Th. Ibobi Singh
Project Director
Loktak Development Authority

Susu Home (Opposite 1st M R Ground)
Babupara, Imphal West - 795001
Manipur, India
Telefax: 0385 - 2448563
URL: www.loktaklake.org