

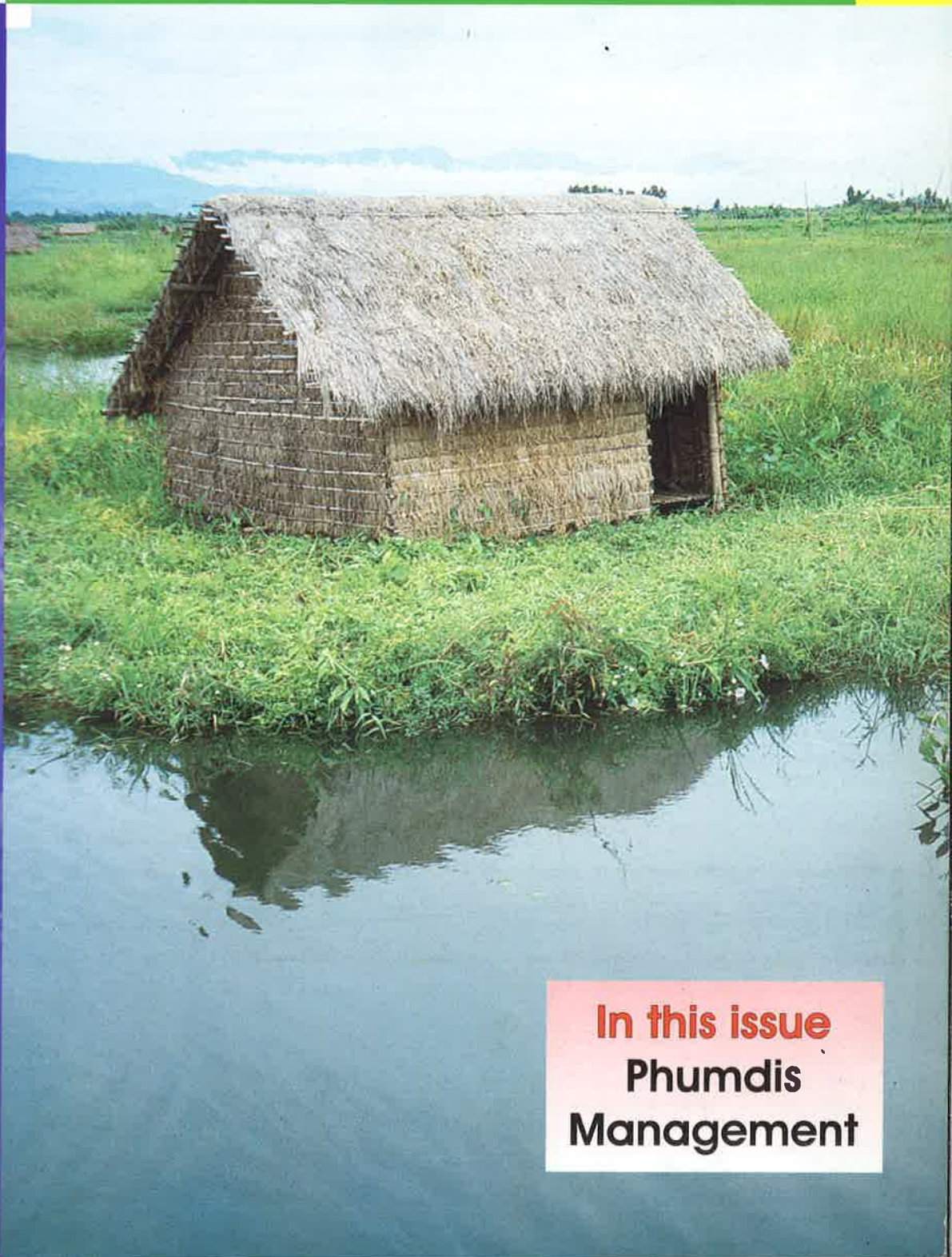


WETLANDS
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JANUARY 2002 - VOL. 2

NEWSLETTER

Loktak



In this issue
Phumdis
Management



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

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For further information please contact the appropriate office:
Loktak Development Authority
Leiren Mansion, Lamphelpat, Imphal - 795004, Manipur.
Fax: +91-0385-312772 E-mail: lda@wisalda.rpg.nic.in

Wetlands International - South Asia
A-127, Defence Colony, New Delhi-110024, India.

Fax: +91-11-469 1557, 462 9906

E-mail: wisaind@del2.vsnl.net.in

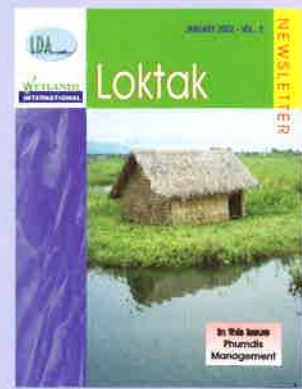
Wetlands International - Asia Pacific

3A39, Block A, Kelana Centre Point, Jalan SS7/19, 47301, Petaling Jaya, Selangor, Malaysia

Fax: +60-3-704 6770

E-mail: wiap@wiap.nasionet.net

URL: <http://www.wetlands.org>



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Editorial Panel

Chief Editors :

Wetlands International - South Asia : Dr. C.L.Trisal

Loktak Development Authority : Th. Manihar

Editor :

Wetlands International - South Asia : Ritesh Kumar

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Phum Hut in Loktak Lake, Manipur.

For subscription information please contact :

Wetlands International - South Asia

A-127, Defence Colony, New Delhi-110024 India

Fax : +91-11-4691557, 4629906 E-mail :

wisaind@del2.vsnl.net.in

or

Loktak Development Authority Leiren Mansion,

Lamphelpat, Imphal - 795004, Manipur.

Fax : +91-0385-312772 E-mail : lda@wisalda.rpg.nic.in

For advertising information and rates please contact
Dr. C.L. Trisal Tel : +91-11-4691294,
Th. Manihar Tel : +91-0385-311030

Management of Phumdis in the Loktak Lake

Loktak Lake, the largest freshwater wetland in northeastern region of India, plays an important role in the ecological and economic security of the region. A large population living in and around the lake depends upon the lake resources for its sustenance. People of Manipur are culturally, socially and economically linked with the Loktak and hence the lake has been referred to as a lifeline of Manipur.



Phumdis in Loktak Lake

The characteristic features of the lake is the presence of floating islands covered with vegetation, locally known as phumdis. These floating islands, occurring in all sizes and thicknesses, are heterogeneous mass of soil, vegetation and organic matter at various stages of decomposition. They float on lake water with about one-fifth of thickness above and four - fifth under the water surface. The core of phumdis is composed of detritus which is black in colour and highly spongy.

The phumdis play an important role in the ecological processes and functions of the lake. They provide a biological sink to the key nutrients and govern the water quality and nutrient dynamics of the lake. They harbour several plant species and support a rich biological diversity. Several plant species of economic and ecological importance take part in the formation of phumdis. Keibul Lamjao National Park (KLNP) is the largest contiguous mass of phumdis providing natural habitat for the highly endangered ungulate species, *Cervus eldi eldi*, locally called Sangai deer.

There has been great concern during the last few decades about the proliferation of phumdis in the main lake and reduction in the thickness of phumdis in the KLNP. A lot of controversy has been generated by different stakeholders in the absence of reliable data. This has created more confusion and no sound solution seems to be available to manage the phumdis. The

University of Manipur has undertaken several studies on the lake including the ecological aspects of phumdis. Several other State Government Departments have tried to utilize phumdis for different purposes. Loktak Development Authority (LDA) and Wetlands International - South Asia (WISA) under the project on Sustainable Development and Development and Water Resources Management of Loktak Lake (SDWRML) have collected lot of information on phumdis of Loktak. Realizing its prolific growth and its several impacts on the lake ecosystem a workshop has been organized inviting all concerned stakeholders, scientists, policy planners, NGOs and community groups to deliberate on the issues relating to the phumdis management. The major areas of concern are briefly discussed in the paper.

Ecological relationships of phumdis in the Loktak Lake

Phumdis play an important role in the processes and functions of the Loktak Lake. Manipur University has carried out studies on the phytosociology, primary productivity and nutrient dynamics of the macrophytes of the lake including those of phumdis. The information on distribution, production and role of macrophytes has been collected under the project SDWRML, which indicates that the macrophytes play an important role in the nutrient dynamics of the ecosystem. More than 50% of the mineral nutrients present in the wetland system are locked within the macrophytic tissues, thus helping to reduce nutrient the concentration within water, thereby suppressing the algal growth. Accumulation of large quantity of nutrients within plants acts as a filter for nutrients and other pollutants. This helps in the purification of water.

Data has also been collected under SDWRML on various limnological aspects including physical and chemical features of water from different locations within the lake. The analysis indicates that the lake water in general is slightly acidic to alkaline, with pH values ranging from 6.1 to 9.6. High amounts of CO₂ were in general observed from the lake. Low concentrations of oxygen were found in some pockets where flushing is very poor. Nutrient concentrations of N, P and K was in general moderate to high in different pockets of the lake.

The results of the microbial analysis indicates high microbial loading in the lake water. The highest bacterial content from plate count was recorded for KLNP (870 000 / ml). Highest faecal coliform was noted from Loktak proper (170 / ml) during April. This high microbial content may be attributed to the direct discharge of human and other animal wastes, seepage of excreta from the islands and surrounding areas and from other indirect sources.

Large amounts of nutrients are discharged into the rivers , finally flowing into the Loktak Lake. Nambul, Maoirang, Merakhong, Thongjaorok rivers contribute to large amounts of nutrients and have highly polluted stretches in between. The stretch of Imphal receives high loading of nutrients. Phumdis play an important role in absorbing most of the nutrients by accumulating them in their tissues. The role of phumdis has to be thoroughly studied to use them effectively for pollution abatement.

Specific studies have been initiated under SDWRML project to understand the factors governing the proliferation of phumdis and their role in the ecosystem. A large number of invertebrate faunal species are associated with phumdis, which serve as a natural food for the fish. Although some information is available with the Manipur University on some faunal groups, the overall information is grossly inadequate.

The major issues of concern regarding the role of phumdis in the ecosystem processes and functions are:

- Assessment of phumdis in qualitative and quantitative terms such as the total extent, proliferation and their role in nutrient cycling particularly, carbon, phosphorous and nitrogen
- Significance of phumdis in relation to genetic diversity
- Relationship of phumdis with invertebrate fauna and microflora
- Impacts of removal of phumdis on the water quality

Lake hydrology and phumdis

The hydrologic and hydraulic characteristics of a wetland would play a major role in the dynamics of growth, spread, and movement of the flora and fauna within the system. Loktak also is not an exception to this rule.

Therefore, an attempt has been made to study the hydrologic and hydraulic status of this wetland before and after the construction of the major hydraulic intervention, namely the Ithai barrage, so that the changes to the growth and spread of phumdis in the pre and post Ithai barrage periods can be understood.

The main changes to the water regime in this wetland are those pertaining to the hydroperiod, water spread area, residence and turnover time, wave hydro-dynamics,



Ithai Barrage

circulation and mixing, and overall water balance, due to the construction of the barrage for the purpose of hydro-power generation and irrigation. All these changes are likely to have an impact on the present trend of growth and spread of phumdis in the wetland. The rate of flow of energy in the wetland has considerably reduced, contributing to stagnation and deposition of chemicals and nutrients, and proliferation of biological growth within the system, which to some degree used to get flushed out downstream before the construction of the Ithai barrage.

The phumdis and the associated flora are capable of exerting a biotic control on the hydrological regime, though this may not be very well pronounced. The role of phumdis in controlling evaporation and enhancing transpiration and in certain seasons, shrinking the growth to reduce the transpiration etc are examples of biotic control of hydrology. These aspects also deserve investigation since the water balance, circulation and mixing and the dynamics of sediment movement will be affected by the proliferation of phumdis in the wetland. The wave action of the wetland will be affected by the phumdis, and therefore, the dynamics of mixing and circulation also.

Before the construction of the Ithai barrage, the area covered by present Loktak lake had several pats or comparatively small water

bodies, separated by alluvial land mass. During the monsoon season, these pats were flooded and often got interconnected with each other. After the retreat of monsoon, the water level would go down due to downstream discharge, percolation, evaporation and even transpiration from the hydrophytes, thus separating the pats. With the construction of Ithai barrage, the entire scenario changed. The water level in the entire area, now designated as the Loktak Lake, was raised to 767.5 msl., and the seasonal water level fluctuations have not been considerable, since it mainly depended on the rate of hydro-power generation, apart from other natural losses and operation of the barrage. Not only the hydroperiod got changed due to the barrage but also the water spread area, which in turn has changed the water holding capacity of the wetland. Because of the changes brought about to the hydrological regime by the barrage, the turnover time has reduced or in other words, the residence time has considerably increased, thereby affecting the circulation and mixing phenomena existing before the construction of the barrage. The reduction in the rate of energy flow has resulted in the stagnation and deposition of materials in the wetland. This tendency is supposed to over-exploit the capacity of the wetland to serve as a sink and transformer. The change in the mixing and circulation pattern has a direct impact on the water quality regime of the wetland, which in turn affects the dynamics of growth and spread of phumdis. The change to the turnover time has brought about more deposition of sediment at the bed of the wetland and this phenomenon will also influence the biological regime of the wetlands.

Even before the construction of the Ithai barrage, the area represented by KLNP was partially separated from the rest of the area by the range of hills on the northern part and the high contour line traversing all around the Park. In the pre - barrage period the Manipur River directly or the Khordak and Ungamen channel indirectly flushed out this area, enabling more flow of energy and high turnover rate. In addition to the natural insulation of this area, the Ithai barrage has brought about an artificial stagnation in the area of the Park, leading to considerable changes to the circulation and mixing pattern.

Based on the studies carried out by WISA

and LDA, the following aspects, directly or indirectly related to the growth and spread of phumdis, have been noticed:

- The chemical regime in certain pockets of KLNP shows shift in trends, such as lowering of pH to the order of 3.8 in the core zone area, substantial increase in CO₂ and drastic reduction in oxygen concentration levels
- High counts of E-coli and increased rate of faecal contamination in KLNP
- Increase in the level of nutrients in all parts of the wetland
- Choking of the river mouths by the phumdis, thereby creating flooding in the northern part.
- Adversely affecting the circulation pattern of KLNP due to the choking of Ungamen and Khordak channel by the phumdis
- High level of deposition of sediment and loss of water holding capacity in the wetland

The issues to be addressed are:

- Whether the drastic changes in the chemical and nutrient regimes have an affect on the dynamics of growth and spread of phumdis
- Whether the changes in the hydroperiod, water spread, residence time and overall water balance of the wetland have an impact on the chemical and nutrient regimes of the wetland
- Whether the changes in the circulation and mixing pattern has a direct impact on the growth, distribution and movement of the phumdis.
- Whether the reduction in the flushing action has enhanced the concentration of pollutants with subsequent impacts on the phumdis
- Whether the stagnation of the wetland has contributed to the choking of the rivers and drainage channels, leading to flooding
- Whether the phumdis are responsible for reduction in the water holding capacity, and obstruction to circulation and mixing and subsequent high rate of deposition
- Whether the Ithai barrage has contributed to high rate of sediment deposition by creating a completely static condition in the wetland
- WHETHER the mixing and circulation pattern of the wetland be enhanced with

a view to avoid most of the adverse conditions faced by the wetland in general, and KLNP in particular.

Biodiversity of phumdis

Several plant species are constituents of phumdis. Recent studies carried out under SDWRML project indicate occurrence of 162 species which include some terrestrial elements as well. However, a thorough survey carried out by the project team of SDWRML in KLNP indicates occurrence of 135 plant species comprising both aquatic and semi-aquatic plants. Eight dominant



Plant Diversity

plant species viz *Zizania latifolia*, *Phragmites karka*, *Echinochloa stegnina*, *Saccharum munja*, *Cyperus sp.*, *Salvania*, *Brachiaria mutica* and *Capilidium sp.* have been recorded from the park. Overall, 22 economically important plant species used by the local inhabitants as food, fodder and medicinal purposes have been identified from KLNP compared to 33 economically important plant species recorded from the lake area.

Changes in hydrological regimes mainly after construction of the Ithai barrage is attributed as the causative factor for degradation of phumdis in KLNP. A comprehensive study carried out involving several organizations and NGOs indicated drastic changes in the physical and chemical composition of water. The most conspicuous feature was in reduction of pH values in the core zone of KLNP supporting major population of Sangai deer. The shift in pH to as low as 4.1 recorded in the some pockets is attributed to changes in circulation and flushing pattern of lake water. The obstruction of water at Ithai promotes increase in humic acid, CO₂ in the lake water which results in reduction of pH values. The changes in pH values affect the uptake of mineral nutrients necessary for the growth of phumdis. It is a paradoxical

situation in which though nutrients are available, they cannot be utilized under the changed pH conditions. This is considered one of the significant outcomes of the project which gives a very strong indication that to restore Loktak Lake, particularly KLNP it is essential to enhance the water circulation in the lake through hydrological interventions. This requires consultation of all concerned stakeholder agencies including NHPC who are operating the barrage. The following issues need to be examined for the restoration of lake ecosystem.

- Nature and extent of invasive species and their control measures
- Impacts of hydrological interventions through construction of barrages and other hydraulic structures on floral and faunal diversity of phumdis
- Impact of changes in biodiversity on feeding habits of wildlife.
- Optimize hydrological conditions for protection of fish breeding grounds in KLNP
- Maintaining water level for the growth of plant species preferred by Sangai deer

Phumdis and fisheries development

The proliferation of phumdis in Loktak Lake after the construction of Ithai barrage has seriously effected the changes in diversity and overall fish productivity of the lake. While the migratory species have been seriously affected by construction of the dam, the decline in fish yield is attributed to several factors.



Fishing in Phumdis

One of the causes for the proliferation of phumdis is the considerable increase in the practice of athaphum fishing. Athaphum fishing is a traditional method of fishing, wherein circular enclosures are made in the lake using pieces of thick phum, with a circumference of 200 - 250 m. Estimated fish yield from an athaphum varies between 100 - 180 kg per harvest, and is harvested twice a year during October - February. Phum fishing has become attractive because of high returns, which are almost



Athaphum circles

double as compared to other methods of harvesting. Annual production from athaphums has been reported 590 Mt, contributing approximately 39% of the total annual fish yield. The number of athaphums in the lake has increased considerably after the construction of the Ithai barrage. As per the remote sensing imageries, the number of athaphums increased from 217 in 1990 to 3019 in February 1999.

The increase in phum fishing may be attributed to the inundation of agricultural fields after the construction of Ithai barrage leading to changes in profession. The other factors responsible for increase in athaphums are increasing population, rising unemployment and overall decrease in fish yield from the lake. The number of phum huts have increased significantly after the construction of Ithai barrage, i.e. from 28 in 1985 to 733 phum huts have been recorded in 2001. The issues for consideration regarding the impacts of phumdis proliferation and fishing are:

- Reduction in open water area
- Deterioration of water quality due to the use of pesticides, insecticides, high energy feeds etc.
- Deposition of stones at the lake bottom
- Abandoning used athaphums which further proliferate

Phumdis and communities

The permanent settlement of the people on the phumdis is a recent phenomenon. The settlements in the past were largely temporary, and people used to come here only in winters for fishing purposes. But, large scale inundation of agricultural fields led to an occupational shift primarily towards fishing. In a recent census conducted amongst the phum dwellers in 2001; a total of 733 phum huts were recorded with a population of 1977 fisherfolks. Three broad population groups can be identified amongst the phum dwellers. Permanent dwellers, which form around 84 % of the total is a

group which does not have a house in the mainland; temporary dwellers, which have a house in the mainland and keep their families there form 8% of the total, and rest of the population comprises of migrant fishermen, who come to the phums only during the fishing seasons.

Phums form a base of sustenance for these communities. Besides providing a base for shelter, the phums are a source of vegetables, food and fodder. Many plants found on the phums have medicinal properties and are used by the local communities as local remedies. Phumdis are utilized for raising low lying areas, as manure, as bunding material for construction of fish pond and as based for floating agricultural field, primarily for cultivation of paddy and winter crops as peas and vegetables. Several plants from the phums are harvested for making handicrafts. Fuelwood, fodder and vegetables sourced from the phumdis form the main source of income of women in most of the lakeshore and island villages.

Traditionally, phumdis were managed by common community effort. Every year, a common schedule was worked out wherein all the communities were involved in deepening of the channels, and cutting and sending the phumdis down through the Khordak channel. Southerly winds aided the flow towards the Khordak channel. The channels were desilted annually. In the lean seasons when the phumdis went dry, they were burnt.



Vegitable collection from Phumdis

But, with the upcoming of the Ithai barrage, the natural process of cutting and sending down the channel was interrupted. Proliferation of phumdis has affected the communities in several ways. Movement within the lakes has been restricted as the boatways are choked. The decaying phumdis lead to lot of foul smell in water and make the water unhygienic. There has been an overall decline in fisheries.

Increasing monetary returns from athaphum fishing has brought several people from mainland into this occupation, leading to more competition within fishermen, exploitation of fisheries resources and decrease in fish catch.

The prolific growth of phumdis in the Loktak Lake has reached an alarming situation, and there has been a great concern by the communities. The enormous growth is impacting the lake ecosystem processes and functions and recent investigations of the project indicated that if unabated growth of phumdis continues, it may affect the whole lake, as already some negative effects of phumdis have been found in the KLNP area. Realizing this, SDWRML project carried out an extensive consultation process through organizing community meetings at nine locations which broadly represent the different sectors of the lake.

The following issues emerged during these meetings regarding the causes of phum proliferation, impacts and suggested control measures :

- Causes:
 - Stagnation of water due to construction of Ithai barrage
 - Pollution from the towns and villages
 - Athaphum farming
- Impacts of phumdis:
 - Restriction of movement inside the lake
 - Waterlogging in peripheral areas
 - Health hazard due to deterioration in water quality
 - Decline in fisheries
 - Decline in availability of vegetables
- Control Measures:
 - Periodic opening of the Ithai Barrage
 - Deepening of the channels associated with the Loktak, like Khordak, Ungamen, Bragenkhom. etc.
 - Restriction of athaphums fishing
 - Cutting and piling to form bundhs
 - Release of grass carps

The community in most of the meetings proposed joint effort of LDA and the community to remove phumdis. It was also suggested that strategies should be developed for long term management of the phumdis in consultation with communities.

Economic utilization of phumdis

A study to determine utilization of phumdis as a carrier of bio fertilizer agents, as a

potting material for floriculture and to determine the best method for degrading phumdis for use as an organic source was undertaken involving College of Agriculture, Central Agriculture University, Imphal. The study brought out the following facts:

- Phumdis have a great value as bio fertilizers owing to its degradability. Phumdi along with rice bran ash could be used as a carrier for bio-fertilizer agents
- The fastest decomposition of phumdis took place when it was treated with cellulolytic bacteria.

Further experiments are being carried to investigate the effectiveness of phumdi as compost in field conditions and its use in floriculture. Further investigations are required to assess the use of phumdis for various value-added products such as cellulose, pulp etc. Agro based industries are being approached to assess the potential of phumdis using biotechnological methods for various products which could provide economic benefits to the local community and are also cost effective.

The workshop being organized by LDA-WISA-ICEF will discuss on all above issues to formulate a strategy for the management of phumdis. The main purpose of the present paper is to highlight issues for the consideration of various stakeholder groups concerned with management of phumdis. The present paper has been prepared based on the hard work and dedication of a strongly committed SDWRML Project Team.

On behalf of the project team, we would like to place on record our appreciation to Late Dr. S. Maudgal, who took great interest and helped in several ways in planning and implementation of the project. We are greatly thankful to Dr. E. J. James, CWRDM, who worked as a part of the whole team and helped us through his invaluable suggestions and in-depth knowledge of hydrology. We are also particularly thankful to the local communities who have invaluable knowledge of the Loktak lake.

C.L.Trisal
Wetlands International - South Asia
and

Th. Manihar
Loktak Development Authority

Reflections on Compiling A Global Bibliography of Floating Islands

To those not acquainted with them, the idea of a floating island usually seems at first like a paradox, a myth, or an impossibility: surely chunks of the solid and massy earth on which we stand cannot drift easily about the surface of a body of water. Yet floating islands exist on at least six of the seven continents, and sometimes in the oceans that separate them; they may have trees growing upon them, be hundreds of meters across, and support the weight of 100 cattle grazing on them. In some cases they have inspired religious veneration, and in other cases the pens of paradoxographers (writers on

they are in Loktak Lake, and also in China, in Lake Chad, and in Niger; crops are or were also grown on floating islands in Dal Lake; Lake Inle, Myanmar; in the Krian district of Perak, Malaya; in various lakes in China; and perhaps to some minor extent near Mexico City. There are many cases of animals pasturing on floating islands, and in several locations people live or once lived on floating islands, including many lakes in China, Lake Titicaca on the border between Peru and Bolivia, the marshes of the Euphrates River in Iraq, Lake Kisale in Zaire, and Lake Kyoga in Uganda. Artificial floating islands have

Problems with floating islands are common in new reservoirs, where aquatic weeds may grow quickly to form huge and ungainly floating bulks, and in addition, masses of peat submerged at the bottom of the reservoir may rise to the surface of the water to become floating islands. Floating islands can cause health problems by providing breeding grounds for malarial mosquitoes, as in Lake Victoria in Africa, and Gatun Lake, Panama; they may interfere with the operation of ports, as happens in Kisumu, Kenya, on Lake Victoria, and also in Montevideo, Uruguay; and indeed they may threaten



"Detail of a Woodcut Illustration of the Floating Islands in the Congo River by A. Goering, 1883 (from the author's collection)"

marvels) and poets; to minds of a contemplative inclination, floating islands, which are pushed here and there by the winds, might seem metaphors for our own lives governed by the fates; or else these mobile biomes, these wandering and fragile little worlds, may be considered as analogues for our own planet in its motion through the solar system and galaxy.

It was this inherent wondrousness of floating islands that first attracted me to the subject, but of course floating islands are not merely objects of poetic musing or philosophical contemplation; they are also often of practical importance. They may be used as fishing platforms, as

been created not only for fishing and for human habitation, but also to improve water quality, to provide habitat for fish, and as nesting platforms for birds.

Floating islands also cause problems. Residents who live around a lake called Island Pond in Springfield, Massachusetts, USA, complain when the lake's floating island comes to rest in front of their property, blocking their view of and access to the water, and twice now the city has had the island towed back to one end of the lake. Residents of the state of Minnesota who live near lakes have so many problems with floating islands that the state's Department of Natural Resources issues special permits for their removal.

the entire ecosystem of a lake, and the economy of the surrounding area. On Loktak Lake in Manipur and on some lakes in Florida in the US, including Orange Lake, Lake Kissimmee, and Lake Istakpoga, floating islands have changed the whole character of the lakes, and adversely impacted those whose livelihoods depend on the lakes.

Floating islands have long been of scientific interest. The causes of their buoyancy, the means by which they form, their flora and fauna, their movements, their role in the dispersal of animals from one point to another, their effects on the water in which they float, methods for controlling or managing them-- these subjects and

others have been considered and studied for decades. There is no shortage of writings on floating islands, but many of these writings are rare or difficult to locate or access, and certainly there has never been a thorough examination of global floating island literature. As a result, the typological and geographical diversity of floating islands has not been fully appreciated, and comparative material that might have been valuable to several studies of floating islands has remained unknown. It was these factors that led me to undertake the compilation of a global bibliography on floating islands. It is my hope that when my bibliography is complete, it will increase interest in, as well as appreciation and understanding of floating islands generally, and that it will help researchers studying floating islands in one part of the world make use of studies that have already been done elsewhere.

The aim of my bibliography is to address all types and aspects of floating islands: real and mythical, natural and artificial, past and present; their history, geography, botany, ecology, and physics;

their uses and the problems they cause; and everything from the means by which they form, to the methods used to manage or destroy them.

One of the benefits of assembling all of the works that have been written about floating islands is that it becomes possible to trace the development of scientific thought about them, from the Greeks and Romans, who for the most part recorded the existence of floating islands merely as marvels, but also speculated about the causes of their floating; to the beginnings of serious inquiry into the nature, formation, and buoyancy of floating islands by Athanasius Kircher in his *Mundus Subterraneus* (Amsterdam, 1665), and a short dissertation about floating islands by Georg Christoph Munz titled "Exercitatio academica de insulis natantibus," (Aldorf, Germany, 1711); to the emergence of a strong interest in the botany of floating islands-- Linnaeus has a note on some plants that form floating islands in an article he published in *Analecta Transalpina* in 1741, which also appeared in Swedish in the *Kongl. Svenska Wetenskaps Academiens*

handlingar Stockholm in the same year. Since Charles Darwin published his writings about evolution, many authors have argued that floating islands played a role in that process by rafting plants and animals from one part of the world to another. At the same time, advances in chemistry led to a better understanding of the buoyancy of floating islands, particularly with regard to the importance of decompositional gases. While these same subject areas are of course still of interest to scientists today, in addition, floating islands have more recently been studied in the context of their role in the ecology of the lakes or rivers where they are found, and also issues of ecological policy and management have become more and more important.

I certainly hope that my bibliography, when it is complete, will both interest and benefit those who manage, study, and live near Loktak Lake, and whose lives influence and are influenced by its floating islands. I would be grateful to learn of any historical descriptions of the floating islands in Loktak Lake or elsewhere in India.

Phumdis in Loktak Lake



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- Mr. Van Duzer is preparing a global bibliography on floating islands, and would be interested and grateful to learn of other works on this subject.

CHET VAN DUZER

12177 Winton Way

Los Altos Hills, CA 94024-6431

USA

email chetv@aol.com

HIGHLIGHTS OF PROJECT IMPLEMENTATION

CATCHMENT AREA TREATMENT

The delineation of catchment of Loktak has been done through remote sensing, GIS and ground truthing studies. As per the studies, the total project area extends to 1046.30 sq. km. The western catchment, comprising of 3 sub watersheds and 45 micro watersheds extends to an area of 293 sq km. The land use / cover study, based on the remote sensing data of 1999, reveals that 23 % of the total area under various categories of forests, (1.8 % under dense, 8.79% under moderate and

The data generated is extremely useful in planning and management of erosion prone areas.

Of these 45 micro watersheds, 16 micro watersheds were selected on a priority basis for undertaking catchment treatment based on the land cover, nature of streams and status of runoff and erosion. The details of the prioritized micro watersheds are:

The following activities have been undertaken under catchment area treatment during the project period:

Name of the Sub-watershed	No. of micro-watersheds	Area (sq. km)	No. of prioritized micro-watersheds (sq.km.)	Area of prioritized micro-watersheds (sq.km.)	Land Use (As % of total micro-watershed area)		
					Forest Cover	Fallow Land	Settlement
Ningthoukhong	20	111.64	7	71.43	9.03	76.00	3.67
Nambol	15	98.95	7	69.94	6.76	71.28	1.87
Nambul	10	82.41	2	25.79	0.31	98.14	1.55
	45	293.00	16	167.16			

12.88% under degraded), 13.96 % under settlements, and 24.63 % under open water and waterlogged category. 10.83% (114 sq. km) of the total area is covered under phumdis.

A study on land capability of Catchment Area of Loktak Lake has been undertaken in collaboration with National Bureau of Soil Survey & Land Use Planning (NBSSLUP), Regional Center, Jorhat and Kolkata. Based on soil characteristics, land features and vegetation cover land capability classification has been developed for catchment area treatment purposes.

Catchment Area Treatment



- Treatment of degraded forests through aided regeneration in 600 Ha of 10 villages located in 8 micro-watersheds.
- Treatment of fallow land through afforestation in 5950 Ha. Preparatory operations were carried out in 3200 Ha of 21 villages located in 12 micro-watersheds. Final operations were carried out in 2750 Ha spread in 21 villages located in 10 micro-watersheds
- Activities for maintenance of one-year-old plantations in 1150 Ha. and activities for maintenance of two year old plantations were undertaken in 450 Ha
- Horticulture (Banana and Pineapple) plantations in 310 Ha. The plantations have been undertaken in 32 hill villages with the main objective of providing people with a source of income alternate to forestry-based occupations and jhum cultivation. The beneficiaries of the project are identified jointly by the village

authority, youth clubs and women organizations. Till date, 673 households of 32 villages have been benefited by the project.

- Treatment of active jhum areas by plantation of alnus spp / leguminous plants in 130 Ha of 8 micro-watersheds
- Engineering measures like contour trenching in an area of 80 Ha in 12 micro-watersheds, Construction of 2632 vegetative check dams, 3750 boulder sausages and 400 bamboo spurs

WATER MANAGEMENT

Data on various hydrological and meteorological parameters is being collected from a network of 12 stream gauging stations, 4 meteorological yards, 8 rain gauging stations and 4 lake level stations. Thirty stations have been established within lake area and tributaries entering the lake for water quality monitoring. A preliminary assessment of the data indicates the following:

- The region receives an average annual rainfall of 1392 mm with 150 rainy days on an average. The temperatures vary from 11 - 25 oC, pan - evaporation ranges from 19-130 mm, relative humidity from 51 - 81%, and average wind speed from 2-5 km/hr
- The total annual inflow from various streams is 1517 Mcum. Of the total inflow from various sources, Loktak receives 27% from precipitation, 21 % from Manipur river system through the Khordak and Ungamel channels and rest (52%) from the streams from the Western catchment. A high percentage of dependable flow is received during the monsoon period only.
- Monthly water balance indicates a surplus from May - November and a deficit in the remaining 5 months.
- There is an annual sediment inflow of 657,437 Tonnes into the lake, with an annual outflow of 62,272 Tonnes,

indicating that 90.52% of the total sediment inflow is trapped in the lake.

- Two phases of hydrographic surveys have been undertaken for the preparation of the contour map of the Loktak Lake. The first phase (HYDREC - 2000) covered the KLNP area, while the second part covered the main lake. The preparation of contour maps is being done using GIS software.

IDENTIFICATION OF FLOOD PRONE AREA:

Flooding has been one of the major problems of the people living in the peripheral area of Loktak. Though losses of lives are not common but it causes serious damages to crops, livestock and properties. The construction of Ithai barrage to maintain the lake water level suitable for hydropower generation has seriously aggravated the flooding problems in several regions. A preliminary survey was carried out by the SDWRML team for identification of areas exposed to frequent flooding.

Areas lying between contour lines of 768.5m and 769 m have been identified as subject to frequent flooding as a result of induced operations, siltation, catchment area degradation, encroachments and other related factors. 31 villages were lying upstream of Ithai barrage and 6 villages downstream have been identified as lying in the flood prone zone.

indicates the following:

- The pH value of the Loktak lake indicates its slightly acidic to alkaline water. The range of variation recorded is 6.0-7.5. However, a low range alkalinity value was recorded during the present study. High amount of free CO₂ was observed from the lake water.
- The dissolved oxygen content varies greatly at different stations and

different months. Lowest average value was recorded on September 4.75 mg/l. station wise lowest value was recorded from Keibul in the month of September (2.2mg/l), where as highest value was recorded from Hibidak (9.2mg/l) in April. BOD values fluctuated between 3.9 mg/l to 8.5mg/l. Total hardness value fluctuated from 39.13 to 51.0 ppm, which indicates its soft to moderately hard water.

- Sodium, Potassium, Calcium, Magnesium concentration were very low in all stations When compared with IS: 2296(1982).
- Nutrients content of the Loktak lake indicates a very balanced system. Inorganic phosphate content varied between 0.09-0.18 mg/l and highest value recorded during May-June. Organic phosphate values showed fluctuation within the range between the range 0.82-1.81mg/l). Nitrate concentration was also very moderate ranging between 0.05-1.98 mg/l. These low nutrients are attributed to luxuriant uptake by the phumdis, aquatic weeds and plankton.
- The results of the microbial analysis in the present investigation clearly indicate high microbial loading in lake water. The highest bacteria content from total plate count was recorded from Keibul Lamjao National Park (220000/100ml). Highest faecal coliform was noted from Sendra/ Takmu area (2500/100ml) during the month of September. This high microbial content of water may be connected with several causes like, the disposal of human and other animal wastes, seepage of excrement matters from the islands and surrounding areas, inflow of sewage etc.

SUSTAINABLE FISHERIES DEVELOPMENT

Fish diversity

- A total of 53 fish species representing 17 families have been recorded from Loktak of which 27 species have common and 20 have rare occurrence. Six species are found to

be vulnerable. *Clarius gueripinnus* is a new record from the Loktak lake. Twelve species, which were recorded earlier were not found during this present study.

- Intensive survey at KLNP was conducted during May-August 2000 for identification of fish breeding grounds. Breeding grounds of Murrels and common carp were observed in certain area of the National Park. A survey was carried out in the main lake along Toubul-Mayang Imphal Road which has been constructed across the lake. Only 5 scattered breeding areas of Murrels and two of common carps have been observed in Toubul area and Mayang Imphal.



Fishing in Phumdis

Stock Assessment

- Fish landing of Loktak lake was estimated as 1685.03 metric tones in 1999 and 1374.98 metric tones in 2000. Fish population of Loktak lake is dominated by exotic major carps (33%), followed by Indian major carps (21%). Minnows also contribute substantially (14%). Other contributing groups were murrels, catfishes and minor carps.
- Maximum Sustainable Yield for Loktak lake using Logistic model (catch /day) was calculated as 1102 MT/annum. The present production is calculated as 1237.56 MT/ annum. This revealed that fishery of Loktak Lake is overexploited.
- A questionnaire survey was carried out in 4 island villages, phum huts and 42 peripheral villages of the lake.

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Estimated fishermen population of the Loktak Lake is 8700 and average daily Catch per Unit Effort of a fisherman is only about 0.45 kg. There are about 2800 fishing boats (drag out canoes) used for fishing and navigation purposes.

Down Stream Survey

The population of some riverine fishes specially *Osteobrama belangeri* were drastically reduced after construction of Ithai barrage. A downstream survey of the Manipur River was conducted between 18-26 October 2000 by the Loktak Development Authority and Wetlands International - South Asia for assessment of the migration of certain fishes from Chindwin-Irrawady river basin to Loktak lake. The multi-disciplinary team conducting the study consists of 19 participants including hydrologists, GIS and Remote Sensing specialists, fisheries experts, limnologists, community development experts, fishermen and other assistants. The area under survey is the down stream part of Manipur river following Ithai barrage to the Indo-Myanmar border. The river stretch from Sugnu to Myanmar Border was divided into three sections. The survey was carried out using rafts on the river downstream and trekking upstream along the riverbanks and hills. Hydrology, Limnology and socio economic study was also carried out during this survey. Twenty fish species representing 8 families were recorded during this survey.



SPECIFIC STUDIES

Phyto-sociological studies on Phumdis

A study on phyto sociology of phumdis of Loktak Lake was undertaken involving Dept of Biosciences, Manipur University. The following findings have been made under the study:

- 55 species belonging to 21 families were-collected from 8 sites of the Loktak lake. Some of the plant species common in all sites were, *Opelismenus compositus* and *Sacciolepis sp* and *Opelismenus compositus* was most dominant in six sites and co-dominant in other two sites along with second ones. 5 rare plant species were also recorded during this study. Hemicryptophytes, Cryptophytes and Phanerophytes were found to be abundant groups. Contagious type of distribution was found in majority of cases. Random mode was another type of plant distribution.
- Some of the Plant species are found to be common in all sites of stream area. These are *Gynura cusumba*, *Zizania latifolia*, *Jussiaea repens*, *Sacciolepis myosuroides*, *Alternanthera sessilis*, *Phragmites karka*, *Hydrilla verticillata*, *Pistia straitoides*, *Salvinia cuculata*, *Eichhornia crassipes*, *Ipomoea aquatica*, *Persicaria perfoliata*, *Allocasia sp.* and *Commelina bengalensis*. Dominant plants are, *Alternanthera sessilis*, *Sacciolepis myosuroides*, *Salvinia cuculata*, *Zizania latifolia*, *Erianthus arundinacea*, *Saccharum spontaneum*, *Leersia hexandra*. 14 rare plant species were also recorded from these area during this study. Hemicryptophytes and Therophytes are found to dominant. Clumped type of distribution pattern of plant species was mostly observed. Random mode of distribution was the next in the order of dominance.

Economic utilization of Phumdis

A study on economic utilization of Phumdis was undertaken involving

Food and feeding habits

A study on food and feeding habits of five economically important fish species of Loktak Lake was carried out since May 2000 to June 2001. This study revealed that *Cyprinus carpio* and *Labeo rohita* are omnivorous and feed on animal matters, plankton and macrophytes. Although these two species have similar feeding habits, no competition has been observed because they are bottom and column feeders respectively. *Chana punctatus*, *Chana striatus*, *Clarius gueripinnus* and *Clarius batracus* have similar feeding habits. They mainly feed on insects and animal matter as was revealed from their gut content representing 63 - 85% animal matters. Among these three species *Clarius gueripinnus* is a predator as well as voracious eater. The occurrence of this species poses a threat to the population structure and fish fauna dynamics.

Fisheries Development

- A community owned fish hatchery with a production capacity of 1 crore spawn (50 lakhs of fry and 25 lakhs of fingerlings) per annum has been constructed at Toubul. The project operates under an MoU, where 50% of the annual produce is released into the lake by the community.
- A demonstration project on construction of mini hatcheries is under implementation. Eight sites have been identified through community meetings, and micro planning for implementation of the project is under progress.
- A project on strengthening existing fish hatcheries through technical and financial assistance is has been initiated on demonstration scale . The project operates through an MoU , under which the beneficiary releases an equal number of fingerlings as provided to him under et project, into the lake after the first harvest.
- Three demonstration projects on integrated fish farming have been undertaken to reduce pressure on lake fisheries. Fish cum duck farming has been introduced in 16 villages, paddy cum fish culture in 3 villages and fish cum pig farming in 2 villages.

College of Agriculture, Central Agricultural University, Imphal. The primary objectives of the study were to determine the utilization of phumdi as a carrier of bio fertilizer agents ; as potting material for floriculture and to determine the best method to degrade the phumdi for use as organic source.

The following facts were brought out during the course of study:

- Phumdi has a tremendous advantage over other bio-fertilizers, which are based on charcoal owing to its biodegradability. Phumdi along with rice bran ash could be utilized as a carrier for agents of bio fertilizer.
- The fastest decomposition took place when phumdi was treated with cellulolytic bacteria (total decomposition time = 52 days).

Further investigations are being carried on effectiveness of phumdi as compost in field condition and use of phumdi in floriculture

Genesis and proliferation of phumdis

Studies on genesis and proliferation of phumdis have been initiated under the project. Phumdis have been found to form naturally as well as artificially. *Salvania* and *Cyperus* have been



Primary Stages of Phumdis Formation

observed as primary plants for natural phumdi formation. Experiments on phumdi growth and proliferation have been carried out in lake area and results are under compilation.

Studies on vegetation of Loktak

A total of 145 plants comprising of both aquatic and semi-aquatic have been identified from the lake area. The dominant plants are *Brachiaria mutica*, *Zizania latifolia*, *Echinocloa stegnina*, *Salvania natans*, *Cyperous brevifolius*. Thirty two economically important plants identified from the lake, which are used as vegetable, fodder and fuel. Biomass of the submerged plants , newly formed phumdis (floating plants) and matured phumdis was found to be 78.18 gm/m²; 723.15 gm/m² and 1.26 kg/m³ respectively. *Brachiaria mutica* , a new

HYDREC 2000

A survey of KLNP was undertaken to assess the ecological and hydrological profile of the area. The study was undertaken by the project team in collaboration with Wildlife Department, NGOs and students of the local schools. Dr. E. J. James, Director CWRDM was instrumental in carrying out the survey and providing lot of support to co-ordinate the survey. ESRSPF led by H.M. Meghachandra was also very much supportive to this study.

The Hydrec was the first comprehensive survey involving hydrologists, remote sensing and GIS experts, botanists, limnologists, wildlife experts, fisheries scientists and community experts. The survey was completed in three months duration. A short documentary on the survey prepared by the survey team is available with the project management team. Some important findings are:

- 135 plant species comprising both aquatic and semi-aquatic were identified. The dominant species amongst the macrophytes were *Zizania latifolia*, *Phragmites karka*, *Echinocloa stegnina*, *Saccharum munja*, *Cyperus sp.*, *Salvania*, *Brachiaria mutica*, *Capillidium sp.* During the present survey thickness of the phumdis was measured at almost all parts of the KLNP.

- Twenty two economically important plants were identified during this present survey which local people used for variety of purposes, like vegetable, fodder or fuel.
- The Phragmites dominated areas in general have very thick phumdis (average thickness 1.5mm) and *Saccharum* dominated areas have thin phumdis. Paragrass of all types were found generally on thin phumdi areas.



- 21 fish species representing 8 families have been identified from different location of KLNP area. Major dominant fish species recorded mostly Murrels (*Chana sp.*), *Cyprinus carpio* and *Cetenopharyngdon idella*.
- Some probable breeding grounds have been identified under KLNP area.

Mostly air breathing fishes (*Channa orientalis*, *Channa striatus*, *Channa punctatus*) and common carps (*Cyprinus carpio*) shows fry and fingerlings in shoals distributed in some of sub-zones.

- The result of microbiological analysis of the water indicates water pollution in these areas. High value of standard plate count for bacteria was observed (74000 - 970000). Microbial analysis of MPN of coliform bacteria / 100ml ranges from 105 - 311 and faecal coliform contributed 92 - 180.
- The pH value remains acidic for most part of the park, 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. The free CO₂ concentration was very high which ranges from 2.4 - 53.7mg/l at the surface and 7.1mg/l - 64.2mg/l at the bottom. Higher value of free carbon dioxide and low values of DO show relatively high process of respiration and decomposition over photosynthesis of phytoplankton and aquatic vegetation. It may be due to the fact that most of the areas are covered by phumdis and almost no light can penetrate inside the water.

species of the lake, has been propagating rapidly in vegetative mode.

COMMUNITY PARTICIPATION AND DEVELOPMENT

Demonstration Projects

• Low cost Sanitation Programme in Island villages

A low cost sanitation programme to control leaching of human waste and nutrients is being implemented in three island villages of Loktak lake i.e., Karang, Ithing and Takmu, under which low cost community toilets are being constructed with community assistance. The project is being implemented by two community groups, Karang Sanitation Committee, and Ithing Welfare Committee. These groups comprise of members of village panchayats, local NGOs and volunteers for project planning and monitoring. As per the MoU signed between the community representatives and LDA representatives, the community is



Construction of Lowcost Sanitation Unit in Karang

providing for the cost of wood, tins and other materials of roofing; charges for unskilled labor and transportation of materials by boat to the village from the nearest village. The LDA is contributing towards the cost of construction material, charges for skilled labor and the transportation costs of materials till Thanga Hoereng village. Eighty six toilet units at Karang and fifty six units at Ithing and Takmu villages are proposed. The project was initiated in September 2000. Forty three units have been constructed at Karang and the work of the remaining units is under progress. In Ithing and Takmu, pits have been dug and material for construction has been provided by LDA. In addition, the Indian Concrete

Institute has provided training on masonry techniques for construction of low cost sanitation projects to the villagers of Ithing and Takmu.

• Indigenous Irrigation Project, Tingkai Khunou

An Indigenous Irrigation Project was implemented at Tingkai Khunou, a hill village in Khujairok micro watershed of Senapati District. The project involved augmentation of the water availability of the terrace fields by construction of a new irrigation canal, with community involvement. Project was initiated in January 2001 with beginning of the excavation work by the villagers.



Foundation Stone in Indigenous Irrigation Project, Tingkai Khunou

Financial assistance was provided to the project in February 2001. Work for the canal was completed in May 2001. As an impact of the project, paddy production in 30 Ha of community land has tripled. There is now a feeling of food security in the village. No incidence of jhumming has been reported from the village community this year.

• Additional / Alternate Income Generation Programmes

- Paddy cum Pisciculture

A demonstration project integrating pisciculture with paddy cultivation is under implementation in five lakeshore villages in a total area of 18 Ha. This farming system is the integration of 3 important major carps namely *Catla catla* (30%), *Cyprinus carpio* (40%) and *Labeo rohita* (30%) with any one of the high yielding varieties such as KD I/ KD II/ KD III. Under this project, 9000 fingerlings per ha have been provided to the farmers with waterlogged lands.

The project is implemented through the Gram Panchayats and the youth clubs, who identify the beneficiaries. The project operated through an MoU signed between the beneficiary and the project, under which the beneficiary provide an equal number of fingerlings provided to him to another beneficiary identified jointly by the LDA, Gram Panchayat and the Youth Clubs.



Release of fingerlings in paddy field

- Duckery cum Pisciculture

An integrated farming project integrating duckery with pisciculture has been taken up in 15 villages in a total area of 22 Ha. Two demonstration plots have been selected from these village by the gram panchayats and the local youth clubs with technical assistance from LDA. As per the MOU drawn between the selected beneficiary and LDA, each beneficiary will supply the required inputs to another beneficiary identified jointly by LDA and local community after the first harvest, which is expected in April of next year. The project operates through an MoU signed between the beneficiary and the project, under which the beneficiary provide an equal number of ducks and fingerlings provided by the project to another beneficiary jointly identified by the LDA, Gram Panchayat and the Youth Clubs.

Duck farming in Toubul



- Piggery cum Pisciculture

A demonstration project on integration of piggery with pisciculture is under implementation in Sadar Joute and Bungte Chiru, two hill villages of the Loktak catchment. The project is being implemented by the Village Authority,



Piggery cum pisciculture in Sadar Joute

Sadar Joute and Bungte Chiru Women's Society, Khunka comprising of 132 members. The project is governed by an MoU as per which these villages shall, after one year, provide equal number of fish fingerlings and piglets to another village jointly identified by these authorities and LDA. 60 piglets and 24000 fingerlings have already been provided to Sadar Joute Village Authority while another 10 piglets and 4000 fingerlings have been provided to B.Chiru Women's Society in November 2001. Linkages have been developed with the Manipur State Veterinary Department for training on maintenance of the piggeries. On successful implementation, these projects shall provide sufficient incomes to desist from forestry based livelihood options.

- Handicrafts and Handlooms

A demonstration project on additional income generation handloom and



Handloom in Sadar Joute

handicrafts has been undertaken in Sadar Joute, a hill village of the Loktak catchment. The project operates through self-help groups and shall benefit 500 women folk. The beneficiaries have been provided with one time assistance of free yarn in the beginning and training on management of self-help groups. Linkages have also been developed with potential markets to provide the beneficiaries with buyers.

• Horticulture

A horticulture project is under implementation in 32 hill villages with the main objective of providing people with a source of income alternate to forestry-based occupations and jhum cultivation. The beneficiaries of the project are identified jointly by the village authority, youth clubs and women organizations. Under a common understanding, the community provides the labor and land, while the project contributes the suckers of indigenous species of banana and pine, bamboo fencing and technical assistance. The plantation is carried under the supervision of the project officials. Since, there is a gap of one and a half year till the first crop, an inter cropping with parkia (*Parkia roxburghii*) is also done in the plots. Plantation of leguminous species in the plot helps retain the fertility of the soil through its nitrogen fixing properties. Till date, 673 households of 32 villages have been benefited by the project.

• Community Owned Fish Hatchery at Toubul

A modified version of Chinese type circular fish hatchery having production capacity of 20 lakhs spawn per operation and a Fish Seed Farm (3.5 Ha) has been constructed at Toubul village on the western side of the lake for restocking of rare and over exploited fish species in the lake. As per the MoU governing the project and signed by the Toubul Welfare Committee (TWC) and the LDA, 50% of the annual seed production shall be released into the lake while the rest shall be sold to the existing fish farms at subsidized rates. The proceeds from the hatchery shall be used for village

developmental works. The construction of this hatchery was completed in July 2001 and a successful trial run was done in August 2001. The hatchery shall be handed over to the Toubul Welfare Committee shortly.



Fish Hatchery at Toubul

• Strengthening of existing fish seed farms

An additional income generation scheme through strengthening of existing hatcheries has been initiated at demonstration scale in the lakeshore villages. Under this project, fish fingerlings are provided to people with existing fish farms, which have been rendered dysfunctional due to lack of capital or technique. The project operates through a MoU, in which the total number of fingerlings provided as seed assistance have to be released into the lake within a year. At present, this project is under operation in Laphu Pat Tera, wherein seed assistance of Rs. 18,000 was provided to a self help group of 6 members having three ponds of half acre each. Besides releasing the fingerlings into the lake, it has also ensured a constant supply of fish spawns at subsidized rates to the nearby fish farmers.

Operation of traditional fish farm



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Operation of traditional fish farm



• Alternate Source of energy

A demonstration project on introduction of smokeless chullahs is under implementation in the villages in and around Loktak lake. The model 'Pubali' (developed by TBU, Guwahati has been adopted for the project as it reduces overall fuel consumption by 60% and halves the overall cooking time besides reducing health hazards due to lesser soot deposition. The villagers have been trained on construction and maintenance of these chullahs, and are initially given a part of the total construction cost as an incentive. Till December 2001, 2073 households of 47 villages have been benefited under the project and 9 training have been conducted.

• Community Capacity Building

i) Self Help Groups

Self Help Groups have been formed under this project to assist individuals / community groups gain a set of skills and attitude to solve common problems and achieve self-reliance. Ten SHGs have been formed under this project, of which eight are women groups. Four groups have been formed in the lakeshore villages, one in the phums and five in the hill villages. Seven groups have started credit and savings operations within themselves. All these groups have been provided with training on the management and conflict resolutions of SHGs. The names of these groups are:

- Chaokhat Khongthang Lup: Narseina
- Panchom Lup : Moirang
- Loktak Khangpok Nupi Ngami Singhi Lup: Phum Village
- Chunnu Lup : Tuikhang Aimol (District Senapati)
- Shinnu Lup: Tuikhang Aimol (District Senapati)
- Chullou Lup: Tingkai Khunou
- Sadar joute Self Help Group (Two Groups)

ii) Training and Workshops

Training and workshops have been organized under the project to enhance



Training on construction of smokeless chullah

the capacity of the communities to initiate collective decisions in issues of common interest. The various themes that have been covered till date are:

- Community Resource Management
- PRA applications for Participatory Watershed Management
- Promotion of Alternate Sources of Energy
- Capacity Building of Women
- Improvement of Loktak Lake Fisheries
- Population Stabilization
- Role of Women in Conservation and Management of Loktak Lake

Participatory Rural Appraisal

Participatory Rural Appraisal exercises to understand social, economic, ecological and institutional profiles of the villages and their felt problems and aspirations have been conducted in 9 lakeshore, 10 phum, 7 island and 8 hill villages. The main exercises conducted were resource mapping, social mapping, time lines, venn diagramming and problem tree analysis. Based on the outputs of the exercises, micro planning was conducted in representative villages, and demonstration projects have been implemented through the involvement of the local community.

Socio Economic Survey:

Socio economic survey through structured questionnaires was conducted in 34 lakeshore villages, 13 island villages, 5 hill villages. A census survey has been conducted in the phum villages. Data on demographic structure, occupational structure, accessibility to social and economic facilities, and utilization of natural resources was

collected during the survey.

Consultation Meetings for Phumdi Management

A series of consultation meetings has been being held with the local communities living in the lakeshore villages and the island villages for management of phumdis of the Loktak Lake. The major issues discussed during these meetings are the impacts of phumdis on the local communities and their livelihoods, traditional approaches for their control and their economic utilization. Till December 2001, seven meetings have been held at Thanga , Shamushang Shantipur, Waheng Khuman, Kholia, Thanga Samukol, Moirangkhem and Keinou. The minutes of these meetings are being systematically recorded, and are being compiled to form a discussion paper for upcoming workshop on 'Management of Phumdis of Loktak Lake' to be organized jointly by Wetlands International - South Asia and Loktak Development Authority.

CAPACITY BUILDING

Training Workshops

The following training were organized for the state government agencies and the research organizations involved in the conservation and management of the Loktak Lake.

- Survey and Mapping of Wetlands using Remote Sensing and GIS Techniques in collaboration with the Indian Institute of Technology, Kharagpur and the Regional Remote Sensing Service Centre, ISRO, Kharagpur.
- Water Quality and Hydrology Models in collaboration with the Department of Civil Engineering, Indian Institute of Technology at Kharagpur.
- Database Application Development using Visual Basic 6.0 in collaboration with Asset International (APTECH)
- Hydrological Modeling, Reservoir Operation and Flood Mitigation management with resource persons from Ministry of Environment and Forests, Central Water Commission,



National Institute of Hydrology, Indian Institute of Technology, Central Ground Water Board and Center for Water Resources Development and Management

- Results Based management in collaboration with ICEF

Infrastructure Development

The following infrastructure has been developed at Loktak Development Authority under the project:

- Laboratory with facilities for physico chemical analysis of water, soil, plant matter and microbiological analysis.
- GIS Laboratory alongwith remote sensing imageries and image processing softwares Arc View and Arc Info
- Computing facilities with 10 workstations and 1 server with Networking
- Oracle Developer 2000 and Visual Basic for Database Management
- Presentation Equipment : Laptop and LCD Projector
- 5 Vehicles
- 2 Motorboats

DATABASE MANAGEMENT

A comprehensive data base has been developed on the following parameters:

i) Catchment Area :

- Soil type, slope & vegetation of the catchment area
- Area undertaken for treatment under SDWRML project for afforestation, horticulture plantation and jhum treatment
- Area undertaken for treatment using engineering measures like construction of boulder sausage, vegetative check dams, bamboo spurs and contour trenching

ii) Lake area

- Water spread area, depth profile & phumdi covered area

iii) Hydrometry:

- Meteorology : Temperature, rainfall, relative humidity, sunshine, wind speed, wind direction, discharge, sediment load and lake level

- Discharge: Discharge of 12 major rivers viz. Imphal, Iril, Thoubal, Manipur, Nambul, Nambol, Awang Khujairok, Potsangbam, Thongjaorok, Merakhong, Khordak and Ungamel

- Siltation : Sediment load (inflow & outflow) in the lake and the rivers/ streams

- Lake level : Water depth of the lake at 4 points (Sendra, KLNP, Khordak and Nongmaikhong)

- Physico-chemical parameters of water: Temperature, transparency, pH, turbidity, total alkalinity, free CO₂, dissolved oxygen, hardness, BOD, COD, chloride, calcium, magnesium, sodium, potassium, nitrate-nitrogen, inorganic phosphate phosphorus, organic phosphorus, total phosphorus, ammonia, total dissolved solids, total suspended solids, total solids

- Micro-biological parameter of water: Standard Plate count for bacteria, faecal coliform and total coliform

- Physico-chemical parameters of sediment: pH, organic carbon, phosphorus, nitrogen, potassium, calcium and magnesium

- Mineral nutrients of vegetation: Total phosphorus, total nitrogen, potassium, calcium and magnesium

- Fish and fisheries: Species composition, yield, food and feeding habits of major fishes, length - weight relationship and fish price

- Socioeconomic: Population, sex ratio, education, social and economic infrastructure, lake relationship

- KLNP: Hydrology, limnology, vegetation, fisheries and wildlife

PROJECT MANAGEMENT

- The second meeting of the Scientific and Technical Advisory Group was held at Imphal in August 2000 under the chairmanship of Late Dr. S. Maudgal, Senior Advisor, Ministry of Environment and Forests was held. Recommendations of extension of the scope of study to Myanmar border area, developing an early earning

system for flood management, development of strategies to ensure fish migration and extended co-ordination between various government departments involved in water management, were given during the meeting. Most of these recommendations were subsequently built in into the project activities.

- The second PMC meeting was held at Imphal, Manipur on 29 August 2000 at Imphal under the Chairmanship of Mr. J. Chaudhuri, Secretary, Irrigation and Flood Control Department, Government of Manipur. Decisions taken included preparation of a comprehensive water management plan by March 2001 based on information collected under the project from primary and secondary sources, and identification of 3 or 4 micro-watersheds to demonstrate the application of watershed treatment models in regulating flow regimes, nutrients and sediments.

WATERFOWL CENSUS

Various kinds of waterfowl used to migrate to Loktak Lake every winter. Environmental Social Reformation and Sangai Protection Forum (ESRSPF) in collaboration of Loktak Development Authority (LDA) organized a four months waterbird census in Loktak Lake (November 2000- February 2001). Dr. Kh. Shamungou and K. Jugeshore were the key persons and forty-four representatives from twenty-one NGO were trained and participated in that programme. A total of 59 species of birds including 14 waterbirds were recorded from 17 observation centers. Some interesting listings are: lesser whistling teal, black headed gull, white ibis, Gadwall, Pintail, White-eyed Pochard, Brown headed gull, great-crested grebe, Ruddy Shelduck, Tufted duck, Wigeon, Garganey Teal etc.

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NEWS BRIEFS

OBITUARY

Wetlands International - South Asia and Loktak Development Authority profoundly grieved over the untimely demise of Dr. S. Maudgal. He was an eminent scientist, who has dedicated his entire career for achieving environment-friendly developmental initiatives. He was basically a civil engineer with specialization in geo-technical engineering and has been all through conscious of the place of Man in the Environment. As Senior Advisor to Ministry of Environment and Forest, Government of India, he was involved in the environmental impact assessment of major developmental projects in the country and promoting major research projects in the field of environment and development. Dr. Maudgal served as the Chairman of the Technical Advisory Committee of the SDWRML project. His keen interest in the project has helped in developing management strategies for the Loktak Lake in the Manipur valley. during his tenure.

U.K. Chaudhary takes over as ICEF Co-Director

U.K Chaudhary has recently taken over as Co-Director of India-Canada Environment Facility (ICEF). Mr. Chaudhary carries with him a long experience of International Corporation dealt by him in the Ministry of Environment and Forest, Government of India. He has been instrumental in promoting several projects funded under JEF, UNDP and UNEP. His experience in the field of environment and resources management will be of eminence value in bringing the projects of ICEF closer to the national and international perspectives. We are sure that several innovative projects focused on wetlands will receive considerable attention

Dr. Max Finlayson takes over from Dr. Chris Kalden as President, Wetlands International



DIARY DATES 2002

22-24 January 2002

Workshop on Management of Phumdis in Loktak Lake
Contact: Wetlands International South Asia, A-127, Second Floor, Defence Colony, New Delhi or Loktak Development Authority, Leiren Mansion, Lamphel pat, Imphal, Manipur, India.

E-mail: wisaind@del2.vsnl.net.in

URL: <http://www.wetlands.org>

3-5 February 2002

West & Central Asian Sub-Regional Meeting on the Convention on Wetlands, Tehran, I.R. Iran

URL: <http://www.ramsar.org>

4-23 March 2002

Training Course on Hydrology of Small Watersheds
Contact: Surface Water Division, Centre for Water Resources Development and Management, Khozikode, Kerala, India 673 571

E-mail: swdcwrmd@eth.net

8-19 April 2002

The Sixth Conference of the Parties of the Convention on Biological Diversity (CBD COP 6), The Hague, The Netherlands

URL: <http://www.biodiv.org/meetings/cop-06.asp>

29 May- 26 June 2002

International Course on Wetland Restoration
Contact: Ministry of Transport, Public Works and Water management, Directorate General of Public Works and Water management, Institute for Inland Water management and Waste Water Treatment, RIZA

E-Mail: watc@riza.rws.minvenw.nl

URL: <http://www.riza.nl>

June 2002

Training course on Successfully Integrating Wetlands into Multiple Land Use Planning Framework
Contact: Ms. Maryanne Mckaige, Centre for Tropical Wetland Management, Northern Territory University, Darwin, Northern Territory, Australia 0909

E-mail: ctwm@ntu.edu.au

URL: <http://www.ntu.edu.au/ctwm/>

11-18 August 2002

8th International Congress of Ecology, Seoul, Korea
Contact: Mr. David Lee, Global Environment Center, 7A, Jalan 19/29, 46300, Petaling Jaya, Selangor, Malaysia
E-mail: farina@intercol.org
URL: <http://www.intercol.org/circolare.htm>

22 August-2 October 2002

International Course on Wetland Management
Contact: The Wetland Advisory and Training Center (WATC), Rijkswaterstaat's Institute for Inland Water management and Waste Water Treatment (RIZA), P.O. Box 17 8200 AA, Lelystad, The Netherlands

E-Mail: watc@riza.rws.minvenw.nl

URL: <http://www.riza.nl>

News from Wetlands International - South Asia

● President, Wetlands International Visits India

Dr. Max Finlayson, President, Wetlands International visited WI-SA office from 11 - 16 December 2001. He visited the Chilika Lake and Keoladeo National Park, Bharatpur, during his seven-day stay in India. He also gave a brief presentation on the activities of National Centre for Tropical Wetland Research, Australia of which he is currently the Director. Several important issues relating to WISA activities were discussed during the meeting.



Wetlands International South Asia Staff with President, Wetlands International Standing (L to R): Ms. Chandrima Sinha, Mr. Ritesh Kumar, Mr. Kamal Dalakoti, Mr. Ch. Rajagopal Singh, Mr. K.L. Bhatt Shing (L to R): Dr. S.Kaul (Director, MoEF), Dr. C.L. Trisal (Director, WISA), Dr. Max Finlayson (President, WI), Dr. Brij Gopal (JNU) Sitting (Front): Ms. Tarveera Tabassum, Ms. Pamposh, Mr. Manoj Vishwakarma

● Wetlands International Board of Members Meeting (BOM)

The third Wetlands International Board of Members meeting was held at Wageningen, The Netherlands from 29 November - 2 December 2001. The meeting was attended by the Board of Directors, members of the regional councils, specialist group coordinators, WI staff and delegates from 32 nations besides representatives of IUCN, UNEP, WWF, Birdlife International and Birdlife/RSPB. Keynote presentations on Wetlands in Changing World and global changes; and wetlands in a changing world and biodiversity were made during the meeting. The strategic plan for 2002 - 2004 was adopted during the meeting. Dr. Max Finlayson, a member of the WI Board of Directors and Director, Environmental Research Institute of the Supervising Scientist (eriss), Australia was elected as the President of Wetlands International.



Wetlands International - BOM Meeting

● WISA's initiatives in Bangladesh

Dr. C. L. Trisal, Director, WISA and Mr. Doug Watkins of WI - Australia programme visited Bangladesh from 11-18 August 2002. Several meetings were held with representatives of IUCN, ICLARM, Center for Natural Resources Studies, Independent University, and Ministry of Environment and Forests, Bangladesh to discuss extension of Wetlands International activities in the country

● International Workshop on Restoration of Chilika Lagoon

A workshop on Restoration of Chilika Lagoon is being jointly organized by Wetlands International South Asia and Chilika Development Authority (CDA) from 18-20 January 2002 at Bhubaneswar, Orissa. The main objective of the workshop was to develop strategies for review the progress of the work carried out by CDA on Chilika Lagoon and discuss the future strategies for its restoration. Several leading scientific organizations at national level, state level, NGO's and community groups have been invited to participate in the workshop for providing inputs into conservation and management of the lagoon.



Birds of Chilika Lagoon

● Economic valuation of Harike Wetland, Punjab

The study on 'Economic valuation of Harike Lake, Punjab was completed in November 2001 and the final project report was submitted to Ramsar Convention Bureau. The study highlights the role of Harike wetland in water purification, sediment retention, flood mitigation, ground water recharge, maintenance of biodiversity habitats and provision of economically important species as fishes and reeds. Valuation methods as Market pricing, Opportunity Cost, Surrogate pricing, Contingent Ranking and Contingent Valuation were used to arrive at the Economic Value of wetland benefits. A cost benefit analysis has been done to assess the resource use efficiency, based on which a framework for resource development and management has been developed.



Harike Wetland, Punjab