CHILIKA

NEWSLETTER February 2013, Volume – VII

Special issue on World Wetlands Day

- Water Management and Wise use of Chilika
- Visit of Secretary General, Ramsar Convention
- Chilika Ecosystem Health Assessment

Chilika
Development Authority

WETLANDS INTERNATIONAL

Chilika
Development Authority

The Chilika Development Authority is the nodal agency of State Government of Odisha entrusted with conservation and sustainable management of Chilka Lake. It was created by the Forest and Environment Department, Government of Odisha vide Resolution No. 20389/F&E dated 20.11.1991. The Authority is registered under Orissa Societies Registration Act. Its Governing Body consists of the Chief Minister of Odisha as the Chairman and the Minister of Environment, Science and Technology as the working Chairman. The members are drawn from various state government departments. NGOs and technical experts besides elected representatives.

WETLANDS INTERNATIONAL

Wetlands International-South Asia

WISA is the South Asia Programme of Wetlands International, a global organization dedicated to conservation and wise use of wetland. 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.

"CHILIKA" is the jointly published newsletter of the Chilika Development Authority and Wetlands International - South Asia

Contents

Editorial Panel

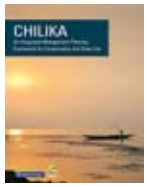
Cover Photograph: Community fishing in Chilika

Back Cover Photograph: Bar headed geese in flight in Chilika

Photograph Credit: K. Ramnath Chandrasekhar/CDA

Design and Print:
Systems Vision, New Delhi
systemsvision@gmail.com

Chilika Integrated Management Planning Framework Released



Mr. Anada Tiega, Secretary General, Ramsar Convention made a visit to Chilika Lake during 20 – 22 October 2012. This is the first visit of a Secretary General of the Ramsar Convention to India.

Mr. Tiega visited the Wetland Research and Training Center, the lake mouth at Magarmukh and interacted with school children, Chilika fishers and the media. He was deeply impressed to see the implementation of various wetland management programmes being undertaken by the Authority.

A key event during Mr. Tiega's visit was the release of an Integrated Management Planning Framework for Chilika.

Hon'ble Chief Minister, Government of Odisha, Mr. Naveen Patnaik released the management plan in a special event organized by Chilika Development Authority on October 20, 2012. Mr. Bijayshree Routray (Hon'ble Minister, Environment and Forests, Government of Odisha); Mr. Pinaki Mishra (Member of Parliament, Puri); Dr. Prasana Kumar Patsani (Member of Parliament, Bhubaneswar), Mr. Sanjay Das Burma (Member Odisha Legislative Assembly, Brahamgiri), Mr. Raghunath Sahu (Member Odisha Legislatively Assembly, Chilika), Mr. R.K.Sharma (Principal Secretary, Forests and Environment, Government of Odisha); Dr. Ganesh Pangare (Asia Regional Office of IUCN); Dr. Ajit K. Pattnaik (Chief Executive, CDA) and Mr. S.K.Pande (Vice President, Wetlands International South Asia) were the key dignitaries present on the occasion.

Formulation of the management planning framework was led by Wetlands International South Asia and Chilika Development Authority. A team of experts from Institute of Land, Water and Society, Charles Sturt University (Australia); Karunya University (Coimbatore); Xavier Institute of Management (Bhubaneswar); Bombay Natural History Society (Mumbai) and Central Inland Fisheries Research Institute (West Bengal) provided the expert review and advisory support to the planning process. Financial support for the plan was provided by Ramsar Convention Secretariat (Switzerland) and International Development Research Center (South Asia Regional Office, New Delhi).

The plan was developed following recommendation of the Ramsar Advisory Mission which advised development of a single unified vision of stakeholders on the way the Lake Chilika as a Ramsar site should be managed.

The management plan framework outlines strategies and actions required to achieve wise use of Chilika and thereby ensure conservation of its rich biodiversity and related ecosystem components and processes as well as livelihoods of dependent communities. An extensive review of scientific information as well as stakeholder consultations, particularly with local communities formed key inputs to plan formulation. A draft framework of the plan was reviewed in a consultation workshop held in October 2009. The plan also includes a strategy for institutional reorganization of Chilika Development Authority to enhance its effectiveness, particularly in linking management of Chilika to river basin and coastal zone management. The document is based on the technical guidelines provided by the Ramsar Convention Secretariat and Ministry of Environment and Forests, Government of India.

Chief Minister, Government of Odisha (fourth from right) releasing the Management Planning Framework of Lake Chilika

CONVENTION ON WETLANDS
CONVENTION SUR LES ZONES HUMIDES
CONVENCIÓN SOBRE LOS HUMEDALES
(Ramsar, Iran, 1971)

From the Secretary General

Dr. Ajit K. Pattnaik
Chief Executive Officer
Chilika Development Authority
C-11, BJB Nagar
Bhubaneswar 751 014, Orissa
India

Gland, 31 October 2012
Ref. ANT/mik

Dear Dr. Pattnaik,

Thanks to your warm hospitality and to the excellent organizational, my visit to Chilika has been a wonderful and worthwhile experience.

I have learnt much and I have been extremely impressed by the demonstration of restoration of a complex and large wetland that you have achieved. Please also thank, on my behalf, your staff and in particular your wonderful team of dedicated scientists.

The meetings that were organized with key officials and local communities were very informative. I was also very impressed by the training given in school on wetlands values and functions and by the sustainable approach taken to the development of tourism.

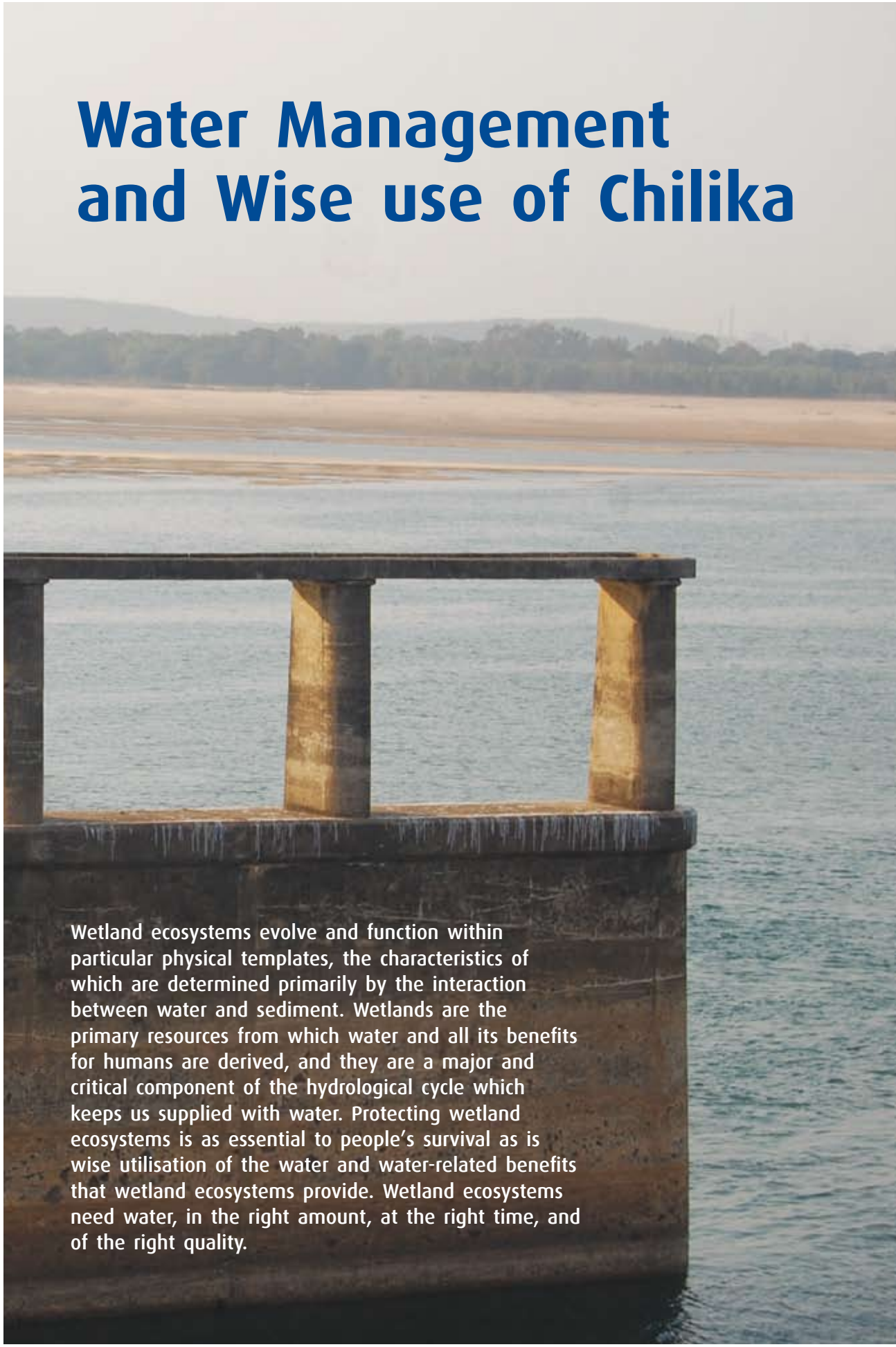
Finally, I would like to express my appreciation for your personal engagement and for your warm welcome. I look forward to hearing further news of the Chilika success story.

Yours sincerely,

Ananda Tiéga

SECRETARIAT/SECRÉTARIAT/SECRETARÍA: RUE MAUVERNEY 28 • CH-1196 GLAND, SWITZERLAND/SUISSE/SUIZA
TEL. + 41 22 999 01 70 • FAX +41 22 999 01 69 • E-MAIL: ramsar@ramsar.org • WEB SITE: http://www.ramsar.org/

Water Management and Wise use of Chilika



Wetland ecosystems evolve and function within particular physical templates, the characteristics of which are determined primarily by the interaction between water and sediment. Wetlands are the primary resources from which water and all its benefits for humans are derived, and they are a major and critical component of the hydrological cycle which keeps us supplied with water. Protecting wetland ecosystems is as essential to people's survival as is wise utilisation of the water and water-related benefits that wetland ecosystems provide. Wetland ecosystems need water, in the right amount, at the right time, and of the right quality.

Mahanadi barrage at the apex of River Mahanadi Delta

The World Wetland Day theme for 2013 - *Wetlands and Water Management* highlights the importance of water in maintaining the important ecological functions of wetlands, as well as the need to consider wetlands as essential components of water management infrastructure. Wise use of wetlands is an important strategy for delivering sustainable water management. The year 2013 has also been declared as the United Nations International Year of Water Cooperation recognizing the critical role of water for sustainable development and for human well-being.

In this article, the role of water in sustaining rich biodiversity and ecosystem services of Chilika, and the efforts being made for integrating water management into management of Chilika is discussed.

Water, Biodiversity and Ecosystem Services interlinkages in Chilika

Chilika is a dynamic assemblage of shallow to very shallow marine, brackish and freshwater habitats. The presence of unique salinity gradient enables the wetland to support a wide range of biodiversity and support livelihoods of dependent communities through its ecosystem services. Hydrological regimes provide the template on which the components and processes of wetlands are structured enabling it to deliver these ecosystem services. The interrelationship of water regimes to biodiversity and ecosystem services can be expressed in several ways and at multiple scales.

Water regimes and fisheries. The ability of Chilika to support highly productive fisheries which is a source of sustenance for nearly 0.2 million fishers is closely related to its hydrological regimes. Nearly 86% of the fish species presently found in the wetland are migratory and dependant on the riverine and marine habitats for a part of their life cycle. Hydrological connectivity of Chilika with the Bay of Bengal, tributaries of River Mahanadi and streams of western catchments provides the necessary biophysical condition for maintenance of this diversity. The flood flow pulses and spatial and temporal gradient in salinity established in Chilika during the year provide migration cues to anadromous, catadromous and resident species to move towards their breeding grounds and facilitate auto-recruitmentin to the lake. Inflow of freshwater during monsoon aids in flushing out the anoxic conditions by inundating the areas rich in nutrients and providing a conducive environment for growth of fish food organisms which in turn influence the recruitment of juveniles to nursing areas and addition to fish stocks.

The traditional fishing systems practiced in Chilika took advantage of the differing water depth. Net fishing areas, called *bahani*, were largely confined to deeper areas whereas *Janos* were used in the shallow areas, set after receding of floodwater. Similarly, *Dian* and *Uthapani* were practised in shallow areas of the Lake. In recent times the traditional practices have been replaced by *gheries* and *khonda*.

Water regimes and waterbirds. Chilika is known for harbouring a wide range of bird species, which apart from being a key component of her biodiversity is also a tourist delight. It is one of the largest wintering ground of migratory birds in Asiatic subcontinent. Water regimes play an important role in creating the necessary habitat conditions for these species in Chilika.

Though entire shallow zone of Chilika is used by waterbirds as habitats, Nalaban and Manglajodi stand out in terms of congregation sizes. The cyclical pattern of emergence and inundation of Nalabana plays an important role in regulating food availability and creation of habitats for water birds. The island is completely submerged during monsoon, emerges during winter and is exposed till late summer. This cycle regulates the growth, survival and reproduction of invertebrates and submerged plants used as food by the visiting birds. As water levels recede and the mudflats exposed, the food availability particularly in the form of gastropods also increase creating ideal conditions for Northern Pintails and Gadwalls to begin congregation. Along with this, major food plants for the migratory water birds, *Potamogeton pectinatus*, *Najas* sp. and *Halophila* sp. are also abundant during this period to support feeding needs. The submergence of the island is an important factor keeping the overall growth of vegetation in check. Similarly, the marshy conditions near Manglajodi are conducive for supporting high density of molluscs and fish fingerlings increasing the viability of the site as feeding and roosting ground of migratory water birds, particularly dabbling ducks.

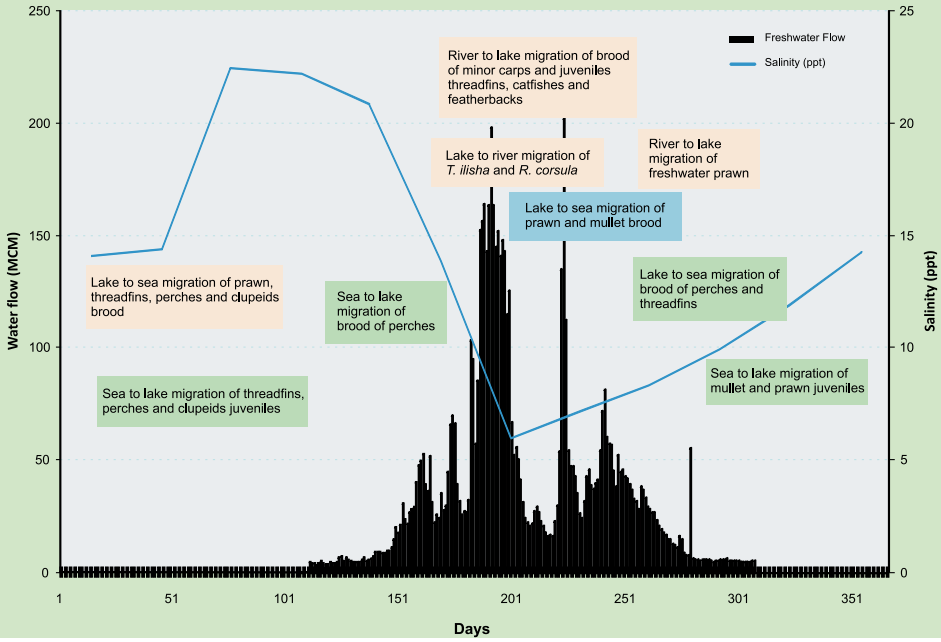
Waterbirds also play an important role in nutrient cycle within Chilika. Guano deposits are important sources of nitrogen and phosphorus in the lake. As per studies done by Bombay Natural History Society, ducks and geese annually add 33.8 t of nitrogen and 10.5 t of phosphorous (in the form of guano) to the lake which supports high biomass production.

Water regimes and vegetation. Depth of water has a major influence on distribution of macrophytes in aquatic systems, including Chilika. Free floating and submerged forms are generally found in deeper water areas, whereas emergent and submerged floating forms are present in shallow waters near shoreline areas. The peripheral areas of northern sector which are shallow and predominantly freshwater is dominated by emergent vegetation (most notably *Phragmites karka*) and submgered (*Hydrilla*

Water regimes and fish migration in Chilika

Dynamic hydrological regimes of Lake Chilika play an important role in influencing salinity regimes and thereby migration. With the onset of monsoon and increase in freshwater flow, there is a sudden fall in lake salinity which triggers the gravid *P. monodon, F. indicus* and *M. monoceros* to undertake migration to high saline areas near the lake mouth for breeding. Fall in salinity with low flows from July till end of August acts as a stimulus for *T. ilisha* to ascend the river Daya and Makara for breeding. The seaward migration of *M. cephalus* also starts during this period and extends upto December. Increase in flow pulses during September and October flushes the juveniles of *T. ilisha, E. tertadactylum, E. suratensis, P. canius* along with the seeds of a number of minor and major carps, catfishes and featherbacks from river into the lake.

The stable flows during winter months with rise in salinity aid in lakeward migration of marine brood stocks of *N. nasus* and *A. arius* and seaward movement of *S. sarba, C. crenidens, P. monodon* and *M. dobsoni*. The tidal influx during the dry period brings along with it the juveniles of *P. monodon, F. indicus* and *M. dobsonii* which require a salinity lower than that of the sea during their post-larval stages. Juveniles of *E. tetradactylum, C. chanos, Thryssa sp., E. sourus, S. sarba* and *M. cyprinoides* are encountered in the outer channel area during the summer months which mainly enter the lake for feeding purpose.



The freshwater flow from northern sector and the intermediate floods are highly essential for addition and distribution of fish stocks in different sectors. The inflow of freshwater during monsoon aids in flushing out the anoxic conditions by inundating the areas rich in nutrients and providing a conducive environment for growth of fish food organisms which in turn influence the recruitment of juveniles.

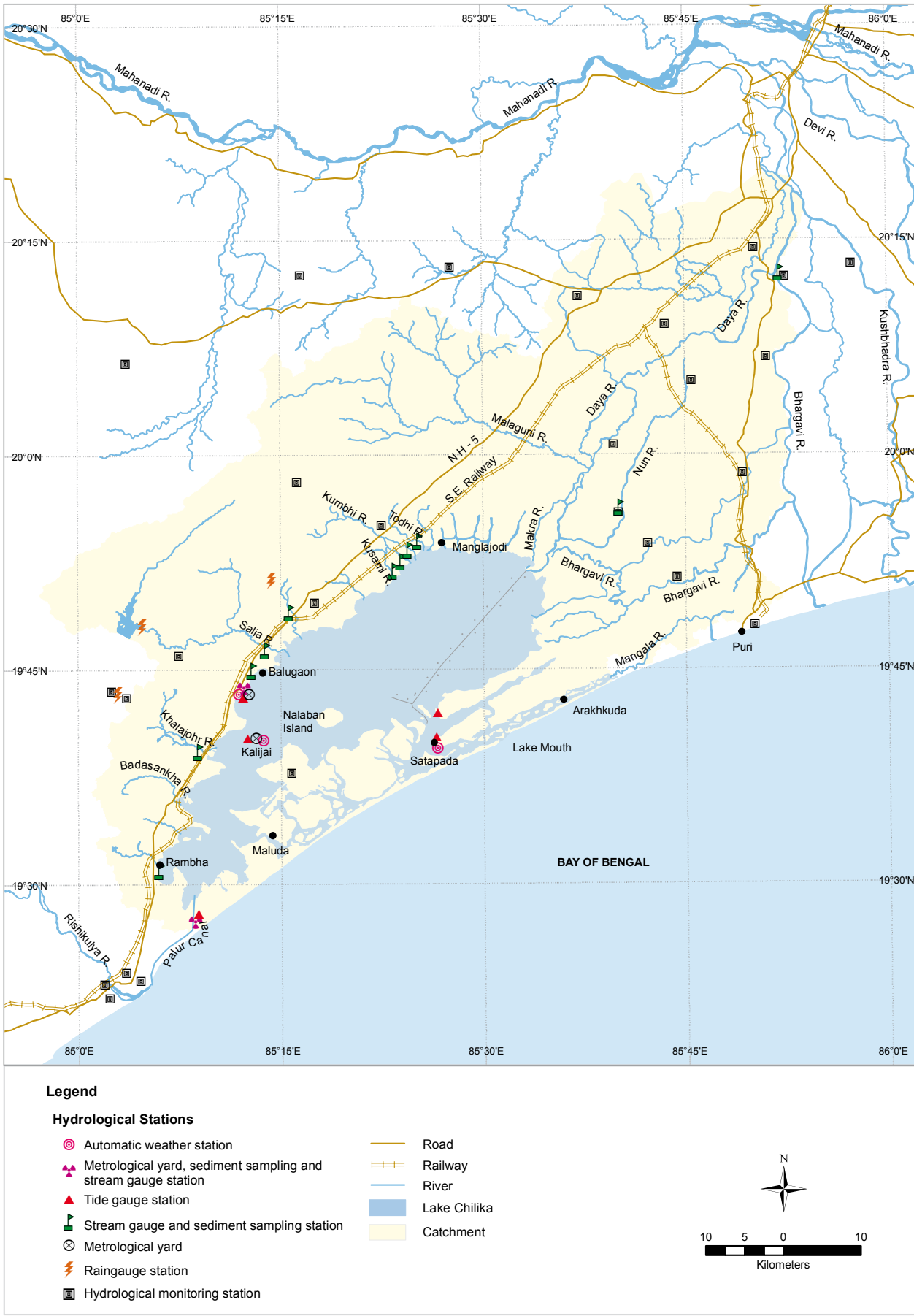
verticillata, Vallisneria spiralis). *Eichhornia crassipes*, a freshwater invasive is confined to the river confluence areas in northern sector. The vegetation in the central and southern sectors is mostly of submerged brackish water type represented by the dominant genus of *Najas sp.* and *Potamogeton sp*. The rich seagrass meadows along the shoreline are predominate due to less fluctuation in the salinity. The outer channel area having marine influence has very less vegetation as compared to other sectors, mostly limited to submerged patches of Seagrass and *Rupia maritima*.

Water regimes and Irrawaddy Dolphins. Chilika is one of the few lagoons in the world that support Irrawaddy Dolphin (*Orcaella brevirostris*). The species is known to have unique hydrological condition preferences, particularly shallow water upto 2 meters deep with sea grass meadows in the near shore areas. Protected, inshore, shallow estuarine waters are their critical habitats. These conditions are mostly found in the outer channel and central & southern sector wherein this species is known to concentrate. Restoration of hydrological regime along with revival of connectivity with sea has witnessed an increase in population and habitat expansion of dolphins. Being at the top of the food chain dolphin is a good indicator of the health of the wetland ecosystem. The significant observations made during the survey for population estmation during 2013 are sighting of 8 numbers of dolphins from Northern sector which is an indication of the expansion of their habitat. Another significant observation is the 38.9% increase of the number of calves and neonates over the last year.

Monitoring water regimes of Chilika

The water regimes of Chilika can be broadly classified into three sub-systems. The freshwater flows are received through the tributaries of the River Mahanadi and the streams of western catchment. Flows from the Bay of Bengal form the third sub-system, which connects to Chilika through the lake mouths (at Magarmukh and Gabakund) and the Palur Canal in the extreme south.

River Mahanadi is the principal source of freshwater for Chilika. The 858 km long river originates in the Bastar Hills of Chhattisgarh and drains 141,589 square kilometre



Hydrological monitoring stations in Lake Chilika basin

Fish productivity and waterbird diversity are linked with water regimes

area within the states of Madhya Pradesh, Chhattisgarh and Odisha. The river creates a complex arc like delta beginning at Naraj (near Cuttack), dividing into three distributaries, namely Kuakhai, Kathjodi and Birupa. Daya and Bhargabi, the two distributaries of Kuakhai bring the Mahanadi flows to Chilika. Within the delta, embankments have been constructed and tributaries channelled as measure of providing flood control to the adjoining agricultural lands and settlements.

The highly ravenous and gullied western catchment is drained by 47 streams, of which eight, namely Badaghati, Badanai, Badasankha, Kansari, Kusumi, Mangalajodi, Salia and Tarimi are the major ones. The flow in these streams is mainly during monsoons.

A systematic hydrological monitoring system has been in place in the lake basin since 1999. A network of 47 monitoring stations provides information on the water and sediment from the river and streams draining into Chilika. In addition, tide gauging stations have been put in place at Sipakuda, Satpada and Magarmukh. Data on water quality is sampled from 30 locations within the lake. The analysis of the data for the period 1999 – 2010 indicates the following major trends:

- Lake Chilika annually receives 5178 million cubic metres of freshwater from the river systems of which 75% is contributed by the Mahanadi Delta river system. The flows received from Mahanadi delta system form around 6% of the undivided flows upstream of Naraj.
- Lake Chilika is subject to sedimentation from its extensive catchments as well from the sea. The average annual sediment loading into the lake is of 0.8 million Metric Tonnes, of which Mahanadi system contributed 76%. Lake is filling with sediment 3–5 times as fast as 100 years ago at the margins of the northern and southern sectors, and 30% higher at the margins of the central sector. Total depths of sedimentation at northern and southern sectors, close to river exits, are 85 and 49 cm respectively, with most of this having occurred post-1950. The total sediment discharged to the sea through the mouth was estimated as 0.13 million Metric Tonnes.
- The longshore sediment transport continues northwards throughout the year. High annual littoral sediment drift (of the order of 1.2 million cubic meters) causes along the east coast tend the sea inlet to continually shift northwards leading to development of a long narrow channel running parallel to the coast. The inlet condition is rendered unstable due to reduction in tidal prism with increasing length of the channel. The northward migration of the channel is irregularly interrupted by major monsoon outflows or cyclones that helps in maintaining the cross section of the inlet. However, outflow velocities are not sufficient to combat the littoral drift.
- Lake Chilika is a shallow, well-mixed, nutrient rich water body that is generally turbid and remains alkaline throughout the year. The lake in general, is well oxygenated throughout the year due to its large size, high photosynthetic activity and wind churning effects. A unique salinity gradient from the northern sector to southern sector during monsoon and post monsoon and towards outer channel in the pre-monsoon period is maintained in the Lake. Transparency is high (1 m) in central sector and southern sector and low in the northern sector.

Linking water to Chilika management

The management of Lake Chilika aims at achieving wise use. Wise use is defined within the text of Ramsar Convention as the "maintenance of ecological character, achieved through implementation of ecosystem approaches, within the context of sustainable development". Ecological character is the sum of ecosystem components (the living and non-living constituents), processes (occurring between organisms, populations and communities) and services (direct and indirect benefits received by humans from ecosystems) that characterize the wetland. Given the influence of hydrological regimes on ecological character of Chilika, the management planning for Chilika adopts an integrated water resources management approach.

Integrated Water Resources Management (IWRM) is based on water being an integral part of an ecosystem, a natural resource and a social and economic good, whose quantity and quality determine the nature of its use (Agenda 21, United Nations, 1992). The framework brings together stakeholders at all levels considering their needs and aspirations while ensuring conservation of the wetland ecosystem within the river basin. A critical requirement for implementation of IWRM in Chilika is introduction of land use and water planning and management mechanisms which focus at the river basin and coastal zone scale.

Over the years, Chilika Development Authority (CDA), with support from central and state government and working in collaboration with a range of international and national agencies has undertaken the following interventions to implement IWRM for conservation and wise use of the wetland system:

- **Institutional arrangements.** CDA was instituted by the Government of Odisha in 1991 under the aegis of Department of Forest and Environment to undertake ecosystem restoration. The governance mechanism of the CDA has been designed to ensure collaboration between various state government departments entrusted with management of natural, human and financial resources of the state, including the basin and coastal zone linked to the wetland system. The Governing Body of the Authority, the apex body which takes the policy decisions with respect to wetland management is chaired by the Chief Minister signifying the high priority accorded by the state to wetland conservation and enabling crosssectoral integration. The body draws its members from the Secretaries of the concerned state government departments, political representatives, community representatives and external experts to support broad based management of Chilika. The authority has effectively adopted a model of networking wherein it coordinates delivery of various elements of implementation plan through the various state government departments. An extensive partner and collaborators network has also been developed over a period of time which provides strategic input to wetland management.
- **Maintaining hydrological connectivity.** Chilika underwent a phase of rapid degradation during 1950 – 2000 owing to increasing sediment loads from the catchments and reduced connectivity with the sea. The lake fisheries underwent a major decline, invasive weeds proliferated and the wetland shrank in area and volume. This had tremendous impact on the livelihood of communities, especially fishers. Introduction of shrimp culture further added pressure on lagoon ecology and ultimately led to significant disruption of traditional community governance of lake fisheries. This formed the background for inclusion of Chilika into the Montreux Record in 1993. In September 2000, a major hydrological intervention was carried out by opening a new mouth to the Bay of Bengal which helped improve salinity levels, enhanced fish landing, decrease of invasive species and overall improvement of the lake water quality. The initiative rejuvenated the lake ecosystem and significantly improved livelihoods of wetland dependent communities. The mouth is maintained through periodic dredging and extensive monitoring to ensure that the connection to the sea is maintained.

  Further, a 22.6 km lead channel has also been dredged in the northern sector to ensure that the sediments received from the Mahanadi River are flushed out from the wetland. The Palur canal has also been dredged to ensure hydrological connectivity with the sea in the Southern Sector. These interventions help in maintaining the hydrological connectivity of Chilika with the river basin as well as coastal zone.
- **Conserving catchments to regulate flow regimes.** The lake basin from which Chilika receives direct freshwater inflow extends to an area of 3,860.54 km^2. Management of this direct catchment forms an important strategy for IWRM implementation. The catchment has been delineated into 6 watersheds, 16 sub-watersheds and 218 micro-watersheds to administer management programmes based on hydrological units. Based on assessment of land use and capability, 570.73 km^2 area has been identified as most erosion prone. CDA has worked with the communities to develop and implement a participatory watershed management programme. The communities are facilitated to formulate site specific microplans building on their indigeneous knowledge and skills, supplemented through learning from various trainings. Under the aegis of the programme, appropriate land management practices are introduced through development of cost effective and sustainable technologies which are convenient to implement and maintain by stakeholders. A land use and land cover change assessment concluded in 2012 underlined the impact of catchment conservation programmes. The overall forest cover in the basin which had declined from 1,255.43 km^2 to 1,099.46 km^2 during 1972 to 1990 was observed to increase to 1,267.27 km^2 in 2011.
- **Environment flows.** The construction of Naraj Barrage over Kathjori under the Odisha Water Resources Consolidation project in 2003 to assist in stabilizing irrigation supply and managing floods was a major intervention affecting the inflow of freshwater into Chilika. Since the barrage provided an opportunity for flow control, an environmental flow assessment was undertaken to determine, from joint environmental and socioeconomic perspective, the preferred inflow regime to Lake Chilika from Naraj

Real- time water quality monitoring in Chilika using buoy mounted sensors

Chilika Development Authority, in its efforts towards increasing reliability and comprehensiveness of wetland monitoring system, is putting in place a real time water quality monitoring system which would significantly enhance efficiency and reliability by reducing human error as well as enhancing capabilities to characterize and monitor the dynamic hydrological environment at appropriate temporal and spatial scales.

Recent advances in communication and sensor technology have catalyzed progress in remote monitoring capabilities for water quality on real time basis. The Authority, in consultation with premier scientific institutes of the country, is in the process of deploying sensors mounted on floating buoys at 10 strategic locations representing the 4 ecological sectors of the wetland system. The sensor would transmit the data on real-time basis telemetrically by use of GSM modem to the modelling computer located at the Wetland Research and Training Center at Chandraput. Herein, software with capability of processing high volume real-time data would perform analysis, reporting and linking to the decision support system.

Each buoy is designed to have 9 sensors i.e. Salinity, Temperature, Conductivity, Dissolved Oxygen, pH, Depth, Turbidity, Chlorophyll-a and Blue Green Algae. The data will be transmitted on real-time basis at 15 minutes interval to the modelling computer. To maintain the precision of the data, calibration of the deployed sensor would be carried out at three week interval.

The state of the art sensors are being procured from YSI, USA, a global leader in manufacturing of the sensors used by USGS, NOAA and the leading laboratories world over. These are equipped with technology to prevent bio-fouling by using an automated wiper. A calibration unit has been established by the company at WRTC. The calibrated sensors would be swapped at each location at an interval of three weeks.

A unit of floating buoy with the solar panel and sensors would cost Rs. 20 lakhs. The toal cost of 10 such units, i.e. Rs. 2 crore is being supported through the World Bank assisted Integrated Coastal Zone Management Project. With the deployment of the sensor that would transmit the data telemetrically on real-time basis, the Lake monitoring system of Chilika Lake is now world-class. Chilika Lake is the first from Asia to put in plane such state of the art monitoring system.

Barrage. This resulted in a multi-disciplinary study employing a range of methods including detailed 2 dimensional hydrodynamic lake modelling, rainfall – runoff and sediment modelling, rapid rural appraisals, lake sediment coring and isotope analysis and GIS analysis of remote sensing data. The investigation adopted a scenario-based approach, assessing the likely implication of four scenarios:

1. A hypothetical "do – nothing" condition
2. Multi – objective: a scenario designed to minimize detrimental floods, but maintain freshwater inflows into Chilika
3. Sediment control: a scenario designed to minimize sediment loading reaching Chilika from Mahanadi River
4. Euroconsult II: a scenario recommended by an investigation from the mid 1990's predicated on sediment control

The assessment concluded that on balance, it is more important to maximize freshwater inflows to Chilika than to minimize sediment loads (which can be managed by on-going dredging of the lead channel and maintenance of the sea mouth for efficient flushing of sediment). In particular, the freshwater inflows from Naraj served an important role in flushing the brackishwater from the lake during each monsoon, creating an conducive salinity gradient critical for productive and economically valuable lake fisheries and for survival of several key species. The socioeconomic assessments brought out the productive role played by medium floods in supporting agricultural productivity within the floodplains and maintaining fisheries in the lake. Based on the assessment, an operation rule for barrage was developed which ensures that current levels of freshwater inflows are maintained whereas the incidence of major damaging floods is significantly reduced. CDA is proactively engaging with the Department of Water Resources to ensure that the flow levels as recommended by the environmental flows assessment are maintained.

- **Communication, Education, Participation and Awareness:** Participation of stakeholders, particularly local communities is crucial for integrated water management. With the existing Wetland Interpretation Center at Satpada as nucleus, CDA is implementing a range of community education and awareness programmes with an effort to create a better understanding and community partnership for managing wetland resources at local levels.

Naraj barrage influences freshwater inflow in Chilika

Implementation of Guidelines for Dolphin Watching and Bird Watching are some of the key outcomes of the engagement process. Creation of boatmen associations, bird protection committees, and water shed associations have further enabled local resource stewardship.

- **Integrated management planning framework.** In October 2012, CDA and Wetlands International South Asia developed a management planning framework to guide wetland management. Development of the framework is based on assessing the status and trends in ecological character of Chilika, identifying the threats to changes in ecological character and management objectives that need to be pursued for ensuring conservation and wise use of wetland systems. The framework provides the mechanism for linking Chilika management to river basin and coastal zone management.
- **Research and development.** Adaptive management forms a key feature of integrated water resources management. Given the range of drivers and pressures that act on Chilika at multiple spatial, temporal and political scales, management needs to be prepared for and accommodative of uncertainties and challenges and allowing for modification based on continuous site monitoring and assessment of new information. CDA in collaboration with expert agencies has initiated the following research programmes which will provide further information on hydrological regimes and ecosystem management interlinkages:
    - o **Regional coastal process assessment:** Supported under the World Bank supported Integrated Coastal Zone Management Project, this study aims to develop baseline information on the sediment shelf, in particular sediment budget for the entire Odisha coastline. The project will provide further information on the overall sediment related processes in Chilika.
    - o **Chilika Climate vulnerability assessment:** This three year research project supported by International Development Research Center and implemented in partnership with Wetlands International South Asia will focus on assessing the impacts of climate change on ecosystem processes of Chilika and related livelihoods. Details of project implementation in the last year are included in a separate article in this newsletter.
    - o **Ecosystem health assessment:** Supported under the UNEP Global Partnership on Nutrient Management, the project aims at development of a nutrient health report card that can be used for ecological monitoring as well as stakeholder dialogue.

Besides these, long term assessments have also been initiated for waterbirds, invasive species and fisheries to detect long term trends and implications for management. Details of these are at page 25.

Challenges

Water management within the River Mahanadi Basin and the coastal zone cuts across several sectors and stakeholders. Most often, the human needs from water resources are met through regulating hydrological regimes, whereas ecosystem functioning is more aligned to unregulated natural regimes. This creates complex ecological as well as socio-political tradeoffs. The Mahanadi Delta segment of the lake basin presents distinct imprints of these processes. In the natural state, the Delta exited as a flood-dependant system with its agriculture benefitting through the natural exchange of water and nutrient-rich silt and sediments.

However, the delta was subject to intensive hydrological regulation primarily during the colonial rule of the 18th century. The dynamic fluvial environment of the delta was constrained by embankments and other hydraulic structures to provide a regulated water supply to irrigated fields and thereby ensure revenue. Interventions in the form of Hirakud Dam, barrages and embankments on the distributaries as Bhargabi and Daya have been done to provide flood protection as well as extend areas under irrigation. However, the hydrological fragmentation has interfered with the natural process of silt distribution in the floodplains, thereby concentrating in the channels and ultimately deposited in the wetland system. Flow impediments have also led to extensive

water logging and increased flood vulnerability. The current management plan is thereby aimed at increasing hydrological connectivity within the floodplains so as to ensure optimal water- sediment exchange. It also aims to manage the land use system, in particular reduce the use of chemical fertilizers and pesticides considering the influence on biodiversity that resides in the wetland system.

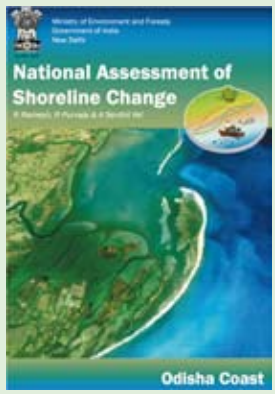
Climate change is expected to have implications for several of wetland features. More intense rainfall spells are also projected in a warmer atmosphere, increasing the probability of extreme rainfall events. State level assessments based on downscaling of general circulation models also confirm the trend. A decline in rainfall during the dry period (September – February) is projected along with an increase in summer and monsoon rainfall coupled with an increase in maximum/ peak rainfall. An increased incidence of hydrological extremes is projected.

Basin level assessments of impacts of climate change on hydrology also indicate an increasing variability of flows within Mahanadi River. The basin is predicted to receive comparatively higher level of precipitation in future and a corresponding increase in evapo-transpiration and water yield. Given the fact that much of the river flows are concentrated during the months of monsoon, enhanced flows would exacerbate flood conditions as well as pose a serious risk to the current flood regulation infrastructure. Changes are also predicted in the coastal processes. The Bay of Bengal has recorded the maximum annual sea level rise of 2.42 – 4.87 mm within the Indian coast. Sea level rise has implications for salinity as well as livelihoods of coastal communities in Chilika. A key response strategy in Chilika management is to assess the vulnerability of Chilika to these changes through scenarios, and develop an adequate response strategy to secure wise use.

Odisha Shoreline Change Assessment

The National Center for Sustainable Coastal Management, Chennai and Institute of Ocean Management published the Odisha Shoreline Change Assessment Report in 2011. Comparing the 1972 shoreline with 2010, it was concluded that the Odisha coastline, on an overall, is an accreting coast. However, 37% of the coast has been identified to be undergoing erosion and requires management.

District wise statistics indicate that erosion is dominant in the coastal districts of Puri and Jagatsinghpur whereas accretion is dominant in Ganjam, Kendrapara, Bhadrak and Balaeswar. Presence of mangroves in Kendrapara, Bhadrak and Baleswar is one off the major contributing factors supporting accretion in over 50% of the coast. High erosion zones are present to the north of Gopalpur, Paradip and Anantpur ports and to the south of Dhamra and Astaranga ports. Accretion is observed on the southern side of Paradip and Gopalpur ports. River mouths such as Subarnarekha, Bansagarh and Balijohri show high erosion in the north. High accretion is observed south of river mouths of Devi, Gamai, Kantiachara, Nunia, Panchapara and Subarnarekha.



Coastal zones are highly dynamic undergoing through erosion (loss of coastal land) and accretion (gain of coastal land) processes. Prediction of shoreline retreat and land loss rates is critical to planning future coastal management strategies. The study provides a very useful baseline for supporting integrated coastal zone management in the state.

Integrated Lake Basin Management Workshop 5 – 7 February 2013

Chilika Development Authority in collaboration with International Lake Environment Committee Foundation, Japan is organising an International workshop on Integrated Lake Basin Management from 5 – 7 February 2013 at Bhubaneswar, Odisha.

Lake basins are very important for the sustainable management of the wetland systems. The Integrated Lake Basin Management (ILBM) offers a framework for sustainably managing and conserving lakes and their basin resources, taking into account the three features of lentic water system, i.e. 1) integration of the nature and human activities in the basin, 2) long retention time, 3) complex response dynamics within the lake. ILBM calls for improving the "Basin Governance" where various management actions would have to be facilitated through formal and informal means that are directly or indirectly responsive to the above three features of lentic water systems. The ILBM frame work developed by the International Lake Environment Committee Foundation (ILEC), Japan is now considered as a very good tool for holistic management of the wetlands globally. The objective of the workshop would be to have a threadbare discussion on the ILBM frame work and to formulate the strategy for adopting the ILBM framework for sustainable management of Indian wetlands.

Dr. M. Nakamura, President, Scientific Committee, International Lake Environment Committee Foundation would participate and would be the key resource person for the Indian ILBM workshop. 10 international case studies and more than 22 Indian case studies would be presented during the three day workshop.

PROJECT UPDATE

Managing Climate Uncertainty in Chilika

Sustained provision of wide range of ecosystem services and maintenance of rich biodiversity of Chilika is linked with coastal and freshwater hydrological processes that govern the wetland system. Assessments on the impacts of climate change indicate variability and long term change in these processes, highlighting the need to factor in climate change and impacts in management planning and implementation of action plans.

This is being addressed through the International Development Research Center supported "Chilika Climate Change" project which aims to strengthen management preparedness through identification of suitable response options and strategies for reducing climate induced risks to ecosystem services. The project is being implemented by Wetlands International – South Asia and Chilika Development Authority, with the technical support of Institute of Land, Water and Society, Charles Sturt University, Australia. The current article provides a summary of the project implementation till date.

Use of ecological character for assessing climate related risks

Management of Chilika is aimed at achieving wise use defined in the text of Ramsar Convention as 'maintenance of ecological character through implementation of ecosystem approaches, within the context of sustainable development'. Assessing and responding to risks of adverse changes in ecological character is therefore fundamental to achieving wise use of wetland ecosystem.

Wetland vulnerability refers to the relationship between exposure to a particular risk event, the impact of that event on a wetland, and the ability of the wetland to cope with the impacts or the efforts needed to minimize the impacts. Coupled with understanding of the elements at risk due to a hazard and occurrence probability, vulnerability is an important element of wetland risk management. The implications of risks due to hazards are seen through changes in ecological character. Inclusion of ecosystem services within the definition of ecological character is the key direct social connect into the concept, bringing emphasis on the benefits people receive from the wetlands, choices and trade-offs made in determining and setting priorities on ecosystem services, and related institutional arrangements and governance.

Assessing vulnerability of wetland ecological character can therefore be decoupled into two interlinked components: viz. biophysical vulnerability and social vulnerability. The biophysical vulnerability assessment focuses on ecological character in more physical sense, akin to the conventional physical vulnerability assessment. Social vulnerability assessment on the other hand focuses on the exposure of communities living in and around the wetland system to the impacts of hazards. Livelihood systems become the entry point of social vulnerability analysis. This approach is in line with an emerging understanding that disaster risk and disasters, while potentiated by an objective, physical condition are fundamentally "social construction", the result of social choice, social constraints, societal action and inaction. The response of the communities living around the wetland system to the climate related risks has implications for the state of wetland ecological character, and therefore need to be factored in management planning processes.

Fisheries are at greatest risk due to changing climate

The distinction between the biophysical and social vulnerability assessment is indeed not watertight. Since, ecosystem components and processes underpin provision of ecosystem services, a choice on the latter implicitly indicates a desirability, and in certain circumstances, subjects conditions on the state of the former through a social decision making process.

Assessing biophysical vulnerability

The methodology used for biophysical vulnerability assessment is schematically presented in Fig 1. The process is initiated by defining a wetland system boundary with reference to the key governing ecosystem processes. Ecological character description entails assessing the status and trends across components, processes and services. The status and trends are assessed in three categories (excellent, good or poor) based on setting limits of acceptable change (using information on known natural variability, or the broad state that needs to be maintained to support good ecological health of the wetland system).

The prioritization process further uses a set of criterions to narrow the range of ecological character elements. For Chilika, three sets of criteria were used: administrative/ regulatory requirements (obligations under Ramsar Convention, National Wetland (Conservation and Management) Rules, 2010, Orissa Marine Fisheries Regulation Acts, 1988); ecological (criticality in supporting important ecosystem services, ability to be an integrative indicator of ecosystem state, species conservation status, key stone species) and social (importance for community livelihoods).

The risk of adverse change is based on risk perception, which is derived from an analysis of sensitivity and adaptive capacity of high and medium priority ecological character element. Sensitivity is defined as the degree to which the ecological character element is likely to be affected, either adversely or beneficially, by climate related stimuli, including the following elements of climate change: mean climate characteristics, climate variability and the frequency and magnitude of extremes. Adaptive capacity refers to the ability of the element to adjust to climate change to take advantage of the opportunities, or to cope with or moderate the consequences. The analysis is based on information generated from the existing monitoring systems, trends discerned from wetlands in similar geographic setting, and expert and community consultations.

The information from sensitivity and capacity assessment, along with information of trends in ecological character elements is used to draw a generic picture of wetland biophysical vulnerability.

Based on the evaluation of ecological character, the threats analysis is presented in Table 1. The sensitivity capacity assessment is presented in Fig 2. Based on the

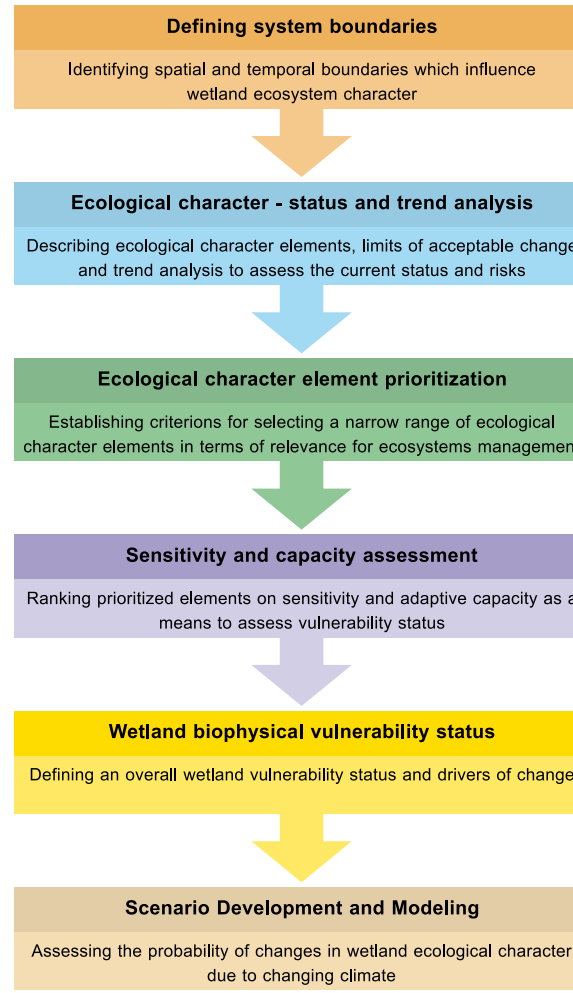


Fig 1: Biophysical vulnerability assessment

analysis, six ecological character elements, namely salinity, sea-lagoon connectivity, freshwater inflow, inundation regime, macro-invertebrate, and sea grass distribution have been identified as being in high risk category. The focus of further modelling is to create a better understanding the likelihood of changes in these elements due to changing climate.

Sensitivity \ Adaptive Capacity	High	Medium	Low
High	Water birds, Dolphins		Salinity, Macro-invertebrates, Sea-grass, FW inflow, Inundation regime
Medium		Bathymetry, Water nutrients, Emergent vegetation, Fisheries, Fish migration	Sea-Lagoon connectivity
Low	Water transport, Recreation and tourism		

Fig 2: Prioritizing ecological character elements

Table 1. Threats analysis for Lake Chilika

Key threats	Likely influence on ecological character (C= Component, P= Process and S= Services)	Likelihood of changes in ecological character in near term (High Medium, Low)
High rates of siltation		
Assessments of current siltation rates as well as results from analysis of sediment cores indicate that Lake Chilika is receiving elevated silt loads. Changes in land use within Chilika Basin aggravate this trend. Further fragmentation of floodplains have also led to changes to overall fluvial dynamics of the deltaic system, with the aggraded channels also being a course of silt into the lake.	Loss of water holding capacity (C) and thereby ability to regulate hydrological regimes (S)	High
Changes in surface-water connectivity		
Maintaining lagoon-sea connectivity is a challenge owing to high littoral drift, basin sedimentation and tidal influence. The inlet condition is rendered unstable due to reduction in tidal prism with increasing length of the channel. While the lagoon is known to go through phases of closure of sea-mouth, these changes have high implications for ecosystem service Additionally, trends indicate increasing demands for upstream water uses, which would impact spatial as well as temporal availability of water resources downstream. This is likely to induce changes in salinity regimes, with concurrent changes in biota and ecosystem services.	Changes in hydrological regimes (C), water balance (C), species migration patterns between sea-lake (P), ability to sustain fisheries (S) and regulate hydrological regimes (S)	Medium
Regional Climate change		
Mahanadi River Basin level climate modelling studies indicate changes in precipitation patterns, impacting temporal variability of the freshwater flow regimes. These changes will have an impact on salinity gradient, which is a key determinant for wetland biota and ecosystem services.	Changes in hydrological regimes with associated changes in several components and processes	Medium to High
Invasion of *Phragmites karka*		
Rapid increase in area under *Phragmites karka* is likely to enhance siltation in northern sector, stress fish breeding grounds, shift vegetation belts and create health hazards for communities.	Increased siltation in northern sector (C), stress on fish breeding grounds (P) and community livelihoods (S)	High
Increasing tourist pressure		
Restoration of overall aesthetics of Chilika, post hydrological intervention has led to increased touristic pressure. Unmanaged tourism beyond carrying capacity of the wetland system would create stresses on biota (for example Irrawaddy Dolphins) and ecosystem services.	Stress on biota (C) and ecosystem services (S)	High
Increasing tourist pressure		
Analysis of historical trends indicates a rapid increase in number of active fishers as wail as fishing boats deployed in the wetland system. The overall catch is also hovering near the recommended sustainable yield levels. If not managed suitably, there is a high risk of overexploitation of fisheries resource, with severe impacts on community livelihoods.	Stress on biota (C) and ecosystem services (S)	High
Continued incidence of destructive fishing practices		
Chilika is subject to several detrimental fishing practices which pose major threats to its sustenance. Shrimp aquaculture on the shorelines of the central, southern and outer channel impedes inundation patterns and stresses the breeding and feeding grounds of fiches and prawns. Prevalence of *Khonda* fisheries on migration pathways leads to loss of valuable biodiversity including juveniles which are destroyed in the process, and creates obstruction to natural recruitment. Cast net operation near now mouth is affecting broad fishes of mullets. Indiscriminate propelling of boats churn lake bottom leading to increased turbidity. Use of fish mesh seine nets in large scale throughout the lake blocks migratory routes of fish and prawns and leads to killing of juveniles. Indiscriminate shrimp post larvae collection has severe implications for biodiversity lost in the by-catch.	Stress an biota (C) and ecosystem service (S)	High
Skewed resource benefit sharing patterns		
The current fish marketing system prevalent in Chilika leads to higher returns to middlemen and commission agents who exploitthe vulnerability of fishers to gain undue returns from the enterprise. Even with increase in efforts, the return to fishers remains insufficient with respect to livelihood needs.	Stress an biota (C) and ecosystem services (S)	Medium

Assessing social vulnerabilities

Social vulnerability was assessed based on the current vulnerability and capacity status of communities living in Chilika basin. Baseline information on demography, social capital, natural capital, financial capital and information on technical knowledge were collected through a set of structured questionnaire at household and panchayat levels. Information on exposure, risk planning and coping and adaptation mechanism was elucidated through participatory appraisals.

An indicator framework was developed for assessing vulnerability and capacity of socio systems, economic aspects, environment aspects, coping and adaptation mechanisms and institutional set up.

The sampling frame used for selection of villages builds on the geo-morphological set up of the Lake Chilika Basin. Overall, 60 villages (~5% of the total villages) were taken up for assessment from the three sub-systems (Mahanadi floodplains, western catchments and Chilika coastline). In each village, 10% of the households were selected for interview, identified based on occupation and income as selection criteria.

Community profile

- The relationship between geo-morphological setting and livelihood systems is well elucidated by the data on occupation profile. Within the basin, wage labour forms the primary occupation of a majority of the households (41%) followed by agriculture farmers (35%) and fishers (20%). Communities in Mahanadi floodplain primarily depend on agriculture (48%) and undertake riverine fisheries (11%) as a secondary livelihood option. Daily wage labour (60%) and agriculture (39%) form the most predominant activities in western catchment. However, communities inhabiting areas closer to the lake mostly engage in agriculture (56%) and fishing activities (76%) in central and southern sector respectively. Communities in the coastline depend on fisheries and related activities for livelihoods (55%). In terms of occupational diversity, Chilika coastal communities have relatively higher sources of incomes per family (2.15) as compared to western catchments (1.94) and Mahanadi floodplains (1.8).
- Access to basic amenities (drinking water, sanitation, roads, source of energy for domestic use and electricity) is at the best marginal. Piped water is accessed by only 2.28% and good quality water by 12.27% of the sampled households, as against 92.7% stated to have access to safe drinking water at State level. The situation in terms of access to sanitation facilities is equally dismal, with < 2 % of the households having access (as compared to access at state level of ~10%).
- The average annual household income within Chilika basin was assessed to be Rs. 25,292 as compared to state average of Rs. 61,313. Chilika coastline communities who primarily depending on fishing and fish trading have lowest average annual income of Rs. 22,000. The Western catchment communities have high average annual income i.e. Rs. 28,171. Frequency of credit is maximum within Chilika coastline communities (with a rank of 0.96) having minimum asset ownership. Limited access to formal credit institutions makes Chilika coastal communities even

Kalijai Temple 'Makara Sankranti'

more vulnerable with more than 50% of households owing credit to middlemen/ fish traders. Communities in western catchment and Mahanadi floodplains have more organized financial institutions with 86% households and 43% households taking credit from SHGs. In terms of seasonality, monsoon is a stress period for fisheries as fishing activity is banned within the lake, and the marine fishing hazardous due to choppy conditions. In Mahanadi floodplains, the post monsoon period which aggravates waterlogging promotes local migration for wage labour. In the western catchments, the summer season with low water availability is a stress period.

- In terms of asset ownership (occupational assets, housing type, livestock, savings and means of transportation), Mahanadi floodplain communities have a higher diversity as compared with western catchment and Chilika coastal communities. Though occupational diversity is maximum within coastal communities, lack of land ownership and livestock makes them vulnerable on account of non fungibility of assets. Agricultural land ownership is maximum in western catchment (100%) followed by Mahanadi floodplains (61%) and Chilika coastline (10%). However, higher dependence on wage labour in western catchment is accounted for by insufficient water availability for agriculture.
- Membership to different community institutions plays a critical role to overcome stress period. In Chilika basin, ~40% of households are member to SHGs. Membership in other community institutions is fairly meger. Households in western catchment are members of farmers club to support agriculture. In Chilika coastline, majority of households are member to primary fishermen cooperative societies and SHGs to support fisheries and allied activities. Similarly, in Mahanadi floodplains, majority of respondent households are members to SHGs to support diversified livelihood options.
- Natural resources play an important role in livelihood systems. Rivers / creeks / village ponds are used as sources of water for domestic use by over 80% of the basin communities. Ponds based aquaculture provides income source to nearly 40% of the households living in western catchment and Mahanadi Delta. Community grazing lands are important natural assets for western catchments and floodplain communities. Forests and plantation are a source of fuelwood for nearly all the villages.

Hazard and Exposure

- The Chilika Basin is routinely frequented by tropical cyclones and floods every year. The landscape of Mahanadi floodplains does not aid in quick discharge of flood water and inundates adjacent settlement areas. Rivers and channels are heavily embanked and regulated with weirs and sluices. The coastal region of Chilika basin lies in the track of south-west as well as retreating monsoon and hence frequented by tropical cyclones. The western catchment region is mostly rainfed with presence of seasonal streams. Failure of monsoon results in a drought like situation in this area.
- The spatial distribution of settlements in those regions makes community vulnerable to cyclone, flood and

Fishers of Chilika coast have developed better abilities for disaster preparedness

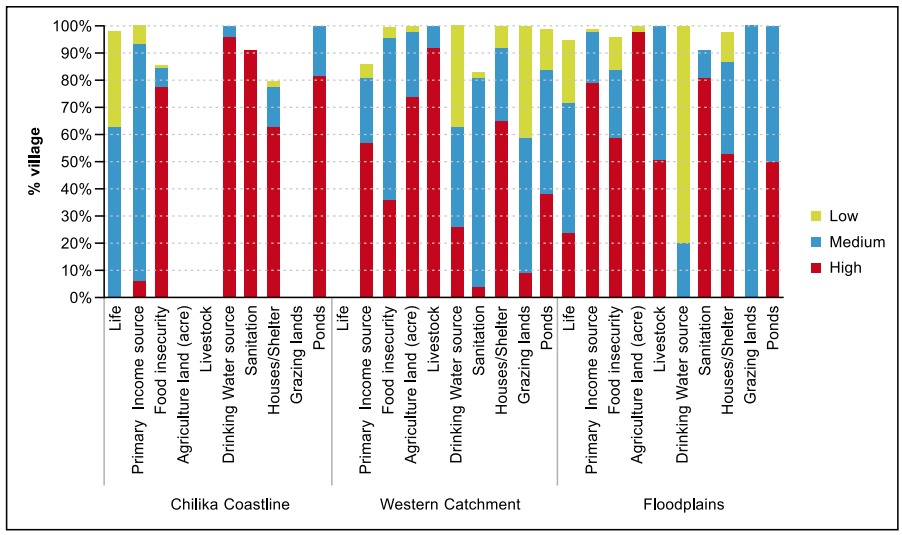


Fig 3: Elements at risk in Lake Chilika basin

drought. Multiplicity and frequency of occurrence of hazard is maximum in Chilika coastline. Limited presence of natural resource to support livelihood (only lake and ponds) in coastal region in comparison to Mahanadi floodplains (ponds, lakes, forest, grazing land) and western catchment (ponds, forest, grazing land) also ranks coastal communities low in the capacity index.

- Exposure of elements contributing towards livelihood needs is at high risk within Chilika basin. Major elements affected include food availability, drinking water source, sanitation, ponds and grazing lands reported by more than 70% of the villages in Chilika coastline. In western catchment, the primary income source i.e. agricultural land, and livestock are the major elements at risk. Life and elements supporting livelihood are at high risk in Mahanadi floodplains, major being agricultural land and sanitation system. Fig. 3 represents a comparative account of elements at risk in the three subsystems.

Coping and Adaptation Mechanisms

- Early warning systems of various forms are used to varying degrees in the Mahanadi Delta and Chilika coastline communities. Drought, or failure of monsoon, does not apparently have an early warning or forecasting system. Repeated exposure to hazards by coastal communities and the requirement to venture sea and lake for livelihoods have made communities strengthen their traditional methods of predicting hazards and using technology (mobile phones, radio/TV). The community has also developed mechanisms to interpret complex weather related information from Block Disaster Management cell. The reach of more sophisticated forecast / early warnings as through the Indian Meteorological Department or State Disaster Management Authorities was almost negligible in the area.

- Use of individual coping mechanisms differs greatly across the three subsystems. Grainbank and fuelbanks are used as coping strategies by over 70% of the communities. Within the floodplains, especially in areas within extended waterlogging, it is a common practice to construct houses on raised plinth levels. In Mahanadi floodplains, investment into corpus funds for use during disasters / stress periods was reported by 45% of the households.

- Use of insurance as risk transfer mechanism was not observed to be popular. Life insurance was subscribed to by nearly 15% of the respondents, the coverage being the minimum in western catchment villages. In Mahanadi floodplains, 22% of the households reported use of crop insurance. None of the households reported use of livestock, accident or asset insurance.

- There is emerging emphasis on Disaster Risk Reduction Planning through the state administration. Orissa was one of the first states to constitute a State Disaster Management Authority for the purpose. On an overall, 30% of the villages reported having a Disaster Management Plan, with the proportion highest in coastal villages. However, in no case was fund allocation made to implement the disaster management plans. In 23% of the villages, developmental works were reported to be carried out which had impacts for the overall risk in the target villages.

Future steps

Future implementation of the project would involve setting up of demonstration pilots within select communities living within the lake basin. The adaptation pilots would help provide insights into the strategies that need to be integrated into the wetland management plan as a means to reduce livelihood vulnerabilities due to changing climate. The biophysical vulnerability assessment would seek to develop scenarios of change for the high risk variables, assess whether the current monitoring and evaluation systems are geared towards detecting these changes and identify specific strategies that need to be included in the wetland management planning framework.

PROJECT UPDATE

Chilika Ecosystem Health Report Card Initiative

CDA in collaboration with the Institute for Ocean Management, Anna University, Chennai and National Centre for Sustainable Coastal Management (NCSCM), Government of India with the funding support from UNEP-GPA (United Nations Environment Programme-Global Programme of Action for the Protection of the Marine Environment from Land-based Activities) facilitated Global Partnership on Nutrient Management (GPNM) has initiated development of a comprehensive 'ecosystem health reporting card' approach for Chilika. The objectives of the initiative are to:

- Develop an integrated ecosystem health assessment for the Chilika Lake and its tidal tributaries using the identified reporting indicators and top-level indices.
- Create a ranking valuation scheme to compare ecosystem health assessments both geographically and over time (annual assessments).
- Effectively communicate the integrated ecosystem health assessments with spatially explicit maps and rigorous scientific analyses to all stakeholders (i.e., the policy makers, managers, resource users and the larger community members) whose actions impact the health of the Chilika Lake.

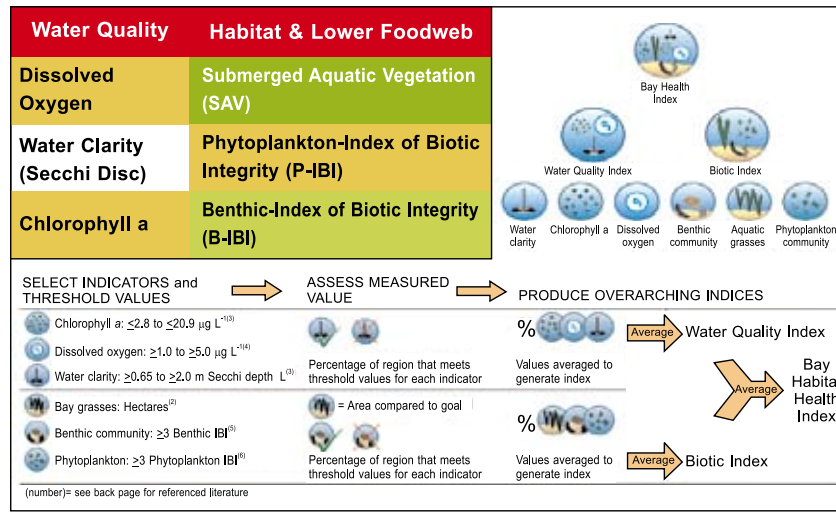
An expert group meeting and an inception workshop was held from 25 – 27 June, 2012 at the Wetland Research & Training Centre. The workshop was attended by thirty participants from ten leading organisations of international, regional and national importance and also by the non-governmental organisations and representatives of the Primary Fisherman Cooperative Societies (PFCS).

The deliberations included six technical sessions with 16 papers on related issues in Lake Management. Besides the technical session; there was an exclusive participatory session on the stakeholder's response; which was participated by the grass root level local NGOs and members of the PFCS. The use of similar monitoring tools and experiences of Manila Bay and Laguna de Bay, Philippines were presented.

The work done under the initiative thus far is summarized in this article.

The ecosystem health report card concept

Increasing non-tidal nutrient inputs to receiving waters have been associated with rising human population densities, changes in land use and the intensification of agricultural practices in watersheds. Problems associated with water quality degradation are nutrient enrichment, phytoplankton bloom, increasing extent and duration of hypoxic and anoxic waters. These issues are threat to aquatic systems worldwide; particularly in urban estuaries and lakes. Multimetric indices are important resource and ecosystem management tools that can give a robust indication of ecosystem status. Different ecosystem indices; both physico-chemical and biological parameters combined together, create an ecosystem health index. Scientific representation of ecosystem health indexes with spatially explicit maps which are readily understandable by policy-makers, scientists and most importantly local-level stakeholders.



Project Approach

The Ecosystem Health Report Card provides the scientific information in clear and simple languages as well as graphics which serves as a basis for better understanding of the health of the system and also provides opportunity to evaluate the impacts of management actions that are pursued to reach the desired goal. It is effective means of tracking and reporting the health of a waterbody at both local and regional scales. It also provides a transparent, timely and regionally detailed integrated ecosystem health assessment by setting the ecological thresholds for Chilika system based on the review of published scientific literature and technical reports.

Ecosystem health is defined as the progress of three water quality indicators (Chl-a, DO, water clarity) and three biotic indicators (seagrass, phytoplankton and benthic community) toward scientifically derived ecological thresholds. The six indicators are combined into one overarching Ecosystem Health Index, which can be presented as the report card score.

Trends from water quality assessments

Studies on biogeochemical cycling and fluxes of carbon and nitrogen in Chilika Lake revealed for the first time, a strong seasonal and spatial variability associated with the salinity. The lake was studied during both monsoon (July, 2005 and July-August, 2006) and pre-monsoon (May, 2006 and March-April, 2007) in 35 selected locations including the 11 major rivers and two tidal locations.

The dominance of nitrification is evident during pre-monsoon due to the prevalence of oxygenated conditions in the lake. NO_2 concentration was higher by 68 % and NO_3^- by 33% during pre-monsoon than in monsoon due to coupled nitrification-de-nitrification. Air-water flux of NO_2 varied considerably from sink to being an atmospheric source both in time and space. The significant diel variation of nutrients along with O_2, exhibited an apparent coupled nitrification-denitrification phenomenon mostly in presence of macrophytes in the lake. The present study indicates that the Lake Chilka is an N-dominated ecosystem in terms of biological transformation of N-species and finally the NO_2 fluxes from the lake surface. Therefore, in order to better predict the future NO_2 emissions in the lake, it is crucial to develop a long-term assessment of the biological mechanisms that produce the NO_2 and the environmental factors that influences these mechanisms.

Water quality index

The Water Quality Index (WQI) needs to be sensitive to changes in the amount of nutrients delivered to the Chilika, so that future changes in management actions can be detected. The methods and thresholds used to calculate WQI scores proved to be sensitive to nutrients. Water quality measures of chlorophyll-a, dissolved oxygen and water clarity (Secchi depth) were averaged to create the Water Quality Index (WQI).

Interpolations of average water quality conditions were produced to show spatial variability. The frequency that each water quality parameter exceeded established thresholds at every site was then calculated and mapped. The Water Quality Index was calculated by averaging the area weighted scores for water clarity, dissolved oxygen and chlorophyll-a, for each reporting region. It is then combined into a single score, the Water Quality Index (WQI) and then mapped.

In general, within each coastal region, threshold values were determined for key metrics based on a comparison to "best sites". The best and worst quality sites were identified from water quality and habitat quality information.

Biotic Indicators

Benthic Index

Submerged aquatic vegetation provide critical habitat to certain key species of crabs and fishes and can improve water clarity. Benthic Index of Biotic Integrity (BIBI) evaluates the health of the benthic or bottom-dwelling community (in soft-bottomed areas only).

Samples for assessing benthic community (bottom habitat) were collected at approximately 30 stations under the Lake Chilika Benthic Monitoring Program. Data from each sampling station is used to calculate a BIBI score. The proportion of the reporting regions meeting the BIBI score is calculated and mapped.

Phytoplankton Index

Phytoplankton (microalgae) is an important component of the Bay's food web. The Phytoplankton Index of Biotic Integrity (PIBI) is a measure of the microscopic algal community condition, as indicated through Species Richness (number of Species in known volume of sample), Shannon Weaver Diversity Index and Species Evenness (E).

Index Range	*Water Quality with respect to Plankton*
1.0-2.0	Poor
2.0-2.67	Fair-Poor
2.67-3.33	Fair
3.33-4.0	Fair-Good
4.0-5.0	Good

Table 1: Thresholds values used for each constituent of the Water Quality Index (WQI)

WQI	Oxygen Saturation	Water Clarity	Chlorophyll-a:
Threshold Values	Oligotrophic water: >80%	Oligotrophic water: >4m	Oligotrophic water: >4 µg l^{-1}
	Mesotrophic water: 10-80%	Mesotrophic water: 2–4m	Mesotrophic water: 4-10 µg l^{-1}
	Eutrophic water: <10%	Eutrophic water: <2m	Eutrophic water: >10 µg l^{-1}

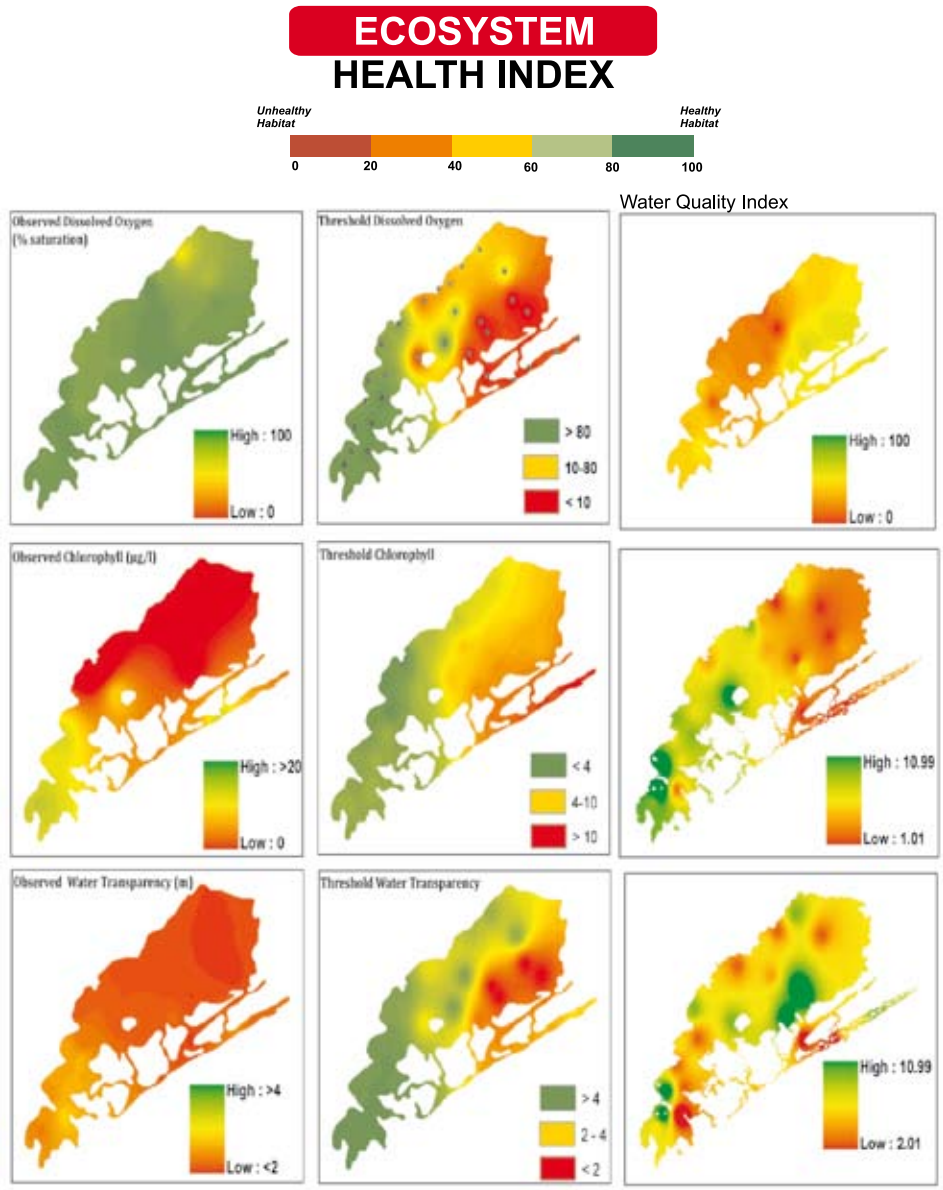


Fig. 1: Example of the Coastal Ecosystem Health Index (CHI) of Lake Chilika

Way ahead

The Lake Chilika report card is unique in that it provides a geographically detailed and integrated approach to form numerical rankings of 3 reporting regions (Northern, Southern and Central) on an annual basis. This approach compliments those focusing on assessment over longer time frames. The geographic detail provided in the report card reflects the complexity of Lake Chilika and its tributaries, and provides information that can help guide and focus restoration efforts. The report card is a product under development, and aims to give a complete assessment of the Bay health on a periodical basis. Future report card will also include indicators of fishery status at suitable spatial scales and time frames.

RESEARCH

Assessing Migration of Mullets in Chilika

Tagging followed by release and recovery is an established method to study migrations, movements, growth, age, mortalities, stocks and races of fishes. Studies on migration and movements of Hilsa (*Tenualosa ilisha*) in Ganga River, sardines (*Sardinella longiceps*) and mackerel (*Rastrelliger kanagurta*) in marine waters (Arabian seas) in India and sea mullet (*Mugil cephalus*) in Florida and Australian Coast were conducted by tagging experiments in the past with considerable success.

The first fish tagging experiment in Chilika – 1959

In Chilika lake, the first tagging experiment for six commercial fish species namely, Khainga (*Mugil cephalus*), Dangala (*Liza macrolepis*), Sahala (*Eleutheronema tetradactylum*), Bhekti (*Lates calcarifer*), Khuranta (*Rhabdosargus sarba*) and Boroga (*Daysciaena albida*) was carried out in 1959 by the erstwhile Central Inland Fisheries Research Institute (CIFRI). The experiment was conducted mainly to gather information on catadromous migration of two larger mullet species (*Mugil cephalus* and *Liza macrolepis*) which formed 77.87% of total number of all species tagged during the experiment. Consequent to the formation of Primary Fishermen Cooperative Societies (PFCSs) and introduction of leasing system for traditional fisheries sources, particularly the *Jano* fisheries to the PFCSs while implementing the first Chilika Fisheries Re-organization Scheme (CFRS) in 1959, a better cooperation and help were forthcoming from the societies in the fish tagging operation which was facilitated by availability of live fishes in good number from the *Jano* fisheries to carry out tagging operation. Maximum recoveries were also made from the *Jano* fisheries during the next *Jano* operation season. The overall percentage of recovery of all species was 6.75% and that of *Mugil cephalus* was 8.6%. Tagged fishes mostly belonged to first year class but some were older fishes as well varying in length from 169-468 mm. The experiment also demonstrated that the average growth rate of *Mugil cephalus* was 8.5 mm per month during the period November 1959 to April 1960. Directional movements showed convergence of fish to certain areas on the one hand as well as dispersion to remote parts. The areas converged at the feeding grounds of mullets where *Janos* were installed. The seaward breeding migration of *Mugil cephalus* and *Liza macrolepis* during October–December was confirmed from the experiment.

The lake had undergone dramatic eco-physiographical changes during the last four decades (1962-2000) with alarming decline in fisheries which was evident from the all time low landing of 1669 t in 1995-96. Large scale expansion of illegal prawn *gheries* (culture of shrimps within enclosures) and year round operation of *khondas* (netted box traps with long leader lines) covering large areas of lake became a threat to the fisheries in general and breeding migration in particular. Almost all the natural feeding grounds of mullets, encroached by illegal *gheries*. Although the hydrological intervention in 2000 led to the spectacular enhancement of fisheries, the relative abundance of mullets did not show marked improvement (as evident from the catch composition which ranged between 5% and 8% during the period 2001-2002 to 2011-2012). Although, the annual landings of mullets increased from average of 651.63 t. during 1954-1965 to average of 823.78 t. during

Team of Scientists and local fishers engaged in fish tagging operation in Chilika.

2001-02 – 2011-12, the percentage composition decreased during the later period due to increased total landing.

The Present Study

With the aforementioned background, Chilika Development Authority (CDA) contemplated to launch fish tagging experiment with active involvement of local fisherman during 2010-2011 after a long gap of 51 years with the main objective of gathering vital biological information on seaward breeding migration of commercially important mullets (*Mugil cephalus* and *Liza macrolepis*) and their directional movements, growth rate, homogeneity/heterogeneity nature of stock, maturity progression etc which can provide scientific basis to formulate effective fisheries resources management and conservation plan.

The experiment assumes special significance as more than 86% of fish species diversity of Chilika are migratory in nature and they maintain a part of their life cycle in the lake. The fish tagging operation under the present experiment with adequate logistic arrangement and massive publicity among the fishing communities of Chilika lake and adjacent coastal waters was commenced on November 15 after a trial operation on November 3, 2010. Much difficulties were experienced in getting live fishes in good number at one place for performing convenient tagging operation, since the old traditional *Jano* fisheries sources were non-existent unlike the situation in 1959. The lake-side outfall area of Palur canal where Khanda were operated by local fishers of Gajapatinagar village (by fixing the leader line across the canal to mainly catch mullets during their seaward migration) was selected as the main place of tagging operation and the second place of operation was selected at the new lake mouth in the outer channel. The Floy T-Bar Anchor Tags made of sterilized monofilament material with 47 mm total length. The Tag Code "CDA with Serial Number" is printed on coloured polyolefin tubing protected by clear polyolefin Shrink-Lock with monofilament through it. Three different coloured tags (blue, green and yellow) were used in the experiment. The Tags which came in cartridges of 50 tags were used by Mark II Tagging gun for a high speed operation. The Mark II Tagging gun was fitted with a heavy duty stainless steel needle (41 mm) supplied by Floy Tag & Manufacturing company, Washington, U.S.A. The tag was inserted at the base of the dorsal fin of the fish to get the T-bar firmly locked behind the rays.

Against the target for tagging 1000 fishes during the current year, 610 live fishes were tagged of which 168 (27.54%) were *Mugil cephalus* and 427 (70%) were *Liza macrolepis*. Besides, 11 number Asian sea bass (*Lates calcarifer*) and 4 number sea bream (*Rhabdosargus sarba*) were tagged during the period November 3, 2010 to December 26, 2010 in three phases involving 21 operations. The size of tagged fishes ranged from 243 mm (140 g) – 534 mm (1800 g) for *Mugil cephalus* and 206 mm (100 g) – 421 mm (880 g) for *Liza macrolepis*. The average size of *Mugil cephalus* and *Liza macrolepis* were 350 mm and 304 mm respectively. Total mortality of tagged fish after 2-4 hours of captive conditioning in FRP circular pools under aeration condition was recorded to be 35 (5.74%). In total, 575 tagged mullets in good live condition were released in the lake at 21 different locations spread over three sectors of the lake within a distance ranging from 15-45 kms from the point of tagging operation as depicted in Map 1. The mortality of tagged fishes was due to long duration transportation by motorized boats to reach the destinations of release. Information on species, sex, body weight, total length, tag serial number, place of tagging operation, duration of captive conditioning, place of release and mortality at release were recorded as initial data in the experiment for scientific analysis of recovered/recaptured tagged fishes.

Recoveries and data analysis

The migratory routes of tagged fishes (*Mugil cephalus* and *Liza macrolepis*) are depicted in Map 2. The details of tagging operation are presented in Table 1. In the present tagging experiment, recoveries were made during

Mark-II tagging gun used in fish tagging operation in Chilika.

Tagging gun loaded with a clip of numbered tags.

Fish with inserted tags

T-bar of the tag firmly locked behind the rays of dorsal fin

Onboard tagging operation

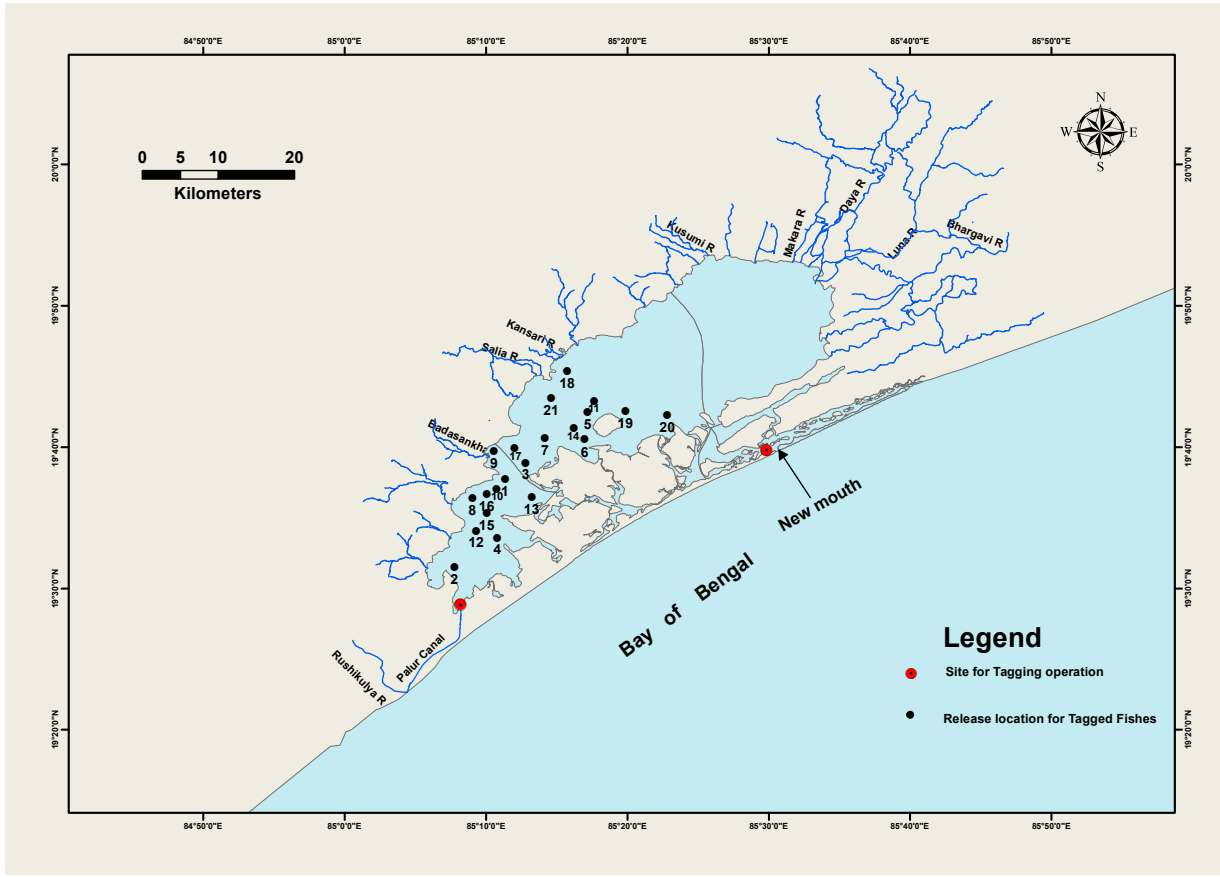
Tagged fish under captive conditioning with aeration

Tag being inserted into the fish at the base of the dorsal fin

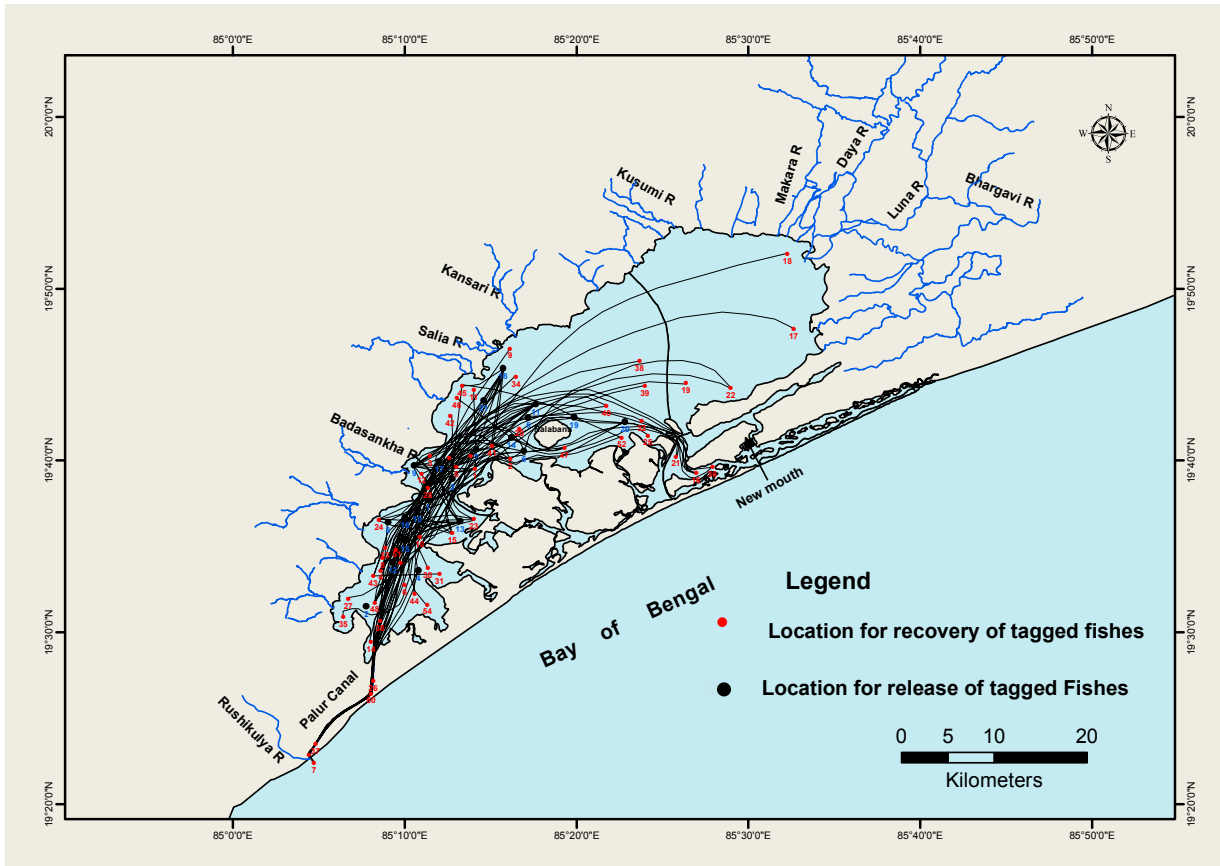
November, 2010 to August, 2011. The first 2 months (November and December 2010) were the months of simultaneous tagging and recovery. By August 2011, the total recovery of tagged fishes were 111 (19.3%) which were received at six pre-announced receiving stations at Chilika; the maximum recovery for one location was 31.25%. The maximum distance travelled by *Mugil cephalus* in the lake was 45 kms in 19 days. Considerably higher recovery of tagged fishes within 3 months of tagging operation is attributable to excessive fishing activities using different types of fishing gears (gill nets and drag nets) in the lake. Since the news of tagging experiment and attractive cash incentives for bringing the recaptured tagged fishes to the receiving stations was widely publicized, a higher percentage of recovery (19.3%) could be possible. The higher percentage of recovery in the present experiment is comparable to overall recovery of all species (6.75%) and that of mullets (8.6%) in the first experiment in 1959.

Recovery of tagged fishes is likely to throw light on impact of changed eco-physiographical condition of the lake as well as the impact of blockage of natural water channels and use of *gheries*. It will also help gather reliable information on growth and movements of the tagged fishes.

However, recovery of 111 tagged fishes during ten months of tagging operation has indicated convergence of directional movements to the known feeding grounds of mullets where *Janos* were erstwhile installed in the past and presently occupied by the illegal ghereis and the dispersion as observed from the recoveries suggested stock homogeneity to a limited extent only, which is a matter of conjecture. Non-recovery of tagged mullets from inner Chilika and fairly good recovery from Palur canal mouth suggested that the obstructions by ghereis have prevented the breeding migration of mullets through inner Chilika during winter. In 1959, the only spawning migration route for mullets was found to be the Outer channel through lake mouth. In the present experiment, Palur canal in the southern sector has been found to be another potential winter spawning migration route for mullets.



Map 1: Location of tagging sites and release of live fish



Map 2: Movement of tagged fish within Chilika

Table 1: Details of fish tagging experiment in Chilika lake during 2010-2011

1)	Period of tagging operation	. . .	3 November to 26 December 2010
2)	No. of locations for tagging operation	. . .	2 (Palur canal mouth and New Lake mouth)
3)	No. of locations for release of tagged fishes	. . .	21
4)	Total fish tagged during 3.11.2010 and 26.12.2010	. . .	610
	Mugil cephalus	. . .	168
	Liza macrolepis	. . .	427
	Lates calcarifer	. . .	11
	Rhabdosargus sarba	. . .	4
5)	Total mortality before release	. . .	35
6)	Tagged fish released in live condition	. . .	575
7)	No. of locations for recovery/recaptured of tagged mullets	. . .	42
8)	Overall recovery	. . .	19.3%
9)	Maximum recovery for single location	. . .	31.25%
10)	Mean size of tagged mullets at release		
	Mugil cephalus	. . .	350.24± 47.23 mm
	Liza macrolepis	. . .	304.00± 37.03 mm

Useful biological information from the experiment

- The average rate of growth for *Mugil cephalus* was 9.9 mm per month as against an average estimated growth rate of 12.5 mm per month between first and second year classes. The average rate of growth for *Liza macrolepis* was 8.1 mm per month.
- Directional movements of tagged fishes showed, in most cases, a convergence of fish to certain areas (where erstwhile *Janos* were located) suggesting for feeding purpose and in certain others dispersion to remote areas of the lake suggesting homogeneity of stocks.
- Maturing and mature mullets (*Mugil cephalus* and *Liza macrolepis*) undertook seaward breeding migrations mostly during the period October to December, November being the peak month.
- Unlike the findings of 1959 experiment, Chilika mullets (*Mugil cephalus* and *Liza macrolepis*) did not undertake seaward spawning migrations through the water channels of "Inner Chilika" (Krushnaprasad area) due to obstructions by illegal prawn gherries.

Flamingoes in Nalabana

Three Long Term Studies Initiated in Chilika to Support Wetland Management

Chilika Development Authority, under the World Bank supported Integrated Coastal Zone Management Project has initiated three long term assessments to support management of Chilika.

Waterbird population monitoring in Chilika Lake

CDA in its ongoing collaboration with Bombay Natural History Society (BNHS) has commissioned a study to monitor bird ecology with special focus on the habitat management in the lake. The proposed study will recommend conservation measures for the important waterbird congregation sites, threatened, and vulnerable species based on extensive field and laboratory studies.

This five year study is funded by World Bank and has following key objectives: i) monitoring species wise composition of migratory birds, waterfowl, and waders in Chilika Lake (ii) establish a correlation between bird congregation and biohydrological parameters of the site (iii) identify suitable sites for the creation of new islands similar to Nalabana to minimize the overcrowding (iv) monitor breeding success of birds to recommend further conservation and habitat improvement measures (v) disease surveillance to monitor avian diseases and highly pathogenic avian influenza virus (vi) to impart training on waterbird monitoring to the personnel of CDA, wildlife division, NGOs, and local community.

In year 2012, fortnightly bird counts, arrival dates for migratory birds, and surveillance for dead and sick birds was recorded from Mangalajodi, Nalabana, Rambha, Kalupadaghat, Gurubai, Palur, and Parikud sites. Several threats to bird habitats such as prawn *gheries* and increased macrophyte covered area were observed in Nalabana and Parikud. Almost the entire exposed mudflats in Parikud-the only feeding and roosting place for the wintering waders in Chilika during their arrival time (November-December) have been found either destroyed or altered due to prawn *gheries*. *Phragmites karka* which was initially confined to some patches in Nalabana has started proliferating to other areas of island and might pose threat to waterbirds that prefers open water surface for resting and diving.

Assessment of macrophyte biodiversity in Chilika and its shoreline

Macrophytes are excellent bioindicator of wetland's ecosystem health and also provide specific ecological services such as shelter to fishes, aquatic invertebrates, and breeding grounds to the waterbirds. CDA in collaboration with Regional Plant Resource Centre (RPRC), Bhubaneswar initiated a comprehensive investigation on mapping of macrophytes of lake water and terrestrial plants growing in lake, shorelines, and islands. Once completed, this World Bank funded study will provide a fine scale resource inventory specifically focused on macrophytes. The data will be useful in formulating appropriate conservation and management strategies, stock assessment, and habitat improvement.

This four year research study has following specific research objectives: i) resource inventory, quantitative assessment, and mapping of aquatic macrophytes and terrestrial plants (ii) analysis of the diversity, distribution, density of aquatic angiosperms and their correlation with physicochemical properties of Lake ecosystem (iii) study on distribution, succession, association, species composition, regeneration potential of vegetation of

shorelines and islands (iv) assessment of yield and productivity of aquatic macrophytes and their economic contribution to the livelihood of local people (v) identification and study of the extent of distribution and spread of invasive species.

This study during its first year of inception has carried out quantitative ecological studies on terrestrial and aquatic vegetation at several sites such as Badakuda, Kalijai, and Kalijugeswar islands. Shoreline vegetation was analyzed at six sites namely Langaleswar, Pathara, Godinala, Patna, Tentuliapada, Keshpur. Plant specimens were collected, identified, and preserved as herbarium specimens. Current satellite based macrophyte distribution maps of Chilika Lake were analyzed and validated for ground reality. Molecular characterization and genetic diversity assessment of selected rare and endangered plants and relict mangroves will be undertaken in the next phase of ongoing research.

Post-restoration assessment of the ecology and fisheries diversity of Chilika

In year 2000, a new mouth was opened in Chilika to restore the declining salinity, biodiversity, and fishery resources. There has been a significant increase in the fish diversity and production after the hydrological intervention.

In year 2012, CDA commissioned a collaborative study with Central Inland Fisheries Research Institute (CIFRI) for sustainable management of the fisheries resources of the lake. The results from this World Bank funded research will aid in designing appropriate management guidelines and conservation measures for the fisheries resources of the lake. The key objectives of this research program are: i) assess the changes in fishery resources that might have occurred during post-restoration period with regard to ecology, species abundance, biomass, and diversity (ii) monitor the species diversity, biomass, fish production trend, and stock assessment of important fish species in commercial catches, and (iii) assessment of stock structure and spawner–recruitment relationship of selected fish species.

Stands of Phragmites in Chilika

Data collection regarding fish production trends, yield potential, recruitment, and stock assessment was done in four major fish landing centers viz. Bhusandapur, Kalupadaghat, Sorana, and Balugaon. Six major fish species; *Eleutheronema tetradactylum, Mugil cephalus*, *Daysciena albida, Etroplus suratensis, Liza macrolepis*, *Valamugil cunnesius* were selected for targeted population biology studies and stock assessment. For regular monitoring of the fish population diversity, benthic community, and water quality (nutrients, heavy metals, and pesticides), 13 stations scattered across four different sectors of the lake were selected. A total of 151 fish species were recorded during first year of study while two species namely, *Favonigobius reichei* (Tropical Sand Goby) and *Neotropius atherinoides* (Indian Potasi) have been found as new records from Chilika Lake. Under the training component of the project, six personnel deputed by CDA have been imparted laboratory and field training on "Ecology and Fisheries Assessment of Chilika Lake" from 21 – 30 August 2012.

Coffee Table Book on Chilika

Chilika: The Celestial Lake – a new coffee table book published by Mr. Abasar Behuria and Mr. Basudeb Pal Majumdar in 2012 is a pictorial tour to the avian grandeur and landscape of Lake Chilika. The book contains 87 beautiful pictures of the floral and faunal diversity, with particular reference to the winged visitors from Siberia and Central Asia.

Irrawaddy Dolphin Population Increases in Chilika

Irrawaddy Dolphin in Chilika *Photo: Muntaz Khan, CDA*

The Irrawaddy Dolphin Census in Chilika carried on January 19, 2013 indicates that their population has increased to 152 as against 145 recorded during the 2012 census.

Of the 152 individuals sighted, 118 are adults, 16 sub-adults and 18-calves and neonates. For the first time, 8 sighting were reported from the Northern Sector, an indication of their expanding habitat within the wetland. The increase in population is due to an increase in number of calves and neonates to 18 from the last years 11 sightings.

The population survey was conducted using the globally practiced line transect method. 18 survey transects were covered, with a team, including three experts assigned to each. The survey was carried out by 130 participants from State Government's Wildlife Wing Officials and Animal Resource Development Department; Honorary Wildfire Wardens; Chilika Wildlife Division; officials from WWF- India; BNHS; NGOs; researchers and academicians from the University and colleges; Wildlife Society of Odisha; Geoenvitech, Bhubaneswar; Regional Plant Resource Center; Electronika Lab; State Project Management Unit, Integrated Coastal Zone Management Project; Peoples for Animals; Chilika Development Authority, and members of local Motor Boat Associations.

The survey was carried out from 6.30 AM to 4.00 PM on January 19, 2013 in the dolphin habitat of the Chilika lagoon. The first attempt on January 7 – 8 had to be abandoned due to low visibility and high velocity winds. Training to participants was held at Wetland Research & Training Center, Chandraput and Visitor Centre, Satapada in the afternoon of 18th January, 2013.

The local motorboat associations in a unique expression of solidarity to the survey process did not operate their boats during the census period.

It is noteworthy that Chilika is a natural abode of highly endangered Irrawaddy dolphins (*Orcaella brevirostris*). The present distribution range of this species is only in Asia i.e. from Chilika to Indonesia within South East Asia and South Asia. Their total global population is estimated to be less than 7500 (highest 6400 reported from Bangladesh). The population in Chilika is considered to be the highest single lagoon population.

Chilika Development Authority has initiated many conservation measures for the protection and conservation of Irrawaddy dolphins in Chilika in close coordination with Wildlife wing of State Forest Department such as: (1) Survey and identification of dolphin habitat in the lagoon for proper management, (2) Development of dolphin watching protocol for safe watching of dolphins, (3) Sensitization and training of tourist boat operators, (4) Widening and deepening of Magarmukh channel for free movement of dolphins from Outer channel to the main lagoon, (5) Acoustic survey of underwater behavior of dolphins through deployment of hydro phones in collaboration with Tokyo University.

Sector	Adults	Sub-adults	Calves/ Neonate	Total
Central Sector	23	5	7	35
Southern Sector	25	4	6	35
Outer channel	63	6	5	74
Northern Sector	7	1	-	8
Total	**118**	**16**	**18**	**152**

Chilika Junior Rangers Programme

Chilika Development Authority in collaboration with State Forest Department, US Consulate, Hyderabad and volunteers of NGO Barefoot will launch Chilika Junior Rangers' Programme on February 2, 2013 -World Wetland Day. This programme is aimed at introducing school children (aged 10-14) to values and functions of Chilika, and the ways they can contribute to her conservation.

During this first of its kind initiative, students shall LEARN, EXPLORE and PROTECT the nature. They will learn about the Irrawaddy Dolphins, bird watching, fisheries and several other aspects of the wetland.

Both children and adults benefit by learning more about the park and sharing the fun of becoming a Junior Ranger. The student would camp at exclusive locations on the islands of the lake and would enrich their knowledge by the inputs from the subject matter experts. On successful completion of the programme they would get the customised certificate and a rangers badge.

Chilika at the side events at the Convention on Biological Diversities CoP11 at Hyderabad

The eleventh conference, widely known as CoP11 was hosted by India and organized at Hyderbad from 1-19 October, 2012. The convention was attended by more than 8000 delegates from 193 member countries.

The Chilika Development Authority & Integrated Coastal Zone Management Project, SPMU, Odisha participated in one of the major side events of the CoP11 i.e. "Lagoons, Lives and Livelihoods" organized by the SICOM, NCSCM and the ministry of Environment and Forests on 15th October 2012. A documentary on the 'restoration of Chilika lagoon with an ecosystem approach "A new lease of life" was premiered in the event.

The Project Director of the Integrated Coastal Zone Management Project (ICZMP) – Odisha led the delegation in the side events named "Lagoons, Lives and Livelihoods" and briefed the panel on the people's participation in biodiversity conservation and wise use of natural resources at Chilika.

The event jointly organized by the ministry of Environment & Forests in association with SICOM, NCSCM was inaugurated by Smt. Jaynthi Natarajan, Hon'ble Environment & Forests Minister, Government of India. The eminent Panelist were Prof K. Kasturirangan, Member, Planning Commission, Dr. Anada Tiéga, Secretary General, Ramsar Convention Secretariat, Dr. Shailesh Nayak, Secretary, Ministry of Earth Sciences, Secretary Ministry of Forest & Environment, Dr. Ajit Pattnaik, Chief Executive of Chilika Development Authority and PD, ICZMP – Odisha, Prof. Alice Newton, Norwegian Institute for Air Research (NILU) and Shri Vivek Wadekar, National Project Director of SICOM, Prof. R. Ramesh, Director, NCSCM along with the local communities from Chilika lagoon.

Side event at CBD CoP11

The panel widely discussed on the need to strengthen ecosystem and community based management strategies. Panelists discussed on the successful restoration of Chilika Lake with ecosystem approach that led to amelioration of the lake ecosystem and enhanced productivity that immensely benefited the local communities.

The case study on Chilika was also highlighted in the side event on Water, Wetlands and Aichi Targets, organized by Wetlands International South Asia on October 9, 2012. The side event aimed at developing concrete and practical recommendations for enhancing recognition of integrated water management as a means of achieving conservation of inland waters and meeting the related targets under the CBD Strategic Plan 2011-2020. Over 40 participants representing Ramsar Convention, CBD Secretariat, national delegates, development banks, representatives of non-governmental organizations and media attended. The presentations and discussions held conclusively underlined that integration of wetlands within water management underpins success in achieving the Aichi targets. This was currently being undermined by lack of emphasis on the co-benefits that the two sector could achieve by working together. Expressing the values of wetland ecosystems would be one of the important means of cross sectoral communication.

Ramsar

Chilika

WETLANDS INTERNATIONAL

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2 February
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2013

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Conserve and restore Chilika Lagoon ecosystem with its rich biodiversity and aquatic resources for the benefit of stakeholders, particularly local communities through participatory processes, research and ecologically sound management techniques for the present and future generations.

WETLANDS INTERNATIONAL

To sustain and restore wetlands, their resources and biodiversity

Dr. Ajit Kumar Pattnaik
Chief Executive
Chilika Development Authority

Plot No. C/11, B.J.B. Nagar
Bhubaneswar - 751 014, Odisha, India
Tel: +91-674 - 2434044
URL: http://www.chilika.com

Dr. Ritesh Kumar
Conservation Programme Manager
Wetlands International - South Asia

A-25, (2nd Floor), Defence Colony
New Delhi - 110 024, India
Tel: +91-11 - 24338906
URL: http://south-asia.wetlands.org