**Chilika Lake: Restoring Ecological Balance and Livelihoods through Re-Salinization**

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## 1. Prologue

Chilika Lake (also referred to here as Lake Chilika, or simply "Chilika"), situated along the east coast of India is a Ramsar site i.e. a wetland of international importance. The lake is an assemblage of marine, brackish and freshwater ecosystem. Spatial and temporal salinity gradients, because of the freshwater river in flow and diurnal seawater in flux, have created unique characteristics of an estuarine ecosystem and exercised a continuous, selective influence on the biota. Unfortunately, its unique ecosystem, biodiversity and productivity were on the decline during the early '90s, because of choking of the inlet due to oceanic long-shore transport. This had a deleterious impact on the lake ecosystem and is considered as the root cause of degradation. The lake was included in the Montreux Record due to change in its ecological characters, by Ramsar Convection. To address these multiple issues involving multi-stakeholder interests and for sustainable management of the lake and its basin, Chilika Development Authority (CDA) was created by the Government of Odisha in 1991. For the restoration of the lake, CDA adopted an ecosystem approach. Based on the outcomes of the numerical modelling, a new inlet was created by CDA in October 2000, to restore the dynamic salinity regime of the lake. To address the lake basin issues an innovative participatory micro-watershed management concept was adopted by CDA, with a "sustainable livelihood" approach for the holistic management of natural resources of the basin. Steps were also taken for treatment of the degraded micro-watershed of the lake basin to reduce silt load. Management efforts by CDA resulted in a spectacular revival of the lake ecosystem and fishery resources and contributed to a sharp rise in the incomes of fisher folk who depend on the lake for their livelihood. Chilika Lake was removed from the Montreux Record because of the improvement of its ecosystem in 2002. The case study illustrates how the strategy adopted by CDA for successful restoration and management of Chilika Lake mimics the ILBM six pillar principles.

## 2. About the Lake

Chilika Lake is situated on the east coast of India, between 19° 28' and 19° 54' North latitude and 85° 05' and 85° 38' East longitudes of Odisha State of India (Fig-1). It is one of the largest brackish water lakes in Asia with estuarine character. The water spread area of the lake varies between 1,165 and 906 $km^2$ during the monsoon and summer, respectively. Freshwater runoff from the drainage basin, combined with saline water inflows from the ocean, results in a wide range of fresh, brackish and saline water environments within the lake, and this spatially and temporally diverse water environment supports an exceptionally productive ecosystem (Ghosh et al., 2006). The lake can be broadly divided into four ecological sectors based on salinity and depth i.e. the southern sector, central sector, northern sector and the outer channel (Figure 1). Hydrologically, Chilika Lake is influenced by three subsystems, including the Mahanadi river system, rivers flowing in the lake from the western catchment, and the Bay of Bengal. The lake receives freshwater from a series of 52 Rivers and rivulets (Figure 2). The Chilika Lake basin, including the lake itself, covers an area of over 4300 km (Das and Samal 1988).

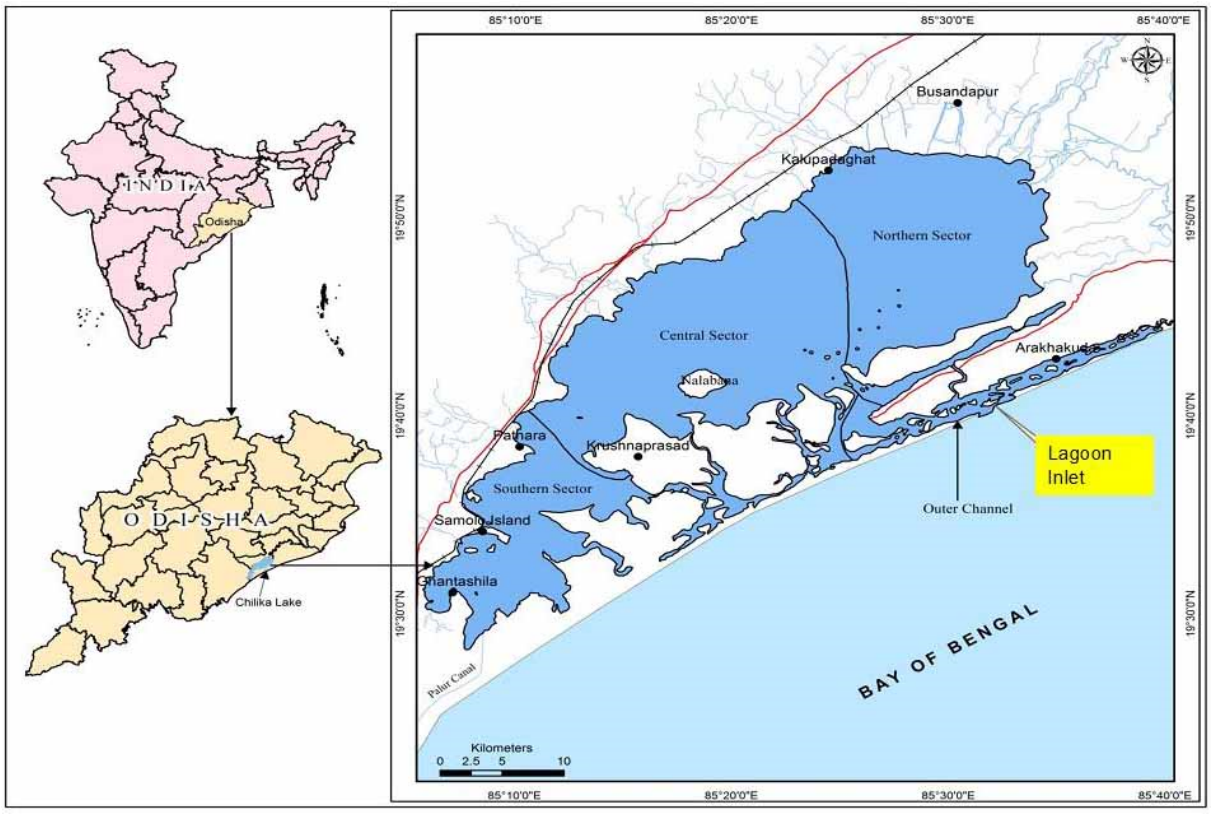


Figure 1. Location of Chilika Lake


Figure 2. Drainage Basin of Chilika Lake

The long-shore sediment transport (littoral drift) along the coast of the Bay of Bengal is ≈0.1 million MT annually and tends to shift the lake's mouth opening to the sea every year, thereby adversely affecting tidal exchange (Ghosh et al., 2006). Although this phenomenon was used to significantly affect the salinity regime, the flushing pattern and consequent natural recruitment of biological species, a new mouth to the ocean has since been created, ameliorating the situation. The spatial and temporal salinity gradients, as a result of freshwater flows from the riverine system and seasonal seawater influx, have given Chilika unique characteristics of an estuarine ecosystem and exercised a continuous, selective influence on the biota (Ghosh et al., 2006).

The salinity level in the lake is dictated by river discharges during different seasons, wind action, and the extent of tidal influx carrying marine water from the Bay of Bengal. Before the new mouth was opened, the average salinity had been reduced by a third by the late 1995 –1996, severely affecting the biota of this saline ecosystem. The seasonality of rainfall also leads to large fluctuations in the size of the lake.

Chilika Lake is one of the hot spots of biodiversity, and habitats for some rare, vulnerable and endangered species listed in the IUCN Red List of threatened animals, which inhabit the lake area for at least part of their life cycle. This list includes species such as highly threatened Irrawaddy dolphin and the limbless skink which is endemic to Chilika Lake. It is the largest wintering ground for migratory waterfowl in the Indian sub-continent. More than 0.5 million migratory birds winter here annually. Nalabana wildlife sanctuary located in the central sector of the lake is the major congregation area. Out of the 164 species of wetland birds recorded from Chilika, 66 are intercontinental migrants from far parts of Asia, including the Caspian Sea, Lake Baikal and Siberia. The highly productive ecosystem of the lake with its rich fishery resources supports the livelihood of more than 200,000 fishers who live in and around the lake. The lake has been extremely important for the local communities from the cultural and spiritual point of view.

## 3. The Problem

Unfortunately, Chilika Lake was facing a series of problems by the early 1990s that impaired many of its ecosystem functions and services. The lake basin and coastal process are integral factors determining the ecological integrity of this coastal wetland. The freshwater inflows drive the temporal and spatial salinity dynamics of the lake, which contributes to the mosaic of aquatic habitats for different plant and animal species, and the varying life cycle requirements of these species. It is primarily this dynamic salinity regime that enables the lake to support diverse biodiversity and a productive fishery. The highly productive ecosystem of Chilika Lake sustains the livelihood of 200,000 fishermen and 800,000 persons in the lake basin community. The lake encountered a combination of increased siltation due to changes in the land use pattern and degradation of the drainage basin, as well as partial closure of the outlet channel connecting the sea. The decrease in salinity caused the proliferation of invasive species, increased turbidity, shrinkage of water-spread area, loss of biodiversity, and depletion of fishery resources.

The retarded flow through the old inlet caused a low tidal flux, variation of water levels, seawater flow into the lake and lower drainage time that resulted in water logging in the agricultural lands of the peripheral villages, around the lake, which subsequently led to complete crop loss, affecting more than 50,000 hectares, to the miseries of the agricultural

communities. The overall decline in productivity both in the lake and its basin adversely affected the livelihood of the local community. Due to changes in its ecological character resulting in loss of biodiversity and productivity, it was included in the Montreux Record maintained by Ramsar Bureau, in 1993.

## 4. Addressing the Problem

In 1992, in response to the steady degradation facing the once lively Chilika Lake, the Government of Odisha created the Chilika Development Authority (CDA). Management issues associated with restoration of this complex ecosystem were so vast in scale ecologically, hydrologically and socioeconomically that meticulous integrated planning was necessary to address them. To address these issues, CDA facilitated a consultation process at the national and international level, to initiate key targeted studies essential to a management-directed understanding of the ecosystem, and to trace the root cause of its degradation, and appropriate corrective measures to restore the ecological integrity and functionality of the lake and its drainage basin.

CDA initiated an integrated adaptive management process to address the complex ecological and socio-economic issues of the Chilika Lake. The lake basin was considered as an integral and the logical starting point of restoration of the lake. There was an assessment of the root causes of degradation to implement appropriate and effective methods to restore the lake to its former healthy state through targeted scientific studies and wide stakeholders' consultation.

Intensive studies of the coastal processes showed that the tidal influx into the lake was adversely affected by the shoal formation along the lead channel and continuous shifting of the mouth due to littoral drift. This also adversely affected the natural recruitment of species through the mouth opening to the sea. For a clear understanding of this complex eco-system, the services of the premier institutes of the country were commissioned by CDA to carry out targeted studies to trace the root cause of degradation of the lake ecosystem. Central Water and Power Research Station (CWPRS), carried out a numerical modelling to trace the cause of poor tidal and salinity flux into the lake. The studies concluded that the tidal influx into the lake was considerably reduced because of the shoal formation along the lead channel and continuous shifting of the mouth that resulted in a significant hydraulic head loss. Based on the model output CWPRS recommended for the opening of a new outlet closer to the lake.

The findings of the model studies were explained to the local communities through grass-root level NGOs and community-based organizations through village level meetings. Interestingly, during the process of consultation, it emerged that the opening of an artificial mouth was a long-standing desire of the local community. The hydrologic restoration was a prerequisite for the restoration of the complex lake ecosystem. The strategy adopted was to opt for a more ecologically beneficial hydrologic regime to; improve water quality, recovering the lost habitat of the important species, enhancement of fishery resources and controlling the invasive species. With the output from the scientific studies and the community endorsement a very convincing restoration plan could be formulated, which enabled the Chilika Development Authority to receive funds from the Government of India to implement the restoration plan. Following the recommendations of the CWPRS, a new mouth was opened on 23rd September 2000,

which reduced the length of the outflow channel by 18 km. In addition to this, the desilting of the lead channels was also accomplished to facilitate proper exchange between the sea and the lake and vice versa. The strategic hydrological intervention by the opening of the artificial mouth and the desiltation of the lead channel not only rejuvenated the lake ecosystem but also immensely benefited the local community by way of amelioration of their livelihood.

After this intervention, there has been significant improvement of fishery resources due to auto-recruitment, improvement of the tidal and salinity flux into the lake, flushing out of sediment to the sea, the decrease of freshwater invasive species, expansion of seagrass meadows, steady increase in the population of Irrawaddy dolphins, and waterlogging.

Simultaneously, an innovative participatory micro-watershed management concept was adopted with a “sustainable rural livelihood” approach for holistic management of natural resources. The lake basin management program was conceived as a long-term participatory process. The objective of this concept was to facilitate the community through empowerment to make decisions and build capacity to work collectively. The participation of local communities and stakeholders in planning and implementing management of natural resources and in sharing the responsibilities of decision-making is a key feature of the ecosystem approach. They have considerable, relevant knowledge of the ecosystem and ways in which it can be sustainably managed. The basic approach was to create an enabling environment, through capacity building of the community, community-based organisations and NGOs at the outset, and a series of need-based training programmes to facilitate integrated and holistic management of micro-watersheds by the community. The goal was to empower the community to manage and reverse the degradation of life support systems within the watershed, particularly land and water, to enhance the productivity, resulting in alleviation of poverty and promoting improvements in livelihoods of agricultural communities. The focus was on the restoration and conservation of a degraded life support system within the micro-watershed.

In general, many find it difficult to recognize that people are an integral part of the ecosystem. An analysis of needs, value and perspectives of local communities are fundamental to ecosystem management. To achieve this, an innovative grassroots approach was adopted by the CDA, by formulating a micro-plan, blended with indigenous knowledge and appropriate experts' input, for optimum utilization of the natural resources in a sustainable manner and to increase productivity and provide equal opportunity for a livelihood for the landless, marginal farmers and women. To ensure the involvement of the community and sustainability, it was ensured that the lake basin community share a part of the costs of the treatment towards the watershed development fund which would be utilised for the maintenance and further improvements of the watershed assets created after the project ended.

The watershed association and the user groups were able to efficiently implement the micro-plan in consultation with the community. One of the most successful initiatives was a series of rainwater harvesting structures, which the community designed and installed. They succeeded in recharging aquifers and transforming the ecosystems as well as their surrounding economies.

## 5. Outcomes

### 5.1 Improvement of the salinity regime and fish landing

The opening of the artificial mouth and the desiltation of the lead channel not only rejuvenated the ecosystem of the lake but also immensely benefited the community depending on the lake whose average annual income increased by more than the US $ 1,040 per family. Salinity is the most dominant factor determining the lake's ecology. As previously mentioned, the lake is connected to the Bay of Bengal by a narrow inlet and constricted outer channel. In the past, the inlet frequently tended to shift to the north, affecting the tidal influx into the main lake. There have been significant improvements in the salinity gradient after the opening of the mouth (Figure 3). Before the opening, the salinity level of the northern sector of the lake used to remain zero throughout the year. There used to be an abrupt change in the salinity level of the central and outer channel at the onset of monsoons.

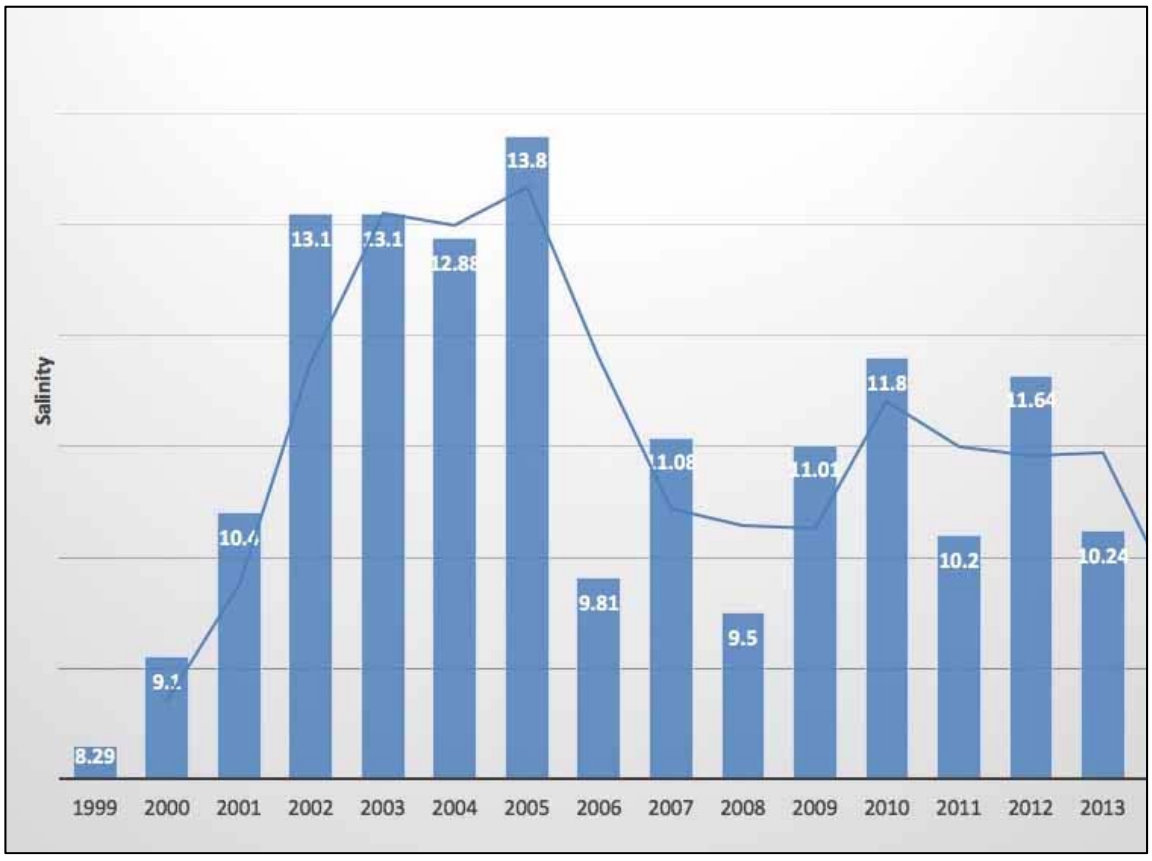


Figure 3. Annual Average Salinity of Chilika Lake from 1999-2014

For an ecosystem with the seasonal and sectoral characteristics as indicated above, an appropriate salinity gradient with a gradual decrease from the lake mouth towards the lake proper is desirable. After the opening of the new mouth, less fluctuation of the salinity gradient was observed. The gradual reduction in the salinity from the lake mouth to the lake interior after the opening of the mouth is providing the desirable sense of direction for the euryhaline forms to enter into the lake from the sea. This facilitated the auto-

recruitment of fish, prawn and crab into the lake. The annual average fish (fish and prawns) landing during the '90s had plummeted to mere 1600 metric tons per annum. In 2000, the average increased by eight times that amount, to an all-time high of 14,000 metric tons in 2004 and is maintained at maximum sustainable yield (MSY) level (Fig-5). Based on the average weighted price, the total financial return from enhanced fisheries alone is estimated at US$20 million. The per-family income has increased by US$1,040 per annum after the hydrological intervention. After the opening of the new mouth, six species of fish and one species of shrimp (of commercial importance) reappeared. The increase in the fishery resources facilitated the community to adopt self-initiated good practices, like regulation of the mesh size, refrain from the juvenile poaching, etc.

### 5.2 Decrease in weed coverage

Improved salinity conditions resulted in a significant decrease in the coverage of invasive freshwater weeds. The area covered by water hyacinth and water ferns prior to the hydrological intervention was estimated to be 21.34 km$^2$ in October 2000 (Pattnaik et al., 2002). After the hydrological intervention, due to the increase in salinity the water hyacinth and water fern almost vanished from the lake.

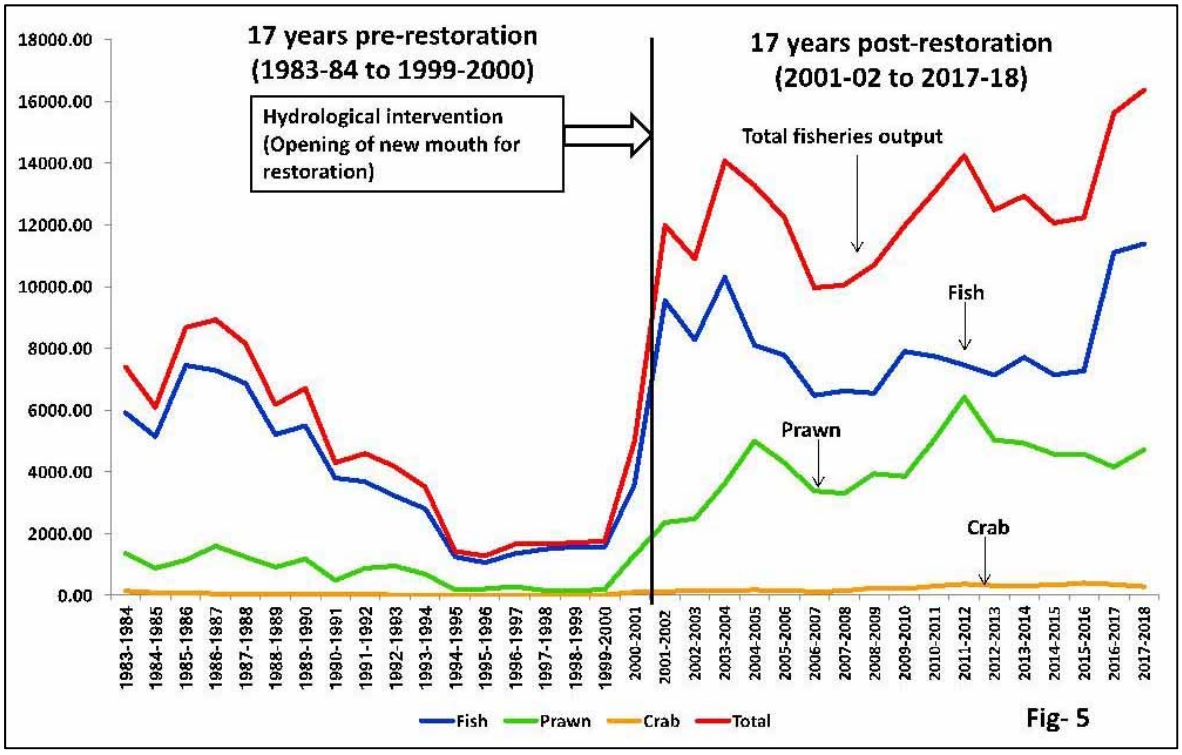


Figure 4. Chilika Lake Fishery Yield (Annual Landing) in Metric Tons

### 5.3 Expansion of the seagrass meadows

The restoration helped improve seagrass meadows and their species diversity, with the post-restoration less fluctuations in salinity and the improvement of the lake water transparency. Four species of seagrasses i.e., *Halodule pinifolia, Halodule uninervis,*

*Halophila ovata, and Cymodocea serrulata* were recorded for the first time from the lake. Before the opening of the new mouth, the seagrass meadows of the lake were 24.8 $km^2$. However, after restoration, the seagrass meadows expanded to 86.84 $km^2$ in 2004 and 102 $km^2$ in 2012 and to 152 $km^2$ in November 2018 (CDA, 2020).

### 5.4 Improved biodiversity and reappearance of the threatened species

In addition to the return of the flagship mullet species, a shrimp species (*Paenaeus indicus*) reappeared in the lake system because of environmental improvement, constituting nearly 50% of the total shrimp landing. The crustacean species, which were rare during the period of degradation, comprised 6,413 MT (45.08 %) of the total catch of 14,228 MT in 2012. It also is noteworthy that six other fish species once considered threatened have since reappeared in the lake during the post-intervention period, including *Hilsa* (*Tenuealosa*) *ilisha, Chanos chanos, Megalops cyprinoids, Elops machnata, Rhabdosargus berda* and *Rhinomugil corsula*. Post restoration ichthyofaunal diversity of the lake comprises of 317 finfish, 32 prawns and lobster and 27 species of crab.

### 5.5 Increase in population of Irrawaddy dolphin population and evolution of community-based ecotourism

After the hydrological intervention, there has been a steady increase in the population of the Irrawaddy dolphin in the lake. The population increased from 70 in 2003 to 145 in 2013. Irrawaddy dolphin being at the top of the food chain is a good indicator of the health of the lake ecosystem. This created opportunity of the community-based eco-tourism based on dolphin watching. Local communities from seventeen villages along the outer channel are involved in conducting the tourists for dolphin watching. This community-based ecotourism resulted in the significant enhancement of their economic condition.

Investments for the restoration of the Chilika Lake ecosystem also provide a lesson of positive return, in terms of fishery productivity and poverty alleviation. In addition to the benefits from the fishery sector, Chilika Lake tourism is expected to exhibit an upwardly moving trend from three different streams of visitors, including winter tourism in the Nalabana Sanctuary for viewing migratory birds, tourists coming from other states throughout the year for aesthetic and recreational purposes, and local pilgrims visiting Kaliaji Temple and other places of worship (Ghosh et al., 2006).

## 6. Lesson Learned and the ILBM Six Pillar Principles

The strategy adopted by the CDA for restoration and sustainable management of the lake and it's Basin is akin to ILBM six pillar principles. The case study illustrates how it mimics the six-pillars ILBM principles as follows:

### 6.1 Institution and Governance

As a macro-level initiative for restoration and sustainable management of the Chilika Lake and its basin as a first step, the Government of Odisha created an institution i.e. the Chilika Development Authority (CDA) in 1992. The mandates of CDA have been:

(i) to protect the lake ecosystem with all its genetic diversity,

(ii) to formulate the integrated resource management plan for the lake and its basin in active consultation with the local community,
(iii) to execute and promote various multidimensional and multidisciplinary developmental activities,
(iv) management of the drainage basin in a participatory manner to reduce the silt load into the lake,
(v) hydrological interventions to facilitate exchange of water between the lake and the sea and to maintain salinity regime of the lake,
(vi) to promote long term multidisciplinary research, prepare environmental status report, (vii) to collaborate with other institutions of the state, national or international institutions for all-around development of the lake, and
(vii) to establish management information system for the lake.

The Chilika Development Authority (CDA) is governed by the Governing Body and headed by Chief Minister of the state, as its Chairperson. The Secretaries from the key departments like, Revenue and disaster management, Home, Finance, Tourism, Forest and Environment, Science and Technology Departments of Government of Odisha and the key functionaries like Engineer in Chief of Water Resource Department, Director Environment, Director Soil Conservation, Chief Executive Odisha Remote Sensing Application Center, are the members of the Governing Body. The people's representatives like, Member of Parliament (MP) and the Members of State Legislative Assembly (MLA) are also members. In addition to this the representative of the Ministry of Environment and Forest, Government of India and experts from the premier research institutes of the country and most importantly a representative from the apex fishermen cooperative society are also members of the Governing Body. The Chief Minister, who is the head of the state administration, being the chairperson of the Governing Body, ensures proper coordination and integration, which is the most vital element for an enabling institution. The decisions are taken in the Governing Body under the chairmanship of the Chief Minister, thus become binding on the line departments. The most difficult task of an institution i.e. coordination between various agencies, department and the resource user group is accomplished through the Governing Body of the CDA. The management history of Chilika Lake demonstrates that clear perception and strong political will, ensure better management results. Effective and strong coordination could be possible because of the Governing Body headed by the Chief Minister. Some bold decisions, like the ban on shrimp farming, and a strong commitment of the state government for sustainable management of the lake resources, are possible because of strong political commitment. This institutional mechanism is the major strength of CDA (Figure 5).

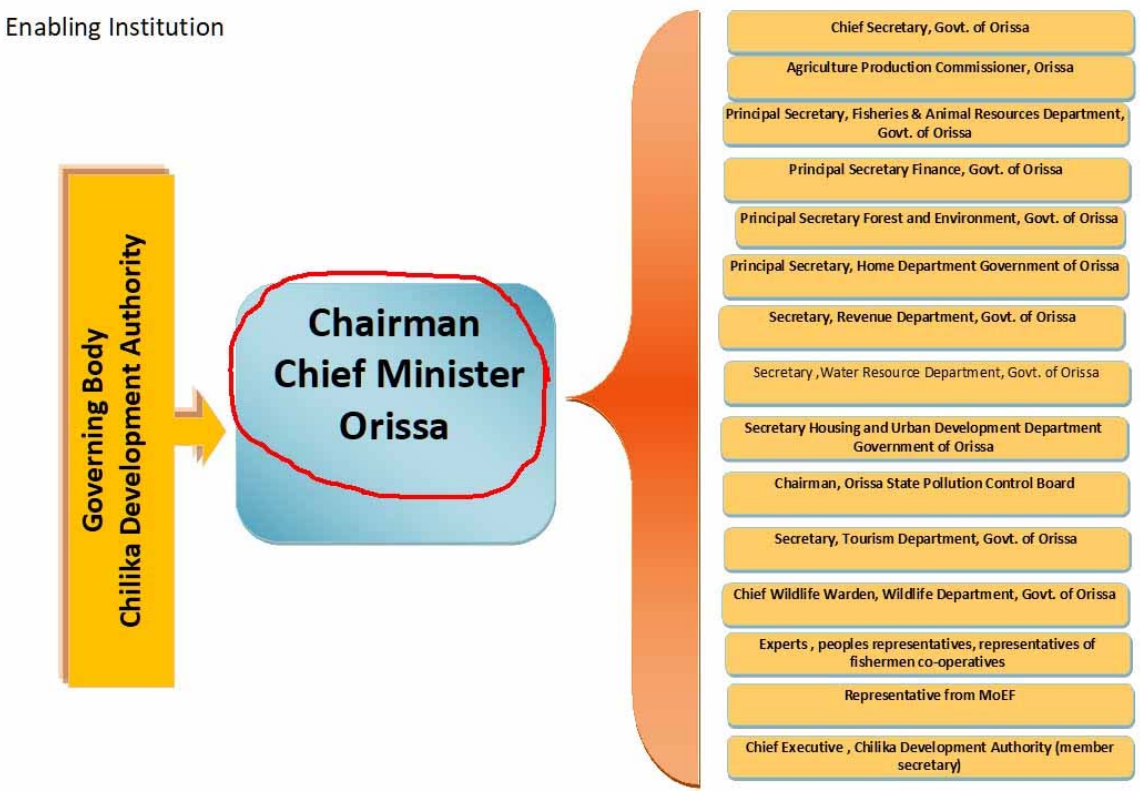


Figure 5. Governing Body of Chilika Development Authority

### 6.2 Finance

The major investment for restoration of the lake has been from the National Government i.e. the Special Problem Grants (SPG), as per the recommendations of the Finance Commissions. The total SPG has been approximately INR 1250 million (or $US17.2 million). However, since from 2014 the special problem grant was dispensed. To ensure a steady flow of funds to CDA, the State Government is providing a yearly grant of INR 60 million ($US 834,000) to carry out the activities and INR 20 million ($US 278,000) to meet the establishment cost of CDA. A major key to achieving complete success of the planned activities is the timely flow of funds and availability of resources. Thus, while the success of many of the management plan components can be lauded, failure to implement some vital components indicates the need for more concerted efforts. The failures are more likely the result of the lack of financial resources, rather than the lack of concept and willingness by the executing agency. It is worthwhile to note that Chilika Lake is located in the province of a developing country with severe resource limitations. With appropriate entrepreneurial skill and strategic partnership, however, the huge restoration task could be accomplished with the limited available resources. Indeed, it can be mentioned that such efforts could be achieved without any external funding or loans from any financial institutions. With strategic planning and sound financial management, and the limited resources available in the form of grants from the government of India, the entire restoration task could be accomplished. To this end, it would be worthwhile to determine the feasibility of sustainable financing for carrying out core activities, generating resources from the lake fisheries and ecotourism.

### 6.3 Participation

The restoration strategy adopted by CDA, derives its strength from the strong participation by local communities, grassroots-level non-government organizations (NGOs), community-based organizations (CBOs), and strategic partnerships with various national and international organizations and experts, government agencies and stakeholder government institutions. The key to success has been a strategic partnership built up through networking, consultation and coordination with the stakeholders. For example, CDA maintains institutional linkages with seven state government organizations, 33 NGOs and CBOs, three national government ministries, six other national organizations, 11 international organizations, 13 research institutions and 135 different categories of community level institutions. This difficult task of coordinating and strategic partnership could be accomplished through strong networking. The current efforts to involve NGOs (e.g. 'Campaign for Conservation of Chilika Lake' a federation of grass root level NGOs who work in and around the lake and its basin.

CDA initiated an innovative participatory micro-watershed management concept, with a "sustainable rural livelihood' approach for holistic management of natural resources". The participation of local communities and stakeholders in planning and implementing management of natural resources, and in sharing the responsibilities of decision-making, is a key feature of the ecosystem approach adopted by the CDA for management of the lake basin.

The network of the NGOs and CBOs, widespread stakeholder consultation, and watershed associations are some of the positive elements in the participatory management approach adopted by the CDA. As a result of good rapport with the local communities and community- based organizations, the restoration activities carried out by the CDA were strongly supported and endorsed by the community as the latter were consulted and taken into confidence at all planning stages.

### 6.4 Communication, Awareness and access to Information

A network of the NGOs and CBOs working in and around Chilika Lake has been developed and coordinated by CDA. The outreach programmes are carried out through this network. The work of 'Pallishree', a grassroots-level NGO working with the support of the Japan Fund for Global Environment, Ramsar Center Japan–Asia and the CDA, can be cited as a good example of creating public awareness. The NGO has established 10 small centres, one for four villages in and around the Chilika area. These centres (Center for Environment Awareness and Education) provide both non-formal education through trained facilitators, and formal education through school-level textbooks in the local language on the Chilika Lake environment, birds of Chilika, fishes of Chilika and plants of Chilika. Each centre has a small museum and library, audiovisual material, facilities for environmental games, etc. A quarterly newsletter in the local language is regularly published, with most of the articles contributed by local stakeholders. Communication, education and public awareness were used as tools for sharing the information, thereby empowering them. To achieve community participation, exchange of information, mutual enhanced understanding, and facilitation of cooperation between different user's groups were ensured through the outreach programme. The self-initiated good practices (e.g. mesh-size restrictions and planting of mangroves) are indications of the confidence the

stakeholders have regained regarding the lake's ecosystem.

The launch of the Chilika website (http://www.chilika.com) provided a new source for detailed information on wetland studies sponsored by the CDA, including restoration history, ecological characteristics, socioeconomic features, forests and agriculture in the basin area, physical characteristics, and a special focus on birds and dolphins. The website can be used as a vehicle to keep other organizations and the public aware of the progress with Chilika restoration and management efforts. A visitors' centre has been established at Satapada, a major entry point to the lake by CDA. The entire Chilika ecosystem is showcased at the centre, via interactive exhibits. Wetland education programmes also are presented in the centre for school children and stakeholders.

### 6.5 Technology

One of the most significant lessons learned from the Chilika experience has been the vital role scientific information can play in achieving management goals. The basic programme of opening a new lake mouth, a major recommendation from numerical modelling carried out by the Central Water and Power Research Station (CWPRS), can be considered a first step in improving the lake environment. Interestingly, this was also a long-standing demand of the local communities, reflecting the value of local knowledge. Environmental impact assessments, undertaken before and after the artificial mouth was opened, showed marked improvements in terms of salinity flux, weed-free areas, recruitment of marine elements, flushing of silts and, finally, increased the productivity for both fish and shell fish. The new mouth also reduced the distance between the lake and the sea by 18 km, which transformed the lake ecosystem into a healthy condition.

To track changes in the ecosystem, close monitoring of the lake and its basin is being carried out by CDA. The data generated on the freshwater flows, silt loads, coastal process, the nature and characteristics of weed infestation, salinity and nutrients, biogeochemical cycles, the role of microbes and other biotas in the lake ecosystem, depth and possible impacts of dredging, constitute vital research information. For effective management of the lake basin, delineation of the most degraded micro-watershed was based on satellite imagery. The application of remote sensing and geographical information system serves as an important management and monitoring tool, and the scientific results obtained from the targeted studies and modelling efforts provided vital clues for restoring the lake's salinity gradient. The prediction of a rapid recovery of salinity regime was then put to the test, demonstrating the connection between research efforts and the management initiative. For generating credible scientific information, a "Wetland Research and Training Center" (WRTC) was established at Chilika by CDA. The state of the art laboratory has multidisciplinary research facilities and more than 30 scientists and researchers are researching the lake ecosystem from this centre. Close monitoring of the lake including the real-time monitoring of water quality is carried out at the WRTC.

WRTC also collaborates with several national and international research institutes and universities. In collaboration with Maryland University, USA, an ecosystem health report card is developed. Wetland health report cards are assessment and communication products that compare ecological indicators against predefined goals or objectives. Similar to school report cards, a wetland health report card provides numeric grades or letters that reflect the status of a wetland. They effectively integrate and synthesize large and often

complex information into simple scores that can be communicated to decision-makers and the general public. CDA produces the Chilika Ecosystem Health Report Card every two years (Fig-7) to disseminate the health of the lake to a wider audience.

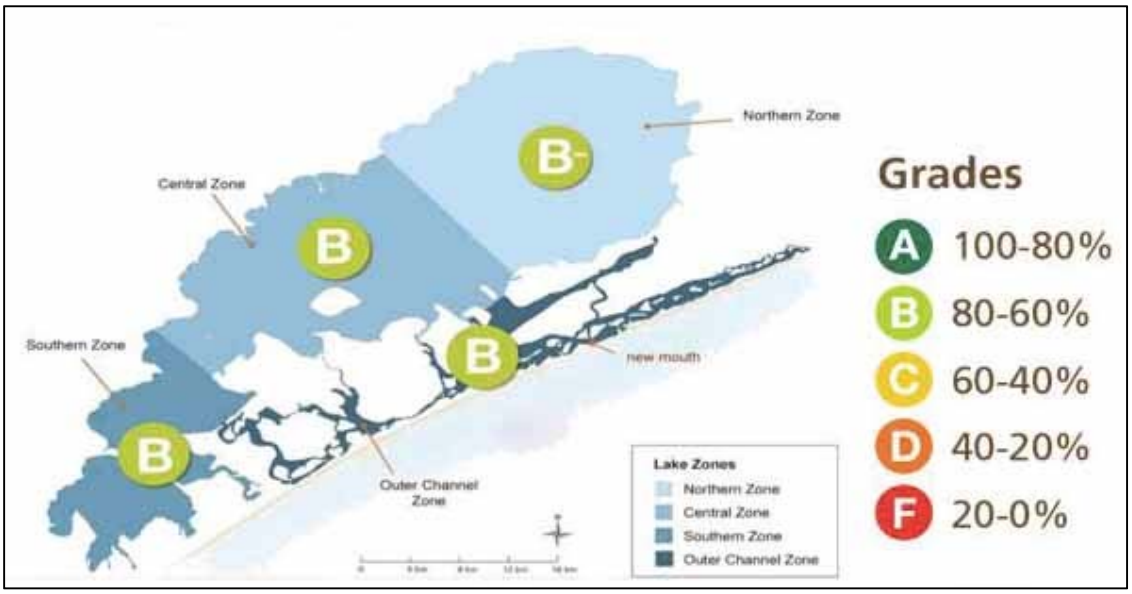


Figure 6. Chilika Lake Ecosystem Health Report Card

In collaboration with the Norwegian Environment Agency, (NINA) Norway, CDA developed Nature Index (NI) for Chilika adopting the methodology developed by NINA. Nature Index (NI) is a policy tool that synthesizes biodiversity data and helps in monitoring the status of biodiversity in an ecosystem. The index is calculated over several indicators, each scaled so that their value is in relation to a reference value. The indicators are therefore comparable to each other and can be combined into an index. The reference value represents what the indicator would be in an ecosystem in a "very good" condition. The scaled indicators, and thus the NI, can range from 0 (very poor/destroyed ecosystem) to 1 (very good condition). Adopting the NI framework, the thematic index of Chilika is worked out to be 0.6 - 0.8. i.e. very good.

CDA carried out Environmental Flow Assessment (EFA) supported by the World Bank to assess the impact of the Naraj barrage upstream, which has the definite potential to affect the lake's hydrology. It was carried out to determine the optimum flow allocations essential for sustaining key ecological functions. Different flow scenarios related to the construction of the Naraj barrage, hydrological, hydrodynamic, biological, and socio-economic modelling, as well as stakeholder consultation, was carried out. This collaborative effort involved the Water Resource Department and Department of Fishery Resources of State Government, the Wetlands International South Asia, the CWPRS, the World Bank, the Center for Water Resources Development and Management, several NGOs and CBOs and an expert from the Australian Commonwealth Scientific and Research Organization (William Young), with extensive stakeholder consultation. Based on the outcome the most suitable scenario was adopted for determining the operational rule of the Barrage ensuring optimal freshwater flow to the lake.

**6.6 Policy**

The institutional framework for Chilika is based on a principle of multi-sectoral collaboration, with the CDA playing the role of central coordinating authority. This will be fortified by a supporting policy. The earlier problem of overlapping areas of authority, and the conflicts arising thereof, will be further addressed with the proposed bill on 'The Chilika (Regulation of Fisheries) Act, 2010' of the Government of Odisha. The provision of the proposed Act vest CDA with the power to lease the fishery resources of Chilika directly to the Primary Cooperative Societies for a better administration. For sustainable management of the fishery, CDA shall prepare a fishery management plan for the sustainable development of the lake fisheries. CDA shall be the Authority to monitor, on a concurrent and day-to-day basis, and evaluate the fishing activities in and around Chilika. The Rules of Business will be amended to allow the Forest and Environment Department to regulate fisheries in the lake without prejudice to the overall responsibility of the Fisheries and Animal Resource Development Department to deal with fisheries in Chilika. The bill identified CDA as the central authority for all other matters, empowering it to make regular inspections, demolish illegal structures, search and seize and confiscate any unpermitted articles, and seek the help of the police wherever needed.

The policies and laws that are relevant to the administration of Chilika Lake include the Indian Wildlife Protection Act, 1972; the Water Act, 1974; the Forest (Conservation) Act, 1980; the Coastal Zone Regulation Rules, 1991; the National Water Policy, 2002; and the Biological Diversity Act, 2003. These federal acts and policies, along with the State Marine Fisheries Act and the Chilika (Regulation of Fisheries) Act, 2010, provide a strong foundation for implementing a process of conservation and sustainable use.

## 7. Importance of the Case

This case study demonstrates how Integrated Lake Basin Management (ILBM) is essential for successful restoration of a wetland and its drainage basin. The primary feature of the restoration model is the integration of the basin and the coastal process with active participation of the local communities with a shared decision-making process. The enhanced productivity strengthened the livelihood of the local community living both in and around the lake and its basin. The intensive monitoring and assessment system, linkages between the targeted scientific studies and the management interventions reflect the distinctiveness of the management practices adopted by Chilika Development Authority (CDA) for restoration of this unique wetland with an ecosystem approach. To ensure the participation of stakeholders an extensive outreach programme was carried out with the help of local NGOs to make the community aware about the ecological goods and services provided by the lake eco-systems, which contribute significantly to their livelihood. The intervention for improvement of the hydrological regime and the participatory management of the watershed resulted in the functional integrity of the ecosystem and enhancement of the productivity thereby increasing the per capita income of the local community. This has also facilitated the self-initiated good practices by the community because they are the immediate beneficiaries of successful ecosystem management. One of the key elements of the restoration model is the successful core partnership built through networking, consultation and coordination.

Another strong attribute of the restoration initiative is the presence of enabling institutional framework, policy support and "good governance" which encompass ideal

procedural aspects of planning and management as well as concepts of legitimacy, fairness, wisdom, acceptability, transparency and accountability. A broad understanding of the physical, chemical and biological processes occurring; long-term goals supported from the highest political level to the local communities; and comprehensive, long-term plans all contributed to the success noted. Supported by a high-level Governing Body and with access to government funding, CDA combines the stability of a government authority with implementation flexibility, avoiding the constraints of the normal bureaucratic system. The management philosophy of CDA is pragmatic and outcome-focused, implemented by innovative leadership and a strong and committed core team.

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