



Chilika
Development Authority



Chilika Lake

2016 Ecosystem Health Report Card



Introduction

The health report card of an ecosystem is an effective tool to communicate the complex volume of data and information into a simple communicable format which is understandable by a wide audience including the local communities, policy makers, and the stakeholders. In this regard the Chilika lagoon was studied scientifically to develop the health report card for better management of the ecosystem.

The Chilika Health Report Card was initially developed in 2012 and repeated in 2014. The initiation was through a collaborative project on "Global foundations for reducing nutrient enrichment and oxygen depletion from land based pollution, in support of Global Nutrient Cycle" by Chilika Development Authority (CDA), National Centre for Sustainable Coastal Management (NCSCM) and United Nations Environment Programme (UNEP/GEF) with partnership of Application Network from the University of Maryland Centre for Environmental Science.

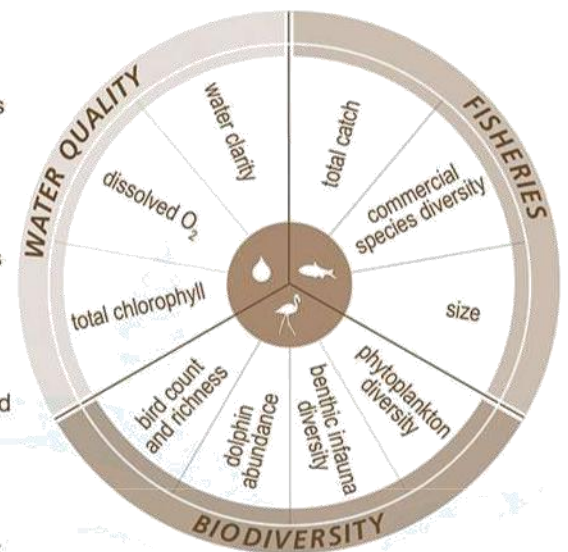
The first "Chilika Health Report Card" was also published in local language for better understanding of coastal fishermen community. The report cards not only provided information about the status of the health but also generated the awareness about pressures which are affecting the ecological values and services of the Lake. In order to monitor the health of Lake, report card based assessment has been an effective tool for Chilika Lake. The current report card is the third in series and would be useful for comparing the changes in Lake health over past years and the responsible environmental variables for the same, which will help to plan strategy for better management of the Chilika Lake.

Measures of ecosystem health

Ecosystem health of Chilika Lake was assessed by taking in to consideration 10 indicators organized into three main indices: Water quality, Fisheries and Biodiversity. Together, these indicators represented the ecosystem features of Chilika Lake that were valued (e.g. fishing, tourism, and biodiversity) and the threats (over fishing and illegal aquaculture, pollution and sedimentation) to these values.

WATER QUALITY

Water clarity is a measure of light that penetrates through the water column. It plays an important role in determining the distribution and abundance of macrophytes, seagrasses, and phytoplankton. It is mostly controlled by wind induced churning of sediment, phytoplankton biomass, CDOM (coloured dissolved organic matter) and influx of sediment from the surrounding rivers. Dissolved Oxygen is a very crucial parameter for the vitality of any aquatic life. The amount of dissolved oxygen needed for aquatic organisms varies from species to species. The dissolved oxygen (DO) mostly varies in the system depending on the rate of production by planktons, macrophytes and seagrasses as well as, respiration by micro-organisms. Chlorophyll-a, is a measure of phytoplankton (microalgae) biomass and is a good indicator for health of an ecosystem (Smith et al., 1999). Its' concentration generally depends on nutrient stoichiometry and water clarity of the ecosystem.



FISHERIES

Total catch of fish, prawns, and crabs was recorded monthly at 27 landing stations around the Lake. This monitoring allows Lake managers to monitor annual yield in comparison to a calculated maximum sustainable yield (CIFRI-ICAR, 2005). Commercial species diversity is the number of species landing each year that are commercially important for the livelihood of fishermen. The body length of landed Bagada or tiger prawns (*Penaeus monodon*), Khainga or mullet (*Mugil cephalus*) and Chilika Crabs (*Scylla serrata*) should be above (or between) a prescribed length to ensure sustainability of the species.

BIODIVERSITY

Bird count and richness: Count of the number of birds and bird species utilizing the Lake for feeding, resting, and breeding. Chilika Lake is the largest wintering ground for migratory waterfowl found anywhere on the Indian sub-continent.

Dolphin abundance: Count of the endangered Irrawaddy dolphins are surveyed annually in the Lake.

Macro-benthic faunal diversity: Simpson's Index of Diversity (D) is used to assess the condition of this community. Macro-benthic faunas are organisms living in or on the bottom areas (substratum) of the Lake (e.g., gastropods, bivalves, polychaetes, isopods, amphipods etc.) and are a key food source for many species particularly fishes.

Phytoplankton diversity (microalgae): Simpson's Index of Diversity (D) is also used to assess the condition of this microscopic algal community through analysis of the number of species present, and the abundance of each species. Phytoplankton is an important component of the Lake's food web.





Threshold for each indicator

Desired conditions were based on available guidelines, current scientific knowledge, and historical data with trends, and by taking into account the influence of a variable climate from year to year. The table below outlines the desired condition and threshold values developed or identified for each indicator.

Category	Indicator	Desired condition (Threshold)	Source of data to derive thresholds
Water quality	Water clarity	≤30 NTU	CPCB, New Delhi; The Environment (Protection) Rules, 1986
	Dissolved oxygen	≥ 5 mg/L or 60% sat.	CPCB, New Delhi; The Environment (Protection) Rules, 1986
	Chlorophyll-a	≤ 5 µg/L	25th percentile of Chl-a data: monthly data of June 2011 to Dec 2014, CDA
Fisheries	Total catch	%deviation above or below maximum sustainable yield (11,500t/yr)	CIFRI-ICAR, 2005
	Commercial species diversity	Ratio of species landed: desired(45 sp. desired)	CDA
	Size	Proportion of species landed above a sustainable size limit. M.cephalus:219-461mm;P.monodon: 116-197 mm; S.serrata:87mm	CDA
Biodiversity	Bird count and richness	Ratio to maximum bird count and diversity recorded since2003	CDA
	Dolphin abundance	Ratio to maximum dolphin count recorded since 2001	CDA
	Macro-benthic faunal diversity	Simpson's Index of Diversity(1-D)	CDA
	Phytoplankton diversity	Simpson's Index of Diversity(1-D)	CDA

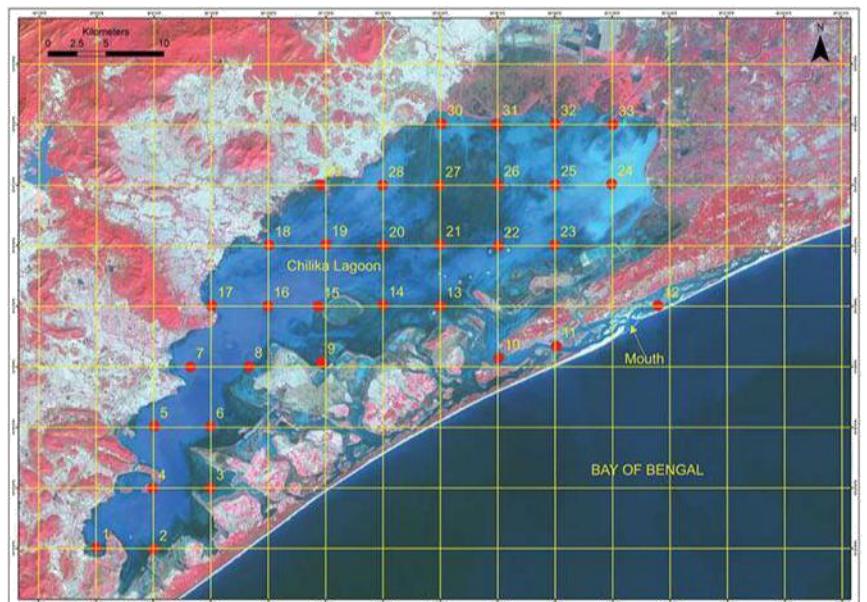
Deciding zonal grades

Chilika Lake was divided into four zones depending on the environmental conditions. The scientific data recorded during January to December 2016 were analyzed in four zones: Northern zone (NZ), southern zone (SZ), central zone (CZ) and Outer channel zone (OCZ). The grades were calculated for each zone from the average of water quality, fisheries and biodiversity indices.

DO, turbidity and chlorophyll-a data was assessed from 30 monitoring stations during the period. In case of indicators of fisheries, monthly landing data was considered during January to December 2016. Bird count and richness, dolphin abundance data from Chilika were collected during January 2016 and February 2015, respectively. Simpson's index calculation for macro-benthic faunal diversity were made using data of 30 sampling locations (during January to December 2016). The same index was made for phytoplankton diversity using data of 15 sampling locations (during January to August 2016) as mentioned in the sampling map.

What does the grade imply?

- A** 80–100%. All water quality and biological health indicators meet desired levels. Quality of water in these locations tends to be very good, most often leading to very good habitat conditions for fish and shellfish.
- B** 60–80%. Most water quality and biological health indicators meet desired levels. Quality of water in these locations tends to be good, often leading to good habitat conditions for fish and shellfish.
- C** 40–60%. There is a mix of good and poor levels of water quality and biological health indicators. Quality of water in these locations tends to be fair, leading to fair habitat conditions for fish and shellfish.
- D** 20–40%. Some or few water quality and biological health indicators meet desired levels. Quality of water in these locations tends to be poor, often leading to poor habitat conditions for fish and shellfish.
- F** 0–20%. Very few or no water quality and biological health indicators meet desired levels. Quality of water in these locations tends to be very poor, most often leading to very poor habitat conditions for fish and shellfish.



Sampling stations for water quality, phytoplankton and benthos sample collection from Chilika





Chilika Lake 2016 Report Card

Overall, Chilika Lake scored a **B** for ecosystem health based on performance of water quality, fisheries, and biodiversity indices. The Lake as a whole displayed excellent (**A**) dissolved oxygen concentrations, total fishery catch, and size. The Lake failed however, for chlorophyll-a concentrations (**D**) based on desired conditions. Of the ten indicators that were assessed within water quality, fisheries, and biodiversity, 69 % (**B**) was obtained in the Southern Zone followed by 71 % (**B**) in the Central Zone, 74% (**B**) in the Outer Channel Zone and 63% (**B-**) in the Northern Zone. A breakdown of these indicators by zone is provided below.

Grades

- A** 100-80%
- B** 80-60%
- C** 60-40%
- D** 40-20%
- F** 20-0%

Northern Zone **B-**

The Northern Zone displayed excellent results for fisheries, good water quality (with the exception of chlorophyll-a and water clarity) and good biodiversity due to abundance of bird congregations and phytoplankton diversity.



Central Zone **B**

The Central Zone displayed excellent results for fisheries, good water quality (with the exception of chlorophyll-a) and good biodiversity highlighted by dolphin abundance and bird count richness.



Southern Zone **B**

The Southern Zone displayed excellent results for fisheries, good water quality and good biodiversity highlighted by bird count and richness, and phytoplankton diversity.



Outer Channel Zone **B**

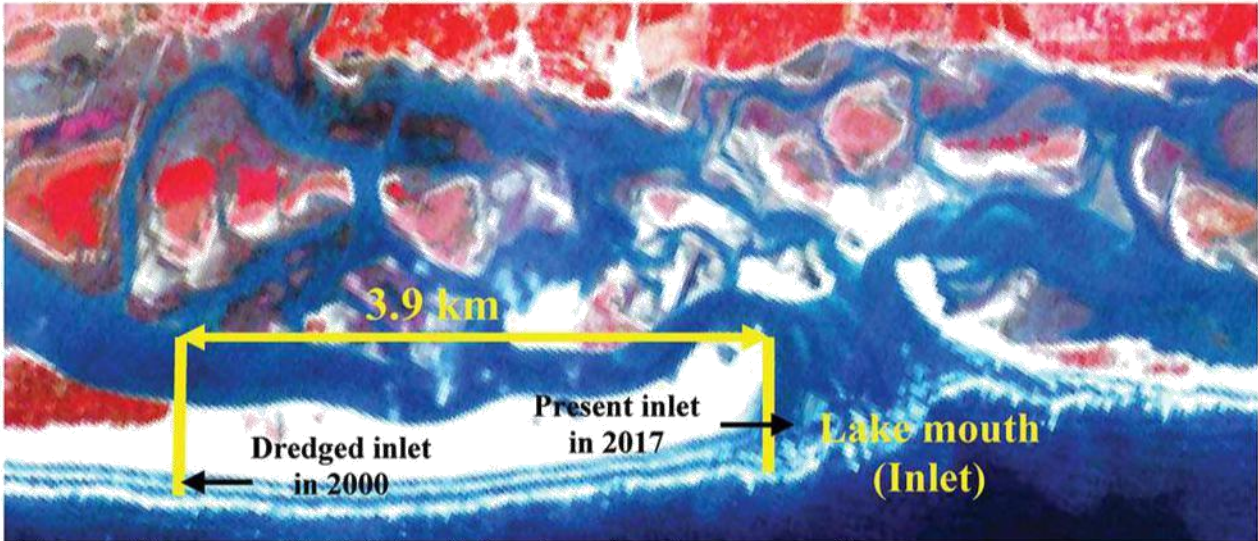
The Outer Channel Zone displayed good results for fisheries, good water quality (with the exception of chlorophyll-a) and good biodiversity highlighted by excellent dolphin abundance.





Chilika Inlets – Main Driver of Hydrological Process

Chilika Inlets act as gateway for water exchanges between the lagoon and the sea which provide natural flushing to maintain good water quality with desirable salinity levels. These inlets largely regulate the overall ecosystem functioning through hydrological process. Besides, it provides for effective corridors for migration and recruitment of fish seeds and other sea life. 86% of the fish species in Chilika are migratory in nature. However, Chilika lagoon has been experiencing many anthropogenic pressures, which have profound negative impact on overall productivity of lagoon ecosystem. The inlet(s) very often change their position and shape due to the coastal processes and affect the lagoon –bay interaction. Before 2000, the lagoon was connected to the Bay of Bengal through a 32km. long narrow outer channel at Arakhakuda village. To restore the ecological characteristics of the lagoon, an effective hydrological intervention was undertaken and an artificial inlet (Lake mouth) was opened on 23rd September 2000. The inlet relocation provided the significant increase in tidal influx and the fish yield. The dredged Inlet has migrated about 3.9 km northeasterly since the intervention was made. It is inferred that the geomorphological changes of inlet and its migration towards north or erosion and deposition of the barrier spit separating the lagoon from Bay of Bengal is a challenging issue for the survival of the lagoon ecosystem and to maintain its ecological characteristics.



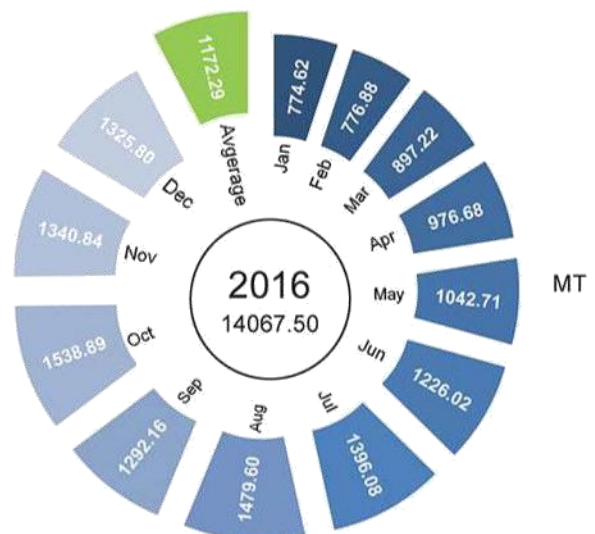
Migration of Lake mouth (Inlet) during 2000 & 2017

How does the current report card compare with 2012 and 2014?

During 2012 and 2014, the overall score was 'B' which is also found to be same for 2016. Individual indicators also showed similar grading. Northern Zone obtained the same score as in the year 2012 and 2014. Similar to 2014, this zone has displayed excellent results for fisheries, good water quality (with the exception of chlorophyll and water clarity) and good biodiversity (with the exception of Dolphin sightings) during the year 2016. Central Zone displayed good results for fisheries, water quality (with the exception of chlorophyll-a) and biodiversity. This zone scored B+ during 2012, B during 2014 and the same grade B is also observed in 2016. Southern zone scored B and B+ during 2012 and 2014 respectively and scored B during 2016. Outer channel has consistently scored B during 2012, 2014 and 2016, with excellent results for dolphin abundance.

Lake Health & Fisheries

During 2016, the total annual fish landing (fish, prawn & crab) from Chilika Lake was estimated at 14067.50 MT valued at 1901.96 million INR which worked out to 10.26% increase as compared to the annual catch value in 2014. The annual fish catch during the year was 15.56% higher than the annual catch in the year 2014. The average per capita income of active fishers during 2016 was estimated at 56035 INR. The annual commercial landings during 2016 registered 66.80% and 32.20% fish and shellfish composition respectively.





Way Forward

Coastal wetlands are one of the nature's richest sources of biodiversity due to their intermediate positioning between the land and sea which provide numerous beneficial services for people and for fish and wildlife other than many ecological and environmental benefits. Chilika Lake, a coastal wetland of international importance and the first Indian Ramsar site is providing many provisioning and regulatory services including fishery production which is the lifeline of coastal communities living in and around the Lake. Sustainable management and monitoring of bio-resources of extremely dynamic ecosystem with estuarine characters like that of Chilika Lake is a challenging issue and needs an interdisciplinary science-based management plan. Chilika Development Authority has adopted science-based tools for regular monitoring of environmental variables, nutrient flux, phytoplankton, macro-benthic organisms, fishery yield, Lake mouth (inlet profiles), periodic monitoring of fecal coliforms, seagrass and microbes for assessment of the ecosystem health status. Through state of the art research facilities available at Wetland Research & Training Centre (WRTC), systematic observations on some vital biological and non-biological parameters of the Lake are being made and are used in the ecosystem health assessment programme. Continuous monitoring has provided important insights on many natural processes such as inlet / Lake mouth shifting, change in salinity dynamics, fishery yield and diversity, seagrass meadows etc. Long term deposition of organic and inorganic pollutants in the Lake from anthropogenic sources through monsoon discharge may result in adverse impact on the health of the Lake as well as the bio resources. Wide biogeochemical functions performed by shoreline microbial communities in areas where nutrient loading is higher due to macrophyte decomposition has become a concern in the context of Lake health. The smaller size phytoplankton that contributes enormously to the productivity of the Lake has yet to be investigated. Similarly, the zooplankton of the Lake forms an important link in the food chain from primary to tertiary level leading to the fishery production and is considered as the chief index of utilization of aquatic biotope at the secondary trophic level and its dynamics of populations, biomass and diversities are considered as important indicators for assessment of Lake health. The zooplankton study has remained unexplored during the post-restoration period and it is imperative that a comprehensive investigation on the zooplankton needs to be undertaken. Thus, the followings other than the regular monitoring programmes would constitute the future line of studies at WRTC in the Lake health assessment perspectives:

- Periodic investigation on pollution status of the Lake.
- Periodic monitoring of cross sections of inlet channel and Lake mouth including mouth shifting pattern.
- Study on smaller size planktons.
- Periodical monitoring of shoreline microbial communities and their biogeochemical functions.
- Periodic monitoring of fecal coliforms.
- Comprehensive study on zooplankton of the Lake.

References

CIFRI-2005. Assessment of fish yield potential of Chilika Lake. Final report of the CDA-sponsored consultancy research project by Central Inland Fisheries Research Institute (Indian Council of Agricultural Research) Barrackpore, Kolkata. 137p.

Smith V.H., Tilman, G.D., Nekola, J.C., 1999, Eutrophication: impacts of excess nutrient inputs on freshwater, marine, and terrestrial ecosystems, *Environmental Pollution* 100 , 179-196.

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An electronic copy of this report card and additional information can be found at:
<http://www.chilika.com>



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