Chilika
Development Authority

CHILIKA LAKE
2017-18
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 and 2016. 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 Costal 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 proved an effective tool for Chilika Lake. The current report card is the fourth in series would be useful for comparing the changes in Lake health over multiple 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 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 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 (microalge) 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 35 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 landed each year that are commercially important for the livelihood of fishermen. The body length of landed Bagada or tiger prawns (Penaeusmonodon), 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 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 (sub-stratum) 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 conditionswerebasedonavailable guidelines,currentscientific knowledge,andhistorical data and trends, and taking into accounttheinfluence ofavariable climate fromyeartoyear.Thetable belowoutlines thedesiredcondition and threshold valuesdevelopedoridentified foreachindicator.

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	≤ 6.22 µg/L	75th percentile of Chl-a data:monthly data of May 2017 to Dec 2018, from 33 monthly monitoring stations (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
Bio diversity	Bird count and rich-ness	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

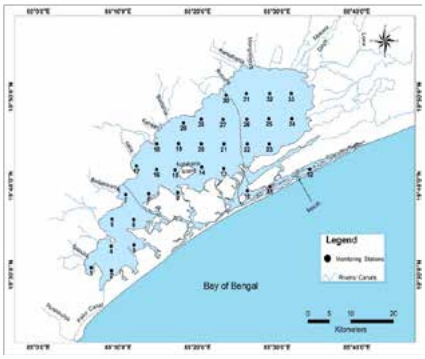
Deciding Zonal Grades

Chilika Lake was divided into four zones depending on the environmental conditions as reported by Muduli et al., 2013. The scientific data recorded during January 2017 to December 2018 were divided in to 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 data of water quality, fisheries, and biodiversity indices.

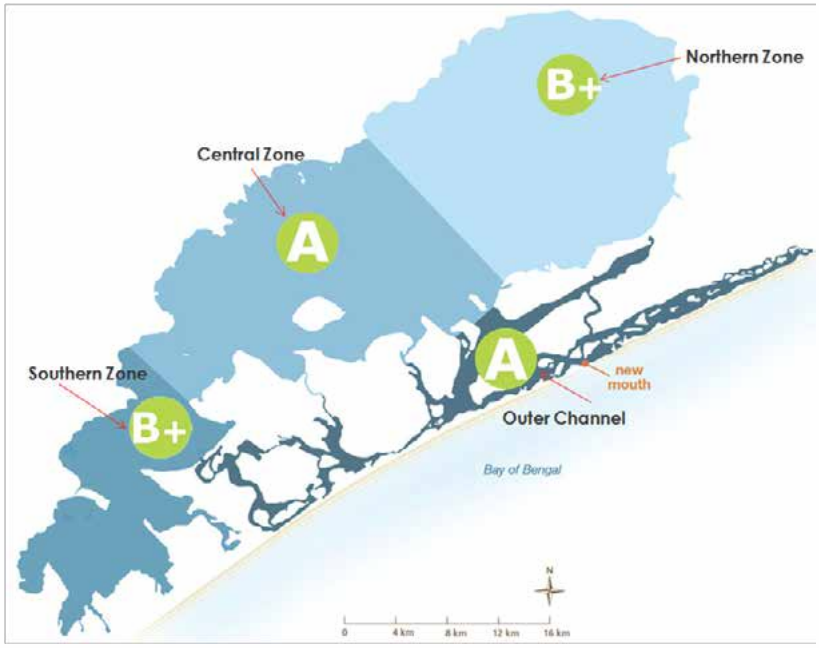
DO, turbidity and chlorophyll-a data was assessed from 33 monitoring stations during the period. In case of indicators of fisheries, monthly landing data was considered during January 2017 to December 2018. Bird count and richness, dolphin abundance data from Chilika were collected during winter season of2017and 2018.Simpson's index calculation for macro-benthic faunal diversitywere made using data of33sampling locations (during January 2017 to December 2018). The same index was made for phytoplankton diversity using data of 25 sampling locations (during January 2017 to Dec 2018) as mentioned in the sampling map.

What does the grade imply?

- 80 to 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.
- 60 to 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.
- 40 to 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.
- 20 to 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.
- 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 2017-2018 REPORT CARD

Overall, Chilika Lake scored a A- for ecosystem health based on performance of water quality, fisheries, and biodiversity indices. The lake as a whole displayed excellent (A) dissolved oxygen concentrations, phytoplankton biodiversity, birds, total fishery catch, and size. The rest of the indicators scored B. Scores of the ten indicators that were assessed within water quality, fisheries, and biodiversity, 85 % (A) in the Central Zone followed by 84 % (A) in theOuter Channel Zone, 80% (B+) in the Southern Zone and 78% (B) in the Northern Zone. A breakdown of these indicators by zone is provided below.

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

Central Zone(A):

The Central Zone displayed excellent results for fisheries, water quality and biodiversity.

Outer Channel Zone (B):

The Outer Channel Zone displayed excellent results for fisheries, water quality and biodiversity

Southern Zone (B):

The Southern Zone displayed excellent results for water quality and good biodiversity highlighted by benthic infauna and phytoplankton diversity.

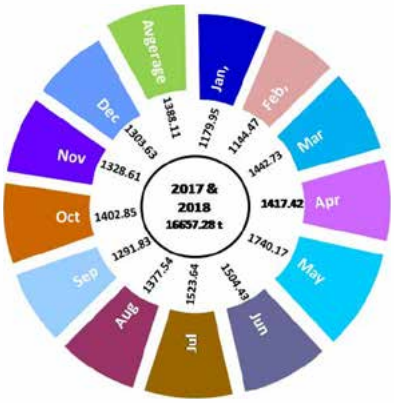
Outer Channel Zone (B):

The Outer Channel Zone displayed excellent results for fisheries, water quality and biodiversity

	2012	2014	2016	2017-18
Overall	B	B	B	A-
Southern Zone	B	B+	B	B+
Central Zone	B+	B	B	A
Northern Zone	B	B-	B-	B+
Outer channel Zone	B	B	B	A

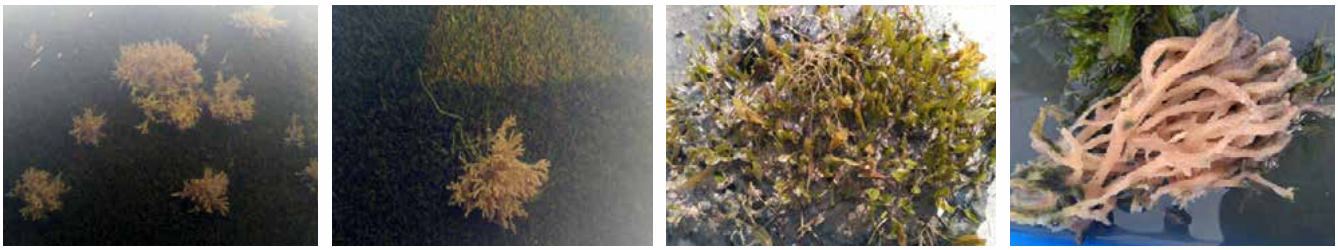
Lake Health & Fisheries

During the study period, the average fish landing data for two years (2017 & 2018) which was estimated at 16657.28 t was increased by 18.41% as compared to the annual landing of 2016 (14,067.50 t).The average value of total landing during the year 2017 & 2018 was 2424.77 Million INR which was increased by 27.51 % as compared with the catch value of the year 2016. The average per capita income of active fishers during the year 2017 & 2018 was estimated at Rs.59,141.00 INR which increased by 5.54% as compared to the year 2016. The percent composition of fish, prawn and crab in two year's average annual landing were, 69.72%, 28.36% and 1.92% respectively.



Demolition of prawn gherries:
Crucial step towards sustainable management of Chilika Lake

The ecological health, biodiversity and fishery productivity of Chilika was threatened due to monopoly from certain group of people for monetary benefits which were promoting prawn and shrimp gherries. The illegal gherries which has occupied almost entire shoreline of Chilika Lake has drastically impacted the lake biodiversity, hydrology and fishery productivity. In last 2 years, Chilika Development Authority has freed around 151 km2 of lake area which was under the illegal prawn gherries. These gherries have severely affected the water flow in Chilika Lake leading to the reduction in open space available for feeding and breeding grounds for birds and fishes. These gherries have also encroached the area which otherwise are good locations for the development and proliferation of seagrass meadows. The impact of eviction drives was visible in the form of re-appearance of important fauna such as sponges and flora like sea-grasses from areas which were encroached by shrimp gherries. Seagrass mapping in year 2018 showed that lake supports rich diversity of seagrasses and around 152 km2 areais under seagrasses. Seagrasses are one of the bio-indicators of the good health of an ecosystem and their luxuriant growth indicates that water clarity, salinity regime, and nutrient conditions are in their optimal range. Seagrasses are well appreciated for their role in water purification through blue carbon sequestration and keep the carbon buried in their sediments. Seagrasses are highly productive sites which also act as feeding, breeding and sheltering grounds of many ecologically and economically important fish species of Chilika Lake.



Sponges observed in Chilika after eviction of gherries

The extensive seagrass meadows and sponge species has important ecological implications. It is a sign that Chilika Lake ecosystem is responding to the positive efforts taken by the CDA to rejuvenate the ecological health of this lake. The strong will power concurrent with political support would be vital for to keep Chilika free from prawn and shrimp gherries. CDA firmly believe that in due course of time the coastal community will realize the impact of these eviction drives in promoting higher fish catches and increasing the natural beauty of Chilika Lake ultimately benefitting the local fishermen populations in and around the Chilika Lake.

Gherry eviction and fishery

The average annual landing (fish, prawn and crab) for 2017 & 2018 was estimated at 16,657.31 t which increased by 18.41% as compared to the annual landing of 2016 (14,067.50 t), which could be attributable to the landmark achievements of complete removal of Net gherries (15,147 ha) by Chilika Development Authority and unauthorized zero nets (mesh size less than 10mm) from the lake under OMFR Act, 1982 during 2017-18. The removal of net gherries contributed significantly to the habitat improvement for fishes and shell fishes with more water spread area and luxuriant growth of sea grass beds in the removed gherry areas. During the said period, seven number of fish species were reported from the lake for the first time by Zoological Survey of India (ZSI), which indicated remarkable enhancement in the fish diversity. CDA has been conducting regular monthly awareness camps and capacity building training among the local fishermen to help promote responsible fisheries in the lake. The local fishermen have realized the long term benefits of gherry eviction in enhanced fish catch and livelihoods.

Way Forward

Following the release of health report card for 2012, 2014 and 2016, more intensive studies were taken in thematic areas to bridge the knowledge gaps to further expand the scope of ecological indicators which could be useful in evaluating the ecological health of Chilika Lake. Ecological health indicators such as total nitrogen (TN) and total phosphorous (TP) could be included in the upcoming report card as part of the water quality indicators. In order to derive the appropriate thresholds for Chilika for these parameters, there is need of enough data for which the data collection already initiated by the team of Chemistry and instrumentation lab, WRTC, CDA using sophisticated instrumentation facilities.Biotechnology research group at WRTC is engaged in the area of molecular microbial ecology and apply state of the art techniques for examining the planktonic and benthic microbial communities of Chilika Lagoon. These studies are crucial in generating the baseline data on microbial components of the lagoon that are least studied but highly important with respect to nutrient biogeochemical cycling. Research studies examining the planktonic microbial communities (phytoplankton and bacterioplankton), benthic microbial communities, and macrophytes (e.g., sea grasses, P. karka) using tools of high-throughput DNA sequencing have been accomplished through the support received from ICZMP. These studies which were undertaken for the first time in Chilika have clearly showed the role of "unseen majority: the microbes" that are often ignored in most of the wetland research. These microbes drive the entire productivity of Chilika by decomposing organic matter and nutrients and recycling back into the system. These 'nature's recycler' needs continuous monitoring through the tools of modern biotechnology which will help in understanding the response of Chilika lake in changing climatic conditions. As the challenge for arriving at the appropriate threshold values is enormous, the ideal way forward is to sustain continuous monitoring of the lake to arrive at the threshold values specific to this tropical lake ecosystem.

References:

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Acknowledgements

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