Eternal Words

"Let every individual and institution now thinks and act as a responsible trustee of Earth, seeking choices in ecology, economics and ethics that will provide a sustainable future, eliminate pollution, poverty and violence, awaken the wonder of life and foster peaceful progress in the human adventure."

– John McConnell, founder of International Earth Day

I think the environment should be put in the category of our national security. Defense of our resources is just as important as defense abroad. Otherwise what is there to defend?

- Robert Redford

The preservation of biodiversity is not just a job for governments. International and non-governmental organisations, the private sector and each and every individual have a role to play in changing entrenched outlooks and ending destructive patterns of behaviour

- Kofi Annan, UN Secretary General on the 2003 International Day of Biological Diversity
Dear Readers,

Evaluating the performance of conventional systems is simple as compared to judging the impacts of ecological restoration process on overall health of the water body. Conventional systems are designed on the basis of absolute parameter values, so the outcome is always well-defined in absolute values only. For example, 10 MLD conventional sewage treatment gives assured output of 8 – 9 MLD (depending on evaporation losses) with COD less than 20 mg/L and BOD less than 20 mg/L and if disinfection system is added then fecal coliforms will be zero! So, the conventional systems have a very definite input and definite output while generating residues to be disposed off properly. Therefore the monitoring of process can be done manually or instrumentally by putting sensors online. Conventional systems are advancing towards more of electronic monitoring systems by reducing human interventions in process operations also.

There is parallel stream of ecological engineering and ecotechnology is enriching from two decades reducing the need for conventional monitoring mechanisms. It is mostly based on the bio-monitoring to evaluate the performance of ecological restoration of rivers and lakes. The duo Sandeep Joshi, ecotechnologist and Pramod Salaskar, well-known limnologist were working on the concept of Ecological Quality Index from last several years since the SERI started ecological restoration projects in India. Ecological health of the river or lake cannot be defined by just testing the samples for conventional parameters such as COD, BOD, TSS, TDS etc. – which are stress parameters. There is need to study status as well as process parameters. Late Dr. Mohan Kodarkar, ecologist of India was insistent on development of ecological quality index of water bodies and he used to discuss the issue with these two ecological workers time to time.

There are various examples of ecological status improvement of water bodies undergoing in-stream ecological operations in India including Buddha Stream – a tributary of Satluj River in Ludhiana, Punjab State. The cover photo is of the ecological restoration work at Buddha Nallah. It has started showing the signs of improvement. EQI of Buddha eco-restoration project is being studied and will be published shortly.

Thank you,

Chief Editor

Shrishti Eco-Research Institute, Pune

From SERI desk: Press release

Ecological Quality Index: Standardized Method for Judging the Ecological Health of Rivers and Lakes

Water pollution is one of the most ghastly catastrophes generated by today’s urban sprawls, we are facing. Modern development without USES (Urban Systems with Ecological Security) has perilous effects on surface and sub-surface waters for example Mumbai’s Mithi River, Pune’s Mula-Mutha-Pavana, and Kolhapur’s Panchganga. It is indispensable to obtain accurate and pertinent information to evaluate the ecological status of any water resources. Maturing some useful tools to keep watch on the quality of valuable freshwater resources is most essential to retain their excellent ecological health for various beneficial uses.

Various methods have been employed for the classification of rivers and lakes on the basis of their trophic (Greek trophe – food or feeding) status. The most commonly and widely used method is based on productivity, and the frequently used biomass related Carlson trophic state index. A Trophic State Index (TSI) condenses large amounts of data into a single, numerical index. Fu-Liu, Shu and Dawson applied GIS technique to synthesize information from the trophic state parameter for spatial distribution of eutrophic conditions. There are many diversity and physico-chemical water quality indices which can be applied to describe toxic or physical pollution. These indices denote the stress on the aquatic systems. Diversity in the aquatic system is an expression of disturbance or stress,

Sandeep Joshi, a well-known river and lake restoration expert with Pramod Salaskar, expert lake ecologist succeeded in combining the status indicators and stress parameters to evolve a very simple numerical value which can describe the healthiness of water body. This standard ecological quality index (EQI) is a combination of Water Quality Index (WQI), Carlson’s Trophic State Index (C.TSI), and Simpson’s Index of Diversity (SID) with net dissolved oxygen in the water body. It can be numerically expressed from 1 (poor ecological health) to 50 (excellent ecological health). Stable aquatic ecosystems are generally characterized by high species diversity, with each species represented by relatively few individuals.

As per evaluations of Mutha River having dissolved oxygen about 0.6 mg/Litre daytime and near zero aerobic biodiversity, the numerical value of Mutha’s ecological health is 4 that means it is very poor while that of Mula River is average and that of Pavana is poor while Indrayani’s ecological health is on the boundary of average and good. Sandeep Joshi, Director of Shrishti Eco-Research Institute told, “With meticulous observations of water quality and biodiversity assessment for
more than 3 years has helped us to develop this water eco-health index. Pramod Salaskar refined the observational data of seven streams or rivers undergoing ecological restoration process and 5 lakes of different sizes in different climatic zones. That’s why, this numerical index has become very simple, flexible, accommodative still very scientific to express the health of rivers and lakes”. He further claimed that this is the first time ever complicated water quality issue is simplified for the layman to understand the usefulness of the water body.

Pramod Salaskar told that the restoration of Ahar River in Udaipur in 2010 improved the ecological health from 3.9 (very poor) to 24.8 (average) in two months and then further improved to 32.7 (good) in next one year. He emphasized that the EQI had been testified in various ecological projects undertaken by SERI, Green Infrastructure and was available for ecologist to validate it. Sandeep Joshi further added that the achievement of ecological restoration project of Ahar River with least maintenance was commendable because it is functional without plugging the point sources (industries and residential premises) of pollution till date. Ecological quality index will have a major role to play in ecological revival of Pune’s Ram and Mutha rivers which are claimed to be ecologically dead rivers.

**Water Quality Index (WQI)**

This index is a mathematical mean of calculating a single value from numerous test results over a period of time. The index result represents the level of water quality in a given water basin, such as a lake, river, or stream. Water Quality Index (WQI) can be calculated by using Deiniger and Maciunas method of 1971 considering five parameters for calculation such as pH, Total Hardness, Total Chloride, B.O.D. and MPN.

\[
WQI = \text{Antilog} \sum_{n=1}^{10} W.log q \quad \text{..............................................................}(1)
\]

Where,

\[ W_n = \text{Unit weight for } n^{th} \text{ parameters; calculated as } \]

\[ W_n = K/Sn \]

\[ Sn = (n = 1, 2, 3, \ldots, 6) \text{ HDL for } n^{th} \text{ water quality parameters, } \]

\[ K = \text{Constant for proportionality; } \]

The quality rating (qn) for the \( n^{th} \) water quality parameters may be obtained for all parameters as follows; except pH.

\[
qu = 100*Vn/Sn \quad \text{..............................................................} (2)
\]

Where, \( Vn = \text{Observed value; } \)

\( Sn = \text{Recommended standard value for } n^{th} \text{ parameter. } \)

It is concluded that the water quality index is an efficient measure to classify the water of the Pond for their various advantageous uses and give a rapid and precise idea about the pollution load in the water body that may be worthwhile for policy makers.

**Carlson’s Trophic Status Index (TSI)**

Ecological indicators for the trophic state of water body were considered energy and specific energy indices having negative correlation with phytoplankton biomass. But Carlson’s Trophic State Index (TSI) with strong positive correlation with water transparency explains the trophic status of water body. This Trophic State Index (TSI) condenses large amounts of productivity data with respect to chemical parameters into a single, numerical index. The Carlson TSI is divided into four main lake productivity categories: oligotrophic (least productive), mesotrophic (moderately productive), eutrophic (very productive), and hypereutrophic (extremely productive). The productivity of a lake can therefore be assessed with ease using the TSI score for one or more parameters.

Jorgensen in 1980 suggested using primary productivity, phytoplankton biomass, total organic carbon, total phosphate and total nitrogen as the parameters to calculate trophic status of a water body. Total phosphorous, the combination of free floating compounds of those incorporated in biota is the most common nutrient measured in lakes. A Secchi disc is used as measure of the transparency of water, which is the function of the density of varying algal populations and other suspended solids.

**Calculating the Trophic State Index (TSI) of Carlson:**

\[
\text{TSI for Chlorophyll-a (CA) TSI} = 9.81 \ln \text{Chlorophyll-a (ug/l)}
\]

\[
\text{TSI for Secchi depth (SD) TSI} = 60 - 14.41 \ln \text{Secchi depth (meters)}
\]

\[
\text{TSI for Total phosphorus (TP) TSI} = 14.42 \ln \text{Total phosphorous (ug/l)} + 4.15
\]

\[
\text{Carlson’s TSI} = \frac{\text{TSI(TP)} + \text{TSI(CA)} + \text{TSI(SD)}}{3}
\]

Determining Trophic State Index (TSI) is a significant feature of ecological health assessment of rivers and lakes.
Simpson's Diversity Index

Simpson's Diversity Index is a measure of diversity which takes into account the number of species present, as well as the relative abundance of each species. As species richness and evenness increase, so diversity increases.

\[
D = 1 - \left( \frac{\sum n(n-1)}{N(N-1)} \right)
\]

Where \( n \) = the total number of organisms of a particular species
\( N \) = the total number of organisms of all species
The value of \( D \) ranges between 0 and 1.
With this index, 1 represents infinite diversity and 0, no diversity.

Increasing diversity tends to suggest more stable ecosystems with more connections within them.

Calculation of Ecological Quality Index

Ecological Quality Index = [numeric value of Carlson’s Trophic State Index (C.TSI) + Simpson’s Diversity Index (SDI) + Numeric value of Diff. of day’s maximum & minimum DO] x numeric value of Water Quality Index (WQI)

EQI of Ahar River, Udaipur is 32.7

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