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The Innovative Water Quality Index (Iwqi) for Lakes of Mysore, Karnataka, India

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Abstract: *A new 'Innovative water quality Index' (IWQI) was applied to 4 lakes of Mysore City, India. Unlike many other indexes, this index requires the analysis of only 5 water chemistry parameters. Dissolved oxygen, Total phosphorous, Turbidity, Specific conductance and fecal coli forms were analyzed. The involvement of only a few parameters has the advantage of using the data in calculating the Total Maximum Daily Load (TMDL) of the undesired variables. Lingambudhi Lake had an index value between 1.9 and 2.2 and is rated between marginal and acceptable. Dalvoi Lake had values less than 2 and is raied as marginal, values in Kukkarahalli lake range between 1.7 and 2.3 which is also rated between marginal and acceptable. Yennehole Lake has values of 2.4 and can be rated as acceptable quality. Poor water quality in lakes imparts the lives of many species including fish and plants. This is often due to the nutrient loads from agricultural fertilizer run off, chemical pollutants, faces and urine of fish and animals. These excess nutrients over power the natural bacterial population that normally would keep the aquatic environment in balance. Due to such processes sludge develops and become overabundant. Oxygen saturation reduces and fish mortality rates increases. Permanent blooms of cyanobacteria were recorded in Kukkarahalli Lake (Microcystis aeruginosa) and Yennehole Lake (Spirulina platensis and Raphidiopsis medetereana). These two lakes have experienced massive fish kill during the past years. The **IWQI** involves only 5 parameters, is simple and can be applied to lake ecosystems also. Smaller number of parameters is advantageous in lake restoration activities.*

Key words: *Innovative water quality Index, TMDL, DO saturation, Microcystis aeruginosa, Spirulina platensis, Raphidiopsis medetereana, Restoration.*

Introduction

Water quality indices are to be studied for two main reasons. General public must be made to understand and share the technical results of monitoring local water quality. Secondly to provide a general means of comparing and ranking various water bodies in a given locality.

Such indices can measure the degree to which water quality is affected by human activities. Some of the advantages of WQI are elimination of technical complexity in describing water quality which reduces the analysis of many factors into a single statement. The amount of pollutant a water body can receive and still meet water quality requirements have to be developed. For this purpose the index applied must contain reduced number of water chemistry variables, which can be effectively used to compare different lakes. Some of the important water quality indices developed are SAFE (1995), Mitchell and Stapp (1996), WEP (1996) Zandbergen and Hall (1998),

Cude(2001), CCME-WQI (2001). These indices are useful but the number of water chemistry variables used in the determination of these indices is many. The disadvantage with these indices is that too many factors have to be included in restoration activities and this becomes difficult. The new Innovative water quality index (IWQI) developed by Ahmed *et.al* (2004) is a simple and useful index for water quality management. It uses only 4 parameters for quantification and can be used conveniently for restoration activities. This index has been very often used for rivers and streams. It has been used for the first time to lakes of Mysore. Conservation and quantification of water quality for four lakes of Mysore have been discussed (Study period: 2010-2013).

Materials and Methods

Four major lakes of Mysore (Karnataka state, India) situated at a distance of 20kms apart have been selected for the present study. They include Lingambudli Lake (LL), Dalvoi Lake (DL), Kukkarahalli Lake (KL) and Yennehole Lake (YL). They differ in size and shape, usage, nature of anthropogenic disturbance and planktonic algae (Study period: 2010-2013). A brief description is presented in table 1. Water sampling procedures are same as described by Hosmani (1975). Standard methods were employed for analysis of water chemistry variables (APHH, 1998) such as dissolved oxygen (DO), total phosphorous (TP), turbidity (TURB) & specific conductance (SC). Fecal coli forms were determined as per the method described by Aneja (2004).

Table-1: Details of the Lakes Studied Mysore (2009-2010)

Sl. No.	Characteristics	Lingambadhi Lake	Dalavai Lake	Kukkarahalli Lake	Yennehole Lake
1.	Latitude	12° 17' N	12° 15' N	12° 18' N	12° 02' N
2.	Longitude	75° 27' E	76° 39' E	76° 38' E	76° 41' E
3.	Monitoring agency	MID	MID	Nom	MID
4.	Highest flow level(meters)	727.09	705.15	755.73	860.10
5.	Area(Sq.km)	0.841	0.527	0.620	0.632
6.	Water spread area(sq.kms)	0.124	0.168	0.393	0.157
7.	Dry area (sq kms)	0.701	Nil	0.180	Nil
8.	Catchment area(ha)	414	1357	2189	1360
9.	Water spread (ha)	36	54	49	56
10	Fore shore area (ha)	60	66	55	60
11	Silt Depth(meters)	0.21	0.89	0.45	0.35
12	Total silt depth 10 power 3(m3)	7.45	4.79	2.20	3.60
13	Lake capacity(ml)	1507.7	1771.2	2533.3	1.872
14	Phytoplanktonic blooms	Nil	Nil	Very high	High
15	Marshy area(sq.km)	0.138	0.359	0.043	0.211
16	Aquatic weeds	Nil	High	High	High

MID: Minor Irrigation Department, UOM: University of Mysore.

The Innovative water quality Index formulated by Ahmed *et.al* (2004) was calculated using the formula:

$$\mathbf{IWQI} = \frac{\log \{ (DO)^{1.5} \}}{(3.8)^{TP} (Turb.)^{0.5} (15)^{FC} + 0.14 (SC)^{0.5}}$$

Where DO is dissolved oxygen (mg/l), TP is Total phosphorus (mg/l), Turb is Turbidity (NTU), Sc is specific conductance (MS/C) and FC is Fecal coliforms in no/100ml/10^4. DO values were converted to percent saturation using the Index calculator which also includes water temperature (NSF-WQI, 2004). The IWQI

and the water chemistry variables are presented in table 2. Standard values of the index are presented in table 3.

Table-2: Innovative Water Quality for Lakes of Mysore (2010-2013).

Parameter	L.L		D.L		K.L		D.L	
Stream direction	Ds	Us	Ds	Us	Ds	Us	Ds	Us
DO (% Saturation)	94	58	58	26	107	38	129	121
TP (mg/l)	0.6	0.5	0.2	0.5	0.2	0.5	0.5	0.6
Turb (MTn)	0.4	03	05	06	05	06	.7	06
SC (Ms/c)	466	436	476	455	709	732	486	476
FC no/100/10 power 4	.088	.009	.009	.007	.009	.007	.008	.006
IWQI	2.2	1.9	1.9	1.4	2.3	1.7	2.4	2.4
Quality Rating	A	M	M	M	A	M	A	A

LL: *Lingambudhi lake,* ***D.L:*** *Dalvoi lake,* ***Kh*** *Kukkarahalli lake,*
YL: *Yennehole lake;* ***A****: Acceptable,* ***MA:*** *Marginally acceptable:*
DO: *Dissolved oxygen;* ***TP:*** *Total phosphate,* ***Turb:*** *Turbidity,*
Sc: *Specific conductance,* ***IWQI:*** *Innovative water quality Index.*

Table- 3: Standard values of the Innovative water quality Index.

Range	Quality
3	Very good
2-3	Acceptable
<2	Marginal
<1	Poor

Result and Discussion

The British Columbia Ministry of Environment and Parks (Canada) developed the BCW-WQI (Zandbergen and Hall, 1998). This was found to be extremely sensitive to sampling design and was highly dependent on the application of the water quality objectives. It also had several limitations for comparing different water bodies and for establishing management practices. The Oregon Department of Environment quality (ODEO) developed the OWQE (1980) and integrated raw analytical results (Cude, 2001). Other WQI developed were Florida Stream Water Quality Index (FWQI) under the strategic Assessment of Florida's Environment (SAFE, 1995). In all these indices, similar to the national sanitation Foundation-WQI (MSF-WQI) high number of water chemistry variables had to be analyzed. This in turn would pose difficulties in identifying the most prominent factor involved in the index.

Ahmed *et.al* (2004) formulated an innovative water quality Index for evaluating water quality in streams. The numbers of parameters to be determined were only five. These were considered as the basic and most important parameters that could be used to construct the new WQI. They include Dissolved oxygen, total phosphorous, Turbidity, Specific conductance and fecal coli forms (Ibrahim Nather khan, and Begham, M. Firuza, 2012).

Prime importance is given to Dissolved oxygen in lakes; mainly as DO % saturation. Vital to aquatic life, oxygen enters the water by diffusion from the atmosphere or through plant photosynthesis. Actual solubility is directly proportional to the partial pressure in gas phase, to salt concentration (Specific conductivity) and temperature. Temperature alters saturation of Dissolved oxygen. The dissolved oxygen content in water is constantly changing and represents a balance between respiration and decomposition in which coli forms and other Cyanobacteria play a significant role in depleting oxygen and increasing

photosynthetic activity. Organic waste, commonly entering lakes may over load a natural system causing a serious depletion of oxygen supply in the water which in turn leads to fish kill. 'Eutrophic water' achieves the same results causing massive proliferation of planktonic algae. These eventually decompose and may use up the available Dissolved oxygen. Algal blooms appear because of excess run off of phosphorous into lakes from the surroundings; algal biomass in turn increases turbidity. The WQI of Ahmed *et.al* 2004 uses these parameters in determining the quality of water.

The IWQI was applied to the four lakes under study and the results are presented in table 2. The standard values of the index are presented in table 3. The index values in Lingambudhi Lake for downstream and upstream are between 1.9 and 2.2 and the water is rated as marginal to acceptable. DO saturation in downstream rises to 94% but in the upstream it reduces to 58%. Dalvoi lake regularly receives city sewage and oxygen saturation values are very low (26% to 58%). The index values range between 1.4 and 1.9 and the water quality is rated as marginal. Oxygen saturation value in Kukkarahalli Lake reaches 107% (Downstream) but reduces to 38% upstream. The rating of water quality is marginal to acceptable. In Yennehole Lake oxygen saturation values are always high (121-129%). The index value is 2.4 and is rated as acceptable.

Lingambudhi Lake is protected to a little extent. It favors a meager growth of algae. Dalvoi Lake is very poor in algal growth and has a very corrosive property. Kukkarahalli Lake supports a permanent bloom of Microcystis *aeruginosa*. The lake emits a foul smell during winter and summer seasons. Wind action carries the surface bloom to the lake and the DO content quite often alters. Yemaehole Lake also supports a permanent minor bloom of *Spirulina platensis* and *Raphidiopsis medetereana* (Hosmani & Linghinmaiah, 2002). Kukkarahalli Lake and Yemaehole Lake experience huge fish kills and control of oxygen saturation is very essential apart from calculating the amount of TMDL for restoration of lakes (Bartholomay, *et al,* 2007).

Conclusion

The Innovative water quality Index is simple and involves only five important parameters in its calculation. The values are small numericals and can be easily conveyed to the general public and in restoration activities. The rating of water quality for Lingambudhi Lake and Kukkarahalli Lake is between marginal and acceptable, while it is marginal in Dalvoi Lake, but acceptable in Yenmehole Lake. This lake receives continuous river water through a channel and hence remains acceptable to a very slight extent. IWQI can be applied to lake ecosystems also and can serve as an important tool in water quality management.

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References

1. Ahmed S.D, K .Stevens and Y. Sehlke 2004. Environmental Assesment: An Innovative Index for evaluating water quality in streams. Environmental Management: 34(3); 401-414.
2. Aneja, KR 2004 Experiments in Microbiology, plant pathology, Tissue culture and Mushroom cultivation. Wishwas Prakashan. New Delhi.
3. APHA 1998: Standard methods for the Examination of water and waste 20th Ed. Washington DC. 1220 pp.
4. Bartholomay, R.C., J.M. Carter, S.L. Qi, P.J. Squillace, and G.L. Rowe. 2007. Summary of Selected U.S. Geological Survey Data on Domestic Well Water Quality for the Centers for Disease Control's National Environmental Public Health Tracking Program: U.S. Geological Survey Scientific Investigations Report 2007–5213, p. 57.
5. CCME- WQI. 2001 Canadian council of Ministress of the Environment. Canadian water quality guidelines for the protection of aquatic life. CCME-WQI 1.0 user's manual in Canadian Environment quality guidelines 1999, Winipeg.
6. CUDE C. 2001. Oregon water quality Index. A tool for evaluating water quality management effectiveness. Journal of American Water Resources Association 37:125-137.
7. Gupta, D. P. 2009. Physiochemical Analysis of Ground Water of Selected Area of Kaithal City (Haryana) India. Researcher, 1(2), 1-5.
8. Hosmani S.P and B. Linghanmiah 2002. Mass mortality of fish in Yenmehole Lake. Mysore. Poll. Res. 21(4): 435- 437.
9. Hosmani S.P. 1976. Limnological studies in ponds and lakes of Dharwar. Ph.D Thesis. Karnataka University, Dharwar.
10. Ibrahim Nather khan, and Begham, M. Firuza. 2012. Biological Assessment of Water Pollution Using Periphyton. Internat. Rev. Hydrobiol- 97(2): 124–156.
11. Productivity and Standing Crop in the Linggi River, Malaysia
12. Mitchell M.K and Stapp. 1996 Field manual for water quality monitoring. An Environmental Education Program for Schools. Thomson-Shore. Inc.Dexter. Michigan.
13. NSF-WQI Wilkes University centre for Environmental quality.Environmental Engineering and Earth sciences.
14. SAFE 1995 Strategic assessment of Florides Environment. Florida Stream Water Quality Index.
15. WEP .1996 Lower great Miami water shed enhancement programs (WEP) Maim Valley River Index.
16. World Health Organization.2011. Hardness in Drinking-water: Background document for development of WHO Guidelines for Drinking-water Quality [online]. Available at http://www.who.int/water_sanitation_health/dwq/chemicals/hardness.[accessed 22 November 2011].
17. Zandbergen PA and K.J. Hall.1998. Analysis of the British Columbia Water Quality Index of water shed managers. A case study of two small water sheds. Water Quality Research Journal of Canada 33: 519-549.