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SURFACE WATER (LAKES) QUALITY ASSESSMENT IN NAGPUR CITY (INDIA) BASED ON WATER QUALITY INDEX (WQI)

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ABSTRACT

This paper is intended to be a study concerning with surface water (lakes) quality in Nagpur city (India) based on water quality index (WQI). In present study, water quality index (WQI) has been calculated for different surface water resources especially lakes, in Nagpur city, Maharashtra, (India), for the session January to December 2008; comprising of three seasons, summer, winter and rainy season. Sampling points were selected on the basis of their importance. Water quality index was calculated using water quality index calculator given by National Sanitation Foundation (NSF) information system. The calculated (WQI) for various studied lakes showed fair water quality in monsoon season which then changed to medium in winter and poor for summer season. Gorewada lake showed medium water quality rating in all season except monsoon season. Futala, Ambazari and Gandhisagar lake has also declined in aesthetic quality over past decade following invasion of aquatic weeds such as hydrilla and water primrose, so the reasons to import water quality change and measures to be taken up in terms of surface water (lakes) quality management are required.

Keywords: Surface water, Water quality index, National Sanitation Foundation, Lakes.

INTRODUCTION

Water pollution means contamination of water by foreign matter such as micro-organism, chemicals industrial or other wastes, or sewage. Such matters deteriorate the quality of water and render it unfit for its intended uses. Water pollution is the introduction into fresh or ocean waters of chemical, physical or biological material that degrades the quality of the water and affects the organisms living in it. Although some kinds of water pollution get occur through natural processes, it is mostly a result of human activities. The water we use is taken from lakes and rivers, and from underground (ground water) and after we have used it and contaminated it – most of it returns to these locations. Water pollution also occurs when rain water runoff from urban and industrial area and from agriculture land and mining operations makes its way back to receiving waters (river, lake or ocean) and into the ground.[1-3] According to WHO[4] organization, about 80% of all diseases in human beings are caused by water. Once the groundwater and surface water quality is contaminated, its quality can't be restored by stopping the pollutants from the source. It therefore becomes imperative to regularly monitor quality of groundwater and surface water resources and to device ways and mean to protect it. Water quality index (WQI) is one of the most effective tools[5-8] to communicate information on the quality of water to the concerned citizens and policy makers. Many civilizations that flourished after developing reliable water supply collapsed when supply was exhausted or its quality deteriorated[9]. It thus becomes important parameters for the

assessment and management of ground as well as surface water resources. Water quality index (WQI) is regarded as one of the most effective way to communicate water quality[10-13]. The (WQI) which was developed in the nearly 1970's can be used to monitor water quality changes in a particular water supply over time, or it can be used to compare a water supply's quality with other water supplies in the region or from around the world. The result can also be used to determine if a particular stretch of water is considered as healthy. Assessments of water quality are very important for knowing it's suitability for various purposes.[14]

Lake pollution is one of the serious environment problems in recent years with socio–economics development and pollutant discharge increase from industry, agriculture and domesticity. Nagpur city with coordinates of 21°8' 55'' N and 79° 4'46''E is second capital of Maharashtra state. Nagpur city is popularly known as orange city, also city of lakes. The city had 10 lakes in the past, but unfortunately only 7 of them are there now. The present water supply to city is made from Gorewada lake, Kanhan River and Pench Dam. Futala Lake is used to irrigate 84 acre of cultivated agriculture land. Ambazari lake water is provided to local residence of MIDC colony, Hingna area, Nagpur also it is used for industrial purpose. The present study was completed to obtain a record of seasonal condition in various lakes such as Futala, Ambazari, Gandhisagar and Gorewada Lake are within Nagpur city, Maharashtra, (India). The specific objective of present study is to determine lakes physical and chemical profile over an annual cycle and its overall water quality in terms of water quality index (WQI).

EXPERIMENTAL

To characterize water quality throughout the main basin of the lakes, four permanent stations for monthly sampling were established and marked within inflow, mid-lake, outflow and corner regions. Regular samples were collected in sterilized glass bottles for bacteriology and various physicochemical analysis of sample; the precleaned plastic polyethylene bottles were used. Prior to sampling, the entire sampling container's were washed and rinsed thoroughly with lake water to be taken for analysis. The samples were analyzed for different physical, chemical and bacteriological parameters of water quality index (Electrical conductivity, TDS, Cl^-, Total Hardness, BOD, DO, pH, Faecal Coliform) using standard method[15] In bacteriological examination, total coliforms and fecal coliforms were determined by Membrane Filtration (MF) technique and average values were recorded.

The National Sanitation Foundation water quality index (NSF, WQI) has the following mathematical structure:

NSF WQI = $\sum_{i}^{n} (W_i X L_i)$ for n parameters

Where, L_i = Sub – index for i [th] water quality parameter;

W_i = Weight (in terms of importance) associated with i [th] water quality parameter; and

n = Number of water quality parameters.

RESULTS AND DISCUSSION

A water quality index (WQI) integrates complex analytical raw data and generates a single number (like a grade) that express subjectively the water quality. Such a rating scale allows for simplicity and consumer comprehensibility. A water quality index can be different type depending on its final intended purpose. It can be highly specific for different bodies of water or could be a general one for all types of water meant for human consumption. A WQI can also be based not just on readings at a single point of time but also on readings collected over a period of time (like a year). A WQI may also be arrived at by calculating the number of objective parameters not met, or by calculating the frequency with which they are not met or the amount by which they exceed the norm.

The WQI was calculated using NSF information software[16] and compared with standard water quality rating, as shown Table 2. The minimum, maximum and average of values obtained for various lakes of WQI rating for monsoon, summer and winter season are represented in Table 2. The graphical representation of WQI rating in different season is given in Fig. 1. Fig. 2 shows location of Futala, Ambazari, Gandhisagar and Gorewada lakes. The contamination of surface water is a significant environmental concern and constitutes a risk to both water quality and aquatic ecosystem. Peoples around

the world have used surface and groundwater as a source of drinking water and even today more than half the world population depends on groundwater and surface water for their survival[17]. The values of ground and surface water lies not only in its wide spread occurrence and availability but also its consistent which makes it an ideal supply of drinking water. Electrical conductivity of water is a direct function of its dissolved salt[18]. Hence it is an index to represent total concentration of soluble salts in water[19]. High values of total dissolved solid in surface water resources (lakes, rives) are generally not harmful to human beings but high concentration of these may affect person who are suffering from kidney and heart diseases[20]. Water containing high solids may cause laxative or constipation effects[21]. High values of TDS in Futala and Gandhisagar Lake is due to dense residential area and intensive irrigation.[22]

The Gandhisagar and Futala lake water samples are poor in quality. In this part, the surface water resources (lakes) may improve due to inflow of fresh water of good quality during rainy season. The low values of WQI at studied lakes have been found to be mainly from the higher values of pH, nitrate, TDS, hardness, bicarbonates and chlorides. The present analysis reveals that surface water resources especially lakes (studied) need some degree of treatment and also need to be protected from perils of contamination.

On the basis of the above discussion it may be concluded that the lake water quality at almost all sites at Futala, Ambazari and Gandhisagar Lake are highly polluted. The observed range of average WQI in monsoon was 36, 44, 32 and 70 in Futala, Ambazari, Gandhisagar and Gorewada lakes respectively. In summer WQI values were 27.5, 46, 22 and 56, whereas in winter it was 34, 54, 22, and 54 for Futala, Ambazari, Gandhisagar and Gorewada lake respectively.

For Futala, Ambazari and Gandhisagar lake, the water quality at almost all the sites showed the increasing trend of WQI index in monsoon, summer and winter season respectively as shown in Table 3.

Table-1: Sub Index Equation for Water Quality Parameter (NSF WQI)[16]

Water Quality Parameter	Range Applicable	Equation
Percent Saturation D.O.	0-40%	IDO = 0.18 + 0.66 X (% Saturation of DO)
	40^{+}- 100 %	IDO = - 13.550 + 1.17 X (%Saturation of DO)
	100 $^{+}$- 140 %	IDO = -263.34 – 0.62 X (%Saturation of DO)
BOD(mg/L)	0-10	IBOD = 96.67-1.23 X (BOD)
	10^{+}- 30	IBOD = 38.90-1.23 X (BOD)
pH	2-5	IpH = 16.10-7.35 X (pH)
	5^{+}-7.3	IpH = -142.67+33.50 X (pH)
	7.3^{+}-10	IpH = 316.96-29.85 X(pH)
	10^{+}-12	IpH = 96.17-8.00X (pH)
Faecal coliform	1-10^{3}	IColi = 97.20 - 26.80 x log (FC)
	10^{3+}-10^{5}	IColi = 42.23-7.75 x log (FC)
	10^{5+}	IColi = 2

Where, IDO : Sub index for Dissolved Oxygen
IpH : Sub index pH
IBOD : Sub index for Biochemical Oxygen Demand
IColi : Sub index for coliform

CONCLUSION

The result obtained in present study revealed that certain human activities such as immersion of idols of God and Goddess (in large ratio) during festival season, washing activities, recreational activities, surface runoff from resulting rainfall, (poor) sewage have contributed considerable pollution in various lakes within Nagpur city area. Water quality from studied lakes is unsafe for consumption of human use and

therefore need serious attention. The present study revealed that water quality form studied lakes is polluted with reference to almost all the water quality physicochemical parameters studied. The Futala, Ambazari and Gandhisagar lake showed poor water quality in all respect. People dependent on this water may prone to health hazard due to polluted drinking water; therefore some effective measures are urgently required to enhance the lake water quality by delineating an effective water quality management plan for lake system in Nagpur city, Maharashtra, India.

Table-2: Description of the Index[16]

NSF WQI	Ranking	Description
63-100	Good to Excellent	Drinking water source without conventional treatment but after disinfections
50-62	Medium to Good	Outdoor bathing , swimming and water contact sport
38-49	Bad	Drinking water source with conventional treatment : followed by disinfection
0-37	Bad to Worse	Propagation of wildlife fisheries, irrigation, industrial cooling and controlled waste disposal.

The index when used has certain figures, which appears as shown below-

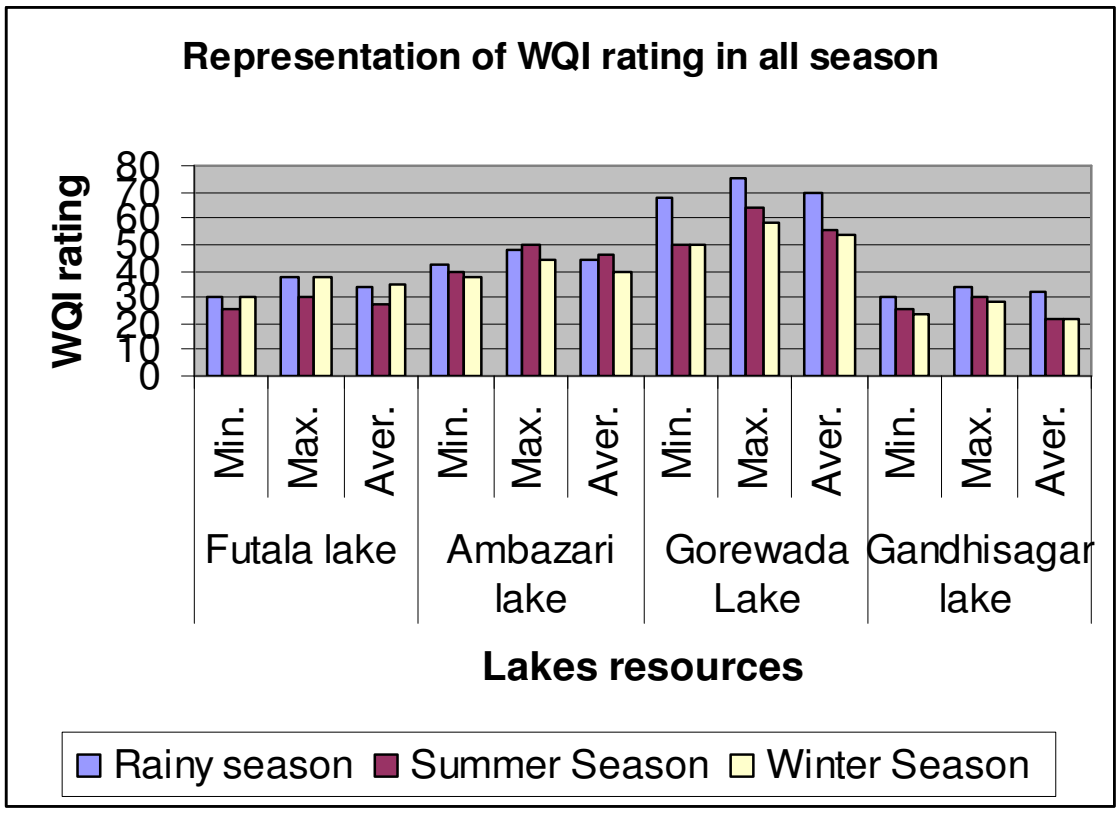

Figure-1

Table-3: Average WQI rating of surface water (lake) sources in different season.

Resources	Rainy Season		Summer Season	Winter Season
Futala lake	Min.	30	25	30
	Max.	38	30	38
	Aver.	34	27.5	34.4
Ambazari lake	Min.	42	40	38
	Max.	48	50	44
	Aver.	44	46	40
Gorewada lake	Min.	68	50	50
	Max.	75	64	58
	Aver.	70	56	54
Gandhisagar lake	Min.	30	25	24
	Max.	34	30	28
	Aver.	32	22	22

Note : Max – Maximum, Min – Minimum, Aver – Average

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Fig.-2: Map showing Gandhisagar, Ambazari, Gorewada and Futala Lake , Nagpur (MS) India.