Use of Water Quality Index Result of Robertson Lake Jabalpur in Remote Sensing Application

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Abstract

The water of Robertson Lake is suffering from severe contamination which is due to heavy discharge of pollutants without adequate treatment to remove harmful compounds. This is leading to the damaging effects not only to the individual species and population but also to natural biological community. The present work highlights the water quality index of Robertson Lake of Jabalpur. Water Quality Index (WQI) using remote sensing was applied in Robertson Lake India using water quality parameters like Temperature, Chloride, Hardness, Alkalinity, pH, Conductivity, Total Dissolved Solids (TDS), Fluoride, Iron, Turbidity, Dissolved Oxygen (DO) and Biochemical Oxygen Demand (BOD). The analysis reveals that Robertson Lake needs some treatment before consumption.

Keywords- Physico-chemical parameters, Water Quality Index, Remote sensing and remedies

I. INTRODUCTION

Globally, there is increasing awareness that the water will be one of the most critical natural resources in future. Water scarcity is increasing worldwide and pressure on the existing water resources is increasing due to growing demand of different sectors such as domestic, agriculture and industrial, hydropower etc. Therefore evaluation of water quality is important research topic in the recent years. Water is one of the most important factors for every living organism on this planet. Water is generally used for drinking, fisheries and other domestic purposes in this area. The available fresh water to man is hardly 0.3 to 0.5% of the total water available on the earth and therefore its judicious use in imperative. Lakes are one of the important water resources used for irrigation, drinking, fisheries and flood control purposes.

The Robertson Lake is situated in Mahakausal region of Jabalpur. It lay behind Jabalpur Engineering College, Jabalpur. It is surrounded by vehicle factory, pump house, hospital, mountains, temples and most importantly the population living around the lake area. The lake shows the marshy vegetation growing at the bank of the lake along with drains and pools that quantify pollution cost by municipal and industrial waste. A large part of this contamination is due to the organic material that comes from neighbouring urban sewage, live stocks, industrial waste and hospital waste . The water is also infested with water hyacinth which stabilised the water quality and provides substantial support to bacterial density which inturn contributes significantly to its growth and nutrient dynamics.

Water quality indices are tools to determine conditions of water quality and, like any other tool require knowledge about principles and basic concepts of water and related issues. It is a well-known method of expressing water quality that offers a stable and reproducible unit of measure which responds to changes in the principal characteristics of water. WQI is a mechanism for presenting a cumulatively derived numerical expression defining a certain level of water quality. In other words, WQI summarizes large amounts of water quality data into simple terms e.g., excellent, good, bad, etc. for reporting to management and the public in a consistent manner.

Remote sensing techniques can be used to monitor water quality parameters (i.e., suspended sediments (turbidity), chlorophyll, and temperature). Optical and thermal sensors on boats, aircraft, and satellites provide both spatial and temporal information needed to monitor changes in water quality parameters for developing management practices to improve water quality. Recent and planned launches of satellites with improved spectral and spatial resolution sensors should lead to greater use of remote sensing techniques to assess and monitor water quality parameters. Integration of remotely sensed data, GPS, and GIS technologies provides a valuable tool for monitoring and assessing waterways. Remotely sensed data can be used to create a permanent geographically located database to provide a baseline for future comparisons. The integrated use of remotely sensed data, GPS, and GIS will enable consultants and natural resource managers to develop management plans for a variety of natural resource management applications.

II. STUDY AREA AND SAMPLING DETAILS

Robertson Lake is one of the important lake of Jabalpur, Madhya Pradesh. Robertson Lake is situated near the Jabalpur Engineering Collage which is also known as Government Engineering Collage. The area of the Robertson Lake is about 122.492 Hectare and its coordinates are 23°11'52"N and 79°59'9"E. Water samples collected from eight sampling stations selected for the analysis are Sharda Nagar as S1, Ram Nagar as S2, Shanti Nagar as S3, Gokhalpur near Ranjhi Govt. Hospital as S4, Gokhalpur near JEC as S5, Near Over Head Tank as S6, Near Vehicle Factory Road as S7 and Near Vehicle Factory Road Sector 2 as S8. Samples are collected in the month of May. Samples for analysis are collected in sterilized bottles using the standard procedure for grab (or) catch samples in accordance with standard methods of APHA (American Public Health Association). The analysis of various physico – chemical parameters namely Temperature, Chloride, Hardness, Alkalinity, pH, Conductivity, Total Dissolved Solids (TDS), Fluoride, Iron, Turbidity, Dissolved Oxygen (DO) and Biochemical Oxygen Demand (BOD) are carried out. All the chemicals and reagents used were of analytical grade.

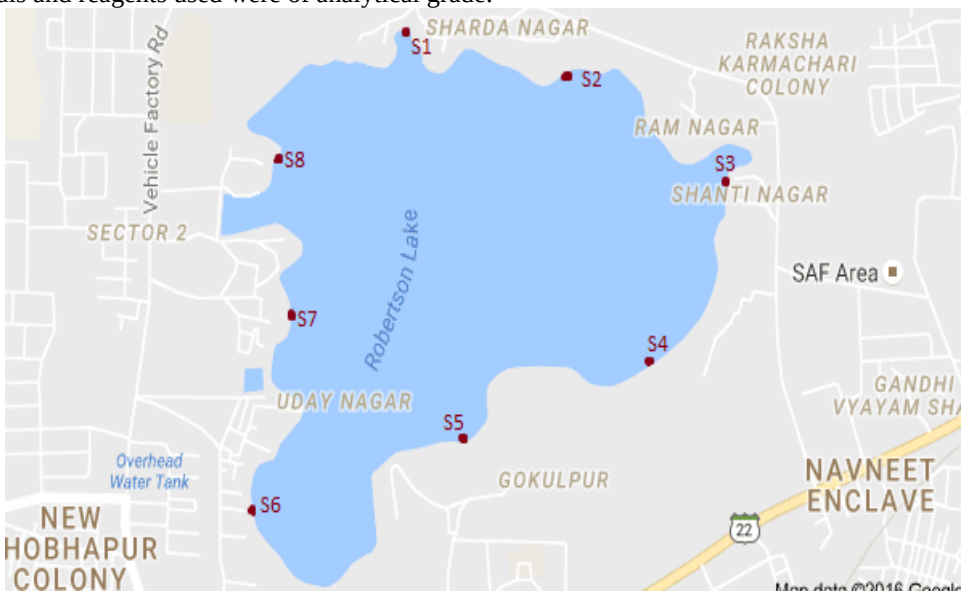

Fig. 1: Study Area and Sampling Details

III. PARAMETERS CALCULATED

A. Temperature

Water temperature is a physical property expressing how hot or cold water is. Temperature is an important factor to co nsider when assessing water quality. In addition to its own effects, temperature influences several other parameters and can alter the physical and chemical properties of water. The average temperature of the present study ranged is 34.1.

B. Chloride

Chloride is present in all natural waters, but mostly the concentrations are low. In most surface streams, chloride concentrations are lower than those of sulfate or bicarbonate. Chloride ions may be retained in solution through most of the processes which tend to separate out other ions. Chloride values obtained in the study are found in the range between 65 to 85 mg / lt.

C. Hardness

Calcium and magnesium dissolved in water are the two most common minerals that make water "hard." The hardness of water is referred to by three types of measurements: grains per gallon, milligrams per liter (mg/L), or parts per million (ppm). The hardness values of the present study were found to range between 210 to 300 mg/lit.

D. Alkalnity

Alkalinity is a measure of the capacity of water to neutralize acids. The predominant chemical system present in natural waters is one where carbonates, bicarbonates and hydroxides are present. The bicarbonate ion is usually prevalent. In the present investigation the total alkalinity of the water samples is found in the Range 300 to 398 mg/lt.

E. pH

pH is a measure of how acidic/basic water is. The range goes from 0 - 14, with 7 being neutral. pHs of less than 7 indicate acidity, whereas a pH of greater than 7 indicates a base. pH is really a measure of the relative amount of free hydrogen and hydroxyl ions in the water. The pH values of the present investigation were between 5.9 to 8.5

F. Conductivity

Conductivity is used to measure the concentration of dissolved solids which have been ionized in a polar solution such as water. The unit of measurement commonly used is one millionth of a Siemens per centimeter (micro-Siemens per centimeter or µS/cm). The values obtained are in the range 1150 to 1250 mhos

G. Total Dissolved Solids

Total dissolved solids (TDS) comprise inorganic salts (principally calcium, magnesium, potassium, sodium, bicarbonates, chlorides, and sulphates) and some small amounts of organic matter that are dissolved in water. TDS values ranged within 500 to 600 mg/lt.

H. Turbidity

Turbidity is the cloudiness or haziness of a fluid caused by suspended solids that are usually invisible to the naked eye. It is an aggregate optical property of the water and does not identify individual substances; it just says something is there. It is an aggregate optical property of the water and does not identify individual substances; it just says something is there.

I. Fluoride

Fluoride is the simplest anion of fluorine. Its salts and minerals are important chemical reagent. In terms of charge and size, the fluoride ion resembles the hydroxide ion. Fluoride ions occur on earth in several minerals, particularly fluorite, but are only present in trace quantities in water. Fluoride contributes a distinctive bitter taste. It contributes no color to fluoride salts. In study it varies in the range of 0.26 to 1.30 mg/l

J. Iron

In present study it is found in the range 0.26 to 1.02 mg/l.

K. Dissolved Oxygen

Dissolved oxygen concentrations are constantly affected by diffusion and aeration, photosynthesis, respiration and decomposition. While water equilibrates toward 100% air saturation. The DO values obtained in the present study are within 3.0 to 6.2 mg/L.

L. Biochemical Oxygen Demand

Biochemical oxygen demand (BOD) is the amount of dissolved oxygen needed (i. e., demanded) by aerobic biological organisms to break down organic material present in a given water sample at certain temperature over a specific time period. This parameter values obtained in the present study are within 100 to 200 mg/l.

IV. CALCULATION OF WQI

In this study for the calculation of water quality index twelve important parameters were chosen. The W.Q.I. has been calculated by using the standards of drinking water quality recommended by the World Health Organization (WHO), Bureau of Indian Standards (BIS) and Indian Council for Medical Research (ICMR). The weighted arithmetic index method (Brown et. al.) has been used for the calculation of WQI of the lake. Further quality rating or sub index (qn) was calculated using the following expression.

$$\text{Quality rating, } Qi = 100\,[(Vn - Vi) / (Vs - Vi)]$$

Where, Vn: actual amount of nth parameter
Vi: the ideal value of this parameter
Vi = 0,
Except for pH and D.O. Vi = 7.0 for pH;
Vi = 14.6 mg/L for D.O.
Vs: recommended WHO standard of corresponding parameter
Relative weight (Wi) was calculated by a value inversely proportional to the recommended standard (*Si*) of the corresponding parameter:

$$Wi = 1/ Si$$

Generally, WQI are discussed for a specific and intended use of water. In this study the WQI for human consumption is considered and permissible WQI for the drinking water is taken as 100. The overall WQI was calculated by using Equation:

$$\text{Water Quality Index (WQI)} = \sum (Qi)\, Wi / \sum Wi$$

Table 1: Water Quality Classification Based On WQI Value

Parameter	*Mean test result*	*Unit*	*Standard permissible value (Si)*	*Relative Weight (Wi)*
Temperature	*34.1*	*°C*	-	-
Chloride	*74.3*	*(mg/L)*	*250*	*0.0040*
Hardness	*296*	*(mg/L)*	*300*	*0.0033*
Alkalinity	*380*	*(mg/L)*	*200*	*0.0050*
pH	*8.4*	-	*8.5*	*0.1176*

Conductivity	*1158*	*(mS/cm)*	*300*	*0.0033*
TDS	*582*	*(mg/L)*	*500*	*0.0020*
Fluoride	*0.85*	*(mg/L)*	*1*	*0.0040*
Iron	*0.37*	*(mg/L)*	*0.3*	*1.6666*
Turbidity	*54.18*	*(mg/L)*	*5*	*0.16533*
DO	*6.0*	*(mg/L)*	*5*	*0.2000*
BOD	*198*	*(mg/L)*	*6*	*0.1667*

Table 2: Samples Calculation Result

WQI	*Quality of water*
0-24	*EXCELLENT*
25-49	*GOOD*
50-74	*POOR*
75-100	*VERY POOR*
>100	*UNFIT FOR DRINKING*

V. CONCLUSION

On the basis of results of research civil engineering structure which control the pollution in lake. To control the pollution in lake through major sewers by Intercept and treat all sewage at Intersection of lake by volume. Divert some and Intercept the others. Treat remaining sewage at intersection of lake. Install sewage treatment network upstream at sources and Intercept for final Treatment at Lake. And to control pollution in lake through minor drains by Connect to main sewers as per gradient or lift stations. Cluster drains in pockets and treat before discharge into lake. Connect Drains to points and lift stations for treatment nearby.

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