

Water Quality Assessment through Water Quality Index (WQI) Determination of Narmada River during Winter Season, at Hoshangabad City, (M. P.)

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Abstract: *The present study is aimed to analyze the physico-chemical properties and water quality index (WQI) determination to assess the water quality of Narmada River at Hoshangabad city (M. P.) for domestic and irrigation purposes. Total 09 physico-chemical parameters such as pH, Turbidity, Electrical Conductivity (EC), Total Hardness (TH), Total Alkalinity (TA), Total Dissolved Solids (TDS), Chloride, Nitrate and Dissolved Oxygen (DO) were analyzed followed by standard methods suggested by APHA (2012). Water quality index (WQI) has also been determined to assess the quality of Narmada River water and obtained results were evaluated and compared with WHO and BIS water quality standards. The results of this present analysis and the values of WQI obtained indicated that river water quality was found under the category of "Good" and it may be used for domestic and irrigation purposes after some degree of proper treatment and it is also suggested that public awareness to maintain the water quality of water sources would be helpful.*

Keywords: Physico-Chemical Parameters, Water Quality Index (WQI), APHA, BIS Hoshangabad city, Madhya Pradesh

1. Introduction

Water is a universal solvent and is one of the prime need of life. Since time immemorial freshwater has always been of vital importance for man, as his early habituation were within easy reach of rivers, dams, etc. Due to industrialization and increase in population the demand of fresh water increases in the last decades. River pollution has become a global problem. For human life and agriculture purposes this demand of water is fulfilled by the rivers. The river water quality is being deteriorated due to industrial as well as human activities. Rivers and streams have become the dump yards of domestic sewage and industrial effluents. Our rivers are the major sources of drinking water, besides their usage in agriculture, washing, bathing etc. Pollution of rivers may invite many unhygienic conditions and water born infectious diseases not only for humans but also the biota depending and living in it. The aim of the present study is to assess the water quality of Narmada River for its domestic and irrigation purpose.

2. Study Area

The Narmada is a river in Central India and the fifth largest river in the Indian subcontinent. It forms the traditional boundary between North India and South India and flows westwards over a length of 1312 km before draining through the Gulf of Cambay (Khambhat) into the Arabian sea, 30 km west of Bharuch city of Gujarat. It flows through the states of Madhya Pradesh (1077 Km), Maharashtra (35 km) border between Madhya Pradesh and Maharashtra and 39 km border between Madhya Pradesh and Gujarat, total (74km) and 161 km in Gujarat. There are 41 tributaries, out of which 22 are in the Satpura Range and the rest on the right bank are in the Vindhya Range. In order to determine the water quality, total 04 water sampling stations were selected for samples collection in the study area along the stretch of the river Narmada, at

Hoshangabad District (M. P.). The sampling stations were: station-1 (Kothibazar), station-2 (Sethani Ghat), station-3 (Hoshangabad Railway Bridge) and station-4 (Budhni Ghat).

3. Material and Methods

Water samples were collected in fresh one litre plastic bottles previously cleaned with 1: 3 HNO₃ from 04 pre-selected sampling stations during the period of three months of winter season from Oct.2021 to Dec.2021 on monthly basis. Samples were collected during the first week of every month in the early hours of the day in between 6.00 am to 9.00 am. Physico-chemical parameters like water temperature, pH, and DO were measured in the field and other parameters were mostly tested within 24 Hrs of collection. Water quality parameters were analyzed by standard methods given by APHA (1992) and Trivedi and Goel (1987). The experimental results were compared with the permissible limit of drinking and irrigation water quality standard WHO and BIS (IS: 10500). In this study, for the calculation of water quality index (WQI), total 09 important water quality parameters such as Temperature, pH, Electrical Conductivity (EC), Total Hardness (TH), Total Alkalinity (TA), Total Dissolved Solids (TDS), Chloride, Nitrate and Dissolved Oxygen (DO) were considered.

Determination of Water Quality Index (WQI)

The WQI is calculated by aggregating the quality rating with the unit weight linearly and can be given by the following expression-

$$WQI = \sum Q_n \cdot W_n / \sum W_n$$

Where, Q_n = Quality Rating for the nth water quality parameter, and

W_n = Unit weight for nth water quality parameter

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4. Results and Discussion

The summary of observations of physico-chemical parameters and WQI values of all the water samples from four water sampling stations are presented in table 1, 2 and 3 as-

pH: pH is a scale of intensity of acidity or alkalinity and measures the concentration of hydrogen ions in water. In the present study, the average value of pH was found as 7.3. The pH value of 6.5 to 8.5 is recommended for drinking purpose.

Turbidity – Turbidity is the cloudiness of water caused by a variety of particles and is another key parameter in the analysis of quality of drinking water. It is also related to the content of diseases causing organisms in water, which may come from soil runoff. Turbidity indicates the muddiness of water therefore measure the extent to which light absorbed or scattered by fine suspended and colloidal solids and is a measure of resistance of water to the passage of light through it. In the present study, the turbidity of Narmada river water was recorded the average value of 4.9 NTU.

Electrical conductivity (EC)-Water capability to transmit electric current is known as electrical conductivity and serves as tool to assess the purity of water. This ability depends on the presence of ions, their total concentration, mobility, valence, relative concentrations and temperature of measurement. The average value of electrical conductivity was found 221.3 μ mhos/cm.

Total Hardness: Total hardness of water is the sum of concentration of alkaline earth metal cations present in it. During the investigation, the average value of total hardness was found as 118.6 mg/l.

Total Alkalinity: Alkalinity of water is its capacity to neutralize a strong acid and is characterized by the presence of hydroxyl ions capable of combining with hydrogen ions. In natural water most of alkalinity is

caused due to the presence of free carbon dioxide. The average value of total alkalinity was found as 112.4 mg/l.

Total Dissolve Solids (TDS): Total dissolve solids are an important factor for drinking water and water to be used for other purposes. Beyond the prescribed limit it imparts a peculiar taste to water and reduce its palatability. In cases where water softening is needed, the type of softening procedure used may be dictated by TDS content. The average value of total dissolved solids was found 154.1 mg/l.

Chloride: chlorides in reasonable concentration are not harmful to humans. At concentrations above 250 mg/l give a salty taste to water, which is objectionable to many people. Before proceeding for bacteriological testes, chloride test served as the basis of detecting contamination of ground waters by wastewaters. Evaporation tends to increase the chloride and salinity at the root zone of irrigated plants, making it difficult for crops to take up water due to osmotic pressure difference between the water outside the plants and within the plant cells. In the present study, the average value of chlorides was found the average value of chloride was found as 38.5 mg/l.

Nitrate (NO_3^-)-Nitrates are contributes to freshwater through discharge of sewage and industrial wastes and run off from agricultural fields. The highest amount of nitrate concentration was known to support the formation of blooms. During the present study, the average amount of nitrate recorded in the water of Narmada River was as 21.6 mg/l.

Dissolve Oxygen (DO): Dissolve oxygen (DO) is one of the most important parameters in water quality assessment and reflects the physical and biological process prevailing in the water. Oxygen can be rapidly removed from the water by discharge of oxygen demanding wastes. In present study, the average value of DO was found as 7.8 mg/l.

Table 1: Summary of Water Quality Index (WQI) and Corresponding Water Quality Status (WQS)

| S. No. | WQI | WQS | Possible Uses |
|--------|---------|-----------------------|---------------------------------------|
| 1 | 0-25 | Excellent | Drinking, Irrigation and Industrial |
| 2 | 26-50 | Good | Domestic, Irrigation and Industrial |
| 3 | 51-75 | Fair | Irrigation and Industrial |
| 4 | 76-100 | Poor | Irrigation |
| 5 | 101-150 | Very Poor | Restricted use for Irrigation |
| 6 | >150 | Unfit for Consumption | Proper Treatment Essential before use |

Table 2: standard permissible limit of various physico-chemical parameters suggested by WHO and IS 10500: 2012

| S. No. | Parameters | Unit | Permissible Limit | | Average Values of Studied Parameters Obtained |
|--------|------------------------------|---------------|-------------------|-----------------|---|
| | | | WHO | BIS 10500: 2012 | |
| 1 | pH | | 7.5 – 8.5 | 6.5 – 8.5 | 7.3 |
| 2 | Transparency | cm | 5.0 | 5-10 | 4.9 |
| 3 | Electrical Conductivity (EC) | μ mhos/cm | 1400 | - | 221.3 |
| 4 | Total Hardness (TDS) | mg/l | 1000 | 200-600 | 118.6 |
| 5 | Total Alkalinity (TA) | mg/l | 120 | 200-600 | 112.4 |
| 6 | Total Dissolved Solids (TDS) | mg/l | 1000 | 500-2000 | 154.1 |
| 7 | Chlorides (Cl) | mg/l | 250 | 250-1000 | 38.5 |
| 8 | Nitrates (NO_3^-) | mg/l | 5.0 | 45 | 21.6 |
| 9 | Dissolved Oxygen (DO) | mg/l | - | >5 | 7.8 |

Table 3: Calculation of WQI value of water samples of Narmada River during Oct.2021 to Dec.2021

| S. No. | Parameters | Average Test values | Standard permissible limit | Relative Weight (W _n) | Quality Rating (Q _n) | Quality Weight (W _n *Q _n) |
|--------|------------------|---------------------|----------------------------|-----------------------------------|----------------------------------|--|
| 1 | pH | 7.3 | 8.5 | 0.1176 | 13.3333 | 1.5686 |
| 2 | Turbidity | 4.9 | 10 | 0.1 | 0.1 | 4.8 |
| 3 | Electrical Cond. | 221.3 | 300 | 0.0033 | 71.4666 | 0.2382 |
| 4 | Total Hardness | 118.6 | 300 | 0.0033 | 37.4 | 0.1246 |
| 5 | Total Alkalinity | 112.4 | 200 | 0.005 | 59.4 | 0.297 |
| 6 | TDS | 154.1 | 500 | 0.002 | 29.62 | 0.0592 |
| 7 | Chloride | 38.5 | 250 | 0.004 | 11.36 | 0.0454 |
| 8 | Nitrate | 21.6 | 45 | 0.0222 | 1.7333 | 0.0385 |
| 9 | Dissolved Oxygen | 7.8 | 6.0 | 0.1666 | 81.25 | 13.541 |

$$\Sigma W_n = 0.628, \Sigma W_n * Q_n = 22.018, WQI = 35.049$$

5. Conclusion

The present study was undertaken to determine the quality of water samples with special reference to physico-chemical properties. The water quality data of the analyzed samples were compared with the prescribed drinking water standards of WHO and BIS (IS: 10500) and have been considered for the calculation of WQI. The Water Quality Indices (WQI) was found in the range 35.049 indicating the "Good" water quality in the study area. On the basis of results obtained, it is concluded that during the study period the water quality of Narmada River water is good and may be used for domestic and irrigation purposes after some proper treatment.

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