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Assessment Of River Water Quality By Using Water Quality Index At Sahdev Nagar, Nashik, Maharashtra 422003 (Latitude -20º01'04"N, Longitude- 73º46'12"E)"

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ABSTRACT
The Water Quality Index (WQI) is a tool used to assess and monitor water quality, considering physical, chemical, and biological parameters from water samples. It calculates and interprets the WQI value by assigning weighting factors and scores to different parameters, combining them into a single value. The WQI measures the degree of contamination and suitability of water for specific uses, providing a representative value for overall water quality. It also aids in selecting water treatment processes and management strategies. The WQI method involves four steps: parameter selection, sub-indices selection, water quality rating for each parameter or sub-index, and WQI calculation and interpretation. It has applications in water pollution assessment, environmental impact monitoring, and prioritizing water management strategies. It facilitates communication between scientific and technical communities, environmental policy makers, legislators, and the general public. However, the interpretations of the rating scale and WQI value vary significantly, and further analysis and field-testing are needed to improve the accuracy and reliability of the WQI.

Keywords –water quality, water, selection, index, calculation, WQI, quality, rating, parameters, methods, factor, analysis, interpretation, area.

1. INTRODUCTION

Water is called as life without pollution but death when it is polluted. Water pollution is the release of substances into bodies of water that makes water unsafe for human use and disrupts aquatic ecosystems. Water pollution is the contamination of water bodies, usually as a result of human activities. River water plays a vital role in our life but now-a-days they are drowning in chemicals, waste, plastic and other pollutants. Water quality is a big issue that mankind is facing in recent year. As per WHO reports 80% of our diseases are water borne(Shamima Shultana & Ruhul A. Khan, 2022).

Water is a vital resource for various purposes, such as drinking, irrigation, and industrial processes(Tyagi et al., 2020). The groundwater quality degradation is due to rapid urban development, industrialization, and unwise water use of agricultural water, either groundwater or surface water(Atta et al., 2022). Ensuring the quality of water is essential to prevent hazards and economic losses. Water quality index serves as an effective tool to assess and communicate the overall quality of water in a simplified manner (Roy et al., 2021). It combines multiple water quality parameters into a single numerical value, making it easier for common people to understand the quality of water (Tyagi et al., 2020).Moreover, water quality indices help in identifying the potential risks associated with water sources and aid in decision-making processes for water management.

Various agencies such as the World Health Organization (WHO) and Centres for Disease Control (CDC) set exposure standards or safe limits of chemical contaminants in drinking water(Akter et al., 2016). Water quality index is a concise numerical representation of overall water quality of a water body, which is convenient to interpret and used widely in research, policy-making, and water resource management. The calculation of water quality index involves the measurement and assessment of various parameters, such as pH, dissolved oxygen, turbidity, total dissolved solids, and concentrations of various pollutants like heavy metals, nitrates, and pathogens. These parameters are compared with established standards or guidelines to determine the acceptability of water for its designated use. Once the parameters are assessed, they are assigned weightings based on their importance and impact on water quality.

1.1 BRIEF HISTORY OF WQI MODELS

Water quality index models have been developed to assess and quantify the overall quality of water bodies. These models aim to condense multiple water quality parameters into a single numerical value, making it easier for people to interpret and understand the overall water quality. These models have been formulated by several national and international organizations. The development of water quality index models can be traced back to the need for assessing and monitoring water quality in various regions (Tyagi et al., 2020). Over time, different models and approaches have been used to calculate water quality indices. These models have been applied for evaluating water quality in specific areas and have helped in identifying spatial and temporal variations, as well as trends in water quality. In the past, the use of individual water quality parameters to describe water quality for the general public was found to be complex and difficult to understand. As a result, water quality index models have been developed to simplify and consolidate the information into a single value. The use of water quality index models has become widely accepted, as they provide a concise representation of overall water quality that is readily understandable by both scientists and the general public.

The development history of the WQI model is presented graphically. Horton developed the first WQI model in the 1960 s which he based on 10 water quality parameters deemed significant in most waterbodies (Kharake & Raut, 2020) Brown with support from the National Sanitation Foundation, developed a more rigorous version of Horton's WQI model, the NSF-WQI, for which a panel of 142 water quality experts informed the parameter selection and weighting (Li, 2014a) Water Quality Indices is organized into three relatively concise parts. The first part consisting of 11 chapters focuses on the introduction and application of physico chemical parameter-based WQIs. Part II comprises four chapters introducing the WQI application integrated with biological parameters that have often been neglected in the past, while Chapter 16 provides a short perspective of WQI. The organization of chapters in the book is helpful for beginners in environmental science and water quality engineering to understand step-by-step the history, current state and future of WQI(Li, 2014b).

2. PROCEDURE FOLLOWED

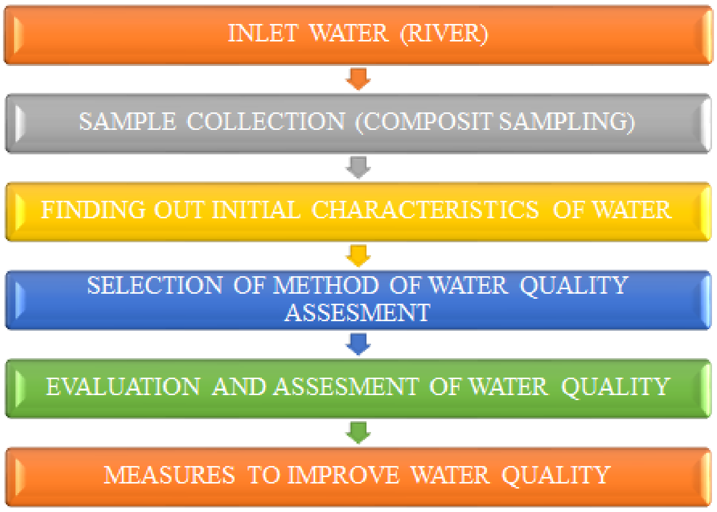

Figure 1. Methodology

2.1 COMPOSITE SAMPLING

Composite samples are collected over time, either by continuous sampling or by mixing discrete samples. A composite sample represents the average wastewater characteristics during the compositing period. Various methods for compositing are available and are based on either time or flow proportioning. The choice of a flow proportional or time composite sampling scheme depends on the permit requirements, variability of the wastewater flow or concentration of pollutants, equipment availability and sampling location.

2.2 PARAMETER SELECTION

Parameter selection is the initial step of the WQI process and considerable variation was determined between models in the type and number of parameters selected and the reasons for selecting them. The analysis was carried out in the laboratory as per BIS standard methods. Various Physio-chemical parameters like Electrical conductivity (EC), Total solids (TS), Total dissolved solids (TDS), Dissolved oxygen (DO), Biological Oxygen demand (B.O.D.), and turbidity were analyzed for the evaluate the impact of human activities on water quality(Kharake & Raut, 2020). It was calculated based on 11 parameters and the normalization factors were based on standards for surface water used for drinking water(Lachhab, 2019). In 1971 PATRI et al. proposed an index based on a water quality classification system. The index has a numerical expression of the degree of pollution. It takes into account the various pollutants present at the same time. However, the measure of each pollutant in a separate way, PATRI index, unlike the Horton index and NSFI, has an increasing scale with pollution. The index scale ranged from 0 for good quality (or no pollution) to 15 or more for poor quality(Aljanabi et al., 2021). Turbidity level was in the range 3 NTU – 5 NTU and E. coli count was Non- Detected (N.D) in all treated samples, which were within the accepted levels for drinking water(Varkey, 2020).

We selected parameters listed below

1. pH
2. DO
3. BOD
4. COD
5. TSS
6. TDS
7. Electrical Conductivity
8. Alkalinity
9. Hardness
10. Ca
11. Mg
12. Iron
13. Turbidity
14. Fluoride

3. RESULTS

Table 1. Results of Tests

Sr. No.	Parameters	Result	Units	Maximum Permissible Limit	As per IS Code	Remark

1.	pH	8.44	-	6.5-8.5	IS 10500 -2012	Water is potable
2.	DO	6.79	Mg/lit	4	IS 3025 (Part 38) 1989	Suitable for aquatic life
3.	BOD	27.44	Mg/lit	3	IS 2296	Treatment is required
4.	COD	396	Mg/lit	250	IS 2490	Treatment is required
5.	TSS	0	Mg/lit	100	BIS 2490	Suitable for Aquatic life
6.	TDS	200	Mg/lit	2100	IS 2296	Suitable for Aquatic life
7.	Conductivity	810	Microoh ms/cm	3000	IS 2296	Treatment Required
8.	Alkalinity	138.33	Mg/lit	200	IS 10500 -2012	Suitable for Aquatic life
9.	Hardness	260	Mg/lit	300	IS 10500 -2012	Suitable for Aquatic life
10.	Ca	60	Mg/lit	75	IS 10500 -2012	Suitable for Aquatic life
11.	Mg	32	Mg/lit	30	IS 10500 -2012	Treatment Require
12.	Iron	0.25	Mg/lit	0.3	IS 10500 -2012	Treatment Require
13.	Turbidity	1.9	Mg/lit	5	IS 10500 -2012	Water is Portable
14.	Fluoride	0.02	Mg/lit	1	IS 10500 -2012	Water is Portable

3.1 Methods of water quality index

1. Weighted Arithmetic index method (brown et al., 1972)
2. Nemerow's pollution index (NPI
3. The National Sanitation Foundation (NSF) Water Quality Index (DWQI)
4. The Canadian Council of Ministers of the Environment (CCME) Water Quality Index (WQI)
5. The United States Environmental Protection Agency (USEPA) Interim Water Quality Index (IWI)
6. The European Water Framework Directive (WFD) Overall Index
7. Bhargava Water Quality Index (BWQI)
8. Weighted Arithmetic Water Quality Index (WA-WQI)
9. Overall Index of Pollution (OIP)
10. Water Quality Index (WQI) by Horton
11. British Columbia Water Quality Index (BCWQI)
12. Oregon Water Quality Index (OWQI)

1. Weighted arithmetic index method (brown et al., 1972)

Step 1:- calculate the unit weight (Wn) factor for each parameters by using the formula

$$Wn = \frac{K}{Sn}$$

$$K = \frac{1}{\frac{1}{S1} + \frac{1}{S2} + \frac{1}{S3} + \cdots \ldots \ldots .. + \frac{1}{Sn}} = \frac{1}{\Sigma 1/sn}$$

Sn = Standard Desirable Value of the n th parameters

On summation of all selected parameters unit weight factor We

Step 2 :- Calculate the subindex (Qn) value by using the formula

$$Qn = \frac{[(Vn - Vo)]}{[(Sn - Vo)]} \times 100$$

Where ,

Vn = mean concentration of the n^{th} parameter

Sn = Standard Desirable Value of the n th parameters

Vo = Actual values of parameters in pure water (Generally,Vo=0)

$$QpH = \frac{[(VpH-7)]}{[(8.5-7)]} \times 100$$

Step 3 :- Combining Step 1 & 2 , WQI is calculate as follows

$$\text{Overall WQI} = \frac{\Sigma WnQn}{\Sigma Wn}$$

Table 2. Parameters and Results

PARAMETERS	Mean conc value (Vn)	BIS STANDARDS (S_n)	UNITS	$1/S_n$	Σ1/Sn	K=1/(Σ1/Sn)	Wi=K/Sn	IDEAL VALUE(Vo)	Vn/Sn	Vn/Sn*100 =Qn	WnQn
pH	8.44	8.5		0.118	4.706	0.212	0.0250	7	0.600	60.000	1.4999
Electrical Conductivity	810	300	µS/cm	0.003	4.706	0.212	0.0007	0	2.700	270.00	0.1912
TDS	200	500	mg/l	0.002	4.706	0.212	0.0004	0	0.400	40.000	0.0170
Total Hardness	260	300	mg/l	0.003	4.706	0.212	0.0007	0	0.866	86.667	0.0614
Ca	60	75	mg/l	0.013	4.706	0.212	0.0028	0	0.800	80.000	0.2266
Mg	32	30	mg/l	0.033	4.706	0.212	0.0071	0	1.066	106.66	0.7555
Iron	0.25	0.3	mg/l	3.333	4.706	0.212	0.7083	0	0.833	83.333	59.0224
Fluoride	0.02	1	mg/l	1.000	4.706	0.212	0.2125	0	0.020	2.000	0.4250
Turbidity	1.9	5	mg/l	0.200	4.706	0.212	0.0425	0	0.380	38.000	1.6149
Total				4.706			1				63.8138

Table 3. Water Quality Index

WQI DEVELPOED by Brown et al., (1972)	
Water Quality Index	Water Quality Stautus
0-25	Excellent
26-50	Good

51-75	Poor
76-100	Very Poor
> 100	Unfit For Consumption

3.2 Nemerow's pollution index (nip)

- NPI is beneficial because it provides a more complete picture of water quality compared to methods that only look at individual factors. This allows for better informed decisions about water management and treatment.
- It is a way to assess the overall quality of water by considering various factors that can affect it :-

  1) Focuses on Most Polluting Factor

  2) Considers Overall Contribution

  3) Provides a Comprehensive Index.

3.3 Working process for nemerow's pollution index (npi) :-

- **Data Collection:** Different water quality parameters are measured, such as dissolved oxygen, pH, nitrates, etc.
- **Single Pollution Index (SPI):** For each measured parameter, a Single Pollution Index (SPI) is calculated. This SPI indicates how much a specific parameter deviates from acceptable limits.
- **Most Polluting Factor:** The NPI identifies the parameter with the highest SPI, highlighting the most concerning pollutant.
- **Overall Pollution Index (NPI):** The NPI is calculated using a formula that considers both the average of all SPIs and the highest individual SPI. This provides a combined score reflecting overall water quality and the most significant pollutant.
- **Water Quality Classification:** Based on the NPI value, the water is classified into different categories, typically ranging from very good to poor

NPI VALUE = $\frac{Cn}{Sn}$

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Cn = concentration of the n^{th} parameter
Sn = prescribed standard limits of the n^{th} parameter
If **NPI Value > 1**

It indicates the presence in surplus amount or concentration

Table 4. NPI Value

PARAMETERS	STATIONS	STANDARDS	UNITS	NPI VALUE
pH	8.44	8.5	-	0.99
Electrical Conductivity	810	300	μ S/cm	0.27
Alkalinity	138.33	200	mg/l	0.69
Total Hardness	260	300	mg/l	0.87
Ca	60	75	mg/l	0.80
Mg	32	30	mg/l	1.07
SO_4	250	200	mg/l	1.25

3.4 Results

1. Water quality is poor according to **weighted arithmetic mean method**.

Table 5. Water Quality Index and Status

WQI DEVELPOED by Brown et al., (1972)	
Water Quality Index	Water Quality Stautus
0-25	Excellent
26-50	Good
51-75	Poor
76-100	Very Poor
> 100	Unfit For Consumption

2. According to **Nemerow's method** the value is greater than **1** Hence , it indicates the presence in surplus amount or concentration.

3.5 Remedial Measure

From above analysis we can conclude that BOD and COD were major concern , the level of oxygen can be increased by disinfectant using Hydrogen Peroxide at some extent, where the analysis should be done to find optimum content of hydrogen peroxide for 50 litres.

Table 6. BOD and COD

SAMPLE	BOD (mg/l)	COD (mg/l)
Raw sample	27.44	396
1 ml	6.4	160
2ml	4.5	148
3ml	2.8	140

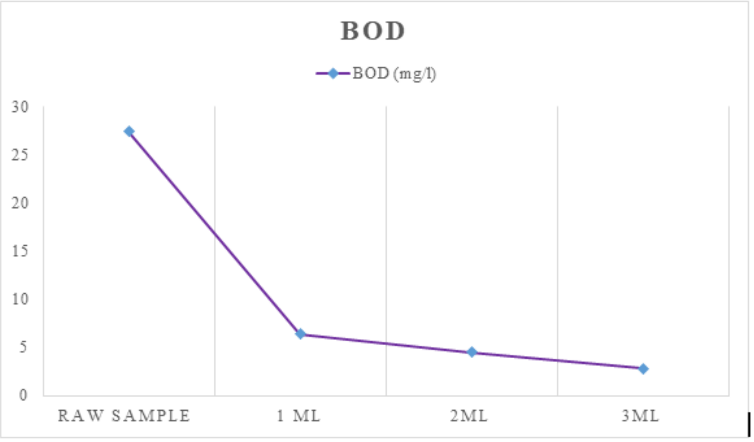

Figure 2. BOD Result

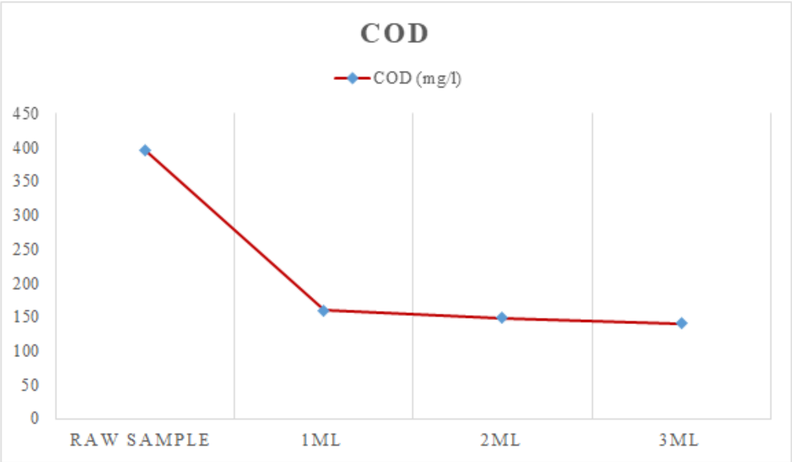

Figure 3. COD Result

3.6 Expected Outcomes

❖ Improved water quality.

❖ The provision of safe and clean water for agriculture and domestic purposes.

❖ Helps prevent water born diseases.

4. CONCLUSION

This index takes into consideration a wide range of water quality parameters and weights them using an analytical hierarchy process tool . The use of a dynamic weighting method for assigning weights to water quality parameters was found to be effective in reducing misclassification of water quality by the index. Overall, this study highlights the importance of accurate and consistent water quality assessment methods. The development of a generalized Composite Water Quality Index in this study provides a valuable tool for categorizing water quality based on established standards. These findings also emphasize the need for ongoing monitoring and assessment of water resources to ensure their suitability for various uses.

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