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GEOGRAPHICAL STUDY OF WATER QUALITY INDEX OF PRAKASHA BARRAGE ON TAPI RIVER IN NANDURBAR DISTRICT

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Abstract:

Water is crucial for sustaining ecosystems and various economic sectors, yet its availability and quality are increasingly threatened by anthropogenic activities. This study evaluates the water quality at Prakasha Barrage in Nandurbar District, Maharashtra, India, using the Water Quality Index (WQI) method to assess its suitability for human consumption and other uses. The research investigates seasonal variations in water quality parameters by systematically collecting water samples across different seasons, followed by analytical testing of key physico-chemical attributes such as pH, hardness, sulfates, nitrates, total alkalinity, total dissolved solids (TDS), chlorides, and iron. Utilizing the Weighted Arithmetic Water Quality Index Method, the study calculates WQI values and classifies water quality from "Excellent" to "Unsuitable for Drinking." Results indicate that the WQI fluctuates with seasonal changes, with values of 64.83, 57.24, and 64.83 for Winter, Monsoon, and Summer, respectively, reflecting a range between "Slightly Polluted" and "Moderately Polluted." Moreover, a correlation analysis among the physico-chemical parameters reveals critical interdependencies, suggesting that fluctuations in one parameter can significantly influence others. The findings emphasize the need for consistent monitoring and management of water quality to ensure its safety and fitness for use, particularly in agricultural and drinking applications. This study contributes to the broader discourse on water resource management and offers a framework for evaluating quality standards through the WQI, highlighting its implications for environmental policy and public health in the region.

Keywords: Water Quality Index (WQI), Seasonal Variation, Prakasha Barrage, Physico-chemical parameters.

Introduction:

Water is a vital natural resource and a valuable national asset, serving as a key component of ecosystems. It is found in various sources, including rivers, lakes, glaciers, rainwater, and groundwater. In addition to being essential for drinking, water resources play a crucial role in numerous sectors of the economy, such as agriculture, livestock farming, forestry, industrial activities, hydropower generation, fisheries, and other productive ventures. However, both the availability and quality of water—whether from surface or groundwater—have been compromised due to factors like population growth, industrialization, and urbanization. The water quality of a specific area or source can be evaluated based on physical, chemical, and biological parameters. If the levels of these parameters exceed certain limits, they can pose serious health risks to humans [1,2,3,4].

As a result, the suitability of water sources for human consumption is often evaluated using the Water Quality Index (WQI), which is one of the most effective methods for assessing water quality. WQI uses water quality data to inform and improve policies created by various environmental monitoring agencies. It has been recognized that relying on individual water quality variables to describe water quality is not easily understandable for the general public [5,6]. That's why, WQI has the capability to reduce the bulk of the information into a single value to express the data in a simplified and logical form [7].

The Water Quality Index (WQI) was initially developed by Horton in 1965 [8] in the United States, using 10 commonly measured water quality variables, such as dissolved oxygen (DO), pH, coliforms, specific conductance, alkalinity, and chloride. This index has since been widely adopted and applied in countries across Europe, Africa, and Asia. The weight assigned to each parameter reflects its significance for a particular use and has a substantial impact on the overall index. Additionally, in 1970, Brown and his team developed a new version of the WQI, similar to Horton's, but with individual weights for each parameter [9]. Over the years, various modifications to the WQI concept have been proposed by scientists and experts [10,11].

A general approach to WQI is based on common factors [12] and is typically divided into three steps:

1. **Parameter Selection**: Experts, agencies, or government bodies in the relevant legislative area determine the parameters to be used. These are chosen from five key categories: oxygen levels, eutrophication, health concerns, physical characteristics, and dissolved substances, all of which significantly affect water quality [13].
2. **Determination of Quality Function (Curve) for Each Parameter**: Each parameter, or sub-index, is converted into non-dimensional values on a scale, using units like ppm, saturation percentage, or counts per volume.
3. **Sub-Indices Aggregation with Mathematical Expression**: This step involves aggregating the sub-indices, often using arithmetic or geometric averages.

In addition to the original WQI, numerous other water quality indices have been developed by various national and international organizations, including the Weight Arithmetic Water Quality Index (WAWQI), the National Sanitation Foundation Water Quality Index (NSFWQI), the Canadian Council of Ministers of the Environment Water Quality Index (CCMEWQI), and the Oregon Water Quality Index (OWQI). These indices are used to evaluate water quality in specific areas [14,15]. They often differ in the number and types of parameters used, which are compared to the standards of the respective region.

Water quality indices are particularly useful for tracking annual cycles, spatial and temporal variations, and trends in water quality, even at low concentrations, in an efficient and timely manner. However, the numerous variations and limitations of the existing indices—due to

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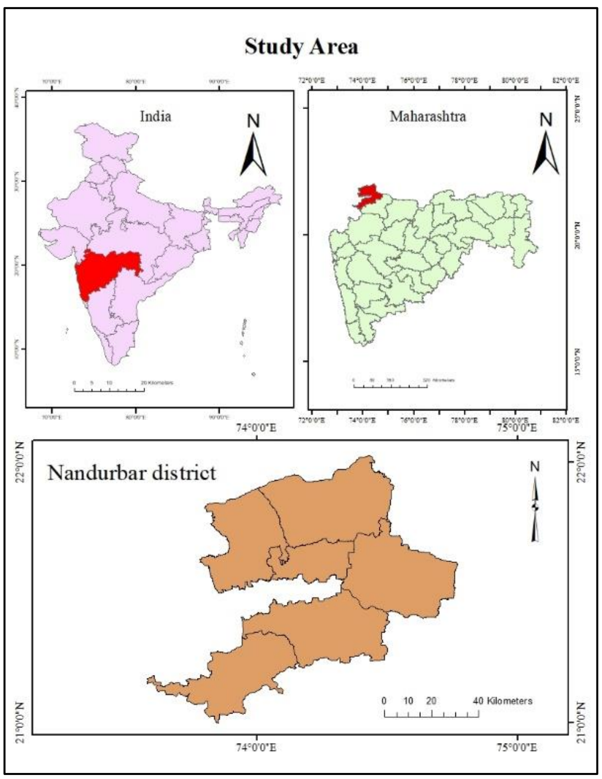
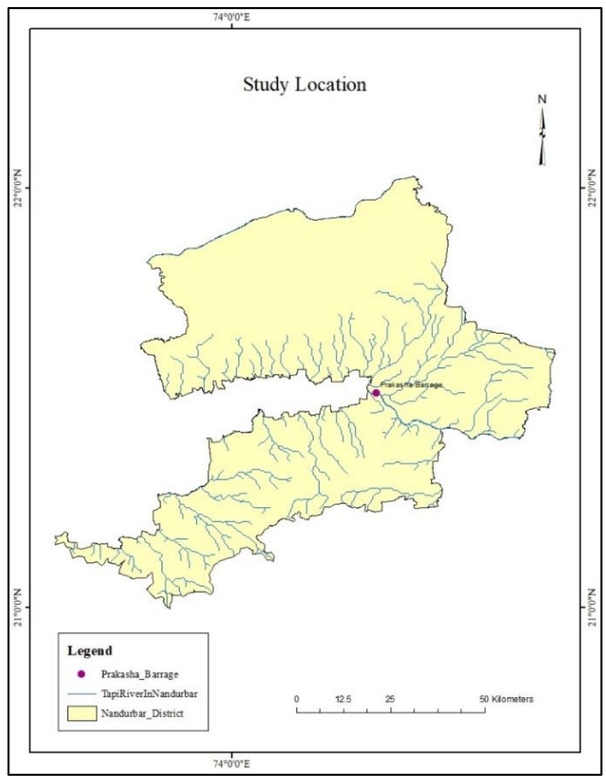
differences in the number of parameters considered—have hindered their global acceptance. There is a need for an index that can be universally accepted, with a flexible number of water quality parameters. The methods for determining WQI have been detailed in various studies [16].

Study Area:

The present study has been conducted at the Prakasha Barrage, which is located on the Tapi River basin in Nandurbar District, Maharashtra, India. The geographic coordinates of the barrage are approximately 21°30'43" N latitude and 74°20'44" E longitude [22]. This infrastructure plays a vital role in the management of water resources for the surrounding area, particularly in terms of irrigation. By regulating water flow, the Prakasha Barrage ensures a consistent supply of water to farmlands in the region, which is essential for supporting agriculture and sustaining the local economy. Additionally, it contributes to broader water management strategies in the region, helping to mitigate the effects of seasonal fluctuations in water availability.





Aims and Objective:

1. To Check whether the water is fit for use.
2. To Calculate Water Quality Index (WQI).
3. To Find Correlation amongst the Physico-chemical parameters.

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Data and Methodology:

In this study, water samples are collected directly from the Prakasha barrage for each season, ensuring that the samples represent the water quality throughout the year. The collection process involves physically visiting the location to obtain fresh samples during different seasonal periods, allowing for a comprehensive analysis of seasonal variations in water quality. Once the samples are collected, they are sent to the laboratory, where various water quality parameters are tested and measured. After the laboratory tests are completed, the data obtained is used to calculate the Water Quality Index (WQI), by Weighted Arithmetic Water Quality Index Method, which provides an overall assessment of the water's quality for each specific season. This approach helps to track changes in water quality over time, ensuring a detailed understanding of how seasonal factors may impact the water's suitability for use.

Weighted Arithmetic Water Quality Index Method:

Weighted arithmetic water quality index method classified the water quality according to the degree of purity by using the most commonly measured water quality variables. The method has been widely used by the various scientists [17,18,19,20] and the calculation of WQI was made [21] by using the following equation:

$$WQI = \frac{\sum Qi * Wi}{\sum Wi}$$

The quality rating scale (Qi) for each parameter is calculated by using this expression:

$$Qi=100[(Vi-Vo/Si-Vo)]$$

Where,

Vi is estimated concentration of its parameter in the analysed water

Vo is the ideal value of this parameter in pure water

Vo = 0 (except pH =7.0 and DO = 14.6 mg/l) Si is recommended standard value of its parameter

The unit weight (Wi) for each water quality parameter is calculated by using the following formula:

$$Wi=K/Si$$

Where, K = proportionality constant and can also be calculated by using the following equation:

$$K = \frac{1}{\sum(1/Si)}$$

The rating of water quality according to this WQI is given in following table.

Table 1: Water Quality Rating as per Weight Arithmetic Water Quality Index Method [23]

WQI Value	Rating Of Water Quality	Grading
0-25	Excellent water quality	A
26-50	Good water quality	B
51-75	Poor water quality	C

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76-100	Very Poor water quality	D
Above 100	Unsuitable for drinking purpose	E

Analysis and Discussion:

Calculation of Water Quality Index: There are two parts of water quality index.

1. Q- value: It is the indication of water quality relative to 100 of one parameter. The Q Value is an indication of how good (or bad) the water quality is relative to one parameter. 100 = Very Good, and 1 = Very Bad

2. Weighting Factor: It sets the relative importance of the parameter to overall water quality.

Table 2: Weighing factors of water quality parameters:

Parameters	Weight	Unit weight (Wi)
pH	4	0.16
Hardness	2	0.08
Sulphate	2	0.08
Nitrate	3	0.12
T-Alkalinity	3	0.12
Total Dissolved Solids	4	0.16
Chlorides	2	0.08
Iron	3	0.12
$\sum$Wi	-	0.92

Table 3: Scale ratings for water quality parameters (Qi)

Parameters	**Standards**	**Permissible**	**Slight**	**Moderate**	**Severe**
pH	7.0-8.5	7.0-8.5	8.6-8.8 and 6.8-7.0	8.9-9.2 and 6.5-6.7	>9.2
		[100]	**[80]**	**[60]**	**[0]**
Hardness	100-500	<100	101-300	310-500	>500
		[100]	**[80]**	**[60]**	**[0]**
Sulfates	200-400	<200	201-300	301-400	>400
		[100]	**[80]**	**[60]**	**[0]**
Nitrates	>45	<20	21-32.5	33-45	>45
		[100]	**[80]**	**[60]**	**[0]**
T-Alkalinity	<120	<50	51-85	86-120	>120
		[100]	**[80]**	**[60]**	**[0]**
TDS	500-1500	<500	500-1000	1001-1500	>1500
		[100]	**[80]**	**[60]**	**[0]**

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Chlorides	200-500	<200	201-400	401-500	>500
		[100]	**[80]**	**[60]**	**[0]**
Iron	0.1-1.0	<0.1	0.1-0.5	0.6-1.0	>1.0
		[100]	**[80]**	**[60]**	**[0]**

Formula for WQI:

$WQI = \sum QiWi / \sum Wi$

Table 4: Calculations of WQI

	Winter	**Monsoon**	**Summer**
pH	6.9	7.3	8.6
Qi	80	100	80
Si	12.8	16	12.8
Hardness	250	140	210
Qi	80	80	80
Si	6.4	6.4	6.4
T-Alkalinity	240	164	150
Qi	0	0	0
Si	0	0	0
TDS	317	182	276
Qi	100	100	100
Si	16	16	16
SO_4^{-2}	6	9	4
Qi	100	100	100
Si	8	8	8
NO^{3-}	2	0.01	0.01
Qi	100	100	100
Si	12	12	12
Cl^-	140	40	200
Qi	100	100	100

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Si	8	8	8
Iron	0.01	1.2	0.01
Qi	100	0	100
Si	12	0	12
Total Qi	600	580	660
Total Si	75.2	66.4	75.2
Final WQI [∑Wi Qi/∑Wi]	64.83	57.24	64.83

Table 5: Physico-chemical parameters

Entry	pH	EC	Chloride	Sulfate	HARDNESS	TN	TDS	Alkalinity
1	7	495	140	6	250	2	217	240
2	7.3	285	40	9	140	0.01	182	164
3	8.5	431	200	4	210	0.01	276	150

Table 6: Correlation amongst the Physico-chemical parameters

Entry	pH	EC	Chloride	Sulfate	Hardness	TN	TDS	Alkalinity
1	1	1	1	1	1	1	1	1
2	0.0316	0.7762	-0.9996	-0.7137	0.7777	-0.1458	-0.2873	--
3	0.6547	-0.7580	0.7333	-0.1147	0.5085	0.9895	--	--
4	-0.6758	0.9979	0.1429	-0.9661	0.6787	--	--	--
5	-0.0339	0.7349	0.9583	0.0301	--	--	--	--
6	-0.6547	0.5638	-0.0017	--	--	--	--	--
7	0.8433	0.6291	--	--	--	--	--	--
8	-0.7570	--	--	--	--	--	--	--

Conclusion:

The study focuses on calculating the Water Quality Index (WQI) using a range of water quality parameters to evaluate overall water quality. The WQI combines multiple indicators to offer a comprehensive assessment of water conditions, facilitating a better understanding of water suitability for consumption, agriculture, or industrial use. The calculation of the WQI relies on two key components: the Q-value and the Weighting Factor (Wi). The Q-value reflects the water quality in relation to each individual parameter, where a value of 100 represents excellent quality, and a value of 1 indicates poor quality for that parameter. The Q-values of different parameters indicate the water quality across seasons. The Q-value for pH is excellent during the Monsoon season. The Q-value for hardness remains consistent throughout all seasons. The Q-value for total alkalinity is very poor in each season. The Q-value for total dissolved solids (TDS) is excellent in Summer, Winter, and Monsoon. The Q-value for iron is very good in Summer and Winter but very poor during the Monsoon season. Lastly, the Q-value for soluble salts is excellent in all three seasons.

Weighting Factor (Wi) reflects the relative importance of each parameter to the overall water quality, with the assigned weight indicating the parameter's impact on the final assessment. The study emphasizes the significance of Weighting Factors (Wi) for each parameter, as detailed in Table 2. The total sum of these weights is 0.92, highlighting the cumulative influence of all water quality parameters on the WQI. The parameters included in this calculation are pH, hardness, sulfate, nitrate, total alkalinity, total dissolved solids (TDS), chlorides, and iron, each contributing differently to the overall quality of water. The importance of these parameters is evident in their weighting, with some playing a more pivotal role in determining the final WQI value.

In addition to the weights, Table 3 provides scale ratings for each parameter, which range from "Very Good" to "Very Bad" or "Severe." These ratings are determined by specific ranges for each water quality parameter, and the corresponding Qi values help assess the water's quality. For instance, pH values between 7.0 and 8.5 receive a Qi score of 100, indicating acceptable water quality. Similarly, hardness levels between 100 and 500 mg/L, sulfate levels between 200 and 400 mg/L, and nitrate concentrations above 45 mg/L all correspond to a score of 100, signifying very good quality. Other parameters, such as total alkalinity, TDS, chlorides, and iron, also have acceptable ranges associated with a score of 100, demonstrating the thresholds for optimal water quality.

Table 4 illustrates how the WQI is calculated across different season’s winter, Monsoon, and summer. The calculated WQI values for these seasons are 64.83, 57.24, and 64.83, respectively. These values indicate that the water quality fluctuates between "Slightly Polluted" and "Moderately Polluted" during these periods, reflecting variations in water quality across seasons.

Table 5 presents the actual values of various physico-chemical parameters for different water samples, which serve as inputs for the WQI calculation. For instance, the first sample has a pH of 7, hardness of 250, and chloride concentration of 140 mg/L, while the second sample has a pH of 7.3, hardness of 140, and a chloride concentration of 40 mg/L. The third sample has a pH of 8.5, hardness of 210, and a chloride concentration of 200 mg/L. These values are crucial for determining the WQI and understanding the water quality.

Finally, Table 6 explores the correlation between various physico-chemical parameters. The correlation values provide insight into the relationships among parameters, helping to identify trends and interdependencies. For example, the pH shows strong positive correlations with electrical conductivity (EC), chloride, hardness, and TDS, suggesting that changes in pH might affect these other parameters. Sulfates and chlorides, on the other hand, exhibit negative correlations with parameters such as hardness and TDS. Additionally, total nitrogen (TN) demonstrates a strong correlation with TDS, indicating that higher levels of TDS may be associated with increased nitrogen concentrations in the water. These correlations are essential for understanding how different water quality parameters interact and influence the overall water quality.

References:

1. Guidelines for Drinking-water Quality, Fourth Edition, World Health Organization ISBN 978 92 4 154815 1. 2012.
2. Bureau of Indian Standards, Specification for drinking water. IS: 10500, New Delhi, India, 2012.
3. United State EPA 816-F-09-004, May 2009, http://water.epa.gov/drink/contaminants/upload/mcl-2.pdf (Accessed 12 July 2013).
4. Guide Manual: Water and Waste Water, Central Pollution Control Board, New Delhi. http://www.cpcb.nic.in/upload/Latest/Latest_67_guidemanualw& wwanalysis.pdf (Accessed 12 July 2013).
5. Bharti, N. and Katyal, D, "Water quality indices used for surface water vulnerability assessment", Int. J. Environ. Sci., 2(1). 154- 173. 2011.
6. Akoteyon, I.S., Omotayo, A.O., Soladoye, O. and Olaoye, H.O., "Determination of water quality index and suitability of urban river for municipal water supply in Lagos-Nigeria", Europ. J. Scientific Res, 54(2). 263-271. 2011.
7. Babaei Semiromi, F., Hassani, A.H., Torabian, A., Karbassi, A.R. and Hosseinzadeh Lotfi, F., "Water quality index development using fuzzy logic: A case study of the Karoon river of Iran", African J. Biotech.., 10(50). 10125-10133. 2011.
8. Horton, R.K., "An index number system for rating water quality", J. Water Pollu. Cont. Fed., 37(3). 300-305. 1965.
9. Brown, R.M., McClelland, N.I., Deininger, R.A. and Tozer, R.G., "Water quality index-do we dare?", Water Sewage Works, 117(10). 339-343. 1970
10. Bhargava, D.S, Saxena, B.S. and Dewakar, R.W., "A study of geo-pollutants in the Godavary river basin in India", Asian Environ., 12. 36-59. 1998.

11. Dwivedi, S., Tiwari, I.C. and Bhargava, D.S., “Water quality of the river Ganga at Varanasi”, Institute of Engineers, Kolkota, 78, 1-4. 1997.
12. Fernandez, N., Ramirez, A. and Solano, F., “Physico-chemical water quality indices - a comparative review”, Revista Bistua. ISSN 0120-4211. Available at: http://redalyc.uaemex.mx/src/inicio/ArtPdfRed.jsp?iCve=9032010 3 Accessed: 18 September, 2012.
13. Dunnette, D.A., “A geographically variable water quality index used in Oregon”, J. Water Pollu. Cont. Fed., 51(1). 53-61. 1979.
14. Lumb, A., Halliwell, D. and Sharma, T., “Canadian water quality index to monitor the changes in water quality in the Mackenzie River–Great Bear”. Proceedings of the 29th Annual Aquatic Toxicity Workshop, (Oct. 21-23), Whistler, B.C., Canada. 2002.
15. Chaturvedi, M.K. and Bassin, J.K., “Assessing the water quality index of water treatment plant and bore wells, in Delhi, India”, Environ. Monit. Assess., 163. 449-453. 2010.
16. Bordalo, A.A., Nilsumranchit, W. and Chalermwat, K., “Water quality and uses of the Bangpakong river (Eastern Thailand)”, Water Res., 35(15). 3635-3642. 2001.
17. Chauhan, A. and Singh, S., “Evaluation of Ganga water for drinking purpose by water quality index at Rishikesh, Uttarakhand, India”, Report Opinion, 2(9). 53-61. 2010.
18. Chowdhury, R.M., Muntasir, S.Y. and Hossain, M.M., “Water quality index of water bodies along Faridpur-Barisal road in Bangladesh”, Glob. Eng. Tech. Rev., 2(3). 1-8. 2012.
19. Rao, C.S., Rao, B.S., Hariharan, A.V.L.N.S.H. and Bharathi, N.M., “Determination of water quality index of some areas in Guntur district Andhra Pradesh”, Int. J. Appl. Bio. Pharm. Tech., I(1). 79- 86. 2010.
20. Balan, I.N., Shivakumar, M. and Kumar, P.D.M., “An assessment of ground water quality using water quality index in Chennai, Tamil Nadu, India”, Chronicles Young Scient., 3(2). 146-150. 2012.
21. rown, R.M, McCleiland, N.J., Deiniger, R.A. and O’Connor, M.F.A. “Water quality index – crossing the physical barrier”, (Jenkis, S.H. ed.) Proceedings in International Conference on water pollution Research Jerusalem 6. 787-797. 1972.
22. https://wikimapia.org/13706635/Prakasha-Dam
23. Tyagi, Shweta, et al. "Water quality assessment in terms of water quality index." *American Journal of water resources* 1.3 (2013): 34-38.

