Grenze International Journal of Engineering and Technology, June Issue

Assessment of Surface Water Quality in terms of Water Quality Index- A Case Study of Jirania Sub Division, Tripura, India

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***Abstract*— Surface water, comprising 1.2% of Earth's fresh water, is crucial for life on Earth, with rivers being significant sources, requiring river-based resource management to address global water quality challenges. Fresh water is primarily obtained from surface waters, and rivers are significant ecological structures that are required to maintain ecological equilibrium. In many places, the country's rapidly expanding metropolitan areas and population have put the quality of the river's water in jeopardy. Water quality is the chemical, physical, and biological characteristics of water that affect its suitability for various uses like drinking, irrigation, industrial processes, and aquatic ecosystems. It is crucial to monitor and address factors like natural processes, human activities, and pollution sources to ensure human and environmental health. The present study emphasises the test of water quality in rivers, ponds, and wetlands used for different purposes and the corresponding impact thereon based on a detailed explanation of the monitoring data obtained through laboratory analysis of samples and relevant field observations. An attempt has been made to develop a water quality index (WQI) using seven water quality parameters: hardness, chloride, temperature, total dissolved solid (TDS), electrical conductivity (EC), pH, and dissolved oxygen (DO) at sixteen different sampling stations in Jirania sub-division, Tripura. The weighted arithmetic water quality index method was used to find WQI in various locations. The WQI in this area ranged from 45.16 to 77.78, with 77.78 being the maximum value. Three samples, according to WQI, were in the "good" category, while twelve samples were in the "poor" category and one sample were "very poor" category.**

***Index Terms*— Water quality parameter, Water Quality Index, Weighted arithmetic mean method, Rating Scale, Tripura**

I. INTRODUCTION

The Weighted Arithmetic Method is a systematic approach used to calculate the Water Quality Index (WQI), which provides a concise evaluation of overall water quality based on various water parameters. This method involves assigning relative weights to different water quality parameters based on their significance. In this study, the water quality index has been calculated considering selected important parameters. The WQI has been calculated by using the standards of drinking water quality recommended by the BIS (BIS 1991). Three steps have

Grenze ID: 01.GIJET.10.2.275

been followed to calculate WQI. Selected parameters have been assigned a weight (wi) according to its relative importance in the assessment of drinking water quality. The weightage has been given to the parameters according to their importance in water quality assessment. In this case, I focus on the water quality index of Jirania Subdivision in Tripura, Jirania Subdivision. The water quality index of Jirania Subdivision NIT Agartala nearby areas is taken into account several key parameters that determine the health and safety of the water sources. These parameters include pH level, dissolved oxygen (DO), Total dissolved solid (TDS), Temperature, Electrical conductivity (EC), Hardness and Chloride. pH level is a measure of the acidity or alkalinity of water. It indicates the presence of certain chemicals and determines the water's suitability for different uses. The DO level represents the amount of oxygen available in the water to support aquatic life. TDS is a measure of dissolved solid and indicates the amount of dissolved solid present in the water samples. Temperature is also plays a vital role in maintain the quality water sample it should also lies within its standardised temperature.EC measures the electrical conductivity of water and it should also lies within the permissible limit of the water sample. Hardness of water also plays a vital role in the Wqi index, Depending on the type of water can Temporary, Permanent Hardness and Soft water. Chloride content of the water Sample also adversely affect the water and aquatic lives, it should lies within its permissible limit, If the water content is high in Cl_2 then also affect animals and human being.These samples are then analyzed in a laboratory, and the values of each parameter are compared with Bureau of Indian standard. Based on the results, a numerical value is assigned to each parameter, and an overall water quality index is calculated. The water quality index provides a holistic view of the water quality in Jirania Subdivision. It helps local authorities, environmental agencies, and community members to understand the current state of water resources and take necessary actions for conservation and improvement. By identifying areas of concern and potential sources of pollution, the water quality index enables targeted interventions and effective management strategies to protect and preserve the water bodies in Jirania Subdivision.

II. Literature Review

Stabak roy et al. (2023) had identify to assess and develop a model of drinking water quality at the railway stations of Tripura, India, with a possible strategic solution. Multivariate statistical tools like multiple regression analysis, principal component analysis, and cluster analysis have been used. Weighted Arithmetic Water Quality Index (WAWQI) and Entropy Weighted Water Quality Index (EWWQI) have been applied to assess the drinking water quality of the railway stations of Tripura.

Ritabrata Roy et al (2023) had identify electrical conductivity, pH, temperature (T), total dissolved solids, dissolved oxygen, turbidity (Turb) and Total nitrate (N) of Rudrasagar were estimated in every month for 3 consecutive years.

Maansi et al. (2022) had identified surface water quality of Sukhna Lake, 13 physico-chemical parameters like temperature, pH, transparency, dissolved oxygen, electrical conductivity, total dissolved salts, chloride, total Aalkalinity, total hardness, calcium, magnesium, nitrate and phosphate were investigated on monthly basis for a period of two year (July 2016–June 2018) by using standard procedures.

Sajid Shahriar et al (2022) had identify the water quality has been carried out by collecting water samples from four sampling sites on November 5, 2021 and analyzed at the laboratory. Fifteen most important water quality parameters namely, pH, Dissolved oxygen (DO), Biochemical oxygen demand (BOD), Electrical conductivity (EC), Temperature, Turbidity, Chloride, Hardness, Total dissolved solids (TDS), Total suspended solids (TSS), Total solids (TS), Fecal coliform (FC), Sulphate, Phosphate, Nitrate were analyzed at the laboratory

III. Objective & Novelty

The main aim of the present study is to water quality index of surface water at jirania sub-division and whether the surface water lies within the permissible limit. To achieve the present objective of the study using weighted arithmetic method WQI have been applied for the calculation of individual parameters is taken into the consideration. In the first step of the study side selection is being done, Followed by sample collection, laboratory test, various parameters, data compilation, computed WQI, Individual WQI of each sample. This study is important because it helps in understanding the composition of surface water and its uses of water for different purposes Irrigation, Fire Draft etc.

IV. Study Area

The State of Tripura, with a geographical area of 10,491 sq. kms, is predominantly a hilly region. It is surrounded on all sides by deltaic basin of Bangladesh except for a small part in North-East which adjoins Cachar district of Assam and Mizoram. Narrow valleys separate these ranges generally 20 km wide. The easternmost range is Jampui, being successively followed to the West by Unokoti-Sakhantlang, Longthorai, Atharamura-Kalajhari and Baramura-Deotamura. The highest peak lies at Bethliangchhip (Thaidawar, Shib-rangkhung), 975.36 m above the sea level.The state is situated between 22°7' and 24°2' North latitudes and 91°0' and 92°0' East longitudes with the Tropic of Cancer passing through it.The study of an area latitude varies from 23.845 to 23.869 and longitude varies from 91.396 to 91.457.

Table I. Location Of Water Sample Its Longitude And Latitude Of An Area

Location Name	Location	Latitude	Longitude
Dakdu River	1	23.845	91.409
Kobra Khamar	2	23.844	91.403
Kobra Khamar	3	23.846	91.404
Kobra Khamar	4	23.845	91.408
Rasbari Para	5	23.849	91.438
Rasbari Para	6	23.849	91.438
Bishram Para	7	23.848	91.446
Bishram Para	8	23.848	91.446
Udhai Kupra	9	23.872	91.457
Thangkami Para	10	23.868	91.396
Thangkami Para	11	23.868	91.396
Thangkami Para	12	23.868	91.396
Thangkami Para	13	23.869	91.396
Thangkami Para	14	23.869	91.396
Thangkami Para	15	23.868	91.399
Lalit Bazzar	16	23.850	91.409

Figure 1. India Map

Figure 2. Tripura Map

Figure 3. Location map of the study area (Source: Google Earth pro)
(Source : https://www.mapsofindia.com/maps/india/india-outline-map.jpg**)**

V. METHOD USED

A. Laboratory Test: Some laboratory tests are taken into consideration

Several parameters are taken

1.Hardness Test (EDTA): Eriochrome Black T and Ammonia Buffer Solution is used for the determination of hardness in the water.

2.Chloride: Chemical like K_2CrO_4 and$AgNO_3$ is used and Burette Dropper is used for the test it also tells the chloride contain in the water.

3.Total Dissolved Solid (TDS): TDS metre is used for the test it used to determine the amount of dissolved solid in the water.

4.Electrical Conductivity: TDS metre is used for the test for measuring EC too it also tells the number of salts present in the water sample for its conductivity.

5. Power of Hydrogen (pH): pH metre is used for the test for measuring its acidity or basicity of water.

6. Temperature: Temperature of water sample test is done by TDS metre it also tells nature of water weather it is in the state of solid, liquid and gas form in the environment.

7. DO test: Dissolved Oxygen is used for measuring the amount of dissolved oxygen present in the water sample.

B. Instrument used: Instrument required of the test are

1.TDS metre: It is an instrument used for measuring TDS, Temperature, EC.

2. pH metre: It is an instrument used for measuring only pH.

3.DO metre: It is an instrument used for measuring amount of dissolved oxygen present in the water.

4. Burette Dropper: It is an instrument used for titration, measure the reading of the titration process.

5.Polywash Bottle: It is an instrument used for cleaning the contaminant chemical present in the instrument used for the test.

6. Beaker: It is used the test for measuring the water sample used for the test and it is used for stir the water sample during the titration process.

7.Spatula Spoon: It is mainly used for taking minute amount of chemical used for respective test.

8. Sample Container: It is used for collecting the water sample for the test from the desired location.

C. Weighted Arithmetic method

In 1965, WQI was first developed by Horton (Horton, 1965). In addition, a new water quality index similar to the Horton Index and based on weight-specific parameters has been developed by the Brown Group. The Water Quality Index (WQI) is a valuable and unique assessment of the overall state of water quality in various bodies of water. However, WQI considers the combined impact of various water quality parameters and informs the public about water quality.

The WQI is computed using the Weighted Arithmetic Water Quality Index (WAWQI) approach. The WQI is calculated using equation 1

$$WQI = \sum_{i=1}^{n} \frac{WiQi}{\Sigma Wi} \quad (1)$$

Wi = Unit weight for the ith water quality parameters is calculated using expression in the given equation 2

$$\text{Wi} = \frac{k}{Si} \quad (2)$$

Qi = quality rating for the ith parameters is calculated using the given equation 3.3

$$Qi = \frac{(Va-Vi)}{(Si-Vi)} \times 100 \quad (3)$$

Where, Va = Actual value of the ith parameters

Vi = Ideal values of the ith parameters (0 except for pH= 7mg/l and for DO= 14.6 mg/l)

Vs = Standard value of ith parameter

K = Relative constant, K = $\frac{1}{\Sigma\frac{1}{Si}}$

VI. *METHODOLOGY*

Experimental investigation is carried out to study the composition of different parameters of surface water of local bodies of nearby NIT Agartala, Jirania sub-division, Tripura and to determine the WQI using various test samples. Experimental program is carried in the following ways-

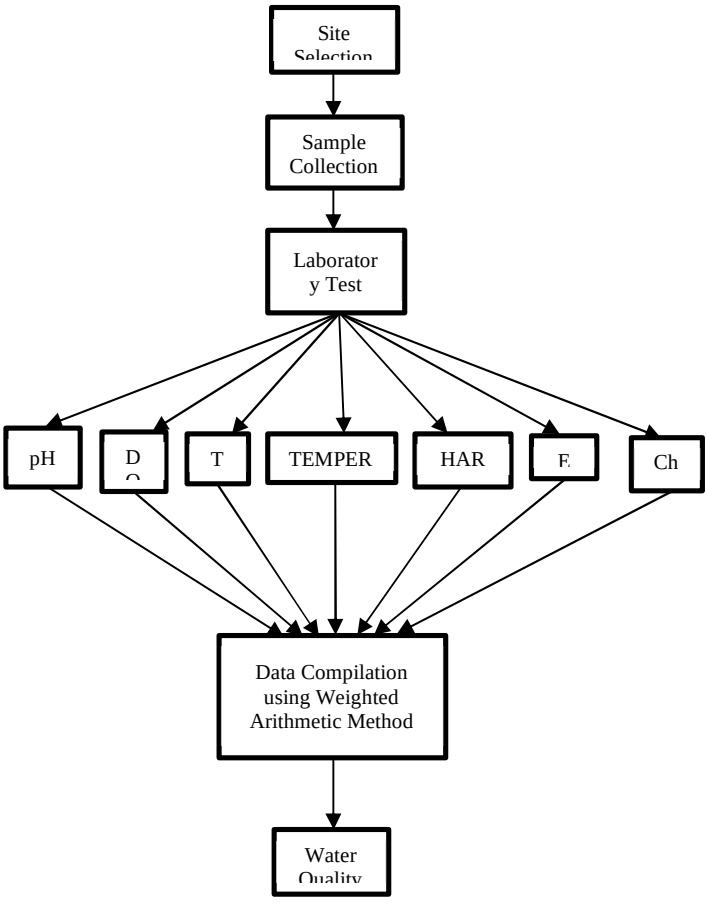

Figure 4. Water Quality Index of Surface water using Weighted arithmetic method

VII. Results and Discussions

The Table II is showing test results of water samples values of its parameters with calculated W_i

TABLE II. TEST RESULTS OF WATER SAMPLES

Parameters / Locations	Hardness (mg/l)	Chloride (mg/l)	Temperature °C	Total Dissolved Solid (g/l)	Electrical Conductivity (mS/cm)	pH	Dissolved Oxygen (mg/l)
Location 1	60	35.45	26.7	86	170	7.53	1.7
Location 2	58	34.04	26	78	166	7.77	2
Location 3	60	36.87	27.3	92	174	7.58	1.5
Location 4	56	38.29	26.6	94	177	7.14	2
Location 5	60	39.71	25.9	91	182	7.03	2.7
Location 6	58	32.62	26	85	181	7.04	1.5
Location 7	70	35.45	27	90	184	6.62	2.9
Location 8	64	36.87	26.6	84	170	6.68	2.7
Location 9	60	32.62	25.7	90	180	6.76	2
Location10	56	39.71	24.5	86	154	6.87	2.5
Location11	52	34.04	26.8	91	172	6.77	1.8
Location12	62	43.96	27.2	92	164	6.81	2.2
Location13	68	34.04	25.8	85	184	6.14	2.4
Location14	52	39.71	26	92	188	6.78	1.9
Location15	54	32.62	25.8	70	182	6.92	2.1
Location16	60	38.29	27	88	178	6.88	2.4
Standard value	300	250	30	500	300	8.5	5
Ideal value	0	0	0	0	0	7	14.6
1/sn	0.003	0.004	0.035	0.002	0.003	0.117	0.2
$\sum 1/sn$	0.366	0.366	0.366	0.366	0.366	0.366	0.366
$k=1/(\sum 1/sn)$	2.732	2.732	2.732	2.732	2.732	2.732	2.732
Wi =k/sn	0.009	0.010	0.097	0.005	0.009	0.321	0.546

The Table IV is showing the ranges of water quality level with respect to water quality status with respect various purposes on the basis on drinking and its unsuitable condition for drinking.

TABLE III. WATER QUALITY INDEX (WQI) AND STATUS OF WATER QUALITY (CHATTERJI AND RAZIUDDIN,2002)

Water Quality Index Level	**Water Quality Status**
0 -25	Excellent Water Quality
26-50	Good Water Quality
51-75	Poor Water Quality
76-100	Very Poor Water Quality
<100	Unsuitable for drinking

Figure 5. Water Quality Index of Surface water of each Locations.

pH is one of the most important factors that serves as an index for the pollution. The measurement of the pH of surface waters is important because many pollutants increase in toxicity with changes in pH. The experimental water bodies were found to be approximately neutral or slightly alkaline. In the present study pH in all the sampling varied between 7.73 to 8.38. The permissible limit of pH value of drinking water specified as 6.5 to 8.5 as per WHO standards. This approves that the nature of surface water samples varies from slightly acidic to slightly alkaline.

Electrical conductivity (*EC*) The importance of *EC* is due to its measure of cations which greatly affects the taste and thus has significant impact on the user acceptance of the water as potable [PRADEEP 1998]. It is an indirect measure of total dissolved salts. High conductivity may arise through natural weathering of certain sedimentary rocks or may have an anthropogenic source, e.g. industrial and sewage effluent [WHO 2004]. The results showed that *EC* values were slightly higher than the permissible level recommended by the WHO for drinking water.

Total Dissolved Solid (TDS) Total dissolved solids is a measure of the dissolved combined content of all inorganic and organic substances present in a liquid in molecular, ionized, or micro-granular suspended form. TDS concentrations are often reported in parts per million. The value TDS found in the test sample ranges from 5 to 55 ppm in the water samples, which is within the permissible limit (i.e. 500ppm).

Hardness: Hardness in water is mostly caused by calcium and magnesium ions, with all other divalent cations also contributing to the concentration. The rocks surrounding the water body is largely the source of hardness, although some industrial wastes and irrigation drainage contribute. The hardness value ranged between 12 to 140 mg/dm^3. The samples water having hardness below 300 mg/dm^3 is considered portable, but beyond this limits cause gastro-intestinal irritation.

Dissolved oxygen (DO) is the measurement of the amount of oxygen dissolved in water and is considered a direct indicator of water quality. The concentration depends on the physical, chemical and biological characteristics of the water body. Warm temperatures reduce the amount of DO a water body can store. Turbulence, photosynthesis and decreases in temperature increase the concentration of DO in the water. The analysis results reveals that the value of DO is within the permissible limit i,e,14.6 mg/l of the test sample.

Chloride: Dissolved chloride in surface waters occurs naturally from the geology but high concentrations typically result from runoff of de-icing salts applied to road surfaces. Chloride is a good conservative element to use for quality assurance in a mass balance model because no natural biological or chemical processes remove or add chloride to the surface water. Therefore, the mass of dissolved chloride remains constant in the surface water unless there is a discharge to or withdrawal from the water body. The drinking water standard and surface water criterion for dissolved chloride is 250 mg/dm^3. In the present study most of the chloride ranged from 310 to 440 ppm and only two of the samples lies above the permissible limit.

VIII. Conclusion

The study was to determine the WQI of surface water of various areas near NIT Agartala. Water suitability of the sixteen water samples collected from different spots in Jirania Sub division, west Tripura district, Tripura, were studied and analysed. The WQI analysis was done based on laboratory test of different parameters such as Hardness, Chloride, TDS, DO, EC, Temperature and pH, using weighted Arithmetic mean method. Thus, the study of water quality index carried out, shows that 3 samples had good water quality, 12 samples had poor water quality and 1 sample had very poor water quality as per the Water Quality Index (WQI) and Status of water quality (Chatterji and Raziuddin,2002). Water from all the locations could not be used for drinking purposes, however it cannot be directly consumed for drinking as it is hard water and several water quality parameters are not up to the permissible limit. Further water treatment is required to make it suitable for drinking and after treatment all the desired parameter should be brought down up to its required parameter for drinking purposes. Although it can be directly used for Irrigation Purposes, Fire Draft, Gardening, Car Wash etc. which very essential for the reuse of water at its maximum potential.

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