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Water quality index for assessment of water quality of Rani Durga River at Titijhola, Rayagada, Odisha, India

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Abstract

Water quality of Titijhola area a tributary of Rani Durga River System was evaluated by water quality Index (WQI) technique. A quality of water index provides a single number that expresses overall water quality at a certain location and time based on several water quality parameters. The aim and objective of an Index is to find out the complex data of water quality into information having useable and understandable by the public. The most important parameters i.e P^H, Suspended solid (SS), Total dissolved solids (TDS), Iron (Fe), Chloride (Cl), Sulphate (SO_4), Nitrate (NO_3), Biochemical Oxygen demand (BOD), Fluoride (F), Alkalinity for the year 2017, 2018 and 2019 were taken for the calculation of Index of water quality of Rani Durga River at Titijhola village ranged in Table-I. The WQI values indicate that the water was not pure at the sampling site except for 3 months having the values were very less. By human activities having Podu Chasa (Shifting cultivation) in the hill near river, water gets polluted and the index of water quality value decreases. It was observed that the parameter having least amount contributes a high statistical value of the index. The water qualities of different sources were used as a tool for comparison of index of water quality. In a particular region of Rani Durga river of Titijhola area is problems of drinking water. It is the effective ways on water quality trends to the public and water quality treatment and management.

Key Words: Water quality Index (WQI), Rani Durga River, Water quality treatment and management (WQTM), Statistical value.

Introduction

Water is life. But all water in the world is not usable. Only 0.0001% fresh water available in the form of river, stream or reservoir are fresh water and available largely for human consumption (Dash, 2001). The source of river water are meeting of glyceor at the mount pick, ground water recharges release surface runoff etc. But due excessive use by human being the river water is polluting day by day which causing a great concern to the human society (Dash & Mishra, 2001).

Rani Durga River as shown in Koraput River Map (Figure 1) below, origin in Kalahandi district of Odisha, then it moves through Dashamantpur block in Koraput district and Rayagada district (DESO, 2016). In Koraput district the Rani Duduma river moves to Rayagada district via the border line between Bandhugaon block in district Koraput and Rayagada block at the area Titijhola village which is termed as local name Rani Durga river situated near the foot hill of the Durga cave (Durga temple). Finally Rani Durga River at Rayagada district joins in Nagabali River. The river Rani Durga at Titijhola village is 120 Kms from Koraput head quarter and 25 Kms from head quarter of Rayagada (DSHB, 2011). There are peak flows in the month of July and August, low flow periods in November and February. The left bank of the river at Titijhola village falls in the Rayagada district and the right bank is Bandhugaon Block of Koraput district. The water of this river is slightly brownish in colour at rainy seasons.

Rani Durga River is environmental issues which concern society and ecologists, geologists, geomorphologists, engineers and hydrologists. Water quality of Rani Durga River at Titijhola area is a serious and important issue for house holders, cultivators, human uses as well as affects wild plants and animal life.

Fig. 1: Koraput River Map

The main aim and objective of the study is to investigate the quality of water of Rani Durga River at Titijhola village. The quality of water index is to summarize large amount water quality data which bears a potential threat to various uses of water i.e habitat for aquatic life, irrigation for agriculture, for drinking purposes, live stock and recreation. Study of water quality index means the standard used to changes in quality of water in particular areas (Titijhola) of Rani Durga River. The index indicates for a general analysis of quality of water in many levels which effects to life.

A view of Rani Durg nallah with shifting cultivation in the hill of the study area is shown in Fig. 2 below while Fig. 3 shows a view of Kandula with cotton cultivation near Nagabali River. Fig. 4 shows the view of cotton with Kandula cultivation near a nallah in the hill of the study area.

Fig. 2: A view of Rani Durga nallah with shifting cultivation in the hill of study area.

Fig. 3: A view of Kandula with cotton cultivation near Nagabali River

Fig. 4: A view of cotton with Kandula cultivation near a nallah in the hill of the study area

Materials and Methods

Sample collection

From Titijhola village, every month water samples were collected from the surface water of the river (ICMR, 1975). The analysis has given for three conjunctive year's i.e January 2017 to November 2019.

Analytical methods

By following standard procedure (APHA-2018) water sampling were done from Titijhola village for consecutive 3 years (2017 to 2019). Parameter like pH, Conductivity, Dissolved oxygen and Alkalinity were done in the site itself by using pH meter, conductivity meter, Alkalinity and dissolved oxygen (DO) by titrimetric method. For other parameters like Calcium (Ca), Magnesium (Mg), Total hardness (TH), Iron (Fe) and (Total dissolved solids (TDS) sampling were taken to laboratory by processing the sample following the standard procedure (APHA-2018).

In the laboratory other parameters were determined by U.V visible spectrophotometer, spectroquont, flame photometer, atomic absorption, spectrophotometer etc. and data recorded according to the standard method of water and waste water (APHA-2018). The physico-chemical parameters are analyzed using different instrument, which details are as follow - (Trivedy and Goel, 2014). These parameters having contributed for quality of river water i.e wightage and Rating scale. Every month the water quality index was observed for assessing the suitability of water for drinking purposes and biotic communities (WHO, 2016).

Weightage

At first we have calculated the water quality index of each factors having higher permissible limits are less harmful i.e in very high quality of Rani Durga river is harmful (harm quality). So wightage of factors has inverse relationship with its permissible limits. (Table 2)

$$Wi \ \alpha \ 1/Vi$$
$$Or \ \ Wi = k/Vi \qquad \text{(i)}$$

$$K = \frac{1}{\sum_{i=1}^{8} \frac{1}{Vi}} \qquad \text{(ii)}$$

where,

K =constant of proportionality
Wi =Unit weight of factor
Vi = Maximum permissible limits as recommended by ICMR and PHEEO

$$\sum_{i=1}^{8} \frac{1}{Vi} = \frac{1}{Vi(pH)} + \frac{1}{Vi(TDS)} + \frac{1}{Vi(Hardness)} + \frac{1}{Vi(Ca)} + \frac{1}{Vi(Mg)} + \frac{1}{Vi(TotalAlkalinity)} + \frac{1}{Vi(DO)} + \frac{1}{Vi(EC)} \qquad \text{(iii)}$$

On the basis of this equation, it is calculated the weightage of the entire chemical factors (Gaur, 2010 & Gupta et al, 2003)

Rating Scale

In Table 3, it is estimated for range of values of parameters. It is devided into five intervals having the rating varies from Zero to 100.

The water is severally polluted that the parameter present in water exceeds the standard maximum permissible limits having the rating value Zero (Vr =0). The parameter contains in water in most desirable value i.e Vr=100. The other rating values stands for excessively polluted (Vr =40), moderately polluted (Vr=60) and less polluted (Vr =80).

Water quality Index Calculation

In Table 4, the parameters which can be used to found the quality of the Rani Durga River at Titijhola area and observed each math the index of water quality. The parameters in the water quality index are PH, Dissolved oxygen, total dissolved solids, hardness, Calcium (Ca), Magnesium (Mg), total Alkalinity and electrical conductivity (EC).

The mortification of rating value (Vr) and unit weight (Wi) is equal to the water quality index (Tiwari, et al, 1985).

$$WQI = Vr \times Wi \quad \text{(iv)}$$

$$Vr \times Wi = Vr_{(PH)} \times Wi_{(PH)} + Vr_{(TDS)} \times Wi_{(TDS)} + Vr_{(Hardness)} \times Wi_{(Hardness)} + Vr_{(Ca)} \times Wi_{(Ca)} + Vr_{(Mg)} \times Wi_{(Mg)} + Vr_{(Total\ Alkalinity)}) \times Wi_{(Total\ Alkalinity)} + Vr \quad \text{(v)}$$

In Table 2 and 3, having given the values of Vi, Wi and Vr.

We got the value of water quality index by multiplying Vr and Wi Which indicates the water quality level.

Result

In Table 1, by the values of mean, variance and standard deviation which obserbed that there is large fluctuation in values of Dissolve Oxygen (DO), Electrical Conductivity (EC), Alkalinity and Total Hardness as compared to other parameters i.e PH, temperature, Total dissolved solids (TDS), Calcium (Ca) and Magnesium (Mg).

Table 1: Physico chemical parameter of water quality with minimum, maximum, mean & Standard Deviation

Parameters	Mnimum	Maximum	Mean	Standard Deviation	Variance
PH	7.04	8.8	8.04	0.46	0.21
Temperature (OC)	15.01	21.86	18.05	2.23	5.06
EC (MS/CM)	118	369	172.66	45.09	2027.21
DO (Mg/l)	3.2	9.95	7.49	1.51	2.32
TDS (Mg/l)	85	294	0.09	0.01	0.0005
TH (Mg/l)	78	728	240.95	116.80	14116.93
Alkalinity (Mg/l)	19	173	59.26	42.36	1722.76
Ca (Mg/l)	17.028	98.55	51.18	19.63	349.54
Mg (Mg/l)	15.56	121.80	30.42	21.02	403.85

(Statistics for different water quality parameters)

The physico-chemical parameters has indentified that the temperature of water was low throughout the year and colourless which is slightly brownish at rainy days. The water is slightly alkaline having PH ranges of the Rani Durga river water is from 7.04 to 8.8 at the sampling site. The value of electric conductivity (EC) changes the composition and on raw water which requireds a change in treatment having the values minimum 118 rs/cm and maximum 369 rs/cm. The total hardness ranged having the values of minimum 78 mg/l and maximum 78 mg/l. The calcium ion contains of water ranged in minimum 15.56mg/l and maximum121.80 mg/l. In the present survej at the sampling site the values of Ca and Mg ions are permissible limits except for one or two months during the rainy season. The value of the dissolved oxygen at the sampling site ranged from 3.2 mg/l to 9.95 mg/l. The total dissolved solids investigates mainly the various types of minerals are present in water having the values varied (Pendency et al, 2007).

From 85mg/l ti 294mg/l, the alkaline values varied from 19 mg/l to 173 mg/l at the sampling site having the capacity of water to neutralize the strong acid having imparted by salts of carbonates, bicarbonates, phosphates, borates, silicates etc. To effect of shifting cultivation and deforestation.

Table 2: Other water quality factors (WQF) as er the ICMR/CPHEEO standards and unit weights

WQF	ICMR/CPHEEO Standard (Vi)	Unit weight (Wi)
PH	7.0-8.5	0.321
EC	<300	0.008
DO	>5	0.549
TH	<600	0.006
Total Alkalinity	<120	0.025
Ca	<75	0.036
Mg	<50	0.057
TDS	<1500	0.002

The ICMR (Indian Council of Medical Research) Standards (1975)/CPHEEO (Central Public Health Environmental Engineering Organization) 1991 standards and Unit weights for different water quality factors (EQF) are mention in Table 2, which is calculating Electrical conductivity, Dissolved oxygen, total alkalinity, magnesium and calcium as per the ICMR standard and PH, TDS Hardness as per the CPHEEO standards. The parameters needed in the least amount have more unit weight which is shown in table 2 (Tiwari et al, 1985).

In table 3 which are shown the rating scale for calculating water quality Index (WQI).

Table 3: (Rating Scale of WQI)

Physico-chemical Factors	Ranges				
PH	7.0-8.5	8.5-8.6 6.5-6.6	8.6-8.7 6.6-6.7	8.8-8.9 6.5-6.7	>9.0 <6.6
EC	0-78	78.1-153	153.1-228	228.1-303	>300
DO	>7.5	5.5-7.5	4.5-5.5	3.5-4.5	<3.5
Handness	0-150.5	150.5-300.5	300.5-450.5	450.5-600.5	>600.5
Total Alkalinity	20-55	55.5-75 15.5-20	75.5-95 10.5-15	95.5-125 5.5-10	>125 <6
Ca	0-20	20.5-41.0	41.5-61.5	62-82	>80
Mg	0-15	15.5-30.5	31-46.5	47-62	>60
TDS	0-300	300.5-600.5	601-901	901.5-1201.5	>1200
Vr	100	80	60	40	0
Extent of Pollution	Pure	Pollution slightly	Pollution moderate	Pollution Excess	Pollution severe

In table 3, it indicates that the Bacterial contamination is positive (+ve) which is not useable for drinking purposes. The water quality standard (Vi) is inversely proportional to the unit weight (Wi). It is obserbed that dissolve oxygen (DO) is low having the water quality index rating shows excess and sever pollution of Rani Durga River at Titijhola area.

In Rani Durga river water, the value of dissolved oxygen is mainly indicates the value of WQI. The purity of the water shows the higher dissolved oxygen in water. At the survey site of Titijhola village, the value of DO is greater than 5 mg/l. According to Tiwari and Mishra in 1985, the WQI ranges are given below (Table 4) which categorized in very bad, bad, medium, good and excellent (Gupta et al 2003; Gupta, 2002; & Hargreaves,1994).

Table 4: Water quality index value with quality indicator

WQI Values	Water quality
0-25	Very bad
25-50	Bad
50-70	Medium (Normal)
70-90	Good
90-100	Excellent (Purity)

As indicated in the table 4 the water quality index values is higher which indicates that the water is very pure that is free of any contamination or not impurities at the survey site except for two three months i.e July, August and September. In the year 2019 which WQI values were less thatn 70 (<70). In the year 2018, the WQI values are fluctuations which are more polluted in the month of March, April and May at the sampling site. In the year 2017 the water quantity is overall normal at Titijhola area. It is obserbed that due to shifting cultivation in that hilly area near Rani Durga River, the upper surface of the soil is washes and flows by the rain water to the river which becomes so polluted and contaminated in rainy seasons.

In Table 5 the months of 2017, 2018 and 2019 mentions the WQI. It is not studied and the status of the Rani Durga River at Titijhola area was not available earlier. In the present investigation of Rani Durga River at Titijhola area, results of several parameters were study in order to assess the quality of water and interpretation of Index. Statement showing up to date District/month wise actual (Average) rainfall for the year 2017-2018 in Koraput District (Rainfall in mm) was shown in Table 6 and Figure 4 gives a description of the comparison of WQI that occurs between 2017 to 2019.

Table 5: Water quality index in different month for the year 2017, 2018 and 2019

Months	Years of (WQI) water quality Index		
	2017	2018	2019
January	92.34	89.98	81.75
February	93.25	94.51	82.39
March	93.94	74.68	87.48
April	94.97	78.82	91.88
May	95.76	79.18	94.85
June	82.87	91.53	95.79
July	82.81	89.78	79.58
August	88.89	82.15	74.49
September	84.86	81.71	76.86
October	91.37	81.78	87.51
November	91.66	90.06	91.28
December	89.53	91.21	----

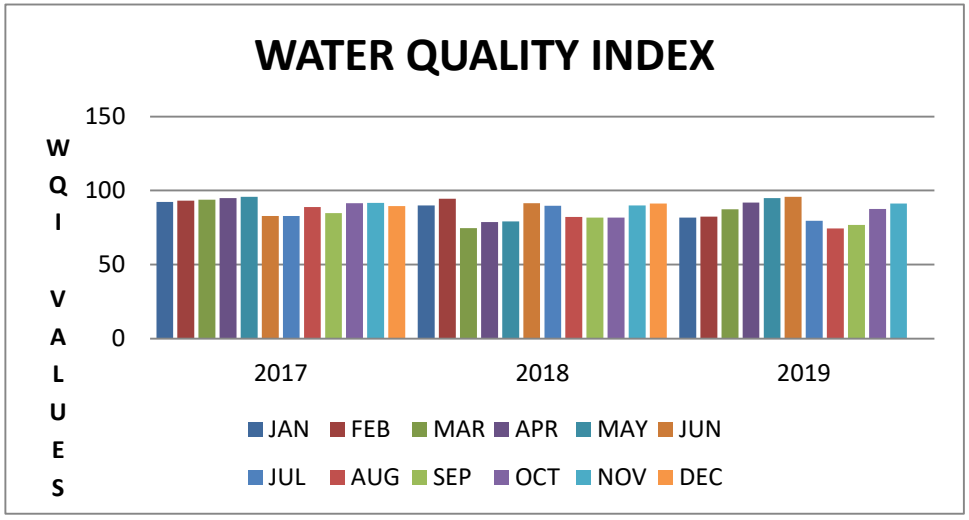

Figure 5: Showing the comparison of WQI for the year 2017 - 2019

Rainfall data

Table 6: Statement showing up to date District/month wise actual (Average) rainfall for the year 2017-2018 in Koraput District (Rainfall in mm)

S.N.	District	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec	Total	Year
	Koraput	0.2	0.0	10.7	14.5	76.8	260.6	374.2	398.2	175.3	181.5	28.6	0.0	1520.5	2017
	Koraput	0.0	0.0	0.6	91.4	75.5	130.8	493.3	611.9	302.0	26.0	1.8	60.8	1794.0	2018

DES (O), District statistical hand book Koraput-2018

Conclusion

The water quality Index of Rani Durga River at Titijhola area may not carry sufficient information regarding the actual and real quality of the water. It is also can't be met with an Index which is so many uses of water quality datas. From the experimental value of water quality index data of three years i.e 2017, 2018 and 2019 (Except the month of December in 2019) of WQI were dicussed and compared and finally obserbed that the water was overally clear except for three months (rainy season) at the sampling time and site. Due to water evaporation of the scorching sum in summer season, the concentration of pollutants increases. After monsoon break soil erosion taken place from nearly hilly area which pods cultivation are being practiced by the tribes, hence water quality deterioted. The values of WQI are high which give supports and benefits to aquatic flora and fauna. From the calculation of WQI it is found that the parameters showing least favourable value contributes a high statistical value to the index was found to be the most contributor to water quality index than other parameters as because it is directly associated with life.

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