International Journal of Current Engineering and Technology
E-ISSN 2277 – 4106, P-ISSN 2347 - 5161

Available at http://inpressco.com/category/ijcet

Research Article

A Study of Water Quality Index (WQI) of the river Brahmani, Odisha (India) to assess its potability

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Accepted 20 Nov 2014, Available online 30 Dec 2014, **Vol.4, No.6 (Dec 2014)**

Abstract

Water quality of the river Brahmani, the second largest river of Odisha is evaluated by WQI technique. The study on water quality provides a single number indicating the quality of water at a particular location and time depending on several water quality parameters. There are several ways to evaluate the quality of water suitable for its potability. WQI expressing its quality in terms of index number provides a useful guidance of overall quality of water for the specified purpose. Twelve number of parameters were chosen for the calculation of WQI following Indian standard drinking water specification IS 10500 : 2012. The index values show that the water quality is excellent (WQI=100) at Rengali and Talcher in the month of May and at Kamlanga and Talcher in the month of June 2013. Water Quality indices are at their very low levels at Tarkera(Rourkela region), Durgapur and Bido due to industrial effluents throughout the year. Water quality is of good standard in several regions of the river in the month of February 2013. On the whole these indices are effective indicators of water quality at different places of the river to generate public awareness and better sanitation.

Keywords: *River Brahmani, water quality index, unit weight, permissible standards for drinking water as per IS10500:2012.*

Introduction

Water is the most fundamental and indispensable component of natural resources. It is universally acknowledged as the lifeline of the civilization. Water constitutes about 70% of the human body by weight. It is really a wonder that water covers 71% of the total earth surface, but only 3% of the total water is fresh water. Out of this 3% of fresh water, 2.5% are stored in the form of ice in Antarctica at North pole and in Himalayan glaciers. Only 0.5% of fresh water is available for human beings and animals. Indicating this scarcity of fresh water, the noted British weight S.T. Coleridge in his famous work "The Rhyme of Ancient Mariner" published in 1978 wrote:

"Water water everywhere
Not any drop to drink".

The crisis of fresh water has posed a formidable challenge worldwide. The crying need of the hour is to provide fresh water to each and every human being in order to increase the standard of living.

The constitution of India throw the provision of article 47 guaranteed the states to provide clean drinking water and improve public health. The judiciary of the country following our constitution has placed drinking water as a derivative right within the purview of right to life under article 21. Since independence various programs have been undertaken by the government to provide safe drinking water to rural habitations. The provision of quality and adequate drinking water in the rural areas will certainly help our nation in achieving high degree of efficiency in terms of productivity through improved health. Among the sources of drinking water rivers play an important role.

The term water quality is used to describe the condition of the water. It largely focuses on its physical and chemical characteristics with respect to its suitability for drinking purpose. The water quality index is basically a mathematical means of calculating a single value from multiple test results (House and Ellis 1987). The index result represents the level of water quality in a given water body. Water quality index records changes in water quality in a particular river over a period of time following a set of standards. It also allows comparison to be made at different locations of the river (Stoner 1978). The objective of this study is to investigate the water quality of the river Brahmani at 14 different points using water quality index following Indian standard drinking water specification IS 10500 : 2012.

Study Area & Materials

The river Brahmani plays a pivotal role in the peninsular river system in India. Its origin can be traced at the confluence of the rivers Koel and Sankh at Vedvyasa near Rourkela in the district of Sundargarh, Odisha and finally

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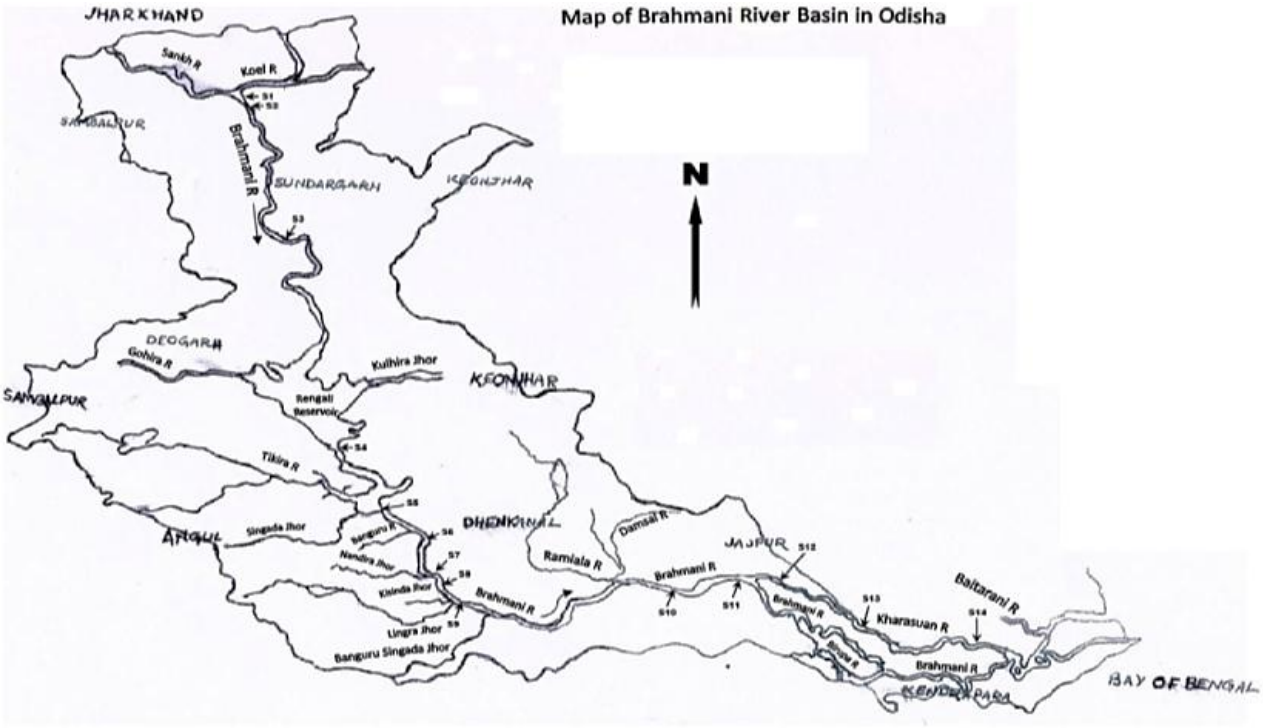

Figure 1: The study area undertaken during the experiment

Table 1: The 14 sampling stations S1, S2,.....S14 descriptions of sampling stations

Sl. No	Sampling Points	Code	Description of the Locations
1	Panposh	S1	It is after the mixing of the river Sankh and the river Koel to form the river Brahmani.
2	Tarkera	S2	Just after the mixing of the drain carrying effluents from Rourkela Steel Plant and the municipal city's sewage.
3	Gomlai	S3	About fifty kilometres downstream of the point S2.
4	Rengali	S4	About five hundred metres downstream of the Rengali dam .
5	Samal	S5	About five hundred metres downstream of the Samal barrage. Effluents from the Super Thermal Power plant at Kaniah and from its ash-pond comes directly to the barrage through the river Tikira .
6	Talcher	S6	At the Talcher-Saranga road bridge .
7	Durgapur	S7	About two hundred metres downstream after the mixing of Nandira Jhor carrying effluents from NALCO, Power plant, ash-pond etc .
8	Kamalanga	S8	About one kilometre downstream after the mixing of Nandira Jhor carrying effluents.
9	Bido	S9	About five hundred metres downstream of the point where Kisinda Jhor and Lingra Jhor mix with the river carrying effluents of the Bhusan Steel Plant and many other nearby industries .
10	Nilakanthapur	S10	Carries the impact of human habitation by its side.
11	Kabatabandha	S11	Before the bifurcation of the river into Brahmani and Kharasrota.
12	Jokadia	S12	About five hundred metres downstream of mixing of Gandanala carrying effluents from Kalinga Nagar Industrial Area.
13	Hasinipur	S13	Before the bifurcation of the river Kharasrota.
14	Gadagadi	S14	After the union of all the segments of river Kharasrota covering a large landscape of agricultural and human activities.

flows in to the Bay of Bengal. The present study reports on the potable quality of river water at 14 different stations starting from Vedvyasa to Gadagadi Ghat in the district of Kendrapada, Odisha. The 14 sampling stations are specified as S1, S2,.....S14 in the map given above in Figure 1 and the descriptions regarding the sampling stations are given the Table 1.

Composite & Manual graph samples were taken from the above stated fourteen different locations to evaluate water quality in the first week of every month in the year 2013.

Methodology

Analytical Methods and Findings: Fourteen different parameters were measured adopting the standard methods of analysis(APHA/2005). pH is measured using pH meter. Turbidity is measured by Nephelometer. The turbidity of a sample is measured from the amount of light scattered by the sample taking a reference with standard turbidity suspension. Total dissolved solid (TDS) is simply the sum of the cations and anions concentration expressed in

Table 2: The maximum, minimum and the mean values of pH, Turbidity (ntu) and Total Dissolved Solid (mg/l)

Sampling Points	pH			Turbidity(ntu)			Total Dissolved Solid(mg/l)		
	Maximum	Minimum	Mean	Maximum	Minimum	Mean	Maximum	Minimum	Mean
Panposh	8.36	7.16	7.588	378	1.3	70.5	156	68	113.75
Tarkera	7.92	7.18	7.478	550	30.4	164.3	333	126	234.1667
Gomlai	7.95	7.42	7.705	468	2	97.05	183	51	110.1667
Rengali	8.05	7.06	7.553	560	0.6	79.94167	86	48	71.66667
Samal	7.96	7.14	7.632	490	1.2	85.925	104	55	80.41667
Talcher	7.93	7.41	7.673	445	0.4	98.825	96	58	77.5
Durgapur	8.01	7.38	7.709	285	1.2	74.025	260	79	170.8333
Kamalanga	8.1	7.42	7.745	394	0.6	75.20833	178	70	130.4167
Bido	8.17	7.43	7.804	306	1.8	61.625	244	95	166.8333
Nilakanthapur	8.23	7.35	7.821	472	1.6	94.23333	112	65	86.25
Kabatabandha	7.92	7.42	7.7	598	1.8	123.9583	111	73	89.5
Jokadia	8.04	7.17	7.713	485	0.6	96.49167	106	62	87.16667
Hasinipur	8.01	7.39	7.703	570	2	104.3	89	66	78.91667
Gadagadi	8.13	7.1	7.773	420	2.8	90.01667	102	76	88.33333

Table 3: The maximum, minimum and the mean values of Calcium (mg/l), Magnesium (mg/l) and Iron Total (mg/l)

Sampling Points	Calcium(mg/l)			Magnesium(mg/l)			Iron Total(mg/l)		
	Maximum	Minimum	Mean	Maximum	Minimum	Mean	Maximum	Minimum	Mean
Panposh	25.65	9.6	17.37	9.72	2.92	6.399167	9.362	0.082	2.048273
Tarkera	41.68	19.24	30.06	20.41	4.86	11.50167	12.47	2.278	5.828917
Gomlai	22.44	6.41	15.5	12.64	1.94	7.0475	10.44	0.076	2.945417
Rengali	17.64	8.02	12.42	5.83	2.92	4.1325	7.46	0.11	1.323833
Samal	14.43	9.62	12.29	6.8	2.92	4.1325	10.455	0.09	2.606083
Talcher	16.03	9.62	12.56	4.86	2.92	4.213333	8.61	0.091	2.705417
Durgapur	36.87	11.22	26.45	14.58	2.92	9.2325	5.95	0.173	2.082167
Kamalanga	25.65	11.22	19.24	11.66	3.89	6.965833	7.9	0.144	2.365667
Bido	38.47	11.22	24.85	15.55	4.86	10.125	10.26	0.287	2.857583
Nilakanthapur	17.64	9.62	13.36	6.8	2.92	4.86	12.85	0.249	3.465417
Kabatabandha	19.24	11.22	13.76	6.8	2.92	4.779167	14.25	0.1	3.425167
Jokadia	17.64	8.02	13.9	7.78	2.92	5.183333	12.62	0.197	3.352833
Hasinipur	17.64	11.22	14.16	5.83	2.92	4.536667	10.68	0.125	2.702167
Gadagadi	17.64	9.62	13.63	6.8	1.94	4.293333	8.54	0.206	2.565833

Table 4: The maximum, minimum and the mean values of Chloride (mg/l), Boron (mg/l) and Alkalinity Total (as CaCO3 mg/l)

Sampling Points	Chloride(mg/l)			Boron(mg/l)			Alkalinity Total(as CaCO3 mg/l)		
	Maximum	Minimum	Mean	Maximum	Minimum	Mean	Maximum	Minimum	Mean
Panposh	19.5	7.56	13.32	0.11	0.01	0.033333	57.5775	30.94	57.5775
Tarkera	39	18.89	28.01	0.2	0.01	0.066667	119.59	30.23	75.06333
Gomlai	24.82	7.56	14.32	0.34	0.01	0.095833	69	21.6	48.22917
Rengali	14.18	5.67	9.1	0.23	0.01	0.061667	49.5	17.28	36.905
Samal	14.18	5.67	9.857	0.52	0.01	0.074167	46	21.6	36.885
Talcher	14.18	5.67	10.62	0.15	0.01	0.069167	50.6	21.6	38.00333
Durgapur	33.68	7.56	22.88	0.52	0.05	0.178333	101.2	34.56	65.98417
Kamalanga	21.28	5.67	13.02	0.33	0.02	0.111667	69	34.56	51.77417
Bido	37.23	10.64	20.92	0.51	0.02	0.1325	99	38.88	70.6775
Nilakanthapur	13.22	7.1	10.07	0.21	0.01	0.05	55.2	30.23	41.70917
Kabatabandha	15.96	7.56	12.2	0.13	0.01	0.041667	55.2	34.56	41.695
Jokadia	17	7.56	12.02	0.14	0.01	0.050833	64.39	25.92	43.23583
Hasinipur	15.11	7.56	9.913	0.12	0.01	0.051667	55.2	30.23	41.3425
Gadagadi	17	7.1	11.3	0.1	0.01	0.0525	50.6	25.92	41.3575

Table 5: The maximum, minimum and the mean values of Sulphate (mg/l), Nitrate (mg/l) and Fluoride (mg/l)

Sampling Points	Sulphate(mg/l)			Nitrate(mg/l)			Fluoride(mg/l)		
	Maximum	Minimum	Mean	Maximum	Minimum	Mean	Maximum	Minimum	Mean
Panposh	11	3	7.333	4.56	0.62	2.125833	0.49	0.118	0.265917
Tarkera	65	17.16	37.55	63.64	7.62	30.365	2.687	0.554	1.593833
Gomlai	32.44	4.64	15.46	8.33	1.64	3.924167	0.64	0.11	0.36575
Rengali	11.52	3.76	7.138	4.65	1.06	2.020833	0.314	0.113	0.21075
Samal	17.52	4.36	9	4.12	0.97	1.9375	0.882	0.127	0.341167
Talcher	12.16	4.28	8.195	3.85	0.8	1.800833	0.398	0.188	0.26825
Durgapur	59.04	10.08	34.82	9.88	1.37	2.631667	1.578	0.33	1.056333
Kamalanga	33.6	7.12	20.86	8.15	1.33	2.524167	0.882	0.23	0.488
Bido	56.16	7.2	26.49	5.98	0.75	2.834167	2.34	0.338	1.209667
Nilakanthapur	12.24	5	8.283	2.79	0.53	1.705833	0.39	0.165	0.258167
Kabatabandha	12.96	3.92	9.07	3.23	0.97	1.9575	0.349	0.174	0.2595
Jokadia	18.88	3.76	10.49	5.05	1.11	2.514167	0.421	0.155	0.278667
Hasinipur	12.12	2.76	8.177	3.63	1.02	2.129167	0.35	0.1	0.227417
Gadagadi	15.84	5.4	8.848	4.96	1.24	2.361667	0.39	0.169	0.259083

Table 6: The required acceptable limit and permissible limit in the absence of alternate source of various parameters for drinking water according to Indian standard drinking water specification IS10500: 2012

Sl No.	Parameters	Required (Acceptable Limit)	Permissible Limit in the absence of alternate source	Unit Weight
1	pH value	6.5 - 8.5	No relaxation	0.0176
2	Turbidity, NTU, Max	1	5	0.132
3	Total dissolved solids, mg/l Max	500	2000	0.000264
4	Boron (as B), mg/l, Max	0.5	1.0	0.264
5	Calcium (as Ca), mg/l, Max	75	200	0.00176
6	Chloride (as Cl), mg/l, Max	250	1000	0.000528
7	Fluoride (as F) mg/l, Max	1.0	1.5	0.132
8	Iron (as Fe) mg/l, Max	0.3	No relaxation	0.44
9	Magnesium (as Mg), mg/l, Max	30	100	0.0044
10	Nitrate (as NO_3), mg/l, Max	45	No relaxation	0.00293
11	Sulphate (as SO_4) mg/l, Max	200	400	0.00066
12	Total alkalinity as Calcium Carbonate, mg/l, Max	200	600	0.00066

milligrams per litre. TDS is measured by filtering the sample with GF/C filter paper and then evaporating the filtrate at 105 deg. C. Calcium and Magnesium are measured volumetrically using EDTA. Iron total is measured using Phenonthroline with the help of Spectrophotometer at 510 nm wavelength. Chloride is measured by argentrometry. Boron is measured by curcumine oxalic acid method using spectrophotometer at 540 nm wavelength. Total alkalinity (TA) is measured by Phenolphthalein titrimetry and bromocresol green titrimetry. Sulphate is measured by turbidimetry method. Nitrate is measured both by nitrate ion selective electrode method and by UV-visible spectrophotometric method and 220 nm and 275 nm wavelengths. Fluoride is also measured both by fluoride ion selective electrode method and by SPADNS method. The maximum, minimum and the mean values of the measured parameters are given in the Table – 2,3,4 and 5 below.

Unit Weight (W): The required acceptable limit and permissible limit in the absence of alternate source of various parameters for drinking water according to Indian standard drinking water specification IS10500 : 2012 is given in Table – 6 along with the unit weight of each parameter.

The parameter which has higher acceptable limit is less harmful because it can harm the quality of water when present in high amount. Thus, unit weight (weightage) of a parameter has an inverse relationship with its acceptable limit. Thus,

$$W_i \ \alpha \ \frac{1}{(Va)i}$$

$$\text{Or } W_i = \frac{K}{(Va)i} \quad (1)$$

w_i = unit weight of the parameter 'i'

v_a = Maximum acceptable limit value of the parameter 'i'

K = Constant of proportionality

The value of K is calculated assuming

$$\sum_{i=1}^{12} Wi = 1 \quad (2)$$

$$W_i = \frac{K}{(Va)i}$$

$$\text{or } \sum_{i=1}^{12} w_i = \sum_{i=1}^{12} \frac{K}{(Va)i}$$

$$\text{or } \sum_{i=1}^{12} w_i = K \sum_{i=1}^{12} \frac{1}{(Va)i}$$

Table 7: The rating values

Rating Scale						
Sl. No.	**Parameters**	**Rating Value (V_r)**				
		100	**75**	**50**	**25**	**0**
1	pH value	≥ 6.5 to ≤ 8.5	6.5 or 8.5	≥ 6.0 to < 6.5 or > 8.5 to ≤ 9.0	≥ 5.75 to < 6.0 or > 9.0 to ≤ 9.25	< 5.75 or > 9.25
2	Turbidity, NTU	≤ 1.0	>1.0 to ≤ 5.0	> 5.0 to ≤ 7.5	>7.5 to ≤ 15.0	> 15.0
3	Total dissolved solids, mg/l	≤ 500	>500 to ≤ 2000	>2000 to ≤ 3000	>3000 to ≤ 6000	> 6000
4	Boron (as B), mg/l	≤ 0.5	>0.5 to ≤ 1.0	>1.0 to ≤ 1.5	>1.5 to ≤ 3.0	> 3.0
5	Calcium (as Ca), mg/l	≤ 75	>75 to ≤ 200	>200 to ≤ 300	>300 to ≤ 600	> 600
6	Chloride (as Cl), mg/l	≤ 250	>250 to ≤ 1000	>1000 to ≤ 1500	>1500 to ≤ 3000	> 3000
7	Fluoride (as F) mg/l	≤ 1.0	>1.0 to ≤ 1.5	>1.5 to ≤ 2.2	>2.2 to ≤ 4.5	> 4.5
8	Iron (as Fe) mg/l	≤ 0.3	0.3	> 0.3 to ≤ 0.45	> 0.45 to ≤ 0.9	> 0.9
9	Magnesium (as Mg), mg/l	≤ 30	>30 to ≤ 100	>100 - to ≤ 150	>150 to ≤ 300	> 300
10	Nitrate (as NO_3), mg/l	≤ 45	45	>45 - to ≤ 67.5	>67.5 to ≤ 135	> 135
11	Sulphate (as SO_4) mg/l	≤ 200	>200 to ≤ 400	>400 to ≤ 600	>600 to ≤ 1200	> 1200
12	Total alkalinity as Calcium Carbonate, mg/l	≤ 200	>200 to ≤ 600	>600 to ≤ 900	>900 to ≤ 1800	> 1800

Using Equation (2),

$$K = \frac{1}{\sum_{i=1}^{12} \frac{1}{(Va)i}} \quad (3)$$

Now w_i with respect to each parameter is calculated with the help of equations – (1), (2), (3) and Table – 2 (Sahu et al 1991).

Rating Scale: In order to ascertain the ratings for each parameter, range of values are selected basing on Indian Standard Drinking Water Specification IS 10 500: 2012. It is a modified version of the rating scale proposed by Tiwari et al (1985 - 86). The rating starts from 100 to 0 and is divided into five categories. If the measured value of a parameter is less than or equal to its acceptable limit, its rating is considered to be 100. If the measured value of a parameter lies between the required acceptable limit and the permissible limit in the absence of alternate source, its rating is said to be 75. The other rating values for the different parameters are determined proportionately taking into account the rating values for the required acceptable limit and permissible limit values respectively. The rating values are enshrined in the Table 7.

Water Quality Index (WQI) Calculation

Water Quality Index is a compilation of a number of parameters that can be used to determine the overall quality of water of a river (Horton, 1965). WQI is a number representing a number of test results Smith (1989) and Sharifi(1990). The parameters involved in the WQI calculation are pH, turbidity, TDS, Calcium, Magnesium, Total Iron, Chloride, Boron, Total Alkalinity, Sulphate, Nitrate and Fluoride. WQI is calculated by aggregating the products of unit weight and its corresponding rating of the measured parameters.

$WQI = \sum_{i=1}^{12} w_i \times (V_r)_i$

Where

w_i = unit weight of the parameter 'i'
$(V_r)_i$ = Rating value of the parameter 'i'
$WQI = w_{pH} \times (V_r)_{pH} + w_{Turbidity} \times (V_r)_{Turbidity} + w_{TDS} \times (V_r)_{TDS} + w_{Calcium} \times (V_r)_{Calcium} + w_{Magnesium} \times (V_r)_{Magnesium} + w_{Total\ Iron} \times (V_r)_{Total\ Iron} + w_{Chloride} \times (V_r)_{Chloride} + w_{Boron} \times (V_r)_{Boron} + w_{TA} \times (V_r)_{TA} + w_{Sulphate} \times (V_r)_{Sulphate} + w_{Nitrate} \times (V_r)_{Nitrate} + w_{Fluoride} \times (V_r)_{Fluoride}$

Result

Monthly water quality index of the fourteen sampling stations presented in the Figures ranging from 2 to 13. Water quality index at each of the fourteen points in every month in the whole year is shown in the Figure – 14.

Basing on WQI, the river water is classified into five categories. The descriptor words and the WQI ranges for the different categories of water are given in Table – 8 below. It is a modified version of the classification of Mitchell and Stapp, 1995.Water quality at its lowest level (WQI-29) is found at Durgapur in the month of January in the whole river and in the whole year 2013. The lowest water quality at Tarkera (WQI-33) and Bido (WQI-36) is found in the month of March and May 2013 respectively. The water of excellent quality is found at Rengali and Talcher in the month of May and at Kamalanga and Talcher in the month of June 2013. Water quality in the river Brahmani is bad (WQI<50) at each of the fourteen sampling stations in the month of August to October 2013. Except the sampling station Rengali, the water quality at all the rest thirteen stations is bad in the month of July 2013. Good quality water is found at only one station (Gomlai) in the month of December, at two stations in the month of May, at eight stations in the month of April and at eleven stations in the month of February 2013. Tarkera is the only sampling station in the river where the water quality is bad throughout the year.

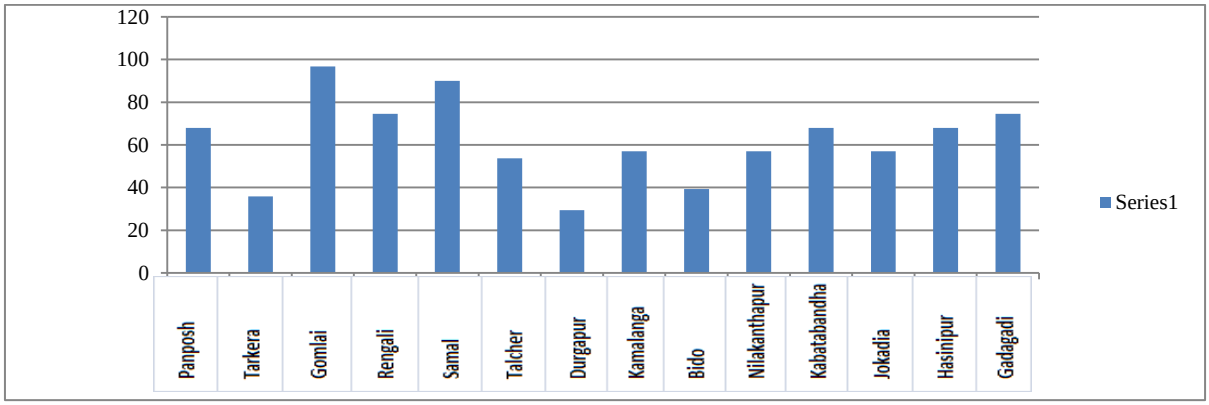

Figure 2: Jan-13

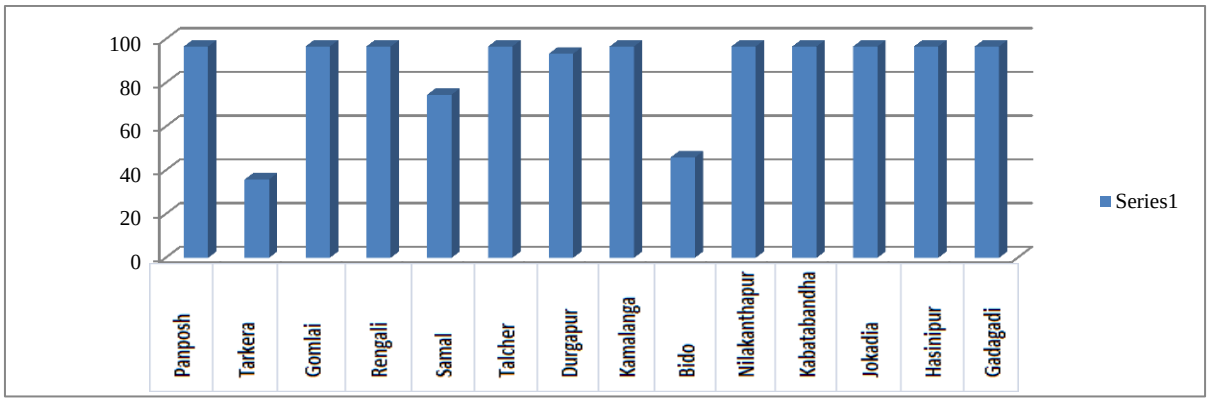

Figure 3: Feb-13

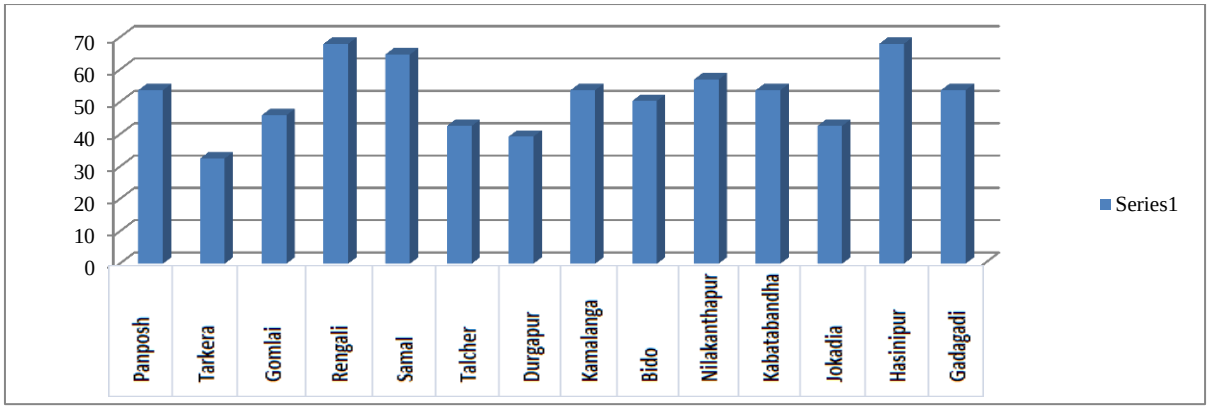

Figure 4: Mar-13

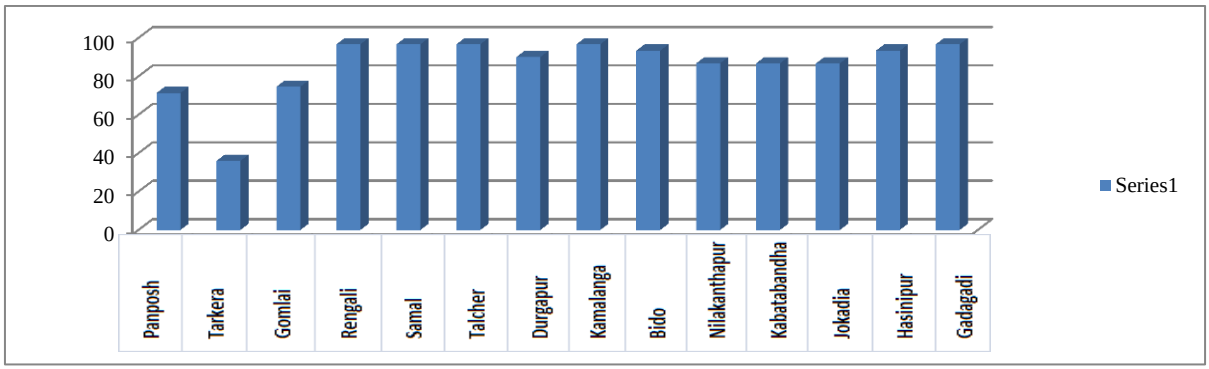

Figure 5: Apr-13

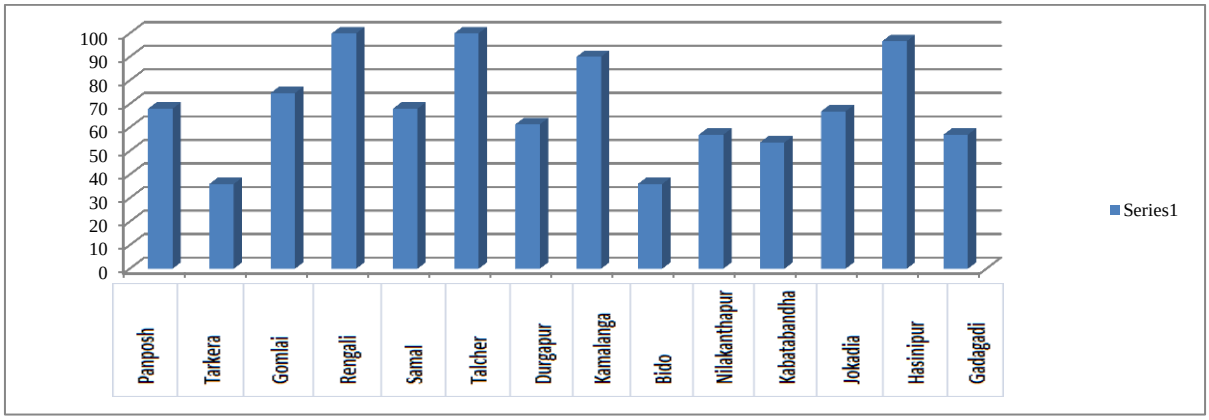

Figure 6: May-13

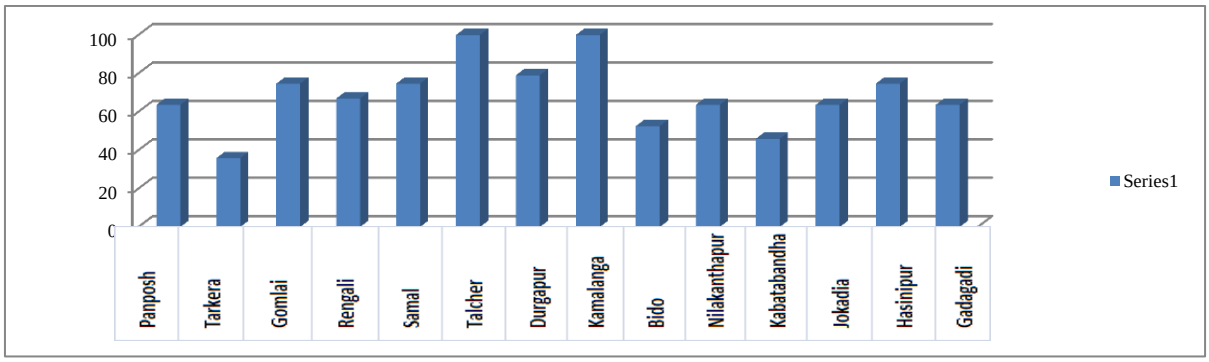

Figure 7: Jun-13

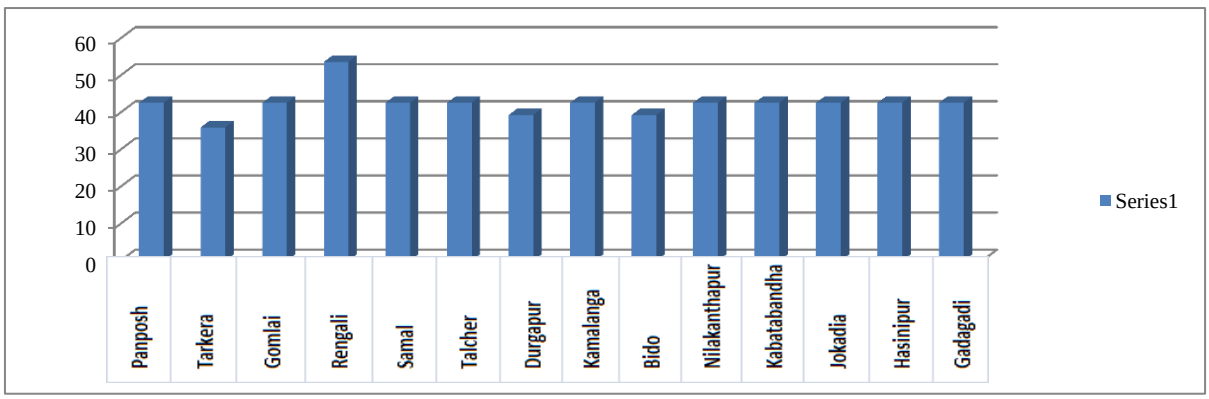

Figure 8: July-13

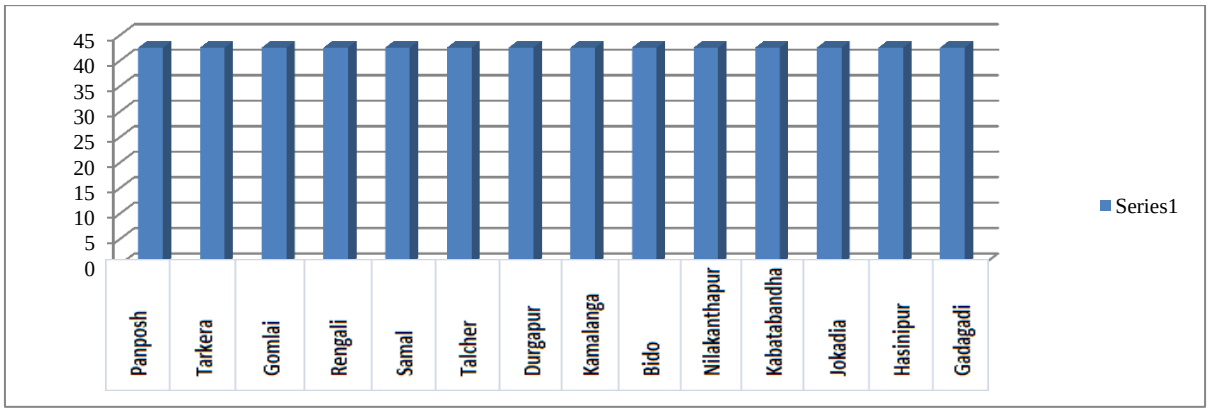

Figure 9: Aug-13

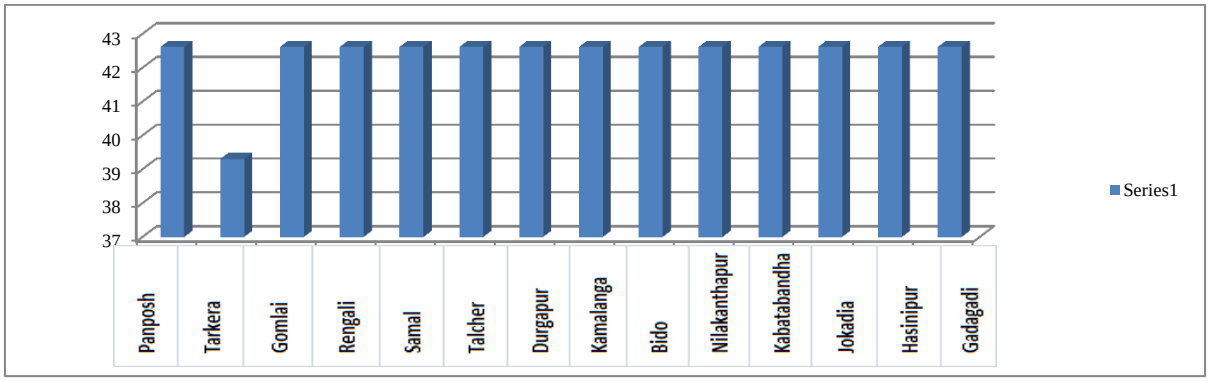

Figure 10: Sep-13

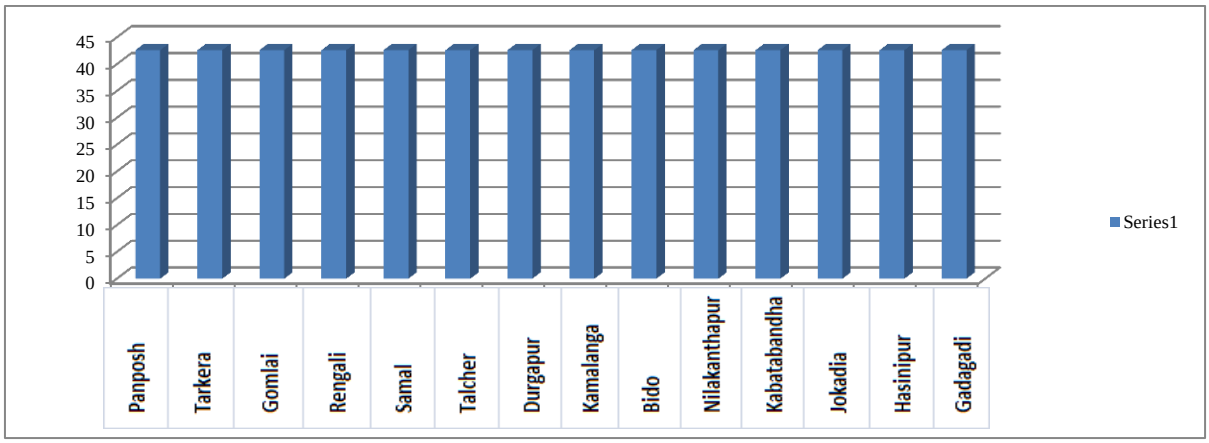

Figure 11: Oct-13

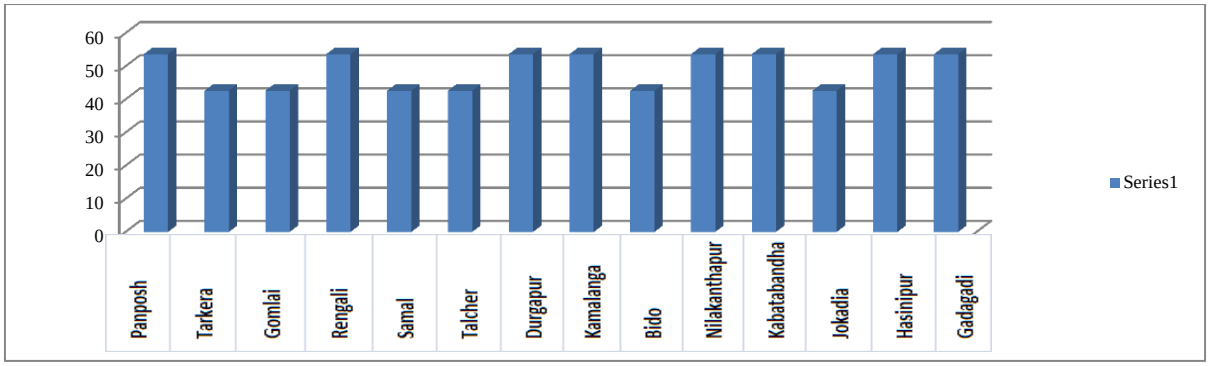

Figure 12: Nov-13

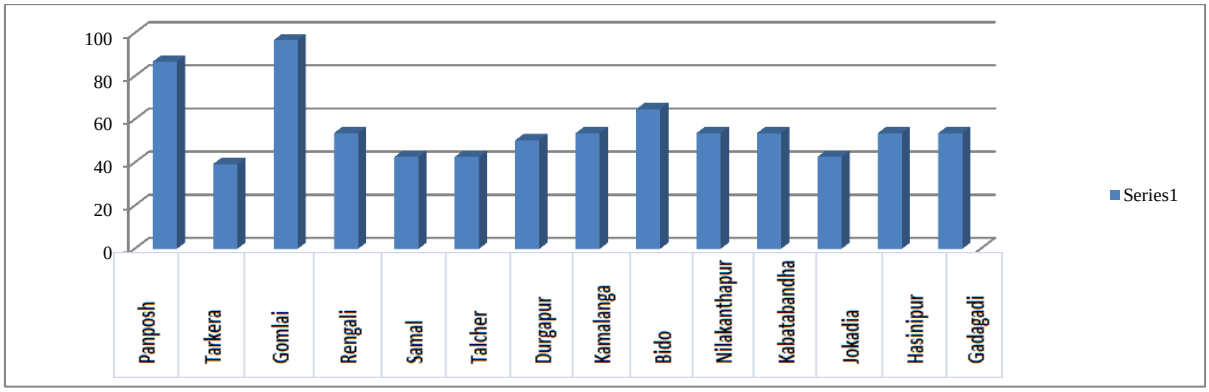

Figure 13: Dec-13

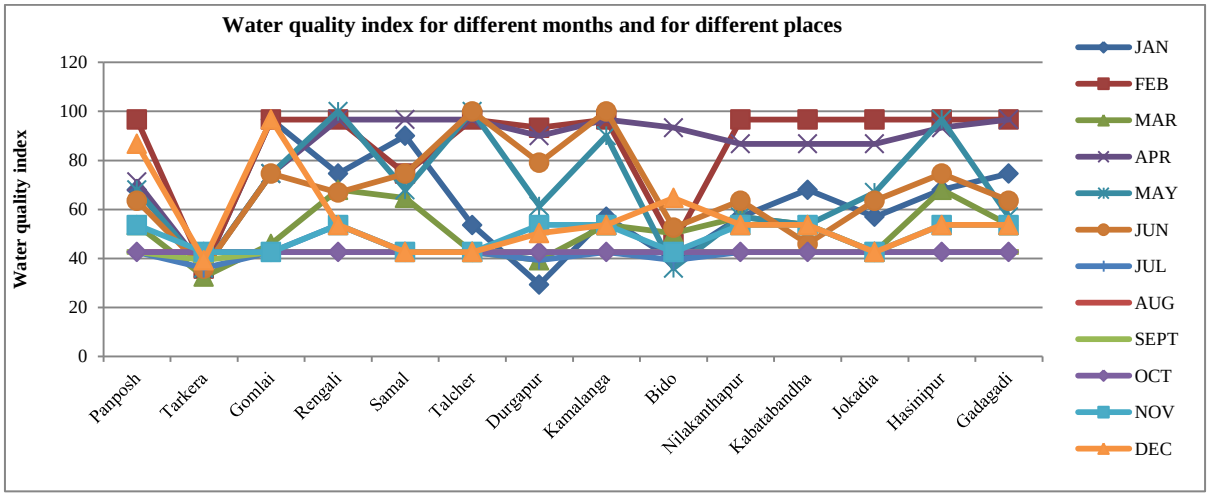

Figure: 14

Table 8

Descriptor Words	Numerical WQI Range
Very bad	0 – 24
Bad	25 – 49
Below Average	50 – 74
Average	75 – 89
Good	90 – 99
Excellent	100

Discussion

Out of the twelve parameters taken for study, it is found that only four parameters i.e. turbidity, total iron, fluoride and nitrate are squarely responsible for water quality degradation. It is further noticed that water quality indices at Tarkera, Durgapur and Bido are at very low level throughout the year. In the month of August and October – 2013, the water quality index is at very low level and same at all stations. It is mainly due to two parameters i.e. turbidity and iron. Iron is an essential element in the metabolism of animals and plants. The recommended upper limit for iron in public water supply is 0.3 mg/l. If present in excess amount, it forms red oxyhydroxide precipitates, an objectionable impurity in domestic water supplies (Hem John D, 1991). Turbidity expresses how much light is scattered by the sample (American Water Works Association). The scattering of the light is generally proportional to the turbidity (Trivedy & Goel, 1984). The high value of turbidity and iron in this period is due to the presence of large amount of silt and soil in water. The values of turbidity and iron usually remain the same in August & September, but this year it is same in October as a flood like situation arose in the first week of October owing to heavy rain. In the entire stretch of the river, it is a noticeable fact that where drains from the industries merge with the river, the water quality indices at those points are at very low level. These drains carry industrial effluents containing large amount of fluoride, iron and nitrate. It is further observed that the contaminated water gets purified through natural processes after covering a long distance. Water quality is at very low level at Tarkera, Durgapur and Bido due to the merger of drains carrying industrial effluents from industry like Rourkela Steel Plant, NALCO and Bhusan Steel Plant etc respectively.

Conclusion & Recommendations

Rivers are pure at its source. It is we who are mainly responsible for polluting it. It indicates man's insatiable craze to acquire money be setting up industries and thereby upsetting the existing balance of nature. Moreover the garbage and effluents coming from communities and industries respectively are not properly treated and utilized for productive purposes. High value of turbidity & iron in rainy season indicates massive deforestation in the river valleys. Stringent measures be taken to check the flow of untreated water to the river. The existing environmental laws should be strictly enforced to check deforestation and environmental imbalance. Last but not the least, the attitude of the people towards mother river be changed so that mankind would not be running shortage of potable water and can be free from an impending crisis of getting pure water indispensable to human living.

Acknowledgement

Authors owe a deep sense of gratitude to Dr. Nigamananda Das, Head, Department of Chemistry, Ravenshaw University and to Dr. Purnendu Padhi, Department of Chemistry, Ravenshaw University for their unstinted help and co-operation in providing necessary laboratory facilities for analysis of samples. My thanks are due to Dr. Smrutiprava Das, Department of Chemistry, Ravenshaw University for the help. Thanks are due to the University Grants Commission for providing me a Teacher Fellowship during the tenure of my research work.

References

House, M.A. and Ellis, J.B. 1987. The Development of Water Quality Indices for Operational Management. Water Science and Technology 19(9):145-154.

Stoner, J.D. 1978. Water Quality Indices for Specific Water Uses. USGS Circular No. 770, Department of the Interior, Arlington, VA. 12p.

APHA.2005. Standard Methods for the Examination of water and waste water (21st Edn.). American Public Health Association, American Water Works Association and Water Pollution Control Fed. Washington D.C.

Tiwari T.N. and Mishra Manorama, 1985 A preliminary assignment of Water Quality Index to major Indian rivers Indian J Environ Protection 5: 276 – 278.

Tiwari T.N., Das S.C and Bose P.K., 1986. Water Quality Index for the river Jhelum in Kashmir and its seasonal variation, Poll Res 5 : 1 – 5.

Sahu B.K., Panda R.B., Sinha B.K. and Nayak A, PG Department of Chemistry, Sambalpur University. Water Quality Index of the river Brahmani at Rourkela Industrial complex of Orissa. J. Ecotoxicol. Environ. Monit, 1(3) 169 – 175 (1991).

Horton, R.K., 1965. An index number for rating water quality. Journal of Water Pollution Control Federation, 37(3):300 – 306.

Smith, D.G. 1989. A New Form of Water Quality Index for Rivers and Streams. Water Science and Technology 21(2) : 123 – 127.

Sharifi, M. 1990. Assessment of Surface Water Quality by an Index System in Anzali Basin. In The Hydrological Basis for Water Resources Management. IAHS Publication no. 197. PP. 163 – 171.

Mitchell, M.K. and Stapp, W.B. 1995. Field Manual for Water Quality Monitoring An Environmental Education Program for Schools Ninth Edition. Green Project, Ann Arbor, MI. 272 p.

Hem. John D. 1991. Study and Interpretation of the Chemical Characteristics of Natural Water (3rd End.) U.S. Geological Survey Water Supply paper 2254. Scientific Publishers, Jodhpur.

American Water Works Association. 6666w. Quincy Avenue Denver. Colorado 80235. Introduction to Water Quality Analysis. Principles and Practices of Water Supply Association. Volume 4.

Trivedy R.K. and Goel P.K. Chemical and Biological Methods for water Pollution Studies. Enviro Media Karad- 415110.