

Studies on Assessment of Water Quality Parameters of Chandan and Orni River of Banka, Bihar

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For river water studies, water quality analysis is one of the most important aspects. Assessing water quality is a critical factor for knowing about pollution as well as its irrigation purposes. The water samples were collected from the randomly sampled two sampling sites of Chandan (C1 & C2) and Orni (O1 & O2) rivers of Banka town. Water samples were analyzed for the considered physicochemical parameters such as temp., pH, EC, T.Alk., T.Hard, TDS, DO, COD, Nitrate, Iron, Silica, Sodium, and Potassium, Sodium Absorption Rate (SAR). The concentration values of almost all the physicochemical parameters have been within the standard limit set by WHO (2004) and SAR value showed that water of both the rivers is most suitable for irrigation to adjoining agricultural land and irrigation, almost all parameters were found within the UCC (1974) and BIS (2012) standard.

Key Words Physico - chemical parameters, WHO, SAR, TDS, DO, T.Hard, T.Alk.

1. Introduction

The good quality of water is very important for mankind because it is directly associated with human health and agronomics requirements. Nowadays, a large number of waterborne diseases and epidemics still prevail in developing and developed nations. Water is needed every day for many domestic, farming, and drinking usages. Our country has an agro-based economy that depends largely on water. People who live in rural areas majorly get their jobs in agricultural-based industries due to the availability of decent and basic irrigation infrastructure and facilities, which includes good quality of water in nearby areas. Due to the growing population and improved living standards, the demand for good water resources is increasing day by day (Narsimhn, T.N. 2005, Patel and Quadri. 2011). Water is the universal solvent (Srivastav. S. 1999). The physical and chemical parameters of water are linked with the types of rocks and minerals available at adjoining riverine systems. The quality of water

varies with the depth of water and source. Drinking water should contain both micro and macronutrients within the appropriate range suited for drinking and farming. Due to human interference, the quality of drinking water gets altered and results in its contamination, through percolation and seepage, drain, and domestic seepage (Panday and Kumar, 1995).

Hill and Webb (1958) reported that rainfall patterns influence changes in changing the physical and chemical environment of water and help in the increase of pollutants.

Therefore, the present investigation has been carried out with the objectives to assess the variation of water quality in the pre-monsoon to post-monsoon period based on some physicochemical characteristics of two main perennial rivers namely, Chandan (East part) and Orni (West part) of the Banka town.

2. Description of Study Areas.

Banka is one of the districts of Bihar. Its latitude is $24^{\circ} 38' 54''$ N and its longitude is $26^{\circ} 92' 73''$ E. Chandan is the main river of Banka district. This river is the largest river of Hill Streams in the District. The river Chandan originated at an altitude of 274m North of Deoghar hill in Jharkhand state. A dam on the river Chandan was constructed at Laxmipur. Below the dam river meets the tributaries like Chhantini, the Dharwa before Banka town and river Orni after Banka town. Finally the river meets river Ganga at Ghogha (20Km East to Bhagalpur district town).

The Chandan river scheme irrigates a large area of land in Banka district. Two water sampling sites in the Chandan river were selected. Site 1 (C1) is 10 km upstream south to Banka Bridge. While site 2 (C2) is near Banka Bridge on Chandan river. Similarly two water sampling sites are selected in Orni river. First O1 is 10 km upstream from Banka town site i.e., near Tara Mandir and second at Tara Mandir (O2) site.

So overall four sites were selected as sampling sites for monitoring the physico - chemical Parameters of the water samples from Chandan and Orni river. Monitoring of water samples from these sites were done during a period of five months starting from June 2013 to October 2013 on bimonthly basis. Composite samplings were collected from each site in the start monsoon, middle monsoon and post monsoon seasons. Samples were collected in sterilized plastic bottles and analyzed and stored according to standard methodologies.

3. Map of Banka Town showing both river, Chandan and Orni and Water sampling sites.



Figure 1 - Map of Banka Town showing both rivers, Chandan and Orni and water sampling sites as C1, C2 on Chandan river and O1, O2 on Orni river.

4. Materials and Methods

Water samples were collected in pre-cleaned plastic bottles in the starting monsoon, middle monsoon and post monsoon seasons (June, August and October). Two sites in each river are selected 10 km upstream and two sites are near Banka town on both rivers. The samples collected were stored in the refrigerator and also preserved until the analysis is not completed.

All parameters were analyzed using standard procedure. (Trivedy and Goel 1986, APHA, 2005) in the laboratory.

Table – 1 – Analytical methodology used for various parameters Analysis.

Sl. N.	Parameters	Analytical method
1.	Temperature	Mercury Thermometer
2.	pH	Digital pH meter
3.	Electrical Conductivity	Conductivity meter
4.	Dissolved Oxygen (DO)	Modified winkler's titration method.
5.	Chemical Oxygen Demand (COD)	Titration method
6.	Total hardness	EDTA Titrimetric method
7.	Total Alkalinity	Acid titration method
8.	Calcium	EDTA Titrimetric method
9.	Magnesium	EDTA Titrimetric method
10.	Chloride	Argentometric method
11.	Sulphate	UV – Visible Spectro photometer
12.	Nitrate	UV – Visible Spectro photometer
13.	Iron	UV – Visible Spectro photometer
14.	Sodium	Flame Photometer
15.	Potassium	Flame Photometer
16.	Total dissolved solid	Evaporation method

The instruments used were in the limit of precision accuracy. The Chemicals used were of AR grade. Utmost care was taken during sampling to avoid any kind of contamination. Temperature and pH were measured at the time of sampling itself.

Table – 1 Result of Physico–Chemical analysis of water samples of Chandan River of district**Banka.**

Parameters Sampling time	site	Temp (°C)	pH	Electrical Conductivity (µS/cm)	T.Hard (mg/l)	T.Alk (mg/l)	Bicarbonate (mg/l)	Ca-Hard (mg/l)	Mg-Hard (mg/l)	Chloride (mg/l)	Ca (mg/l)	Mg (mg/l)
June 2013	C ₁	25	7.3	398	140	124	124	116	24	80	46.40	5.85
	C ₂	26	7.4	372	132	112	112	96	36	72	38.40	8.78
Aug. 2013	C ₁	24	7.8	438	152	144	144	116	36	86	46.40	8.78
	C ₂	23	7.8	470	172	148	148	112	60	94	44.80	14.64
Oct. 2013	C ₁	20	7.5	382	124	132	132	104	20	68	41.6	4.88
	C ₂	20	7.4	346	120	120	120	84	36	68	33.6	8.78

Table – 2 Result of Physico–chemical analysis of water samples of Chandan River of District**Banka**

Parameters Sampling time	site	D.O. (mg/l)	COD (mg/l)	T.S. (mg/l)	T.S.S. (mg/l)	T.D.S. (mg/l)	Fe (mg/l)	SiO ₂ (mg/l)	Nitrate (mg/l)	Sulphate (mg/l)	Na (mg/l)	K (mg/l)	SAR
June 2013	C ₁	6.66	44	322	60	262	0.70	5.4	6.0	12	48	2.8	9.39
	C ₂	6.66	36	292	52	240	1.52	7.40	5.4	6.4	40	3.8	8.23
Aug. 2013	C ₁	8.88	54	354	68	286	1.24	6.0	6.2	9.8	51.2	3.8	9.74
	C ₂	7.77	60	398	88	310	1.32	8.6	4.2	10.0	53	5.5	9.72
Oct. 2013	C ₁	7.80	40	282	48	254	0.96	5.2	4.8	8.0	50	3.8	10.37
	C ₂	8.88	32	268	40	228	1.58	6.2	6.0	7.2	39	3.6	8.47

Table – 3 Result of Physico chemical analysis of water samples of Orni river of district Banka.

Parameters Sampling time	site	Temp (°C)	pH	Electrical Conductivity (µS/cm)	T.Hard (mg/l)	T.Alk. (mg/l)	Bicarbonate (mg/l)	Ca-Hard (mg/l)	Mg-Hard (mg/l)	Chloride (mg/l)	Ca (mg/l)	Mg (mg/l)
June 2013	O ₁	24	7.5	302	96	94	94	60	36	56	24	8.78
	O ₂	25	7.7	298	88	76	76	48	40	60	19.2	9.86
Aug. 2013	O ₁	23	7.8	344	112	104	104	72	40	64	28.8	9.76
	O ₂	23	7.9	326	104	92	92	52	52	70	20.8	12.69
Oct. 2013	O ₁	20	7.6	278	88	80	80	56	32	52	22.4	7.80
	O ₂	21	7.6	282	80	88	88	44	36	52	17.6	8.75

Table – 4 Result of physico chemical analysis of water samples of Orni River of district, Banka.

Parameters Sampling time	site	D.O. (mg/l)	COD (mg/l)	T.S. (mg/l)	T.S.S. (mg/l)	T.D.S. (mg/l)	Fe (mg/l)	SiO ₂ (mg/l)	Nitrate (mg/l)	Sulphate (mg/l)	Na (mg/l)	K (mg/l)	SAR
June 2013	O ₁	6.6	32	272	84	188	2.4	4.8	5.4	8	32	3.44	7.90
	O ₂	6.6	24	228	46	182	1.8	3.6	2.8	12	37	4.20	9.70
Aug. 2013	O ₁	7.77	44	314	96	218	1.8	5.2	4.6	10	40	4.88	9.10
	O ₂	7.77	40	276	64	212	2.2	5.2	3.0	10	42	4.60	10.26
Oct. 2013	O ₁	8.88	28	230	60	168	2.0	3.6	4.8	6.0	31	3.48	7.98
	O ₂	8.88	20	208	38	170	1.6	3.2	3.2	8	38	4.52	10.46

5. Results and Discussion

Results of the physico - chemical analysis of all the river sites of both the rivers of district Banka have been given in Table 1 to Table 4.

Temperature

Temperature of water samples varied between 20⁰C and 26⁰C and were found to be in accordance with the limits prescribed by (BIS 10500 : 2012).

pH

Most of the waters analyzed were slightly alkaline water. Water samples pH values varied between 7.3 and 7.9 and it was found to align with the limitations prescribed by (BIS 1500 : 2012). The highest pH 7.9 was noted for water samples of Orni river in Banka town site (O2), in Aug. 2013. While lowest pH 7.3 is observed at upstream site (C1) of Chandan river in June, 2013.

Electrical Conductivity (EC)

Electrical conductivity is a measure of the capacity of water to conduct electrical current. It signifies the total amount of dissolved salts in water (Dahiya et al. 1979).

EC concentration varied between 278 $\mu\text{s}/\text{cm}$ at site O2 of Orni river in post monsoon season while maximum concentration of EC is observed at site C1 of Chandan river in monsoon season. Overall Chandan river has shown higher value of EC and all sites in all seasons in comparison to Orni river sites.

Ions liberation results in the increase of EC.

T. Hardness

In Chandan river minimum value of total hardness (120 mg/l) was observed at sites C2 in the post monsoon season and maximum value (172 mg/l) at C2 in the middle monsoon season. While in Orni river minimum value T.Hard. was observed at O2 site (80 mg/l) in post monsoon season and maximum value (112 mg/l) was observed at sites O1 in middle monsoon season.

T. Alk and Bicarbonate

The maximum alkalinity concentration of 148 mg/l was found at Chandan river Banka bridge site in monsoon season while minimum 112 mg/l was also found at the same site in the start monsoon period. This value was comparatively lower in Orni river (Varied from 76 mg/l to 104 mg/l). Presence of bicarbonates in the water can be detected by Alkalinity in water samples indicating the pH. Excessive input of organic waste enriched waste water in agricultural and domestic areas results in high values of alkalinity.

Ca – Hardness and Mg – Hardness

Ca – Hardness varied between 84 mg/l to 116 mg/l for Chandan river and 44 to 72 mg/l for Orni river. High range was observed during the middle monsoon season in both the river samples.

Similarly the value of mg – Hardness varied between 20 to 60 mg/l. Maximum value observed in the middle monsoon season for both the rivers.

Chloride

The concentration of chloride in the studied area fluctuated from a maximum (94 mg/l) at site – 2 of Chandan river in monsoon season to a minimum (68 mg/l) at both site in post monsoon season while its minimum concⁿ (52 mg/l) was found in post monsoon season at both site of Orni river. The values found were below the standard value for all the study samples i.e. 250 mg/l (WHO 2004).

DO

Dissolved oxygen varied between 6.66 mg/l to 8.88 mg/l. During the middle monsoon season, high value of DO was observed which is largely contributed due to increase in aeration level with increase in flow current of river water. Gupta et.al (1996) found a similar observation that the DO content in river water is higher in monsoon as compared to summer season. Gupta and Mehrotra (1991) also reported similar results. Therefore, the result goes hand in hand with the above discovery by other researchers.

COD

COD concentration varied from 20 mg/l at O2 sites of Orni river in post monsoon season to maximum value 60 mg/l at C2 site of Chandan river in the middle monsoon season. Chandan river shows more COD values in all seasons at both sites in comparison to both sampling sites of Orni river.

T.S., T.SS. and TDS.

Values of TS, TSS, and TDS were generally observed maximum in middle monsoon water samples in each site of both the rivers. Highest concentration of TDS was recorded 310 mg/l in middle monsoon season at site C1 of Chandan river; while minimum value was recorded as 168 mg/l in post monsoon season Oct. for Orni river samples.

Nitrate – Nitrogen

The concentration of nitrates ranged from maximum (6.2 mg/l) at C1 of Chandan river in monsoon season to a minimum (2.8 mg/l) at site O2 of Orni river. The higher amount of NO₃ – N at site C1, Chandan river may be due to the disposal of agricultural organic waste from agricultural fields containing nitrogenous substances and use of Nitrogen containing fertilizer around the river banks. This was due to natural occurring sources of nitrate – nitrogen level. The values were within the standard limit of 50 mg/l in these sites (Nyamangaara et. al. 2013)

Fe

The iron concentration varied between 0.72 mg/l to 1.58 mg/l Chandan river. The minimum value was observed as site C1 in monsoon period. For Orni river Fe concentration was found to be minimum (1.6 mg/l) at O2 site in post monsoon period while maximum concentration (2.4 mg/l) was observed at site O1 in the start monsoon season. Iron's(Fe) concentration at all sites are within the permissible limit (WHO, 2004).

SiO₂

Silica concentration varied from 3.2 mg/l (minimum) at site O2 of Orni river in post monsoon while maximum value (8.6 mg/l) was found at site C2 of Chandan river in monsoon

season. These values of SiO₂ concentration are well within the permissible limit as per WHO standards (50 mg/l). High silica contained in water samples implies more intense water rock interaction (Drever, J.I. et al 1994).

Na and K

Na concentration was recorded maximum (53 mg/l) in monsoon season at site C2 of Chandan river and minimum concentration (31 mg/l) was found for site O1 of Orni river in post monsoon season.

Potassium concentration was found maximum (5.5mg/l) in monsoon season at site C2 of Chadan river while minimum concentration (2.8 mg/l) was observed at site C1 of Chandan river in the start monsoon season. Weathering of rocks is very common in lower stretches of upper Ganges which result in addition of sodium and potassium in water bodies.

Sodium Adsorption Ratio (SAR)

It is an irrigation water quality parameter used in management of sodium affected soils. SAR value can be used to predict the degree due to which irrigation water tends to enter into the cation exchange section in soil. If SAR value is less than 10 then water is excellent for irrigation to all soils. If SAR value is between 10 to 18, then it is good for irrigation purposes (Todd et. al, 1980). In this study, we found SAR values of all water samples below or almost equal to 10, hence water from these two rivers are excellent for irrigation.

6. Evaluation of water quality for irrigation

For irrigation purposes both quantity and quality of water are of equal importance (Samgodoyin and Ogedengbe, 1991). The quality of water is assessed based on its intended use. The quantity of water is highly dependent on its source and anthropogenic activities occurring around it. For irrigation water, the concern is not just its suitability for crops productivity, its effect on agricultural soil and irrigation systems must also be taken into consideration.

The suitability of irrigation water (SIW) is expressed is :-

$$\text{SIW} = f(Q, S, P, C, D)$$

Where,

Q = Quality of irrigation water

S = Soil type

P = Salt tolerance characteristics of plant

C = Climate

D = Drainage characteristics of the soil

Risk of Sodality

Plant growth is affected by excess sodium content in irrigation water in such a manner that it affects pH and damages soil structure. In some extreme cases, it may also lead to toxicity in plants, so sodium content in the water level must be evaluated.

Sodality is the presence of excess sodium in soil (Singh, 2000). When concentration of sodium in water and soil increases, it causes sodality, which results in swelling and dispersion of clay particles, surface crusting and pore plugging (Bauder et al. 2011) both of which aggravate infiltration problems. In this condition, plants cannot get enough water. Sodium being extremely reactive, it reacts with nutrients in plants and causes problems for plants, which in turn results in less availability of nutrients for plants. The potential effect of sodium is reduced.

Salinity Problem Evaluation

Water for irrigation purposes contains different kinds of natural salts and minerals. So, if this water is used for irrigation purposes, it results in soil having a higher concentration of these salts in the same proportions than in the applied water (Oster and Rhoades 1983).

To evaluate the salinity of irrigation water, one needs to know sodium absorption ratio (SAR) and electrical conductivity. (Rhoades, 1977). SAR value is used to know feasibility of water to be used for irrigation by measuring sodium hazard and SAR value is determined as follows :-

$$SAR = \frac{Na^+}{\sqrt{0.5 (Ca^{2+} + Mg^{2+})}}$$

7. Conclusion

From the present study of the seasonal variation of physico – chemical parameters of Chandan river and Orni river situated in East and West side of Banka town respectively, it is concluded that in some extent waters of upper stream is less polluted in comparison to downstream of Chandan river while Orni river has different nature. Its downstream site O2 near Tara Mandir water has better quality and it has a very lower concentration of many parameters. Waters of the Orni river have good quality in comparison to the Chandan river.

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