Application of water quality index to assess suitability of groundwater quality for drinking purposes in Some Rural Areas Receiving Industrial Wastewater Discharges in Nagpur District, Maharashtra State, India.

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Abstract: **W**ater quality index has been applying in the present study to assess suitability of groundwater quality for drinking purposes in some rural areas receiving industrial waste water discharges in Nagpur District, Maharashtra State, India. This was carried out by subjecting nine groundwater samples, collected from nine selected site, to comprehensive physico-chemical analysis in pre and post monsoon seasons.Five parameters have been considered for calculating the WQI such as pH, DO, BOD, chloride and total alkalinity. The values obtained from all the studied sampling sites were found to be higher than 100, indicates that the water is unsuitable for drinking and human use in pre and post monsoon seasons.

Index Terms **- Water quality index, industrial waste water discharges, physico-chemical analysis.**

I. INTRODUCTION

As per the United Nations Report published on 22 March 2010, contaminated and polluted water kill more people than all forms of violence including war. (United Nations, 2010) The crucial role ground water plays as a decentralized source of drinking water for millions of rural and urban families cannot be over-stated. According to some estimates, it accounts for nearly 80% of the rural domestic water needs, and 50% of the urban water needs in India. (Nayar and Tiwari, 2008). Ground water is generally less susceptible to contamination and pollution when compared to surface water bodies, but once contaminated, it is difficult to restore its quality. (Sasane and Patil, 2013, Hadithi, 2012). Rapid industrialization especially in developing countries like India, has affected the availability and quality of ground water due to over exploitation and improper disposal of waste. Hence, there is always a need for and concern over the protection and management of groundwater quality. (Patil et al, 2001). Industrial development results in the generation of industrial effluents, and if untreated, results in water, sediment and soil pollution. (Patil et al, 2012).Considering the above aspects of groundwater contamination, the present study was undertaken to investigate the possible impact of groundwater quality of some open wells and hand pump in rural areas on and around Nagpur-Raipur National Highway No.6 in Nagpur District, Maharashtra State, India.In this particular area, different industries are located like paper and pulp, food processing, oil processing mills etc. All these industrial effluents produce a wide variety of water pollutants that are directly discharged without any treatment in Nag-Nullah which originates from Nagpur city carrying waste water and domestic sewage. This Nag-Nullah flows through the study area contaminating the surface and ground water bodies before meeting a perennial river Kanhan at Sawangi village. Most rural people living in this area use ground water directly from available sources without any treatment and hence are exposed to a variety of water-borne diseases, and therefore it is necessary to assess the amount of water pollution in terms of WQI.

I. RESEARCH METHODOLOGY

1.1 Study area:

Study area is located in Nagpur district, Maharashtra state, India. The area covered is from Kadholi village to Mathani village about 35 km. east from Nagpur (Longitude 790 25'E and Latitude 210 10' N), A perennial River Kanhan and a sewage carring Nullah flows through the area. People in this area use available ground water for drinking and daily needs. The literature survey reveals that no water quality management studies were made in this region so far hence; the present study was planned and undertaken. For the present study, nine sampling sites are selected and labeled as S2, S3, S4,OW-5,OW-6,OW-7,OW-8,OW-9 and HP-10. Site S-2 is Nag river water at Chapegadi village, Site S-3 is Water sample at Kahan river and Nag river confluence near Sawangi village, Site S-4 is Kahan river water at Mathani village ,Site OW-5 is Open-well near food processing mill near Kadholi village Site OW-6 is Open well located at oil processing mill near Kadholi village, SitE OW-7 is Open well near oil processing mill at Wadoda village,site OW-8 is Open well near pulp and paper industry near Mathani village,site OW-9 is Open well at Mathani village and site HP-10 is Hand-pump water at Borgaon Chikhana village. (Table:1).

1.2 Sample Collection:

The ground water samples were collected from open wells and hand pump at different villages on and around Nagpur-Raipur National Highway No.6 in Nagpur District, Maharashtra State, India. The sites are represented in Table 1. The samples were collected in clean plastic cans of three-liter capacity for physicochemical analysis. pH, was determined within the field of collection, the other parameters like TA, chlorides, DO,BOD etc. were analyzed in the laboratory within the stipulated period. The collected samples were transferred to the laboratory by following all the precautions laid by standard methods (APHA, 1995). The samples were kept in refrigerator maintained at 4^0C until used. Physical and chemical parameters were analyzed as per the standard methods. (APHA, 1989, Trivedy and Goel, 1986).

Table: 1. Sampling locations.

S.N.	Name of sampling area	Sample code	Source	Longitude Latitudes
1	Nag river water at Chapegadi village.	S-2	River	N21^{0}04'53.70'' E79^{0}25'47.18''
2	Water sample at Kanhan river and Nag river confluence near Sawangi village.	S-3	River	N21^{0}05'36.68'' E79^{0}27'56.99''
3	Kanhan river water at Mathani village.	S-4	River	N21^{0}08'20.98'' E79^{0}23'29.69''
4	Open-well near food processing mill near Kadholi village.	OW-5	Open well	N21^{0}08'00.72'' E79^{0}14'51.07''
5	Open well located at oil processing mill near Kadholi village.	OW-6	Open well	N21^{0}08'22.26'' E79^{0}14'22.20''
6	Open well near oil processing mill at Wadoda village.	OW-7	Open well	N21^{0}08'01.64'' E79^{0}19'24.38''
7	Open well near pulp and paper industry near Mathani village.	OW-8	Open well	N21^{0}07'52.84'' E79^{0}20'31.60''
8	Open well at Mathani village.	OW-9	Open well	N21^{0}08'15.30'' E79^{0}21'09.70''
9	Hand-pump water at Borgaon Chikhana village.	HP-10	Hand pump	N21^{0}05'49.83'' E79^{0}23'15.35''

II RESULTS AND DISCUSSION

WQI indicates the quality of water in terms of index number which represents overall quality of water for any respective intended use. It is defined as a rating reflecting the composite influence at different water quality parameter on the overall quality of water.

For Calculation of WQI, five physicochemical parameters such as pH, DO, BOD, chloride and alkalinity of water samples in pre-monsoon and post-monsoon seasons were taken. The results of the physicochemical parameters have been summarized in table 2. Drinking water standards recommending agencies and unit weights of parameters are given in table 3. and WQI is given in table 4.

According to table 5 and 6, status of water qualities based on WQI (Mishra and Patel,2001), the values obtained from all the studied sampling sites were found to be higher than 100, indicates that the water is unsuitable for drinking and human use in pre and post monsoon seasons. The variation of WQI of water samples in pre and post monsoon seasons were illustrated in the figure 1.

Table 2.Physicochemical Analysis of Water Samples in pre and post monsoon seasons.

SITES	pH		DO		BOD		Chloride (mg/lit)		Alkalinity (mg/lit)	
	Pre monsoon	Post monsoon	Pre monsoon	Post monsoon	Pre monsoon	Post monsoon	Pre monsoon	Post monsoon	Pre monsoon	Post monsoon
S-2	8.5	7.2	2.21	2.95	80.68	66.07	503	470	916.96	826.90
S-3	8.0	7.2	3.16	3.55	96.80	92.09	390	369	560.93	532.14
S-4	8.9	7.3	4.23	5.55	47.20	40.25	430	412	380.89	363.45
OW-5	8.6	7.2	2.91	3.56	66.48	60.02	384	360	628.16	560.19
OW-6	8.5	7.4	2.32	2.83	45.60	42.92	373	329	700.15	645.54
OW-7	8.4	8.2	2.96	2.93	47.20	43.51	258	234	710.14	656.18
OW-8	7.9	7.2	2.56	2.84	45.54	41.49	476	330	908.33	840.60

OW-9	8.4	7.6	2.33	2.93	60.69	57.16	392	360	608.56	571.22
HP-10	8.4	7.3	2.26	2.63	16.08	11.52	340	329	768.49	750.32

Table 3. Drinking water standards and unit weights
(all values except pH are in mg/L).

Sr. No.	Parameters	* Standards (Sn)	Unit Weight (Wn)
1	pH	7.0 to 8.5	0.129
2	DO	5.0	0.2
3	BOD	5.0	0.2
4	Chloride	250	0.004
5	Total Alkalinity	120	0.0083

*ICMR Standards.

Table 4.Status of water qualities based on WQI.
(Quoted by Mishra and Patel,2001).

WQI	Status
0-25	Excellent
26-50	Good
51-75	Poor
76-100	Very poor
100 and above	Most unsuitable For drinking.

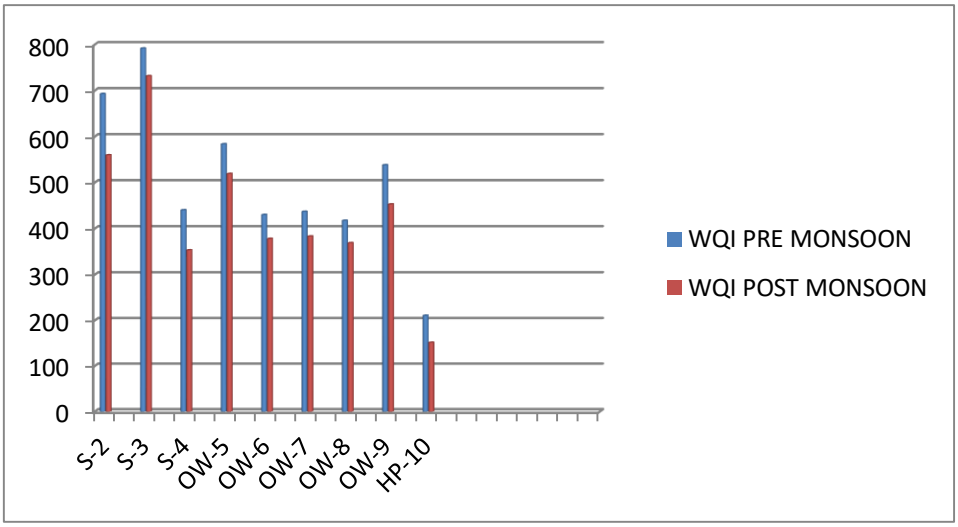
Table 5.Water Quality Index in pre-monsoon season.

S.N.	**Sites**	$q_n w_n$					$\sum q_n w_n$	$\sum w_n$	$WQI = \sum q_n w_n / \sum w_n$
		pH	DO	BOD	$C l^-$	Alkalinity			
1	S2	19.35	25.81	322.72	0.8048	6.3423	375.03	0.5413	692.83
2	S3	12.9	23.83	387.2	0.624	3.8797	428.43	0.5413	791.49
3	S4	24.51	21.60	188.8	0.688	2.6345	238.23	0.5413	440.11
4	OW5	20.64	24.35	265.92	0.6144	4.3448	315.87	0.5413	583.54
5	OW6	19.35	25.58	182.4	0.5968	4.8427	232.77	0.5413	430.02
6	OW7	18.06	24.25	188.8	0.4128	4.9118	236.44	0.5413	436.79
7	OW8	11.61	25.08	182.16	0.7616	6.2826	225.89	0.5413	417.32
8	OW9	18.06	25.56	242.76	0.6272	4.2092	291.22	0.5413	537.99
9	HP10	18.06	25.71	64.32	0.544	5.3154	113.95	0.5413	210.51

Table 6.Water Quality Index in post-monsoon season.

S.N.	**Sites**	$q_n w_n$					$\sum q_n w_n$	$\sum w_n$	$WQI = \sum q_n w_n / \sum w_n$
		pH	DO	BOD	$C l^-$	Alkalinity			
1	S2	10.84	24.21	261.08	0.7553	5.9832	302.87	0.5413	559.52
2	S3	7.48	21.77	362.52	0.602	3.5839	395.96	0.5413	731.49
3	S4	13.93	19.71	154.24	0.6702	2.5294	191.08	0.5413	353.00
4	OW5	13.42	22.48	240.6	0.5856	3.8864	280.97	0.5413	519.06
5	OW6	14.58	23.92	161.36	0.5359	4.2246	204.62	0.5413	378.02
6	OW7	13.93	23.46	164.96	0.3839	4.6957	207.43	0.5413	383.21
7	OW8	8.90	23.92	160.08	0.6548	6.0249	199.58	0.5413	368.70
8	OW9	14.45	23.75	202.24	0.592	4.0637	245.09	0.5413	452.78
9	HP10	11.48	24.44	40.28	0.53	5.1300	81.86	0.5413	151.23

Figure 1.Variation of Water Quality Index of Water Samples in pre and post monsoon seasons.



III CONCLUSION:

The high value of WQI at these sites has been found to be mainly from the higher values of pH, Alkalinity, BOD, Chloride and very low value of DO in the water. All the studied water samples come under most unsuitable for drinking purpose. As compared to pre-monsoon season, WQI values of post-monsoon season were higher; this may be due to inflow of freshwater in this season due to which the water quality may get improved. Goel, 1996, reported similar variation in WQI.

IV ACKNOWLEDGMENT

Authors are grateful to the principal, Government Polytechnic, Hingoli, Maharashtra, India for supporting this research work.

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