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Evalution of Water Quality Index at Goalpara Town and its Surrounding Areas in Assam, India

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ABSTRACT

The water quality index (WQI) of Goalpara town and its surrounding areas in Assam was studied and evaluation made for suitability of water for drinking purposes. Twenty groundwater samples from tube wells and open wells were collected during the period from November, 2007 to March, 2008 and chemically analyzed. It was found that WQI of tube well is 5.5% excellent, 60% good, 14% poor and 20% very poor for drinking purpose, while for open wells it was 38% good, 31% poor and 31% very poor. Comparatively tube wells water is better than the open wells water. It was found that excessive application of fertilizers, pesticides and irregular uses are mostly responsible for degrading water quality, and to mitigate it proper treatment and measures have to be taken.

INTRODUCTION

The pollution of water bodies is increasing steadily due to rapid population growth, urbanization, increasing living standards and diverse human activities. Time is perhaps not too far when pure and clean water may be unavailable for maintaining normal human life. Groundwater is one of the main sources of water requirement of people in India as well as the other parts of the world. Pollution of water has been reported to cause 80% of human diseases and 30% of infant mortality. It is, therefore, important to monitor the quality of groundwater of various parts in the country. The study of water quality Index for assessing the suitability of water for human consumption is utmost essential.

MATERIALS AND METHODS

The groundwater quality of Goalpara town and its surrounding areas appears to be not very good since most of the population is suffering from various waterborne diseases. Groundwater is available for domestic use in the form of tube wells and open wells water. The present study has been made on these waters for evaluating the water quality index. The selected sites for the study are shown in Fig. 1.

Standard equipments and chemicals were used for chemical analysis following the methods of APHA (2002) and and Trivedy & Goel (1986).

Water quality index (WQI): The water quality index was calculated considering eleven important physio-chemical parameters using ICMR and ISI standards by following formula.

$$WQI = \sum_{i=1}^{n} QiWi / \sum_{i=1}^{n} Wi$$

Where, Wi is the unit weight factor given by the formula, Wi = K/Si
Si is standard value of the parameter and K is the proportionality constant.

$$Qi = 100 \, [Vi - V_{ideal}] \, / \, Si - V_{ideal}$$

Where,
Qi is the rating for n^{th} water quality parameter.
Vi is the estimated value of the ith parameter.
Si is the standard permissible value.
V_{ideal} value for pH = 7.0 and for DO = 14.6 mg/L and except these all others are taken as zero.

RESULTS AND DISCUSION

The values of various physio-chemical characteristics for calculation of WQI are given in Table 1, 2,3, subindex values and WQI values in Table 2, and recommended standards for drinking water and unit weights (Wi) in Table 3. Status of water quality based on WQI is given in Table 4, and status of WQI in Table 5. Graph of WQI virsus sources is shown in Fig. 2, and pi-diagram of quality status in Fig. 3.

pH values of different water samples vary from 7.3 to 8.00 for tube wells, and from 6.8 to 8.0 for open wells waters. It is known that pH of groundwater does not cause any severe health hazard. Hardness values were recorded between 65.6 mg/L and 194.5 mg/L for tube wells, and from 61.8 mg/L to 348.7 mg/L for open wells waters. High values were recorded in sample S6 (Krishnai), which is below permissible limit (500 mg/L, BIS 1993). The scale of hardness from the consumers point of view may be taken as follows.

0-50 mg/L - Soft
50-100 mg/L - Moderately soft
100-150 mg/L - Slightly hard
150-250 mg/L - Moderately hard
Over 250 mg/L - Hard

The groundwater was found hard in S6 (348.7 mg/L), which may be considered potable, but this limit produces gastrointestinal irritation.

Electrical conductance is indicative of total dissolved solids. The gradual increase of conductance shows entry of greater quantities of ionic matter into the sources. Conductance values range from 142 to 308 µmho and 153 to 315 µmho for tube wells and open wells water respectively.

The values of TDS range from 70.3 mg/L to 198.4 mg/L for tube wells and 89.7 mg/L to 478.5 mg/L for open well waters. The minimum values were recorded at S3 (89.7 mg/L, Baladmari) and maximum at the spot S7 (478.5 mg/L, Krishnai). Chloride imparts a salty taste and, sometimes, high concentration causes laxative effect in human beings. The chloride content ranged from 16.8 mg/L to 151.8 mg/L for tube wells waters, and from 57.5 mg/L to 585.8 mg/L for open well waters. The minimum value was recorded at the sampling point S9 (Solmari), and the maximum value at the sampling station S7 (Krishnai).

The sulphate is an important anion present in natural waters, and produces cathartic effect in human beings when present in execss amount. The sulphate concentration ranges from 18.5 mg/L to 108.2 mg/L in tube well waters, and from 32.6 mg/L to 169.3 mg/L is open well waters. The minimum value was recorded in sampling points S6 (Harimura) and S1 (Agia), and maximum concentration in spot S7 (Krishnai).

Table 1: Values of various physio-chemical characteristics for calculation of Water Quality Index (QWI) of Goalpara town and its surrounding areas from November 2007 to March 2008.

Sl. No.	Parameters	S_1	S_2	S_3	S_4	S_5	S_6	S_7	S_8	S_9	S_{10}
Tube well water (TWW)											
1	pH	7.6	7.4	7.5	8.0	7.3	7.8	7.6	7.8	7.9	7.8
2	Conductance	167	142	308	252	305	199	200	233	315	174
3	TH	65.6	558	120.7	70.5	194.5	49.6	98.6	78.3	129.1	81.9
4	TDS	98.2	83.6	191.3	128.7	198.4	70.3	86.3	177.8	185.4	92.3
5	Cl	32.8	191.8	26.5	29.7	22.8	24.6	109.7	68.3	16.8	119.2
6	SO_4	39.2	27.2	108.2	37.6	28.2	18.5	48.7	39.9	40.1	82.6
7	NO_3	4.78	6.37	13.8	4.02	2.37	2.5	16.7	27.8	1.95	21.8
8	Fluoride	0.21	0.17	0.14	0.37	0.19	0.30	0.79	0.93	0.17	0.10
9	Mg	10.98	7.68	19.95	24.37	16.73	14.87	38.88	18.08	8.15	24.14
10	Ca	27.18	24.82	12.24	29.83	26.13	41.74	126.5	79.83	71.89	103.8
11	Fe	0.19	0.08	0.12	0.28	0.18	0.18	0.39	0.05	0.12	0.19
Open well Water (OWW)											
1	pH	7.4	7.6	7.8	7.2	7.8	6.9	6.8	7.3	8.0	7.3
2	Conductance	197	276	303	257	315	187	153	312	186	213
3	TH	68.3	72.7	61.8	119.3	83.2	348.7	169.8	285.2	97.1	129.8
4	TDS	208.8	168.9	142.3	207.6	118.3	398.7	478.5	89.5	143.2	89.7
5	Cl	43.5	37.5	182.3	116.4	169.6	294.1	585.8	365.2	57.5	76.8
6	SO_4	32.6	29.6	128.4	49.6	114.7	24.6	169.3	84.2	47.1	97.8
7	NO_3	3.29	5.68	1.68	19.2	8.36	11.6	6.83	27.8	2.32	12.63
8	Fluoride	0.39	0.26	0.19	0.8	0.13	0.05	0.16	0.30	0.27	0.12
9	Mg	24.8	17.68	29.8	33.4	46.05	16.3	49.8	19.6	14.6	37.4
10	Ca	32.6	39.1	23.2	41.6	68.8	117.6	148.2	140.3	76.2	96.7
11	Fe	0.21	0.29	0.12	0.39	0.27	0.27	0.59	0.22	0.23	0.21

S_1-Agia, S_2-Balbala, S_3-Baladmari, S_4-Dubapara, S_5-Golapara, S_6-Harimurah, S_7-Krishnai, S_8-Pancharatna, S_9-Solmari, S_{10}-Srisurya; All values except pH and conductance are in mg/L; Conductance, µmho/cm

The nitrate concentration is very important in public water supplies, because if it exceeds 45 mg/L, it causes blue baby diseases (methaemoglobinaemia) in children, which hampers the transport of oxygen in blood (Khan & Hasant 2005). The nitrate values in all the spots were below permissible limit of 45mg/L.
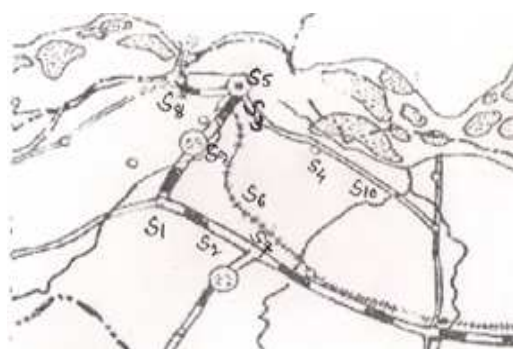

Fig. 1: Map of study area.

Fluoride concentration in tube well waters was comparatively higher than that of the open well waters with all the values below the permissible limit. The concentration ranged from 0.10 mg/L to 0.93 mg/L for tube wells, and from 0.05 mg/L to 0.8 for open well waters. Execess fluoride causes dental, skeletal and non-skeletal fluorosis. The skeletal fluorosis can be observed in the form of gastrointestinal complaints and intermittent diarrhoea in lactating mothers (Harish Babu & Puttaiah 2006). The values of magnesium varied in range of 7.68 mg/L to 38.8 mg/L in tube well waters, and from 14.6 mg/L to 49.8 mg/L in open wells. The permissible limit is 30 mg/L. Magne-

Table 2: Calculated subindex (QiWi) values of different parameters and WQI of Goalpara town and its surrounding areas from November 2007 to March 2008).

Sl. No.	Parameters	S_1 Qiwi	S_2 Qiwi	S_3 Qiwi	S_4 Qiwi	S_5 Qiwi	S_6 Qiwi	S_7 Qiwi	S_8 Qiwi	S_9 Qiwi	S_{10} Qiwi
(Tube Well water (TWW)											
1	pH	13.1400	8.7600	10.95	21.9	6.57	17.52	13.14	17.52	19.17	17.52
2	Conductance	0.3439	0.2924	0.6303	0.5191	0.6241	0.2450	0.4119	0.4799	0.6485	0.3584
3	TH	0.1351	0.1153	0.2494	0.1457	0.4019	0.1024	0.2037	0.1618	0.2667	0.1692
4	TDS	0.0726	0.0618	0.1415	0.0952	0.1468	0.0520	0.0638	0.1315	0.1371	0.0683
5	Cl	0.0984	0.4554	0.0795	0.0891	0.0672	0.0738	0.03291	0.2045	0.0504	0.3576
6	SO_4	0.3229	0.2240	0.8915	0.3097	0.2323	0.1523	0.4012	0.3287	0.3303	0.6805
7	NO_3	0.4375	0.5829	0.2631	0.3679	0.2167	0.2286	0.5289	2.5449	0.1783	1.9965
8	Fluoride	11.3134	9.1557	7.5395	19.9277	10.2305	2.6909	42.5545	50.1022	9.1557	5.3819
9	Mg	1.8088	1.5820	4.1097	5.0200	3.4459	3.0628	8.0129	3.7240	1.8434	4.9724
10	Ca	0.8990	0.8177	0.4036	0.9831	0.8812	1.3734	4.1692	2.6311	2.3694	3.4212
11	Fe	47.6874	20.0749	30.1200	70.2774	45.1800	45.1800	97.8900	12.5449	40.0000	47.6874
	ΣQiWi	76.2591	42.1221	56.3781	119.6345	68.0038	70.6799	168.6997	90.3733	64.2702	82.6134
	WQI	39.23	29.00	21.67	61.55	34.98	36.36	86.8	46.5	33.06	42.5
Open Well Water (OWW)											
1	pH	8.76	13.14	17.52	4.38	17.52	-2.19	-4.38	6.57	21.90	6.57
2	Conductance	0.4057	0.5685	0.6241	0.5293	0.6489	0.3851	0.3151	0.6427	0.3831	0.4387
3	TH	0.1411	0.1502	0.1277	0.2465	0.1719	0.7206	0.4030	0.5890	0.2006	0.2682
4	TDS	0.1545	0.1249	0.1053	0.1536	0.0875	0.2950	0.3540	0.0662	0.1059	0.0665
5	Cl	0.1305	0.1347	0.5469	0.3492	0.5090	0.8823	1.7587	1.0950	0.1725	0.2304
6	SO_4	0.2685	0.2438	1.0580	0.4078	0.9450	0.2027	1.3949	0.6937	0.3881	0.8058
7	NO_3	0.3011	0.5199	0.1536	1.7575	0.7646	1.0617	0.6250	2.5449	0.2121	1.1560
8	Fluoride	21.0106	14.0043	10.2305	43.0959	6.9981	2.6909	8.6143	16.1620	14.5458	6.4668
9	Mg	5.1083	6.1385	6.1385	6.8800	9.4863	3.3775	10.2588	4.0373	3.0071	7.7002
10	Ca	1.0743	0.7645	0.7645	1.3215	2.2675	3.8760	4.8846	4.689	2.4967	31.1871
11	Fe	52.7100	72.7800	30.1200	97.8900	67.7700	67.7700	148.0849	45.1800	57.7249	52.7100
	ΣQiWi	89.9624	108.5692	67.4156	157.0137	107.1687	79.0509	172.3133	92.3134	101.1363	79.5968
	WQi	46.3	55.9	34.7	808	55.1	40.7	88.8	47.5	52.03	41.0

S_1-Agia; S_2-Baladmari; S_3-Balbala; S_4-Dubapara; S_5-Goalppara; S_6-Harimura; S_7-Krishnai; S_8-Pancharatan, S_9-Solmari; S_{10}-Srisurjya

Table 3: Drinking water standards recommending agencies and unit weights.

Sl. No.	Parameters	Standards	Recommending agencies	Unit weight (Wi)
1	pH	6.5-8.5	ICMR and ISI	0.2190
2	Conductance, μmho/cm	300	ICMR	0.00618
3	TH	300	ICMR & ISI	0.00618
4	TDS	500	ICMR & ISI	0.0037
5	Chloride	250	ICMR & ISI	0.0075
6	Sulfate	150	ICMR & ISI	0.01236
7	Nitrate	45	ICMR & ISI	0.0412
8	Fluoride	1.5	ICMR	0.8081
9	Mg	30	ICMR	0.0618
10	Ca	75	ICMR	0.02472

All values expect pH and consuctance are in mg/L.

Fig. 2: WQI against the sources.

TWW (Tube Well)

OWW (Open Well)
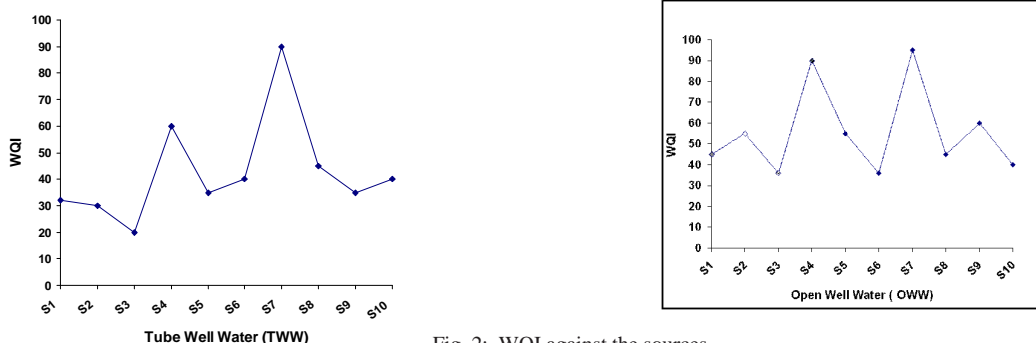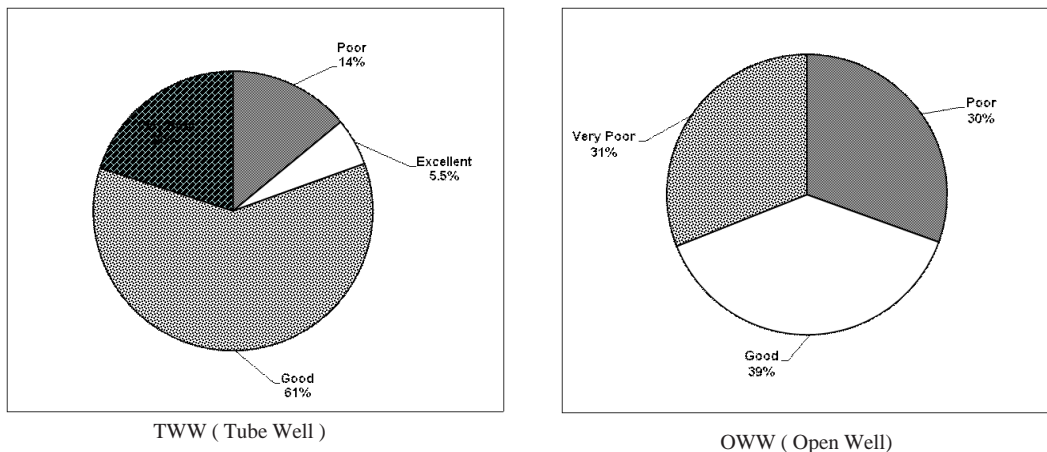
Fig. 3: Pi-Diagram of quality status of study area.

sium is an essential element for man. However, at higher levels it causes laxalive effect. High calcium content in water is undesirable for washing, bathing and laundering. It tends to create scales on utensils. The permissible limit for calcium is 75 mg/L. The values ranged from 12.24 mg/L (S3) to 126.5 mg/L (S7) in tube well waters, and from 32.6 mg/L to 148.2 mg/L in open well waters.

Table 4: Status of water quality index (WQI) of the respective sources.

Sl. No.	Source	WQI	
		Tube well water	Open well water
1	S_1	39.23	46.3
2	S_2	29.0	55.9
3	S_3	21.67	34.7
4	S_4	61.55	80.8
5	S_5	34.98	55.1
6	S_6	36.36	40.7
7	S_7	86.8	88.8
8	S_8	46.5	47.5
9	S_9	33.0	52.0
10	S_{10}	42.5	41.0

Iron concentration ranged from 0.08 mg/L to 0.39 mg/L in tube well waters, and from 0.12 mg/L to 0.59 mg/L in open well waters. WHO international standards for iron is 0.3 mg/L. The maximum iron concentration was found in sampling point S7 (Krishnai) for both tube wells and open wells having 0.39 mg/L and 0.59 mg/L respectively. Iron intake in large amounts through drinking water and other sources is known to lead constipation and other problems (Sarma & Bhattachyarjee 2000).

Application of WQI is a useful tool in

assessing the water quality of groundwaters. In the present study, application of WQI gives a comparative evaluation of water quality at different sampling points. WQI indicates that tube well waters in spot S3 (Baladmari) have excellent status with 21.67 value. Open well waters of all the sampling points lack excellency.

In case of tube well waters, the study area comprises 5.5% excellent water, 14% poor water, 20% very poor water and 60.5% good water. In case of open well waters, only 38.5% is good water, 30.5% poor water and 31% very poor water. It can be concluded from the study that the water quality in various locations is in the following decreasing order.

S3 > S2 > S9 > S5 > S6 > S1 > S10 > S4 > S7 (Tube wells)

S3 > S6> S10 > S1 > S9 > S5 > S2 > S4 > S7 (Open wells)

Where, S_1 – Agia, S_2 – Balbala, S_3 – Baladmari, S_4 – Dubapara, S_5 – Golapara, S_6 – Harimurah, S_7 – Krishnai, S_8 – Pancharatna, S_9 – Solmari, S_{10} – Srisurya

Table 5: Status od water quality based on WQI (Chatterje & Raziuddin 2002).

Sl. No.	WQI	Status
1	0-25	Excellent
2	26-50	Good
3	51-75	Poor
4	76-100	Very Poor
5	> 100	Unsuitable for drinking

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