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Abstracted and Indexed

Appraisal of groundwater quality from Sirpur Kaghaznagar area,Adilabad district, Telangana

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Abstract

Ground water quality plays an important role in promoting agricultural production and standard of human health and the sources and causes of ground water pollution are closely associated with human use of water. For many years ground water was thought to be protected from contamination by the layers of rocks and soil that acts as a filter, but contaminants do make their way into the ground water and affect its quality. The present paper deals with the assessment of seasonal variation in ground water and its suitability for drinking purpose. For this purpose major ions were assessed and Water Quality index was calculated for both pre monsoon and post monsoon season. A comparison of ground water quality in relation to drinking water quality standards proves that the ground water quality was altered with respect to parameters such as pH, EC, TDS, Ca^{2+}, Mg^{2+} and TH showcased higher levels. Similarly WQI calculated for both the seasons ranged to fall in poor to unsuitable category. From the above results it is clear that the ground water of the study area is deteriorated due to paper industry effluents, use of agricultural fertilizers and the local geology and is found unsatisfactory for drinking purpose.

Key Words: Water Quality Index, Physico-chemical parameters, Groundwater quality and seasonal variation.

Introduction

Groundwater is of vital importance with respect to domestic, industrial and agricultural purposes and can be linked to human welfare and development. In the recent past tremendous increase in fresh water usage and its huge demand has created environmental stress and is being threatened and overexploited posing adverse consequences in the near future (Ramakrishna *et al*., 2009) Unchecked growth of population with rapid developmental activities leading to urban sprawl along with fertilizers and fungicide use in agricultural productions are main reasons for the change in the quality of ground water. Groundwater being the main source of drinking water, wastes from industries, agricultural sector and excess nutrients from domestic sewage are being constantly added by man's activities to make it polluted (Panda and Sinha 1991). Most of the epidemics which create adverse impact on human health especially in developing countries can be linked to unsafe water quality lacking wholesome water supply.

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Study Area: Sirpur Kaghaznagar area is located in the north eastern part of Adilabad district, Telangana and lies on 19^0 33'33" North Latitude and 79^0 48' 33" East Longitude with an average elevation of 174 metres. It is situated on Chennai-Delhi railway line. As of 2011 India census the town had a population of 57,583. Average population density of the Sirpur Kaghaznagar town is 6,900 per sq. Km and well known for Sirpur Paper Mills (SPM) one of the oldest paper mills in India (Figure.1). In the geological history of peninsular India, the district of Adilabad has special significance in some of the areas. The study area is mainly underlain by the Sullavai formation comprising grits, conglomerates and sandstone. Important mineral resources like coal, limestone, iron ore and clays are found in abundant quantity making it earn good revenue.

Material and Methods

Total 5 representative water samples (Ground water: 4 no s and Surface water: 1 no s) were collected for two seasons, viz., pre-monsoon, and

post-monsoon seasons of 2012-2013 (Table.1). Samples were collected as per the standard procedure laid down in APHA (1998) in 1 litre polythene bottles pre-cleaned with double distilled water. The samples were filtered by Whatman filter paper prior to analysis in the lab. Analysis was carried out major ions (cat and anions) by following standard methods (APHA. 1998).

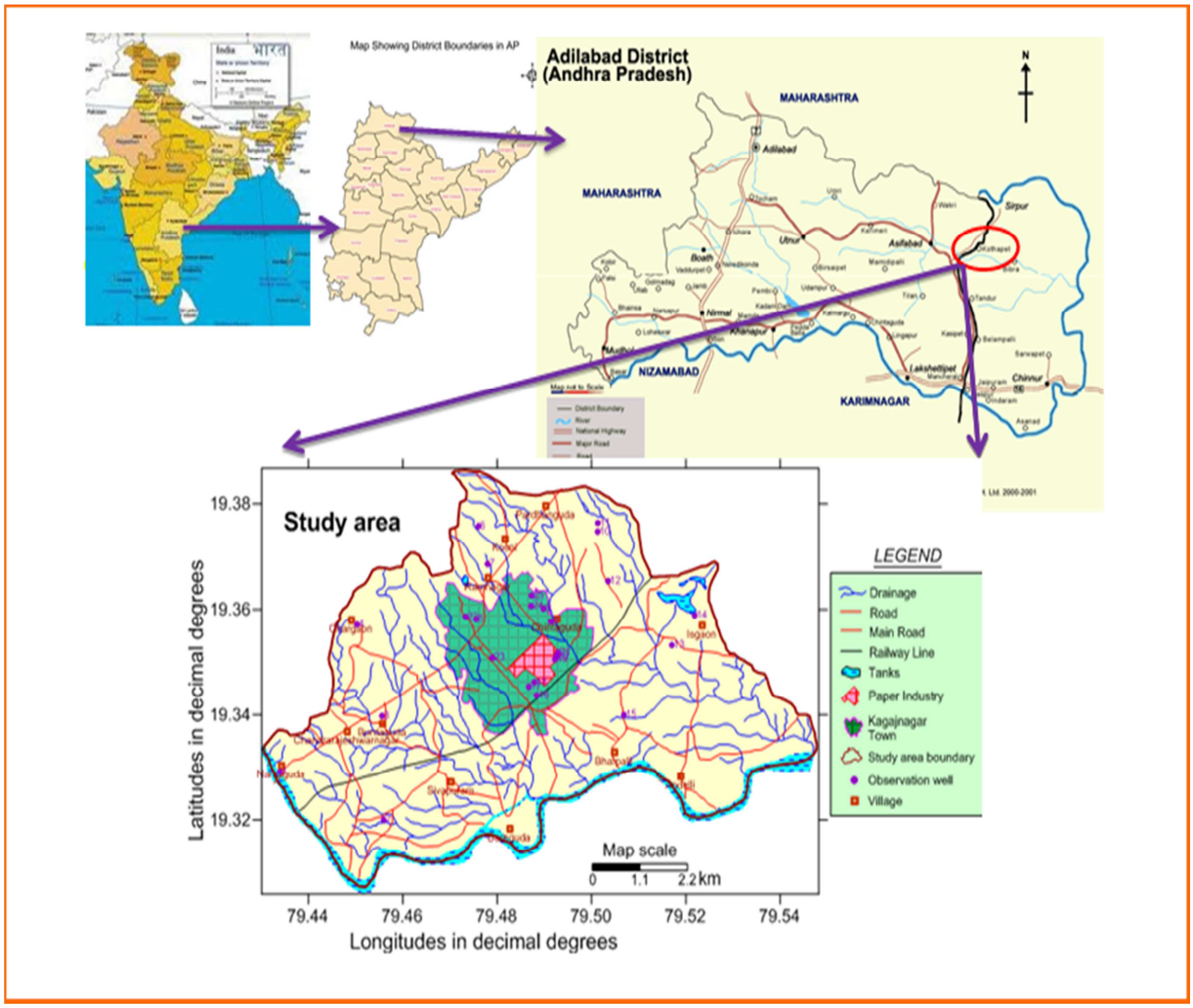

Figure.1 Location map of the study area

Table.1 Location of sampling stations with latitude & longitude

Sample No.	Location of sampling stations	Longitude	Latitude
1	Peddavagu River	79.433935	19.329136
2	Sarsilk (Hand Pump)	79.489785	19.360207
3	Chintaguda (Hand Pump)	79.501303	19.374788
4	Sangam Basthi (Dug Well)	79.473309	19.358634
5	RamMandir Area(Hand Pump)	79.487272	19.362682

The parameters like pH and conductivity were measured in the field with the hand held instrument (Hanna Make). Total dissolved solids were estimated by gravimetric method, total hardness and calcium by ethylene di amine tetra acetic acid (EDTA) titration method using Eriochrome black-T and murexide indicators, chlorides by argentometric method, nitrate-nitrogen by colorimetric method using brucine sulfanilic acid, magnesium by indirect method and sodium and potassium were estimated with the help of Flame photometer were analyzed.

Calculation of Water Quality Index (WQI)

The water quality index was calculated based on twelve parameters by using drinking water quality standard recommended by the World Health Organization (WHO, 2011). The weighted arithmetic index method Brown *et al.*, (1972) used for the calculating WQI of the water body in following steps:

a. Calculation of Sub Index of Quality rating (*qn*)

Let there be ***n*** water quality parameters, where the quality rating or sub index (***qn***) corresponding to the ***nth*** parameters is a number reflecting the relative value of these parameters in the polluted water with respect to its standard permissible value. The value of ***qn*** is calculated using the following expression.

$$qn = 100\,[Vn - Vio]/[Sn - Vio]$$

Where, ***qn*** = Quality rating for the ***nth*** water quality parameters

Vn = Estimated value of the ***nth*** parameter at a given sampling station.

Sn = Standard permissible value of the ***nth*** parameters

Vio = Ideal value of ***nth*** parameter in pure water. (i.e., 0 for all other parameters except the parameter pH and dissolved oxygen (7.0 and 14.6 mg l-1 respectively) (Tripaty and Sahu, 2005).

b. Calculation of Quality rating for pH

For pH the ideal value is 7.0 (for natural water) and a permissible value is 8.5 (for polluted water). Therefore, the quality rating for pH is calculated from the following relation:

$$qpH = 100\,[(VpH - 7.0)/(8.5 - 7.0)]$$

Where, ***VpH*** = observed value of pH during the study period.

If quality rating $qn = 0$ means complete absence of pollutants,

While $0 < qn < 100$ implies that, the pollutants are within the prescribed standard.

When $qn > 100$ implies that, the pollutants are above the standards.

c. Calculation of Unit Weight (*Wn*) Calculation of unit weight (***Wn***) for various water quality parameters are inversely proportional to the recommended standards value ***Sn*** of the corresponding parameters.

$$Wn = K/Sn$$

Where, ***Wn*** = Unit weight for the ***nth*** parameters.

Sn = Standard value for ***nth*** parameters.

K = Proportional constant, this value considered (1) here, also can calculate using the following equation:

$$K = 1/\Sigma\,(1/Sn)$$

The overall Water Quality Index was calculated by aggregating the quality rating with the unit weight linearly.

If water quality index (WQI) is less than 50 such water is slightly polluted and fit for human consumption, WQI between (51 - 80) moderately polluted, WQI between (50 -100) excessively polluted and WQI-Severely polluted (Sinha *et al.,* 2004) (Table.2).

$$WQI = \sum_{n=1}^{n} qn\,Wn \Big/ \sum_{n-1}^{n} Wn$$

Table.2 Water Quality Index (WQI) and status of water quality [Chaterjee and Raziuddin, 2002]

Water Quality Index Level	Water Quality Status	Grading
0-25	Excellent Water quality	A
26-50	Good Water quality	B
51-75	Poor Water Quality	C
76-100	Very Poor Water quality	D
>100	Unsuitable	E

Results and Discussion

Table 3 to table 10 shows the results of the present study. Water Quality Index of the ground water samples was established based on various important physico-chemical parameters for five different sites from for both seasons. The WQI, from 5 different sites during pre monsoon varied from 52.42 (site 1) to 145.62 (site 2), and during post monsoon season it ranged from 50.95 (site 1) to 141.70 (site 2). The mean of major ions during pre and post-monsoon season is given in table-3 and table-4 respectively. pH is indicated by the acidity and alkalinity is the hydrogen ion concentration contributed by many factors. Many of the mineral constituents coordinate to give the resultant pH. The results obtained for pH ranged between (8.76- 8.9). The minimum of 8.76 at site 1 (Peddavagu) and maximum pH of 8.9 was found at sites 2, 3, 4 and 5 (Sarsilk), (Chintaguda), (Sangam Basthi) and (Ram mandir) constantly in pre monsoon season. During the post monsoon season it ranged between (8.78 - 8.9) with minimum of 8.76 at site 1 and maximum was recorded at sampling sites 2, 3, 4 and 5. The pH was alkaline mostly in both the seasons in the study area. The alkaline pH above 8.6 could be due the surface water interaction with ground water and agricultural runoff. The alkaline pH might be due to the use of alkalis in the production of pulp from raw material where the alkali reacts with the water and produces higher number of hydroxyl ions which raises the pH (Pooja Tripathi *et al*., 2013).

Electrical conductivity values investigated for the study period ranged between (300 – 2000 µmhos/cm) in pre monsoon season. The minimum was recorded at site 1 and maximum at site 2 where as it ranged from (350- 2004 µmhos/cm) in post monsoon with minimum value of (350 µmhos/cm) at site 1 and maximum value of (2004 µmhos/cm) at site 2. The higher values of EC recorded at sarsilk colony are obviously due to presence of paper mill in the nearby surrounding area. Excess dissolved organic and inorganic salts causes increased levels of EC. The results are in accordance with (Pandiya Rajan and Dheenadayalan., 2015).TDS concentration monitored for pre-monsoon season was found to vary between (192- 1280 mg/L) with a minimum value of 192 mg/L at site 1 and maximum of 1280 at site 2. In the post monsoon it ranged between (205- 1284 mg/L) with lowest value of 205 mg/L at site 1 and highest 1284 mg/L at site 2. The high values of TDS at site 2 (Sarsilk) may be due to excess usage of insoluble organic matter and seepage of chemicals from pulp and paper industry. Significant fluctuation with respect to TDS in Nagavali river water on seasonal variations at the vicinity of JK paper mill, Rayagada were reported by (Bamakanta *et al*., 2013). Similar studies were also reported by (Vinod Kumar *et al*., 2015; Patil and Patil., 2011; and Srinivas *et al*., 2000) during their investigations.

Table.3 Mean of physico-chemical parameters during pre monsoon season.

Sampling Sites	**Peddavagu River**	**Sarsilk HandPump**	**Chintaguda HandPump**	**Sangabasthi Hand pump**	**RamMandir Hand Pump**
Code	1	2	3	4	5
pH	8.76	8.9	8.9	8.9	8.9
EC	300	2000	901	1070	1560
TDS	192	1280	577	685	998
Chloride (Cl^-)	6	150	100	150	170
Fluoride (F)	0.45	4	0.54	0.28	3.3
Calcium (Ca^{2+})	194.93	26.59	162.61	149.87	43.95
Magnesium (Mg^{2+})	80.5	75.2	72.34	65.54	153.13
Sulphates(SO_4^{2-})	31	90	115	152	92
Nitrates (NO_3^-)	2.15	1.15	36.9	22	2.15
Sodium (Na^+)	198.21	415.06	222.08	376.81	657.48
Potassium (K^+)	17.48	5.44	6.74	66.6	10.6
TotalHardness(TH)	100	160	340	280	351

All parameters are expressed in mg/L except pH & EC.

Chloride may be available from natural phenomenon of the earth and also from industrial use. High levels of chloride impart a salty taste and affect people with hypertension and cardiac problems. In the present study chloride concentration varied from (6- 170 mg/L) at sites 1 and 5 in pre monsoon whereas it varied between (5-170 mg/L) at site 1 and 5 in post monsoon season. The fluoride concentration in the pre monsoon ranged between (0.45 - 4 mg/L) at sites 1 and 2 whereas in the post monsoon season it was recorded as (0.19 - 3.9 mg/L) at sites 4 and 2. Calcite and gypsum containing minerals are responsible for calcium leaching in aquifers and up to some extent human use. Calcium values were in the range of (26.59- 194.93 mg/L) in pre monsoon and in the post monsoonal season the values ranged between (26.12-195.17 mg/L). The values were within the permissible limit prescribed by Bureau of Indian Standards (BIS., 2012).The concentration of magnesium in the study area during pre monsoon varied between (65.54-153.13 mg/L) and in the post monsoon it ranged between (71.24-153.13 mg/L) at sites 3 and 5. Sulphate concentrations in the study area ranged from (31- 152 mg/L) in pre monsoonal season whereas in the post monsoon it recorded as (31.5-143 mg/L) at sites 1 and 4. Use of agricultural fertilizers and domestic sewage rich with organic matter enhance the nitrate in water. Nitrate values recorded in the pre monsoon ranged from 1.15-36.9 mg/L and in post monsoon it was (1.01- 34.3 mg/L) at sites 2 and 3.In both the seasons the nitrate values were within the permissible limit given by BIS. However increased levels of nitrate at site 3 in pre and post monsoon seasons with values 36.9 and 34.3 mg/L may be contributed from usage of agricultural fertilizers and domestic sewage. Sodium and potassium concentrations ranged from (198.21- 657.48 mg/L and 199- 452 mg/L) and (5.44 -66.6 and 4.6- 66.29 mg/L) in both the seasons respectively. High values of sodium in water clearly hints the use of sodium based chemicals from paper industry. Total Hardness was found to range between (100-351 mg/L) in pre monsoon and in post monsoon it ranged as (130-336 mg/L) at sites 1 and 3.

Table.4 Mean of physico-chemical parameters during post monsoon season

Sampling Sites	Peddavagu River	Sarsilk HandPump	Chintaguda HandPump	Sangabasthi Hand pump	RamMandir Hand Pump
Code	1	2	3	4	5
pH	8.78	8.9	8.9	8.9	8.9
EC	350	2004	900	1085	1006
TDS	205	1284	630	690	1030
Chloride (Cl^-)	5	135	101	145	122
Fluoride (F)	0.4	3.9	0.32	0.19	3.4
Calcium (Ca^{2+})	195.17	26.12	160.01	149.71	95.75
Magnesium(Mg^{2+})	81.63	75.21	71.24	63.91	104.25
Sulphates(SO_4^{2-})	31.5	90	115	143	56
Nitrates (NO_3^-)	2.15	1.01	34.3	22	2.15
Sodium (Na^+)	199	395.24	219.02	356	452
Potassium (K^+)	17.23	4.6	6.95	66.29	8.5
Total Hardness(TH)	130	150	320	301	336

All parameters are expressed in mg/L except pH & EC.

Table.5 Calculation of WQI for site 1 Peddavagu River during pre monsoon & post monsoon seasons for 2012-2013 year

Parameter	**Observed Value (Vn)**		**Standard Value (Sn)**		**1/sn**		**Unit Weight (Wn)**		**Quality Rating (qn)**		**qnWn**	
	Pre mon	Post mon	Pre mon	Post mon	Pre mon	Post mon	Pre mon	Post mon	Pre mon	Post mon	Pre mon	Post mon
pH	8.76	8.78	8.50	8.50	0.12	0.12	0.10	0.10	117.33	118.67	11.61	11.74
EC	300.00	350.00	1500.00	1500.00	0.00	0.00	0.00	0.00	20.00	23.33	0.01	0.01
TDS	192.00	205.00	1000.00	1000.00	0.00	0.00	0.00	0.00	19.20	20.50	0.02	0.02
Cl^-	6.00	5.00	250.00	250.00	0.00	0.00	0.00	0.00	2.40	2.00	0.01	0.01
F	0.45	0.40	2.00	2.00	0.50	0.50	0.42	0.42	22.50	20.00	9.46	8.41
Ca^{2+}	194.93	195.17	75.00	75.00	0.01	0.01	0.01	0.01	259.91	260.23	2.91	2.92
Mg^{2+}	80.50	81.63	100.00	100.00	0.01	0.01	0.01	0.01	80.50	81.63	0.68	0.69
SO_4^{2-}	31.00	31.50	200.00	200.00	0.01	0.01	0.00	0.00	15.50	15.75	0.07	0.07
NO_3^-	2.15	2.15	10.00	10.00	0.10	0.10	0.08	0.08	21.50	21.50	1.81	1.81
Na^+	198.21	199.00	250.00	250.00	0.00	0.00	0.00	0.00	79.28	79.60	0.27	0.27
K^+	17.48	17.23	12.00	12.00	0.08	0.08	0.07	0.07	145.67	143.58	10.21	10.06
TH	100.00	130.00	500.00	500.00	0.00	0.00	0.00	0.00	20.00	26.00	0.03	0.04
			K	k	0.84	0.841	0.71	0.707			37.08	36.04
WQI =Σ qn Wn / Σ Wn = 52.43 (Pre Monsoon)												
WQI =Σ qn Wn / Σ Wn = 50.95(Post Monsoon)												

Table.6 Calculation of Water Quality index for site 2 Sarsilk during pre monsoon & post monsoon seasons for 2012-2013 year

Parameter	**Observed Value (Vn)**		**Standard Value (Sn)**		**1/sn**		**Unit Weight (Wn)**		**Quality Rating (qn)**		**qnWn**	
	Pre Mon	Post mon	Pre Mon	Post mon	Pre mon	Post mon	Pre mon	Post mon	Pre mon	Post mon	Pre mon	Post mon
pH	8.90	8.90	8.50	8.50	0.12	0.12	0.10	0.10	126.67	126.67	12.53	12.53
EC	2000.00	2004.00	1500.00	1500.00	0.00	0.00	0.00	0.00	133.33	133.60	0.08	0.08
TDS	1280.00	1284.00	1000.00	1000.00	0.00	0.00	0.00	0.00	128.00	128.40	0.11	0.11
Cl^-	150.00	135.00	250.00	250.00	0.00	0.00	0.00	0.00	60.00	54.00	0.20	0.18
F	4.00	3.90	2.00	2.00	0.50	0.50	0.42	0.42	200.00	195.00	84.10	82.00
Ca^{2+}	26.59	26.12	75.00	75.00	0.01	0.01	0.01	0.01	35.45	34.83	0.40	0.39
Mg^{2+}	75.20	75.21	100.00	100.00	0.01	0.01	0.01	0.01	75.20	75.21	0.63	0.63
SO_4^{2-}	90.00	90.00	200.00	200.00	0.01	0.01	0.00	0.00	45.00	45.00	0.19	0.19
NO_3^-	1.15	1.01	10.00	10.00	0.10	0.10	0.08	0.08	11.50	10.10	0.97	0.85
Na^+	415.06	395.24	250.00	250.00	0.00	0.00	0.00	0.00	166.02	158.10	0.56	0.53
K^+	5.44	4.60	12.00	12.00	0.08	0.08	0.07	0.07	45.33	38.33	3.18	2.69
TH	350.00	150.00	500.00	500.00	0.00	0.00	0.00	0.00	70.00	30.00	0.12	0.05
			K	k	0.84	0.84	0.71	0.71			103.10	100.22
WQI =Σ qn Wn / Σ Wn = 145.71(Pre Monsoon)												
WQI =Σ qn Wn / Σ Wn = 141.70(Post Monsoon)												

Table.7 Calculation of Water Quality index for site 3 Chintaguda during pre - monsoon & post-monsoon seasons for 2012-2013 year

Parameter	**Observed Value (Vn)**		**Standard Value (Sn)**		**1/sn**		**Unit Weight (Wn)**		**Quality Rating (qn)**		**qnWn**	
	Pre Mon	Post Mon	Pre Mon	Post mon	Pre Mon	Post mon	Pre mon	Post mon	Pre mon	Post mon	Pre mon	Post Mon
pH	8.90	8.90	8.50	8.50	0.12	0.12	0.10	0.10	126.67	126.67	12.53	12.53
EC	901.00	900.00	1500.00	1500.00	0.00	0.00	0.00	0.00	60.07	60.00	0.03	0.03
TDS	577.00	630.00	1000.00	1000.00	0.00	0.00	0.00	0.00	57.70	63.00	0.05	0.05
Cl^-	100.00	101.00	250.00	250.00	0.00	0.00	0.00	0.00	40.00	40.40	0.14	0.14
F	0.54	0.32	2.00	2.00	0.50	0.50	0.42	0.42	27.00	16.00	11.35	6.73
Ca^{2+}	162.61	160.01	75.00	75.00	0.01	0.01	0.01	0.01	216.81	213.35	2.43	2.39
Mg^{2+}	72.34	71.24	100.00	100.00	0.01	0.01	0.01	0.01	72.34	71.24	0.61	0.60
SO_4^{2-}	115.00	115.00	200.00	200.00	0.01	0.01	0.00	0.00	57.50	57.50	0.24	0.24
NO_3^-	36.90	34.30	10.00	10.00	0.10	0.10	0.08	0.08	369.00	343.00	31.03	28.85
Na^+	222.08	219.02	250.00	250.00	0.00	0.00	0.00	0.00	88.83	87.61	0.30	0.30
K^+	6.74	6.95	12.00	12.00	0.08	0.08	0.07	0.07	56.17	57.92	3.94	4.06
TH	340.00	320.00	500.00	500.00	0.00	0.00	0.00	0.00	68.00	64.00	0.11	0.11
			K	k	0.84	0.84	0.71	0.71			62.77	56.02
WQI =Σ qn Wn / Σ Wn = 88.74 (Pre Monsoon)												
WQI =Σ qn Wn / Σ Wn =79.21 (Post Monsoon)												

Table.8 Calculation of WQI for site 4 Sangam Basthi during pre- monsoon & post- monsoon seasons for 2012-2013 year

Parameter	**Observed Value (Vn)**		**Standard Value (Sn)**		**1/sn**		**Unit Weight (Wn)**		**Quality Rating (qn)**		**qnWn**	
	Pre Mon	Post Mon	Pre Mon	Post mon	Pre Mon	Post mon	Pre mon	Post mon	Pre mon	Post mon	Pre mon	Post Mon
pH	8.90	8.90	8.50	8.50	0.12	0.12	0.10	0.10	126.67	126.67	12.53	12.53
EC	1070.00	1085.00	1500.00	1500.00	0.00	0.00	0.00	0.00	71.33	72.33	0.04	0.04
TDS	685.00	690.00	1000.00	1000.00	0.00	0.00	0.00	0.00	68.50	69.00	0.06	0.06
Cl^-	150.00	145.00	250.00	250.00	0.00	0.00	0.00	0.00	60.00	58.00	0.20	0.20
F	0.28	0.19	2.00	2.00	0.50	0.50	0.42	0.42	14.00	9.50	5.89	4.00
Ca^{2+}	149.87	149.71	75.00	75.00	0.01	0.01	0.01	0.01	199.83	199.61	2.24	2.24
Mg^{2+}	65.54	63.91	100.00	100.00	0.01	0.01	0.01	0.01	65.54	63.91	0.55	0.54
SO_4^{2-}	152.00	143.00	200.00	200.00	0.01	0.01	0.00	0.00	76.00	71.50	0.32	0.30
NO_3^-	22.00	22.00	10.00	10.00	0.10	0.10	0.08	0.08	220.00	220.00	18.50	18.50
Na^+	376.81	356.00	250.00	250.00	0.00	0.00	0.00	0.00	150.72	142.40	0.51	0.48
K^+	66.60	66.29	12.00	12.00	0.08	0.08	0.07	0.07	555.00	552.42	38.90	38.71
TH	280.00	301.00	500.00	500.00	0.00	0.00	0.00	0.00	56.00	60.20	0.09	0.10
			K	K	0.84	0.84	0.71	0.71			79.83	77.69
WQI =Σ qn Wn / Σ Wn = 112.87 (Pre Monsoon)												
WQI =Σ qn Wn / Σ Wn = 109.85 (Post Monsoon)												

Table.9 Calculation of Water Quality index for site 5 Ram Mandir during pre monsoon & post monsoon seasons for 2012-2013 year

Parameter	Observed Value (Vn)		Standard Value (Sn)		1/sn		Unit Weight (Wn)		Quality Rating (qn)		qnWn	
	Pre Mon	Post Mon	Pre mon	Post mon	Pre Mon	Post mon	Pre mon	Post mon	Pre mon	Post mon	Pre mon	Post Mon
pH	8.90	8.90	8.50	8.50	0.12	0.12	0.10	0.10	126.67	126.67	12.53	12.53
EC	1560.00	1006.00	1500.00	1500.00	0.00	0.00	0.00	0.00	104.00	67.07	0.06	0.04
TDS	998.00	1030.00	1000.00	1000.00	0.00	0.00	0.00	0.00	99.80	103.00	0.08	0.09
Cl^-	170.00	122.00	250.00	250.00	0.00	0.00	0.00	0.00	68.00	48.80	0.23	0.16
F	3.30	3.40	2.00	2.00	0.50	0.50	0.42	0.42	165.00	170.00	69.38	71.48
Ca^{2+}	151.24	95.75	75.00	75.00	0.01	0.01	0.01	0.01	201.65	127.67	2.26	1.43
Mg^{2+}	153.13	104.25	100.00	100.00	0.01	0.01	0.01	0.01	153.13	104.25	1.29	0.88
SO_4^{2-}	92.00	56.00	200.00	200.00	0.01	0.01	0.00	0.00	46.00	28.00	0.19	0.12
NO_3^-	2.15	2.15	10.00	10.00	0.10	0.10	0.08	0.08	21.50	21.50	1.81	1.81
Na^+	657.48	452.00	250.00	250.00	0.00	0.00	0.00	0.00	262.99	180.80	0.89	0.61
K^+	10.60	8.50	12.00	12.00	0.08	0.08	0.07	0.07	88.33	70.83	6.19	4.96
TH	351.00	336.00	500.00	500.00	0.00	0.00	0.00	0.00	70.20	67.20	0.12	0.11
			k	k	0.84	0.84	0.71	0.71			95.03	94.22
WQI =Σ qn Wn / Σ Wn = 134.36 (Pre Monsoon)												
WQI =Σ qn Wn / Σ Wn = 133.22 (Post Monsoon)												

Table.10 Water Quality statuses with sample locations for two different seasons.

S. no	Sampling Sites	Water Quality Status	
		Pre monsoon	Post monsoon
1	Peddavagu River	Poor	Poor
2	Sarsilk Colony	Unsuitable	Unsuitable
3	Chintaguda	Very poor	Very poor
4	Sangam Basthi	Unsuitable	Unsuitable
5	Ram Mandir	Unsuitable	Unsuitable

A study was performed on evaluation of groundwater quality for seasonal variations during pre monsoon and post monsoonal seasons from Sirpur-Kaghaznagar town and the result reveals that important parameters like pH is above the permissible limit prescribed by BIS standards in both the seasons. EC was measured above permissible limit at sampling station 2 in post monsoon season. TDS, Ca^{+}, Mg^{+} and TH was recorded higher than the acceptable limits in both the seasons where as the highest water quality index status was recorded at site 2 (sarsilk) pre monsoon and post monsoon (WQI= 145.62 and 141.70) as shown in (Table 6) and the lowest Water quality index was found at site 1 (Peddavagu) (WQI= 52.42 and 50.95) as shown in (Table 5). From the WQI analysis it is very clear that out of the five sampling locations three falls in unsuitable category, one in very poor and one sample site in poor water quality status category (Table 10) indicating the impact of paper mill effluents and indicate some degree of treatment before use. It is also very much evident from WQI analysis that almost all the sites are severely affected with the paper mill effluents on a long term basis through percolation. Therefore there is a need for integrated approach in people to protect ground water contamination in the study area.

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