



## Assessment of Groundwater Pollution and its Impact in and around Punnam Area of Karur District, Tamilnadu, India

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**Abstract:** Various samples of groundwater were collected from different areas in and around the Punnam village of Karur District, India and analyzed for their physicochemical characteristics. The results of this analysis were compared with the water quality standards of WHO and CPHEEO. In this analysis the various physicochemical parameters such as pH, electrical conductivity, turbidity, total dissolved solids, Cl<sup>-</sup>, F<sup>-</sup>, SO<sub>4</sub><sup>2-</sup>, NO<sub>3</sub><sup>-</sup>, Na<sup>+</sup>, K<sup>+</sup>, Fe, Cr, calcium and magnesium *etc.*, were determined using standard procedures. The quality of groundwater samples were discussed with respect to these parameters and thus an attempt were made to ascertain the quality of groundwater used for drinking and cooking purposes in the sampling areas.

**Keywords:** Groundwater, Physicochemical parameter, Water quality, Correlation coefficient.

### Introduction

Water sources available for drinking and other domestic purposes must possess high degree of purity, free from chemical contamination and microorganisms. The rapid growth of urban areas has further affected the groundwater quality due to over exploitation of resources and improper waste disposal practices<sup>1</sup>. Also, the effluent from the textile industry are characteristics of waste water released from sizing, desizing, kiering, bleaching, mercerizing, dye house and printing sections of composite cotton textile mills. The wastewater is highly viscous with high suspended solids and total dissolved solids<sup>2</sup>. Therefore, pollution of water resources needs a serious and immediate attention through periodical checkup of water quality. The purpose of this study was to evaluate the composition and quality of groundwater and the saline water intrusion in and around the Punnam village of Karur District, India.

## Experimental

The study area, the Punnam village, is situated ( $11^{\circ}0'23''N$  and  $77^{\circ}57'47''E$ ) in 8 km away from Karur District of Tamilnadu, India. The Punnam village is spread over 17 sq. km and having population about 12,000. As large textile industries are situated in the Karur district, the ground water gets contaminated at highest rate. Particularly, Punnam village is depending on textile industries, wells and bore wells are significantly polluted. Hence, it is proposed to study the ground water pollution and its impact in and around the Punnam village.

Overall, 30 samples (3 samples from each location) were collected from the bore wells of various places in and around of Punnam in Karur district and during this collection the distance between one and other location was maintained at a minimum of one kilometer in order to carry out a broad study on the quality of water in this area. The area of the sample collected includes; Pasupathipalayam (1), Kulathur (2), Naduppalayam (3), Chathiram (4), Sadaiyampalayam (5), Govindampalayam (6), Kuttakadai (7), Kuppam (8), Pavithram (9), Punnam (10).

### *Collection of samples*

Various water samples were collected in clean and dry polyethylene bottles from bore wells after running them for 5 minutes. All the collection of samples are immediately preserved in dark boxes and processed for the different analysis within 6 hours after collection. In this present study, various physical and chemical parameters of water samples were determined and the results were compared with the values of various water quality standards such as World Health Organization (WHO) and Central Public Health and Environmental Engineering Organization (CPHEEO).

### *Physicochemical analysis*

The temperature of the samples was noted at their sampling point itself. The samples collected were analyzed for important physical and chemical parameters such as temperature, taste, turbidity, conductivity, pH, hardness, total solids, total dissolved solids, total suspended solids, chlorides, sulphate, nitrate, fluorides dissolved oxygen, sodium, potassium and heavy metals. Standard procedure involving spectrophotometry, flame photometry and volumetry were used for the experiment<sup>3</sup>.

### *Bacteriological analysis*

In bacteriological examination<sup>4</sup>, total coliforms (28 °C for 24 h) and *faecal coliforms* (44.5 °C for 24 h) were determined by Membrane Filtration (MF) technique, and the average values were recorded. The TC was enumerated by M-Endo Agar, (Hi-Media Mumbai) which appeared as metallic sheen colour colonies, and FC was enumerated by M-FC Agar, (Hi-Media Mumbai) which appeared as blue colour colonies.

## Results and Discussion

The various physical, chemical and biological parameters determined for the water samples were given in Tables 1, 2 and 3 respectively. The statistical evaluation was given in Table 4. From the analyzed results it was found that the quality of water considerably varies from location to location.

**Table 1.** Physical parameters, in mg/L

Parameters	1	2	3	4	5	6	7	8	9	10
Temp, °C	31.5	31.5	32.5	31	30	31.5	29.5	29.5	30.5	30.0
Colour	CL	CL	CL	CL	CL	CL	CL	CL	CL	CL
Odour	OL	OL	OL	OL	OL	OL	OL	OL	OL	OL
Taste	S	B	SS	B	N	SS	SS	SS	N	SS
Turbidity	CLR	CLR	CLR	CLR	CLR	CLR	CLR	CLR	CLR	CLR
Conductivity	2.16	2.91	1.59	2.80	1.01	2.14	2.06	2.09	1.16	1.93
Total solids	2,125	2,845	1,695	3,020	925	2,060	2,328	2,080	988	1,885
TDS	2,065	2,790	1,675	2,940	905	2,030	2,278	2,040	968	1,865
TSS	60	55	20	80	20	30	50	40	20	20

CL – Colourless; OL – Odourless; S – Salt; SS – Slightly Salt; N – Normal; B – Bitter; CLR – Clear; TDS – Total Dissolved Solid; TSS – Total Suspended Solid

### Physical parameters

As far as the physical parameters are concerned all the samples were appeared colorless, clear and odourless. The temperature of the sample is lies between 29.5 to 32.5 °C. The increase in the temperature decreases the portability of water due to expel of taste imparting CO<sub>2</sub> and others gases. Thus, the taste of sample differs from place to place<sup>5</sup>.

**Table 2.** Chemical parameters, in mg/L.

Parameters	1	2	3	4	5	6	7	8	9	10
pH	8.6	8.0	8.5	8.0	7.3	8.7	7.8	7.3	7.4	8.1
Total hardness	315	455	225	520	210	245	912	424	188	245
Total Alkalinity	818	725	388	905	315	445	894	495	310	325
Calcium Hardness	205	165	71	223	85	92	124	85	98	106
Magnesium Hardness	147	68	96	88	75	112	52	126	78	64
Sodium	550	470	420	390	170	330	340	350	180	450
Potassium	135	95	80	40	20	40	40	30	20	40
Iron	0.2	0.3	0.1	0.2	0.3	0.2	0.1	0.2	0.4	0.2
Chromium	0.06	0.09	1.0	0.07	0.09	0.05	0.08	0.07	0.06	0.09
Chloride	195	305	158	382	125	228	115	195	178	125
Sulphate	165	228	104	290	115	196	75	148	155	195
Nitrate	75	40	40	35	20	25	15	30	40	50
Fluoride	0.72	0.82	0.57	1.20	0.68	1.30	0.91	0.89	0.75	0.30

**Table 3.** Biological parameters, in mg/L.

Parameters	1	2	3	4	5	6	7	8	9	10
Dissolved oxygen	2.2	2.5	3.5	1.6	5.5	2.4	2.6	2.3	3.9	3.7
COD	65.4	85.2	47.0	98.5	46.0	65.7	67.8	62.0	51.0	48.0
BOD	2.5	3.2	1.4	3.1	1.2	2.6	2.3	1.9	1.4	1.5
faecal coliforms, MPN/100 mL	50	80	40	70	20	70	50	70	30	100

COD – Chemical Oxygen Demand; BOD – Biological Oxygen Demand

*Chemical parameters*

Conductance of water samples varied from 1.01 to 2.91 mS/cm. But samples **2** and **4** had relatively higher conductivity, which may be due to contamination of conducting material in water samples. According to WHO and CPHEEO Standards, the acceptance limit for TDS in groundwater is 500 mg/L, which may go up to 1500 mg/L in case of any alternative source. But, almost all the samples exceed the permissible limit and sample **5** and **9** are found moderately hard.

The pH values of all the sample shows in the range of pH 7.3 to 8.7, which indicates they were with in the desirable limit except sample **6**. The mild alkalinity may be due to the bicarbonates. The alkalinity of the samples **1**, **2**, **4** and **7** are found to be high due to more seepage of effluent, domestic sewage around the stations.

**Table 4.** The minimum, maximum, average concentration and standard deviation of chemical parameter with water quality standard.

Chemical Parameters	Observed Concentration				Water Quality Standard	
	Min.	Max.	Mean	Std. Dev.	WHO	CPHEEO
Temp	29.50	32.50	30.75	1.01	30	30
Conductivity	1.01	2.91	1.99	0.61	1.8	1.4
TS	925.00	3020.00	1995.10	680.96	500	500
pH	7.30	8.70	7.97	0.53	6.5-8.5	6.5-9.2
Total Alkalinity	310.00	905.00	562.00	247.01	250	250
Total hardness	188.00	912.00	373.90	221.18	500	600
Ca <sup>2+</sup> Hardness	71.00	223.00	125.40	53.64	75	200
Mg <sup>2+</sup> Hardness	52.00	147.00	90.60	29.89	50	150
Sodium	170.00	550.00	365.00	120.39	100	100
Potassium	20.00	135.00	54.00	37.40	10	10
Iron	0.10	0.40	0.22	0.09	0.3	1.0
Chromium	0.05	1.00	0.17	0.29	0.05	0.05
Chloride	115.00	382.00	200.60	85.44	250	1000
Sulphate	75.00	290.00	167.10	63.35	200	400
Nitrate	15.00	75.00	37.00	17.03	45	45
Fluoride	0.30	1.30	0.81	0.29	1-1.5	1.5
DO	1.60	5.50	3.02	1.14	5.0	-
COD	46.00	98.50	63.66	17.32	-	-
BOD	1.20	3.20	2.11	0.73	-	-
<i>f. coliforms</i> , MPN/100 mL	20.00	100.00	58.00	24.40	-	-

The total hardness is relatively high in all samples due to the presence of calcium, magnesium, and chloride and sulphate ion. Hence, the water available in these areas is not suitable for drinking, washing, cleaning and laundering purpose. Also, leads to heart diseases and kidney stone formation<sup>6</sup>.

Sodium and potassium of water samples collected lies in the range of 170 to 550 mg/L and 20 to 135 mg/L respectively. These values are exceeds the permissible limit proposed by WHO and CPHEEO. Thus, the excess amount of potassium present in the water sample may leads nervous and digestive disorder<sup>7</sup>. Except sample **1**, all has chloride content more than permissible limit. And also, fluoride was found with in the permissible limit for all samples.

High amount of sulphate imparts bitter taste to the sample 2 and 4. Also, this will cause laxative effect to the children in hot weather climates<sup>8</sup>. As sample 1 and 10 has nitrate concentration above permissible limit (45 mg/L) according to WHO, It has been reported that nitrate concentration causes *Methemoglobinemia* and *cyanosis* in these sampling area<sup>9</sup>.

### Biological parameter

The DO level of all samples except station 5 shows very low value because of the effluent from the industries containing high amount of organic wastes depletes the oxygen level. It is observed from the experimental data that the COD ranges from 46 to 98.5 g/L, which exist in the permissible limit except sample 2 and 4. It clearly indicates the toxic nature of water found in those areas. Also, it was further confirmed by higher concentration of BOD found in those areas. Hence, water from sampling area 2 and 4 was not suitable for drinking purpose. The *faecal coliforms* values are in the range of 20 to 100 MPN/100 mL. This is higher than the permissible limit according to ISI. Hence, they may not be used for drinking purpose.

**Table 5.** Correlation coefficient (r) for different parameter.

Parameters	EC	pH	TH	TA	Ca <sup>2+</sup>	Mg <sup>2+</sup>	Na <sup>+</sup>	K <sup>+</sup>	Cl <sup>-</sup>	SO <sub>4</sub> <sup>2-</sup>	NO <sub>3</sub> <sup>-</sup>
EC	1.00										
pH	0.38	1.00									
Total Hardness	0.48	0.12	1.00								
Total Alkalinity	0.74	0.23	0.78	1.00							
Calcium	0.69	0.27	0.34	0.82	1.00						
Magnesium	0.10	0.36	0.33	0.07	0.17	1.00					
Sodium	0.69	0.68	0.16	0.50	0.54	0.34	1.00				
Potassium	0.42	0.65	0.01	0.44	0.52	0.45	0.82	1.00			
Chloride	0.75	0.18	0.11	0.51	0.69	0.16	0.28	0.19	1.00		
Sulphate	0.67	0.22	0.12	0.28	0.64	0.09	0.32	0.10	0.87	1.00	
Nitrate	0.17	0.45	0.38	0.10	0.47	0.51	0.67	0.74	0.11	0.28	1.00

### Correlation coefficient analysis

Sources of measured parameters in groundwater were examined through the analysis of linear correlation<sup>10</sup>. The correlation metric for all samples are given in Table 5. We considered the correlation as good if  $r > 0.6$  and marginal of  $0.47 < r < 0.6$ . Since the total hardness and total alkalinity ( $r = 0.78$ ) has good correlation as well as pH with Sodium and Potassium ( $r = 0.68, 0.65$  respectively), it clearly indicates the level of bicarbonate and carbonate of Sodium and Potassium were found excess in the ground water. Hence, it makes ground water more alkaline. Calcium has good correlation with chloride and sulphate ( $r = 0.69$  and  $0.64$  respectively) indicating that it is in the form of  $\text{CaCl}_2$  and  $\text{CaSO}_4$  so as to produces permanent hardness. Also, Nitrate shows marginal correlation with magnesium ( $r = 0.51$ ) and good correlation with sodium ( $r = 0.67$ ) and potassium ( $r = 0.74$ ). It means that nitrate exist in the non-acidic salt form. Similarly, the conductivity has good correlation with calcium ( $r = 0.69$ ), sodium ( $r = 0.69$ ), chloride ( $r = 0.75$ ) and sulphate ( $r = 0.67$ ).

### Conclusion

The water quality parameter of the various areas around Punnam clearly indicates that the water samples are highly polluted. It is observed that the water taken from Pasupathipalayam,

Kulathur, Chathiram are alarmingly get polluted followed by Kuttakadai. These areas situated nearer to the textile industries. So, the proper environment management plan may be adopted to control the release of effluent. Hence it is suggested to exercise all the necessary precaution before the water is used for drinking and irrigation. Otherwise, it may lead to much adverse health effect.

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