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Water Quality Analysis of HSIIDC Industrial Area Kundli, Sonipat Haryana

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Abstract: The present study is the water quality analysis of HSIIDC industrial area Kundli, Sonipat and their surrounding areas which includes tests for various physico-chemical parameters like Temperature, pH value, Total solids, Total suspended solids, Total dissolved solids and Total fixed solids, Total volatile solids, Total hardness, Alkalinity, Water quality index and Correlation coefficient matrix. Kundli is one of the most important industrial complexes in the state of Haryana which has Integrated Steel Plant, a number of sponge iron industries, automobile, chemicals, explosives, ceramics and distillery units and large number of small and medium industries. A water quality standard is a rule or law comprised of the uses to be made of a water body or segment and the water quality criteria necessary to protect that uses. In our study 20 samples were collected from Kundli and their surrounding areas. Out of 20 samples 10 samples found within permissible limit, 10 samples found out of permissible limit set by WHO, BIS, IS 10500. The water is badly affected may be due to disposal of industrial wastes into ground, open land areas and water bodies. In the light of this analysis we can conclude that these water samples require some treatment before their use for drinking purpose. Such poor quality of water reasoned severe waterborne diseases like diarrhea, cholera etc.

Key Words: Water quality, IS: 3025, pH, hardness, total suspended solids, alkalinity, total dissolved solids.

INTRODUCTION

Water is indispensable natural resources on earth and is the primary need for every human being and other animals as well as for plants and micro-organisms [1]. The quality of water is of vital concern for mankind since it is directly linked with human health, protection of the environment, plant growth and sustainable development. Due to increase in human population, industrialization, use of fertilizers and pesticides in the agriculture and several other activities, water get polluted with different harmful contaminants in past few decades. Water pollution is a serious problem in India as almost 70 % of its surface water resources and a growing percentage of its groundwater reserves are contaminated by biological, toxic, organic, and inorganic pollutants. In many cases, these sources have been rendered unsafe for human consumption as well as for other activities, such as irrigation and industrial needs. This shows that degraded water quality can contribute to water scarcity as it limits its availability for both human use and for the ecosystem sustainability [2].Therefore it is necessary that the quality of drinking water should be checked at regular intervals, as use of contaminated drinking water, may lead to rise in water borne diseases. The quality of ground water varies with location, depth of water table, season and by the extent and composition of dissolved solids. Generally, higher proportions of dissolved constituents are found in ground water than in surface water because of greater interaction of ground water with various materials in geologic strata. Water quality index is one of the most effective tools to communicate information on the quality of water to the concerned citizens and policy makers. The greater part of the soluble constituents in ground water comes from soluble minerals in soils and sedimentary rocks [6] .

The growing competition for water and declining fresh water resources, the utilization of marginal quality water for agriculture has posed a new challenge for environmental management. Contamination of water resources available for household and drinking purposes with heavy elements, metal ions and harmful microorganisms may cause serious major health problems. The research in Haryana (India) [8] concluded that it is the high rate of exploration of groundwater than its recharging, inappropriate dumping of solid and liquid wastes, lack of strict enforcement of law and loose governance are the cause of deterioration of ground water quality [1]. A water quality index provides a single number (like a grade) that expresses overall water quality at a certain location and time based on several water quality parameters. The objective of an index is to turn complex water quality data into information that is understandable and useable by the public. A single number cannot tell the whole story of water quality; there are many other water quality parameters that are not included in the index. The index presented here is not specifically aimed at human health or aquatic life regulations. However, a water index based on some very important parameters can provide a simple indicator of water quality. It gives the public a general idea about the possible problems with the water in the region. The rest of the paper is organized as follows. Section II introduces the complete detail of water quality index and section III gives mathematical calculation of WQI. Simulated results of the proposed study are discussed in Section IV. The conclusions are given in Section V.

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I. Water Quality Index

A water quality index provides a single number (like a grade) that expresses overall water quality at a certain location and time based on several water quality parameters. The objective of an index is to turn complex water quality data into information that is understandable and useable by the public. A single number cannot tell the whole story of water quality; there are many other water quality parameters that are not included in the index. The index presented here is not specifically aimed at human health or aquatic life regulations. However, a water index based on some very important parameters can provide a simple indicator of water quality. It gives the public a general idea the possible problems with the water in the region. WQI is a mathematical tool to integrate the complex water quality data into a numerical score that describes the overall water quality status. WQI may be used as indicator to measure the watershed pollution as recommended by Enrique was also pointed out the quality index could be used for groundwater to assess the scenario in a distributed manner and subsequently a communication tool has been developed for adaptation strategy towards agro-environment at policy level.

Many International and National agencies have set up the permissible limits for drinking water quality. Permissible limit given by WHO (World Health Organization), BIS (Bureau of Indian Standards) and IS-10500 (Indian Standard) are shown in the table 1 given in appendix. (Except pH and EC other parameters are in mg/l. And EC is in µmho/cm.)

II. Mathematical Calculation of WQI

Quality rating or sub index (q_n) was calculated using the following expressions.

$$q_n = 100\,[V_n - V_{i0}]/[S_n - V_{i0}]$$

Let there be n water quality parameters and quality rating or sub index (q_n) corresponding to n^{th} parameter is a number reflecting the relative value of this parameter in` the polluted water with respect to its standard permissible value.)

Where q_n = quality rating for the n^{th} water quality parameter.

V_n= estimated value of the n^{th} parameter at a given sampling station.

S_n= standard permissible value of the n^{th} parameter. V_{i0} = ideal value of n^{th} parameter in pure water

$W_n = K/S_n$

Where W = Unit weight for the n^{th} parameters S_n = standard value for n^{th} parameters
K = Constant for proportionality .

The overall water quality index was calculated by aggregating the quality rating with the unit weight linearly. WQI = $\sum q_n W_n / \sum W_n$.

The suitability of WQI values for human consumption according to are rated as Table 1

Table 1 Rating and Grading of Water Quality

WQI	Rating of Water Quality	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
Above 100	Unsuitable for drinking purpose	E

20 samples were collected from Kundli village and various physico-chemical parameters were analyzed in the laboratory by using standard APHA methods. Analysis result of our study is shown in table 3 given in Appendix.

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III. Correlation Coefficient Analysis

Correlation and regression analysis are related in the sense that both deal with relationships among variables. The correlation coefficient is a measure of linear association between two variables. Values of the correlation coefficient are always between -1 and +1. A correlation coefficient of +1 indicates that two variables are perfectly related in a positive linear sense; a correlation coefficient of -1 indicates that two variables are perfectly related in a negative linear sense, and a correlation coefficient of 0 indicates that there is no linear relationship between the two variables.

IV. Result Analyses

A total of 20 water samples as shown in table 2 from hand pumps and tube wells used by people and industries of Kundli were collected in clean polythene bottles and brought to the laboratory for analysis. The temperature of the water samples was determined on the spot using thermometer. The standard methods of (APHA) were used for the determination of various parameters. Sampling locations are discussed below in table 2 which is used for water quality analysis of Kundli village.

Table 2 Sampling location in Kundli, Sonipat

Sr. No.	Sampling Location	Source of Sample
S1	Sersa Village Near moja shoe Factory	Hand pump
S2	1 km away from location S1	Hand pump
S3	1.2km away from location S2	Tube well
S4	800m away from location S3	Tube well
S5	1.5KM away from location S4	Hand pump
S6	Sersa Village Temple	Hand pump
S7	Kundli Village	Tube well
S8	Singhu Village	Tube well
S9	1km away from Kundli village	Tube well
S10	Piomanyari	Tube well
S11	Plot no.22 phase 4sec-57	Hand pump
S12	Multi concept collection plot-51 phase-3	Tube well
S13	Near DTDC office	Tube well
S14	Jenius pvt .ltd Plot no.511 phase-4	Tube well
S15	Lohia pvt .ltd plot no-160	Tube well
S16	Santosh Vaishno Dhabba Kundli	Tube well
S17	Plot no.18 phase-1	Tube well
S18	Allwyn bikes pvt .ltd	Tube well
S19	Sarveshwari pvt .ltd plot no-408 phase-3	Tube well
S20	Antarctica Equipment pvt ltd plot-440	Tube well

We have to calculate the WQI for the 20 samples collected from the Kundli village with their analysis result as mentioned in table 5.

Table 4 gives analysis result of physico-chemical parameters with their standard value (S_n) and ideal value (V_i). The ideal values & standard values give in Appendix. The results observed that the maximum and minimum value of WQI has been found to be 96.97 and 27.58 delineated as S-2 and S-6 respectively. In the present study it is observed that 10 water samples can be placed under good in status. Eight water samples are being fallen under poor category. Two samples are fallen under very poor category. [11] Studied six parameters have been considered by them to calculate water quality index. Parameters considered were pH, TDS, TH, Chlorine and Iron for 18 groundwater samples analysis .In their study 33% sample comes under the very poor status, 33% in poor status, 17% sample in good category and remaining 17% in excellent category. Table 6 shows the status categories of WQI for the groundwater and number of sample come under the status for HSIIDC Kundli the industrial area, Sonipat, Haryana. Table 7 gives Correlation Coefficient Analysis.

CONCLUSION

The present study characterizes the physico-chemical parameters of groundwater from twenty different locations of Kundli village, Sonipat, Haryana is carried out. On the basis of above analysis following conclusion have been drawn out of 20 samples of ground water 2 water sample (Outside from the Moja factory and 1 km away from Moja factory) are in very poor category and

8 samples (1.2 km away from Moja factory, 800 km away from Moja factory, Kundli residential area, Singhu village, Jenius pvt ltd, Allwyn bikes pvt ltd, Sarveshwari pvt.ltd and Antarctica equipment pvt ltd) are in poor category. These are most pollution prone areas, requires kind of treatment before drinking. Some of water samples has higher amount of total hardness. Groundwater of location S3 (near Moja shoe factory) has highest value of TS. TS of S3 water sample is very much high and is recorded as 5170 mg/l may be due to so much groundwater contamination from industrial effluents. TS of 10 ground water samples (Sersa village temple, Piomanyari, plot no.22, plot no.51, near DTDC office, Jenius Pvt. Ltd, plot no.18, Allwyn bikes pvt.ltd, Sarveshwari pvt. ltd and Antarctica equipment pvt ltd. are within the range of 1000-2000 mg/l much more than permissible limit. Remaining 10 samples are within the range of 2000-5000 mg/L. The TSS of the water in the study area range from 90–955 mg/L. 4 samples S3, S4, S5 and S9; 1.2 km away from Moja factory, 800 km away from Moja factory, 1.5 km away from Moja factory and 1 km away from Kundli village respectively) are out of the permissible limits. The value of total dissolved solids (TDS) in the ground water varied from 1000 to 4215 mg/l. All samples analyzed were found out of the desirable limit of 500 mg/L, while some samples were found above the desirable limit but well within the maximum permissible limit of 2000 mg/L and 6 samples were out of the permissible limit. Total alkalinity ranged from 59.34 to 690 mg/l. According to WHO standards, two locations have higher value of Alkalinity from its permissible limit. Remaining locations are within the permissible limit. Water with high amount of alkalinity results in unpleasant taste to water and it turns boiled rice to yellowish color. Most alkalinity in surface water comes from calcium carbonate ($CaCO_3$) being leached from rocks and soil. In this analysis of groundwater, the results of temperature and pH fell within the safe limits set by the WHO for water used for drinking and other domestic purposes. WQI for groundwater samples of Kundli village found that 50% water samples are good for drinking purpose and 50% not suitable for drinking and other domestic purposes. These localities having poor water quality status are most pollution prone areas, requires kind of treatment before drinking, and thus requiring treatment. Reverse Osmosis can be used individually at home to purify water.

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APPENDIX

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Table 3 Drinking water standards

Parameter	BIS		Indian Standards (IS:10500,1992)		WHO Standard	USPHS
	Acceptable Limit	Maximum Limit	Acceptable Limit	Maximum Limit		
pH	6.5-8.5	6.5-9.2	7.0-8.5	6.5-9.2	6.5-9.2	-
EC	300	-	-	-	1000	-
TS	-	-	-	500	-	-
TDS	500	2000	500	2000	1500	-
TSS	-	-	-	-	-	5
Alkalinity	200	600	200	600	500	-
Carbonate Estimation CO_2^{2-}	75	200	-	-	75	-
Bicarbonate Estimation HCO_3^-	-	-	30	250	150	-
TH	300	600	300	600	500	-
Ca^{2+}	75	200	75	200	200	-
Mg^{2+}	30	100	30	100	50	-

Table 4 Physico-chemical parameters of water sample

	PH	EC	TH	Ca^{2+}	Mg^{2+}	Alkalinity	CO_2^{2-}	HCO_3^-	TS	TDS	TSS
S1	7.1	975	1250	305	945	189.24	27.52	148	2595	2500	295
S2	7.14	735	1337.5	540	798	104.08	22.36	70.5	2310	2200	110
S3	7.19	655	975	510	465	85	24.08	49.9	5170	4215	955
S4	7.16	924	700	310	390	216.72	34.4	165	3835	3225	610
S5	7.1	790	760	365	395	119.54	34.4	67.9	4140	3500	640
S6	7.17	1017	740	320	420	107.5	ND	108	1660	1500	160
S7	7.54	682	785	305	480	139.34	48.16	67.1	3420	3000	420
S8	7.25	1010	1190	415	775	59.34	ND	59.3	2172	2032	140
S9	7.9	790	640	80	560	134.18	48.16	61.9	3870	3200	670
S10	7.5	844	470	135	335	138.44	72.24	30.1	1265	1060	205
S11	6.95	906	1920	200	1720	132.4	32.68	83.4	1904	1634	270
S12	7.1	840	1800	200	1600	120.38	29.24	76.5	1971	1691	280
S13	7.55	946	1145	90	1055	158.28	44.72	91.2	1712	1532	180
S14	6.99	865	1000	200	800	690.62	87.72	559	1180	1000	180
S15	6.59	950	1640	160	1480	171.18	36.12	117	2187	1967	220
S16	7.74	972	1220	220	1000	144.48	ND	144	2092	1882	210
S17	7.6	982	890	180	710	131.54	58.48	43.9	1315	1185	130
S18	7.9	956	1110	355	755	144.46	29.24	101	1300	1110	190
S19	7.5	854	1185	225	960	116.96	ND	75.7	1090	1000	90
S20	7.8	954	1410	290	1120	129.82	75.68	16.3	1320	1250	120

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Table 5 Analysis result of physico-chemical parameters with their standard value (S_n) and ideal value (Vi)

	PH	EC	Ca Hard as $CaCo_3$	Total hardness	Alkalinity	CO_2^{2+}	HCO_3^-	TDS
Standard value S_n	**7.5**	**300**	**75**	**300**	**200**	**75**	**150**	**500**
V_i	**7**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
S1	7.1	975	305	1250	189.24	27.52	148	2500
S2	7.14	735	540	1337.5	104.08	22.36	70.5	2200
S3	7.19	655	510	975	85.96	24.08	49.9	4215
S4	7.16	924	310	700	216.72	34.4	165	3225
S5	7.1	790	365	760	119.54	34.4	67.9	3500
S6	7.17	1017	320	740	107.5	ND	108	1500
S7	7.54	682	305	785	139.34	48.16	67.1	3000
S8	7.25	1010	415	1190	59.34	ND	59.3	2032
S9	7.9	790	80	640	134.18	48.16	61.9	3200
S10	7.5	844	135	470	138.44	72.24	30.1	1060
S11	6.95	906	200	1920	132.4	32.68	83.4	1634
S12	7.1	840	200	1800	120.38	29.24	76.5	1691
S13	7.55	946	90	1145	158.28	44.72	91.2	1532
S14	6.99	865	200	1000	690.62	87.72	559	1000
S15	6.59	950	160	1640	171.18	36.12	117	1967
S16	7.74	972	220	1220	144.48	ND	144	1882
S17	7.6	982	180	890	131.54	58.48	43.9	1185
S18	7.9	956	355	1110	144.46	29.24	101	1110
S19	7.5	854	225	1185	116.96	ND	75.7	1000
S20	7.8	954	290	1410	129.82	75.68	16.3	1250

Table 6 Status categories of WQI and number of sample come under the status.

WQI	**Status**	**Sampling source no. under the status**	**Total no. of sample comes under the status**	**% of sample comes under the status**
0-25	Excellent	-	0	-
26-50	good	S5, S6, S9, S10, S11, S12, S13, S15, S16, S17	10	50
51-75	poor	S3, S4, S7, S8, S14, S18, S19, S20	8	40
76-100	Very poor	S1, S2	2	10
Above 100	Unsuitable for drinking	-	0	-

Table 7 Correlation Coefficient Analysis

	PH	EC	TH	Ca^{2+}	Alkalinity	CO_3^{2-}	HCO_3^-	TSS
PH	1							
EC	0.034716	1						
Total Hardness as $CaCO_3$ mg/l	-0.37677	0.198545	1					
Calcium Hardness as ($CaCo_3$ mg/l)	-0.18035	-0.30542	-0.00353	1				
Alkalinity	-0.26335	0.046219	-0.06146	-0.21028	1			
Carbonate estimation (CO_3^{2-})mg/l	0.108639	-0.15826	-0.1955	-0.39298	0.469932	1		
Bicarbonate estimation(HCO_3^-)mg/L	-0.31832	0.090441	-0.02678	-0.13325	0.982693	0.312838	1	
Total Dissolved Solids(mg/l)	-0.16441	-0.57538	-0.27015	0.418833	-0.23761	-0.18077	-0.19609	1