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ASSESSMENT OF GROUNDWATER QUALITY FOR DRINKING IN DERABASSI REGION

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Abstract: ***Ground water is an elite source of fresh water around the globe. With the edification of the human world the value of this resource has increased whereas the quality of it has been compromised. Devaluation of groundwater quality due to anthropogenic activities is increasing atfrightening rate in most parts of the Punjab, different land use pattern lead to the contamination of groundwater but limited work has been carried out on groundwater quality and monitoring. This paper focuses on the overall groundwater quality and contrasts on its suitability for drinking and irrigation purpose in the region. The suitability of groundwater quality of 12 sites in the areas surrounding industrial belt in Derabassi in Mohali district in state of Punjab was assessed for drinking purpose at an interval of 15days for 5 months, on the various water quality parameters.Standard methods are applied for physicochemical analysis of groundwater samples.Physiochemical parameters concentrations including pH ,EC ,cations (Ca^{2+},Mg^{2+},Na^{+},K^{+}),anions(HCO_3^-, Cl^-, SO_4^{2-}, NO_3^- ,F^-),TDS, TH, and heavy metals (Cu,Pb ,Cd Cr ,Mn ,Fe and Zn) were determined in groundwater samples. Most of the samples analyzed were above the Guidelines set by both national (BIS) and international (WHO, 2011) bodies for drinking water. Reasons of high levels of pollution can be attributed to the disposal of untreated waste of industries and sewage. Regular monitoring of groundwater should be done to minimize the health effects.***

Keywords: Groundwater Quality, Correlation coefficient. Physico-chemical, Derabassi

1. INTRODUCTION

Due to hasty industrialization and growing human population, the stress on natural resources are increasing and resulting in depletion of these resources sharply.One such key resource is waterand importance of potable water needs no introduction.The most vital factors of our civilization like food and development depend solely on water quality (Cai 2008; Liu and Xia 2004; Barth *et al.*2009; Singh *et al.*2013; Gurunadha Rao *et al.*2013). Ofall the water that is present on the Earth, 96.5% is as oceans, seas and bays. Only around 3.5% of the water can be termed as fresh but 1.7% of this is locked as ice caps, glaciers and permanent snow. Rest, the meagre 1.8 % is left to us as rivers, lakes, groundwater etc. Most of the North India exploits these sources for Agriculture, Industries and domestic activities of which groundwater remains a popular source. The quality of the groundwater is as important as its quantity for the fact of its utilization as per the needs. The concentration of the chemical constituents are greatly influenced by the geology and anthropogenic activities which determines the groundwater quality. The major anthropogenic activities are agriculture and industrialwhich have resulted in deterioration of water quality subsequent serious threats to the health of living beings.

Once the groundwater is contaminated it is impossible to reach to the same quality as before and it may remain unusable for long periods of time (Mishra *et al.*2005). Many chemicals which are useful in small quantity cause havoc if present in larger amounts. For example, Fluoride occurs naturally in groundwater and provides protection against dental caries, especially in children. But concentration less than 0.5 mg/L leads to the risk of tooth decay while higher concentration causes dental fluorosis (Thivya et al. 2015).

The literature has much research work on monitoring and tappingthe health of ground water. Quality of water depends on many variables and that can be understood and constituted under a term called "Index"(Sánchez *et al.*2007; Bordalo*et al.*2006). First well organized and structured chassis for measuring groundwater quality was developed and termed as Ground Water Health Index (GHI), considering both biotic and abiotic parameters (Korbel and Hose2011).Many new reliable and flexible experimental hybrid techniques and formulations to quantify ground water quality have been proposed.

Over time, water chemistry undergoes temporal and spatial variation, to tap these changes, a monitoring program which produces reliable and realistic data is necessary (Aswathanarayana 1995,Babiker*et al.*2007). Many new reliable and flexible experimental hybrid techniques and formulations to quantify ground water quality have been proposed.

The present research aims to inspect the groundwater quality around the industrial zone of Derabassi region, Punjab. Heavy industrialization and parallel agriculture are the major highlights of the land use pattern of Derabassi. This region has a humid subtropical climate characterized by a seasonal pulse: very hot summers, trivial winters, unpredictable rainfall and great variation in temperature. The average annual rainfall is 1110.7 mm. The city also receives occasional winter rains from mid-December till end of April which can be heavier sometimes with strong winds and hails if the weather turns colder (during March–April months)

II .MATERIALS AND METHODS

Study Area

Derabassiis a municipal council in Mohali district in state of Punjab having total area of 1.098 km^2. The exact cartographic co-ordinates of Derabassiis 30.5872°N Latitude 76.8428°E Longitudeit has an average elevation of 321 metres (1053 ft).Derabassi is most famous for its industrial belt. Derabassi is located near the foothills of the Shivalik range of the Himalayas in northwest India.The city, lying in the northern plains, has vast fertile and flat land. Derabassipopulation in 2016 of 3.65 lacs.Derabassihas a humid subtropical climate characterized by a seasonal rhythm: very hot summers, mild winters, unreliable rainfall and great variation in temperature. The average annual rainfall is 1110.7 mm.

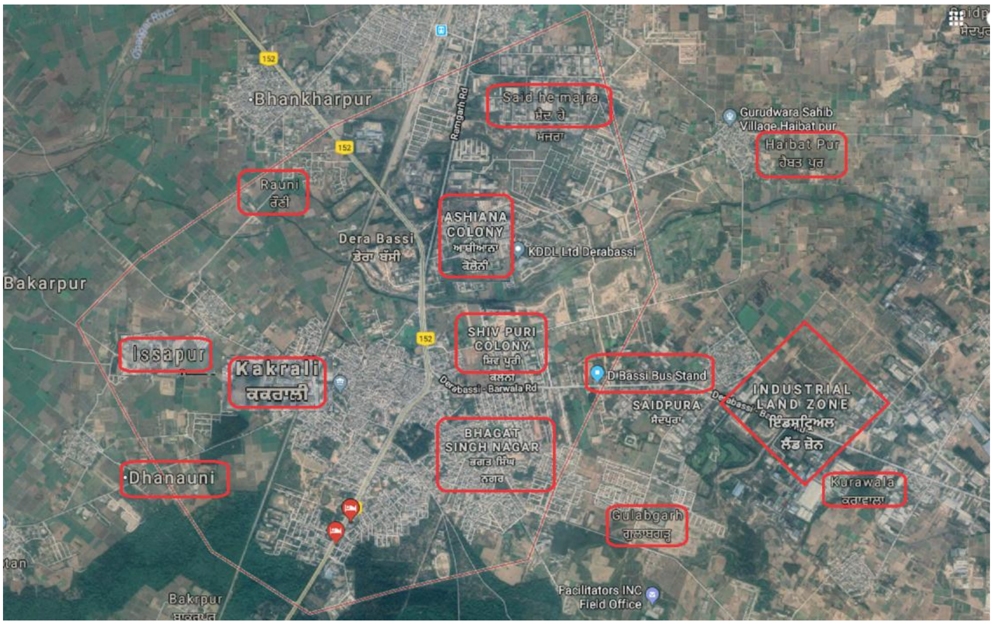

Figure 1. Sampling sites in Derabassi

Sampling & Analysis:

Groundwater samples were collected from 12 different sites fromtube wells and hand pumps of the unconfined aquifer. Samples were collected in new pre-cleaned polypropylene bottles (1L capacity) from the month of Nov 2017-Mar 2018. Sites naming Gw1-Issapur, Gw2-Kakrali, Gw3-Rauni, Gw4-Saidmajra, Gw5-Bhagat Singh Nagar, Gw6-Ashiana Colony, Gw7-Gulabgarh, Gw8-Haibatpur, Gw9-Shivpuri, Gw10-Dhanauni, Gw11-Kurawala, Gw12-Derabassi Bus Stand. Before collecting the water samples, the water was pumped out from bore wells for about 10-15 min to remove standing groundwater and bottle is being washed with the water to be sampled. The physical parameters were measured and recorded in the field are colour, taste, odour, temperature, EC (using conductivity meter) and pH (using pH meter). Groundwater samples observed were yellowish, odourless but were very unpleasant in taste.

As far as temperature is concerned there was not much difference between the groundwater and that of atmosphere excepting in a few samples wherein the temperature varied some degrees around 2-5 degrees. Water samples meant for cation estimation were acidified with 1% HNO_3 to decrease the pH value to 2. Water samples meant for NO_3 estimation was acidified with H_2SO_4 to decrease the pH value to 2. All samples were stored at 40 ^{0}C. Calcium (Ca^{2+}),magnesium (Mg^{2+}), bicarbonate (HCO_3^-) and chloride (Cl^-) were analyzed by volumetric titration methods, sodium (Na^+) and potassium (K^+) were measured using the flame photometer, Sulfate (SO_4^{2-}), nitrate (NO_3^-) and fluoride (F^-) were determined by spectrophotometric technique as per the methods described by the American Public Health Association (APHA 2017). The analyses were completed within a week from the date of collection of the water samples.

Determination of Water Quality Index

In this study, for the calculation of water quality index, eight parameters were chosen. The WQI has been calculated using the standards of drinking water quality recommended by World Health Organization (WHO), Bureau of Indian Standards (BIS) and Indian Council of Medical Research (ICMR).The weighted arithmetic index method (Brown et al.) has been used for the calculation of WQI of the samples. Further, quality index or sub index (q_n) was calculated using the following equation:

$$\mathbf{qn = 100[Vn - V_{io}] / [S_n - V_{io}]}$$

n = Number of water quality parameters

q_n = Quality rating of n^{th} water quality parameter

V_n = Estimated value of the n^{th} parameter at a given sampling location

S_n = Standard permissible value of the n^{th} water quality parameter

V_{io} = Ideal value of water quality parameter in pure water (i.e 0 for all parameters except for pH and Dissolved Oxygen (7.0 and 14.mg/l respectively))

Unit weight was calculated by a value inversely proportional to the recommended standard value (S_n) of the corresponding parameter.

$$\mathbf{W_n = K/S_n}$$

W_n = Unit weight of the n^{th} parameter

K = Constant of proportionality

K = [1 / (∑1/ Sn=1,2,..n)]

S_n = Standard value of the n^{th} parameter

The overall Water Quality Index is calculated by clubbing the Quality rating and Unit weight into the following equation:

$$\mathbf{WQI = \Sigma\, q_nW_n / \Sigma\, W_n}$$

III .RESULTS AND DISCUSSIONS

A large no of factors and geological conditions influence the correlations between different pairs of physico-chemical parameters of water samples directly or indirectly.In the present study, variousPhysico-chemical were properties studied to evaluate variations in groundwater quality of Derabassi region .Physical and chemical properties of water samples were highly affected by contaminants samples are collected from 12 different points which were identified and close to the industrial area.

Table 1. Permissible standards by Bureau of Indian Standards (IS 10500-2012) for Drinking water

Sr. No.	Parameter	Acceptable limit	Permissible limit in the absence of alternate source
1.	pH	6.5-8.5	-
2.	Cu	0.05	1.5
3.	Total Hardness (mg/l as $CaCO_3$)	200	600
4.	Total Alkalinity (mg/l as $CaCO_3$)	200	600
5.	Cl^- (mg/l)	250	1000
6.	Fl^- (mg/l)	1	1.5
7.	NO_3^- (mg/l)	45	No relaxation
8.	SO_4^{2-} (mg/l)	200	400
9.	Fe (mg/l)	0.3	No relaxation
10	Cd (mg/l)	0.003	No relaxation
11.	Zn (mg/l)	5	15
12.	Mn^{2+} (mg/l)	0.1	0.3
13.	Ca^{2+} (mg/l)	75	200
14.	Mg^{2+} (mg/l)	30	100
15.	Pb (mg/l)	0.01	No relaxation
16.	Total Chromium (as Cr) (mg/l)	0.05	No relaxation

Table 2. Mean values of the physico-chemical parameters at different sites.

sampling point	pH	EC(μS/cm)	HCO_3^-	Cl^-	SO_4^{2-}	NO_3^-	F^-	Ca^{2+}	Mg^{2+}	Na^+	K^+	TH	TDS	Cd	Cr	Cu	Fe	Mn	Pb	Zn
gw 1	7.879858	785.1236	250.5198	42.3564	119.9983	55.57363	0.04666	49	23.2	77.2	35.2	202.2475	434.2724	0.017	0.030	0.019	0.018	0.043	0.054	0.075
gw 2	7.879858	360.1019	181.7075	30.40972	10.90894	1.111473	0.442	52.2	14.2	9	1.66	153.2178	254.5027	0.019	0.019	0.023	0.245	0.510	0.037	0.305
gw 3	7.329868	552.8325	344.0615	19.54911	10.90894	24.4524	0.04732	67.4	24	24.2	1.62	270.6848	456.6088	0.006	0.020	0.108	0.181	0.006	0.003	0.203
gw 4	7.919857	762.8074	407.4979	53.21702	5.45447	3.445565	0.2456	17.8	34.8	85	15	175.6898	379.6063	0.007	0.045	0.012	1.314	0.437	0.034	0.066
gw 5	7.839859	451.3953	299.9786	19.54911	16.36341	0.889178	0.206	42	29.4	31.6	5.6	202.2475	359.0724	0.014	0.069	0.152	0.131	0.002	0.062	0.852
gw 6	8.099854	704.9882	388.1444	30.40972	59.99917	0.555736	0.2444	35	40	76	4.7	239.0198	461.0947	0.011	0.039	0.362	1.734	0.192	0.004	0.826
gw 7	7.289869	766.8649	344.0615	53.21702	38.18129	53.35068	0.3042	66.4	29.4	47.8	19.2	306.4356	554.6855	0.011	0.065	0.087	0.087	0.020	0.040	0.091
gw 8	7.059873	1033.645	481.6861	72.76613	98.18045	63.35393	0.211	84.6	62.6	65.8	22.2	449.4389	803.272	0.011	0.007	0.137	0.294	0.065	0.052	0.098
gw 9	7.499865	654.2697	281.7004	30.40972	27.27235	88.9178	0.1674	78	31.8	14.2	4.78	318.693	526.1729	0.010	0.055	0.007	0.063	0.019	0.031	0.060
gw 10	7.459866	610.6517	344.0615	22.80729	40.36308	2.778681	0.1612	65.2	26.4	31.6	5.52	270.6848	467.9088	0.017	0.038	0.001	0.774	0.539	0.019	0.985
gw 11	7.609863	1021.472	269.8733	165.0814	119.9983	72.24571	0.053	85	48.2	76.8	3.88	436.16	774.819	0.010	0.058	0.113	0.142	0.306	0.004	0.248
gw 12	8.289851	414.878	256.971	15.20486	13.09073	6.113099	0.4736	19	35	30.4	0.46	173.6468	307.2151	0.003	0.031	0.073	0.100	1.243	0.011	1.956

As per the ISO 10500 permissible limits the pH, EC, HCO_3^{2-}, Cl^-, SO_4-$^{2-}$, F^-, Na^+, K^+, Zn falls under the safe limits.

pH 7.05-8.28 , EC 1033.645 - 360.1019 mg/l , HCO_3^{2-} 481.68-181.707 mg/l , Cl^-165-15.204 mg/l , SO_4^{2-} 119.99 - 5.45 mg/l , NO_3^- 88.9178 - 0.55 mg/l , F^- 0.053 - 0.42 mg/l, Ca^{2+} 85 - 17.8 mg/l , Mg^{2+} 62-14.2 mg/l, Na^+ 77.2-9 mg/l, K^+ 35.2-0.46 mg/l, TH 449 - 153.21 mg/l, TDS 803.272 - 254 mg/l, Cd 0.019 - 0.003 mg/l, Cr 0.069 - 0.007 mg/l, Cu 0.362 - 0.001 mg/l, Fe 1.73-0.18 mg/l, Mn 1.243 - 0.002 mg/l, Pb 0.062 - 0.003 mg/l, Zn 1.956 - 0.066 mg/l. From Table no. 2, It is concluded that the TDS is highly correlated with all the parameters for the months of nov 2017 to march 2018.

Water Quality Index

Water quality index was calculated keeping key parameters in the equations for the 12 groundwater sampling sites over the period of five months. From the literature, the range, status and possible usage of water sample relating to a particular value of water quality index is presented in Table 3

Table 3.Water quality index and status of water quality

S.No	WQI	Status	Possible usages
1	0 -25	Excellent	Drinking, Irrigation, & Industry
2	25-50	Good	Domestic, Irrigation, & Industry
3	51-75	Fair	Irrigation, & Industry
4	76-100	Poor	Irrigation
5	101-150	Very poor	Restricted for irrigational use
6	Above 150	Unfit for Drinking	Proper treatment before use .

The parameters considered for calculation of Water Quality Index, the value of coefficient used in the equation are tabulated in Table 4.

Table 4. Drinking water quality standards recommending agencies and unit weights (All values except pH are in mg/l).

Sr. no.	Parameter	S_n	Recommending agency for S_n	K value	Unit Weight
1.	TDS	500	ICMR/BIS	0.286	0.000572
2.	pH	6.5-8.5	ICMR/BIS	0.286	0.033647
3.	TH	200	ICMR/BIS	0.286	0.000953
4.	NO^-_3	45	ICMR/BIS	0.286	0.006356
5.	Cl^-	250	BIS	0.286	0.001144
6.	Fe	0.3	BIS	0.286	0.953333
7.	SO_4^{2-}	150	ICMR/BIS	0.286	0.00143
8.	TA	120	ICMR	0.286	0.002383

The WQI values of the samples for five months are summarized in Table 5

Table 5 Water Quality Index of the groundwater samples over five months period.

Sr. no.	Sample Location	November	December	January	February	March
1.	Issapur	50	49	51	48	53
2.	Kakrali	35	37	31	39	33
3.	Rauni	46	49	42	48	41
4.	Saidmajra	79	81	77	110	105
5.	Bhagat Singh Nagar	43	36	35	39	34
6.	Ashiana Colony	56	61	60	52	55
7.	Gulabgarh	71	56	55	54	45
8.	Haibatpur	72	77	45	49	51
9.	Shivpuri	34	45	41	40	36
10.	Dhanauni	71	55	64	66	75
11	Kurawala	81	76	75	82	80
12.	Derabassi Bus Stand	54	55	51	50	53

Five sites namely Saidmajra, Gulabgarh, Haibatpur, Dhanauni and Kurawala have water samples poor to unfit for drinking purposes. Although it can be used for irrigation purposes but the effect of heavy metals like Cadmium, Zinc etc. are not involved in the calculation of Water Quality Index.

From Table no. 2, It is concluded that the TDS is highly correlated with all the parameters for the months of Nov 2017 to march 2018.

Table 2. Depicts the correlation among various water quality parameters of total area

	pH	EC(μS/cm)	HCO_3^-	Cl^-	SO_4^{2-}	NO_3^-	F^-	Ca^{2+}	Mg^{2+}	Na^+	K^+	TH	TDS	Cd	Cr	Cu	Fe	Mn	Pb	Zn
pH	1.00																			
EC(μS/cm)	-0.49	1.00																		
HCO_3^-	-0.45	0.55	1.00																	
Cl^-	-0.26	0.77	0.06	1.00																
SO_4^{2-}	-0.22	0.78	0.11	0.67	1.00															
NO_3^-	-0.56	0.65	0.03	0.54	0.58	1.00														
F^-	0.44	-0.53	-0.20	-0.37	-0.53	-0.46	1.00													
Ca^{2+}	-0.84	0.51	0.09	0.48	0.47	0.74	-0.51	1.00												
Mg^{2+}	-0.29	0.75	0.66	0.57	0.51	0.39	-0.14	0.30	1.00											
Na^+	0.09	0.75	0.48	0.55	0.63	0.14	-0.34	-0.14	0.54	1.00										
K^+	-0.23	0.54	0.27	0.13	0.56	0.38	-0.30	0.07	0.15	0.57	1.00									
TH	-0.74	0.79	0.43	0.69	0.61	0.73	-0.46	0.84	0.75	0.25	0.12	1.00								
TDS	-0.69	0.90	0.50	0.74	0.70	0.73	-0.51	0.76	0.79	0.43	0.27	0.98	1.00							
Cd	-0.07	-0.12	-0.33	-0.08	0.22	-0.11	-0.07	0.19	-0.41	-0.13	0.26	-0.16	-0.16	1.00						
Cr	0.10	0.02	-0.15	0.19	-0.10	0.12	-0.11	-0.04	-0.08	0.06	-0.11	0.01	0.01	-0.04	1.00					
Cu	0.16	0.15	0.37	0.05	0.18	-0.20	-0.01	-0.10	0.41	0.33	-0.17	0.16	0.19	-0.19	0.04	1.00				
Fe	0.32	0.09	0.50	-0.11	-0.13	-0.51	0.08	-0.45	0.15	0.46	-0.11	-0.21	-0.13	-0.06	-0.03	0.48	1.00			
Mn	0.59	-0.40	-0.29	-0.13	-0.29	-0.47	0.65	-0.53	-0.07	-0.15	-0.40	-0.39	-0.41	-0.26	-0.21	-0.21	0.09	1.00		
Pb	-0.17	0.03	0.03	-0.15	0.09	0.13	0.05	0.01	-0.05	0.02	0.62	-0.10	-0.05	0.49	0.09	-0.28	-0.32	-0.38	1.00	
Zn	0.59	-0.53	-0.19	-0.37	-0.30	-0.56	0.50	-0.52	-0.04	-0.25	-0.49	-0.37	-0.42	-0.23	0.00	0.20	0.09	0.76	-0.32	1.00

CONCLUSION:

The above observations states that water quality of Derabassi region is degrading andshould be considered as polluted. The main cause of this pollution was human activities and discharge of the industrialeffluent without prior treatment. The sampling sites like GW-11(Kurawala))and GW-8 (Haibatpur) were found to be most polluted.During the present study, it was also observed that there is no treatment of domestic sewage in the region before discharging them into the rivers . Some anthropogenic activities like disposal of treated and untreated waste effluents from industries along with agricultural wastes and human wastes has resulted in deterioration of water quality of Derabassi region.To improve the quality of water there should be continuous monitoring of pollution level. Five sites namely Saidmajra, Gulabgarh, Haibatpur, Dhanauni and Kurawala have water samples poor to unfit for drinking purposes. Although it can be used for irrigation purposes but the effect of heavy metals like Cadmium, Zinc etc. are not included in the calculation of Water Quality Index.

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