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A review study of groundwater quality of Malwa region, Punjab

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Abstract

Ground water pollution has been one of the main topics in the environmental issue of Punjab, northern India. This study was conducted to find out the pollution situation of ground water and the health problem of the surrounding residents. The results clearly determine that the water quality of Ground water may not be in a position to suitable for using domestic purpose. This is indicated by the very low dissolved oxygen (DO) levels and other measured parameters in the river. The maximum recorded values of pH, color, turbidity, biochemical oxygen demand (BOD5), hardness, total dissolved solids (TDS), chloride (Cl⁻), chemical oxygen demand (COD), turbidity, BOD, hardness, TDS, and COD found in the ground water of Punjab is much higher than the standard permissible limit.

Keywords: groundwater quality, turbidity, environmental, pollution

1. Introduction

Water is indeed required in all aspect of life and health for domestic purposes, drinking, cooking, bathing, washing clothes, utensils, producing food, agricultural activity, energy generation, maintenance of environment and development for life. Water plays important role in several metabolic, physiological and other activities in human body as well as in other living beings (Mittal and Arora, 2014) ^[10].

Groundwater is the major source of drinking water in both urban and rural areas and is used for agriculture, irrigation and industrial purposes. The accumulation of pollutants in water and soil is of increasing concern due to the safety issues of drinking water and food which imposing potential health risks and is unfavorable for the ecosystem. Water is polluted on all over the earth and Malwa region in Punjab (North India) is no exception to this phenomenon. According to World Health Organization safe drinking water could prevent 1.4 million child deaths.

Malwa region of Punjab is facing problems related to deteriorating health of people due to unavailability of clean and safe drinking water. The Malwa region of Punjab, India, is less than 15% of the total area of Punjab (only 0.5% of the total geographical area of India), but it consumes nearly 75% of the total pesticides used in Punjab. With this objective present work is planned to assess the quality of ground water in Malwa region, Punjab (North India) from 15 different locations.

2. Study Area (Malwa region, Punjab)

The Malwa region is the largest part of the three main divisions (the other two being Majha and Doaba) of the present Punjab state of India. Figure 1 showing that Malwa region includes 12 districts of the districts of

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Table 1: Showing the sampling locations, source and depth

S. No.	Location	Source	Depth	Type of water
1	Guru Nanak Dev Thermal Colony, Bathinda	Hand pump	100	Ground water
2	National Fertilizer Limited (NFL), Bathinda	Hand pump	80	Ground water
3	Ambuja Cement Factory, Colony, Bathinda	Hand pump	60	Ground water
4	GHTP Colony, Lehra Mohabbat	Tube well	150	Ground water
5	Sangrur (Bus stand)	Hand pump	100	Ground water
6	Mohali (Bus stand)	Hand pump	100	Ground water
7	Barnala (Guru Nanak Nagar)	Hand pump	150	Ground water
8	Patiala (Sabji mandi)	Hand pump	100	Ground water
9	Moga (Civil lines)	Hand pump	95	Ground water
10	Mansa (Arvind Nagar)	Hand pump	200	Ground water
11	Ludhiana (Dugri)	Hand pump	80	Ground water
12	Ferozpur (Railway Colony)	Hand pump	130	Ground water
13	Saheed Bhagat Singh Nagar (SBS), (Vikas Nagar)	Hand pump	90	Ground water
14	Roopnagar/Roper (Railway Station)	Hand pump	100	Ground water
15	Muktsar (Field near Adesh Nagar)	Hand pump	95	Ground water

Fazilka, Bathinda, Mansa, Moga, Faridkot, Patiala, Sangrur, Barnala, Ferozpur, Muktsar, Ludhiana and Navan Shehar (Shaheed Bhagat Singh, Nagar), that comprise an area of 32,808 km² (65.1% of Punjab's area). Bathinda is home to two modern Thermal Colony power plants (1) Guru Nanak Dev Thermal (GNDT) Colony Plant in the city Bathinda (2) Guru Hargobind Thermal (GHT) Colony Plant at Lehra Mohabbat. Bathinda is also a home to fertilizer plant that is National fertilizer Limited (NFL), Ambuja Cement Industry, Bathinda Chemicals, a large oil refinery. Groundwater quality of Bathinda is continuously degrading due to these thermal plant and other industrial activities and the soils of the nearby fields is also being affected by the use of pesticides.

3. Material and Methods

Groundwater samples were collected from fifteen different locations of Malwa region, Punjab. Borosilicate glassware, distilled water were used throughout the experiment. Samples were collected in pre sterilized polyethylene bottles, were properly labeled, record was prepared (Table1) and analyzed in laboratory for their physico-chemical parameters. If immediate analysis is not possible store the samples at 4°C till further analysis. Parameters analyzed by standard methods (APHA, AWWA, WEF, 1998 ^[3], APHA, AWWA, WEF, 1995 ^[1], APHA 1992) ^[2]. Various physico-chemical parameters and techniques for their analysis are given in the table 2.

Table 2: Table showing the parameters analyzed and methods

Parameters	Methods
Odor	Physiological Sense
Temperature °C	Thermometer
pH	pH metry
Turbidity (NTU)	Turbidity Meter
EC (μ mhos/cm)	Conductometry
TDS (mg/l)	Standard methods by APHA, AWWA, WEF, 1998 ^[3]
TSS (mg/l)	Standard methods by APHA, AWWA, WEF, 1998 ^[3]
TS (mg/l)	Standard methods by APHA, AWWA, WEF, 1998 ^[3] ; IS, 2003
DO(mg/l)	Iodometric method (Winkler-Azide method)
BOD(mg/l)	Iodide Azide method
COD(mg/l)	Potassium Dichromate Reflux Method

4. Results and Discussion

The Ground water had no color, odor and turbidity. Physical parameters analyzed were pH, temperature, turbidity, conductivity and TDS, TSS and TS. Chemical characteristics analyzed such as odor DO, BOD, COD etc. Table 3 showing the guidelines for drinking quality recommendations, WHO and BIS (1998) standards, IS: 10500, 1991 Study and Evaluation of Groundwater Quality of Malwa Region, Punjab (North India)

5. Physical Parameters

Odour: All the ground water samples were odorless following the BIS drinking standards.

pH: pH is the hydrogen ion activity and a measure of acidity and alkalinity in aquatic bodies. The pH value of water samples in the study area ranged from minimum of 7.40 ± 0.17 (Ambuja cement factory) to maximum of 8.45 ± 0.44 (Muktsar). On an average all the samples have pH

values within the desirable limit as prescribed for drinking water standard (BIS, 1998), slightly alkaline and if pH is above 7 than water is probably hard and contains calcium and magnesium (David, 2004) ^[5].

Temperature: Results shows that the temperature fluctuated between minimum value of 25.54 ± 0.55 °C (Muktsar) to maximum 28.43 ± 0.67 °C (Patiala). in cold temperature, the viscosity increases which diminishes the efficiency of settling of the solids that the water may contain because of the resistance that the high viscosity offers to the downward motion of the particles as they settle. The minimum turbidity value was recorded (0.7 NTU) at GNDT colony plant, Bathinda and maximum turbidity value of 1.47 NTU was recorded in ground water sample of Barnala. The excessive turbidity in water causes problems with water purification process.

Electrical conductivity: It is a measurement of water's capacity for carrying electrical current and is directly related to the concentrations of ionized substance in the water. Lowest value of 403 $\mu\text{s}/\text{cms}$ was obtained in ground water sample of Moga and highest value of 1762.67 $\mu\text{s}/\text{cms}$ in ground water sample of National Fertilizer Limited (NFL),

Bathinda. Results Shows that all the values of EC are beyond the permissible limits of

Results of physicochemical properties of samples given in the table

Table 3: Table showing the average results of Physical Parameters of ground water and comparison with drinking water standards BIS (1998).

Parameters	Odor	pH	Temp ⁰ C	TDS	TSS	TS	DO (mg/l)	BOD (mg/l)	COD (mg/l)
GNDT, Colony Bathinda	Odorless	7.85±0.37	26.13±0.15	323.33±1.53	41.33±1.53	364.67±0.58	4.80±0.10	8	17.43±0.15
NFL, Bathinda	Odorless	7.73±0.12	26.73±0.64	429.00±2.00	67.07±3.00	496.00±5.00	4.73±0.12	10	19.80±1.71
Ambuja Cement Factory	Odorless	7.40±0.17	26.43±0.49	490.33±2.08	58.00±2.00	548.00±2.00	4.50±0.26	6	14.53±0.42
GHTPP Colony Lehra Mohabbat	Odorless	8.03±0.15	25.68±1.11	444.00±2.65	46.00±2.00	491.00±1.00	7.77±0.15	12	23.37±0.47
Sangrur	Odorless	8.37±0.55	27.03±0.95	556.67±3.2	57.00±1.00	614.00±3.00	7.40±0.10	10	21.60±0.60
Mohali	Odorless	27.48±0.37	7.80±0.20	580.83±2.93	60.30±0.61	641.13±3.23	4.51±0.50	5.2	13.50±0.46
Barnala	Odorless	28.43±0.67	8.07±0.57	301.63±2.03	44.87±2.20	346.50±0.50	3.82±0.75	8.6	32.50±0.50
Patiala	Odorless	26.42±0.62	7.65±0.35	322.80±1.71	52.53±1.50	375.10±2.82	4.54±0.50	5.8	11.30±0.66
Moga	Odorless	27.42±0.29	7.70±0.26	347.77±1.37	65.40±1.97	413.07±1.68	4.63±0.78	17	27.83±0.76
Mansa	Odorless	27.23±0.23	7.67±0.49	549.40±1.51	63.47±1.36	612.80±1.31	9.50±1.32	16.6	18.10±1.35
Ludhiana	Odorless	26.80±0.17	7.80±0.20	402.70±1.47	54.63±2.03	457.33±1.15	5.13±0.81	12.2	24.63±0.55
Permissible limit (BIS standard)	Unobjectionable	-	6.5-8.5	500 mg/l	50 mg/l	-	-	5 mg/l	10 mg/l
Max Permissible Limit (BIS standard)	Unobjectionable	-	6.5-9.5	1000 mg/l	-	-	-	-	-

Parameters	Odor	pH	Temp ⁰ C	TDS	TSS	TS	DO (mg/l)	BOD (mg/l)	COD (mg/l)
Ferozpur	Odorless	27.45±1.03	8.05±0.48	451.20±1.93	59.67±2.31	510.87±4.23	5.01±0.39	9.8	20.07±0.90
SBS Nagar	Odorless	25.80±1.21	7.77±0.21	413.90±1.01	46.50±1.80	460.40±2.69	6.13±0.81	10.4	20.53±0.25
Roop Nagar	Odorless	27.51±0.29	8.33±0.49	467.13±1.80	72.53±1.29	539.63±0.78	8.01±40	7.2	15.27±0.40
Muktsar	Odorless	25.54±0.55	8.55±0.44	519.83±1.61	66.60±1.87	586.47±0.84	4.15±0.50	11.6	23.33±0.42
Permissible limit (BIS standard)	Unobjectionable	-	6.5-8.5	500 mg/l	50 mg/l	-	-	5 mg/l	10 mg/l
Max Permissible Limit (BIS standard)	Unobjectionable	-	6.5-9.5	1000 mg/l	-	-	-	-	-

BIS Standard value of 300 $\mu\text{s}/\text{cms}$. Conductivity is not a problem in itself and just above certain level does not mean that the water will cause illness (Jayalakshmi *et al.* 2011) [7].

Total Dissolved Solids (TDS): The fluctuations in electrical conductivity correlated positively with the total dissolved solids which are the common indicators of polluted waters (Jayalakshmi, 2011) [7]. Sample of Sangrur, Mohali, Mansa and Muktsar shows the TDS value 556.67 mg/l, 580.83 mg/l, 549.40 mg/l and 519.83 mg/l respectively that are beyond the permissible limit of BIS Standard value of 500 mg/l. The observation shows that the TDS is above the permissible range as prescribed by WHO (2004) [16].

Total Suspended Solids (TSS): TSS is materials that are not dissolved in water and are not filterable in nature of 41.33 ± 1.53 (Guru Nanak Dev Thermal Power Plant, Bathinda) to maximum value of 72.53 ± 1.29 mg/l (Roper). The permissible limit for TSS is 50 mg/l (WHO and Samples of NFL, Bathinda (67.07 ± 3.00 mg/l), Ambuja cement factory, Bathinda (58.00 ± 2.00), Sangrur (57.00 ± 1.00), Barnala (60.30 ± 0.61mg/l), Patiala (52.53 ± 1.50 mg/l), Moga (65.40 ± 1.97 mg/l), Mansa (63.47 ± 1.36 mg/l), Ludhiana (54.63 ± 2.03 mg/l), Ferozpur (59.67 ± 2.31mg/l) and Muktsar (66.60 ± 1.87 mg/l) have TSS values greater than the prescribed limit for drinking water (WHO and BIS, 1998, ISI, 1991).

Total Solids (TS): Total solids are summation of TDS and TSS. Results of TS fluctuates in between minimum of 346.5 ± 0.50 mg/l (Barnala) to maximum of 641.13 ± 3.23 mg/l (Mohali). Sangrur (614.00 ± 3.00 mg/l), Mansa (612.80 ± 1.31 mg/l), Ferozpur (510.87 ± 4.23 mg/l), Roper (539.63 ± 0.78 mg/l), Muktsar (586.47 ± 0.84 mg/l) have higher value of TS.

Dissolved Oxygen (DO): Substantial variations were recorded in the DO level in the present study. The minimum DO values of 3.82 ± 0.75 mg/l (Barnala) and maximum DO value of 9.50 ± 1.32 mg/l (Mansa). Samples of ground water which have DO values slightly above the permissible limit are GHTP, Lehra Mohabbat (7.77 ± 0.15 mg/l), Sangrur (7.40 ± 0.10 mg/l), Ludhiana (5.13 ± 0.81 mg/l), SBS Nagar (6.13 ± 0.81 mg/l) and Roop Nagar (8.01 ± 40 mg/l). The desirable limit of BOD in drinking water is 5 mg/l. Minimum BOD value is present in the sample of Mohali (5.2 mg/l) and maximum BOD value is present in the sample of Moga (17 mg/l).

Chemical Oxygen Demand (COD): COD variations which changed with seasons and also with the release of chemical substances from agricultural waste and sewage. The minimum COD value was recorded at Sabji Mandi, Patiala (11.30 mg/l) and the maximum value of 32.50 mg/l was observed Barnala Ground water.

6. Conclusion

The results of study of ground water show that the ground water of the Malwa region is highly contaminated with TDS, TSS and TS. As a result of high concentration of TDS, water loses its portability and reduces the solubility of oxygen in water so unfit for drinking purposes. Ground water of Malwa region is too contaminated so people of Malwa region especially Bathinda are prone for the immediate health problems.

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