Environment & Ecology 29 (2) : 658—662, 2011
 ISSN 0970-0420

Ground Water Quality in Residential Colonies of Moga (Punjab, India)

SUNITA MITTAL[1*] AND SANGEETA SHARMA[2]

[1]*Lala Lajpat Rai Institute of Engineering and Technology, Moga 142001, Punjab India*
[2]*SBS College of Engineering and Technology, Ferozepur, Punjab, India*
E-mail : sunita72mittal@rediffmail.com
**Correspondence*

Abstract

Quality of water refers to number of physical, chemical and biological characteristics. The study was conducted to assess the drinking water quality at Moga (Punjab) as this area ties in central Punjab where consumption of fertilizers and pesticides is the highest in the state. It was found that the major physico-chemical parameters of drinking groundwater were within the permissible limits. But certain parameters such as total dissolved solids (TDS), electrical conductivity, total hardness and magnesium content were above the WHO permissible limits at almost all places in Moga city. Maximum contribution to pollution was by electrical conductivity, as Nemerow's Pollution Index (NPI) value for this parameter was even greater than 2.0 for some of the sampling locations. Other main parameters which caused pollution were TDS and total hardness, where NPI value approached 2.0. NPI for sulphates was above 0.6 but below 1.0, which indicated that this parameter can become possible source of pollution in near future if remedial measures are not taken.

Key words : Ground water quality, Residential colonies, Moga.

For almost all the water needs of the country, groundwater is by far the most important water resources. This constitutes about 95% of the fresh water on this planet (discounting that locked in the polar ice caps), making it fundamental to human life and economic development. Worldwide, over 2 billion people depend on aquifers for their drinking water. Forty percent of the world's food is produced by irrigated agriculture that relies largely on groundwater. Groundwater systems are dynamic and water is continuously in slow motion down gradient from areas of recharge to areas of discharge. Direct human intervention over the years has led to reduction in groundwater recharge. These include deforestation, destruction of local water system like ponds, tanks, lakes and wetlands etc and stoppage of river flows by the dams (1). Farmers adopt groundwater irrigation due to apparent reliability of storage offered by mechanized drilling and pumping and flexibility of groundwater exploitation. Thus large scale need for food security and urban drinking water supply is dependent on groundwater. On the other hand, domestic use is extended to potable water, personal hygiene usae, stock watering and small scale irrigation for gardening. The dependency becomes acute particularly during summer, when demand for different purposes increased dramatically as compared to supply position. This grim situation is likely to aggravate further with rapid growth in population, urbanization and industrialization. The availability of this important natural resource has been taken for granted. Increasing groundwater use and pollution generation has crossed the sustainable limits in many parts of the country. The story of each place may be different but the main reasons for water crisis are common, such as, increasing demand, zonal disparity in distribution of water supply, major land use changes and pollution (2). Water quality refers to physical, chemical and biological characteristics of water. The physical characteristics include the temperature, turbidity, clarity, color and similar qualities. Chemical water characteristics include the presence of organic and inorganic substances in water. Biological characteristics of water include identity and impact of organisms which are present in water. These characteristics of water are formed not only during its penetration through the atmosphere, soil and rocks but also during its contact with the vegetation canopy and cultivation practices. Man

through a variety of activities and modern technologies is changing the characteristics of groundwater systems. Various activities like intense agriculture, power generation, chemical and other industries are potential sources of groundwater contamination. The most important types of groundwater contamination are urban pollution due to seepage of municipal landfills, septic tank effluents and drainage water, industrial pollution due to seepage of effluents, agricultural pollution due to excessive use of fertilizers and pesticides. Microbial contamination of ground water is due to the presence of biodegradable organic matter in wastewater discharges from domestic and industrial effluents. The wide range of contamination sources is one of many factors contributing to the complexity of groundwater quality and its assessment (3). Punjab is basically an agriculture dominant state, where intensity of cultivating crops in a year is quite high. This state stands third after Andhra Pradesh and Utter Pradesh in the total consumption of pesticides. Also the consumption of plant nutrients is highest (158.9 kg/ha) in this part of country. There has been increasing concern on health hazards associated with heavy metals entering into the food cycle via soil water. Analysis of lead and cadmium content of different commercial fertilizers commonly used in Punjab revealed that a combination of low analysis and straight fertilizers can add more lead and cadmium than the high analysis and mixed fertilizers (4). All these factors lead to the pollution of groundwater because most of these chemicals leach deep into the soil. Moreover much of the irrigation is dependent on groundwater resources. Out of the total 138 blocks of Punjab, 84 blocks are categorized as over exploited as far as groundwater resources are concerned. Most of these blocks are in central plains of the state. Central groundwater authority has notified six areas of the state for registration of groundwater abstraction structures (5). Out of six areas two lie in Moga district of Punjab (India) state. The present study was confined to the City Moga of Punjab for assessing the groundwater quality for drinking purposes. The main objectives of the study were to determine the different physico-chemical parameters of drinking water samples collected from representative sites of the city and to find the quality in terms of Nemerrow's index as discussed by Madhuri and Subhashini (6).

Lot of work has been done to assess the different quality parameters like physical, chemical and biological characteristics of the water obtained from different sources like rivers, lakes, groundwater sources, industries. Mariappan (7) analyzed the physico-chemical characteristics of ground water quality in and around Sivakasi town. On the basis of water quality index, it was found that among the 20 samples, 12 samples were slightly polluted, 6 samples were slightly to moderately polluted and two samples were moderately polluted. The parameters EC, TDS, sodium, chloride, sulfate and sulfide contents were found to be high in all the samples and most of them were above permissible limits and were responsible for pollution in and around Sivakasi. Sinha and Saxena (8) assessed the drinking water quality at Hasanpur, JP Nagar by measuring certain physico-chemical characteristics. Water quality index was calculated by giving the standard weightage to different parameters. They found that the drinking water at almost all the sites was found to be severely polluted. Only at few sites, it was moderately polluted. They opined that the water quality management was urgently required in the catchment area of the study.

(The Authors are thankful to the Principals of LLRIET Moga and SBSCET, Ferozepur for allowing to work in the chemistry laboratories).

Methods

In Punjab (India) state, Moga city was selected as study area. The sites for collection of water samples were selected through the length and breadth of the Moga city. The sites were so chosen that the local sources of contamination like sewage, effluents, standing water etc. might not interfere directly with the water sites.

Groundwater samples were mainly collected from Municipal tube wells. The depth of these tube wells varied from 122 to 137 m. Groundwater samples were collected by running the tube wells for about 10—15 minutes to ensure that standing water in the pipes have been taken out and normal running water has started coming out. The water samples were collected in 2 liter PET (poly ethylene terephthalate) bottles after thoroughly rinsing with the same water. Temperature of the water was noted with the help of an ordinary thermometer at the site itself. For the other quality parameters, samples were immediately trans-

Table 1. Impurities assessment using Nemerow's pollution index (NPI). All the physico-chemical parameters are in mg/liter unless otherwise specified.

Location		Committee Ghar		Bus Stand		Dosanjh Road		Godhewala		Bhim Nagar	
Parameter	Permissible limit	Actual value	NPI	Actual value	NPI	Actual value	NPI	Actual value	NPI	Actual value	NPI
pH	8	7.48	0.935	7.68	0.960	7.39	0.924	7.27	0.909	7.31	0.914
Total solids	500	560	1.120	600	1.200	650	1.300	630	1.260	635	1.270
Total dissolved solids	500	550	1.100	560	1.120	640	1.280	620	1.240	620	1.240
Turbidity (NTU)	5	2	0.400	2	0.400	2	0.400	1	0.200	1	0.200
Electrical conductivity (mmho/cm)	0.300	0.790	2.633	0.802	2.673	0.820	2.733	0.810	2.700	0.810	2.700
Total hardness	100	193	1.930	196	1.960	181	1.810	204	2.040	193	1.930
Free CO2	10	0.88	0.088	1.32	0.132	0.44	0.044	1.76	0.176	0.88	0.088
alkalinity	100	20	0.200	15	0.150	23	0.230	14	0.140	16	0.160
Calcium	75	22.64	0.302	21.332	0.284	22.64	0.302	20	0.267	21.332	0.284
Magnesium	30	33.17	1.106	34.7	1.157	30.25	1.008	37.45	1.248	33.97	1.132
Chlorides	200	23	0.115	21	0.105	40	0.200	45	0.225	30	0.150
Sulfate	200	133.57	0.668	139.41	0.697	128.46	0.642	124.08	0.620	124.81	0.624
Nitrate	10	0.9	0.090	0.8	0.080	0.9	0.090	1	0.100	1.1	0.110
Phosphates	0.1	0.05	0.500	0.03	0.300	0.07	0.700	0.07	0.700	0.05	0.500
BOD	6	0.4	0.067	0.8	0.133	0.8	0.133	0.8	0.133	0.4	0.067
COD	10	4	0.400	4	0.400	4	0.400	4	0.400	4	0.400
Dissolved O_2	5	6.6		7.1		6.9		6.8		6.5	

Table 1. Continued.

Location		Civil hospital		Zira road		Amritsar road		Gita Colony		Shahidi Park	
Parameter	Permissible limit	Actual value	NPI	Actual value	NPI	Actual value	NPI	Actual value	NPI	Actual value	NPI
pH	8	7.52	0.940	7.49	0.936	7.61	0.951	7.2	0.900	7.5	0.938
Total solids	500	730	1.460	655	1.310	610	1.220	590	1.180	620	1.240
Total dissolved solids	500	710	1.420	635	1.270	590	1.180	565	1.130	600	1.200
Turbidity (NTU)	5	4	0.800	3	0.600	2	0.400	2	0.400	1	0.200
Electrical conductivity	0.300	0.87	2.903	0.815	2.717	0.8	2.667	0.789	2.630	0.801	2.670
Total hardness	100	179	1.79	202	2.020	185	1.850	188	1.880	180	1.800
Free CO2	10	0.88	0.08	1.32	0.132	0.44	0.044	0.88	0.088	0.88	0.088
Alkalinity	100	17	0.17	19	0.190	21	0.210	18	0.180	18	0.180
Calcium	75	20	0.26	22.64	0.302	21.33	0.284	20	0.26	18.84	0.251
Magnesium	30	31.3	1.04	35.36	1.179	32.02	1.067	33.56	1.119	32.321	1.077
Chlorides	200	22	0.11	23	0.115	31	0.155	32	0.160	28	0.140
Sulfate	200	137.9	0.69	142.3	0.712	129.1	0.646	135.61	0.678	143.1	0.716
Nitrate	10	0.75	0.07	0.85	0.085	0.9	0.090	1.2	0.120	1	0.100
Phosphates	0.1	0.06	0.60	0.08	0.800	0.04	0.400	0.02	0.200	0.02	0.200
BOD	6	0.4	0.06	0.8	0.133	0.4	0.067	0.4	0.067	0.8	0.133
COD	10	4	0.40	4	0.400	4	0.400	4	0.400	4	0.400
Dissolved O_2	5 (Minimum)	7.3		7		6.5		7.5		7.6	

ferred to the laboratory and were analyzed within 48 hours.

Analysis of Water Samples

The analysis of water samples was done at the Chemistry Laboratory of the Department of Applied Sciences of Lala Lajpat Rai Institute of Engineering and Technology, Moga (Punjab) and SBB College of Engineering and Technology, Ferozepur. The main quality parameters determined were pH, turbidity, electrical conductivity, total alkalinity, total acidity, free carbon dioxide, total solids, total dissolved solids, dissolved oxygen, biological oxygen demand, chemical oxygen demand, total hardness, calcium, magne-

sium, chlorides, total phosphates and nitrates.

These parameters were determined using the standard procedure as outlined by Americal Public Health Association (9) and as described in laboratory manual on water and waste water test (10).

Nemerow's Pollution Index

A simplified pollution index which is generally known as Nemerow's pollution index (NPI) (6) was used for quality analysis of water. It may be mathematically expressed as

$$NPI = \frac{C_i}{L_i}$$

Where Ci = Observed concentration of i parameter, Li = Permissible limit of i parameter.

In this expression, units of Ci and Li should be identical. Each value of NPI shows the relative pollution contributed by single parameter. NP values exceeding 1.0 indicate the presence of impurity in water and hence require some treatment to use. This index was measured for all the parameters like pH, TDS, TS, hardness and sulfates.

Results and Discussion

Data related to various physico-chemical parameters of water samples collected from various representative sites are presented in Table 1. Most of the parameters such as pH, total suspended solids, turbidity, free CO_2, calcium, chlorides, sulfates, nitrates. DO and BOD were within the permissible limits as set by WHO (Table 2). The total dissolved solids (TDS) and total suspended solids (TS) in all the water samples were well above the permissible limits of 500 mg/liter. This shows the presence of some inorganic and organic salts in the drinking water of Moga. As there is positive correlation between electrical conductivity (EC) and TDS, EC limits were also higher than the permissible limits of 0.300 mmho/cm. The values of total hardness as $CaCO_3$ ranged from 179 to 204 mg/liter, well above the WHO permissible limits of 100 mg/liter. This shows that the water of Moga is quite hard. As far as calcium concentration is concerned, it was well below the WHO permissible limit of 75 mg/liter, but the concentration of magnesium was slightly above the WHO permissible limit of 30 mg/liter.

Table 2. World Health Organization (WHO) standards for drinking water quality (maximum permissible limits).

Parameters	WHO Standard
pH value	7.0-8.5 (8.0)
Turbidity, NTU	5.00
Electrical conductivity mmhos/cm	0.300
Total alkalinity	100.00
Total solids	500.00
Total dissolved solids	500.00
Dissolved oxygen (minimum)	5.00
Biological Oxygen Demand	6.00
Chemical Oxigen Demand	10.00
Total Hardness ($CaCO_3$ scale)	100.00
Calcium	100
Magnesium	30.00
Free CO_2	10.00
Chloride	200.00
Nitrates (as $NaNO_3$)	45
Total phosphates	0.1

Nemerow's Pollution Index

Nemerow gave this index to assess the pollution contribution by individual quality parameters. The values of the NPI for all the water quality parameters except dissolved oxygen are given in Table1. The values of NPI exceeded unity for the parameters such as total dissolved solids, total solids, total hardness, electrical conductivity and magnesium. Maximum contribution to pollution was by electrical conductivity, as NPI value for this parameter was even greater than 2.0 for some of the sampling locations. Other main parameters which caused pollution were TDS and total hardness, where NPI value approached 2.0. NPI for sulphates was above 0.6 but below 1.0, which indicated that this parameter can become possible source of pollution in near future if remedial measures are not taken. The NPI value for other parameters was hovering around 0.1, indication no chance of pollution from such parameters.

References

1. Anonymous. 2002. *Some critical issues on groundwater in India, A report by center for water policy.* Delhi, India. Areas notified for ground water regulation. Cen. Ground Water Auth. ww.cgwb.gov.in/groundWater/authority_area.htm (2007, Jan 10).

2. Datta P. S. 2005. Groundwater ethics for its sustainability. *Curr. Sci*. 812—817.
3. Agarwal S. K. 2005. *Water pollution.* A.P.H. Publ. Crop., New Delhi, India.
4. Anonymous. 2006. Groundwater resourcess of Punjab. punjabsewa.gov.in/citizen-services
5. Anonymous 2005. *Some critical issues on groundwater in India. A Report by Center for Water Policy.* Delhi, India.
6. Madhuri T. U. and B. Subhashini. 2004. A study of ground water quality in residential colonies of Viskhapatnam. *In* A. Kumar (ed). *Water pollution* A.P. H. Publ. Crop., New Delhi, India.
7. Mariappan V. 2004. Analysis of physico-chemical characteristics of ground water quality and quality index in and around Sivakasi town. *In* A. Kumar (ed). *Water pollution* A.P. H. Publ. Corp., New Delhi, India.
8. Sinha D. K. and R. Saxena. 2006. Assessment of drinking water quality at Hasanpur, J. P. Nagar : A mathematical approach. *Ind. J. Env. Prot.* 26 : 163—168.
9. APHA, AWWA and WPCF. 1995. Standard methods for the examination of water and wastewater. 4th edition. APHA. NY, USA.
10. Mathur R. P. 1999. Water and waste water testing (lboratory manual). Nem Chand & Bros, Roorkee, India.