ISSN: 0974-2115
www.jchps.com Journal of Chemical and Pharmaceutical Sciences

Impact of industrial effluent on ground water and surface water quality- A case study of Dhampur region (U.P.), India

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ABSTRACT

In order to assess the ground water and surface water quality, water samples were collected from different sources to analyse the physico-chemical parameters and some expected heavy metals. The results show that surface water is affected by industrial effluents which have high concentration of COD. However the study shows that the surface water pollution in Dhampur industrial development areas has significantly reduced, due to fact that the emission of effluents are treated regularly for the last few years. This makes the groundwater quality in the catchments area of study is found to be severely polluted and moderately polluted in respect of heavy metal concentration. The level of pollution is unfit for human consumption.

KEY WORDS: Water analysis, hand pump water, industrial effluents, heavy metals.

1. INTRODUCTION

In the recent time, it is well known that what is the value or importance of freshwater to the all kind of animals, plant and human beings, because freshwater relates to their health. As Fresh water is naturally occurring water on the Earth's surface in ice sheets, ice caps, glaciers, icebergs, bogs, ponds, lakes, rivers and streams, and underground as groundwater in aquifers and underground streams (Matta, 2010; 2014). Fresh water is generally characterized by having low concentrations of dissolved salts and other total dissolved solids. Out of all the water on Earth, saline water in oceans, seas and saline groundwater make up about 97% of it. Only 2.5–2.75% is fresh water, including 1.75–2% frozen in glaciers, ice and snow, 0.5–0.75% as fresh groundwater and soil moisture, and less than 0.01% of it as surface water in lakes, swamps and rivers (U.S. Geological Survey).

Groundwater is the water located beneath the earth's surface in soil pore spaces and in the fractures of rock formations. A unit of rock or an unconsolidated deposit is called an aquifer when it can yield a usable quantity of water. The depth at which soil pore spaces or fractures and voids in rock become completely saturated with water is called the water table. Groundwater is recharged from, and eventually flows to, the surface naturally; natural discharge often occurs at springs and seeps, and can form oases or wetlands. Groundwater is also often withdrawn for agricultural, municipal, and industrial use by constructing and operating extraction wells. The study of the distribution and movement of groundwater is hydrogeology, also called groundwater hydrology.

Groundwater, being a fragile and important source of drinking water, must therefore be carefully managed to maintain its purity within standard limits. Groundwater degradation occurs when its quality parameters are changed beyond their natural variations by the introduction or removal of certain substances (Ramesh, 2001).
Groundwater has long been regarded as the pure form of water compared to surface water, because of purification of the former in the soil column through anaerobic decomposition, filtration and ion exchange(Matta and Kumar, 2015; Matta 2015a and 2015b). This is one of the reasons for the excessive consumption of groundwater in rural and semi-urban areas all over the world (WHO, 1984; Saha, 2008).

Increased industrialization, urbanization and agricultural activities during the last few decades have deteriorated the surface water and groundwater quality of Uttar Pradesh. The northern most state of India (CGWB, 2005). Groundwater contamination can often have serious ill effects on human health. Water pollution is the contamination of water bodies such as lakes, rivers, oceans, and groundwater (Matta, 2015). It occurs when pollutants are discharged directly or indirectly into water bodies without adequate treatment to remove harmful constituents. Water pollution is a major problem in the global context (Radha Krishnan, 2007; Matta, 2015). It has been suggested that it is the leading worldwide cause of deaths and diseases and that it accounts for the deaths of more than 14,000 people daily. Water for rural supply is mainly withdrawn from underground sources. Development of the city has been accompanied by increased waste production and discharge with progressively more serious groundwater pollution (Bajpayee, 2001; Bhadauriya, 2011; Arora, 2014).

All the sugar industries play an important role in state economy and contribute to country’s economy. Some other developmental economic activities are also related to sugar industry, like cooperative dairies, paper mills and poultry farms, in their respective regions. In spite of the fact that sugar industry is very important for economy, the need has arisen to review and recognize environmental problems related to it. The rapid increase in sugar industrialization leads to increase in urbanisation and population, hence the degradation of air, water and soil quality. The effluents of these industries gave a great deal of influence on the pollution of the water bodies, these effluents can alter the physical, chemical and biological nature of the receiving water body (Sangodoyin, 1991).

Sugar mills play a major role in polluting the water bodies and land by discharging a large amount of wastewater as effluent. The sugar mill effluents are having higher amount of suspended solids, dissolved solids, BOD, COD, chloride sulphate, nitrates, calcium and magnesium. The continuous use of these effluents harmfully affects the crops when used for irrigation. As a result, a higher amount of various elements get deposited in the soil and make them polluted.

Work elements: Here are some work elements involved in the study are:-

- Selection of various groundwater sources (hand pumps) used by the local people and sugar mill discharge water.
- Physico-chemical and heavy metal analysis of significant parameters of water from the sources.
- Understanding the need for water management programs.

2. MATERIALS AND METHODS

Water samples were taken from different sources like-4 hand pump, 2 pond water, one sugar mill waste water & one domestic waste water were collected in and around Dhampur.

Study area: The present study was conducted in ground and surface water at Dhampur, District-Bijnor (U.P.) India. The Following four sampling sites were selected for analysis of physico-chemical parameters and Heavy metals:

a) Sugar Mill, Dhampur
b) Suhagpur village, Dhampur
c) Jaitra, Dhampur
d) Durga Bihar Colony, Dhampur

Sample collection: Water samples were collected during February-2014 to April-2014 for the analysis of the physio-chemical parameters and Heavy metals. Water samples were collected from different sources at varying interval in thoroughly washed and sterilized bottle. Physico-Chemical analysis was done within 48 hours and the sample stored at room temperature.

A kit containing sample collection bottles, standard chemical reagents, glassware's, pH meter, thermometer and other accessories was used for sampling. Samples were collected fortnightly throughout the study period in morning hours (7 A. M.-10A.M). Water was collected after discarding the stagnant water where as it was after sufficient wastages from hand pump. At the industrial drain/surface water, representative samples were obtained at 15-60 cm depth below surface. Plastic Jerry cans and glass bottles of 1-2 litres thoroughly rinsed were used for collection. The water samples collected from different sources were analysed in the laboratory with the procedure as recommended by standard method of examination and wastewater (APHA, 2005). The analysis was carried out for various physicochemical parameters such as temperature, pH, TS, TDS, TSS, Temperature, DO, BOD, COD, Alkalinity and Hardness. Some expected heavy metals such as, Fe, Ni, Cu, Zn, Cr and Mn also analysed.

3. RESULTS AND DISCUSSION

P^H was recorded between the range of 6.60 to7.70 of ground water and 6.10 to 7.50 of surface water. Total Solid was recorded between the ranges of 210 to 330 mg/l of ground water and 600 to 950 mg/l of surface water. In water, total dissolved solids are composed mainly of carbonates, bicarbonates, chlorides, phosphates and nitrates of calcium, magnesium, sodium, potassium and manganese, organic matter, salt and other particles (Mahananda, 2010). Groundwater with a TDS values less than 500 mg/L can be considered as excellent for drinking purpose (WHO, 1984). Total dissolved Solid was recorded between the ranges of 70 to 120 mg/l of ground water and 300 to 440 mg/l of surface water. Total suspended Solid was recorded between the ranges of 130 to 210 mg/l of ground water and 360 to 570 mg/l of surface water. Total dissolved oxygen was recorded between the ranges of 5.00 to 8.20 mg/l of ground water and 3.00 to10.13 mg/l of surface water. High BOD level indicates decline in DO, because the oxygen that is available in the water is being consumed by the bacteria leading to the inability of fish and other aquatic organism to survive in the river (Pathak 2011). Biological oxygen demand was recorded between the ranges of 2.80 to 4.90 mg/l of ground water and 2.0 to7.70 mg/l of surface water. COD pointing to a deterioration of the water quality caused by the discharge of industrial effluents (Mamais 1993). Chemical oxygen demand was recorded between the ranges of 5.00 to 10.00 mg/l of ground water and 22 to 990 mg/l of surface water. Total alkalinity was recorded between the ranges of 175 to 320 mg/l of ground water and 125 to 630 mg/l of surface water. Total Hardness was recorded between the ranges of 130 to 180 mg/l of ground water and 110 to 150 mg/l of surface water.

Table.1. Average of Physico – chemical Parameters in Ground water

Parameters	Sites			
	Site-1	Site-2	Site-3	Site-4
pH	7.31±0.267	7.01±0.239	7.01±0.257	7.20±0.135
Total solids	263.75±47.32	245±34.15	249±29.69	254±25.23
Total dissolved solids	103±15.25	85.75±11.78	93.25±9.25	99.15±8.23
Total suspended solids	162±32.75	159.25±29.47	155.75±20.75	149.34±18.32

Temperature	19.07±0.830	21.25±1.050	22.27±0.556	23.18±0.634
Dissolved oxygen	6.28±0.696	7.29±0.795	6.11±1.104	6.54±0.675
BOD	3.84±0.773	4.20±0.504	3.79±0.556	4.15±0.453
COD	7.8±1.24	7.0±0.95	7.5±1.64	7.1±0.57
Alkalinity	287.50±31.75	216.25±31.98	241.25±27.80	250±29.68
Hardness (Ca and Mg)	138.5±6.06	121±8.40	134.75±7.71	127±4.86

Table.2. Average of Physico – chemical Parameters in Surface water

Parameters	**Sites**			
	Site-1	**Site-2**	**Site-3**	**Site-4**
pH	6.85±1.087	6.53±0.430	6.84±0.163	6.93±0.670
Total solids	942±53.28	790±137.84	817.5±120.38	850±54.87
Total dissolved solids	399.5±41.364	287.5±46.457	329.7±56.097	251.3±34.987
Total suspended solids	542.5±19.152	502.5±105.31	487.7±109.454	432.2±28.56
Temperature	20.8±3.108	20.7±1.053	22.2±1.723	21.5±2.124
Dissolved oxygen	5.11±1.924	6.23±2.211	6.17±3.124	5.56±2.232
BOD	4.81±2.319	5.11±0.256	2.43±1.374	4.11±0.566
COD	380.6±418.93	306.9±309.52	350.8±373.47	377.8±322.43
Alkalinity	398.7±149.65	258.7±105.05	241.2±27.80	321±90.30
Hardness (Ca and Mg)	154±7.117	155.5±14.082	149.5±16.633	167.9±12.257

Temporal variation trends of heavy metals in groundwater and surface water: Total Iron was recorded between the ranges of 1.70 to 3.20 of ground water and 1.50 to 4.70 of surface water. Total Nickel was recorded between the ranges of 1.40 to1.50 of ground water and 2.10 to 3.50 of surface water. Total copper was recorded between the ranges of 2.40 to 3.0 of ground water and 1.90 to 3.0 of surface water. Total Zinc was recorded between the ranges of 3.20 to 4.50 of ground water and 1.20 to 3.30 of surface water. Total Chromium was recorded between the ranges of 1.40 to 1.80 0f ground water and 1.00 to 2.20 of surface water. Total Manganese was recorded between the ranges of 1.30 to 1.60 of ground water and 0.70 to 2.10 of surface water.

Table.3. Average of Heavy metals in Ground water

Parameters	**Sites**			
	Site-1	**Site-2**	**Site-3**	**Site-4**
Iron	2.537±0.432	2.445±0.386	2.865±0.260	2.983±0.675
Nickel	1.552±0.183	1.66±0.202	2.307±0.201	2.105±0.786
Copper	1.854±0.773	1.984±0.823	2.329±0.771	1.745±0.675
Zinc	3.475±0.191	3.652±0.311	3.990±0.432	3.554±0.121
Chromium	1.54±0.0784	1.57±0.0484	1.64±0.1035	1.72±0.2374
Manganese	1.352±0.0576	1.392±0.0294	1.43±0.1067	1.265±0.458

Table.4. Average of Heavy metals in Surface water

Parameters	**Sites**			
	Site-1	**Site-2**	**Site-3**	**Site-4**
Iron	1.885±0.446	2.395±0.695	3.555±0.701	2.231±0.234
Nickel	2.705±0.346	2.850±0.299	3.122±0.190	2.578±0.345
Copper	1.947±0.237	2.4±0.373	2.517±0.421	1.842±0.345
Zinc	2.325±0.345	2.932±0.521	3.932±0.423	2.632±0.456
Chromium	1.39±0.890	1.487±0.785	1.735±0.534	1.543±0.456
Manganese	1.057±0.0576	1.56±0.0294	1.569±0.1067	1.732±0.1217

4. CONCLUSION

On the basis of above discussion, it may be concluded that the surface water of the Dhampur tehsil area, Bijnor district, Uttar Pradesh, India in general is found to be alkaline in nature. The total iron content is found to be more than 0.5 mg/L in certain areas of the region. The BOD, alkalinity and all heavy metal contents in all groundwater sources were found to be slightly high. Based on these observations the groundwater quality in the catchments area of study is found to be severely polluted and moderately polluted. People depended on the polluted water are prone to health hazards of polluted drinking water and water quality management in needed. The present study is urgently required to draw the attention towards this region for taking necessary steps to minimize the adverse impacts likely to occur because of polluted water.

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