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Research Paper

Groundwater Quality Assessment of Firozabad City (India) – A Physico-Chemical Analysis

Geography

KEYWORDS : Groundwater, Water Quality, Physico-chemical Parameters, linear correlation, glass bangle industry.

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ABSTRACT

This paper assesses the status of ground water quality in Firozabad city. The city is a hub of glass bangle and glassware industries. The main components of the study included a field sampling, analysis of groundwater pollution. Therefore water samples were collected from thee different sites during July to December 2012. The aim was to determine the water quality by studying the physical parameters including temperature and electrical conductivity and chemical parameters which include pH, alkalinity, total hardness, chloride, calcium, magnesium and total dissolved solids as well as microbiological parameter include total coliform using standard procedure and the results of this analysis were compared with the water quality standards of WHO and IS and interrelationship between the variables were analyzed through linear correlation method which explicitly express that the water of the city is not appropriate to be used for drinking consumption.

Introduction

Groundwater contamination is one of the major public health and environmental threats in the world (AEHS 1998-b). Water is one of the indispensable natural resource on our environment. The fresh water present on the earth is only 2.0 percent out of the all waters on the earth and 20 percent of the fresh water constitutes the ground water (Sharma 2004). Growing population, urbanization, erosion of soil, increasing living standards, unscientific management and other anthropogenic activities including unhygienic conditions have severe impact on this quality of limited water resources (Indermitte et al 2007, Shusheela 1995). Ground water is the major source of drinking water in both urban and rural areas and it is the important source for the industrial and agricultural sectors (Rani et al 2003, Senthilnathan et al 2011). The term water quality is intimately related to water pollution. Water quality refers to physical, chemical and biological characteristics of water. The physical characteristics include the chemical water characteristics include the presence of organic and inorganic substance is water. Biological characteristic of water include identity and impact of organisms which are present in water. These characteristics of water are formed not any during its penetration through the atmosphere, soil and rocks but also during its contact with the vegetation canopy and cultivation practices (Agarwal 2005). The quality of water is of vital concern for the mankind since it is directly linked with human welfare. There are several states in India where more than 90% populations are depending on ground water for drinking and other purpose (Ranachandraiah 2004, Tank, Singh 2010). The uncontrolled disposal of industrial and urban wasted and the use of chemical substances in agriculture (fertilizers, herbicides and pesticides) is the primary causes of groundwater contamination (Ullah et al 2009). During last decades, this is observed that groundwater get polluted drastically because of increased human activities consequently; number of cases of water born diseases has been seen that is a cause of health hazards.

Firozabad city is a rapidly expanding class I city and a major hub of glass bangle industries in India. The city is also famous as "Suhag nagri" due to its unique characteristics of bangle manufacturing industries. The status of the groundwater depends on a large number of individual physico-chemical parameters and heavy metals. Pollutants are added to the ground water system through anthropogenic activities and natural processes. The uncontrolled industrial and urban activities are the primary cause of the water contamination as the city is surrounded by many glass bangles and glass wares industries and household bangle dying chemical and compressor activities and the effluents from these activities are discharged in to the Yamuna River causing impact on the quality of the underground water. Solid wastes of the city is being dumped in an unorganized manner in vacant areas of the cities and subjected to reaction with percolating rain water and reaches the ground water level. The percolating water picks up a large amount of dissolved constituents and reaches the aquifer system and thus it contaminates the ground water.

Objectives

The specific objectives of the study were however to assess physical and chemicals properties of ground water in the study area.

Study area

Firozabad city is situated in western U.P between latitude and longitude. Its altitude above mean sea level is 189 meters. Firozabad, the glass city is located in north central India, in the western Uttar Pradesh state 40 km away from Agra and 218 km away from Delhi at the northern edge of the Deccan Plateau, at 27^0 15′ N and 72^0 42′ E. Firozabad city is spread in 21.35 sq.km area bounded by river Yamuna from southern and western side. Firozabad city is the leading manufacturer of glass bangles and other glass products in India.

Methodology

Sample collection: water sample from the three selected sites namely Agra gate (S1), Suhag Nagar (S2) and Raja Ka Tal (S3) were collected during July to December 2012 and collected a pre-cleaned polythene bottles of 2 liter capacity. The samples were collected from municipal tube wells by running the tube wells from 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 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 taken to the laboratory of Agra pollution control board where analysis is done within 48 hours.

Physico- Chemical Analysis

The collected samples were analyzed for major physical and chemical water quality parameter like pH (PH), Electrical conductivity (EC), Total Dissolved solid (TDS), Total Alkalinity (TA), Total Hardness (TH), Calcium (Ca++), Magnesium (Mg++), Chloride (Cl^-) and Total coliform (TC) were carried out referring the standard methods 2002.

Statistical Analysis

The simple linear correlation analysis has been carried out to find out the correlation between the two tested parameters. The study of correlation reduces the range of uncertainly associated with decision making. The correlation co-efficient 'r' was calculated using equation (Patil and Patil, 2010) Where, x and y represens two different parameters.

$$r = \frac{N\Sigma(xy) - \Sigma(x).\Sigma(y)}{\sqrt{[N\Sigma x^2 - (\Sigma x)^2][N\Sigma y^2 - (\Sigma y)^2]}}$$

Where, x and y represens two different parameters.

N= number of total observation.

Result and Discussion

The average results of the physico-chemical parameters for wa-

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ter samples are presented in Table 1 and matrix of correlation among different parameters are shown in Table 2.

Hydrogen ion concentration (pH)
Higher values of pH hasten the scale information in the water heaters and reduce the germicidal potential of chlorine (Mahapatra and Purohit 2000). PH is considered as an important ecological factor and provides an important piece of information in many type of geochemical equilibrium or solubility calculation (Shyamala et al 2008). The maximum PH was recorded as 7.82 at sampling location S1 and minimum was 7.46 at S2. When compared with the standard values of WHO and is 10500-91, the samples are found to be in the permissible limit as prescribe.

Electrical conductivity (EC)
Electrical conductivity is the measure of mineral content (Mishra et. Al., 2011). It is a useful tool to evaluate the purity of water (Acharya et al., 2008) EC values was in the range of 968.0 micromhos/cm (S3) to 2483.20 micromhos.cm (S1). EC values for all the investigated samples were found to be greater than the limits prescribed by WHO. High EC values indicates the ionized form which is due to the drains carrying domestic waste water.

Total Dissolved Solids (TDS)
The total dissolved solids were found to be in the range of 653.60 mg/l (S3) to 1766.40 mg/l (S1). Total dissolved solids usually related to conductivity. Water containing more than 500 mg/l of TDS is not considered desirable for drinking water supplies, though more highly mineralized water may be used where better quality water is not available (Jain, 2002). The TDS values fall the water samples of the selected places are greater than the prescribed limit by Is-10500-91. TDS concentration above the permissible limit causes gastro intestinal irritation (Shankar, 1994).

Total Hardness (TH)
Hardness is very important parameter in decreasing the toxic effect of poisonous element. It is the property of water which prevents the lather formation with soap and increases the boiling points of water (Patil and Patil, 2010). Hardness was found to be in the range of 264.60 mg/l (S3) to 1286.40 mg/l (S1). Which shows the values higher than the permissible limit prescribed by WHO. The adverse effects of total hardness are formation of kidney stones and heart disease (sastry et al, 1988).

Alkalinity (AL)
Alkalinity was found in the range of 193.60 mg/l (S1) to 213.2 mg/l (S2). Except as location S1 values are found greater than the limit prescribed by WHO. Alkalinity values in water provide an idea of natural salts present in water. The alkalinity varies in accordance with the fluctuation in pollution load**.**

Calcium and Magnesium
The source of calcium and Magnesium in natural water are various types of rocks, industrial waste and sewage (Trivedy and Goel, 1984). The values of calcium varied from 18.20 mg/l (S3) to 1066.40 mg/l (S1) and the values of magnesium ranged from 90.4 mg/l (S2) to 220 mg/l (S1). Both the ions are found to be greater than the prescribed limit of IS. and are very high at S1 location because of sewage waste.

Chloride
Chloride is also one of the important parameters to know the quality of water. Chlorides usually occurs as NaCl, CaCl2 and MgCl in widely varying concentration, in all natural waters. They enter water by Anthropogenic source like fertilizers, voad salts, sewage, human and animal waste (sheikh and Mandre, 2009; Trivedy and Goel, 1984). Chloride content of the water samples ranged from 53.80 mg/l (S3) to 982.60 mg/l (S1). Chloride in excess impacts the salty taste to water and people who are not accustomed to high chlorides subjected to laxative effect.

Total Coliform
Total coliform was found in the range of 6.0 MPN/100ml (S3) to 12.60 MPN/100ml (S1) which is well below the desirable range of Is. Total coliforms are a group of bacteria that have been used for many decades as the indicator of choice for drinking water (Nassery and Falsafi 2012).

Table 1: Average results of the Physico-chemical Parameters

Sl.no.	Parameters	Sampling Sites			WHO (2002)	IS (10500-91)
		S1	S2	S3		
1	pH	7.82	7.464	7.80	6.5-9.5	6.5-8.5
2	EC	2483.20	1319.8	968.00	250	NI
3	TDS	1766.40	909.4	653.60	1500	500
4	TH	1286.40	358.4	264.60	150-500	300
5	TA	193.60	213.2	208.00	250	200
6	Ca^{++}	1066.40	268	118.20	100	75
7	Mg^{++}	220.00	90.4	136.80	50	30
8	Cl^{-}	982.60	130.4	53.80	250	250
9	TC	12.60	10.2	6.00	NI	NI

All parameters are in mg/l except pH, EC and TC, EC in micromhos/cm, TC in MPN. NI: NO Indection.

Correlation between Physical and Chemical water quality Parameters
The high positively correlated values are found between chloride and Total Hardness (1.000), TDS and EC (1.000), Calcium and Total Hardness (0.998), Calcium and EC (0.997), Calcium and TDS (0.997), Chloride and Calcium (0.997). While the negatively correlated values were found between Total Alkalinity and TDS (-0.887), Akalinity and EC (-0.886), Alkalinity and pH (-0.74) Total coliform and pH (-0.106). however, alkalinity is negatively correlated with all the parameters (Table 2).

Table 2: Matrix of correlation between water quality parameters

Parameters	pH	EC	TDS	TH	AL	Ca^{++}	Mg^{++}	Cl^{-}	TC
pH	1								
EC	0.343	1							
TDS	0.345	1.000**	1						
TH	0.471	0.99	0.99	1					
AL	-0.74	-0.886	-0.887	-0.942	1				
Ca^{++}	0.413	.997*	.997*	.998*	-0.919	1			
Mg^{++}	0.804	0.834	0.835	0.903	-0.995	0.873	1		
Cl^{-}	0.479	0.989	0.989	1.000**	-0.945	.997*	0.907	1	
TC	-0.106	0.898	0.897	0.827	-0.591	0.862	0.505	0.822	1
**. Correlation is significant at the 0.01 level (2-tailed).									
*. Correlation is significant at the 0.05 level (2-tailed).									

Conclusion and Recommendation
The quality of water of Firozabad city is obviously very unhealthy and unhygienic for drinking. The analysis clearly reveals

that most of the parameters of the water sample do not comply with WHO and Indian Standards recommendations; hence it is suggested that precautionary measures be adopted before drinking in order to avoid adverse health effects on human beings.

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