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Monitoring of groundwater chemistry in terms of physical and chemical parameters of Gajraula, a semi-urbanized town of North India

Bineet Singh *, Vikas Jain, Anuraag Mohan

Department of Chemistry, Bareilly College, Bareilly, M.J.P. Rohilkhand University, Bareilly 243 005, UP, India

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ABSTRACT

Groundwater happens to be a major source of drinking water for urban and rural India. With rapid growth in industrial sector, the shallow groundwater regime has become more vulnerable to industrial contamination and human activity. In this study, the drinking water quality of Gajraula and its suburbs, a semi-urbanized town of northern India, was assessed. The water samples from pre-identified 14 wells with different depths were analyzed for 2 years, i.e. 2008 and 2009. The samples were taken thrice a year in May (summers), August (monsoon) and December (winters). The compiled results were compared with recommended values of World Health Organization (WHO) and Bureau of Indian Standards (BIS) for drinking water. The analysis showed that concentration levels of TDS, BOD, NO_3^- and Ca^{2+} exceeded the desirable limits of WHO and BIS in certain wells. The levels of trace metals Fe and Pb exceeded the limits in almost all the wells, while pH, Cl^-, SO_4^{2-}, Mg^{2+}, Zn, Cr and Ni were well within the limits. The contamination levels in most cases were higher during summers as compared to monsoon and winters, which may be due to high build-up of dissolved solids. The quality of water from shallow hand pumps in vicinity to industries were unsuitable for human consumption as compared to public deep bore wells. Agro-chemicals, irrigation by effluent discharge and wastewater from commercial cum residential area were the main sources of groundwater pollution. A study based on long-term surveillance of water systems, incorporating individual exposure assessment of users of private wells, should be considered for a lasting solution.

1. Introduction

The role of groundwater as a potent potable water source for millions cannot be ignored. Over the years, the water resources become vulnerable to anthropogenic activity leading to undesirable changes in groundwater quality (Pritchard et al., 2007, 2008). The population of Gajraula is no exception as it is heavily dependent on groundwater for sustaining life. Most of the households in this area use water from private wells generally in form of shallow hand pumps (10–20 m) for drinking and domestic purposes, while others use public supply wells which are deep bore holes (25–32 m) (Fig. 1). Gajraula, a semi-urbanized town in northern India falls under the Indo-Gangetic plains at 28°50′N latitude, 78°13′E longitude and is at an altitude of 273 m above sea level (Fig. 2). The total coverage area is about 10 km^2, with a population of around 40,000 comprising of 6806 households (2001 census). No perennial stream exists in this area, except for short-distance stream "Bhagat River". Run-offs from industrial and commercial–residential area joins the said stream flowing towards the main river 'Ganga'. The groundwater hydrology of this region is characterized by unconfined and semi-confined aquifers at depths of about 10–20 m below ground level (Jain et al., 2005). The climate of this region is generally dry with hot summers and harsh winters. The average annual rainfall is about 800 mm, of which 75% falls during monsoon months, i.e. July to October. Rice, wheat and sugarcane are the prominent crops grown in this area.

A number of industries have come up since last three decades including large molasses-based distillery, installed with a capacity of about 350 kL alcohol/day, running for the last 35 years. Molasses-based distilleries are one of the most polluting industries generating large volumes of high strength wastewaters (Satyawali and Balakrishnan, 2008). The treated or partially treated effluent of distillery often finds access to watercourses (Mohana et al., 2009). This area is home for many industries like pharmaceutical, chemical, food and vegetable oils. These industries are installed with modern equipments. However, the amount of treated effluent generated is relatively low in comparison to the distillery effluents, still contamination from these industries cannot be overlooked. It is a customary practice that treated distillery effluent is often used for crop irrigation in this area. The said effluent is often applied as manure via overflowing or furrow irrigation to crops that are grown almost year round. Over a period of time, the water

* Corresponding author. Tel.: +91 0581 2511768.
E-mail addresses: bineet05@gmail.com (B. Singh), jain.vikas2812@gmail.com (V. Jain), mohan.anuraag@gmail.com (A. Mohan).

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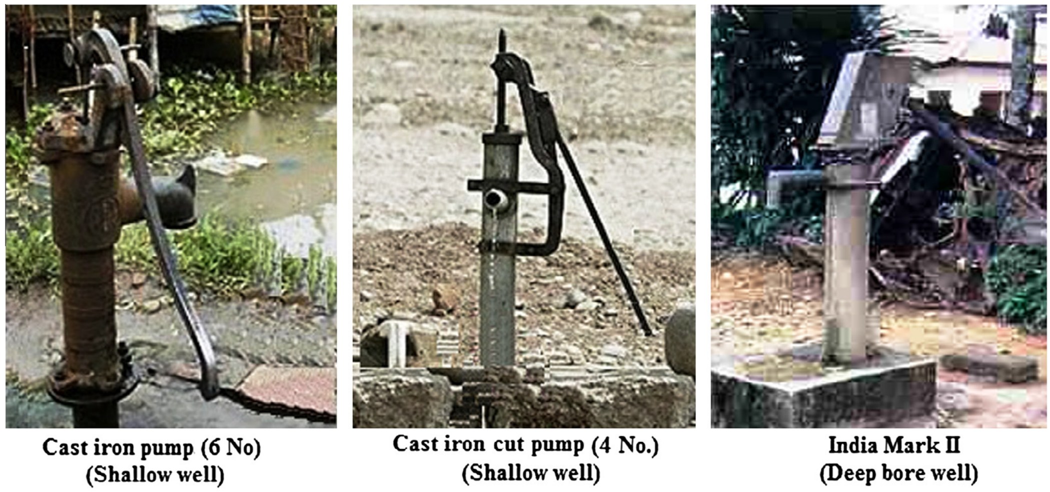

Fig. 1. Type of hand pumps used in the area.

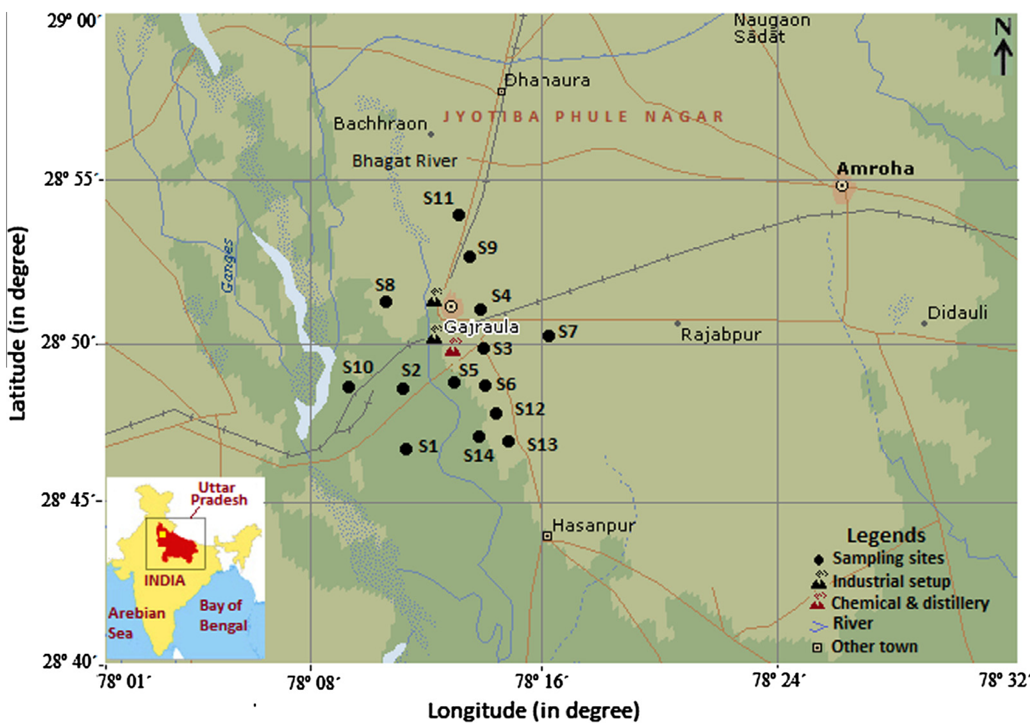

Fig. 2. Geographical location of study area (Source: Microsoft).

Table 1
Summary of the sampling locations.

Station code	Sampling Stations	Type of hand pumps	Depth of hand pumps (m)	Distance from the industry[a] (km)	Direction from industry
S1	Fattehpur	Caste iron (No. 6)	15	7.0	SE
S2	Sahbazpur Idgah	Caste iron cut (No. 4)	12	3.0	N
S3	Alipur	India Mark II	28	0.5	E
S4	Basti	India Mark II	32	1.0	E
S5	Bhartiyagram (JOL)	Caste Iron (No. 6)	15	0.5	S
S6	Tigaria Khadar	India Mark II	28	2.0	SW
S7	Bhanpur	India Mark II	32	5.0	E
S8	Kumrala	India Mark II	32	4.0	NW
S9	Ahrola	Caste iron (No. 6)	20	6.5	NE
S10	Azadpur (DM Farm)	Caste iron (No. 6)	15	8.0	NW
S11	Ahrola (Raja Farm)	Caste iron (No. 6)	15	8.0	N
S12	Sihali	Caste iron (No. 6)	12	4.0	SE
S13	Sheshauli	Caste iron (No. 6)	20	5.5	SE
S14	Sadullapur	Caste iron cut (No. 4)	15	5.0	SW

[a] Chemical and distillery plant.