RP Current Trends in Agriculture and Environmental Sciences
Vol. 1, No. 2 (October – December 2022) pp. 50–53
e-ISSN: 2583-6293

RESEARCH PLATEAU PUBLISHERS

Cite this article: H. Arya, Physico-chemical analysis of underground water samples of Delhi, the Capital of India, *RP Cur. Tr. Agri. Env. Sci.* **1** (2022) 50–53.

Original Research Article

Physico-chemical analysis of underground water samples of Delhi, the Capital of India

Hariom Arya
Department of Zoology, Pt. Neki Ram Sharma Govt. College, Rohtak – 124001, Haryana, India
*Corresponding author, E-mail: hariomsheoran@gmail.com

ARTICLE HISTORY
Received: 27 September 2022
Revised: 8 November 2022
Accepted: 10 November 2022
Published online: 12 November 2022

KEYWORDS
Physicochemical parameters; Trace metals; BIS limits; Groundwater; Delhi.

ABSTRACT
Delhi water sample's physicochemical characteristics and trace metal concentration were evaluated. Physicochemical parameters including pH, conductivity, total dissolved solids, total alkalinity, Ca^{2+} and Mg^{2+} hardness, chloride ion, dissolved oxygen, biochemical oxygen demand, sulphate, and heavy metal contents including Cu, Cr, Cd, Co, Zn, and Ni were examined in a total of 20 water samples that were obtained from boring, tube wells, and hand pumps. The outcomes were contrasted with drinking water BIS standards. The quality of the water samples used for the study was within acceptable bounds. As a result, the groundwater samples can be consumed by humans directly.

1. Introduction

In sand, sandstone, limestone, and other rocks, there is water that fills the pores and crevices [1]. It is impossible to overestimate the importance of groundwater as a distributed source of drinking water for millions of rural and urban populations. According to some estimates, it provides 50% of India's urban water needs and approximately 80% of the country's residential water needs in rural areas [2]. Drinking water is not provided from a single source in Delhi. Water from the Yamuna River is used to supply 68 percent of the population. Other sources of groundwater include tube wells, hand pumps, and digging [3]. Yet, there is far less fresh groundwater of high quality that may be used without depleting our supplies or harming the ecosystem. Because that groundwater is frequently used directly, it is crucial to safeguard these resources from pollution. The general public, municipalities, and business owners should be aware that there are numerous ways for contaminants to reach groundwater [4].

The ensuing groundwater contamination plumes may reach distances of several hundred metres or even more. As a result of gravity and hydraulic pressure, groundwater moves both vertically and horizontally. Water-borne infections are becoming highly prevalent because the evaluation of groundwater quality has not been given the proper consideration. The poor quality of the world's drinking water is to blame for over 80% of all ailments [5]. The current monitoring effort's main emphasis and goal were to determine the extent of contamination in Delhi's groundwater.

2 The study area

The study area covers 1,483 sq km (573 sq miles), of which 700 sq km (270 sq miles) is designated as urban and 783 sq km (302 sq miles) as rural. It is located between latitude 28.38° N and longitude 77.12° E, and by the end of the tenth five-year plan, 17.5 million people are expected to live there.

Delhi's semi-arid climate has a wide range of summer and winter temperatures (25 to 46°C and 22 to 5°C, respectively). Early April to early October are the lengthy summer months, with the monsoon season in between. 714 mm of rain fall annually on average (28.1 inches).

The Yamuna flood plain and the Delhi ridge are two notable geographical characteristics of Delhi. A fertile alluvial soil, originating from the nearby quartzite ridge, is present in the low-lying Yamuna flood plains and is good for farming. But these plains are vulnerable to frequent flooding. Khadar is another name for this region. The ridge, which can be found in this area and rises to a height of 318 m (1043 ft), is the most prominent physiographic feature. It surrounds the city's west, northeast, and northwest regions and is made up of quartzite rocks that come from the Aravalli Range in the south. The whole national capital territory of Delhi is referred to as Bangar, or the plain, with the exception of the Yamuna flood plain (Khadar) and the ridge. Delhi, New Delhi, and the Delhi cantonment are all situated on this plain, along with a significant chunk of other villages. Much of the plain's land is fertile. West of the river, the majority of the city, including New Delhi, is located. The city of Shahdara is located to the east of the river. Given that Delhi sits in seismic zone IV, it is susceptible to large earthquakes.

The Delhi region's soils are primarily light in texture with minor amounts of medium soils. Sand, loam, sand, and sandy loam are the soils with light textures; silty loam is the soil with medium textures. All of the blocks' soils are typically appropriate for irrigation of crops like wheat, barley, and mustard that are fairly salt tolerant.

Twenty samples were taken from borings, hand pumps, and tube wells that extract water from the earth. They were examined using the established techniques for significant ion chemistry [6]. (APHA).

Using pH, TDS, and conductivity metres, the following parameters were measured: conductivity, hydrogen ion concentration (pH), and total dissolved solid (TDS).

Using HCl, total alkalinity (TA) was calculated titrimetrically. Using standard EDTA, total hardness (TH) and calcium (Ca^{2+}) were titrimetrically evaluated. Calculating magnesium (Mg^{2+}) involved subtracting the values for TH and Ca^{2+}. Sulphate (SO_4^{2-}) was evaluated with the use of a spectrophotometer, whereas chloride (Cl^-) was determined using a conventional $AgNO_3$ titration [7–10]. Titrimetric analysis was performed on the dissolved oxygen (DO) and biochemical oxygen demand (BOD) using a standard sodium thiosulfate ($Na_2S_2O_3$) solution. Atomic Absorption Spectrophotometer (AAS), Perkin Elmer model 3100, was utilised for the analysis in order to determine the amounts of copper, chromium, cadmium, cobalt, zinc, and nickel in water samples. Before use, all of the glassware used for the analyses was thoroughly cleaned with nitric acid and then rinsed with double-distilled water. Analytical-grade reagents were utilised throughout. Water that has been twice distilled was used for the entire investigation.

3 Results and discussion

The monitoring process began with the collection and evaluation of a water sample at the collection site. The sample's temperature ranged from 27 to 32 degrees Celsius, with daytime temperatures between 26 and 38 degrees Celsius (max). Table 1 contains all of the readings.

Table 1. The outcomes of several physicochemical tests performed on Delhi groundwater samples.

Sr. No.	Sampling point	Type	pH	EC	TDS	Alkalinity	Ca^{2+}	Mg^{2+}	Cl^-	DO	DOB	SO_4^{2-}
1	Sultanpuri	B	7.4	1.06	311	442	125	65	95	7.2	1.85	18
2	Mandi	B	7.6	2.27	640	480	110	25	352	10.0	0.45	50
3	Chattarpur	B	7.4	0.72	235	428	90	40	32	7.9	1.45	15
4	Bhati Gao	B	7.3	0.81	235	348	110	45	40	9.0	1.65	15
5	Fatehpuri Beri	HP	7.4	0.99	295	478	180	35	63	8.5	1.85	11
6	Alipur	HP	7.4	3.42	972	362	202	218	535	8.9	1.00	67
7	Singhola	HP	7.6	3.24	880	462	198	250	450	6.2	3.00	63
8	Lampur	TW	7.5	4.40	1248	448	180	190	675	7.5	2.60	65
9	Singhu border	TW	7.3	2.41	648	352	175	215	300	8.3	2.20	60
10	Bhakhtawar pur	TW	7.4	4.42	1252	308	98	215	930	8.4	1.78	69
11	Burari	HP	7.3	2.45	686	402	235	145	380	8.0	2.50	68
12	Matiala	B	7.5	2.65	735	328	148	98	610	9.0	2.10	68
13	Nawada	B	7.7	2.29	640	592	142	180	258	6.3	3.99	44
14	Yamuna Vihar	HP	7.8	0.96	255	348	50	88	32	7.4	0.82	63
15	Mangolpuri	HP	7.8	2.90	758	648	50	70	418	3.2	3.00	40
16	Karala	B	7.8	2.62	685	522	75	142	258	5.5	1.20	70
17	Kanghawala	HP	7.7	0.70	191	258	75	20	26	2.9	0.50	72
18	Khod Punjab	HP	8.5	1.34	360	472	98	12	54	4.1	3.60	45
19	Qutab Garh	HP	8.2	5.20	1428	858	10	10	862	4.4	3.00	66
20	Bawana	HP	7.6	3.20	828	748	12	78	395	3.2	0.95	74

B = Boring, TW = Tube Well, HP = Hand Pump except pH and EC (mS/cm); all units are in ppm.

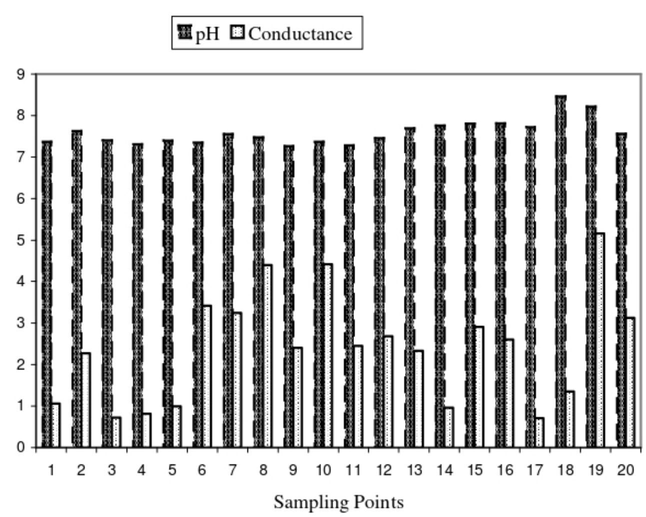

Figure 1. Several groundwater samples taken from Delhi have been tested for pH and conductivity.

The pH range for the groundwater sample is between 7.26 and 8.46, which is within the acceptable range (6.5 to 8.5) for home usage. According to Figure 1, the conductivity ranged from 0.711 to 5.16 (mS/cm).

The samples' total hardness (Ca^{2+} plus Mg^{2+}) is divided into the several categories. The majority of which (11%) fall into the category of very hard with TH more than 180 ppm. 7% of the samples are classified as hard water (120–180 ppm), and the remaining 10% are classified as soft water (0-60 ppm) No sample had hardness in the medium range of 60 to 120 ppm. Only two samples, Ca^{2+} and Mg^{2+}, fall within the acceptable range of 75 and 30 ppm, respectively.

Values for total alkalinity changed from 260 to 860 ppm (Figure 2). All of the water samples were found to be above the maximum desirable limit of 200 ppm, however only 15% of them showed readings beyond the permissible limit, or 600 ppm. The remaining 85% of the samples were found to be within permissible limits.

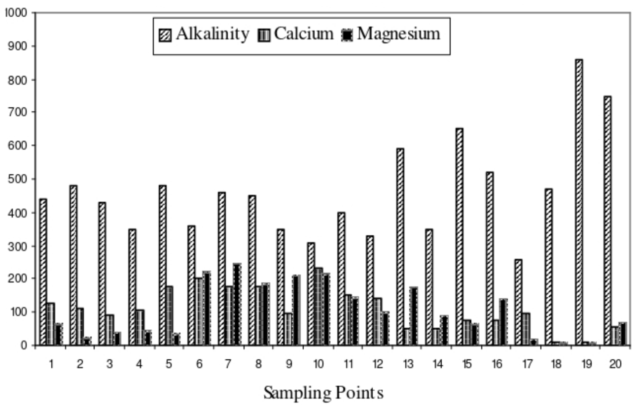

Figure 2. Alkalinity and Hardness of various groundwater samples collected from Delhi.

Figure 3 displays the excessively high concentrations of dissolved oxygen, a sign of organic pollution. The values ranged from 2.85 at Kanjhawala to 9.69 at Mandi, with variations in BOD values between 0.44 at Mandi and 3.90 in the water sample from Nawada.

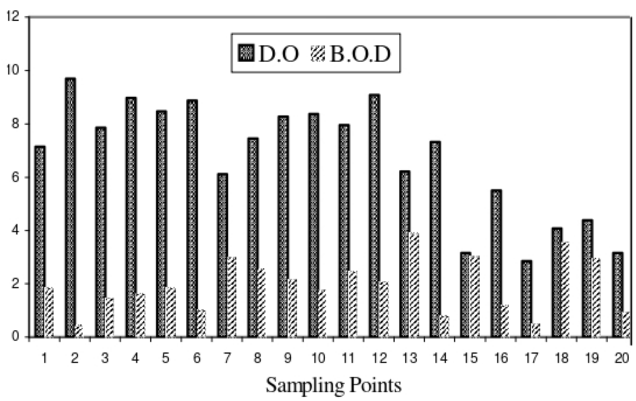

Figure 3. Values for D.O. and B.O.D. of various groundwater samples taken in Delhi.

The majority of the samples (85%), as determined by the TDS categorization, are fresh water with a TDS level under 1000 ppm. The remainder of the samples (15%) are brakish type and have TDS levels above 1000 ppm. Yet, only 25% are discovered to be within the BIS recommended level for drinking water of 300 ppm. Figure 4 depicts the results of the experiment that revealed a link between TDS and anion concentration (Cl^-). The TDS is often higher when the Cl^- ion concentration is higher. The amount of Cl^- in the Qutab Garh sample was high (860.87 ppm), and the amount of TDS was likewise high (1430 ppm). 931 ppm of Cl^- ion and 1250 ppm of TDS are high values in the Bhakhtawarpur water sample. Certain locations, including Yamuna Vihar and Chattarpur, display Cl^- ion concentrations of 31.06 ppm and TDS concentrations of 254 and 236 ppm, respectively. The Cl^- and TDS concentrations at Kanjhawala were reported to be 26.26 ppm and 190 ppm, respectively. The Cl^- ion values are below the ideal limits of 250 ppm.

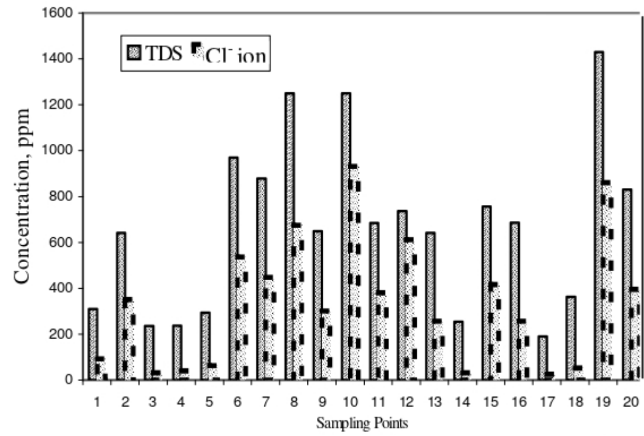

Figure 4. Values of TDS and Cl^- in groundwater samples taken from Delhi.

The lowest sulphate value was found at Fatehpur Beri, and the highest was found at Qutab Garh (73.5 ppm) (10.5 ppm). The ideal sulphate limits are 250 ppm (Figure 5).

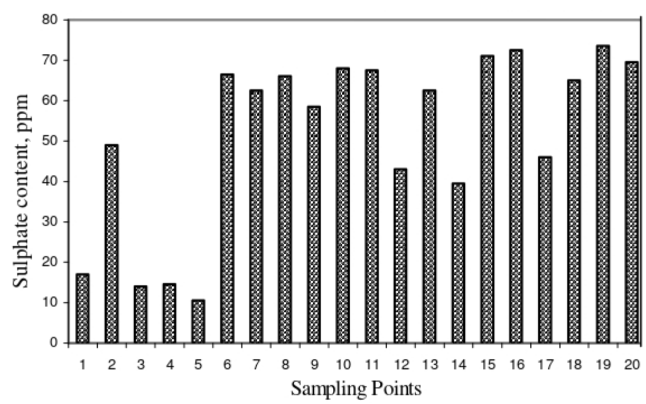

Figure 5. Sulphate content of various groundwater samples collected from Delhi.

Table 2 lists the amount of heavy metals present in water samples. The concentration of Cu varied between 0.04 and 0.01 ppm. Zn is one of the most prevalent trace elements in water, with concentrations ranging from 2.56 to 0.04 ppm.

Table 2. Concentration of heavy metals in groundwater samples of Delhi.

Sr. No.	Sampling point	Cu (ppm)	Cr (ppm)	Cd (ppm)	Co (ppm)	Zn (ppm)	Ni (ppm)
1	Sultanpuri	BDL	BDL	BDL	0.04	0.04	0.02
2	Mandi	0.01	BDL	BDL	0.07	0.10	0.06
3	Chattarpur	BDL	BDL	0.03	0.06	0.04	0.05
4	Bhati Gao	BDL	BDL	BDL	0.06	0.50	0.06
5	Fatehpuri Beri	0.03	BDL	BDL	0.07	2.60	0.13
6	Alipur	BDL	BDL	BDL	0.08	0.20	0.10
7	Singhola	BDL	BDL	BDL	0.11	1.45	0.07

8	Lampur	BDL	BDL	BDL	0.15	0.11	0.09
9	Singhu border	BDL	BDL	BDL	0.10	0.04	0.09
10	Bhakhtawar pur	BDL	BDL	BDL	0.21	0.06	0.11
11	Burari	BDL	BDL	BDL	0.13	0.04	0.10
12	Matiala	0.01	BDL	BDL	BDL	0.05	0.11
13	Nawada	BDL	BDL	BDL	BDL	0.05	0.10
14	Yamuna Vihar	BDL	BDL	BDL	0.02	0.19	0.10
15	Mangolpuri	BDL	BDL	BDL	0.02	0.30	0.09
16	Karala	BDL	BDL	0.01	0.01	1.17	0.11
17	Kanghawala	0.04	BDL	BDL	BDL	0.07	0.10
18	Khod Punjab	0.01	BDL	BDL	BDL	0.08	0.10
19	Qutab Garh	BDL	BDL	BDL	0.02	0.29	0.12
20	Bawana	BDL	0.01	BDL	0.02	0.03	0.15

The greatest Zn concentration was found at Fateh Pur Beri (2.56 ppm), yet the value is within the BIS-permitted range of 15 ppm. Co was below the detection threshold, with readings ranging from 0.2 to 0.01 ppm and occasionally zero. Except for one Bawana sample that contained 0.01 ppm of Cr, which is well under the BIS Maximum Desirable Limit of 0.05 ppm, Cr was not discovered in nearly all of the samples. Only two samples from Chattarpur and Karala had Cd identified, at concentrations of 0.03 and 0.01 ppm, respectively. All of the remaining samples' concentrations fell below the instrument's detection threshold. Ni was measured at a maximum concentration of 0.16 ppm and a low concentration of 0.04 ppm (Figure 6).

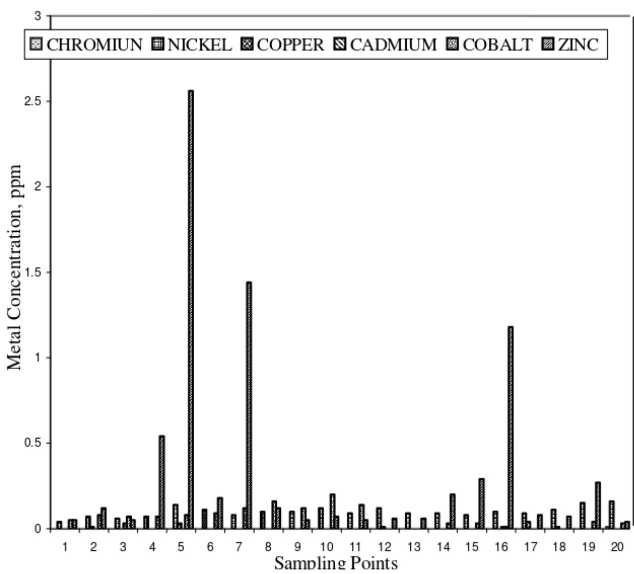

Figure 6. Heavy Metal content (ppm) in various groundwater samples of Delhi.

4 Conclusions

The results of the current examination have led us to the conclusion that the majority of the physicochemical parameters of the water samples under study were of acceptable quality and fall within the BIS's maximum allowable limits for drinking water. Zn, Ni, and Co were more prevalent than Cu, Cr, and Cd among heavy metals. The results suggest that the groundwater samples are suitable for human consumption without additional filtration.

References

[1] Water Facts- water and rivers commission, Government of Western Australia, December 1998.

[2] M.D. Kumar, S. Tushaar, The Hindu Survey of the Environment, (2004), 7-9, 11-12.

[3] L. Sanjeev, T.D. Dogra, D.N. Bhardwaj, R.K. Sharma, O.P. Murty, V. Aarti, *Ind. J. Clin Biochem*. **19** (2004) 135-140.

[4] Preventing Groundwater Contamination, Fact Sheet, Michigan Department of Environmental Quality Environ Sci Services Division (1994).

[5] S. Jasechko, Global isotope hydrogeology – Review, *Rev. Geophysics* **57** (2019) 835-965.

[6] Standard methods for the examination of water and waste water, 1985, 16th Ed., APHA, AWWA and WPCF Inc. New York.

[7] P.N. Palanisamy, A. Geetha, M. Sujatha, P. Sivakumar, K. Karunakaran, E. J. Chem. 4 (2007) 434-439.

[8] W.A. Siddiqui, M. Waseem, Ground water hydrology in Muzaffarnagar District, Uttar Pradesh, India, *Curr. World Environ*. **6** (2011) 275-278.

[9] P.T. Kadave, M.B. Bohr, A.B. Bohr, M.S. Bhosale, Physiochemical analysis of open well water samples near industrial area of Niphad, Nashik District, (Maharashtra), India, *IOSR J. Environ. Sci. Toxicol. Food. Tech.* **1** (2012) 1-4.

[10] D.G. Shah, P.S. Patel, S. Prajapati, S. Maheshwari, Physio-chemical and microbial analysis of drinking water of Kathalal Territory, Gujarat, *Int. J. Phar. Res. Allied Sci*. **1** (2012) 119-122.

Publisher's Note: Research Plateau Publishers stays neutral with regard to jurisdictional claims in published maps and institutional affiliations.