INTERNATIONAL JOURNAL OF HIGHER EDUCATION AND RESEARCH
IJHER, Vol., 9(2), 2019, 38-47.
www.ijher.com

IJHER
(ISSN 2277 260X)

CODEN:IJHER ORIGINAL ARTICLE

GROUNDWATER QUALITY ASSESSMENT OF SAMPLA (ROHTAK DISTRICT), HARYANA, INDIA – A CASE STUDY

Hemant Kumar*
School of Environmental Sciences
Jawaharlal Nehru University, New Delhi 110067, India
Corresponding Author Email: hemantjnu10@gmail.com

ABSTRACT

This study investigates different physico-chemical parameters of groundwater samples from Sampla (Rohtak district), Haryana, India. In total, 18 groundwater samples (collected from hand-pumps and tube wells) were analyzed for pH, conductivity, total dissolved solids (TDS), total hardness, total alkalinity, bicarbonate, nitrate, sulphate, chloride, sodium, potassium, calcium and magnesium ions. TDS (281-4589 mg/L), nitrate (0.0-186.0), sulphate (57.3-1320.0) and chloride (102.0-1621.0) were found to be very high in most of the samples. Results of piper diagram showed that Na^{+}-Cl^{-} type is the most dominant hydrochemical facies in the groundwater samples.

Keywords: *Water quality parameters, Groundwater chemistry, Hydrochemical facies, Sampla (Rohtak district), case study*

INTRODUCTION

Water is an indispensable natural resource and vital component to sustain life (Meenakshi and Maheshwari, 2006). Groundwater alone fulfils 61 percent of the total agriculture, domestic and industrial use. The survival of more than half of world's population depends upon groundwater (Ayoob and Gupta, 2006; Iqbal and Gupta, 2009). Thus, the availability of clean groundwater is the most essential commodity to sustain human civilization. But, sustainable groundwater sources are shrinking everyday in the world (Shah et al., 2001). Groundwater's chemical composition depends on the contact time with rocks or soil (Nag and Ghosh, 2011). Additionally, geological conditions, climate of particular terrain determine the water constituents and its consumption suitability (Brindha and Elango, 2011).

Apart from natural conditions, anthropogenic activities including population growth, overexploitation, improper solid waste disposal, industrial effluent discharge, wastewater from sewage treatment plant, agrochemicals, and agricultural fields runoff are deteriorating the

quantity and quality of groundwater (Brindha and Elango, 2011; Shah et al., 2001). Thus, the groundwater contamination is a critical issue for sustainable development around the world.

Various natural and anthropogenic activities directly affect chemical, biological and physical characteristics of water. The water contaminants including salinity (Mohanty and Rao, 2019; Maurya et al., 2019), pesticides (Mondal et al., 2018; Lapworth et al., 2018), fertilizers (Vinod et al., 2015; Rao et al., 2017), dyes (Prabha et al., 2013), heavy metals (Singh et al., 2018; Mor et al., 2018; Ahamed et al., 2018; Biswas et al., 2018), anion such as nitrate (Agrawal et al., 1999; Rawat et al., 2019) and radio isotopes (Kumar et al., 2016; Sharma et al., 2019) have been widely reported in the literature.

This study was conducted to explore various water quality parameters, its spatial distribution and contaminants sources in groundwater of Sampla block in Rohtak district, Haryana, India.

Study area

Sampla is a small town, located in south-eastern part of Rohtak district in Haryana, India. Geographical coordinates of the town falls at latitude 28º 46'30" N and 76º 46' 15" E (Fig. 1). Sampla is one of the five blocks of Rohtak district which lie in Yamuna sub-basin of the Ganga river system. The block area is mainly irrigated by artificial drain. This area is situated in subtropical climate zone which is characterized by cold and dry winter, hot summer and normal rainfall with annual average of 560 mm (CGWB, 2013). Soil type of the Sampla block is sandy loam (Hirekhan et al., 2007). The aquifer system is characterized by shallow groundwater table with fluctuation of around 1.5 m between monsoon and summer season (Rao and Leeds-Harrison, 1991).

METHODOLOGY

Sample collection

In total, 18 groundwater samples (either from hand-pumps or from electricity operated tube well) were collected from the study area in thoroughly rinsed, sterilized polyethylene bottles of one litre capacity. These groundwater sources are generally used for drinking, household and irrigation purpose. Before collecting groundwater samples, the source was run for 2-3 minutes so that the pH and conductivity could be stabilized. Samples were then taken into laboratory and stored at ambient room temperature for further physico-chemical analysis.

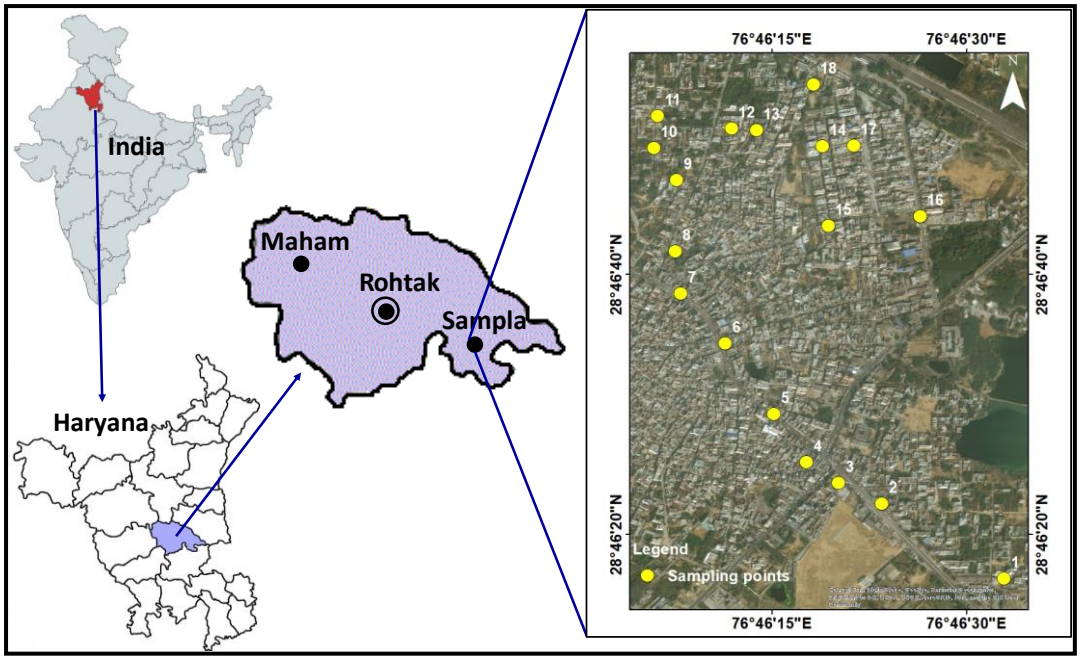

Fig. 1. Study area map showing sampling locations.

Analytical techniques

The water quality parameters of collected groundwater samples were evaluated using different analytical techniques and standard methods as mentioned in APHA (APHA, 1995). The pH, conductivity and total dissolved solids were analysed by Thermo scientific multi-ion meter (model ORION 5 STAR). Light metals like sodium, potassium and calcium were determined by flame photometer (model ELICO CL378). Alkalinity, hardness, bicarbonate and chloride concentration of groundwater samples were measured by titration method. Nitrate and sulphate on the other hand was estimated by UV-visible spectrophotometer (model Lamda35, Perkin Elmer).

RESULTS AND DISCUSSION

Groundwater chemistry

Different water quality parameters of the collected groundwater samples were analysed and shown in Table 1**.** The concentration range and values related to statistical analysis of different water quality parameters are listed in Table 2. Spatial variation of parameter's value for pH, bicarbonate, sodium, sulphate, calcium and potassium of groundwater samples were demonstrated by ArcGIS 10.2 software and shown in Fig. 2. Most of the samples pH comes

under slightly alkaline range with a mean value of 7.16. The conductivity ranges are 0.57-9.37 mS/cm with a mean value of 3.87 mS/cm. Total dissolved solids (TDS) varies from 281-4589 mg/L with a mean value 1895 mg/L. Most of the samples exceed the TDS desirable limit (500 mg/L) as recommended by BIS (BIS (IS10500), 2012). Hardness in more than 50 percent samples is much higher than the permissible limit of 600 mg/L (as $CaCO_3$). Out of eighteen, eight samples exceeded the permissible limit for nitrate (45 mg/L) for the drinking purpose. Therefore, the groundwater containing high TDS, hardness and nitrate concentration cannot be used for drinking and purification is needed for making the groundwater suitable for consumption.

Hydrochemical facies

Geochemical nature of groundwater depends upon dissolution and deposition of mineral ions. The piper diagram (also referred as trilinear diagram) is used to explore groundwater major ion chemistry and its origin (Piper, 1944). The two triangular fields at lower flanked end describe relative dominance of cations and anions in the groundwater. Central diamond-shaped field is the projection of both the triangular field and explain overall hydro-chemical facies. The collected groundwater samples were analysed for major cations and anions and introduced into piper diagram using Aqua chem 4.0 software. The piper diagram as shown in Fig. 3 indicates that about 9 (i.e. 50 percent) groundwater samples out of total fall in the field of Na^+-Cl^- type, 7 (i.e. 39 percent) in no dominance field and other 2 (i.e. 11 percent) in Ca^{2+}-Cl^- type. Thus, the most dominant hydro-chemical facie in groundwater samples is Na^+-Cl^- type.

Table 1. Results of physico-chemical parameters analysis of groundwater collected from Sampla, Haryana, India.

Sample number	pH	Cond. (mS/cm)	TDS (mg/L)	T. Hard. (mg/L as $CaCO_3$)	T. Alk. (mg/L as $CaCO_3$)	HCO_3^- (mg/L as $CaCO_3$)	NO_3^- (mg/L)	SO_4^{2-} (mg/L)	Cl^- (mg/L)	Na^+ (mg/L)	K^+ (mg/L)	Ca^{2+} (mg/L)	Mg^{2+} (mg/L)
1	6.80	3.04	1492	836	510	226	0.0	296.2	541.8	192.8	454.0	335.2	130.7
2	6.84	3.78	1846	936	1250	598	1.8	379.3	591.8	172.5	440.8	333.1	193.9
3	6.81	4.18	2050	836	660	476	14.4	398.6	681.8	189.6	437.5	323.3	138.0
4	7.46	2.48	1216	416	670	720	20.3	157.1	231.9	557.8	20.5	34.0	81.2
5	7.89	0.57	281	296	210	177	0.0	57.3	102.0	543.0	17.6	33.2	53.5
6	7.70	2.19	1071	356	590	610	30.2	147.4	201.9	543.9	14.8	27.9	60.7
7	7.40	2.21	1083	416	630	714	9.9	146.5	201.9	1389.0	26.6	58.7	65.6
8	7.09	2.25	1101	596	650	647	9.8	146.7	291.9	1379.0	23.4	58.1	112.8
9	6.57	6.76	3309	1936	250	195	186.2	531.1	1351.6	1387.0	28.8	50.6	196.3
10	6.76	3.23	1581	976	240	110	87.0	141.8	651.8	183.2	464.1	336.4	142.9
11	6.93	2.01	983	696	290	165	29.6	124.1	352.0	155.3	448.6	321.8	109.4
12	7.11	3.22	1579	1336	300	268	72.5	184.4	701.8	171.6	422.9	304.5	239.1
13	6.58	6.03	2957	2236	290	92	177.6	330.2	1371.6	525.1	19.3	30.4	154.1
14	7.11	5.90	2881	876	540	323	124.5	528.3	1141.7	520.4	17.5	28.5	173.5
15	6.94	4.30	2101	1176	640	506	86.1	502.4	691.8	517.2	14.0	23.7	229.9
16	7.75	3.41	1670	576	840	836	20.6	373.1	451.9	1407.0	26.5	58.7	122.5
17	7.92	9.37	4589	556	840	1031	138.2	1320.3	1621.5	1457.0	24.8	56.0	118.6
18	7.24	4.74	2327	776	800	641	154.4	391.0	611.8	1394.0	20.6	49.5	168.6

Table 2. Statistical summary of analyzed groundwater quality parameters.

Parameters	Min.	Max.	Mean	Median	Std. Dev.	BIS Limit	
						Desirable	Permissible
pH	6.6	7.9	7.2	7.1	0.4	6.5-8.5	No relaxation
Conductivity (µS/cm)	574.0	9370.0	3870.8	3320.0	2095.2	-	-
TDS (mg/L)	281.0	4589.0	1895.4	1625.5	1025.9	500	2000
Alkalinity (mg/L as $CaCO_3$)	210.0	1250.0	566.7	610.0	273.3	200	600
Total hardness (mg/L) as $CaCO_3$	296.0	2236.0	879.3	806.0	522.1	200	600
NO_3^- (mg/L)	0.0	186.0	64.6	29.9	65.4	45	No relaxation
SO_4^{2-} (mg/L)	57.3	1320.0	342.0	313.2	287.5	200	400
Cl^- (mg/L)	102.0	1621.0	655.1	601.8	444.1	250	1000
HCO_3^-	91.5	1030.0	462.9	491.1	278.3	-	-
Na^+ (mg/L)	171.6	1457.0	704.7	534.1	529.5	-	-
K^+ (mg/L)	14.0	464.0	162.4	25.7	205.6	-	-
Ca^{2+} (mg/L)	23.7	336.0	136.9	57.1	138.0	75	200
Mg^{2+} (mg/L)	53.5	239.1	138.4	134.4	55.0	30	100

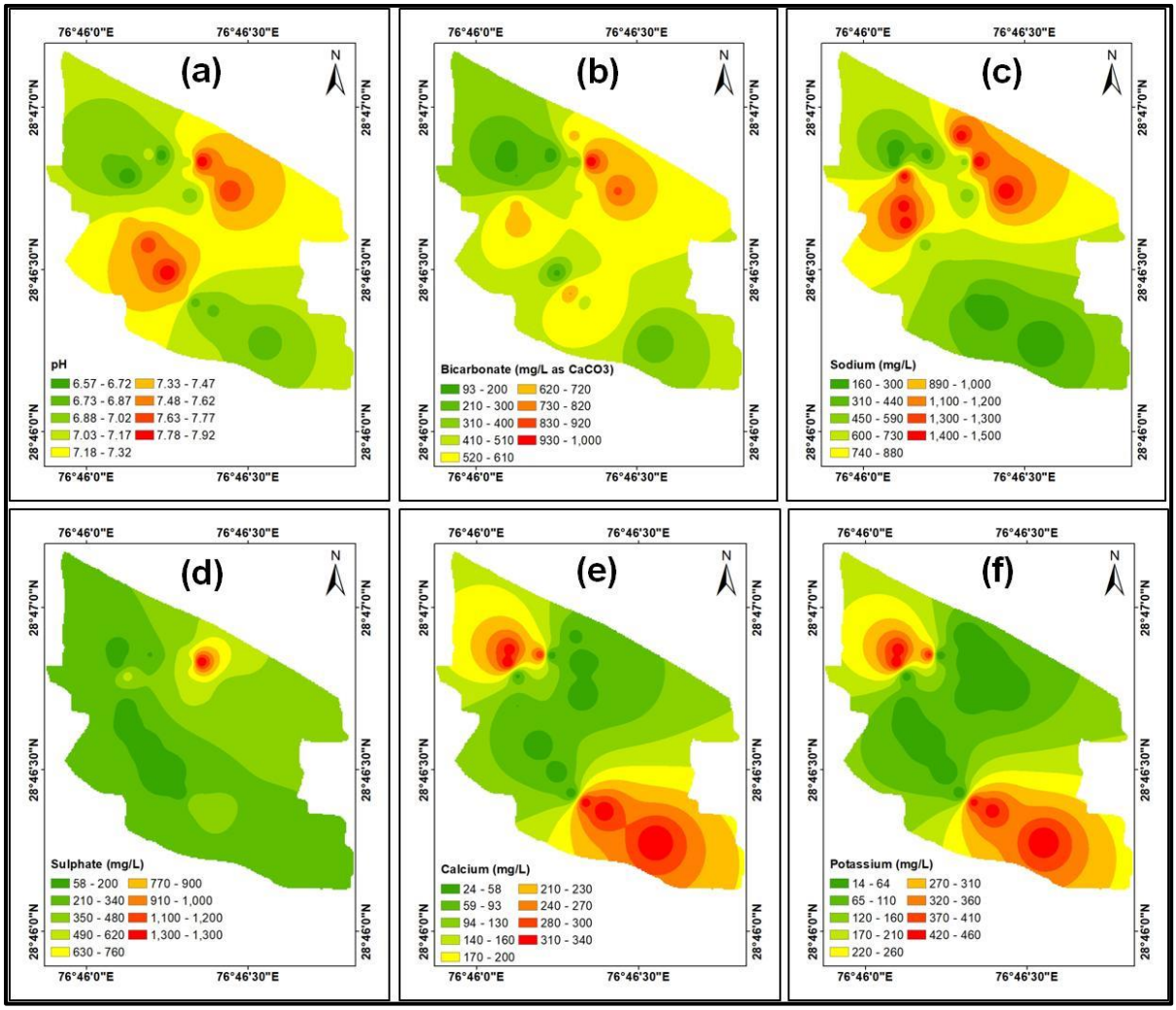

Fig. 2. Spatial variation of (a) pH, (b) bicarbonate, (c) sodium, (d) sulphate, (e) calcium and (d) potassium in groundwater of the study area

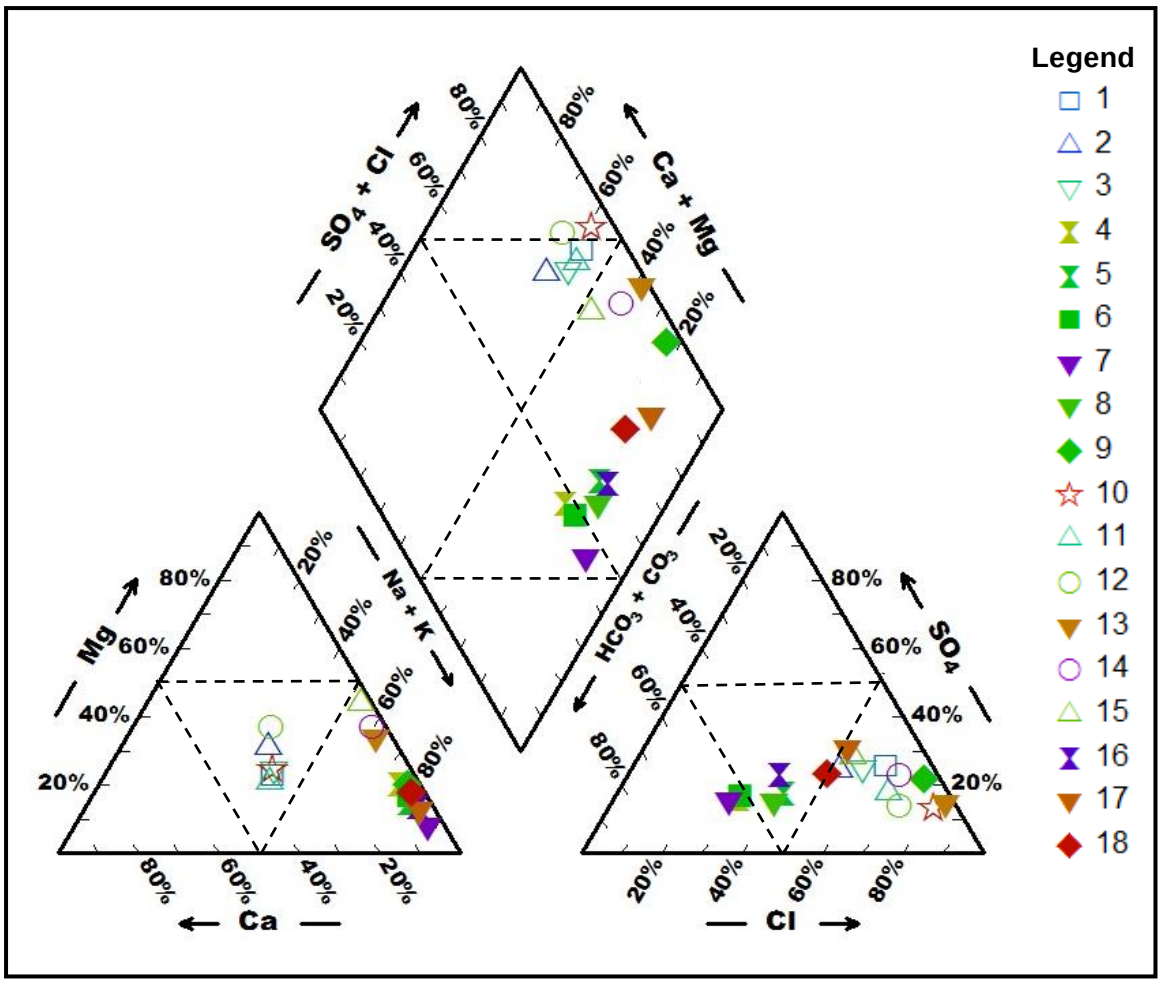

Fig. 3. Piper diagram showing water type for groundwater sample

Acknowledgement

The author is grateful to Council of Scientific and Industrial Research (CSIR), New Delhi for financial assistance and support through CSIR-SRF fellowship grant.

Conclusions

The aim of this study is to evaluate different water quality parameters of groundwater samples collected from Sampla (Rohtak district), Haryana, India. The study reveals that the Na^{+}-Cl^{-} type is the most dominant hydrochemical facie in groundwater. The pH of groundwater was slightly alkaline. Total dissolved solids (TDS), hardness, sulphate and chloride ions in most of the sample exceeded permissible limit as recommended by BIS. Therefore, the groundwater has to be purified before consumption.

REFERENCES

Agrawal, G. D., Lunkad, S. K., & Malkhed, T. (1999). Diffuse agricultural nitrate pollution of groundwaters in India. *Water science and technology*, *39*(3), 67-75.

Ahamed, M. N., Rajeshkumar, S., Ragul, V., Anand, S., & Kaviyarasu, K. (2018). Chromium remediation and toxicity assessment of nano zerovalent iron against contaminated lake water sample (Puliyanthangal Lake, Tamilnadu, India). *South African Journal of Chemical Engineering*, *25*, 128-132.

APHA, 1995. Standard Methods for the Examination of Water and Wastewater, 19th Ed.; *Washington*, DC.

Ayoob, S., & Gupta, A. K. (2006). Fluoride in drinking water: a review on the status and stress effects. *Critical Reviews in Environmental Science and Technology*, *36*(6), 433-487.

BIS (IS10500), 2012. Indian standard drinking water-specification (second revision). *Bureau of Indian Standards, New Delhi*.

Biswas, A., Biswas, S., Das, A., & Roychowdhury, T. (2018). Spatial variability and competing dynamics of arsenic, selenium, iron and bioavailable phosphate from ground water and soil to paddy plant parts. *Groundwater for Sustainable Development*, *7*, 328-335.

Brindha, K., & Elango, L. (2011). Fluoride in groundwater: causes, implications and mitigation measures. *Fluoride properties, applications and environmental management*, *1*, 111-136.

CGWB, 2013. Ground water information booklet, Rohtak district, Haryana. Central ground water board, Ministry of Water Resources, Government of India, 1-13.

Hirekhan, M., Gupta, S. K., & Mishra, K. L. (2007). Application of WaSim to assess performance of a subsurface drainage system under semi-arid monsoon climate. *Agricultural water management*, *88*(1-3), 224-234.

Iqbal, M. A., & Gupta, S. G. (2009). Studies on heavy metal ion pollution of ground water sources as an effect of municipal solid waste dumping. *African Journal of Basic and Applied Sciences*, *1*(5-6), 117-122.

Kumar, A., Karpe, R. K., Rout, S., Gautam, Y. P., Mishra, M. K., Ravi, P. M., & Tripathi, R. M. (2016). Activity ratios of 234U/238U and 226Ra/228Ra for transport mechanisms of elevated uranium in alluvial aquifers of groundwater in south-western (SW) Punjab, India. *Journal of environmental radioactivity*, *151*, 311-320.

Lapworth, D. J., Das, P., Shaw, A., Mukherjee, A., Civil, W., Petersen, J. O., Gooddy, D. C., Wakefield, O., Finlayson, A., Krishan, G., Sengupta, P., & MacDonald, A. M. (2018). Deep urban groundwater vulnerability in India revealed through the use of emerging organic contaminants and residence time tracers. *Environmental pollution*, *240*, 938-949.

Maurya, P., Kumari, R., & Mukherjee, S. (2019). Hydrochemistry in integration with stable isotopes (δ18O and δD) to assess seawater intrusion in coastal aquifers of Kachchh district, Gujarat, India. *Journal of Geochemical Exploration*, *196*, 42-56.

Meenakshi. & Maheshwari, R.C. (2006). Fluoride in drinking water and its removal. *Journal of Hazardous Materials, 37(1*), 456-463.

Mohanty, A. K., & Rao, V. G. (2019). Hydrogeochemical, seawater intrusion and oxygen isotope studies on a coastal region in the Puri District of Odisha, India. *Catena*, *172*, 558-571.

Mondal, R., Mukherjee, A., Biswas, S., & Kole, R. K. (2018). GC-MS/MS determination and ecological risk assessment of pesticides in aquatic system: A case study in Hooghly River basin in West Bengal, India. *Chemosphere*, *206*, 217-230.

Mor, S., Negi, P., & Khaiwal, R. (2018). Assessment of groundwater pollution by landfills in India using leachate pollution index and estimation of error. *Environmental nanotechnology, monitoring & management*, *10*, 467-476.

Nag, S. K., & Ghosh, P. (2011). Groundwater quality and its suitability to agriculture-GIS based case study of Chhatna block, Bankura District, West Bengal, India. *International Journal of Environmental Sciences*, *1*(7), 1770.

Piper, A. M., 1944. A geographic procedure in the geochemical interpretation of water analysis. Transactions - American Geophysical Union. 25, 914–928.

Prabha, S., Kumar, M., Kumar, A., Das, P., & Ramanathan, A. L. (2013). Impact assessment of textile effluent on groundwater quality in the vicinity of Tirupur industrial area, southern India. *Environmental earth sciences*, *70*(7), 3015-3022.

Rao, E. P., Puttanna, K., Sooryanarayana, K. R., Biswas, A. K., & Arunkumar, J. S. (2017). Assessment of Nitrate Threat to Water Quality in India. *The Indian Nitrogen Assessment: Sources of Reactive Nitrogen, Environmental and Climate Effects, Management Options, and Policies*, 323.

Rao, K. V. G. K., & Leeds-Harrison, P. B. (1991). Desalinization with subsurface drainage. Agricultural Water Management, 19(4), 303-311.

Rawat, K. S., Jeyakumar, L., Singh, S. K., & Tripathi, V. K. (2019). Appraisal of groundwater with special reference to nitrate using statistical index approach. *Groundwater for Sustainable Development*, *8*, 49-58.

Shah, T., Molden, D., Sakthivadivel, R., & Seckler, D. (2001). Global groundwater situation: Opportunities and challenges. *Economic and Political Weekly*, 4142-4150.

Sharma, T., Sharma, A., Kaur, I., Mahajan, R. K., Litoria, P. K., Sahoo, S. K., & Bajwa, B. S. (2019). Uranium distribution in groundwater and assessment of age dependent radiation dose in Amritsar, Gurdaspur and Pathankot districts of Punjab, India. *Chemosphere*, *219*, 607-616.

Singh, C. K., Kumar, A., & Bindal, S. (2018a). Arsenic contamination in Rapti River Basin, Terai region of India. *Journal of Geochemical Exploration*, *192*, 120-131.

Vinod, P. N., Chandramouli, P. N., & Koch, M. (2015). Estimation of nitrate leaching in groundwater in an agriculturally used area in the state Karnataka, India, using existing model and GIS. *Aquatic Procedia*, *4*, 1047-1053.