Bulletin of Pure and Applied Sciences.
Vol.40F, Geology (Geological Science), No.2,
July-December 2021: P.254-259
Original Article

Print version ISSN 0970 4639
Online version ISSN 2320 3234
DOI: 10.5958/2320-3234.2021.00022.6
Available online at www.bpasjournals.com

Study of Groundwater Quality for Drinking Purposes in Parts of Upper Dhudhna Basin of Maharashtra

Megha Deshmukh[1], *Afroz Osman Baig[2]

Author's Affiliations:
[1,2]Department of Geology, Maulana Azad College, Aurangabad, Maharashtra 431001, India.

***Corresponding Author: Afroz Osman Baig,** Department of Geology, Maulana Azad College, Aurangabad, Maharashtra 431001, India.
E-mail: afrozbaigg@gmail.com

(Received on 09.08.2021, Accepted on 17.11.2021)

How to cite this article: Deshmukh, M. & Baig, A.O. (2021). Study of Groundwater Quality for Drinking Purposes in Parts of Upper Dhudhna Basin of Maharashtra. *Bulletin of Pure and Applied Sciences- Geology,* 40F(2), 254-259.

ABSTRACT

Groundwater is a reliable source for drinking water and for irrigation purpose in semiarid areas of country. Composition of groundwater is generally influenced by geogenic activity and anthropogenic activities which includes population, urbanization, industrialization, dissolving of chemical from agricultural farms etc. Hence groundwater quality in aquifers gets affected which give rise to health problems. Hence it is essential to evaluate and monitor ground water quality to reduce health problems and protect drinking water quality for sustainability. Groundwater samples from thirty-five wells were collected from Uppar Dudhna river basin (GP-9 watershed) of Aurangabad district to study its groundwater geochemistry and to evaluate its suitability for drinking uses. The water samples were analyzed to determine various physic-chemical parameters like pH, electrical conductivity, total dissolved solids, total hardness, alkalinity, chloride, calcium, magnesium, sodium, potassium, fluoride and nitrate. Groundwater suitability has been evaluated through processed-based hydro geochemical signatures and is compared with the BIS (2012) concerning drinking uses shows that majority of groundwater samples are suitable for drinking purposes. The groundwater chemistry is primarily controlled by rock-water interaction.

KEYWORDS: *Groundwater, Hydro-geochemistry, Upper Dudhna, Water quality parameters.*

INTRODUCTION

Groundwater is one of the important sources of water used for domestic and industrial purpose. In Maharashtra, basaltic aquifers are the important source of groundwater. Changes in groundwater quality are due to rock–water interaction and oxidation–reduction reactions during the percolation of water through the aquifers (Kumar et al, 2009). Water is essential to sustain life and satisfactory means adequate, safe and accessible supply must be available to all. Improving access to safe drinking water can result in tangible benefits to health. Every effort should be made to provide drinking water that is as safe as practicable. Safe drinking water as defined by the Guidelines does not represent any significant risk to health over a lifetime of consumption, including different sensitivities that may occur between life stages. Those at greatest risk of waterborne disease are infants and young children, people who are debilitated and the elderly. Those who are generally at risk of waterborne illness may need to take additional steps to protect themselves against exposure to waterborne pathogens, such as boiling drinking water. Safe drinking water is required for all usual domestic purposes, including drinking, food preparation and personal hygiene. Ground water is a very valuable natural resource for the economic development and secure provision of potable water supply in both urban and rural environments (Foster et al. 2002; Ghezelsofloo and Ardalan, 2012; Wakode et al. 2014). An assessment of groundwater quality and the identification of the hydrogeochemical processes are necessary for the effective management and utilization of groundwater resources and for the assurance of drinking water safety and the promotion of environmentally sustainable development (An and Lu 2018; Appelo and Postma 2005; Hem 1991; Richards 1954; Tolera et al, 2020). The assessment and classification of groundwater based on its quality can be obtained by analyzing its chemical characteristics. Variations in ion chemistry of groundwater are used to identify geochemical processes that control the groundwater quality (Varade et al, 2018; Deshpande et al, 2021). The aim of the present study is to know the groundwater geochemistry of the GP-9 watershed and to evaluate its suitability for drinking uses.

STUDY AREA

The Upper Dhudhna basin is a parts of Aurangabad districts and located in the central part of Maharashtra, between Latitudes 19°56' and 20°03' N and Longitudes 75°26' and 75°38'E. It has a total geographical area of 176.25 km. The study area is included in the elementary watershed called as GP-9 watershed (GSDA, 2009) and is a part of Survey of India, Toposheet no. 47M / 5, 47M / 9, 46P / 8, and 46P / 12. The Dudhna River is the main drainage of the study area. The average annual rainfall is 764.20 mm with about 80% of the rainfall received during the northeast monsoon from June to October, the community in the region depends on groundwater for their use, major part of the study area fall in the agricultural activities. The whole area is underlain and surrounded mainly by basaltic lava flows belonging to the Deccan volcanic province. Weathered, fractured and jointed basalt act as good aquifers in this study area.

MATERIALS AND METHODS

A total of 35 groundwater samples were collected from various locations of the study area as per the standard protocol prescribed by APHA (1995). In this study twelve groundwater quality parameters such as pH, electrical conductivity, total dissolved solids, total hardness, calcium, magnesium, sodium, potassium, alkalinity chloride, nitrate and fluoride were analyzed. The electrical conductivity and pH were measured in immediately after the sampling. The flame photometry method was used to assess the concentration of alkali metals (Na and K). The concentrations of alkaline earth metals (Ca and Mg) and total hardness were measured volumetrically with standard EDTA. The HCO_3^- and total alkalinity were assessed by alkalinity titration. The Cl content in samples was determined by using the silver nitrate titration. The concentration of NO_3 and F were evaluated using a UV-visible spectrophotometer.

RESULTS AND DISCUSSION

Hydrochemical Facies

Groundwater classifications are used to understand the groundwater body that differs in their chemical properties and compositions (Mahlnecht et al. 2004). Depending on lithology, regional flow patterns of water and resident time hydrochemical properties of groundwater vary (Domenico, 1972).

Gibbs (1970) has established the mechanism controlling the chemical composition of water and ascertained a close relationship that exists between water chemistry and aquifer lithology. Gibbs diagram is an effective tool to comprehend the dominant hydrochemical processes and factors controlling groundwater chemistry. These are precipitation dominant, rock dominant or rock-water interaction and evaporation dominant. The result indicates that all groundwater samples of the study area fall in the rock dominant category, indicating an interaction between rocks and percolating water into the subsurface by means of mineral dissolution (Fig. 1).

Geologically, the study region is occupied by Deccan volcanic province (DVP) of basaltic rocks. The distribution of the sampling points also suggests that the major ion chemistry of the groundwater seems to be controlled by chemical weathering of rock forming minerals and anthropogenic activities (Aher, 2012; Deshpande et al, 2020).

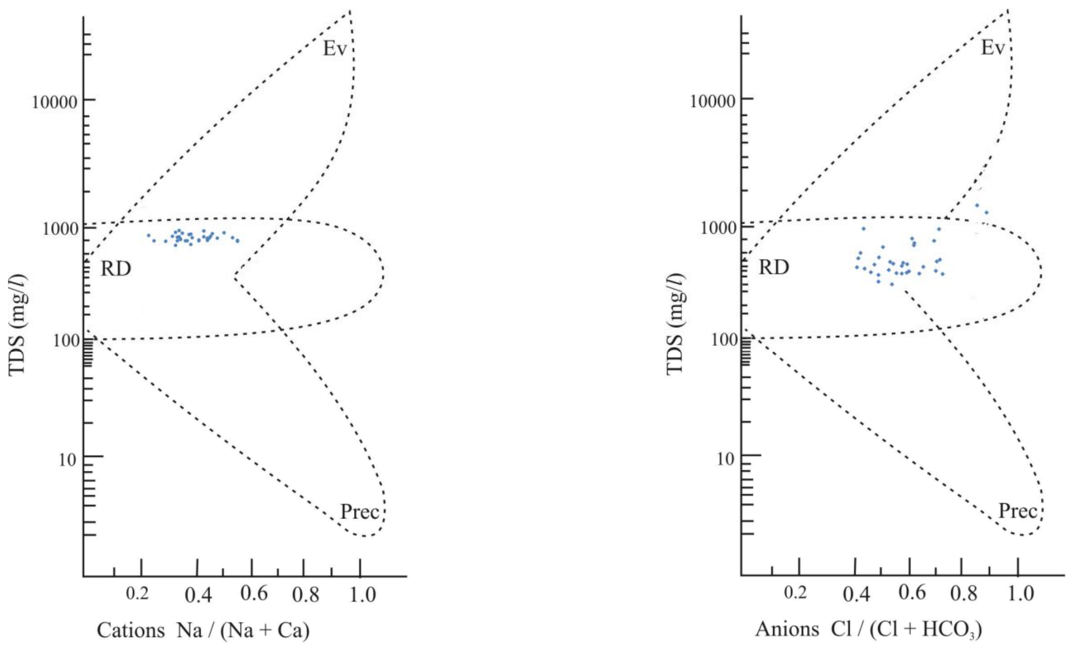

Figure 1: Mechanism controlling the groundwater chemistry (*after* Gibbs, 1970).

Groundwater Quality

pH is the measure of hydrogen ion concentration value in water which indicates whether a solution is acidic, neutral or basic. In present study, pH concentration ranges from 6.6 to 8.20 (av. 7.65), which shows that it is within the permissible limit as prescribed by BIS (2012) (Table 1). EC measures the ability of a material to conduct an electric current. Higher EC indicates enrichment of salts in the groundwater. In the study area, EC ranges from 563 to 1823 µS/cm with mean 1023 µS/cm (Table 1). EC is an approximate index of the total content of dissolved substance in water. It depends upon the type of ions present, temperature and concentration (Hem, 1991). EC can be classified as type I if the enrichment of salts is low (EC<1500 µS/cm) type II, if the enrichment of salts is medium (EC: 1500-3000 µS/cm) and type III, if the enrichment of salts is high (EC >3000 µS/cm). In the study area, 91% groundwater samples indicate type-I showing low enrichment of salts and 9 % groundwater samples falls in type –II indicating medium enrichment of salts. TDS indicate the nature of salinity in water due to leaching of salts from soil and domestic sewage (Singh et al, 2004; Aher and Deshpande, 2014).

The desirable value of TDS in groundwater is up to 500mg/L and maximum permissible limit is up to 2000mg/L (BIS, 2012). In the study area, TDS in groundwater varies from 367 to 1188 mg/L (av. 667 mg/L) (Table 1), indicating that all the groundwater samples has TDS within the permissible limit. Majority of groundwater samples showing that the quality of groundwater is fresh (TDS<1000 mg/L) and it can be used for drinking (TDS: 500-1000) (Davis and DeWiest, 1966; Todd, 1980). In the present study area, Ca concentration ranges from 27 to 143 mg/L (av. 72 mg/L), whereas Mg ranges from 20 to 75 mg/L (av. 48 mg/L) (Table 1), indicating that Ca and Mg are within maximum permissible limit given by BIS (2012). In the study area, Na varies from 8.60 to 111.20 mg/L (av. 41.59 mg/L) (Table 1). The maximum permissible of Na is 200mg/L and all the groundwater samples of the study area are within the permissible limit of BIS (2012).

Potassium (K) is an essential element for humans, plants and animals and is derived from the food chain mainly vegetation and soil. The main sources of potassium in groundwater include rain water, weathering of potassium bearing silicate minerals, use of potash fertilizers and use of surface water for irrigation (Reddy, 2012; 2014). In the study area, K concentration in groundwater samples ranges from 1.10 to 8.40 mg/L (av. 3.79 mg/L) (Table 1). The maximum permissible limit for K+ in drinking water is 12mg/L (WHO, 2004) and it has been observed that all the groundwater samples of the study area are below the permissible limit set by WHO. In the study area, Cl concentration in groundwater samples ranges from 16 to 201.94 mg/L (av. 77.23 mg/L) (Table 1). Almost all the groundwater samples show chloride Cl concentration within the allowable limit given by BIS (2012). Alkalinity in water is due to bicarbonate, carbonate and hydroxides ions and it is a measure of the capacity of water to neutralize a strong acid. In the present study area, TA concentration ranges from 120 to 412 mg/L (av. 167.20 mg/L) (Table 1).

Fluoride (F) in small amount is necessary for good health for preventing dental carries but high concentration causes health risk such as dental fluorosis and skeletal fluorosis (Baskaradoss, 2008). In present study area, F concentration in groundwater samples ranges from 0.31 to 0.58 mg/L (av. 0.39 mg/L) (Table 1) and all samples are within permissible limit for drinking purposes prescribed by BIS (2012). The main source of nitrate (NO_3) concentration in drinking water is anthropogenic activity such as septic tank, degradation of organic waste, livestock farming and domestic sewage (Aguilar, 2019; Ahamad, 2019; Chen, 2017; Jalali, 2011; Adimalla, 2020). NO3 concentration in the groundwater samples of the study area ranges from 0.18 to 1.22 mg/L (av. 0.42 mg/L) (Table 1). All groundwater samples are within limit (45 mg/L) as prescribed by BIS (2012).

Table 1: Physico-chemical parameters of groundwater of the study area

Parameter	BIS Standard	Minimum	Maximum	Mean	Std. Deviation
pH	6.5-8.5	6.6	8.2	7.65	0.43
EC		563	1823	1022.91	316.22
TDS	500-2000	367	1188	666.83	205.64
Na	200.00	8.60	111.20	41.59	26.39
K	12.00	1.10	8.40	3.79	1.66
Mg	30-100	20	75	48.03	13.82
Ca	75-200	27	143	72.46	23.86
TH	200-600	150.14	656.01	378.19	115.24
CO_3		0.00	1.76	0.27	0.55
HCO_3	200-600	120	412	167.20	51.53
Cl	250-1000	16	201.94	77.23	49.47
NO_3	45.00	0.18	1.22	0.42	0.19
F	1-1.5	0.31	0.58	0.39	0.07

CONCLUSIONS

The results of the hydrogeochemical studies carried out in study area are compared with the BIS, with the objective of inferring water quality with respect to drinking uses. The various physic-chemical parameters like pH, electrical conductivity, total dissolved solids, total hardness, alkalinity, chloride, calcium, magnesium, sodium and potassium, fluoride and nitrate was evaluated and compared with the BIS (2012) concerning drinking uses shows that majority of groundwater samples are suitable for drinking purposes. The groundwater chemistry is primarily controlled by rock-water interaction. The study concludes that the suitable managing strategy is needed to protect such valuable groundwater resources.

REFERENCES

1. Adimalla, N., Qian, H., and Tiwari, D. M. (2020). Groundwater chemistry, distribution and potential health risk appraisal of nitrate enriched groundwater: A case study from the semi-urban region

of South India. *Ecotoxicology and Environmental Safety,* 207, 111277.

2. Aguilar, L., Gallegos, A., Arias, C.A., Ferrera, I., S´anchez, O., Rubio, R., Saad, M.B., Missagia, B., Caro, P., Sahuquillo, S., P´erez, C., and Morat´o, J. (2019). Microbial nitrate removal efficiency in groundwater polluted from agricultural activities with hybrid cork treatment wetlands. *Sci. Total Environ.* 653, 723–734.
3. Ahamad, A., Raju, N.J., Madhav, S., Gossel, W. and Wycisk, P. (2019). Impact of non-engineered Bhalswa landfill on groundwater from Quaternary alluvium in Yamuna flood plain and potential human health risk, New Delhi, India. *Quat. Int.,* 507, 352-369.
4. Aher, K.R. (2012). Groundwater quality studies of Chikalthana area of Aurangabad. Unpub. Thesis submitted to Dr. B. A. Marathwada University, Aurangabad, 172p.
5. Aher, K.R. and Deshpande, S.M. (2014). Groundwater hydrochemistry of Mula River basin, Maharashtra, India. *Gond. Geol. Magz., Spl.* 14, 167-176.
6. An, Y., & Lu, W. (2018). Hydrogeochemical processes identification and groundwater pollution causes analysis in the northern Ordos Cretaceous Basin China. *Environmental Geochemistry and Health,* 40(4), 1209–1219. https://doi.org/10.1007/s10653-017-0037-0.
7. APHAC (1995). Standard methods for the examination of water and waste water. Am. Public Health Asso., 19th Edition.
8. Appelo, C. A. J., and Postma, D. (2005). Geochemistry, groundwater and pollution (2nd ed.). Boca Raton, London, New York: CRC Press, Taylor & Francis Group.
9. Baskaradoss, J.K., Clement, R.B., and Narayanan, A. (2008). Prevalence of dental fluorosis and associated risk factors in 11-15 year old school children of Kanyakumari district, Tamilnadu, India:Across sectional survey. *Indian Jour. Dental Res.,* 19(4), 297-303.
10. BIS (2012). Drinking water specifications, IInd Rev. IS10500:2012. Bureau of Indian standards, New Delhi, 16 p.
11. Chen, J., Qian, H., Wu, H., (2017). Nitrogen contamination in groundwater in an agricultural region along the New Silk Road, northwest China: distribution and factors controlling its fate. *Environ. Sci. Pollut. Res.* 24 (15), 13154–13167.
12. Davis, S. and DeWiest, R.M. (1966). Hydrogeology, Wiely, New York.
13. Deshpande S.M., Bhagwat U.S. and Aher K.R. (2021). Assessment of Groundwater Quality in parts of Jalna district of Maharashtra, India using water quality index. *Journal of Water Engg. and Management*, 2 (2), 40-47.
14. Deshpande, S.M., Shinde, P.D., Aher, K.R. (2020). Groundwater quality assessment for drinking purpose in Aurangabad urban city, Maharashtra, India. *Jour. Geosci. Res.,* 5(2), 123-132.
15. Domenico P.A. (1972). Concepts and models in groundwater hydrology. McGraw-Hill, New York. 72.
16. Foster, S., Hirata, R., Gomes, D., D'Elia, M. and Paris, M. (2002). Groundwater quality protection: a guide for water utilities, munciple authorities and environment agencies. The international Bank for Reconstruction and Development/World Bank Technical Paper. Washington, D.C.
17. Ghezelsofloo, A.A. and Ardalan, V.R. (2012) Identifying the major sources of groundwater contaminants and estimating their pollutions potential in the Mashhad plain aquifer. Groundwater Modeling and Management under Uncertainty Proceedings of the Sixth IAHR International Groundwater Symposium Kuwait, pp.69–76. doi: 10.1201/b13167-13.
18. Gibbs, J.R. (1970). Mechanisms controlling world water chemistry. *Science* (80) 170, 1088–1090.
19. GSDA (2009). Comprehensive Base Line Systematic Hydrogeological Survey Report of GP-9 Pilot, Aurangabad District, Aquifer Water Management Pilot Project, Groundwater Surveys and Development Agency, GoM. Pp.1-80.
20. Hem, J. D. (1991). Study and Interpretation of the Chemical Characteristics of Natural Water (Third.). United States Government Printing Office.
21. Jalali, M. (2011). Nitrate pollution of groundwater in Toyserkan, western Iran. *Environ. Earth Sci.* 62 (5), 907–913.
22. Kumar, S. K., Rammohan, V., Sahayam, J. D., & Jeevanandam, M. (2009). Assessment of groundwater quality and hydrogeochemistry of Manimuktha River

basin, Tamil Nadu, India. *Environmental Monitoring and Assessment,* 159(1), 341-351.

23. Mahlnecht J, Steinch B, Navarro de León I (2004) Groundwater chemistry and mass transfers in the Independence aquifer, central Mexico, by using multivariate statistics and mass-balance models. *Environ Geol* 45, 781–795. doi:10.1007/s00254-003-0938-3
24. Reddy, C.S.L., Deshpande, S.M., Aher, K.R. and Humane, K. (2014). Impact of mining on groundwater quality in and around Mangampeta, Andhra Pradesh. Gond. *Geol. Magz., Spl.* 14, 177-185.
25. Reddy, L. C. S., Deshpande, S. M., Reddy, K. R., and Aher, K. R. (2012). Hydro geochemical processes in the groundwater environment of Vemula area, Kadapa District, South India. *Int. J. Recent Trends Sci. Technol,* 3(1), 18-24.
26. Richards L.A (Ed.). (1954). Diagnosis and Improvement of Saline and Alkaline Soils. U. S. Government Printing Office Washington 25, D. C.
27. Singh, K.P., Malik, A., Mohan, D. and Sinha, S. (2004). Multivariate statistical techniques for the evaluation of spatial and temporal variations in water quality of Gomti River (India)-a case study. *Water Res.*, 38(18), 3980-3992.
28. Todd, D.K. (1980). Groundwater hydrology. Wiley, New York.
29. Tolera, M. B., Choi, H., Chang, S. W., & Chung, I. M. (2020). Groundwater quality evaluation for different uses in the lower Ketar Watershed, Ethiopia. *Environ Geochem Health,* 42, 3059–3078. https://doi.org/10.1007/s10653-019-00508-y
30. Varade, A.M., Yenkie, R.O., Shende, R.R., Golekar, R.B., Wagh, V.M. and Khandare, H.W., (2018). Assessment of water quality for the groundwater resources of urbanized part of the Nagpur District, Maharashtra (India). *American Journal of Water Resources,* 6(3), 89-111.
31. Wakode, H.B., Baier, K., Jha, Ahmed, S. and Azzam, R. (2014) Assessment of Impact of Urbanization on Groundwater Resources using GIS Techniques-Case Study of Hyderabad, India. Internat. *Jour. Environ. Res.*, 8(4), 1145–1158.
32. WHO (2004). Guidelines for drinking water quality. World Health Organisation, Geneva.

****