ChemTech

International Journal of ChemTech Research
CODEN(USA): IJCRGG ISSN : 0974-4290
Vol. 3, No.3, pp 1129-1134, July-Sept 2011

Physicochemical and statistical evaluation of groundwater of some places of Deesa taluka in Banaskantha district of Gujarat state (India)

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Abstract: The demand of water is incessantly rising in today's world due to substantial increase in population and human activities. As a complementary resource to surface water, groundwater is a precious natural resource for drinking water. Like the other natural resources, it should be monitored sporadically and citizens should be made aware of the quality of drinking water. For the present study, different samples of groundwater were collected from the locations of Deesa taluka of Gujarat state of India and analysed for their physicochemical parameters like temperature, colour, odour, turbidity, electrical conductance (E.C.), pH, total dissolved solids (TDS), total alkalinity and concentrations of ions like fluoride, calcium, magnesium and nitrate. The results were compared with the drinking water standards of ICMR and WHO (1993). For the statistical analysis, values of mean, standard deviations and correlation co-efficients (r) were calculated.

Key words: Physicochemical characteristics, groundwater, correlation co-efficient, quality, welfare of human being.

Introduction

Without water, life can not survive. Water and life are two sides of the same coin. Life initiates and grows in the lap of water. Water is very vital to all forms of life: from very small living creatures to very complex systems of animals and human being. The purity of water varies from place to place in nature. Rain water, if not contaminated by atmospheric pollutants, is highly pure while the sea water contains large amount of salt. Water for a variety of uses can be obtained from the sources like precipitation in the form of rain, snow and hail while surface water in the form of glaciers, streams, rivers and sea water. Besides these sources of water, there is also a natural rich source of water in the form of groundwater which is complementary to the surface water.

Groundwater occurs as a part of the hydrological transformations of permeable structured zones of the rocks, gravel and sand. Groundwater can be obtained from aquifers and hypopheric zones. Fractured crystalline bedrocks are excellent sources of potable water in many parts of the world. Groundwater satisfies the domestic, agricultural and industrial need of the people. In today's world, the demand of water is swiftly increasing due to substantial increase in population, industrialisation and urbanisation. This demand is fulfilled by surface water and groundwater. Both the water resources largely bank on ice melting and rainfall. In this scenario, to provide safe drinking water is a very big accountability for the governments. Today, a big part of the population does not have pure water to drink. Easily and regularly available clean drinking water is still a harsh task to achieve not only in deserts but also in most of the mega cities and small towns.

In rural arid and semi arid regions, where well managed water transportation system and related infrastructures are not available, groundwater serves as chief source of drinking water. Groundwater is an excellent reservoir of water but as rivers, lakes and streams are influenced by natural and human factors, groundwater is also facing the same situation around the world. Human activities, hydrological aspects and characteristics of recharged water affect the quality of groundwater. As groundwater is used in high extent, some troubles are created such as water logging, land subsidence, lowering of water table, sea water intrusion in coastal aquifers and deterioration in water quality [1]. Groundwater is a very sensitive topic which has significance not only at local level, but at global level also. [2-4]. Similar to other countries, issue of groundwater has become an issue of importance for the progress of India. Unrestricted exploration of groundwater and excessive use of fertilizers and pesticides make possible the infiltration of detrimental constituents to the groundwater. Domestic and industrial waste also defiles groundwater [5]. As a result, groundwater becomes unhygienic [6-7].

Groundwater is a valuable asset for any country of the world. In India, as groundwater is ultimate and key water resource, people use groundwater for drinking purpose. In addition to this, groundwater is also used in agricultural and industrial fields.

If the groundwater used for drinking and other domestic activities is contaminated, it creates intimidation to the health of the people. Hence, periodical evaluation of water quality requires serious attention. Water quality assessment is pre-requisite to the water quality management. To protect and manage quality and quantity of groundwater is essential for the healthy development of any country.

Experimental

The present study is related to the groundwater quality of some places of the Deesa Taluka which is situated in Banaskantha district of Gujarat state of India. In this taluka, agriculture and dairy production are the major monetary activities. Potatoes, Wheat, Bajara, Juwar, Maize and Groundnuts are generally the crops which are cultivated here. From this taluka, groundwater samples of bore wells were collected in November-December, 2009. The samples were collected from the different places like: (a) Aseda, (b) Kuchavada, (c) Deesa, (d) Juna Deesa, (e) Dama, (f) Bhiladi. These samples were collected, preserved and analysed for physicochemical characteristics such as temperature, colour, odour, turbidity, electrical conductance, pH, total dissolved solids, total alkalinity, chemical oxygen demand and concentrations of ions like chloride, fluoride, calcium, magnesium and nitrate by the standard methods which are described in the literature [8-15].

Results and Discussion

Values of different physicochemical characteristics are shown in **Table-1**. Quality of these water samples is compared with the Indian Council of Medical Research (ICMR: 1975) specifications for drinking water and standards suggested by the World Health Organisation (WHO: 1993) for water. These agencies drew up directives for the purity of water intended for human consumption.

Temperatures of these samples were in the range of $25^{o}C$ to $26^{o}C$. It was noted by direct observation that all the water samples were found colourless and clear. Similarly, direct inspection of the samples for odour was done and found that samples were odourless.

Turbidity is a measure of murkiness of water. Turbidity is the condition which results due to the suspension of solid particles in water. High value of turbidity indicates presence of many suspended particles in it. It is an important factor for characterisation of water [16]. Clear water contains low turbidity level while muddy water contains high turbidity level. For all the water samples, turbidity was in the range of 1 to 3 NTU (Nephelometric Turbidity Unit) having standard deviation of 0.75. It indicates that suspended and colloidal matters like decomposed vegetation, sewage, sediments and clay particles are present in very negligible amount in the samples of water.

High values of electrical conductivity (E.C.) exhibits large amount of salts dissolved in water. This kind of property is not desired because it makes water inappropriate for drinking purpose. Electrical conductivity of these water samples varied from 1069 to 1540 $\mu s\ cm^{-1}$ having standard deviation of 183.37 $\mu s\ cm^{-1}$.

pH is a measure of hydrogen ion concentration. The pH value of water is indication of how acidic or basic the water is on the scale of 0 to 14. Generally, pH values of groundwater are variable in the range of 3 to 10 [17]. pH values of water samples were found in the range of 8.20 to 9.55 having mean value 8.87 and standard deviation 0.54. pH values (>7) are indicative of alkaline nature of water. Four samples (a, b, c and f) were beyond the desirable limit of pH suggested by ICMR, while two samples (b & c) were violating the maximum permissible limit of pH (ICMR). Only two samples (d & e) were within the WHO standards for pH.

Table-1: Values of physicochemical parameters

Parameter	a	b	c	d	e	f	Mean	S. D.	ICMR Standards 1975		WHO Standards 1993
									DL	MPL	
Temp ^{0}c	25	25	26	26	25	26	25.50	0.55	-	-	-
Colour	Cl	Cl	Cl	Cl	Cl	Cl	-	-	-	-	-
Odour	Ol	Ol	Ol	Ol	Ol	Ol	-	-	-	-	-
Turbidity (NTU)	2	2	1	2	3	1	1.83	0.75	-	-	<5*
E.C.(µs cm^{-1})	1410	1540	1390	1130	1408	1069	1324.50	183.37	-	-	250*
pH	8.80	9.55	9.25	8.30	8.20	9.10	8.87	0.54	7.0-8.5	6.5-9.2	(6.5-8.5)*
TDS (mg/l)	1230	1192	800	870	986	695	962.17	215.08	500	1500-3000	-
Total Alkalinity (mg/l)	244	278	256	173	165	262	229.67	48.32	-	-	-
F^{1-} (mg/l)	1.20	1.56	1.09	0.88	1.27	1.6	1.27	0.28	1	1.5	1.5
Ca^{2+} (mg/l)	124.44	109.50	72.14	89.00	107.00	96.00	99.68	18.16	75	200	-
Mg^{2+} (mg/l)	72.85	70.40	48.03	60	79.30	41.17	61.96	14.97	50	-	-
NO_3^{1-} (mg/l)	2.40	2.58	3.57	3.05	2.89	3.40	2.98	0.46	-	-	-

Cl : Clear, **Ol :** Odourless, **S.D.** : Standard Deviation, **DL** : Desirable Limit,
MPL : Maximum Permissible , Limit, *** :** Desirable Limit.

As water is very good solvent, it picks up many impurities. Total dissolved solids in water originates from various factors like minerals, sewage, natural sources, the nature of piping which is used to convey the water, agricultural runoff, etc. The value of TDS describes the general quality of water. TDS values for the samples varied from 695 to 1230 mg/l. For TDS, ICMR suggests 500 mg/l as the desirable limit while 1500-3000 mg/l as the maximum permissible limit in the absence of alternate source. Here, all the samples (a to f) showed TDS values which were exceeding the desirable limit. High TDS value reduces the quality and affects the taste of water.

Excessive alkalinity may cause eye irritation in human and chlrosis in plants [18]. If alkalinity value in drinking water is higher than 200 mg/l, the taste of the water becomes unlikable. In the water samples, total alkalinity was from 165 to 278 mg/l having mean value 229.67 and standard deviation 48.32.

In water resources, concentration of fluoride is increasing due to geochemical dissolution of fluoride containing minerals, fast urbanization and modern industrialization. The amount of fluoride in ground water varies greatly in the same region. Vertically and horizontally, fluoride is distributed in groundwater in uneven manner [19]. Presence of large amount of fluoride (> 1.5 mg/l) is associated with dental and skeletal fluorosis, while inadequate amount of fluoride (<1.0 mg/l) is associated with dental carries. Large population in India is affected by fluorosis. In groundwater, fluoride is found in different concentrations [20-23]. The F^{1-} concentration in samples was from 0.88 to 1.6 mg/l having mean value 1.27. Two samples (b and f) were slightly violating permissible limit (1.0-1.5 mg/l) indicated by ICMR and WHO while the other samples were within the permissible limit for fluoride.

Calcium is a chief constituent of different types of rocks. It is a cause for hardness in water. Similarly, magnesium is also responsible for hardness of water. With an increase in hardness of water, its suitability decreases for cooking, cleaning and laundry jobs and if the concentration of magnesium is more than 300 mg/l, it is toxic [24]. In the samples, Ca^{2+} concentration ranged from 72.14 to 124.44 mg/l, while Mg^{2+} content was found from 41.17 to 79.30 mg/l. So, the amount of Ca^{2+} present in the samples was within the desirable limit indicated for Ca^{2+} by ICMR. No sample was exceeding the maximum permissible limit indicated by ICMR. Four samples (a, b, d and e) were exceeding the desirable permissible limit for Mg^{2+} suggested by ICMR.

Table - 2: Correlation matrix

Parameter	Temp. ^{0}c	Turb. (NTU)	E.C. (µs cm^{-1})	pH	TDS (mg/l)	T.A. (mg/l)	F^{1-} (mg/l)	Ca^{2+} (mg/l)	Mg^{2+} (mg/l)	NO_3^{1-} (mg/l)
Temp ^{0}c	1.000									
Turb.(NTU)	-0.728	1.000								
E.C.(µs cm^{-1})	-0.766	0.396	1.000							
pH	0.034	-0.636	0.329	1.000						
TDS(mg/l)	-0.885*	0.560	0.761	0.088	1.000					
T. A.(mg/l)	0.015	-0.678	0.242	0.964**	0.110	1.000				
F^{1-} (mg/l)	-0.304	-0.147	0.143	0.582	0.084	0.614	1.000			
Ca^{2+}(mg/l)	-0.842	0.564	0.364	-0.106	0.793	0.027	0.359	1.000		
Mg^{2+}(mg/l)	-0.895	0.924**	0.654	-0.389	0.824*	-0.411	-0.092	0.707	1.000	
NO_3^{1-} (mg/l)	0.863*	0.642	-0.541	0.090	-0.948**	0.030	-0.112	-0.908*	-0.833*	1.000

Turb. : Turbidity, **T.A. :** Total Alkalinity
* Correlation is significant at the 0.05 level (2-tailed).
** Correlation is significant at the 0.01 level (2-tailed).

In groundwater, nitrate may result due to livestock facilities, agrochemicals and sewage disposal [25]. Increasing presence of nitrate in water is a big threat to the public health. The nitrate rich water is not fit for drinking [26]. Excess of nitrate in drinking water may become the cause of methemoglobinemia (blue baby syndrome) [27]. The nitrate values of the samples varied from 2.40 to 3.57 mg/l having mean value 2.98 and standard deviation 0.46. Hence, the observed values were not too high.

Statistical Analysis

For the values of physicochemical parameters, mean and standard deviation are calculated and are shown in **Table-1**.

In statistics, correlation is a broad class of statistical relationship between two or more variables. Hence, it can be considered as a normalized measurement of covariance. The correlation study is useful to find a predictable relationship which can be exploited in practice. It is used for the measurement of the strength and statistical significance of the relation between two or more water quality parameters. Hence, it is a helpful tool for the promotion of research activities [28-29]. It can put forward possible causal or mechanistic relationships of research work [30]. The correlation coefficients(r) were calculated and correlation matrix was obtained [31-35]. Here, r is a dimensionless index which is in the range of -1.0 to +1.0 inclusive. It exhibits the extent of a relation between variables. The values of correlation coefficients are listed in Table-2**.** Very high positive correlation was found between temperature and NO_3^{1-}, total alkalinity and pH, Mg^{2+} and TDS, Mg^{2+} and turbidity. Very poor positive correlation was found between E.C. and turbidity, E.C. and pH, total alkalinity and E.C., F^{1-} and E.C., Ca^{2+} and E.C., pH and TDS, NO_3^{1-} and pH, total alkalinity and TDS, F^{1-} and TDS, Ca^{2+} and F^{1-}. Very negligible positive correlation was observed between pH and temperature, total alkalinity and temperature, Ca^{2+} and total alkalinity, NO_3^{1-} and total alkalinity. Very high negative correlation was observed between TDS and temperature, Ca^{2+} and temperature, Mg^{2+} and temperature, TDS and NO_3^{1-}, Ca^{2+} and NO_3^{1-}, Mg^{2+} and NO_3^{1-}.

Conclusion

Water is indispensable not only for the existence of the mankind but also for human development and healthy functioning of the eco-system. The present study has led to conclude that the quality of water samples studied were acceptable from the majority of the physicochemical parameters but as TDS values of most of the samples were violating the desirable limit suggested by ICMR, the water should be treated properly before its usage as drinking water to avoid probable adverse effects. Therefore, public should be made aware of drinking water quality and careful management of precious natural resources. Water quality also should be monitored continuously for the welfare of the human being.

References

[1] Rastogi A.K., in Inland Water Resources-India, Vol.-2, Durgaprasad M.K., Sankara P. Pitchaiah (Eds.), Discovery Publishing House, New Delhi (India), 1999, 305.

[2] Shahbazi A., Esmaeili-sari A., Groundwater Quality Assessment in North of Iran, A case Study of the Mazandaron Province, World Applied Sc. J., 2009, 5, 92-97.

[3] Konstantopoulou F., Lin S., Papageorgion L.G., Gikas P., Water Resources Management for Paros Island, Greece, Int. J. Sustainable Water and Environmental System, 2011, 2(1), 1-6.

[4] Nwidu L.L., Oveh B., Okoriye T., Vaikosen N.A., Assessment of the Water Quality and Prevalence of Waterborn Diseases in Amassoma, Niger Delta, Nigeria, African J. Biotechnol., 2008, 7(17), 2993-2997.

[5] Aoto O., Adiyiah J., Chemical Analysis of Drinking Water From Some Communities in the Brong Ahafo Region, Int. J. Environ. Sci. Tech., 2007, 4(2), 211-214.

[6] Rajankar P.N., Gulhane S.R., Tambekar D.H., Ramteke D.S., Wate S.R., E. J. Chem., 2009, 6(3), 905-906.

[7] Alam M., Rais S., Aslam M., Hydrochemical Survey of Groundwater of Delhi, India, E. J. Chem., 2009, 6(2), 429-430.

[8] Food and Agriculture Organization (FAO), Chemical Analysis Manual for Food and Water, FAO, Rome, 1997, 20-26.

[9] Gray N.F., Water Technology-An Introduction for Environmental Scientists and Engineers, Viva Books Pvt. Ltd., New Delhi (India), 1999, 134-144.

[10]Clesceri L.S., Greenberg A.E., Eaton A.D. (Eds.), Standard Methods for the Examination of Water and Wastewater, American Public Health Association(APHA), American Water Works Association (AWWA), Water Environment Federation (WEF), Washington D.C., 20 th edition, 1998.

[11] Trivedi R.K., Goel P.K., Chemical and Biological Methods for Water Pollution Studies, Environmental Publication, Karad (India), 1986, 1-112.

[12]Abbasi S.A., Water Quality, Sampling and Analysis, Discovery Publishing House, New Delhi(India), 1998, 1-12, 13-33, 51-57, 65-82, 102-110.

[13]Barcelona M.J., Gibb J.P., Miller R.A., A Guide to the Selection of Materials for Monitoring Well Construction and Groundwater Sampling, ICWS Contract Report 327, Illinois State Water Survey, Champaign, Illinois, 1983, 78.

[14]Nkansah M.A., Ephrain J.H., Physicochemical Evaluation of the Water From Boreholes Selected From E J and BAK Districts of the Ashanti Region of Ghana, Thammasat Int. J. Sc. Tech., 14(3), 2009, 64-73.

[15]Kudesia V. P., Water Pollution, Pragati Prakashan, Meerut (India), 2007, 555-591.

[16] Khopkar S.M., Environmental Pollution Analysis, Wiley Eastern Ltd., New Delhi (India), 1993, 86-87.

[17]Ruhela A., Recent Advances in Environmental Science, Oxford Book Company, Jaipur (India), 2008, 13.

[18] Sisodia R., Moundiotiya C., J. Environmental Hydrology, 2006, 14, Paper-23, 1-11.

[19] Tewari A., Dubey A., J. Chemical and Pharma. Research, 2009, 1(1), 31-37.

[20] Dinesh C., Indian J. Environ. Prot., 19(2), 1999, 81-89.

[21]Yadav J.P., Lata S., J. Indian Water Works Association, 2004, 131-136.

[22]Gupta S.C., Rathore G.S., Doshi C.S., Ind. J. Environ. Hlth., 1993, 35(2), 97-106.

[23] Ram Gopal, Gosh P.K., Def. Sci. J., 35(1), 1985, 71-88.

[24]Venkateswarlu K.S., Water Chemistry-Industrial and Power Station Water Treatment, New Age International Pvt. Ltd., New Delhi (India), 1999, 7, 11.

[25]Agrawal G.D., Lunkad S.K., Malkhed T., Water Sci. Tech., 1999, 39(3), 67-75.

[26]Ghosh S., Environmental Chemistry, Dominant Publishers and Distributors, New Delhi (India), 2003, 47.

[27] Santro S.C., Environmental Science, New Central Book Agency Pvt. Ltd., Kolkata (India), 2008, 226.

[28]Joshi D.M., Bhandari N.S., Kumar A., Agrawal N., Statistical Analysis of Physicochemical Parameters of Water of River Ganga in Haridwar District, Rasayan J. Chem., 2009, 2(3), 579-587.

[29] Jain N., Saxena S., Shrivastava R.K., Correlation Coefficient of Some Physicochemical Characteristics of Groundwater of Jabalpur, Ind. J. Environ. Prot., 2004, 24(1), 57-59.

[30]Cohen J., Cohen P., West S.G., Alken L.S., Applied Multiple Regression / Correlation Analysis for the Behavioural Sciences, Hillsdale Lawrence Erlbaum Associates, 3rd edition, 2003.

[31]Gilbert R.O., Statistical Methods for Environmental Pollution Monitoring, Van Nostrand Reinhold Co., New York, 1987, 320.

[32] Mahadev J., Hosamani S.P., Ahmed S.A., World Appl. Sci. J., 2010, 8(11), 1370-1380.

[33]Box G.F.P., Hunter W.G., Hunter J.S., Statistics for Experiments, An Introduction to Design, Data Analysis and Model Building, John Wiley and Sons, Toronto, 1978, 653.

[34]Chapman D.(Ed.), on the behalf of UNESCO,WHO, UNEP, Water Quality Assessments-A Guide to Use Biota, Sediments and Water in Environmental Monitoring, F & F Spon, London, 1996, Chapter-9.

[35]Prasad R. N., Chandra R., Tiwari K. K., A Correlation Study of Ground water Chemistry of Bapi and Sundarsanpura Industrial Area of Dausa District, Rajasthan, Poll. Res., 2010, 29(2), 359-363.

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