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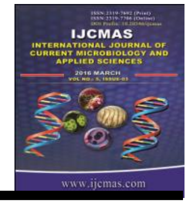

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Assessment of Ground Water Quality and its Suitability for Drinking and Domestic Uses by Using WQI and Statistical Analysis in River Basin Area in Jahzpur Tehsil, Bhilwara District (Rajasthan, India)

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An attempt had made to understand the ground water quality and its suitability for drinking and other uses by using water quality index (WQI) in river basin area in Jahazpur tehsil, Bhilwara district (Rajasthan, India). It is a technique of rating water quality. A comprehensive assessment of water quality parameters in ground water samples was carried out which were collected from 40 different locations of study area from dug wells, tube wells, hand pumps and PHED supply in 2014. For calculating water quality index nine parameters had selected such as pH, TDS, TH, EC, Cl^-, F^-, NO_3^-, HCO_3^- and DO. The average value of water quality for samples was found 22.94. 72.50% samples water was found in excellent category and 27.50% water samples in good WQI. The ground water of study area found alkaline, fresh to brackish type, brackish-salty to saline type and very hard category, 37.50% sample exceeded fluoride and nitrate concentration, Hardness is exceeded in most of the samples. WQI indicates that ground water from most of the samples is suitable for drinking and domestic purposes but need proper removal of excess TH, TDS, Cl^-, F^-, NO_3^- and HCO_3^-. Correlation coefficient values revealed that some parameter pairs have very strong and strong positive correlation but not have very strong and strong negative correlation.

Introduction

Water is essential for all forms of life including human beings. Groundwater is the sole resource of drinking water in arid areas, which is also used in domestic consumption and irrigation (Switzman *et al.*, 2015). Information about groundwater occurrence and recovery is critical in the arid and semi-arid areas because of the poor yearly precipitations rate and over use of groundwater resources in these areas (Hussain *et al.*, 2013). On the other hand, groundwater quality is dominant to use it as drinking water or in domestic uses and irrigations; its quality depends on different factors such as recharged water quality, rainfall, geochemical processes, and human activities (Vasanthavigar *et al.*, 2010). The ground water quality is degraded by modern civilization, industrialization, urbanization and increase in population (Bhattacharya, 2012). In several states of India, more than 90% of populations are dependent on groundwater for drinking and other purpose (Varadarajan *et al.*, 2011). Water pollution affects simultaneously the water quality and threats the economic development and social prosperity by affecting the human health (Al-Rajab 2014). Physico-chemical properties of groundwater are being the key tool to estimate the water quality and its suitability for drinking, irrigation, or domestic uses (Subha, 2006).Water quality analysis is one of the most important aspects in groundwater studies. The hydro chemical study reveals quality of water that is suitable for drinking, agriculture and industrial purposes. Water quality standards help to identify problems caused by improperly treated waste water discharge from active or abandoned mixing sites, sediments and fertilizers. These standards also support efforts to achieve and maintain protective water quality conditions (CGWB, 2004 and Gajendra *et al.*, 2008). A continuous monitoring of groundwater becomes mandatory to minimize the groundwater contamination and to make control over the pollution causing agents. Usually ground water quality modified by the hydrological cycle that depends on the natural and anthropogenic processes. Change in quality of natural waters may disturb the equilibrium in between different forms of life and ultimately would become unfit for intended purpose of the human being. In Rajasthan Bhilwara district including Jahazpur tehsil have fluoride problem (Meena *et al*. 2015), Tonk district affected with excess fluoride and hardness and other districts also affected with fluoride, hardness, nitrate and other water parameter born problems (Meena *et al*, 2012). The main objective of the present research work is to study the distribution of physic-chemical parameters in ground water of river basin area in Jahazpur tehsil, Bhilwara district (Rajasthan, India), discuss the major ion chemistry and to provide reliable water quality data and to design economically effective methods for treatment of ground water and to make the water potable with standards permissible limits of pollutants. In this case the methods proposed by WQI, TDS, EC and TH classification and correlation study have been used to study critically the hydrochemical characteristics of ground water of study area to evaluate its suitability for drinking and domestic purposes.

Materials sand Methods

Study Area

The Bhilwara district is situated between $25^0$01’ & $25^0$58’ North latitude and $74^0$01’ & $75^0$28’ East longitude covering geographical area of 10,455 sq km and part of semiarid zone. It is part of semiarid zone and hydrogeology is phyllite and schist and Granite and gneiss type, Potential zone yield is 30-50 m^3/day (CGWB, 2013). Bhilwara district is part of Ajmer division and comprises of 12 tehsils & 11 blocks in these one of the Jahazpur tehsil that is situated at north eastern part of district. Jahazpur tehsil comprises of 37 panchayats and one municipality and its hydrogeology is phyllite and schist type and situated between $25^0$21’6”N to $25^0$46’23”N longitude and $75^0$2’50”E to $75^0$27’42”E latitude. The climate of the tehsil is generally dry except in the short south-west monsoon season. Jahazpur belt rocks are considered as early proterozoic and these rocks are encompassed by quartz, soda feldspar, biotite, potash feldspar, hornblende, actinoite along with zircon and apatite.

Methodology

Ground water samples from 40 sampling

sites were collected in pre cleaned, dry and sterilized plastic bottles. Water samples from hand pumps, dug wells and bore wells have been collected in 2014 during the pre-monsoon period. The collected samples were carefully sealed with proper labelling. For all samples, temperature, pH and electrical conductivity (EC) were determined in the field with standard field equipment's. Samples were analysed for major ions chemistry employing standard methods (APHA, 2012). The range of analysed parameters along with their mean and standard deviation values are presented in Table-2. Total Dissolved Solids were estimated by calculation method. Nitrates were measured with Spectrophotometric method, Carbonate, Bicarbonate, Total Hardness, Total alkalinity and Chloride by titrimetric methods, Fluoride concentration was measured with Orion ion analyzer with fluoride ion selective electrode. Dissolved Oxygen (DO) is by Winkler method, Biochemical Oxygen Demand (BOD) by 5 days incubation at 20° C and titration of initial and final DO and Chemical Oxygen Demand by open reflux method.

Water Quality Index

Water quality and its suitability for drinking and domestic purpose can be examined by determining its water quality index (WQI). The standards for drinking purpose (Ramakrishnaiah *et al.*, 2009) have been considered for calculation of WQI. In this method the weightage for various water quality parameters is assumed to be inversely proportional to the recommended standards for the corresponding parameters (Ahmad I. Khwakaram *et al.*, 2012). The WQI has been calculated to evaluate the suitability of groundwater quality of the study area for drinking purposes. The WHO (2005) standards for drinking purposes have been considered for the calculation of WQI.

For the calculation of WQI nine parameters such as: pH, TDS, TH, EC, DO, Cl^-, F^-, NO_3^- and HCO_3^- have been used.

Calculation of Water Quality Index

Water quality index [WQI] = $\sum q_i W_i$, Where, q_i is water quality rating

q_i = 100*[Va-Vi]/[Vs-Vi], Va = Actual value of the parameters present in water sample, Vs = Standard value, Vi = ideal value.

Wi = K/Sn, Where W_i = Unit weightage

K[constant] = $1/[(1/S_1) + (1/S_2) + (1/S_3) + \ldots + (1/S_n)]$ and WQI= $\sum W_i q_i / \sum W_i$

Estimation of Correlation Coefficient between Different Parameters

Correlation coefficient is a commonly used to establish the relationship between two variables. It is simply a measure to exhibit how well one variable predicts the other (Kurumbein and Graybill, 1965). For this purposes, Spearman's rank correlation coefficient has been calculated between groundwater quality parameters in study area as shown in Table 4. Spearman's rank correlation coefficient is denoted by "r" and its value will always be between -1.0 and +1.0. A positive "r" corresponds to an increasing while a negative "r" corresponds to a decreasing monotonic trend between two water quality parameters. A high correlation coefficient (near 1 or -1) means a good relationship between two variables and its value around zero means no relationship between them (Patil and Patil, 2010). The correlation co-efficient 'r' was calculated using the equation.

$$r = \frac{N\sum(XiYi) - (\sum Xi)(\sum Yi)}{\sqrt{[N\sum(Xi)^2 - (\sum Xi)^2][N\sum(Yi)^2 - (\sum Yi)^2]}}$$

Where, Xi and Yi represents two different parameters, N = Number of total observations.

Results and Discussion

Hydrgeochemical properties of ground water mainly depend on the behaviour of dissolved chemical constituents which occur as ions, molecules or solid particles, undergo reactions and also redistribution among the various ionic species.

The chemical composition of groundwater is related to the product of rock weathering and changes with respect to time and space. The usefulness of ground water for domestic and agricultural purposes is determined by variation on the concentration levels of different hydrogeochemical constituents dissolved in water. However, the use of water for any purpose is guided by standard set up by the World Health Organization, BIS, ICMR and other related agencies. The summary of physic-chemical parameters evaluated for ground water samples for study area is represented in Table 2.

Physico-Chemical Parameters of Ground Water

pH is the measure of acidity or alkalinity of water. pH is considered as an important attributed to different types of buffers normally present in the ground water (Weber and Stun, 1963). The mild alkalinity indicates the presence of weak basic salts in the soil (Kumar and Kumar, 2013). The mild alkaline nature suggests that approximately 95% of CO2 in water is present as bicarbonate (Azeez *et al.*, 2000). The pH values of the ground water samples of study area varies from 7.6 to 8.71 (Fig. 2) with an average of 8.18 which indicates that water is slightly alkaline in nature suitable for drinking other purposes.

The concentration of Total Dissolved Solids (TDS) ranged from 273 to 3600 mg/L with 1030.98 mg/L average concentration in the study area. Normally TDS in water may originate from natural sources and sewage discharges. TDS values obtained in the study area are beyond the desirable limits (<500 mg/L) for 62.50% water samples, but only ten samples have TDS values more than the permissible limits (> 600 mg/L), making the water unsuitable for various domestic activities. 60% water samples found under fresh and 40 % in brackish categories. The ground water in the study area falls under fresh (TDS<1000 mg/L) to brackish (TDS>1000 mg/L) types of water (Fig. 3) (Freeze and Cherry, 1979). The electrical conductivity (EC) in the study area varies from 390.00 to 5142.86 µS/cm with an average of 1469.30 µS/cm. It is a measure of water's capacity to conduct electric current. As most of the salts in the water are present in the ionic form, are responsible to conduct electric current. Generally, groundwater tends to have high electrical conductivity due to the presence of high amount of dissolved salts.

Electrical conductivity (EC) is a decisive parameter in determining suitability of water for particular purpose. Based on conductivity classification (Table 3) 32 % ground water samples fall under good (250-750 µS/cm), 43 % ground water samples fall in permissible (750-2000 µS/cm), 15 % under doubtful in categories and 10 % water samples are unsuitable for drinking purpose (Fig. 4).

If the TDS is high then EC will be high since the higher ionic concentration carries current more. In Figure 5 the TDS and EC is correlated that is showing that the water samples with higher TDS also have higher EC.

Bicarbonate and carbonate ions vary from 48.00 to 681.00 mg/L and 0.00 to 256.79 with an average of 281.28 and 102.22 mg/L respectively. The sources of the most of the bicarbonate in the water being are sewage and various human activities. Water with a high concentration of bicarbonates, if used for irrigation, may cause white deposits on fruits and leaves, which is undesirable (Subrahmanyam and Yadaiah, 2001).

Chloride concentration in groundwater samples in the study area ranged from 49.63 to 1155.67 mg/L with average of 220.13 mg/L. WHO has set standards of 200-500 mg/L for chloride in drinking water. Too much of chloride leads to bad taste in water and also chloride ion combines with the Na (that is being derived from the weathering of granitic terrains) and forms NaCl, whose excess presence in water makes it saline and unfit for drinking and domestic purposes. The higher consumption can cause significant increase in the development of hypertension, risk for stroke, left ventricular hypertension, osteoporosis, renal stones and asthma in human beings (Ramesh and Soorya, 2012). Naturally, chloride occurs in all types of waters. The contribution of chloride in the groundwater is due to minerals like apatite, mica, and hornblende and also from the liquid inclusions of igneous rocks (Das and Malik, 1988). For groundwater classified on chloride (Table 3), 80 % of water samples are fall in brackish, 10% brackish-salt and 10% are in salty category.

Fluoride plays an important role in drinking water parameters excess concentration from prescribed level produce harmful effects such as dental and skeletal fluorosis, the concentration of fluoride varies from 0.0.061 to 5.2 mg/L and average value is 1.02 mg/L (Fig. 6). 37.50% water sample exceeded the maximum permissible limit (<1.5 mg/L) of fluoride and 60% samples have more than the maximum desirable limits (<1.00 mg/L).

Excess consumption of nitrate mainly causes methaemoglobinemia (Blue baby disease) in children due to the oxidation of Iron in haemoglobin from Fe(II) to Fe(III). Nitrate concentration ranged from 1.72 to 277.00 mg/L with an average of 62.12 mg/L that is more than the permissible standards, 37.50% water samples water exceeded the permissible limits (45 mg/L) of nitrate. The main sources of nitrate in ground water are excess use of fertilizers in farming, animal waste, septic tanks etc.

Table.1 Weight and Relative Weight Assignment to Physic-chemical Parameters for WQI

SN	Parameters	S_i	1/Sn	Wi=K/Sn
1	pH	8.5	0.1176	0.0869
2	TDS	500	0.0020	0.0015
3	TH	200	0.0050	0.0037
4	EC	1500	0.0007	0.0000
5	Cl^-	250	0.0040	0.0030
6	F^-	1	1.0000	0.7390
7	NO_3^-	45	0.0222	0.0164
8	HCO_3^-	500	0.0020	0.0015
9	DO	5	0.2000	0.1478
			∑1/Sn=1.3535	∑Wi=1.0000

Table.2 Statistical Summary of Physico-Chemical Parameters of Ground Water Samples

SN	Parameters	Min	Max	Avg.	SD
1	pH	76	8.71	8.18	0.25
2	TDS	273	3600	1030.98	775.12
3	TH	340	1550	686.73	269.64
4	EC	390	5124.86	1469.3	1116.55
5	Cl^-	49.63	1155.67	220.13	239.69
6	F^-	0.061	5.2	1.02	1.05
7	NO_3^-	1.72	277	62.12	67.38
8	HCO_3^-	48	681	281.28	140.01
9	DO	3	5	3.99	0.52
10	BOD	0	21	6.8	6.23
11	COD	0	84	29.3	24.7
12	T A	170	1011	470	221.58
13	CO_3^{-2}	0	265.79	102.22	79.25
14	Temp	25	33	27.82	1.78

Table.3 Classifications of Ground Water Upon the Basis of Different Parameters

Classification Pattern	Categories	Ranges	No. of Samples	%age of Samples
	Extremely-Fresh	< 0.14	-	-
	Very-Fresh	0.14-0.85	-	-
	Fresh	0.85-4.23	-	-
Chloride (Cl^-) (Stuyfzand, 1989)	Fresh- Brackish	4.23-8.46	-	-
	Brackish	8.46-28.21	-	-
	Brackish-Salt	28.21-282.06	32	80%
	Salt	282.06-564.13	5	12.50%
	Hyper Saline	>564.13	3	7.50%
Total Hardness (TH) (Sawyer & McCarty, 1967)	Soft	0-75	-	-
	Moderately	75-150	-	-
	Hard	150-300	-	-
	Very hard	>300	40	100%
	Fresh water	<0-1000	24	60%
	Brackish	1000-10000	16	40%
TDS (Carroll, 1962)	Saline	10000-100000	-	-
	Brine	>100000	-	-
	Excellent	<250	-	-
Electrical Conductance (EC)	Good	250-750	13	32.50%
	Permissible	750-2000	17	42.50%
	Doubtful	2000-3000	6	15%
	Unsuitable	>3000	4	10%

Table.4 Correlation Matrix for Different Water Quality Parameters

	pH	TDS	F^-	DO	BOD	COD	TH	EC	NO_3^-	Cl^-	CO_3^{-2}
pH	1	0.30 98	0.5308	0.0458	0.1147	0.1113	-0.0246	0.3001	0.1182	0.1611	0.5486
TDS		1	0.4586	-0.1713	0.0141	0.1099	0.7338*	0.9951#	0.6430	0.9468#	0.6770
F^-			1	-0.3494	0.2421	0.1374	0.0571	0.4553	0.3209	0.2148	0.6102
DO				1	-0.5541@	-0.2926	-0.2277	-0.1925	-0.1303	-0.0848	-0.3610
BOD					1	0.7761*	0.0139	0.0272	-0.0889	0.0326	-0.1113
COD						1	0.0583	0.1135	-0.0263	0.1786	-0.1797
TH							1	0.7176*	0.6540	0.7824*	0.3751
EC								1	0.6449	0.9442#	0.6768
NO_3^-									1	0.5703	0.4647
Cl^-										1	0.4782
CO_3^{-2}											1
HCO_3^-											
TA											

HCO_3^-	TA
0.3306	0.5509
0.0537	0.5643
0.5208	0.8016*
-0.2008	-0.3339
0.3029	0.0954
0.2133	-0.0184
-0.1996	0.1504
0.0560	0.5585
-0.1839	0.2529
-0.0659	0.3104
0.1089	0.8872*
1	0.5108
	1

#=very strong positive correlation, *=strong positive correlation and @= negative correlation

Figure.1 Study Area Map

Figure.2 pH Distribution in Ground Water Samples

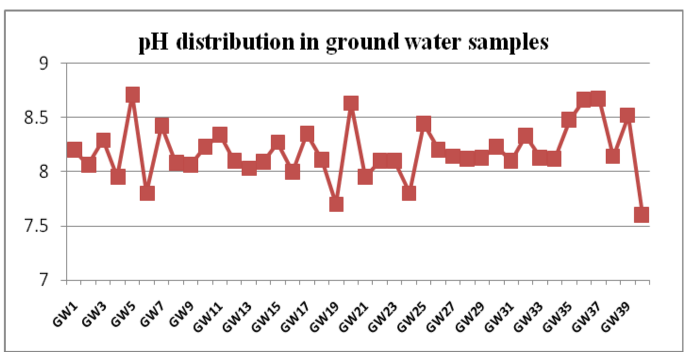


Figure.3 Classification of Ground Water Based on Total Dissolved Solid Concentration

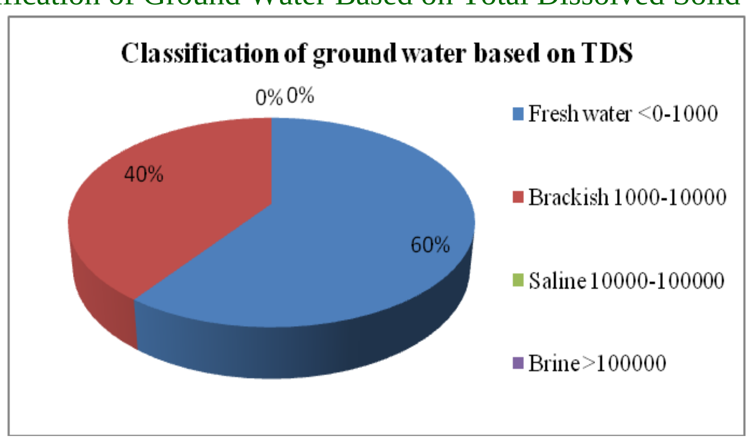


Figure.4 Classification of Ground Water Based on Electrical Conductance (EC)

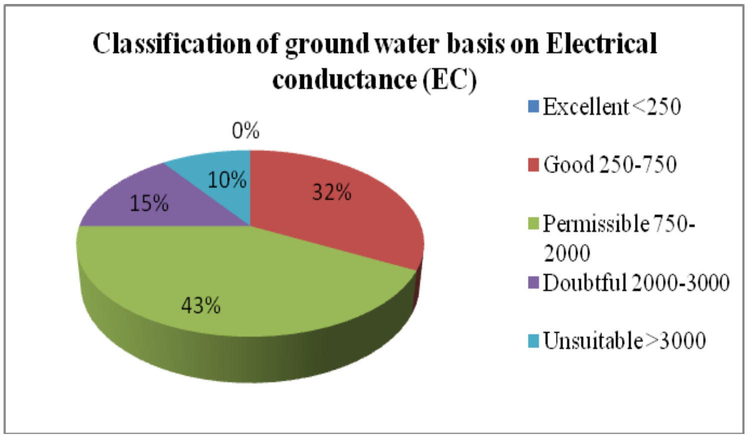


Figure.5 Correlation between TDS and EC of Ground Water Samples

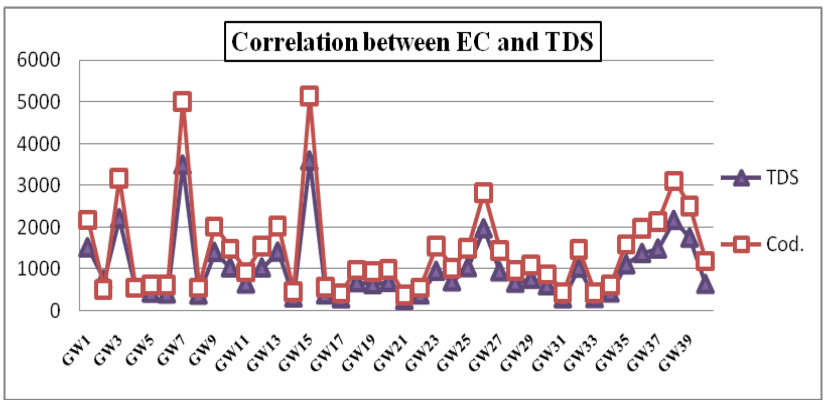


Figure.6 Fluoride Distribution in Ground Water Samples

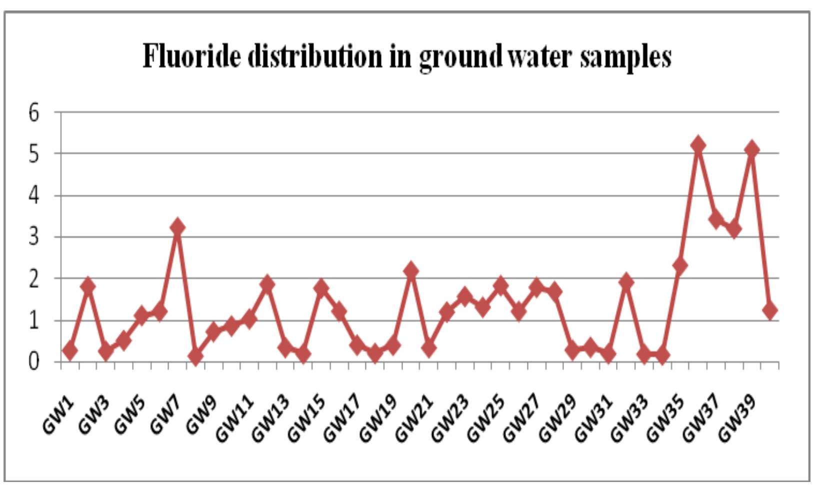


Figure.7 Classification of Ground Water Based on WQI

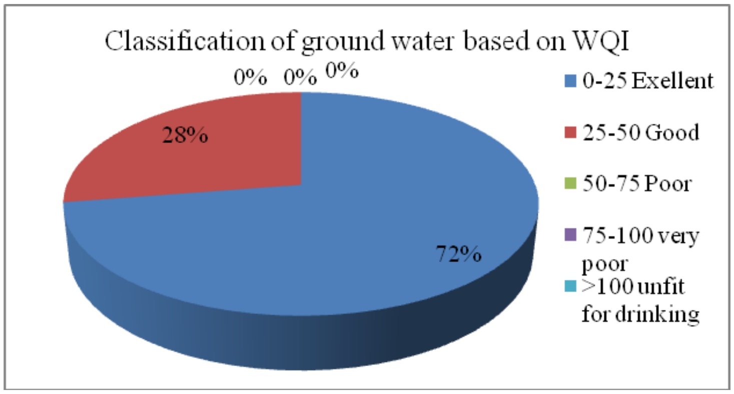
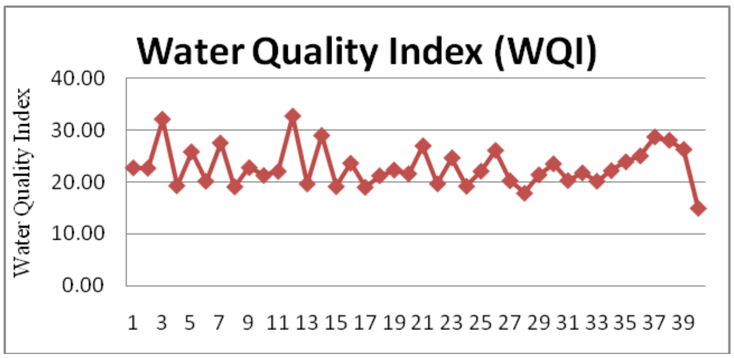


Figure.8 Distribution of WQI in Water Samples



The excess of alkalinity could be due to the minerals, which dissolved in water from mineral rich soil. The various ionic species that contribute mainly to alkalinity includes bicarbonates, carbonates, hydroxides, phosphates, borates, silicates and organic acids. Alkalinity of study area varies from 170.00 to 1011.00 mg/L and average value is 470.00 mg/L, which indicates that ground water is alkaline in nature and most of the ground water samples exceeded the desirable limit (200 mg/L) of alkalinity.

Dissolved oxygen, BOD and COD are ranged from 3.00-5.00, 0.00-21 and 0.00-84.00 respectively and average values are 3.99, 6.80 and 29.30 mg/L. DO, BOD and COD in all the samples was found within the permissible limits.

Water hardness has no known adverse effects; however, some evidence indicates its role in heart disease (WHO, 2008). Hard water is unsuitable for domestic use and it is a measure of the Ca^{2+} and Mg^{2+} content expressed in equivalent of calcium carbonate. Hardness of water is by the inhibition of soap action in water due to the precipitation of Ca^{2+} and Mg^{2+} salts like carbonates, sulphates and chlorides. Hardness of water limits its use for industrial purposes; causing scaling of pots, boilers and irrigation pipes may cause health problems to humans, such as kidney failure. Total hardness (TH) in study area ranges between 340.00-1550.00 mg/L with an average of 683.73 mg/L which indicates that water hard. All the water samples found in very hard category (>300 mg/L) as shown in Table 3. Hard water might be expensive for domestic usage, and the cause of the water hardness of the study area can be said to be geogenic. The hardness may be advantageous in certain conditions; it prevents the corrosion in the pipes by forming a thin layer of scale, and reduces the entry of heavy metals from the pipe to the water (Shrivastava *et al.*, 2002).

Water Quality Index

The estimated water quality index revealed that 72.50% of ground water in the study area fall in excellent water category, 27.50% was in good water categories respectively (Fig.7). The WQI of ground water for study area is ranged from 22.52 to 32.42 with an average of 22.94 (Fig. 8). It can be said from this assessment that the groundwater in the study area was generally in excellent-good water quality status and water from the most of the samples is suitable for drinking and domestic purposes.

Correlation of Physicochemical Parameters of Groundwater

Data of 40 dug wells, tube wells, hand pumps and PHED water supply ground water samples during the period from 2014 has been used to build the correlation matrix between the groundwater quality parameters which are pH, EC, TA, TDS, TH, Cl^-, F^-, CO_3^{-2}, HCO_3^-, NO_3, DO, BOD and COD. The results of correlation matrix revealed that the very strong positively correlated values were found between TDS and EC (r=0.995), TDS and Cl^- (r=0.999), EC and Cl^- (r=0.944), The strong positively correlated values which range between (r=0.7 to 0.9), were observed between TH and Cl^- (r=0.887), TA and F^- (r=0.801), TH and TDS (r=0.734), COD and BOD (r=0.776), and EC and TH (r=0.717). The very strong Negative and strong negative both correlated values were not appeared between any parameter.

In conclusion, the groundwater quality has been assessed for its drinking and domestic suitability purposes. The quantitative chemical analysis results reflect that the groundwater in the area is of alkaline nature. The average value of water quality index for samples was found 22.94. 72.50% samples water was found in excellent category and 27.50% water samples in good WQI. The ground water of study area found alkaline, fresh to brackish type, brackish-salty to saline type, 37.50% sample exceeded fluoride and nitrate concentration. All water samples found in very hard category in which TH exceeded 300 mg/L level. WQI indicates that ground water from most of the samples is suitable for drinking and domestic purposes but need proper removal of excess TH, TDS, Cl^-, F^-, NO_3^- and HCO_3^-. From the results of correlation matrix it is observed that TDS and EC, TDS and Cl^-, EC and Cl^- pairs of parameter have very strong positive correlation and TH and Cl^-, TA and F^-, TH and TDS, COD and BOD, and EC and TH pairs of parameter have strong positive correlation and neither very strong negative nor strong negative correlation is observed between any pair of parameter.

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References

Ahmad, I. Khwakaram, Salih, N. Majid, Nzar, Y. Hama. 2012. Determination of Water Quality Index (WQI) for Qalyasan Stream in Sulaimani City/ Kurdistan Region of Iraq. *Int. J. Pl. Ani. Environ Sci.*, 2(4).

Al-Rajab, A.J., Hakami, O. 2014. Bahavior of the non-selective herbicide glyphosate in agricultural soil. *Amer. J. Environ. Sci.*, 10(2): 94–101.

APHA, 2012. Standard APHA Methods for the Examination of Water, 22nd Edn., 2012., American Public Health Association, American Water Works Association and Water Pollution Control Federation, Washington DC, USA.

Azeez, P.A., Nadarajan, N.R., Mittal, D.D. 2000. The impact of monsoonal wetland on ground water chemistry. *Poll. Res.*, 19(2): 249–255.

Bhattacharya, T., Chakraborty, S., Tuck, N.I. *Res. J. Environ. Sci.*, 1(1): 28–33.

Central Ground Water Board, 2013. Repot on ground water scenario, Bhilwara District, Rajasthan, Regional Office, Central Ground Water Board, Jaipur, 1–18.

Central Ground Water Board (CGWB). 19 95-2004, Annual report and other related reports on ground water quality, Central Ground Water Board, New Delhi.

Carroll, D. Rain water as a chemical agent of geological process-a view. USGS, 1962.

Das, P.K., Malik, S.D. 1988. Groundwater of Khatra region of Bankura district, West Bengal: Some chemical aspects in reference to its utilization. *J. Ind. Water Res. Soc.*, 8(3): 31–41.

Freeze, R.A., Cherry, J.A. 1979. Groundwater, Prentice Hall, Englewood Cliffs.

Gajendra, C., Thamarai, P. 2008. Study on statistical relationship between ground water quality parameters in Namibiyar river basin, Tamil Nadu, India. *Poll. Res.*, 27(4): 679–683.

Hussain, J., Husain, I., Arif, M. 2013. Fluoride contamination in groundwater of central Rajasthan, India and its toxicity in rural habitants. *Toxicol. Environ. Chem.*, 95(6): 1048–1055.

Kumar, M., Kumar, R. 2013. Assessment of Physico-Chemical Properties of Ground Water in Granite Mining Areas in Goramachia, Jhansi, UP, India. *Int. Res. J. Environ. Sci.*, 2(1): 19–24.

Kurumbein, W.C., Graybill, F.A. 1965. An Introduction to Statistical Models in Geology, McGraw-Hill, New York.

Meena, K.S., Gunsaria, R.K., Meena, K., Kumar, N., Meena, P.L. 2012. The Problem of Hardness in Ground Water of Deoli Tehsil (Tonk District) Rajasthan. *J. Curr. Chem. Pharm. Sci.*, 2(1): 50–54.

Meena, P.L., Meena, A.S., Meena, K.S., Jain, P.K., Kumar, N. 2015. Comparative study of fluoride toxicity in ground water of hilly terrain area and Banas river basin area of eastern Bhilwara (Rajasthan, India) and its impact, causes and prevention. *Der Chemica Sinica*, 6(10): 19–24.

Patil, V.T., Patil, P.R. 2010. Physicochemical Analysis of Selected Groundwater Samples of Amalner Town in Jalgaon District, Maharashtra, India. *E-J. Chem.*, 7(1): 111–116.

Ramakrishnaiah, C.R., Sadashivaiahand, C., Ranganna, G. 2009. Assessment of Water Quality Index for the Groundwater in Tumkur Taluk, Karnataka State, India. *E-J. Chem.*, 6(2): 523–530.

Ramesh, K., Soorya, V. 2012. Hydrochemical Analysis and Evaluation of Groundwater Quality in and around Hosur, Krishnagiri District, Tamil Nadu, India. *Int. J. Res. Chem. Environ.*, 2(3): 113–122.

Sawyer, G.N., McCarthy, D.L. 1967. Chemistry of sanitary Engineers, 2nd ed, McGraw Hill, New York. pp. 518.

Shrivastava, V.S., Patil, P.R. 2002. Tapti river water pollution by industrial wastes: A statistical approach. *Nat. Environ. Pollut. Tech.*, 1(3): 279–283.

Stuyfzand, P. J. 1989. Nonpoint source of t race element in potable ground water in Netherland. In: Proceeding of the 1 8th TWSA Water Working, Testing a nd Research Institute, KIWA, Nieuwegein, The Netherland s.

Subba, R.N. 2006. Seasonal variation of groundwater quality in a part of Guntur District, Andhra Pradesh, India. *Environ. Geol.*, 49: 413–429.

Subrahmanyam, K., Yadaiah, P. 2001. Assessment of the industrial effluents on water quality in Patancheru and environs, Medak district, Andhra Pradesh, India. *Hydrogeol. J.*, 9: 297–312.

Switzman, Coulibaly, H.P., Adeel, Z. 2015. Modeling the impacts of dryland agricultural reclamation on groundwater resources in Northern Egypt using sparse data. *J. Hydrol.*, 520: 420–438.

Varadarajan, N., Purandara, B.K., Kumar, B. 2011. *J. Environ. Sci. Engg.*, 53(3): 341–348.

Vasanthavigar, M., Srinivasamoorthy, K., Vijayaragavan, K., Ganthi, R.R., Chidambaram, S., Anandhan, P., Vasudevan, S. 2010. Application of water quality index for groundwater quality assessment: Thirumanimuttar sub-basin, Tamilnadu, India. *Environ. Monitoring and Assessment*, 171(1-4): 595–609.

Weber, W.J.Jr., Stun, W. 1963. Mechanism of hydrogen ion buffering in natural waters. *J. Amer. Water Works Association*, 55: 1553–1555.

WHO. 2008. Guidelines for drinking-water quality: incorporating first and second addenda, Vol. 1, Recommendations, 3rd edition, WHO Press, pp. 668.

WHO. 2005. International Standards for drinking-water quality, World Health Organisation, Geneva.

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