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Cyclic Dissimilarity in Physico-Chemical Variables in Groundwater Quality of Honnali Taluk, Davangere District Karnataka, India

Bindu Pavan V [1*], S Manjappa [2], MH Moinuddin Khan [3], Sachin HP [4], Suresh B [5]
[1, 3, 4] Department of Chemistry, J N N College of Engineering, Shivamogga, Karnataka, India
[2] Department of Chemistry, University BDT College of Engineering, Davangere-577005, Karnataka, India
[5] Department of Civil Engineering, Bapuji Institute of Engineering & Technology, Davangere-577 005, Karnataka, India

* Corresponding Author: **Bindu Pavan V**

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Abstract
Ground Water quality plays a key role in groundwater management and quality protection; hence it is very much essential to appraise the groundwater quality not only for its current needs but also a probable source of water for upcoming consumption. The study area selected was ground water of Honnali Taluk, Davangere district, Karnataka, India. In our study, first we mark the sampling locations in twenty five different zones of the city, then locations were established and groundwater samples were collected. In the present work an attempt has been made to identify the ground water quality of the region in Pre monsoon, monsoon and Post monsoon phase in year 2020. The physico-chemical variables like pH, electrical conductivity, total hardness, total alkalinity, chloride, fluoride, sulphate, sodium, potassium, calcium, magnesium and nitrate were chosen to analyze the potable ground water quality of the city. Better water quality was found in Pre-monsoon season than Post-monsoon season. Extent of pollution happened due to over utilization of ground water, urbanization and anthropogenic activities. TDS shows highly positive correlation with EC in pre monsoon and post monsoon indicating. In some of the area, nitrate concentration increases in post monsoon.

Keywords: cyclic, ground water, TDS, EC, correlation, topography

Introduction

Groundwater, the water present in an aquifer matrix locked below the sub-surface in the waterlogged zone, act as the primary shield against deficiency for both human necessities and flora production (Siebert, 2010) [1]. Significance of groundwater for irrigation in India has been enhanced in the current years, especially due to the fact that groundwater proposes consistency and elasticity in contact to water that irrigation channel can play competition (Abbas Abbasnia, *et al*., 2018) [1].

Ground water is the most significant source of water supply for drinking purposes in rural zones. Ground water quality acting an chief role in groundwater security and quality conservation. Hence, it is very important to appraise the ground water quality not only for its current use but also from the view point of a probable source of water for upcoming utilization (Kori, *et al*., 2006) [7]. Water sources accessible for drinking and other household needs must acquire high degree of purity, free from contamination (Machiwal,, *et al.*, 2018) [8].

In India severe water shortage is becoming common in several parts of the country, especially in arid and semi-arid provinces. Due to enhanced in population and human activities, the quality of groundwater is degrading in day to day life. The opportunity of groundwater contamination is due to the current usage, application and decreasing in the surface water availability, the discharging industrial waste into surface water, municipal and household into the nearby watercourse and surface water bodies. The majority usage of groundwater for agricultural activity are enhancing the ionic strength of the groundwater and making it more salty (Karthikeyan, *et al*., 2013) [6]. Water pollution is the situation of deviation from pure condition, whereby its normal reactions and properties are affected. Motivated environment problems often reproduce the changes in technology (Singh, *et al*, 2002) [12].

Materials and methods

Location Details

Geologically rocks of granodiorite and granite associated with iron and manganese ore bands. The rock formations are joined and are traversed by doleritic Dykes, Weathering in hard rock's is limited to 5 meters from ground level where as in schist and phyllite extends upto 20 meters.

Experimental Work

Present study comprises of interpretation and analysis of ground water samples collected from different locations at all over Honnali taluk. In our study, first we mark the sampling locations in five different zones of the city, then locations were established and groundwater samples were collected. The samples were analyzed for different physico-chemical parameters and results were carefully studied and analyzed. The present study provides a detailed description of the physicochemical parameters level in groundwater. Total twenty five representative ground water samples were collected during the year 2020.

Collection and Analytical procedure for Samples

Ground water samples were collected in plastic bottles, which were previously thoroughly washed with tap water and rinsed with double distilled water. Groundwater level in the wells is documented and pH of groundwater samples is measured in the field using a handy pH meter. In the present study bore well water samples are collected after pumping the water for 10 min. Samples collected are transported to the laboratory and filtered using 0.45-µm Millipore filter paper. The fluoride concentration of groundwater samples is determined using Specific Ion Electrode method (APHA 2005). The samples were collected in both pre and post periods. Preservation of water samples and chemical analyses were carried out as using standard methods. Analysis was carried out for various water quality variables such as pH, electrical conductivity (EC), Total Dissolved Solids (TDS), total hardness (TH), calcium (Ca++), total alkalinity (TA), chloride (Cl-), magnesium (Mg++), sodium (Na+), potassium (K+), Sulphate (SO4-), Fluoride (F-) and nitrate (NO_3^-) were estimated using standard method laid out by the American Public Health Association (APHA 2005). The groundwater sampling locations and dumpsite are depicted in Fig. 4.

Results and discussion

Groundwater quality for drinking purposes

Electrical Conductivity (EC) in µ mhos/cm: Electrical conductivity (EC) is a measure of water capacity to convey electric current. It signify the amount of total dissolved salts EC values were in the range of 2460.0 µ mhos/cm at Anjaneyapura [S-11] to 552.0 µ mhos/cm at Benakanahalli (Infront of Govt.Hospital) [S-25] during pre monsoon period given in Table 1. High EC values were observed in Anjaneyapura [S-11] during post monsoon season and minimum EC value in Benakanahalli (Infront of Govt. Hospital) [S-25] during pre monsoon period indicating the presence of high amount of dissolved inorganic salts in ionized form.

Total Alkalinity (TA) in mg/L: Alkalinity of water is its capacity to neutralize a strong acid and it is normally due to the presence of bicarbonate, carbonate and hydroxide compound of calcium, sodium and potassium. Total alkalinity values for most of the investigated samples were found to be higher value prescribed by WHO. Alkalinity was found in the range of 713.0 mg/L in Channambapura (infront of Mallikarjuna house) [S-23] to 363.0 mg/L in Bidaragadde (Basavanadurga) [S-4) Post monsoon and 263.0 mg/L Bidaragadde (Basavanadurga) [S-4] to 679.0 mg/L in Chikkahalivana (Opp to SriKari college) [S-5] Pre monsoon given in Table 1. Alkaline water may reduce the solubility of metals. The alkalinity varies in agreement with the fluctuation in the pollution load (Parashar, *et al.*, 2006) [9].

Total Hardness (TH) in mg/L: Hardness is the property of water which prevents the lather formation with soap and swells the boiling points of water hardness of water mainly depends upon the amount of calcium or magnesium salts or both. The hardness values shown range from 170.05 mg/L to 745.02 mg/L. The values for sample from point in Bijogatte (In front of Primary Health Centre) [S-16] and Channambapura (in front of Hospital) [S24] were higher than the prescribed limit. In some areas of the city, the hardness is very high, also beyond permissible limit. It is due to rocks bearing salts of Calcium and Magnesium. BIS has prescribed desirable limit of total hardness is 200 mg/L and permissible limit in the absence of alternate source is 600 mg/lit (De, 2002).

Calcium (Ca^{++}) in mg/L: Calcium is directly related to hardness. Calcium concentration ranged between 40.10 mg/L [S-17] during pre monsoon season to 196.40 mg/L [S-10] and found below permissible limit of WHO and BIS in the entire study period and all the sampling locations.

Magnesium (Mg^{++}) in mg/L: Magnesium is directly related to hardness. Magnesium content in the investigated water samples was ranging from 7.01 in Belimallur (Near Main road) [S-2] mg/L to 43.20 mg/L in Chilapura [S-22] during which were found within WHO limit.

Sodium (Na^+) in mg/L: Sodium concentrations were found in between 16.90 mg/L and 17.61 [S-5] to 50.60 mg/L and 54.60 mg/L [S-7]. In the entire study all the sampling locations were showed lower sodium concentration than the prescribed limit by WHO and BIS.

Potassium (K^+) in mg/L: The major source of potassium in natural fresh water is weathering of rocks but the quantities increase in the polluted water due to disposal of waste water Potassium content in the water samples varied from 0.89 mg/L [S-3] during pre monsoon season to 4.73 mg/L [S-17] during post monsoon season. It is found that the contents of potassium in site S-17 and S-12 is higher ie 4.73 and 4.12 mg/L, whereas all other locations are showing below 4.0 mg/L potassium content.

Chloride (Cl^-) in mg/L: The chloride concentration serves as an indicator of pollution by sewage. People accustomed to higher chloride in water are subjected to laxative effects. In the present analysis, chloride concentration was found in the range of 367.05 mg/L [S-18] to 39.31 mg/L [S-8]. The values are within the limit in all ground water sample collected from Hospet taluk. Higher chloride concentration in samples from sites [S-18] may be due to big discharge of sewage near the sampling location.

Nitrate (NO_3^-) in mg/L: Groundwater contains nitrate due to leaching of nitrate with the percolating water. Groundwater can also be contaminated by sewage and other wastes rich in nitrates. The nitrate content in the study area varied in the range 7.94 mg/L and 9.20 mg/L to 58.09 mg/L and 56.41 mg/L during pre and post monsoon season respectively. In the entire study all the collected ground water samples are found within the prescribed limit except [S-3, S-7, S-8, S-9, S-10, S-11] during pre monsoon season. In all other locations

were showing below the permissible limit of WHO and BIS.

Sulphate (SO_4^{2-}) in mg/L: Sulphate occurs naturally in water as a result of leaching from gypsum and other common minerals. Discharge of industrial wastes and domestic sewage tends to increase its concentration. The sulphate concentration varied between 13.92 mg/L [S-11] and 84.32 mg/L [S-10] to 18.60 [S-20] mg/L to 82.70 mg/L [S-10] during post and pre monsoon seasons respectively and found within the prescribed limit.

Descriptive statistics of 13 measured variables at 25 sampling locations for the whole sampling period are summarized in Table 1. The results shows that pH (mean range, 7.62–7.67), TDS – (mean range, 739.68 – 802.56 mg/L), Ca++ (mean range, 102.55-117.53mg/L), Mg++ (mean range, 27.20-52.40 mg/L), Cl- (mean range, 130.34-156.38 mg/L), Fluoride (mean range, 1.14-1.24 mg/L), SO4 (mean range, 32.10-37.42 mg/L), Na (mean range 29.86-30.86 mg/L) and K (mean range, 1.69-2.66 mg/L) is within the permissible levels, while all other parameters exceed average levels set by national guidelines for drinking purposes and other needs. It is evident that distribution of TDS, Cl and alkalinity was significantly correlated with EC in Pre monsoon and post monsoon seasons (Table 2 and 3) indicating the high mobility of these ions. EC is positive correlated with pH, TH, Ca^{++}, Mg^{++}, and K and negatively correlated with Na, F-, NO_3 and SO_4. Highly positive correlation is observed between TDS and pH, TH, Cl, Ca, Mg and alkalinity (Jothivenkatachalam, *et al*., 2010) [5], pH, F and Cl, Cl and F, Na and Cl, Na and F. While highly negative correlation is seen among Na and all parameters except CL, So4 and Alkalinity. Positive correlation occurs between pH and Na, TDS and TH (Udayalaxami, *et al.*, 2010) [13]. Good relation to Ca and TH indicating that Hardness in groundwater is mainly due to $CaCO_3$ (Ramakrishna, *et al.*, 2009) [10]. TDS shows highly positive correlation with EC in pre monsoon and post monsoon indicating in Figures 1and 2.

Conclusions

Higher concentration of Total Dissolved Solids during Post Monsoon samples exhibits poor quality of water as compared to Pre Monsoon due to leaching of various salts into Post Monsoon ground water by infiltrating recharge waters. In pre monsoon only one sample out of 12 shows high value of total hardness than the prescribed limit by WHO but in Post Monsoon 8 samples show high value of total hardness. According to study in urban area of Hospet have high value of hardness in post monsoon. In some of the area, nitrate concentration increases in post monsoon. Study of water quality indices revealed that the drinking water in most locations of Hospet taluk region was found to be slightly contaminated.

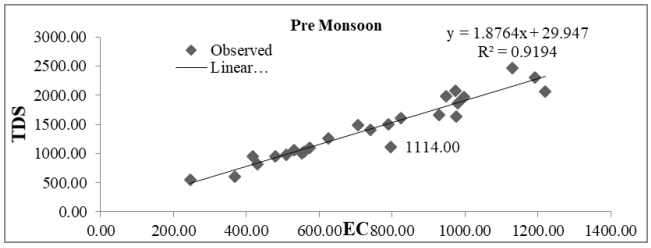

Fig 1: Correlation between TDS and EC during Pre Monsoon Season

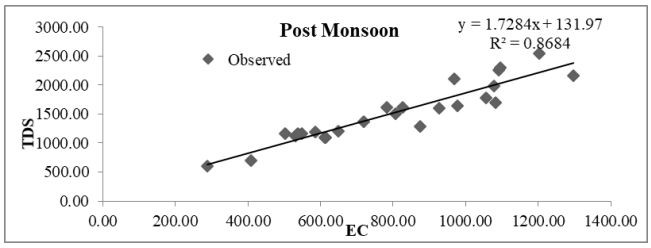

Fig 2: Correlation between TDS and EC during Post Monsoon Season

Table 1: Descriptive statistical value for pre and post monsoon seasons

Sample No	Pre-Monsoon				Post-Monsoon				Standards	
	Max	SD	SD	Mean range	Max	Min	SD	Mean range	WHO	BIS
EC	2460.0	499.99	531.33	1417.88	2538.0	602.0	499.99	1519.08	-	-
TDS	1220.0	269.58	271.51	739.68	1298.0	288.0	269.58	802.56	500-1500	500-2000
pH	8.3	0.28	0.27	7.67	8.5	7.1	0.28	7.62	6.5 - 8.5	6.5 - 8.5
TA	679.0	99.93	108.93	449.84	713.0	363.0	99.93	522.80	-	200 - 600
TH	690.0	145.98	149.72	399.71	745.0	223.1	145.98	435.86	-	200 - 600
Ca^{2+}	196.4	40.48	39.13	102.55	192.4	54.6	40.48	117.53	75 - 200	75 - 200
Mg^{2+}	40.2	7.64	7.25	27.20	43.2	7.0	7.64	52.40	50 - 150	30 - 100
Cl^-	264.2	75.95	67.89	156.38	387.1	39.3	75.95	130.34	200-600	250-1000
F^-	2.1	0.56	0.52	1.14	2.5	0.7	0.56	1.24	1.0 – 1.5	0.6 – 1.2
SO_4^{2-}	82.7	22.33	19.62	37.42	84.3	13.9	22.33	32.10	200-400	200-400
NO_3^{2-}	56.4	16.23	17.41	28.81	58.1	7.9	16.23	26.52	> 45	> 45
Na^+	54.6	7.83	8.43	30.86	50.6	17.6	7.83	29.86	200	-
K^+	2.8	0.85	0.47	1.69	4.7	1.6	0.85	2.66	-	-

Table 2: Correlation matrix of Ground water in Hospet taluk during pre monsoon season

	pH	TH	Cl-	Ca	Mg	TDS	ALK	K	Na	F	NO_3	SO_4	EC
pH	1.000												
TH	-0.071	1.000											
Cl-	0.176	0.163	1.000										
Ca	-0.323	0.878	-0.080	1.000									
Mg	-0.187	0.612	0.237	0.497	1.000								
TDS	0.340	0.258	0.729	0.008	0.094	1.000							
ALK	0.158	-0.238	0.338	-0.235	-0.058	0.490	1.000						

K	-0.044	0.062	0.019	0.267	0.122	0.040	0.330	1.000					
Na	-0.402	-0.150	-0.077	-0.095	0.086	-0.234	-0.203	-0.264	1.000				
F	-0.123	0.275	-0.260	0.415	-0.170	-0.250	-0.104	0.138	-0.139	1.000			
NO3	-0.205	0.088	-0.182	0.234	-0.146	-0.212	0.173	0.170	-0.094	0.840	1.000		
SO4	0.268	0.087	-0.246	0.173	-0.324	-0.093	-0.155	0.087	-0.307	0.385	0.101	1.000	
EC	0.252	0.226	**0.741**	0.024	0.075	**0.959**	**0.401**	0.083	-0.124	-0.253	-0.211	-0.117	1.000

Table 3: Correlation matrix of Ground water in Hospet taluk during pre monsoon season

	pH	**TH**	**Cl-**	**Ca**	**Mg**	**TDS**	**ALK**	**K**	**Na**	**F**	**NO_3**	**SO_4**	**EC**
pH	1.000												
TH	-0.071	1.000											
Cl-	0.176	0.163	1.000										
Ca	-0.323	0.878	-0.080	1.000									
Mg	-0.187	0.612	0.237	0.497	1.000								
TDS	0.340	0.258	0.729	0.008	0.094	1.000							
ALK	0.158	-0.238	0.338	-0.235	-0.058	0.490	1.000						
K	-0.044	0.062	0.019	0.267	0.122	0.040	0.330	1.000					
Na	-0.402	-0.150	-0.077	-0.095	0.086	-0.234	-0.203	-0.264	1.000				
F	-0.123	0.275	-0.260	0.415	-0.170	-0.250	-0.104	0.138	-0.139	1.000			
NO_3	-0.205	0.088	-0.182	0.234	-0.146	-0.212	0.173	0.170	-0.094	0.840	1.000		
SO_4	0.268	0.087	-0.246	0.173	-0.324	-0.093	-0.155	0.087	-0.307	0.385	0.101	1.000	
EC	0.252	0.226	**0.741**	0.024	0.075	**0.959**	0.401	0.083	-0.124	-0.253	-0.211	-0.117	1.000

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