THINK INDIA (Quarterly Journal)

ISSN:0971-1260

Vol-22-Issue-4-October-December-2019

Comparative Statistical Analysis Of Surface and Underground Water Of Ramgarh, Alwar, Rajasthan

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Abstract:

The present study deals with the statistical analysis of hydro chemical parameters of surface and underground water quality of Ramgarh, district Alwar (Rajasthan). The quality of surface water (Pond Water) and underground water (Hand Pump Water) were analyzed for one year total 13 important parameters were included in statistical analysis. The qualities of surface water and underground water have been assessed by calculating mean, standard deviation, mode, median and correlation coefficients. The observed value of mean, mode and median of samples were compared with standard values recommended by WHO. Some parameters were found within and some parameters beyond the desirable limit for drinking purpose. Hand pump water contains higher Nitrate, Total Hardness, Calcium Hardness, Magnesium Hardness, Alkalinity but pond water only BOD & COD were found in higher level than the desirable limits. In pond water significant positive correlation were found between some pair of parameters such as Alkalinity and F^- (0.885), TH and CaH (0.889). Hand Pump water showed highest correlation in between BOD and Cl^- (0.896), Nitrate and DO showed negative correlation with almost all parameters.

Introduction:

In developing country like India around 80% of all diseases are directly related to poor potable water quality and unhygienic conditions. (Limbachiya M.C., Nimavat K.S. and Vyas (2011). Water quality reflects the composition of water as affected by natural cause and man's cultural activities expressed in terms of measurable quantities and related to intended water use. Generally water resources problem are of three main types, too little water, too much water and polluted water (Ayode, J.O. 1988 and Adibola, 2001). The composition of surface and ground water is dependent on natural factors (geological, topographical, meteriological, hydrological and biological) in the drainage basin and various seasonal difference in runoff volumes, weather conditions and water levels (Muller, 2001).

Statistical investigation offers more attractive options in Environment Science, though the results may deviate from more real situations (Nemade and Shrivastava, 1997). The correlation provides an excellent tool for the prediction of parametric values within a reasonable degree of accuracy (Helsel D.R. and Hirsch R.M.2002). The main objective of this work is to compare surface and underground water on the basis of statistical studies of hydro

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chemical parameters of Ramgarh, Alwar district, Rajasthan and compare the data with WHO standards.

Ramgarh is now facing the problem of water depletion and quality deterioration due to over exploitation. This area is declared as dark zone. Study area comprises of town Ramgarh in Alwar district of Rajasthan. The area lies between 27^0 04′ and 28^0 04′ northern latitudes, through 76^0 07′ and 77^0 13′ east longitudes. Water samples were taken from, hand pump and pond water (jharna), this area surrounded by Aravali hills consisting of lime rocks.

Materials and Methods:

Surface water sample were collected from the Jharna pond and the ground water sample from the hand pump of the main Market of Ramgarh. Water samples were collected in clean sterile, plastic containers of capacity 2 litre. The physico chemical parameters like colour, odour, turbidity, suspended solids, temperature, pH, F^-, Cl^-, NO_3^-, total hardness, calcium hardness, magnesium hardness, alkalinity, DO, BOD, COD, TDS and bacteriological parameters were analyzed. The collection preservation and analysis of various parameters from pond and hand pump water were carried out by standard method, (APHA 1995, 1998 Manivasakum, 2005, NEERI, 1986, De, 1996, Khudesia, 2007). The results were compared with WHO standards min, max, mean, standard deviation; median and mode were calculated as normal statistical analysis. The correlation coefficient value among the parameters of pond water and hand pump water was performed by Karl Pearson's equation (P.K. Goel 1983).

Result and Discussion:

Normal statistical analysis of hydro chemical parameter of pond water and hand pump water are depicted in table No.1.

pH values varied from 6.6 to 7.6 for pond water & 6.6 to 8 for hand pump water. Both pond water and Hand Pump water sample are slightly alkaline.

Fluoride:

Fluoride of pond water collected lies in the range 0.2 mg/l to 4 mg/l. avg. value 0.78 mg/l and median 0.4 mg/l. Pond water exceeded the permissible limits proposed by WHO i.e. 1.5 mg/l. High fluoride value may cause fluourisis which is characterized by molting of teeth enamel and nervous skeleton disorders. In pond water high fluoride value may be due to weathering and leaching. In hand pump water fluoride ranged 0.3 to 1.2 mg/l. Mean, mode and median were 0.7 mg/l. All the values are within the desirable limits of WHO.

Chloride:

Chloride concentration in water indicates presence of organic waste particularly of animal origin. In pond water chloride distribution ranged from minimum 20 to maximum 90 mg/l ,average 48.3 mg/l, median value 45 mg/l. All the values were within the desirable limits i.e. 250 mg/l proposed by WHO. It means the pond water is free from human sewage and animal manure or industrial waste. In hand pump water chloride ranged from 130 to 200 mg/l. It was higher than pond water but it is within the desirable limits.

Nitrate:

Nitrate levels are ranged from 5 to 25 mg/l for pond water sample. Average value for this parameter is 11.3 mg/l. In hand pump water sample nitrate ranged from 50-150 mg/l, average

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110 mg/l ,median 112.5 mg/l values are very much higher than desirable and permissible limits proposed by WHO i.e. 45 mg/l. This shows that hand pump water have higher contents of nitrate not safe for drinking. Higher concentration of nitrate level causes Blue baby syndrome. High concentration of nitrate in pond water leads to eutrophication. Human animal waste, in use of agrochemical and seepage through drainage system are the main source of nitrate contamination of water.

Alkalinity:

In pond water alkalinity varied from 140 to 290 mg/l. Avg. 166 mg/l, Mode 140 mg/l and Median value 152.5 mg/l are within the desirable and permissible limits of WHO, whereas hand pump water showed higher values of alkalinity 430 to 470 mg/l which are higher than desirable limits. The value of alkalinity gives idea of natural salts present in water. High value of alkalinity gives undesirable taste to water.

Total Hardness:

Total hardness of pond water was found to be in the range of 90-330 mg/l;. TH of pond water within the range of desirable and permissible limits i.e. 500 mg/l and 2000 mg/l. It means it is moderately soft water. The hardness level in hand pump water has higher value of total hardness from 410 to 700 mg/l. Higher value of mean 569 mg/l, mode 560 mg/l and median 579 mg/l were found in hand pump water. Hand pump water is hard water not suitable for drinking, washing, cleaning and laundering. Cause of hardness in ground water is due to natural accumulation of salts from contact with soil & geological formations.

CaH:

The mean concentration of CaH measured as mg $CaCO_3$/l. In pond water and hand pump water resources are 114 mg/l and 251 mg/l which are much higher than desirable limits i.e. 75 mg/l.

MgH:

The desirable and permissible limits of Mg^{+2} are 30 mg/l to 100 mg/l. Both the samples have higher values of mean, mode and median than the desirable limits. At higher level magnesium salts have laxative effect. Increase in the concentration of Mg^{+2} may be due to the dissolution of Magnesium calcite gypsum and dolomite (Garrels and Christ, 1965)

TDS:

In hand pump water high value of TDS, mean (1062 mg/l), Mode (800 mg/l) and Median (893 mg/l) the Value of TDS is above than desirable and permissible limits causes gastrointestinal irrigation. TDS of pond water is within the range of permissible limits i.e 500mg/l. The most noticeable effect of excessive TDS it impart's taste to water and it deteriorated the house hold appliances.

Dissolved Oxygen (DO):

DO is an important parameter for water quality assessment. Mean (3.95 mg/l), Mode (3.1 mg/l) and Median (3.25) mg/l of pond water are less than desirable limits of DO. It may be due to surface water contain oxygen demanding pollutant like organic waste which causes rapid depletion of dissolved oxygen from water (Swant et.al, 2000). In hand pump water all the value of Mean (4.92 mg/l), Mode (5 mg/l) and Median (5 mg/l) are quite near to desirable limits. The amount of DO also varies with temperature. Increase in the temperature decreases dissolved oxygen.

COD:

Chemical Oxygen demand is the amount of oxygen required to stabilize organic matter determined by using a strong oxidant. Hand Pump water shows very low COD value. Mean

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(34.1mg/l), Mode (5.56 mg/l) and Median (25.58 mg/l) values are higher than desirable limits. But in pond water much higher values of COD mean (97.93 mg/l), mode (95 mg/l) and median (90.5 mg/l) found indicates that it is polluted by solid wastes.

BOD:

In hand pump water BOD is very low avg. value 0.9 mg/l, mode (1.2 mg/l), and median (0.9 mg/l). But in pond water high BOD is found value of mean (80 mg/l), mode (85 mg/l) and median is (82.5) mg/l. Low BOD indicates the hand pump water bodies are free from biodegradable compounds. The high BOD value indicates organic pollution, in pond water, maximum value of BOD is 215 mg/l at this level all the fish of pond dies and odour of water was also very bad. Eutrophication is visible.

Temperature of both the samples varied according to the climatic changes. Water temperature places an important factor which influences the chemical, biochemical and biological characteristics of water body. Average value of temperature in pond water is 24.14^0C and for hand pump water the value is 29^0C. The rise in temperature of water accelerates chemical reactions, reduces solubility of gases, amplifies taste and odour and elevates metabolic activities of organisms.

Statistical Study of correlation:

Statistical study of correlation and regression coefficients of the water quality parameters not only helps to assess the overall water quality but also quantify relative concentration of various pollutants in water and provide necessary clue for the implementation of rapid water quality management programmes. (Mishra et.al, 2003, Aravinda 1991, Mahajan et. Al. 2005)

The correlation coefficient among various water quality parameters of pond water and hand pump water has been calculated and numerical values of correlation coefficient are tabulated in table No. 2 and 3.

The **correlation coefficient (r)** has a value between +1 and -1 (Achuthan, 2005). The correlation between the parameters is characterized as strong, when it is range of +0.8 to 1.0 and -0.8 to -1, Moderate when it is having value in the range of +0.5 to 0.8 and -0.5 to -0.8, weak when it is in range of +0.0 to 0.5 and -0.0 to 0.5 (Karuna Karan et.al 2009).

In pond water, Alk and F^-(0.885), TH and F^- (0.715) TH and CaH (0.889) were found to be correlated significantly positively. The parameter nitrate and DO were found to be negatively correlated with most of the parameters. Some moderate positive correlation was found between CaH and F^- (0.789), TH and Alk (0.765), TDS and Alk (0.602), Alk and CaH (0.797), CaH and Temp. (0.514).

In Hand pump water BOD and Cl^- were strongly correlated with r (0.896). TH and MgH were moderately related to each other. CaH and MgH found moderately negative correlation (-0.573). It means if CaH increases in hand pump water MgH concentration will decrease. CaH bears the negative correlation with number of parameters such as chloride, Alk, BOD, COD, TDS. This indicates the presence of calcium in hand pump water is in less soluble forms. Temp and DO were observed with moderately positive correlation with alkalinity. (r = 0.623 and r = 0.609). Nitrate also bears negative correlation with number of parameters.

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In this sample higher values of nitrate were observed. DO showed moderate negative correlation with COD. In this sample value of DO is always higher than the values of COD.

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	Pond Water						Hand Pump Water									
parameters	**Min**	**Max**	**Avg.**	**SD**	**Mode**	**Median**	**Min**	**Max**	**Avg**	**SD**	**Mode**	**Median**	**D.L.** WHO	**P.L.** WHO	**Sample exceeds from DL**	**Impact**
pH	6.6	7.6	7.17	0.249	7.3	7.2	6.6	8	7.1	0.456	6.6	7.25	6.5-8.5	6.5-8.5	Nil	Taste
F^-	0.2	4	0.78	1.087	0.2	0.4	0.3	1.2	0.7	0.246	0.6	0.7	1.0	1.5	PW	Dental floursis
Cl^-	20	90	48.3	22.89	20	45	130	200	157	23.094	130	160	250	1000	Nil	-
NO^-_3	5	25	11.3	8.561	5	7.5	50	150	110	35.191	150	112.5	45	45	HW	Blue-Baby Syndrome
Alk	140	290	166	42.44	140	152.5	430	470	450	12.071	440	449	200	600	HW	Bitter taste
TH	90	330	159	72.29	90	135	410	700	569	80.392	560	575	300	600	HW	Hard Water
Ca^{+2}	50	310	114	73.54	70	85	120	370	251	67.750	280	260	75	300	HW	Scale formation
Mg^{+2}	20	110	51.8	25.58	30	45	170	450	327	75.116	360	340	30	100	HW	Laxative effect
TDS	100	504	240	139.4	100	196	740	1960	1062	358.46	800	893	500	2000	HW	Gastroinstienstinal irritation
DO	2.2	10	3.95	2.112	3.1	3.25	3.4	8.6	4.92	1.3998	5	4.75	6.0	-	Nil	-
BOD	20	215	80	52.49	85	82.5	0.1	2	0.9	0.5577	1.2	0.9	5.0	-	PW	Eutrophication
COD	30	220	97.93	51.04	95	90.5	4.3	115	34.1	31.956	5.56	25.58	10.0	-	PW	Polluted by Solid waste

Table -1 Statistical analysis of Hydro Chemical Parameters of Pond Water and Hand Water

Note: All the values in mg/l except temperature (^{0}C) and pH. DL = desirable limits, PL = permissible limits, PW=Pond water, HW=Hand pump water

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Table -2 Correlation Matrix for Pond Water

PW	*pH*	*F^-*	*Cl^-*	*NO_3^-*	*Alk*	*TH*	*BOD*	*COD*	*TDS*	*CaH*	*MgH*	*DO*	*Temp.*
pH	1												
F^-	0.429	1											
Cl^-	0.375	0.422	1										
NO_3^-	-0.585	-0.177	-0.313	1									
Alk	0.436	0.885	0.461	-0.173	1								
TH	0.288	0.715	0.482	-0.078	0.765	1							
BOD	0.079	0.290	0.045	-0.219	0.005	0.190	1						
COD	-0.298	0.258	0.059	0.317	0.193	0.235	-0.310	1					
TDS	0.191	0.358	0.446	-0.401	0.602	0.536	0.045	0.035	1				
CaH	0.337	0.789	0.350	-0.182	0.797	0.889	0.211	0.116	0.496	1			
MgH	0.207	-0.198	0.398	0.276	0.250	0.289	0.088	0.381	0.450	-0.172	1		
DO	0.367	0.070	0.187	-0.348	-0.139	-0.071	0.106	-0.053	-0.279	-0.069	-0.357	1	
Temp.	0.205	0.388	0.282	-0.065	0.523	0.621	-0.267	0.209	0.455	0.514	-0.041	-0.532	1

Table -3 Correlation Matrix of Hand Pump Water

HW	*pH*	*F^-*	*Cl^-*	*NO_3^-*	*Alk*	*TH*	*BOD*	*COD*	*TDS*	*CaH*	*MgH*	*DO*	*Temp.*
pH	1												
F^-	0.513	1											
Cl^-	-0.209	0.340	1										
NO_3^-	-0.151	-0.470	-0.650	1									
Alk	-0.018	-0.331	-0.090	-0.187	1								
TH	0.55	0.069	0.179	0.374	-0.407	1							
BOD	-0.414	0.131	0.896	-0.710	0.183	-0.140	1						
COD	0.149	-0.065	0.091	-0.408	0.494	-0.180	0.203	1					
TDS	0.108	-0.200	0.221	-0471	0.575	-0254	0.268	0.499	1				
CaH	0.075	0.483	-0.085	0.280	-0.782	0.342	-0.291	-0.191	-0.717	1			
MgH	-0.152	-0562	0.129	0.200	0.353	0.548	0.068	0.101	0.470	-0.572	1		
DO	0.336	0.267	0.208	-0.374	0.623	0.115	0.199	0.530	0.483	-0.364	0.330	1	
Temp.	0.559	-0.281	0.061	-0.120	0.609	-0.237	0.190	0.719	0.424	-0.344	0.220	0.461	1

Conclusion:

In present study, the correlation of 13 hydro chemical parameters of surface and underground water revealed that all the parameters were more or less; correlated to each other. A large number of factors and geological conditions influence the correlation between different pairs of Hydro chemical parameters of water samples directly or indirectly. In pond water high avg. value of COD and BOD indicate pond water is polluted by organic and sewage waste. It can be used only after primary treatment. Hand pump water contains high nitrate, total

ISSN:0971-1260

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hardness, calcium hardness, magnesium hardness, alkalinity, TDS. So the hand pump water should be properly treated before drinking purpose.

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