RESEARCH PAPER:

Correlation on physico-chemical characteristics of Dynaneswar dam water Rahuri, Ahmednagar (M.S.)

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SUMMARY

In present investigation attempt has been made study correlation coefficient of water quality parameters *viz.,* physical (pH, EC, TDS), major cationic constituents (Ca, Mg, Na, K) major anionic (Cl, TA, SO_4), minor constituents (PO_4, NO_3), indicators (DO, BOD, COD) and heavy metals (Fe, Zn, Cd, Cr) from the given reservoir. The analyses data were compared with standard values recommended by WHO, ICMR and BIS. The correlation coefficient 'r' among all studied quality parameters has been also worked out. The high positive correlation (r=>0.60) was observed in between pH-PO_4, EC-SO_4, TH-OD, TH-BOD and DO-Fe. Also high negative (r=>-0.60) correlation observed between pH-SO_4 and TH-BOD. The linear equation was evaluated in between highly correlated pairs. The analysis was very useful in the rapid study of ground water quality. The study reveals that many samples of water in the area are suitable for potable.

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Key Words :
Water quality, Correlation, Water parameters, Dynaneshwar dam

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Ground water quality has emerged as one of the most important and confronting environmental issues. According to WHO, 80 per cent of all the diseases of human being are caused by water or water related or water borne 4.6 lakh due to contaminated water and lack of sanitation. Now a days water bodies are contaminated by one or the other ways. Hence study was assigned.

Management of water quality presents various problems to scientists, policy makers and general public. Water quality parameter-relations are able to facilitate quantification, simplification and communication of complex water parameters. Even then studies made in the field of limnology have acquired high importance and desired attention from the concerned workers and ecologists. However, studies on water quality are raising importance in our county. Important contributions on these aspects are by Dhembare and Pondhe (1977a and b), Patil and Tijar (2001), Singh *et al.* (2001), Raka *et al*. (1999), Doctor *et al*. (1997), Venkatasubaraman *et al*. (2006).

The quality of water is described by its physical, chemical and microbial characteristics. But if some correlation is possible among these parameters, the significant once would be fairly useful to indicate the quality of water. Dynaneshwar dam water is the major source of drinking for Ahmednagar city, a district place. The overall impact of catchments area of dam has been resulting in deterioration of the water quality by various ways. Present research work has been carried out to understand the status of dam water. This is needed for continuous of the pollution level in order to promote better condition around and city health. In view of this the study was undertaken in the Dynaneshwar dam water ($19^0$35' N latitude and $74^0$27' E longitude at 572 m MSL).

EXPERIMENTAL METHODOLOGY

Collection of samples:

Collection of samples was carried out as per the methods suggestd by APHA (1998). Water samples were collected early in the morning (9.00 am) from ten selected points.

Table A : Seasonal mean and statistical characteristics of water from Dynaneshwar dam during 2008

Water parameters			Seasonal mean			Statistical parameters					
			R	S	W	X	Mn	Mx	SE	SD	CV%
Physical properties		PH	7.13	7.1	7.0	7.1	6.8	7.3	0.05	0.17	2.39
		EC	682	711.3	686.3	693.2	550	830	27.61	95.5	13.77
		TDS	440.3	528.0	585.8	518.0	338	764	43.03	148.9	28.75
		TH	474.8	316.8	367.3	386.3	180	632	32.25	111.6	28.89
Major constituents	Cationic	Ca	37.0	111.0	111.8	86.6	30	210	15.86	54.9	63.39
		Mg	68.3	45.5	77.3	63.7	13	97	8.70	30.1	47.25
		Na	50	59.3	31.5	46.9	17	86	0.17	0.60	1.28
		K	1.15	1.30	2.15	1.53	0.7	2.5	14.02	48.5	31.76
	Anionic	Cl	133.8	135.0	168.8	145.9	97	198	12.86	44.5	30.50
		TA	173.3	167.5	205.8	182.2	110	265	2.66	9.21	5.05
		SO_4	41.3	41.8	39.5	40.9	30	58	0.1	0.33	8.06
Minor constituent		PO_4	0.58	0.98	0.75	0.77	0.3	1.2	0.44	1.50	19.48
		NO_3	2.58	0.90	0.95	1.48	0.3	5.8	0.26	0.89	60.14
Indicator parameters		DO	3.03	3.23	3.58	3.28	2.0	4.9	0.26	0.89	27.34
		BOD	31.0	21.0	9.75	20.58	7	64	4.51	15.6	75.80
		COD	29.3	39.8	52.0	43.7	11	91	5.90	20.4	46.68
Heavy metals		Fe	0.32	0.06	0.48	0.29	0.09	1.1	0.12	0.41	14.13
		Zn	0.04	0.34	0.09	0.16	0.01	0.91	0.07	0.25	15.63
		Cd	0.06	0.06	0.27	0.13	0.08	0.91	0.07	0.25	19.23
		Cr	0.05	0.03	0.04	0.04	0.08	0.01	8.67	0.03	7.50

All figures are mg/L except pH and EC, R =Rainy, S =Summer, W =Winter, X = Mean, Mn=Minimum, Mx =Maximum, SD =Standard deviation, SE =Sum of error and CV =Covariance.

Plastic bottle (2L) rinsed with perchloric acid and distilled water were used for the sample collection. At the time of sampling, the bottles were rinsed with the water to be sampled and then filled by the sample and brought to the laboratory. The dam water samples were collected in a monthly interval for the period of January–December during 2008.

Analysis of samples:

The pH of water samples was noted on the spot with the digital pen pH meter and samples were brought to the laboratory. The analysis of filtered water samples was carried out for the parameters, as Electrical conductivity (EC), Total dissolved solids (TDS), Total hardness (TH), Major cationic constituents [Calcium (Ca), Magnesium (Mg), Sodium (Na), Potassium (K) and anionic-chloride (Cl), Total alkalinity (TA), Sulphates (SO_4), Minor constituents (Phosphate (PO_4) and Nitrate (NO_3)], Indicator parameter [dissolved oxygen (DO), biological oxygen demand (BOD) and chemical oxygen demand (COD)]. Heavy metals [Iron (Fe), Zinc (Zn), Cadmium (Cd) and Chromium (Cr)] were determined according to the standard methods given by APHA (1998) in the laboratory. All the twenty parameters of bimonthly analysis were averaged and presented in Table 1.

Statistical analysis:

The statistical analysis was performed using Window™/ Excel/ 2007. Values were evaluated as mean, minimum, maximum, standard deviation, sum of error and covariance. The correlation coefficient 'r' between all parameters was evaluated according to Pearson. The numerical values of the correlation coefficient 'r' between two variables is high, it indicates that two variables are highly correlated. In such cases linear relation in the form Y=AX +B worked out. Where as A and B are constant to be determined by fitting the experimental data, the constant A and B are given by the normal equation.

EXPERIMENTAL FINDINGS AND DISCUSSION

The data pertaining to water physico-chemical quality of the Dynaneshwar dam water are depicted in Table A, correlation coefficient 'r' in Table 1, least square fitting in Table 2 and linear equation of highly correlated parameters in Table 3.

It is revealed from Table 1 that, the observed pH value showed that water samples were neutral ranging from 6.8 to 7.3. These values were within maximum permissible limit prescribed by ICMR. No prescribed standards are suggested by WHO, ICMR and BIS for electrical conductivity. So, comparison could not be made from the observed values regarding the EC. It ranged from 550 to 830 µmho/cm.

The present study clearly demonstrated that, the total dissolved solid (TDS) values of water samples were within the permissible limits according to WHO, ICMR and BIS ranging from 338 to 764 mg/L, which indicates that water had tolerable concentration of soluble salts. The total alkalinity value of water sample varied from 110 to 265 mg/L CaCO3 equivalent. These values were within maximum permissible limits as per WHO and ICMR specifications. So, from alkalinity point of view, quality of water is poor.

The calcium hardness and magnesium hardness of water samples ranged from 30 to 210 mg/L and 13 to 97 mg/L respectively. These values were within permissible limits prescribed by WHO, ICMR and BIS. Total hardness of water sample ranged from 180 to 632 mg/L which exceeds the maximum permissible limits according to WHO, ICMR and BIS. As per Durfer and Beker's classification water sample is hard in nature, which may cause scale deposition followed by subsequent scum formation.

The chloride is the most common anion found in water and sewage. The source of chloride in water is the discharge of domestic sewage. Chloride content of water samples ranged from 97 to 198 mg/L which was within described limits of prescribed by WHO, ICMR and BIS. Chloride in drinking water is not harmful to human beings.

The dissolved oxygen is most important parameter in assessing water quality and it reflects the physical and biological processes prevailing in the water. The observed DO values of water samples ranged between 2 to 4.9 mg/L. These values were within permissible limits as per WHO and ICMR. ICMR and WHO have not recommended any standard for chemical oxygen demand. The values of COD for water samples varied from 11 to 91 mg/L. According to BIS standards these values were within prescribed limits.

The correlation coefficient 'r' for various physico-chemical parameters of dam water is given in Table 2. It is revealed that the high positive correlation (r=>0.50) was observed in between pH-PO_4, TH SO_4, TH-Cd, Ca-SO_4, K-COD, EC-SO_4, TH-OD and DO-Fe. Also high negative (r=>-0.50) correlation was observed between pH-TDS, pH-SO_4, TH-Fe, Na-SO_4, K-BOD, PO_4-DO, DO-BOD and TH-BOD. The analysis is very useful in the rapid study of ground water quality.

Table 1 : Pearson correlation coefficient 'r' for the physico-chemical attributes of the Dynaneshwar dam water

	pH	EC	TDS	TH	Ca	Mg	Na	K	Cl	TA	SO_4	PO_4	NO_3	DO	BOD	COD	Fe	Zn	Cd	Cr
pH	1.0	0.13	-0.57	0.31	0.06	-0.24	0.15	-0.03	0.07	-0.13	-0.14	-0.66	0.40	0.21	0.17	-0.23	-0.22	0.40	0.25	0.38
EC		1.0	-0.08	0.13	0.19	-0.34	-0.31	-0.09	-0.04	0.28	0.62	-0.03	0.13	0.04	-0.09	-0.30	-0.06	-0.05	-0.33	-0.27
TDS			1.0	-0.35	0.26	0.31	-0.06	0.11	0.22	-0.16	0.21	0.46	-0.22	-0.25	-0.23	0.48	0.16	001	0.01	-0.47
TH				1.0	-0.14	-0.09	-0.41	0.19	-0.11	0.29	-0.46	0.55	-0.33	0.73	-0.65	-0.06	-0.55	-0.03	0.58	-0.28
Ca					1.0	0.001	-0.42	0.32	0.40	-0.17	0.50	0.09	-0.37	0.03	-0.36	0.06	-0.21	0.16	0.36	-0.14
Mg						1.0	-0.08	0.02	-0.12	-0.02	-0.37	-0.18	-0.13	0.13	-0.46	0.11	0.37	-0.43	-0.05	-0.08
Na							1.0	-0.28	-0.19	-0.28	-0.55	0.07	0.23	0.25	-0.05	0.46	014	0.28	-0.06	-0.40
K								1.0	-0.03	0.46	-0.01	-0.01	-0.40	025	-0.54	0.52	-0.11	0.36	0.32	0.07
Cl									1.0	-0.29	0.43	-0.38	0.02	0.34	0.17	0.14	0.39	0.001	-0.03	0.11
TA										1.0	-0.25	-0.03	0.13	0.05	-0.25	-0.01	-0.28	-0.01	-0.07	0.18
SO_4											1.0	0.16	-0.25	-0.18	0.22	-0.30	0.02	-0.15	-0.09	-0.20
PO_4												1.0	-0.47	-0.56	-0.04	0.11	-0.39	007	0.21	-0.52
NO_3													1.0	-0.10	0.45	-0.14	-0.06	-0.18	-0.05	0.34
DO														1.0	-0.55	0.44	0.68	0.19	-0.07	-0.10
BOD															1.0	-0.55	-0.25	-0.21	-0.16	0.44
COD																1.0	0.35	0.34	0.30	-0.43
Fe																	1.0	-0.27	-0.12	-0.18
Zn																		1.0	-0.10	0.35
Cd																			1.0	0.12
Cr																				1.0

Statistical analysis suggested that pH bears negative correlation with TDS and PO_4 (r=-0.57 and r=-0.66, respectively). It indicates that resulting pH of the experimental water sample depends upon dissolve solids and phosphate.

Table 2 indicates that total hardness was also in positive correlation with DO, PO_4 and Cd while negative correlation with BOD and Fe (r=0.73, r= 0.55, r= 0.58, r=-0.65 and -0.55, respectively). It reveals that the total hardness of water samples may depend upon soluble DO, PO_4 and COD. Calcium showed positive correlation with SO_4 (r=0.50). The Na was having negative correlation with SO_4 (r=-0.55). It indicates the SO_4 depends on Ca and Na. K showed positive relation with COD (r=0.52) and negative relation with BOD (r=-0.52). DO showed positive correlation with Fe (r=0.68) and negative with BOD (r=-0.55). The linear relationship between highly correlated pairs (r=>0.60) of various parameters is presented in Table 3 for better understanding.

Table 2 : Least square fitting correlation Y= AX+B among significantly correlated pairs of parameters ('r'> 0.50)

x dependent	y dependent	r	r^2	A	B
pH	TDS	-0.57	0.3249	0.871	26.881
pH	PO_4	-0.66	0.4356	0.313	23.913
EC	SO_4	0.62	0.3844	0.712	30.132
TH	PO_4	0.55	0.3025	0.072	4.508
TH	DO	0.73	0.5329	0.252	48.73
TH	BOD	-0.65	0.4225	0.013	3.53
TH	Cd	0.58	0.3364	0.017	34.414
TH	Fe	-0.55	0.3025	0.077	7.1142
Ca	SO_4	0.50	0.2500	0.021	14.221
Na	SO_4	-0.55	0.3025	0.025	19.221
K	BOD	-0.54	0.2916	0.011	6.791
K	COD	0.52	0.2704	0.086	18.318
PO_4	DO	-0.56	0.3136	0.019	19.306
PO_4	Kr	-0.52	0.2704	0.074	84.331
DO	BOD	-0.55	0.3025	0.085	14.912

Table 3 : Comparison of observed and predicted values of PO_4, SO_4, DO and BOD ('r' > 0.60)

Expected Y= AX+B	Obtained
Y=(0.313* 1127.44+23.913) 376.801	376.003 (PO4)
Y=(0.712*1127.44+30.132) 832.869	831.912 (SO4)
Y=(0.252*1127.44+48.731) 332.845	333.001 (DO)
Y=(0.013*1127.44+3.531) 18.187	18.001 (BOD)

Positive correlation obtained between 85 unions (*i.e.* 44per cent of the total number) and remaining 105 unions showed negative correlation (*i.e.*55% of the total number). Shah *et al.* (2006) reported 35 unions (64 %) positive correlations and 20 unions (36 %) unions negative related to the total number from the 15 stations in between Ahmedbad to Khedbrahma rail route water samples. Patel and Desai (2006) noticed positive correlation between 42 unions and rest of the unions showed negative correlation from some village's water of Surat district. So, it reveals that the correlation studies of the water quality parameters have a great significance in the study of water sources.

Venkatasubraman *et al.* (2006) reported highly positive correlation between EC-TDS, EC-Cl, EC-Mg TH-Mg TDS-Cl TDS-Mg and Cl-Mg from Coimbatore. Dhembare and Pondhe (1977a) reported the high correlated parameters between EC-TDS, TDS-HCO, Mg-Cl and HCO-RSC from Sonai, Ahmednagar district and also they (1977b) noticed high correlation between the parameters TA-TH, Cl-SO_4 and Mg-Cl from Pravara area Ahmednagar district Maharashtra. The above study showed that it is equality use tool for the quick assessment of water resource. The correlation of physico-chemical parameters varies water to water, season, location, industrialization, uncontrolled population, agriculture resulting pollution load, soil and rock conditions of water habitats.

Conclusion:

In this study an attempt has made to identify the contamination of water with major physico-chemical parameters. The dam water is polluted due to industrialization and uncontrolled growth. Excessive exploitation of water and improper management of natural resources lead to the unequal distributions of cations and anions. The parameters like PO_4, SO_4, DO and BOD have good relation and the equation obtained from the correlation analysis is very useful in the rapid analysis of water quality. The study revealed that dam water sample is non-potable either by one parameter or the other and there is need for water treatment before drinking.

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