

## Correlation, Regression Study on Physico-chemical Parameters and Water Quality Assessment of Ground Water of Mansa Taluka in Gujarat

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Present work deals with the assessment of physico-chemical parameters of ground water samples of 40 villages of Mansa Taluka in Gujarat, India during May-2005. Statistical studies including correlation and regression analysis have been carried out for physico-chemical parameters of water. The observed values of various physico-chemical parameters of water samples were compared with standard values recommended by WHO. Results show that water of all villages of Mansa Taluka is safe for drinking purpose except Pundhara and Anodiya villages and a linear relationship was established between pair of physico-chemical parameters of water of Mansa Taluka.

**Key Words:** Quality assessment, Ground water, Mansa Taluka.

### INTRODUCTION

In India ponds, dams and ground water are used for domestic and agriculture purposes. The utilization and consumption of these sources raises several environmental issues. Water pollution is a serious problem as almost 70% of India's surface water resources and a growing number of its ground water reserves have been contaminated by biological, organic and inorganic pollutants<sup>1</sup>. Studies of physico-chemical parameters of drinking water of various villages of different Talukas in Gujarat state have been carried out by some workers<sup>2-4</sup>.

The present studies deals with study of physico-chemical parameters of ground water of Mansa Taluka villages in Gujarat. The analyzed data were compared with standard values recommended by WHO. Statistical studies such as standard deviation, coefficient of variance, correlation and regression have been carried for water quality parameters.

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## EXPERIMENTAL

Water samples were collected from borewells of 40 villages of Mansa Taluka situated in North Gujarat, India during May-2005 (Table-1). 10 Villages in each region of Mansa Taluka were selected for water sampling. Samples were collected in polyethylene bottles. They were analyzed for various physico-chemical parameters like H<sup>+</sup> concentration (pH), electrical conductivity (EC), total dissolved solids (TDS), total alkalinity (TA), calcium hardness (CaH), magnesium hardness (MgH), total hardness (TH), chloride content (Cl<sup>-</sup>), sulphate (SO<sub>4</sub><sup>2-</sup>), sodium (Na<sup>+</sup>), potassium (K<sup>+</sup>) and dissolved oxygen (DO) as per standard methods<sup>5,6</sup>. AR grade reagents and double distilled water were used for preparation of reagents. The statistical analysis such as mean, standard deviation and coefficient of variance of obtained data were carried out. All possible correlation coefficient (r) between the parameters and values of a and b in regression equation (Y = a + bx) were determined<sup>7</sup>.

TABLE-1  
LIST OF VILLAGES FROM WHERE EXPERIMENTAL WATER  
SAMPLES ARE COLLECTED

Villages of various regions of Mansa Taluka			
North region	South region	East region	West region
Ranasan	Mansa	Pilvai	Amrapura
Veda	Parbatpura	Rangpur	Dhameda
Patanpura	Gulabpura	Badpura	Kharna
Delvada	Khata Amba	Ambod	Solaiya
Khadat	Rampura	Anodiya	Samou
Chadasana	Boru	Varsoda	Parsa
Paldi Vyas	Amarpur	Lodra	Harnahoda
Pundhara	Indrapura	Mahudi	Charada
Bilodra	Dholakuva	Galthara	Bapupura
Paldi Rathod	Bhimpura	Lakroda	Padusma

## RESULTS AND DISCUSSION

The standard and observed values of physico-chemical parameters of experimental water samples are presented in Table-2.

The observed pH values ranging from 7.12 to 8.25 show that the present water samples are slightly alkaline. These values are within highest desirable limit prescribed by WHO.

TABLE-2  
PHYSICO-CHEMICAL PARAMETERS OF GROUND WATER IN MANSA TALUKA  
IN NORTH GUJARAT

Parameters	Unit	WHO values		Experimental values(Range)	Mean value (n=40)	SD	CV (%)
		HDL	MPL				
pH	-	7.0-8.5	6.5-9.5	7.12-8.25	7.76	0.23	2.96
EC	ms/cm	-	-	0.75-3.03	1.32	0.28	21.21
TDS	mg/L	500	1000	354-1300	588.32	234.44	39.85
Total alkalinity	mg/L	120	250	275-630	391.75	74.19	18.94
Ca Hardness	mg/L	75	200	36-284	135.70	45.55	33.57
Mg Hardness	mg/L	30	150	32-280	130.10	63.15	48.54
Total Hardness	mg/L	100	500	140-520	278.30	91.51	32.88
Cl <sup>-</sup>	mg/L	200	600	148.39-836.38	304.47	160.63	52.76
SO <sub>4</sub> <sup>2-</sup>	mg/L	200	400	12.87-129.25	44.91	32.73	72.88
Na <sup>+</sup>	mg/L	-	200	82.50-545	265	96.66	36.48
K <sup>+</sup>	mg/L	-	-	32.50-90	68	19.81	29.13
DO	mg/L	-	> 5	3.85-7.09	5.61	0.83	14.80

HDL : Highest desirable limit; MPL : Maximum permissible limit

TDS values of all water samples of Pundhra and Anodiya villages ranged from 354 to 1300 mg/L exceeds the maximum permissible limit of WHO. It indicates that all water samples of this Taluka have tolerable concentration of soluble salts except Pundhara and Anodiya villages. Table-2 shows that the total alkalinity values of water samples varied from 275 to 630 mg/L CaCO<sub>3</sub> equivalent. These values also exceeds the maximum permissible limit as per standards of WHO. Thus, from alkalinity point of view quality of water samples is poor.

The calcium hardness values of water samples varied from 36 to 284 mg/L as CaCO<sub>3</sub> equivalent. The calcium hardness values of 7.5 and 87.5 % of water samples are within the higher desirable limit and within the maximum permissible limit as per WHO, respectively. The calcium hardness values of water samples of Anodiya and Varsoda exceeds the maximum permissible limit. The magnesium hardness value of all water samples varied from 32 to 280 mg/L as CaCO<sub>3</sub> equivalent. The magnesium hardness value of water samples of 26 villages and 14 villages are within and exceed the maximum permissible limit, respectively as per standards of WHO. The total hardness values of all water samples ranged from 140 to 520 mg/L as CaCO<sub>3</sub> equivalent which falls within the maximum permissible limit of WHO except that of Anodiya village.

The chloride content of 30 and 62.5 % water samples of Mansa Taluka is within the higher desirable limit and maximum permissible limit, respectively as per WHO. Water samples of Ranasan, Pundhara and Anodiya villages have exceed chloride content to the maximum permissible limit according to WHO standards.

Studied water samples of Mansa Taluka are free from sulphate pollution as  $\text{SO}_4^{2-}$  content varied from 12.87 to 129.25 mg/L. It is within the highest desirable limit prescribed by WHO. The observed DO values of all water samples ranged from 3.85 to 7.09 mg/L. DO values of water samples of 20% of villages of Mansa Taluka exceeds the maximum permissible limit as per WHO.

Since no prescribed standards are suggested by WHO for parameters like electrical conductivity, sodium and potassium content for drinking purpose. So, no comparison can be made from observed values. Correlation coefficient and values of a and b of least square fitting of equation  $Y = a + bx$  amongst various parameters of water samples of Mansa Taluka are presented in Table-3. Statistical analysis (Table-2) show that among the all parameters pH and sulphate bear lower (% CV = 2.96) and higher (% CV = 72.88) values of coefficient of variance, respectively. It indicates that low variance was occurred in obtained pH data where as high variance was occurred in obtained sulphate values among the all studied physico-chemical parameters of water samples. Table-3 reveals that pH and TA do not bear significant positive correlation with studied parameters. Electrical conductivity bears significant positive correlation with TDS, CaH, MgH, TH, Cl<sup>-</sup>,  $\text{SO}_4^{2-}$  and Na<sup>+</sup> ( $r = 0.99$ ,  $r = 0.63$ ,  $r = 0.77$ ,  $r = 0.85$ ,  $r = 0.95$ ,  $r = 0.31$  and  $r = 0.59$ , respectively). TDS bears significant positive correlation with CaH, MgH, TH, Cl<sup>-</sup>,  $\text{SO}_4^{2-}$  and Na<sup>+</sup> ( $r = 0.60$ ,  $r = 0.79$ ,  $r = 0.85$ ,  $r = 0.96$ ,  $r = 0.33$  and  $r = 0.55$ , respectively). It suggests that electrical conductivity depends on dissolved solids which depends on  $\text{CaCl}_2$ ,  $\text{MgCl}_2$  and/or  $\text{Na}_2\text{SO}_4$ . It also shows that amount of chloride salts are higher than that of sulphate salt in all the water samples.

Chloride ion bears significant positive correlation with CaH, MgH, TH and Na<sup>+</sup> ( $r = 0.59$ ,  $r = 0.71$ ,  $r = 0.79$  and  $r = 0.52$ , respectively) and sulphate ion does not bear significant positive correlation with CaH, MgH, TH and Na<sup>+</sup>. It reveals that  $\text{Ca}^{2+}$  mainly remains present as  $\text{CaCl}_2$ ,  $\text{Mg}^{2+}$  as  $\text{MgCl}_2$  and Na<sup>+</sup> as NaCl. Cl<sup>-</sup> and  $\text{SO}_4^{2-}$  bear negative correlation with K<sup>+</sup>. It indicates that KCl and  $\text{K}_2\text{SO}_4$  may be absent in water samples. Total hardness bears positive correlation with CaH, MgH and Na<sup>+</sup> ( $r = 0.76$ ,  $r = 0.89$ ,  $r = 0.79$  and  $r = 0.35$ , respectively). So, it may be suggested that total hardness of the experimental water samples is mainly due to the presence of the  $\text{CaCl}_2$ ,  $\text{MgCl}_2$  and NaCl.

The linear relation for each pair of variables can be obtained by substituting numerical values of A and B in equation  $Y = a + bx$  from Table-3. These linear relation can be used to find out value of one variable of the pair when the other is known from experiment.

TABLE-3  
CORRELATION COEFFICIENT AND VALUES OF A & B OF LEAST SQUARE  
FITTING OF THE EQUATION  $Y = a + bx$  AMONGST VARIOUS PARAMETERS  
OF WATER SAMPLES OF MANSAL TALUKA

Parameters		Correlation Coefficient	a	b
x	y	r		
pH	EC	-0.32*	7.23408	-0.76211
	TDS	-0.30*	3009.267	-312.118
	TA	-0.39*	1363.511	-125.283
	CaH	-0.46**	845.6778	-91.5333
	MgH	-0.23	627.8342	-64.17
	TH	-0.39*	1473.512	-155.703
	Cl <sup>-</sup>	-0.19	1367.333	-137.028
	SO <sub>4</sub> <sup>2-</sup>	0.14	-111.432	20.15611
	Na <sup>+</sup>	-0.28	1215.925	-122.597
	K <sup>+</sup>	-0.11	143.8866	-9.65147
EC	DO	0.11	2.447241	0.408368
	TDS	0.99**	6.635988	439.7573
	TA	0.10	374.2631	13.22012
	CaH	0.63**	66.16923	52.56531
	MgH	0.77**	9.718793	91.00828
	TH	0.85**	75.88803	143.5736
	Cl <sup>-</sup>	0.95**	-73.2538	285.562
	SO <sub>4</sub> <sup>2-</sup>	0.31*	20.19048	18.68703
	Na <sup>+</sup>	0.59**	120.8089	109.0086
	K <sup>+</sup>	-0.48**	93.18531	-18.2652
TDS	DO	-0.04	5.701189	-0.06535
	TA	0.10	374.2706	0.02971
	CaH	0.60**	68.6273	0.114006
	MgH	0.79**	5.639484	0.211550
	TH	0.85**	74.26678	0.325557
	Cl <sup>-</sup>	0.96**	-76.5849	0.6477
	SO <sub>4</sub> <sup>2-</sup>	0.33*	18.05588	0.045643
	Na <sup>+</sup>	0.55**	128.9844	0.231191
	K <sup>+</sup>	-0.52**	95.46354	-0.04494
	DO	-0.07	5.755649	-0.00024
TA	CaH	0.03	129.1633	0.016686
	MgH	0.21	60.17614	0.178491
	TH	0.16	189.3394	0.195177
	Cl <sup>-</sup>	-0.12	408.5645	-0.26571
	SO <sub>4</sub> <sup>2-</sup>	-0.07	57.8652	-0.03307
	Na <sup>+</sup>	0.29	114.686	0.383699
	K <sup>+</sup>	0.25	42.23784	0.068378
	DO	-0.16	6.313896	-0.00178
CaH	MgH	0.37*	59.22692	0.522278
	TH	0.76**	59.22692	1.522278
	Cl <sup>-</sup>	0.59**	18.00561	2.111036
	SO <sub>4</sub> <sup>2-</sup>	0.19	25.89876	0.140088

Parameters		Correlation Coefficient	a	b
x	y	r		
MgH	Na <sup>+</sup>	0.37*	153.1988	0.823885
	K <sup>+</sup>	0.005	68.72342	0.002222
	DO	0.31*	4.839419	0.005714
	TH	0.89**	101.7999	1.26057
	Cl <sup>-</sup>	0.71**	70.96574	1.794831
	SO <sub>4</sub> <sup>2-</sup>	0.30	25.14993	0.151874
TH	Na <sup>+</sup>	0.23	217.7338	0.363306
	K <sup>+</sup>	-0.54**	91.85406	-0.17547
	DO	-0.14	5.845901	-0.00178
	Cl <sup>-</sup>	0.79**	-70.2756	1.40989
	SO <sub>4</sub> <sup>2-</sup>	0.30	15.72863	0.109782
	Na <sup>+</sup>	0.35*	163.1102	0.383333
Cl <sup>-</sup>	K <sup>+</sup>	-0.38*	91.96802	-0.08632
	DO	0.06	5.473454	0.000532
	SO <sub>4</sub> <sup>2-</sup>	0.29	27.19782	0.058169
	Na <sup>+</sup>	0.52**	167.6335	0.319787
	K <sup>+</sup>	-0.50**	88.32672	-0.06339
	DO	0.006	5.605386	3.08
Na <sup>+</sup>	Na <sup>+</sup>	0.01	263.0021	0.044488
	K <sup>+</sup>	-0.25	75.95318	-0.15427
	DO	-0.18	5.816057	-0.00448
	K <sup>+</sup>	0.24	55.71842	0.050214
	DO	0.09	5.40586	0.000788
	K <sup>+</sup>	0.37*	4.577342	0.015029

\*Significance at 5 % level,  $r > 0.30$ ; \*\*Significance at 1 % level,  $r > 0.39$

### Conclusion

This study shows that water of all villages of Mansa Taluka except Pundhara and Anodiya villages is safe for drinking purpose. Water samples of Pundhara and Anodiya contains higher TDS value with compare to maximum permissible limit as per WHO. Significant positive correlation is obtained in 24 out of 66 pairs of physico-chemical parameters of water.

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