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Study of physico-chemical characterization of irrigation tanks and fishponds of Gujarat by statistical analysis

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ABSTRACT

This study analyzed seasonal variation in physico-chemical parameters from the data collected at 7 irrigation tanks and 2 village fish ponds at 2 sites from 2000-2001. The data was analyzed statistically using multifactorial correlation analysis in order to study the inter-relationship of 10 parameters of 2 sites of the seven irrigation tanks and two village fishponds of Balasinor taluka, Matar taluka of Kheda district and Tarapur taluka of Anand district of Gujarat. The impact of various seasons on water quality of 10 physico-chemical parameters like pH, Total Alkalinity, Dissolved Oxygen, Free $Co_{2,}$ Calcium, Magnesium, Hardness, Chloride, Sulphate and Inorganic Phosphate of irrigation tanks and village fishponds was assessed by multifactorial statistical analysis.

Keywords: Statistical analysis, physico-chemical parameter, irrigation tanks, village fishponds.

INTRODUCTION

Water is essential to sustain life, and a satisfactory (adequate, safe and accessible) supply must be available to all. Improving access to safe drinking-water can result in tangible benefits to health. Every effort should be made to achieve a drinking-water quality as safe as practicable. The water quality of water resources is a subject of ongoing concern. The assessment of long-term water quality changes is also a challenging problem. During the last decades, there has been an increasing demand for monitoring water quality of many rivers, ponds and irrigation tanks by regular measurements of various water quality variables. Water quality is defined in relation to the use intend to put the water and for each use there are indicators which show the degree of purity (Akinnibosun et al., 2009). Quality assurance tests of portable water produced and packaged by major companies classified under food and beverage industries in Southern Nigeria, were carried out based on the standard parameters (Okolo et al., 2011). The result has been the gradual accumulation of reliable long-term water quality records and the examination of these data for long-term trends (Hirsch et al., 1991). Miller and Hirst (1998) used the hydro chemical databases from an upland catchment in Scotland for a period of five years to assess the annual variation in amounts and concentration of solutes and to examine the variation in stream water quality due to changes in flow, season and long time trend. Ferrier et al. (2001) analyzed in detail databases for Scotland and identified temporal changes in water quality over the last 20 years. Chloride content of water is another important parameter to be considered to know the quality of water as its higher concentrations can impart undesirable taste to water and may cause corrosion in the distribution system (McConnell, 1972). The major water quality factors that determine whether the precipitate forms a protective scale are pH and alkalinity. The concentrations of calcium, chloride and sulfate also influence iron corrosion. Successful control of iron corrosion has been achieved by adjusting the pH to the range 6.8–7.3, hardness and alkalinity to at least 40 mg/litre (as calcium carbonate), oversaturation with calcium carbonate of 4–10 mg/litre and a ratio of alkalinity to Cl^- +SO_4^{2-} of at least 5 (when both are expressed as calcium carbonate) (WHO, 2006). In the inter relationships of physico-chemical parameters of 3 station of Vishwamitri river by statistical analysis through Baroda city (Patel and Nandan, 1984). Taste impairment varies with the nature of the associated cation; taste thresholds have been found to range from 250 mg/litre for Sodium sulphate to 1000 mg/litre for calcium sulfate. It is generally considered that taste impairment is minimal at levels below 250 mg/litre (WHO, 2006).

MATERIALS AND METHODS

Study area

Gujarat state is located in the western part of India. In this study, Balasinor taluka & Matar taluka of Kheda district and Tarapur taluka of Anand district were selected area. The Kheda district is located (between 72^o 32' to 73^o 37' East longitude and between 22^o 30' to 23^o 18' North latitude) and Anand district is located (between 72^o 15' to 73^{o}18' East longitude and between 22^o 07' to 23^o 29' North latitude) in Gujarat. A multifactorial correlation analysis of the data was made to study the inter-relationship of 10 parameters of 2 sites of the seven irrigation tanks and two fishponds of Balasinor taluka, Matar taluka of Kheda district and Tarapur taluka of Anand district of Gujarat. In Balasinor taluka five irrigation tank, like 1) Jatholi irrigation tank (JIT), 2) Bhamaria irrigation tank (BIT), 3) Bhagvan ji na muvad irrigation tank (BMIT), 4) Koidam irrigation tank (KOIT), 5) Khanta irrigation tank (KHIT) was studied. In Matar taluka one 6) Pariaj irrigation tank (PIT) and two village fishpond 7) Machhial village fishpond (MVF), 8) Sandhana village fishpond (SVF) and in Tarapur taluka 9) Kanaval irrigation tank (KIT) was studied.

Sample collection

The statistical analysis of physico-chemical parameters were studied during 2000-2001. Surface water samples were collected from the selected sites to study seasonal variation in physico- chemical parameters. Water samples were collected in 1 litre capacity polyethylene bottles during morning.

Physico-chemical analysis of water

The physico-chemical parameters like pH and Inorganic Phosphate (APHA, 1995), Total Alkalinity, Dissolved Oxygen, Free $Co_{2,}$ Calcium, Magnesium, Hardness, Chloride and Sulphate (Trivedi and Goel, 1986) were estimated by standard methods. Data was computer processed from the Department of Computer Science, Sardar Patel University for general statistics. The significance of the different parameters was tested by Mean, Standard deviation (SD), Coefficient of variance (CV), to show the interrelationships among the parameters. The significance of the difference between three means was tested by test at 50% level of significance with 48 degree of freedom for 13 parameters during December 1980 to December 1982 following Rao et al. (1975). To show the inter-relationships among the parameters, correlation matrix (r) of each parameter was compared to every parameter of each station.

RESULTS AND DISCUSSION

Most of the observations related to different parameters are agreeable by statistical analysis of the data. The relationships among different parameters like pH, Total Alkalinity, Dissolved Oxygen, Free $Co_{2,}$ Calcium, Magnesium, Hardness, Chloride, Sulphate and Inorganic Phosphate were stastically analyzed for three seasons of winter, summer and monsoon. The parameters showed either a direct or indirect relationship with a particular parameter during three seasons at both sites. The statistical comparison among various physico-chemical parameters of seven irrigation tanks and two village fish ponds at site-I and site-II are shown in tables 1 and 2 respectively. The mean effects of the parameters for three seasons were observed to be statistically insignificant. It might be due to less difference in the three seasons between the two sites. The mean value pH at two study areas ranged between 8.46-8.40 in winter. The alkalinity of water is closely related to pH. The influence of photosynthesis on pH is greater in low alkalinity waters because of their low buffering capacity related to water quality (Boyd, 2000). As the pH is related to a variety of different parameters, it is not possible to determine whether pH has a direct relationship with human health but it is argued that pH has an indirect effect as it can affect water treatment processes (Aramini et al., 2009). The values of total alkalinity standard deviation at site -I & site- II were 26.45 & 20.70 during summer and 53.80 & 39.51 during monsoon season respectively. At site-I the dissolved oxygen standard deviation value was recorded 0.3345, 0.4247, 0.5206 and site-II 0.4468, 0.4349, 0.3778 during winter, summer and monsoon respectively. The DO content is important of drinking water because oxygen imparts a good taste to water and is an absolute requirement for the metabolic organisms in water bodies. The dissolved oxygen content of water is influenced by the source, raw water temperature, treatment and chemical or biological processes taking place in the distribution system. Depletion of dissolved oxygen in water supplies can encourage the microbial reduction of nitrate to nitrite and sulfate to sulfide (WHO, 2006). The SD value of free CO_2 was registered highest at site- I i.e. 2.5978 and at site-II i.e. 2.3206 during summer. The minimum mean value of calcium, magnesium, chloride, sulphate and inorganic phosphate were recorded 35.2, 21.2, 104, 0.16 & 0.11 and 32.4, 23.68, 99.76, 0.13 & 0.13 in site-I and site-II respectively. The highest hardness mean value was recorded 156.0 and 150.7 during winter at site-I and site-II respectively. Venkata et al. (2006) reported high positive correlation between TDS-Mg, TH-Ca and Mg. Hardness caused by calcium and magnesium is usually indicated by precipitation of soap scum and the need for excess use of soap to achieve cleaning. Depending on the interaction of other factors, such as pH and alkalinity, water with hardness above approximately 200 mg/litre may cause scale deposition in the treatment works, distribution system and pipe work and tanks within buildings. It will also result in excessive soap consumption and subsequent "scum" formation. On heating, hard waters form deposits of calcium carbonate scale. Soft water, with a hardness of less than 100 mg/litre, may, on the other hand, have a low buffering capacity and so be more corrosive for water pipes (WHO, 2006).

Table- 1

Table- : 1 Showing Statistical comparison of nine ponds in three different seasons. Site I 2000-2001.

Parameter	Season	Ponds No.									Statistical data		
		1	2	3	4	5	6	7	8	9	Standard Deviation	Mean	Coefficient of Var
pH	Winter	7.8	8.2	8.1	8.7	8.4	8.5	8.9	8.9	8.6	0.371184	8.46	0.043898274
	Summer	7.3	7.3	7.5	7.3	7.5	8.2	8.3	8.3	8.3	0.479004	7.78	0.061586177
	Monsoon	7.2	7.3	7.3	7.2	7.4	7.2	7.7	8.2	7.2	0.337062	7.41	0.045480694
Total Alkalinity	Winter	70	70	50	40	40	40	60	70	45	13.64225	53.9	0.25315524
	Summer	50	50	50	100	110	100	100	60	100	26.45751	80	0.330718914
	Monsoon	150	100	150	200	100	50	60	60	50	53.80004	102	0.526304752
Dissolved Oxygen	Winter	8.3	8.7	8	8	8.7	8.7	8.1	8.7	8.7	0.334581	8.43	0.039699789
	Summer	7.7	7.3	7.7	6.7	6.7	7.3	6.7	7	6.7	0.424735	7.09	0.059878084
	Monsoon	7.5	6.7	7.7	7.7	7.3	7.3	7	6.1	7.3	0.520635	7.18	0.072523103
Free Co_2	Winter	10	10	8.8	5.5	10	5.5	6.6	8.8	5.1	2.122711	7.81	0.271909974
	Summer	5.5	6.6	5.5	6.6	6.6	10	13	8.8	10	2.597809	8.09	0.321157694
	Monsoon	10	10	6.6	6.6	5.5	6.6	6.6	8.8	5.5	1.77631	7.36	0.241492318
Calcium	Winter	30	32	48	18	24	58	48	80	60	20.06124	44.2	0.453714461
	Summer	48	48	48	64	60	28	27	16	28	16.59906	40.9	0.406297577
	Monsoon	40	32	28	36	20	32	48	40	40	8.208346	35.2	0.233331574
Magnesium	Winter	20	31	27	27	26	17	35	46	16	9.595968	27.2	0.352663282
	Summer	40	25	25	44	24	16	32	33	13	10.28138	27.8	0.369213986
	Monsoon	20	26	18	25	24	17	22	20	20	3.511101	21.2	0.165349306
Hardness	Winter	110	160	160	130	130	130	190	270	124	49.18333	156	0.31527776
	Summer	210	150	150	240	160	92	160	150	80	49.95998	155	0.323017138
	Monsoon	120	140	100	140	120	100	140	120	120	15.63472	122	0.12792043
Chloride	Winter	142	178	127	142	185	128	170	185	128	25.2072	154	0.163955173
	Summer	114	114	142	163	156	50	57	57	80	44.50849	104	0.429802971
	Monsoon	142	71	85	85	107	85	142	227	120	48.2815	118	0.408280989
Sulphate	Winter	0	0.1	0.1	0	0	0.1	0.5	0.5	0.1	0.184055	0.16	1.151140914
	Summer	0.2	0.3	0.4	0.3	0.2	0.8	0.3	0.9	0.2	0.263615	0.4	0.667003664
	Monsoon	2	1.3	1.9	0.8	1.5	0.6	0.3	0.3	0.6	0.632645	1.04	0.607209787
Inorganic Phosphate	Winter	0.1	0.1	0.1	0	0	0.2	0.1	0.1	0.2	0.074226	0.11	0.677521035
	Summer	0	0.2	0	0.8	0	0	0	0	0	0.255252	0.14	1.803195781
	Monsoon	0.4	0.3	0.3	0.1	0.2	0.1	0.5	0.5	0.2	0.151002	0.3	0.506153576

All parameters are in mg/lit, except pH and Temperature.

(Note: 1- JIT, 2- BIT, 3- BMIT, 4- KOIT, 5- KHIT, 6- PIT, 7- MVF, 8- SVF & 9- KIT)
(Coefficient of Var- Coefficient of Variance)

Table- 2

Table: 2. Showing Statistical comparison of nine ponds in three different seasons
Site II 2000-2001.

Parameter	Season	Pond No.									Statistical data		
		1	2	3	4	5	6	7	8	9	Standard deviation	Mean	Coefficient of var
pH	Winter	7.6	8.1	8.2	8.8	8.3	8.4	8.8	8.8	8.6	0.40311	8.4	0.0479896
	Summer	7.2	7.3	7.6	7.4	7.4	8.1	8.3	8.2	8.2	0.44752	7.744	0.0577865
	Monsoon	7.3	7.3	7.4	7.3	7.3	7.1	7.7	8.2	7.3	0.32787	7.433	0.0441083
Total Alkalinity	Winter	70	70	60	40	40	50	80	71	40	15.7357	57.89	0.2718253
	Summer	80	60	100	100	120	100	110	62	100	20.7069	92.44	0.2239934
	Monsoon	150	100	150	100	100	50	60	60	50	39.5109	91.11	0.4336562
Dissolved Oxygen	Winter	8.3	8.3	8	8	8.8	8.1	9.1	9.1	8	0.44681	8.399	0.0531983
	Summer	7.3	7.7	7.8	6.4	7.3	7.7	7	7.3	7	0.43497	7.287	0.0596941
	Monsoon	7.3	6.7	8	7.7	7.3	7.7	7.3	7.3	7.7	0.37786	7.444	0.0507572
Free CO_2	Winter	10	10	8.8	5.5	10	5.5	10	8.8	5.1	2.18281	8.184	0.2667028
	Summer	5.1	6.6	6.6	5.5	5.1	10	11	8.8	9.5	2.32063	7.591	0.3057032
	Monsoon	10	5.5	6.6	5.5	5.5	6.6	6.6	8.7	5.1	1.65542	6.673	0.2480642
Calcium	Winter	24	32	48	18	24	58	48	83	40	20.4804	41.66	0.4916603
	Summer	4.1	40	40	60	60	27	28	16	16	19.4945	32.4	0.6015994
	Monsoon	48	16	29	36	21	28	32	56	32	12.4691	33.17	0.3758775
Magnesium	Winter	19	31	27	27	26	18	27	43	21	7.70531	26.6	0.2896854
	Summer	41	29	18	27	14	15	22	30	16	9.04628	23.68	0.38204
	Monsoon	37	33	27	40	19	18	26	25	21	7.76159	27.43	0.2829827
Hardness	Winter	100	160	160	130	130	130	160	260	126	45.6508	150.7	0.3029924
	Summer	210	160	110	170	120	90	120	140	81	41.0704	133.4	0.3077715
	Monsoon	200	150	140	200	80	100	140	160	120	40.6202	143.3	0.2833967
Chloride	Winter	142	178	127	142	185	128	170	185	128	25.1815	153.8	0.1637646
	Summer	107	114	156	163	121	50	50	57	81	43.4135	99.76	0.4351983
	Monsoon	99	107	85	87	107	85	121	192	120	33.089	111.4	0.2970883
Sulphate	Winter	0	0.1	0.1	0	0	0.1	0.3	0.4	0.1	0.12238	0.133	0.9178771
	Summer	0.7	0.3	0.3	0.4	0.1	0.6	0.4	0.4	0.2	0.1716	0.366	0.4692873
	Monsoon	2	1.2	1.9	0.8	1.4	0.6	0.5	0.2	0.7	0.61034	1.025	0.5951993
Inorganic Phosphate	Winter	0.1	0.1	0.1	0.1	0	0.2	0.2	0.2	0.3	0.07759	0.134	0.579991
	Summer	0	0.3	0.6	0.6	0.1	0	0.1	0.1	0	0.22644	0.196	1.1526946
	Monsoon	0.4	0.3	0.3	0.1	0.2	0.1	0.6	0.6	0.1	0.18936	0.289	0.6549745

All parameters are in mg/lit, except pH and Temperature.

(Note: 1- JIT, 2- BIT, 3- BMIT, 4- KOIT, 5- KHIT, 6- PIT, 7- MVF, 8- SVF & 9- KIT)
(Coefficient of Var- Coefficient of Variance)

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