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Studies on the physico-chemical status of two water bodies at Sagar city under anthropogenic Influences

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ABSTRACT

Rajghat reservoir and Lakha-banzara pond is one of the major water bodies in Sagar city (M.P.). Physico-chemical statuses of two water bodies were studied in the year 2007-10. Both the water bodies, reservoir (source-Bebas River) and pond (still water) are affected by various anthropogenic activities. In the present study, physico-chemical characteristics of two water bodies have been compared. Water samples have been analyzed of pond/reservoir sample collection places during 2 years for their 15 physico - chemical parameters viz. Water Temperature, Colour, Conductivity, Turbidity, Total solids, Total dissolved solids, pH, Alkalinity, Chlorides, Total hardness, Dissolved oxygen, Biological oxygen demand, Chemical oxygen demand, Iron and Fluoride were analysed during different seasons. The correlation and multiple regression analysis applied to the datasets indicated their interrelationships, for evaluating water quality during the pre monsoon, monsoon, and post monsoon seasons. On the basis of analysed parameters, the results indicated the, satisfactory water quality of the Rajghat reservoir water and Lakha-banzara ponds were found to be polluted condition.

Key words: water bodies, physico-chemical status, anthropogenic activity.

INTRODUCTION

Good water quality is essential for the well-being of all people. Rajghat reservoir provides drinkable water to the populations of Sagar city, is the main water resources for domestic purposes [1]. In Sagar city drinking water supplied by Municipal Corporation from Rajghat dam. Lakha Banzara pond is a still water body having an area of 68 hectares situated middle of the Sagar city [2].

D. G. Shah *etal.*[3], Rakh Mahesh S *etal.*[4], Yadav S.S *etal.*[5], O. N. Maitera *etal.*[6], is the groups of prominent scientists contributed to assessed the quality of water resources. In this study, for quality assessment of water samples following physico-chemical parameters viz. water temperature, Colour, conductivity, Turbidity, Total solids, Total dissolved solids, pH, alkalinity, chlorides, Total hardness, Dissolved oxygen, Biological oxygen demand, chemical oxygen demand; Iron and fluoride were determined by using standard analytical methods[7]. The statistical tools such as Pearson correlation, regression and multiple regression has been very important method to determine interrelationship among water quality parameters. It is also helpful to determine dominant parameter [8].

Study area and collection of water samples

Sagar city was chosen as study area and sample collected from central of reservoir and pond. Water samples were collected from pre to post monsoon seasons, three each during June 2007 to may 2010 by using standard methods (APHA) [7].

MATERIALS AND METHODS

All the chemicals used were of AR grade. Analysis was carried out for various water quality parameters were measured by using Standard methods.

Table 1- List of Chemical parameters and their test methods

S.N.	Parameters	Unit	Test Methods
1	pH	-	pH meter
2	Dissolved Oxygen (DO)	mg/L	Winkler method
3	Biochemical Oxygen Demand (BOD)	mg/L	5 days incubation at 20° C and titration of initial and final DO.
4	Chemical Oxygen Demand	mg/L	Open Reflux Method
5	Conductivity	ms/cm	Conductivity meter
6	Alkalinity	mg/L	Titration
7	Total dissolved Solids	mg/L	Digital conductivity meter (LT-51)
8	Chloride	mg/L	Argentometric titration
9	Orthophosphate ($P0_4^{3-}$ — P)	mg/L	Ammonium molybdate ascorbic acid reduction method
10	Nitrate -Nitrogen (NO_3 — N)	mg/L	Spectrophotometric method
11	Ammonia-Nitrogen (NH_3 — N)	mg/L	Spectrophotometric (Phenate method)
12	Total Hardness as $CaCO_3$	mg/L	EDTA titration
13	Fluoride	mg/L	Colorimetric Method
14	Iron	mg/L	Colorimetric Method

Results obtained were subjected to multivariate statistical analysis using SPSS.11 [9], Winks SDA 6.0.5 [10], multivariate statistical analysis has been performed using standard methods test results compare to IS: 10500 Standards [11].

Table 2: Comparison of Physico-Chemical parameters of Lakha bazara Pond (mean) and Rajghat Reservoir (mean)

Parameter	M- 07		Po-M 07		PrM- 08		Mo-08		PoM-08		PrM-09		M- 09		PoM- 09		PrM-10	
	L.B.	R.G.	L.B.	R.G.	L.B.	R.G.	L.B.	R.G.	L.B.	R.G.	L.B.	R.G.	L.B.	R.G.	L.B.	R.G.	L.B.	R.G.
Temperature	25.3	21.4	17.6	22.5	27.4	26.2	24.6	25.5	22.4	24.1	26.1	27.8	25.2	23.8	22.4	22.1	27.4	25.1
Colour	39	27	35	24	40	21	40	24	41	20	36	22	42	22	38	20	37	16
pH	9.24	8.25	9.44	8.34	9.51	8.44	8.75	8.05	8.81	8.45	8.96	8.49	8.45	8.25	8.5	8.24	8.65	8.3
Turbidity	25	20	28	22	31	25	26	18	30	21	35	22	44	21	47	18	51	19
DO	2.45	6.2	3.2	7.6	3.15	7.1	2.65	6.32	3.7	7.91	3.54	6.4	2.6	6.5	3.46	7.81	3.3	5.42
BOD	37.2	11.67	28.65	4.2	38.56	10.29	41.62	10.31	31.38	10.31	39.5	11.18	46.45	10.82	31.24	8.65	36.95	12.25
COD	104.3	26.63	94.63	21.53	104.3	26.63	102.7	25.35	92.1	15.4	95.36	21.32	112.6	14.32	91.65	15.25	101.6	17.26
Conductivity	1.22	0.522	1.041	0.441	1.045	0.57	1.251	0.585	1.092	0.704	1.082	0.732	1.426	0.83	1.317	0.606	1.338	0.642
Alkalinity	396	286	344	216	412	325	356	278	310	275	410	305	416	280	379	192	470	296
TS	944.09	370.47	721.71	316.17	753.18	389.42	798.57	422.09	763.46	478.47	751.15	505.21	988.55	565.82	902.05	429.92	921.44	457.86
TSS	98.26	51.52	86.18	46.62	115.56	41.45	35.05	65.23	97.31	48.63	90.63	58.63	118.62	59.25	98.37	60.25	105.18	65.67
TDS	845.83	318.95	635.53	269.55	637.62	347.97	763.52	356.86	666.15	429.84	660.52	446.58	869.93	506.57	803.68	369.67	816.26	392.19
TH	568.75	262.49	530.16	259.37	593.42	290.43	539.82	268.06	476.96	252.12	548.64	282.67	541.86	251.54	523.59	196.73	544.67	249.82
Temporary Hardness	376.54	191.34	396.34	189.43	485.16	139.51	430.76	212.69	412.93	196.22	452.09	226.71	449.27	202.12	442.86	162.65	439.34	216.34
Permanent Hardness	192.2	71.15	133.8	69.94	108.2	150.9	109	55.37	64.03	55.9	96.55	55.96	92.59	49.42	80.73	34.08	105.33	33.48
Ca Hardness	428.14	192.88	412.4	140.23	411.46	215.24	413.26	192.79	386.55	151.52	436.5	181.2	466.72	115.5	412.4	129.34	471.24	224.37
Mg Hardness	140.61	69.61	117.76	119.14	181.96	75.19	126.56	75.27	90.41	100.6	112.14	101.47	75.14	136.04	111.19	67.39	73.43	25.45
Fluoride	3.2	1.85	3.13	1.53	3.34	1.72	3.46	2.35	3.63	2.26	3.85	2.4	3.58	2.12	3.06	2	3.64	2.03
Iron	2.27	1.61	2.2	2.51	2.61	2.08	3.22	1.98	3.05	1.76	3.86	1.06	3.13	1.47	3.08	1.3	3.1	1.36
Chloride	146.9	32.6	114.05	25.43	137.97	53.27	136.37	37.19	113.36	52.17	143.36	41.61	108.16	28.61	88.64	49.2	109.34	88.43
Resi.Chlorine	0.26	0.09	0.2	0.1	0.25	0.14	0.28	0.1	0.21	0.09	0.3	0.14	0.2	0.16	0.24	0.14	0.22	0.17
Phosphate	5.32	1.83	0.894	1.869	4.54	2.3	5.36	4.64	1.64	4.41	5.64	2.41	5.4	1.908	0.64	3.76	1.69	2.01
Nitrate	17.09	5.03	15.33	6.33	18.32	9.2	12.3	4.1	11.36	3.9	16.34	6.5	14.34	5.7	10.96	7.2	19.82	8.1
Ammonia	0.94	0.42	0.24	0.31	0.85	0.49	0.37	0.65	0.66	0.52	0.23	0.64	0.62	0.98	0.34	0.38	0.34	0.59

L.B. - Lakha bazara Pond (Centre) and R.G. - Rajghat Reservoir (Center)

Table 3: Regression Analysis of chemical Parameters with DO in pond's water Samples of Sagar city

Dependent Variable	Independent Variable	Regression equation	Slope	R^2
DO_{mean}	BOD_{mean}	DO = 31.93 + 1.551 * BOD	1.551	0.007
DO_{mean}	COD_{mean}	DO = 303.1 - 66.81 * COD	-66.81	0.834
DO_{mean}	BOD_{mean}, COD_{mean}	DO = 2.6645816 + .0081708 * BOD + .0021325 * COD		.0323
DO_{mean}	$Alkalinity_{mean}$	DO = 493 - 33.58 * alkalinity	-33.58	.228
DO_{mean}	TDS_{mean}	DO = 250.7 + 184.5 * TDS	184.5	.113
DO_{mean}	pH_{mean}	DO = 3.757 + 1.718 * pH	1.718	.665
DO_{mean}	$Chloride_{mean}$	DO = - 112.1 + 74.33 * Chloride	74.33	0.579
DO_{mean}	Residual $Chlorine_{mean}$	DO = 0.092 + 0.039 * Residual Chlorine	0.039	0.016
DO_{mean}	o-$Phosphate_{mean}$	DO = 9.664 - 1.510 * o- Phosphate	-1.510	0.465
DO_{mean}	$Nitrate_{mean}$	DO = 13.60 - 1.171 * Nitrate	- 1.17	.191
DO_{mean}	$Ammonia_{mean}$	DO = 0.442 + 0.002 * Ammonia	0.002	.001
DO_{mean}	TDS_{mean} $Chloride_{mean}$	DO = 2.8947197 + .0006395 * TDS -.0021692 * Chloride		0.151
DO_{mean}	TDS_{mean} $Chloride_{mean}$, Residual $Chlorine_{mean}$	DO = 3.2000125+.0003551 * TDS-.0007378 * Chloride - 1.125849 * Residual Chlorine		0.2344
DO_{mean}	TDS_{mean} $Chloride_{mean}$, Residual $Chlorine_{mean}$ o-$Phosphate_{mean}$	DO = 1.8955758 + .000345 * TDS - .0013377 * Chloride -2.049152 *Residual Chlorine+ .2572442 * o-Phosphate		0.4843
DO_{mean}	TDS_{mean} $Chloride_{mean}$, Residual $Chlorine_{mean}$ o-$Phosphate_{mean}$ $Nitrate_{mean}$	DO = 56.332194 + .0217746 * TDS -.1663759 * Chloride+ 51.923978 *Residual Chlorine+ .1293998 * o-Phosphate - 6.342301 * Nitrate		0.0
DO_{mean}	TDS_{mean} $Chloride_{mean}$, Residual $Chlorine_{mean}$ o-$Phosphate_{mean}$ $Nitrate_{mean}$ $Ammonia_{mean}$	DO = 8.2230225 - .0023214 * TDS + .0472021 * Chloride -25.00903 * Residual Chlorine + .2979269 * o-Phosphate + 1.4023132 * Nitrate - 44.00537 * Ammonia		0.0
DO_{mean}	Total $hardness_{mean}$	DO = 1128 - 190.9 * Total hardness	- 191	0.572
DO_{mean}	Temporary $hardness_{mean}$	DO = 1.6116 + .0036 * Temporary hardness		.338
DO_{mean}	Permanent $hardness_{mean}$	DO = 3.2268 -.0007 * Permanent hardness		.016
DO_{mean}	Calcium $hardness_{mean}$	DO = 672.9 – 78.98 * Calcium hardness	– 78.98	0.353
DO_{mean}	Magnesium $hardness_{mean}$	DO = 455.6 - 111.9 * Magnesium hardness	- 111.9	.554
DO_{mean}	Temporary $hardness_{mean}$ Permanent $hardness_{mean}$	DO = 1.6642151 - .0034803 * Temporary hardness - .0002226 * Permanent hardness		0.3381
DO_{mean}	Calcium $hardness_{mean}$ Magnesium $hardness_{mean}$	DO = .2102607 + .0078471 * Calcium hardness - .0036364 * Magnesium hardness		.7292
DO_{mean}	$Fluoride_{mean}$	DO = - 0.046 + 0.422 * Fluoride	0.422	0.357
DO_{mean}	$Iron_{mean}$	DO = 1.778 + .416 * Iron	.416	.009
DO_{mean}	$Fluoride_{mean}$ $Iron_{mean}$	DO = 4.5251761 - 1.030661 * Fluoride -.0115327 * Iron		0.4785

Table 4: Multiple Regression Analysis for different Parameters in the pond water Samples of Sagar city

Dependent variable is DO, 25 independent variables, 6 Cases.

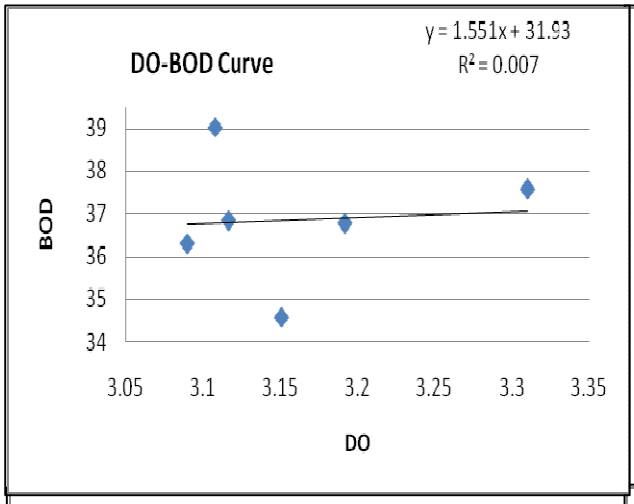
Variable	Coefficient	Variable	Coefficient
Intercept	-201.6736	RESI.CHLORINE	-1128.698
TEMPRATURE	-5.034885	PHOSPHATE	-25.91547
COLOUR	.554081	NITRATE	6.3528748
pH	1.962738	AMMONIA	1702.0193
TURBIDITY	-6.728149	TH	-.7138295
BOD	.4344635	TEMP. HARD.	.4002013
COD	-3.902765	PERM. HARD.	1.0264835
CONDUCTIVITY	131.28717	Ca HARDNESS	1.0984085
ALKALINITY	-1.360245	Mg HARDNESS	3.3672943
TS	-.2134173	FLUORIDE	73.385498
TSS	-.5208067	IRON	-25.2218
TDS	-.0318923	Ca CONTENT	.321209
CHLORIDE	.681066	Mg CONTENT	4.4594574

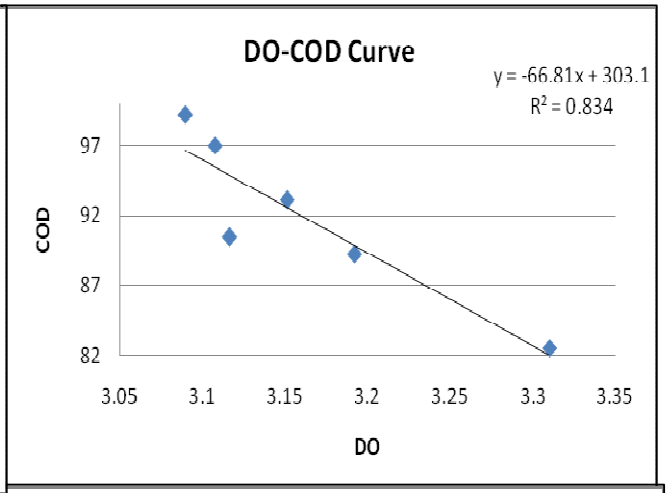
Analysis of Variance to Test Regression Relation

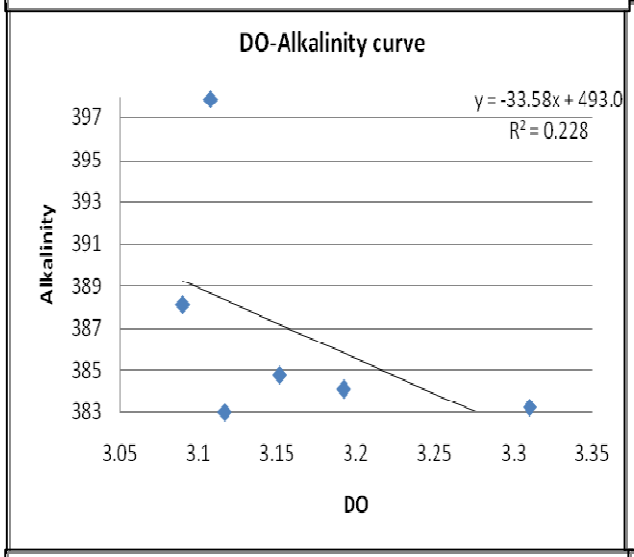
Source	Sum of Sqs	df	Mean Sq	F	p-value
Regression	1402.7771	25	56.111084	.	N.A.
Error	-1402.318	-20	.		
Total	.4596	5			

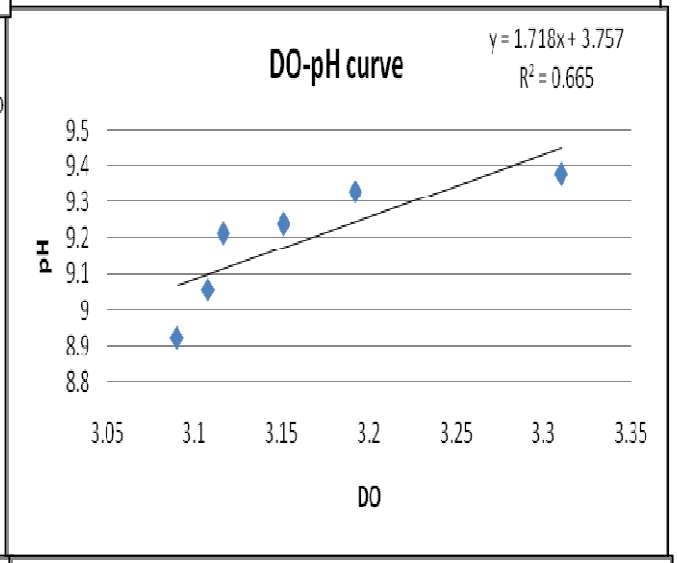
Note: - A low p-value suggests that the dependent variable DO may be linearly related to independent variable(s).

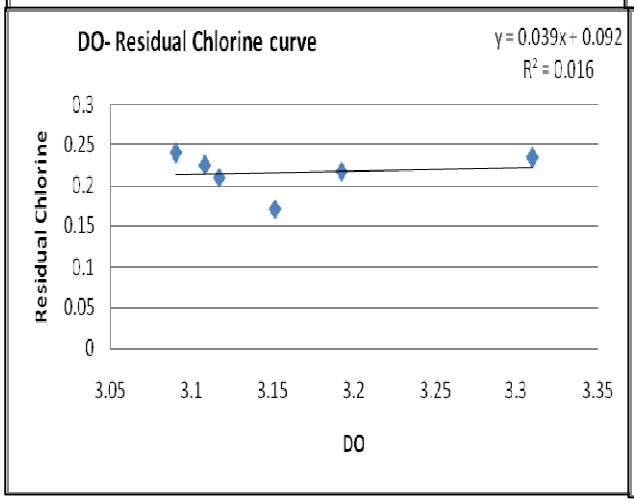
Table 5: Regression curve between the mean chemical Parameters (independent) and the mean DO (dependent) in ponds water Samples of Sagar city (Monsoon 2007 to Pre Monsoon 2010)

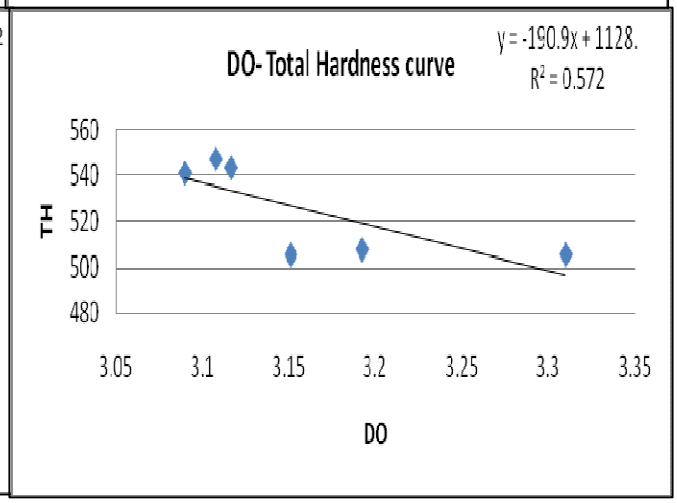


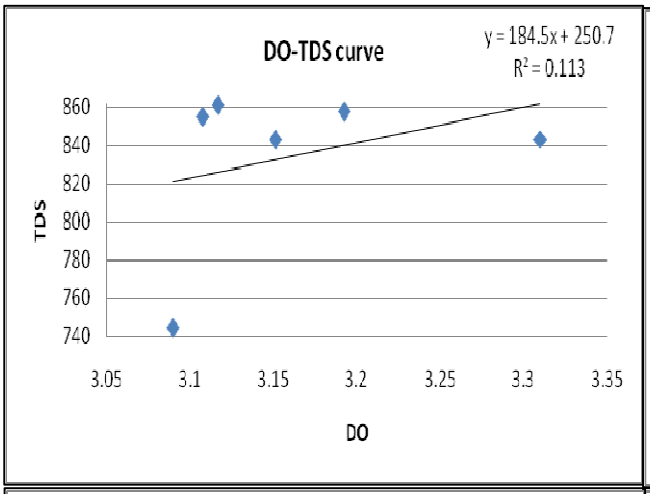


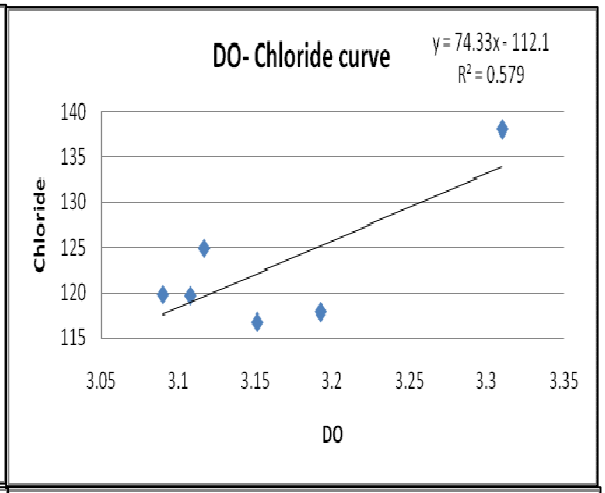


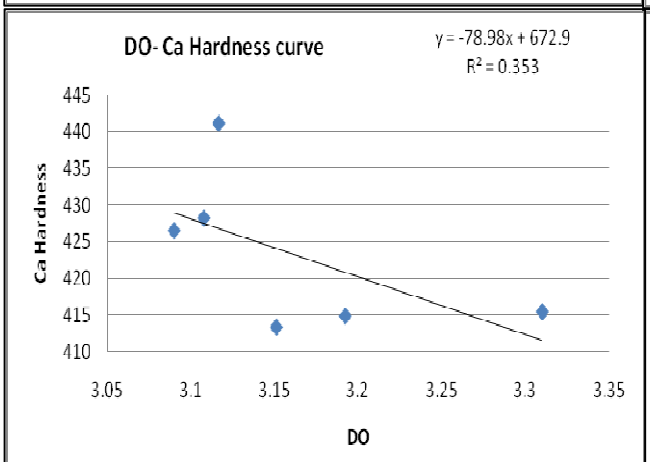


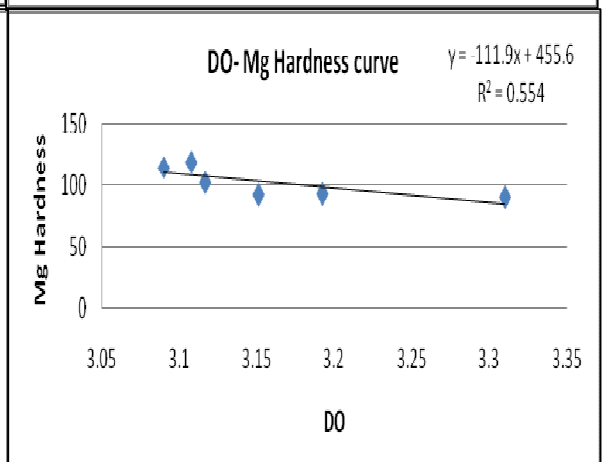


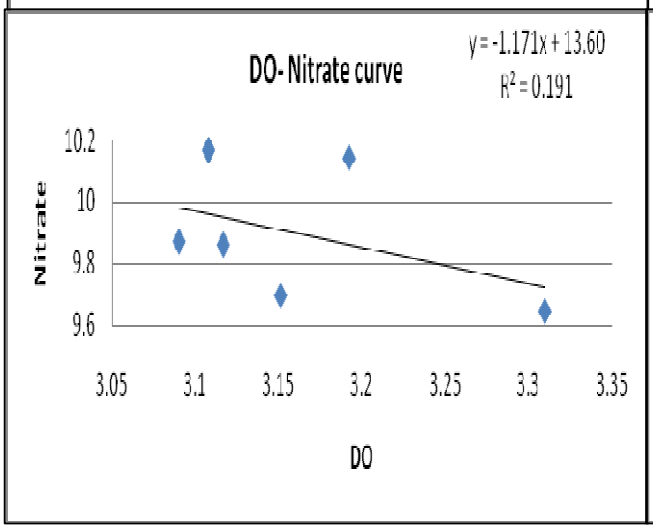


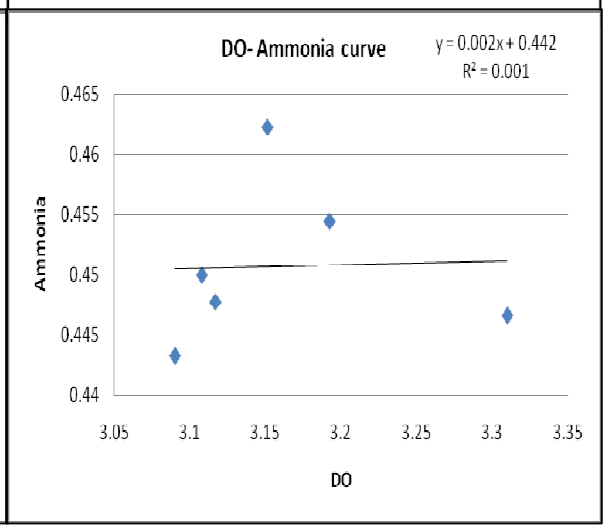

DO-TDS curve
y = 184.5x + 250.7
R² = 0.113
TDS
860
840
820
800
780
760
740
3.05
3.1
3.15
3.2
3.25
3.3
3.35
DO

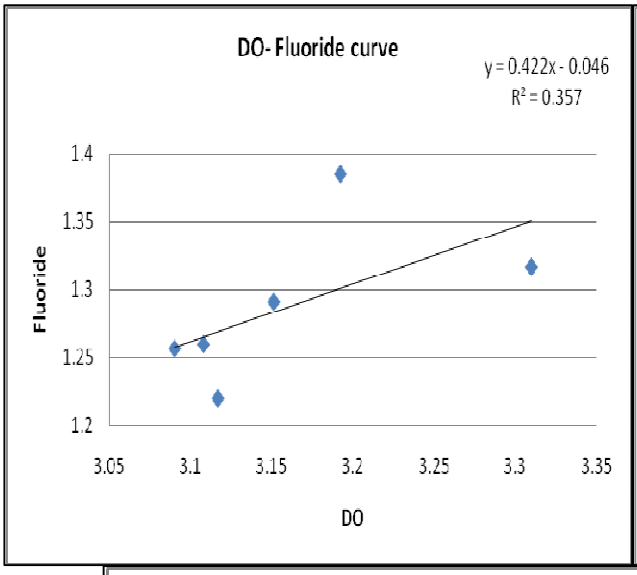

DO- Chloride curve
y = 74.33x - 112.1
R² = 0.579
Chloride
140
135
130
125
120
115
3.05
3.1
3.15
3.2
3.25
3.3
3.35
DO

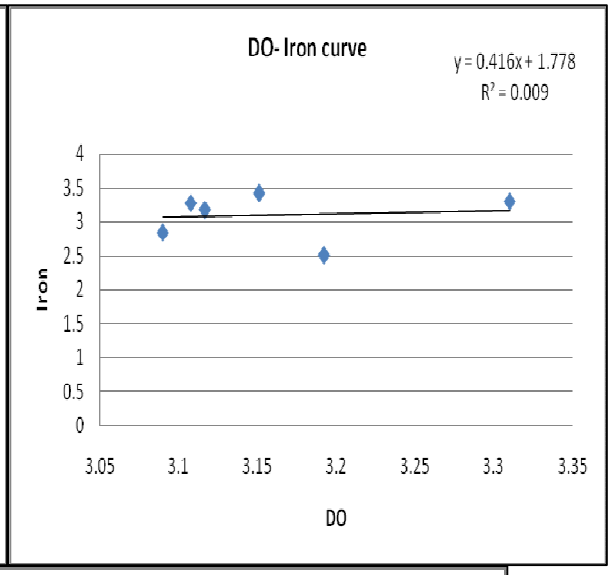

DO- Ca Hardness curve
y = -78.98x + 672.9
R² = 0.353
Ca Hardness
445
440
435
430
425
420
415
410
3.05
3.1
3.15
3.2
3.25
3.3
3.35
DO


DO- Mg Hardness curve
y = 111.9x + 455.6
R² = 0.554
Mg Hardness
150
100
50
0
3.05
3.1
3.15
3.2
3.25
3.3
3.35
DO


DO- Nitrate curve
y = -1.171x + 13.60
R² = 0.191
Nitrate
10.2
10
9.8
9.6
3.05
3.1
3.15
3.2
3.25
3.3
3.35
DO


DO- Ammonia curve
y = 0.002x + 0.442
R² = 0.001
Ammonia
0.465
0.46
0.455
0.45
0.445
0.44
3.05
3.1
3.15
3.2
3.25
3.3
3.35
DO


DO- Fluoride curve
y = 0.422x - 0.046
R² = 0.357
Fluoride
1.4
1.35
1.3
1.25
1.2
3.05
3.1
3.15
3.2
3.25
3.3
3.35
DO


DO- Iron curve
y = 0.416x + 1.778
R² = 0.009
Iron
4
3.5
3
2.5
2
1.5
1
0.5
0
3.05
3.1
3.15
3.2
3.25
3.3
3.35
DO

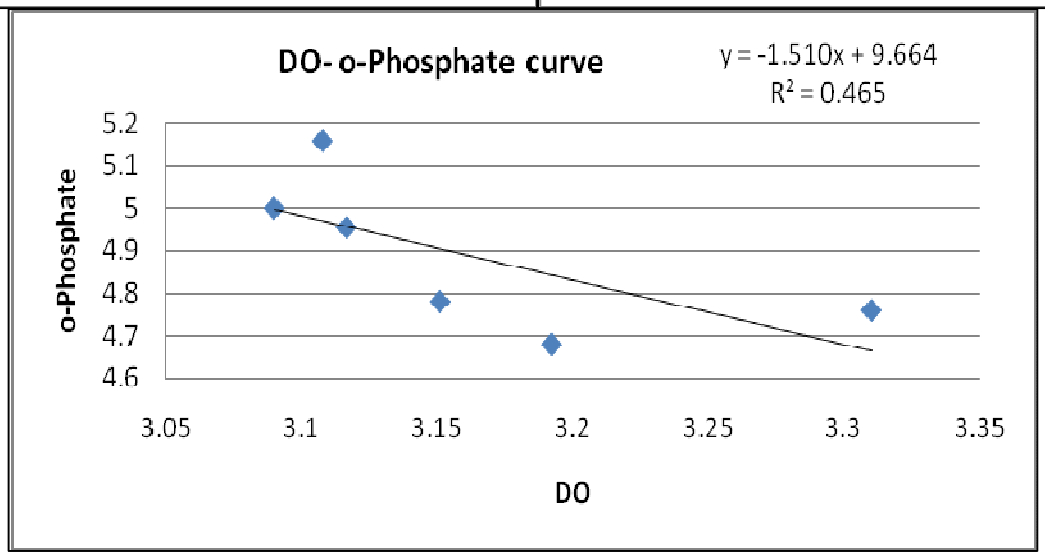
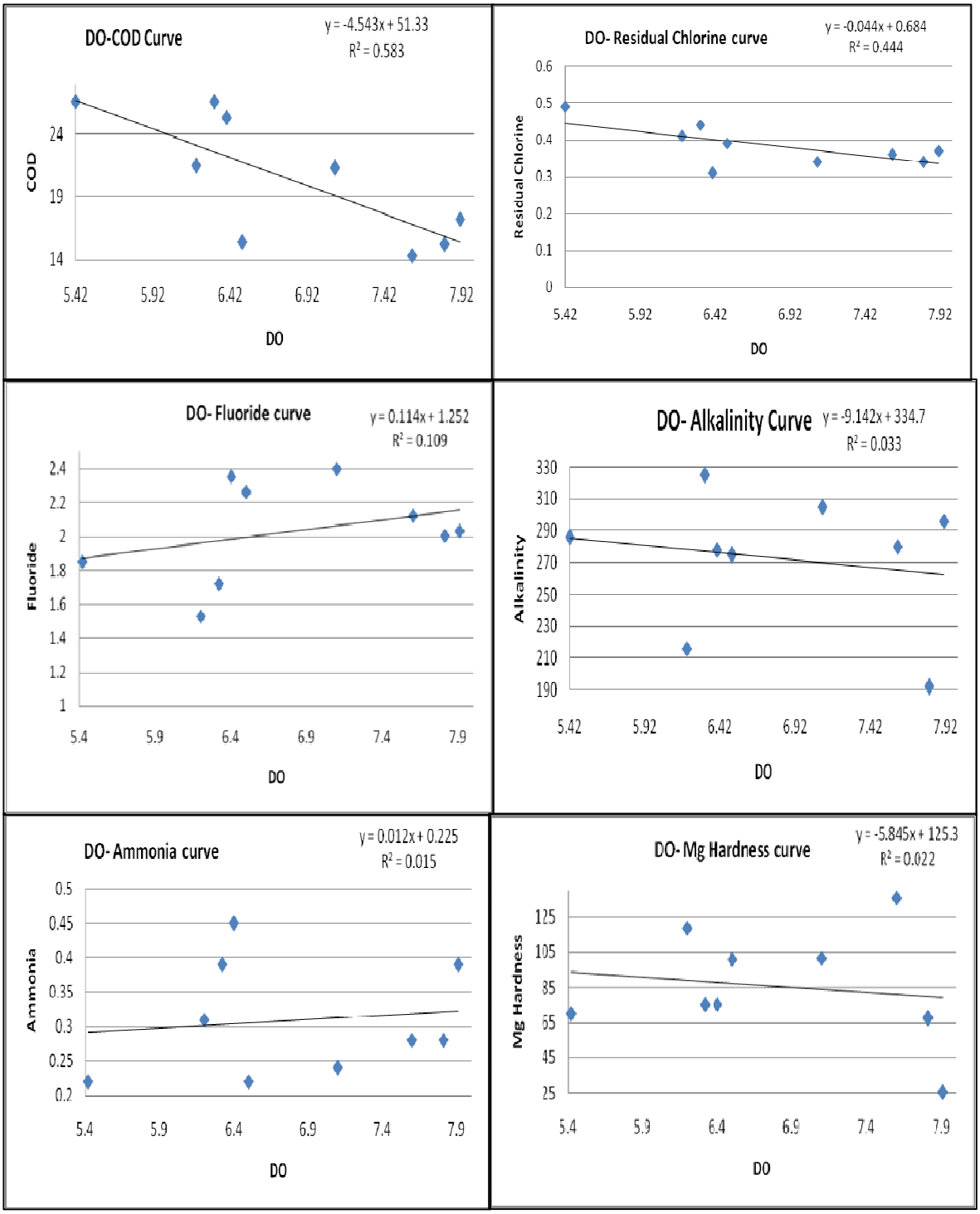
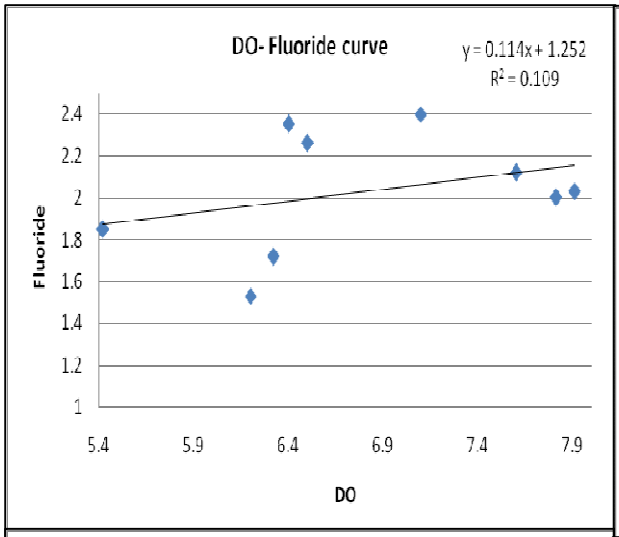

DO- o-Phosphate curve
y = -1.510x + 9.664
R² = 0.465
o-Phosphate
5.2
5.1
5
4.9
4.8
4.7
4.6
3.05
3.1
3.15
3.2
3.25
3.3
3.35
DO

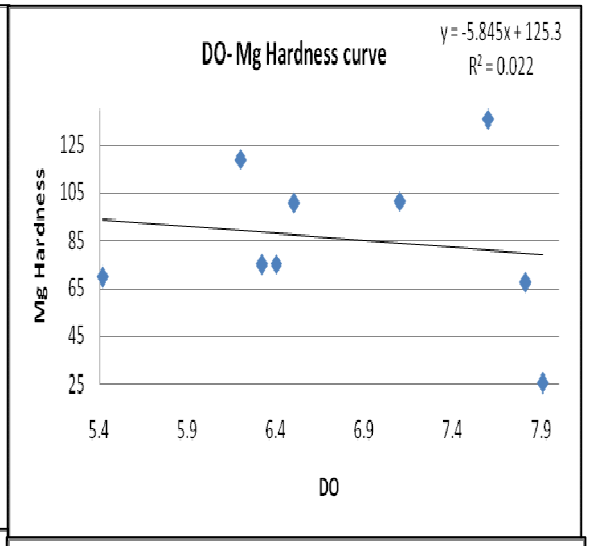
Table 6: Regression Analysis of chemical Parameters with DO in reservoir water Samples of Sagar city (Monsoon 2007 to Pre Monsoon 2010)

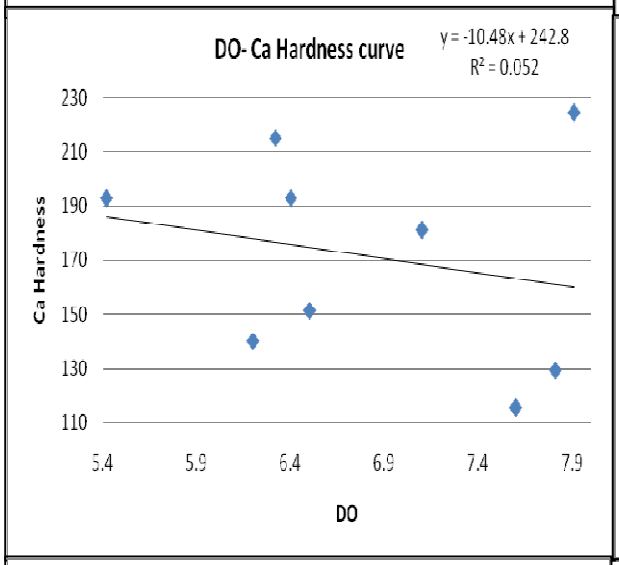
Dependent Variable	Independent Variable	Regression equation	Slope	R^2
DO_{mean}	BOD_{mean}	DO = 31.93 + 1.551 * BOD	1.551	0.007
DO_{mean}	COD_{mean}	DO = 303.1 - 66.81 * COD	-66.81	0.834
DO_{mean}	$BOD_{mean,}$ COD_{mean}	DO = 2.6645816 + .0081708 * BOD + .0021325 * COD		.0323
DO_{mean}	$Alkalinity_{mean}$	DO = 493 - 33.58 * alkalinity	-33.58	.228
DO_{mean}	TDS_{mean}	DO = 250.7 + 184.5 * TDS	184.5	.113
DO_{mean}	pH_{mean}	DO = 3.757 + 1.718 * pH	1.718	.665
DO_{mean}	$Chloride_{mean}$	DO = - 112.1 + 74.33 * Chloride	74.33	0.579
DO_{mean}	Residual $Chlorine_{mean}$	DO = 0.092 + 0.039 * Residual Chlorine	0.039	0.016
DO_{mean}	o-$Phosphate_{mean}$	DO = 9.664 - 1.510 * o- Phosphate	-1.510	0.465
DO_{mean}	$Nitrate_{mean}$	DO = 13.60 - 1.171 * Nitrate	- 1.17	.191
DO_{mean}	$Ammonia_{mean}$	DO = 0.442 + 0.002 * Ammonia	0.002	.001
DO_{mean}	TDS_{mean} $Chloride_{mean}$	DO = 2.8947197 + .0006395 * TDS -.0021692 * Chloride		0.151
DO_{mean}	TDS_{mean} $Chloride_{mean,}$ Residual $Chlorine_{mean}$	DO = 3.2000125+.0003551 * TDS-.0007378 * Chloride - 1.125849 * Residual Chlorine		0.2344
DO_{mean}	TDS_{mean} $Chloride_{mean,}$ Residual $Chlorine_{mean}$ o-$Phosphate_{mean}$	DO = 1.8955758 + .000345 * TDS - .0013377 * Chloride -2.049152 *Residual Chlorine+ .2572442 * o-Phosphate		0.4843
DO_{mean}	TDS_{mean} $Chloride_{mean,}$ Residual $Chlorine_{mean}$ o-$Phosphate_{mean}$ $Nitrate_{mean}$	DO = 56.332194 + .0217746 * TDS -.1663759 * Chloride+ 51.923978 *Residual Chlorine+ .1293998 * o-Phosphate - 6.342301 * Nitrate		0.0
DO_{mean}	TDS_{mean} $Chloride_{mean,}$ Residual $Chlorine_{mean}$ o-$Phosphate_{mean}$ $Nitrate_{mean}$ $Ammonia_{mean}$	DO = 8.2230225 - .0023214 * TDS + .0472021 * Chloride -25.00903 * Residual Chlorine + .2979269 * o-Phosphate + 1.4023132 * Nitrate - 44.00537 * Ammonia		0.0
DO_{mean}	Total $hardness_{mean}$	DO = 1128 - 190.9 * Total hardness	- 191	0.572
DO_{mean}	Temporary $hardness_{mean}$	DO = 1.6116 + .0036 * Temporary hardness		.338
DO_{mean}	Permanent $hardness_{mean}$	DO = 3.2268 -.0007 * Permanent hardness		.016
DO_{mean}	Calcium $hardness_{mean}$	DO = 672.9 – 78.98 * Calcium hardness	– 78.98	0.353
DO_{mean}	Magnesium $hardness_{mean}$	DO = 455.6 - 111.9 * Magnesium hardness	- 111.9	.554
DO_{mean}	Temporary $hardness_{mean}$ Permanent $hardness_{mean}$	DO = 1.6642151 - .0034803 * Temporary hardness - .0002226 * Permanent hardness		0.3381
DO_{mean}	Calcium $hardness_{mean}$ Magnesium $hardness_{mean}$	DO = .2102607 + .0078471 * Calcium hardness - .0036364 * Magnesium hardness		.7292
DO_{mean}	$Fluoride_{mean}$	DO = - 0.046 + 0.422 * Fluoride	0.422	0.357
DO_{mean}	$Iron_{mean}$	DO = 1.778 + .416 * Iron	.416	.009
DO_{mean}	$Fluoride_{mean}$ $Iron_{mean}$	DO = 4.5251761 - 1.030661 * Fluoride -.0115327 * Iron		0.4785

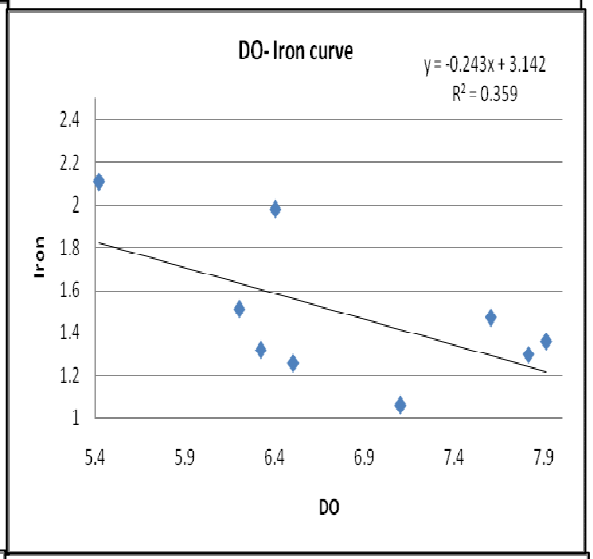
Table 7: Regression curve between the chemical Parameters (independent) and the DO (dependent) in reservoir water Samples of Sagar city (Monsoon 2007 to Pre Monsoon 2010)

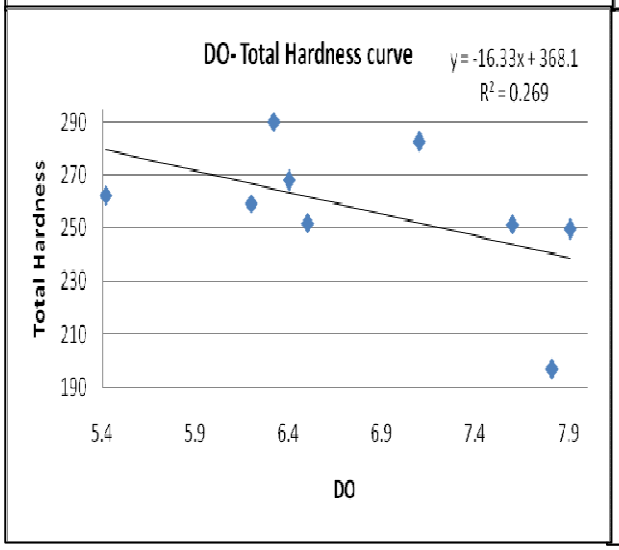


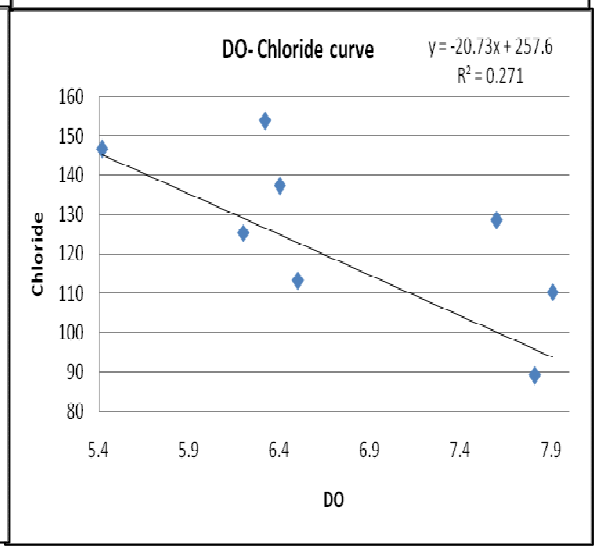

DO- Fluoride curve
y = 0.114x + 1.252
R² = 0.109
Fluoride
DO

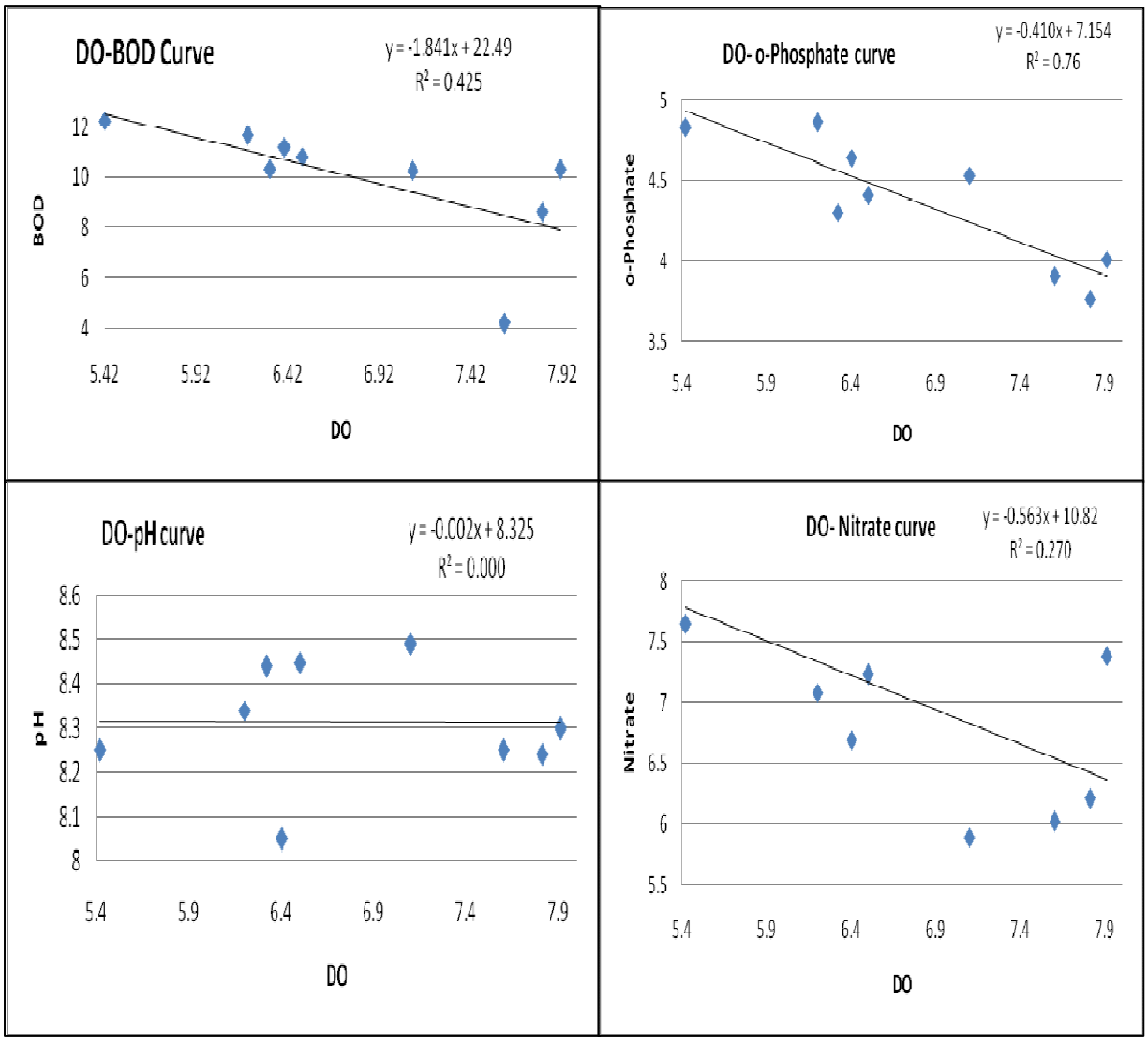

DO- Mg Hardness curve
y = -5.845x + 125.3
R² = 0.022
Mg Hardness
DO

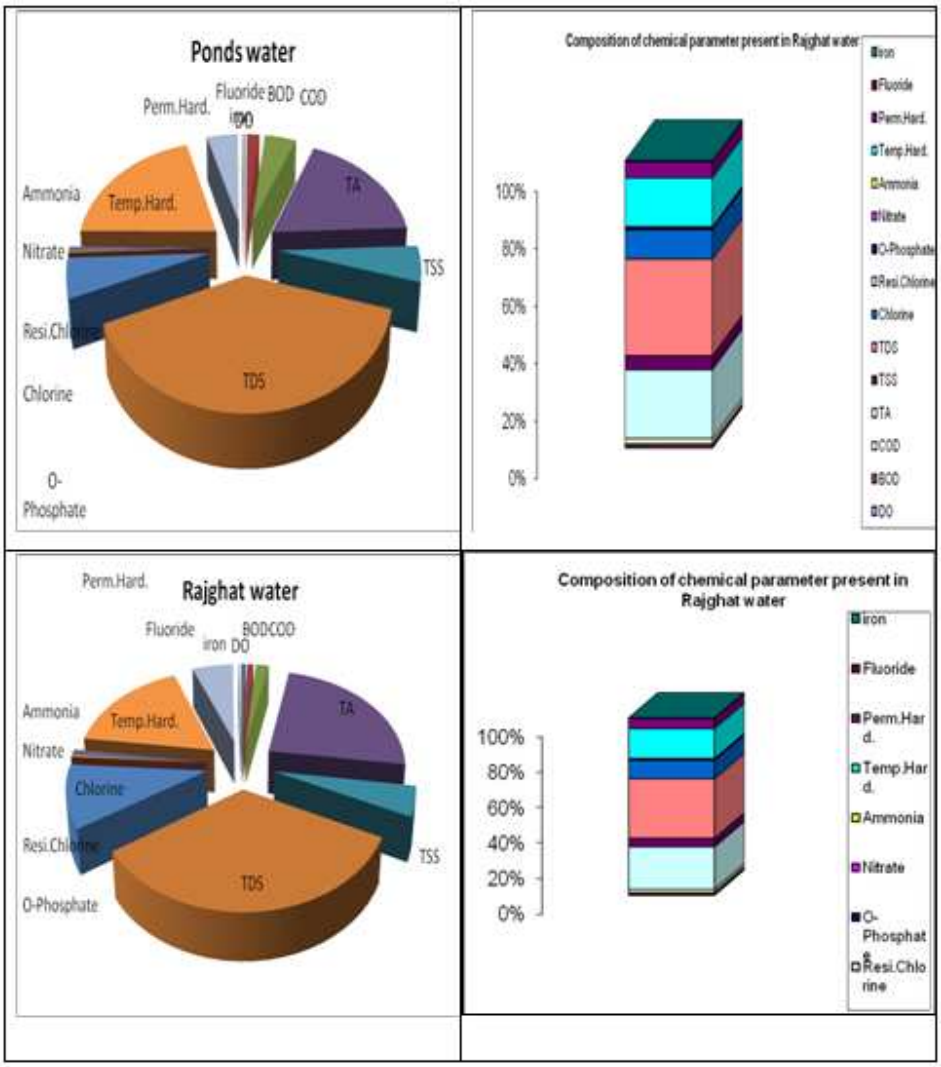

DO- Ca Hardness curve
y = -10.48x + 242.8
R² = 0.052
Ca Hardness
DO


DO- Iron curve
y = -0.243x + 3.142
R² = 0.359
Iron
DO


DO- Total Hardness curve
y = -16.33x + 368.1
R² = 0.269
Total Hardness
DO


DO- Chloride curve
y = -20.73x + 257.6
R² = 0.271
Chloride
DO


DO-BOD Curve
y = -1.841x + 22.49
R² = 0.425
BOD
DO
DO- o-Phosphate curve
y = -0.410x + 7.154
R² = 0.76
o-Phosphate
DO
DO-pH curve
y = -0.002x + 8.325
R² = 0.000
pH
DO
DO- Nitrate curve
y = -0.563x + 10.82
R² = 0.270
Nitrate
DO



RESULTS AND DISCUSSION

The physico-chemical parameters of both the water bodies were taken into consideration as characteristic values to see the Comparison of Physico-Chemical parameters of Lakha bazara Pond (mean) and Rajghat Reservoir (mean) during 3 different seasons were analysed from monsoon 2007 to premonsoon 2010 and are presented in table 2. From all results it is cleared that, Lakha banzara (previously used drinking water resource) was ultimate polluted compare to Rajghat reservoir. As per study of physico-chemical parameters of both water bodies, pH is the controlling factor for silicate. Higher value of pH in pond compare to reservoir shows that pond water is more alkaline in nature. In reservoir the average values of BOD, COD, Ammonia and Iron recorded higher in monsoon compare to post monsoon, which could be due to acidification of water by elevated microbial degradation of organic debris and concentrated dissolved solids in monsoon period. On the other hand in pond, parameters like BOD, COD, Ammonia and Nitrate are clearly higher in all the season showed a clear cut temporal effect. As a momentous role of DO amount in water quality of ground water, the average concentration of DO was highest in post monsoon period (inversely proportional to temperature) and lowest in monsoon (Increase in phytoplankton and microbial activity) consequently increase in BOD and COD. The temperature affects the metabolic rate of living organisms in water bodies and highest at premonsoon while DO value slightly lower at preMonsoon, It might be due to copious growth of phytoplankton with less water flow, disturbance and uprooting leading to increased generation of O_2 by photosynthetic activities. TH was recorded comparatively highest in pre-monsoon and lowest in post-monsoon

(beyond desirable limit prescribed by IS: 10500). Alkalinity values are mostly exhibited higher values in pre-monsoon and lowest in post-monsoon. Application of chemical fertilizers, run off from agricultural field, leaching of industrial/domestic waste and sewage inflow and other anthropogenic sources are the mainly responsible for over degraded quality of Lakha banzara ponds water, Alkalinity may also be caused due to evolution of CO_2 during decomposition of organic matters. The bicarbonate and total alkalinity in both the water bodies vary from 98.0 mg/l to 185.4 mg/l and 117.0 mg/l to 167.6 mg/l respectively. The high alkalinity is a function of ion exchange that is Ca ions are replaced by Na ions and later contributed to alkalinity. According to WHO, The data revealed that, all the sources had TH and conductivity which recorded high values. At throughout the sampling periods, the concentrations of the major ions in reservoir were below the permissible limits given by the WHO/IS: 10500. In reservoir average Hardness levels were found to be in the water samples were below the WHO permitted limit.

The pH of both the water bodies indicate the alkaline nature of ponds and it varies from 7.6 to 8.10. The higher values may be due to accumulation of ions owing to evaporation, biological turnover and interaction with sediments. The dissolved oxygen varies from 3.8 mg/l to 7.1 mg/l. Low content of DO, a sign of organic pollution, is also due to inorganic reductants like hydrogen sulphide, ammonia, nitrates, ferrous ion and other such oxidisable substances. TDS, TH are higher at Lakha banzara pond; the higher dissolved solids are mainly responsible to reduce the clarity of water. The chloride content in pond water was higher compare to reservoir. Chloride is one of the important indicators of pollution. Cl is lower in the post monsoon period than in the PreMonsoon in Rajghat reservoir. High amounts of nutrients lead to eutrophication.

The main source of nitrate is the run-off and decomposition of organic matter. The higher inflow of water and consequent land drainage cause high value of nitrate in pond water. The increase in the value of phosphate in pond is mainly because of the run-off from catchment area including some agricultural fields. The average of alkalinity in ponds has exceeded the desirable Limits, which are due to improper drainage system. Calcium is linked with the carbon dioxide and is an important constituent of the skeletal structure of organisms. Calcium forms the most abundant ions in Rajghat water. Multiregression gives the interrelationship between the parameters, regression coefficients were calculated. After regular monthly monitoring on Results of Multivariate analysis show that, all applied water quality parameters in ponds are beyond the permissible limit set by IS: 10500.

CONCLUSION

Comparing the values of water quality parameters for both water bodies in Sagar city, it can be concluded that water quality of the pond water is very worst condition viz. alkalinity, BOD, COD and ammonia value is out of the maximum permissible limit set by WHO/ IS: 10500, hence in case of Rajghat reservoir these sample water can be absolutely fit for drinking after disinfectants treatment.

In conclusion, from the results of the present study it may be said that water quality analysis should be carried out from time to time to monitor the rate and kind of contamination. It is need of human to expand awareness among the people to maintain the ground water at their highest quality and purity levels. From the results obtained, it can be concluded that pond are more polluted compare to reservoir water bodies due to the continuous discharge of domestic sewage and run-off. The results also indicate that the Lakha banzara pond is comparatively more polluted due to greater biotic stress.

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