



Impact of Seasonal Variation on Physicochemical Parameters of Mansi Ganga, Radha and Shyam Kund, Mathura

KEYWORDS

Mansi Ganga, Radha kund, Shyam kund, , ANOVA, Pearsons correlation coefficient

Maheepal Singh

Department of Zoology, M.S.J. Govt. P.G. College, Bharatpur-321001, Rajasthan, India.

S.K Singh

Department of Zoology, M.S.J. Govt. P.G. College, Bharatpur-321001, Rajasthan, India.

ABSTRACT

The present analysis reveals the analysis of physicochemical parameters for all the seasons for Mansi Ganga, Radha and Shyam kunds at Govardhan. It was observed that parameters like color, turbidity, TDS, DO, BOD and COD have greater impact seasonally in all the kunds. Statistical tools like ANOVA and Pearson coefficient of correlation was employed. ANOVA analysis shows that color turbidity, alkalinity, hardness, sulphate, and chloride, TDS, DO, BOD and COD vary significantly within and among the kunds for each season namely pre monsoon, monsoon and post monsoon. Correlation study indicates that pH, alkalinity, nitrate, BOD, COD and DO have strong association with temperature while parameters like temperature, color, turbidity, TDS, TSS and BOD have strong correlation with pH. Seasonal variation has strong impact on the physicochemical parameters of the water body.

1.0 Introduction

Govardhan is a town situated in Mathura district of Uttar Pradesh, India. It is located at 27.5°N 77.47°E. It is very famous for the temples. The town is also famous for its 21 kilometre long Parikrama of the very old hill called Govardhan. The parikrama procession is held in very high religious belief. Along the religious Govardhan Parvat Parikrama, there are a numerous kunds or water tanks which are associated with myths and legends of the lifetime of Krishna and Radha. Among the various kunds along the route, Radha kund, Shyam Kund and Manasi Ganga are considered the most sacred kunds and hence chosen for the study.



Figure:1: Location of Mansi Ganga, Radha and Shyam kund on map

1.1 Mansi Ganga

Mana means "mind" and Ganga is another name for the Ganges River. Mansi Ganga Kund is traditionally the starting and ending point of the circumambulation of Govardhana Hill.

Mansi Ganga, is a close-ended lake which is one of the place for devotees visiting this town. On the banks of this lake, there are quite a few temples; one side of the lake shore now houses a regular marketplace. Being close-ended, pollution is rampant in the lake.

1.2 Radha and Shyam Kund

The Radha Kund is forever linked with the Shyam kund that is situated right beside it. The lake area has many structures, including temples, shrines and memorials. The confluence of the two lakes is held in especially high esteem for obvious reasons.

The local people use the water of the kunds for washing, clothes, bathing, for their cattle and other recreational purposes. The locals residing in the area utilize the water not only for basic activities but also for religious purposes. Inadequate arrangements of the sewer system results in discharge of their domestic waste water into the kunds creating a significant problem for the kund ecology.

Surface water plays a key role in the development of human civilization. Good water quality resources depend on a large number of physicochemical parameters and the magnitude and source of any pollution load. To analyze the source and magnitude these essential parameters are analyzed (Reddi et al., 1993). Chemical composition of water is a function of hydrogeochemical processes acting in a given environment, thus, monitoring of water quality parameters provide important information for water management (Matthieu et al., 2005; USEPA, 1983).

Seasons are generally defined by precipitation and temperature patterns expected during different times of the year. Seasons varies greatly depending on our geographic location, however lakes and ponds commonly respond in similar ways to the same ecological inputs. Hence physicochemical analysis of the kund water is essential in different seasons.

The current study involves the physicochemical characterization of Mansi Ganga, Radha and Shyam Kunds. Further the data has been statistically analyzed by ANOVA to study the effect of seasonal variation on the parameters within and among the kunds. Also Pearson coefficient correlation has been employed to study the correlation among the parameters.

2.0 Material and Methods

2.1 Sampling

Water samples were collected during the year 2012 and

2013 from six sampling points (S1-S6) from all the kunds. They were collected three times in the year- premonsoon (October to January), monsoon (June to September) and postmonsoon (March to June). Samples were collected from the surface from the different areas before sunrise. They were collected in HDPE (High density polyethylene) bottles and analyzed within 2 hrs of sampling.

2.2 Analysis

The study includes the analysis of physical and chemical parameters which are as follows:

2.2.1 Physical Characteristics: The physical characteristics included temperature (Direct thermometer), color (Visual comparison), turbidity (Nephelometric method), total dissolved solids (TDS) (Evaporation method), total suspended solids (TSS), total solids (TS).

2.2.2 Chemical Characteristics: The chemical characteristics included pH (Direct pH meter), alkalinity (Titration method), hardness (EDTA method), dissolved oxygen (DO)(Winkler's method), chemical oxygen demand (COD) (Closed reflex method), biological oxygen demand (BOD) (Iodometric azide method),chloride (Argentometric method), nitrate (Brucine method) phosphate (Colorimetric Method), sulphate (Turbidimetric Method) and fluoride (SPANDS method).

2.3 Statistical analysis

The analysis includes ANOVA and Pearson Coefficient of Correlation.

2.3.1 ANOVA

Analysis of variance (ANOVA) is a statistical tool which is used to check variance in and among groups between variables. In this study ANOVA is employed to analyze the variation among the various physicochemical parameters within a kund and between the three kunds -Mansi Ganga, Radha Kund and Shyam Kund.

2.3.2 Pearson Correlation Coefficient

Pearson correlation (r) is widely used in the sciences as a measure of the degree of linear dependence between two variables. In our study it is used to see the correlation between pH and other parameters and temperature and other parameters of Mansi Ganga, Radha and Shyam kund. The calculation was done using the online calculator (Social science statistics).

3.0 Results and Discussion

3.1 Physicochemical analysis

The various physicochemical parameters for Mansi Ganga, Radha and Shyam kund analyzed during the Premonsoon, monsoon and post monsoon seasons are shown in Table 1.

Table 1: Physicochemical parameters for the three kunds recorded in pre monsoon, monsoon and post monsoon

Parameter	Mansi Ganga				Radha kund				Shyam kund			
	Pre-Monsoon	Monsoon	Post-Monsoon	Mean	Pre-Monsoon	Monsoon	Post-Monsoon	Mean	Pre-Monsoon	Monsoon	Post-Monsoon	Mean
Temperature (°C)	31.45	36.16	15.09	27.57	31.35	36.31	15.62	27.76	31.35	36.28	15.50	27.71
pH	7.21	7.73	6.68	7.21	7.27	7.71	6.69	7.22	7.24	7.64	6.69	7.19
Colour	25.63	56.35	23.65	35.21	17.60	48.65	19.27	28.51	21.25	50.42	18.44	30.03
Turbidity(NTU)	64.21	95.00	34.73	64.65	31.60	69.38	23.27	41.42	32.52	69.56	22.06	41.38
Alkalinity(mg/l)	197.69	184.44	160.75	180.96	312.88	348.06	248.58	303.17	303.71	343.60	249.77	299.03
Hardness(mg/l)	1844.17	1823.83	1792.77	1820.26	1395.06	1325.17	1277.94	1332.72	1394.81	1328.73	1279.94	1334.49
Sulphate(mg/l)	742.13	1097.17	753.69	864.33	570.88	663.81	551.75	595.48	549.75	645.77	547.08	580.87
Chloride(mg/l)	1821.23	1252.06	1530.92	1534.74	714.92	665.73	672.88	684.51	705.21	645.00	673.23	674.48
Fluoride(mg/l)	0.70	0.71	0.71	0.71	0.75	0.74	0.76	0.75	0.75	0.73	0.74	0.74
Nitrate(mg/l)	0.94	0.89	0.72	0.85	0.70	0.65	0.50	0.62	0.71	0.67	0.50	0.62
Phosphate(mg/l)	0.75	0.83	0.88	0.82	0.75	0.84	0.88	0.82	0.75	0.85	0.87	0.82
TSS (mg/l)	60.31	75.31	50.88	62.17	55.81	69.33	48.60	57.92	56.63	68.02	49.15	57.93
TDS (mg/l)	1300.35	1976.77	1188.71	1488.61	744.21	902.75	679.88	775.61	743.63	902.58	679.02	775.08
DO (mg/l)	5.82	6.33	8.14	6.76	6.03	6.59	8.28	6.97	5.99	6.64	8.25	6.96
BOD (mg/l)	25.56	26.88	20.91	24.45	16.18	17.47	11.43	15.03	16.17	17.49	11.40	15.02
COD (mg/l)	55.75	49.10	34.21	46.35	54.21	48.15	35.44	45.93	59.06	46.96	32.73	46.25

The changes in lake water temperature depend on the season, geographic location, sampling time and temperature of effluents entering the lake (Ahipathy, 2006).The maximum temperature was recorded in the month of June ranging from 42-45 °C for all the kunds and the minimum temperature was ranging from 7-9 °C seen in the month of January for all the kunds. Temperature directly affects the amount of oxygen that can be dissolved in water; the rate of photosynthesis by algae and larger aquatic plants; the metabolic rates of aquatic organisms; and the sensitivity of organisms to toxic wastes, parasites and diseases (M. R. Islam et al; 2012).

Major parameters that show highest variation seasonally are color, turbidity, TDS, DO, BOD and COD.

The color intensity is highest during the monsoon season for the three kunds. It is lowest during post monsoon for Mansi Ganga and Shyam kund i. e 23.65 and 18.44 color units respectively. But in case of Radha kund it is during the pre monsoon i. e 17.60 color units. The mean values of color during monsoon for Mansi Ganga, Radha and Shyam kund are 56.35, 48.65 and 50.42 respectively. As a consequence of heavy rainfall the color intensity of the kunds is increased. This is due to dissolved organic matter originating from soils and vegetable matter entering the kunds. Humic or fulvic acid and metal ions impart color to the water (Gupta, 2001).

The seasonal variations in TDS are mainly due to the ionic composition of water. Fresh water contains various kinds of inorganic minerals as well as some organic materials in

dissolved state. Higher dose of these substances creates pollution. Dissolved solids do not contain gas and colloids. In natural water dissolved solids are mainly contain minerals. (Misra et al, 2009 and Senthilnathan T, et al, 2011) . The TDS values are highest during monsoon which is 1976.77mg/l for Mansi Ganga, 902.75 for Radha kund and 902.58 for Shyam kund. The values are lowest during post monsoon which are 1188.71, 679.88 and 679.02 mg/l for Mansi Ganga, Radha and Shyam kund respectively. TDS mainly contributes to the solid particles and inorganic matter.

The clarity of natural body of water is an important factor to determine its quality. Turbidity in water is caused by suspended and colloidal matter such as clay, silt, finely divided organic and inorganic matter, and plankton and other microscopic organisms (Jain et al, 1996). The turbidity is also highest in monsoon and lowest in the post monsoon period in case of all the kunds. The mean values for turbidity during monsoon are 95, 69.38 and 69.56 NTU and post monsoon are 34.73, 23.27 and 22.06 NTU for Mansi Ganga, Radha and Shyam kund respectively. Higher turbidity and TDS during monsoon may be due to the higher deposition of the above matter by surface run offs and seepage.

Dissolved oxygen is one of the fundamental variable in lake and pond ecology. The dissolved oxygen values are highest during the post monsoon period and lowest in premonsoon period for all the three kunds. The average values for DO during postmonsoon are 8.14, 8.28 and 8.25 mg/l for Mansi Ganga, Radha and Shyam kund respectively. The average values for DO during pre monsoon are 5.82, 6.03 and 5.99 mg/l for Mansi Ganga, Radha and Shyam kund respectively. Colder water holds more oxygen than warmer water. Thus the DO values are higher during post monsoon when the temperature is lowest (Addy and Green, 1997). High temperatures increase the rate of metabolic reactions thus increasing the microbial load which in turn reduces the DO concentration.

Biochemical Oxygen Demand is a measure of the oxygen in the water that is required by the aerobic organisms. The BOD values are highest during monsoon that is 26.88, 17.47 and 17.49 mg/l for Mansi Ganga, Radha and Shyam kund respectively. They are found to be lowest during postmonsoon that is 20.91, 11.43 and 11.40 mg/l for Mansi Ganga, Radha and Shyam kund respectively. The biodegradation of organic materials exerts oxygen tension in the water and increases the biological oxygen demand which is seen to be highest in monsoon (Abida and Harikrishna, 2008).

Chemical Oxygen Demand is a measure of the oxidation of reduced chemicals in water. It is commonly used to indirectly measure the amount of organic compounds in water (Kumar et al. 2011). The measure of COD determines the quantity of organic matter making it an indicator of organic pollution in surface water (Faith, 2006). Higher COD during pre monsoon indicates higher organic matter in the kund.

The maximum value for COD is seen during premonsoon which is 55.75, 54.21 and 59.06 mg/l for Mansi Ganga, Radha and Shyam kund respectively. The minimum value for COD is during post monsoon which is 34.21, 35.44 and 32.73 mg/l for Mansi Ganga, Radha and Shyam kund respectively.

3.2 Statistical Analysis

3.2.1 ANOVA

ANOVA is used to compare differences of means among more than 2 groups. It does this by looking at variation in the data and where that variation is found. Analysis of variance was carried out to check the variations within and among the parameters of the kunds. Specifically, ANOVA compares the amount of variation between groups with the amount of variation within groups. It can be used for both observational and experimental studies. The F statistic is a ratio of 2 different measure of variance for the data, which can be used to determine the p value (Probability) The F and p value was determined using Analysis of variance online calculator (Dr Daneil Soper calculator version 3).The parameters with p value less than 0.05 show significant variation while those that have p value greater than or equal to 0.05 are non significant variation.

Comparative analysis of the physicochemical parameters for each kund along different seasons is shown in table 2, 3 and 4.

Table 2: ANOVA analysis of Mansi Ganga for different parameters along the three seasons.

Parameter	Pre-Monsoon	Monsoon	Post-Monsoon	Mean	SD	F value	P value
Temperature (°C)	31.35	36.15	15.00	27.53	11.04	15.27227	0.00
pH	7.21	7.23	6.60	7.21	0.52	451.036	0.00
Colour	25.63	66.95	29.65	35.21	18.33	14.781	0.00
Turbidity(NTU)	84.21	95	34.25	64.65	30.14	2.30150	0.00
Alkalinity(mg/l)	597.69	134.44	160.75	130.96	18.71	116.279	0.00
Hardness(mg/l)	1044.17	522.83	1792.77	920.26	25.89	150.209	0.00
Sulphate(mg/l)	742.13	297.17	793.68	644.33	201.73	11.89787	0.00
Chloride(mg/l)	1827.23	1262.06	1630.52	1614.78	268.60	18.62736	0.00
Fluoride(mg/l)	0.7	0.71	0.71	0.71	0.01	6.353	0.008
Iron(mg/l)	0.94	3.80	0.72	2.65	0.12	300	0
Phosphate(mg/l)	0.75	0.63	0.68	0.68	0.02	129	0
TSS (mg/l)	60.21	75.31	60.88	62.17	12.32	299.77	0
TDS (mg/l)	1300.25	505.77	1100.71	1400.61	426.43	3.00210	0
DO (mg/l)	5.82	5.33	6.14	5.76	1.22	5.57415	0
BOD (mg/l)	25.56	26.88	20.91	24.45	3.14	10.35193	0
COD (mg/l)	65.75	42.1	34.21	46.35	11.03	581.684	0

Table 3: ANOVA analysis of Radha Kund for different parameters along the three seasons.

Parameter	Pre-Monsoon	Monsoon	Post-Monsoon	Mean	SD	F value	P value
Temperature (°C)	31.35	36.31	15.62	27.76	10.80	19.61190	0
pH	7.27	7.21	6.89	7.22	0.51	415.263	0
Colour	17.60	48.95	19.27	28.61	17.46	229.482	0
Turbidity(NTU)	31.80	85.36	23.27	41.47	24.57	263.102	0
Alkalinity(mg/l)	212.88	343.06	246.58	333.17	60.44	5.26276	0
Hardness(mg/l)	1295.00	1252.17	1277.54	1274.72	59.93	2.27421	0
Sulphate(mg/l)	673.88	663.81	661.76	664.28	69.96	4.98838	0
Chloride(mg/l)	714.92	686.72	672.88	691.51	26.59	542.138	0
Fluoride(mg/l)	0.75	0.74	0.76	0.75	0.01	4.4	0.229
Iron(mg/l)	0.70	3.66	0.60	1.65	0.10	326	0
Phosphate(mg/l)	0.75	0.64	0.68	0.68	0.02	133	0
TSS (mg/l)	55.81	69.33	48.60	57.92	10.52	556.191	0
TDS (mg/l)	744.21	902.75	679.88	775.61	114.21	9.66148	0
DO (mg/l)	6.03	5.55	6.20	5.57	1.17	3.49029	0
BOD (mg/l)	16.18	17.47	11.45	15.03	3.18	491.22	0
COD (mg/l)	64.21	47.15	35.44	46.93	24.68	616.614	0

Table 4: ANOVA analysis of Shyam Kund for different parameters along the three seasons

Parameter	Pre-Monsoon	Monsoon	Post-Monsoon	Mean	SD	F value	P value
Temperature (°C)	31.35	36.20	15.60	27.71	13.66	15.28036	0
pH	7.24	7.64	6.89	7.19	0.47	758.333	0
Colour	21.25	50.42	18.44	30.00	17.71	726.75	0
Turbidity(NTU)	32.52	89.56	22.08	41.38	24.96	2.42871	0
Alkalinity(mg/l)	303.71	243.80	246.77	298.03	47.09	897.712	0
Hardness(mg/l)	1354.81	1320.73	1279.54	1351.40	59.65	3.48744	0
Sulphate(mg/l)	649.76	645.77	647.08	647.87	66.72	21.91014	0
Chloride(mg/l)	105.21	645.00	675.23	674.88	33.12	545.944	0
Fluoride(mg/l)	0.75	0.75	0.74	0.74	0.01	0.818	0.46
Iron(mg/l)	0.71	0.67	0.60	0.62	0.11	746	0
Phosphate(mg/l)	0.75	0.65	0.67	0.68	0.05	248	0
TSS (mg/l)	56.63	59.02	49.15	52.93	9.50	89.305	0
TDS (mg/l)	741.63	802.68	679.02	774.08	115.25	11.81331	0
DO (mg/l)	5.99	6.64	6.25	6.29	1.17	3.56532	0
BOD (mg/l)	16.17	17.49	11.40	15.02	3.20	3.19817	0
COD (mg/l)	69.06	46.96	32.73	46.25	18.18	2.61664	0

Analysis for all the kunds i.e Mansi Ganga, Radha and Shyam kund shows that all the physicochemical parameters except fluoride vary significantly in pre monsoon, monsoon and post monsoon from each other within the kunds. The p value for almost all the parameters is less than 0.05 implicating that all the parameters show significant seasonal variation.

Anova analysis for the various seasons that is pre monsoon, monsoon and post monsoon was carried out for the three kunds to see the variation between the kunds. Table 5, 6 and 7

Table 5 : ANOVA analysis of different parameters in pre monsoon for the three kunds

Parameter	Mansi Ganga	Radha Kund	Shyam Kund	Mean	SD	F value	P value
Temperature (°C)	31.76	31.35	31.35	31.35	0.00	0.00	-
pH	7.21	7.27	7.24	7.24	0.03	3.6	0.093
Colour	26.63	17.60	21.26	21.46	4.02	21.64	0
Turbidity(NTU)	64.71	31.80	32.42	42.78	18.52	99.696	0
Alkalinity(mg/l)	19.69	31.99	30.71	27.42	64.02	7.16484	0
Hardness(mg/l)	184.17	139.06	139.03	154.08	293.36	33.29577	0
Sulphate(mg/l)	742.13	676.89	646.76	655.92	139.60	13.62749	0
Chloride(mg/l)	1627.25	174.92	735.21	1080.46	641.56	5.4936356	0
Fluoride(mg/l)	0.7	0.75	0.75	0.74	0.03	0.624	0.003
Nitrate(mg/l)	0.94	0.73	0.71	0.78	0.14	1.10600	0
Phosphate(mg/l)	0.75	0.75	0.75	0.75	0.00	0.00	-
TSS (mg/l)	60.31	56.61	56.65	57.56	2.40	10.149	0.002
TDS (mg/l)	1300.36	744.21	743.63	929.39	321.26	10.63076	0
DO (mg/l)	5.92	6.33	5.99	6.36	0.11	54.995	0
BOD (mg/l)	25.46	18.89	16.17	19.96	6.42	7.44324	0
COD (mg/l)	66.76	64.21	69.08	66.34	2.48	36.66	0

Table 6: ANOVA analysis of different parameters in monsoon for the three kunds

Parameter	Mansi Ganga	Radha Kund	Shyam Kund	Mean	SD	F value	P value
Temperature (°C)	36.16	36.31	36.20	36.25	0.00	2.16	0.15
pH	7.73	7.71	7.64	7.69	0.06	3.288	0.066
Colour	56.26	40.66	50.42	51.00	4.54	41.26	0
Turbidity(NTU)	66	89.36	89.96	77.96	14.74	306.76	0
Alkalinity(mg/l)	184.44	348.06	345.60	292.04	99.21	16.70991	0
Hardness(mg/l)	1623.03	1325.17	1320.72	1452.50	266.00	66.20300	0
Sulphate(mg/l)	1097.17	663.81	648.77	802.95	266.52	31.06148	0
Chloride(mg/l)	1562.06	866.73	646.00	854.26	344.86	36.78152	0
Fluoride(mg/l)	0.71	0.74	0.73	0.73	0.02	2.411	0.189
Nitrate(mg/l)	0.89	0.66	0.67	0.73	0.13	632	0
Phosphate(mg/l)	0.83	0.64	0.66	0.64	0.01	2	0.17
TSS (mg/l)	75.31	69.33	68.02	70.89	3.89	20.41	0
TDS (mg/l)	1676.77	902.76	902.68	1260.73	620.13	46.81189	0
DO (mg/l)	6.33	6.95	6.64	6.62	0.17	73.304	0
BOD (mg/l)	26.86	17.47	17.48	20.61	6.43	10.79440	0
COD (mg/l)	69.1	64.16	66.56	68.27	1.27	9.323	0.034

Table 7: ANOVA analysis of different parameters in post monsoon for the three kunds

Parameter	Mansi Ganga	Radha Kund	Shyam Kund	Mean	SD	F value	P value
Temperature (°C)	19.09	19.62	19.60	19.42	0.28	36.769	-
pH	8.89	8.89	8.89	8.89	0.01	0.066	0.947
Colour	23.66	19.27	19.24	20.45	2.30	20.132	0
Turbidity(NTU)	34.73	29.27	23.66	28.56	6.99	129.602	0
Alkalinity(mg/l)	902.72	240.90	248.77	217.73	21.00	7.23449	0
Hardness(mg/l)	1792.77	1277.94	1279.94	1450.22	296.98	38.09672	0
Sulphate(mg/l)	261.89	665.76	647.08	617.61	117.96	12.21736	0
Chloride(mg/l)	1520.92	874.88	825.23	960.01	456.20	50.71588	0
Fluoride(mg/l)	0.71	0.76	0.74	0.74	0.02	6.708	0.008
Nitrate(mg/l)	0.72	0.70	0.70	0.72	0.13	404	0
Phosphate(mg/l)	0.89	0.88	0.87	0.88	0.00	2	0.17
TSS (mg/l)	91.88	49.60	49.65	49.54	1.19	3.053	0.063
TDS (mg/l)	1189.11	679.88	672.02	847.20	254.02	17.15102	0
DO (mg/l)	8.14	8.26	8.26	8.23	0.02	26.836	0
BOD (mg/l)	20.91	11.43	11.40	14.50	5.40	70.26120	0
COD (mg/l)	34.21	35.44	32.73	34.13	1.36	17.953	0

Anova analysis for pre monsoon shows that the parameters such as temperature, pH and phosphate do not show any significant differences between the kunds under study while the other parameters like color turbidity, alkalinity, hardness, sulphate, chloride, fluoride, TSS, TDS, DO, BOD and COD vary significantly.

During monsoon, parameters like Temperature, pH, fluoride and phosphate do not show remarkable differences. But the remaining parameters show substantial variation between Mansi Ganga, Radha and Shyam kund.

Temperature, pH, phosphate and TSS do not vary significantly while the others vary in great proportion during the post monsoon season for the three kunds under study.

It has been observed that physicochemical parameters are almost similar for Radha and Shyam kunds and they both significantly differ from that of Mansi Ganga.

3.2.2 Pearson coefficient of correlation

Pearson coefficient of correlation (r) is a measure of the linear correlation (dependence) between two variables. The r value ranges between +1 and -1 inclusive, where 1 is total positive correlation, 0 is no correlation, and -1 is total negative correlation.

The study includes the correlation of pH and temperature with other parameters.

pH maintenance (buffering capacity) is one of the most important attributes of any aquatic system since all the biochemical activities depend on pH of the surrounding water. Any alteration in water pH is accompanied by the change in other physicochemical parameters (Agarwal and Rajwar, 2010).

Change in temperature affects the physiological, chemical and biological activities in water. Temperature varies remarkably during every season. Thus it is very essential to study the change in temperature and its effect on other parameters.

Thus pH and temperature were chosen for the correlation study.

Table 8: Correlation of temperature with physicochemical parameters of Mansi Ganga, Radha and Shyam kund.

Parameters	r value		
	Mansi Ganga	Radha Kund	Shyam Kund
pH	0.8709	0.8026	0.8034
Colour	0.6572	0.5897	0.6736
Turbidity(NTU)	0.8149	0.7043	0.7127
Alkalinity(mg/l)	0.8249	0.8785	0.899
Hardness(mg/l)	0.8379	0.7159	0.7347
Sulphate(mg/l)	0.657	0.6078	0.449
Chloride(mg/l)	-0.1704	0.3278	0.1722
Fluoride(mg/l)	0.0652	-0.4836	-0.0215
Nitrate(mg/l)	0.8682	0.8649	0.8996
Phosphate(mg/l)	-0.5392	-0.4556	-0.4329
TSS (mg/l)	0.7229	0.7294	0.6942
TDS (mg/l)	0.7188	0.657	0.6501
DO (mg/l)	-0.8276	-0.8429	-0.8527
BOD (mg/l)	0.9	0.9625	0.9614
COD (mg/l)	0.8859	0.8528	0.7637

In the correlation of temperature with other parameters in pH, alkalinity, nitrate, BOD and COD show highly positive correlation while parameters such as color, sulphate and TDS and TSS are moderately positive and fluoride are weakly positive for all the three kunds under study. The association of temperature with turbidity, hardness is highly positive for Mansi Ganga while moderately positive for Radha and Shyam kund.

DO shows highly negative association with temperature. Chloride shows weakly negative association with temperature in Mansi Ganga and weakly positive association for the other two kunds. Phosphate has moderately negative association for Mansi Ganga but weakly negative association for Radha and Shyam kund.

Table 9: Correlation of pH with physicochemical parameters of Mansi Ganga, Radha and Shyam kund

Parameters	r value		
	Mansi Ganga	Radha Kund	Shyam Kund
Temperature	0.8709	0.8026	0.8034
Colour	0.8709	0.818	0.8585
Turbidity(NTU)	0.9867	0.9451	0.9397
Alkalinity(mg/l)	0.4895	0.9018	0.9495
Hardness(mg/l)	0.5633	0.2864	0.3284
Sulphate(mg/l)	0.8448	0.8593	0.7445
Chloride(mg/l)	-0.4077	-0.0918	-0.2793
Fluoride(mg/l)	0.1698	-0.6317	-0.3224
Nitrate(mg/l)	0.6288	0.6413	0.6705
Phosphate(mg/l)	-0.1731	-0.0138	0.0044
TSS (mg/l)	0.915	0.939	0.8996
TDS (mg/l)	0.9108	0.922	0.9031
DO (mg/l)	-0.599	-0.593	-0.6388
BOD (mg/l)	0.7543	0.8315	0.8378
COD (mg/l)	0.6897	0.5752	0.51

In the correlation study of parameters with pH it was seen that parameters like temperature, color, turbidity, TDS, TSS and BOD are in highly positive correlation while moderately positive with nitrate and COD for all the kunds. Alkalinity is weakly positive for Mansi Ganga and highly positive for Radha and Shyam kund with respect to pH. The association of pH with hardness is highly positive for Mansi Ganga while moderately positive for Radha and Shyam kund while sulphate is highly positive for Mansi Ganga and Radha kund while moderately positive for Shyam kund.

DO shows moderately negative association while phosphate and chloride show weakly negative association with pH. COD is moderately positive for Mansi Ganga and Shyam kund while moderately negative for Radha kund. Fluoride is in weakly positive correlation for Mansi Ganga,

moderately negative for Radha and weakly negative for Shyam kund with respect to pH

Positive correlation indicates that the increase in temperature or pH leads to increase in the value of respective parameter while a decrease in temperature or pH decreases the corresponding value of the parameter. Negative correlation implies that the parameters are inversely proportional with the values of temperature or pH.

4.0 Conclusion

- Seasonal variations have a great impact on most of the physicochemical parameters for all the kunds
- Seasonally the parameters like color, turbidity, TDS, DO, BOD and COD have maximum change in all the kunds.
- Anova analysis shows that all the parameters except fluoride show substantial variation seasonally within Mansi Ganga, Radha and Shyam kund.
- Anova analysis among the three kunds for every season shows that color turbidity, alkalinity, hardness, sulphate, and chloride, TDS, DO, BOD and COD vary significantly.
- Correlation study of temperature with other parameters reveals that parameters like pH, alkalinity, nitrate, BOD, COD and DO have strong correlation whereas chloride, fluoride and phosphate have weak correlation.
- Correlation study of pH with the other parameters shows that temperature, color, turbidity, TDS, TSS and BOD have strong correlation whereas chloride and fluoride have weak correlation.
- The physicochemical and statistical analysis implies that seasonal changes strongly affect the physicochemical parameters.
- Also most of the physicochemical parameters are inter-related thus an increase in one could result in increase or decrease of the other thus changing the complete ecology of the water body.

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