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Correlation Study on Physico-Chemical Parameters and Quality Assessment of Kosi River Water, Uttarakhand

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Abstract: Present work deals with the assessment of physico-chemical parameters of water samples of Kosi river at Kosi sampling station during 2004 and 2005 in pre monsoon, monsoon and post monsoon seasons. Statistical studies have been carried out by calculating correlation coefficients between different pairs of parameters and *t*- test applied for checking significance. The observed values of various physico-chemical parameters of water samples were compared with standard values recommended by WHO. It is found that an appreciable significant positive correlation holds for chloride with pH, Mg, Na, hardness and total suspended solid; and sodium with hardness, EC and sulphate. A significant negative correlation was found between potassium with turbidity, Cl^-, EC and hardness. All the physico-chemical parameters of Kosi water are within the highest desirable limit or maximum permissible limit set by WHO except turbidity and BOD which recorded a high value.

Keywords: Chemical composition, Statistical analysis, *t*- test, Potability.

Introduction

In India ponds, rivers and ground water are used for domestic and agricultural purposes. The quality of water may be described according to their physico-chemical and micro-biological characteristics. For effective maintenance of water quality through appropriate control measures, continuous monitoring of large number of quality parameters is essential. However it is very difficult and laborious task for regular monitoring of all the parameters even if adequate manpower and laboratory facilities are available. Therefore, in recent years an alternative approach based on statistical correlation, has been used to develop mathematical relationship for comparison of physico-chemical parameters[1-3].

The present study deals with study of physico-chemical parameters of Kosi river water in Uttarakhand. The analyzed data were compared with standard values recommended by WHO.

Systematic calculation of correlation coefficient between water quality parameters has been done with the objective of minimizing the complexity and dimensionality of large set of data. The significant correlation has been further verified by using *t*-test.

Experimental

Water samples were collected from sampling station, Kosi in pre monsoon, monsoon and post monsoon seasons for two consecutive years, 2004 and 2005. All the chemicals used were of AR grade. pH, electrical conductivity and turbidity were measured by using MAC Digital Portable Kit (MSW-551). Flame photometer (Model Systronic 128) was used for determination of metal ions Na^+, K^+ and Ca^{2+}. Silver nitrate method was used to estimate the chloride present in water samples[4a]. Sulphate was determined by turbidimetric method[4b]. Total hardness was calculated by complexometric titration using EDTA[4c].

The statistical analysis has been performed using standard methods[5]. Karl-Pearson correlation coefficient (r) was calculated and correlation for significance has also been tested by applying *t*-test[6].

Results and Discussion

The standard and observed values of physico-chemical parameters of experimental water samples are presented in Table 1.The observed pH values ranging from 8.1 to 8.7 shows that the present water samples are slightly alkaline. These values are within maximum permissible limit prescribed by WHO[7]. The calcium (4.9-58.6 mg/L), chloride (0.12-0.17 mg/L), SO_4^{2-} (0.32-0.45 mg/L), hardness (70-495 mg/L), TDS (24.3-54.3 mg/L) values of water samples are within the highest desirable or maximum permissible limit set by WHO[8]. 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.

Table.1. The average values of physico-chemical parameters of Kosi River water.

Parameters	WHO Standards		Experimental Values (Range)
	HDL	MPL	mg/L
pH	7 -8.5	6.5-9.5	8.1-8.7
EC	-	-	0.123-0.139*
Na^+	-	200	8.4-8.8
K^+	-	-	2-2.93
Ca^{2+}	75	200	49.0-58.6
Mg^{2+}	30	150	75.24-86.4
NO_3^-	45	45	0.041-0.05
Cl^-	200	600	0.12-0.17
TDS	500	1000	24.3-54.3
TSS	-	-	4.3-10.66
HRD	100	500	70-495
SO_4^{2-}	200	400	0.32-0.45
PO_4^{3-}	-	-	0.04-0.063
COD	-	-	21.33-24
Turbidity	5	-	8-11.6 **
BOD	1.3	-	6.56-9.03

HDL: Highest desirable Limit; MPL: Maximum permissible limit,* EC in $dsm^{-1;}$ **Turbidity in NTU.

Table 2. .Different pair of correlations

Parameters	Parameters	r	| t |
EC	TSS	-0.8868	3.9316
	TDS	-0.9477	5.9386
	HRD	-0.8979	4.0795
Na	NO_3^-	-0.6272	1.6105
	SO_4^{2-}	-0.9353	5.2863
	TDS	-0.9353	6.2982
	TSS	-0.9666	7.5430
	HRD	-0.993	16.8142
	EC	-0.9224	4.7763
K	TSS	0.7933	2.6059
	Turbidity	-0.7605	2.3423
	Cl	-0.8686	3.5058
	EC	-0.6778	1.8437
	HRD	-0.7351	2.1685
Mg	Turbidity	0.8771	3.6504
	pH	0.8436	3.1420
	SO_4^{2-}	0.7831	2.5184
	TSS	-0.8025	2.6900
	HRD	-0.7954	2.642
Cl^-	pH	0.8748	3.6112
	HRD	0.8121	2.7834
	TSS	0.8874	3.8498
	Na	0.7442	2.2282
	Mg	0.8211	2.8770
TDS	TSS	0.9056	4.2703
TSS	pH	-0.7887	2.5658
TSS	Ca	0.1346	2.1653
	TDS	0.8037	2.7013
HRD	TSS	-0.9878	12.6862
	pH	0.7379	2.1866
SO_4^{2-}	pH	0.7537	2.2936
	HRD	0.9392	5.4704
	TSS	-0.8991	4.1078
	Turbidity	0.8543	3.2871
	EC	0.8061	2.7263
	TDST	-0.9207	4.7182
Turbidity	HRD	0.91	4.3896
	TSSD	-0.8816	3.7356
	EC	0.7465	2.2438
	Cl^-	0.7405	2.203
	TDS	-0.8703	3.5340
BOD	Cl^-	0.9027	4.125
	EC	0.743	2.606
	HRD	0.9640	2.479
	Mg	0.885	3.8039
	Turbidity	0.883	3.770

Note: Significant if t 0.05 > 2.132

In the present study for the years 2004 and 2005 EC has strong significant negative correlation with TSS (r= -0.8865, t= 3.9316), TDS (r= -0.9477, t = 5.9386) and hardness (r = -0.8979, t = 4.0795). This shows that with increase or decrease in the values of EC; TSS, TDS and HRD also exhibit decrease or increase in their values.

A significant positive correlation was found between Na and HRD (r = 0.993, t = 16.8142), EC (r = 0.9224, t = 4.7763), SO_4^{2-} (r = 0.9353, t = 5.2863). Sodium showed negative significant correlation with NO_3^- (r = 0.6272, t = 1.6105), TDS (r = 0.9353, t = 6.2982), TSS (r = -0.9666, t = 7.5430). so with increase or decrease in the values of Na, the values of HRD, EC and SO_4^{2-} increases or decreases while NO_3^-, TDS, TSS decreases or increases with increasing or decreasing in values of Na. Potassium showed positive correlation with TSS (r = 0.7933, t = 1.6059). A significant negative correlation was found between potassium with turbidity (r = -0.7605, t = 2.3423), Cl^- (r = 0.8686, t = 3.5058), EC (r = -0.6778, t = 1.8437) and HRD (r = -0.7351, t = 2.1685). The magnesium content of Kosi water increases or decreases with increase or decrease in the value of turbidity, pH, HRD and SO_4^{2-}, as it shows significant positive correlation with these parameters[9,10].

Chloride ion bears significant positive correlation with pH (r= 0.748, t = 3.6112), Mg (r= 0.821, t = 2.8770), Na (r = 0.7442, t = 2.2282), HRD (r = 0.8121, t = 2.7834), TSSD (r = 0.8874, t = 3.8498) and sulphate ion does not bear significant positive correlation with Mg and Na. It reveals that Mg^{2+} mainly remains present as $MgCl_2$ and Na^+ as NaCl. Cl^- ions bear negative correlation with K^+. It indicates that KCl may be absent in water samples. Total hardness bears positive correlation with Mg and Na^+. So it is suggested that total hardness of water samples is mainly due to the presence of the $MgCl_2$ and NaCl[11].

Total dissolved solid shows significant positive correlation with TSS (r=0.3056, t = 4.278) and TSS shows significant positive correlation with pH (r=-0.7887, t = 2.5658). TSS shows significant positive correlation with Ca (r = 0.7346, t = 2.1653) and TDS (r = 0.8037, t = 2.7013). A significant positive correlation was found between hardness with pH (r = 0.7379, t = 2.1866). While hardness showed negative correlation with TSS (r = 0.9878, t = 12.6862). Negative correlation was found of SO_4^{2-} with TSS (r = 0.8991, t = 4.1078). SO_4^{2-} showed significant positive correlation with pH (r = 0.7537, t = 2.2936), HRD (r = 0.9392, t = 5.4704), turbidity (r = 0.8543, t = 3.2871) and EC (r = 0.8061, t = 2.7263).

Turbidity showed significant positive correlation with HRD (r = 0.91, t = 4.3896) EC (r = 0.7465, t = 2.2438), Cl^- (r = 0.7405, t = 2.203) and negative correlation with TSS (r = -0.8816, t = 3.7356) and TDS (r = -08703, t = 3.5340). BOD showed significant positive correlation with Cl^- (r = 0.9027, t = 4.125), EC (r = 0.743, t = 2.606), HRD (r = 0.9640, t = 2.479), Mg (r = 0.885, t = 3.8039) and turbidity (r= 0.883, t = 3.770).

Conclusion

All the physico-chemical variables of Kosi river water at Kosi are within the highest desirable limit or maximum permissible limit set by WHO except turbidity and BOD which recorded high values. Kosi water recorded higher values of Mg than Ca. Soil erosion and mining of dolomite in the region can be attributed to high values of magnesium than the calcium in the river water. A large number of factors and geological conditions influence the correlations between different pairs directly or indirectly. An appreciable significant positive correlation have been recorded for chloride with pH, Mg, Na, hardness and TSS and sodium with hardness, EC and SO_4^{2-}. A significant negative correlation was found between potassium with turbidity, Cl^-, EC and hardness.

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