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WATER QUALITY OF GOMATI RIVER WATER IN AND AROUND SULTANPUR OF UTTAR PRADESH, STATE, INDIA

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ABSTRACT

The physico-chemical characteristic of the natural Gomati river draining the Sultanpur (U.P.) are studied vis-s-vis to the urban effluents. An ionic dominance patteren of Ca^{++}<Mg^{++}<Na^{+}<K^{+} : HCO_3<-SO_3^{-} in river water and Ca^{++}<Na^{+}<Mg^{++}<K^{+}: HCO_3<-Cl<-SO_4^{-} in effluent water was recorded. The effluent water registered increase in variable amounts of biogenically active $PO_3^{-}P$ and in all the ionic species. The level of alkalinity, hardness, BOD, COD, DOM and WQI also depicted a response similar to the ionis spectra. However, the DO was significantly lower in the polluted water samples. Seasonal variations in various factors are illustrated in relation to percental water quality indices.

KEYWORDS : Water Quality, Pollution, Gomati, Sultanpur

As freshwater are becoming a scarce resource day by day, concern about the water quality remain no longer a national issue. There is an extensive body of literature which stresses deterioration of water quality in a number of freshwater ecosystems (Reddy and Venketashwar, 1987). Increasing industrialization and urbanization over the years, have led to a potential rise in the number of hypertrophied fluvial waterbodies. Further, many investigators have described that the concentrations of population in the urban centres as the principal contributors to man-induced eutrophication; prominent amongst then include, Chattopadhayay et al., (1984); Nandan and Patel, (1985); Venkateshwarlu, (1986); Salgare and Andhyarjuna, (1989); and Kulshreshtha et al., (1989). The water quality parameters and the extent of pollution in the rocky alpine upland streams of Kumaun is much scanty . Although several reports describe the deteriorating nature of the lotic waters of Kashmir (Shah, 1988 and Sunder, 1988) and Garhwal Himalaya. The present communication deals with a study of the limnological characterstics of a high altitude riverine, Gomati which is the alone source of water supply for human consumption and agriculture. Further, the data have been compared with those obtained for a major sewage effluent channel.

MATERIALS AND METHODS

Surface water samples in two replicates from river Gomati, which is one of the most important tributaries of the Distt. Sultanpur (U.P.) were collested monthly during January 2010-2012 and from the effluents originating from Sitakund (975 masl) having a human population of roughly 10,000. It may be stated that the urban effluent in question is one of the major potential non point sources of organic pollution seen in the river basin of the entire Sultanpur.

Standard methods were employed during the collection, preservation and analysis of the natural and polluted effluent samples (Trivedy and Goel, 1986 and APHA et al., 1985). The data were statistically analyzed according to Snedecor and William, (1967).

RESULTS AND DISCUSSION

Two-yearly average of the physico-chemical attributes of the riverine and the waste effluent waters are summarized in table,1. Compared to natural river water, there is an appreciable increase in the water temperature of the effluent runoff. The absence at all times of thermal stratification indicates mixing of water throughout the water columns. The pH of the effluent samples remain more on the alkaline side with the values fluctuating between 7.0 and 9.1 as compared to 7.2-8.0 for river water. Further, two peaks of the parameter are discernible in the effluent water which is in sharp contrast to the pH values of Gomati where no seasonal surge is depic-table. This may be accounted to the existance of high buffering capacity in the river water. The alkalinity of the effluent water follows an eight-fold increase (from X = 58.8 mg/I in River Gomti to X = 410.39

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Table 1: Mean physico-chemical composition of River Gomati and urban effluent for the period, January 2010 to January 2012

Parameters	Gomati		Effluentwater	
	X	CV	X	CV
Air Temp. (^{0}c)	16.0	49.85	18.1	30.47
Water Temp. (^{0}c)	18.1	33.16	18.2	28.24
Humidity (%)	80.5	16.77	85.5	14.40
pH	7.30	13.74	8.07	5.56
Total Alkalinity	58.80	32.85	410.39	28.42
Total Acidity	10.10	47.23	49.34	20.82
Total Hardness	52.00	20.28	184.0	30.19
DO	9.96	16.28	2.68	55.29
BOD	2.20	39.54	16.21	34.86
COD	4.73	47.79	41.76	19.10
Free CO_2	7.15	61.98	43.48	20.60
Conductivity	73.00	23.22	855.24	830.75
Total dissolved solids	60.45	67.44	624.59	61.13
Total suspended solids	26.00	94.13	480.84	154.69
Ca^{++}	11.57	24.37	35.82	26.92
Mg^{++}	5.87	37.76	21.58	48.60
Na^{++}	4.45	56.28	32.42	21.29
K^+	2.72	27.18	18.87	17.97
SiO_2	3.63	59.43	-	-
HCO_3	58.80	32.85	410.19	28.42
Cl^-	10.06	35.35	211.78	50.93
SO_4	2.02	53.08	15.40	51.86
PO_4^- P	0.308	111.04	31.92	68.08
NO_3^- N	0.018	95.82	0.459	73.86

All parameters are in mg/I, except pH and conductivity (in S=cm at 250C) (X= mean, CV= Coefficient of Variance)

mg/l in the urban effluents). While high values of alkalinity in the river water are indicative of the productive nature of the media, as suggested earlier (Bhatt and Pathak 1990), its many fold increase in the polluted water may be associated with high concentration of bicarbonates. Presence of free CO_2 throughout the period of the study, further supports this contention. The absence of phenolphthalein alkalinity in both the cases clearly shows the very absence of hydroxide and carbonates in them. Similar to the observations of Sunder (1988) on River Jhelum of the Kashmir Himalaya, accumulation of large quantities of bicarbonates during summer months may be ascribed to the presence of an excess of free CO_2 produced in the process of decomposition of bottom deposits which probably resulted in conversion of insoluble carbonates into soluble bicarbonates.

Similar to the findings of Kulshrestha et al. (1989) on polluted Kshipra river, total hardness values summarised in Table,1 indicate an urban impact on the water quality characteristics; its level effluente stream evince a five times increase (from X = 52.0 mg/I to X = 184.0 mg/l). Following the classification given by Sinha (1988), the river water with hardness ranging between 20-150 mg/l may be considered as moderately hard, while that of the effluent water with hardness range of 150-300 mg/l as hard. The correlation coefficient (Y) values presented in Table, 2 show significant juxtapository associations between hardness and some of the important water quality parameters in the waterbodies under reference. It may be noted that, compared to natural river water, several statistically significant correlations are

Table 2: Total hardness (mg/l) of effluent water and its statistical correlation with other chemical parameters

	X	Sx±SEM	r	r^2
Hardness	184.00	55.54±17.57	-	-
Water Tamp.	18.20	5.15±1.63	0.68	.4624***
Ca-Hardness	95.34	25.55±8.08	0.67	.4489***
Mg-Hardness	87.75	43.49±13.76	0.89	.7921***
Calcium	35.82	9.64±3.05	0.78	.6084***
Magnesium	21.58	10.49±3.32	0.89	.7921***
Sodium	32.42	6.90±2.19	0.45	.2025**
Bicarbonate	410.39	116.63±36.89	0.47	.2209**
Chloride	211.78	107.84±34.10	0.23	.0529*

All parameters are in mg/I, except water temperature are in 0C. (X = mean; Sx = standard deviation; r = correlation coefficient, r2= coefficient of determination;
***P<0.01; **P<0.1; *did not show any significance at these levels).

discernible in the urban effluent showing the relative roles played in respect to the control of hardness, by different ionic species.

The values of specific conductance in the effluent runoff record a massive increase from a moderately low mean value of 73.02 in the river water to 855.24 in the polluted one. The conductivity data depict an inverse relationship with water level and a low water during the autumn and winter monthe may be associated with maxima of conductance observed during the period. Likewise, compared to those of the effluents, the total dissolved solids (TDS) of the Gomati water are very low (Table, 1). An increasing trend observed in conductivity and total solids has been attributed to pollution in River Kshipra of the plains (Kulshrestha et al., 1989) and River Sarju (Bhatt and Pathak, 1990) of the uplands. In the present study, a change in the seasonal pattern observable between two waters : the effluents contain high TDS values at the winter-spring interphase when the parameter in the natural Gomati water, few decline below the detectable limits. On the contrary, the levels of suspended solids (TSS) of the two waterbodies show a similar response for most of the period except during November when their quantities in the effluent register an abrupt pulse.

An ionic sequence of $Ca^{++}<Na^{+}<Mg^{+}K^{+}<$: $HCO_3<Cl^{-}<SO^{-4}$ prevails in river water and Ca<Na<Mg<K : $HCO_3<Cl<SO^4$ in effluent water (Table ,2). However, the cationic concentrations in the effluent stream undergo, depending on the ionic species, a three-to ten fold rise. Nevertheless, the water quality with regard to these metallic elements may not be considered deletrious as their levels fall well within the permissible limits given by I.C.M.R., Ministry of Works and Housing and W.H.O. (Table, 3). The values of chlorides and sulphates in the polluted water record an increase respectively to the extent of twenty-five and fifteen-times compared to that of the natural river water. These ions have been considered as being important vehicles for cationic transport mechanisms (Mason and Seip, 1985), and are probably leached into surface waters accompanied by charge balancing bivalent cations, such as Ca^{++} and Mg^{++}. While a low content of these anions in the basin area, alarming increase in the urban emissions may be considered as index of pollution from animal origin, as suggested earlier by the authors. Sodium chloride from domestic origin could perhaps be a contributing factor, while the rise in sulphate content in the effluent water be linked to extensive house-building programmes in progress. Further, these anionic species may play a decisive role in the acidification of the effluent flow (Table, 1) as a mobile carrier of H^{++} ions. However, as the pH and free CO_2

Table 3:Allowable/highest Desirable Limits Of Chemical Substance In Drinking Water

Characteristics	ICMA	WHO	MWH
pH	7.0—8.5	7.0—8.5	7.0—8.5
DO	5.00	—	—
BOD	0-1.0	—	—
Nitrates	20.0	45.0	45.0
Alkalinity	120	—	—
Total hardness (as Ca CO_3)	300.0	100.0	200.0
Mg^{++}	50.0	30.0	30.0
Ca^{++}	75.00	—	—
Cl^-	250.0	200.0	200.0
Sulphates (as SO_4^{--})	-	200.0	200.0
Total Soilids	-	500.0	500.0

(All parameters are in mg/l, except pH).

contents of the effluent water are well above to that of natural river water, it is likely that a rise in sulphate concentration is compensated by the rising HCO_3 ions.

The increasing amounts of sulphate may also be associated with accmulation of a large amount of oxidizable organic matter (DOM) observed in the urban effluent, as a consequence of which the value of oxygen demands (BOD and COD) aggravate to the objectionable amounts (Table, 3). It may be seen from the data given in Table, 1 that, in contradistinction to a nadir value in Gomati water, the BOD in the effluent runoff show a high range of 19.5-25.5 mg/l. Similarly a four-fold rise in the COD content of the effluent water indicates the load of organic pollution.

An increase of over thirty-fold in PO_4^-P inevitably aggravates the extent of pollution in the urban effluent (Table ,1). The present study shows that the DO maxima of the effluent water never reaches even the minima of River Gomati besides that the percent saturation of DO in the river usually remain close to 100 percent in the absence of biological activity. A further increase in the percentage of oxygen saturation in the effluent water, together with an appreciable fall in DO content, indicates the pollution load in the system being devoid of usual biotic community. Confirming the finding of Sinha ,(1988), the present study reveals that the amplitude of DO in running waters pertains mainly to biotic functions.

A comparison of data on quality rating (QI) and arithmetic water quality index (WQI) (Table, 4) reveals many features of the month to month variations, that is, the extent of overall pollution in the test waters.

The findings on the WQI of R. Gomati are comparable with those recorded for several other rivers of India and Nepal . It may be observed that while the WQI levels of the natural river water are consistantly below 100 mark the limit for the drinking water those of the effluent runoff are well above this level (X = 185.17, N = 72). This depict that the water quality of the river before the confluence into it of the urban effluents is with in the

Table 4: Correlation between the water body and effeluent indicating water quality sub Index and WOI

Waterbody	Quality rating	Sub-index	WQI
Gomati	20.35	30.92	30.47
Effluent	121.88	122.25	188.17

permissible limits for use in domestic purpose.

However, the water quality deteriorates significantly as municipal effluents and organic waste of animals and human beings become mixed with the river water which then becomes practically unfit for drinking, aquaculture and irrigation. Nevertheless, about 2 km downstream, a gradual cleaning up or the riverine environment, a reduction in those features that form adverse conditions for biocenotic entities (Kulshrestha et al., 1989), an increase in the texa diversity index (H'max), a gradual fall in the organism population owing to deminished food supply and presence of some of the predators that are less sensitive individually to pollutional effect, have been observed . This may be adjuncted to the self-purification, homeostatic mechanisms prevailing in the master stream Sarju (Bhatt and Pathak, 1990), on which River Gomati merges a little downstream of the second sampling station.

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