Poll Res. 14 (4) : 447-454 (1995)
Copyright © Enviromedia

PHYSICO–CHEMICAL CHARACTERISTICS OF KHANDEPAR RIVER, GOA, INDIA

P.V. DESAI*, S.J. GODASE** AND S.G. HALKAR**

Department of Zoology, Goa University & Dept. of Zoology, Dhempe College, Goa, India

Key Words : River, Hydrology, Pollution.

ABSTRACT

The water of Khandepar has been used for irrigation and for domestic supply. As the river passes through the mining belts the effluents get mixed with it. The mixing of the domestic sewage, transport of mining ores by the barges, industrial wastes deteriorate the water quality. The Khandepar river showed peak alkalinity in January and peak chlorinity in April and the water was very hard in summer. The water was acidic throughout the study period. It also had high sulphates, phosphates and nitrates.

INTRODUCTION

It has been a practice in India to use the perennial rivers and their tributaries for disposing off the domestic and industrial wastes, thereby causing the deterioration of the water quality. Rapid urbanisation associated with industrial growth has been causing the increase of pollution load in rivers. But there is hardly any report on the rivers of Goa, especially that of Khandepar which usually receives effluents from mining belts during its course towards sea.

Therefore, it was decided to assess the water quality of Khandepar river from which water is pumped for irrigation and domestic supply.

MATERIALS AND METHODS

The surface water samples were taken fortnightly in polystyrene bottles (500 ml.) from two stations from Khandepar river (74°20′ 30"E, 15°25′ 50"N) in the year Aug. 1987-Aug. 1988 and Aug. 1993 to Aug. 1994. The samples were collected on 15th of each month in the early hours of the day i.e. between 7.0 a.m. to 9.0. a.m. Care was taken to avoid air bubbling during the sampling. The sampling bottles were iodine treated. Analytical techniques as described in standard methods for examination of water and waste water (APHA,

1980) and chemical and Biological methods for water pollution studies (Trivedy & Goel, 1986) were adopted for the physico-chemical analysis of river water. Water temperature, transparency, pH, dissolved oxygen, free CO_2, alkalinity were determined at the site while hardness, chlorides, sulphates, phosphates and nitrates were determined in the laboratory. Dissolved oxygen, free CO_2, alkalinity were determined by titrimetric method while phosphates, nitrates, sulphates, iron were anlaysed with the help of Systronic (108) spectrophotometer.

OBSERVATIONS

The results obtained at the two sites were identical, hence the combined average figures of the results are given. Tables 1 & 2 show the physico-chemical Characteristics of the water.

The transparency in the River water varied between 12 to 25 cm in 1987-88 while in 1993-94 it varied between 12 to 26 cm. The low transparency was observed in monsoon when the water was turbid. The D.O. values varied between 6 to 12 mg/L for 1987-88 while for 1993-94 it ranged between 7.4 to 12.2 mg/L. The monsoon figures for D.O. were high while the summer figures indicated low level. The CO_2 level was low in monsoon, especially in June 88 it was 8.0 mg/L while in May 88 the highest level of CO_2 was observed (30.0 mg/L). In the year 1993-94 the low level (10.0 mg/L) was noted in June and high (22.0 mg/L) in May 94.

The alkalinity was in the range of 20 to 80 mg/L for 1987-88 whlie for 1993-94 it ranged between 20 to 90.4 mg/L. Least values were recorded in monsoon and the highest in January in both the study periods.

The least (11.36 mg/L) chloride content was observed in June 88 and July 94 (23.0 mg/L) and the maximum value was obtained in May 88 (278.32 mg/L) and April 94 (210.0 mg/L). Generally April and May exhibited high chloride content. The hardness expressed as $CaCO_3$ ranged between 13.3 to 264 mg/L in the year 1987-88 and in 1993-94 it showed a range of 12.5 to 208 mg/L. Generally in summer the hardness was maximum. In the rest of the season the hardness was quite low. The iron concentration in the water varied between 0.68 to 1.0 mg/L in 1987-88 and in the year 1993-94 it varied between 0.7 to 1.3 mg/L. The iron contents of water was high during monsoon (July & August). The least level (0.097 mg/L) of phosphate was observed in Aug. 87 and maximum (1.482 mg/L) was observed in March 88. In the year 1993-94 the low (0.98 mg/L) level of phosphate was seen in July 93 and the high phosphate level (1.34 mg/L) was observed in May 94. The nitrate contents varied between 0.1 mg/L to 10.0 mg/L in 1987-88 while it exhibited a range of 0.5 to 6.8 mg/L in the year 1993-94.

The sulphate concentration varied between 10.0 mg/L to 210.0 mg/L in 1987-88 while it fluctuated between 11.0 to 168.0 mg/L in 1993-94. The maximum concentration was observed in summer.

Table 1. Physico-chemical Characteristics of Khandepar River, Goa. 1987-88

Month	pH	Temp. O_C	Transp. rancy cm	D.O. mg/L	CO_2 mg/L	Alkali nity mg/L	Cl mg/L	Hard ness mg/L	PO_4 mg/L	Nit. mg/L	SO_4 mg/L	Fe
August	6.3	26.0	16	12.0	18.8	50	213	13.3	0 097	0.94	128	1.0
September	6.5	26.3	16	12.0	12.0	20	79.52	48.0	0.085	0.85	48	0.98
October	6.15	27.6	18	8.0	16.0	30	19.88	14.66	1.77	4.0	30	0.92
November	6.2	27.4	20	6.4	14.4	80	14.2	16	0.379	5.0	12	0.84
December	6.3	26.9	21	8.0	14.0	40	22.72	8.0	0.305	1.0	10.6	0.78
January	6.28	26.5	24	9.6	12.0	80	28.4	24	0.379	2.0	15	0.73
February	6.1	27.3	24	9.6	16	55	48.28	16	0.42	10	30	0.68
March	6.0	28.5	24	9.0	16	55	45	16	1.48	2.0	39.2	0.71
April	6.1	29.2	25	9.6	24	80	272.6	264	1.0	0.1	210	0.64
May	6.2	30.1	23	8.0	30	80	278.32	256	1.1	0.12	202	0.65
June	5.0	28	20	11.2	8.0	40	11.36	14	1.2	0.24	22	0.79
July	4.7	27	12	9.6	12	30	12.84	16	0.18	0.45	10	0.89

Nit = Nitrates

DISCUSSION

Most of the Rivers in the world are polluted due to sewage, domestic waste, industrial waste water and agricultural runoff having hazardous substances. In Goa the mining effluents from the mining sites and sites of the mining reject dumps add to the pollution level of the Rivers.

The fluctuation in the river water temperature usually depend on the season, geographic location, sampling time as well as upon the temperatue of the effluents pouring into the river. The water transparency depends upon the suspended and dissolved matters but even the flow rate of water alters the transparency (Mishra and Saksena, 1991). The low transparency observed in the present study, especially in monsoon was due to the water turbidity and partly due to the mixing of domestic sewage. The higher sediments and phytoplanktons during rainy season may settle down and thus increases the turbidity and decrease transparency (Patric, 1971).

The pH of the waterbody indicates the degree of pollution (Verma *et al.*, 1984). In Ganga water pH was above 8.0 in all seaosns except monsoon (Saxena *et al.*, 1966). Kalinadi had pH value between 7.2 to 7.6 and due to mixing of factory wastes it dropped to 4.8 to 5.9 (Verma and Dalela, 1975), Chandra Prakash *et al.* (1978) noted the alkaline pH in Jamuna. Similar observations have been reported by Shyamsunder (1988), Shalh (1988) and Mishra and Sexena (1991). In the present work the river showed acidic pH throughout the study period and was never on alkaline side. The pH of the Khandepar river is within the permissible values (6.0 to 9.0) for summer but lowering of pH in June and July could be due to the mixing of mining effluents in monsoon. Fergusson (1982) argued that one common component of mining rejects is FeS_2 which has an important role in the formation of acid mind water. The river water showed a significant amount of iron contents which may be causing the drop in pH, especially in summer when the water temperature is high.

The deterioration of water quality results in the depletion of oxygen. The increase in temperature may alter the concentration of D.O., Free CO_2 and other gases dissolved in water. In the present study the river exhibited considerably high level of D.O., in rainy seasons and it could be so as the rain water in rich in oxygen. In other season the D.O. level could be fluctuating due to the fluctuating water temperature. Besides this the mixing of the waste demanding oxygen can also induce drop in oxygen level.

Some investigators have reported increase in CO_2 in polluted waters (Verma & Dalela, 1975; Saxena & Chauhan 1993). Verma and Dalela (1975) have reported high CO_2 level (27.6 mg/L) in winter in river Kal but the present observations do no agree with these observations thoug CO_2 level is quite higher than that o D.O. level in winter. On the contrar in the present work the maximun CO_2 level is found in summer Saxena and Chauhan (1993) foun the inverse relationship between CO and D.O. In the present study th

Table 2. Physico-chemical characteristics of Khanderpar river, Goa. 1993-94

Month	pH	Temp. O_C	Transp-rancy cm	D.O. mg/L	CO_2 mg/L	Alkali nity	Cl mg/L	Hard ness mg/L	PO_4 mg/L	Nit. mg/L	SO_4 mg/L	Fe mg/L
Aug.	6.1	26.1	13	12.2	12.2	20.0	30.1	12.5	0.1	1.0	20.0	1.1
Sept.	6.3	26.8	12	12.0	14.0	25.0	60.4	28.32	0.14	0.9	30.0	0.9
Oct.	6.3	27.4	18	7.4.	16.4	60.0	24.26	15.0	1.162	2.9	12.6	0.8
Nov.	6.1	28.3	17	8.0	14.1	50.0	23.8	18.0	0.40	3.2	11.0	0.7
Dec.	6.3	27.6	18.	10.0	12.6	30.6	23.2	12.0	0.41	4.6	15.0	0.7
Jan.	6.32	26.4	20	8.6	18.0	90.4	30.6	20.	0.392	4.0	20.4	0.82
Feb.	6.25	26.7	24	8.8	18.2	80.0	45.0	22.0	0.405	3.8	38.0	0.75
Mar.	6.1	28.6	26	9.2	16.0	60.23	40.0	18.0	1.32	6.8	26	0.88
Apr.	6.15	29.2	25	8.6	20.12	64.0	210.0	208	1.26	2.0	168.0	0.92
May.	6.3	30.1	24	8.0	22.0	70.0	196.0	190.0	1.34	1.40	152.0	0.90
June	5.6	28.2	16	9.4	10.0	40.0	40.0	28.0	1.18	1.0	23.0	1.0
July	5.38	26.3	12	9.6	10.5	30.0	23.0	16.0	0.98	0.5	15.0	1.3

Alkal = Alkalinity, D.O. = Dissolved oxygen, Cl = Chlorides, Nit = Nitrates

general inverse relationship was not seen though it existed in all seven months. Thus, the present observations partly agree with the observations of Saxena and Chauhan (1993). Increase in summar CO_2 level could be due to the increase in aerobic population as well as pollution load. Georage *et al.*, (1966), Saxena *et al.* (1966); Somashekar (1984); Ajmal *et al.* (1985); Ajmal and Razi-Ud-Din (1988); Ghose and Sharma (1988); Shah (1988) have observed very high alkalinity in contrast to the present study. The present observations of fluctuation in alkalinity in the range of 20.0 to 80.0 mg/L (1987-88) and 20.0 to 90.4 mg/L (1993-94) may be due to the mixing of domestic sewage.

The chloride concentrations depends upon the charactersitics of sediments and the pollution load. In unpolluted rivers the values of chlorides are usually low (2.0 to 10.0 mg/L). The increase in chloride values in the present study could be partly due to the back influence of sea water and partly due to the increase in pollution load caused by the sewage effluents. Thus, the high chloride values indicate the deterioration of water quality, Steep. increase in chloride values in summer may be due to evaporation of water and addition of large amount of organic matter. Ajmal *et al.* (1985) found the influence of season on the chloride contents of the river but in the present study no such direct influence could be seen.

The rainfall is said to be responsible for increasing the amount of nitrate in water but in the present study the maximum amount of nitrate was observed in February. Ajmal *et al* (1985) reported least value of nitrate (0.1 mg/l) in winter and maximum (4.5 mg/L) in summer for Kalinadi. Shyamsunder (1988) observd minimum nitrates during July through September and maximum in the month of January in river Jhelum. Shah (1988) reported minimum nitrate level in April and maximum in December. Nitrate concentration between 4 to 6 mg/L is considered high. According to Kapoor (1993) higher amounts of nitrates and phosphates represent high pollution load.

Major sources of phosphate in the water are domestic sewage, agricultural effluents with fertilizers and industrial effluents. The high phosphate concentration therefore indicates pollution. Verma and Dalela (1975) observed 0.77 mg/L concentration of phosphate in river Kali Mahadevan and Krishnaswamy (1983) noted phosphate range o 0.08 to 0.83 mg/L for river Vaigai Somshekhar (1984) found phosphate concentration as high as 1 mg/L in June and July in rive Cauvery. Shyamsunder (1988) observed mean phosphate values i river Jhelum as 0.005 mg/L and 0.0 mg/L at two sampling stations.

The high sulphate concentration in the river water indicate pollutio caused by the domestic sewage an effluents. Especially the hig summer values for sulphate clear indicate the deterioration of wat quality.

The higher concentration of ir in monsoon could be due to t effluents coming from the mini sites.

Thus it could be concluded that the Khandepar river of Goa is getting polluted. Also there is not much diference in the pollution status observed in 1987-88 and 1993-94.

REFERENCES

Ajmal, M., Razi-Ud-Din and Khan, A.U. 1985. Physico-chemical aspects of pollution in Kalinadi. *AAWPC Tech. Annu.* **XII** : pp. 106-144.

Ajmal, M. and Razi-Ud-Din. 1988. Studies on pollution of Hindon river and Kalinadi river (India). *In Ecology and Pollution of Indian Rivers* (Ed. R.K. Trivedy) pp. 87-111. Ashish Publ. House, New Delhi.

APHA, AWWA and WPCF 1980. *Standard methods of examination of water and waste water.* American Public Heatlh Association, N. York. Chandraprakash Rawat, D.C. and and Grover, P.P. 1987. Ecological study of Januna. *IAWPC Tech. Annu.* pp. 32-45.

Fergusson, J.E. 1982. In *Inorganic chemistry and Earth*, Pergamon Press New York, pp. 329-330.

George, M.G. Quasim, S.Z. and Siddiqui 1996a. Limnological survey of river Kali with special reference to fish mortality *Environ. Hlth* **8** (4) : pp. 262-269.

Ghose, N.C. and Sharma, C.B. 1988. Effect of drain water on the physico-chemical and Bacteriological characters of the river Ganga at Patna, Bihar. In *Ecology and Pollution of Indian Rivers* (Ed. R.K. Trivedy) pp. 255-269. Ashish Publishing House, New Dehli.

Kapoor Prakash 1993. Physico-chemical and Biological study of four rivers at Bareilly (U.P.) *Poll. Res.* **12** (4) : pp. 1.

Mishra, S.R. and Saksena, D.N. 1991. Pollutional ecology with reference to physico-chemcial characteristics of Morar (Kalpi) river, Gwalior (M.P.). In *Current trends in Limnology* (Ed. N.K. Shastree) **1** : pp 159-184. Narendra Publishing House, New Delhi.

Patrick, R. 1971. The effect of increasing light and temperature on the structure of Diatoms communities. *Limnol. Oceangr* **16** : pp. 405-521.

Saxena, K.K. and Chauhan, R.S.S. 1993. Physico-chemial aspects of pollution in river Yamuna at Agra. *Poll. Res.* **12** (2) : 101-104.

Saxena, K.L. Charkraboarty, R.N. Khan, A.O., Chattopadhya, S.N. and Harish Chandra 1966. Pollution studies of the river Ganga near Kanpur. *Environ. Hlth.* **8** : pp 270-285.

Sengupta, B. Lasker, S. Das, A.K. and Das, J. 1988. Inorganic pollutants of Ganga water in the region of Berhampur to Katwar, West Bengal. *Ind. J. Environ. Hlth* **30** (1) : pp. 202-208.

Shah, A.R. 1989. Physico-chemical aspects of pollution in river Jhelum (Kashmir) during 1981-83 In : *Ecology and Pollution of Indian Rivers* (Ed. R.K. Trivedy) pp 163-207. Ashish Publishing House, New Delhi.

Shyamsunder A. 1989. Monitoring the water quality in a stretch of river Jhelum, Kashmir, In : *Ecology and Pollution of Indian Rivers* (Ed. R.K. Trivedy) pp 131-161. Ashish Publishing House, New Delhi.

Somashekhar, R.K. 1984. Studies of water pollution of the river Cauvery-Physico-chemical characteristics. *Intern. J. Environ. Studies* **23** (314) : pp 209-216.

Somashekhar, R.K. 1989. Ecological studies on the two major rivers of Karnataka. In : *Ecology and Pollution of Indian Rivers* (Ed. R.K. Trivedy) pp 39-53, Ashish Pub-

lishing House, New Delhi.

Trivedy, R.K. 1989. *Ecology & Pollution of Indian Rivers.* Ashish Publshing House, New Delhi.

Trivedy, R.K. 1990. *River Pollution in India,* Ashish Publshing House, New Delhi.

Trivedy, R.K. and Goel, P.K. 1986. Chemical and Biological methods of water pollution studies. *Envion. Publ.* Karad, India.

Verma, S.R. and Dalela, R.C. 1975. Studies on the pollution of the Kalindai by industrial wastes near Manasurpur, Part I, Hydrometric and physico-chemical characteristics of the wastes and river water. *Acta Hydrochim Hydro + Biol.* **3** (3) : pp 239-257.

Verma, S.R. Sharma, P. Tyagi, A. Rani, S. Gupat, A.K. and Dalela, R.C. 1984. Pollution and Saprobic status of Eastern Kalinadi. *Limnologica* (Berlin) **15** (1) : pp 69-133.

National Symposium on
Integrated Coastal Zone Management
Feb. 25 & 26, 1996

BERHAMPUR UNIVERSITY
ORISSA

For details contact :
DR. R.C. PANIGRAHY
Organising Secretary
Department of Marine Sciences
Berhampur University, Bhanja
Bihar - 760 007
ORISSA