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A physico-chemical assessment of the river Ganga at Varanasi, U.P.

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SUMMARY

Varanasi ($25^0$18' N and $83^0$1' E) is an ancient city situated on the left bank of river Ganga. Various physico-chemical characteristics of river Ganga flowing in varanasi were studied in the summer, winter and rainy seasons. Ecological parameters like dissolved oxygen (D.O.), pH, nitrate, phosphate, biochemical oxygen demand (B.O.D.) and temperature were analyzed and compared with standard permissible limits to assess the best designated use of the river water for various purposes. The important sources of pollution in the river Ganga include discharge of raw sewage at different ghats, the disposal of dead animals and human bodies, the garbage coming from household activities, discharge of faecal matters etc. Raj ghat is the main sewage disposal point of the Varanasi city. The physico-chemical analysis shows higher value of B.O.D. and lower value of D.O. at Raj ghat and Assi ghat. Ganges water was found to be rich in nitrate and phosphate contents, Dissolved oxygen and biochemical oxygen demand were found to be two important parameters, which showed strong correlation with several other parameters and hence can serve as good indices of river water quality.

Key words : Water quality parameters, Ganga water pollution

Ganges, the holiest of Indian rivers is highly polluted near many cities on its banks. The problem of pollution at many other places, is due to sewage inflow, industrial waste, animal carcasses, unclaimed human bodies, plastic bags etc. Ganges in her 2500 km long journey from the Gomukh in the Himalayas to Ganga Sagar in the Bay of Bengal passes through Varanasi. The seven km long river, face along the city of Varanasi extending from Assi to Varuna is a hallowed place. Today the famous ghats of Varanasi add to the grandeur of this holy river-face.

About 60,000 people take a holy dip in the Ganga at the ghats each day. River has always been the most important fresh water resources, along the banks of which our ancient civilizations have flourished and most developmental activities are still dependent upon them. River water has multiple uses in every sector of development like agriculture, industry, transportation, aquaculture, public water supply etc. However, since old times rivers have also been used for cleaning and disposal purposes. Huge loads of waste from industries, domestic sewage and agricultural practices find their way into rivers, resulting in large scale deterioration of the water quality. The growing problem of degradation of our river ecosystem has necessitated our the monitoring of water quality for various rivers all other the country to evaluate their production capacity, utility potential and to plan restorative measures. In any system where organic matter is present, the organic matter can be broken down (biodegraded) to inorganic matter by the action of microbes, oxygen is utilized during the biodegradation process. It has been found that the rate of biodegradation of the organic matter at any given time is proportional to the amount of organic matter and also the microbial population present in the system at that time (Tchobanoglous, 1979, Ademoroti, 1987). Dissolved oxygen is the amount of oxygen in the gaseous form present in water available for aerobic organisms to carry out their life processes. A well balanced warm water where fish can thrive requires a dissolved oxygen level of not less than 5 mg/l . The dissolved oxygen in highly polluted waste water is used up by microorganisms (Ademoroti, 1996).

The parameter used as a measure of the amount of oxygen required by microorganisms is "Biochemical oxygen demand (B.O.D.). This parameter also measures the strength of any given waste water (Ademoroti, 1984). The B.O.D. is an empirical biological test in which the water condition such as temperature, oxygen concentration or type of bacteria plays a decisive role. These and other factors cause the reproducibility to be much less than that of pure chemical tests. Inspite of the disadvantage, the B.O.D. is of special importance in the assessment of pollution in waste water. A high D.O. is an indication of a high state of purity of water and a low D.O. is an indication of pollution. An estimated 6 million

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tons of chemical fertilizer and around 9000 tons of pesticides are added to the Ganges each year, along the raw sewage and factory effluents (Sampat, 2001) . The photoautotrophic mode of algal behariour is influenced by interaction of various physico – chemical and biological characteristics of the habitat (Tare, 2003). Photosynthetic activity of algae plays an important role in maintaining high level of D.O. in Ganges. The tolerance of algae with reference to organic pollution has already been worked out by Palmer (1969).

The use of algae in conjunction with physico – chemical characteristics of water has now been widely accepted for monitoring water quality of aquatic ecosystems. Palmer (1969) published a list of algae for measuring and indicating the organic pollution. The idea of indicator species concept was later challenged by Cairns (1974), who pointed out that species listing might not give as much useful information as the study of community structure. A very useful authoritative work has been done by Patrick (1971) where she used the diatom flora for measurement of water quality. The use of both physico – chemical and phycological parameters in assessment of river Ganges water quality is no exception. Since this river is the holiest of all the rivers in India, much interest has been taken by the Government of India. Ministry of Environment and Forest through Central Ganga authority take up this study of establishing correlation between physico – chemical and phycological characters of this sacred river.

MATERIALS AND METHODS

River water sampling :

The five study sites namely Rajghat Assighat, Dasashwamedh ghat, Maan Mandir ghat and Lalita ghat were chosen for the purpose of study. River water samples were collected at each site during every month. All the samples were collected from mid stream at a depth of 10 to 15 cm from surface. Estimation of temp., pH, D.O. and alkalinity were done at the site immediately after the collection of the sample. Five litre samples collected from each site were brought back to the laboratory for the estimation of other parameters such as B.O.D., nitrate phosphate etc. During the transport, samples were kept in icebox and subsequently transferred to the refrigerator.

Analysis:

All samples were analyzed as described in the standard methods for the examination of water and waste water and standard methods for water and effluent analysis (APHA, 1992).

RESULTS AND DISCUSSION

The physico – chemical analysis shows in Table 1 that the Ganges water remained alkaline throughout the study period. Rajghat and Assighat showed lower values of D.O. and high values of B.O.D. Acidity values were low. Ganges water was found to be rich in nitrate and phosphate.

Rainy season show the low value of alkalinity and

Table 1 : Seasonal variation in physico-chemical properties of Ganga water at different study sites 2007–2008

Sr. No.	Study site	Seasons	Parameters							
			pH	Temp. ^{0}C	Alkalinity mg^{-l}	Acidity mg^{-l}	D.O. mg^{-l}	B.O.D. mg^{-l}	NO_3^- mg^{-l}	PO_4^- mg^{-ml}
1.	Assi ghat	Summer	8.34	30.25	257.50	12.75	6.10	5.10	1.22	1.05
		Rainy	7.60	30.75	174.75	11.75	6.00	4.55	1.00	0.30
		Winter	8.44	24.25	262.75	12.00	6.27	6.30	1.15	0.57
2.	Dashashwamedh	Summer	8.40	30.50	219.50	15.75	6.50	3.52	1.12	0.95
	ghat	Rainy	7.65	31.25	126.00	11.75	6.00	2.62	1.12	0.30
		Winter	8.50	23.75	218.00	14.50	6.95	2.85	0.57	0.35
3.	Mannmandir ghat	Summer	8.35	29.75	208.00	13.50	6.72	3.30	0.87	0.82
		Rainy	7.80	30.75	135.75	13.00	6.07	3.05	0.92	0.25
		Winter	8.41	24.75	207.25	16.00	6.90	3.37	0.82	0.52
4.	Lalita ghat	Summer	8.37	31.25	211.25	14.00	6.80	3.40	0.95	0.95
		Rainy	7.86	30.00	134.25	11.00	6.25	3.02	1.00	0.30
		Winter	8.42	24.75	212.50	15.75	7.10	3.52	0.92	0.35
5.	Raj ghat	Summer	8.42	29.75	334.25	15.25	4.55	10.30	1.17	1.32
		Rainy	7.60	30.25	222.25	15.25	4.95	8.92	1.72	0.85
		Winter	8.44	23.75	314.25	17.00	5.47	10.57	1.00	0.80

phosphate. Temperature is high in the month of June and minimum in January. However, the value of alkalinity varied as compared to other physico-chemical parameters. Acidity value was maximum at Rajghat. The dissolved oxygen concentration was found to be minimum in the month of June at Rajghat.

Low dissolved oxygen content as noticed in summer may be due to high atmospheric temperature and low flow rate (Imevbore, 1970; Tiwari, 1983) and decreased volume of water, while the disposal of waste water and sewage remains virtually the same. However, the lower value of D.O. at Rajghat and Assighat may be due to discharge of huge quantity of domestic sewage at these sampling stations. These stations receive the main city sewage.

The high B.O.D. values at Raj ghat and Assi ghat may also be due to discharge of domestic sewage at these point. The low value of D.O., B.O.D., alkalinity, phosphate and nitrate in rainy season could possibly be due to the large volume and high flow rate (Imevbore, 1970; Tiwari, 1983). Due to large input of these substances, there could develop an anaerobic atmosphere, thus leading to decreased oxygen contents at these sampling stations. The temperature was found to be maximum in the month of June and minimum in January with a few exceptions. A minor fluctuation (7.50 – 8.60) in the pH of Ganga water has also been noticed. Low pH value as recorded in rainy season may be due to high flow rate and large valume of water, which are expected to bring changes in the levels of carbon dioxide and corbonate and hence a fall in the pH values.

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