

## Assessment of Physico-Chemical Parameters of River Ganga and Its Tributaries in Uttarakhand



### Microbiology

**KEYWORDS :** Temperature, pH, Dissolved Oxygen, Biological Oxygen Demand

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### ABSTRACT

Water quality assessment conducted in the tributaries of Ganga River in the year 2012 and 2013 identified human activities as the main sources of pollution. For the study three tributaries of river Ganga in Uttarakhand were chosen i.e. Alaknanda (A), Bhagirathi (B) and Ganga (G). Water samples were collected from five sampling stations on river Alaknanda viz. Devprayag (A1), Rudraprayag (A2), Karnaprayag (A3), Chamoli (A4) and Vishnuprayag (A5), only one sampling station on Bhagirathi near residential area at Devprayag (B), two sampling station on river Ganga viz. Har ki pauri (G1) and Rishikesh (G2). The samples were analysed for physical and chemical parameters using standard methods. The sample temperatures ranged from 7.7 – 18.3 °C. Summer maxima and winter minima were observed at all the sites of sampling stations (A, B and G). pH ranged from 7.4 - 8.2, DO ranged from 7 – 8.61 mg/l and BOD ranged from 0.2 – 1.9 mg/l. All samples showed permissible limit except samples from Harki pauri and Rishikesh on river Ganga.

### INTRODUCTION

Rivers have been used by man since the dawn of civilization as a source of water, for food, for transport, as a defensive barrier, as a source of power to drive machinery, and as a means of disposing of waste. Rivers water finds multiple uses in every sector of development like agricultural, industry, transportation, aquaculture, public water supply etc. The growing problem of degradation of our river ecosystem has necessitated the monitoring of water quality of various rivers all over the country to evaluate their production capacity, utility potential and to plan restorative measures (Datar and Vashistha, 1992; Das and Sinha, 1993). Many rivers in India, including the river Ganga, are polluted by indiscriminate discharge of wastewater. Domestic effluents mostly carry organic wastes, which are biodegradable and require oxygen. High levels of sewage consume most of the dissolved oxygen leaving little for other aquatic organisms. At extremely low oxygen levels, fishes begin to die off. The disease causing agents, organic plant derivative, industrial waste, chemicals and radioactive substances are the usual river pollutants. The river Ganga might have all these pollutants. But the unique pollutants of the river Ganga are religious and fertility mater including dead bodies of ghats.

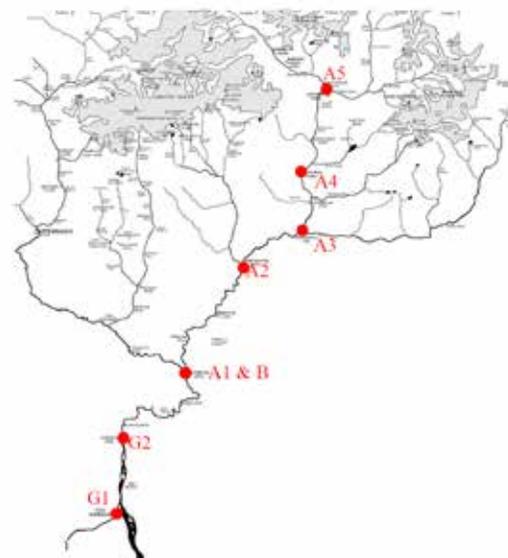
The assessment of water quality lies on carefully examining the delicate interface between Physics, Chemistry and Biology. The most common physical assessment of water quality is the measurement of temperature. Temperature impacts both the chemical and biological characteristics of surface water. Another important aspect to check quality of water is pH. The pH is measure of the intensity of acidity or alkalinity and the concentration of hydrogen ion in water. The pH has no direct adverse effects on health, however, higher values of pH reduce germicidal potential of chloride. High pH induces the formation of trihalomethanes which are toxic (Kumar and Chandel, 2010). According to FWPCA report published in 1968 regarding water quality criteria, the pH affects the dissolved oxygen level in the water, photosynthesis of aquatic plants, metabolic rates of aquatic organisms and the sensitivity of these organisms to pollution, parasites and disease. Most rivers have a neutral to slightly basic pH of 6.5 to 8.5. If stream water has a pH less than 5.5, it may be too acidic for fish to survive in, while stream water with a pH greater than 8.6 may be too basic. A change in stream water pH can also affect aquatic life indirectly by altering other aspects of water chemistry e.g. low pH levels can increase the solubility of certain heavy metals. This allows the metals to be more easily absorbed by aquatic organisms (Schlesinger, 1991).

Since all natural waterways contain bacteria and nutrients, almost any waste compounds introduced into such waterways will

initiate biochemical reactions. These biochemical reactions are measured as BOD and COD in laboratory (Tchobanoglous et al., 2003). Both the BOD and COD tests are a measure of the relative oxygen-depletion effect of a waste contaminant. Both have been widely adopted as a measure of pollution effect. The BOD test measures the oxygen demand of biodegradable pollutants whereas the COD test measures the oxygen demand of oxidizable pollutants. It is expressed in milligrams per litre (mg/l), which indicates the mass of oxygen consumed per litre of solution (Clair and Sawyer, 2003)

### STUDY AREA

For the present study three rivers of Uttarakhand was chosen for the study of physicochemical analysis of the water samples taken in different seasons such as summer, post monsoon and winter from different spots. The three rivers for study were Alaknanda (A), Bhagirathi (B) and Ganges (G). Five spots for water sampling were chosen on River Alaknanda namely Devprayag, Rudraprayag, Karnaprayag, Chamoli, and Vishnuprayag and were tagged as A1, A2, A3, A4 and A5 respectively. Only one sampling station was chosen to collect the water sample from River Bhagirathi near the residential area at Devprayag and coded as sample B. Two sampling spots namely Harki Pauri and Rishikesh were chosen as sampling spots on the River Ganga and coded as G1 and G2 respectively as shown in the figure:1.

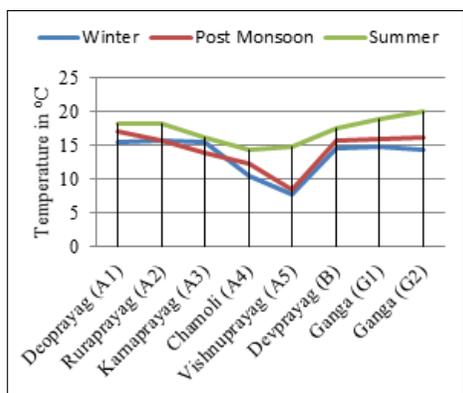


**Figure1 River Map of Uttarakhand showing sampling points**

**Table 1** Table showing the recorded temperature (in °C) of water samples of different sampling stations on Alaknanda River in different seasons (2012-2013)

Name of Sampling Station	Season			Mean
	Winter	Post-monsoon	Summer	
Devprayag (A1)	15.4	17.2	18.3	16.9
Rudraprayag (A2)	15.7	15.8	18.3	16.6
Karnaprayag (A3)	15.6	13.8	16.2	15.2
Chamoli (A4)	10.4	12.3	14.3	12.3
Vishnuprayag (A5)	7.7	8.4	14.8	10.3
Devprayag (B)	14.6	15.7	17.6	15.9
Ganga (G1)	14.9	15.9	18.9	16.6
Ganga (G2)	14.3	16.2	20.1	16.7

**Figure 2** Comparative study of the recorded temperature of the water samples from different sampling spots on the Alaknanda River during the season of winter, post monsoon and summer (2012-2013)

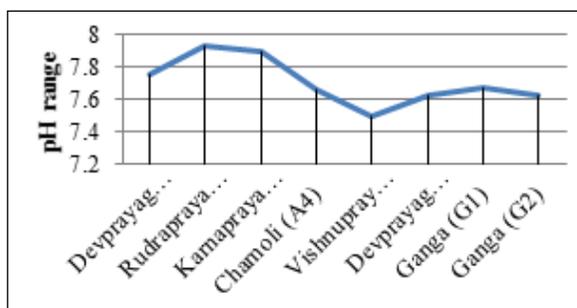


pH of water was analysed in order to observe the condition of water of River Alaknanda, Bhagirathi and Ganges. It was observed that the pH of drinking water was in the range 6.5-8.5 as fixed by World Health Organization (WHO) standard (WSC 2004). The pH of the tributaries are found tabulated in the table 2 and The mean of pH on the sampling spots is graphically represented in the Figure 3.

**Table 2** pH of water at different sampling spots on the river Alaknanda in different season during study period 2012-2013

Name of Sampling Station	Season			Mean
	Winter	Post-monsoon	Summer	
Devprayag (A1)	8.0	7.6	7.7	7.76
Rudraprayag (A2)	8.2	7.7	7.9	7.93
Karnaprayag (A3)	8.1	7.9	7.7	7.90
Chamoli (A4)	8.1	7.6	7.6	7.66
Vishnuprayag (A5)	7.9	7.6	7.4	7.63
Devprayag (B)	7.9	7.5	7.6	7.67
Ganga (G1)	7.8	7.5	7.6	7.63
Ganga (G2)	7.3	7.4	7.8	7.5

**Figure 3** Mean of pH variation of water samples from different sampling stations during study period 2012-2013

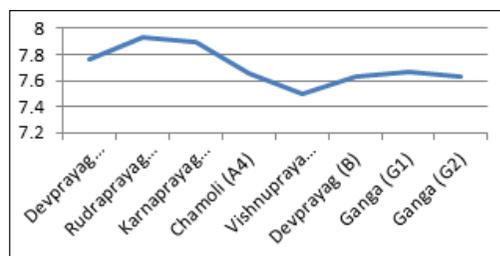


Dissolved oxygen of the water samples from different sampling spots were measured in different seasons during 2012-13 and tabulated in the table 3. The mean of DO on the sampling spots is graphically represented in the Figure 4.

**Table 3** Seasonal variation of Dissolved Oxygen (mg/l) measured from water samples from different sampling station in the year 2012-13

Name of Sampling Station	Season			Mean
	Winter	Post-monsoon	Summer	
Devprayag (A1)	7.92	7.55	7.32	7.60
Rudraprayag (A2)	7.80	7.39	7.79	7.66
Karnaprayag (A3)	7.94	7.55	7.48	7.67
Chamoli (A4)	8.28	7.80	7.10	7.73
Vishnuprayag (A5)	8.61	8.11	7.70	8.14
Devprayag (B)	7.97	8.04	7.32	7.77
Ganga (G1)	7.9	7.5	7.2	7.53
Ganga (G2)	7.5	8	7.3	7.60

**Figure 4** Mean of DO variation of water samples from different sampling stations during study period 2012-2013

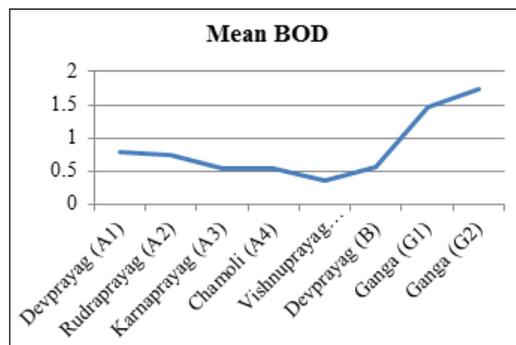


Biological Oxygen Demand of the water samples from different sampling spots were measured in different seasons during 2012-13 and tabulated in the table 4. The mean of BOD on the sampling spots is graphically represented in the Figure 5.

**Table 4** Seasonal variation of BOD (mg/l) measured from water samples from different sampling station in the year 2012-13

Name of Sampling Station	Season			Mean
	Winter	Post-monsoon	Summer	
Devprayag (A1)	0.90	0.70	0.76	0.79
Rudraprayag (A2)	0.70	0.76	0.80	0.75
Karnaprayag (A3)	0.52	0.48	0.65	0.55
Chamoli (A4)	0.44	0.36	0.80	0.53
Vishnuprayag (A5)	0.34	0.36	0.40	0.36
Devprayag (B)	0.86	0.65	0.20	0.57
Ganga (G1)	1.8	1.6	1.0	1.47
Ganga (G2)	1.7	1.6	1.9	1.73

**Figure 5** Mean of BOD variation of water samples from different sampling stations during study period 2012-2013



## CONCLUSION

During the investigation, the maximum temperature was found at sampling station Deoprayag i.e 18.3°C and minimum temperature was found at sampling station Vishnuprayag i.e. 7.7°C. The pH value of water samples at different selected sites were within the acceptable range of 7.4-8.2 at all the sampling station on the Alaknanda river and 7.2 – 7.9 for sampling station on Ganga river. The pH lied between 7.5-7.9 for Bhagirathi river at Devprayag. Dissolved Oxygen varies from 7-8.61 mg/l. In observation maximum dissolved oxygen was recorded 8.61 mg/l at Vishnuprayag on the River Alaknanda during winter season. The minimum value of dissolved oxygen 7.10 mg/l was observed in summer season at Chamoli. The value of dissolved oxygen ranged between 7.32 mg/l to 8.04 mg/l in the water samples from the river Bhagirathi whereas the value of DO was observed ranged between 7.0 mg/l to 8.0 at both the sampling station on the river Ganges. The range of Biochemical Oxygen Demand (BOD) was observed between 0.34 mg/l to 0.90 mg/l for the water sample at all the sampling stations on the river Alaknanda. The value of BOD ranged between 0.20 mg/l to 0.86 mg/l for the river Bhagirathi. The minimum BOD of water sample from River Ganges was recorded i.e. 1.0 mg/l in winter season at Rsishikesh and Maximum at Haridwar i.e.1.9 in summer. Highest annual average value of biochemical oxygen demand at Haridwar may be due to drainage of several sewage drains into the river. A negative relationship has been observed between BOD and DO contents.

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