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Physico-chemical and microbiological status of River Asan in Dehradun Uttarakhand

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Abstract

India is rich in water resources, being endowed with a network of rivers and blessed with snow cover in the Himalayan range that can meet a variety of water requirements of the country. However, with the rapid increase in the population of the country and the need to meet the increasing demands of irrigation, human and industrial consumption, the available water resources in many parts of the country are getting depleted and the water quality has deteriorated. In the present study physico-chemical and microbiological characteristics of the water of River Asan in Doon valley of Uttarakhand India were determined seasonally during April 2011 to March 2012.Turbidity, TS, TDS and TSS values were maximum on all the sites in rainy season which may be due to the gradual disturbances in sedimentation of solids as well as dust particlesdeposited along with runoff rainwater. High temperature, Total alkalinity, Total hardness, Calcium, Magnesium, BOD and low velocity and DO showed high load of pollution in river Asan. The microbiological studies include Total Colliform/ml (462±113.13),Faecal Colliform/ml (294.5±47.37) and SPC/ml (16×10^2) gives a clear indication of poor water quality. The results of bacterial parameters studies exceed the drinking water permissible limits suggested by WHO, ICMR and ISI.

Keywords: *Coliform, Himalayan, ICMR, microbiological, WHO*

Introduction

India is facing a serious problem of natural resource scarcity, especially that of water in view of population growth and economic development. Water is a prime natural resource, a basic human need and a precious national asset and hence its use needs appropriate planning, development and management (Khanna*et al*., 2010). However, studies related to ecology and environment are often perceived as ‘anti-development and detrimental to the overall growth and welfare of human beings and are viewed with suspicion and generally considered as nuisance. The trophic status of a water body depends on the locality and its topography. Of all renewable resources of planet, water has the unique place. It is essential for sustaining all forms of life, food production, and economic development and for general well being (Mane*et al*., 2005). Due to tremendous development of industry and agriculture, the water ecosystem has become perceptibly altered in several respects in recent years and as such they are exposed to all local disturbances regardless of where they occur (Khanna and Chugh, 2004). Availability of clean and potable water has become a key issue in several developing countries. Burgeoning population and water scarcity is affecting the quality of life significantly; India is no exception to this. Providing water in adequate quantity and quality for domestic water supply, irrigation and industrial requirements in all parts of the country is a tremendous challenge from several angles economic, technical management and social(Vaidya*et al*., 2001). Water supports life on earth and around which the entire fabric of life is woven.The requirement of water in all lives, from micro-organism to man, is a serious problem today because all water resources have been reached to a point of crisis due to unplanned urbanization and industrialization (Khanna*et al*.,2007). Generally speaking, water pollution is a state of deviation from pure condition, whereby its normal functioning and properties are affected (Okpokwasili and Akujobi, 1996). Aggravated environmental problems often reflect the misuse or

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misunderstanding of technology. A number of limnologists have done work on physico-chemical and microbiological aspects of riverine ecosystem in India and abroad (Khanna*et al.* 2000, 2006; Sinha*et al.*, 2000; Merritts*et al.* 1998; Pipes, 1981; Scott *et al.*, 2000; Pathak and Gopal, 2001).The aim of present study was to analyze the Physico-chemical and microbiological study of River Asan in Dehradun Uttarakhand.

Study area

Dehradun or Doon Valley is the capital city of the State of Uttarakhand in North India. It is surrounded by the Himalayas in the north, Shivalik Hills in the south, the River Ganges in the east and the River Yamuna in the west. It is located between 29 ° 58 'and 31 ° 2' 30 "north latitude and 77 ° 34 '45" and 78 ° 18' 30 "east longitude. Originating from the hills of Mussoorie range the river Asanis an important tributary of River Yamuna flowing northwest of Doon valley.

Material and Methods

The present study was conducted on River Asan covering a stretch of approximately 10 km from (S7) at Chanderbani to (S8) at Asarori. The study was carried out for a time period of one year from April 2011-March 2012 on monthly basis. Seasonal relation was later found to know the effect of different environmental conditions on river water. Water samples were collected every month early in the morning in sterilized sampling bottles and were analysed for important physical and chemical and microbiological parameters. Few physico-chemical parameters like Temperature (^{0}C), Transparency (cm), Velocity (m/s), pH, Free CO_2 (mg/l), and Dissolved Oxygen (mg/l) were performed on spot and other parameters like Turbidity (JTU), Electric conductivity (µmho/cm), Total Solids (mg/l), TDS (mg/l), TSS (mg/l), Total Alkalinity (mg/l), Total Hardness (mg/l), Calcium (mg/l), Magnesium (mg/l), Chloride (mg/l), BOD (mg/l), COD (mg/l), Phosphate (mg/l), Nitrate (mg/l), Sodium (mg/l) and Potassium (mg/l) were analysed in laboratory by following the methodology of APHA (1998); Khanna and Bhutiani, (2004); Trivedi, and Goel (1986); Wetzel and Likens (1991). Temperature, Transparency, Velocity was measured by using Celsius thermometer (0–110 ^{0}C), Secchi disc, and flow meter. Turbidity, Conductivity and pH were measured by using Jackson Turbidity unit, Conductivity meter and digital pH meter. Total Solids TDS, TSS were measured by volumetric analysis. Total Alkalinity, Total Hardness, Calcium, Magnesium, Chloride, Free $CO_{2,}$ DO BOD and COD were analysed by titration method. Phosphate and Nitrate were analysed by using UV-VIS Spectrophotometer and Sodium and Potassium by Fame photometer. The water quality was determined by the standard most probable number (MPN) method. Coliforms were detected by inoculation of samples into tubes of MacConkey broth and incubation at 37.0 ± 1 ^{0}C for 48 h. The positive tubes were subcultured into brilliant green bile broth (BGBB) and were incubated at 44.5 ± 1 ^{0}C. Gas production in BGBB at 44.5 ± 1^{0}C were used for the detection of faecal coliform after 48-h incubation and SPC for assessing bacterial load was made by pour plate technique using Nutrient Agar media and colonies were counted by colony counter following the standard methodology of APHA 1998.

Results and Discussion

The physico-chemical analysis carried out from the different site during different seasons has been presented in table 1 and Figs.1 to 6. Temperature is the most important factor, which influences chemical, physical and biological characteristics of water bodies. The present study revealed that temperature varied from (17.25±0.95) to (21.25±0.95) however maximum temperature was found maximum in summer and minimum in winter. Similar pattern were observed for Electric Conductivity. The pH values did not show remarkable differences between sampling sites and seasons ranged from (7.35±0.12) to (7.60±0.21). Turbidity, TS, TDS and TSS were found highest in monsoon period and minimum in winter. Alkalinity of water is a measure of weak acid present in it and of the cations balanced against them. In the present investigation also, total alkalinity level reduced in the post-rainy months. Higher level of alkalinity during summer months as observed in the in summer season has also been reported by Singh and Saha (1987); Khanna, *et al.* (2011). The water hardness was higher in monsoon but it was highest during summer season which might have caused increased concentration of salts by excessive evaporation as also observed by Bhatt *et al*. (1999). The hardness of river increases in the polluted waters by the deposition of calcium and magnesium salts. Khanna*et al*. (2001) found a more or similar

Table 1 showing average seasonal variation in physico-chemical parameters of River Asan for the year April 2011-March 2012

Parameter	Summer		Monsoon		Winter	
	S7	S8	S7	S8	S7	S8
Temp. (^{o} C)	21.25±0.95	20.75±1.25	20.5±1.29	20.5±1.29	17.25±0.95	17.75±0.95
Transp.(cm)	11.22±2.02	8.75±3.54	9.77±1.60	8.85±2.84	14.52±0.75	14.77±0.42
Velocity (m/s)	0.75±0.37	0.44±0.07	1.44±0.07	0.71±0.05	0.68±0.19	0.54±0.06
Turbidity (JTU)	172.5±152.7	57.5±28.43	401.25±300.84	238.75±223.62	37.5±2.88	37.5±2.88
Cond.(μmhocm^{-1})	0.536±0.007	0.588±0.04	0.567±0.01	0.477±0.009	0.506±0.02	0.484±0.02
T.S (mg/l)	725±95.74	750±129.09	900±258.19	1150±251.66	375±95.74	525±125.8 3
TDS (mg/l)	425±125.83	375±50.0	450±129.09	575±50.0	250±57.73	300±163.2 9
TSS mg/l	300±141.42	375±95.74	450±238.04	575±262.99	125±50.0	225±50.0
pH	7.45±0.12	7.42±0.09	7.60±0.21	7.52±0.09	7.35±0.12	7.4±0.21
Total alkalinity (mg/l)	297±36.06	306.25±43.13	232.75±9.10	255.25±20.07	230.7512.25	239.5±9.25
Total Hardness (mg/l)	188.5±20.07	164.25±8.69	207.0±14.35	148.0±4.69	181.5±5.19	157.75±4.1 1
Calcium (mg/l)	59.63±6.13	50.81±8.17	69.97±5.03	49.99±6.76	55.75±2.22	59.36±5.07
Magnesium (mg/l)	31.43±3.87	26.67±3.00	33.42±2.68	23.90±2.17	30.67±0.84	24.00±1.52
Chloride (mg/l)	49.32±3.73	56.30±9.01	41.12±2.38	47.55±4.45	45.93±1.89	38.75±2.79
Free CO_2 (mg/l)	2.33±0.08	3.47±0.15	2.50±0.18	2.50±0.15	2.42±0.08	2.64±0.28
D.O (mg/l)	7.71±0.63	7.74±0.52	8.24±0.61	8.22±0.24	9.40±0.45	8.92±0.57
B.O.D (mg/l)	4.44±0.38	4.22±0.27	4.09±0.64	3.43±0.20	3.70±0.52	3.62±0.53
C.O.D (mg/l)	9.29±0.68	6.74±0.54	8.18±0.52	6.96±0.53	7.21±0.33	6.86±0.52
Phosphates (mg/l)	1.82±0.10	1.51±0.21	1.11±0.19	0.95±0.25	1.42±0.07	1.53±0.10
Nitrates (mg/l)	1.27±0.06	1.40±0.14	0.64±0.08	1.34±0.03	0.60±0.06	1.42±0.08
Sodium (mg/l)	0.64±0.13	0.56±0.08	0.78±0.09	0.58±0.11	0.55±0.05	0.57±0.09
Potassium (mg/l)	0.58±0.18	0.49±0.12	0.56±0.06	0.45±0.06	0.51±0.12	0.52±0.05

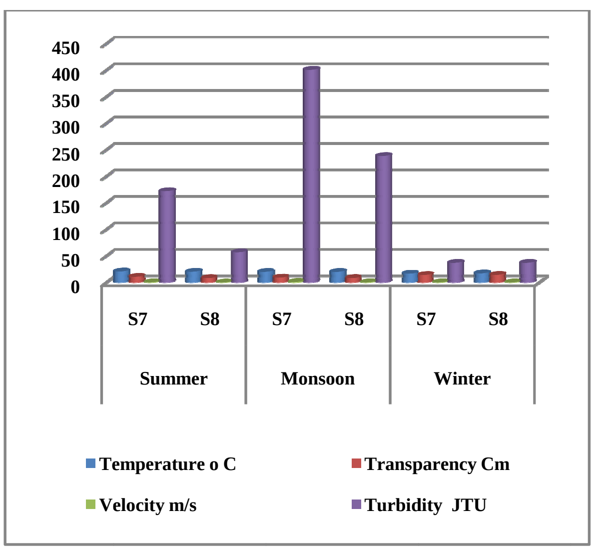

Fig1 Showing average seasonal variation in Temp., Transparency, velocity and turbidity in River Asan

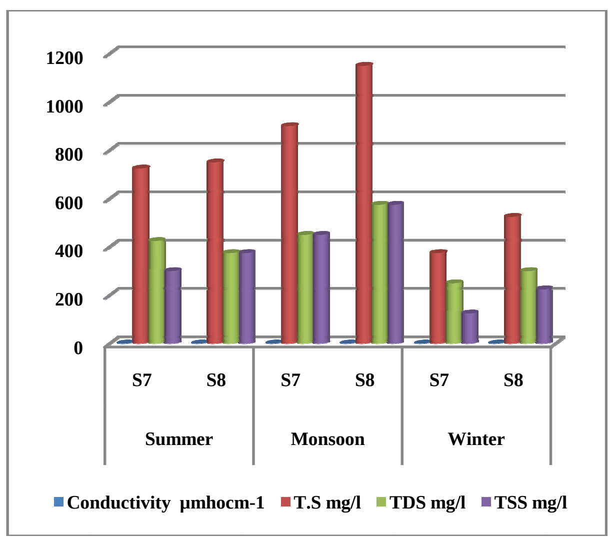

Fig2 Showing average seasonal variation in Conductivity, TS, TDS and TSS in River Asan

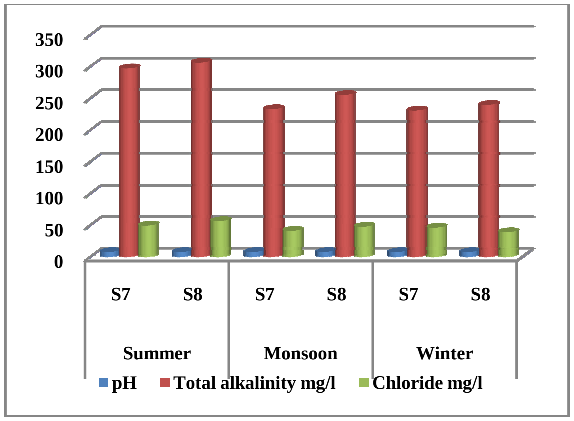

Fig3 :Showing average seasonal variation in pH, Total alkalinity and Chloridein River Asan

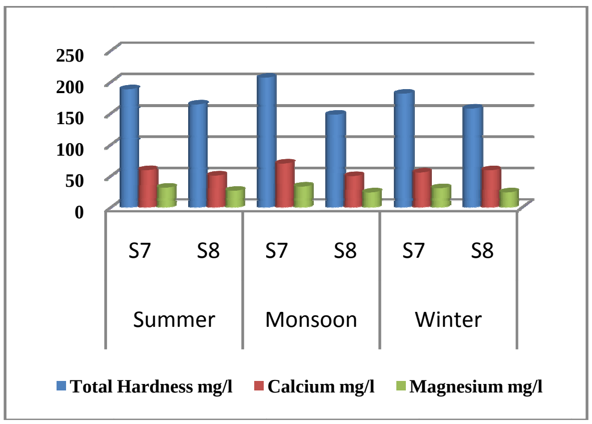

Fig4: Showing average seasonal variation in Total hardness, Calcium and Magnesium in River Asan

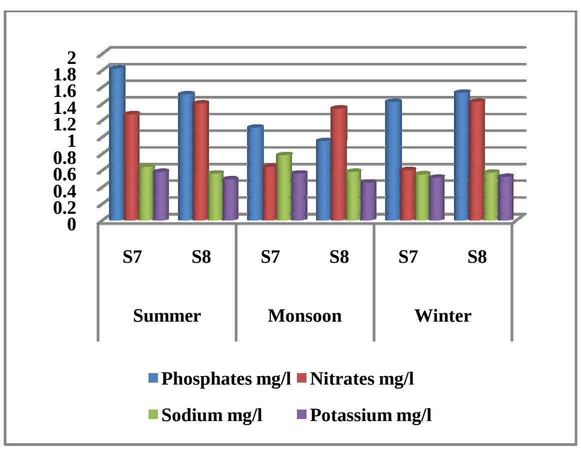

Fig5: Showing average seasonal variation in Phosphate, Nitrate, Potassium and Sodiumin River Asan

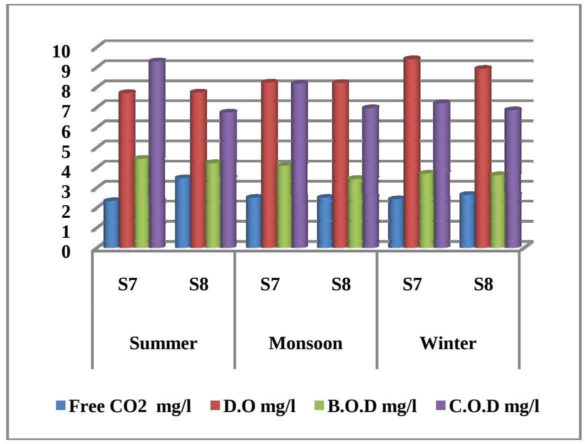

Fig6 Showing average seasonal variation in DO, Free CO2, BOD and COD in River Asan

trend in river Ganga at Haridwar. Chloride is one of the important indicators of pollution. Chlorides are present in sewage, effluents and farm drainage. The value of chloride concentration in the present study was highest in summer at S8 (56.30±9.01) and lowest in winter (38.75±2.79) at S8. The value of DO is remarkable in determine the water quality criteria of an aquatic system. In the system where the rates of respiration and organic decomposition are high, the DO values usually remain lower than those of the system, where the rate of photosynthesis is high. The mean value of the dissolved oxygen ranged between (7.71±0.63) to (9.40±0.45). Lowest DO means maximum pollution due to effluent and human activities. BOD or biochemical oxygen demand represents the amount of oxygen that microbes need to stabilize biologically oxidizable matter (Khanna, *et al.* 2007). BOD range varies from (3.43±0.20) to (4.44±0.38) (Table 1) in river samples. Desirable limit for BOD is 4.0 mg/l and permissible limit is 6.0 mg/l according to Indian standards. BOD demand below 3 mg/l or less is required for the best use. The chemical oxygen demand (COD) ranged from (6.74±0.54) to (9.29±0.68) (Table 1). The test is commonly used to indirectly measure the amount of organic compounds in water. Most applications of COD determine the amount of organic pollutants found in surface water, making COD a useful measure of water quality. It is expressed in milligrams per liter (mg/l), which indicates the mass of oxygen consumed per liter of solution (Clair 2003). Phosphates come from human and animal wastes, phosphate-rich rocks, wastes from laundries, cleaning and industrial processes, and farm fertilizers (Khanna, *et al.* 2009). In present study phosphate was highest in all the seasons and showed a slight variation from summer to winter. Plotting the monthly values of nitrate concentration verses time, maxima during the summer are obtained (Sinha and Banerjee, 1995). The highest concentration was probably partially a result of washing out nitrate from laundries and fertilizers. Sodium and potassium does not show a great variation in all the seasons, however sodium was found highest in monsoon and potassium in summer.The luxurious growth of bacterial population during summer and monsoon months is the outcome of the influx of washed organic matter in the river from the surrounding residential areas as given in table 2. It is natural that the incoming nutrient load finds its way first to the surface, thereby encouraging bacterial proliferation during monsoon. Collins (1963) has suggested that the rains bring in particulate matter, which serves as sites of adsorption for bacteria, thereby increasing the bacterial load. In the present study, the maximum number of coliforms and bacteria were maximum in summer followed by monsoon. The minimum number was recorded in winter. The Total plate count ranged between (12×10^2 to 19.5×10^2) colonies on the study sites. The higher values were recorded on sites during summer season. The above observation indicates that the bacterial contamination increases from winter to summer. This may be due to increased anthropogenic and socio-cultural activities at different sites. Rapid development of town ships and industries in the surrounding vicinity of the lower stretch may also have added strains in the water and to an extent resulted in the degradation of its quality. McLellan*et al*. (2001); Pathak*et al.* (1991)stated that faecal pollution indicator organisms can be used to a number of conditions related to the health of aquatic ecosystems and to the potential for health effects among individuals using aquatic environments. Khanna and Chugh (2004) revealed that the presence of such indicator organisms may provide indication of water-borne problems and is a direct threat to human and animal health. Our studies on microbial ecology in the river in relation to pollution have clearly revealed that there is significant presence of bacterial indicators of faecal pollution in river Asan, the situation of river Asan is very serious and alarming. Presence of bacterial indicators of faecal contamination in different site of runoff of river clearly revealed the bacteriological status of the water at that site. For this reason, monitoring of microbial contamination should be an essential component of the protection strategy of river Asan.

Table 2: Spatial seasonal variation in Total Coliform (MPN/100ml), Faecal Coliform (MPN/100ml) and Standard Plate Count (SPC/ml) in River Asan at S7and S8 during April 2011-March 2012

Parameters	**Total Coliform/ml**			**Faecal Coliform/ml**			**SPC/ml**		
	Summer	**Winter**	**Monsoon**	**Summer**	**Monsoon**	**Winter**	**Summer**	**Monsoon**	**Winter**
S7	421	382	327	354	261	236	18×10^2	15×10^2	11×10^2
S8	617	542	447	463	328	295	21×10^2	17×10^2	13×10^2
Avg.± S.D	**519 ±138.59**	**462 ±113.13**	**387 ±84.85**	**408.5 ±77.07**	**294.5 ±47.37**	**265.5 ±41.71**	$\mathbf{19.5\times10^2}$	$\mathbf{16\times10^2}$	$\mathbf{12\times10^2}$

Conclusion

The study infers that the bacterial water quality assessment depends totally on hydrological conditions along with the natural or man-made activities influencing the water body at the time of sampling and provides an integrated effect of pollution prevalent in the water body. Present study also revealed the high level of bacterial population indicates pollution state of river Asan. The concentration of different physico chemical and bacterial parameters is much beyond the permissible limit prescribed by WHO. Hence, direct consumption water and bathing in the river is at high risk for human health. The present investigations conclude that thequality of water samples subjected to study was acceptable from physico-chemical parameters,whilecolliform pollution wasfound in all samples. The present study revealed that the river Asan in Dehradun was most polluted and the data generated on physico-chemical and microbiological water quality parameters provided a clue for the requirement of urgent management strategies for its conservation.

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