Evaluation Of Garhwal Springs Water For Drinking Purpose By Using Water Quality Index

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Abstract: A very few studies have been carried out on natural springs of Garhwal Himalayas which is the main source of potable water in Garhwal Himalayas. This paper based on water quality status of these springs, for this purpose parameters like alkalinity, acidity, DO, BOD, free CO_2, nitrate, chlorides, hardness, pH and coliform number were studied. The study elucidates that the water quality of selected natural water springs is suitable for drinking purpose.
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Introduction:

According to Times of India that one of every 10 diseases and 6% of all deaths globally are caused by unsafe water and improper water and improper hygiene. In India 1.03 crore people die annually of which, nearly 7.5%-7.8 lakh deaths are related to water, sanitation, and hygiene. In India 15% of disease burden could be prevented by improving water sanitation and hygiene. The fraction of total deaths attributed to unsafe water, inadequate sanitation or insufficient hygiene is more than 20 % in children up to 14 years of age in developing countries. According to UNICEF and WHO report that 1.1 billion peoples do not access to clean water and 2.7 billion people do not have access to basic sanitation (Cohn et al., 1999; Stewart et al., 1988). Continuous assessment of physical, chemical and biological parameters of water is an essential part of current water quality control programmes (Chauhan et al., 2010).

Water quality index (WQI) is well-known method as well as one of the most effective tools to expressing water quality that offers a simple, stable, reproducible unit of measure and communicate information of water quality to the concerned citizens and policy makers. It, thus, becomes an important parameter for the assessment and management of surface water (Chauhan and Singh, 2010).

Springs

Natural springs are major source of potable water in most of villages in Garhwal Himalaya. In natural springs water directly emerges from earth. In hills middle and upper dense vegetation of broad leaved trees viz. *Quercus leucotrichophora* (Banj Oak), *Q. floribunda* (Moru Oak), Rhododendron arboretum etc., absorbs rain water during monsoon. This water is slowly released over the year by these broad leaved plants. Released water percolates in land and forms numerous channels which flows over the year and called as natural springs. The main objective of this research is to obtain a water quality status of springs which is main sources of potable water in Garhwal Himalaya.

Material and Methods

The physico-chemical and biological parameters of the water and sediments were recorded monthly at different stations followed APHA (1998). Total five sites were selected for the study as followings:

Site-1, River Alaknanda

Water samples were collected from the left bank of river near Srikot town just below the Indane LPG store which is at about 450 m upstream from pedestrian bridge which connects Srinagar to Chauras.

Site-2, Kothar Dhara

This sprig lies in Srinagar .Water emerges after passing through dense vegetation at sampling site.

Site-3, Sweeth Bridge

This spring lies adjacent to Government Medical College. Water emerges directly from earth. Spring is surrounded by cemented pool which remains covered by slabs. Water is directly distributed by pipe line from pool. Collection site 15m distant away from pool.

Site-4, Bhola Mahadev

This spring is situated at Srikot. Spring is surrounded by cemented pool. Sample is directly collected from pool.

Site-5, Barkot Spring

The sampling site lies 3.0 km. away from Chauras campus in north. Water was flowing in cemented channels. Water of this spring largely used for irrigation and drinking purpose at Barkot village and Chauras village.

The present study was undertaken during April to May, 2008 for evaluation of water for drinking purpose by using CCME water quality index 1.0. Note a zero (0) value signifies very poor water quality, whereas a value close to 100 signifies excellent water quality.

Conceptual Framework of CCMEWater Quality Index

The CCME WQI was originally developed as the Canadian Water Quality Index (CWQI). It comprises of three factors and is well documented (CCME, 2001).

Factor 1: *F*1 (Scope)

Scope assesses the extent of water quality guideline non-compliance over the time period of interest, which means the number of parameters whose objective limits are not met. It has been adopted directly from the British Columbia Water Quality Index:

$$F_1 = \left\{ \frac{\text{Number of failed variables}}{\text{Total number of variables}} \right\} \times 100$$

Where, the variables indicate those water quality parameters whose objective values (threshold limits) are specified and observed values at the sampling sites are available for the index calculation.

Factor 2 : F_2 (Frequency)

The frequency (i.e. how many occasions the tested or observed value was off the acceptable limits) with which the objectives are not met, which represents the percentage of individual tests that do not meet the objectives ("failed tests"):

$$F_2 = \left\{ \frac{\text{Number of failed tests}}{\text{Total number of variables}} \right\} \times 100$$

The formulation of this factor is drawn directly from the British Columbia Water Quality Index.

Factor 3 : *F*3 (Amplitude)

The amount by which the objectives are not met (amplitude) that represents the amount by which the failed test values do not meet their objectives, and is calculated in three steps.

The number of times by which an individual concentration is greater than (or less than, when the objective is a minimum) the objective is termed an "excursion" and is expressed as follows. When the test value must not exceed the objective:

$$\text{excursion}i = \left\{ \frac{\textit{Failed Test Value}_i}{\text{Objective } j} \right\} - 1$$

For the cases in which the test value must not fall below the objective:

$$\text{excursion}i = \left\{ \frac{\text{Objective } j}{\text{Failed Test Value}i} \right\} - 1$$

The collective amount, by which the individual tests are out of compliance, is calculated summing the excursions of individual tests from their objectives and then dividing the sum by the total number of tests. This variable, referred to as the normalized sum of excursions (*nse*) is calculated as:

$$\text{nse} = \left\{ \frac{\sum_{i=1}^{n} \text{excursion}i}{\text{number of tests}} \right\}$$

F_3 is then calculated by an asymptotic function that scales the normalized sum of the excursions from objectives (nse) to yield a value between 0 and 100.

$$F_3 = \left\{ \frac{\text{nse}}{0.01\text{nse} + 0.01} \right\}$$

The CWQI is finally calculated as:

$$\text{CWQI} = 100 - \left\{ \frac{\sqrt{F_1^2 + F_2^2 + F_3^2}}{1.732} \right\}$$

The assignment of CCME WQI values to different categories is somewhat subjective process and also demands expert judgment and public's expectations of water quality. The water quality is ranked in the following 5 categories:

1. Excellent: (CCME WQI values 95–100)
2. Good: (CCME WQI values 80–94)
3. Fair: (CCME WQI values 60–79)
4. Marginal: (CCME WQI values 45–59).
5. Poor: (CCME WQI values 0–44)

Results

Table-1 represents results of various physico-chemical and biological parameters for selected natural springs in Garhwal Himalayas.

The alkalinity of water samples was recorded as 58.00±2.32, 190.00±4.43, 170.00±6.34, 180.00±5.59 and 250.00±7.67 mg/L at site 1, 2, 3, 4 and 5, respectively, whereas the permissible limit is 120 mg/L as per BIS. Acidity of spring was determined as 5.00±0.09, 85.00±2.83, 57.00±1.70, 115.00±3.63 and 80.00±2.76 mg/L at site 1, 2, 3, 4 and 5, respectively, whereas the permissible limit is 120 mg/L as per WHO standard. D.O. was recorded as 11.20±1.69, 2.00±0.69, 2.80±0.39, 1.20±0.27 and 6.00±0.43 mg/L at site 1, 2, 3, 4 and 5, respectively. The acceptable limit of D.O. varies from 5.00 mg/L. BOD of water sample was recorded as4.40±2.37, 0.80±0.17, 1.40±0.29, 0.40±0.13 and 1.20±0.26 mg/L at site 1, 2, 3, 4 and 5, respectively. The acceptable limits of BOD are 5.00 mg/L as per ICMR standard, above this limit water is considered to be not fit for drinking purpose. Nitrate of water sample was recorded as 0.80±0.17, 0.50±0.09, 0.30±0.07 and 0.29 mg/L at site 1, 2, 4 and 5, respectively. Chlorides of water samples were recorded as 5.68±0.66, 35.50±2.19, 15.62±1.17, 36.92±1.98 and 12.78±1.12 mg/L at site 1, 2, 3, 4 and 5, respectively. Free CO_2 recorded as 8.80±0.71, 48.40±2.39, 35.20±2.18, 74.80±3.93 and 39.60±2.34 mg/L at site 1, 2, 3, 4 and 5, respectively. Hardness of water samples were recorded as 60.00±2.02, 188.00±3.88, 147.00±8.86, 242.00±12.13 and 254.00±6.96 mg/L at site1, 2, 3, 4 and 5, respectively. pH was recorded as 7.05±0.66, 6.98±0.43, 7.33±0.14, 7.40±0.19 and 7.40±0.29 at site 1, 2, 3, 4 and 5, respectively.

Discussion:

Chauhan et al., (2010) have studied the physico-chemical parameters of River Ganga at Rishikesh, Uttarakhad, India. Okram et al., (2003) also studied the physico-chemical parameters of Waithou Lake in Manipur state of India on monthly basis. It is well know that groundwater is rich in carbonic acid and dissolved oxygen usually possesses a high solubilizing potential towards soil or rocks that contain appreciable amount of mineral calcite, gypsum and dolomite and consequently hardness level may increased. That's why the values of conductivity, TDS and DO were observed beyond the limit of drinking purpose (Singh et al., 2007). BOD is an indicator of organic pollution. Unpolluted natural waters have a BOD of 5 mg/L or less (Schulze et al. 2001). The world average for nitrate in unpolluted freshwaters as reported by Reid (1961) is 0.30 mg/l.

Table: 1, Showing physico-chemical and biological properties of selected water parameters.

Sampling sites / **Parameters**	**River Alknanda** (Site-1)	**Kothar-dhara** (Site-2)	**Sweeth Bridge** (Site-3)	**Bhola Mahadev** (Site-4)	**Barkot** (Site-4)	**Permissible limit (BIS/ICMR/ WHO)**
Alkalinity (mg/L)	58.00 ±2.32	190.00 ±4.43	170.00 ±6.34	180.00 ±5.59	250.00 ±7.67	120 mg/L
Acidity (mg/L)	5.00 ±0.09	85.00 ±2.83	57.00 ±1.70	115.00 ±3.63	80.00 ±2.76	120 mg/L (WHO)
D.O. (mg/L)	11.20 ±1.69	2.00 ±0.69	2.80 ±0.39	1.20 ±0.27	6.00 ±0.43	5.00 mg/L
B.O.D (mg/L)	4.40 ±2.37	0.80 ±0.17	1.40 ±0.29	0.40 ±0.13	1.20 ±0.26	5.00 mg/L (ICMR)
Nitrate (mg/L)	0.80 ±0.17	0.50 ±0.09	0.30 ±0.07	NT	0.29 ±0.04	45 mg/L
Chlorides (mg/L)	5.68 ±0.66	35.50 ±2.19	15.62 ±1.17	36.92 ±1.98	12.78 ±1.12	250 mg/L
CO_2 (mg/L)	8.80 ±0.71	48.40 ±2.39	35.20 ±2.18	74.80 ±3.93	39.60 ±2.34	10.00 mg/L
T. Hardness (mg/L)	60.00 ±2.02	188.00 ±3.88	147.00 ±8.86	242.00 ±12.13	254.00 ±6.96	300 mg/L
pH	7.05 ±0.66	6.98 ±0.43	7.33 ±0.14	7.40 ±0.19	7.40 ±0.29	6.5-8.5
Overall CWQI Value-72.18						
CWQI category- Fair (CCME WQI values 60–79)						

Whereas, NT=Not Traceable

Conclusion

From present investigations we concluded that the quality of most of the water samples under study was suitable for drinking purpose but it is strongly recommended that these should be protected from any polluted activity while it is main source of potable water in Garhwal Himalayas and Uttarakhand

Government should take appropriate steps in this regard as soon as possible. Moreover plantation of native trees such as *Quercus leucotrichophora* (Banj Oak), *Q. floribunda* (Moru Oak), *Rhododendron arboretum* etc. should be done with effective manner so that availability can maintain. We also recommend to Uttarakhand Government to take suitable steps to aware people of this reason at school level, college and university levels so that people can realize the importance of these precious springs which meet the thrust of local people in this areas.

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