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Physico Chemical Analysis of River Baldi Sahastradhara (Dehradun)

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Abstract:

The water quality of River Baldi, Sahastradhara Dehradun an important domestic and potable water source of Sahastradhara and the near villages has been assessed. Water samples were collected from the river along different points and analyzed for various physico-chemical quality parameters during summer and winter. Effects of hotels, shops, and municipality sewage, domestic and agricultural runoff on the river water were investigated. The study was conducted between the top point of the river and bus stand of Sahastradhara The study involved determination of physical and chemical parameters of surface water at five different points. The mean values of Water Temperature, Total Suspended Solids (TSS), Total Dissolved Solids (TDS), Total Solids (TS), Turbidity, Dissolved Oxygen (DO), pH, Electric Conductivity (EC), Salinity and Chloride content.

Keywords: *Physico-chemical parameters, Baldi River, pollution, water quality, Sahastradhara.*

1. Introduction

Water is essential for the survival of all forms of life. Though 80% of the earth's surface is covered by water, the fresh water supply has increasingly become a limiting factor because of various reasons. The expansion of industrialization and exploding population are the major once. Acute shortfall of heavy rains, poor watershed management, abundant use of water for household and agricultural and hotel purposes have led to the overexploitation of the surface water sources especially from the river bodies. Many perpetual rivers become short-lived and even dried up. Water quality characteristics of aquatic environments arise from a massive amount of physical, chemical and biological interactions. The water bodies: rivers, lakes and estuaries are continuously subjected to a dynamic state of change with respect to their geological age and geo chemical characteristics. This dynamic balance in the aquatic ecosystem is upset by human activities results in pollution, which in turn manifests dramatically as fish kill, bad taste of drinking water, offensive odors and unchecked growth of aquatic weeds, etc. Quality of water is now a great concern for environmentalists as well as the common publics in all parts of the world. There are numerous sources of pollutants that could deteriorate the quality of water resources

Likewise, in Sahastradhara Dehradun, a famous tourist place where there is no as such environmental protection practice, there are a number of pollutant sources that continuously deteriorate the quality of surface water. Based on obtained information, observation made during site, visit and analytical results, the following hazard centers have been considered as major category of sources of pollutants in the study area. These are Hotel establishment, agricultural activities, municipal wastes, parking stations for buses and small vehicles. The wastes finally enters into the water bodies and detoriate the quality of water.

On the other hand, surface water bodies become the dumping source for industrial effluent and domestic wastes. As a result, the naturally existing dynamic equilibrium among the environmental segments get affected, leading to the state of polluted rivers. According to World Health Organization's (WHO) decision, water for the consumers should be free from pathogenic organisms and toxic substances. In spite of vast water resources in lakes and rivers and good monsoon, Sahastradhara and the nearby villages faces perennial problems of water shortage and droughts and high pollution of fresh water resources.

It is a fact that good water quality produces healthier humans than one with poor water quality. Baldi River is life line of Sahastradhara as a tourist spot and a major source of income for the local people and the people who dpo their business n this Area and its water is used for domestic and agriculture purposes. Therefore, effective maintenance of water quality is required through appropriate measurements. Physico-chemical and micro-biological characteristics may describe the quality of water. Therefore, our previous analysis on water of river Baldi of Sahastradhara. In addition, with increasing number of Hotels and stakeholders of the river, the concern over the quality has also grown up and hence warranted for the present investigation.

In the present study various parameters (Water Temperature, Total Suspended Solids (TSS), Total Dissolved Solids (TDS), Total Solids (TS), Turbidity, Dissolved Oxygen (DO), pH, Electric Conductivity (EC), Salinity and Chloride content) of water samples from twelve five different sites were analyzed.

1.1. Study Area

Sahastradhara meaning “thousand fold spring” is one of the most popular tourist destinations in the Utrakhand state and is located in Dehradun place. It lies on 30.387231 latitude and 78.131606 longitude. The place has an ecstatic beauty of nature where water drips from limestone stalactites, making the water sulphur abundant and thus the place is also called as sulphur springs. It is a warehouse of excellent beauty of caves, waterfalls and steppe farming by local people. Its extreme magnificent essence of nature thrives people from faraway places. It surely rejuvenates the soul and mind. This place is at about 11 km from the city of Dehradun. All the transport facility as buses, taxi, autos or cabs are available to get to the Sahastradhara.

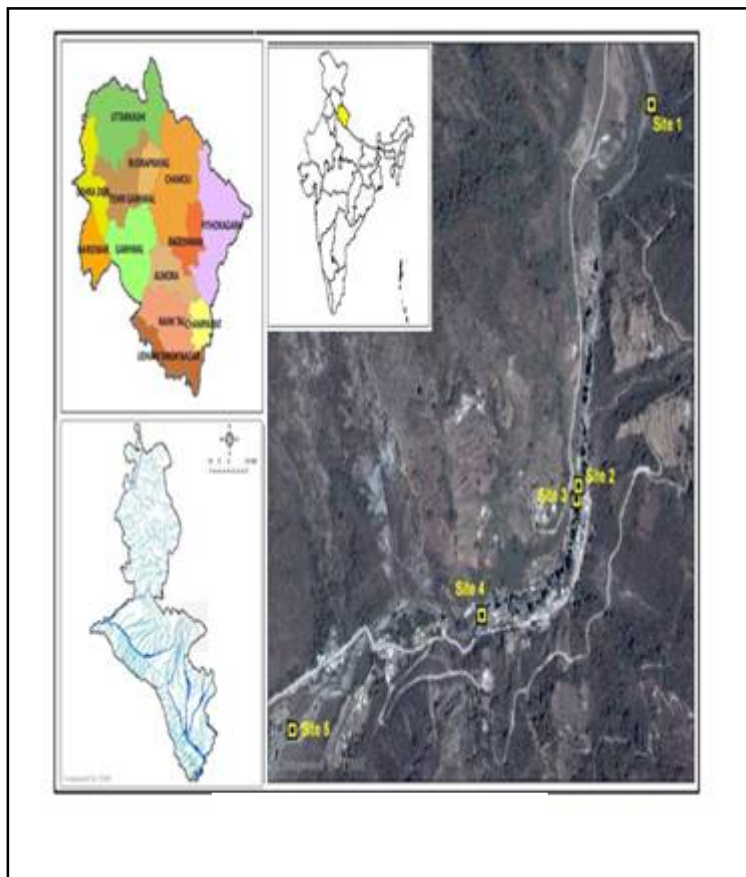


Figure 1: Study area of Sahastradhara Dehradun city

Following tables depicts the selected sites of river Baldi, waterfall and a sulphur spring for water quality monitoring and assessment:

1.2. Sampling Sites

SITES #	Sampling sites	Site code	Distance
1	Up stream of Baldi river near Karligarh	Site-1	0 - m
2	waterfall Baldi river Near Sahastradhara	Site-2	70-80 m
3	Downstream of waterfall near bridge	Site-3	80 – 100 m
4	Sulphur spring at Sahastradhara	Site-4	100–200 m
5	Near Sahastradhara bus stand	Site-5	200-250 m

Table 1

- Site I (upstream): This site is located in the upstream near at Karligarh. In this site, limited or no anthropogenic activities are observed. The river flows in its normal condition through the large rocks and boulders. The turbulence of water is high in November and decreases on words as the summer approaches. The river is narrow in the upstream and the depth of water in about 3 feet. In the summer months, tourist activities and the associated pollution were observed.
- Research site II (Sahastradhara Waterfall): This site is about 70-80 meters from site I. this is the most famous waterfall of about 10 feet high. This site is also covered by green hills on both the sides. It has also some small restaurants and other shops. The site is of the prime attraction due its scenic beauty and bathing activities under waterfall. Hence very much tourist activities and pollution are observed at this site.

- Research site III: This site is on the downstream to the waterfall near the bridge. The water at this site is slow with no turbulence. This site is covered by small restaurants, shops, hotels, and tourist activities are also observed at this site. Pollution level is high at this site as the shop keepers, hotels and restaurants dump their wastes at the site. Litter, plastic bottles, tins, canes, clothes, scraps etc. are found in this site.
- Research site IV (Sulphur Spring): This site is the ground water emerging in the Sahastradhara near Shiva temple. The water in the spring is rich in sulphur content which is evident from the rotten egg smell from the spring. Sulphur water is supposed to be good for skin. This is the reason for tremendous bathing activities in the area. The water being ground water is relatively warmer in winter months and cooler in summer months.
- Site V: This site is about 200-250 meters away from the site IV located near the Sahastradhara bus stand. The turbulence of water is high in November and decreases on words to summer. The site is covered by residential settlement, agricultural land, green hills and slums. Pollution level was observed less in November due to high turbulence of water as the water flow washes off the wastes disposed into the river. As the water flow decreases in the summer months, the disposed materials get accumulated in the area. The slums and the residential dump their wastes in this site. Fecal contamination was also viewed in this area. Aquatic diversity was fairly good. Algal growth was high in the summer months.

2. Materials and Methods

The water samples were collected in pre-cleaned, acid washed, plastic bottles from the river Baldi Sahastradhara Dehradun at Five different points (Fig.1) starting from Karligarh to Sahastradhara bus stand on October 2010 to march 2010 and was later stored in a refrigerator below 4°C until used. Physico-chemical properties such as Total Suspended Solids (TSS), Total Dissolved Solids (TDS), Total Solids (TS), Water Temperature, Turbidity, Dissolved Oxygen (DO), Bio-chemical oxygen demand (BOD), chemical oxygen demand (COD), pH, Electric Conductivity (EC), Salinity and Chloride content were measured using standard methods. The description of sampling sites is provided in Table I.

3. Result and Discussion

Water samples were collected from the five sites of the Baldi River during summer and winter seasons and tested for physical and chemical parameters. The important water quality parameters, such as Color, Odor, Temperature, pH, TSS, TDS, TS, BOD, COD, DO, Turbidity, EC, Salinity and Chloride were analyzed. Assessment of the water samples for pollution is made by comparison of the assessed values of all the physico-chemical parameters with the corresponding standards prescribed for drinking water by WHO.

PARAMETERS/SITES	1	2	3	4	5	Min. value	Max. value	Mean
PHYSICAL Parameters								
Transparency (%)	90	85	65	60	50	50	90	70
smell (odour)	odorless	odorless	muddy smell	Rotten egg	Moderate			
sanitary condition	unhygienic	Hygienic	Hygienic	Hygienic	Hygienic			
Colour	colourless	colourless	Muddy	Blackish	Bluish			
Presence of fish/fish fry	Good	No	very few	No	No			
Total suspended solids	200	180	320	360	280	180	360	268
Air temperature (°C)	30	30	30	30	30	30	30	30.0
Water Temperature (°C)	18	18	18.9	17	19	17	19	18.18
Total dissolved solids TDS (mg/l)	1211	1178	1174	1752	1155	1155	1752	1294
Conductivity (µmho)	1.852	1.805	1.873	2.743	1.82	1.805	2.743	2.0
CHEMICAL Parameters								
Ph	7.37	7.39	7.38	7.4	7.38	7.37	7.4	7.4
Total Hardness (mg/l)	720	700	790	780	740	700	790	746.0
Total Alkalinity (mg/l)	500	480	490	470	490	470	490	483.3
Dissolved oxygen (mg/l)	6.6	6.5	5	0	5	0	5	4.6
Chloride (mg/l)	16	12	17.8	10	12.5	10	17.8	13.4
Nitrate-Nitrogen (mg/l)	2.3	1.21	2.29	1.21	2.12	1.21	2.29	1.8
Phosphate-phosphorus (mg/l)	0.028	0.01	0.012	0.019	0.018	0.012	0.019	0.0
Sodium (mg/l)	7.72	7.21	7	7.01	7.53	7	7.72	7.3
Potassium (mg/l)	5.11	5.19	6	5.9	6.1	5.11	6.1	5.7
calcium (mg/l)	500	510	515	532	590	500	590	529.4
Magnesium	75	70	90	85	80	70	90	80.0

Table 2: Physico Chemical characteristics of River Baldi (October 2010)

Baldi (November 2010)								
PARAMETERS/SITES	1	2	3	4	5	Min. Value	Max. Value	Mean
PHYSICAL Parameters								
Transparency (%)	90	90	85	85	90	85	90	88
smell (odour)	odorless	odorless	Muddy	Rotten egg	odorless			
sanitary condition	Unhygienic	Unhygienic	Unhygienic	Unhygienic	Unhygienic			
Colour	Colourless	Colourless	Colourless	Greenish	Colourless			
Presence of fish/fish fry	High	No	Good	No	Good			
Total suspended solids	80	85	105	200	120			
Air temperature (°C)	25	25.9	25.1	24	27	24	27	25.4
Water Temperature (°C)	18	18.5	18.7	19	18.9	18	19	18.62
Total Dissolved solids	600	630	705	700	650	600	705	657
CHEMICAL Parameters								
pH	7.72	7.33	7.79	7.39	7.69	7.33	7.79	7.58
Total Hardness (mg/l)	600	560	440	480	430	430	600	502
Total Alkalinity (mg/l)	500	490	370	390	400	370	500	430
Dissolved oxygen (mg/l)	6.65	6.6	5.55	0	5	0	6.65	4.76
Chloride (mg/l)	10	12.31	19	13	12.5	10	19	13.362
Nitrate-Nitrogen (mg/l)	1.28	1.49	2.5	2.2	2.6	1.28	2.6	2.014
Phosphate-phosphrous (mg/l)	0.02	0.001	0.005	0.2	0.004	0.001	0.2	0.046
Sodium (mg/l)	3	3	3	4	3	3	4	3.2
Potassium (mg/l)	5.42	5.32	6.21	6	6.29	5.32	6.29	5.848
calcium (mg/l)	320	355	410	405	411	320	411	376
Magnesium	55.22	60	63.21	62.43	47.72	47.72	63.21	57.716

Table 3: Physico Chemical characteristics of River

PARAMETERS/SITES	1	2	3	4	5	Min. value	Max. value	Mean
Physical Parameters								
Transparency (%)	90	90	90	85	90	85	90	88
smell (odour)	odorless	odorless		Rotten egg	odorless			
sanitary condition	No	Hygienic						
Colour	Colourless	Colourless	Colourless	greenish	Colourless			
Presence of fish/fish fry	High	No	Good	NO	Good			
Total Dissolved solids TDS (mg/l)	620	640	740	660	770	620	770	686.0
Air temperature (°C)	20	20.7	20.9	20	21	20	21	20.5
Water Temperature (°C)	18	18.3	18	19	18.8	18	19	18.4
Chemical Parameters								
pH	7.5	7.3	7	7.5	7.7	7	7.7	7.4
Total Hardness (mg/l)	600	630	660	640	700	600	700	647.1
Total Alkalinity (mg/l)	500	480	490	500	500	480	500	492.9
Dissolved oxygen (mg/l)	6.6	6.5	5	0	4.45	0	6.6	4.5
Chloride (mg/l)	18.4	13	19.8	14.2	17.6	13	19.8	16.5
Nitrate-Nitrogen (mg/l)	1.2	0.58	1.2	2.4	1.28	0.58	2.4	1.4
Phosphate-phosphorus (mg/l)	1	0.21	0.57	1.6	2	0.21	2	1.1
Sodium (mg/l)	5.78	5.32	6.66	6	6.72	5.32	6.72	6.1
Potassium (mg/l)	3.68	3.8	4	3.76	4.32	3.8	4.32	3.9
calcium (mg/l)	372	368	388.7	400	390	372	400	383.7
Magnesium	50	52	55	54	60	50	60	54.2

Table 4: Physico Chemical characteristics of River Baldi (December - 2010)

PARAMETERS/SITES	1	2	3	4	5	Min. value	Max. value	Mean
PHYSICAL								
Transparency (%)	90	90	90	85	90	85	90	88
smell (odour)	odorless	odorless	odorless	Rotten egg	odorless			
sanitary condition	Unhygienic	Hygienic	Hygienic	Hygienic	Hygienic			
Colour	Colourless	Colourless	greenish	greenish	Colourless			
Presence of fish/fish fry	Good	No	Few	No	Few			
Total suspended solids	160	182	200	192	169	160	200	180.42
Air temperature (°C)	20	20.5	20.6	20	21	20	21	20.42
Water Temperature (°C)	17	17.7	17	19	18	17	19	17.74
Total dissolved solids (mg/L)	790	830	980	900	870	790	980	877.14
CHEMICAL								
pH	7.7	7.65	7.75	7.85	7.77	7.65	7.85	7.74
Total Hardness (mg/L)	560	578	590	570	567	560	590	573
Total Alkalinity (mg/L)	550	470	430	480	485	430	550	483
Dissolved oxygen (mg/L)	9.8	9.44	8.6	0	9.8	7.528		7.52
Chloride (mg/L)	15	12.21	17	15.21	12.09	13.456	13.174	12.89
Nitrate-Nitrogen (mg/L)	3.6	2.4	3.3	2.1	3.5	2.1	3.6	2.98
Phosphate-phosphorus (mg/l)	2	1.8	1.5	1	2	1	2	1.66
Sodium (mg/L)	7	8	7	5	7	5	7	6.8
Potassium (mg/L)	3.33	3.11	2.82	2.32	3.21	2.32	3.33	2.96
calcium (mg/L)	444	409	310	370	315	310	444	369.6
Magnesium(mg/L)	45.21	47.1	50	49	51	45.21	51	48.46

Table 5: Physico Chemical characteristics of River Baldi (January - 2010)

PARAMETERS/SITES	1	2	3	4	5	Min. value	Max. value	Mean
PHYSICAL Parameters								
Transparency (%)	90	90	90	85	90	85	90	88
smell (odour)		odorless	odorless	Rotten egg	odorless			
sanitary condition in catchments	Hygienic	Unhygienic	Unhygienic	Unhygienic	Unhygienic			
Colour	colourless	Colorless	Colourless	Bluish	colourless			
Presence of fish/fish fry	High	low	Good	No	Good			
Total suspended solids	121	129	139	200	155	121	200	152.14
Total Dissolved solids	730	770	834	790	800	730	834	784.8
Air temperature (°C)	19	19.3	19.6	19	20	19	20	19.4
Water Temperature (°C)	16.9	16.7	17	18	17.9	16.7	18	17.3
CHEMICAL Parameters								
pH	7.44	7.66	7.29	7.19	7.69	7.19	7.69	7.5
Total Hardness (mg/l)	560	600	590	570	600	560	600	584.0
Total Alkalinity (mg/l)	450	470	450	480	490	450	490	468.0
Dissolved oxygen (mg/l)	7.34	7.24	7	0	6.89	0	7.34	5.7
Chloride (mg/l)	13.72	14.7	15.86	16.32	12.15	12.15	16.32	14.6
Chemical oxygen Demand (COD)mg/L	2.72	2.12	2.16	2.9	2.15	2.12	2.9	2.4
Nitrate - Nitrogen (mg/L)	1.1	1.3	1.34	2.2	2.05	1.1	2.2	1.6
Phosphate-phosphorus (mg/l)	0.01	0.04	0.007	0.5	0.69	0.007	0.69	0.2
Sodium (mg/l)	6.32	6.55	7.1	7	7.6	6.32	7.6	6.9
Potassium (mg/l)	5	5	6	4	5	4	6	5.0
calcium (mg/l)	405	470	430	440	420	350	410	433.0
Magnesium	50	70	65	48	75	48	75	61.6

Table 6: Physico-Chemical characteristics of River Baldi (February-2010)

PARAMETERS/SITES	1	2	3	4	5	Min. value	Max. value	Mean
PHYSICAL Parameters								
Transparency (%)	90	85	65	60	50	60	90	79
smell (odour)	odorless	odorless	Muddy	Rotten egg	Moderate			
sanitary condition in catchments	unhygienic	Hygienic	Hygienic	Hygienic	Hygienic			
Colour	colourless	Colourless	Muddy	blakish	Bluish			
Presence of fish/fish fry	Good	No	very few	No	No			
Total suspended solids	200	180	320	360	280	180	360	268
Air temperature (°C)	30	30	30	30	30	30	30	30.0
Water Temperature (°C)	18	18	18.9	17	19	17	19	18.2
Total dissolved solids (mg/L)	1211	1178	1174	1752	1155	1155	1752	1294.0
Conductivity (µmho)	1.852	1.805	1.873	2.743	1.82	1.805	2.743	2.0
CHEMICAL Parameters								
pH	7.37	7.39	7.38	7.4	7.38	7.37	7.4	7.4
Total Hardness (mg/l)	720	700	790	780	740	700	790	746.0
Total Alkalinity (mg/l)	500	480	490	470	490	470	490	483.3
Dissolved oxygen (mg/l)	6.6	6.5	5	0	5	0	5	4.6
Chloride (mg/l)	16	12	17.8	10	12.5	10	17.8	13.4
Nitrate-Nitrogen (mg/l)	2.3	1.21	2.29	1.21	2.12	1.21	2.29	1.8
Phosphate-phosphorus (mg/l)	0.028	0.01	0.012	0.019	0.018	0.012	0.019	0.0
Sodium (mg/l)	7.72	7.21	7	7.01	7.53	7	7.72	7.3
Potassium (mg/l)	5.11	5.19	6	5.9	6.1	5.11	6.1	5.7
calcium (mg/l)	500	510	515	532	590	500	590	529.4
Magnesium	75	70	90	85	80	70	90	80.0

Table 7: Physico - Chemical characteristics of River Baldi (March - 2010)

4. Discussion

The impact on water quality of anthropogenic pollution from industrial, agricultural sources quarrying and tourist activity has concerned environmentalists and scientists for the past two decades. Based on the monthly data collected for six months (October, 2010 to march 2011) from five selected sites of River Baldi, the range and mean of physico – chemical parameter are depicted in table 2, 3, 4, 5, 6 and 7. Physical test do not directly measure the safety of water supply: however, they do give an indication of its acceptability from portability point of view.

4.1. Sanitary Condition of the Area

One of the striking features of streams/rivers is the way in which they interact with and are affected by the surrounding environment. Drainage and discharge from the surrounding area (hotels, shops, residential people and agricultural land) effect both quantity and quality of water flowing downstream. From a sanitary point of view the condition of dumping wastes in the Baldi river were observed to be highly unhygienic mainly due to various tourist activities and the catchment area of the River Baldi which deteriorate the water quality, which affect the people lying downwards and also affect aquatic diversity.

4.2. General Appearance, Colour, Odour and Taste

The water of the upper stream area is clear and there is a good aquatic diversity. As the river Baldi flows downwards the amount of floating and settle led matter was observed. The density of floating and settled matter was observed vary high in the near waterfall and sulphur spring due the tourist activities. This floating matter gets accumulated in the area due to barriers formed in the river for stopping the water of river Baldi due to bathing activities for tourists. The water is colorless, odorless and tasteless at the upstream, as the water flows downwards all these parameters are changed (colour, odour and taste) due to tourist activities and the surrounding catchment area which dump their wastes in the river water which change the physical parameters.

4.3. Transparency

According to central pollution control Board (C.P.C.B) guidelines, seechi – disc transparency of water bodies when observed above 100 cm. it should be regarded as excellent, above 76 cm good, above 50 cm safe and below 25 cm unsafe for any use. In the present study seechi- disc transparency was observed 90% in the upstream due to less disturbance of tourist, while downstream area the transparency decreases due to tourist and the surrounding catchment area. In site 3th and 4th the transparency decreases in summer months due the tourist's who takes bath in these sites, and in site 5th the transparency decreases also due to less flow of water as the wastes gets accumulated in the site and suspended matter increases which reduces transparency.

4.4. Total Suspended Solids

According to Albaster (1972) concentration of suspended solids exceeding 100 mg/L are generally detrimental to river fishes. During the present study, it was observed that fish was sighted in the river Baldi during October – February and it decreases due to the disturbances of tourist in summer months. The suspended solids also increase in summer months and are higher than the value of BIS (1991) and WHO (1984).

4.5. Temperature

The Baldi River has a difference in the fluctuation of water temperature was recorded maximum (18.62) in the month of March and minimum (7.4) in the month of January.

In site 3rd the temperature is always high as compared to other four sites, as the source of water is ground water and the sulphur content is very high and there is no aquatic diversity observed like fish in this site and there is little or no Dissolved oxygen present in this site. The temperature of water decreases from September and increases from January onwards. Badola and Sing (1981) observed similar trends in the river Alakananda in Garhwal region.

4.6. pH

In this study it was recorded that the pH was always slightly Alkaline. The pH of water of River Baldi was recorded highest (7.58) in December and lowest (7.4) in the month of May. Various workers in their study have shown similar results in other Rivers of Garhwal region. Sharmal (1986) has also indicated the same trend of pH on seasonal basis in the Bhagirathi River, Garhwal Himalayas.

4.7. Dissolved Oxygen

The highest value of Dissolved oxygen was recorded (9.80mg/l) in month of January and the lowest (6.60) in month of April. This trend was also started by Khanna et al. (1992) in Ganga River at Hardwar. The Highest value of dissolved oxygen during winter months can be attributed to increased solubility of oxygen at lower water temperature and high photosynthesis rate.

In site 4th (sulphur spring) there is very little or no dissolved oxygen present, because of the fact that the source of water is underground and contains high amount of sulphur content and other salts. There is no Aquatic Diversity in the spring especially fish species.

4.8. Total Hardness, Calcium and Magnesium

The calcium content is high in River Baldi but the magnesium content varies in the water. Similar reports were observed by Trivedy (1988) and Sing (2004) of the Rivers of Garhwal Himalayas. Soil erosion and cutting of rocks result in an increase in the Magnesium content.

The amount of magnesium in Baldi River was found maximum in the month of May and minimum in the month of January. Castana et al. (1905) in river Parna and Meybeck (1984) in river Zaire also reported similar trends of Mg availability in natural water.

Carbonates of calcium and magnesium in solution mainly contributed to the Hardness of Streams although other ionic complexes in the form of sulphates, phosphates, chlorides etc. may also contributed to the Total Hardness.

4.9. Chlorides

The minimum chloride content was recorded in the month of January and increases onwards at the month of March. Temporal change in the chloride content may cause to the large amount of sewage waste and anthropogenic activities in the catchment areas as suggested by several workers Bhatt et al. and Sing (2004) in Alakananda and Mandaking.

4.10. Sodium

Sodium at lower concentration has no direct effect on human health. The maximum sodium concentration was recorded (7.3) in the month of April and Minimum (6.8) in the month of January. Pande and Mishra (2000) observed similar results of Baldi River in Sahastradhara (Doon)

4.11. Potassium

Potassium concentration was observed highest in the month of March (5.66) and lowest in the month of January (2.96) similar results were obtained by Sarien et al. (1989) and Subramanian (1989) observed the similar trend on the River Brahmaputra.

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