

Physiochemical Analysis of natural water resource from Rishikesh to Uttarkashi (Gangotri Yatradham)

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ABSTRACT

Uttarakhand, a northern Indian state, is distinguished by its distinct physical, historical, and environmental characteristics, with multiple rivers originating in its hilly regions, including the Bhagirathi and Yamuna. These rivers provide critical freshwater supplies for both locals and visitors. This study looks at the quality of natural water sources along the Rishikesh to Uttarkashi route in Uttarakhand, with a particular emphasis on the Tehri District. Eleven water samples were obtained from several springs, known locally as "Gaderas," and tested for a variety of physicochemical characteristics such as pH, turbidity, total dissolved solids (TDS), electrical conductivity, dissolved oxygen (DO), hardness, alkalinity, chloride, and sulfur. The results showed that the majority of the water sources met the Bureau of Indian requirements' (BIS) acceptable requirements for drinking water, with pH values ranging from 6.5 to 8.5. However, several sites have higher levels of turbidity and total hardness, which could have an impact on water quality. The study also found that local environmental conditions such as rainfall and cloudbursts had a substantial impact on water quality, especially during the monsoon season. Overall, the findings indicate that, while the water from these springs is generally safe to drink after simple treatment, improvements in water management and pollution control are required to keep the region's water quality stable. This study emphasizes the significance of monitoring and conserving water supplies, which are critical to the livelihoods of local populations and the tourism industry.

1. INTRODUCTION

India is unique among South Asian countries and the globe at large because of its religious, political, historical, geographical, environmental, sociocultural, and developing economic might. Numerous Indian rivers, including those that are fed by glaciers, non-glacial water, and rainfall, originate in Uttarakhand. Surface water bodies are the Ganga, Yamuna, Ramganga, Kali, and Koshi rivers and their tributaries. [1]

Uttarakhand is a hilly state located in northern India. It has various geographical conditions based on social, economic, and environmental factors. The state is divided into thirteen districts. Uttarkashi is one of the districts. It is a distant district in Uttarakhand, India. Uttarkashi District is the source of two major holy rivers: Bhagirathi and Yamuna. The Bhagirathi River originates from Gangotri glaciers and flows through the Uttarkashi district headquarters. Significant rainfall and cloud bursting can harm drinking water quality during the rainy season. In 2013, cloud bursting and landslides along the Bhagirathi River caused erosion and damage to agricultural fields and roads. [2] Rivers are freshwater resources used for home and drinking purposes worldwide, as well as for farming irrigation, building construction, power generation, fishing, and amusement park operations [3]. Along with this, the chemical, pharmaceutical, textile, bleaching, paper-pulp, and other sectors require a significant amount of water [4]. These industrial facilities continued to discharge pollutants into rivers and other bodies of water throughout their existence, which caused rivers' and lakes' capacity to purify themselves to steadily decline. [5] Both the quantity and quality of water resources are in danger due to the exploitation of these resources to meet the demands of the rapidly expanding population, which is aided by industrialization and urbanization [6]. Water quality varies throughout geological contexts due to factors such as soil, geology, climate, and human activity, which alter the composition of dissolved minerals and other parameters [7]. River water quality is significantly impacted by several activities, including garbage dumping, mining, road construction, and hydro-irrigation, fishing, and rafting [8]. Industrial contamination has significantly impacted river water quality [9]. Agricultural runoff from heavy rains can transport soil nutrients, insecticides, herbicides, and other contaminants to nearby water bodies, damaging aquatic life. Nitrate, phosphate, and organic materials in water bodies promote algae development, leading to eutrophication [10].

MATERIAL AND METHODS

Eleven water samples were collected by choosing the Gangotri Dham route via Rishikesh to Uttarkashi and collecting the water sample in Tehri District, Uttarakhand, in the Garhwal region. Water quality analysis requires two types of water collection bottles, known as "Tarson bottles," which are 250 ml and 1000 ml and are unaffected by heat or pressure. After the water samples were collected, the following tools were needed: an electric pH meter, turbidity meter, conductivity meter, and multimeter made in Japan (HORIBA); glassware included a beaker, flask, measuring cylinder, and funnel; some chemicals are used for the analysis of chemical parameters of water quality.

Study Area

The study sites were selected in the Uttarkashi and Rishikesh districts of the Garhwal region of Uttarakhand. Pauri Garhwal is the headquarters of the Garhwal division. There are 15 blocks in the Pauri district. The study was carried out in Rishikesh, the capital of Uttaranchal state. A total of 11 samples were collected along the Rishikesh-to-Uttarakashi route in May 2022. Rishikesh, surrounded by virgin forests at the toe of the Himalayas, is the first town on the Ganga taken up under the Ganga Action Plan (GAP) Phase-I for pollution abatement of the river. The first samples were collected from Banditi and Bandra koti in the Uttarakhand district of Tehri Garhwal. All villagers depend on natural water resources; they never store rainwater during the rainy season. All samples are collected from natural dhara falls in hilly areas. These are known as Gadera by local villagers, and this water is fully usable for all people's animals and daily purposes. This water is consumed by tourists also, who is going to Gangotri Yatra Dham via Rishikesh and Uttarkashi. We covered all natural water resources from Uttarkashi to Rishikesh. The total number of samples is eleven. We have collected all eleven samples in two types of bottles, which are known as tarson bottles, bottles in different volumes. The first is a 250 ml bottle used for collecting biological samples filled up to the neck for BOD and biological examination like coliform bacteria, and the second is a one-liter bottle filled up to the top for examination for physical and chemical examination or other parameters. A total of 11 samples were collected in the whole study from Uttarkashi to Rishikesh. Sampling sites were identified before the samples went for collection. the total number of 11 samples of natural water springs were collected and were collected from different The villages were covered during the smpling work. Some of the Some are on the hills' crests, others in the valleys, and still others in the foothills. Some villages have a large population, but some have a smaller population. Some water resources were directly collected. The samples were collected within 4 days in May of 2022.

Table 1: Collection of Samples & Sampling sites description

SAMPLE NO.	LOCATION	SOURCE	LONGITUDE	LATITUDE
A1	BADITI	TEEN DHARA	78.314889	30.600456
A2	BANDRA KOTI	BANDRAKOTI DHARA	78.390968	30.491898
A3	KOTISERA (LWARKHA)	KATISERA DHARA	78.349509	30.472144
A4	RATNAGARH	RATNAGARH	78.385111	30.443374

A5	SABLI	SABLI DHRA	78.395203	30.321168
A6	NARENDRA NAGAR	PATER DHARA	78.302858	30.17269
A7	NARENDRA NAGAR	MOTANALA DHARA	78.286115	30.15705
A8	NARENDRA NAGAR	CHUNGI POINT DHARA	78.29488	30.165614
A9	NARENDRA NAGAR	KUMAR KHERA DHARA	78.291448	30.160338
A10	NARENDRA NAGAR	KINWANI DHARA	78.34799	30.2436
A11	RISHIKESH	KHARA SROT LIGHT BRIDGE	78.308444	30.120429

pH (Potential of Hydrogen)

The most crucial factor in determining how corrosive water is its pH. Water with a lower pH value is more corrosive. pH had a positive relationship with both total alkalinity and electrical conductivity. The assimilation of carbon dioxide and bicarbonate, which are ultimately in charge of raising pH, is slowed down by the pace of photosynthetic activity. During the summer, the high temperatures were accompanied by low oxygen levels. The pH of water can alter due to a number of factors. The conventional pH meter was used to measure the pH. **(fig-1)** After dipping the pH electrode into the fluid, the pH was noted. (1)



Fig 1:- Determination of pH value by pH meter.

TOTAL DISSOLVED SOLIDS

TDS was tested using a digital conductivity meter, displaying PPM data. The technique entailed connecting the device, turning it on, and then cleaning the electrode with pure water. The 40mL beaker was washed and half-filled with the sample. The reading was taken after dipping the electrode into the sample and the device signified that it was ready. This procedure was repeated for each sample, with the electrode and beaker cleaned after each use. Following testing, the electrode was rinsed with distilled water, and the device was switched off and unplugged.

TURBIDITY

A digital turbidity meter and a Cephalometric meter were used to test the turbidity of water samples. The device was turned on using the "Power Button" and calibrated using standard solutions (0.8 NTU, 20 NTU, 200 NTU, and 800 NTU). The vile was then cleaned with tissue after being rinsed with distilled water and the sample. The vile was then placed inside the apparatus after being filled with the sample to the specified line and covered with tissue. After pressing the "READ" button, the reading was recorded. The instrument was cleaned with tissue paper after each use, and this procedure was repeated for every sample.

TOTAL HARDNESS

Take 50 ml of well-mixed sample in a conical flask or porcelain dish; add 1-2 ml of buffer solution and 1 ml of inhibitor; add a pinch of trichrome black T and titrate with standard EDTA (0.01) until the wine red color changes to blue; note the volume of EDTA required by sample (A); run a reagent blank; note the volume of EDTA required by sample, $c=(A-B)$; calculate the volume of EDTA required by sample, $c=mg/ml = C \times D \times 1000/ml$ of sample, where, $D = mg \text{ caco}_3$ equivalent to 1 ml EDTA titan.

$$\text{HARDNESS} = \frac{\text{EDTA used (ml)} \times 1000}{\text{SAMPLE USED(ml)}}$$

CHOLRIDE

Using potassium chromate as the indicator and AgNO₃ as the titrant, the titration method was used to measure chloride. Conical flask, burette, dropper, volumetric flask, 5% potassium chromate, 0.02N silver nitrate solution, tissue paper, wash bottle, and distilled water were all necessary. Silver nitrate solution 0.02N-dissolve 3.40g of dried AgNO₃ in a volumetric flask using distilled water, shake the flask, and add water slowly into it. After all the solid particles are dissolved, fill the flask till the mark of the ring on the neck of the flask. Leave it in a dark bottle in a dark place. b) Potassium chromate 5%-weigh 5g of K₂CrO₄ by using butter paper and a weighing machine. Dissolve it in 100mL of distilled water.

$$\text{CHLORIDE} \left(\frac{\text{mg}}{\text{L}} \right) = \frac{\text{Titrant used} \times \text{Normality of Titrant} \times 1000 \times 35.5}{\text{Volume of sample used (ml)}}$$

SULPHIDE

The titration method was used to evaluate sulphide. The reagents used were 6N HCl and iodine solution (0.025N), the indicator was the starch solution, and the titrant was sodium thiosulphate (0.025N). Reagents, solution, indicator, tissue paper, butter paper, distilling water, and a wash bottle. Use distilled water and sample to rinse the conical flask, burette, and measuring cylinder. Pour the 100/50 mL sample into the conical flask. Add a drop of starch, 10mL/5mL iodine solution, and 1mL/0.5mL HCl. The mixture becomes reddish-brown.

$$\text{Sulphide} = \frac{\{A \times B\} - \{C \times D\} \times 16000}{\text{Volume of Sample used (ml)}}$$

ALKALINITY

The titration method was used to determine the sample's alkalinity. Burette, Bromo Cresol Indicator, Methyl Orange 0.05% indicator, dropper, funnel, measuring cylinder, conical flask, and volumetric flask were among the tools and supplies utilized for this analysis. A 0.02N standard sulfuric acid (H₂SO₄) solution is made in this process by mixing 1 liter of distilled water with 2.8 milliliters of concentrated H₂SO₄. After rinsing with distilled water, the burette is filled with the conventional H₂SO₄ solution. Also rinsed with distilled water are the conical flask and measuring cylinder. The conical flask is filled with a 50 mL sample that has been measured and then 1-2 drops of Bromo-cresol indicator and 2-4 drops of Methyl Orange (0.05%) indicator are added.

$$\text{Alkalinity} = \frac{A \times N \times 50000}{\text{sample used}}$$

DISSOLVED OXYGEN AND OXIDATION REDUCTION POTENTIAL

"MULTIMETER FOR WATER QUALITY PARAMETER" was used to measure salinity. It consists of a single instrument with a screen and jug. You will want tissue paper, distilled water, and a wash bottle for this procedure. First, use the connector wire to attach the apparatus to the display. The "Power Button" is used to turn the gadget on. Make sure the device is correctly dipped into the jug without overflowing by rinsing both the jug and the device with distilled water before to each measurement. A suitable volume of water for the measurement should be added to the jug. Once the apparatus has reached balance and the reading has stabilized, press the "READ" button. Record the ORP in pH-mV and mV and the salinity reading in ppm after it has stabilized. **(Fig: 2)**



Fig: - 2: Dissolved Oxygen and Oxidation Reduction Potential.

RESULT AND DISCUSSION

Physio-chemical examination in including parameter is color, oxidation reduction potential (ORP), dissolved oxygen (DO), pH, total dissolved solute (TDS), conductivity, turbidity, hardness alkalinity, chloride, and sulphide examination from collected 11 sample site of the Tehri district route of Gangotri yatra.

Oxidation-reduction potential

It was recorded in mv and ppmv. In May, a minimum of 196.0mv was recorded from sample no.A4 and a maximum of 230.0 mv from sample no. A10. **(fig-3)**

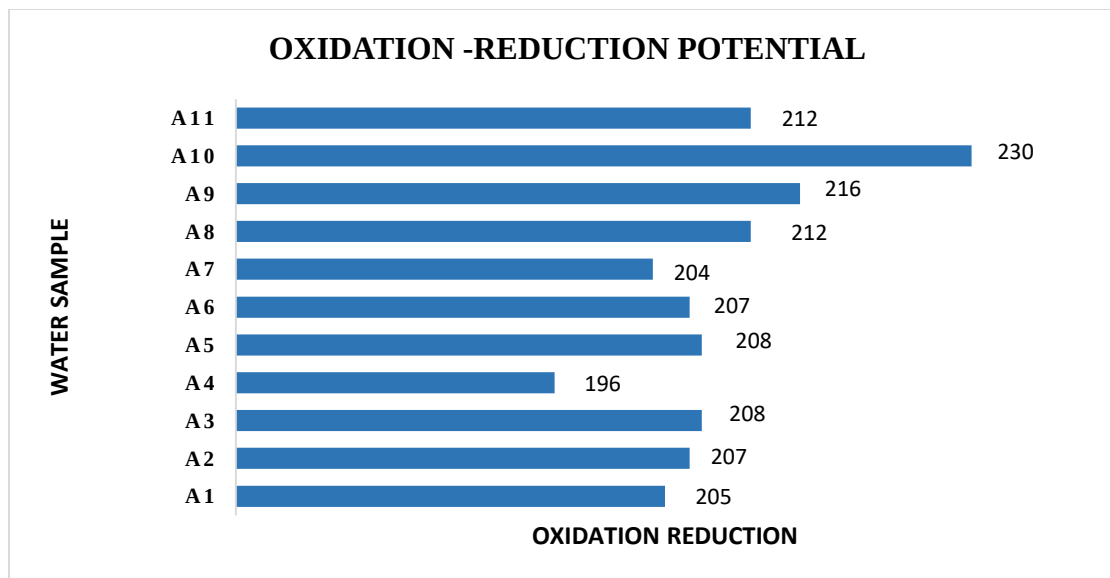


Figure 3:- Oxidation-Reduction Potential values of the collected water samples.

DISSOLVED OXYGEN.

All living thing need oxygen to survive oxygen from the atmosphere dissolves in river and lake water, and it's the oxygen that fish and other aquatic animals use to breath .oxygen change level on the depth of the water in the lake and ocean, oxygen obtained DO in sample is maximum in sample site A4 and A5, obtained minimum in sample site A9 (fig.4)

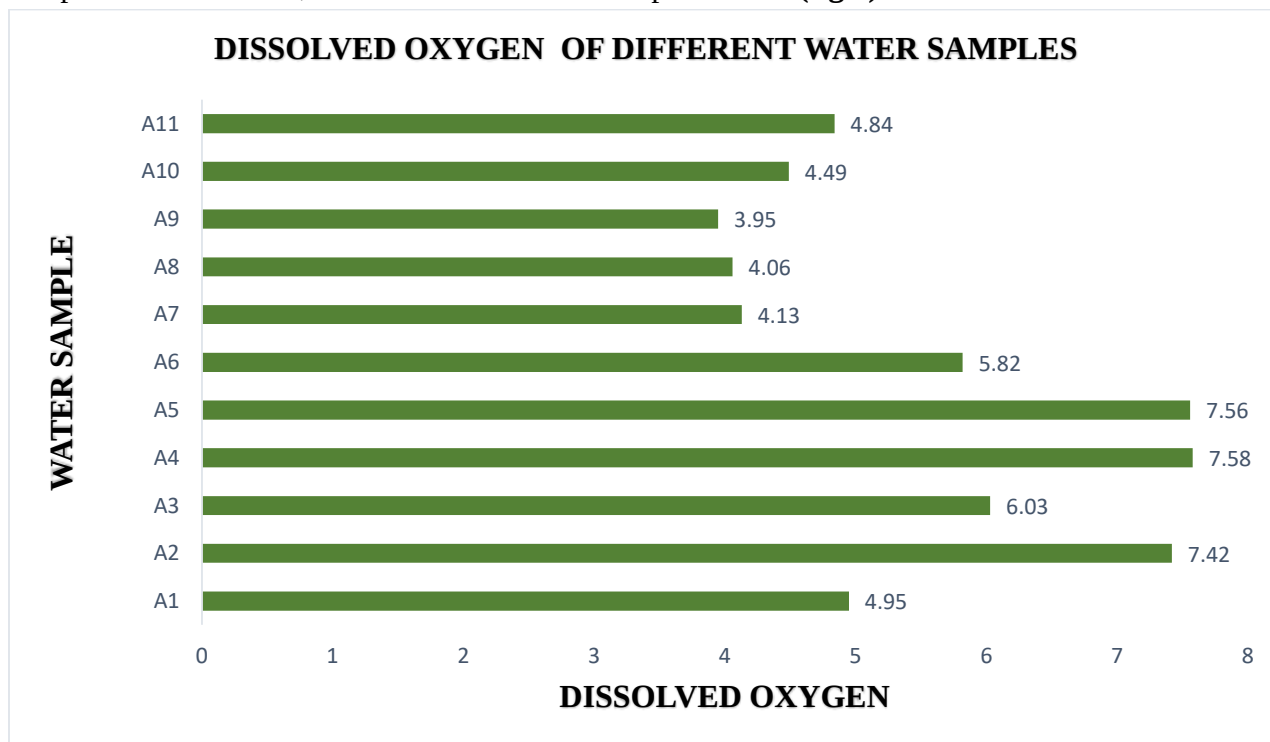


Figure 4:- Dissolve Oxygen (mg/l) values of water samples

pH of collected water samples

The pH of all the sites is within the desirable limit. Minimum pH sample no. A7 and sample no. A10 (pH 7.12) were slightly alkaline and the maximum was recorded as 7.88 at sample no. A4. Excess amounts of alkalinity in our body may cause gastrointestinal issues and skin irritation. Liver disease and nausea. The body strictly regulates its pH levels. Changes in the body's internal pH, such as blood pH, can mean serious problems in the organs and tissues. So, if it were possible to change the body's pH using food and drink, it would be dangerous to do so. All the pH values are found within the BIS limit of 6.5 to 8.5. (fig.5)

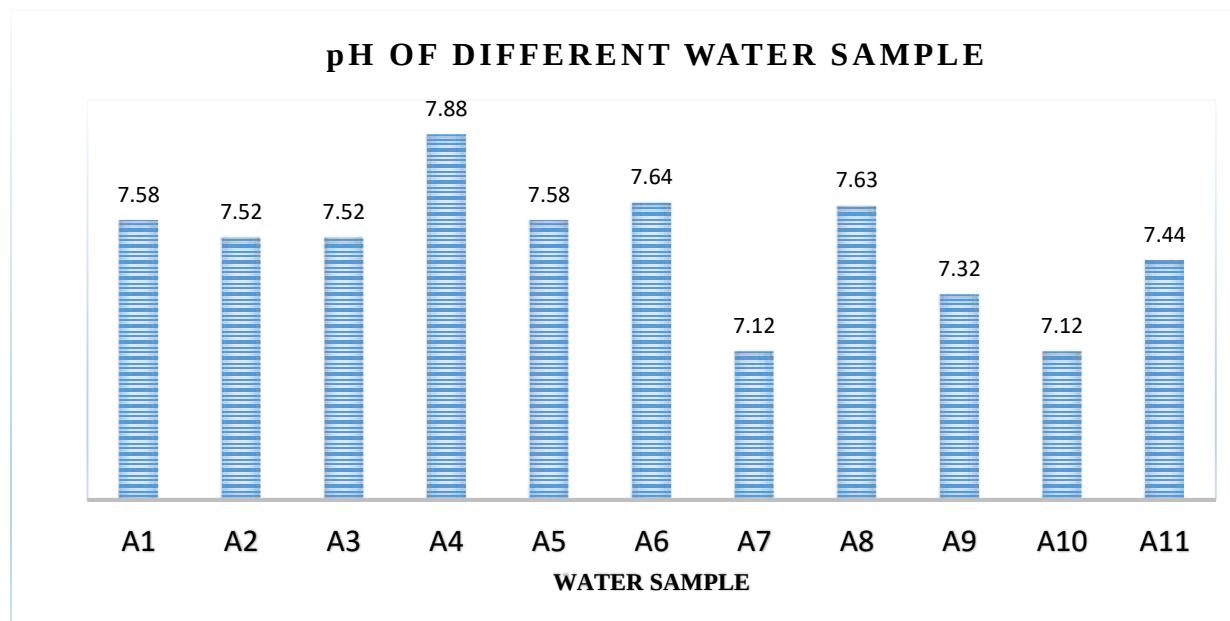


Figure 5:- pH values of water samples

Total Dissolved Solids(TDS) of collected water samples

It was calculated in ppm (parts per million). In the May month sampling, the minimum was 35.9 ppm of sample no. A4 and the maximum was recorded as 427 ppm. In May High TDS can increase the corrosive property. High TDS water can be used for cooking, but it will alter the taste of food. Drinking high TDS water can cause kidney and liver diseases. Low TDS water can cause a deficiency of many minerals in the human body. All sample shows that TDS limits within the BIS limits of 500-2000mg/l. (fig 6)

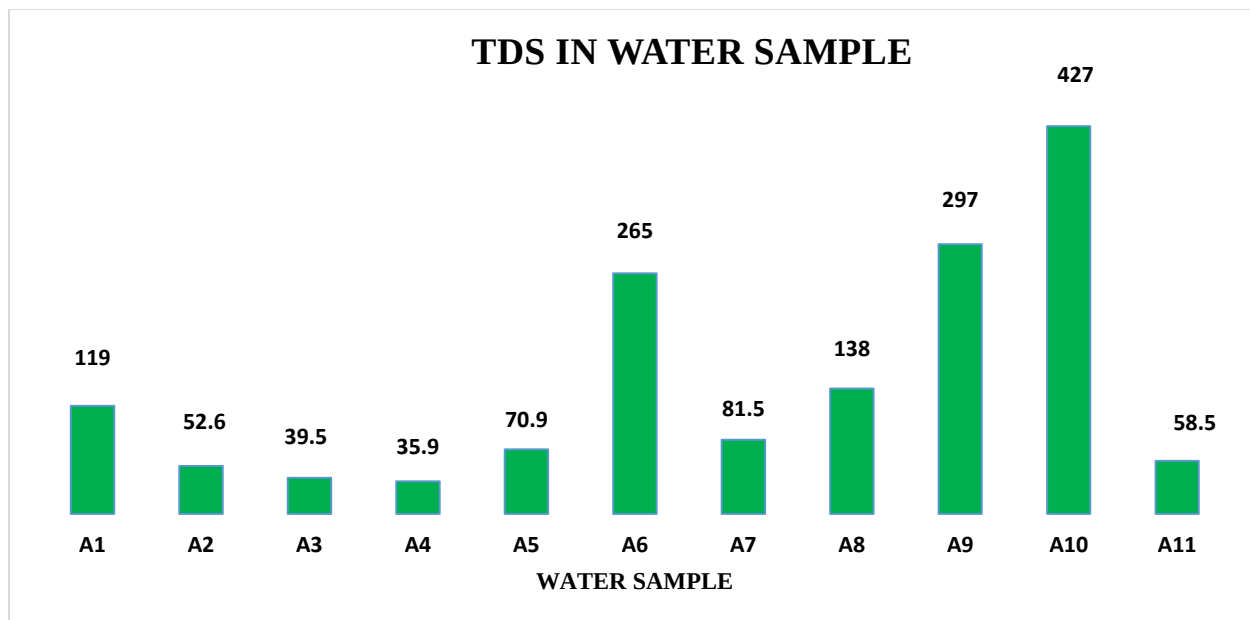


Figure 6:- Total Dissolved Solids (mg/l) in water samples

CONDUCTIVITY OF WATER SAMPLES.

The conductivity of a solution is a measure of its ability to conduct electricity, sound, and transmit heat. The units of conductivity of water are Siemens per meter in SI and milliohms per centimetre in CGS. The symbol of conductivity of water is κ or s . Pure water is not a great conductor of electricity rather it acts as an insulator. The conductivity of water enhances if its ion concentration increases. Distilled water in equilibrium with carbon dioxide in the air can conduct electricity. The electrical conductivity of water is a measure of the ionic activity of a solution that can transmit current.(fig.7)

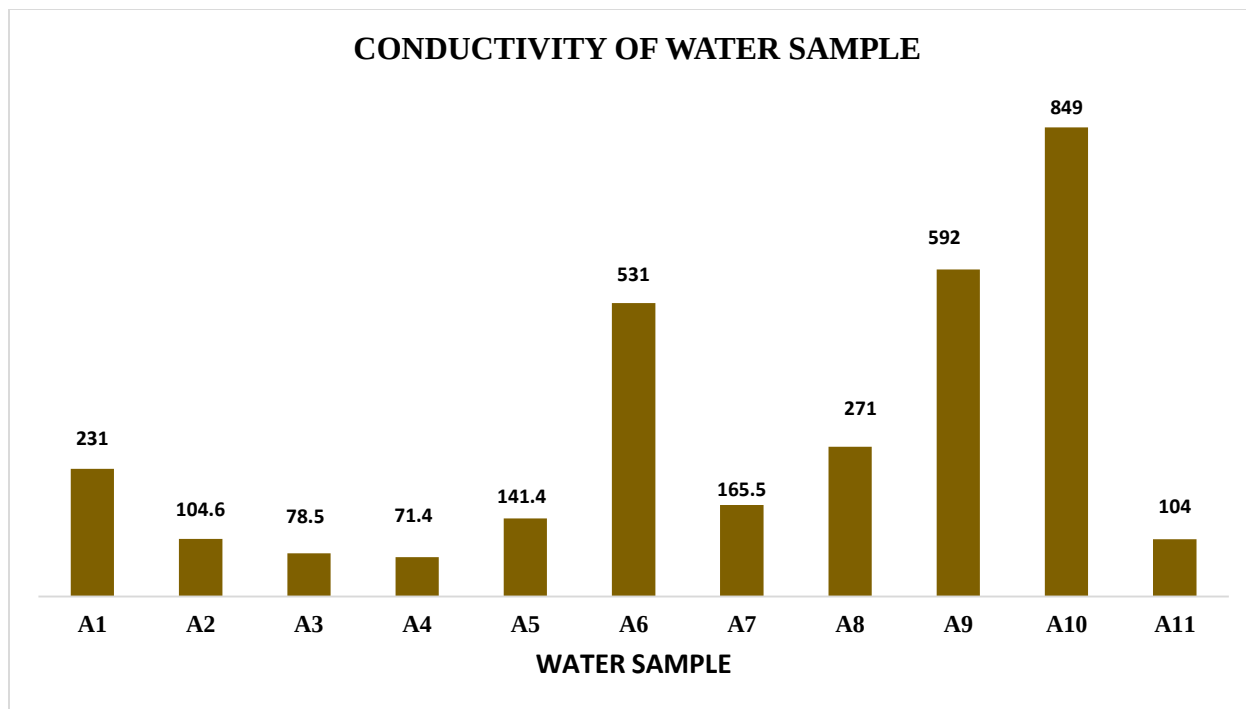


Figure 7:- Conductivity of water samples.

TURBIDITY IN COLLECTING WATER SAMPLE

Turbidity was recorded in NTU (Nephelometric Turbidity Unit) . The resultant turbidity in May month was within the desirable limit and a minimum was recorded as 0.31 NTU from sample no. A7 and a maximum was recorded from sample no. A11 (75.8 NTU). In May, turbidity was slightly higher than normal. Values of turbidity are observed in the district at more than the desirable limit. Turbidity can increase the treatment cost of water. It can change the color of the water. It can affect aquatic life. The observation applied to humans with identical conclusions from the two diagnostic methods. Results corroborate that different turbidity-causing substances affect chlorination efficiency to very different extents, with chlorine demand by organic material probably being the most important determinant. High turbidity requires high chlorination.(26)All the samples except A10 and A11 represented the TDS values with 1-5NTU limit of BIS (**fig.8**)

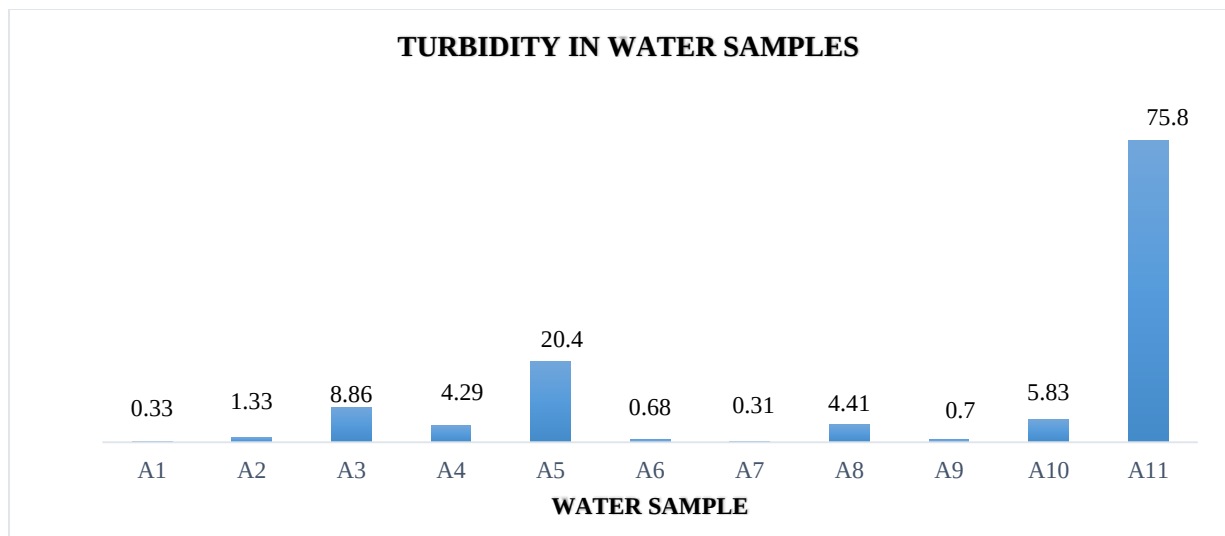


Figure 8:- Turbidity (NTU) in water samples

Total hardness of collected water sample

It was recorded in mg/l. In May, the sampling site May, the sampling site recorded the maximum from sample no. A 10 as 782 mg/l and 38 mg/l of sample no.A4 hard water can cause dry hair and dry skin. It produces less lather, requires more soap, and also produces calcium carbonate. More hard water is unfit for washing. It can damage plumbing and cause a layer on pipes, affecting water flow or causing a blockage. It also affects aquatic life. Regularly drinking soft water by humans can increase sodium levels in the body and blood pressure problems can also be identified. Cooking with soft water makes food taste free from minerals Very low or very high concentrations of calcium (Ca) and magnesium (Mg) or total hardness in drinking water have been empirically recognized as the cause of the problems with corrosion, scaling, or taste of water. Only sample no.A10 shows the high value of total hardness as 782mg/l as per BIS standard. **(fig.9)**

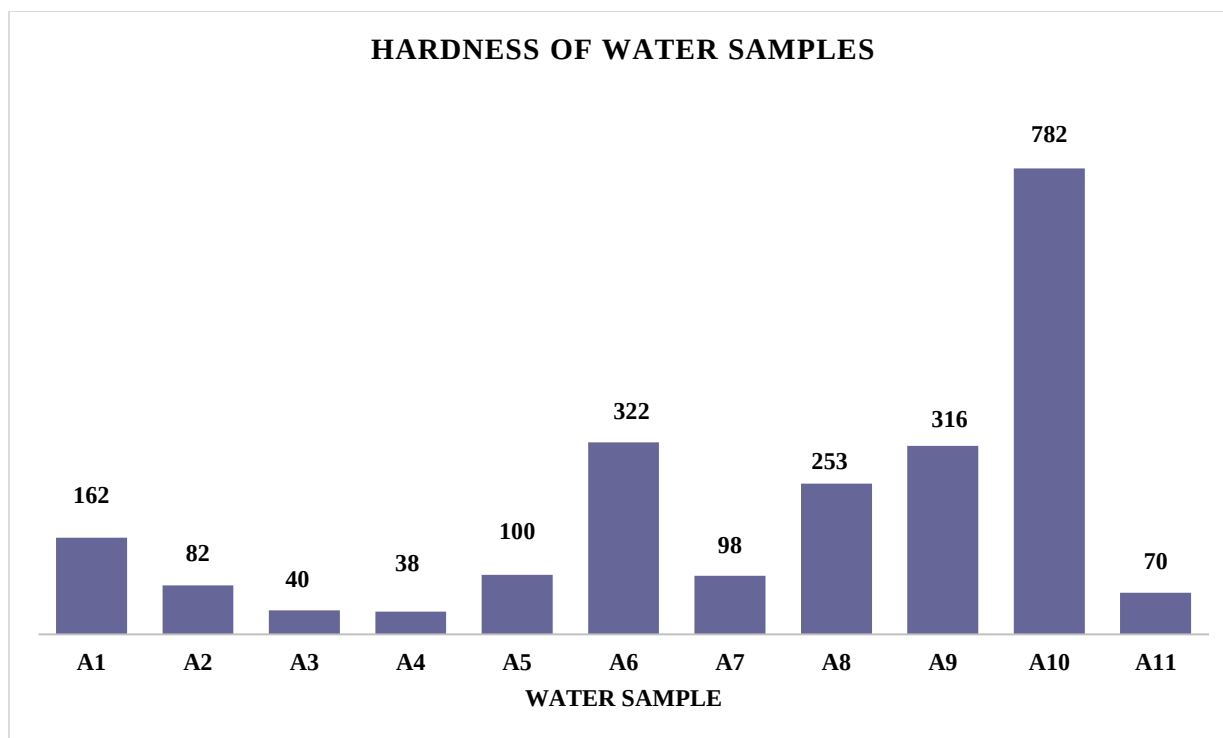


Figure 9:- Hardness of water samples

ALKALINITY OF WATER SAMPLE.

Sample No. A6 had the highest alkalinity of 30.0 mg/l and Sample No. A11 had the lowest at 4.0 mg/l. in May. Alkalinity can be defined as the buffering capacity of water due to bicarbonate, carbonate, and hydroxide. The geology and soils affect the nature of water. pH also changes the alkalinity of water. The wastewater treatment plant outlet affects the alkalinity of water. Alkaline nature in water is developed due to the presence of impurities such as sodium carbonate, potassium bi carbonate or potassium carbonate. Renal tubules play an important role in maintaining water, electrolyte, and acid-base balance. Renal tubule dysfunction can cause electrolyte disorders and acid-base imbalance. Clinically, hypokalemic, renal tubular disease is the most common tubule disorder. All samples have been found within BIS range of Alkalinity. **(fig 10)**

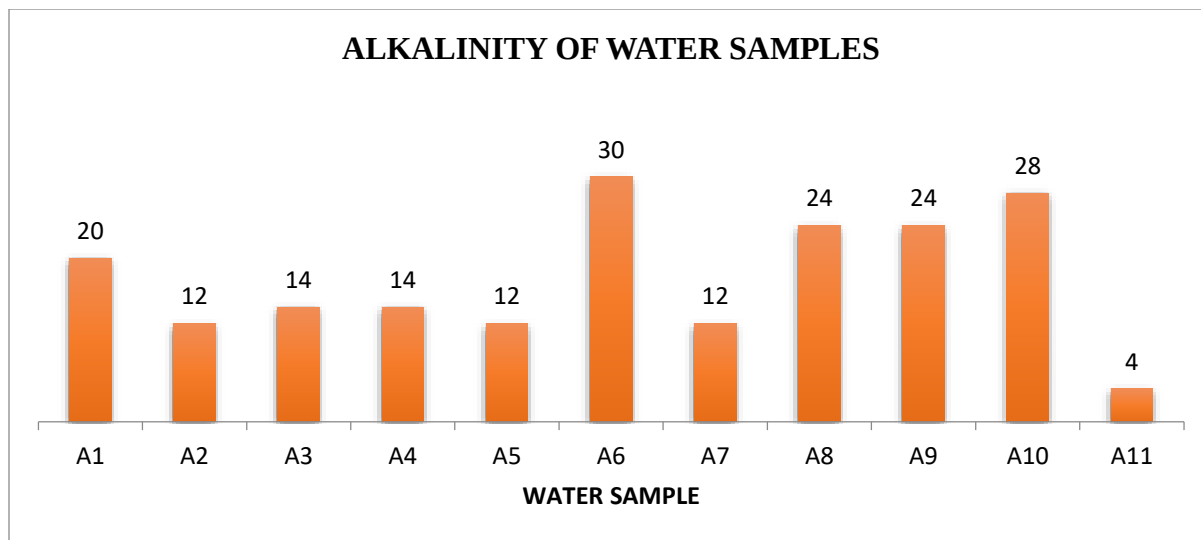


Figure 10:-Alkalinity of water samples

CHOLORIDE IN WATER SAMPLE

Chloride is present in the form of salts in the water and it was recorded as dissolved total mg/l. In May, the maximum was 36.52 mg/l from sample no.A7 and no A8 respectively In May 8.52mg/l was the minimum recorded. Exposure of chloride to air is negligible. It can be found in water from both natural and anthropogenic sources. It contributes to osmotic activity in body fluids. It is almost completely absorbed. Increase to 250mg/l concentration .Makes a salty taste in water. All chloride values of 11 samples were found within BIS limit for chloride as 250-1000mg/l (**fig 11**)

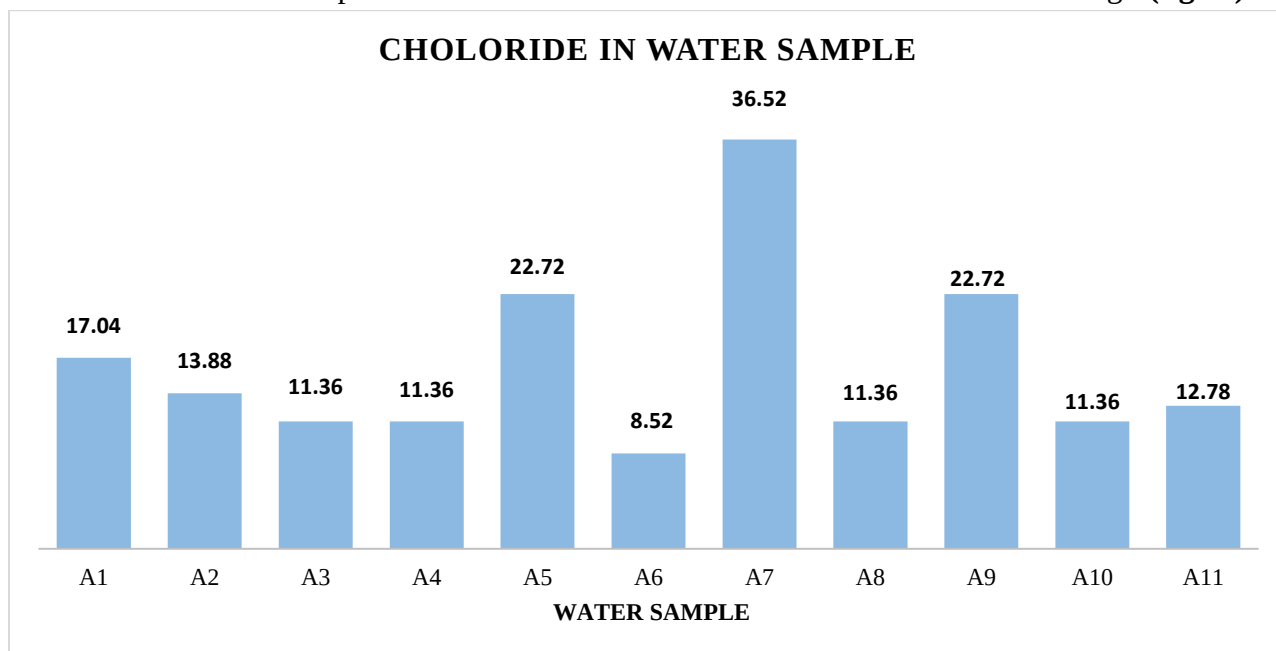


Figure 11:- Chloride in water Samples.

SULPHIDE IN WATER SAMPLE

Sulphide levels above 250 mg/L may make the water taste bitter or like medicine. High sulfate levels may also corrode plumbing, particularly copper piping. In areas with high sulfate levels, plumbing materials more resistant to corrosion, such as plastic pipe, are commonly used. The maximum was recorded as 22.4 mg/l from sample no. A8 and the minimum was recorded from sample no. A11 in May. Higher concentration. Sulfate in drinking water can cause cathartic effects; dehydration as a side effect is also seen due to sulfate; weight loss; laxative effects are also observed in some people. Oxidation process involving transformation of organic matter and its components and taking place in the aquatic environment produced by sediment water bodies in anaerobic conditions. (fig.12)

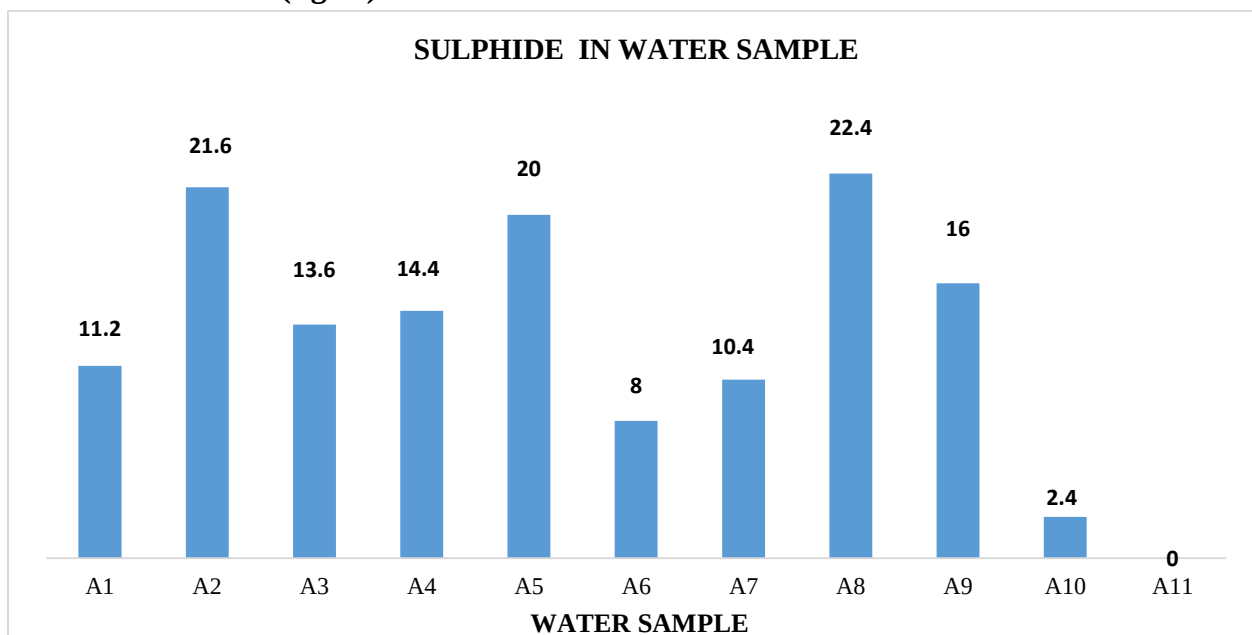


Figure 12:- Sulphide in water samples

CONCLUSION

The Tehri district's natural water resources between Uttarkashi and Rishikesh were analyzed, and the results showed that every sample satisfied the BIS's drinking water pH requirements. On the other hand, other locations had higher turbidity levels. Water from these sources is generally safe for drinking and other purposes, despite this. Some water resources had an alkaline pH, while others had a slightly acidic pH. Despite several samples exceeding the desired levels, the total hardness was found to be within acceptable bounds. All samples had total dissolved solids within allowable bounds, and all sampling locations had appropriate levels of chloride. Notably, it was discovered that the Ganga River at Rishikesh has good water quality, particularly in the town area. The water in the upper Ganga was of good quality and could be drunk with little treatment as long as it was disinfected.

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