

**ASSESSMENT OF WATER QUALITY OF RIVER GOMTI IN  
LUCKNOW CITY, UTTAR PRADESH**

Submitted for the partial fulfillment for the Award of the degree of

**M.Sc. in Environmental Science**

Submitted by

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Submitted to

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UTTAR PRADESH POLLUTION CONTROL BOARD

संदर्भ सं०.....UPPCB/ce/245/training/23

दिनांक.....23.6.23

**TO WHOM SO EVER IT MAY CONCERN**

This is to certify that Ms. Pragati Sharma, M.Sc. Environmental Science (final Year) student of Integral University, Lucknow has undergone project work titled "Assessment of Water Quality of River Gomti in Lucknow" in Central Laboratory of U.P. Pollution Control Board, Lucknow. She has completed this project work successfully.

I wish her good luck and success in her future endeavours.

  
(Ram Gopal)

Chief Environmental Officer  
केन्द्रीय प्रयोगशाला



# INTEGRAL UNIVERSITY

## इंटीग्रल विश्वविद्यालय

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### CERTIFICATE

This is to certify that **Ms. Pragati Sharma**, a bonafide student of M.Sc. Environmental Science, 4<sup>th</sup> Semester, Session 2021-2022 to 2022-2023 at Integral University, Lucknow. She has completed her three months compulsory Industrial Training (Feb-May 2023) and Dissertation work entitled “**Assessment of Water Quality of River Gomti in Lucknow**” in partial fulfilment of the requirements for the award of degree of **MASTER OF ENVIRONMENTAL SCIENCE**. The work embodied in the dissertation was conducted at Central Laboratory of U.P. Pollution Control Board, Lucknow. The Internal Supervisor was Dr. Amina Jafri, Asst. Professor, Department of Environmental Science, Integral University, Lucknow.

I wish her success in her future life.

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## **DECLARATION**

This is to certify that project entitled “**ASSESSMENT OF WATER QUALITY OF RIVER GOMTI IN LUCKNOW**”, which is submitted by me in a partial fulfillment of the requirement for the award of degree M.Sc. in Environmental Science to the Integral University, Lucknow. Comprises only my original work and due to acknowledgement has been made in the text to all other materials used.

**PRAGATI SHARMA**  
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**PRAGATI SHARMA**

**MAY 2023**

## LIST OF ABBREVIATIONS

<b>ABBREVIATION</b>	<b>BACKRONYM</b>
<b>&amp;</b>	And
<b>°</b>	Degree
<b>&gt;&lt;</b>	Less than & Greater than
<b>/</b>	Slash
<b>()</b>	Bracket Open & Close
<b>μ</b>	Micro
<b>Dr.</b>	Doctor
<b>Mr.</b>	Mister
<b>Mrs.</b>	Missus
<b>%</b>	Percentage
<b>EDTA</b>	Ethylene Di-amine Tetra Acetic Acid
<b>Approx.</b>	Approximately
<b>pH</b>	Power of Hydrogen
<b>TSS</b>	Total Suspended Solids
<b>TDS</b>	Total Dissolved Solids
<b>BOD</b>	Biological Oxygen Demand
<b>COD</b>	Chemical Oxygen Demand
<b>Etc.</b>	Et cetera
<b>WHO</b>	World Health Organization
<b>U.P</b>	Uttar Pradesh

**Table.1. Abbreviations**

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## **INTRODUCTION**

Water is fundamental to life on our planet. It covers about **71%** of the Earth's surface , **326 million cubic miles** of water is found in the oceans, **3%** of water is fresh, out of which **2.5%** is unavailable as it is locked up in glaciers , polar ice caps, atmosphere and soil. So, **0.5%** of Earth's water is available Fresh water.

The water quality is degrading day by day as all forms of pollution eventually make their way to water and results in Water Pollution.

**WATER POLLUTION** is a serious problem for the entire world. It threatens the health and well-being of humans, plants and animals. As the world become more industrial and smaller due to communications and trade, accidental and purposive hazardous dumping have contributed to the problem of **River Pollution**.

All water pollution is dangerous to the health but river pollution can be especially detrimental to the health of living creatures. Rivers and Seas are used as primary source of potable water by populations all over the world.

This study examines the importance of River Gomti, Pollution of Gomti, analysis and comparative study of upstream and downstream water flow of river Gomti.

### **Water Quality Index**

Water Quality Index	Water Quality Status
<50	Excellent Water Quality
50-100	Good Water Quality
100-200	Moderately Polluted
200-300	Severely Polluted
>300	Unsuitable For Human Use

**Table.2. *Water Quality Index & their Status***

## **OBJECTIVE**

- To Assess and Evaluate the Water Quality of river Gomti in Lucknow city, UttarPradesh.

## **REVIEW LITERATURE**

Water pollution refers to the contamination or degradation of water bodies, such as rivers, lakes, oceans, and groundwater, by various harmful substances or pollutants. These pollutants can be either naturally occurring or man-made and have detrimental effects on aquatic ecosystems, human health, and the environment as a whole. (Arvind Kumar, 2004), (M.C Mehta), (P.K Goel, 2006). It can be assessed by monitoring various physicochemical parameters. Here is a summary of some commonly measured parameters and their significance in evaluating water quality. Parameters like pH, Alkalinity, DO, BOD, COD, Hardness etc. Monitoring and analyzing these physicochemical parameters provide valuable insights into the quality of water bodies, helping identify pollution sources, assess environmental impacts, and guide appropriate remediation measures. (Dr. S.K Agarwal & Dr. S.K Sharma, Environmental Chemistry), (Dr.P.C.Trivedi).

Rivers in India are facing severe pollution issues due to a combination of factors, including industrialization, urbanization, agricultural practices, and inadequate waste management. Industrial Pollution, Urban Waste Disposal, Agricultural Runoff, Solid Waste Dumping, Religious and Cultural Practices, Deforestation and Soil Erosion, Dams and Interference with Natural Flow, Inadequate Waste Management etc. ., are the major factors influencing river pollution. The pollution of rivers in India has wide-ranging consequences, including the degradation of water quality, loss of biodiversity, damage to ecosystems, and adverse effects on public health. Efforts are being made to address these issues through stricter regulations, implementation of pollution control measures, and public awareness campaigns. However, sustained and collective action is necessary to mitigate pollution and restore the health of India's rivers. (Mathew Koshy Punnackadu, 2003)(R.K.Trivedy, 1988), (Radha Swami, 2011), (Shardendu Kislaya).

The Gomti River is a major river in the Indian state of Uttar Pradesh, with its capital city, Lucknow, situated on its banks. Over the years, the water quality of the Gomti River in Lucknow has deteriorated significantly due to various factors, including urbanization, industrial activities, agricultural runoff, and inadequate wastewater treatment. Some key points

regarding the water quality of the Gomti River in Lucknow are like high pollution load, high BOD, Nutrient Enrichment, Suspended Solids & Turbidity, Heavy metal contamination, Microbial Contamination, Inadequate Wastewater Treatment etc. Efforts have been made by the government and various organizations to address the water pollution issues in the Gomti River. These include the construction of sewage treatment plants, river cleaning campaigns, and the implementation of pollution control measures. However, significant challenges remain, and sustained efforts are required to improve the water quality of the Gomti River in Lucknow and restore its ecological health. (Dr. Rajiv K. Singh), (Dr. Rakesh Kumar) (R.K.Trivedy, 1988). The pollution of Gomti River, is influenced by various factors, such as human activities, industrial discharges, agricultural runoff, and improper waste disposal. The pattern of downstream pollution being more severe than upstream pollution in the Gomti River can be attributed to several reasons like Accumulation of pollutants, Discharge of untreated effluents, Agricultural runoff: Pesticides, Urbanization and population density, Lack of treatment facilities and etc. It's important to note that the pattern of downstream pollution being more severe than upstream pollution is not universally applicable to all rivers. Factors such as topography, the presence of natural purification mechanisms, and the types of pollutants involved can influence the specific pollution patterns in different rivers. (Dr. Mishu Singh, 2022), (Ramsa Khan et.al, 2022).

The assessment of the Gomati River's quality highlights the pressing need for improved wastewater treatment, regulation of industrial discharges, and measures to reduce agricultural runoff. Restoration efforts and pollution control measures are crucial to mitigate pollution, preserve the river's health, and ensure the well-being of the surrounding communities. Assessing river quality involves monitoring and analyzing various parameters to evaluate the physical, chemical, and biological characteristics of the water. Steps involved in monitoring the river quality is to Select Monitoring Sites, Define Monitoring Parameters, Sample Collection, Laboratory Analysis involves using analytical instruments, kits, or standard laboratory techniques, Data Interpretation, Ecological Assessment, Long-term Monitoring, Integrated Assessment, Reporting and Communication. River quality assessments are essential for understanding the state of aquatic ecosystems, identifying pollution sources, and guiding

management and conservation efforts. Regular monitoring and assessment provide a basis for effective water resource management and the protection of rivers for both human use and ecological sustainability. (Dr.Arvind Kumar, 2008), (P.Kumar, 2018).

## RIVER GOMTI

The **GOMTI RIVER**, an alluvial river of the Ganga Plain and one of the important tributaries of the Ganga, originates near **Mainkot**, from **Gomat Taala Lake** also known as ‘ **Fulhar Jheel** ’ in **Madhotanda** about **30 km, 3 km east** of **Pilibhit** town in **U.P** at an elevation of **185 m**.

The river flows through an incised valley southwards through the districts of **Sitapur**, **Lucknow**, **Lakhimpur**, **Barabanki**, **Sultanpur** & **Jaunpur** before meeting Ganga river at **Kaithi**, **Dist. Ghazipur**, bordering **Varanasi** (at an elevation of 61 m) after travelling **940 km** in **South South-East** direction. Various tributaries of river Gomti are **Gachai**, **the Sai**, **the Jomkai**, **the Barna**, **the Chuha**, **the Saryu**, **the Giri**, **the Kalyani** and **Kathna**.

According to **Hindu Mythology**, the river is the daughter of **Sage Vashistha** and bathing in the Water of Gomti on **Ekadashi** (**the 11<sup>th</sup> day of the Sanatana Dharma Hindu Calender**) can wash away one`s sins. The characteristics of River is Perennial. The River is characterized by sluggish flow throughout the year, except during Monsoon season, when heavy Rainfall causes a manifold increase in the runoff.



**Fig.1. Pakka Pull at Gomti River in Lucknow**

## **GOMTI RIVER POLLUTION**

The river Gomti is a medium sized river. The river flows richly cultivated lands, densely populated area has several industries located near its bank. The runoff from lands, untreated industrial waste effluents, sometimes and the whole river surface is hidden by green aquatic plants indicating that Eutrophication conditions are prevailing.

From the recent study, The major source of Pollution in Gomti are:

- Industrial Waste and Effluent from sugar factories and Distilleries.
- Domestic wastewater and sewage from habitations.

The river collects large amounts of human & industrial pollutants as it flows through the highly populous areas (18 million approx.) of U.P.

High Pollution levels in the river have negative effects on the ecosystem of the Gomti, threatening its Aquatic Life. Heavy silting of the river reduces its carrying capacity resulting in floods during the Monsoons.

The main cause of the deterioration of the water quality was the lack of proper sanitation, unprotected river sites & high Anthropogenic activities.

The Pollution level of the Gomti River has already reached the critical limit and a water quality doesn't match with the drinking water standard of WHO. At present, Gomti River is on alarming stage not only for pollution but for its own existence as well and needs proper management and actions.



**Fig.2. Kudiya Ghat, Chowk, Lucknow**



## **UTTAR PRADESH POLLUTION CONTROL BOARD**

The Uttar Pradesh Pollution Control Board (UPPCB) is the environmental regulatory agency of the state of Uttar Pradesh, India. Its primary objective is to prevent and control pollution, protect the environment, and promote sustainable development within the state.

Here are some key functions and responsibilities of the Uttar Pradesh Pollution Control Board:

- **Implementation of Environmental Laws:** UPPCB is responsible for enforcing various environmental laws and regulations, including the Water (Prevention and Control of Pollution) Act, 1974, the Air (Prevention and Control of Pollution) Act, 1981, and the Environment (Protection) Act, 1986.
- **Granting Environmental Clearances:** UPPCB plays a crucial role in granting environmental clearances for various industries, projects, and activities that have the potential to cause pollution or environmental degradation. It assesses the potential environmental impacts and ensures compliance with applicable standards and guidelines.
- **Monitoring and Assessment:** UPPCB monitors air, water, and soil quality across different regions of Uttar Pradesh. It collects samples, conducts laboratory analysis, and assesses the pollution levels. Based on the findings, the board takes necessary actions to mitigate pollution and protect the environment.
- **Environmental Impact Assessment (EIA):** The UPPCB reviews and evaluates Environmental Impact Assessment reports for developmental projects. It assesses the potential environmental impacts and suggests measures to minimize or mitigate adverse effects.
- **Public Awareness and Education:** UPPCB conducts awareness campaigns, workshops, and training programs to educate the public, industries, and other stakeholders about pollution control, environmental conservation, and sustainable practices.
- **Regulatory Compliance and Enforcement:** The board ensures that industries, businesses, and other entities comply with environmental regulations and standards. It conducts inspections, issues notices for non-compliance, and takes legal actions against violators.



- **Research and Development:** UPPCB promotes research and development activities related to pollution control technologies, waste management, and environmental conservation. It collaborates with research institutions, universities, and industry experts to find innovative solutions for environmental challenges.
- **Environmental Planning:** UPPCB assists in the formulation of environmental policies, plans, and guidelines at the state level. It provides technical expertise and recommendations to the government for sustainable development and environmental protection.

The Uttar Pradesh Pollution Control Board plays a crucial role in safeguarding the environment and promoting sustainable development in the state of Uttar Pradesh.



**Fig.3. At UPPCB Gomtinagar, Lucknow**



## **PHYSICOCHEMICAL PARAMETERS TO ASSESS THE RIVER QUALITY**

This study was aimed to determine the current status of River Gomti. Assessment of physicochemical parameters is generally considered to set guidelines and categorize the physicochemical water quality. these parameters involves the principles of both Physics and Chemistry , means that they are dependent on , or produced by , the combined actions of physical and chemical attributes .

Water quality parameters matter because of the different requirements that application can have. It is important to know chemical measures of water quality because the presence of certain contaminants in our water can lead to health issues, include Gastrointestinal illness , Reproductive problems & Neurological disorders. And if we talk about its effects on environment, then food chain disruption, effects on aquatic life , destruction of biodiversity , drinking water contamination are the some causes of Water Pollution.

Physicochemical parameters are important water quality parameters of river water i.e., pH , Temperature , Turbidity , conductivity , TDS , TSS , COD , BOD , Calcium , Alkalinity , Hardness etc.

## **METHODS AND METHODOLOGIES**

- **STUDY SITES**

- (a) **WATER INTAKE / GAUGHAT : UPSTREAM :** If Gomti is lifeline of Lucknow, the site where it enters the city from Sitapur may soon become a sight to behold for those visiting Gaughat. The river water is purest form here as before Gaughat, there is only one drain that falls into the river.
- (b) **HANUMAN SETU : DOWNSTREAM :** Hanuman Setu is one of the downstream site of River Gomti hence is one of the most polluted site. The main reasons contributing to the increase in Pollution Levels: decline in water level; discharge of no. of drains; indiscriminate growth of Water Hyacinth and obstructions in flow.



**Fig.4. Fixing DO at Ghaugat**



**Fig.5. Fixing DO at Hanuman Setu**

S.No.	Locations	Latitude	Longitude
a.	Gaughat	X:80.899893	Y:26.886799
b.	Hanuman Setu	X:80.935602	Y:26.858943

**Table.3 Site Description**

• **WATER SAMPLING :**



**Fig.6. Water Sampling at Gaughat**

Take the empty bottles for the collection of water. Make sure that the sample bottle is clean and rinsed. Flush the bottle with the water to be sampled a few times prior to gathering the sample.

Each sample in the collected bottles was capped tightly to avoid leakage and contamination from any pollutants during handling and transportation. The bottles were adequately labeled by dates and location. All the collected samples are preserved thoroughly.

## **PARAMETERS THAT ASSESED**

- pH
- Conductivity
- Dissolved Oxygen (DO)
- Hardness
- Calcium
- Chemical Oxygen Demand (COD)
- Total Dissolved Solid (TDS)
- Biological Oxygen Demand (BOD)
- Chloride
- Alkalinity

**pH:** pH is one the most important attributes of any aquatic systems since all the biochemical activities depend on pH of the surrounding medium. Scientific definition of pH is that it indicates the concentration of Hydrogen ions in a liquid while a low pH indicates a higher concentration of Hydrogen, a high pH indicates a lower Hydrogen concentration.

In its purest form, water has a pH of 7, which is at the exact center of the pH scale. Particles in water, and most water for use has a pH of somewhere between 6.5 & 8.5.

pH plays an important role in the properties of a liquid containing water. The pH may also be a sign of other contaminants or bacterial life in a liquid. In general, a very high or very low pH can make water unusable for certain applications.

Water with a low pH may corrode metal pipes & extract metal ions into the water, making it harmful to drink or use in the home.

### **EXPERIMENT 1: pH**

#### **PRINCIPLE:**

The pH is determine by the electromotive force of a cell comprising of an indicator electrode (an electrode responsive to hydrogen ion such as glass electrode) immersed in the test solution and reference electrode (usually a Calomel Electrode). Contact is achieved by means of a liquid junction, which forms a part of reference electrode. The emf of this cell is measured with the pH meter. pH is defined operationally on a Potentiometric scale, the measuring instrument is also calibrated potentiometrically with an indicating glass electrode and a reference electrode using standard buffer having definite pH value.

**APPARATUS AND EQUIPMET REQUIRED:** pH meter, Water samples, Sensor Glass Electrode, Beaker, Stirrer

**REAGENTS AND STANDARDS:**

- pH 4 buffer solution; (Potassium Hydrogen Phthalate Buffer): Dissolve 10.21 g of Potassium hydrogen phthalate previously dried for 2 hours at  $120^{\circ}\text{C} \pm 2^{\circ}\text{C}$ , in purified water and make-up the volume to 1000 ml with purified water.
- pH 7 buffer solution: Add 29.1 ml of 0.1 molar NaOH to 50 ml 0.1 molar potassium di-hydrogen phosphate. Alternatively: Dissolve 1.20g of sodium di-hydrogen phosphate and 0.885g of di-sidium hydrogen phosphate in 1 liter volume distilled water.
- pH 9.2buffer solution: Dissolve 3.18 gm. og Borax in distilled water, which has been previously boiled and cooled, Dilute it to 11.

**PROCEDURE:**

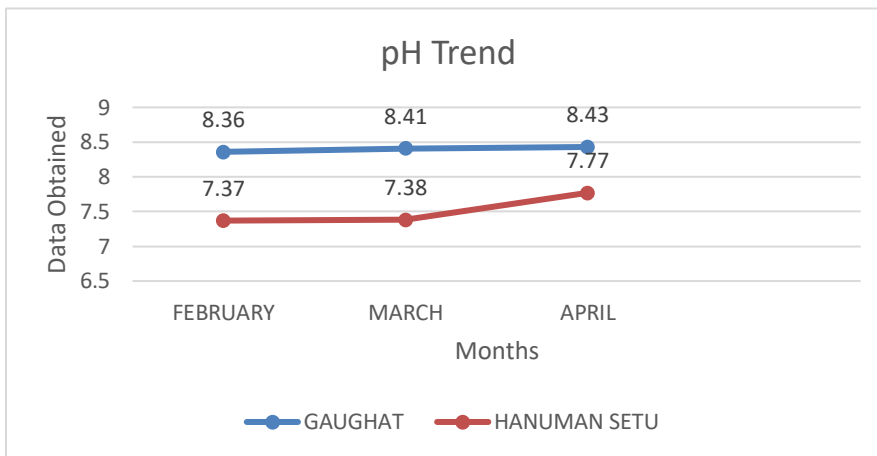
- Before use, remove electrodes from storage solution and rinse it with distilled water
- Dry electrodes by gently blotting with a soft tissue paper, standardize instrument with electrodes submerged in buffer solution within 2 pH units of sample pH.
- Remove electrodes from buffer, rinse thoroughly it with distilled water and blot dry. Immerse the electrode in second buffer below pH 10, 12 approx... 3 pH units different from the first. The reading should be within 0.1 pH for the second buffer. If the meter response shows a difference greater than 0.1 pH from expected value, look for troubles with electrode or pH meter as shown in Fig.7.
- For sample analysis, establish equilibrium between the electrodes and the sample by stirring sample to ensue homogeneity and measure the pH .



**Fig.7. pH Meter**

sample and read pH. With poorly buffered solutions (dilute), equilibrate the electrodes by immersing in three or four successive portions of the samples. Take fresh samples and record pH.

**Graphical Representation of pH have been studied in two different sites :**



**Graph.1.** pH trend of Gaughat & Hanuman Setu in February, March & April in 2023.

## **CONDUCTIVITY:**

Conductivity is a measure of the ability of water to pass an electrical current. Because dissolved salts and other inorganic chemicals conduct electrical current, conductivity increases as salinity increases.

Conductivity is also affected by temperature: the warmer the water, the higher the conductivity.

Significant changes in conductivity could then be an indicator that a discharge or some other source of pollution has entered the Aquatic Resource.

As most of the Salts in water are present in ionic forms capable of conducting electric current. Conductivity is the good and rapid measure of dissolved solids. Generally, human disturbance tends to increase the amount of dissolved solids entering waters which results in increasing conductivity.

## **EXPERIMENT 2: CONDUCTIVITY**

**PRINCIPLE:** This ability of conductance in water is directly proportional to the concentration of the ions present in the water. The more the number of ions present in the electrolyte, then the higher the conductivity of water.

**APPARATUS & EQUIPMENTS REQUIRED:** Self-contained conductance instruments (conductance meter) as shown in Fig.8.

- Thermometer with the least count  $0.1^{\circ}\text{C}$  and covering the range  $10^{\circ}$  to  $50^{\circ}\text{C}$ .
- Conductivity cells: The choice may depend on expected range of conductivity and the resistance range of the instrument. Experimentally check the range of the conductivity of the assembly by comparing the instrumental results with the true conductance of Potassium Chloride solution.

**REAGENTS & STANDARDS:** Conductivity of water should be less than  $1\text{ mmho/cm}$ .

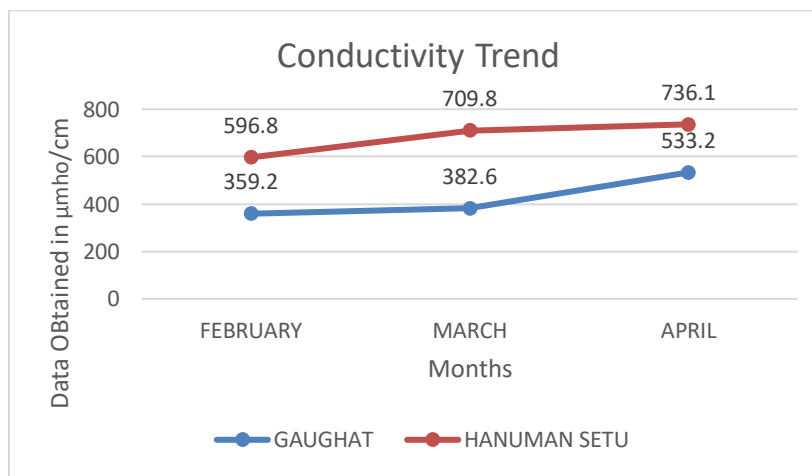
- Standard Potassium Chloride solution  $0.01\text{ M}$ .



**Fig.8. Conductivity Meter**

- Dissolve  $745.6\text{ mg}$  anhydrous  $\text{KCl}$  in conductivity water and makeup to  $100\text{ml}$  at  $25^{\circ}\text{C}$ . This is standard reference solution which at  $25^{\circ}\text{C}$  has specific conductance of  $1.413\text{ mmho/cm}$ . It is satisfactory for most water when using the cell with the constant between 1&2.
- Store the solution in the glass stoppered Pyrex bottle.

**Graphical Representation of Conductivity have been studied in two different sites:**



**Graph.2. Conductivity trend of Gaughat & Hanuman Setu in February, March & April in 2023.**

### **DISSOLVED OXYGEN:**

The amount of oxygen in water is known as dissolved oxygen or DO. All forms of life depend on sufficient dissolved oxygen, which is necessary for high water quality. When dissolved oxygen levels fall below 5.0 mg/L, aquatic life is put under stress. More stress is experienced at lower concentrations. When oxygen levels drop below 1-2 mg/L even for a short time, large fish fatalities can happen. Biological Oxygen Demand (BOD) is the name for the drop in dissolved oxygen content. Any discharge of untreated sewage into a river causes the level of dissolved oxygen to drop because the bacteria that consume sewage expand in population and breathe. Fish die as a result of this respiration swiftly depleting the water's oxygen supply.

### **EXPERIMENT 3: DISSOLVED OXYGEN**

**PRINCIPLE:** The volume of oxygen that has been dissolved in water is known as dissolved oxygen (DO). Aquatic plants and atmospheric oxygen both contribute to the oxygenation of water bodies. In comparison to quiet pond or lake water, running water, such as that of a fast-moving stream, dissolves more oxygen.

**REAGENTS:** 2ml Manganese sulfate, 2ml alkali-iodide-azide, 2ml concentrated sulfuric acid, 2ml starch solution, Sodium thiosulfate

#### **PROCEDURE:**

- Carefully pour sample water into a 300-mL glass Biological Oxygen Demand (BOD) stoppered bottle.
- Immediately add 2mL of manganese sulfate to the collection bottle by inserting the calibrated pipette just below the surface of the liquid. (If the reagent is added above the sample surface, you will introduce oxygen into the sample.) Squeeze the pipette slowly so no bubbles are introduced via the pipette.
- Add 2 mL of alkali-iodide-azide reagent in the same manner.
- Stopper the bottle with care to be sure no air is introduced. Mix the sample by inverting several times. Check for air bubbles; discard the sample and start over if any are seen. If oxygen is present, a brownish-orange cloud of precipitate or floc will appear. When this floc has settle to the bottom, as shown in Fig.9., mix the sample by turning it upside down several times and let it settle again.





**Fig.9** Floc has settle to the bottom



**Fig.10.** 203ml sample ready to titrate

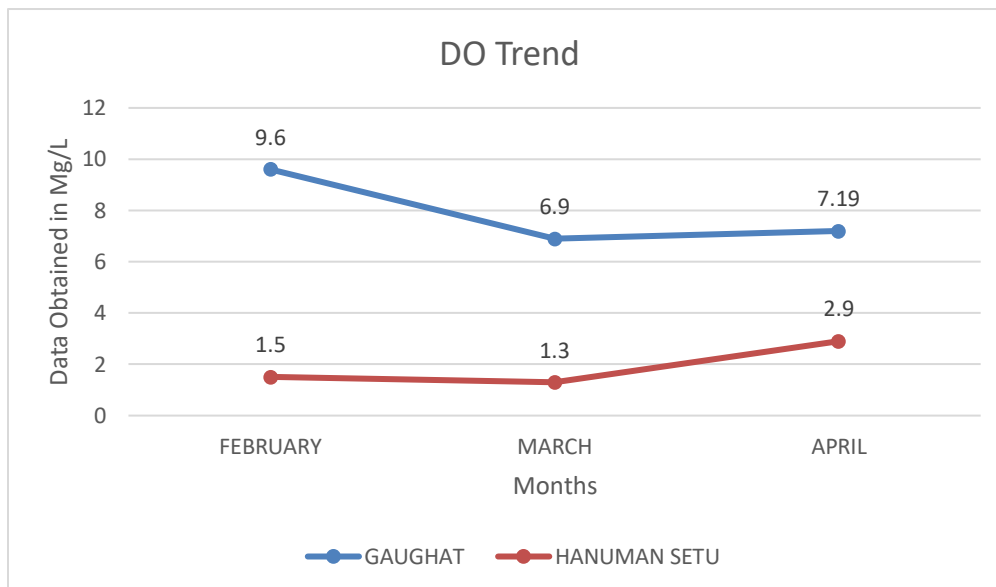
- Add 2 mL of concentrated sulfuric acid via a pipette held just above the surface of the sample. Carefully stopper and invert several times to dissolve the floc. At this point, the sample is "fixed" and can be stored for up to 8 hours if kept in a cool, dark place. As an added precaution, squirt distilled water along the stopper, and cap the bottle with aluminum foil and a rubber band during the storage period.
- In a glass flask, take 203 mL of the sample as shown in Fig.10. & titrate it with sodium thiosulfate to a pale straw color. Titrate by slowly dropping titrant solution from a calibrated pipette into the flask and continually stirring or swirling the sample water.
- Add 2 mL of starch solution so a blue color forms. Continue slowly titrating until the sample turns clear. As this experiment reaches the endpoint, it will take only one drop of the titrant to eliminate the blue color. Be especially careful that each drop is fully mixed into the sample before adding the next. It is sometimes helpful to hold the flask up to a white sheet of paper to check for absence of the blue color.
- The concentration of dissolved oxygen in the sample is equivalent to the number of milliliters of titrant used. Each mL of sodium thiosulfate as shown in Fig.11. Added in steps 6 and 8 equals 1 mg/L dissolved oxygen.



**Fig.11.** Sodium Thiosulphate (0.025N)



### Graphical Representation of DO have been studied in two different sites:



Graph.3. DO trend of Gaughat & Hanuman Setu in February, March & April in 2023.

### HARDNESS:

The presence of soluble bicarbonates, chlorides, and sulfates of calcium and magnesium is what causes water to be hard. Hard water is water that does not foam up with soap. The most crucial element required for the survival of life on earth is water. Oceans, rivers, ponds, lakes, glaciers, etc. all contain water. Even though there are dissolved gases present, rainwater is regarded as pure water because it doesn't have any salt dissolved in it. Hardness can be classified into two types

- **TEMPORARY HARDNESS:** Water becomes momentarily hard due to magnesium and calcium carbonates present. In this instance, boiling the water will get rid of the hardness. When water is heated to a boil, the soluble  $Mg(HCO_3)_2$  salts are changed to  $Mg(OH)_2$ , which is insoluble and precipitates out when it cools. The water we receive after filtering is soft water.
- **PERMANENT HARDNESS:** We refer to the presence of soluble magnesium and calcium salts in the form of chlorides and sulphides in water as permanent hardness since boiling cannot dissolve this hardness. By adding washing soda to the water, we can soften it up. When washing soda combines with the sulphide and chloride compounds of magnesium

and calcium, insoluble carbonates are created, resulting in the transformation of hard water into soft water.

### **EXPERIMENT 4: HARDNESS**

**PRINCIPLE:** Testing the hardness of water is a common practice to determine the concentration of minerals, primarily calcium and magnesium ions, present in the water supply. Hard water can cause various issues, such as scaling in pipes, reduced efficiency of soap and detergent, and potential health concerns.

**MATERIALS REQUIRED:** Water samples (preferably from different sources or locations), Soap or detergent, Distilled water (for comparison), EDTA solution (Ethylenediaminetetraacetic acid), Eriochrome Black T indicator (or any other suitable indicator), Burette or graduate, cylinder, Erlenmeyer flask or beaker, Pipettes, Funnel, Stirring rod, Titration setup (burette stand, clamp, and burette), Safety goggles and gloves

#### **PROCEDURE:**

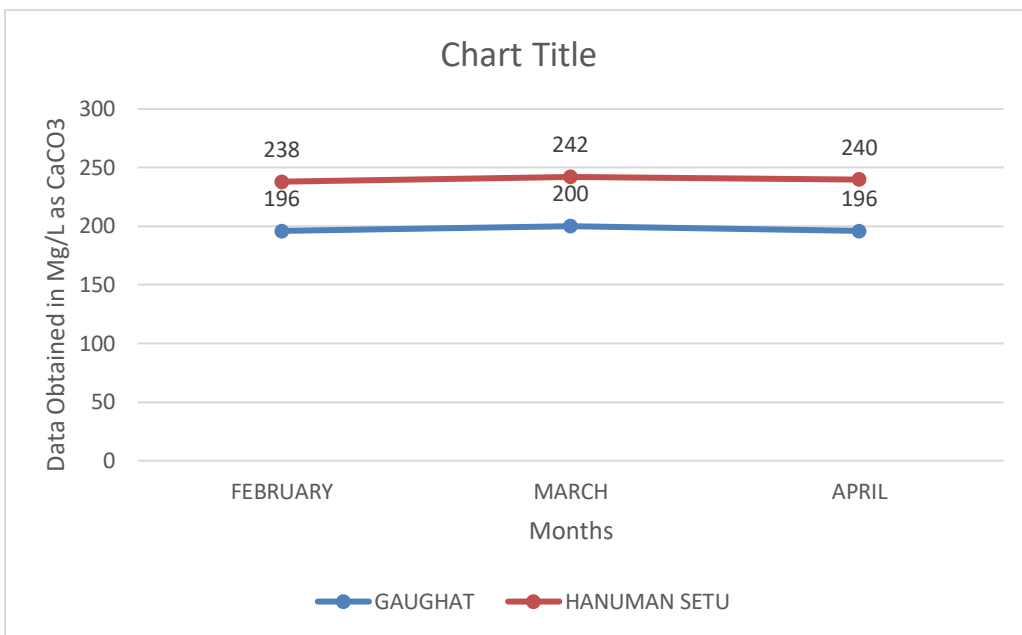
- Start by preparing a soap or detergent solution. Dissolve a known quantity of soap or detergent in distilled water and mix thoroughly until a consistent solution is obtained. This solution will be used later for testing the hardness of water samples.
- Set up the titration apparatus by attaching the burette to a burette stand and placing the Erlenmeyer flask or beaker below it.
- Fill the burette with the EDTA solution. Make sure there are no air bubbles in the burette tip.
- Pipette a measured volume (e.g., 50 mL) of the water sample to be tested into the Erlenmeyer flask or beaker.
- Add a few drops of Eriochrome Black T indicator to the water sample. The indicator will change color depending on the presence of metal ions.
- Start the titration by slowly adding the EDTA solution from the burette to the water sample while continuously stirring the mixture. The Eriochrome Black T indicator will change color as the metal ions in the water react with the EDTA as shown in Fig.12.



**Fig.12. Tested Hardness from EDTA**

- Continue adding the EDTA solution until the indicator changes color permanently. The color change indicates that all the metal ions in the water sample have reacted with the EDTA.
- Note the volume of EDTA solution for the titration. This volume is proportional to the concentration of metal ions in the water sample.
- Repeat steps 4 to 8 with different water samples and record the volume of EDTA solution used for each sample.
- As a control, perform the same titration using distilled water and record the volume of EDTA solution used. This will help determine the background level of metal ions in the reagents and equipment used.
- Calculate the hardness of each water sample by subtracting the volume of EDTA solution used for the distilled water from the volume used for each water sample. This gives the volume of EDTA required to react with the metal ions present in the water.
- Convert the volume of EDTA solution used to milligrams of calcium carbonate ( $\text{CaCO}_3$ ) per liter (mg/L) using the molar mass of calcium carbonate and the stoichiometry of the reaction between EDTA and the metal ions.
- Compare the hardness values obtained for different water samples. Higher hardness values indicate a higher concentration of calcium and magnesium ions, indicating harder water.

**Graphical Representation of Hardness have been studied in two different sites:**



**Graph.4. Hardness trend of Gaughat & Hanuman Setu in February, March & April in 2023.**

**CALCIUM** : Calcium hardness of water refers to the concentration of calcium ions (Ca<sup>2+</sup>) present in the water supply. It is one component of overall water hardness, which is a measure of the concentration of divalent cations, primarily calcium and magnesium ions, in the water. Calcium ions in water come from the dissolution of minerals such as limestone, gypsum, and dolomite, which contain calcium carbonate (CaCO<sub>3</sub>) and calcium sulfate (CaSO<sub>4</sub>). When water comes into contact with these minerals, calcium ions are released and dissolved in the water. Calcium hardness is important to measure and monitor because it can have various effects:

- Scale formation, Soap and detergent efficiency, Corrosion, Taste and odor

By measuring and monitoring calcium hardness, water treatment professionals and individuals can better understand the mineral content of the water and take appropriate measures to address any issues related to scale formation, soap efficiency, or potential equipment damage.

## EXPERIMENT 5: CALCIUM

**PRINCIPLE:** Calcium hardness refers to the concentration of calcium ions ( $\text{Ca}_2^+$ ) in water. It is one component of overall water hardness, with the other major component being magnesium ions ( $\text{Mg}_2^+$ ). Calcium hardness is typically expressed in terms of milligrams of calcium carbonate per liter (mg/L) or parts per million (ppm) of calcium carbonate.

### **MATERIALS REQUIRED:**

Water sample, EDTA solution (Ethylenediaminetetraacetic acid), NaOH & Ammonium Purpurate (or any other suitable indicator), Burette or graduated cylinder, Erlenmeyer flask or beaker, Pipettes, Funnel, Stirring rod, Titration setup (burette stand, clamp, and burette), Safety goggles and gloves

### **PROCEDURE:**

- Prepare the titration setup by attaching the burette to a burette stand and placing the Erlenmeyer flask or beaker below it.
- Fill the burette with the EDTA solution. Ensure there are no air bubbles in the burette tip.
- Pipette a measured volume (e.g., 50 mL) of the water sample into the Erlenmeyer flask or beaker.



**Fig.13 NaOH**



**Fig.14. Ammonium Purpurate (Indicator)**



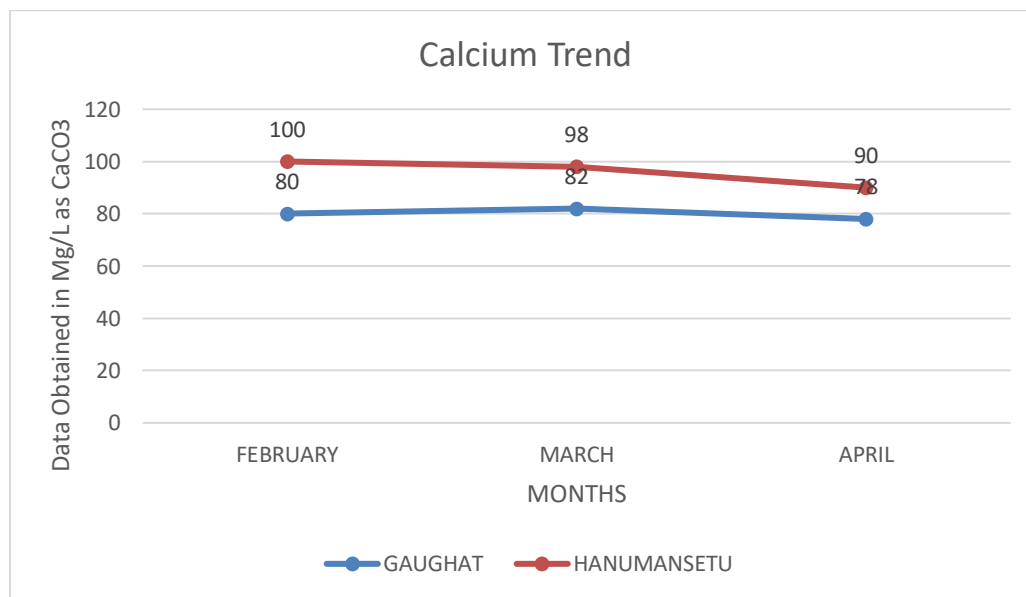
**Fig.15. Color changes after titrating with EDTA**

- Add NaOH (Fig.13.) and Ammonium Purpurate as an Indicator to the water sample. The indicator will change color depending on the presence of metal ions.
- Start the titration by slowly adding the EDTA solution from the burette to the water sample while continuously stirring the mixture. The Ammonium Purpurate indicator as shown in Fig.14. will change color as the calcium ions in the water react with the EDTA.

- Continue adding the EDTA solution until the indicator changes color permanently. The color change indicates that all the calcium ions in the water sample have reacted with the EDTA as shown in Fig.15.
- Note the volume of EDTA solution used for the titration. This volume represents the amount of EDTA required to react with the calcium ions in the water sample.
- Calculate the calcium hardness of the water sample by multiplying the volume of EDTA solution used by the calcium hardness factor. The calcium hardness factor is determined by the molar mass of calcium carbonate (100.09 g/mol) and the stoichiometry of the reaction between EDTA and calcium ions. Typically, the calcium hardness factor is 0.1, as 1 mL of 0.01 M EDTA solution is equivalent to 1 mg/L (or 1 ppm) of calcium carbonate.
- Calcium Hardness (mg/L) = Volume of EDTA solution used (mL) × Calcium Hardness Factor (0.1)

By performing this titration, you can determine the calcium hardness of the water sample. Remember that this method specifically measures the calcium ions and may not account for other forms of calcium present in the water. If you want to determine the total water hardness, you would need to include the magnesium hardness as well.

**Graphical Representation of Calcium have been studied in two different sites:**



**Graph.5. Calcium trend of Gaughat & Hanuman Setu in February, March & April in 2023.**

## **CHEMICAL OXYGEN DEMAND:**

Chemical Oxygen Demand (COD) is a measure of the amount of oxygen required to chemically oxidize organic and inorganic matter in water. It is a widely used parameter for assessing the pollution level and the organic content of wastewater or surface water.

In the context of water quality, COD is a key indicator of the amount of organic pollutants present in the water. It provides an estimate of the oxygen-consuming capacity of the water sample, which is mainly attributed to organic compounds such as carbohydrates, fats, proteins, and other organic substances.

The COD test involves adding a strong oxidizing agent, typically potassium dichromate ( $K_2Cr_2O_7$ ), to the water sample under controlled conditions. The oxidizing agent reacts with the organic matter present in the water, causing it to be chemically oxidized. The amount of oxygen consumed during this process is then measured and reported as the COD value.

The COD value is typically expressed in milligrams per liter (mg/L) or parts per million (ppm). Higher COD values indicate a greater amount of organic pollutants and a higher oxygen demand, suggesting a higher level of water pollution. Consequently, high COD values can indicate the presence of industrial wastewater, untreated sewage, or other sources of organic contamination.

## **EXPERIMENT 6: CHEMICAL OXYGEN DEMAND**

**PRINCIPLE:** The principle behind the COD testing method is that, under acidic conditions, a strong oxidizing agent will oxidize almost any organic compound to carbon dioxide. COD analysis will measure the equivalent amount of oxygen that is required to chemically oxidize organic compounds in water.

### **MATERIALS REQUIRED:**

Water Sample, Mercuric Sulphate, Silver Sulphate &  $K_2Cr_2O_7$  (Fig.16.), Distilled Water, Sulphuric Acid, COD tubes, COD digester, Conical Flasks, Ferroin Indicator and FAS Solution (0.1N)

- **PROCEDURE:** Sample Preparation: A representative water sample is collected and prepared for analysis. The sample is often filtered to remove any suspended solids or particles that could interfere with the analysis.

- Digestion: In this step, a known volume of the filtered sample is mixed with a digestion reagent. The digestion reagent typically contains a strong oxidizing agent, such as potassium dichromate ( $K_2Cr_2O_7$ ), sulfuric acid ( $H_2SO_4$ ), and a silver sulfate ( $Ag_2SO_4$ ) catalyst.



**Fig.16.  $HgSO_4, Ag_2SO_4$  &  $K_2Cr_2O_7$**

**Fig.17. COD Digester**

**Fig.18. Ferroin Indicator**

- The mixture is heated at a high temperature, by putting it in a COD Digester as shown in Fig.17, usually around 150- 170°C, for a specific period, typically 2 hours.
- During this digestion process, the organic and inorganic substances present in the water sample are oxidized by the strong oxidizing agent.
- Ferroin Indicator of 0.025 M is used as an Indicator. (Fig.18.)

Colorimetric Measurement: After digestion, the remaining unreacted oxidizing agent (excess dichromate) is determined by a colorimetric method. A reducing agent, such as ferrous ammonium sulfate (FAS) as shown in Fig.19. is added to react with the excess dichromate, resulting in the formation of a colored complex. The intensity of the color is directly proportional to the amount of excess dichromate remaining, which is in turn related to the COD of the original water sample.

- Titration or Spectrophotometric Measurement: The color intensity is measured either by titration, where a known concentration of a reducing agent is added until the color disappears, or by using a spectrophotometer that measures the absorbance of the colored complex at a specific wavelength. The amount of reducing agent used (in titration) or the absorbance reading (in spectrophotometry) is used to calculate the COD value of the water sample.

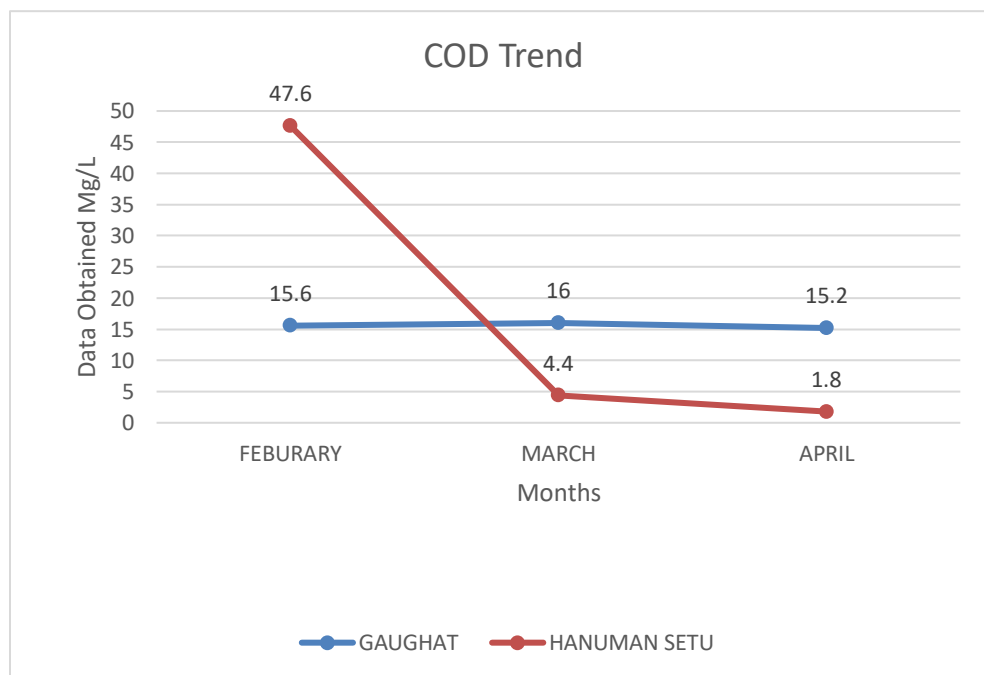




**Fig.19. Titration with FAS (0.01N)**

- Calculation and Reporting:
  - a. Determine the COD value using a calibration curve or formula provided by the method or manufacturer.
  - b. Report the COD value in the appropriate units (mg/L or ppm).
  - c. Document the sample information, experimental details, and any dilutions or corrections made during the analysis.

**Graphical Representation of COD have been studied in two different sites:**



**Graph.6. COD trend of Gaughat & Hanuman Setu in February, March & April in 2023**

## **TOTAL DISSOLVED SOLIDS**

Total Dissolved Solids (TDS) refers to the collective measurement of all inorganic and organic substances dissolved in water. It represents the total concentration of dissolved solids, including minerals, salts, metals, ions, and other compounds.

When water comes into contact with its surroundings, it has the ability to dissolve various substances due to its solvent properties. As water passes through rocks, soil, and other materials, it can pick up dissolved minerals and compounds, increasing its TDS content.

TDS is typically expressed in units of milligrams per liter (mg/L) or parts per million (ppm). It can be measured through various analytical methods such as gravimetric analysis, conductivity measurement, or by using specialized TDS meters.

High TDS levels in water can be indicative of several factors:

- **Natural Sources:** Water bodies that pass through mineral-rich geological formations may have naturally elevated TDS due to the dissolution of minerals and salts.
- **Anthropogenic Pollution:** Human activities such as industrial discharges, agriculture, and improper wastewater treatment can introduce pollutants into water sources, thereby increasing TDS levels.
- **Saline Intrusion:** In coastal areas, TDS can rise due to the intrusion of seawater into freshwater sources, resulting in increased salt content.

## **EXPERIMENT 7: TOTAL DISSOLVE SOLID**

**PRINCIPLE:** Total Dissolved Solids (TDS) is a measure of the sum of all inorganic and organic substances in a liquid in molecular, ionized or micro-granular colloidal suspended form. The solids must be small enough to survive filtration through a sieve the size of two micrometer.

**MATERIALS REQUIRED:** Water Sample, Rinsed Beaker, Distilled Water, Weighing Apparatus, Filter Paper, TDS Oven, and Desiccator.

### **PROCEDURE:**

- Take a beaker, Rinse it with Distilled Water to avoid contamination.
- Dry it by putting it in TDS oven at Temperature 180°C as shown in Fig.20.

- After half an hour put it in a Desiccator (Fig.21) for removing moisture from specimens and protecting them from water vapor in the air.

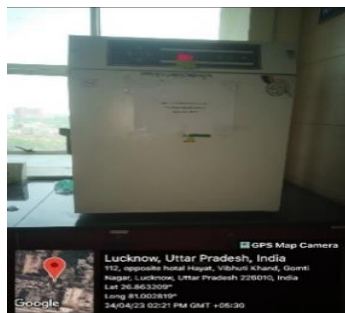


Fig.20 TDS Oven



Fig.21 Desiccator

- As it cools down in Desiccator, weigh it for the initial weight.
- Take same beaker, filter the 50ml sample (Fig.22.) into it and put it in an oven at 180°C until it dry. After taking it out from oven weigh it (Fig.23) again to get the final readings.

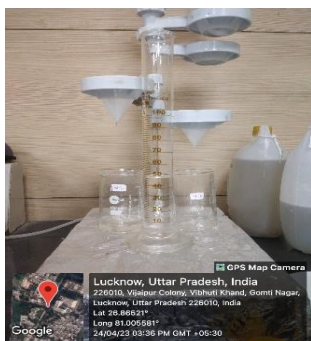


Fig.22 Filtering the sample

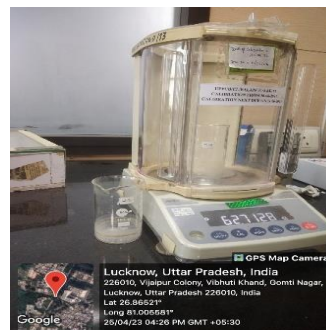
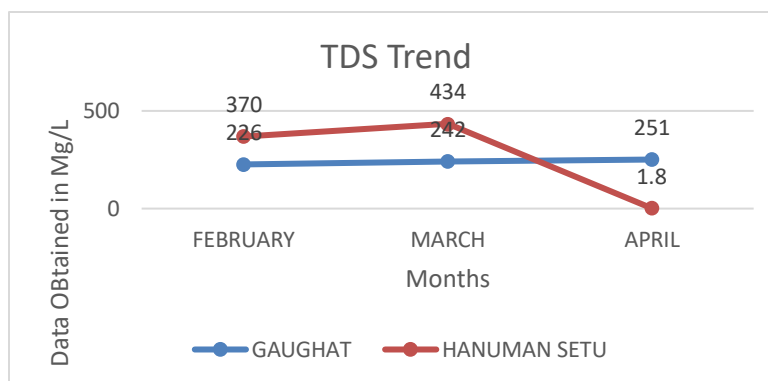


Fig.23 Desiccator

Graphical Representation of TDS have been studied in two different sites:



Graph.7. TDS trend of Gaughat & Hanuman Setu in February, March & April in 2023.

## **BIOLOGICAL OXYGEN DEMAND:**

BOD stands for Biological Oxygen Demand. It is a measure of the amount of dissolved oxygen required by microorganisms in water to break down organic material present in the water. BOD is commonly used as an indicator of the level of organic pollution in water bodies, such as rivers, lakes, and streams.

When organic matter, such as sewage, agricultural runoff, or industrial waste, enters a water body, bacteria and other microorganisms decompose the organic material. This decomposition process consumes oxygen from the water. BOD is a measure of the oxygen depletion caused by these microorganisms.

The BOD test is conducted by measuring the dissolved oxygen levels in a water sample initially and after a specific incubation period, usually 5 days at a specific temperature (20°C). The difference between the initial and final dissolved oxygen concentrations is the BOD value. Higher BOD values indicate a greater amount of organic pollutants and a greater potential for water pollution. High BOD levels can lead to oxygen depletion in water bodies, harming aquatic life and ecosystems.

## **EXPERIMENT 8: BIOLOGICAL OXYGEN DEMAND**

**PRINCIPLE:** The principle of Biological Oxygen Demand (BOD) analysis is based on the fact that microorganisms require oxygen to break down organic matter in water. The BOD analysis measures the amount of dissolved oxygen consumed by microorganisms during the biological oxidation of organic material over a specific period.

**MATERIALS REQUIRED:** Water Sample, BOD Bottles, Incubator, Manganese Sulphate, Alkaline potassium iodide, Sulfuric Acid, Sodium Thiosulphate, Analytical balance, Glassware & Lab wares.

**PROCEDURE:** The process of conducting a Biological Oxygen Demand (BOD) analysis of water typically involves the following steps:

- **Sample Collection:** Collect a representative water sample from the desired location in a clean, airtight container. Ensure that the container is free from any contaminants that could affect the analysis.



**Fig.24.** BOD initial sample after adding  $MnSO_4$  & Azide solution.

- Initial Dissolved Oxygen (DO) Measurement: Measure the initial dissolved oxygen level of the water sample using a dissolved oxygen meter or a chemical titration method. This measurement represents the initial DO concentration and is typically expressed in milligrams per liter (mg/L) or parts per million (ppm).
- BOD Bottle Preparation: Thoroughly clean the BOD bottles to remove any residues from previous use. Rinse the bottles several times with the water sample to be analyzed. Fill each BOD bottle to the brim, ensuring that there are no air bubbles or gaps.
- Incubation: Place the filled BOD bottles in an incubator (Fig.25) or water bath set at a constant temperature (usually  $27^{\circ}C$ ).
- Incubation Period: Incubate the BOD bottles for a specified period, typically 3 days (Fig.26). During this time, microorganisms in the water consume oxygen while decomposing organic matter.



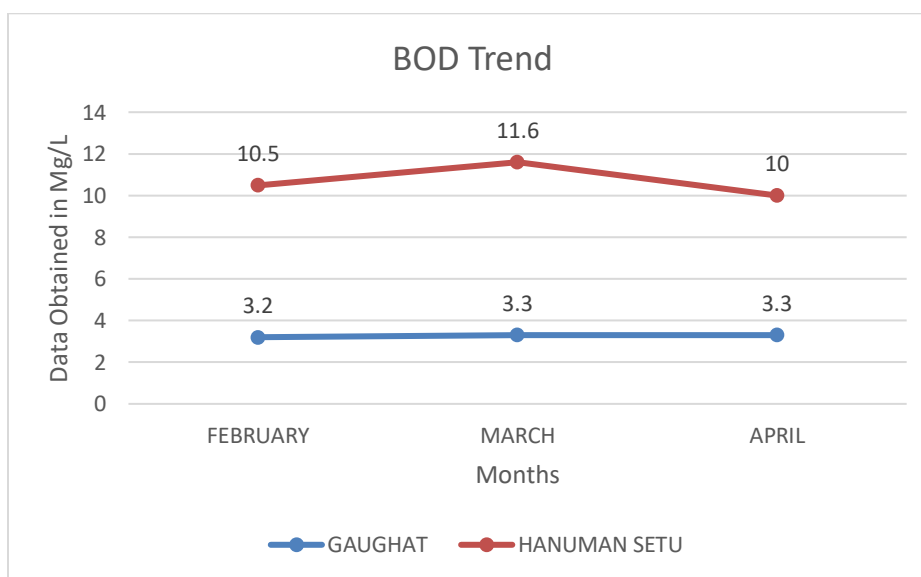
**Fig.25.** Incubator



**Fig.26.** Inside view of Incubator

- Final Dissolved Oxygen (DO) Measurement: After the incubation period, carefully remove a BOD bottle from the incubator, being cautious not to disturb any settled solids.
- Measure the final dissolved oxygen level using the same method used for the initial DO measurement.
- Blank Control: To account for any changes in dissolved oxygen due to the incubation process or other factors, prepare a blank control. This is a BOD bottle filled with sterile water that undergoes the same incubation process as the sample bottles. Measure the initial and final DO levels of the blank control as well.
- Calculation: Calculate the BOD value using the formula:  $BOD = (Initial\ DO - Final\ DO) - (Initial\ DO\ of\ Blank\ Control - Final\ DO\ of\ Blank\ Control)$ . The result is typically reported in mg/L or ppm.
- Quality Control: Perform any necessary quality control checks to ensure the accuracy and reliability of the results. This may include running duplicate samples or using control standards to validate the analysis.
- Reporting: Record the BOD value obtained for the water sample and any relevant details such as location, date, and time of analysis. Compare the result to regulatory standards or guidelines to determine the level of organic pollution in the water.

**Graphical Representation of BOD have been studied in two different sites:**



**Graph.8. BOD trend of Gaughat & Hanuman Setu in February, March & April in 2023.**

## **CHLORIDE:**

Chloride testing of water is a process used to measure the concentration of chloride ions (Cl<sup>-</sup>) in a water sample. Chloride ions are a form of dissolved salt and are commonly found in natural water sources, such as rivers, lakes, and groundwater.

Chloride testing is important for several reasons:

- **Salinity Assessment:** Chloride levels in water can provide an indication of the overall salinity or saltiness of the water. High chloride levels suggest increased salinity, which may impact the water's suitability for various purposes, such as drinking water, irrigation, or industrial use.
- **Source Identification:** Elevated chloride levels in water can indicate potential contamination from industrial discharges, road salts, sewage, or other sources. Monitoring chloride levels helps identify potential pollution sources and assess their impact on water quality.
- **Corrosion Assessment:** High chloride concentrations in water can contribute to the corrosion of metal pipes and infrastructure. Testing chloride levels aids in evaluating the corrosive potential of water and helps implement appropriate corrosion control measures.

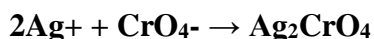
## **EXPERIMENT 9: CHLORIDE**

**PRINCIPLE:** The principle of chloride testing in water is based on a chemical reaction known as the silver nitrate titration method. This method is commonly used to determine the concentration of chloride ions (Cl<sup>-</sup>) in a water sample.

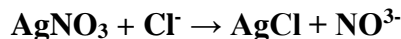
**MATERIALS REQUIRED:** Water sample, Conical Flasks, Potassium Chromate, Silver Nitrate Solution

### **PROCEDURE:**

- Take 50ml sample in a conical flask.
- **Indicator:** Potassium chromate (K<sub>2</sub>CrO<sub>4</sub>) is commonly used as an indicator in this test. It forms a reddish-brown precipitate of silver chromate (Ag<sub>2</sub>CrO<sub>4</sub>) in the presence of excess silver ions.



- Silver Nitrate Solution: A standardized solution of silver nitrate ( $\text{AgNO}_3$ ) is prepared. Silver nitrate reacts with chloride ions to form a white precipitate of silver chloride ( $\text{AgCl}$ ).



- Titration: A water sample is taken and a few drops of the potassium chromate indicator solution are added as shown in Fig.27.



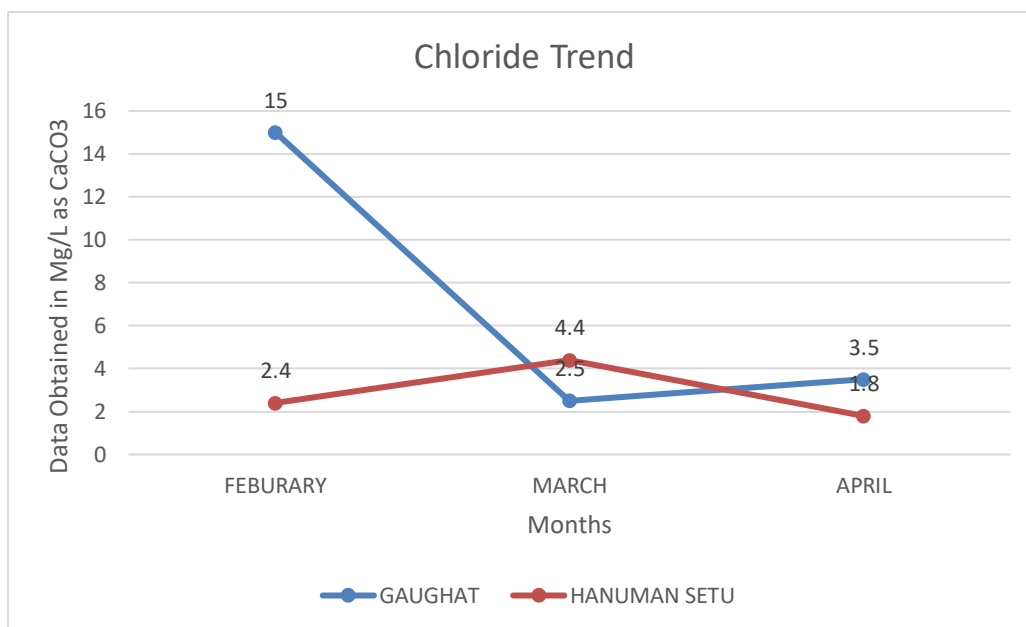
Fig.27.50ml sample+  $\text{K}_2\text{CrO}_4$

- The silver nitrate solution is then slowly added to the sample while stirring until the appearance of a reddish-brown color indicates that all chloride ions have reacted and the solution is saturated with silver ions. The endpoint of the titration is reached when the reddish-brown color persists.
- Calculation: The volume of the silver nitrate solution used for titration is recorded. From this, the concentration of chloride ions in the water sample can be determined using stoichiometry. The molarity of the silver nitrate solution and the volume of the water sample are used to calculate the concentration of chloride ions.

It is important to note that this is a simplified explanation of the principle behind chloride testing in water. There may be variations in the specific procedures or additional steps depending on the testing method or equipment used. It is always recommended to refer to the specific guidelines or protocols provided by the testing laboratory or manufacturer for accurate and precise chloride analysis.



### Graphical Representation of Chloride have been studied in two different sites:



Graph.9. Chloride trend of Gaughat & Hanuman Setu in February, March & April in 2023.

### ALKALINITY:

The alkalinity of water refers to its capacity to resist changes in pH when an acid is added to it. It is a measure of the water's ability to neutralize acids and maintain a relatively stable pH level. Alkalinity is primarily influenced by the presence of certain ions, particularly bicarbonate ( $\text{HCO}_3^-$ ), carbonate ( $\text{CO}_3^{2-}$ ), and hydroxide ( $\text{OH}^-$ ) ions.

When an acid is added to water, it reacts with alkaline substances present in the water, leading to the consumption of acid and preventing a significant drop in pH. This buffering capacity is crucial in maintaining the stability of aquatic ecosystems and protecting organisms living in the water.

Alkalinity is usually expressed in terms of milligrams per liter (mg/L) or parts per million (ppm) of equivalent calcium carbonate ( $\text{CaCO}_3$ ). The term "equivalent calcium carbonate" is used because the alkalinity of water is typically measured by titration with an acid, and the results are reported as the amount of acid required to neutralize the alkaline substances present. High alkalinity in water can occur naturally in areas with high concentrations of alkaline minerals or as a result of human activities such as the discharge of certain industrial or domestic

wastewaters. Low alkalinity, on the other hand, can make water more susceptible to rapid changes in pH, which can be detrimental to aquatic life.

### **EXPERIMENT 10: ALKALINITY**

**PRINCIPLE:** The principle of alkalinity analysis of water involves measuring the water's capacity to neutralize acids. Alkalinity is a measure of the water's buffering capacity and its ability to resist changes in pH when acids are added. It is primarily determined by the presence of carbonate ( $\text{CO}_3^{2-}$ ), bicarbonate ( $\text{HCO}_3^-$ ), and hydroxide ( $\text{OH}^-$ ) ions in the water.

**MATERIALS REQUIRED:** Water sample, Conical flasks, Burette, Pipette, Distilled water, pH meter or indicator strips, Methyl Orange, Sulfuric Acid

#### **PROCEDURE:**

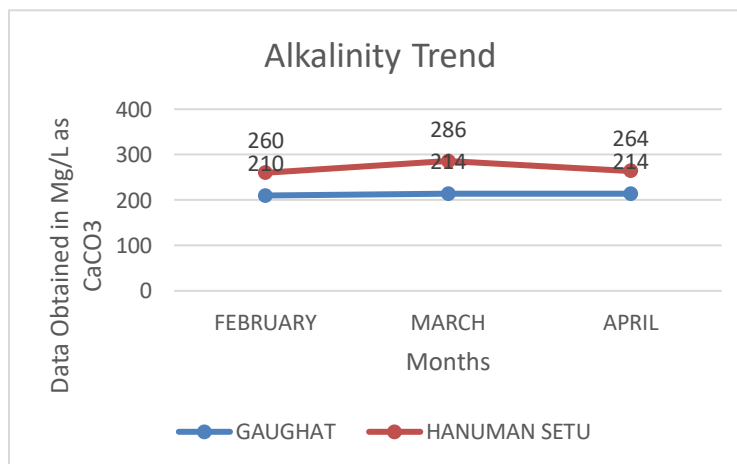
- Prepare the water sample: Collect a representative sample of the water to be tested in a clean and dry container. If the sample is turbid or contains suspended particles, filter it through a filter paper or a suitable filtration apparatus.
- Preparation of the acid solution: Dilute the sulfuric acid solution to a suitable concentration based on the expected alkalinity of the water sample. The exact concentration will depend on the anticipated alkalinity range and the volume of the sample being tested. Typically, a concentration of 0.02 N (normal) or 0.02 M (molar) is used.
- Calibration of the pH meter (if using): If you're using a pH meter, calibrate it according to the manufacturer's instructions. Use standard pH buffer solutions of known pH values (e.g., pH 4 and pH 7) to calibrate the meter.
- Indicator preparation: Prepare a methyl orange indicator solution by dissolving a small amount of methyl orange powder (Fig.28) in distilled water. The concentration is not critical, but a concentration of approximately 0.1% should be sufficient.
- Titration:
  - a. Transfer a measured volume of the water sample (e.g., 50 mL) into a clean conical flask using a graduated pipette.
  - b. Add a few drops of the methyl orange indicator solution to the water sample. The color should change from orange to yellow.



**Fig.28. 50ml sample + Methyl Orange**

- c. Start adding the sulfuric acid solution from the burette into the conical flask, while swirling the flask gently.
  - d. Continue adding the acid solution drop by drop until the color changes from yellow to pink. This color change indicates the endpoint of the titration.
- Record the volume of the acid solution: Note the volume of the acid solution ( $H_2SO_4$ ) used from the burette to reach the endpoint. This volume represents the amount of acid required to neutralize the alkalinity of the water sample.
  - **Calculation:**
    - a. Convert the volume of acid solution used to the equivalent volume of pure sulfuric acid.
    - b. Determine the alkalinity of the water sample using the appropriate conversion factors. The alkalinity is typically expressed in terms of milligrams per liter (mg/L) or parts per million (ppm) of equivalent calcium carbonate ( $CaCO_3$ ).

**Graphical Representation of Alkalinity have been studied in two different sites:**



**Graph.10. Alkalinity trend of Gaughat & Hanuman Setu in February, March & April in 2023.**

## RESULT AND DISCUSSION

After analyzing the various physicochemical parameters such as pH, Conductivity, Dissolve Oxygen, Hardness, Calcium, Chemical Oxygen Demand (COD), Total Dissolve Solid (TDS), Biological Oxygen Demand (BOD), Chloride, Alkalinity we collected the data from the given Upstream & Downstream site respectively.

Let's have a look at the table given below:

S.No.	Parameters	Units	FEBRUARY	MARCH	APRIL
			Gaughat/ Hanuman setu	Gaughat/ Hanuman setu	Gaughat/ Hanuman setu
1.	pH	-	8.36/7.37	8.41/7.38	8.43/7.77
2.	Conductivity	µmho/cm	359.2/596.8	382.6/709.8	533.2/736.1
3.	Dissolved Oxygen	Mg/L	9.6/1.5	6.9/1.3	7.19/2.9
4.	Hardness	Mg/L as CaCO <sub>3</sub>	196.0/238	200.0/242	196/240
5.	Calcium	Mg/L as CaCO <sub>3</sub>	80/100	82.0/98	78/90
6.	COD	Mg/L	15.6/47.6	16.0/52.4	15.2/43.6
7.	TDS	Mg/L	226/370	242/434	251/447
8.	BOD	Mg/L	3.2/10.5	3.3/11.6	3.3/10.0
9.	Chloride	Mg/L as CaCO <sub>3</sub>	15.0/34	17.0/37	14.0/32
10.	Alkalinity	Mg/L as CaCO <sub>3</sub>	210.0/260	214.0/286	214/264

**Table.4. Analysis of Various Water Parameters**

LOCATION	WQI	WQS
	a. Gaughat	182.02
b. Hanuman Setu	277.244	Severely Polluted

**Table.5. WQI & their status at different locations**

## **CONCLUSION**

Conclusion Regarding How Health Benefits Are Affected by Water Quality. Water of a high standard is not only acceptable for human consumption but also beneficial to both human health and that of both animals and plants, as it contains essential nutrients and other elements required for survival. Domestic sewage, farms, industries, mining, quarries, and cooling are just a few examples of the many various sources of pollution. Pollutants come in many different forms, such as naturally occurring organic matter, living things, plant nutrients, organic and inorganic compounds, sediments, and heat. The economic, physical, and social well-being of the populace depend heavily on the availability of high-quality water. Maintaining dependable and secure water sources and removing any potential health hazards associated with water contamination need continuous testing and monitoring of water quality.

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