# “Analyzing the Statistical Quality of India's River and Ground Water: Gunaamrit Study”

**Dr. Deepika Bhatia[1], Shiva Khatter[2] , Vaibhav Mudgal[3] , Yatharth Sharma[4]**

*[1]Assistant Professor at Vivekananda School of Engineering & Technology*
*VIPS-TC, New Delhi, India*
*[2,3,4]Sholars of Artificial Intelligence and Data Science at Vivekananda School of Engineering & Technology*
*VIPS-TC, New Delhi, India*

## ABSTRACT

India’s rivers play a crucial role in the country’s economy, providing water for agriculture, hydropower, and transportation. However, many of India’s rivers are facing significant challenges, including pollution, over-extraction of water, and climate change. In this research paper, focus was to analyze the current state of India’s rivers and identify potential solutions to address these challenges. The analysis shows that India’s rivers are facing significant challenges that require urgent attention and action from all stakeholders. The research paper focuses on the comparative analysis of water quality measures based upon various parameter that affects water quality. Ground water and River water quality analysis is done. The paper also presents various solutions, such as strengthening water management policies, investing in pollution control measures, promoting cleaner technologies and practices, restoring river ecosystems, and raising public awareness, to conserve India’s rivers for future generations.

***Keywords—****Hydropower, Pollution, Climate change, State of India's rivers, , Water management policies etc.*

## I. INTRODUCTION

India has many waterways which are essential for the country's economy and society. India's waterways support hydropower, transportation and a variety of habitats for many plants and mammals. Despite their importance, many waterways in India face many challenges. The Government of India has initiated various programs and procedures to isolate and monitor India's water bodies, including the National River Conservation Plan, the Ganga Basin Management Plan and the National Water Mission. However, these works face several challenges such as incompetent practice, lack of capital and lack of public knowledge and partnership. River management in India is a complex and challenging problem due to multiple factors such as climate change, population growth, industrialization and unsustainable water management

practices. The administration has come up with various tactics and programs, to some extent the National River Conservation Scheme, the National Water Policy and the National Clean Ganges Mission, to address the challenges of managing India's waterways. One of the most important procedures in managing India's waterways is the implementation of river basin management plans. These plans aim to create a comprehensive basis for the sustainable management of water resources, taking into account environmental, public and economic concerns. The Agency has continued to implement several measures to control the pollution of water bodies so that the fulfilment of the guidelines to prevent pollution from the work and sewage situation, the system guiding the organization of disposal sites and the publication of the results of detergents are guaranteed. Easier with anti-pollution measures, the administration launched a few waterway restoration and revitalization projects, such as the Namami Gange program to clean and restore the Ganges detention basin. The program includes measures such as the creation of landfills, the promotion of chemical-free agriculture and the protection of wetlands and riverbanks. However, professionals continue to encounter significant misconduct in the management of Indian waterways, such as lack of self-imposition of procedures and programs, incompetent capital and money, and conflicting interests with partners.

More professional coordinated efforts and collaborative approaches to whole river management with complex partners are needed to ensure sustainability of waterway environment and water resources in India. The purpose of this research is to address the current state of India's water bodies and find possible answers to the challenges they face. The paper is divided into various sections that provide an overview of India's waterways, the challenges they face and possible solutions to address these issues. The article uses several sources, including peer-reviewed research, case studies and expert opinion, to provide a comprehensive analysis of the topic.

## II. LITERATURE REVIEW

India has a complex and different hydrological plan, accompanying abundant waterways and watersheds connecting across the country. The country's bigger waterways are the Ganges, Brahmaputra, Sabarmati (Thaker R. (2016)), Yamuna, Godavari, Krishna, Kaveri, Narmada, and Tapi. These waterways spring from the Himalayan Mountains, the Western Ghats, and the Eastern Ghats, and flow into the Bay of Bengal, the Arabian Sea, and the Indian Ocean. The hydrology of waterways in India is affected by various determinants in the way that migratory precipitation, snowmelt, groundwater revitalize, and anthropogenic projects. The cyclone season, that spans from June to September, causes most of the annual precipitation in India and is the basic beginning of surface water for waterways.

Sargaonkar et. al. (2003) considered about overall index of dirtiness of Indian waterway water condition located upon limit like Dissolved oxygen, BOD, pH, Turbidity, Hardness, Arsenic, and Fluoride, Total separated solid residue from liquid solution, Total Coliforms. In current age, trend change has considerably

jolted the hydrology of waterways in India. Changes in hotness, rain, and land-use patterns have changed the organize and capacity of water chance in many waterway basins, chief to more repeated and harsh floods and drynesses. Water administration in India is a fault-finding issue, and the administration has achieved various tactics and programs to address the country's water challenges. These involve the National Water Policy, the National River Conservation Plan, and the National Mission for Clean Ganga, between possible choice. However, skilled are still important break in water government and foundation that need expected discussed to guarantee tenable water administration in India.

Girolami, M. et al (2003) discussed about pattern recognition techniques and used Principal component analysis (PCA) and hierarchical cluster analysis (CA), based upon various parameter like EC, pH, TDS, NH4, NO3, NO2, Turbidity, Total Hardness, Ca, Mg, Na, K, Cl, SO4, SiO2. India has a rich diversity of river ecosystems, which support a wide range of aquatic and terrestrial biodiversity. The rivers in India can be classified into several types based on their ecological characteristics, such as Himalayan rivers, coastal rivers, and peninsular rivers. The preservation of waterways in India is affected by several determinants, containing water chance, flow patterns, sedimentation, and dirtiness. The Himalayan waterways, that originate from the snow and snowmelt in the Himalayas, are from extreme flow instability and are important for experiencing the ecological and human schemes coming after. Coastal waterways, in another way, are concerned apiece tidal influence of the sea and support various singular amphibious and earthly environments. However, many of these rivers are further densely jolted by dirtiness, clear-cutting, and become worn of water resources. environments. The biodiversity of waterway environments in India is endangered by various determinants, including residence depravity, obtrusive class, overfishing, and contamination. The management has implemented various procedures and programs to save and replace waterway environments in India, such as the National River Conservation Plan, the Wildlife Protection Act, and the National Mission for Clean Ganga. However, skilled are still meaningful challenges in saving and replacing waterway environments in India, and more concerted works are necessary to guarantee the sustainability of these detracting environments.

Roy R. et. al. (2018) studied conventional methods and artificial neural network to measure the hardness from Water Quality Parameters by Artificial Neural Network. The study proposed a model to predict the hardness of water with water quality parameters that have high correlations with hardness. Experiments were done based upon field data and results indicate that the model was successful in predicting the hardness of water accurately with a high correlation of 0.92.

## III. METHODOLOGY

The figure 1 given below show the methodology opted the system implementation. Initially, dataset from the government website was taken, after preprocessing and cleaning steps; data aggregation, data filtering,

and data manipulation was done to create a structured and organized dataset that is fit for analysis The processing involved removing any inconsistent readings, ensuring that all data points were within the expected range, and dealing with any missing or incomplete data. Then data visualization is done to make individual plots for each parameter against the tested states. Various machine learning techniques are applied to check for acceptability of polluted states' rivers water quality (Roy R. (2019)).

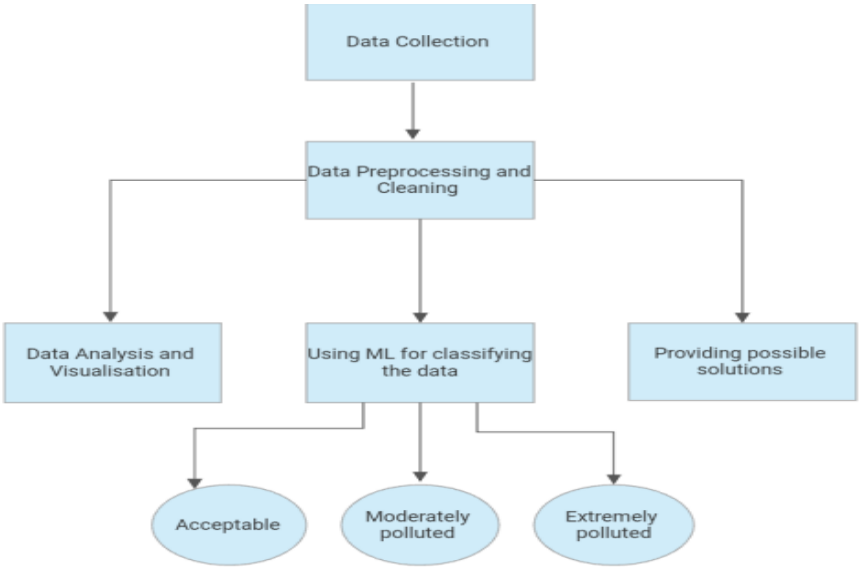


**Figure 1: Block diagram of the system**

## IV. RESULTS

The Central Pollution Control Board (CPCB) website is a primary source of water quality data in India. In the India's water quality analysis project, data was collected from the website and processed to ensure that it is clean, consistent, and suitable for analysis. This involved several steps, such as removing missing or erroneous data, standardizing units of measurement, and resolving inconsistencies in data formatting. Once the data was cleaned and processed, it was ready for analysis. To explore the data and identify patterns and trends, data visualization tools were used. These tools allow us to create graphs, charts, and maps that help to communicate our findings effectively whilst doing exploratory data analysis. By visualizing the data in various formats, we can identify relationships between different variables and gain insights into the factors that affect water quality in different regions of India. The use of data visualization tools in the India's water quality analysis project has proven to be particularly useful. By creating visual representations of the data, we were able to communicate complex information in a simple and intuitive way. We have done data analysis and its visualization on the following parameters: The results show various visualization of river water data based on different parameters. The table 1 and table 2 below shows

the sample data set for ground water of AP state and river water of various states along with all its parameters.

**Table1: Ground water parameters of Indian Rivers**

| S.No | STATE | pH | Conductivity | BOD | Nitrate N | Faecal Coliform | Total Coliform | Total Dissolved Solids | Fluoride |
|---|---|---|---|---|---|---|---|---|---|
| 1 | AP | 7 | 776 | 2 | 9 | 3 | 70 | 782 | 1 |
| 2 | AP | 8 | 620 | 2 | 4 | 4 | 70 | 623 | 1 |
| 3 | AP | 8 | 759 | 2 | 2 | 5 | 84 | 764 | 0 |
| 4 | AP | 7 | 2536 | 3 | 23 | 6 | 93 | 2576 | 1 |
| 5 | AP | 8 | 2203 | 2 | 25 | 4 | 78 | 2242 | 0 |
| 6 | AP | 8 | 1363 | 2 | 4 | 3 | 25 | 1214 | 1 |
| 7 | AP | 8 | 717 | 2 | 3 | 6 | 82 | 711 | 1 |
| 8 | AP | 8 | 7516 | 2 | 9 | 8 | 135 | 7654 | 1 |
| 9 | AP | 7 | 1610 | 1 | 7 | 3 | 12 | 1333 | 1 |
| 10 | AP | 7 | 2448 | 1 | 11 | 4 | 18 | 2006 | 1 |
| 11 | AP | 8 | 1275 | 2 | 2 | 3 | 18 | 1164 | 1 |
| 12 | AP | 7 | 1540 | 1 | 6 | 3 | 9 | 1211 | 1 |
| 13 | AP | 7 | 4799 | 1 | 6 | 2 | 8 | 4241 | 1 |
| 14 | AP | 8 | 701 | 2 | 3 | 3 | 93 | 680 | 1 |

**Table2: River water parameters of Indian Rivers**

| LOCATIONS | STATE | TEMP | DO | pH | Conductivity | BOD | Nitrate_N_ Nitrate_N | Fecal_ Coliform | Total_ Coliform |
|---|---|---|---|---|---|---|---|---|---|
| Amaravati, Guntur Dist., A.P | AP | 27.6 | 7 | 7.8 | 669 | 0.6 | 0.4 | 2 | 1613 |
| Godavari At Basara, Adilabad | AP | 28 | 5.5 | 8.1 | 826 | 1.7 | 1 | 27 | 161 |
| Godavari At Bhadrachalam D/S Bathing Ghat, Khammam | AP | 20.2 | 5.6 | 8 | 462 | 0.8 | 1 | 3 | 5280 |
| Godavari At Burgampahad, Khammam | AP | 19.8 | 6.1 | 7.9 | 666 | 1.8 | 0.84 | 2 | 1160 |
| Godavari At Mancherial, A.P. | AP | 29.5 | 4.1 | 9.1 | 518 | 16.5 | 0 | 240 | 900 |
| Godavari At Polavaram, A.P. | AP | 27 | 6.2 | 7.7 | 380 | 1.2 | 1.56 | NA | 170 |
| Godavari At Rajahmundry U/S, A.P. | AP | 26.6 | 6.1 | 7.4 | 480 | 1.3 | 1.98 | 3 | 432 |
| Godavari At Rajamundry D/S Of Nalla Channel | AP | 26.8 | 5.9 | 7 | 315 | 1.2 | 1.29 | 23 | 1100 |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Godavari At Rajamundry U/S Of Nalla Channel | AP | 26.6 | 5.8 | 6.9 | 290 | 1.2 | 2.4 | 48 | 628 |

### *A. Temperature:*

The temperature of rivers in India varies widely depending on the season and location. Rivers in mountainous regions generally have lower temperatures, ranging from 5-20°C, while those in lower altitude regions can reach up to 40°C. Changes in water temperature affects the dissolved oxygen levels in the water, as well as the growth and reproduction of aquatic organisms. High water temperatures decrease the amount of dissolved oxygen in the water, making it difficult for fish and other aquatic organisms to breathe. Changes in water temperature also trigger changes in the timing of reproductive cycles, migration patterns, and feeding habits of aquatic species. Ideal temperature according to BIS standards is between 15 to 30 degree Celsius. Figure 2 below shows the temperature parameter of different rivers in various states of India.

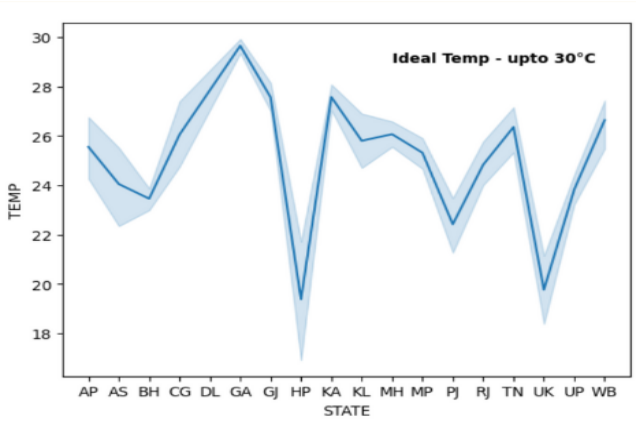


**Figure 2: Temperature analysis of river water**

### *B. Dissolved Oxygen (DO)*

Dissolved oxygen (DO) is the amount of oxygen that is dissolved in water. The dissolved oxygen levels in rivers of India can vary depending on various factors such as the location, weather conditions, season, and pollution levels. The dissolved oxygen levels in several major rivers of India were found to be below the acceptable limits. Figure below shows the DO parameter of different rivers in various states of India. Ideal level is between 4 to 6 mg/L. Figure 3 below shows the DO level of river water data and total dissolve solid levels for ground water data

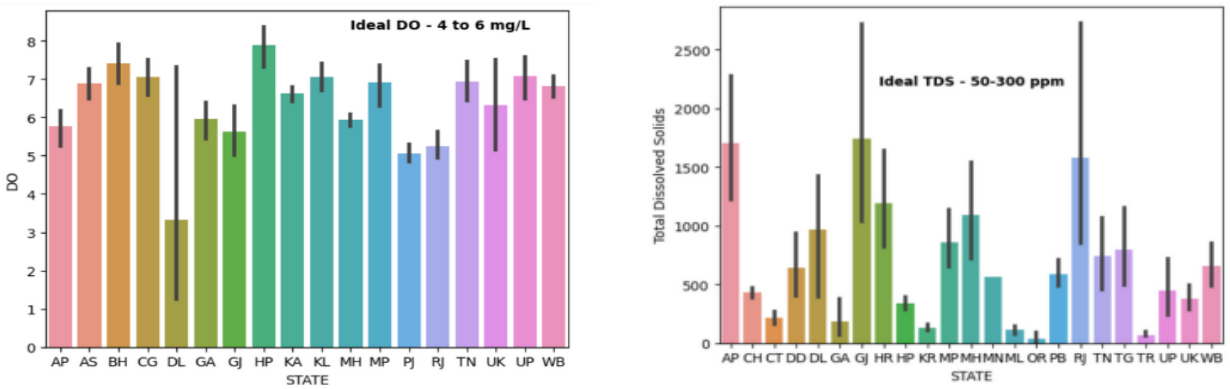


**Figure 3: DO level analysis of river water and dissolve solid levels for ground water data**

### *C. pH:*

pH is a measure of the acidity or basicity of a solution, such as water. The pH scale ranges from 0 to 14, with 7 being neutral. A pH below 7 indicates acidity, while a pH above 7 indicates basicity. Extreme pH levels can lead to the death of aquatic organisms and also have negative impacts on human health. The pH level of a river also affects the solubility of nutrients and pollutants, which further impacts the water quality. Figure below shows the pH parameter of different rivers in various states of India. It shows the pH level of river water data. Result show that pH of all the bodies were fond to be within the range. The range for BIS standard for river water and ground water is 6.5 to 8.5

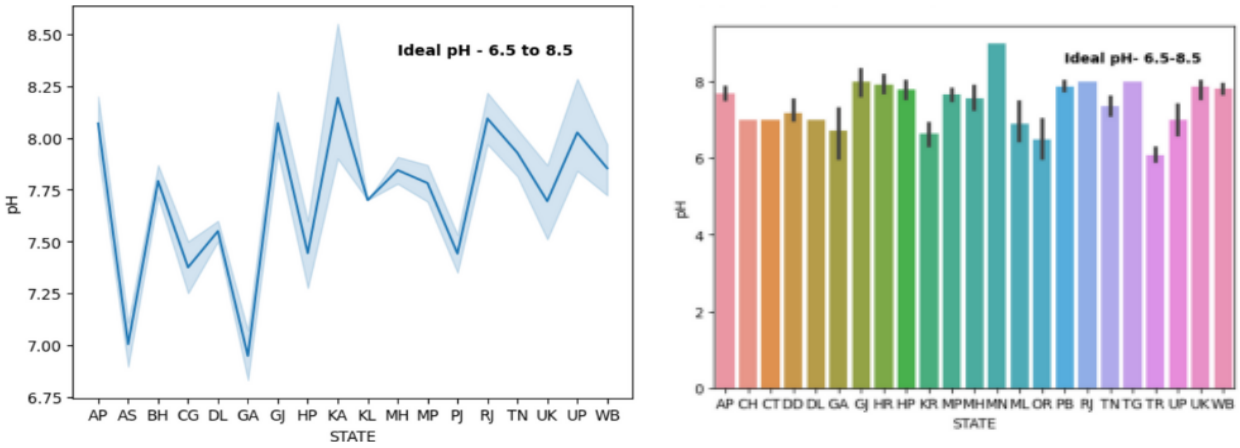


**Figure 4: pH level analysis for river and ground water data**

### *D. Conductivity:*

Conductivity is a measure of the ability of water to conduct electricity and is a key indicator of the total dissolved solids (TDS) present in the water. High conductivity levels in rivers can indicate the presence of pollutants, particularly dissolved salts, and heavy metals, which can have negative impacts on aquatic life and human health. Figure5 below shows the conductivity parameter values of different river water and ground water data for various states of India. Conductivity level standard value is upto 50 mg/L for river water.

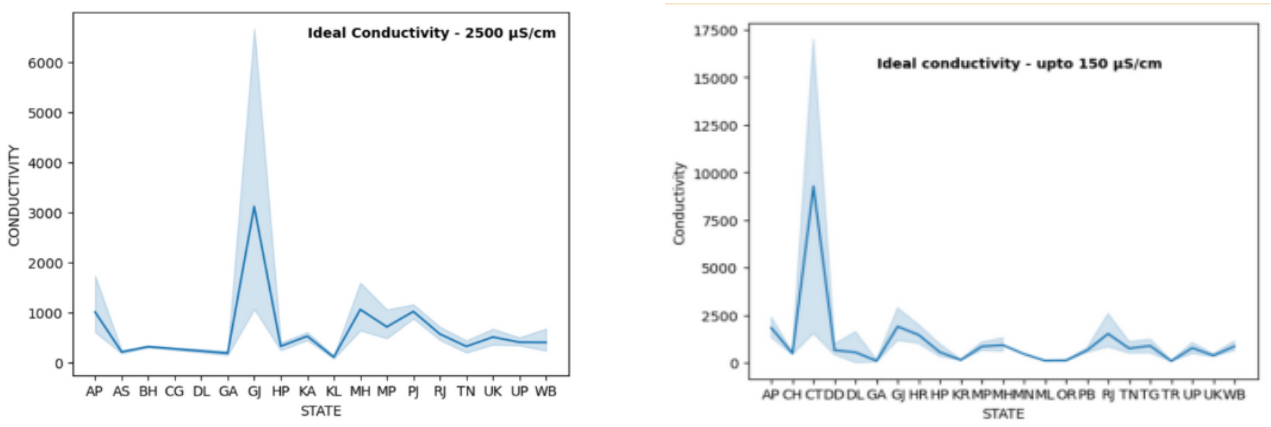


**Figure 5: Conductivity analysis of river and ground water data**

### *E. Biochemical Oxygen Demand (BOD):*

Biochemical Oxygen Demand (BOD) is a measure of the amount of dissolved oxygen needed by microorganisms to break down the organic matter present in water. High levels of BOD in rivers can indicate the presence of high levels of organic pollution, such as untreated sewage and agricultural runoff. Figure6 below shows the BOD parameter for river and ground water data of different rivers in various states of India. Ideal BOD for river water is 50 mg/l and for ground water its value is 1 to 2 ppm.

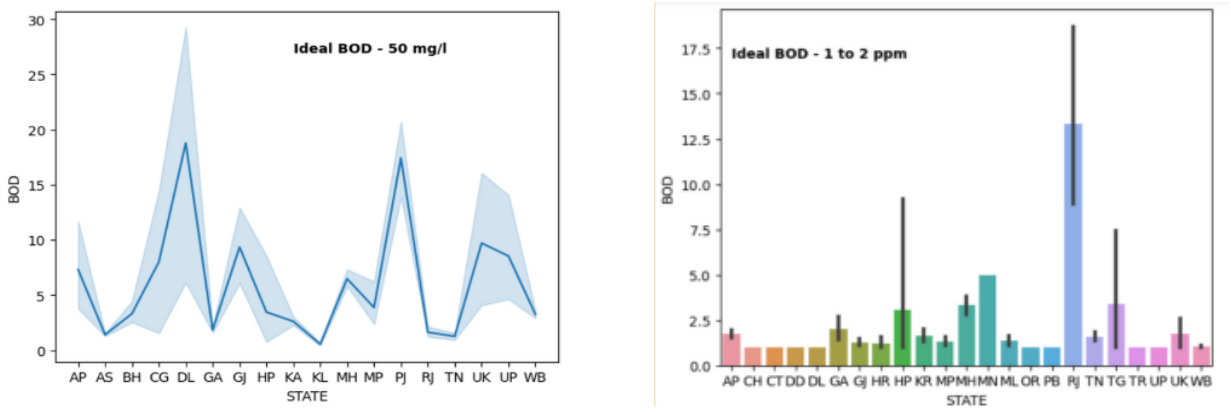


**Figure 6: BOD level analysis for river and ground water data**

### *F. Nitrate N Nitrite N:*

Nitrate and nitrite are forms of nitrogen that are present in water bodies and can originate from various sources such as agricultural runoff, untreated sewage, and industrial effluents. High levels of nitrate and nitrite can have negative impacts on aquatic life and human health. Regular monitoring of the nitrate and nitrite levels in rivers is essential for identifying and managing potential sources of pollution, and for ensuring the health of the aquatic ecosystem and the availability of clean water for various purposes. Figure7 below shows the Nitrate parameter-river and ground water of different rivers in various states of India.

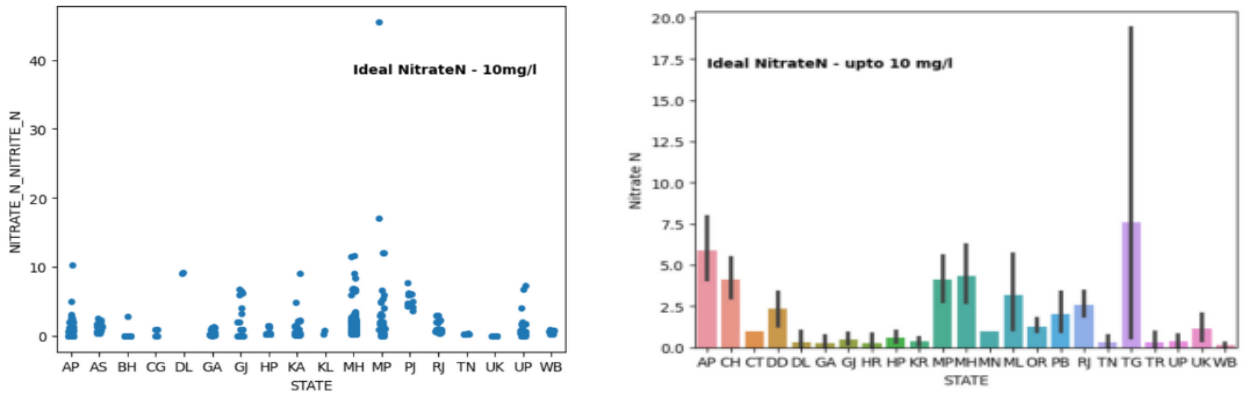


**Figure 7: Nitrate level analysis of river and ground water data**

### *G. Fecal Coliform:*

Fecal coliform is a type of bacteria that is commonly found in the intestines and feces of animals, including humans. The presence of high levels of fecal coliform in rivers is an indicator of contamination by untreated sewage, animal waste, or other sources of human or animal fecal matter. Figure8 below shows the Fecal parameter of different rivers in various states of India.

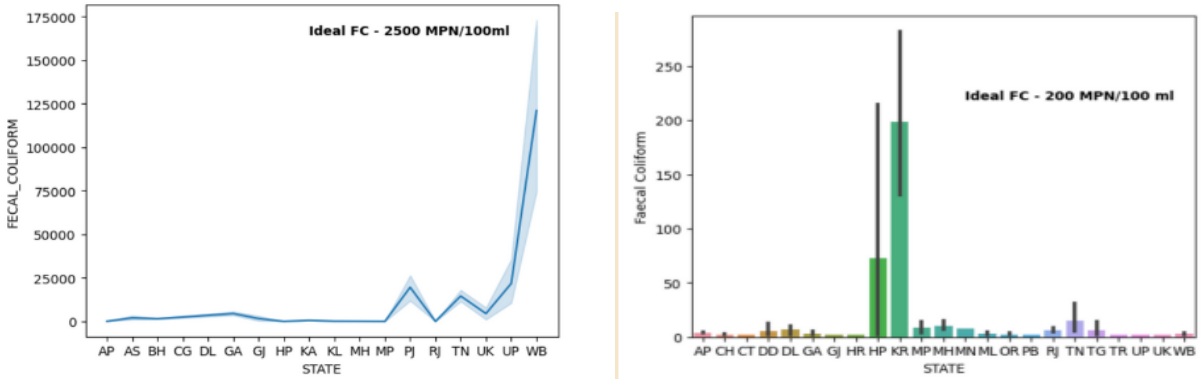


**Figure 8: Fecal level analysis of river and ground water**

### *H. Total Coliform:*

Total coliform is a type of bacteria that is commonly found in the environment, including soil, water, and vegetation. Total coliform is used as an indicator of water quality, as its presence in water bodies can indicate contamination by fecal matter, sewage, or other sources of pollution. Figure9 below shows the Total Coliform parameter of different rivers in various states of India.

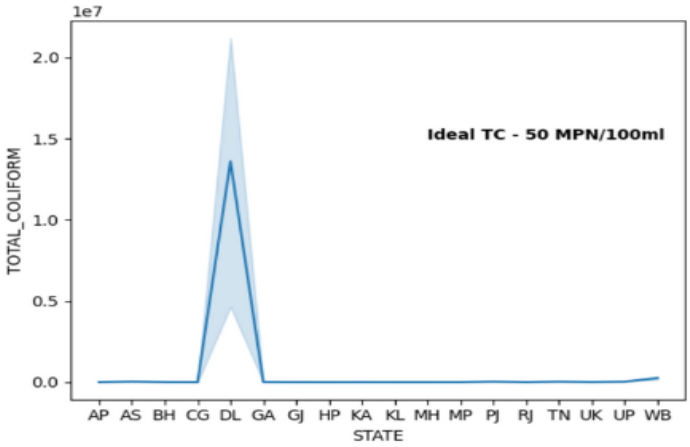


**Figure 9: Total Coliform level analysis**

## V. CONCLUSION AND FUTURE WORK

In conclusion, India supports an expansive range of maritime and earthly biodiversity. However, the country's waterways are covering various challenges, containing dirtiness, become worn of water money, clear-cutting, and surroundings change. To guarantee the sustainability of waterway environments and water possessions in India, skilled is a need for more coordinated exertions and cooperative approaches between all partners complicated in waterway administration. Overall, waterway administration in India is a complex and disputing issue, but it is essential for the environmental, public, and business-related welfare of the country. With tenable and cooperative approaches, it is attainable to overcome the challenges and guarantee the unending sustainability of India's waterways and water possessions. We attained SDG 6 goal focusing on ensuring a clean and stable water supply and effective water sanitation for all people. In future, machine intelligence and machine intelligence methods will be used to analyse and envision waterway and water status limits.

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