

# Web based IoT System for Monitoring and Visualizing Qualitative and Quantitative Data of River

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## Article History:

**Received:** 12-10-2024

**Revised:** 15-11-2024

**Accepted:** 01-12-2024

**Abstract:** Rapid urbanization, industrial effluents, agricultural runoff, and climate variability have increasingly degraded river water quality and disrupted natural flow patterns. Traditional monitoring methods—based on manual sampling and lab analysis—lack real-time capability and scalability. This study presents a real-time river monitoring system built on an Internet of Things (IoT) architecture using a Raspberry Pi microcontroller. The system connects to environmental sensors (pH, turbidity, temperature, dissolved oxygen, and flow rate) for on-site data acquisition and processing. Sensor data is transmitted to the ThingSpeak cloud platform, enabling remote access and real-time visualization via interactive dashboards. Optional GIS and satellite integration enhance geospatial insights. The system offers a reliable, cost-effective, and scalable solution for continuous monitoring, early pollution detection, and informed water resource management—providing a practical alternative to conventional methods for sustained environmental oversight.

**Keywords:** River Monitoring, Water Quality, Real-time Data, Environmental Sustainability, Pollution Detection. ThingSpeak.

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## 1.Introduction

Rivers and other freshwater habitats are essential for biodiversity as well as for human needs like industry, transportation, irrigation, and drinking water. Urbanization, agriculture, industrial discharge, and climate change have all contributed to the decline of river quality, especially in places where real-time monitoring isn't available. Traditional approaches have low temporal resolution, are expensive, and take a lot of time, despite their accuracy.

By using sensor networks to detect water quality metrics like pH, turbidity, temperature, dissolved oxygen, and conductivity, real-time river monitoring is now possible thanks to developments in IoT, embedded systems, and cloud computing. This allows for early intervention.

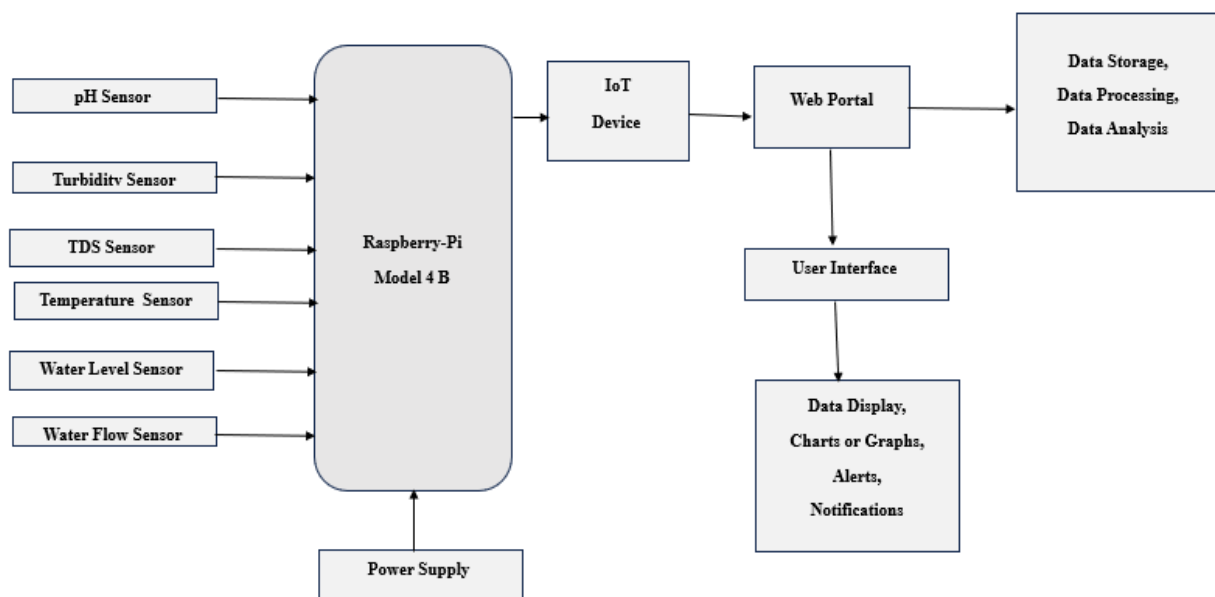
Using a Raspberry Pi and built-in sensors, this study introduces an Internet of Things system that streams data to the ThingSpeak cloud for real-time visualization. The system supports timely environmental management and river conservation since it is self-sufficient, scalable, and an effective substitute for conventional techniques

## 2. Literature Survey

Real-time, economical tracking of water quality has been made possible by the incorporation of IoT into environmental monitoring [1]. While Wireless Sensor Networks (WSNs) provide continuous remote monitoring [2], early methods relied on Arduino-based sensors for basic parameter detection [1]. ZigBee was popular at first [3], but for better scalability, newer systems prefer Wi-Fi and GSM [4]. Real-time analytics improve accessibility, and cloud platforms are essential for data visualization and storage [5]. Decision-making and the prediction of contamination trends are further supported by machine learning models [6]. Due of their versatility, inexpensive microcontrollers such as Arduino and Raspberry Pi are being used extensively [7][8]. In fluctuating aquatic settings, precise sensor calibration is still crucial [9]. The global quest for sustainable, IoT-driven infrastructure is exemplified by large-scale smart water programs [10].[11].

These investigations verify that scalable, precise, and predictive river water monitoring systems rely on low-cost microcontrollers, cloud dashboards, contemporary wireless connectivity, and machine learning models.

## 3. Methodology



**Figure 1 : System Architecture of Proposed System**

With a Raspberry Pi serving as the primary controller, this project deploys an Internet of Things-based system for real-time river water monitoring. Through ADCs, it communicates with waterproof sensors that measure temperature, turbidity, pH, TDS, water level, and flow rate. For threshold warnings, historical trends, and real-time visualization, data is periodically gathered and sent to the ThingSpeak cloud by Wi-Fi or cellular modules.

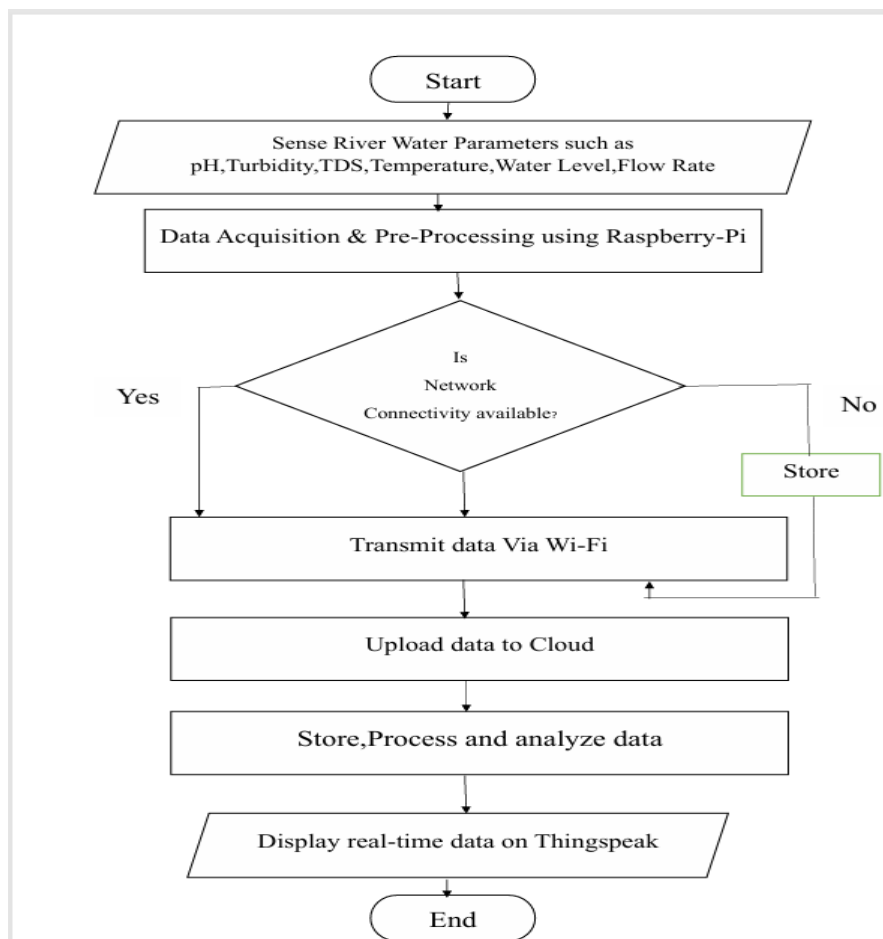


Figure 2: Flowchart of Proposed System

#### 4. Real-Time Monitoring of River Water Parameters

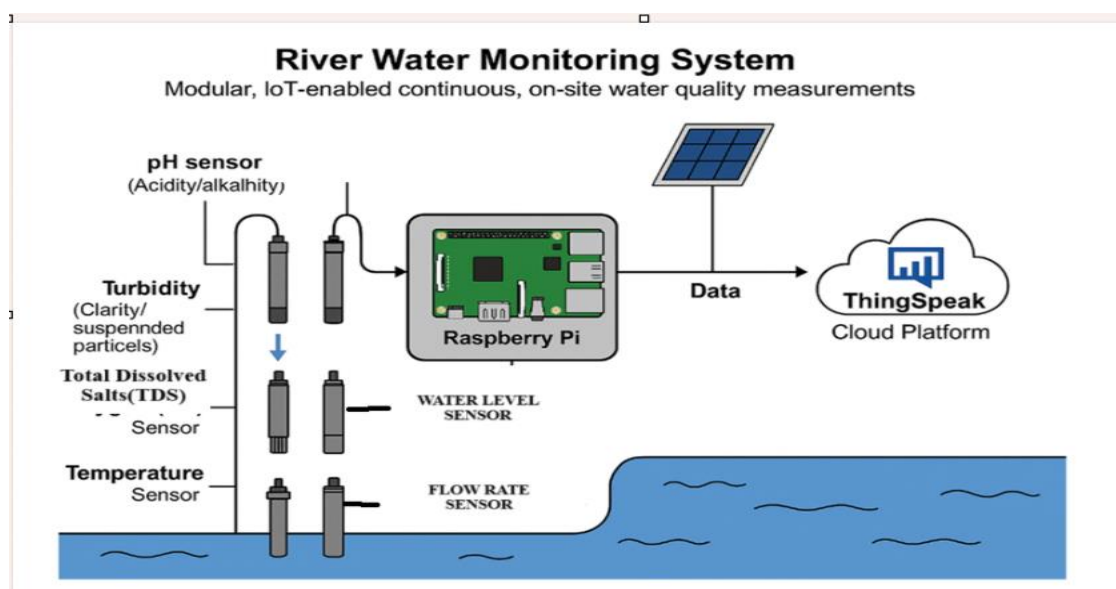


Figure 3: Data Collection And Sensor Deployment for River monitoring

The system's primary goal is to continuously monitor river parameters in real time, both qualitatively and quantitatively. pH, turbidity, TDS, temperature, flow rate, and water level are measured at key river points via sensors that are connected to a Raspberry Pi 4B. Through a web dashboard that stakeholders can access, data is sent to the ThingSpeak cloud via the Pi's built-in Wi-Fi, allowing for historical tracking and real-time visualization for prompt environmental decisions.

### 5. IOT Based Data Acquisition & Communication

Another goal of this research is to create an Internet of Things-based system for ongoing river monitoring. A Raspberry Pi 4B, chosen for its processing capacity and integrated wireless capabilities, connects to a number of sensors (pH, turbidity, TDS, temperature, flow, and water level) that are positioned at three points along the Gunjavani River in Bhor.



**Figure 4(a): Water Sample1 at Inflow of Gunjavani River Bandhara**

Sample 1 had the highest level (65%) with clean water (TDS 312 ppm, turbidity 5 NTU, pH 7.23).



**Figure 4(b): Water Sample2 at outflow of Gunjavani River Bandhara**

Sample 2 showed strongest flow (85 L/s) but worst quality (TDS 456 ppm, turbidity 16 NTU, pH 6.83).



**Figure 4(c): Water Sample1 at Pool zone of Gunjavani River Bandhara**

Sample 3 had the lowest level (16%) and moderate quality (TDS 336 ppm, turbidity 10 NTU, pH 7.32).

Temperatures were consistent (~24–26 °C), enabling ongoing environmental assessment.

## 4.2. Multi-Source Water Sampling in River Monitoring

Although river monitoring is the main emphasis, hydrological context was supplied by additional observations from neighbouring sources, including spring inflows, wells, forest streams, and filtered water. These sources either have an impact on the environment of the river or provide as standards for system validation and sensor calibration. All of the sources listed provided real-time observations.

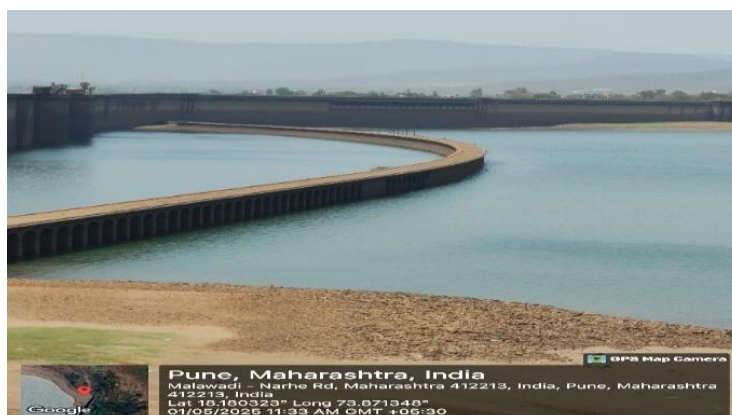
### 4.2.1. Water Sample 4 : Spring Water



**Figure 5 :Water Sample 4 : Spring Water**

With low TDS (104 ppm), low turbidity (5.23 NTU), low flow (15.12 L/s), and level (20.84%), the spring water sample demonstrated clean natural conditions and validated successful data collection.

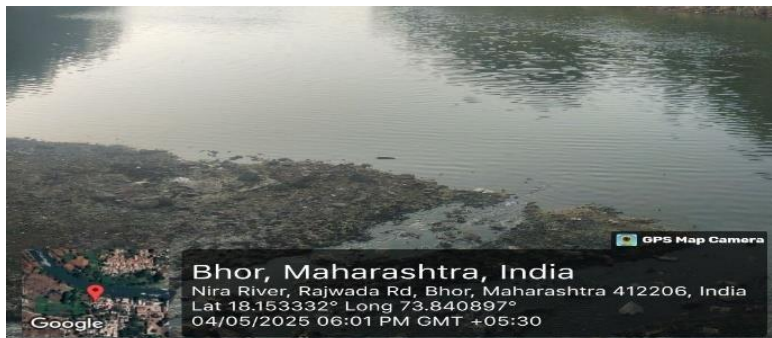
### 4.2.2. Water Sample 5 : Pool zone of Bhatghar Dam



**Figure 6 :Water Sample 5- Pool zone of Bhatghar Dam**

Good quality and dependable data transmission were confirmed at Bhatghar Dam by the high water level (95.84%) and flow (90.64), moderate TDS (310 ppm), turbidity (8.92 NTU), consistent pH (7.20), and temperature (24.84 °C).

#### 4.2.3. Water Sample 6 : Urban Polluted River -Nira River



**Figure 7:Water Sample 6 Urban Polluted (Nira) River**

With verified real-time data transmission, the Nira River sample collected by IoT sensors revealed excessive turbidity (25.21 NTU) and TDS (652 ppm), indicating contamination.

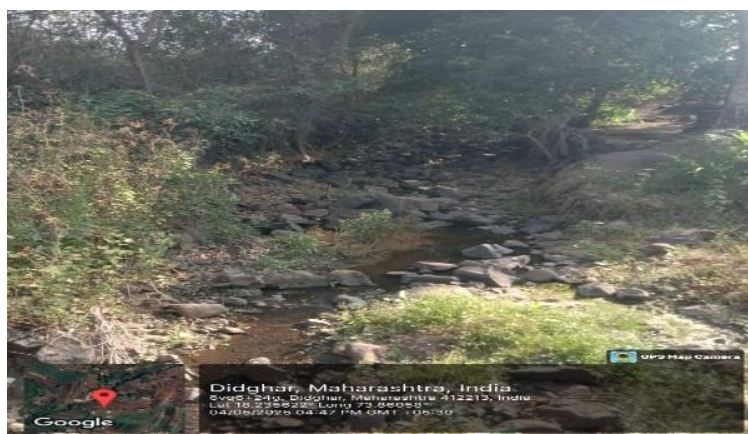
#### 4.2.4. Water Sample 7 : Groundwater Well



**Figure 8 :Water Sample 7 : Groundwater(Well)**

With dependable real-time data transfer, the groundwater well displayed a high level (88.57%), moderate flow (10.21), and elevated TDS (851 ppm) and turbidity (12.53 NTU), all of which suggested pollution.

#### 4.2.5 Water Sample 8 : Forest Stream



**Figure 9 :Water Sample 8 : Forest Stream**

Clean water was indicated by the woodland stream sample's near-neutral pH (7.05), acceptable TDS (215 ppm), low turbidity (4.36), and moderate flow (20.34). **4.2.6. Water Sample 9 : Lake Shore**



**Figure 10 :Water Sample 9 : Lake Shore**

Indicating satisfactory quality and trustworthy data (0.31–2.65V), the lake shore sample showed high water, active flow, moderate TDS/turbidity, and stable pH (7.25) and temperature (24.9°C).

**.4.2.7. Water Sample 10 : Filtered Water**



**Figure 11 :Water Sample 10 : Filtered Wate**

Effective purification was demonstrated by the filtered water's moderate levels (60.15%), low flow (5.54), low turbidity (0.86 NTU), and TDS at 559 PPM. Stable temperature (23.84°C), clean voltage, and nearly neutral pH (7.56) all attest to precise monitoring.

#### 4.2.8. Summary Of Observation of water Quality & quantity parameters from different Sources

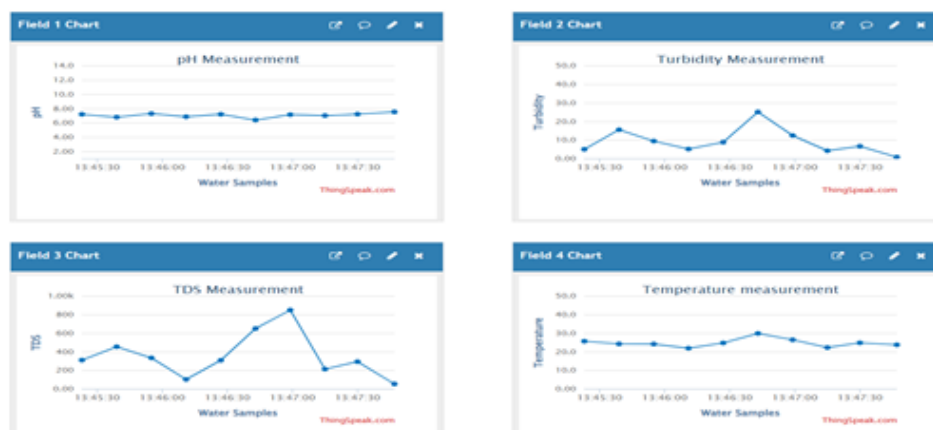
**Table 1: Observation of water Quality & quantity parameters from different Sources**

Water Sample Id	Source	Water Level (%)	Flow Rate	TDS (PPM)	Turbidity	pH	Temp(°C)
1	Gunjavani River (Inflow at Bandhara)	65.23	33.31	312	5.11	7.23	25.77
2	Gunjavani River (Outflow at Bandhara)	45.26	85.46	456	15.63	6.83	24.32
3	Gunjavani River (Pool Zone Bandhara)	15.65	47.50	336	9.53	7.32	24.23
4	Spring Water	20.84	15.12	104	5.23	6.89	21.99
5	Bhatghar Dam	95.84	90.64	310	8.92	7.2	24.84
6	Urban River Polluted (Nira River)	65.23	40.39	652	25.21	6.43	29.98
7	Groundwater (Well)	88.57	10.21	851	12.53	7.18	26.54
8	Forest Stream	30.12	20.34	215	4.32	7.05	22.35
9	Lake Shore	75.82	55.48	295	6.71	7.25	24.90
10	Filtered Water	60.15	5.54	55	0.89	7.56	23.84

By situating the river's conditions within a more comprehensive environmental and analytical framework, the inclusion of such many readings strengthens the study's robustness.

#### 6. Data Visualization on ThingSpeak

Using ThingSpeak, a web-based visualization system was created to facilitate real-time river monitoring. The monitoring equipment sends sensor data to ThingSpeak, which stores it in time-series format and displays it through specific channels and dashboards. This data includes water level, flow rate, temperature, pH, TDS, and turbidity.



**Figure 12(a) : Visualization of qualitative parameters**

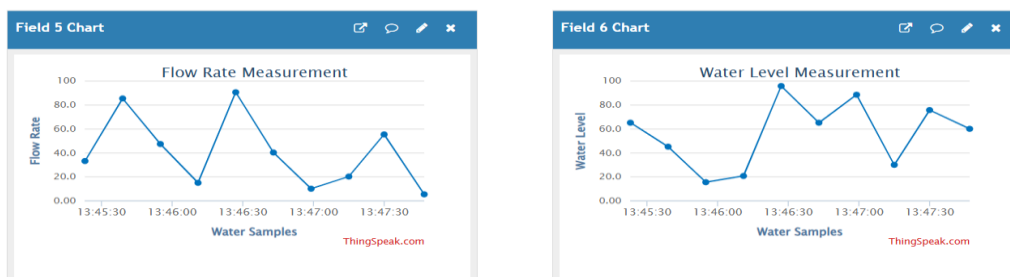


Figure 12(b) : Visualization of quantitative parameters

### 6.1 Custom Alerts with Threshold Values

Environmental standards are used to determine thresholds for important factors that will help identify problems early: pH (6.5–8.5), turbidity ( $\leq 50$  NTU), TDS ( $< 500$  ppm), temperature ( $< 30^\circ\text{C}$ ), water level (site-specific flood limits), and flow rate (usually  $< 150$  L/s).

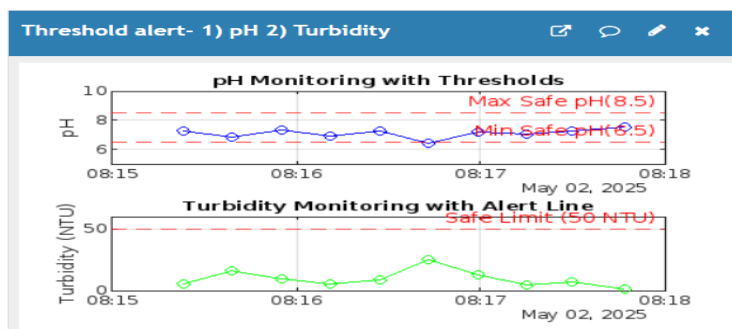


Figure 13(a). Qualitative Data Visualization with custom alerts for for pH,Turbidity

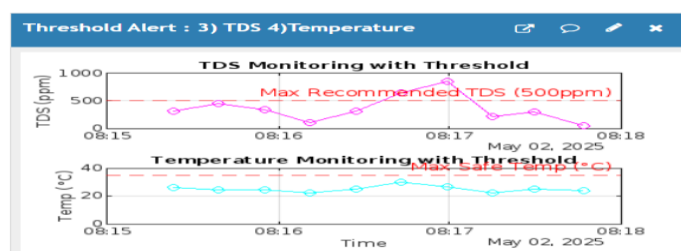


Figure 13(b). Qualitative Data Visualization with custom alerts for TDS,Temperature

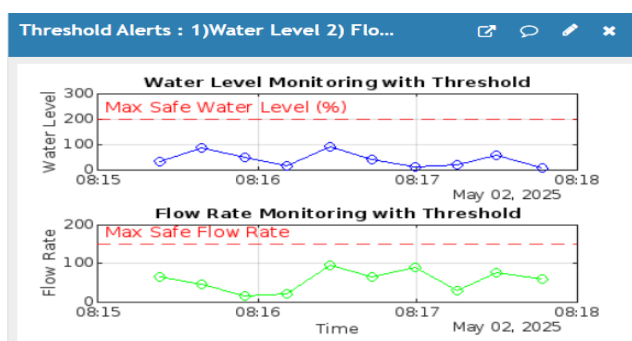
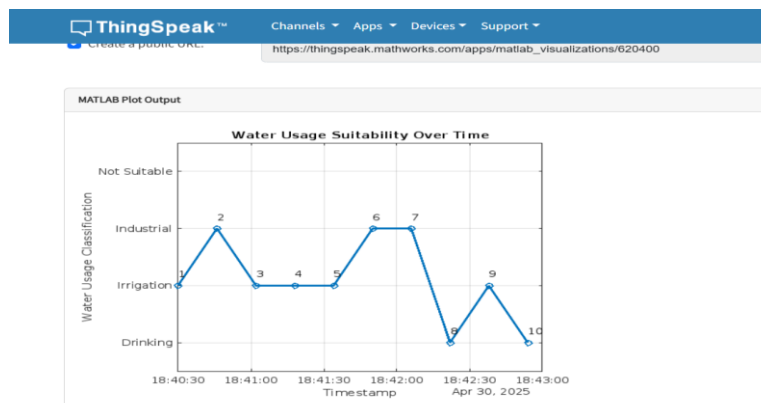


Figure 13(C). Quantitative Data Visualization with custom alerts for Water level,Flow Rate

## 7.Data Interpretation of River Parameters



**Figure 14: Data Interpretation on Thingspeak Dashboard**

In order to identify patterns and hazards to the health of rivers, this Internet of Things technology converts real-time sensor data into insights. In order to identify high-risk areas, ThingSpeak was used to evaluate data from ten sites, including inflows, springs, and reservoirs. MATLAB was utilized for averages, deviations, and event detection. Water usage suitability was classified as follows using a MATLAB-generated plot: Drinking (1, 5, 8), Irrigation (3, 4), Industrial (2, 6, 7), and Not Suitable (9, 10). While filtered and spring water had low values, urban river and well samples had high TDS (652–851 PPM) and turbidity (12.53–25.21 NTU). Flow and temperature varied per source, and the majority of pH values were close to neutral (6.8–7.5).

## 8.Results and Discussion

The IoT-based monitoring system was set up at locations along the Gunjavani River in Bhor to continuously monitor important water quality and quantity metrics. The ThingSpeak cloud received data from smart sensors that monitored pH, turbidity, temperature, TDS, water level, and flow rate.

Figure 15's comparative study demonstrated consistent sensor performance across a range of scenarios. TDS was within allowable bounds, turbidity varied with rainfall and disturbances, and pH ranged from neutral to slightly alkaline (7.1–8.3). Water level and flow rate recorded environmental variations, while temperature followed diurnal trends.

Real-time data visualization was made possible for trend analysis and decision-making through a web-based dashboard. Additionally, threshold-based notifications for early warnings were offered by the system. The results show that IoT may be used to monitor rivers autonomously and in real time. This provides a low-maintenance, scalable alternative for water management and research.

## 9.Conclusions

Enhancing environmental oversight and data-driven action has been made possible by the web-based Internet of Things system designed for real-time river water monitoring. Key factors including pH, turbidity, TDS, temperature, and flow are precisely tracked by the system using a Raspberry Pi and built-in sensors. Targeted interventions and prompt anomaly detection are made possible by real-time visualization using ThingSpeak. Human effect is shown in elevated turbidity and TDS in urban inflows, whereas steady values in spring and filtered water signify improved quality. The system's

wireless design makes it a useful tool for sustainable river management because it guarantees dependable functioning even in remote areas.

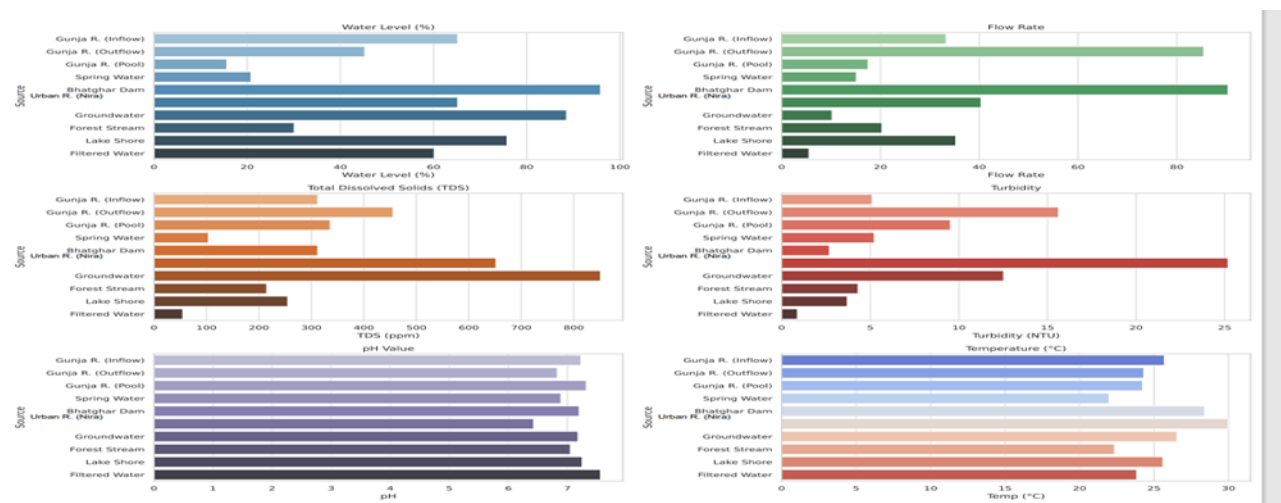


Figure 15: Comparative Analysis Water Quality & Quantity Parameters

## 10.Future Scope

The river monitoring system will be improved in the future with self-cleaning sensors to lower maintenance and biofouling. By using edge computing for anomaly detection and localized data processing, cloud dependence would be reduced. In remote locations, hybrid connectivity—GSM, LoRa, and satellite—would enhance data transfer. By mapping pollution sources and flow patterns, GIS integration would improve environmental analysis. Adding conductivity, ammonia, and nitrate to the sensor array would provide further information on the quality of the water. These developments would turn the system into a sustainable, scalable way to monitor rivers in real time and manage ecosystems.

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