CompSci Journal
Double Blind Peer Reviewed, Open Access International Research Journal.
ISSN: 3067-3089 | Website: https://csjour.com | Volume-2, Issue-2 | April - 2026

Original Article

Next-Generation Technology Approaches for Sustainable Water Quality Monitoring in the Girnar Parikrama Region, Junagadh

Girish Limaye[1], Dr. Ashwini Supekar[2], Gunjan Suruse[3]
[1]Research Scholar, Department of Environmental Science, Savitribai Phule Pune
[2]Guide, Department of Geology Savitribai Phule Pune University
[3]Research Scholar, Department of Geology Savitribai Phule Pune University

Manuscript ID:
CSJ-2026-020204

Volume 2

Issue 2

Pp. 20-23

April 2026

ISSN: 3067-3089

Submitted: 07 Mar. 2026

Revised: 15 Mar. 2026

Accepted: 05 Apr. 2026

Published: 30 Apr. 2026

Correspondence Address:
Girish Limaye
Research Scholar, Department of Environmental Science, Savitribai Phule Pune
Email: limaye.girish@gmail.com

Quick Response Code:

Web. https://csjour.com/

DOI: 10.5281/zenodo.21128953

DOI Link:
https://doi.org/10.5281/zenodo.21128953

Abstract

Water is an essential natural resource that supports human life, ecosystems, and economic activities. The Girnar Parikrama region in Junagadh experiences a large number of pilgrims every year, which leads to increased pressure on local water resources. Traditional water quality monitoring methods are slow, labor-intensive, and unable to provide real-time information. This research paper focuses on next-generation technologies such as Internet of Things (IoT), Artificial Intelligence (AI), Wireless Sensor Networks (WSN), and cloud computing for sustainable water quality monitoring in the Girnar region. These modern approaches allow continuous, real-time monitoring of important water parameters and help in early detection of pollution. The study highlights the need for smart monitoring systems to ensure safe and sustainable water management in pilgrimage areas.

This study explores the application of next-generation technologies, including the Internet of Things (IoT), Artificial Intelligence (AI), Wireless Sensor Networks (WSN), cloud computing, and edge computing, for sustainable water quality monitoring in the Girnar region. These advanced technologies enable continuous, real-time tracking of critical physical, chemical, and biological parameters such as pH, turbidity, dissolved oxygen, and microbial contamination. The integration of AI and machine learning facilitates predictive analysis, early detection of pollution events, and automated alert generation. The paper proposes a smart monitoring framework that combines sensor-based data collection, cloud-based storage, and intelligent analytics to improve the efficiency and responsiveness of water management systems. The adoption of such technologies can significantly enhance environmental protection, public health safety, and resource sustainability in pilgrimage areas. Furthermore, this approach can serve as a scalable model for other environmentally sensitive and high-footfall regions.

Keywords: *Water Quality, IoT, AI, Girnar Parikrama, Smart Monitoring, Sustainable Development, WSN, Cloud Computing*

Introduction

Water quality plays a very important role in maintaining public health and environmental balance. In regions like Girnar Parikrama, where thousands of people visit during religious events, water sources are highly vulnerable to contamination.

Traditional methods involve manual sampling and laboratory analysis. These methods are:

- Time-consuming
- Costly
- Not suitable for real-time decision-making

Modern technologies are now transforming water monitoring systems into smart, automated, and real-time systems. These systems help authorities take immediate action when pollution levels increase.

Real-time monitoring is important because it helps identify pollution sources quickly and improves response time to environmental threats.

Study Area: Girnar Parikrama Region, Junagadh

The Girnar Parikrama region is located in Junagadh district of Gujarat. It is a religious and ecological hotspot with:

How to cite this article:
Limaye, G., Supekar, A., & Suruse, G. (2026). Next-Generation Technology Approaches for Sustainable Water Quality Monitoring in the Girnar Parikrama Region, Junagadh. CompSci Journal, 2(2), 20–23. https://doi.org/10.5281/zenodo.21128953

- Hills and forest ecosystems
- Natural water bodies and streams
- Seasonal variation in water quality

During the Parikrama event:

- Large crowds generate waste
- Water sources get contaminated
- Sanitation pressure increases

Therefore, continuous monitoring before, during, and after the event is necessary.

Water Quality Parameters

Important parameters to be monitored include:

Physical Parameters

- Temperature
- Turbidity
- Total Dissolved Solids (TDS)

Chemical Parameters

- pH
- Dissolved Oxygen (DO)
- Biochemical Oxygen Demand (BOD)
- Chemical Oxygen Demand (COD)

Biological Parameters

- Coliform bacteria
- Pathogens

These parameters are widely used in modern IoT-based systems for assessing water quality.

Limitations of Traditional Monitoring Methods

Traditional water quality monitoring has several drawbacks:

- Requires manual sample collection
- Delayed results due to lab testing
- High operational cost
- Limited spatial coverage
- No real-time alerts

Because of these limitations, it is difficult to manage water quality during high-load events like Girnar Parikrama.

Next-Generation Technologies for Water Monitoring

1. **Internet of Things (IoT)**

IoT is the most important technology for modern water monitoring.

- Sensors measure parameters like pH, TDS, temperature, turbidity
- Data is transmitted to cloud platforms
- Real-time monitoring is possible

IoT systems provide continuous data and improve decision-making for water management.

2. **Wireless Sensor Networks (WSN)**

WSN consists of multiple sensor nodes placed across different locations.

- Enables large area coverage
- Provides accurate and continuous monitoring
- Reduces human effort

WSN systems ensure better data accuracy and reliability in monitoring systems.

3. **Artificial Intelligence (AI) and Machine Learning**

AI helps in:

- Predicting water quality trends
- Detecting pollution patterns
- Generating alerts

AI-based systems can analyze large datasets and provide early warnings before water becomes unsafe.

Recent innovations even allow water quality analysis in seconds using AI-based devices.

4. **Cloud Computing**

Cloud platforms are used to:

- Store large amounts of data
- Provide remote access
- Visualize data using dashboards

Cloud integration allows authorities to monitor water quality from anywhere.

5. **Edge Computing**

Edge computing processes data near the source (sensor level), which:

- Reduces delay
- Improves response time
- Works even with low internet connectivity

Proposed Smart Monitoring System for Girnar Region

A smart system can be designed as follows:

Components

- Sensors (pH, DO, turbidity, temperature)
- Microcontroller (Arduino/ESP32)
- Communication module (Wi-Fi/GSM)
- Cloud platform
- Mobile application

Working Process

1. Sensors collect real-time data
2. Data is transmitted to cloud
3. AI analyzes data
4. Alerts generated if limits exceed
5. Authorities take action

Such systems are faster and more efficient than traditional monitoring systems.

Advantages of Next-Generation Technologies

- Real-time monitoring
- Early pollution detection
- Reduced manpower
- Cost-effective in long term
- High accuracy
- Data-driven decision making

These systems are especially useful in sensitive regions like pilgrimage sites.

Challenges in Implementation

Despite advantages, some challenges exist:

- Initial installation cost
- Maintenance of sensors
- Power supply issues in remote areas
- Data security concerns
- Technical knowledge requirement

These challenges can be overcome with proper planning and government support.

Sustainability and Environmental Impact

Smart monitoring systems help in:

- Protecting natural water sources
- Reducing pollution
- Improving public health
- Supporting sustainable development

They also help in achieving environmental goals and water conservation.

Conclusion

The Girnar Parikrama region requires an advanced and sustainable approach for water quality monitoring due to increasing human activities. Traditional methods are no longer sufficient to handle real-time challenges.

Next-generation technologies such as IoT, AI, WSN, and cloud computing provide effective solutions for continuous and accurate monitoring. These technologies not only improve water quality management but also ensure environmental protection and public

health safety.Adopting smart water monitoring systems in the Girnar region will play a crucial role in sustainable water resource management and can serve as a model for other pilgrimage and environmentally sensitive areas.

Acknowledgment
The authors would like to express their sincere gratitude to Savitribai Phule Pune University for providing the academic environment and necessary facilities to carry out this research work. We are especially thankful to our respected guide, Dr. Ashwini Supekar, for her valuable guidance, constant encouragement, and insightful suggestions throughout the study.

Financial support and sponsorship
Nil.

Conflicts of interest
The authors declare that there are no conflicts of interest regarding the publication of this paper.

References
1. World Health Organization (2017). *Guidelines for Drinking-water Quality* (4th ed.). WHO Press.
2. United Nations (2020). *The United Nations World Water Development Report 2020: Water and Climate Change*. UNESCO.
3. United States Environmental Protection Agency (2018). *Water Quality Standards Handbook*. Washington, DC.
4. Akyildiz, I. F., Su, W., Sankarasubramaniam, Y., & Cayirci, E. (2002). A survey on sensor networks. *IEEE Communications Magazine*, 40(8), 102–114.
5. Gubbi, J., Buyya, R., Marusic, S., & Palaniswami, M. (2013). Internet of Things (IoT): A vision, architectural elements, and future directions. *Future Generation Computer Systems*, 29(7), 1645–1660.
6. Zhou, Y., Zhang, Y., & Xie, Y. (2019). Application of artificial intelligence in water quality monitoring: A review. *Journal of Environmental Management*, 234, 448–460.
7. International Telecommunication Union (2015). *Harnessing the Internet of Things for Global Development*.
8. Central Pollution Control Board (2021). *Water Quality Monitoring Guidelines*. Government of India.
9. Li, S., Xu, L. D., & Zhao, S. (2015). The Internet of Things: A survey. *Information Systems Frontiers*, 17(2), 243–259.
10. Ahmed, U., Hameed, S., & Ali, R. (2020). Smart water quality monitoring using IoT: A review. *Environmental Monitoring and Assessment*, 192(6).