

# Water Resource Management – Digital Treatment

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**Abstract :** Water and environmental management offers a multi-disciplinary understanding of water resources and environmental issues. Although the science of water management has experienced significant improvements over the past century, many issues still require the attention of the scientific community. Water bodies are ecological, culturally and economically important ecosystems which provide many valuable services to mankind. Effective management and conservation are vital to ensure this resource remains available for future generations amidst challenges like pollution and climate change. Digital water treatment along with technology solutions, methods of digital water management and drinking water distribution data are addressed and discussed.

**IndexTerms - Universal solvent, water harvesting, digital treatment of water, telemetry, GIS, SCADA and IoT-based solutions.**

## I. INTRODUCTION

Water is the most vital asset in almost every aspect of our lives, and there's no substitute for it. Water-related issues continue to increase and are the defining challenge we might face in the 21st century. With the global population rising, the United Nations predicts a 40% global water supply shortfall by the end of 2030. This would be the case if current consumption and production patterns remain unattended and unchanged.

Water is known as the "universal solvent" due to its ability to dissolve many substances. In this article, the importance of water resource management and how it may affect our lives is introduced. From ecosystem preservation to climate change adaptation, water is important for everyone. Effective management and conservation are vital to ensure this resource remains available for future generations amidst challenges like pollution and climate change. Glancing at literature it is found much attention is needed for addressing challenges in water resource management and environmental issues which may be possible through digital treatment.

## II. INDIA'S RICH TRADITION OF WATER HARVESTING SYSTEMS

The history of India tells us that floods, droughts or both were a perennial occurrence. If the overflow of rivers and streams in spate could be redirected and stored, the water could be used during drought. Even rainfall as low as 100 mm, if harvested properly, can meet the drinking water needs of the people. The practice of harvesting rainwater dates back to Vedic times when the need to create water sources that would remain both clean and provide plentifully was recognized.

Monumental waterworks continued into the early historical era. If the Mahabharata promised the builder of a tank a hundred times more *punya* than would get the digger of a well, it is simply because a tank restores water to the earth, while a well draws from it—simple, but even today we are far from such basic awareness, despite the severe water crisis staring in our face. *Arthashastra*, again, shows prescience by paying minute attention to water management and irrigation techniques.

Kautilya systematically deals with different situations; for instance, he declares, 'No one irrigating his field from a reservoir or tank shall cause danger to the ploughed or sown field of another. The water from a lower tank shall not submerge a field fed from a higher tank built earlier. A higher tank shall not prevent the filling up of a lower tank, except when the latter has not been in use for three years'

## III. DIGITAL WATER TREATMENT

A fundamental change in approach or underlying assumptions in water resource management to prevail over challenges is required. Hence, Digital water treatment [2] is the use of digital technologies to improve the efficiency, effectiveness, and sustainability of water treatment processes. These technologies can be used to monitor water quality, optimize treatment processes, and manage water resources.

Some of the benefits of digital water treatment include:

- Improved water quality: Digital technologies can be used to monitor water quality in real time, which can help to identify and address problems early on.
- Increased efficiency: Digital technologies can be used to optimize treatment processes, which can lead to reduced energy consumption and waste.
- Improved sustainability: Digital technologies can help to reduce the environmental impact of water treatment, such as by reducing the use of chemicals.

There are a number of digital technologies that can be used for water treatment, including:

- **Sensors:** Sensors can be used to monitor water quality in real time. This data can be used to identify problems, optimize treatment processes, and track the performance of water treatment facilities.
- **Telemetry:** Telemetry is the use of sensors to transmit data over long distances. This allows water utilities to monitor water quality and treatment processes from remote locations.
- **Data analytics:** Data analytics can be used to analyze water quality data to identify trends and patterns. This information can be used to improve water treatment processes and make better decisions about water management.
- **Artificial intelligence:** Artificial intelligence (AI) can be used to automate tasks in water treatment plants. This can free up staff to focus on other tasks, such as improving water quality.

Digital water treatment is a rapidly growing field. As the cost of digital technologies continues to decrease, more and more water utilities are adopting these technologies. Digital water treatment has the potential to revolutionize the water treatment industry, making it more efficient, effective, and sustainable.

Digital Water Management takes water monitoring program beyond the data dump to the insights

### Methods for Digital Water Management

Here an overview of water management categories, digital tools to be employed and benefits output are tabulated.

Management Categories	Overview	Digital Tools	Benefits
Drinking Water	Ensure safe and reliable drinking water supply to the community	Smart meters, sensors for real-time monitoring of water quality and flow, automated billing systems.	Improved water quality, efficient billing, reduced water loss
Sewage Management	Efficient treatment and disposal of wastewater	Automated monitoring systems for sewage treatment plants, IoT sensors for tracking system performance, real-time data analytics	Enhanced treatment efficiency, early detection of system failures, compliance with environmental regulations
Rainwater Management	Collection and utilization of rainwater for various purposes	Rainwater harvesting systems with sensors for monitoring water levels, smart distribution systems	Reduced dependence on groundwater, sustainable water usage, flood mitigation
Flood Water Management (Water Network Optimization)	Prevent and manage urban flooding	Real-time flood monitoring systems, predictive analytics for flood risk assessment, automated flood control systems	Early flood warnings, optimized water network, minimized flood damage
Groundwater Management	Sustainable use and protection of groundwater resources	Groundwater monitoring wells with sensors, data analytics for tracking water levels and quality, digital dashboards for decision-making	Improved groundwater management, early detection of contamination, sustainable water supply

### Technology solutions [3]

Various technologies are being deployed to address the prevalent issues in water network management. Automation also has a key role to play, as seen in the use of endobots that are sent into the water pipelines to detect wear and tear. Further, technology for effective management of the water supply network would also lead to enhanced water security.

#### GIS

GIS is an effective tool that is being increasingly used in various projects in the sector. GIS-based mapping enables visualisation of the water network and the creation of detailed maps. Consumer data can also be used to analyse water consumption trends in different areas to ensure adequate water supply. It would also facilitate leak detection and subsequently, help in NRW reduction. For example, the use of GIS aided in reducing NRW in Nagpur from 41 per cent to 39 per cent. The process involved mapping retrofitted pipes and implementing house-to-house connections.

#### SCADA and IoT-based solutions

SCADA systems also prove to be advantageous in the management of water networks. These systems bring together the hardware and software aspects. These systems are also used for addressing NRW levels and ensuring continuous water supply. For instance, Nashik made use of SCADA-based meters in zones of high water consumption for real-time monitoring. Further, Bengaluru adopted digital meters in place of mechanical ones, also facilitating real-time monitoring of water usage.

On related grounds, metropolitan cities are shifting to data-driven systems for the management of water supply through the use of sensor-based technologies. IoT-based sensors were used by IIT Jodhpur for upgrading its 13 km water distribution system to a smart grid. These sensors facilitated real-time monitoring of distribution of water.

#### **AI and integrated digital platforms**

Technologies such as artificial intelligence (AI) have the potential to be leveraged for smart water management. AI tools can also be used for predictive analysis, given their potential to account for numerous factors or variables to predict water demand.

#### **Digital twins**

Digital twins enable different physical assets, processes, systems, etc. to be represented in a digital form, and can be implemented at different scales. A digital twin is a unified model that comprises data originating from various sources and is technology agnostic. All data can be imported to a single cloud-based platform.

#### **The way ahead**

The use of advanced technologies helps reduce NRW levels by a considerable extent, mainly through the enhancement of efficiency. The effective utilisation of these technologies also enables enhanced monitoring of water supply. Technologies such as GIS can be further tapped to map and analyse water supply networks. With the use of IoT sensors, continuous monitoring and optimisation of distribution networks can also be ensured. Additionally, machine learning algorithms can also be used for predictive analysis to understand water demand trends. Looking ahead, these solutions indicate an overall positive outlook for the reduction of NRW, ensuring water security in the future.

### **IV. DRINKING WATER DISTRIBUTION DATA**

In India, for example, over 95% of rural households rely on hand pumps or tube wells, while piped water is the primary source for urban households. Bottled water has become an important source, especially in southern states like Andhra Pradesh, Karnataka, and Telangana.

Over the past two decades, there has been significant progress in improving access to clean drinking water. However, access to tap water in urban areas has been slower to expand.

Despite progress, challenges remain, including pollution, overuse, and climate change-induced water scarcity. Sustainable practices are essential to ensure the availability of clean drinking water for future generations.

#### **CONCLUSION**

Implementing digital drinking water management systems is essential for ensuring a reliable, efficient, and sustainable water supply. By integrating smart technologies like IoT sensors, smart meters, and real-time data analytics, water distribution networks, enhance leak detection, and improve billing accuracy can be optimized. These advancements not only reduce water loss and operational costs but also provide residents with better service and access to clean, safe drinking water. Furthermore, the use of digital tools enables proactive maintenance and swift response to issues, ensuring the longevity and stability of water infrastructure. Embracing digital water management is a vital step toward securing a sustainable future for urban water supply systems.

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