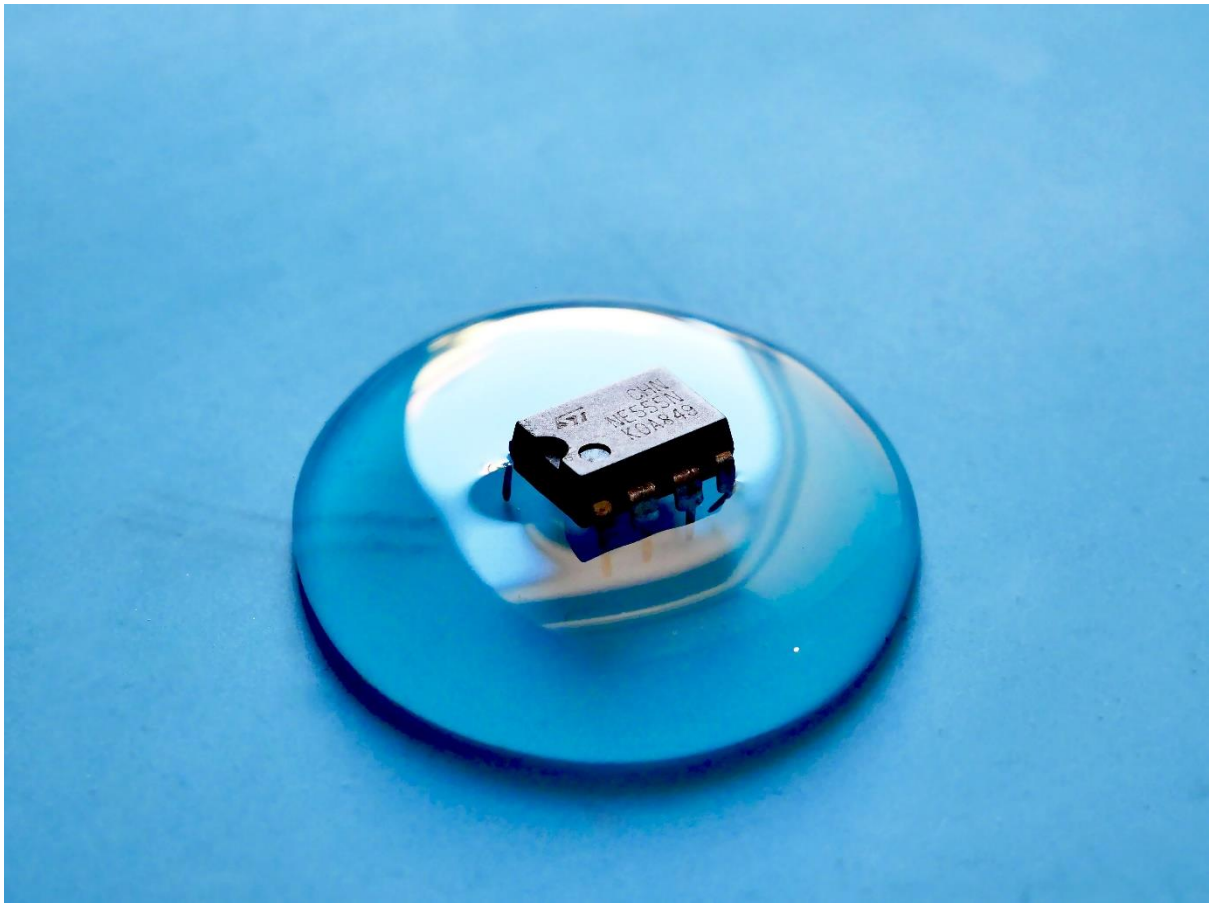
Smart Water Management Technologies: A Way Forward for Achieving Sustainable Development Goals in India



By Shiv Chattrala

Over 2 billion people live in water-stressed countries,[1] and this number is expected to rise due to climate change and speedy population growth. Rapid rural-urban migration will also skew the existing water management systems, which can lead to ultimate water scarcity. It is estimated that almost half of the urban population will reside in water-stressed regions by 2025.[2] Uneven rainfall, inefficient water management systems leading to a mismatch in supply & demand for water, and wastage or overuse of water are the prominent causes of increasing water scarcity.

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[1] *United Nations. 2022. "Drinking-water." World Health Organization (WHO). https://www.who.int/en/news-room/fact-sheets/detail/drinking-water.*

[2] *Bellias, Matt. 2017. "IoT for water utilities: intelligent water management." IBM. https://www.ibm.com/blogs/internet-of-things/iot-for-water-utilities/.*

The per-capita availability of water in India has declined from 1,815 cubic metres in 2001 to 1,545 cubic metres in 2011.[3] As per the United Nations, any region with annual water availability below 1,700 cubic metres per person is a water-stressed region; therefore, India cannot ignore the need to explore the avenues of smart water management for efficient water governance.

According to the Central Water Commission, India is not a water-scarce country; it has a potential water resource of 1,869 billion cubic meters.[4] However, due to leaks or thefts, more than 40% of the water produced in many cities is wasted before reaching the final consumer. As a result, reducing water losses while maintaining water quality and a sufficient supply is critical for the efficiency and financial sustainability of water utilities in Indian cities.

Role of SCADA and IoT in Promoting Efficient Water Management Practices

Fortunately, there is hope in technological innovations that enable smart water management. Examples of these technologies include smart meters, sensors, Supervisory Control and Data Acquisition (SCADA) Systems, Pipe Network Management System (PNMS), and Geographic Information Systems (GIS), which are used to provide consumers with a highly efficient water supply system. Such technologies have the potential to significantly reduce the impact of the growing water crisis.

Technological innovations for smart water management can help achieve sustainable water management. Smart metres, sensors, Supervisory Control and Data Acquisition (SCADA) Systems, Pipe Network Management System (PNMS), and Geographic Information Systems (GIS) are examples of such innovations used to provide consumers with a highly efficient water supply system.

In order to efficiently manage the water distribution systems, urban local bodies (ULBs) are adopting supervisory control and data acquisition (SCADA) systems in their daily operations. SCADA is a control system architecture comprising computers, networked data communications, and graphical user interfaces (GUI) for high-level process supervisory management. Remote monitoring of the water distribution system and its various process parameters, such as water quality, process variables and control elements is possible with the SCADA system. The data and process variables are collected and analysed at the SCADA-based master control station.[5] This facilitates the management of inequitable water distribution issues and reduces the number of complaints.

Similarly, the Internet of Things (IoT) can be explored in greater depth for smart water management to avoid anticipated water crises. The Internet of Things (IoT) is a rapidly expanding network of interconnected devices, sensors, and systems that can collect, share, and analyse data in real time. The key attainable outcomes by using an IoT smart water management system are detecting leakages, quality assurance, matching supply with demand for water, and overall optimization of

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[3] *Economic Times. 2021. "OPINION: Smart water management: Six reasons why some projects fail, Energy News, ET EnergyWorld." ETEnergyworld.com.* https://energy.economictimes.indiatimes.com/news/renewable/opinion-smart-water-management-six-reasons-why-some-projects-fail/82864896.

[4] *Smart Utilities. 2021. "SCADA Control: ULB initiatives for water network management." Smart Utilities.* https://smartutilities.net.in/2021/06/30/scada-control/.

[5] *Smart Utilities. 2021. "SCADA Control: ULB initiatives for water network management." Smart Utilities.* https://smartutilities.net.in/2021/06/30/scada-control/.

resource consumption. Through the IoT, remote monitoring and the use of various sensing technologies for quick responses are used to tackle the challenge of information asymmetry on the amount of water usage.

As part of the Jal Jeevan Mission, the government of India deployed its first sensor-based IoT device in 2021 to monitor rural drinking water supply systems. To ensure functional tap water in every home, real-time measurement and monitoring are critical for the Jal-Jeevan mission. Here, the installation of IoT can enable real-time visibility for state water supply officials, officials of the public health engineering department, and citizens; this can lead to operational efficiencies, cost reduction, and grievance redressal. The use of IoT in the Jal-Jeevan mission includes the deployment of various types of sensors, such as flow metres, ground water level sensors, chlorine analyzers, pressure sensors, pump controllers, and so on, to measure all relevant aspects of water service delivery, such as quantity, duration, quality, pressure, and sustainability. Furthermore, the cloud- and analytics-powered IoT platform is integrated with a GIS, resulting in a robust decision-support system. Data-enabled leak detection, predictive maintenance, and automation enabled by the IoT have aided in the identification of distribution issues such as outages, leaks, low pressure, etc.[6]

The central government recently extended financial support of INR 3.29 crores to a start-up incubated at the IIT, Kanpur, for developing smart water management technologies. An MoU was signed between the Technology Development Board and the start-up for the production and commercialization of the Dhaara smart flow meter.[7] The flow metre is a complete online monitoring system. It employs two-beam ultrasonic flow metres that track water distribution in real time for applications such as drinking water supply, groundwater extraction, industrial water usage, and precision irrigation. The device collects data via sensors, stores it locally, and transmits it to online cloud servers. The data sent to servers is then analysed and displayed on a dashboard. For flow measurement and water management, the solution employs a combination of hardware and software.

Role of GIS

It is imperative that we explore the role of Geographic Information Systems (GIS) in achieving efficient water governance. GIS is a technology that integrates geospatial data with traditional data sources to provide powerful mapping and analysis capabilities. The integration of GIS technology in water management can enable the visualization and analysis of complex water data sets, which can help in making informed decisions for sustainable water management.

One of the critical applications of GIS in smart water management is the creation of water balance models. A water balance model is a quantitative tool used to evaluate the water resources of a region or a water system. By creating a water balance model, one can assess the water availability, demand, and use in a region, which can provide insights into the optimal allocation and

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[6] *Press Information Bureau. 2021. Jal Jeevan Mission deploys first-of-its-kind sensor-based IoT devices to monitor rural drinking water supply systems. https://pib.gov.in/PressReleaseIframePage.aspx?PRID=1708701.*

[7] *Dharmaraj, Samaya, and Alita Sharon. n.d. "India Funds Smart Water Management Technology Project." OpenGov Asia. Accessed February 12, 2023. https://opengovasia.com/india-funds-smart-water-management-technology-project/.*

management of water resources. Water balance models can be used to identify water-stressed areas, forecast water availability, and evaluate the impact of climate change on water resources. GIS technology can help create accurate and robust water balance models by integrating various geospatial data sources such as land use, climate data, topography, hydrology, and water infrastructure.

Another crucial application of GIS technology in smart water management is asset management. Asset management is the process of managing and maintaining water infrastructure assets such as pipes, valves, pumps, and tanks to ensure the optimal delivery of water to the end-user. GIS technology can enable real-time monitoring and tracking of these assets, which can help in identifying the assets that need maintenance or replacement. By using GIS, asset managers can locate and identify critical assets, track their maintenance history, and monitor their performance. This can help in reducing the downtime of water infrastructure and improving the overall reliability of water supply.

Moreover, GIS technology can enable effective water conservation by promoting water-efficient practices in households and industries. By using GIS, water utilities can identify the areas or industries with high water consumption and implement water conservation measures accordingly. GIS can provide insights into the water use patterns of households and industries, which can be used to develop water conservation strategies tailored to their specific needs. For instance, GIS can help in identifying households with leaky pipes and faucets, which can cause significant water loss. By identifying such households, water utilities can educate and promote water-saving practices such as fixing leaks, using water-efficient appliances, and reducing water usage. GIS technology can also be used for effective disaster management during water-related emergencies. During natural disasters such as floods, hurricanes, or droughts, GIS technology can provide timely and accurate information on the extent of damage and the availability of water resources. This can help in the efficient deployment of emergency services and resources. For example, GIS can provide insights into the areas with damaged water infrastructure, which can be used to prioritize the repair and restoration of critical water infrastructure.

In recent years, there has been a growing trend of integrating GIS technology with other smart water management technologies such as SCADA, IoT, and AI. By integrating these technologies, water utilities can achieve a more holistic and integrated approach to water management. For instance, by integrating SCADA with GIS, water utilities can monitor and control the water distribution network in real-time and identify the areas with inefficient water distribution. Similarly, by integrating IoT with GIS, water utilities can collect real-time data on water consumption and identify households or industries with high water usage.

Policy Action

Among the SDGs, SDG 6 specifically aims to ensure availability and sustainable management of water and sanitation for all by 2030. To achieve this goal, governments around the world, including the Government of India, have developed policies and schemes that focus on using advanced technologies, such as Geographic Information Systems (GIS), Supervisory Control and Data

Acquisition (SCADA), Internet of Things (IoT), and Artificial Intelligence (AI), for smart water management.

The Government of India has launched various schemes and initiatives, such as the Atal Bhujal Yojana, Jal Jeevan Mission, National Hydrology Project, and National Water Mission, to promote the sustainable management of water resources. These schemes focus on improving water quality, promoting efficient water use, and reducing water wastage. One key aspect of these initiatives is the use of advanced technologies, such as GIS, SCADA, IoT, and AI, to optimize the management of water resources.

GIS technology has been widely used by the Government of India to create a detailed database of water resources across the country. The National Water Informatics Centre (NWIC) has developed a comprehensive GIS database of surface and groundwater resources, which is used to support planning and management of water resources. This database is being used to map hydrological zones, water quality, and groundwater recharge zones, and to develop water conservation plans.

In addition to GIS, SCADA technology is being used to manage water supply systems in urban areas. The Jal Jeevan Mission, launched by the Government of India in 2019, aims to provide potable water to every rural household by 2024. Under this mission, the government is using SCADA technology to monitor the performance of water supply systems in rural areas. SCADA systems help in monitoring the water supply, identifying leaks and water losses, and improving the efficiency of the water supply systems.

The IoT is another technology that is being used by the Government of India to monitor and manage water resources. The Jal Jeevan Mission has also deployed IoT devices to monitor rural drinking water supply systems in real-time. The IoT devices include various types of sensors, such as flow meters, groundwater level sensors, chlorine analyzers, pressure sensors, pump controllers, and so on, to measure all relevant aspects of water service delivery, such as quantity, duration, quality, pressure, and sustainability. The IoT is being used to detect leakages, quality assurance, and overall optimization of resource consumption. Through the IoT, remote monitoring and the use of various sensing technologies for quick responses are used to tackle the challenge of information asymmetry on the amount of water usage.

AI technology is also being used by the Government of India to optimize water management. The National Hydrology Project, launched in 2016, aims to improve the management of water resources through the use of advanced technologies, including AI. The project aims to use AI to develop water supply and demand models, drought forecasting, flood forecasting, and water quality modeling. AI can also be used to predict water demand, optimize water distribution, and improve the efficiency of water supply systems.

The use of these technologies is critical to ensuring sustainable water management and meeting the water demands of a growing population. These policies and schemes are expected to play a crucial role in the management of water resources in India, and with continued government support, the country can achieve its ambitious water management goals.