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RESEARCH ARTICLE

A STUDY ON WATER RESOURCES IN INDIA AND ROLE OF IOT

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ABSTRACT

With the famous quote of Leonardo Da Vinci, 'Water is the driving force of all Nature', water conservation is mandatory item of human being. Even though the India's current water supply is 740 billion cubic meters, water demand will reach 1.5 trillion cubic meters in 2030. About forty percentages of the people in India may not get water to drink by 2030. Many of the states are rich in water resources and some states are struggling for fresh water. As per UNICEF, by 2040, roughly one in four children worldwide will be living in areas of extremely high water stress. Poor quality of water negatively affects ecosystems and human health, and makes water unfit for many purposes which results reduction of water resources availability. Information technology, especially Internet of water has tremendous role in water management. This paper is an eye opener to water resources and scarcity in India and role of IoT to solve the same for some extend

INTRODUCTION

Water resources are natural resources that have the potential to be used as a source of water and are available in ocean, rivers, ponds, lakes, icecaps, wetlands etc. Saltwater makes up about 97% of the world's water. Freshwater makes up only 3% of the total. The country has 18 percent of the world's population, but only 4 percent of its water resources, making it among the most water-stressed in the world. A large number of Indians face high to extreme water stress (1).

Availability and Potential of water Resources in India: India covers around 2.45% of the world's surface area and has 4% of world's water resources. In India, rainfall is the primary source of fresh water. For a country of its size, India receives the second most amount of rainfall. India receives average of 1170 millimeters of rain per year.

Water Resources of India can be classified as follows

Surface water Resources: Four significant surface water resources are rivers, lakes, ponds and tanks. In India, there are around 10360 rives and their tributaries with a length of more than 1.6 kilometers. The total yearly flow in India's river basins is estimated to be 1,869 cubic kilometers. But, only roughly 690 cubic(37%) kilometers of accessible surface water can be used. Within the catchment areas of the Ganga, Brahmaputra , and hence the Barak rivers, precipitation is abundant and cover less than a third of India's total land area. It controls 60% of India's surface water resources. In India, surface water availability was 2309 m^3 in 1991 and 1902 m^3 in 2001.

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Groundwater Resources: The country's totals replenish able groundwater resources are 432 cubic kilometers. But, about 46% of the totals replenish able groundwater resources are in the Ganga and Brahmaputra basins. To conserve river waters and improve groundwater recharging, India has built about 5.000 major or medium dams, barrages and other structures. Overharvesting of groundwater resources is causing a water crisis in villages. Groundwater supplies over 80% of the country's drinking water.

Per Capita availability of water in India.

Table 1. Per capita availability of water

Per capita water availability(2010)	1588m^3
Average Annual rainfall	1160mm (world average 1110mm)
Range rainy days	5-150 days
Rank in water quality	122
Rank in per capita availability	132
Water as % of world water	4%
Population as % of world population	17.1%
Area of the country as % of world area	2.4%

The gross per capita water availability in India will decline from about 1820 m3 per year in 2001 to as low as about 1140 m3 per year in 2050 (2).

Water Usage: Irrigation is by far the biggest consumer of India's water reserve, accounting for 78% of total water reserve, followed by the household sector 6% and the industrial sector 5%.In both urban and rural India, groundwater is the key supply of drinking water. Groundwater reserves provide 45% of total irrigation and 80% of household water.

Table 2. Per capita availability of water –exptectation.

Per capita water availability of India (1951)	5200m^3
Per capita water availability of India (2010)	1588m^3
Per capita water availability of India (2025) Expectation	1401m^3
Per capita water availability of India (2050) Expectation	1140m^3

Eighty percentage of surface water is polluted in India. The major contributors to water contamination are waste water from Infrastructural development, intensive agriculture, industrial output and untreated urban runoff. Another reason is uncontrolled overuse of groundwater. The supply of water is inadequate compared to its growing demand in our country (3).

CAUSES OF WATER SRESS IN INDIA

By the comparison of demand and supply, in 2030 demand and supply will be 1498 and 744 respectively. Household and agriculture both require a lot of water as the population increases. India's large agricultural sector consumes the majority of the country's water, leaving less for industry and homes. Fetching water in India has been perceived as a woman's job for centuries. Women, especially in the rural areas, walk miles to collect water from the nearest source (4). Main causes are as follows

- Rapid urbanization: The high water demand of India's densely populated cities.
- Climate change: will have huge impact on monsoonal rainfall and Himalayan water resources.
- Rising temperature: will boost evaporation and precipitation.
- Droughts and floods: Mountainous areas can expect major variations in snowfall and snowmelt.
- Pollution and water protection: 2.9 billion gallons of untreated wastewater from industrial and domestic sources are discharged into Ganga every day.

According to several UN reports, water scarcity will directly affect nearly twenty percentage of the human population by 2025. By 2040, roughly one in four children worldwide will be living in areas of extremely high-water stress. Only three percentage of the world's water is fresh water, and 3/2 of that is hidden away in frozen glaciers or unavailable for use. According to several NGO's, about 1.1 billion people worldwide lack access to water, and a total of 2.7 billion find water scarce for at least one month of the year Demand and supply of water in India is described in table 3.

Table 3. Demand –Supply of water in past and future

Category \Year	2008	2030
Demand	634	1498
Supply	650	744

India constitutes around 16% of world's population ,but has only 4% of the world's fresh water resources. Gujarat is facing a massive water crisis. At present Gujarat has only 2% of the countries water resources with 5% of population. Indian states like Tamil Nadu , Telangana and Karnataka where the groundwater level is less than the national average. Jharkhand and Rajasthan continue to be the worst performer in both time periods. Water poverty was the least in the states of Goa and Chandigarh for both time periods (5).

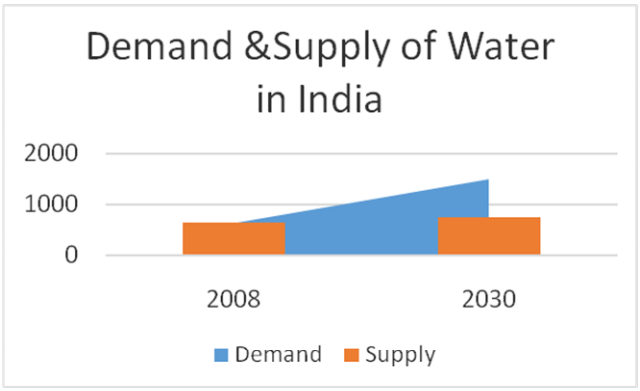

Figure 1. Demand –Supply of water in past and future

Best Water Conservation Practices

- The **'Mukhya Mantri Jal Swavlamban Abhiyan'** is a scheme in Rajasthan. Effective utilization of water conservation and harvesting in rural regions.
- Maharashtra has initiated a program named **'Jalyukt-Shivar,'** which aims to eliminate water scarcity in 5000 villages every year.
- **"Mission Kakatiya"** Launched by Telangana Government with the aim of improving agriculture-based income development for small and marginal farmers.

Ninety one per cent of river water gets diverted for irrigation, leaving aside all other priority uses. The wastewater generated in the form of sewage, effluent etc. are also considered as displaced resources. Therefore, it needs to be converted into water resources (by various treatment processes), so that they can be used as first-order resources to cut, reduce and prevent further exploitation. We need to remember that maintaining a strong ecology is key to a strong economy. No treated or untreated water should be allowed to discharge into any river; there should be no indiscriminate withdrawal of water from any source except from water harvesting.

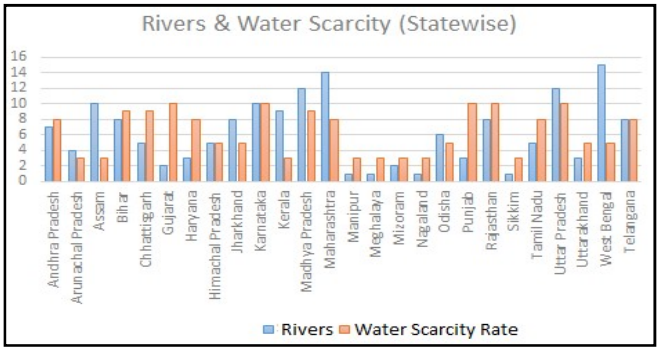

Figure 2. States with minimum and maximum water scarcity

Water conservation methods can be described as

- Limiting the consumption of water
- Elimination of losses
- Preserving pollution
- Minimizing the consumption

On global scale, fresh water usage can be broadly classified into Domestic, Agricultural and Industrial.

Table 4. Water Scarcity States in India

Sl.No.	States with Major Rivers	Number of Major Rivers	Water Scarcity of states
1	Andhra Pradesh	7	High
2	Arunachal Pradesh	4	Low
3	Assam	10	Low
4	Bihar	8	High
5	Chhattisgarh	5	High
6	Gujarat	2	High
7	Haryana	3	High
8	Himachal Pradesh	5	Moderate
9	Jharkhand	8	Moderate
10	Karnataka	10	High
11	Kerala	9	Low
12	Madhya Pradesh	12	High
13	Maharashtra	14	High
15	Manipur	1	Low
15	Meghalaya	1	Low
16	Mizoram	2	Low
17	Nagaland	1	Low
18	Odisha	6	Moderate
19	Punjab	3	High
20	Rajasthan	8	High
21	Sikkim	1	Low
22	Tamil Nadu	5	High
23	Uttar Pradesh	12	High
24	Uttarakhand	3	Moderate
25	West Bengal	15	Moderate
25	Telangana	8	High

Table 5. Percentage of water usage in different areas.

Water usage in %	Area	Purpose
40	Agricultural	Irrigation, Crops, Livestock
47	Industrial	Power generation and mining
13	Public Supply	Domestic and Commercial

Water Saving Tips for Home

- Always wash full loads in laundry.
- Fill the sink or pot with water rather than continually running the tap. Install an efficient dishwasher and wash full loads of dishes in it.
- Identify leak of water. A faucet leaking 60 drops per minute will waste 192 gallons(726.8 liters) per month, which is equal to 2304gallons per year.
- Install water sense-labeled models in toilets instead of inefficient one. Really some older toilets may use much as 10 liters per flush. A leaky toilet waste in around 700 liters of water each day, which may be same as India's average daily consumption of a household.
- Educate family members about the importance of less water usage.
- Regularly check the sprinkler heads to make sure that are not malfunctioning or damaged.
- Real time metering and frequent billing.
- The IoT technology can help the consumer to shutoff water supply remotely if an leakage is alarmed.

In 2008, for the first time in history, the global urban population outnumbered the rural population. This milestone marked the advent of a new 'urban millennium' and, by 2050, it is expected that two-thirds of the world population will be living in urban areas. With more than half of humankind living in cities and the number of urban residents growing by nearly seventy three million every year it is estimated that urban areas account for seventy per cent of the world's gross domestic product.

Internet of things & water management

With IoT, the whole water supply chain can become more transparent and easier to control. With the help of sensors, a smart city water management system can enable you to collect real-time data—information that helps you visualizes water distribution across the network.

The important of smart water management are

- A better understanding of the water system
- Detection of leaks
- Conservation
- Monitoring of water quality.

The water quality monitoring system can be implemented using IoT as system uses different sensors for monitoring the water quality by determining pH, turbidity, conductivity and temperature. The Arduino controller used will access the sensor data. With the use of IoT, the collected data is analyzed and the pollution of water can be investigated by a stringent mechanism. Smart water systems, much like smart energy systems, use the Internet of Things enabled sensors to collect real-time data. IoT can work with the water industry by giving utilities and consumers new information on water use. Through the use of sensor technology, IoT can deliver data about water consumption, quality, points of loss or leakage, distribution and wastewater.

Table 5. Comparison of advantage and disadvantage

Advantages IoT	Disadvantages of IoT
Higher Employee Productivity	Time consuming and expensive
New consumer insights	Lack of Technical knowledge
Better customer experiences	Security and privacy issues
Lower operating costs	Internet & power connectivity dependency

Key advantages of IoT water management systems: According to UN reports, water scarcity will directly affect nearly 20% of the human population by 2025.Smart water systems based on the combination of Internet of Things, big data and AI technologies can help stop these predictions from happening and undo the damage the imprudent usage of water resources has already caused. Water supply management is going to be an essential need in near future as water crisis is emerging as a major challenge (6). Smart water management (SWM) meaning means smart water management requires the integration of systems and a complex of measures to monitor, control and regulate the usage and quality of water resources as well as maintain the associated equipment (pipes, pumps, etc.). There's a wide range of software and hardware instruments, like meters, sensors, , data processing and visualization tools, actuators and web and mobile controls connecting people with water systems.

Modern smart water technologies: Today, smart water technology brings transparency and improved control to the whole water supply chain starting from a freshwater reservoir to wastewater collecting and recycling. This category includes IoT devices for water management, systems and software tools that help optimize production, distribution and consumption of water and enable smart water treatment practices.

Sensors: The sensors measure the changing water quality in the storage reservoir and raw catchment, chemical composition after treatment, pressure on the pipes during distribution, wear of the equipment and more. Automated distribution systems and precision algorithms can play vital role. Using environmental sensors and predefined or machine learning algorithms, distribution systems can dynamically regulate and control the supply of water. In the case of smart irrigation, for example, sprinklers provide just enough water depending on the reads from soil moisture, air humidity and crop condition sensors.

Objectives of smart water management: The primary objective of smart water management is reasonable and sustainable usage and recycling of water resources. Growing population, increasing environmental issues and pressure on the food and agriculture sector make water even a more precious asset.

- Reduce wasting water by introduction of technology for precision farming crop water management, smart irrigation , real-time water metering and other IoT application in agriculture.
- **Improve water quality** and prevent contamination by chemical waste and natural pollution such as acidification by use of sensors and IoT technologies for real-time monitoring and control.
- **Improve the efficiency of water systems** like treatment plants , distribution hubs and recycling or waste water centers.
- **Install leakage control** by using smart water management devices equipped with leak and moisture sensors, and Internet of Things devices.
- **Practice consumption monitoring** via IoT-based water management systems

Benefits of using for water management: Today, the concept of IoT in this sector already translates into a brand new idea — the **Internet of Water.** It requires connecting all the systems and players in the water supply chain — water sources, treatment plants and industrial water management systems, distribution facilities, utility and clean energy companies, and consumers. Leveraging on the advancement in emerging blockchain, Internet of Things (IoT), and sensor technologies offers a means for efficient water management (7).

Transparency: Improving the transparency of all the processes in water supply chain is the one of the biggest benefits of smart water management using IoT. Blockchain features such as decentralization, immutability and transparency (DIT), auditing, and data encryption help to solve various IoT architectural problems (8).

Immediate response: Smart water management system detects a slight contamination due to chemical composition and intimate sudden response before it becomes a major problem.

- **Automation and optimized use of human resources:** With connected smart meters, real-time monitoring systems and dynamic pricing models, IoT water supply companies can automate the entire lifecycle of supplying water to consumers.
- **Optimized cost:** By the use of IoT in water management, it is easy to reduce operational cost in long run.
- **Sustainability:** Smart water industry try to reach different environmental goals like water preservation , carbon footprint , pollution .
- **Reducing waste of water-intensive industries :** Libelium, an Internet of Things solutions for agriculture could help to reduce the consumption of water per capita by ten percent, reduce leakage by twenty percentage, predict potential failures and for better management of water pressure and consumption.

IoT applications in water management

- **Smart irrigation:** One of the leaders among IoT professionals, Bosch provides a sensor-based solution for smart on-demand irrigation. It measures water status in plants to make sure they get just enough water for the best nutritional value and highest yield. Collected data on the plant's "thirst" is combined with the weather forecast. AI algorithms then calculate the ideal irrigation scheme based on this data and help farmers keep their crops at the ultimate health. In recent year, many works have presented innovative ideas and prototypes which can be used for IoT-based smart farming (9).
- **Water system integrity:** Sensative https://sensative.com/strips/drip/strips are sensor-based leak detectors that help identify pipe or connection damage immediately and prevent heavy leakage and waste of water resources.
- **Smart water monitoring:** Adcon is a smart water company that provides a wide range of water management services from leakage detectors to irrigation management and rainwater monitoring. Water Quality Monitoring (WQM) is a cost-effective and efficient system designed to monitor drinking water quality which makes use of Internet of Things (IoT) technology (10).
- **Smart water management:** Sensus provides water suppliers and utility networks with sensor and data solutions for smart water management.

Conclusion

With the knowledge of ' Prevention is better than Cure', preserving our natural resources is essential to living beings .Even though, 70% of the surface of our planet is covered by water, only less than 3% water covering the earth is fresh water. Information Technology can play a vital role , especially Internet of Thing (IoT) in reduction of misuse of water , reuse and recycling. With the use high capacity 3D sensors and currently updated mobile apps with internet connectivity, anyone can remotely monitor and control Utilization of it. This paper motivates the readers to use recent advance in Information technology in water management.

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