Solution to Address Water Scarcity in Nashik

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Abstract - Water is one of the most important natural resources for human life. Every activity such as drinking, cooking, farming, industry, sanitation, and electricity production depends on water. Even though Nashik city is located near the Godavari River and has dams like Gangapur and Darna, the city still faces serious water shortages every year, especially in summer.

The main reasons for water scarcity in Nashik are fast population growth, urban development, leakage in pipelines, groundwater overuse, irregular rainfall, and poor water management. The city's daily water demand is around 200 to 320 million Liters per day (MLD), but the available supply is only 150 to 250 MLD. Because of this difference, many areas receive water only once a day or on alternate days. Around 25–30% of water is also lost due to leakage and illegal connections.

This research study explains the causes and effects of water scarcity in Nashik and suggests practical and modern solutions. The proposed solution includes smart IoT water monitoring systems, Bhungroo groundwater recharge technology, circular water reuse systems in buildings, and fog harvesting in hilly areas. If these methods are properly implemented, Nashik can reduce water loss, recharge groundwater, reuse wastewater, and improve overall water security.

This study concludes that Nashik's water problem is mainly due to mismanagement and wastage, not because there is no water at all. With smart planning and sustainable technology, Nashik can become a water-secure city in the future.

Keywords: Water Scarcity, Nashik City, IoT Sensors, Bhungroo System, Fog Harvesting, Circular Water System, Sustainable Water Management

1. INTRODUCTION

Water is essential for survival. Without water, humans, animals, plants, and industries cannot function. Even though 71% of the Earth is covered with water, only a small portion is fresh water suitable for drinking and domestic use.

In India, water scarcity has become a major issue because of rapid urbanization, industrial growth, climate change, and increasing population. Maharashtra is one of the states facing frequent drought conditions. Nashik, which is an important religious and industrial city, also experiences serious water shortages.

Nashik is located on the banks of the Godavari River. The city depends mainly on Gangapur Dam, Darna Dam, and Gautami Godavari Dam for its water supply. However, due to increasing population (more than 18 lakh people in 2024), the demand for water has increased very fast.

During summer, many areas in Nashik receive water for only one hour per day. Some outer areas depend on water tankers. This shows that there is a serious gap between water demand and supply.

This project aims to study:

- Why water scarcity is increasing in Nashik
- What are the impacts of this shortage
- How modern technology and sustainable methods can solve this problem

2. LITERATURE SURVEY

IoT Sensor–Based Water Management Systems

The use of Internet of Things (IoT) technology in water management has increased significantly over the last two decades. IoT systems use sensors to monitor water flow, pressure, level, and quality in real time.

Several researchers developed low-cost water quality monitoring systems using pH, turbidity, and temperature sensors connected to cloud platforms. These systems help authorities detect contamination quickly and reduce water loss.

Recent studies also combined IoT with artificial intelligence to predict pipe leakage and maintenance needs. Results showed reduction in water wastage and maintenance cost. Long-range communication systems such as LoRaWAN have made smart water meters more reliable and energy efficient.

In agriculture, IoT-based irrigation systems using soil moisture sensors have reduced water usage by 25–30% without affecting crop yield. Overall, research shows that IoT technology plays an important role in improving efficiency and reducing water loss.

Bhungroo Groundwater Recharge Technology

Bhungroo technology is an Indian innovation designed to solve both flooding and water scarcity problems. It works by storing excess rainwater underground during monsoon and using it later during dry periods.

Studies conducted in Gujarat showed that Bhungroo systems improved groundwater levels and increased agricultural productivity. Farmers who adopted this method reported higher crop yields and better income.

Research also found that Bhungroo systems require less land area compared to traditional recharge structures and are cost-effective. Due to its success, this technology has been implemented in other countries as well.

Bhungroo is considered a sustainable and community-based solution for groundwater management.

Circular Water Systems in Buildings

Circular water systems focus on reuse and recycling of water within buildings. Instead of sending greywater (from bathrooms and sinks) to drains, it is treated and reused for flushing, gardening, and cleaning.

Research in various countries showed that such systems can reduce freshwater demand by 30–50%. Studies also indicate that public acceptance increases when proper safety measures are maintained.

Recent developments include combining circular systems with smart monitoring using IoT and digital modelling tools. These systems improve efficiency and reduce operational cost.

Circular water systems are especially useful in cities facing water shortages.

Fog Harvesting Technology

Fog harvesting is a method of collecting water droplets from fog using mesh nets. This technology is useful in hilly and dry regions where rainfall is low but fog is frequent.

Early studies in desert regions showed that fog collectors can produce 5–10 Liters of water per square meter per day. Improvements in mesh design and material have increased efficiency in recent years.

Research in India also confirmed that fog-harvested water can meet quality standards after basic filtration. Because it requires low energy and simple installation, fog harvesting is considered an eco-friendly alternative water source.

Combined Analysis of Literature

The reviewed studies show that modern water management requires a combination of technology and sustainability. IoT systems help in monitoring and reducing water loss. Bhungroo technology improves groundwater recharge. Circular water systems reduce freshwater demand in buildings. Fog harvesting provides additional water sources in suitable regions.

Together, these approaches support the concept of a circular water economy, where water is monitored, stored, reused, and conserved efficiently. Integrating these technologies can significantly improve water security in urban and rural areas.

3. PROPOSED SOLUTION

4.1 IoT-Based Smart Water Monitoring

IoT sensors measure:

- Flow rate
- Pressure
- Water level
- pH and turbidity

These sensors send real-time data to control rooms. Leakages can be detected immediately, reducing water

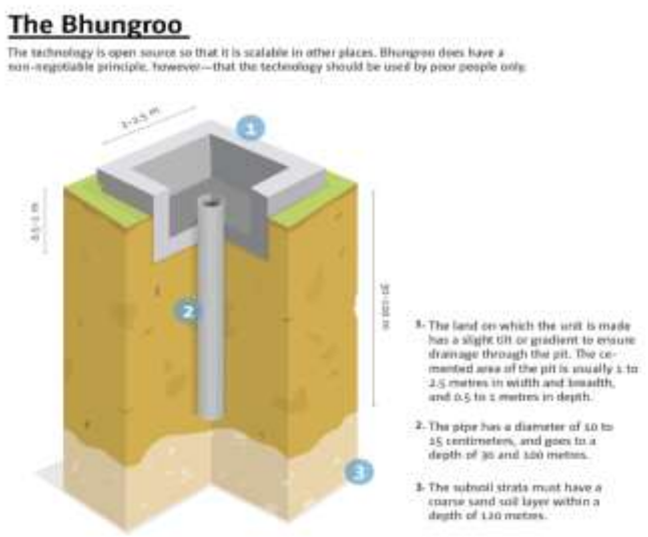
loss.

Benefits:

- Reduces leakage
- Improves water distribution
- Saves 15–20% water
- Provides accurate data for planning

4.2 Bhungroo Groundwater Recharge System

Bhungroo is a rainwater recharge system developed in Gujarat. During heavy rainfall, excess water is injected underground through pipes. This water is stored in aquifers and used during dry season.



Benefits:

- Prevents flooding
- Recharges groundwater
- Improves water table
- Supports agriculture

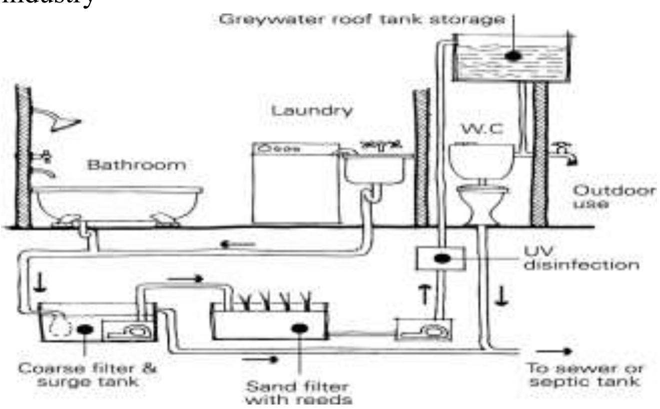
This system can be used in rural Nashik and flood-prone areas.

4.3 Circular Water System (Reuse and Recycling)

Circular water system means reuse of greywater and treated wastewater.

Example:

- Bathroom water → Treated → Used for flushing
- Treated sewage → Used for gardening & industry



Advantages:

- Reduces freshwater demand by 30–40%
- Saves water bills
- Reduces pressure on dams

4.4 Fog Harvesting in Hilly Areas

Fog harvesting collects tiny water droplets from fog using mesh nets. The water drops flow into storage tanks.

This method is useful in Trimbakeshwar and Igatpuri hill regions.

Advantages:

- Eco-friendly
- Low maintenance
- Useful in fog-prone regions
- Alternative water source

4. METHODOLOY

4.1 IoT Sensors

Overview

IoT (Internet of Things) technology allows real-time monitoring of water systems. Sensors are installed in tanks, pipelines, and reservoirs to measure water level, flow, and pressure. These sensors send data to cloud platforms, which helps in better control and decision-making.

Main Components

1. Ultrasonic Sensors

- Used to measure water level in tanks and reservoirs.
- Measuring range: 2–400 cm.
- Accuracy: ±3 mm.
- Prevents overflow and dry tank conditions.

2. Node MCU ESP8266 Microcontroller

- Wi-Fi enabled and low-cost.
- Collects data from sensors.
- Sends information to cloud platforms.
- Can automate water pumps.

3. Buzzer and LCD Display

- Provides alert signals when water level is low.
- Detects leakage.
- Displays real-time water usage data.

Applications

- Smart irrigation reduces water use by around 25–30%.
- Leak detection reduces municipal water loss.
- Households can monitor daily consumption.

Challenges

- Sensors require proper calibration.
- Power supply problems in rural areas.
- Risk of data security issues.

4.2 Fog Harvesting

Overview

Fog harvesting is a simple and eco-friendly method to collect water from fog using mesh nets. It works best in hilly or coastal areas where fog is frequent but rainfall is limited.

Design Features

- Vertical mesh panels (10–40 m^2 area).
- Installed in elevated windy locations.
- Made of polypropylene mesh with hydrophilic coating.
- Thread thickness: 0.2–0.5 mm.

Efficiency

- Best wind speed: 5–15 km/h.
- Water collection: 3–10 liters per m^2 per day.
- Water is filtered and treated using UV before use.

Applications

- Drinking water (after purification).
- Irrigation.
- Livestock use.

Challenges

- Fog availability depends on season.
- Mesh maintenance required.
- Initial setup cost.

4.3 Circular Water Systems

Overview

Circular water systems follow the principle of reuse and recycle. Instead of wasting greywater, it is treated and reused for other purposes.

Treatment Stages

1. Primary Treatment – Sedimentation and filtration.
2. Secondary Treatment – Biological treatment using bacteria.
3. Tertiary Treatment – Advanced filtration and UV disinfection.

Applications

- Irrigation in agriculture.
- Cooling water in industries.
- Flushing and gardening in houses.

Benefits

- Reduces freshwater demand by up to 40%.
- Decreases pollution.
- Supports sustainable urban development.

Challenges

- High energy use in advanced treatment.
- Public hesitation to use recycled water.
- Infrastructure cost.

4.4 Bhungroo System

Overview

Bhungroo is a traditional rainwater harvesting system improved with modern techniques. It stores excess rainwater underground during monsoon and uses it during dry periods.

Design Features

- Underground storage chambers.
- Lined to prevent contamination.
- Protects water from evaporation.
- Stores water for several months.

Community Role

- Built and maintained by local communities.
- Encourages participation.
- Empowers farmers and women.

Impact

- Converts flood-prone areas into productive land.
- Improves groundwater level.
- Increases agricultural productivity.

Challenges

- Requires community training.
- Initial construction cost.
- Need for groundwater quality monitoring.

4.5 Integration of Systems

This methodology combines all four systems into one smart water management framework:

1. IoT sensors monitor water levels and detect leakage.
2. Fog harvesting provides additional water in suitable regions.
3. Circular systems recycle wastewater for reuse.
4. Bhungroo stores excess rainwater underground.

Combined Benefits

- Reduces water wastage.
- Improves groundwater recharge.
- Provides alternative water sources.
- Increases drought resilience.
- Encourages community participation.

4.6 Expected Outcomes

After implementation, the system is expected to:

- Improve agricultural productivity.
- Reduce water losses.
- Increase water availability during summer.
- Improve public awareness.
- Reduce dependence on tankers.

4.7 Limitations

- High initial installation cost.
- Need for trained technicians.
- Seasonal fog variability.
- Public acceptance of recycled water.

4.8 Future Prospects

In future, the system can be improved by:

- Integrating AI for demand prediction.
- Using smart analytics for water distribution.
- Expanding Bhungroo systems in drought-prone regions.
- Developing low-cost fog collectors.
- Strong government policy support.

➢ **FLOW CHART :-**

5. RESULT AND ANALYSIS

6.1 Present Water Condition in Nashik

From the collected data, it is clear that Nashik city is facing a shortage of water. The population is increasing every year, but the available water supply is not increasing at the same rate.

Current Situation:

- Population: 1.8 Million
- Daily Water Demand: 200–320 MLD
- Available Supply: 150–250 MLD
- Water Shortage: 40–70 MLD
- Water Loss (Leakage and wastage): 25–30%

Analysis of Present Situation

1. The demand for water is more than the supply, especially in summer.
2. Nearly one-fourth of treated water is lost due to leakage, old pipelines, and illegal connections.
3. Many areas depend on water tankers during shortage periods.
4. Groundwater levels are decreasing because of overuse.
5. The existing water system is not fully modern or smart.

This shows that the problem is not only lack of water, but also poor management and wastage.

6.2 Expected Results After Applying Proposed Solutions

The project proposes the use of:

- IoT sensors for monitoring
- Leak detection system
- Circular water reuse system
- Fog harvesting
- Bhungroo recharge system

After applying these solutions, the expected improvements are:

- Water loss reduced to 10–15%
- Freshwater demand reduced by 30%
- Groundwater level slowly improves
- Tanker use reduces significantly

6.3 Explanation of Results

1. Reduction in Water Loss

By using IoT sensors and smart monitoring, leaks can be detected quickly.

This can reduce water loss from 25–30% to around 10–15%.

This means more water will reach people without increasing total supply.

2. Reduction in Freshwater Demand

Circular water systems allow reuse of wastewater for gardening, flushing, and industrial use.
Because of this, fresh dam water use can reduce by nearly 30%.
This will reduce pressure on dams and reservoirs.

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3. Improvement in Groundwater Level

Bhungroo systems and rainwater harvesting help store water underground.
Over time, this will increase groundwater levels and reduce borewell depth.
This is helpful for farmers and rural areas.

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4. Reduction in Tanker Dependency

Currently, many people depend on private tankers during summer.
After proper monitoring, recharge, and reuse systems, tanker demand will reduce.
This will reduce extra expenses for citizens.

6.4 Overall Conclusion of Results

The study shows that Nashik's water problem is mainly due to water loss and improper management, not complete lack of water.
By using smart technology and sustainable methods:

- Water wastage can be controlled
- More water can be reused
- Groundwater can improve
- Supply can become more balanced

If these solutions are properly implemented, Nashik can become a more water-secure and sustainable city in the future.

6. APPLICATION

The proposed smart water management system can be used in many places. Since it combines monitoring, reuse, and groundwater recharge, it is useful for both city and village areas.

7.1 Residential Buildings

The system can be used in houses, apartments, and housing societies.

- IoT sensors can check water levels in tanks.
- Leak detection helps stop water wastage.
- Greywater (bathroom and washing water) can be reused for gardening and flushing.
- Rainwater harvesting can store rainwater for future use.

This will reduce water bills and decrease the need for water tankers.

7.2 Industrial Areas (Satpur and Ambad MIDC)

Industries use a large amount of water for production and cleaning.

- Smart meters can monitor how much water industries use.
- Treated wastewater can be reused in cooling systems.
- Circular water systems can reduce fresh water usage.

This will save water and reduce operating costs for industries.

7.3 Rural Agricultural Areas

Farmers can use this system to improve irrigation.

- Bhungroo systems can store rainwater underground.
- IoT-based irrigation can supply only required water to crops.
- Drip irrigation can reduce water wastage.

This will improve crop yield and prevent groundwater overuse.

7.4 Smart City Projects

In smart city projects, the system can be used for city-level monitoring.

- IoT sensors can monitor pipelines and water tanks.
- Authorities can see real-time data on dashboards.
- Leak detection can reduce water loss.

This will make water management more efficient and transparent.

7.5 Flood-Prone Areas

In areas where heavy rainfall causes flooding:

- Bhungroo systems can store excess rainwater underground.
- IoT sensors can monitor dam and reservoir water levels.
- Early alerts can help prevent flood damage.

This helps in both flood control and water storage for dry seasons.

7.6 Use in Other Cities

This system is not only for Nashik.
It can also be used in other cities facing water problems.
Any city that has:

- Water shortage
- High leakage
- Falling groundwater levels

can apply this model to improve water management.

7. LIMITATION

Although the proposed system is useful, it also has some limitations:

1. High Initial Installation Cost
Setting up IoT sensors, fog harvesting structures, circular water systems, and Bhungroo recharge systems requires a large amount of money in the beginning. Many small communities or housing societies may find it difficult to afford the initial cost.
2. Need for Trained Technicians
IoT systems and water treatment units need skilled people for installation, monitoring, and maintenance. Without proper training and technical knowledge, the system may not work efficiently.
3. Seasonal Fog Availability
Fog harvesting works only in areas where fog is available. In some seasons or regions, fog density is low, so water collection may reduce. This makes fog harvesting dependent on weather conditions.
4. Public Acceptance of Recycled Water
Some people may hesitate to use recycled water, even if it is treated properly. Lack of awareness and trust can slow down the adoption of circular water systems.

CONCLUSIONS

Water scarcity in Nashik is a serious problem, but it can be solved with proper planning and management. The city actually has enough water sources like dams and groundwater. However, due to water wastage, leakage, and old infrastructure, an artificial shortage is created.

If Nashik properly implements:

- IoT-based smart monitoring systems
- Bhungroo groundwater recharge methods
- Circular water reuse systems
- Fog harvesting technology

then the city can move toward long-term and sustainable water security.
However, technology alone cannot solve the problem. Public awareness, strong government support, proper maintenance, and responsible water use by citizens are equally important.
If everyone works together — government, industries, farmers, and residents — Nashik can become a model water-secure city in Maharashtra.

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REFERENCES

[1] Punmia, B. C., Jain, A. K., and Jain, A. K., *Water Supply Engineering*, 2nd Edition, New Delhi: Laxmi Publications, 2016.

[2] Garg, S. K., *Water Supply Engineering*, New Delhi: Khanna Publishers, 2017.

[3] Metcalf & Eddy, *Wastewater Engineering: Treatment and Resource Recovery*, 5th Edition, New York: McGraw-Hill Education, 2014.

[4] World Bank, "Water Scarcity and Water Management Report," 2023. Available at: https://www.worldbank.org

[5] Nashik Municipal Corporation, "Annual Water Supply Report," Nashik, India, 2023. Available at: https://nmc.gov.in

[6] Ministry of Jal Shakti, Government of India, "Jal Shakti Abhiyan Report," 2023. Available at: https://jalshakti-dowr.gov.in

[7] Maharashtra Water Resources Department, "Water Resource Development Report," 2023. Available at: https://wrd.maharashtra.gov.in

[8] Central Ground Water Board (CGWB), *Groundwater Year Book – Maharashtra*, 2022. Available at: https://cgwb.gov.in

[9] Geetha, S., and Gouthami, S., "Internet of Things enabled real-time water quality monitoring system," *Smart Water*, SpringerOpen, 2017. Available at: https://smartwaterjournal.springeropen.com/articles/10.1186/s40713-017-0005-y

[10] Zulkifli, Z., et al., "IoT Based Water Monitoring System: A Review," *Water*, MDPI, 2022. Available at: https://www.mdpi.com

[11] Alam, M., et al., "AI Based Predictive Maintenance of Water Systems Using IoT," *IEEE Access*, 2020. Available at: https://ieeexplore.ieee.org

[12] Park, S., et al., "LoRaWAN Smart Water Metering System," *Sensors*, MDPI, 2021. Available at: https://www.mdpi.com

[13] United Nations Environment Programme (UNEP), "Fog Harvesting Report," 2024. Available at: https://www.unep.org

[14] Schemenauer, R., and Cereceda, P., "Fog Collection Systems in Chile," *Atmospheric Research*, 1994.

[15] Sharan, G., et al., "Fog Harvesting in India," *Current Science*, 2017. Available at: https://www.currentscience.ac.in

[16] UNFCCC, "Bhungroo Climate Change Adaptation Technology," 2020. Available at: https://unfccc.int