International Journal for Multidisciplinary Research (IJFMR)
E-ISSN: 2582-2160 ● Website: www.ijfmr.com ● Email: editor@ijfmr.com

Enhanced Water Resource Management in Electronic City

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Abstract

Urbanization has become one of the defining trends of the 21st century, with cities around the world expanding at unprecedented rates.

While urban growth brings economic opportunities and improved infrastructure, it also places immense pressure on natural resources—particularly water.

Water scarcity has emerged as a critical challenge in many rapidly growing cities, where the demand for water is outpacing supply due to a combination of population explosion, industrial expansion, unplanned urban development, and climate variability.

In many cities, the situation is aggravated by the over-reliance on depleting groundwater sources, the degradation and encroachment of natural water bodies, and inefficient water distribution networks. Aging infrastructure, inequitable access, and poor governance further compound the crisis. Cities like Bangalore, Cape Town, and Mexico City exemplify how once water-abundant regions can reach the brink of "Day Zero"—the day when municipal water taps run dry.

Urban water scarcity is not merely a supply-side problem. It is a multi-dimensional issue encompassing economic, social, and environmental aspects, often disproportionately affecting the urban poor. As cities continue to grow, it becomes imperative to adopt sustainable water management practices, including demand-side strategies, conservation, recycling, decentralized systems, and community participation.

Addressing urban water scarcity requires integrated, forward-looking solutions that align with urban planning, climate resilience, and social equity. Without urgent and innovative interventions, water insecurity could undermine the very foundations of urban sustainability.

Keywords: Water Scarcity, Electronic City, Bangalore

1. Introduction

Bangalore, known as the "Silicon Valley of India," has experienced rapid urbanization and population growth over the past few decades. This growth has led to a significant increase in water demand, straining the existing water supply systems.

Electronic City, a major IT hub within Bangalore, exemplifies these challenges due to its high concentration of businesses and residents.

As per latest news sources, currently, Bengaluru relies heavily on groundwater, with over 6,000 out of 14,000 borewells drying up due to plummeting groundwater levels. The city needs 2,600 MLD (million litres per day) of water for both drinking and industrial purposes.

A study by the IISC's Centre for Ecological Sciences says that water spread area has fallen from 2,324 hectares in 1973 to just about 696 hectares in 2023, a 70 per cent drop.

2. Research Question

- Can resilient urban planning effectively mitigate water scarcity in rapidly growing urban areas ?

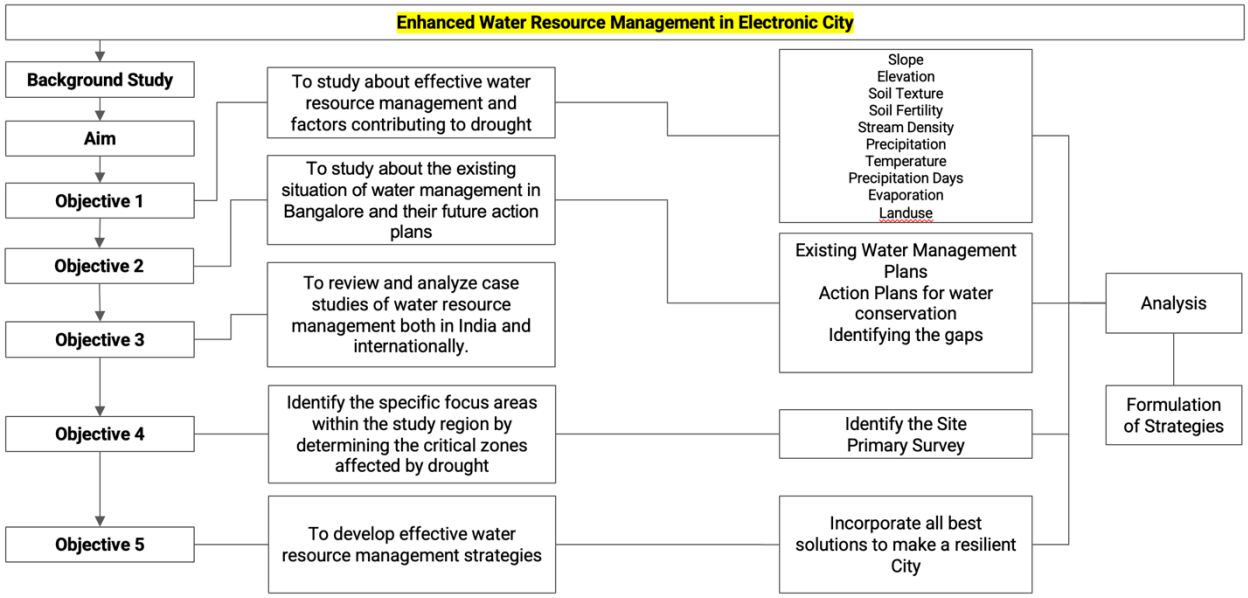
3. Aim

To develop effective water resource management strategies, enhancing resilience in Electronic City .

4. Objectives

- To study about effective water resource management and factors contributing to drought.
- To study about the existing situation of water management in Bangalore and their future action plans.
- To identify and study the specific focus areas within the study region by determining the critical zones affected by drought.
- To review and analyze case studies of water resource management both in India and internationally.
- To develop effective water resource management strategies for Electronic City.

5. Methodology



6. Literature Review

6.1 Water Scarcity in Cities

Water scarcity in rapidly growing urban areas refers to the imbalance between the increasing demand for water and the available supply of usable freshwater resources due to rapid population growth, urban sprawl, industrialization, and climate variability.

It is a condition where water availability is insufficient to meet the basic needs of urban populations for drinking, sanitation, economic activities, and ecosystem services in a sustainable and equitable manner.

In cities, water scarcity is often intensified by:

- Unregulated groundwater extraction
- Pollution of surface and groundwater sources
- Inadequate or aging infrastructure
- Inequitable distribution and water governance issues

6.2 Factors Influencing Water Scarcity

- **Population Growth:** As the global population increases, so does the demand for water for drinking, agriculture, and industry.
- **Increased water usage:** The more people there are, the more water is needed for basic human necessities like drinking, sanitation, and hygiene. Agricultural and industrial activities also require enormous volumes of water.
- **Pollution:** As water sources become contaminated with chemicals, waste, and pollution, the supply of usable, clean water diminishes. Purifying and treating water requires resources and funds that some communities need more.
- **Climate change:** Changes in weather patterns are altering precipitation levels and temperatures, which threatens water security. Some areas are experiencing decreased rainfall, while others face more frequent water scarcitys or floods. Glaciers and snowpacks that provide water are melting.
- **Inefficient infrastructure:** Outdated or poorly maintained water supply systems lead to wasted water through leaks and spills. Improvements in infrastructure and technology can maximize water usage and access.

7. Recommendations

7.1 Residential Zones

Problem

High groundwater extraction, paved surfaces, poor recharge.

Strategies

- Mandatory rooftop rainwater harvesting (RWH) in all apartment complexes.
- Greywater recycling for landscaping and toilet flushing.
- Implement pervious paving in footpaths, driveways, and internal roads.
- Promote native and low-water-use landscaping in housing layouts.
- Install smart water meters and tiered pricing for households.

7.2 Industrial Zones

Problem

High water demand + wastewater generation; almost no natural recharge zones.

Strategies

- Mandate Zero Liquid Discharge (ZLD) and effluent treatment plants (ETPs) for all industries.
- Treated wastewater reuse for toilet flushing, HVAC systems, landscaping.
- Establish centralized common effluent treatment plant (CETP) where smaller industries cluster.
- Stormwater harvesting systems integrated into industrial plots.

7.3 Agricultural Zones

Problem

Underutilized for recharge or storage; risk of encroachment.

Strategies

- Create recharge parks or urban wetlands in agricultural/open zones to collect rainwater.
- Restore and desilt existing lakes and tanks visible in the map.
- Identify aquifer recharge zones and protect them via zoning restrictions.

Encourage farm ponds and micro-irrigation (drip/sprinkler) for remaining agriculture.

7.4 General Strategies

1. Rainwater Harvesting (RWH)

Capturing rainwater can replenish groundwater and reduce dependence on external sources.

- Mandate RWH for all new buildings and incentivize retrofitting old buildings.
- Create neighborhood – level RWH systems for community recharge.
- Decentralize storage in large public buildings (schools, offices).

2. Aquifer Mapping and Groundwater Recharge

Scientific understanding of groundwater helps recharge and regulate use.

- Map aquifers using GIS and remote sensing to identify recharge zones.
- Build percolation pits, recharge wells, and infiltration trenches in public and private lands.

3. Lake Restoration

- Desilt and de-encroach existing lakes.
- Decentralized wastewater treatment plants (DEWATS) around lakes to ensure only treated water enters.
- Promote community stewardship of lakes (e.g., lake adoption by RWAs or schools).
- Close to two years after 'floating islands' were introduced into Hyderabad's historic Neknampur Lake, the water body has seen considerable results.
- Once a sewage and dumping ground, activist Madhulika Choudhary and her NGO Dhruvansh have been working on the revival of the lake since 2016.
- The first 'floating island' was introduced into the lake in May last year. Today the lake holds 3,500 such saplings.

4. Wastewater Recycling and Reuse

- Enforce zero liquid discharge policies in large apartment complexes, tech parks, and industries.
- Scale up dual plumbing systems in new developments.
- Promote use of treated wastewater for landscaping, flushing, and industrial use.
- Through the NEWater initiative, Singapore treats 40% of its used water and reuses it, reducing freshwater dependence significantly.

While NEWater is of potable quality, its primary use is non-potable, catering to:

Industrial Processes: Industries requiring high-purity water, such as wafer fabrication and electronics manufacturing, utilize NEWater extensively.

5. Implementing Xeriscaping Principles

- Use mulch to retain soil moisture and reduce weed growth.
- Group plants based on water needs (hydrozoning).
- Use drip irrigation or clay pot (olla) irrigation to water deeply but infrequently.
- Incorporate hardscapes (pebbles, decomposed granite) and native rock features to reduce lawn space.

8. Conclusion

This research concludes that water scarcity in Electronic City is not merely the result of climatic factors but is deeply rooted in structural and planning deficiencies. The mismatch between supply and demand, coupled with poor recharge practices, has created a fragile water ecosystem vulnerable to seasonal shortages and long-term depletion. To address this, the study emphasizes the importance of integrated water resource management that combines technological solutions with ecological restoration and community participation. Strategies such as mandatory rainwater harvesting, rejuvenation of existing

lakes, wastewater recycling for non-potable uses, aquifer mapping, and smart metering must be urgently implemented. Landscape transitions toward native and drought-resistant plant species can further reduce water demand in public and private spaces. Importantly, the success of these strategies depends on coordinated governance, backed by clear policy mandates, institutional accountability, and civic engagement. By drawing lessons from cities that have successfully navigated similar challenges, the thesis provides a roadmap for transforming Electronic City into a model of sustainable urban water resilience.

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