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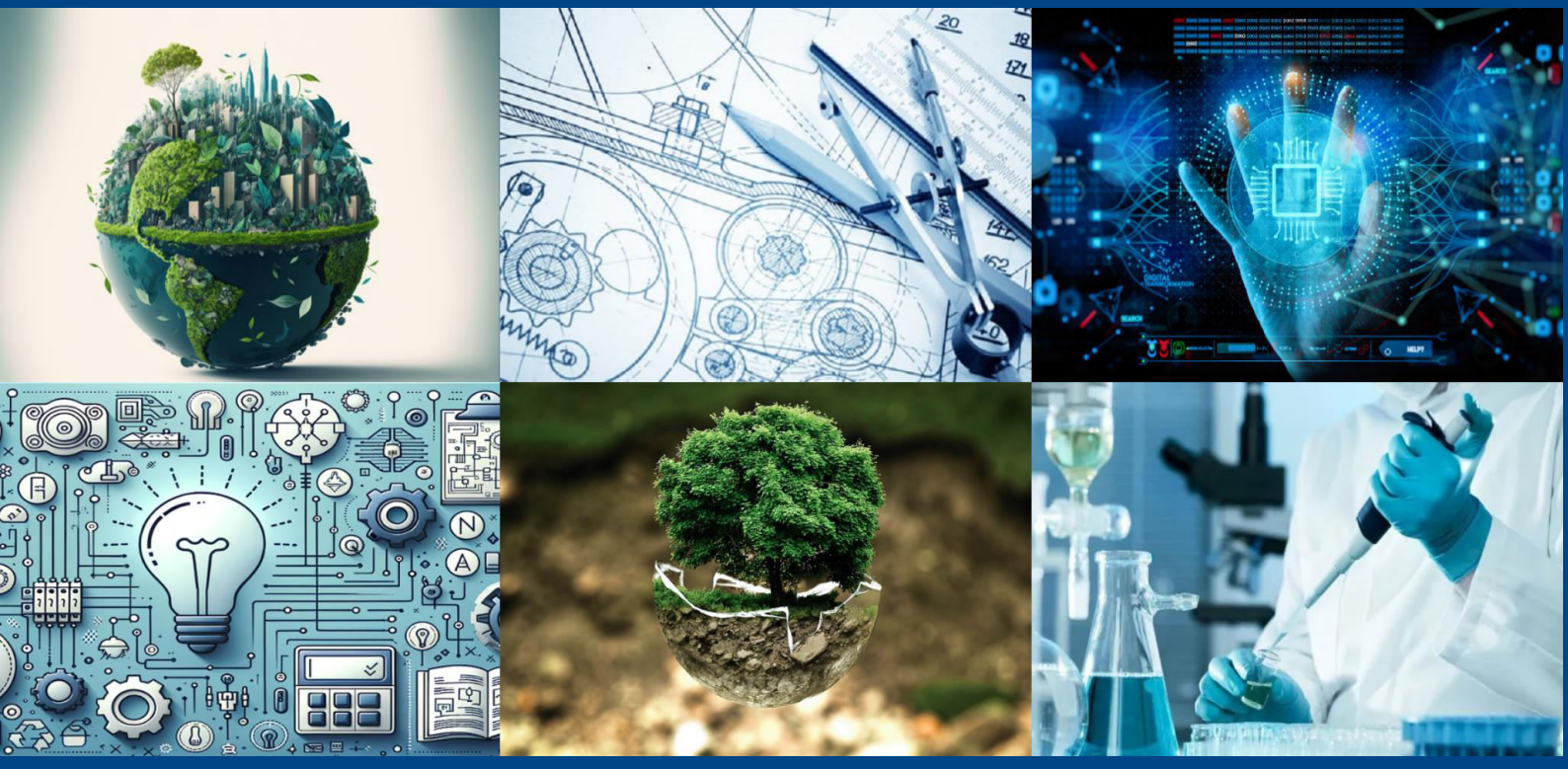

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Analysing the Water Demand-Supply Gap in Pune Amidst Rapid Population Growth

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ABSTRACT: Pune has witnessed an unprecedented surge in population, surpassing projected figures much earlier than expected. As per Pune Municipal Corporation (PMC) records, the population forecast for 2047 was reached by 2023, leading to an unanticipated strain on the city's water resources. Moreover, the latest population projection using the Linear Growth method, as per World Population Review, estimates Pune's population at 12,409,970, further exacerbating the water crisis. This study analyses the mismatch between water demand and supply, evaluates existing water management strategies, and proposes sustainable solutions for efficient water resource management in Pune.

I. INTRODUCTION

Pune, one of India's fastest-growing cities, has experienced rapid urbanization, surpassing its projected population for 2047 in 2023. This unexpected growth has placed significant stress on the existing water supply infrastructure, necessitating urgent upgrades and planning for future sustainability. This report assesses the current system, identifies challenges, and proposes solutions to meet the growing demand.

II. LITERATURE REVIEW

Pune Municipal Corporation (PMC) Water Supply Department Reports

1. **Population Growth and Water Demand Analysis**
   - **Projected Population for 2047:** ~7.5 million (as per 2010 estimates)
   - **Achieved Population in 2023:** ~7.5 million
   - **Current Water Demand (2023):** 1600 MLD (Million Liters per Day)
   - **Projected Water Demand (2047):** 2200 MLD

2. **Existing Water Supply Infrastructure**

Water Sources.

- **Khadakwasla Dam System** (Main source)
- Includes Panshet, Varasgaon, and Temghar dams
- Total capacity: ~30 TMC (Thousand Million Cubic feet)
- **Mula-Mutha River**
- **Groundwater Wells and Borewells**
- **Alternate Sources** (Rainwater harvesting, recycled water)

3. **Water Treatment Plants (WTPs)**
   - **Parvati WTP:** 550 MLD
   - **Wadgaon WTP:** 350 MLD
   - **Cantonment WTP:** 200 MLD
   - **Other smaller WTPs:** ~300 MLD
   - **Distribution Network**
     - **Pipeline Length:** ~3200 km
   - **Storage Capacity:** 1100 ML (Million Liters) in overhead tanks

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- **Non-Revenue Water (NRW) Losses:** ~30%

4. **Challenges in the Current System**
   1. **Water Shortages** due to demand exceeding supply
   2. **High NRW Losses** due to leakages, theft, and aging infrastructure
   3. **Unequal Distribution** affecting certain areas
   4. **Dependency on Monsoon** for water storage
   5. **Pollution in Mula-Mutha River** affecting water quality
   6. **Lack of Efficient Water Recycling** and reuse systems
   7. Proposed up gradation and Expansion Plan

5. **Increasing Water Supply Capacity**
   - Augmentation of **Khadakwasla Reservoir System**
   - Development of **new reservoirs** and water source diversification
   - **Desalination and water recycling** initiatives

III. METHODOLOGY OF PROPOSED SURVEY

1. **Water Demand and Supply Analysis**
   - **Current Water Demand**: As per global standards, an urban population requires 135-150 litters per capita per day (LPCD). With over 12.4 million residents, Pune's estimated demand exceeds 1,860 MLD (million litters per day).
   - **Current Water Supply**: PMC supplies approximately 1,350 MLD, but due to inefficiencies such as leakage and wastage, the effective supply falls short of demand.
   - **Challenges**: Unregulated groundwater extraction, infrastructure bottlenecks, and climate variability further exacerbate the issue.

2. **Factors Contributing to Water Stress**
   - **Uncontrolled Urbanization**: High migration rates increase demand for residential and commercial water usage.
   - **Infrastructure Deficiency:** Aging pipelines and treatment plants contribute to inefficiencies.
   - **Inefficient Water Management**: Lack of rainwater harvesting and recycling facilities.
   - **Climate Change Impact**: Erratic monsoon patterns affect water availability from reservoirs.

3. **Proposed Solutions for Sustainable Water Management**
   - **Water Conservation Strategies**: Implementation of rainwater harvesting and wastewater recycling at both household and city levels.
   - **Infrastructure Improvement**: Upgrading pipelines to reduce losses and optimizing treatment plants.
   - **Smart Water Management**: Adoption of IoT-based monitoring systems to track leaks and consumption.
   - **Public Awareness Campaigns**: Encouraging responsible water usage practices among citizens.
   - **Alternative Water Sources**: Exploring desalination, treated wastewater reuse, and decentralized water storage solutions.
   - **Waste water treatment** - Potable
     - **Wastewater treatment for potable use** involves purifying sewage or industrial wastewater to make it safe for drinking.
     - It includes processes **like filtration, sedimentation, biological treatment, and advanced purification** (e.g., reverse osmosis, UV disinfection).
     - **Primary treatment removes solids, secondary treatment** removes organic matter, and tertiary treatment eliminates contaminants.
     - Advanced methods like **membrane filtration and chemical disinfection** ensure water meets drinking standards.
     - Recycled potable water is used in water-scarce areas to ensure **sustainability and safe consumption**

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- **Rainwater harvesting (@ Society Level)**
  - **Rainwater harvesting at the society level** involves collecting and storing rainwater from rooftops and open areas.
  - It is directed through **filters into storage tanks** for domestic use or **groundwater recharge** via recharge pits.
  - This helps in **water conservation, reducing dependence on municipal supply, and preventing waterlogging.**
  - It is a **cost-effective and sustainable** solution for addressing urban water scarcity.
- **Protection of fresh water**
  - **Protecting freshwater** involves preventing pollution, overuse, and habitat destruction in lakes, rivers, and groundwater sources.
  - Measures include **wastewater treatment, sustainable water use, afforestation, and reducing plastic and chemical waste.**
  - Community participation and **strict regulations** ensure long-term water availability for future generations.
- **Deep Well / Bore Well**
  - **Deep wells and Borewells** provide groundwater in water-scarce areas but contribute to depletion if overused.
  - Excessive extraction **lowers the water table**, causing wells to dry up and increasing dependence on deeper drilling.
  - **Sustainable groundwater management,** recharge techniques, and controlled usage are essential to prevent long-term water shortages.
- **Eco Friendly / Water Saving Strategy**
  - **Industrial, Commercial, Domestic.**
  - **Metering System**
  - **Public Awareness**
  - **Plantation**
- **Tracing Illegal/ unauthorised water connection theft of water though GPS / GIS as..**
- **Detecting and Solving Water Leakage Using GIS & GPS:** Managing water supply efficiently is important to prevent water wastage and ensure a smooth supply. Using GIS (Geographic Information System) and GPS (Global Positioning System), we can detect leaks and fix them quickly.
  - **Water leakage is detected faster and accurately.**
  - **Repairs happen quickly, saving water and money.**
  - **Citizens can also report issues, improving public participation.**
  - **The water supply system becomes more efficient and reliable**

4. **Infrastructure Development**
   - **Expansion of WTPs**: Increase treatment capacity to 2500 MLD by 2047
   - **Pipeline Network Rehabilitation**: Reduce NRW losses to <15%
   - **Smart Water Metering** for real-time monitoring and reduction of wastage

5. **Sustainable Water Management**
   - **Rainwater Harvesting Mandates** in urban structures
   - **Wastewater Treatment and Reuse**: Increase recycled water usage for non-potable purposes
   - **Groundwater Recharge** through artificial recharge projects

6. **Policy and Governance Initiatives**
   - **Public-Private Partnerships (PPP)** for efficient management
   - **Awareness and Citizen Participation** programs

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Regulatory Framework for Sustainable Use Implementation Timeline and Cost Estimation

Phase	Timeline	Estimated Cost (INR Crores)
Phase 1: Immediate Interventions (2024-2027)	3 years	2500
Phase 2: Medium-Term Expansion (2027-2035)	8 years	6000
Phase 3: Long-Term Sustainability (2035-2047)	12 years	9000
Total Cost Estimate	-	17500

IV. RESULT AS PER SURVEY AND ANALYZATION OF RESERCH WORK

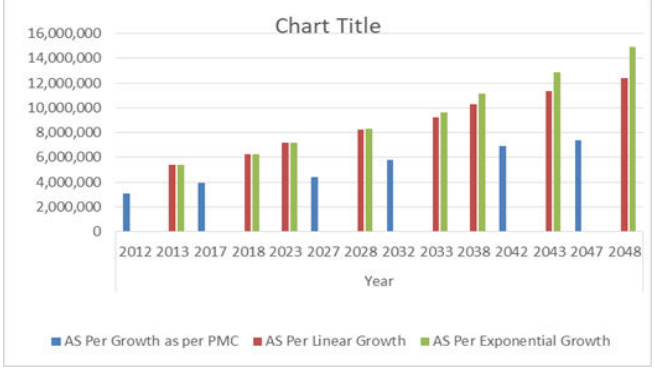
Population Growth Trends

The population data provided by PMC and World Population Review indicate a sharp rise:

- 2012: 3,115,433
- 2017: 3,918,763
- 2027 (Projected): 4,430,320
- 2032 (Projected): 5,771,754
- 2042 (Projected): 6,939,529
- **2047 (Projected, but achieved by 2023): 7,375,348**
- 2023 (New Estimate, Linear Growth Method): 12,409,970

The premature realization of the 2047 population projection and the much higher new projections indicate a severe miscalculation, leading to an unprepared water management system.

Year	Growth as per PMC	AS Per Linear Growth	AS Per Exponential Growth
2012	3,115,433		
2013		5,417,250	5,417,250
2017	3918763		
2018		6,275,750	6,275,750
2023		7,166,370	7,166,370
2027	4430320		
2028		8,214,290	8,320,050
2032	5771754		
2033		9,263,210	9,645,540
2038		10,312,130	11,157,920
2042	6939529		
2043		11,361,050	12,876,450
2047	7375348		
2048		12,409,970	14,915,210



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V. CONCLUSION AND FUTURE WORK

Pune's accelerated population growth has outpaced water demand projections, resulting in an urgent need for an adaptive and efficient water management strategy. With the new projection of 12.4 million residents, the city's water crisis is even more severe than previously anticipated. A combination of policy interventions, technological advancements, and community engagement is essential to ensure sustainable water availability for the city's growing population. By implementing proactive measures, Pune can mitigate future water crises and set a precedent for urban water resilience.

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Personalized Traffic Management: AI can offer tailored routing suggestions based on the driver's preferences, such as avoiding toll roads or prioritizing routes with less traffic, enhancing the user experience.

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