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RESTORING ANCIENT AQUEDUCTS TO ADDRESS PUNE'S CURRENT WATER REQUIREMENTS

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ABSTRACT
Pune is presently experiencing a serious water scarcity as a result of extreme groundwater withdrawal that has caused catastrophic depletion of aquifers and borewell depths of nearly 450 feet in certain places. The building industry is a significant contributor to the practice of drinkable water, which exacerbates the issue. Despite being available, treated wastewater from sewage treatment plants (STPs) is still infrequently used. An 18th-century water supply system that formerly stretched over 20 kilometers and served more than 200 locations throughout the city, the historic Peshwa-era aqueducts are inspected in this study to see if they can be restored as a sustainable addition to the city's present water supplies. The study employs a multidisciplinary methodology that incorporates stakeholder participation, historical analysis, and technological evaluation. Additionally, it involves monthly water sampling from key sites such as Bagul Udyan and Tapowan Society in Parvati Paytha to evaluate the water's quality for probable use in drinking (with minimal treatment), gardening, and construction. The goal of the suggested sustainable water management system is to lessen dependency on groundwater while integrating heritage infrastructure into new urban development.
Keywords: Groundwater Depletion, STP Water, Peshwa-era Aqueduts etc.

INTRODUCTION:
Pune, often famous as the cultural sentiment of Maharashtra, has seen a extraordinary evolution—from a quiet, tradition-rich town during the Maratha rule to a dynamic urban center brimming with industry and innovation. While its origins date back to the 8th century, it was during the 18th-century Peshwa era that Pune experienced significant growth in civic infrastructure. Among the most notable advancements of that time were water management systems, including the Katraj reservoir and an intricate network of aqueducts and stone-lined channels that supplied water to key locations like Shaniwar Wada. These systems showcased not only technical sophistication for their era but also a clear vision for sustainable urban planning.
Today, as one of India's fastest-growing cities, Pune is witnessing rapid industrial expansion, booming IT parks, and an ever-growing real estate sector. This urban growth has led to a sharp rise in water demand, pushing the limits of existing water sources. Municipal supply, mainly drawn from reservoirs like Khadakwasla, Panshet, and Temghar, often falls short, prompting increased reliance on borewells and private water tankers, particularly in new metropolitan settlements. A key driver of this demand is the construction industry, which consumes massive volumes of water each day—not just for building processes like concrete mixing and curing, but also for basic needs of on-site labor. Estimates suggest that for every 1,000 sq. ft. of built-up area, construction activities require between 6,000 to 10,000 liters of water, which, when scaled to city-wide development, translates into an immense strain on resources. Even though Pune's Sewage Treatment Plants (STPs) produce a substantial volume of treated wastewater, its use in construction remains limited. Instead, the industry continues to rely heavily on potable and groundwater sources, further depleting aquifers and often clashing with domestic water needs. In several neighbourhoods, the dependence on water tankers—many of which source water from unregulated bore wells—has become the norm, raising concerns about long-term sustainability.

This study tackles this urgent problem by investigating how Pune's traditional water systems, notably the aqueducts from the Peshwa period, can be restored and modified for contemporary application. By learning from past water management methods and integrating them with present technologies like wastewater recycling, the research suggests a more environmentally-friendly strategy for meeting urban water needs—especially those caused by the building industry—while also safeguarding the city's historical legacy.

DESCRIPTION :

This study takes a closer look at Pune's rising water challenges, focusing on how the revival of historic infrastructure—specifically the Peshwa-era aqueducts—could offer a sustainable solution to the city's rising dependence on groundwater and treated potable water. The research is grounded in the backdrop of Pune's rapid urban expansion, where the construction industry has become one of the most water-hungry sectors. Construction projects, big and small, often require water in the range of thousands to even millions of liters, with most sites depending heavily on borewells, municipal supply, or groundwater delivered by tankers. This pattern of usage has significantly strained local aquifers and added stress to the city's already burdened water supply system. Interestingly, while Pune operates multiple Sewage Treatment Plants (STPs) that produce large volumes of treated wastewater daily, only a fraction of this resource is actually put to use—particularly in non-potable areas like construction, where it could easily substitute fresh water. Meanwhile, a forgotten piece of Pune's water heritage still exists: the 18th-century Peshwa aqueducts. Once capable of carrying approximately 2.5 million liters of water per day across various parts of the city, these aqueducts stand as a testament to the ingenuity and sustainability of past urban planning. This research explores the potential of reactivating and integrating these historical systems with modern-day needs, offering an innovative way to reduce pressure on current water resources.

PROBLEM STATEMENT:

Pune faces severe water stress due to overdependence on groundwater, especially in the construction sector. Despite available alternatives like treated wastewater and historic Peshwa-era aqueducts, their utilization remains minimal.

AIM:

To evaluate the potential of reviving the Peshwa-era aqueducts and integrating treated wastewater as sustainable alternatives to reduce groundwater dependency in Pune's construction and urban water sectors.This study aims to address Pune's growing water crisis by evaluating the potential of reviving the historic Peshwa-era aqueducts and promoting the use of this in the construction and urban water supply sectors. With groundwater levels depleting rapidly and construction activities consuming massive amounts of potable water, there is an urgent need to implement alternative, sustainable solutions. The study focuses on understanding the capacity, condition, and feasibility of reactivating the Peshwa-era aqueducts, which once transported nearly 2.5 million liters of water daily across the city. Through historical analysis, technical assessment, and PMC engagement, the research proposes an integrated approach that combines heritage infrastructure with modern water reuse strategies to ensure long-term water sustainability in Pune.

STUDY AREA :

The study is centered on Pune city, located in western Maharashtra, covering an area of approximately 516 square kilometers. Known for its historical water systems and rapid urban growth, Pune now faces increasing pressure on its water resources. Major water supply sources include the Khadakwasla, Panshet, and Varasgaon dams. However, with the city's expanding real estate and construction sectors — especially in regions like Baner, Hinjewadi, Kharadi, and Wagholi —

groundwater extraction has drastically increased. Many of these areas are heavily dependent on borewells and tanker water due to limited municipal supply. The presence of the underutilized Peshwa-era aqueduct system, which historically supplied millions of liters of water daily, offers a promising opportunity for sustainable water management in the city.

METHODOLOGY:

This study takes a multidisciplinary approach to explore the feasibility of bringing Pune's historic Peshwa-era aqueducts back into practical use. It starts with a detailed review of the original aqueduct system and recent revival efforts, with particular attention to the Pune Municipal Corporation's (PMC) work on restoring the water supply line to Taljai Hill. On-ground field surveys will help assess the current physical state of these old structures and whether they can be adapted for today's urban needs. To understand how this water could be used, samples will be tested for quality to see if it's suitable for various purposes like drinking (with minimal treatment), gardening, and construction activities.

The study will also look at how water is currently used in the city, especially in high-consumption sectors like construction, to identify where aqueduct-supplied water could ease the pressure on groundwater sources. Technical feasibility will be examined by analyzing flow capacity, potential upgrades, and practical delivery systems. Importantly, input from PMC officials, engineers, and heritage conservation experts will be gathered to ensure that the findings are grounded in both technical and cultural realities. The ultimate goal is to develop a sustainable water management plan that blends the city's rich water heritage with the practical demands of modern urban life.

WATER TEST

Parameter	Jan 2025	Feb 2025	Mar 2025	Apr 2025	Permissible Limit (IS 10500:2012)	Remarks
pH at 25°C	7.28	7.35	7.31	7.33	6.5–8.5	Within permissible range
Total Dissolved Solids	598 mg/L	620 mg/L	605 mg/L	610 mg/L	500 (desirable), 2000 (max)	Slightly above desirable, within max
Total Hardness (as $CaCO_3$)	318 mg/L	328 mg/L	321 mg/L	323.46 mg/L	200 (desirable), 600 (max)	Above desirable, within max
Calcium (as Ca)	74.8 mg/L	78.5 mg/L	76.2 mg/L	76.91 mg/L	75 (desirable), 200 (max)	Slightly above desirable
Magnesium (as Mg)	30.8 mg/L	32.3 mg/L	31.6 mg/L	31.92 mg/L	30 (desirable), 100 (max)	Slightly above desirable
Total Alkalinity (as $CaCO_3$)	229 mg/L	233 mg/L	230 mg/L	231.15 mg/L	200 (desirable), 600 (max)	Slightly above desirable
Chloride (as Cl^-)	33.9 mg/L	35.2 mg/L	34.1 mg/L	34.74 mg/L	250 (desirable), 1000 (max)	Within permissible limits
Turbidity (NTU)	< 1	< 1	< 1	< 1	1 (desirable), 5 (max)	Excellent clarity

Sulphate (as SO_4^{2-})	11.6 mg/L	12.3 mg/L	11.8 mg/L	12 mg/L	200 (desirable), 400 (max)	Within permissible limits
Fluoride (as F^-)	< 0.1	< 0.1	< 0.1	< 0.1	1.0 (desirable), 1.5 (max)	Safe
Nitrate (as NO_3^-)	1.18 mg/L	1.26 mg/L	1.20 mg/L	1.22 mg/L	45 (max)	Very low – good quality
Sodium as Na	21.7 mg/L	22.8 mg/L	22.0 mg/L	22.14 mg/L	No IS limit, < 200 preferred	Safe
Potassium as K	< 1	< 1	< 1	< 1	No IS limit	Safe
Carbonate	19.8 mg/L	20.5 mg/L	20.0 mg/L	20.1 mg/L	No IS limit	Acceptable
Bicarbonate	188.4 mg/L	193.6 mg/L	190.0 mg/L	190.95 mg/L	No IS limit	Acceptable

Table -1: Monthly Water sample Analytical Results (Jan to April 2025)

RESULT AND DISCUSSION

The water samples collected and analyzed from January to April 2025 are of generally high quality and can be utilized for various purposes. The water has low turbidity and the pH levels consistently fall within the recommended range of 6.5 to 8.5, suggesting clarity and minimal suspended particles. Certain parameters, such as total dissolved solids (TDS), hardness, calcium, and magnesium, slightly exceed the ideal range but nonetheless comply with the acceptable limits outlined in IS 10500:2012. The water poses no significant health or environmental threats, as critical indicators like fluoride, nitrate, sulfate, chloride, and heavy metals are well below the safety limits. Additionally, the water's features, particularly its moderate hardness, low chloride content, and low turbidity, make it suitable for use in construction because they lower the risk of corrosion in reinforced concrete structures.

CONCLUSION :

Water samples analyzed between January and April 2025 were deemed safe and versatile for various uses. The findings indicate that, following basic treatment such as UV or RO filtration, the water is suitable for drinking, as no significant contamination was detected. It also fulfills the criteria for gardening, landscaping, and agricultural irrigation, with nutrient levels well within safe limits for plant growth. Additionally, the clarity and low corrosiveness of the water make it ideal for construction purposes, including concrete mixing, curing, and masonry work. While the samples were largely appropriate for all assessed applications, slightly elevated levels of hardness and total dissolved solids (TDS) suggest that periodic quality assessments should continue. For drinking, some light purification is advisable. Importantly, there were no signs of chemical, biological, or industrial pollutants, confirming the water's overall safety and reliability for both domestic and construction uses.

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