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Integrated Watershed Management for Urban Resilience: A Strategic Planning Framework for Ahmedabad

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Abstract: ***Ahmedabad, which is a rapidly expanding urban center within western India, faces very meaningful challenges that relate to water management, for example flooding, water scarcity, also groundwater depletion. Urban sprawl as well as encroachments upon natural water bodies can exacerbate all these issues. Degradation to customary water systems also contributes. Recognizing the urgency of these concerns, this study proposes an Integrated Watershed Management (IWM) framework that will tailor resilience within the city to challenges related to water. The research does employ such a mixed - methods approach as it assesses the current state within Ahmedabad's watersheds. For this approach, Geographic Information Systems (GIS) mapping, remote sensing, field surveys, and also stakeholder interviews are combined. The study assesses policies and pinpoints flood and scarcity susceptible zones, so an integrated framework of ecological restoration, community engagement, and sustainable land use planning is built. Key findings show urban lakes must be revitalized, green infrastructure implemented, and community conservation promoted. To foster a holistic approach to watershed management, the proposed IWM framework stresses that sectors collaborate, policies integrate, with capacity building. For Ahmedabad, this thesis advances discussion of urban resilience through a specific, practical framework. It offers valuable perceptions for policymakers, urban planners, together with community stakeholders if they seek to create a sustainable and water - resilient urban future.***

Keywords: urban water management, integrated watershed planning, ecological restoration, urban resilience, community engagement

1. Introduction

Using sustainable and community - driven methods, this thesis suggests a strategic watershed planning framework for Ahmedabad that addresses urban flooding and water scarcity while enhancing water security and urban resilience.

Integrated watershed management is the process of managing human activities and natural resources on a watershed basis, taking into account social, economic and environmental issues, local community interests and issues such as the impacts of development and climate change. A watershed is an area of land that catches rain and drains or seeps into a stream, river, lake or groundwater.

1.1 Aim

The project aims to develop a comprehensive framework for Integrated Watershed Management (IWM) in Ahmedabad, integrating community involvement, sustainable urban planning, and ecological restoration.

1.2 Objectives

1) Identification and rehabilitation of natural resources.
2) Promotion of sustainable use of natural resources.
3) Provision of stable, productive and high quality ecosystem.
4) Promotion of community participation.
5) Coordination of policies, programmes and activities.

1.3 Why Watershed Development?

- Captures water resources for improved soil and vegetation management.
- Aims to increase agricultural productivity in rainfed, semi - arid areas.
- Despite being bypassed by the green revolution, these areas have seen little growth.

1.4 Total Project Cost

Watershed Development Component of Pradhan Mantri Krishi Sinchayee Yojana (WDC - PMKSY 2.0) in India

- Set unit cost norms for watershed management, revised from 2021.
- Funding distribution: General States: 60% Central share and 40% State share, Hilly States & North - Eastern States (including Sikkim): 90% Central share and 10% State share, Union Territories: 100% Central funding.
- Indicative Central financial outlay for 2021 - 2026: ₹8, 134 crore, targeting 49.50 lakh hectares of land.
- Neeranchal National Watershed Project: Total project cost of ₹2, 142 crore, 50% Government of India and World Bank Loan. Additional expenses may arise for advanced interventions, capacity building, and monitoring.

1.5 Significance of the Study

Watershed management is a crucial approach for sustainable water resource management, enhancing agricultural productivity, protecting the environment, and promoting economic stability, poverty reduction, and ecological balance, ultimately leading to improved livelihoods and ecological balance.

2. Literature Review

Study of Rain Water Harvesting in Bengaluru Urban Regions

Introduction

The Cauvery River basin's decreased water supply as a result of fluctuating precipitation levels is causing a water shortage crisis in Bengaluru, India's Silicon Valley. The city could have

prevented this by putting Rain Water Harvesting (RWH) into place, even though the average annual rainfall is 787 mm. Rainwater from rooftops, parks, roads, and open spaces is gathered, stored, transported, and purified as part of RWH. This technology lowers expenses, lowers water demand, encourages energy and water conservation, enhances the quantity and quality of groundwater, and lessens flooding, storm water runoff, soil erosion, and surface water pollution. Additionally, it offers a water source free of chemicals, dissolved salts, and minerals for landscape irrigation. Bengaluru will never run out of water thanks to this solution.

Many researchers believe that rainwater harvesting systems are a sustainable water management system. With an estimated catchment yield of 7.32 TMCft of water in the Vrishabhavathi valley, effective harvesting can supply 73% of Bengaluru's water needs. About 14.80 TMCft of rainwater is produced annually in the city; treating 18 TMCft of wastewater could produce an additional 16 TMCft, creating a surplus.

Only 1.65 lakh buildings have been installed in Bengaluru, indicating a slow pace of RWH system implementation. The availability of heavily subsidized Cauvery water and investment apprehension are blamed for the sluggish progress. Rooftop Rainwater Harvesting Systems and Surface Runoff Rainwater Harvesting Systems are the two most popular varieties of RWH systems in Bengaluru.

In addition to analyzing the current challenges in promoting rainwater as an alternative drinking water source, the study intends to investigate the effectiveness of rainwater harvesting as a domestic water supply option, as well as its usage, benefits, and costs.202 Bengaluru residents between the ages of 20 and 69 who either have or intend to install a rainwater harvesting system participated in the survey. Several statistical tools were used to analyze the data.

Experimental Studies and Statistical

Table 1: Count of type of system installed and reasons for installing

Types of system/ Reason	Cost effective	High Storage Capacity	More Hygienic	Suitable For My Place	Total
Roof Top Rain Water Harvesting	46	22	8	55	131
Surface Runoff Rain Water Harvesting	17	16	3	35	71
Total	63	38	11	90	202

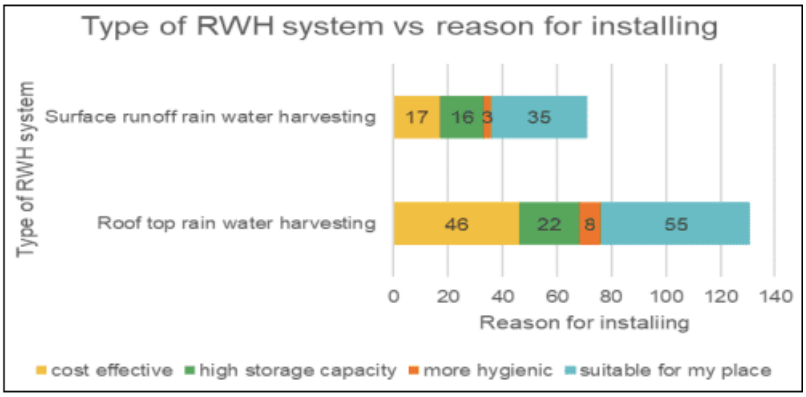


Figure 1: Bar chart: Type of system installed against reason for installing

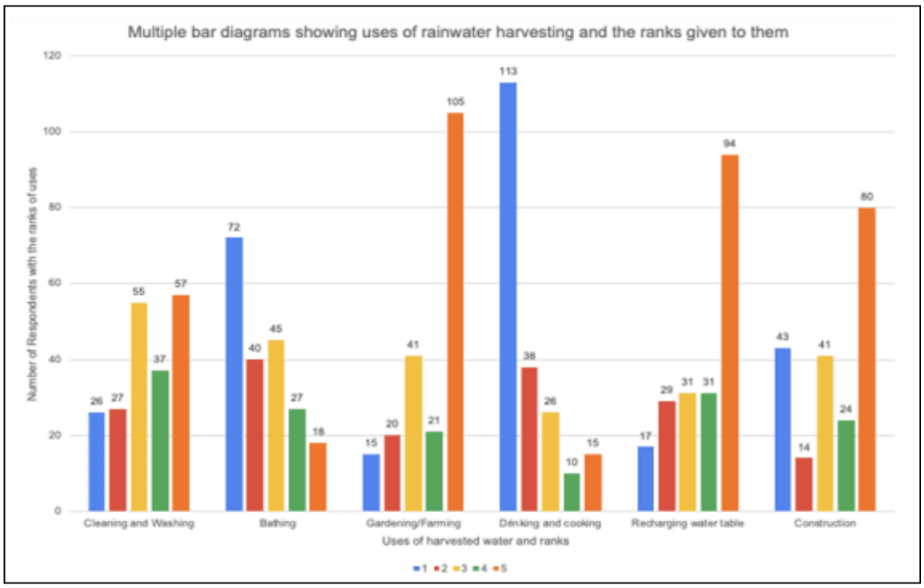


Figure 2: Multiple Bar Diagram: Usage of Rainwater Harvesting against the ranks allotted to them

From the graph above, we observe that the use "Recharging Water Table" has been given a ranking of 5 (most desirable use) and the use "Drinking and Cooking has been given a ranking of 1 (least desirable use

Advantages of rainwater harvesting

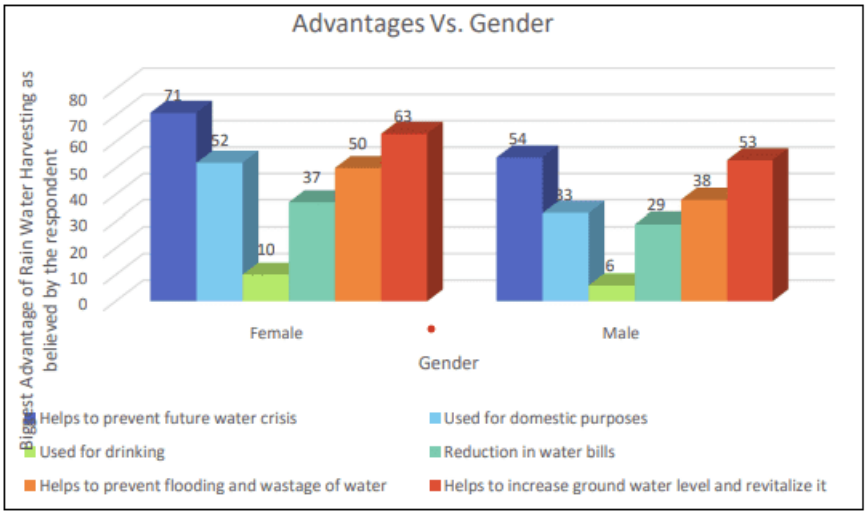


Figure 3: Multiple Bar Diagram: Advantages against Gender

According to the study, graduate students are more likely than those at other educational levels to have installed a rainwater harvesting system. Nonetheless, a greater number of respondents who are post - graduate or above have not installed the system, presumably as a result of their greater awareness and higher income levels. Additionally, according to the data, 77.6% of government employees, 82.8% of private sector employees, 81.8% of self - employed individuals, and 67.9% of non - working individuals are aware that Rainwater Harvesting (RWH) systems must be installed in government buildings, apartments, industrial buildings, residential complexes, and educational institutions. About 25% of the population is still ignorant of this regulation, according to the 74.8% of respondents who said they were aware of it.

According to the study, only 30% of respondents in Bangalore who live in rented or leased homes have a RWH system installed, compared to 61.11% of respondents who own a home. By holding workshops in workplaces, schools, and colleges, the BBMP can inform the public about this mandate and the value and advantages of RWH.

Table 2: The Amount of Water Harvested in Liters and the Dimension of the House

Dimension of house	Litres of water harvested					
	Less than 50000	50000 - 100000	100000 - 150000	150000 - 200000	More than200000	total
30x40	42	39	10	3	6	100
40x60	12	37	6	4	3	62
60x80	2	9	3	1	1	16
80x100 and above	6	10	2	1	5	24
total	62	95	21	9	15	202

Table 3: Type of rainwater harvesting system and Dimension of House

Dimension of house	Types of rainwater harvesting system		
	Rooftop RWH System	Surface RWH system	Total
30x40	70	30	100
40x60	38	24	62
60x80	9	7	16
80x100 and above	14	10	24
total	131	71	202

3. Conclusion

There are water shortages in many parts of Bengaluru, and rainwater harvesting is thought to be an accessible, economical, and sustainable solution. With 131 users, rooftop rainwater harvesting is the most popular technique. Drinking and cooking are the least preferred uses, while farming and gardening are the most preferred. The ability of harvested water to avert future water crises is its greatest benefit. Through its RWH theme park in Jayanagar, which trains architects, engineers, and plumbers and features 27 operational models, the BWSSB promotes rainwater harvesting. After Chennai, Bengaluru presently has the second - highest number of RWH installations in India.

4. Study Area

Introduction

Water Project Department Constantly liaisons with the State Government to get required quantity of raw water from Narmada Main canal, Dholka branch canal and Shedhi Branch Canal.

Raw water is treated by different Water Treatment Plants and converted to portable water as per CPHEEO norms. Civil and Maintenance of Water Treatment Plants is also the responsibility of this Department.

Raw water is treated by different Water Treatment Plants and converted to portable water as per CPHEEO norms. Operation and Maintenance of Water Treatment Plants is also the responsibility of this Department

For the future requirement of water Supply, different project are carried out by water project division. Works related to Operation, maintenance & monitoring of treated water supplied to the different water distribution station of city is carried out by the Department.

Issues Identified in Region

- Ahmedabad experienced heavy rainfall for four hours, causing flooding in the western part of the city and highways.
- Waterlogging affected areas including CG Road, 132 Feet Ring Road, Helmet Circle, University Road, Gota, Vandemataram Road, Bopal, Ghuma, Ambli Road, Sindhu Bhavan Road (SBR) to Bopal Road, SG Highway to Pakwan Cross Roads, Seema Hall to Anandnagar Road, Ramdev Nagar cross road, Manekbaugh and Srinandnagar in Vejalpur.
- Vehicles parked near the roads in these areas ended up submerged, and some societies faced power outages.
- The waterlogged situation was exacerbated by ongoing Metro Rail and overbridge work in some parts of the city.
- Four underpasses - Akhbarnagar, Mithakali, LC 26 at Makarba and LC 1C at Chandlodiya - were closed to traffic for varying amounts due to waterlogging.
- The rains resulted in several tree uprootings, 31 instances of severe waterlogging, two instances of road damage, and two wall collapse cases.
- Ahmedabad and Surat were among the major cities to record heavy rainfall on Sunday in Gujarat.

Urban Waterlogging and Flooding in Ahmedabad Severe waterlogging and flash floods due to insufficient stormwater drainage systems and unplanned road construction. Areas like Berhampur, Paldi, Navrangpura, and Vasna at risk. Extreme Heat and Urban Heat Island Effect Increased ambient temperatures due to loss of green spaces and heat - retaining building materials. Health risks for susceptible groups. Air Pollution Issues with air quality, especially in winter due to dust from building sites, industrial operations, and vehicle emissions.

Potential impact on public health due to city's climate and inland location. Degradation of Wetlands and Reduced Lakes Rapid urbanization leads to ecological imbalance and flooding. Poor urban design impacts 28% of the city's urban land. Infrastructure strain due to uncontrolled development and encroachments. Waste management issues lead to environmental pollution and public health issues. Communities with low incomes are especially vulnerable to environmental risks.

AMC'S Percolating Well Scheme

The Amdavad Municipal Corporation (AMC) has not been able to collect rainwater through its '80 - 20' scheme, which aims to construct percolating wells in communities at a 20% cost. Just three of the 40 societies that signed up for the project have finished it. In 18 societies, the administration has finished the estimating and tendering process; however, 15 societies have yet to deposit the required sum. The Water Conservation Program's 48 wards were urged by the AMC to construct percolating wells as part of the "80 - 20 scheme. " Twenty percent of the total cost must be deposited by the consenting society.

Zone - wise applications:

Zone	Applications Received
West	2
South	6
East	17
North West	15

Zone - wise percolating wells:

In the year 2018–19, AMC surveyed percolating wells in various ward areas of the city. The zone - wise numbers as per the survey stand as follows:

Zone	Percolating Wells
North	63
West	367
New West	363
Central	91
South	75
East	250

It is noteworthy that under the Water Conservation Programme, AMC appealed to the societies in 48 wards under the '80 - 20 scheme' to build percolating wells.

It costs an estimated ₹2.65 lakh to build a percolating well. The consenting society has to deposit 20% of the total cost, i. e., ₹52, 000, as a contribution to AMC.

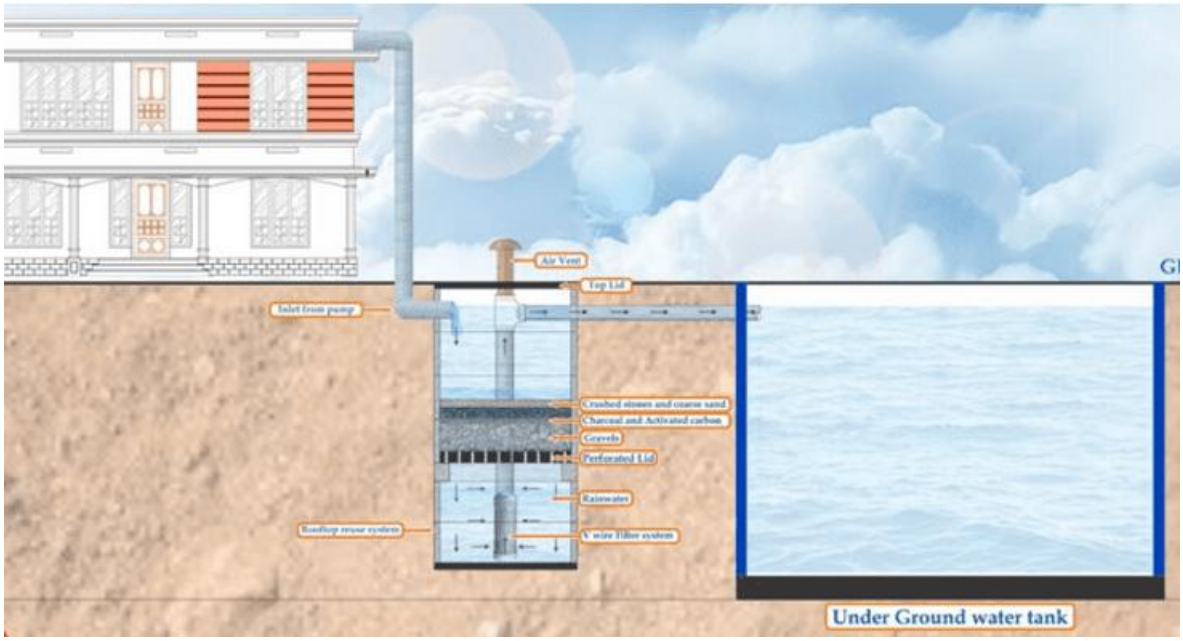
Rain Water Harvesting and other water saving techniques in a practical, reliable and cost - effective manner, in Ahmedabad and Gujarat.

Ahmedabad: Ahmedabad Municipal Corporation (AMC) has decided to install rainwater harvesting systems on the rooftops of all zonal offices, sub - zonal offices, ward offices, hospitals, schools, urban health centres, libraries, water pumping stations, drainage pumping stations, and other buildings of the civic body.

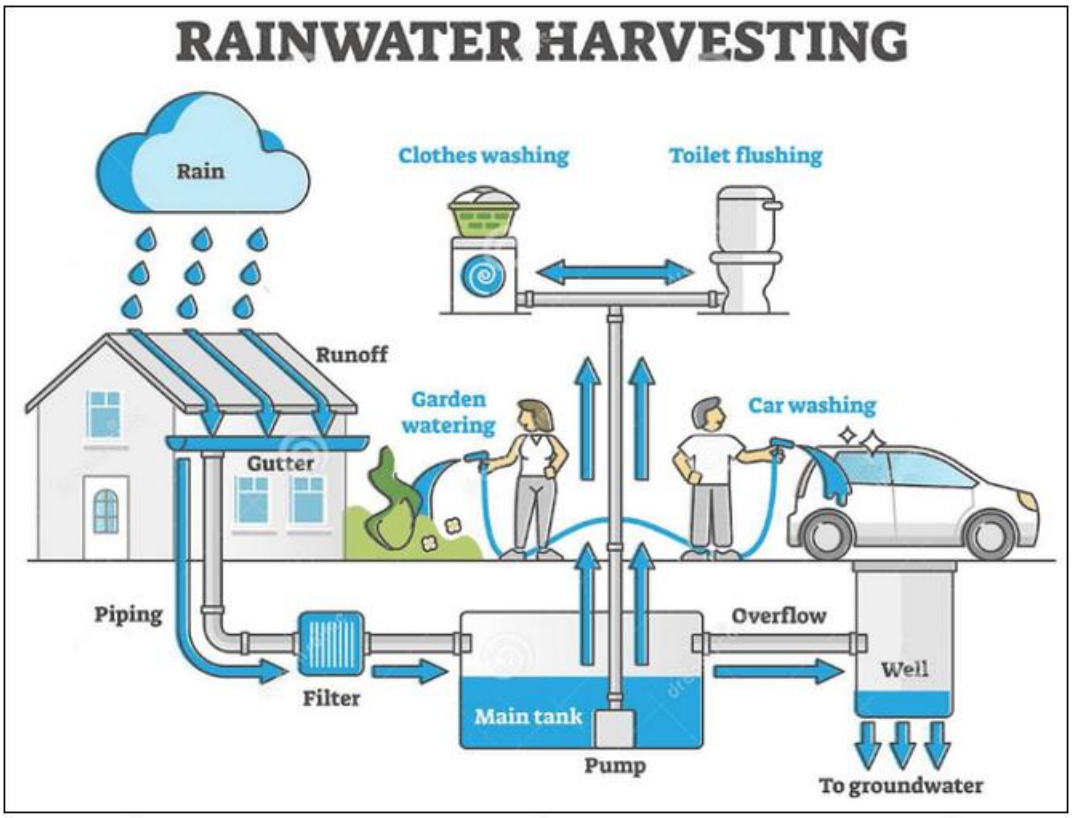
Additionally, a five - year operation and maintenance plan will be implemented, with a budget of Rs 5.32 crore. The proposal will be presented for approval at the road and building committee meeting on Dec 16. Although percolating wells are constructed in all new buildings by the AMC, they are not functioning effectively, leading to the decision to install rainwater harvesting systems in new buildings as well.

Ahmedabad Flooding and Municipal Corporation Funding

- Most applications received from western city areas.
- Flooding in western part like Prahladnaga, Jodhpur, Satellite, and Bodakdev.
- Flooding in eastern area like New Nikol, Odhav, and Kathwada.
- AMC seeks standing committee approval for 'percolating wells scheme'.
- AMC to bear 80% construction cost, residential societies to bear rest.



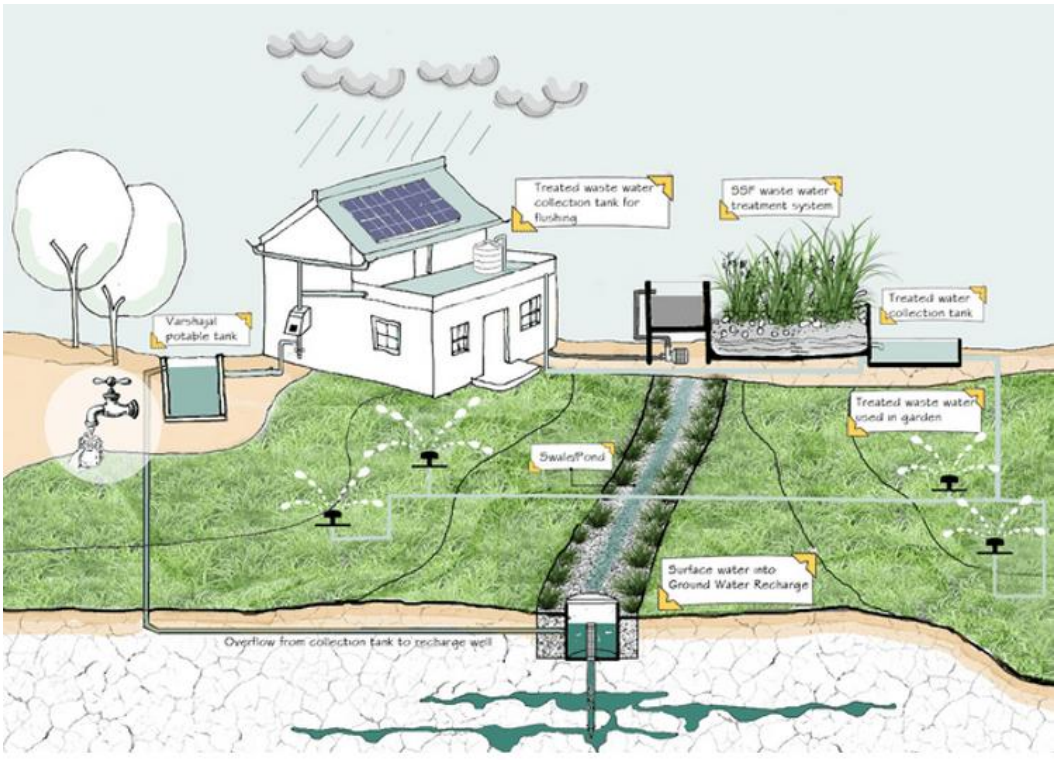
Ahmedabad Municipal Corporation (AMC) has announced a scheme for residential societies to build percolation wells, but applications are not being processed due to the lack of a contractors' panel. The AMC plans to establish a panel of contractors to carry out the construction, which will be passed on to zonal and sub - zonal offices. The scheme aims to overcome hurdles in the construction of wells, which were mandatory in 2001 for rainwater harvesting. The AMC is seeking permission from the standing committee to launch the scheme.



AMC plans to create sponge parks to combat waterlogging by retaining rainwater. Modeled after Chennai and China's' sponge cities', these parks absorb, filter, and retain rainwater, contributing to the city's stormwater management. The parks will be located in five locations and are expected to expand to 22 sites.

Parks for Water Management

- Absorb excess water during heavy rainfall to mitigate flood risks.
- Release moisture in summer to cool surroundings and replenish groundwater.
- Include water retention tanks and injection wells for enhanced water percolation.
- Include sports facilities like cricket pitches, badminton courts, and open gyms.
- Estimated cost: ₹78 lakh to ₹1.72 crore.



Study Area Neelkanth Apartments.

Project location: Neelkanth Apartment, PMAY Scheme, near Asarwa bridge, Behind city center, Idgah circle, Ahmedabad, Gujarat.

Problem Identification

Due to a number of factors, including an increase in paved and impervious land, the encroachment of lakes and other bodies of water, a decrease in tree cover, and an increase in rainfall intensity, water logging following rain is an issue in many parts of urban Gujarat. Neelkanth Apartments is a PMAY scheme apartment complex located in Ahmedabad that spans six blocks. Although the location has access to municipal water for daily use, rooftop rainwater harvesting is being taught and a system is being installed in light of the groundwater table's daily decline and the need to avoid a water shortage.

Solution Identified

In order to install the RWH system, the WIN, Sujalaam, and MHT teams went to the site and determined where the

rainwater filter should be placed in order to connect it to the existing borewell and underground tank.

As you can see in the picture above, there are six blocks total; three are on one side of the site, two are on the other, and one is standing by itself. Because of this, it was challenging to implement rainwater harvesting (RRWH) in every block under the current circumstances. The team decided to look at three blocks for RRWH after visiting the location and examining the current pipe connections and underground storage tank.

The outlets from the two terraces on the two blocks that are next to each other have been connected at the top floor of the apartment building, and one pipe has been brought down at the ground floor. Rainwater flows through this prefabricated filter, which has been installed here, and the filtered water enters the existing borewell.

In comparison to other blocks, this one is close to the existing subterranean tank; therefore, the terrace's downtake pipe reaches ground level here, and a ready - made filter is connected. Water that has been filtered then enters the UG tank.

In addition, the team has instructed committee members on how to maintain the system, use the first flush valve.

Benefits

The primary advantage is that rainwater is collected and any excess is reclaimed as groundwater. Now, water that was going down the drain is gathered and recycled. In this manner, monsoon water logging is avoided, and the water can be used as needed in the summer.

A sizable amount of water has been stored for the apartment residents during this monsoon.