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Water conservation: Need and Opportunities in rapid developing Residential dwellings in Suburb of Cities

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Abstract
Water is not an infinite resource. These days, water supply is a emergent concern for cities with booming urban populations, especially in the large portions of the country which are struggling with protracted drought, conservation as a means to adapt to threat is in spotlight. Water conservation encompasses policies, strategies and activities to manage fresh water as a sustainable resource, to protect the water environment, to meet current and future human demand. Population, household size and growth and affluence all affect how much water is used. Factors such as climate change will increase pressures on natural water resources.
In metropolitan city like Pune, Residential development is rapidly growing vertically up in the form of housing instead of individual apartment. The speed of the growth is at such a speed that local authority is unable to complete the water requirement of such housing areas for present water demand and conserving the water for future generations.
This paper deals with the water supply related problem and water conservation opportunities which can use to reduce water shortage problems in city suburb areas having a Moderate climate.

Keywords: Water Conservation, Opportunities, City suburb areas, Housing, Development, Moderate Climate.

1. Introduction
Our survival depends on water. With the increase in population growth and urbanization in the last few decades, the manifold increase in demand for water is of great concern.
India experiences either excess or scarce water because of varied rainfall and land topography. Yet they have managed to use natural water resources efficiently by integrating local water resources and technologies with community participation Water availability is currently a matter of grave concern in India, especially urban areas. It demands immediate attention from the government to safeguard its sustainability for future generations.
Water conservation encompasses the policies, strategies and activities to manage fresh water as a sustainable resource, to protect the water environment, and to meet current and future human demand. Population, household size and growth and affluence all affect how much water is used. Factors such as climate change will increase pressures on natural water resources especially in manufacturing and agricultural irrigation. (Mishra, 2013)
Hence it is necessary to conserve the water without disturbing the present water demand and conserving the water for future generations. To trim down such issues, the conservation of water by various alternatives is important.

1.1 Water Conservation
Water conservation is important just because overall water available on earth is 71% out of which 96.5% of water is sea water and 2% is in the form of ice caps. Only 1% fresh water is available on earth. Also, as the population increases human are doing deforestation which results in reduced rainfall.
According to a 1997 report of the New Mexico office of the State Engineers, water conservation is any action that reduces the amount of water withdrawn from water supply sources, reduces consumptive use, reduces loss or waste of water, improves efficiency of water use, increases recycling and reuse of water, or prevents pollution of water. It also states

that water conservation involves two distinct areas, technical and human. The technical side includes collecting data from water audits and installing water involves changing behaviours and expectations about water use and the way things should be done.

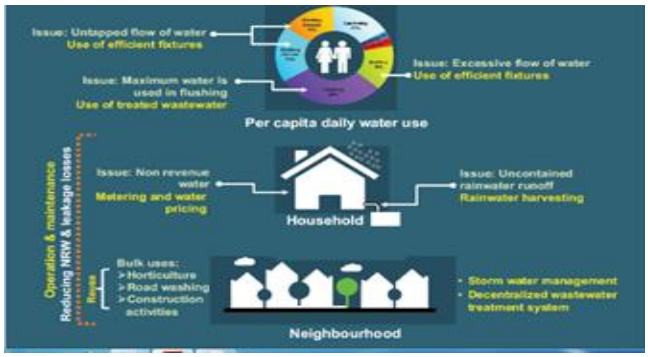
Also conserving water helps in conserving energy. The research shown that out of total energy, 6.5% energy is used for transportation of water from corporation storage to each user. Hence conserving the water at individual level will also result in reducing light consumption resulting in minimum electricity bill.

The Water Conservation principles are focused on :

a) Any beneficial reduction in Water loss, Use & Waste of resources

b) Avoiding any damage to water quality

c) Improving water management practices that reduce or enhance the beneficial use of water.



(Mahreen Matto, 2007)

2.0 Objective

This paper is focused on identifying and study the water supply related problem and the water conservation opportunities in High – rised Housing in suburb area of Pune.

With modernisation there is a growing number of nuclear families, senior citizens to live alone, students or interns living in dormitories or in shared accommodation during college and the early working years. As Pune city is expanding its limits day by day and also increasing the density rapidly. The peoples are fulfilling their problems by asking for extra water supply with the help of water tanker. Hence the report is focused on what are the various water conservation opportunities this housing project can use to reduce water shortage problems by following:

- By deriving various water conservation opportunities at all stages i.e. from site level to individual people's level, reducing the load on the municipal corporation water demand.
- By evaluating the water savings from various water conserving fixtures, advising the users the importance and also pay back period
  Evaluating the water conservation percentages by Xeriscaping.
- Deriving how the re – use of water for various purposes to conserve the water.

This paper will not only serve the purpose of reducing the load on water requirement but also will serve the various alternatives to conserve the water as well as help to make people aware about the use of water as well as re – use of grey water.

3.0: Need of Water Conservation in suburb areas

Rapid and unregulated urbanization and outdated urban water management models impacts water quality and quantity by jeopardizing the security and safety of our existing water resources. Cities are overwhelmed with water-related challenges.

In the city like Pune, Residential development is rapidly growing up in the form of housing instead of individual apartment. This growth is happening surrounding areas of Pune city instead of core city, as there are no chances of such kind of development within city. The speed of the growth is at such a speed that municipal corporation is unable to complete the water requirement of such housing areas. The housing scheme a growing vertically are also increasing the density of area. Such housing areas are unable to get enough amount of water from the municipal corporation which results in asking additional water supply with the help of private water tankers.

Hence for such areas, it is necessary to conserve the water without disturbing the present water demand and conserving the water for future generations. Water conservation helps to save energy, protect wild animals, and prevent people from using so much water that it cannot be replaced by Rain. To ensure availability for future generation, the withdraw of fresh water from an ecosystem should not exceed its natural replacement rate.

Water conservation is necessity of today's generations in every city, as the density is increasing, it became essential to conserve the water and reduce the load on municipal water supply.

In implementing water conservation principles there are number of key activities that may be beneficial: -

a) Any beneficial reduction in Water loss, use & waste of resources,

b) Avoiding any damage to water quality,

c) Improving water management practices that reduce or enhance the beneficial use of water.

The water conservation opportunities include various activities and those are divided at 3 different scales.

3.1.1 Site Scale

Planting the native species for Landscaping which consumes less amount of water. i.e. Xeriscaping. -

Selecting the native species for plantation which requires less water with compare to other species. This reduces the water demand required for landscape purpose by 30 to 55%.

Using proper irrigation system and schedule to reduce evaporation losses - Use of proper irrigation system also helps in reducing the water demand.Use of sprinkler irrigation system reduces the water demand by 15 % than supplying the water directly by pipe, whereas drip irrigation reduces the water demand by 27% to 32% as compare to sprinkler system.

The sensors should be used with irrigation system so when there are chances of Rainfall, the irrigation system will shut down automatically.

- **Using "Rain water harvesting** – It is the accumulation and deposition of rainwater for reuse before it reaches the aquifer. Uses include water for garden, water for livestock, water for irrigation, and indoor heating for houses etc. In many places the water collected is just redirected to a deep pit with percolation. Rainwater harvesting provides an

independent water supply during regional water restrictions and in developed countries is often used to supplement the main supply. It provides water when there is a drought, can help mitigate flooding of low-lying areas, and reduces demand on wells which may enable ground water levels to be sustained. It also helps in the availability of potable water as rainwater is substantially free of salinity and other salts. (Corporation)

Sizing: Rainwater harvesting systems can be installed with minimal skills. The system should be sized to meet the water demand throughout the dry season since it must be big enough to support daily water consumption. Specifically, the rainfall capturing area such as a building roof must be large enough to maintain adequate flow. The water storage tank size should be large enough to contain the captured water.The design of storage tank depends on factors which are listed below

- Number of persons in the household.
- Per capita requirements.
- Average annual rainfall.
- Rainfall pattern.
- Type & size of catchment area.

The design of storage tank can be done using following three approaches:

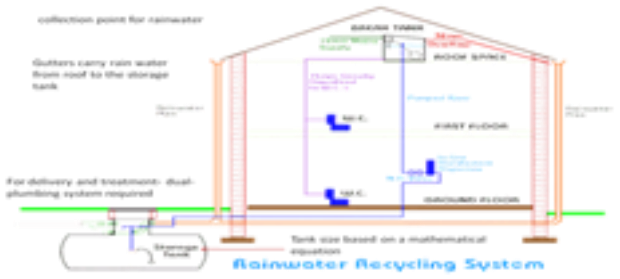
- Matching the capacity of tank to the area of the roof.
- Matching the capacity of tank to the quantity of water required by its users.
- Choosing the tank size that is appropriate in terms of costs, resources & construction methods.

At present in Pune, Rainwater harvesting is compulsory for any new society to be registered.

Calculation for the Rain water harvesting is important for finalising the size of water tank.For the calculation of water tank the key points need to be consider are Area of catchment, amount of rainfall, co-efficient of catchment area.The co-efficient of catchment area changes according to finishes of the particular area.

Methods of Rain Water Harvesting:

- Storing rain water for direct use.
- Recharging ground water aquifers, from roof top run – off
- Recharging ground water aquifers with run – off from ground area.



3.1.2: Building Scale

- **Reducing Building Footprint**

The building footprint means the area covered by building at ground level. By reducing the building footprint results in maximizing the pervious areas through which the water seep in to the ground and results in increase in water table as well as recharging the aquifer. As per the green building norms, the building footprint must be less than 30% of the total site area.

- **Avoiding Evapouration Losses**

Under this, various terms like location of underground water tank, location of pipes, location of overhead tank, shading devices to be provided for water tanks, location of high rise and medium rise trees has to be considered which reduces the losses of water happening due to evaporation due to solar radiation.

- **Providing Separate Drainage Line**

Designing of separate pipe line for grey water and black water which further helps to recycle and reuse the water. The grey water can be treated with the help of root zone system etc. and can be reused for various purposes like washing vehicles, flushing, gardening etc. ((IGBC).)

3.1.3 Component Scale

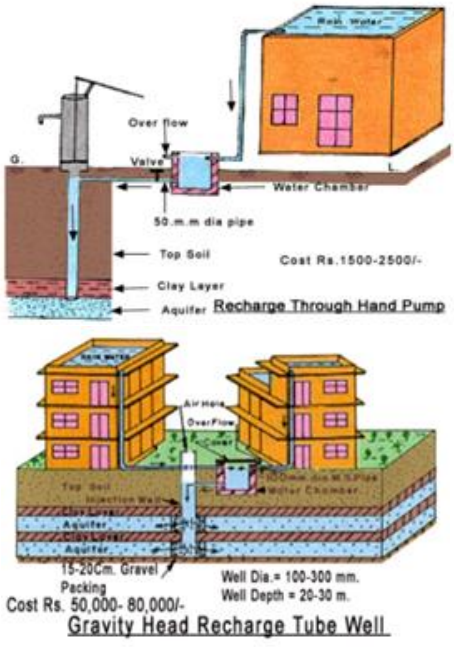
- Re – using treated waste water for flushing

The waste water collected from urinals, washing machines, kitchen sinks, bathrooms etc is collected separately and then treated by various purification methods and re – used for the flushing in W.C.

- Using Water Efficient Fixtures

Limiting the use of water with the help of fixtures also results in conserving the water.The fixtures which consumes less water for cleaning compare to the conventional fixtures helps to reduce the consumption of water by 30% to 40%.

3.2.1 Rain Water Harvesting Techniques



Roof-top rainwater only needs minor treatment to make it safe for service water. For use as drinking water, filtration and disinfection is required. There should be no debris in the tanks and no light. Quality control is a must.

Two types of systems:

- Rooftop water harvesting
- Rooftop rainwater recharging
- Rooftop water harvesting costs:

- Rs.50/m3 for 20-year life
- Rs.25 for a 40-year life

Conditions Suitable for RWHS	Conditions Unsuitable for RWHS
High mean annual rainfall with low inter-annual variability	Low mean annual rainfall with high inter-annual variability
Rainfall spread over large number of rainy days	Intense rainfall in few rainy days with little gap between two wet spells
Hilly areas with scattered populations	Plains with dense settlements
Houses with large per capita roof area in cities	Houses with small per capita roof area like multi-storey apartments
Eg: The Dangs, Western Ghats	Eg: Kachchh, Saurashtra

Calculation Procedure for Rain Water Harvesting tank

- Total collection of rain water depends upon the catchment area and its coefficient of collection.Coefficient of collection depends upon the surface finishes and the amount of water that can seap in and amount of water that will flow through it.

Care To Be Taken In Rain – Water Harvesting

- No sewage or waste water should be admitted into the system.
- No waste water from areas likely to have oil, grease or other pollutants should be connected to the system.
- Each structure/well shall have an inlet chamber with a silt trap to prevent any silte from finding its way into the sub-soil water.
- The wells should be terminated at least 5 m above the natural static sub-soil water at its highest level so that the incoming flow passes through the natural ground condition and prevents contamination hazards.
- No recharge structure or a well shall be used for drawing water for any purpose. (IGBC)

3.2.2 Water Conserving Fixtures

a) Aerator Taps

Taps involved after 2010 having aerator facility consumes 0.5 gallon (1.89ltr.) per minute. whereas old fixtures consume 2.2 gallon (8.32 ltr.) per minute. Shower with aerator consumes 1.5 gallon (5.67 ltr.) per minute, and old fixtures consumes 2.5 gallon (9.46 ltr.) per minute.

(Kohler)

b) W.C. Flush

Designed dual flush valve consumes 3 ltr. To 6 ltr. Per use whereas conventional flush valve consumes 13.0 ltr per use.

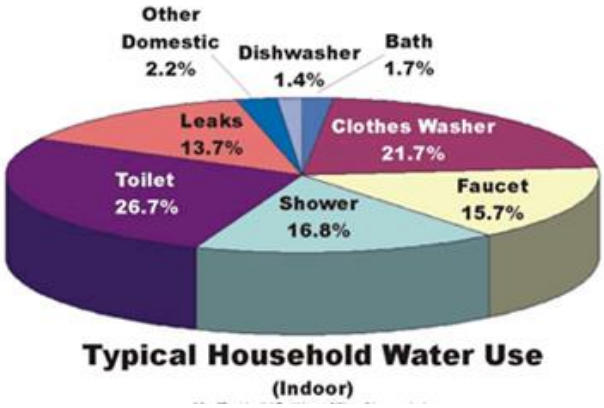
(Grohe)

4.0: Data Collection

Water is essential to life on earth. As per todays scenario,People are using the fresh water at faster speed than it can naturally be replenished. Hence it is necessary to conserve the water.

Today's water scenario is

Out of this,The amount of water consumption in residential housing is :



The water conservation alternatives are:

4.1 Case Study

4.1.1 "Asavari", Nanded City, Nanded, Pune.

4.1.2 "Aishwaryam", Akurdi, Pune.

These are the housing scheme located outside the main pune city, having population of around 2000 to 5000 no.s having density of one person per 15 sq.m. to 25 sq.m.These housing schemes receives 50% water supply from municipal corporation and they have to manage balance 50% water from other sources out of their total water demand.This results in wastage of water as well as energy.Also Pune is the city having moderate climate and minimum annual rainfall of 780 to 850 mm. The case studies above are selected for the reason of water conservation alternatives can be implemented in these housing schemes as a retrofitting and the load on municipal water supply and other water supply sources can be reduced in a large amount & maximum amount of water can be conserved.

4.1.1 "Asavari", Nanded City, Sinhgad Road, Pune

Area :

- Plot Area - 87915.30 sq.m.
- F.S.I. - 1.5
- Total Built up - 131872.95 sq.m.
- Ground Coverage - 19242.49 sq.m.
- Area under Road - 22192.29 sq.m.
- Lawn Area - 7040.62 sq.m.
- Height - 22 storied structures.
- No. of Apartments - A to K
- Type of Flats - 2 BHK & 3 BHK
- No. of Tenants - 1936 no.s
- Approx. Population - 7744 no.s

Map:

Sr No	Surface	Area in sq.m.	Cnst	Annual Rainfall	Possible collection (ltr)	Loss	Qty. of Water Harvested
1	Roof Area	19242.49	0.95	672.8	12299292	1844893.8	10454398.2
2	Paved (Road) Area	22192.29	0.75	672.8	11198229	1679734.3	9518494.26
3	Lawn Area	7040.62	0.35	672.8	1657925.2	248688.77	1409236.42
	Hence total possibility of rain water harvestment is						21382128.88

2 BHK flats – 200 no.s

Total no. of occupants = 1100 no.s
3 BHK flats – 152 no.s
Total no. of Occupants = 1012 no.s

Rain Water Harvesting
Amount of Rain Water can be harvested
Amount of Water consumption in % that can be reduced by using water conservation opportunities: 55
Water consumption as per Water meter readings are as follows

Sr. No.	No. of Persons			Cold water Bill	Cold water consumtion	Hot water Bill	Hot water consumption	Actual Water consumption	Consumption / person/day
	Adult	Child	Total						
1	3		3	300	15000	100	5000	20000	222.22
2	5		5	350	17500	150	7500	25000	166.67
3	3	2	5	500	25000	100	5000	30000	200.00
4	4	1	5	400	20000	100	5000	25000	166.67
5	3		3	300	15000	100	5000	20000	222.22
6	2	1	3	300	15000	100	5000	20000	222.22
7	3		3	300	15000	100	5000	20000	222.22
8	3		3	500	25000	300	15000	40000	444.44
9	4		4	500	25000	100	5000	30000	250.00
10	4	2	6	500	25000	150	7500	32500	180.56
11	2	2	4	300	15000	100	5000	20000	166.67
12	2	1	3	200	10000	100	5000	15000	166.67
13	2	2	4	200	10000	75	3750	13750	114.58
14	4	1	5	400	20000	100	5000	25000	166.67
15	3		3	300	15000	100	5000	20000	222.22
16	5		5	350	17500	150	7500	25000	166.67
			64						3300.69
	Average water consumption =								206.2934028

Water consumption in flats (1356 Flats):

No.	Fixture	No.s	Tap	User	Uses	Conv. Use	Min.	Total (ltr.)	Efficient Fixture	Total (ltr.)
1)	W.C. flush	2	2	2	1	13 ltr.		104	3 ltr.	24
	Tap	2	2	3	2	8.5 ltr	01	102	2 ltr.	48
2)	Bathroom shower (hot)	2	1	3	1	25/min	05	750	4.5 ltr.	135
	(cold)	2	1	2	2	8.5/min	05	340	2 ltr.	80
3)	Wash basin	2	1	2	3	8.5/min	01	102	2 ltr.	24
4)	Kitchen Sink (hot)	1	1	2	2	8.5/min	05	170	2 ltr.	40
	(cold)	1	1	1	2	8.5/min	10	170	2 ltr.	40
5)	Washing Machine	1	1	1	2	60 ltr.		120	13.1 ltr.	26.2
6)	Terrace garden	10.76 sq.m.	1	1	2	1.0/sq.m.		21.52	0.2 ltr	4.30
7)	Drinking water	1	1	5	5	6 ltr.		150	3 ltr	75
	Total Water Consumption							2031.52 ltr.		496.5

Above result states that the water bill can be reduced by 55% for each flat by using water efficient fixtures.

- Total water required per day after replacing the conventional fixtures by water efficient fixture = 10,71,344.32 Ltrs. Reduces the original requirement by 55%
- Out of 10,71,344.32 Ltrs, 60% of recycle water can be used.
- Rain water harvesting system will provide additional 6% water.
- This will reduce the required amount of fresh water to be supplied from Municipal corporation by 45%
- Water consumption is reduced by 55%

4.1.2: **"Aishwaryam", Akurdi, Pune.**
Data was collected and analised same like above case study done at Asawari, Nanded city, Pune and findings are :

- Total water required per day after replacing the conventional fixtures by water efficient fixture = 2,04,081.77 Ltrs. Reduces the original requirement by 52%
- Out of 2,04,081.77 Ltrs, 59.14% of recycle water can be used.
- Rain water harvesting system will provide additional 15.98 % water.
- This will reduce the required amount of fresh water to be supplied from Municipal corporation by 48%
- Water consumption is reduced by 52%

5 Conclusion

Rapid and unregulated urbanization and outdated urban water management models impacts water quality and quantity by jeopardizing the security and safety of our existing water resources. Cities are overwhelmed with water-related challenges. Hence there is the need to develop a policy and enabling framework aimed at mainstreaming conservation and efficiency in urban water and drainage/storm management, conservation of lakes and other waterbodies, and rainwater harvesting and groundwater recharge, including reuse/recycle of treated wastewater. With use of the various techniques

- Total water required can be reduced per day after replacing the conventional fixtures by water efficient fixture = by 45-55%
- 50-60% of recycle water can be used.
- Rain water harvesting system will provide additional 6-12% water.
- This will reduce the required amount of fresh water to be supplied from Municipal corporation upto 40-50%
- Water consumption is reduced upto 50%

Hence there should be approach to supply quality water to urban areas, prevent crisis by making best use of available technologies, conserving existing water resources, converting them into usable form and making efficient use of them in different sectors. Strategies are detailed to improve existing management models by working on demand management, including usage of water efficient fixtures and operating, maintaining and monitoring these systems.

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