Design of water supply system for a G+12 residential building by water neutrality

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Abstract - Freshwater 'Scarcity' and security has been identified as major global environmental problems of the 21st century. India is home to one of the world's highest number of people who lack access to clean water, imposing a huge financial burden for some of the country's poorest population. Water neutrality is an important, but relatively new concept for managing water resources in the context of new development. This study aims to 'Develop a broader understanding of water neutrality, especially with respect to thespatial/temporal dynamics of achieving neutrality so that it becomes a useful concept for the Environment Agency to apply operationally.' In our effort to study the various methods used for conservation of water and to design the system of Water Neutrality for a G+12 structure in Sion, Mumbai, we have adopted a simple yet effective approach towards our subject. Combining literature references from various sources, enablesenhanced perspective of strength and weaknesses of the method of managing the Rain Water in cities facing water scarcity like Mumbai.

***Key Words*: Water neutrality, freshwater scarcity, Ground water management, Rain water harvesting.**

1. INTRODUCTION

Fresh water scarcity has been cited as the major crisis of the 21st century, but it is surprisinglyhard to describe the nature of the global water crisis. Freshwater 'Scarcity' and security has been identified as major global environmental problems of the 21st century. Although, global population isexpected to increase to about 9 billion by 2050, the planet's endowment of accessible renewable freshwater has been or remain more or less constant. Although, some additional freshwater could beappropriated for human uses by capturing flood waters and increasing storage capacity, humans already use over 50% of all available renewable freshwater, rising legitimate concerns that water shortages may limit agricultural and industrial production and human wellbeing in the future.

In the past decade, there has been increasing evidence of the interconnected nature of the global system through the hydro-climatic system and 'virtual water' transfers among regions. But despite the recognition of the existence of a global hydro-commons, most water is abstracted, managed, and used at the regional to local scale. Depending on the local socioeconomic, political andhydrological circumstances, the common global drives of change, such as climatic change, population growth and globalization have diverse regional impacts.

1.1 SOMETHING MUST BE DONE: URGENCY & RISK

The magnitude of the global freshwater crisis and the risks associated with it have been greatlyunderestimated. Water stress is expanding globally nut especially at mid-latitude countries that are already deemed to be water scarce, threatening to further undermine important progress. The environmental impacts of the water crisis are equally alarming. Multiple, cumulative and compounding problems with water supply and quality are converging globally. Increasing population growth is already competing with nature for infinite water resources. A growing number of rivers do not make it to the sea, and there is widespread surface and ground water contamination that makes valuable water supplies unfit for other uses. A growing number of contaminants, such as endocrine- altering substances, will demand higher wastewater treatment standard and more exhaustive monitoring treatments.

1.2 THERE IS HOPE: CHALLENGES & OPPORTUNITIES

A number of recommendations were made to the policy community on concrete steps that canbe taken for a water-secure future:

1) Continue the global dialogue on the water crisis.
2) Endorse the human rights to water.
3) Support Ratification of the UN water-courses convention.
4) Encourage the human security council to focus on water security.
5) Facilitates links between National and Global Water, Agriculture and energy policies.
6) Support the Protection of Ecologically Sustainability Boundaries and Investment in Ecological Restoration.
7) Encourage cooperation and act as a mediator in water conflicts.

8) Involve the private sector.

The water quality monitoring results obtained during 1995 to 2006 indicate that the organicand bacterial contamination are continued to be critical in water bodies. This is mainly due to discharge of domestic wastewater mostly in untreated form from the urban centres of the country. The municipal corporations at large are not able to treat increasing the load of municipal sewage flowing into water bodies without treatment. Secondly the receiving water bodies also do not have adequate water for dilution. Therefore, the oxygen demand and bacterial pollution is increasing day by day. This is mainly responsible for water borne diseases.

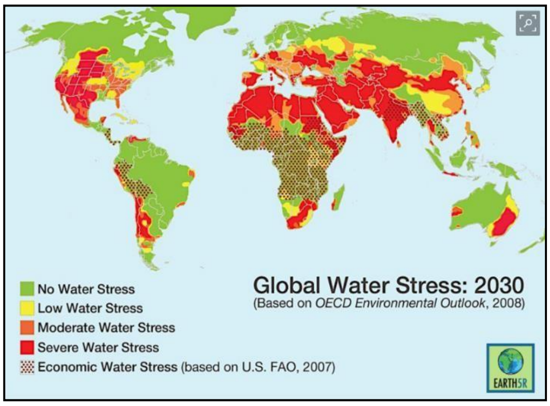

Fig. 1- Predicted water scarcity

1.3 SCENARIO OF WATER IN INDIA

India is home to one of the world's highest number of people who lack access to clean water, imposing a huge financial burden for some of the country's poorest population. Evidently, these werelinked to unsafe water and the lack of hygiene practices. These include parasitic and infectious diseases, nutritional deficiencies such as underweight and stunting, as well as respiratory infections. The alarming condition of water quality is based on the fact that the lack of clean drinkingwater has put over 11.5 million people of India at a high risk of a bone crippling disease, fluorosis. The ministry of health and family welfare has identified 19 states severely affected by high fluoride content in drinking water, and at least 10 states suffering from arsenic contamination causing the quality of water available to the country is in a very poor state. It is affected by sewage discharge, run-off from agricultural fields and urban run-off, and discharge from industries. Floods and droughts,in combination with the lack of awareness and education among users, affects the quality of water ina great way. The World Bank estimates of 2015 show that in India 28.1 percent of the deaths took place due to communicable diseases Arsenicosis – a disease that affects the lungs, skin, kidneys, andliver due to arsenic poisoning.

1.4 PURPOSE OF WATER NEUTRALITY

This study aims to: 'Develop a broader understanding of water neutrality, especially with respect to the spatial/temporal dynamics of achieving neutrality so that it becomes a useful concept for the Environment Agency to apply operationally.'

- What are the key environmental risks (and benefits) of moving towards water neutrality? For instance, what are the potential environmental impacts of point source discharge returns to the hydrological system?
- What is the most meaningful spatial scale to achieve water neutrality over, i.e., community, sub catchment, water resource zone, region?
- Does the environment or specific ecological parameters require water neutrality over all timescales and what is the environmental justification for seeking to achieve water neutralityover a particular time step and spatial scale?
- In what circumstances is water neutrality (or variation of) an appropriate aim (i.e. develop a criterion for water neutrality based on water availability)? The study will be from a hydrological and water neutrality delivery perspective, focusing on the environmental risks and benefits and potential delivery issues that may have greater relevance at different spatialscales or in different geographical contexts.

2. WATER SUPPLY ENGINEERING

Water supplied by the municipalities to urban and rural areas for domestic commercial or industrial uses has to be priced in such a way that the RMO (Running, Maintenance and Operation) costs as well as the depreciation and interest charges on the capital investment is returned by the beneficiaries in form of revenue returns from the sale of water. Although, no official estimates have been made to compute the tariff levels, which will allow full recovery of operation, maintenance and capital costs; yet various expert analysis have suggested a tariff of 15/-rupee per kL (cu.m). For the treated water supplied through piped supplies. As compared to this economic rate of rupee 15/- per kL the existing rates in the country vary from about0.01rupee per kL to about rupee 3.60 per kL over most of the States of India, except for Mizoram (where minimum rate is 10 rupees per Kl. A minimum economical rate of 6 rupee per litre has been suggested to be fixed by NGO- PPILF (Public Private Infrastructure Advisory Facility) which can be afforded even by the poorest of the families. Higher water prices will not only encourage all users to use water more efficiently but will also generate funds to maintain the existing water infrastructure and to build new infrastructure. The State Governments will have to show political courage to do so, before the water completely runs out, and people become totally dependent upon.

The various types of water demand, which a city, may have, may be broken down into the followingclasses:

1. Domestic water demand.
2. Industrial water demand.
3. Institution and commercial water demand.
4. Demand for public uses.
5. Fire demand; and
6. Water required to compensate losses in wastes and thefts.

2.1 Design considerations

Considering a G+12 Urban residential building based in Sion, Mumbai in Maharashtra, for evaluation.

Design for G+12 Urban residential building :-

1. Number of Floors= Stilt + 12 floors = 40m
2. Refuge floor at 8th floor
3. Considering 4 flats on each floor except on refuge floor.
4. Rate of water supply= 135 lpcd
5. Each floor consists of four 2 BHK.
6. Number of flats = 2 BHK (11 x 4)=44
7. Assuming 5 persons per flat, Population to be served= 44 x 5= 220 souls.
8. Total demand considering rate of water supply as 135 lpcd,
   = 135 x 220

   = 29,700 litres ~ 30,000 litres

Designing the sump or suction tank for a capacity of 90 lcpd

= 90 x 220

= 19,800 litres ~20,000 litres. + fire requirement

=20,000 + 5,000

=25,000 litres

Designing the overhead tank for a capacity of 45 lpcd

= 45 x 220

= 9,900 litres ~ 10,000 litres

Total capacity of overhead tank = 8000 + fire requirement
= 10,000 + 5,000
= 15,000 litres

9. Dimensions of tanks:

a) Suction tank = 25,000 litres = 25 cu.m
= 4 x 3 x 2.5 = 30 cum > required.

b) Over Head tank = 10,000 litres = 10 cu.m
=4.8 x 3.1 x 1.2 = 17.85 cu.m > required

c) Recharge pit = 2 x 2 x 2 cu.m

10. Borewell dimensions = 0.15 m (6”) diameter and 60 meters depth

3. RAINWATER HARVESTING

Rainwater Harvesting is a technology used for collecting and storing of rainwater from rooftops, the land surface or rock catchments using various simple techniques such as jars and pots as well as more complex techniques such as check dams. Also, harvesting surface and groundwater, prevention of losses through evaporation and seepage and all other hydrological studies and engineering inventions, aimed at conversation and efficient utilization of the limited water endowment of physiographic unit such as a watershed. In general, water harvesting is a activity of direct collection of rainwater. The rainwater collected can be stored for direct use or can be recharged into the groundwater. We get a lot of rain and yet we do not have water. This is because we have not reflected enough on the value of raindrop. The annual rainfall over India is computed to be 1,170mm. In Mumbai alone, we have an annual rainfall of around 2147mm. However, this rainfall occurs during short spells of high intensity. Because of such intensities and short durations of heavy rain, most ofthe falling on the surface tends to flow away rapidly, leaving very little for recharge of groundwater. This makes most Mumbai experience lack of water even for the domestic uses. This is because the rainwater is not conserved and allowed to drain. Thus, it does not matter how much rain we get, if we don’t capture or harvest it. This highlights the need to implement measures to ensure that he rain falling over a region is tapped as fully as possible through water harvesting, either by recharging it into the groundwater aquifers or storing it for direct use.

3.1 Cost of Rain Water Harvesting

Table 1: Rates for Rainwater Harvesting Project

Sr. No.	Item of Work	Unit Rate	Cost
1	Excavation in Soil	cu. m.	225
2	Excavation in rock	cu. m.	309
3	Brickwork in cement mortar (1:6)	cu. m.	5868
4	Plain Cement Concrete (1:3:6)	cu. m.	5028
5	Reinforced Cement Concrete	cu. m.	6147

	(M30)		
6	Centering and Shuttering	sq. m.	759
7	PVC Piping for rainwater pipes		
	110mm diameter	meter	275
	160mm diameter	meter	597
8	Brick masonry for recharge pit	cu. m.	5868
9	Making deep recharge	meter	300

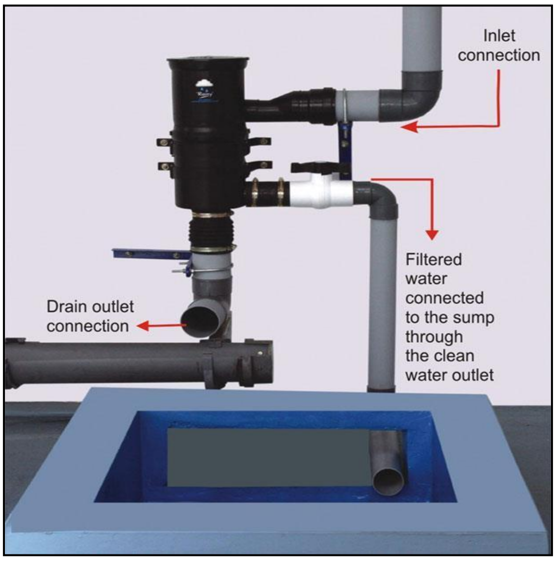

Fig 2- Onsite Installation of Rainy Filter

3.2 Plumbing

Considerations:

Average Annual Rainfall: 2500mm.

All calculations are made on a higher side

1. Assumptions: For each 100 sq m area, 1 FL100 Rainy filter is used
2. For each 200 sq m area, 1 FL 100 Rainy filter is used

Hence, Total No. of Rainy Filter used are: FL 100- 1,

FL 200- 5

Table 2: Details of Rainy Filter

Sr. No.	Description	Capacity (LPM)	Cost
1	FL 100	105	10707
2	FL 200	225	14812

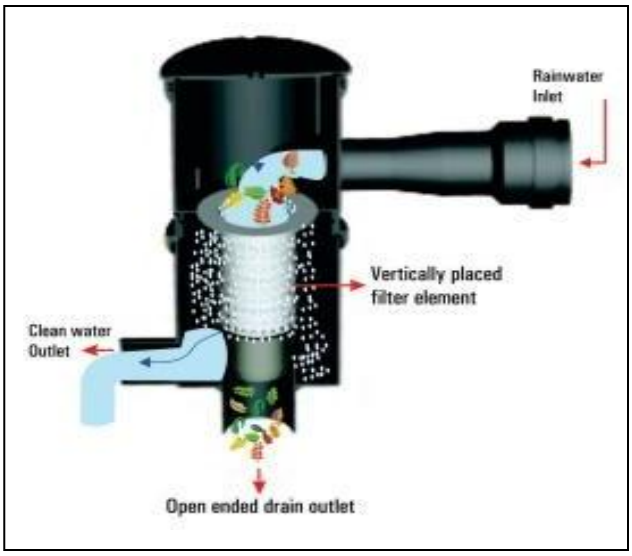

Fig 3- Cross Section of Rainy Filter

Potential of rainwater:

Table 3: Potential of rainwater that can be collected

BUILDING	ROOF TOP AREA (sq.m)	RAIN FALL (m.)	COEFFICIENT	POTENTIAL (cu.m)
1	1027	2.5	0.8	2054
	TOTAL RAIN WATER HARESTING POTENTIAL =			2054
			Say	**2054000 Lits/Year**
			(Considering 80 Rainy Days)	**25675 Lit/Day**

For calculation of the potential a co-efficient is used. The values for the same vary with the type ofroof in the system. The table below shows coefficient values for different types of roof.

Table 4: Coefficients for potential calculation

Type of Roof	Coeffic-ient Values
Flat roof	0.8
Sloped Roof	0.95
Open ground with Grass	0.1
Open ground without grass	0.3

Estimate:

Table 5: Estimate for project

1	**Provision of Rain water harvesting system**				
i)	Rainy filter FL100	1	No.	10707	10707
ii)	Rainy filter FL200	5	No.	14812	74060
2	**Provision of Pipes**				
i)	**Collection System**				
a)	PVC SWR Pipe of 4kg/pressure of 63 mm	9	Rmt	650	5850
b)	PVC SWR Pipe of 4kg/pressure of 75 mm	9	Rmt	750	6750
c)	PVC SWR Pipe of 4kg/pressure of 90 mm	75	Rmt	850	63750
d)	PVC SWR Pipe of 4kg/pressure of 110 mm	9	Rmt	950	8550
	Contingencies	1	LS	10000	10000
	Grand Total				**179667**
	Total Tax	6%			10780.02
	Total Price				190447.02
	Say				**200000**

Table 6: Cost of Accessories

Sr. No.	Description	Rate (Rs.)	Quantity	Cost (Rs.)	Remark
1	Non-Return Valve	100	15 nos	1500	100*15=1500
2	Pipe Fittings	-	-	9000	5% of total cost of pipes
3	2 HP Pumps	12000	3 nos	36000	12000*3 =36000
4	Borewell Investigation	8000/acre	0.793 acres	7000	Area of plot = 3194.6 sq.m = 0.793acre
5	Borewell Drilling	100/ft	200ft	20000	Depth of borewell = 60.96m
6	Casing	320/m	20 m	6400	Only for initial 20m
7	Transport at-ion	LS	-	2000	-
8	Flushing of Bore w-ell	LS	-	2000	-
9	Construc ti-on of Recharge Pit	125000	1	125000	-
10	Total cost for Water Neutrality of G+12 residential building				400000

The total cost of the system for G+12 Residential Building is **Rs. Four Lakh** Only.

4. MODEL FOR DEMONSTRATION OF WATER SUPPLY SYSTEM AND RAINWATER HARVESTING SYSTEM IN A G+12 RESIDENTIAL BUILDING PRACTICING WATER NEUTRALITY

4.1 Aim of model

To demonstrate how a Water Neutrality Project can be effective enough to reduce the water wastage and to reduce the disposal, and to explain the rainwater harvesting system for the G+12 building using various standards.

4.2 Salient features

1. To put forth the advantages of the down take pressure reducing value system.
2. To study the Rainy filter used.
3. To reduce the water consumption

4.3 Materials used

1. 3mm Sun-Board.
2. Adhesive
3. Cutter.
4. Acrylic.
5. Spray paint.
6. A detailed drawing of plan, elevation and section of the G+12 building.
7. Masking tapes.
8. Acrylic Sheet
9. Paper Straws.

4.4 Components

The various components of Rainwater Harvesting System are:

1. Catchments
2. Conduits
3. A) Storage Facility
   B) Recharge Facility

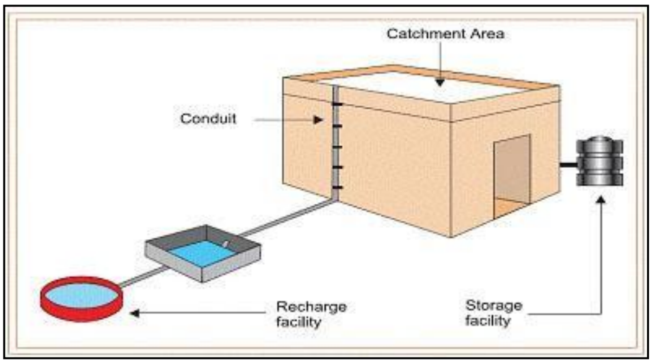

Fig 4: Components of Rainwater Harvesting

The method we are going to use is by using a borewell:

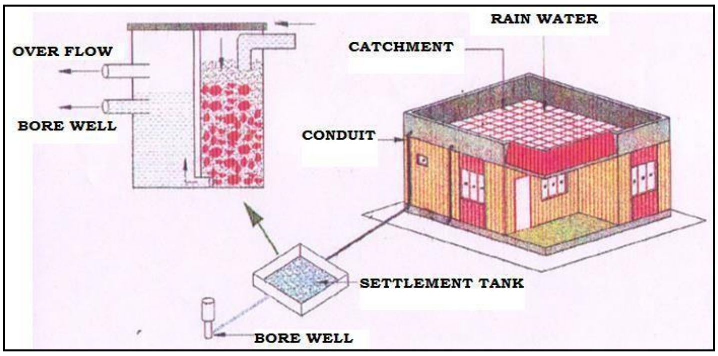

Fig 5: Recharge through Borewell

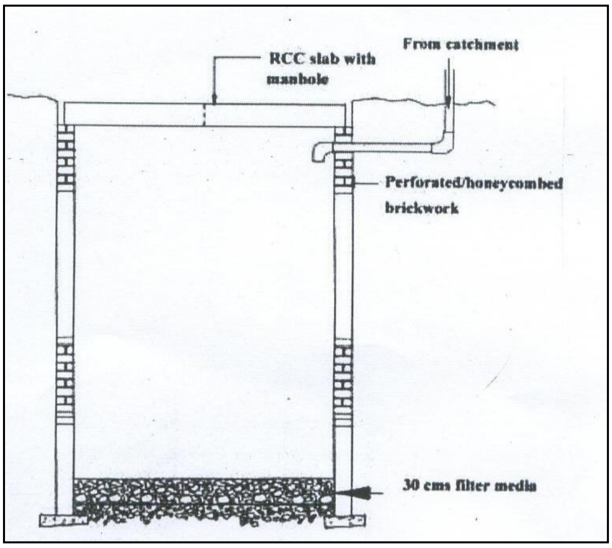

Fig 6: Cross Section of Recharge Pit

4.5 Procedure

1. The model comprised of the G+12 structure including water supply system and Rainwater Harvesting system, with the aim to achieve Water Neutrality.
2. The model has been made in 3 parts i.e. the artificial recharge pit, part of the structure from ground floor to the 7th floor along with refuge area, and the last part consists of the remaining top 4 floors.
3. Using the detailed drawing of plan, accurate dimensions are marked on the sunboard andthen cut in the required using the cutter. The scale used was 1:75.
4. All the openings were properly marked and the cut.

5. These three parts are then spray painted with a dark brown shade.
6. Similarly, other components like the overhead tank, underground storage tank, and therecharge pit were then accurately made to the scale.
7. We have tried to give a simple but representative look to the model.
8. The model is assembled by joining the 3 pieces

4.6 Future scope of the study

1. Waste water treatment for the project can be designed.
2. Recycling of waste water generated in the building can be implemented.
3. Automation of the entire system's working.
4. Add systems or collected rain water according to health consideration.
5. With further working, this building could be Water Efficient Building (WEB).
6. Reuse and Recycle of Grey Water.
7. The Water Footprint of the system could be calculated and worked on.
8. Use of other non-conventional sources of water.

Water Efficient Building encompasses the following:

1. A harmony with the natural features surrounding site
2. Minimize use of water in construction and building premises
3. Reuse and Recycle of waste water generated
4. Use of plants which needs minimum or no water
5. Adopts Rainwater Harvesting structures to recharge ground water during monsoonand its efficient use.

Conventional sources of water, supplementing regular sources, shall be practiced. These are useful even in crisis period. Some of them are:

1. Rejuvenating of old discarded sources.
2. Use if recycle water.
3. Recharging of ground water aquifer.
4. Use of water saving devices.
5. Use of less water consuming flush tanks.
6. Use of flow taps/showers.

4.7 Preliminary conclusion

With this model we aim to demonstrate that 'Achieving Water Neutrality is an important task to conserve the water and to fully use the supplied water with zero liquid discharge. It is also important to know that this is only a demonstration model, aimed at roughly showing a part of water neutrality and how it can be achieved. It must not be considered as standard.

5. CONCLUSIONS AND DISCUSSSIONS

1. As the water crisis of the country is becoming critical at an alarming rate, we thought there was a need to find a sustainable solution to this problem.

2. We have tried our best to give many solutions to minimize the wastage of water.

3. We have tried to use rainwater to its full potential and reduce surface runoff.

4. We have tried to bring about awareness about relatively new concepts like water neutrality among the people.

5. Mainly because of increasing water scarcity and increasing demands on a finite supply of freshwater, there is need to adopt some alternative and find a sustainable solution. Therefore, this neutralization method will help us to achieve the same with the help of Rain water Harvesting.

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