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Water Management In An Institutional Building In Northern, India

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Abstract

The consumption of natural resources available on earth is increasing heavily day by day, by the human beings due to rapid urbanization, luxury living trends, industrialization and several other similar activities. While their consumption the human kind is less attentive and feels free without giving a thought to make the same available for future generations. Water as a natural and finite source is one of the most essential issues to be discussed and pondered over in the present scenario globally. It plays an important role as a basic element for energy formation, climatic conditions and daily routine activities i.e. agriculture production, drinking, cooking and cleaning etc. Its limited quantity with required quality forces us to make a sustainable use of it. By adopting different water management practices, latest techniques and concepts for water sustainability, the mankind would lead a quality life today without any adverse affect on the universe and at the same time preserving the equal rights and opportunities for future generations, Hence prudent use of water as a natural resource is a must and need of the hour.

Keywords: Water Sustainability, Reduce, Reuse and Recycle.

Introduction

Population and Fresh Water
The present world population is around 6.5 billion and the water shortage is estimated to be around 8% now. By 2050 AD it is estimated approximately to be 24%.

Distribution of The World's Water
Some 70% of the earth's surface is water, but most of it is ocean. By volume, only 3% of all the water on earth is fresh water, and most of it is largely unavailable. About 3 quarters of all fresh water is locked away in the form of ice caps and glaciers located in the polar areas far removed from most human habitation. Only about 1% surface

fresh water is easily accessible. This is primarily the water found in the lakes, rivers, and the soil at underground levels.

Water Use and Scarcity

The world's present population, nearly 6 billion, is growing by about 80 million people each year. This number implies an increased demand for freshwater of about 64 billion cubic meter a year. A country is said to experience water stress when annual water supplies drop below 1,700 cubic meters per person. When annual water supplies drop below 1,000 cubic meters per person, the country faces water scarcity. Once a country experiences water scarcity, it can expect chronic shortage of freshwater, the threaten food production, hinder economic development, and damage ecosystems.

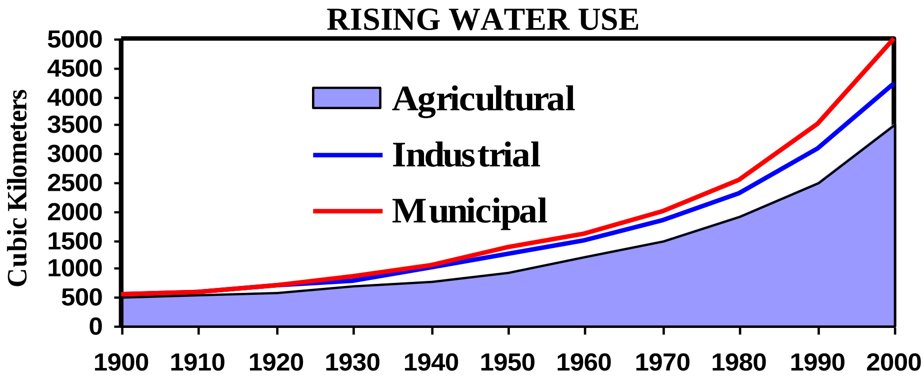

Figure 1.1: Global annual water withdrawal by sector, 1900-2000 Source: Abramowitz 1996 (I)

Water Consumption

To estimate the consumption of water in a building following mitigation measures are used:

Step 1: Estimate total water demand based on the occupancy and type of building.

Step2: List various efficient fixtures and other measures.

Step 3: Calculate demand reduction in per capita water consumption as compared to the Bureau of Indian Standards (BIS).

Water Management Practices

Water management

To manage is to conduct, to control or to administrate. Whenever there is demand for something (requirement), the source is located for supply and then the consumption is made accordingly. The skillful handling of the demand, means of supply and consumption is called management.

Similarly, we can define water management as the administration of demand, supply sources and transportation of water for consumption with the help of different types of structures, systems, storage and supply techniques. It includes harvesting of (surface and ground) water, its storage and supply.

Water Management Approach

3R Concepts

Reduce: Water consumption is reduced by incorporating latest techniques in building design and adopting preventative measures & careful practices in routine activities.

Recycle: Rain water is used for secondary applications (cooling tower, maintenance of building etc.) through rain water harvesting techniques from roof top into open wells (if any) and surface run off into percolation pits etc.

Reuse*:* Water is used again in other routine applications (irrigation, toilet flushing etc.) with / without treatment through either of the, Activated sludge process, Fluidized aerobic bio reactor (FAB) and Root Zone Treatment, ultimately leading to **“Zero water Discharge."**

Efficient use of water in the building can result in major savings to the community by lowering short-term operating costs for energy, chemicals and labor, along with extending the design life of major infrastructures like wells, and pipes and sewers.

Principles of Water Management

Water management includes reduce, reuse and recycling of water through various aspects such as water conservation, waste water treatment, rainwater harvesting, etc. The objective is to give guidelines to the general public along with the developers and builders, on various aspects of water management which covers following issues:

1. Minimizing the demand of water required within building, landscape, cooling process (air-conditioning etc) and construction activities.
2. Adopting related techniques, best practices and standards for recycling of wastewater.
3. Minimizing the load on the municipal supply and groundwater sources through recycling of water.
4. Adopting techniques for rainwater harvesting (Conserving as much rainwater as possible at the place where its falls) including estimation of the potential of rainwater harvesting for different regions with draining out excess water to the storage tanks.
5. Adopting measures for quality control of various water sources such as fresh water, underground water, municipal supply, water tankers, rainwater and recycled water.

Water Conservation Within Buildings

Reducing the water demand within buildings is the first and foremost step in water management. Water conservation helps to ensure that this important resource will be available for many generations to come. Conserving water indirectly also saves energy, which is needed to process, treat, transport and to heat water in colder regions.

Hence to have the maximum savings, optimal and economical use of water through water conservation should be the priority for the new constructions. In addition to technical measures such as use of water efficient domestic appliances, there is a need to create awareness and to educate people to address water leakage problems through proper maintenance of fixtures which can be summarized as under:

Water saving toilets

In the past a typical non-conserving 5.5 gallon flush toilet (many of which are still in use) would contaminate 13,000 gallons of fresh water per year to remove 165 gallons of human body waste. There should be a better way to conserve water as a finite natural source. For this reason, water saving toilets are required for new constructions.

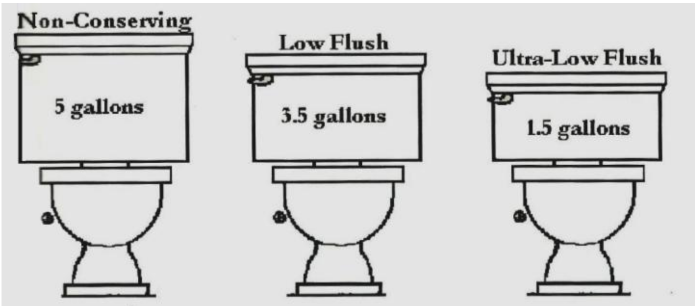

Figure 2.1: Consumption of water in flushing

Since almost all water from the toilet goes directly into the sewer or septic tank, water saving toilets reduces both consumption and wastewater flows.

A quarter of clean water that enters a building goes off in flushing through WCs and urinals. A conventional WC flush consumes 13 liters of water per flush (13 lpf).

To allow a plausible consumption of water, low- flow faucets and small toilet tanks are now required even by different codes in many areas of the country. Hence following type of WCs are already in use in most of the office & commercial buildings these days, which can be further improved upon.

a) Using a low flush or ultra low flush WC can save up to 55 % - 75 % of water per flush.
b) Water efficient dual flush WCs use 6-8 liters of water for full flush & 2-4 liters with a separate reduced flush button giving the user a choice for full or reduced flush.
c) Bio composting toilets, available on both residential and commercial scales, treat sewage on site, eliminating the need for energy- intensive municipal treatment.

Water Saving Faucets

Since faucets have a wide range of application in wash basins, kitchen sinks, showers etc., reduction in the flow of water from faucets can result in tremendous reduction in water consumption. A conventional faucet gives a flow of 11.35 - 18.9 per min.

Suggesting such faucets to users which reduce water consumption as discussed below, can spread awareness and let the new trend come into practice.

a. Aerators and pressure inhibitors reduce the amount of water in a flow (up to 3.7 to 2.0 I per min), but the pressure reducing devices in them maintain pressure by making air in with the water.
b. Low flow showers also reduce the amount of water as the flow rates of those shower heads are as low as 9.4 to 11.4 per min.
c. Auto control valves result in reduction of water flow by 80%.

Landscape and irrigation

Landscape architects should take the following points into consideration while preparing their concepts, intelligent measures, if taken in types of plantation and irrigation methods, can also lead to reduction in the consumption of water.

A. Types of plantation

1. Landscape scheme comprising of trees, shrubs and ground cover should be prepared instead of using turf grass to avoid enormous water loss by evaporation.
2. Indigenous landscaping - using plants native to the local ecosystem - which have adapted to the local rainfall levels will eliminate the need for additional watering.
3. Xeriscape & Brown lawns - Drought resistant bedding and perennial plants maximize conservation of water by using site appropriate plants placing them together in groups based on their drought tolerance and irrigation needs.
4. Mulch around plantings - also reduce water evaporation by 70%
5. The application of water bodies should also be limited to reduce the consumption of water.

B. Irrigation Methods

We can minimize this consumption of water by using efficient methods of irrigation like drip irrigation, sprinkler irrigation, trigger nozzle system and reusing grey water for irrigation.

Swimming Pools

The average pool can lose up to one inch of water per week through evaporation (720 - 3000 gallons per month). Providing a pool cover can reduce evaporation by up to 95 %. Windbreaks should be designed around pools so as to help reduce evaporation.

Reuse Water Onsite

Apart from planning for efficient consumption of water, the professionals should design plumbing systems so as to allow the reuse of water onsite. Water consumed in building can be classified as two types: Gray water and Black water (Sewage) which can be collected and utilized further is explained here as under:

Gray water recycling

"Gray water" is waste water collected from clothes washers, bathtubs, showers, and laundry or bathroom sinks. If properly collected and stored, it can be safely reused, thereby reducing fresh water consumption, along with reducing the load on septic tanks. Hence it can be recycled within a building, either to irrigate ornamental plants or flush toilets, by separating grey water through well- planned plumbing systems.

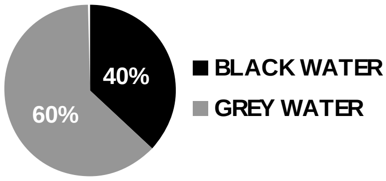

Figure 2.2: Proportion of black water and gray water in an average building

As a general rule, gray water does not require extensive chemical or biological treatment before it can be used in its most useful places, the lawn and garden etc. It is to be noted that gray water may contain food particles, detergent or soap residue, and possibly some human pathogens. Reuse of grey water can save up to 30% of the total water used.

Sewage / black water use

Perhaps the most significant difference between black water and grey water lies in the rate of decay of the pollutants in each. By separating, black water can be utilized, as odor free fertilizers and a valuable soil conditioner and even save the ground water from pollution. Since it is an expensive process, at small scale, therefore it is generally disposed into the main sewer line. In buildings at large scale like commercial, institutional and industrial buildings, separate sewage treatment plants (STP) are installed to treat the black water and recycle the soft water for air cooling and irrigation purposes.

Rain Water Harvesting

Rainwater harvesting is the technique of collection and storage of rainwater at the surface or in sub-surface aquifers, before it is lost as surface runoff. It is a water management practice with the objectives of increasing availability of water in a water stress area, adopted for collecting the rain water, which otherwise would be lost as surface runoff. It is diverted either to a storage system or to underground aquifer. Emphasis is on preserving good quality rain water. There could be many different options for RWH however; broadly it can be classified into following categories

- Rainwater Harvesting with storage facility for later use.
- Rainwater Harvesting for groundwater augmentation/ recharge.

In both the cases there can be three main components:

1. Catchments area from where rainfall is collected (Roof top, Sloping ground, Agricultural fields, and Water shed area of small streams)

2. Piping, Guttering system for transport of water, may include silt trap, filter unit etc.
3. Storage tank / recharge structure.

Rain Water Collection

In most parts of the world, rainwater falling on building has not been considered as a useful resource. Buildings are typically designed to keep the rain away from the occupants, and the idea of utilizing rain water falling on building surfaces has not been widely explored. The following practices may be adopted to make a prudent use of rain water for secondary purposes:

a) By providing impermeable surfaces on the site, such as bare ground or pavement, or roof with gutters and downspouts, rain water can be collected and directed for landscaping.
b) Surface runoff can be directed to surfed areas or shallow basins around trees and shrubs by contouring the land surface. The goal is to collect the runoff, direct it to where it can be of use, and slow it down so it has time to soak into the ground.
c) Rain that falls onto roofs can not only be directed to landscape plants, it can be stored in tanks or rain barrels for later use in car wash, firefighting and flushing waste in toilets etc.

Case Study

First five star griha rating to centre for environmental sciences and engineering building (cese), (**india's** 1st 5-star griha rated **building at** iit kanpur)

Figure 3.1: Front view of CESE, IIT, Kanpur

Introduction

The building, spread over 1.75 hectares, has been designed by New Delhi-based architect Kanvinde Rai & Chowdhury. The Center for Environmental Science and Engineering (CESE) building at IIT Kanpur is the first building in India to be awarded the ‘five-star' GRIHA (Green Rating for Integrated Habitat Assessment) rating by TERI (The Energy and Resources Institute), with a score of 93 out of 100, on the basis of its 'green features' including insulated walls, ceiling and window glasses, reflective terrace, rain water harvesting, eco-friendly refrigerant for air conditioning and the use of solar energy for heating and lighting. These energy efficient features reduce the impact on the environment by reducing consumption of electricity and **water demand** and other requirements.

The building facilitates laboratories, seminar rooms, and discussion rooms for various disciplines of the department and has been conceptualized, designed and constructed as a 'building in the garden', that is sustainable, environment friendly and energy efficient.

Energy Performance Index (EPI) of CESE building is predicted to be45.43kWh/m^2/annum, which is 4 1.3% less than the TERI GRIHA benchmark. In comparison to a conventional building 59% energy savings are predicted in the CESE building.

The Centre has attempted to conserve and utilize natural resources efficiently, recycle, reuse and recharge the systems at every stage of design and construction of the building. It was a collaborative effort of all the consultants including TERI which enabled the building to achieve the FIVE STAR TERI GRIHA rating.

Water conservation measures would be adopted in the building through selection of efficient fixtures and rain water harvesting. The basic amenities of the building is as under:

Figure 3.2: Water Storage in natural contours

- Total plinth area: 2240 Sq-mt, * Total working area: 4240 Sq-mt,
- Labs: 10 nos.* Faculty rooms: 18 nos.*Meeting rooms: 4 nos.
- Library, *Seminar Hall: 100 cap. * Class rooms: 60 cap. & 40 cap.
- Exhibition area, * Amphitheatre integrated with water body.
- Shaded indoor landscaped court.

The building incorporates many green features following TERI-GRIHA recommendations. Some special features related to water management (sustainability) in the building are as follows:

- The building is fully complaint with the ECBC (Energy Conservation Building Code).

- Sustainable site planning and architectural design has been integrated to maintain favorable micro climate.
- Energy efficient HVAC design (air conditioning etc.) with controls integrated to reduce annual water and energy consumption.
- Existing landscape and vegetation are largely protected and preserved. Sustainable site planning to resources and minimize disruption of natural ecosystem.
- Integrating the water body with design for optimal microclimate.

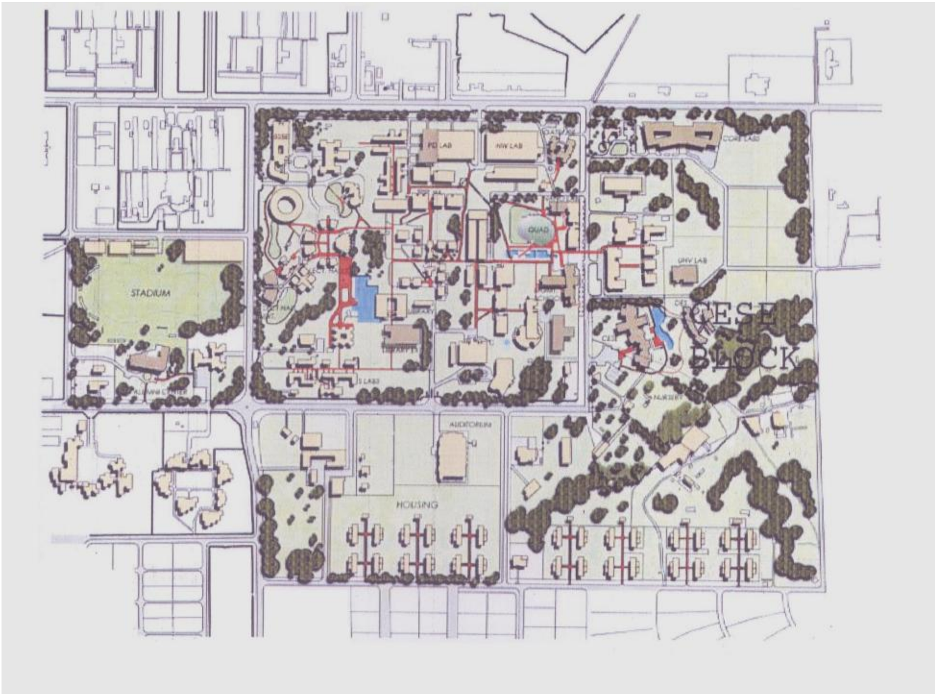

Figure 3.3: Site plan of CESE Building

- Reduction in water demand by selection of efficient fixtures.
- Dedicated sewage treatment plant provided and the grey water used for horticulture.

Water Conservation

Water conservation and water retention is an integral part of design. The roof water and run-off from open spaces next to the buildings are drained through a system of catch basins, filtered and collected in the water body. Grass swales are constructed to collect the surface run off from rest of the green and paved areas. The grass swales, with shallow longitudinal gradients, slope towards the lowest point in the northeast. Grass swales help in increased surface infiltration and reduction in the sediments transported from the site. The kerbed edge is detailed to direct the road runoff to these grass swales. Some of the salient features adopted for water conservation are:

- The water body has been located in accordance with the site contour, thus acting as a reservoir for the storm water runoff from the building.
- Rain water from the building and surrounding area collected and routed through a sedimentation tank to water body for AC cooling. Overflow is led to a groundwater recharge pit.
- The building boasts of an artificially in corporate lake which creates a micro-environment and helps optimizing the microclimate.
- Also during construction, the water requirements were kept to a minimum by storing and reusing water in make-shift water holes.
- The building is well equipped with solar water heaters. There are 20 solar collector panels to meet the hot water requirements. The building also has a water treatment unit to maintain water quality. This continuously supplies clean water in building.
- Treated water is mainly used to meet landscape water demands. Dedicated sewage treatment plant has been provided and the grey water is used for horticulture.

All this has led to **59.6% water saving** in the building.

Inferences

Parameters for water management

Based on the abovementioned & other case studies and primary data collected regarding the Water Management for Institutional Building in Northern India, a brief information can be presented as under:

Sl.	Components	Indicators (Sub components)	Sub- indicators	Threshold			Data Availability
				Unit	Max	Min	
1.	Water Availability	Municipal supply or Self supporting system	-----	Lt./Cap/yr.	10.30 cm./per/yr	08.20 cm./per/yr	Water supply norms./Data collected by surveys.
		Conservation	Reduce Reuse Rainwater harvesting	% % %	50.0 [a] 100[a] 100 [a]	0.0 [b] 0.0 [b] 0.0 [b]	Quantity of Water (rain + waste) conserved is collected from surveys/case studies.
3.	Water use (Consumption)	Water Demand	Toilets Pantry (Including Drinking) Cooling (Desert Coolers) and Cooling towers forA.C. Maintenance (Floor Cleansing etc. Fire fighting & misc .uses. Landscape Water losses (leakages & Misuses)	Lt./cap/day Lt./cap/day . Lt./hr/Cooler Ton Lt./Sq mt./day Lt. Lt./canopy area/day %	16.0 6.0 20.0 (or as / actual use) 60.0(or as/ use. as/ use 0.40 No. record found 10.0 Lt. 13 [b]	10.0 3.5 19.0 41.0 0.20 ------ 2.4 Lt./ sq. mt. of open land 8 [a]	Norms 15.0 5.0 20.0 Inst. Stand. / case study data. 1% of the total use as / NBC

4.	Environment	Rain fall	--------	mm	273.20	4.6	Data for Kanpur from metrological dept.
		Ground Water Level	--------	mbgl. (Pre monsoon depth to water level) (Post Monsoon depth to water level)	27.13 27.13	2.20 2.08	Data from local govt. body.(Water supply/Mgt.)
5.	Maintenance Aspect	Annual budget for water consumption	Price to pay to municipality for supply water (metered Usage) Electricity charges for pumping etc.	Rs. Rs.	Yearly fixed charges from local body No record found		Yearly expenditure as per off. Records.
		Annual maint. for infrastructure	Motors Supply pipe lines & plumbing items. (Metered usage) S.T.P./Waste water treatment plant	Hrs/capacity of pump/discharge	368/= sqmt./year No record found	200/=	Running cost occurred yearly as per off. records./ Data collected by surveys.
		Action for awareness to the employees	Motivation by communication	--------	-------	--------	Documents / Policies disclosed to the employees through seminars/work shops.

Note:- a: Preferable & b: Not preferable

An Architect's Role

Architect should contribute to conserve water, as there is severe water scarcity especially in urban area. No doubt water is not the only issue, but let it be one of the steps for moving forward. There are so many ways suggested to reduce the consumption of water under the 'jal bachao abhiyan' for layman in day to day activities. But what dimensions, technical professionals can add to reduce the water consumption at various levels are being researched at global level. A building requires a large quantity of water for the purpose of drinking, cooking washing, cleaning, flushing toilets and irrigating plants, etc. Designing a system (which reduces the consumption of water and manages the output of the used water) would actually help for the prudent use of natural resources. To achieve the aim followings actions need to be taken:

1. Reduce demand.
2. Waste water recycling techniques should be adopted on site and even if water recycling is not incorporated at the outset of a project, allow for its incorporation (in terms of space for storage, pipes, etc.)
3. Consider rain water and bath-water recycling for all new projects.
4. Try to ensure that the quality of water is as high as required for the use but no higher.
5. For rain water harvesting organize the site in a way that much of the rainwater falling over it can be used sensibly, as possible.

6. Choose vegetation that does not need irrigation in the summers.

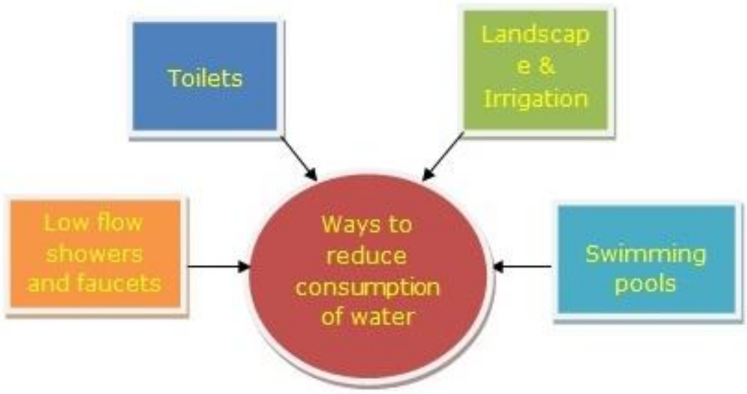

Figure 4.1: Parameter For Reducing Water Use In Buildings

Conclusion

The irony is that water is available on earth in ample amounts, but merely 0.007% of it is available as clean water for human use. The number of water stressed regions is increasing due to rapid advancement today and the urban areas are facing twin challenges of water scarcity and inadequate capacity of waste water disposal systems. According to the U.N., a child dies from water related disease in every 15 seconds. It's even being said that we are going to run out of water before we run out of oil.

If adopted, the above suggested water management techniques/practices can contribute in relieving immense pressure from the water resources. Therefore, the design criteria of the building hereby utilize recycled water for non potable use and thereby eliminating the need of potable water to maximum can help us to conserve water by 10 - 50 %.

So, still it's never too late, to strictly work and achieve Water Sustainability, the future generations may not have to suffer due to our callousness.