On the Best Practices of Rainwater Harvesting at Goa University Campus

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Goa University has developed rainwater harvesting and groundwater recharging facility at its Campus at Taleigao Plateau with the following objectives:

A) Create an experimental site for evaluating the efficiency, effectiveness and benefits of rainwater harvesting and groundwater recharging in Goa and its terrains.
B) Arrest declining groundwater levels and recharge the aquifers to reduce dependence on overstretched municipal water supply for a more sustainable source of water in the Campus so that future needs of water are met without scarcity.
C) Sensitize stakeholders about awareness of conservation and acceptability of rainwater harvesting and conservation for meeting the individual, community and industrial requirements by replicating these experiments elsewhere.

Brief descriptions of the two rain water harvesting structures installed at the Goa University Campus are given below:

Rooftop Rain Harvesting and Recharging:

The rooftop rainwater harvesting site has been chosen keeping in mind the proximity of the existing bore wells for recharging and the potential of the underlying aquifers to store the recharged water over a period of time. Besides the adequate availability of the roof top area is also taken into account in selecting the site. The surface storage tank of 10mx10mx1.1m dimension has been built with concrete base and brick walls having a storage capacity of 1 lakh liters (Fig.1). The roof water from existing buildings from Boy's hostel and the electronics department buildings has been diverted through 8" diameter PVC pipes. The foul flush mechanism has been provided to divert away the initial rainwater so that contaminants if any are kept out of the storage tank (Fig.2). The storage tank is provided with a filter bed made up of gravel, sand and coal material to filter any unwanted constituents if present. The filtered water from the storage tank is then connected to the two bore wells by an underground pipe.

Fig. 1: Site of roof water harvesting at Goa University


Fig. 2: Foul Flush Mechanism to divert first rains

The water meter and valve have been fixed at the exit points from the storage tank to quantify the subsurface recharge. The roof area tapped is about 400m^2 only and it is proposed to increase this roof top area to about 1500m^2 by linking the Men's hostel I and other nearby roofs so that full capacity utilization of the structure is achieved in due course of time. The total quantity of roof water available at the present site for recharging is about 25000m^3 per year for 2.5m of annual rainfall.

1) The two existing bore wells drilled to a depth of 117 meters below ground level tap sizable thickness of the potential aquifer and have good water absorbing and storage capacity. These wells are connected by underground PVC pipe to the storage tank where the roof water gets collected. These bore wells act as groundwater recharging wells.
2) Each of these recharging wells has a capacity to recharge about 150m^3 of water per day.

3) The water quality of the roof water is much higher purity than any groundwater in terms of dissolved chemical constituents and the bacterial content. Therefore the use of working bore wells for recharging shall enhance the groundwater quality in the aquifer by dilution process in the sub-surface.

Surface Water Harvesting and Recharging:

At this site the rainwater falling on 15000m^2 area (Fig.3) is collected into a 70m by 50m size artificial depression by gravity flow. The structure has three parts of which the first part having 20mx10m size and 2m deep structure allow the suspended solids to settle down. The clear water then moves through a sand bed filter of 3mx3mx3m size by gravity flow. The final part of the structure has 3mx3mx3m trench and 89m deep bore well in the center (Fig.4). The water column of 3m in this trench creates adequate pressure to push the water through the slotted bore well casing into the sub-surface and the aquifer at depth. The injected water into the aquifer shall slowly percolate to the surrounding areas in the subsurface and hence enhances the storage of groundwater. As the velocity of groundwater is normally very slow it takes quite a time for the injected water to reach the pumping wells located at about 400m to 600m away from the recharge site. During this slow movement the injected water undergo quality changes due to its interaction with the surrounding rock matrix and the groundwater already present. This recharged water is pumped back during summer months from the existing bore wells around the recharging site.

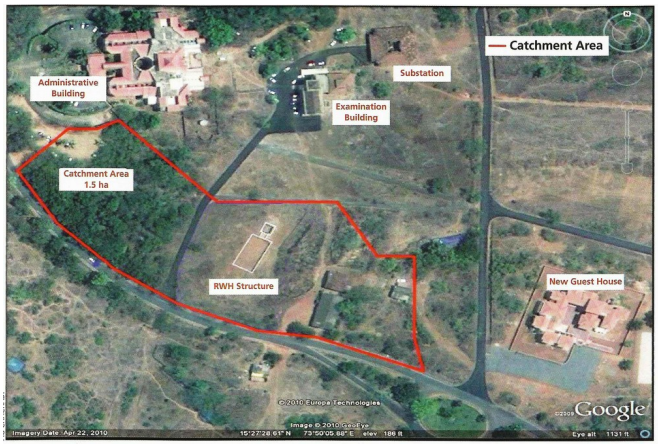

Fig.3: Site layout of surface water harvesting

Fig.4: Site of surface water harvesting at Goa University

The Advantages of Surface Runoff Harvesting:

1) The collection of surface runoff into a smaller area reduces significant evaporation losses and makes water availability for groundwater recharging over longer periods.
2) Longer the water storage time more is the percolation into the sub soil from the storage pit.
3) It is expected that over a period of years the village wells located in the periphery of the plateau would receive recharged water and alleviate some of their water scarcity problems.
4) Storing rainwater in the subsurface is safe, eliminates need for surface storage space and water is protected from likely pollutants as it is protected by overlying geological strata.

The Annual Groundwater Recharge Quantification:

The total drainage area contributing to runoff is 15000m^2, with an annual average rainfall of 2.5m at the site the volume of rainfall works out to be 37500m^3. Accounting for about 30% of this quantity for evaporation and other losses, nearly 26000m^3 of water is being recharged per year in the sub-surface at this site. In Goa University campus groundwater is pumped at a rate of about 250m^3 per day from bore wells for about 300 days in a year which amounts to about 75000m^3 per year. The recharged volume of water therefore amounts to about 34% of the total groundwater pumped per year in the University Campus. The well yield tests carried out during May 2008 on nearby bore wells have confirmed the increased groundwater levels in the area.

Operation and Maintenance Activities and Costs:

The rainwater harvesting structures built in the campus have minimum maintenance activities and recurring costs. The various annual maintenance activities include: removal of grasses and weeds and general cleaning in and around the surface water harvesting structure and cleaning of the storage tank during pre-monsoon period. Spraying of bleaching powder around the structure to avert any unwanted bio-contaminants entering along with the first runoff water The sand

filters are reworked every three years to avoid compaction and to increase bed permeability. The recharge bore-wells shall require flush cleaning every 10 years to decongest the perforations. The annual costs of maintenance have been to the tune of Rs. 5000 to 8000 so far.

Fig.5: School children at the structure

Socio-Economic and Environmental Benefits:

Social Impacts: The structures implemented in the campus have become a platform of creating awareness, information dissemination, and learning about groundwater conservation methods. Various stakeholders, NGOs, government officers, school children (Fig.5), industry representatives, citizens and researchers regularly visit the sites. At least a dozen of industrial houses have replicated these models in their plots other than colleges and private institutions. The success of these activities has influenced the Goa government to make rain harvesting mandatory for industries, housing colonies and institutions.

Environmental Impacts: The reduced pressure on the public water supply system and enhanced aquifer recharge has positive environmental impacts. At small scale the systems contribute toward resource conservation. This activity can also earn carbon credit in terms of energy conservation for in-situ water augmentation on campus instead of sourcing water from distant sources. Microclimatic changes from this small lake (Fig.6) attract many birds in the site.

Economic Benefits: Every unit of water conserved has a corresponding saving on the water bill. The total capital cost of both the structures was about Rs.1.6 million. A water tanker of 10000 liters capacity generally costs about Rs.600/-. In economic terms the rain water harvesting in the campus which otherwise would have been supplied by the tankers from outside has resulted in an annual saving of about Rs.1.8 million. The capital costs of both the surface runoff as well as the roof water harvesting sites have already been recovered.

Fig.6: Synoptic view of the rainwater harvesting Lake

The roof top rainwater harvesting and groundwater recharging facility have been replicated at several industrial and other establishments in Goa. Some of these locations are given in table below:

Name of Industry/Institution	Year
CIBA, IDC Corlim, Goa	2002
International Centre, Dona Paula, Goa	2011
Britacel Silicones Ltd, IDC Verna, Goa	2011
Panandiker R & D Pvt Ltd., IDC Verna, Goa	2011
Finolax Company Ltd, IDC Verna, Goa	2011
Duraline India Pvt Ltd, IDC Verna, Goa	2011
MES College, Zuarinagar, Goa	2012
Universal Cables Pvt Ltd., IDC Verna, Goa	2012
HCL,IDC Kundaim, Goa	2013