Rainwater Harvesting Potential in Educational Institution

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Abstract

Due to the increasing scarcity of good quality water of sufficient quantity and water related problems like water logging during rainy season, arsenic contamination & ground water depletion, the word 'WATER' takes the number one priority in urban areas of Bangladesh. It is therefore necessary to make decisions about conservation and allocation of water that are compatible with social objectives such as economic efficiency, sustainability and equity. Rain Water Harvesting potential in urban Bangladesh fulfills all the criteria to be economically efficient, sustainable and equitable source of safe water. But due to lack of knowledge and proper design guidelines and awareness the RWH system has not been popularized as it should have been. This paper is written with the intention of promoting the Rain Water Harvesting System and it also includes the rain water harvesting potential in an educational institute and a complete design for the system.

Keywords: rain water harvesting; sustainable system; RWH potential.

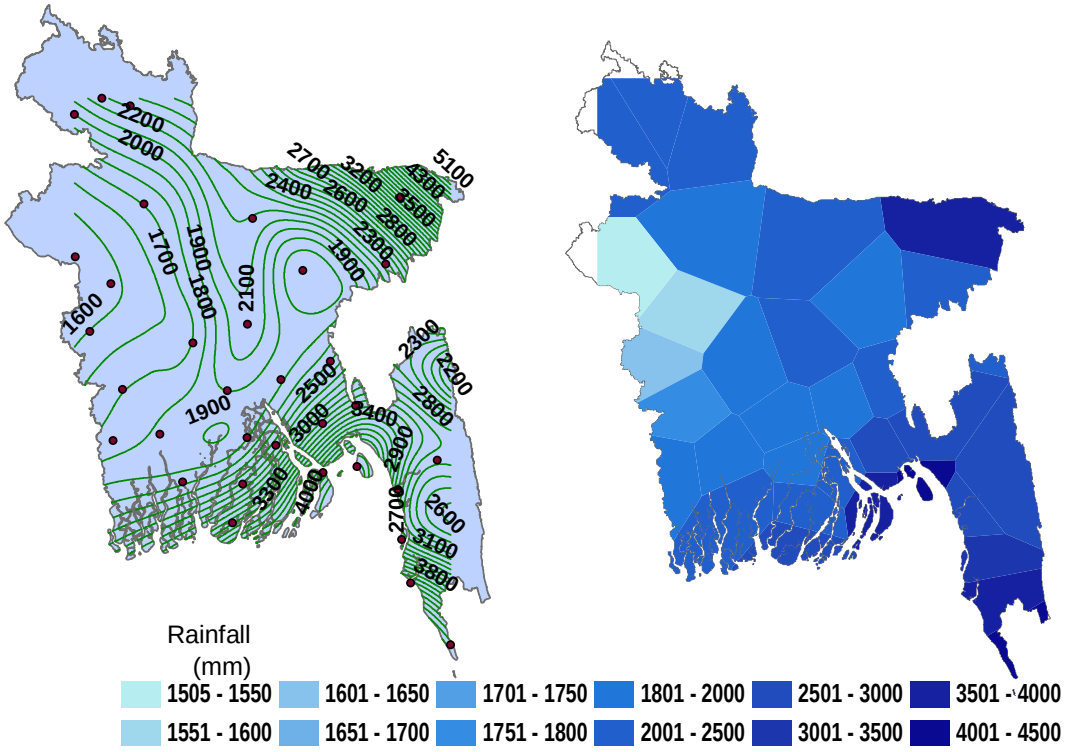
1. Introduction

Rainwater harvesting is not a new concept in Bangladesh and the fact is that, those who are harvesting rainwater are not doing it efficiently due to lack of knowledge and proper guidance. Most of the remaining is not practicing it due to lack of initiation and awareness. Some government agencies like Public Works Department, Department of Architecture, Dhaka Water and Sewerage Authority, Public Health Engineering Department and Local Government Engineering Department has started implementing programs of rainwater harvesting in a very limited way. Private sectors are also implementing programs throughout the country to promote urban rainwater harvesting system as the mitigation of water crisis to some extent.

2. Water Scenarios in Bangladesh

2.1 Present Condition in Urban Areas of Bangladesh

Dhaka Water supply and Sewerage Authority (WASA) provides only 75 percent of its city population water demand from extraction of underground water by about 350 deep tube wells. Rests depend upon shallow tube wells or surface water. The total water demand for the population of Dhaka city is about 1500 million liters per day. But the available water supply is 1336 million liters per day .In Chittagong 50 percent of the urban area has been covered by piped water supply system. About 69 percent of urban slums and fringe areas use water from private tube wells and over 29 percent use water from public tube wells. In Khulna only 20 percent of urban area has been covered by public water supply system and in Rajshahi only 19 percent of city dwellers collect water from hand tube wells. In rest 60 districts of Bangladesh, piped water supply system covers only 19 percent of the population in the core areas of those districts, another 27 percent depend upon public hand tube wells. The remaining population depends on private wells, ponds and rivers as their sources of water.



Average annual rainfall (mm) over Bangladesh form 1996-2007

Contour of average annual rainfall over Bangladesh has been developed using GIS for recent 12 years (1996 to 2007) which show relatively higher rainfall in the Eastern part of the country than the Western part. The spatial distribution of this analysis is also shown in figure for 34 BMD stations over

Bangladesh. The lowest average annual rainfall is observed in Rajshahi (1532 mm) and highest average annual rainfall is observed in Teknaf (4345 mm) for 12 year average.

The figure indicates increase of rainfall in NW region (up to 13%), in NC region (up to 7%), in NE region (up to 9%), in SW region (up to 14%), in SC region (up to 10%), in SE region (up to 4%), in EH region (up to 11%) and in the RE regions (up to 21%). It was observed that average annual rainfall is 2505 mm (5.7% increase considering with last 30 years rainfall).

2.2 Alternative sources of water

It has become clear that most of the rural people can neither be depending upon shallow ground water nor will be getting water from deep tube well soon. Most of the urban people are running in shortage of water. Furthermore heavy extraction of ground water causing the water level down by about one meter every year .From the above facts it is understood that from now on we should not be fully dependent upon ground water as the only source of water. We must look for its alternative sources. Among the alternatives, there are only three other options. These are-i) Treated wastewater / Recycled wastewater ii) treated surface water iii) Rainwater.

2.3 Cost of water from various sources

Cost of water supply includes cost for collection, treatment if needed and its distribution. Among the alternative sources of water, the cost for treatment will be the highest for wastewater and cheapest for rainwater because it is proportionate to the pollution potential present in water. The other factor is the location of sources of water, which incurs cost for collection from the sources and distribution to the consumers. In this regard rainwater is at the doorsteps. So it needs less cost for collection and treatment also. The price of water charged by Dhaka Water Supply and Sewerage Authority (WASA) for its supplied water is U.S. $ 0.09 per thousand liters. The low income households, who cannot afford a house connection, shall have to buy water of substandard quality from private vendors at a high price, sometimes hundred times higher than that could be provided by public authority. In a study it is revealed that where cost for Dhaka WASA supplied water stands for about taka 0.2 to 0.25 per liter, the cost for rainwater required only taka 0.07 per liter.

3. Methodology

For the calculation of rainwater harvesting potential rainfall intensity and run-off coefficient of roof material has been used. For the calculation of rainfall intensity for Dhaka city data for past 30 years from 16 station points have been collected and the average rainfall intensity is been used for calculation of rainwater harvesting potential. The measurements for the catchment area are taken directly from the catchment. The designs for sedimentation and filtration chambers are done according to the requirement as well as space available for their installment.

3.1 Potential of RWHS in UITS

Considering 22 working days and demand varies with using purpose, Demand is calculated as following:

Table 1: Total demand for the selected purposes

Purpose	**Total Demand(liters per month)**
Toilet Flushing	6600
Ablution for Prayer	8800
Mopping	2200
Gardening	1000
Total Demand	**18600**

From the calculation total demand for the mentioned purpose is 18600 liters/month but for the simplicity of the further calculation the demand is assumed 2000 liters/month.

For the calculation of RWH potential, average rainfall intensity is taken from figure 1. It is found that the average rainfall intensity over the years is 2150 mm.

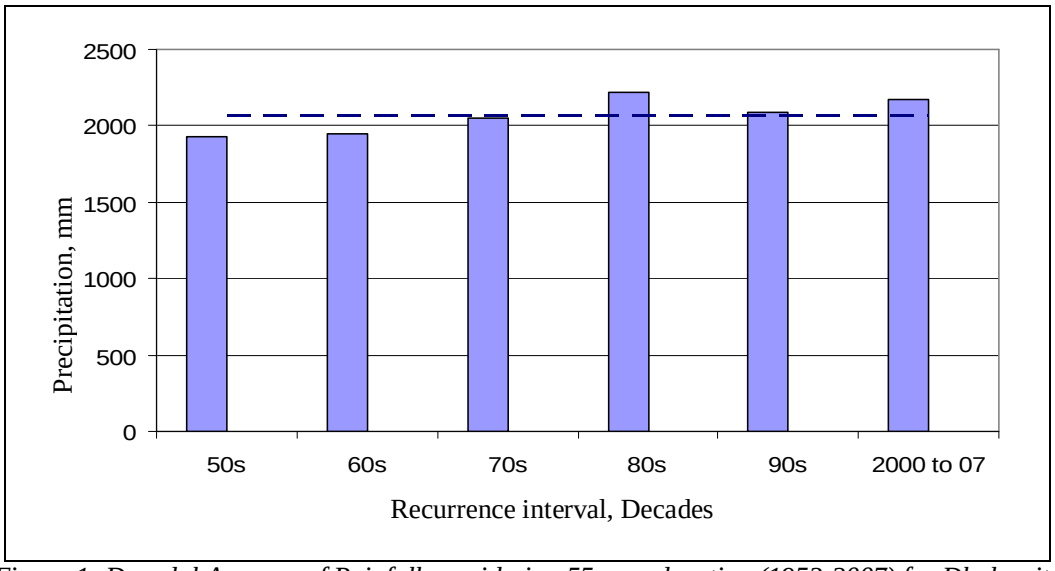


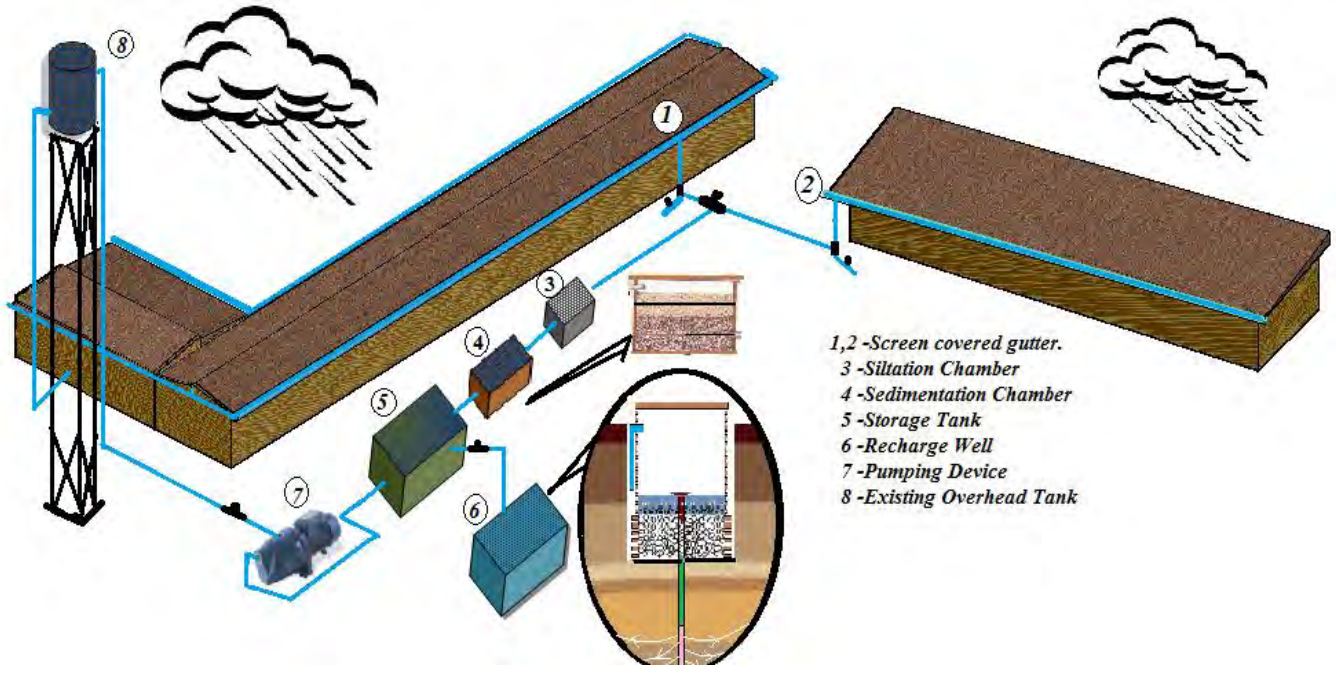
Figure 1: Decadal Average of Rainfall considering 55 year duration (1953-2007) for Dhaka city

Using the decadal average rainfall intensity 2150 mm and run-off coefficient 0.8 for corrugated tin, the rainfall harvesting potential in **UITS** is summarized in table 2.

Table 2: Rain Water Harvesting Potential

Catchment	**Area(m^2)**	**Annual Average Rainfall (m)**	**RWH Potential(L)**
Machine Shop	136.2	2.15	2,34,200
Class Room	263		4,52,500
		Total	686700

3.2 Design of the RWH system in UITS



4. Results and discussion

The system is designed with two first flush devices having the length of 19 m and 36 m for the catchment of machine shop and classroom accordingly. To design the storage tank over the year water deficiency is calculated and shown in figure 3.

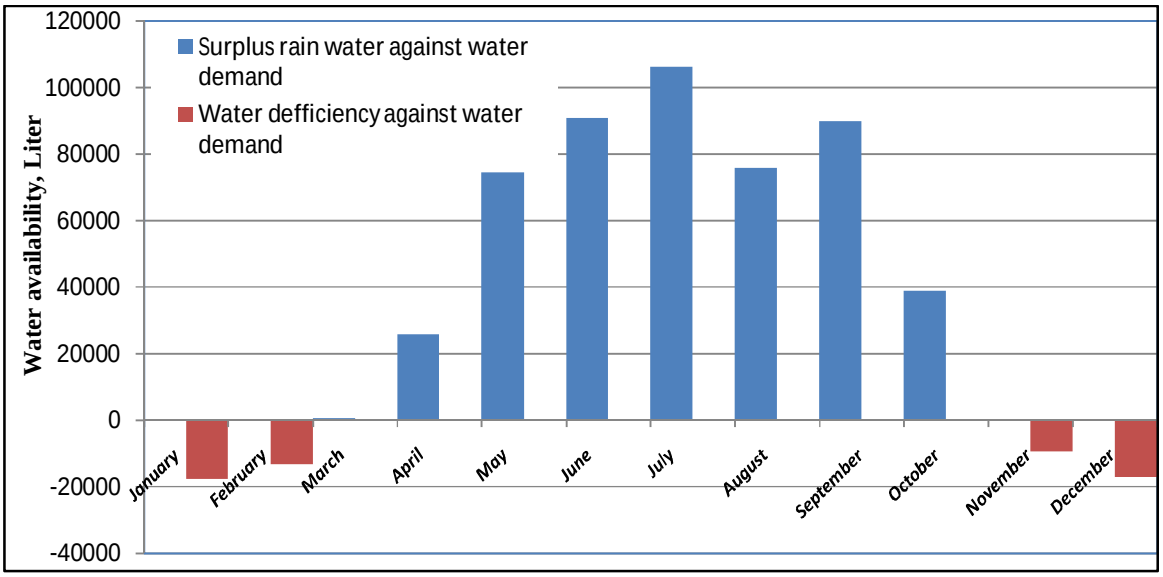


Figure 3: RWH potential and Demand.

Deficiency during the month of November-December-January-February is 56679.712 L. Rest of Eight months can easily be served by the Rainwater. Cost-effective Size of the storage tank is **9.5 ft*6.5ft*6ft**. (considering during the month from March to October Heavy shower will fulfill the Tank Twice). A siltation chamber of size **6ft*3ft*5ft** with capacity 2500L will accommodate 25% of Potential Volume of rainfall during high Intensity before passing the sedimentation chamber. The Sedimentation Chamber will consist of 3 or 4 layer of material varying from coarse chips to fine sand. As the infiltration rate of fine particles is quite low (0.15 to 0.25 L/sec for $1m^2$ filter chamber), a sedimentation unit of size **6ft*3ft*5ft** will yield 1505 liter filtrated water per hour. As first 42 m soil is clay and silt, recharge should be performed at a depth from 42 m to 109.73 because this soil strata contains fine sand (FM=1.6). To recharge rainwater in the first aquifer, 60 ft strainer with slot number #30 will be adequate. A recharge unit of size **6ft *x 4ft x 6ft*** with recharge capacity 4200l/hr will take about 2.25 hr to empty the recharge tank.

From the pay back analysis it is found that about 30,000 BDT will be saved every year and the payback period for this project is about 10 years.

5. Conclusions and Recommendations

Rain water harvesting is a part of integrated water management to mitigate the water crisis not only for the Bangladesh but also for the whole world. Water in the world is treated as a economic product and rain water harvesting system is a efficient way to achieve a sustainable source of this most necessary product. But for the sustainability of the system some research regarding the quality of water, contribution to the water footprint from the consumers and detailed economic and environmental evaluation should have to be done. Also as the system installed in the UITS campus

includes recharging the aquifer for which sufficient testing of the chemical property of the water should have to be conducted.

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