

Potentials of Roof water Harvesting in a dry city (N-E of Iran)

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Abstract

As a selected 2008 APFED showcase project to be implemented in N-E of Iran, a rainwater harvesting system have been constructed and monitored for the purpose of demonstration the potentials of rainwater collection and utilization to combat water shortage in a very representative arid region. Scaled RWH model consists of 1700 m² isolated roof catchment and a 125 m³ ground reservoir used for collecting runoff generated during rainy season and utilizing it for subsequent long and dry period of the year. The simultaneous rainfall and runoff recording showed considerable improvement saving with regard to the city water saving and runoff contamination prevention.

1- Introduction

Mashhad is a holy city with population of 2.5 million permanent resident and 15 million pilgrim visitors each year. The water situation is more critical than many other cities in Iran. The annual rainfall is about 250 mm which happens during winter and spring time. Despite suffering from water crisis during hot and dry summer period, high intensity rainfall causes city inundation due to sewerage overflow during rainy seasons every year. The groundwater, which is the main source of water, does not meet the necessary water quality standards (Hosseini, 2005). In order to promote using rain as one of the most effective countermeasures for water shortage (Ghoddosi,1995), a RWH demonstration project has been implemented at the office building of Khorasan Agricultural and Natural Resources Research Center (KANRRC). The effectiveness of the system has been evaluated by monitoring rainfall, runoff and water consumption in the building during one year after completion of the construction works.

2- Design, construction and monitoring

For design of RWH system, information has been gathered including the meteorological and hydrological as well as data about construction site. The KANRRC's two story building has 1700 m² roof area, and the number of residents is 30 persons during daytime and 10 persons during night time. Long term average monthly rainfall data were employed as input data. Water demand was calculated with regard to the number of resident and visitors who may use sanitary facilities of the building. A simple balance equation was employed and maximum required reservoir volume in relation with the possible water shortage was estimated (Table 1). Maximum cumulative storage multiplied by a safety factor was selected as the required reservoir volume ($V=125\text{ m}^3$). It can be predicted from the results that the rainwater utilization ratio (the ratio that shows how much of the rainwater that is fallen on the roofs can be utilized) would be near to 100% since no spillage is allowed.

Table 1: Calculation for required storage based on monthly runoff and demand

Month	Rainfall (mm)	Yield (lit)	Demand (lit)	Cumulative Storage (lit)	Municipal Use (lit)
January	32.9	39151	26875	12276	0
February	35.9	42721	26875	28122	0
March	54.8	65212	26875	66459	0
April	46.8	55692	26875	95276	0
May	27.4	32606	26875	<u>101007</u>	0
June	4.2	4998	26875	79130	0
July	1	1190	26875	53445	0
August	0.7	833	26875	27403	0
September	1.8	2142	26875	2670	0
October	8.8	10472	26875	0	16403
November	16.2	19278	26875	0	7597
December	24.5	29155	26875	2280	0

According to the preliminary design, the rainwater collected from the roof area has been conveyed to a masonry underground reservoir. The water is pumped from reservoir and being distributed among 12 toilet's flash tanks. Device to avoid cross-connection has been provided.

Using a number of self recording data loggers and flow meter, rainfall, runoff and water consumption have been continuously measured during rainy season of the year 2010 and sometime afterward. Monitoring has been made during one year after project completion.

3- Results and Discussion

Daily rainfalls and reservoir volume change has been shown in Figure (1) for the rainy season of year 2010. A sum of 140 mm rainfall have been recorded during 45 rainy days which is far less than city long term average of 250 mm. According to the results, reservoir level shows several jumps with considerable volume changes mainly at the times with rainfall magnitude higher than about 5 mm. Occasional losses have been occurred due to water utilization where as reservoir starts to show a continuous decrease with the rate of about 3.5 lit/h (= 5 m³/30 days) after the last rainy day on 20/5/2010. Reservoir has been almost filled at the end of rainy season whereas no spillage was recorded. Taking into account of total rainfall and runoff measured during study period, a runoff coefficient of about 60% (= 125 m³/1700 m²*1000/140 mm) could be considered for roof catchment runoff harvesting in the city of Mashhad.

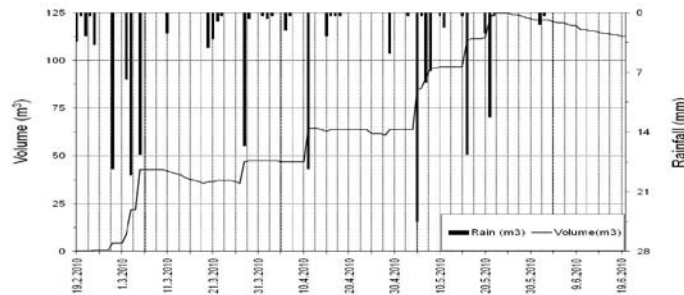


Figure (1): Distribution of measured rainfall and cumulative runoff volume

4- Conclusions

RWH can be considered as a powerful tool for surface water management in dry cities similar to Mashhad region. Most critical system components would be a reservoir with appropriate storage capacity in order to provide required water for the long dry period of the year with almost no rain at all. This factor makes distinct difference between dry and wet region of the world with regards to feasibility study of RWH systems.

5- References

Ghoddoozi J. (1995). "An overlook to the development and use of rainwater harvesting systems in Iran". Proc. Of 7th Int. Conf. on Rainwater Catchment Systems, 21-25 June, 1995, Beijing, China, Vol. 2, pp. 26-36.

Hossaini, S.M., (2005). "Status of water resources in Khorasan province", Integrated Water Resources Management Workshop, Khorasan Water Association with collaboration of Unesco, 21-22 Dec. Mashhad, Iran.

Asian Pacific Forum for Environment and Development (APFED) showcase program, (2008). "Rainwater Harvesting for Sustainable Water Resource Development and Climate Change Adaptation (N-E of Iran)