International Journal of Advanced Research in Engineering Technology & Science

ISSN: 2349-2819

Email: editor@ijarets.org Volume-4, Issue-12 December- 2017 www.ijarets.org

Rain Water Harvesting: A technique of Sustainable Development for society and Environment

Dr. A.K. SIROYA[#] and Dr. NISHA SIROYA[@]

[#]Department of Zoology, S.P.S.B. Govt. College Shahpura, Bhilwara (Raj.)
[@]Department of Zoology, S. D. Govt. College Beawar (Rajasthan)
(Affiliated with- M.D.S. University Ajmer, Rajasthan, India 305001)

ABSTRACT

Water is considered an everlasting free source but most precious resource that can be acquired naturally. Increasing population is making pressure on demand for processed water supply. Sustainable use of resource could maintain a balance between its demand and supply. Rainwater harvesting (RWH) is the most traditional and sustainable method, which could be easily used for potable and other domestic purposes both in residential and commercial buildings. This could reduce the pressure on processed supply water which enhances the quality of living being and environment. In Govt. College Beawar in –situ harvesting system has been developed. Where, the rainfall precipitation is collected from roof top collection, for the purpose of daily use and drinking for the college campus. A water quality assessment has been carried out to explore the comparative analysis of ground water and rain harvested water. The results show that the water procured from rain water harvesting is more qualitative than ground water of the area. This research work ensures the sustainability of this system through assessing several water-quality parameters of collected rainwater with respect to allowable limits. A number of parameters were included in the analysis: pH, fecal coliforms, total coliforms, total dissolved solids, Nitrate, hardness, Fluoride and Chloride. The study reveals that the overall quality of water is quite satisfactory as per ISI Standard. RWH system offers sufficient amount of water and energy savings through lower consumption. Harvested water beneath the ground is not directly exposed to evaporation and pollution and is environment friendly and less vulnerable as compared to surface water. Moreover, if we consider the cost for installation and maintenance expenses, the system is much effective and economical.

KEY WORDS– *Sustainability, Environment, Water Harvesting and Fluorosis*

INTRODUCTION

Water is food and fire is the eater of the food. Fire is established in water and Water is established in fire

-Taittiriya Upanishad 3.8

Life is sustained in the environment and by the environment. Our Vedas have proclaimed that it is the ecosystem, which nurtures the life. All seers and saints have paid obeisance to every aspect of the environment and they firmly believed that life consists of five elements – Earth, Air, Water, Fire and Space. In "*Ram Charitara Manas*" it is mentioned that these five elements are necessary for construction of human body and after death all five element returns to the nature.

"छिति – जल – पावक – गगन – समीरा,

पंच रचित यह अधम सरीरा"

The Greek medieval philosophy says, "Matter consists of four elementary substances"-namely Water, Air, Stone and Fire. Water is the most essential and prime necessities of life. Water quality focuses the presence of foreign substances and their effects on environment. Change in water quality beings with precipitation and also very much affected by human activities including land use and direct discharge of municipal or industrial waste water to the pond system. Due to over increasing industrialization in the urban areas with its wastes making a head way in to the ponds and also due to the rapid urbanization and growing population there is an impending danger of deterioration in the quality of water resources. The rapidly developing countries like India are facing several problem of population of surface sources due to unplanned urban, industrial and agricultural growth in the catchments, lacks of concerns for the environment and lastly ineffective in regulatory control mechanism. Hence it is essential to assess the quality of the surface water sources before it can be safely utilized for various purposes. Therefore, water resource is a priceless national asset, which needs to be harnessed with proper care.

Oceans cover about three fourth of earth's surface. According to the UN estimates, the total amount of water on earth is about 1400 million cubic kilometers which is enough to cover the earth with a layer of 3000 meters depth. However the fresh water constitutes a very small proportion of this huge quantity. About 2.7 percent of the total water available on the earth is fresh water of which about 75.2 percent lies frozen in polar region and another 22.6 percent is present as ground water. The rest is available in lakes, rivers, atmosphere, moisture, soil and vegetation. What is effectively available for consumption and other uses is a small proportion of the quantity available in rivers, lakes and ground water. The crisis about water resources development and management thus arises because most of the water is not available for use and secondly it is characterized by its highly uneven spatial distribution. Accordingly, the importance of water has been recognized and greater emphasis is being laid on its economic use and better management. (Ministry of Jal Shakti-general facts, 2016)

The quality of harvested water has been assessed and found suitable for drinking and other purposes of the college whereas the other ground water sources contain fluoride and chloride found beyond the permissible limits. Harvested water beneath the ground is not directly exposed to evaporation and pollution and is environment friendly and less vulnerable as compared to surface water.

RAIN WATER HARVESTING

Rainwater harvesting is the technique of collection and storage of rainwater at the surface or in subsurface aquifers to avoid lost as surface runoff. Groundwater augmentation through diversion of rainfall to household and subsurface reservoirs by various artificial recharge techniques has special relevance in India. Check dams, recharge shafts, dug-well recharge, subsurface dykes, and adopting rooftop rainwater harvesting in urban areas can go a long way in redeeming the worsening situation of shortage of groundwater. Scarcity of water also pertains in the area due to terrain conditions, most of the rainwater is lost as flash floods and local streams remain dry for most part of the year.

Uncovered areas, particularly in urban and semi urban localities, are continuously diminishing due to urbanization and industrialization. Massive use of concrete all around in the country making the ground water condition worsens. This phenomenon is constantly reducing the scope for percolation of rainwater to the ground during monsoon and thus perpetual reduction in groundwater recharge year after year. With a view to offset this loss in recharge of groundwater, there is apparent need for making roof rainwater harvesting mandatory, either through legislation or by promulgating ordinance, for every public as well as private new and existing buildings in urban and semi-urban areas within specified time frame. Apart from this, harvesting of surface runoff in open areas, both public and private, may also need to be encouraged.

Rain water harvesting is most useful effective processes of water management and water conservation for sustainable development. It is used to indicate the collection and storage for rain water as well as used for human, animals and plant needs. The main purpose of RWH is to increase the ground water recharge, reduce surface runoff from rainfall area and to use the storage water for drinking and domestic purposes during scarcity period.

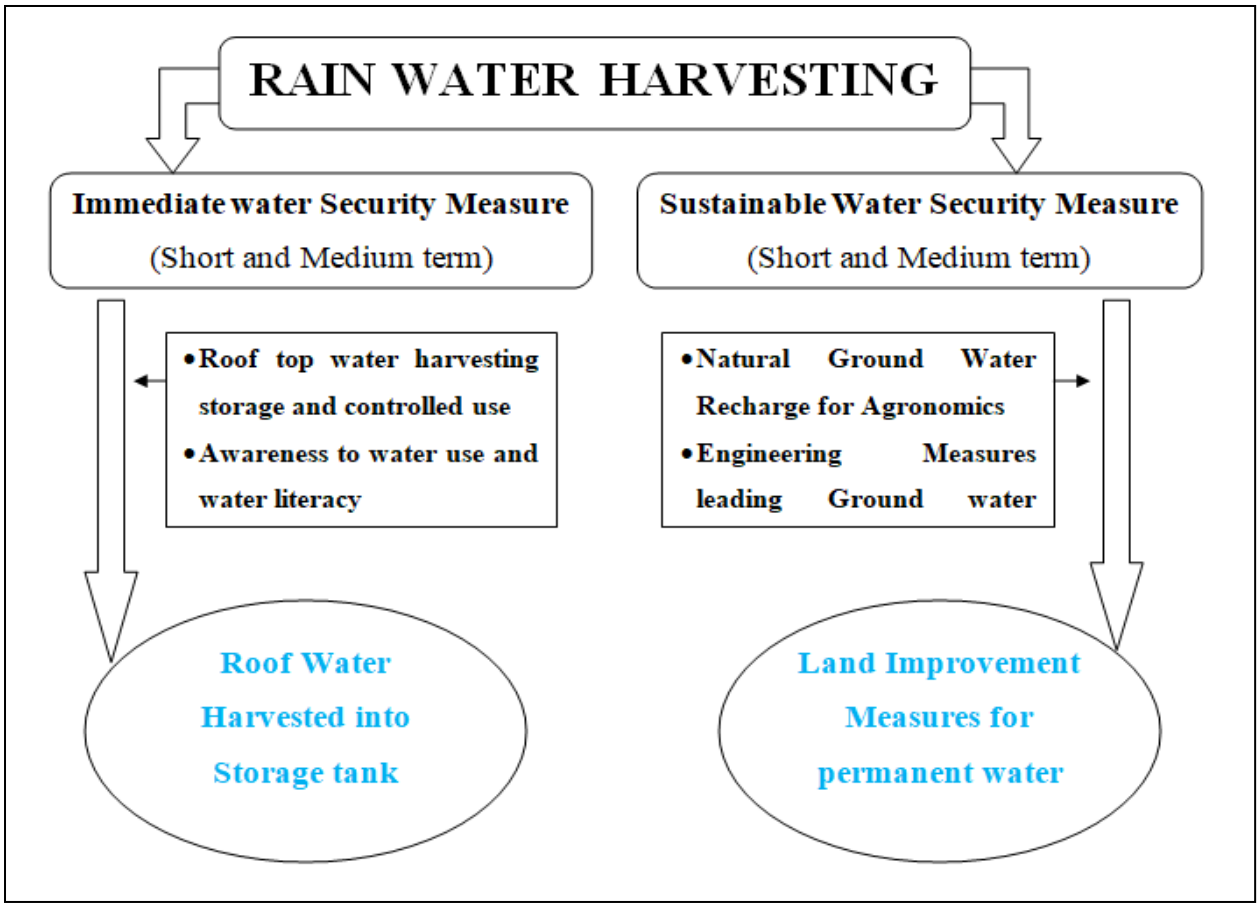

Figure -01 Flow Chart of Rain Water Harvesting

Due to over population and increasing use of water in urban as well as in rural areas; the water supplying agencies are in trouble to cope up the demand from surface sources like dams, reservoirs, rivers, *etc*. However, the water precipitation in country depends upon the monsoon which is limited to about three to four months period ranging around 20 to 30 days (Inderjeet, 2009). Therefore, for augmenting the natural supply of groundwater, the artificial recharge to groundwater has become an important management and conservation strategy. The efforts are basically to locate the natural movement of surface water into groundwater reservoirs through suitable civil structures. This practice increases the sustainability of groundwater in the areas where the groundwater levels are declining and water scarcity is being experienced. Rainwater harvesting is also necessary for Agriculture, continues to be the single largest consumer of water especially in north and south India, and maintains the balance of ecological and hydrological cycle of environment. Rain water harvesting encourages water conservation and self-dependence and meets the domestic and other industrial needs.

STUDY AREA

The S.D. Government College Beawar is geographically situated at 26.095076 North latitude and 74.307249 East longitudes. There are no surface water sources for the college except Bisalpur water project. The water table varies from 35 to 75 Meters from monsoon to summer respectively. Due to scanty rainfall the recharging of ground water is much less. It is a fluorosis affected area of Ajmer district in the state of Rajasthan. In the College in –situ harvesting system has been developed by Government agency in 2015-16. Where, the rainfall precipitation is collected from roof top collection, for the short term of daily use and drinking for the college campus as well as long term purpose to recharge the ground water reservoir.

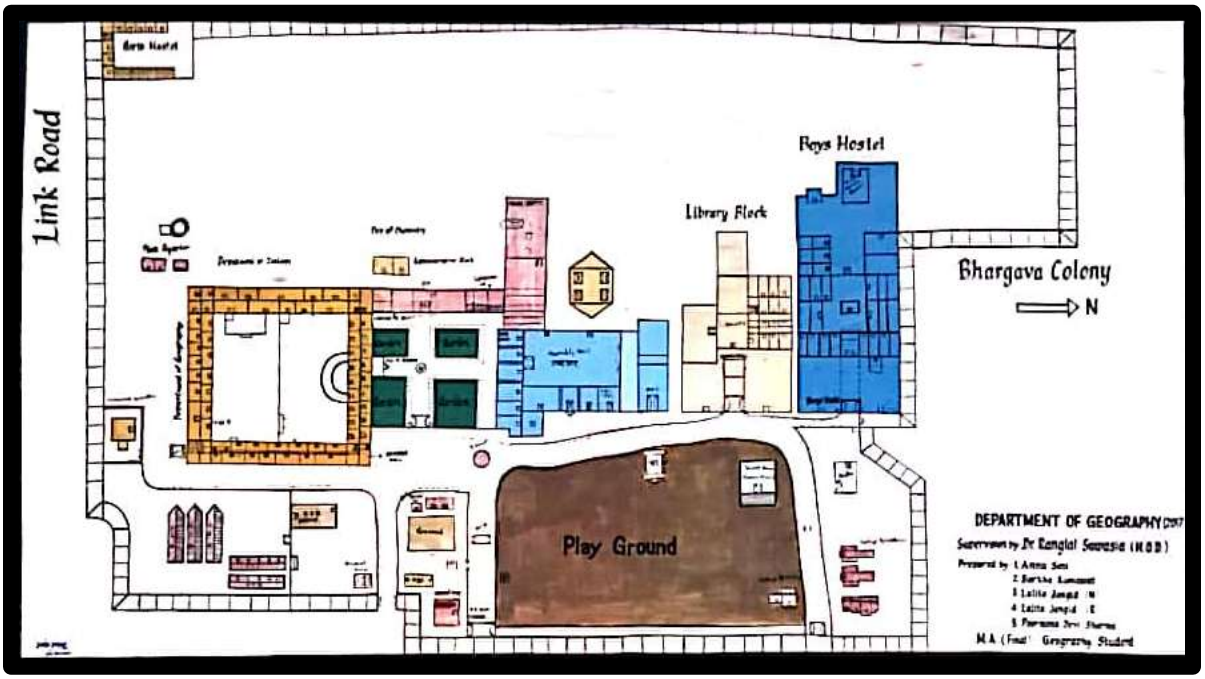

Figure- 01 Building map of S.D. Government College Beawar

METHODOLOGY

In the present study we have calculated water quality and its index. Ten water samples were collected from tube wells, open wells (O/W) and hand pumps (HP). All the samples were examined for five major parameters *viz* pH, Nitrate, Total dissolve solid, Chlorides and Fluoride as per standard methods prescribed in APHA (1992). Parameters and methods employed in the physico-chemical and biological examination of samples.

Table-01 Parameters and Methodology

S. No.	Parameters	Methods
1	pH	Direct pH meter
2	Fluoride	Ion selective electrode
3	Total dissolve solid	Conductivity bridge
4	Chloride	Argentometric
5	Nitrate	Spectrophotometric
6	Total Hardness	By Titration
7	Total Coliforms	Plate Count Method

RESULT & DISCUSSION

In the present study, we have collected 10 samples from 10 locations of Beawar city of Ajmer district. The average values of these parameters are attributed in table-02. The water samples were analyzed as prescribed by standard methods of water and waste water examination in APHA (2003). The average physico-chemical characteristics and their BIS standard values of these samples are tabulated in table-02.

The observed range of water quality index value is beyond the limit of scale, that is zero to hundred. The drinking water quality is found to be severally polluted in the ground water with the value of WQI>100. All Sources found to be highly polluted with more than desirable values in some important parameters. Their water quality is unsuitable for drinking purpose. Higher values of certain parameters at certain sources indicate that the water of those sources is not suitable for drinking as such. In the other hand the quality of rain harvested water is up to the standards prescribed by BIS, quality criterion of all studied parameters were found to be in desirable limit. Fluoride is the most common problem in ground water sources which varies up to5 mg/L, this create fluorosis disease in local population, whereas rain water is almost free from this problem. In the samples we have chloride level in their ground water in concentration of over 450 mg/l which is higher compare to BIS desirable limits. Total dissolved solids found more in ground water then rain water, this creates gastrointestinal problems. Hardness is an aesthetic quality of water that is used to describe the ease with which soap forms a lather. Total Hardness in rainwater almost nil whereas ground water has 240 mg/L or in higher concentration. We can drink extremely hard water but it may not make a good cup of tea or coffee. Excessive hardness also causes gastrointestinal problems. As far as biological quality of water as total

coliforms present in the rain water, rain water can be treated to boil or simple purification for use as potable and domestic purpose.

Table No-02 Comparative Statement of Water Quality

Parameter		BIS	Rain Water (RWH)	Ground Water (Tube Well)
pH	Desirable limit	6.5 - 8.5	6.9-7.1	7.8
	Max.per.limit	No relaxation		
Fluoride	Desirable limit	1	.1	1.7
	Max.per.limit	1.5		
Total Dissolve Solids	Desirable limit	500	70	1500
	Max.per.limit	2000		
Chloride	Desirable limit	250	20	450
	Max.per.limit	1000		
Nitrate	Desirable limit	45	2	35
	Max.per.limit	No relaxation		
Total Hardness	Desirable limit	300	05	240
	Max.per.limit	600		
Coli form counts	Desirable limit	0	10	00
	Max.per.limit	No relaxation		

All values are in mg/L except pH
BIS - Bureau of Indian Standards

CONCLUSION

In the present study based on water quality parameters in ground water and rain harvested water concluded that water quality parameters are very poor within the limits of BIS standards in ground water quality of the area, So water is not fit for drinking purpose, whereas the rain harvested water was found to be suitable for drinking and other domestic purpose. Quality parameters of rain harvested water are well within BIS limits hence the water could be used for drinking after disinfection by bleaching powder. It is well established that Rain Water Harvesting is a water management strategy for fulfillment the demand of water at water scarce area.

SUGGESTIONS AND RECOMMENDATIONS

1. The quality of the college premises should be regularly monitored to formulate the protective measures to control pollution.
2. Awareness among the students about the water quality should be spread by administration, NSS program, NCC activities and other volunteer programs.
3. All traditional water harvesting devices like well, tube-wells and hand-pumps of the college premises should be rain harvested and rejuvenated.
4. The present study suggests that Rain water harvesting should be adopted and implemented as a national program.
5. The harvesting scheme should be planned and executed on scientific principles and integrated with suitable land-use practices.
6. In the present harvesting system rain water harvesting is recommended to recharge the ground water reservoir in rural area and Roof top rain water harvesting should be taken up in urban areas.
7. Suitable legislative measures should be invoked for compulsory inclusion of rain water harvesting in building byelaws in urban areas.

REFERENCES

Agarwal, A. and Narain, S. (1997) "Dying Wisdom: Rise and Fall of Traditional Water Harvesting Systems" *Centre for Science and Environment*, New Delhi, India.

Akther, H; Ahmed, M. S. and Rasheed, K. B. S. (2010) "Spatial and temporal analysis of groundwater level fluctuation in Dhaka city, Bangladesh" *Asian Journal of Earth Sciences*, vol. 3, no. 4, pp. 222–230, 2010.

Angrill, S; Farreny, R; Gasol C.M. *et al*. (2012) "Environmental analysis of rainwater harvesting infrastructures in diffuse and compact urban models of Mediterranean climate" *The International Journal of Life Cycle Assessment*, vol. 17, no. 1, pp. 25–42, 2012.

APHA (2003)"Standard methods for the examination of water and waste water" 20th Ed. *American Public Health Association*, Washington, DC, 2003.

Bates, B; Z. Kundzewicz; Wu, W.S. and Palutikof, J. (2008) "Climate Change and Water" *Inter governmental Panel on Climate Change (IPCC)* 2008.

BIS, Bureau of Indian Standards, Drinking Water Standards IS:10500;1993.

Choudhury, I. and Vasudevan, L. (2003) "Factors of biological contamination of harvested rainwater for residential consumption," in *Proceedings of the Hawaii International Conference on Social Sciences*, University of Hawaii, Honolulu, Hawaii, USA, June 2003, http://www.watercache.com/docs/rwquality1.pdf

Eroksuz E. and Rahman,A. (2010) "Rainwater tanks in multi-unit buildings: a case study for three Australian cities," *Resources, Conservation and Recycling*, vol. 54, no. 12, pp. 1449–1452, 2010.

Farreny, R; Morales-Pinz´on, T; Guisasola, A; Tay`a, C; Rieradevall, J; and Gabarrell, X; (2011) "Roof selection for rainwater harvesting: quantity and quality assessments in Spain" *Water Research*, vol. 45, no. 10, pp. 3245–3254, 2011.

Ghisi, E; Bressan, D. L. and Martini, M. (2007). "Rainwater tank capacity and potential for potable water savings by using rainwater in the residential sector of southeastern Brazil" *Building and Environment*, vol. 42, no. 4, pp. 1654–1666, 2007.

Haigh, M. J. (2004) "Sustainable management of headwater resources: the Nairobi' Headwater' Declaration (2002) and beyond," *Asian Journal of Water, Environment and Pollution*, vol. 1, no. 1, pp. 17–28, 2004.

Helmreich, B. and Horn, H. (2009), "Opportunities in rain water harvesting," Desalination, 248(1-3), pp.118–124.

Hoque, M. M. and Shahabuddin, M.(1998) "An evaluation of groundwater conditions in Dhaka City" in *Proceedings of the International Conference on Hydrology in a Changing Environment*, vol. 2, pp. 175–184, Exeter, UK, 1998.

Horton, R. K. (1965) "An Index Number System for Rating Water Quality" *Journal of the Water Pollution Control Federation*, Vol. 37, No. 3, 1965, pp. 300-306.

Hussain, I. Sharma, K.C. and Ojha, K.G. (2002) "Fluoride in Drinking water and Health Hazards" in *Environmental Scenario of 21st Century;* Ed S.K. Agarwal, APH Publishing corp. (India). 355 (2002)

Inderjeet (2009) "Rainwater Harvesting*"* Mittal Publication, New Delhi.

Karami, E. and Hayati, D. (2005) "Rural poverty and sustainability: the case of groundwater depletion in Iran" *Asian Journal of Water, Environment and Pollution*, vol. 2, no. 2, pp. 51–61, 2005.

Karn, S. K. and Harada, H. (2001) "Surface water pollution in three urban territories of Nepal, India, and Bangladesh" *Environmental Management*, vol. 28, no. 4, pp. 483–496, 2001.

Khan, N. (2014) "Contribution of rainwater harvesting in agriculture of Gujarat: A case study of Ahmadabad district" *IOSR Journal Econ. and Finance* **5** : 30-36.

Kumar, P. (2016) "Rain water harvesting and artificial recharge in Haryana" *Journal of Environ. and Social Sci.* **3** : 123.

Lye, D.J., (2009), "Rooftop runoff as a source of contamination: A review," Science of The Total Environment, 407 (21), pp. 5429–5434.

Prescott, S. C.; Winslow, A. C.; Macrady, M. H.(1946) Water Bacteriology; John Wiley and Sons: New York, 1946; pp 207–212.

Rahman, S. and Hossain, F. (2008) "Spatial assessment of water quality in Peripheral Rivers of Dhaka City for optimal relocation of water intake point" *Water Resources Management*, vol. 22, no. 3, pp. 377–391, 2008.

Roon, M. V. (2007) "Water localization and reclamation: steps towards low impact urban design and development" *Journal of Environmental Management*, vol. 83, no. 4, pp. 437–447, 2007.

Shahabuddin, M. (1996) "An Evaluation of Dhaka City Groundwater Conditions" *Institute of Flood Control and Drainage Research, Bangladesh University of Engineering & Technology, Dhaka, Bangladesh*, 1996.

Sharma, K.C., and Ojha, K.G., (2001) "Ground water quality of an Industrial town Bhilwara, Rajasthan" *Journal of Environmental and Pollution.* 8(1), 109-114, (2001).

Shirazi, S. M; Akib, S. F; Salman, A; Johnson A. U. and Jameel,M. (2010) "Agro-ecological aspects of groundwater utilization: a case study" *Scientific Research and Essays*, vol. 5, no. 18, pp. 2786–2795, 2010.

Shittu, O. I., Okareh, O. T. and Coker, A. O. (2015) "Development of rainwater harvesting technology for securing domestic water supply in Ibadan, Nigeria" *Int. Res. J. Engg. Sci., Technol. and Innov.* **4** : 32-37.

Sinha, D.K. and Saxena, Ritesh (2006) "Statistical assessment of underground drinking water contamination and effect of monsoon at Hasanpur, J. P. Nagar (Uttar Pradesh, India)" Article in *Indian journal of environmental health* 48(3):157-64 August 2006

Thomas, T. (1998) "Domestic water supply using rainwater harvesting" *Building Research and Information*, vol. 26, no. 2, pp. 94–101, 1998.

Villarreal, E. L. and Dixon, A. (2005) "Analysis of a rainwater collection system for domestic water supply in Ringdansen, Norrk¨oping, Sweden" *Building and Environment*, vol. 40,no. 9, pp. 1174–1184, 2005.