Can Rain Water Harvesting be A Solution for Household Water Security?

(Case Study in Monaragala District)

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ABSTRACT

Finding out of alternative water supply strategies is essential for Household Water Security (HWS) in water scarcity regions. The objective of this study was to assess the contribution of rain water harvesting for HWS towards accessibility of safe water consumption. A case study was conducted usingarandomly selected thirty households with active Rain Water Harvesting Structures (RWHS) and thirty households without RWHS from SiripuraGramaNiladari (GN) division of Monaragala district. Questionnaire survey was conducted to collect data related to the water accessibility, quantity of consumption and related health issues during the period from September to December 2014. Results revealed that average quantity of water consumed was 149.11±35.18liter/capita/day by rain water harvesters during rainy season and it was significantly higher ($p < 0.05$) than that of non rainy season in which the average consumption was 51.14±22.61liter/capita/day. The average evaluation of water considered by the non-rain water harvesters during rainy and dry seasons were respectively as 36.25 ±24.11 and 38.99 ±24.61 liter/capita/day. Nearly 93% of total water consumption by the active rain water harvesters was rain water during rainy season whereas it was nearly 22% during the dry season. The households having RWHS sustained with HWS and optimally accessed during rainy season while intermediately accessed during dry season. The households without having RWHS were not sustained with HWS throughout year. Further, it has been reported that nearly 80% non rain water harvesters suffering from urinary problems and hardness problems whereas there was no such problems reported by the respondents who used rain water.As rain water harvesting had plugged a significant role in HWS, action should be taken to encourage the households for harvesting rain water.

KEYWORDS: *Household Water Security, Rain Water harvesting, Water quality*

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1 Introduction

Sri Lanka receives 1800mm of average rainfall and experiences high seasonal and spatial variations due to the bi-modal pattern of monsoonal rainfall. The country has a long history associated with rain water harvesting for domestic and agricultural purposes. The complex ancient reservoir systems and the connected structures evidently illustrate the rain water heritage of the country. Traditionally, rainwater was collected for domestic uses from tree trunks using banana or coconut leaves and from rooftops into barrels, domestic containers or small brick tanks. In recent years there has been revival of domestic rainwater harvesting and much research has been conducted to improve the technology.

Today there are more than twenty three institutions and organization are implementing rainwater harvesting projects and there are more than 31,000 rain water harvesting systems constructed throughout the country (Ariyananda, 2010). In 2005 the government of Sri Lanka, realizing the importance of rainwater harvesting as a solution to overcome the water scarcity in the country, passed a national policy on rainwater harvesting. The policy objective was aimed at encouraging communities to control water flow near its source by harvesting rainwater.

2 Statement of the problem

Drinking water supply coverage in Sri Lanka was estimated to be 78%. Out of this 35% of the population is access to piped borne water supply service. The balance 43% relied on sources such as dug wells, tube wells, spring and rain water harvesting. Due to lack of surface and ground water resources in some locations, alternative drinking water supply facilities such as rain water harvesting was needed to be promoted among people in Sri Lanka. HWS can be defined as the accessibility, reliability and timely availability of adequate safe water to satisfy basic human needs. Rain water harvesting is one of the strategies, that to address as household water security in Sri Lanka. Water scarcity and poor water quality are the major problems especially in the dry zone of Sri Lanka. The households are finding difficulties in satisfying their household needs and spent a lot of time to travel and take water from nearly half a km distance sources. Hence, government and Non Governmental Organizations provided the RWHS for the rural households to harvest rainwater to satisfy their household needs and to make them water secured. It was also suspected that the quality of water, especially high level of fluoride concentration in ground water, might be the reason for prevalence of water hardness problem and brown decaying teeth in children and young adults. The study was carried out to find out the effectiveness of the rain water harvesting using RWHS for HWS.

3 Objective of the study

The objective of this study was to assess the contribution of rain water harvesting for HWS towards the accessibility of safe water consumption, considering rainwater harvesting as a better strategy to overcome water scarcity and water quality problems.

4 Review of the literature

Household water security was an important component in the complicated water supply mix where demands for economic efficiency, agricultural growth and ecosystem integrity were expected to be met simultaneously. Especially supplies for more than one of these demands had to be provided at the same time (Ariyabandu, 2001).

Ariyabandu (2001) defined the household water security simply as the ratio of water supply to water demand. If the water demands higher than water supply, then there would be a water deficit while the opposite situation of water surplus in which it could be theoretically assumed that household water security was satisfied. Further he suggested that the holistic definition of household water security as accessibility, reliability and timely availability of adequate safe water to satisfy basic human needs. Many researchers defined the household water security as how they perceived the concept of household water security.

People use multiple sources of water to achieve water security. In the absent of good quality water on a continuous basis from a single source, people had adopted using different sources of water and satisfy their water needs. Among the rainwater harvesting community in rural Sri Lanka, people had used from two to six sources to satisfy household water needs. The increase in number of sources depends on the climatic regime, availability of water, sustainability of the source and quality of water. The latest addition to the list of water sources in rural Sri Lanka was rainwater harvesting (Ariyabandu, 2001).

The study conducted in Badulla district by Gunasekara and Thiruchelvam (2002) indicated that rain water harvesting had increased the water consumption and water security in the household as much as 80% during the wet season. However, during the dry season the rain water usage was low as 40%. It was further found that negative attitude on quality of the rainwater and poor management practice adopted by people were found to be the major constraints to the sustainability of the rain water harvesting system. The study conducted by Nilminiet *al* (2013) in Northern Province reported that before adopting the rain water harvesting system construction project, many people spent time to bring water travelling nearly 500m but after the construction of rain water harvesting systems, the number of hours spent by them to bring water was reduced.

John (1998) found that high fluoride levels in potable water caused children to have brown decaying teeth; Young men were bent over and crippled with pain in their joints and hips. There was premature hardening of the arteries, and loss of appetite. Fawell*et al.* (2006) observed that fluoride at high levels could cause severe skeletal fluorosis including pains in bones and joints, reduced appetite backache, osteoarthritis. As fluoride built up in different parts of the body over decades it could disrupt the actions of many key enzymes. Further Jayasumana(2014) reported that there is some relation between the chronic kidney disease and poor quality ground water consumption.

5 Methodology

Siripura GN division where 120 households provided with RWHS was the study area located in Wellawaya division in Monaragala district. Thirty households having RWHS and thirty households without having RWHS and utilized well water as a major source of water during dry season in Siripura GN division were randomly selected for this study. The field data from the sample respondents were collected with the help of pre-tested questionnaire. All the questions were arranged to collect the information on reliability, timely availability, accessibility and related health issues commencing each water sources.

The data regarding to accessibility to water was concerning to the average distance to the water sources, responsible person for water fetching activities and quantity of water consumption in respective rainy and dry season including all water requiring activities except for bathing and washing clothes outside the house. Average water consumption per capita per day in respective dry and wet season from each water source was calculated using following equation.

Water consumption/capita/day =
Average daily consumption of water per household per day /number of members in a household

Finally household water security was calculated as the ratio of water supply to water demand. Water supply was taken as the total water consumption/capita/day and water demand was taken as the acceptable minimum level of water to meet the needs for consumption and basic hygiene, reported as 11.25 liter per day by the World Health Organization (2003). Water samples were analyzed to measure the total hardness as $CaCO_3$ using EDTA titration method. The survey was conducted during September to December of 2014. Rainfall data in Monaragala district were collected from the meteorology department as a secondary data and MS Excel and Minitab 16 software were used to analyze the data statistically.

6 Result and discussion

6.1 Accessibility to water in dry season

Households needed to travel with an average distance about 154 meters to become accessible to well water. During dry season women spent 116 minutes/day for fetching water than that of men (88 minutes) and children (56 minutes). However during rainy season, the households who had active RWHS spent less time for manually fetching of water and it was assessed as 56 minutes/day for women, 52 minutes/day for men and 36 minutes/day for children. The result indicated that the households those who had active RWHS accessible to rain water during rainy season without spending their valuable time.

6.2Reliability of water

Nearly 77% respondents reported that they were more reliable on rain water than that of well water during rainy season, however they use well water during dry season. All rain water harvesters used the harvested rain water for drinking purposes without treating it since they believed that it will not affect their health while no one used tank water and stream water for drinking purposes.

6.3 Timely availability of water

Average annual rainfall in Monaragala district was reported as 1830 mm by Meteorology department (Figure 1). The respondents did not empty the RWHS during rainy season and normally used harvested rain water whenever it is available and not kept for a long time to use. The households those who did not have RWHS, harvest rain water using small structures such as tanks or barrels.

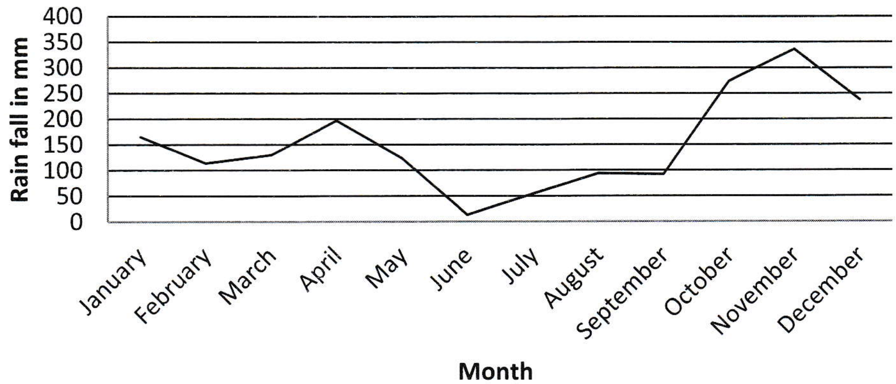

Figure 1: Average monthly rain fall pattern in Monaragala district from 2009 to 2014 (Source: Department of Meteorology, Colombo)

6.4 Water quality

All the households having RWHS cleaned roof and gutters before the onset of rain and the average frequency of cleaning RWHS was less than 6 times per year. Nearly 70% households reported that they did not have filter as a supplementary component of RWHS however they used harvested rain water without any pre treatment. Respondents did not report diarrhea or urinary problems related with the use of rain water while nearly 7% households reported that presence of mosquito larvae in the RWHS.
More than 80 % of households reported hardness problems and urinary problems related with well water. The respondents have experienced the hardness of well water by the taste of the water, deposits in the kettles while boiling water and abnormal color of cooked rice. Rain water harvesters reported that they secured from those problems by consuming harvested rain water at least during rainy season. Nearly 94 % households reported that the deposits in RWHS were observed after filled the well water during dry season and it was measured as $640mgL^{-1}$ of total hardness. According to the water quality standards prescribed by the World Health Organization (WHO) for the drinking water, it was classified as "very hard water".

6.5 Water consumption

Average water consumption was assessed including all water consuming activities excluding bathing and washing clothes outside the house (Table 1) and statistical analyses (t test) were done to list the statistics significance of differences in the water consumption in each season (Table 2).

Table 1: Average water consumption /capita/day

	Average water consumption /capita/day by households with RWHS			**Average water consumption /capita/day by households without RWHS**
	Rain water	Well water	Total	
Rainy season	139.17 ±30.34	11.27 ±6.27	149.11 ±35.18	36.25 ±24.11
Non rainy season	11.52 ±4.71	40.02 ±21.90	51.14 ±22.61	38.99 ±24.61

Source : Field Survey (2014)

Table 2: Cluster wise mean and p value for quantity of water consumption using t-test

	Season	**Mean**	**Standard deviation**	**P value at 95 % confidence interval**
A	Dry	149.11	22.5	0.000***
	wet	51.54	35.6	
B	dry	38.99	24.6	0.769
	wet	35.65	24.1	
A & B	A wet	149.11	35.6	0.000***
	C wet	35.65	24.1	
A - households with RWHS ,B- households without RWHS *** indicated that significant difference at 95 % confidence interval				

According to table 1 and 2, average quantity of water consumed was 149.11±35.18liter/capita/day by rain water harvesters during rainy season and it was significantly higher ($p < 0.05$) than that of non rainy season in which the consumption was 51.14±22.61liter/capita/day and also with non rain water harvesters during rainy and non rainy seasons were respectively as 36.25 ±24.11 and 38.99 ±24.61 liter/capita/day. Nearly 93% of total water consumed by the active rain water harvesters was rain water during rainy season whereas it was nearly 22% during dry season. This is because they used RWHS to store well water during dry season. However non rain water harvesters consumed only 24% of water consumed by rainwater harvesters (Table 1) due to low accessibility to the well water because they faced difficulties on manual fetching of well water due to long distance to the water sources and lack of human resource to carry water.

World Health Organization (WHO) defines that if average consumption of ≥ 50 liter/capita/day then that person sustained with HWS whereas the consumption of about 50 liter/capita/day was categorized as intermediately access and optimal access if it was ≥100 liter/capita/day. The results confirms that households having active RWHS sustained with HWS throughout the year whereas they optimally accessed during rainy season by consuming 149 liter/capita/day while intermediately accessed during non rainy season by consuming 51 liter/capita/day. The households who did not have the RWH structure consumed 36 liter/capita/day during rainy season while 39 liter/capita/day during dry season indicated that they did not sustain with HWS throughout year.

Ariyabandu (2001) reported when water demand was less than water supply then there was a water surplus situation in which it could be theoretically assumed that HWS was satisfied. Supply of water was taken as the average water consumption/capita/day while the demand for water was taken as 11.25

liter given by WHO as average minimum level of water to meet the needs for consumption and basic hygiene.

Table 3: Household water security (supply/demand)

	Water security (supply/demand)	
	Rainy season	Non rainy season
Household with RWHS	149.11/11.25=13.25	51.14/11.25 = 4.55
Household without RWHS	36.25/11.25 = 3.22	38.99/11.25= 3.47

According to the table 3, water supplies in all households were higher than that of average minimum level of water to meet the needs for consumption and basic hygiene. The households those who had active RWHS consumed more water than the demand for minimum quantity of water. So they were more satisfied of water security in complicated mix demand of water during rainy season and also during dry season. But the households who did not have the RWHS consumed smaller amount water even in the rainy season and dry season, as a result they were not much satisfied with water security.

7 Conclusion and recommendation

The households having RWHS sustained with HWS and optimally accessed during rainy season while intermediately accessed during dry season. The households without having RWHS were not sustained with HWS throughout the year. As rain water harvesting has significant role in household water security towards water management, action should be taken to strengthen the rain water harvesting in other districts in the dry area through government and nongovernmental organizations. Awareness programme regarding safeguarding, harvesting of good quality water and correct utilization of rainwater would pave the way to make households more water secured and enhancing their livelihood.

References:

Ariyabandu, R. De. S. (2001). Household water security using rainwater harvesting. Domestic Roof water Harvesting Workshop. IIT Delhi April 2001.

Ariyananda, T. (2010). Domestic Rainwater Harvesting as a Water Supply Option in Sri Lanka.HYDRO NEPAL.ISSUE NO. 6,27.

Ariyananda, T., and Aheeyer, M.M.M. (2011). Effectiveness of Rain Water Harvesting (RWH) Systems as a Domestic Water Supply Option. Sri Lanka. Water Supply & Sanitation Collaborative Council.

Fawell, J., Bailey, K.., Chilton, J., Dahi, E., Fewtrell, L., and Magara, Y. (2006).Fluoride in Drinking water, IWA Publishing.

Gunasekara, A.J.M., and Thiruchelvam, s. (2002). Impact of Roof Rain Water Harvesting on domestic water consumption And Rural Livelihood – A case study in Badulla District .Tropical Agricultural Research.Vol 15, 2003.

Jayasumana, C. (2014). Glyphosate, Hard Water and Nephrotoxic Metals: Are They the Culprits Behind the Epidemic of Chronic Kidney Disease of Unknown Etiology in Sri Lanka? International Journal of Environmental Research and Public Health.

John, Y. (1998). Fluoride, The Silent Killer. Consumer Health. Volume 21, January

Nilmini, K.P.I., Kandasami, K..,Ariyananda, T., (2013). Water & food security for resettlement area in the Northern province of Sri Lanka through rain water harvesting.Thesis, University of Moratuwa.

Annex 1:

Summary of requirement for water service level

Service level	Household water security
No access (quantity collected often below 5 l/c/d)	no
Basic access (average quantity unlikely to exceed 20 l/c/d)	partial
Intermediate access (average quantity about 50 l/c/d)	sustained
Optimal access (average quantity 100 l/c/d and above)	sustained

Source: World Health Organization (2003)