Rain Water Harvesting in Sri Lanka

Dr Tanuja Ariyananda

Director,
Lanka Rain Water Harvesting Forum.

Prof. S. S. Wickramasuriya

Department of Civil Engineering,
University of Moratuwa.

Abstract

There has been a significant increase in the use of rain water harvesting in Sri Lanka, which has proved to be a boon to rural people, particularly for domestic water supplies in water scarce situations. An estimated thirty thousand systems are presently in operation, scattered over a large number of districts. Interestingly, several large-scale projects have also been implemented in the urban context, and this too is likely to increase in the future. With a national policy on rainwater harvesting and other legislation in effect, Sri Lanka stands to benefit significantly by the appropriate use of this technology.

Introduction

Many water problems in the world can be attributed to the uneven distribution of rainfall in time and space. Extremities of weather give rise to floods and droughts, often causing considerable damage to life and property. Countries subject to monsoonal weather patterns, such as, Sri Lanka, can experience flooding after a prolonged dry spell or a period of drought. There is also a growing concern globally about the implications of climate change on rainfall patterns, and about appropriate strategies to be adopted as far as infrastructure is concerned for proper management of rain water. In addition, globally, a Millennium Development Goal has also been set, which aims to halve the number of people who do not have access to safe drinking water by the year 2015. Thus, rainwater harvesting has emerged as an important issue in the international scenario, and was highlighted at the third World Water Forum held in Kyoto, Japan in 2003. In the context of Millennium Development Goals and the issue of sustainability, the following conclusions are noteworthy:

- Harvested rain water is a major water supply option, as important as surface and groundwater
- That decentralised water utilisation and resource management uses rain water harvesting for the sake of the people and the Earth

Furthermore, at the Global Ministerial Environmental Forum held in Korea in 2004, it was concluded that alternative and cost effective technologies, such as rainwater harvesting, should be explored and promoted and the transfer of appropriate technology increased. Suggesting rain water harvesting as a new paradigm, Han (2004) suggests the building of a worldwide network to promote rain water harvesting.

Rain water Harvesting Policy and Legislative Support

One of the earliest policy statements on water resources development and management in Sri Lanka, mentions rainwater harvesting. The famous proclamation by King Parakarambahu the Great (1153-1186AD), ".....let not even a small quantity of water obtained by rain, go to the sea without benefiting man" (Arumugam, 1969, quoted from Mahawamsa), shows the wisdom and commitment of ancient kings and people to conserve and efficiently manage water resources.

The ancient tanks of the dry zone and the complex water collection and distribution system of the Sigiriya rock fortress bear ample testimony to this fact.

In June 2005, the government of Sri Lanka accepted a "National Policy on Rainwater Harvesting and Strategies" presented to the Parliament by Minister for Urban Development and Water Supply. The policy objective is aimed at encouraging communities to control water near its source by harvesting rain water. This results in minimising the use of treated water for secondary purposes, providing water for domestic use with adequate treatment, reduction of flooding, improving soil conservation and groundwater recharge, agricultural benefits and reduced energy consumption.

This policy document states the legislative changes needed in the Urban Development Authority (UDA) and Road Development Authority (RDA) by-laws on drainage and National Water Supply and Drainage Board (NWSDB) by-laws to incorporate rain water harvesting as a source of domestic water. Regulations have been gazetted on 17th April 2009, which make rain water harvesting mandatory in certain categories of new buildings in areas under municipal and urban council jurisdiction.

Rain water Harvesting - Current Situation

Sri Lanka has used rain water for both domestic and agricultural purposes for many centuries. However, institutionalised rain water harvesting

became a practice in Sri Lanka in 1995, under the World Bank-funded Community Water Supply and Sanitation Project (CWSSP) which introduced rain water harvesting as a water supply option in the districts of Badulla and Matara (Heijnen and Mansur,1998).

This project initiated the emergence of the Lanka Rain water Harvesting Forum (LRWHF), which is a non-governmental organisation (NGO) actively engaged in promoting rain water harvesting in the country. Since the CWSSP, a number of other organisations and institutions have adopted rain water harvesting as a means of supplying water to water scarce households in both the wet and dry zones. Some of the noteworthy contributions in rain water harvesting for domestic use have been made by the Southern Development Authority, the Dry Zone Development Project funded by International Fund for Agricultural Development (IFAD), National Water Supply and Drainage Board 3rd and 4th Asian Development Bank Water and Sanitation projects and the 2nd CWSSP project. During the last 13 years, LRWHF has actively promoted the concept of rain water harvesting in all districts through demonstration projects, awareness programs, training, research and development, and networking. Presently, there are more than 30,000 domestic rain water harvesting systems recorded in 25 districts (Table 1). Most of these rain water harvesting systems are in rural areas, and have been implemented through government projects or by NGOs.

Table 1 : Distribution of rain water harvesting systems in Sri Lanka

Province	District	No. of total number of rain water tanks		
		By LRWHF	By other organisations	
			No. of tanks	Organisations
Central	Kandy	10	2663	CWSSP
	Matale		994	CWSSP
	Nuwara Eliya	5	964	CWSSP, PALM
Eastern	Ampara	652	31	CI
	Batticaloa	11	36	Asia Onlus
	Trincomalee	19	-	-
North Central	Anuradhapura	13	3483	Plan, KOPBMO, ITDG, BLIA, NWSDB
	Polonnaruwa	-	1096	NWSDB, NCC
North Western	Kurunegala	51	577	GTZ, NWSDB, Sarvodaya, Plan
	Puttalam	14	1652	ORDE, PRDA, NWSDB
Northern	Jaffna	14	-	-
	Kilinochchi	09	-	-
	Mannar	11	98	IOM
	Mulathivu	03	-	-
	Vavunia	48	66	WV, IOM
Sabaragamuwa	Rathnapura	-	111	EC, HKLM
	Kegalle	8	1664	NWSDB
Southern	Galle	1397	-	-
	Hambanthota	1107	2811	Sarvodaya, WV, ADRA, OXFAM, NWSDB, ITDG, SDA
	Matara	629	1089	CWSSP
Uva	Badulla	1	5488	CWSSP
	Moneragala	40	1904	Sarvodaya, NWSDB, SDA, ITDG
Western	Colombo	5	41	USIP
	Gampaha	1	23	EC, CWSSP
	Kalutara	-	1443	NGOWSSDS, Asia Onlus, NWSDB
Total		4048	26234	
Grand total			30282	

Source: www.lankarainwater.org

Water Quality Issues

Rain water is one of the purest sources of water available, as it does not come into contact with many of the pollutants often discharged into local surface waters. It comes free and can be used to supply potable (drinkable) water and non-potable water. If collected properly, it can be used for all domestic purposes including drinking.

Rainwater from well-managed roof catchment sources is generally safe to drink without treatment. Except in heavily urbanised and industrialised areas or regions adjacent to volcanoes, atmospheric rain water is pure.

Any contamination of the water usually occurs after contact with the catchment system (roof). Regular cleaning and inspection of the catchment area and gutters are important to ensure good quality water (Heijnen and Pathak, 2006). Further treatment through boiling, exposure to sunlight and chlorination can be undertaken if there are concerns about water quality.

Insects breeding inside the tank can be prevented, by keeping the storage tanks and other openings sealed. Awareness and education are the two most important strategies to prevent water pollution.

Rain water Harvesting in Urban Buildings

Households in urban areas use pipe-borne water, not only for drinking and cooking, but also for gardening, car washing and all other activities. A close examination of Table 2 shows that apart from drinking and cooking, there is immense potential to utilise rain water to supplement household water supply for non-potable requirements, thereby reducing the use of treated pipe-borne water. Thus, authorities will be able to supply pipe-borne water to more households.

In view of the existing constraints faced by the authorities in meeting the increasing demand for water, it is vital that rain water harvesting be used as a supplementary source of water in urban areas where pipe-borne water consumption is very high.

A study indicates that, on average, in low income households in Sri Lanka, if 30% of the monthly water requirement was met by rain water, there will be a 34% reduction in water bill (Ariyananda and Gunasekara, 2004). In middle income households, if 30% of the monthly water requirement is met by rainwater, then the monthly water bill can be reduced by 61% at the present water rates.

The potential of rain water harvesting for large housing projects as a supplementary source and the required structural measures to be adopted have been studied and presented by Jayasinghe (2004).

Rain water harvesting in urban areas has many functions. It can supplement pipe-borne water for non-drinking purposes, thus conserving pipe-borne water, reduce energy cost of pumping, and also reduce flooding. Rain water collection in commercial and public buildings has particular advantages resulting from large roof areas.

Some examples of rainwater harvesting systems in commercial and public buildings in Sri Lanka are; Millennium Information Technologies Ltd., David Peries Motor Company and the Sabaragamuwa Provincial Council complex (Gunatilake et al., 2009).

Millennium Information Technologies Ltd. located in Malabe is a state of the art software company with about 300 occupants in a 12,000-sq.m. facility. Rain water from roof areas are collected and stored in ponds. The system which is designed for a 90-day dry period uses rain water for toilet flushing, gardening and washing and meets about 70% of the water demand, thereby contributing significantly to water conservation.

David Peries Motor Company which is a leading motor company has its assembly plant in Madapatha. Rainwater from roof and ground areas is effectively used for non-potable purposes with approximately 50% of the water demand being met, which also incorporates a treatment process.

The system is used to mitigate water scarcity from January to March and is also an example of a company's commitment to Corporate Social Responsibility of conserving natural resources.

The Sabaragamuwa Provincial Council Complex, which is located in Ratnapura, has 400 office staff and 200 visitors per day. The rain water harvesting system uses a roof area of 2842 sq.m., two storage tanks of 22 cu.m. capacity, an underground well and a sump, together with two three-phase motors for water pumping. It is reported that the annual saving due to harvested water is Rs. 120,000/-. Various technical problems faced were overcome with the assistance of the University of Moratuwa and the Institute for Construction Training and Development (ICTAD).

Abbreviations

ADRA	- Adventist Development & Relief Agency Sri Lanka
Asia Onlus	- ASIA ONLUS
BLIA	- Buddha's Light International Association
CI	- Care International
CWSSP	- Community Water Supply & Sanitation Project (under the Ministry of Urban Development and Water Supply (*www.urbanlanka.lk/Agencies.htm#cwwsp*)
EC	- Ekamuthu Cultivators
GTZ	- GTZ
HKLM	- HKL Menike
IOM	- International Organization for Migration
ITDG	- Intermediate Technology Development Group (Practical Action)
KOPBMO	- Kala Oya River Basin Management Office
LRWHF	- Lanka Rain Water Harvesting Forum
NCC	- National Christian Council
NGOWSSDS	- GO Water Supply and Sanitation Decade Service
NWSDB	- National Water Supply & Drainage Board (under the Ministry of Urban Development and Water Supply) (***www.waterboard.lk***)
ORDE	- Organization for Resource Development and Environment
OXFAM	- OXFAM
PALM	- PALM Foundation
Plan	- Plan Sri Lanka
PRDA	- People's Rural Development Association
Sarvodaya	- Lanka Jathika Sarvodaya Shramadana Sangamaya
SDA	- Southern Development Authority
USIP	- Urban settlement Improvement Project
WV	- World Vision

Rain water for Drought Mitigation and Recharging Groundwater

Domestic use

Rain water harvesting has brought much relief to people during times of drought, water scarcity and, more recently, to those affected by the devastating tsunami of 2004.

Even though Sri Lanka has a relatively high rainfall, it varies both temporally and spatially. Some areas can experience extreme dry spells between monsoons or on occasions even a total failure of the monsoons. Several dry zone districts of Sri Lanka experience prolonged drought, causing tremendous hardships to people. Rain water harvesting systems constructed in Hambantota, Moneragala and Anuradhapura were able to use rain water stored in the tanks for as long as 5-6 months during dry period. (Ariyanbandu and Aheeyar, 2000).

Research done by Kumari (2008) on rainwater harvesting for rural water supply shows that a 5 cu.m. tank with a roof area between 75 to 100 sq.m. can supply 300 litres/day to a household, with an overall probability of success of 50%, in the districts of Anuradhapura, Hambantota and Puttalam. However, this figure will reduce depending on the season. Substantially higher degrees of success can be obtained within the wet and intermediate zones (Ranasinghe, 2008). Further work on appropriate tank capacities for rainwater harvesting in the Jaffna district has been done by Gamage (2006).

Agricultural use

The rural sector in Sri Lanka constitutes around 80% of the population and most of those in the rural sector depend on rainfall-based sources of income, such as, agriculture, livestock production and inland fisheries. Freshwater availability is a vital element in food production and improvement of livelihood in these areas.

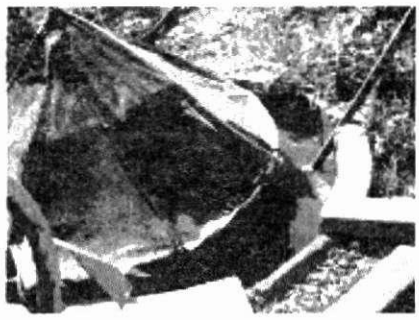

Figure 1:

Run-off tank at Kurundamkulama

Lack of a dependable water supply is often a major limiting factor in our attempts to develop the rural sector. From the total rainfall, on average, around 50% of rain water is lost in the form of surface run-off, and conserving this water will promote crop growth in areas where water is limited. An effective and economical method of conserving this water is by storing it in surface tanks which are abundant in the dry zone. However, many small tanks are dilapidated and/or silted and need rehabilitation.

If the run-off water is stored in the land itself, it would be available to plants when there is a water shortage. In some parts of the dry zone, small ponds called "Pathahas" have been used to collect and store rainwater. Such a water collecting system on farm would enable farmers to cultivate crops during the dry seasons.

A study was carried out in Kurundamkulama (a village in Mihintale in Anuradhapura District) to harvest/collect run-off rain water in tanks. Water from the Maha season rain was collected in a 5 cu.m. run-off tank (Figure 1) and was used during Yala for crop production. As a result, the incomes of the families in the study increased substantially (Weerasinghe et al. 2005). Collection of run-off rain water, not only conserves water, but also reduces soil erosion and degradation of the land.

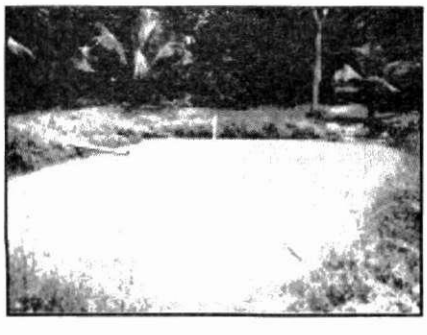

Figure 2: "Pathaha" at Nikawaratiya

Recharging groundwater

Water lost from the ground by way of evaporation, tube wells, etc, needs to be replenished. Collecting rainwater in ponds and pools in a manner where water percolates in to the ground, raises the water table. A study conducted in Nikaweratiya on the use of *pathahas* (Figure 2) (Shanthi de Silva, 2005), shows that these elevate the ground water level, thus increasing the quantity of water available for both domestic and agricultural use, even during the dry season.

In several Indian states, ground water recharging in urban areas through recharging structures (Figure 3) is encouraged and legalised to increase the exploitable quantity of groundwater, improve the quality of groundwater and to mitigate flooding.

Social and Economic Aspects

As with any new technological intervention, rain water harvesting too needs changes in attitudes, perceptions and behaviour of the community, if the new technique is to be successful in terms of social, economic, cultural and environmental factors. Training and awareness are key factors to ensure quality construction, proper operation and maintenance, management of harvested water, and to change attitudes and wrong perceptions of the concept of rainwater harvesting.

Community mobilisation and training of beneficiaries are vital components,

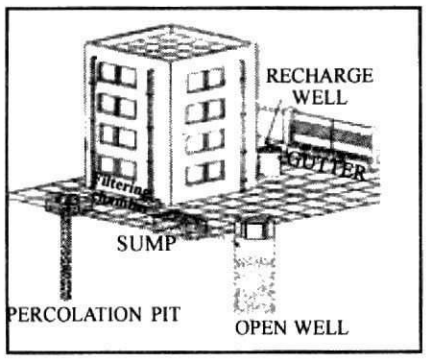

Figure 3 : Recharging structures (Raghavan, 2006)

since rain water tanks will ultimately be managed at private cost at the household level. Community contribution towards the project is recommended in order to increase the sense of ownership and motivate people towards sustainable management.

The beneficiaries can easily supply unskilled labour and local materials towards the project. The contribution of unskilled labour alone provides almost 15% of the total value of the system (Table 3).

Institutional and commercial-level rainwater harvesting in schools, government offices, hospitals and other public places is highly recommended due to their large roof areas, but proper institutional arrangements are vital for sustainable operation and maintenance.

Figure 4: Underground tank

One of the major disadvantages of roof rainwater harvesting technology is that it requires a higher capital investment initially for the construction of storage cisterns and other supplementary components.

The cost is much higher when the rainfall is low and there is a longer dry period, which results in the need for a larger cistern to ensure water security.

The success of any technological intervention also depends on the cost and affordability. The use of an appropriate tank size and suitable cost effective materials, less labour and simple construction aids are important factors for reducing the cost of construction.

Rain water harvesting system tanks can be placed above ground, underground (Figure 4-6) or partially underground.

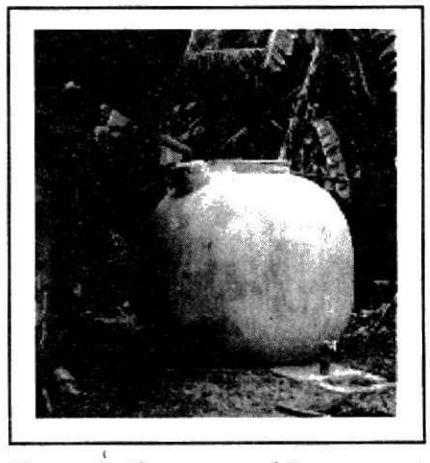

Figure 6: Above ground Ferrocement tank

According to past research (Thomas and Rees, 2001), the unit cost of construction of rainwater tanks shows a negative relationship with the size of the cistern.

Figure 5: Partially underground tank

It is cheaper to go for a larger tank and to avoid using two smaller tanks, and larger communal systems compared to small individual units.

High initial cost has been a prohibitive factor for many poor households in adopting rainwater harvesting systems, though they are willing to collect rain water for their household needs.

Therefore, some supportive mechanisms such as loans and subsidies can be effectively used to promote the technology among poor families.

Use of subsidies in the past have shown positive results in introducing rain water harvesting systems among rural poor (Gould and Petersen, 1999).

Table 3 : Cost estimates for different sizes of Ferro cement tanks

Cost of cistern	5 m^3	7 m^3	8 m^3	10 m^3
Material	24,305.50	26,919.50	29,719.50	35,370.50
Skilled labour	4,500.00	5,400.00	5,580.00	8,000.00
Unskilled labour	5,000.00	5,500.00	6,000.00	10,000.00
Transport of materials	2,500.00	2,500.00	2,500.00	2500
Reusable Frame/Miscellaneous	1427.5	1,500.00	1595	1750
	37,733.00	**41,819.50**	**45,394.50**	**57,620.50**
Pipes, First flush, Gutters (26 feet), other accessories & fixing charges	5,000.00	5,000.00	5,000.00	5,000.00
Total	**42733.00**	**46,819.50**	**50,394.50**	**62,620.00**

Source: Aheeyar (2009).

Some of the social and economic benefits identified by households using rain water harvesting systems are -

- Easy access to clean drinking water
- Less time spent on collecting water
- Time saved (average 1.5 hrs per day) is used for social and economic activities
- Skills enhancement in the village
- Less reliance on external water providers
- More water security at household level
- Better sanitation due to more water availability
- Enhanced income through use of rainwater for home gardening, animal rearing, brick making, etc.
- Reduction in incidence of diarrhoea
- Better quality water, especially in areas with high levels of Fluoride in ground water, saline water (after the tsunami) and brackish water.

Conclusions and Recommendations

Even though Sri Lanka presently has no water scarcity, except in some areas during the dry season, due to increase in population, urbanisation, pollution of water sources and climate change issues, it may face water problems in the future. Adopting rainwater harvesting and utilising it to the maximum will help the country to overcome this problem. The main recommendations are:

- Using rain water for drinking purposes should be encouraged in dry zone districts where the groundwater is both mineralised and contaminated, especially in areas where a high incidence of kidney problems due to polluted ground water has been reported.
- Rain water harvesting should be encouraged as a supplementary water source in urban areas to reduce water bills, save on energy and water treatment costs, and reduce flooding in some areas.
- Incentives, such as tax rebates, should be offered to encourage householders to adopt rain water harvesting.
- Incorporate rain water harvesting in all public and commercial buildings with large-scale use of pipe-borne water.
- Encourage ground water recharge in potentially suitable areas.
- Rain water harvesting system components for urban houses should be made available locally.
- Professionals should use innovative designs incorporating rain water harvesting in new buildings.

References:

Aheeyar, M.M.M. (2009). Economic and Social Aspects of RWH Systems. In Ariyananda T. (Ed). Rain water Harvesting Practitioners Guide for Sri Lanka. *Lanka Rain Water Harvesting Forum.*

Ariyanbandu, R. De S. and Aheeyar, M.M.M. (2000). Evaluation of the Effectiveness of Rain water as Domestic Water source in Rural Sri Lanka. *Lanka Rain Water Harvesting Forum.*

Ariyananda, T. and Gunasekara, J. (2004). Study of potential Feasibility of Roof Rain water Harvesting in Urban Area. *Proceeding of 7th Symposium of Lanka Rain water Harvesting Forum, Colombo, Sri Lanka.*

Arumugam, S. (1969). Water resources of Ceylon. *Water Resources Board, Sri Lanka.*

Gamage, N.P.D. (2006). Guidance on use of rainwater tanks for the Jaffna Peninsula. *Annual Transactions, Institution of Engineers, Sri Lanka.*

Gould, J. and Petersen, E.N. (1999). Rainwater catchment systems for domestic supply: Design, construction and implementation. *Intermediate Technology Publications Ltd., London.*

Han, M. (2004). Rain water harvesting: A new paradigm to meet MDG and sustainability. Rain water Harvesting Workshop, *IWA 4th World Water Congress and Exhibition, Morocco.*

Heijnen, H and Mansur U. (1998). Rain water harvesting in the community water supply and sanitation project. Proceeding of the Symposium on *Rain Water Harvesting for Water Security Feb. 1998.* Lanka Rain Water Harvesting Forum. *Publication* Sri Lanka. P53-56.

Heijnen, H. and Pathank, N. (2006). Rain water Quality Health and Hygiene Aspects. Proceeding of International Workshop in Rain Water Harvesting, Kandy, Sri Lanka.

Jayasinghe, M.T.R. (2004). Rainwater harvesting to supplement water for large housing projects. *Annual Transactions, Institution of Engineers, Sri Lanka.*

Kumari, D.M.C.S. (2008). Drought mitigation using rain water harvesting in the dry zone of Sri Lanka. *M.Eng. dissertation.* University of Moratuwa.

National Rain Water Harvesting Policy & Strategy, Ministry of Urban Development and Water Supply, Government of Sri Lanka.

Ranasinghe, R.K.W.K. (2008). Improved water conservation practices using rain water harvesting in the wet and intermediate zones of Sri Lanka. *M.Eng. dissertation.* University of Moratuwa.

Raghavan, S. (2006). Rainwater Harvesting - Need, Relevance And Importance Of Groundwater Recharge In Urban Areas With Particular Reference To Coastal Cities. Proceeding of International Workshop in Rain Water Harvesting, Kandy, Sri Lanka.

Shanthi de Silva (2005). Impact of Artificial Recharging of Groundwater with Rain water: a case Study in Kotewehera of Sri Lanka, *Lanka Rain Water Harvesting Forum, Sri Lanka.*

Thomas, T. and Rees, D. (2001). New technology for roof rain water harvesting. *Rain water harvesting Workshop, Indian Institute of Technology New Delhi, India.*

Weerasinghe P.A , Ariyananda T.N, Weeraratna, C.S. (2005). Rain water Harvesting for Home Gardens in Dry Zone of Sri Lanka. *Proceeding of XII IRSCA Conference, New Delhi, India.*

■