Chapter 3

Transforming tradition of rainwater harvesting in Sri Lanka

T. N. Ariyananda

Lanka Rain Water Harvesting Forum, Sri Lanka

Keywords: tank cascade system, rainwater harvesting, rainwater policy, disasters, climate change, health

3.1 INTRODUCTION

Sri Lanka is a tropical island of 65,000 sq.km located in the Indian Ocean and rain is the primary source of water. Sri Lanka has an average annual rainfall of 1800 mm which ranges from 900 mm in the dry zone to 5000 mm in the wet zone. The rainfall is bi-monsoonal and varies both seasonally and spatially. According to rainfall, the country is divided into three zones viz. dry zone, intermediate zone and wet zone. The dry zone covers nearly two thirds of the total land extent of the country, where the elevation is less than 300 m and receives an annual rainfall less than 1750 mm (Punyawardane, 2008) (Figure 3.1). Annual evaporation in the dry zone ranges between 1700 and 1900 mm which results in a soil moisture deficit during dry periods (Panabokke *et al*., 2002). Dry zone is characterized by a long dry spell (nearly eight months in some cases from Feb. to Oct.) and a short rainy season (nearly four months from Sep. to Jan.), during which 80% of the annual rainfall is received. The dry season in the dry zone is plagued by chronic and recurrent droughts and desiccating winds, while seasonal flooding dominates the rainy season. The water problem in the dry zone is further aggravated by the low water retention capacity of the unique soil group (reddish brown earth) which dominates most parts of the dry zone (Mapa *et al*., 2010).

Editor(s): José Arturo Gleason Espíndola, César Augusto Casiano Flores, Raul Pacheco-Vega and Margarita Rosa Pacheco Montes
doi: 10.2166/9781789060584_0041

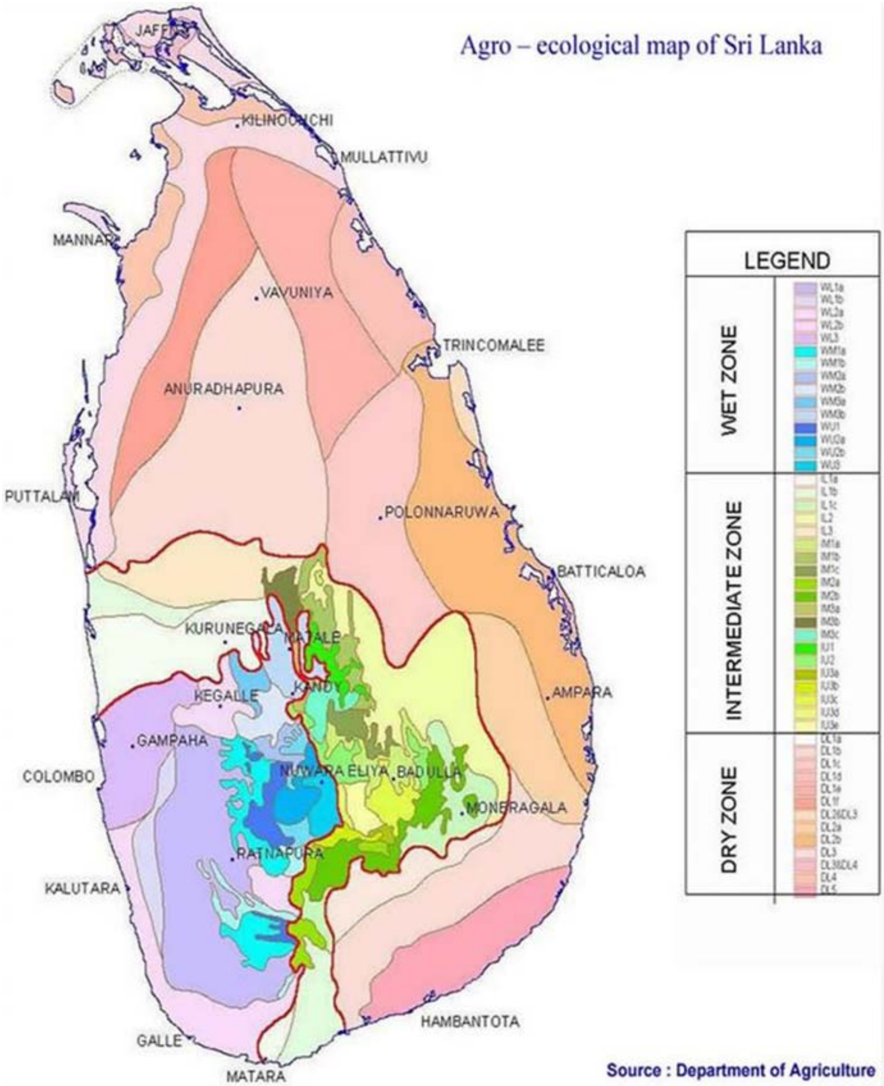

Figure 3.1 Agro-ecological map of Sri Lanka. (*Source*: Punyawardena B.V R. Bandara T.M. Munasinghe M.A.K. Banda. N.J (2003)).

Temporal and spatial disparities in annual rainfall led the ancient rulers of Sri Lanka to develop the tank cascading system (Figure 3.2). The main principle behind the Tank Cascade Systems (TCSs) is recycling and reuse of water through a network of small to large scale tanks. Brohier (1935) has also reported village

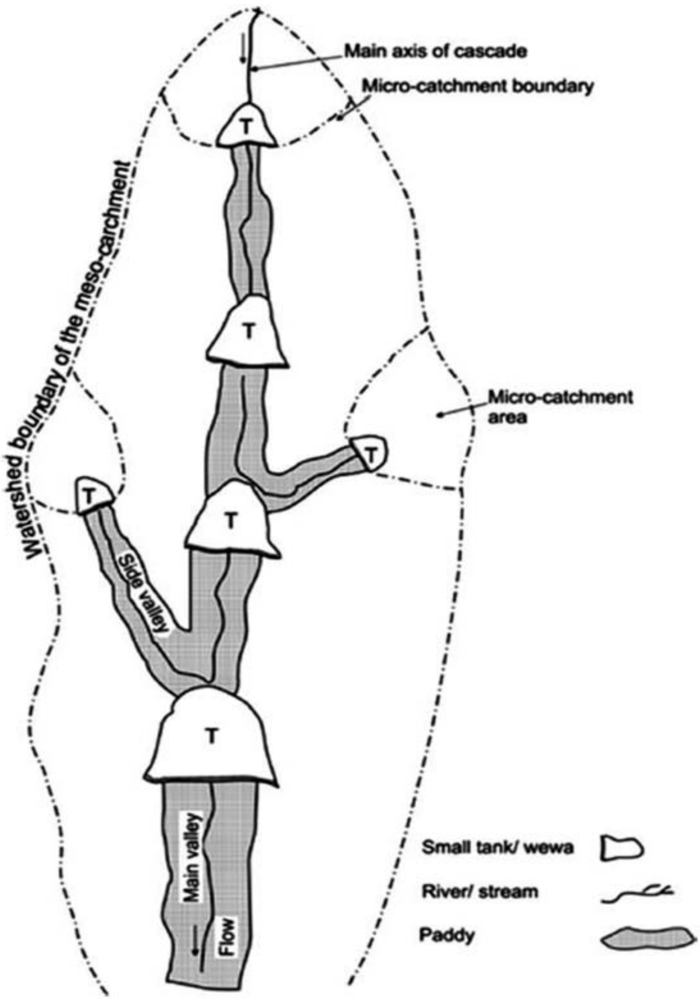

Figure 3.2 Schematic representation of a small Tank Cascade System. (Adapted from Panabokke *et al*., 2002).

tanks and their association with ancient irrigation works in Sri Lanka. Tank cascading system controlled the seasonal flooding and drought in the dry zone and also ensure the continuous cultivation of paddy during both rainy and dry seasons and provide a seasonal water supply for domestic and livestock consumption.

The first great reservoir of the world ever constructed was Panduwewa or Panda Wewa (1,360 acres) of Sri Lanka built by King Dappula II (807–812 AD) according to Henry Parker, a British colonial irrigation engineer (1873–1904) in British

Ceylon (1815–1948). There are around 30,000 such tanks or wewa (Figure 3.3) constructed in the dry zone from which the majority was built during 3rd–12th century BC. Our ancestors conserved water not only for irrigation and domestic purposes, but also for conservation of the environment, retention of soil moisture and maintenance of the water table. The famous quote of the Sri Lanka King, Parakramabahu the Great (1153–86 AD) that 'Let's not allow a single drop of water to flow into the sea without being used for the benefit of mankind' (Arumugam, 1969 quoted from Mahawansa), is an indication of the commitment of the ancient rulers and the people to conserve water and minimize the runoff. Further, use of rainwater by kings for landscaping and aesthetics is seen at the 5th Century rock fortress of Sigiriya (Figure 3.4) comprising man-made rainwater reservoir feeding the pools, ponds and fountains by means of an underground network of conduits.

There are many traditional domestic rainwater systems also reported and still in operation in Sri Lanka (Ariyabandu R D.S, 1998). They are: (1) tree trunk collection where rainwater is collected for domestic use from tree trunks using banana or coconut leafs specially in the hilly areas in the wet zone (Figure 3.5); (2) collection into pots and buckets where rainwater is collected during the rainy period by using the roof (Figure 3.6) or temporary collection surface such as cloth or sari tied between four poles and a pot kept in the middle; and (3) brick tank collection where an open square brick tank placed on the side of the dry zone houses collects water from the roof for use using temporary gutters.

Over the last 25 years, traditional rainwater harvesting has been revived to address the acute water shortage experience due to temporal and spatial variation in rain fall and climate change disasters and many research studies were conducted to improve the technology. In 19995 Community Water Supply and Sanitation project initiated by government of Sri Lanka with World Bank funds

Figure 3.3 Tank or *wewa* in North central Province. (*Source*: LRWHF, s.f).

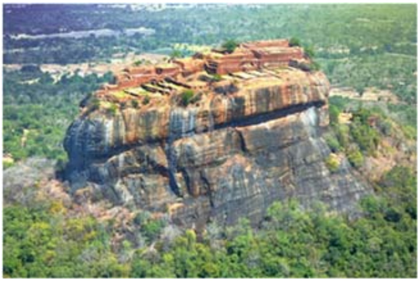

Figure 3.4 Sigiriya Rock Fortress. (*Source*: Tennakoon, Amila. *Sigirita Rock Fortress*. 2012. https://flic.kr/p/cVaSBo.

Figure 3.5 Rainwater collected from tree trunks. (*Source*: LRWHF, s.f).

Figure 3.6 Rainwater collected from roof top into containers. (*Source*: LRWHF, s.f).

introduced rainwater harvesting as a water supply option in two wet zone districts Badulla and Matara. Since then, government and non-government organisations throughout the country have promoted the technology. There has been a significant increase in the use of roof water harvesting in Sri Lanka, which has proved to be a boon to rural people, particularly for domestic water supplies in water scarce situations. As a result, presently there are estimated 42,000 domestic rainwater systems which has brought much relief to households during times of drought, floods, tsunami, chronic kidney disease of unknown etiology and resettlement for many people living in rural areas.

3.2 INSTITUTIONAL UPTAKE OF RWH

In 1992, the government of Sri Lanka initiated Community Water Supply and Sanitation Project (CWSSP) with assistance from the World Bank with an objective of providing affordable safe drinking water and sanitation facilities to rural community in three districts in the wet zone and hilly area of the country: Badulla, Matara and Ratnapura districts. During the implementation of CWSSP, it was clearly identified that several villages in Badulla district could not be served with available conventional water supply technology. For these uphill settlements, rainwater harvesting was thought to be a possible option to provide water with minimum cost.

The feasibility study on rainwater harvesting was conducted in 1995 (Hapugoda, 1995). The study, after much experimenting was able to design and construct two types of tanks that could be built within the financial limits of the project (in

Figure 3.7 (a) Constructing a ferrocement pumpkin tank. (*Source*: LRWHF, s.f). (b) Finished ferrocement pumpkin tank. (*Source*: LRWHF, s.f).

1995, US$100). One tank made of ferrocement, has the shape of a pumpkin (Figure 3.7a, b) and is unique to the project. The second tank is built under ground and is an adaptation of the Chinese style biogas pit, using a simple, low cost technique to do the dome roof.

The special feature in the ferrocement pumpkin tank is the skeleton mould made of eight or ten 'T' iron legs and a 6 mm re-enforcement bar. At the end of construction both the legs and the 6 mm bar are removed leaving a pumpkin-shaped tank (so far tanks can be made up to 10 cubic meters) made of 40 mm thin wall reinforced only with two layers of 12.5 mm chicken mesh.

Initially there was a great deal of protest to the project due to misconceptions of rainwater harvesting. A petition was also submitted to the Minister in charge of water supply. However, after the successful demonstration of one pilot project in a village called Dematawelihina in Badulla district, there were 146 applications from the village. Since then there has been 5350 rainwater tanks constructed in the Badulla district.

Since the initiation of the CWSSP, a number of organizations and institutions have adopted rainwater harvesting as a means of supplying water to water scarce households in both the wet and dry zones. Some of the noteworthy contributions in rainwater harvesting for domestic use have been made by: the Southern Development Authority; the Dry Zone Development Project funded by IFAD (International Fund for Agricultural Development); National Water Supply and Drainage Board (Chronic Kidney Disease Project, 3rd and 4th ADB Water and Sanitation projects); and the 2nd CWSSP project.

3.3 LANKA RAINWATER HARVESTING FORUM

The CWSSP project initiated the emergence of the Lanka Rain Water Harvesting Forum (LRWHF), which is an NGO actively engaged in promoting rainwater harvesting in the country. In early 1996, a small group of persons interested in rainwater harvesting, who aspired to organise a network to pool and share the experience of the country, came together to form the Lanka Rain Water Harvesting Forum (LRWHF). The group consisting of members from government, non-government, research and private sector organisations placed advertisements in the local papers (local languages) to gather interest and experience in the country. With the encouraging response received from the public the group considered its role and potential in promoting the use of rainwater harvesting and established itself with the following objectives:

- Identify existing rainwater harvesting practices in the country
- Develop further techniques for collection of rainwater
- Promote the application of rainwater for domestic purposes through information, communication, and awareness raising
- Initiate further studies to make recommendations for maintaining good rainwater harvesting practices.

During the last 23 years LRWHF has actively promoted the concept of rainwater harvesting in all districts through demonstration projects, awareness programs, training, research and development, and networking. A large number of masons (500) and professionals/officials (around 400) were trained in design, planning and construction of rainwater harvesting systems in many districts. Awareness programs conducted by the Forum in the villages, media as well as in the form of seminars created much public and official interest in rainwater harvesting. Forum also conducted research studies to improve on the present technology and to study water quality and water user patterns of the rainwater-harvesting units. Information generated by these studies is disseminated through seminars and web site.

3.4 RAINWATER POLICY AND REGULATIONS IN SRI LANKA

As a result of influencing and lobbing carried out by LRWHF, in 2005 the Hon. Minister for Water Supply and Urban Development appointed a committee to formulate a national policy on rainwater harvesting and strategies. LRWHF members played an active role in formulating the national strategy and policy on rainwater harvesting. Public as well as government ministries and other relevant authorities were invited to comment on the draft policy and make suggestions to improve it. In June 2005, the government of Sri Lanka passed the world's first national policy on rainwater harvesting (National Rain Water Harvesting Policy and Strategy, 2015). The policy objective is aimed at encouraging communities to control water near its source by harvesting rainwater. This resulted in: minimizing the use of treated water for secondary purposes; reduction of flooding; improving soil conservation and groundwater recharge; providing water for domestic use with adequate treatment; agricultural benefits and reduced energy consumption.

This policy document, states the required legislative changes needed to amend the Urban Development Authority (UDA) and Road Development Authority (RDA) by laws on drainage and National Water Supply & Drainage Board (NWSDB) by-laws to incorporate harvesting rainwater as a source of domestic water. The regulation has been gazetted on the 17th April 2009, which makes rainwater harvesting mandatory in certain categories of new buildings (and old building after 3 years) in areas under municipal and urban council jurisdiction (Urban Development Authority Act, 2009).

3.5 PROVIDING WATER AND FOOD SECURITY FOR COMMUNITIES AT TIMES OF DISASTER

During the tsunami of 26th December 2004 an estimated ten pipe-bourn water schemes and 50,000 house connections were damaged. In addition, it is estimated that nearly 40,000 wells (60%) were contaminated bacteriologically and with salinity (Saltori & Giusti, 2006). Therefore, the people living in these areas faced serious problems in fetching quality water for domestic use. Especially since the bowsers supply of water by the donor agencies and government was also soon diminished.

LRWHF implemented a project to introduce rainwater harvesting systems (RWHS) in households, schools and institutes in three of the tsunami affected districts in the southern and eastern coastal areas in Sri Lanka. Around 4000 rainwater-harvesting units have been built for the tsunami reconstructed houses in two districts in the south and one district in the east. RWH systems significantly addressed the shortage of domestic water at household levels by providing easy access to clean drinking water, less time spent on collecting water, skilled enhancement in the village, less reliance on external water providers, more water security at household level and better sanitation practice due to more water being available. The system also supported the improvement and maintainance of a home garden of the newly resettled community, thus providing livelihood and improving food security (Figure 3.8).

Government policy and support has also encouraged the uptake of rainwater harvesting in the tsunami reconstruction process. Ministry of Urban Development and Water Supply incorporated rainwater harvesting in the design of tsunami reconstructed houses, which was an essential requirement in a standard tsunami house.

In 2009, after the end of 30 years of civil war in Sri Lanka, the communities resettled either in their own homes or in newly built homes in the Northern Province. Ground water is the main source of potable water in most of this area, which is been over exploited or polluted due to excessive use of fertilizers. In 2011, LRWHF with the support of USAID introduced a program to install RWH systems in 850 households, 31 schools and 5 hospitals. Home garden development and plant nursery centers were also introduced during this project.

Figure 3.8 Home gardening with RWH. (*Source*: LRWHF, s.f).

The program has helped communities in the former northern conflict zone return to normalcy as quickly as possible through restoration of water sanitation and hygiene, food security and livelihoods.

3.6 CLIMATE RISK RESILIENCE

During the last few years, the frequency of climate disaster occurrence in the country has caused water stresses to people in almost all districts due to drought and floods. Heavy rainfall, floods and long droughts are frequent occurrences and have increased significantly over the past ten years, leading to Sri Lanka being positioned second in the recent ranking based on vulnerability to climate change (Global Climate Risk Index, 2019).

Lanka Rain Water Harvesting Forum in partnership with USAID constructed rainwater harvesting systems in households (360), schools (45) and hospitals (10) in the drought and flood prone areas in the Northern Province and Uva Province of Sri Lanka. It has been reported that during the drought and floods in recent years these households and institutes installed with rainwater harvesting systems were able to cope better. During the droughts experienced over 2017–2018, households which had rainwater collected and stored were better off since they had readily available water at home. In 2018, during floods in Kilinochchi district when the surface water sources and well water were contaminated, the only clean water source that was available to the community was the rainwater harvesting tank. Through this project disaster risk reduction measures and tools have been introduced to local communities. More than 10,000 persons are provided with access to safe drinking water through RWH.

Figure 3.9 RWH systems constructed in schools. (*Source*: LRWHF, s.f).

RWHS built in schools, which function as flood shelters, provide water to the people until government aid can reach them (Figure 3.9). Around 100 RWHS were constructed by LRWHF and maintaining groups are set up with students, teachers and parents as a sustainability measure. A manual for operation and maintenance of RWHS in schools was published by LRWHF with collaboration of PLAN SL and National Water Supply & Drainage Board to provide practical solutions and guidance for school teachers, parents, caretakers and students for operation and maintain RWHS to ensure long term sustainability.

Lanka Rain Water Harvesting Forum, recognizing the importance of knowing about the day to day weather data by the community in order to prepare for extreme events, has made available weather stations in 12 remote schools in eight districts of Sri Lanka. Low cost solar-powered mobile weather stations have been developed by International Water Management Institute (IWMI) in collaboration with Moratuwa University which measure weather data such as temperature, rainfall, wind direction, wind speed, pressure and humidity. The weather stations are established in schools to build awareness among school children about weather and weather changes. LRWHF has trained school children on how to operate and maintain these weather stations. The weather data is shared with all students and teachers in the school through the display boards provided. The data, which play an important role in the daily lives and livelihoods of rural community members previously not accessible by the community, is now provided at their fingertips. This information is communicated to the community through SMS or mobile application to be better prepared for these crisis situations. The data collected is also fed into a wunderground web site (https://www.wunderground.com/) which also gives ten-day weather prediction. This data can then be used for decision making in regular water resource management and other climate-related application including helping to avoid crises situation, such as droughts and floods. The schools installed with mobile weather station are able to better manage the water in the rainwater harvesting tank by knowing about the rainfall patterns in the area. This will help them to conserve during the dry periods and to use up tank water before the rainy season.

3.7 IMPROVING HEALTH

An alarming and new form of chronic kidney disease of an unknown origin (CKDu) has been reported in several areas of Sri Lanka. The total number of affected individuals is estimated to be around 70,000, and reports a death toll of 20,000 so far (Edirisinghea *et al.*, 2017). Despite many studies conducted, the causal factor of this disease is still uncertain (thus 'u' in CKDu). There is widespread consensus among scientists that improving the quality of drinking water in these areas may prevent, or retard the progress of this kidney disease.

Survey of RWH system constructed in households with CKDu patients reports that conditions of patients at early stage of CKDu either remains the same or has reversed by drinking rainwater (LRWHF, 2016). However, it is yet to be clinically proven. High demand for RWH from people in these areas is evidence of the anxiety to obtain clean drinking water.

A study conducted in North Central Province where most CKDu patients have been recorded, indicated that harvested rainwater quality was better (bacteriologically and chemically) compared with well and reservoir water tested (Aioma, 2018). A recent survey recorded that 52.8% of households with CKDu patients drink rainwater (UNDP, 2018).

3.8 RUNOFF COLLECTION FOR CROP GROWTH

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

Lack of a dependable water supply is a major limiting factor in attempts to develop the rural sector. From the total rainfall, on average around 60% of rainwater is lost in the form of surface runoff and conserving this water will promote crop growth in areas where water is limited.

In some parts of the dry zone, small ponds called 'Pathahas' have been used traditionally to collect and store rainwater (Figure 3.10). Such a water collecting system on a farm has enabled farmers to cultivate crops during the dry seasons. These ponds vary from 300 to 500 m^3. Usually ponds are constructed in a valley, at the bottom of the cultivated land to facilitate the gravitational flow of runoff water via contour drains towards the ponds for collection. Harvested water is lifted out of the pond manually by use of a bucket or using pedal and kerosene pumps.

Figure 3.10 Garden pond or ‘pathahas’. (*Source*: LRWHF, s.f).

Studies have shown that collection of runoff water can be used for agriculture as well as to improve the ground water levels both qualitatively and quantitatively. A study was carried out by LRWHF in Kurundamkulama (a village in Mihintale in Anuradhapura District to harvest/collect runoff rainwater in a 5 m^3 underground tank enabling the farmers to cultivate a crop during Yala (lesser rain season). As a result, the incomes of the families in the study area increased substantially (Weerasinghe *et al.*, 2005). Collection of runoff rainwater in this manner not only conserves water but also reduces soil erosion and degradation of the land.

Another study conducted by LRWHF in Nikaweratiya (de Silva, 2005) has shown that collecting rainwater in ponds or pathahas, as in the ancient systems, elevates the ground water level by allowing the water to percolate into the ground, thus, increasing the quantity of water available for both domestic and agricultural use even during the dry season.

3.9 CONCLUSION

Rainwater is a valuable resource, which should be exploited in the most efficient way. In order to achieve SGD6 of universal access to safely managed water by 2030, rainwater harvesting is a must in Sri Lanka and many other South Asian and African countries. Rainwater harvesting can also facilitate achieving seven more of the 17 goals, namely: SDG1 (No Poverty), SDG2 (Zero Hunger), SDG 3 (Good Health and Well-being), SDG5 (Gender Equality), SDG 8 (Decent Work and Economic Growth), SDG11 (Sustainable Cities and Communities) and SDG13 (Climate Action). Governments should promote and implement rainwater harvesting policy to encourage rainwater harvesting for human consumption and domestic use, to protect the people’s health and livelihood, ensure good utilization and conservation of water resources, adapt for climate change disasters and facilitate guidance and capacity building.

REFERENCES

Aioma G. V. N. (2018). Rain Water as a Source of Safe Water in Northern Central Province. International Conference on Water Security through Rain Water Harvesting, LRWHF, Colombo, Sri Lanka.

Ariyabandu, R. de S. (1998). Study of existing rainwater harvesting technology prepared for the Lanka Rainwater Harvesting Forum, unpublished.

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

Brohier R. L. (1935). Ancient Irrigation Work of Ceylon (Sri Lanka), 1st ed. (Translated by Piyasena L.) Mahaweli Center, Mahaweli Authority of Sri Lanka, Colombo.

de Silva S. (2005). Impact of Artificial Recharging of Groundwater with Rainwater: a Case Study in Kotewehera of Sri Lanka, Lanka Rain Water Harvesting Forum, Sri Lanka.

Edirisinghea E. A. N. V., Manthrithilake H. and Pitawalac H. M. T. G. A. (2017). Geochemical and isotopic evidences from groundwater and surface water for understanding of natural contamination in chronic kidney disease of unknown etiology (CKDu) endemic zones in Sri Lanka. *Isotopes in Environmental and Health Studies* 2017 https://doi.org/10.1080/10256016.2017.1377704 (accessed 15th July 2019).

Global Climate Risk Index. (2019). David Eckstein, Marie-Lena Hutfils and Maik Winges, Germanwatch e.V, www.germanwatch.org/en/cri, www.germanwatch.org/en/cri (accessed 15th July 2019).

Hapugoda K. D. (1995). Action Research Study on Rain Water Harvesting. Project Report 2. CWSSP, Ministry of Housing and Construction. Sri Lanka.

LRWHF. (2016). Survey of rainwater harvesting households with CKDu patients in Mahakachchakody, Vavuniya District 2016. Lanka Rain Water Harvesting Forum, Sri Lanka.

Mapa R. B., Somasiri S. and Dassanayake A. R. (2010). Soils of the Dry Zone of Sri Lanka; Morphology Characterization and Classification. Soil Science Society of Sri Lanka, Peradeniya, Sri Lanka.

National Rain Water Harvesting Policy and Strategy. (2015). Ministry of Urban Development and Water Supply, Sri Lanka, www.lankarainwater.org/rwhsl/nrwpolicy-2005.pdf (accessed 15th July 2019).

Panabokke C. R., Sakthivadivel R. and Weerasinghe A. D. (2002). Evolution, Present Status and Issues Concerning Small Tank Systems in Sri Lanka. International Water Management Institute, Colombo, Sri Lanka.

Punyawardena B. V. R., Bandara T. M., Munasinghe M. A. K. and Banda N. J. (2003). Agro Ecological Regions of Sri Lanka. Department of Agriculture, Sri Lanka.

Punyawardane B. V. R. (2008). Rainfall in Sri Lanka and Agroecological Zones (Sinhala Version). Department of Agriculture Press, Peradeniya, Sri Lanka.

Saltori R. and Giusti A. (2006). Challenges of tsunami and conflict affected rural water supply in Sri Lanka. 32nd WEDC International Conference, Colombo, Sri Lanka, 2006.

UNDP. (2018). Survey on the Perception of Users of Rain Water Harvesting Systems in the Seven Project Districts, Climate Resilient Integrated Water Management Project, Lanka Rain Water Harvesting Forum, Sri Lanka.

Urban Development Authority Act, Extra Ordinary Gazette No. 1597/08 on 17-04-2009 of Social Republic of Sri Lanka, http://lankarainwater.org/wp/?page_id=72 (accessed 15th July 2019).

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