MILESTONE REPORT D3

CURRENT RURAL WATER SECURITY PRACTICES WITH DRWH

Programme 'Domestic Roofwater Harvesting in the Humid Tropics'

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CURRENT RURAL WATER SECURITY PRACTICES WITH DRWH

1. Introduction

The Domestic Roof Water Harvesting study, supported by the European union has been in operation since August 1998. The study itself has four research components, Low cost Rainwater harvesting technology, Health Aspects, Institutional Aspects of Rainwater Harvesting for domestic use and household water security using domestic roof water harvesting. The household water security research component is the responsibility of the Lanka Rainwater Harvesting Forum (LRWHF). Each research component has its own milestone reports to denote the completion of specific tasks assigned for a specific period. The household water security component has six milestone reports, of which the last milestone report is a book entitled "Domestic Roof Water Harvesting: Prospects and Problems in the Humid Tropics". Since the beginning of the study, two milestone reports have been completed and the present report is the third in the series of six milestone reports.

This reports entitled "Current Rural Water Security Practices with Domestic Roof Water Harvesting" illustrates the water use practices of different rural communities in Sri Lanka. The report highlights, water use practices of rural communities from the Southern Dry Zone, intermediate zone and southern wet zone. All communities selected for the study use roof water (rainwater) as a supplementary, partial sources of rural water supply for household needs. Information on water use from these communities have been generated through systematic field studies conducted over a period of 3 - 12 months in these locations.

This report also contains the development of the household water security model which was started during the milestone report No. 2. As this is the first attempt to establish a household water security modes, work progress on this aspect has been slow, mainly because it has been a learning process for the researches involved in the study. Though work on the model is still progressing, what is presented in this report is an advancement from the presentation given in the milestone report two. While most of the basic work on establishing water use ratings are completed, this report presents on an attempt made to establish weights for different responses given by households. These responses focus on the degree of convenience in getting adequate water, availability of water and quality of water that are used by rural households.

Water use rating when expressed to the power of the weights obtained for each activity gives an approximate water security value for a particular activity (i.e drinking or cooking water). Summation of water security values for different activities would give the total household water security. The value of water security could change depending on the season even within the same household.

1.1 Rural Community

Rural community in Sri Lanka comprises nearly 70% of the population of 18.6 million. Predominately, the rural population is engaged in farming as an occupation. This too is mainly confined to paddy farming, as the staple food of the country is rice. From the total land area available for cultivation, 57% is agricultural land 37% is forest and scrub land and only 0.45% is non-agricultural land. (Sri Lanka water vision 2025). Most of the land used for agriculture is rainfed land without using surface or ground water for cultivation. 20% of the rainfed land is used as chena (slash and burn) cultivation, mostly in the dry zone. Suitability of this land for shifting cultivation has reduced the islands forest cover from 40% to 27% during the past 50 years. (Dias 1999). Irrigated land occupies 24% of agricultural land. Paddy is the main crop cultivated under irrigation, which accounts for 70% of irrigated land.

Village settlements in the dry zone are mostly located near or around reservoirs mainly due to the availability of irrigation water for the paddy crop and secondarily due to assured availability of water for domestic use. In the wet zone village settlement pattern is not purely based on irrigation facilities mainly due to adequate availability of rainfall and absence of reservoirs to the same degree in the dry zone. While the countries overall population density is estimated at 350 persons per sq: km., the population density of the wet zone is much higher than the dry zone. This invariably has forced wet zone settlements to move further away from town centers, where basic infrastructural facilities are minimum or not available. Increasing population density in the wet zone is mainly due to its geographic location in the country where much of the economic activities are concentrated. On the other hand, the sparsely populated dry zone too lack basis infrastructural facilities be it the town centers or peripheral areas.

Therefore rural communities living in both climatic zones in Sri Lanka lack basic infrastructural facilities, thus effecting quality of life. In Sri Lanka, 11% of the total population is entitle for the Samurdhi benefits. (Government handout scheme for those earning less than Rs. 1500 per month). It is this population that is vulnerable to social and economic stresses due to lack of basic facilities. While most of the basic facilities are lacking in rural areas, this report will concentrate on availability of water supply facility to this vulnerable group. Available statistics suggests that 14% of the rural population is served with pipe water supply, 11% by tube wells, 40% by protected dug wells and 35% by other sources. (Water Resource Council 1999). "Other Sources" of water supply as mentioned here refers to natural springs, lakes, streams and small reservoirs. Besides large lakes, all other sources in this category are subjected to depletion and total drying-up during the dry season. While the above categorization is based on availability of water by source and percentage access by population, the total coverage of safe drinking water in rural areas in only 57% (Central Bank Annual Report 1998). This emphasis the need for further expansion of water supply facilities to the rural areas in order to improve the hygienic conditions of rural population.

1.2 Climate and Weather Pattern

As stated earlier, Sri Lanka receives an annual average rainfall of 1200 mm with a range of 500 mm to 6000 mm. Hence, there is abundance of rainfall for both agriculture and domestic use. However much of this rainfall occurs during October to

March. In the dry zone, 75% of the rainfall is received during this period with 70% between October and December. In the wet season, however, there is even distribution of rainfall between the wet/dry seasons. On the demand side, 96% of the water is withdrawn for agriculture, mainly for paddy cultivation most of the available paddy lands are in the dry zone were the water supply is limited to few moths a year. While 44% of the 1991 population of 17% million lived in the dry zone, the majority living in the wet zone had to survive with limited water which is shared between, domestic and industrial use. Thus, the seasonal and spatial variation in water supply creates a sever deficit among the heavily populated wet zone settlements and also among sparsely populated dry zone rural communities.

Sri Lanka's weather pattern can be mainly categorised into four sections. Two monsoon seasons and two inter monsoonal period. South West Monsoons bring rain from May to September and the rainfall ranges between 500 mm - 4000 mm.

North East Monsoons bring rain from December to February and rainfall ranges between 500 mm - 2500 mm.

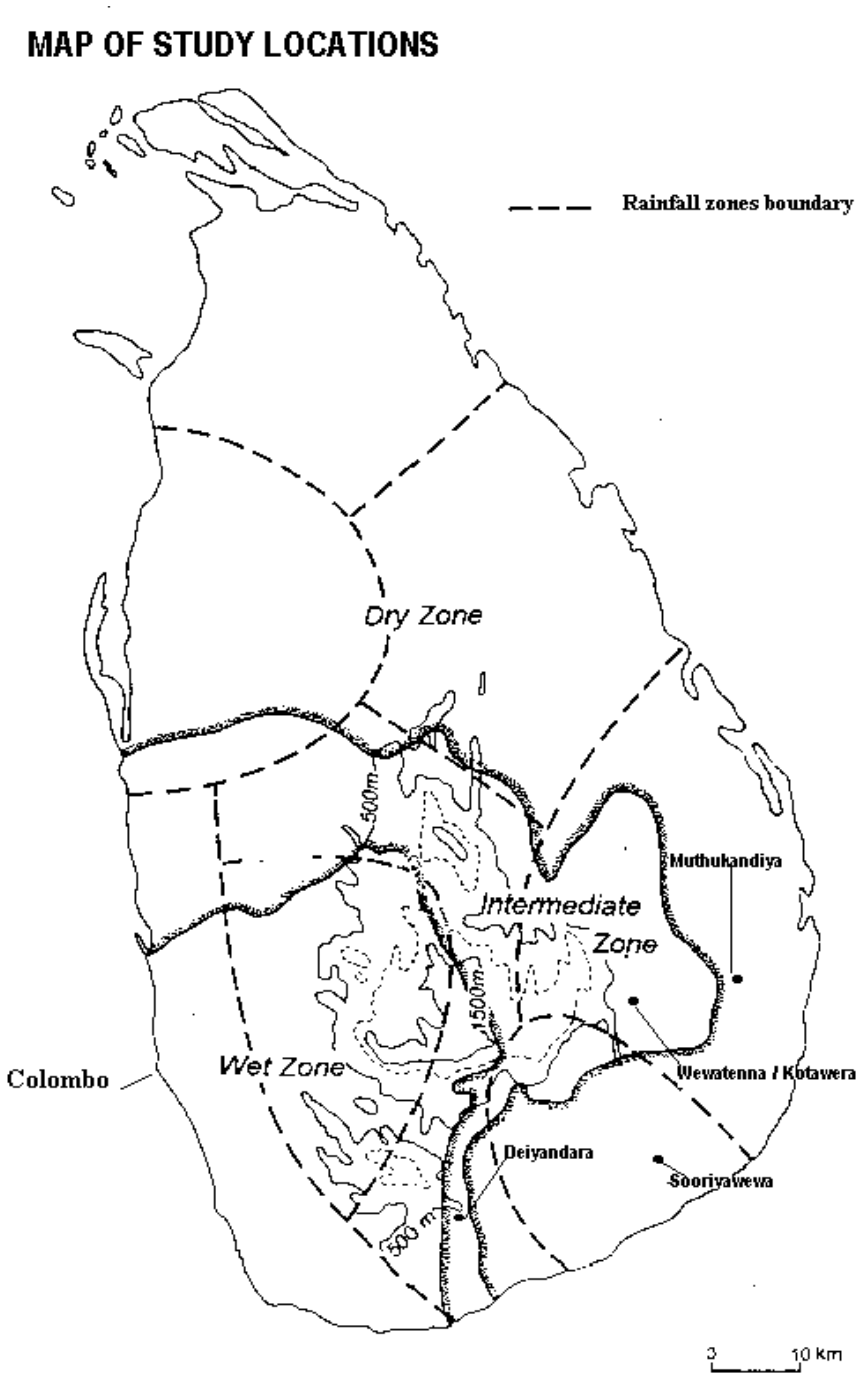
1st Inter monsoonal period is from March to April brings about 5 - 30% of annual rainfall.

2nd Inter monsoonal period is from October to November and bring widespread rainfall through out the country, mainly due to disturbances in Southwest bay of Bengal and south - East Arabian Sea.

According to the climatalogical classification of Sri Lanka, the present study locations falls into the following categories.

Muthukandiya	-	Intermediate mid country	($I M_2$) RF > 1150 mm.
Sooriyawawe	-	Dry zone low country	(DL_1) RF > 775 mm.
Badulla	-	Intermediate mid country	(IM_1) RF > 1400 mm.
Matara	-	Wet zone low country	(WL_1) RF > 1900 mm.

The first two study locations are in the southern dry zone and the last two locations in the central and southern wet zone. In all four study locations ground water aquifers are productivity but moderate to low recharge. Temperature in all study locations vary from 25.0 ^{0}C to 27.5 ^{0}C. However, in months of April, May, June and July the temperatures in Muthukandiya and Sooriyawawe rises beyond 27.5 ^{0}C. Rural communities in the two locations face acute water shortages during this period.



(Adapted from Chandrapala, 1996)

1.3 Water Use Pattern of Rural Communities

Water is an essential commodity for all living beings. Therefore, people, irrespective of caste, creed and ethnicity will attempt to satisfy their water needs. Those who are fortunate and live in countries or localities where there is abundant of precipitation spend less energy and time to satisfy their water needs while those who live in the dry and arid areas have to spend more energy and time to satisfy their water needs. Hence, the former community of people are relatively more water secure than the latter community. Thus, water security is a relative term. Therefore, what we are

attempting to understand is the water use behavior of different communities in Sri Lanka living in varying environmental conditions.

Most people in rural Sri Lanka are not supplied with pipe borne water. However, the state has always attempted to provide safe drinking water to rural communities through tube wells, dug wells and spring water gravity schemes. State sponsored water supply programmes are supported by foreign multilateral and bilateral donors. However, with all the efforts taken from 1980's (beginning of the water decade), still about 42% of the rural population are without any access to safe drinking water. Even those people who has access to safe water often encounter difficulties in securing adequate water during the dry season. Therefore what matters most for rural communities is availability of water when they need it and in adequate quantities to satisfy basic human needs. In Sri Lanka rural communities in the dry zone are blessed with a large number of small and large reservoirs which store water for agriculture. However in dry seasons most of the small tanks run-dry forcing people who depended on these reservoirs to look for alternative water sources for domestic use. In the wet zone, though there are fewer reservoirs, the rainfall is more widespread and water holding capacity of the soil is greater. Hence, dug wells are often used as domestic water supply sources. Besides, natural streams and water falls also function as water supply sources. Apart from a very few households who are supplied with pipe borne domestic water from natural springs, the rest have to fetch water from either public/private dug wells, tube wells, stream/lakes or reservoirs. The following description illustrate the pattern of water use for domestic purpose in the four study locations.

2. Water Security Practices in Domestic Water Use

2.1 Village	-	***Sooriyawawe***
Location	-	Southern dry zone
Climate	-	Low rainfall, high temperature
Ground water	-	Poor, Saline

Sooriyawawe is a village located in the Southern dry zone classified as one of the most difficult areas for people to live due to poor infrastructure facilities and low water availability (low rainfall). People in this area use dug wells both public and private (public are those built by the government for domestic purposes, private are those belonging to individuals), tube wells and small and medium tanks (reservoirs). People use all these sources or select a few depending on the requirement and convenience.

2.1.1 Distance to fetch water

As most of the ground water available are saline in natural, people have to search for water sources that are suitable for domestic use. In Sooriyawawe, most people use the tube well constructed by the state to fetch water for uses other than drinking and cooking. As tube well water is saline, it can not be consumed or used for cooking. However, the tube well too breaks down frequently due to heavy use by the community. (165 Families). For repairing the tube well, the community collects Rs. 25.00 from each family to get the services of the government technician attached to the water supply board.

Depending on the dispersion of the village community people have to walk between 25 - 200 meters to reach the tube well. However, during the dry season (May - August) people have to walk between 800 meter to 5 km to fetch domestic water. During this time most dug wells and the tube well run dry forcing people to travel long distances to collect water.

People in Sooriyawawe use small to medium reservoirs for bathing. During the wet season they use the small reservoirs nearby for bathing purposes. Depending on the location where they stay, they may have to travel between 50 - 300 m to the reservoirs. However in the dry season these reservoirs dry up or the “dead storage” of the water is unfit for bathing due to the growth of green Algae. The growth of green Algae during the dry season is promoted by cattle waste that gets washed into the reservoir from cattle ranches up stream of the reservoir. During this time people have to walk 2 - 3.5 km for bathing. Frequency of bathing also reduces to about 2 - 3 times a week during the dry season.

2.1.2 Time Taken for Collecting Water and Bathing

Depending on the distance time taken to fetch water for domestic use vary from 10 minutes to about 90 minutes, if the distance is about 3 km. The time of fetching can increase if there are lot of people at water points. Time taken for bathing depends on the mode of transport and amount of cloths to wash.

Usually people wash cloths when they bathe. Hence, the time can vary from 1 -3 hours. If people use bicycles it may taken about 1 ½ hrs, by motorcycle 1 hr, by two wheel tractor 3 hrs and by bullock driven cart about 3 ½ - 4 hrs. Depending on the ownership of mode of transport people pay about Rs. 5 per passenger when they go by tractors.

2.1.3 Containers Used in Collecting Water

People use two types of containers in fetching water. Pots (10-12 liters) are mostly used by women to bring water from short distances (less than 1 km). Jerry cans are the other type of containers used to bring water. These cans can vary from 20 - 45 liters. Jerry cans are more popular with men as they have to bring water from distant places in either bicycles or motorcycles. In both modes of transport Jerry cans can be tied to the vehicle. Jerry cans are preferred because they are easy to carry, easy to transport and water waste on transport is minimum.

2.1.4 Types of Water Transport

Most common way of transporting water is by physically carrying water by women. This is done in the wet season when water is available close by. In the dry season people use bicycles, motorcycles, two-wheel tractors, bullock carts to transport water. When bullock carts are used to transport water to house located in hilly areas or where the road conditions are poor, people have to refill water from drums (200 liters) brought in carts to small containers at household level.

2.1.5 Water Carriers

Water carriers in households vary with distance to carry water. From short distances (less than 1 km) it is usually the women and young girls who carry water. When the distance is more than 1 km it is the responsibility of men and young boys to fetch water. If people have to hire somebody to bring water they pay Rs. 5 per trip to collect water. When men have to leave the house in the dry season they bring more water to compensate for their absence from the house. However, if they do not return back on the schedule day, the women would borrow water from a near by house for home use. Hence, there is a kind of water culture among this community for mutual survival in difficult situations.

Water is usually brought in the mornings and evenings. If water is available within 500 meters, people may also bring water in the nights depending on the need. People always fetch water in the morning when they have to bring water form long distances. They use tractors and bullock carts only twice a week to bring water.

2.1.6 Use of Rainwater for Domestic Use

While dug wells, tube wells and reservoirs are the main sources of water for most households, some of them collect rainwater during the rainy season. As rainwater is a secondary source of water, its collection is not systematic. During the wet months (December - February) people use 200 liter drums, household utensils, and some have permanently constructed rectangular tanks of 400 - 2000 liter capacity, collecting roof run-off. As rainwater is the non-premium water, maintenance of storage tanks are also poor. These tanks are usually kept open, hence, they are subjected to contamination, some leak due to poor construction and upkeep. People use different types of gutters on the roof to collect roof run-off. Most people use tin sheets of

different lengths as gutters. Most of these gutters are corroded and unclean. The roof coverage varies from 20-80% of the roof. During the rains, these people use a first flush for about 10 - 15 minutes. Also they strain rainwater with a piece of clean cloth before they use it for any premium use (i.e cooking). While this system of rainwater collection improves the water security situation with an additional supply, it only lasts for a few days or 1 - 2 weeks at maximum due to poor storage of harvested rainwater. Therefore, enhanced water security also lasts for a short period.

2.1.7 Introduction of Systematic Rainwater Harvesting and Improving Water Security

As described in the preceding section, the Sooriyawawe community had to toil hard to satisfy their domestic water requirement. In 1997, six village households were selected by a local NGO to be beneficiaries of a rainwater harvesting program. These householders were given rainwater harvesting units on a 50% subsidy 50% equity basis.

Though the storage tanks and the rainwater harvesting systems were completed by the first half of 1998, it took almost one year for people to accept rainwater as another source of domestic water. During the initial one year, people used collected rainwater for toilet use, gardening and washing kitchen utensils. The main reason for this situation is the cement taste of stored water and the fine film of cement dust visible on the surface of the water. The reason for this situation is the inadequate replenishment of tank water. In Sri Lanka this situation is common in the dry zone where rainfall is limited to 2 - 3 months a year. Under this situation people do not prefer to wash their new tanks as often done by their counter parts in the wet zone.

While water use in the dry zone is also limited due to stringent water management, collected water stagnates for a longer time, thus the cement taste and colour lasts for a longer time than in the wet zone. By the end of 1999 with the on-set of the monsoon rain, people have fully accepted rainwater as another source of water and come to terms with all its positive and negative aspects.

As survey conducted in January, 2000 in Sooriyawawe reveals the following situation.

All rainwater harvesting units were fully completed, with proper standardised guttering and down pipes. Proper water filters were installed at the entrance to the storage tank and a cloth filter was used between the gutter and down pipe. All households practiced first flush systems and the tanks were covered with standard concrete covers. 50% of the householders used water pumps to extract water from underground strong tanks while the rest used buckets to fetch water. Four out of the six householders used stored rainwater for drinking. The reasons attributed for drinking rainwater were;

a) Saline water in the only tube well in the area
b) Too far away to the tube well
c) Easy access
d) Good to drink
e) Not saline

Reasons for not drinking stored rainwater were;

a) Due to unclean roof
b) Due to the presence of alligators and rats on the roof.

Use of rainwater as against water from other sources are given in table 1. This table suggests that except for one household most others use rainwater for drinking which has improved their drinking water security prior to using rainwater. Though they collected rainwater even prior to rainwater tanks, management of such water was poor, thus, they were not used for drinking, with the new technology, quality of rainwater has improved due to use of filters and better management.

Table 1 : Drinking Water Usage by Sooriyawawe Community (liter/day)

	Rainwater					**Water from Other Sources**				
Households	1	2	3	4	5	1	2	3	4	5
wet season	-	24	12	36	6	15	-	-	-	-
Dry Season	-	24	12	24	6	20	-	-	24	6

Source : Survey data 2000

Priority of rainwater use at household level suggest that four household consider drinking as the first priority and cooking as the second priority table 2.

Table 2 : Household Prioritization of Rainwater Use

Household No. / Water Use / Activity	**1**	**2**	**3**	**4**	**5**
Drinking	**-**	**1**	**1**	**1**	**1**
Cooking	**1**	**2**	**2**	**2**	**2**
Personal Washing	**2**	**-**	**3**	**-**	**-**
Toilet Use	**3**	**-**	**3**	**3**	**-**

Source : Survey data 2000

Most householders believe that the quality of rainwater is good enough to consume even without boiling during the wet season. This is mainly due to quick replenishment of water during this season. During the dry season people prefer to boil and drink as they believe that water loses its quality in stagnation. Table 3.

Table 3 : Quality Perceptions of Rainwater by Households

Household No. / Quality Perceptions	Wet season					Dry season				
	1	**2**	**3**	**4**	**5**	**1**	**2**	**3**	**4**	**5**
- Not suitable for drinking poor quality	**X**	**-**	**-**	**-**	**-**	**X**	**-**	**-**	**-**	**-**
- Poor quality but can be consumed after boiling	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
- Good quality but can't be consumed without boiling	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**X**	**-**
- God quality can be consumed without boiling	**-**	**X**	**X**	**X**	**X**	**-**	**X**	**-**	**-**	**-**

Source :Survey data 2000

People have also experienced mosquito larvae during the dry season. This could be due to two reasons.

a) Due to poor maintenance of gutters or faulty tank covers.
b) During low water situations in the dry season mosquito larvae becomes more visible.

In the above case in Sooriyawawe, the second reason appears to be cause of mosquito larvae. With respect to adequacy of household water, four out of the five household beneficiaries believe that their rainwater tanks provide adequate water to manage the dry period from June to August. However, people do not depended totally on rainwater during the entire dry season. They still bring water from other sources but the number of times they have visit these sources have declined. Most households visit other sources to fetch drinking water, that too to collect one pot (12 liters) or two pots maximum for a day.

The total water use pattern of these households with rainwater as a partial source suggests that, water from other sources supplement rainwater use in the wet season and during the dry season, rainwater supplements the other water sources to meet household water security. Table 4.

Table 4 : Household Water Use Pattern Using Rainwater as a Partial Source (in liters)

	Rainwater					**Other Sources**				
Household No.	1	2	3	4	5	1	2	3	4	5
Wet season	30	20	60	80	80	40	50	40	-	-
Dry season	20	20	30	30	20	70	70	50	50	50

Source : Survey data 2000

The improved water security among the rural community due to use of rainwater has saved time for the rural people. The time thus saved has been used mostly in improving cultivation practices and attending to children. Table 5.

Table 5 : Prioritization of Activities Due to Saved Time

Household No / Activity	1	2	3	4	5
Use more time in household up keep	-	-	-	2	-
Tending to children	-	2	-	-	2
Leisure time	-	-	-	3	-
Income generating activities	-	1	1	-	-
Cultivation practices	1	-	-	1	1

Source :Survey data 2000

The above description indicates that the rainwater beneficiary community in Sooriyawawe has improved their household water security situation. Thus gaining excess time that is being used more productively to improve the livelihood of these households.

2.2 Village - Muthukandiya

Location - South Eastern dry zone
Climate - Low rainfall, high temperature
Ground Water - Poor Recharge, deep

Muthukandiya is a village located in the South Eastern dry zone bordering the war-torn North-East of the country. Muthukandiya has a large reservoir scheme rehabilitated under Australian aid cultivating more than 2500 acres of paddy lands.

However, the rainwater study community lives in the "Dry Farm" area of Muthukandiya. The concept of dry farms under irrigation settlement schemes were first experimented in Muthukandiya. The dry farm area, by the very name of it, is dry and has no access to irrigation water. Each settler family was given a 6 Acre block which had an agricultural pond of 500 m^2. Water collected during the wet-season in these ponds were used for cultivation towards the end of the wet season. As pond water was mainly surface run-off, it could only be used for cultivation and for cattle. Domestic water was provided with dug wells and tube wells. However, during the dry season from May to October agricultural ponds run dry and most of the dug wells too run dry or reduce to a trickle. It is at this time of the year that rain water harvesting become most useful.

Collecting rainwater when it rains is a common practice in most dry zone villages. There is evidence to suggest that same has been happening in Muthukandiya too. In the village temple, the incumbent priest use rain water collected in a rock tank for

temple use. Villagers also have used rain water directly collected from open air through large polythene sheets and also through rain falling from tree-trunks. These are standard traditional rain water harvesting practices adopted by many rural households in water scarce areas. Besides these methods, most people use roof run-off to collect domestic water. However, these collections are limited to 2-3 weeks depending on the type of container used for collecting water. People do not make full use of the rain falling on the roofs. Most of the gutters found in these houses are tin sheet improvised gutters which usually cover less than 30% of the roof area. These gutters are often subject to corrosion, thus effecting the quality of water. However, few households have used gutters made out of dried Royal Palm leaves. These are strong and rigid when dried hence it can function as a gutter but will last only for a season the maximum. Water collected from these Royal Palm leaf gutters are much better quality than water collected from rusted tin sheets.

Rainwater thus collected is usually not used for drinking but under very difficult conditions people have used this water after boiling. The major uses of this water had been for toilet use, washing kitchen utensils, washing vegetables before cooking and washing cloths. As this type of roof water collection is unsystematic, collection of water varies from kitchen utensils to large barrels of 200 liters. Type of containers used to collect water depends on the economic status of the household.

2.2.1 Collecting water from Conventional Water Sources

Like in most other dry zone villages, settlers in Muthukandiya too collect their domestic water needs from public/private dug wells, reservoirs and small water way. During the dry season most of these sources dry-up leaving people to treck for long distances and spend lot of time at water lines.

2.2.2 Distance to Collect Water

Villagers in Muthukandiya collect domestic water mainly from public or private wells either situated in ones own land or in near by neighbors land. Distance traveled in this case varies between 50m to about 200 meters. However, there had been problems reported on trespassing land while travelling to fetch water. Also there are instances where people have refused access to well water during the month of August which is the driest month in the year. However, during sever dry period people have walked up to 4 km to fetch water from wells. For bathing purposes during the dry season people use the same drinking water wells, though few prefer to use other wells rather than polluting the drinking water wells.

2.2.3 Water Carriers and Containers

In Muthukandiya most of the water carriers are women specially when they have to fetch water from short distances. If water has to be brought from long distances, as in most dry zone areas, it is the men who fetch water in the bicycles or motorcycles. As women are the rain water carriers, they mostly use aluminum pots or clay pots of 10-12 liters. These are either carried on their head or on their hips, when water is brought in bicycles they use 25 liter Jerry cans. However, when people have to transport water for social functions or religious festival water is transported in 200 liter drums on two-wheel/four wheel tractors.

2.2.4 Frequency of Collecting Water

Women usually collect water in the mornings and evenings. During the dry months they have to fetch water at mid-night or early in the morning. When people fail to collect water during the dry moths, some even avoid cooking meals to save on water.

Most people bath only 2-3 times a week. This can take place either in the early hours of the morning or late at night depending on the availability of water and number people at bathing points.

2.2.5 Time to Collect Water

Time taken to collect water depends on the distance to fetch water. Usually if the distance is less than ½ km time taken various between 10 minutes to 20 minutes. If the distance is between 1-1 ½ km and water carriers have to walk, then the time taken can vary between 25 minutes to one hour. When people go for bathing the time varies between 40 minutes to 2 ½ depending on the distance to the source and amount of cloths taken to wash. Usually, people wash their cloths from the same source they bath. The general observation is that males take less time to bath than women. Also, women take longer time for bathing as they consider that going for a bath is a social event where they exchange pleasantries with other women in the community.

This situation depicts the situation in a typical dry zone village where they have to survive on ground water with a varying wet and dry weather conditions. In this respect their household water security depends primarily on the availability of water and secondarily on adequacy of water, distance to travel and availability of water carriers. Quality of water is also an issue for water security specially during the dry season when available water sources are subjected to contamination due to over use.

2.2.6 Food and Water Security Project of the Disaster Management Programme

The food and water security project of the disaster management programme of ITDG intervened to improve the livelihood of Muthukandiya settler community by introducing rainwater harvesting tanks to 17 most needy households in the dry farm. These tanks were mainly of brick-dome under ground tanks of 5000 - 6000 liter capacity. The tanks were constructed by village masons with labour and material provided by the community and cement and skilled labour provided by the project. Most of these tanks were constructed towards end of 1998 but the actual use of stored water stared by mid 1999. Those who are drinking rain water started only towards end of 1999. Incidentally, drinking rain water has been instigated by the results of rain water quality tests conducted by the Lanka Rain Water Forum. When the users were convinced that the quality of rain water was good, they have stated to drink rain water, specially during the wet season. This shows that quality assurance has changed the water use pattern of this people.

47% of the Rain Water Harvesting Community in Muthkandiya use it for drinking, mainly in the wet season. The two main reasons for drinking water are due to its superior quality compared to that of dug wells and the convenience in access to water. Of the 53% who do not use rainwater for drinking, the main reasons being poor maintenance of the tank, poor maintenance of the roof, cement taste of water and also due to the belief that consuming rainwater is bad for health.

Community prioritization of rain water use at household level indicates that most households use rainwater for cooking as their first priority. Only three households use rainwater as their first priority for drinking water table 6.

Table 6 : Prioritization of Rainwater Use in Different - Household Activities

	← Priority →						
Activities	**01**	**02**	**03**	**04**	**05**	**06**	**07**
Cooking	7	5	-	-	-	-	-
Personal washing	5	6	2	1	-	-	-
Toilet use	-	3	5	4	1	-	-
Domestic cattle	-	-	-	3	1	-	-
Washing utensils	-	-	1	-	-	-	-
Home gardening	-	-	-	-	-	1	-
Bathing	-	-	2	-	1	-	-
Drinking	3	-	2	-	-	-	-

Source : Survey data 2000

Unlike in the earlier village, people of Muthukandiya are convinced about the quality of rain water irrespective of the season (table 7). Hence, one would observe the same households who confirm that quality of rain water was good, have consumed it even without boiling. However, table 7 indicate certain changes between the seasons. Household No. 5 consumes water in the dry season but not in the wet season. This is mainly due to the belief that rain water is too cold during the wet season, thus, consuming could cause illnesses. Household No. 13 also consumes rain water in the dry season because their dug well completely runs dry during this period.

Table 7 : Quality Perceptions of Rainwater by Households

Wet Season

Quality Perceptions	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17
Not suitable for drinking, poor quality	-	X	-	-	-	-	X	-	-	-	X	-	-	X	-	-	-
Poor quality but can be consumed after boiling	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	X
Good Quality but can't be consumed without boiling	-	-	-	-	-	-	-	X	-	-	-	X	-	-	-	-	-
Good quality can be consumed without boiling	-		X	X		-	-	-	X	X	-	-		-	X	X	-

Source : Survey data 2000

Dry Season

Quality Perceptions	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17
Not suitable for drinking, poor quality	-	X	-	-	-	-	X	-	-	-	X	-	-	X	-	-	X
Poor quality but can be consumed after boiling	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Good Quality but can't be consumed without boiling	-	-	-	-	-	-	-	X	-	-	-	X	-	-	-	-	-
Good quality can be consumed without boiling	-	-	X	X	X	-	-	-	-	X	-	-	X	-	X	X	-

Source : Survey data 2000

The total water use pattern of rainwater tank beneficiaries in Muthukandiya indicate that approximately 50% of the beneficiaries use stored rain water as the main source of domestic water in the dry season. Interestingly only 29% of the households in the wet season used other water sources as the main supply source. This indicates that the majority of households use rain water as the main supply source even in the wet season. However, use of rain water in the wet season includes not only rain water collected in $5m^3$ tanks but also rain water collected in other containers such as 200 liters drums.

Table 8 : Household Water Use Pattern using Rainwater as a Partial Source (in liters)

Use of Rainwater ← No. of Households →

	01	**02**	**03**	**04**	**05**	**06**	**07**	**08**	**09**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**
Wet season	-	-	60	44	50	-	50	10	32	-	30	60	-	45	30	-	90
Dry season	-	-	-	66	40	-	50	30	-	60	-	45	20	-	45	-	90

Use of Other Sources ← No. of Households →

	01	**02**	**03**	**04**	**05**	**06**	**07**	**08**	**09**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**
Wet season	50	70	70	33	20	-	10	10	24	60	20	15	20	30	90	-	-
Dry season	90	80	10	11	30	-	10	10	32	12	50	15	20	90	30	30	-

Source : Survey data 2000

Like in Sooriyawawe, Muthukandiya rain water users have also used their saved time to engage in agricultural and other small scale income generating activities. While this has been their priority activity, household work and attending to children has been their second priority. Table 9.

Table 9 : Prioritization of Activities Due to Saved Time

Activities	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17
Engaged in household activities	-	-	3	-	-	-	-	-	2	2	1	2	2	1	2	2	-
Tendering to children	-	-	2	-	-	-	-	-	-	-	-	-	-	-	3	-	-
Leisure time	-	2	-	2	-	-	-	-	-	-	-	-	-	-	-	-	-
Income generating activities	-	1	1	1	1	-	-	-	-	-	-	1	-	-	-	-	-
Cultivation practices	-	-	-	-	2	-	1	1	1	1	-	-	1	-	1	1	-

Source : Survey data 2000

2.3 Village - Wawethenna and Kotawera

District	-	Badulla
Climate	-	High rainfall moderate temperature
Ground water	-	Moderate to low acquifer

Wawethenna and Kotawera are two villages in the Badulla district. Though the area receives more than 1400 mm of annual rainfall, duration of rainfall is limited to few months (October to January), hence, rest of the months either receive very little rainfall or totally dry. However, the traditional wisdom in the area suggest that if there is adequate rainfall during the wet months in a year, the following dry season can be managed with available ground and spring water. Therefore the water use behavior of this community is different to that of communities in the dry zone. People in this area cultivate vegetables and paddy in the valleys where water is freely available and tea in mountain areas.

Domestic water supply for these households are mainly from wells, tube wells, natural springs, rivers and rain water collected from roof run-off. These people clearly define their water sources. While rivers are specifically used for bathing, wells are used for drinking water only. Besides the natural water sources, there are two tube wells and two pipe borne water systems installed by the state, community water supply project. However, the tube wells run totally dry during the dry season and only 2-3 pots of water can be collected per household from the pipe borne water system originating from natural springs. Due to there difficulties, and the mountain terrain to travel to fetch water, people always collected whatever rainwater they could. The type of rainwater harvesting culture that existed used the following containers to collect rain from roof run-off.

1. Household utensils
2. 200 liter steel drums
3. Surface rectangular open cement motar tanks
4. Ferro-cement and under ground brick-dome tanks of the community water supply and sanitation project (CWSSP)
5. Private individual tanks constructed to the CWSSP prototype.

Household utensils to collect rain water is a practice common to most house in this area. However, those who uses only these containers to collect water are economically poorer than the others. In this case they collect rain water falling from the roof at all points. These households usually do not have proper roof gutters to drain water. Water so collected can only last for 2-3 days and the major uses of this water is limited to toilet use and personal cleaning. Those households who uses 200 liter drums have more systematically constructed roofs and gutter systems.

The water collected depends on the number of drums available and it can also last for about 1-2 weeks. Collected water is used for personal washing, toilet use, cleaning cooking utensils and sometimes for drinking after boiling.

The cement motar tanks of 700-7000 liter capacity are usually constructed by economically better off people in the village. Water collected in these tanks can be used for about 2 months, but as the tanks are open at the top, water gets contaminated. Therefore use of this water too become limited to activities other than drinking and

cooking. However, some households use variety of fish in these tanks to maintain the quality of water. During heavy rains few households use this water for drinking after boiling.

2.3.1 Attaining Drinking Water Security

Due to its geographic location, the two villages selected for the study in Badulla, has number of drinking water sources. Dug wells, tube wells and pipe borne water systems originating from natural springs. Most of the drinking water wells have protective parapets built around the wells to protect from external contamination. People use these wells for their drinking water needs only if they can not get water from pipe water systems. People prefer the latter source because it originates from natural springs where the quality of water is considered best (according to peoples perceptions).

In the absence of pipe water people prefer dug well water for drinking but they have their own criteria for selecting such wells. Some of the important criteria are; Distance to the well and status of the approach road, water use behavior of other users using the well and quality of well water. People have their own indicators to assess each of this criterion and they will select the best and the most convenient well for drinking water. As an example, people will not use a well where people use their own buckets to fetch water. They would prefer to select a well where only one bucket it used by all users to fetch water. Thus, people are concern about the quality of water. Hence drinking water security will be achieved depending on the above factors. If they can not find water to their liking they will either look for another source or boil water if the problem is moderately poor quality water. Under this situation, people have sometimes achieved their household drinking water security by drinking boiled collected rain water. Incidentally, the incumbent priest of the village temple uses only boiled rain water for drinking purposes. However, villagers who has the means to collect water from other sources would endeavor to do so rather than drinking rain water towards the dry season. However, in total water scares situation people have restored to drinking rain water after boiling.

2.3.2 Water for Cooking Food

Usually villagers use the same water brought for drinking for cooking purposes too. However, if water is in short supply for drinking, they would use lesser quality water for washing vegetables and use drinking water only for cooking. The lesser quality water is this case is the stored rain water. If the stored rain water too goes dry, then they would get water from a nearby stream or a river to wash vegetables and rice but final cooking of food is always with drinking water. This shows how much people are concerned about the quality of water and related health implications.

2.3.3 Water Use for Toilet Purposes

In most rural households in Sri Lanka , maximum water use is for toilet purposes. In this situation people look for quantity rather than quality. Therefore, households use the closest water source for toilet purposes and in most cases it is the stored rainwater that is being used for toilets. Hence rain water tanks have been able to meet the toilet water security for most households. However, if there is no rain water, people would bring water from either wells or streams depending on the distance and type of use of

the particular source. For those households residing on hilly areas and have no easy access to water, they use pit toilets instead of water seal toilets to save on water use.

2.3.4 Bathing and Washing Cloths

Villagers in Kotawera use the nearby Uma Oya (river) for bathing. However those residing away from the river use drinking water wells for bathing as well, During the dry season when most drinking water wells reduce to a trickle, Most people use the river for bathing though they have to travel some distance. However, the old and infants use drinking water wells for bathing even in the dry season. School children usually use small streams for bathing due to safety reasons. Children bathe in groups and that too takes place while coming back from school so that they do not have to make a special trip to bathe.

Washing cloths is always synonymous with bathing. People use the same source for bathing and washing. Hence, change in the bathing source invariably changes the washing source also. Distance and time to bath and washing cloths depends on the location of the household with respect to water sources. Depending on the location of houses the time can vary from 15 minutes to 2 ½ hours for both bathing and washing cloths. During the months of October to January when this area receives lot of rain and the climate is cooler people reduce the frequency of bathing. However, during July and August when its very hot the frequency of bathing increases. Due to the climatalogical conditions of the area people have adequate security of bathing water. The only variable being the distance to travel and time spent per day.

2.3.5 Water Use for Cattle and Home Gardening

For both these activities, premium quality water is not sort for, usually people use stored rain water for both these activities. Those who do have rain water tanks, use water collected for feeding cattle and home gardening. When there is no water in rainwater tanks, few wealthy people have used water pumps to pump water from the nearby river to fill the tanks and feed cattle. Therefore, water security with respect to cattle have been fulfilled though it has a financial cost at times.

2.3.6 Water Security for Religious and Social Functions

As part of the cultural traditions, rural households help each other with their water requirements during social and religious functions. Usually its the women who help each other in storing water for functions. When women visit any social function (weddings, funerals etc) in the village, they carry a pot of water as a practice to the household concern. By this way the entire water requirement of the concerned household can be met. During religious functions in temples people participate to transport 200 liter drums filled with water on tractors and bullock carts. Hence, during festival times and social functions, water security is met with participation of people.

2.4 Village - Deiyandara

Climate	-	High Rainfall
Ground Water	-	Moderate to low aquifer

Deiyandera is situated in the Southern wet zone with high rainfall and moderate temperatures. Due to the rainfall pattern, this area receives more than 1900 mm of average annual rainfall. Like in most parts of Sri Lanka heavy rainfall is limited to few months per year (November to January). However, during the last year there had been widespread rainfall, thus, there had been adequate water for agriculture and domestic use. Therefore during the last year the supply had been high while the demand had remain almost the same due no major water consuming industries or projects that have been established in the area. Though water is available in plentiful, often the problem has been access to water when required in adequate quantities and quality. The geographical locations of most people in the Southern wet zone are hilly settlements, which gives less access to water.

Introduction of rainwater harvesting systems for these settlers have given them the assurance of access to water at all times of the day. Hence, the household water security has increased many fold with respect to their water requirement for most household activities, besides, drinking. Use of Rainwater is not a new concept for people of this area. Even before the systamatised rainwater harvesting was introduced people have collected rainwater from roof run-off, tree trunks and many other indigenous methods to satisfy their household needs. Following is a list of household activities and sources of water use prior to establishment of systematised rainwater harvesting systems.

Household Activity	**Source of Water**
Drinking	Dug well
Cooking	Dug well, Rainwater
Toilet use	Dug well, Rainwater
Washing Cloths	Dug well, Rainwater
Bathing	Dug well
Personal Washing	Dug well, Rainwater

This indicates that dug wells have been the main source of water for this community. On the average they have brought about 70 - 100 liters of water per household from these sources. Most people have used one dug well to satisfy their family's need but when labour was available some have used two sources. Most of there sources are between 50 m - 75 m from their house and they spend about 5 minutes to 1 hour in fetching water. During the last year, due to widespread rain, they could satisfy their water need by 2-3 visits to wells and the waiting time at water points are less than 10 minutes.

This clearly indicates adequacy of water and assurance of water security. During this period water requirement for religious and social functions have been easily fulfilled with young males and females participating to fill 200 liter drums to transport water for festivals/social functions. Women have been mostly responsible for carrying water. But when the terrain is difficult men have taken the responsibility.

While the general situation in the community with respect to domestic water is satisfactory, introduction of rainwater harvesting systems from roof Catchments have enhanced their water security situation. Since collecting rain water household water use per day has increased from 70-100 liters per day to 70-120 liters per day. The collected water has been mainly used for personal washing, laundry, cooking and toilet use. During the rains and 1-2 weeks after the rains people have been using rain

water even for drinking. Though rain water is mostly used for non-premium water uses, people have their own judgment in deciding for its use. They use tank water for washing cloths only if they are certain about future rains and only if their is adequate water in the tank. However, cloths of infants are always washed with tank water to save time on visiting other source for this purpose.

Since the enhanced water security using rain water, this community now bring only 10 - 15 liters per day per household to meet their water requirement. The water brought from out side is mainly used for drinking and cooking, while fetching water from other sources is more a practice, few households now fetch water from out side sources when rain water declines in quality or when rain water in the tank contaminates over long stagnation time. Most people in this community uses the second and third source of water due to convenience but some do it due to variation in water quality and also when water dries-up in their normal water sources.

When water is collected from distance sources it has a special value due to time and energy that has to be spent to collect this water. Hence, this water becomes premium water with a very high value. People use this water only for drinking and cooking. The differential priority given for waters from different sources can be explained when one observes the pattern of water use of these households. For drinking they use the premium water from the most suitable (quality wise) water source. Washing hands prior to eating meals is from a lesser quality water. Brushing teeth and washing mouth before bed time is from a even lesser quality water. Hence, people have their own method of prioritising waters from different sources depending on their quality and type of use.

In the prioritisation of water sources before rain water harvesting tanks, people identified dug wells as their main source of water for both quality and quantity. However, since getting the tanks, this prioritisation has changed to the following;

Household Activity	**Source of Water**
Drinking	Dug well
Cooking	Rainwater tank
Toilet use	Rainwater tank and dug well
Washing cloths	Rainwater tank and dug well
Bathing	Dug well
Personal washing	Dug well

This indicates that people have now accepted rain water as another water supply source and it has increased the household water security due to easy accessibility and availability when needed.

Use of rainwater as a percentage in daily household activities, indicates that in some households rainwater use is as high as 90% specially during the wet season. However, the range of rainwater use in domestic activities varies form 30% to 90% depending on the season, availability and accessibility.

2.4.1 Water Use Pattern of Rain Water User Community In Deiyandera

Analysing the domestic water use pattern of the Deiyandera community, one observes that they have been using three sources of water. Primarily they used natural spring water mainly due to the traditional use and secondly due to its superior quality. The other two sources are the rainwater tanks and a combination of rainwater and spring water. This means that, spring water and rain water supplements the water demand of some households.

Figures 1 to 6 resembles a typical dry month (August) of this area while figures 1.1 to 6.1 resembles the water use pattern of the same households using a second and a third sources to fetch water during a typical wet month (December).

Figure 1 and 1.1 indicates that people drink more water during the wet season due to adequate/excess water availability. While rainwater alone has not been accepted by many people as a drinking water source, rain water in combination with spring water has been used by the same community in Deiyandera. However, use of rain water and spring water in combination is mostly evident in the wet months i.e. December, January.

Due to the excess availability of water during December water consumption has increased from 4-6 lpcd in August to 8-10 lpcd in December. However a large proportion of rural households still use spring water for drinking.

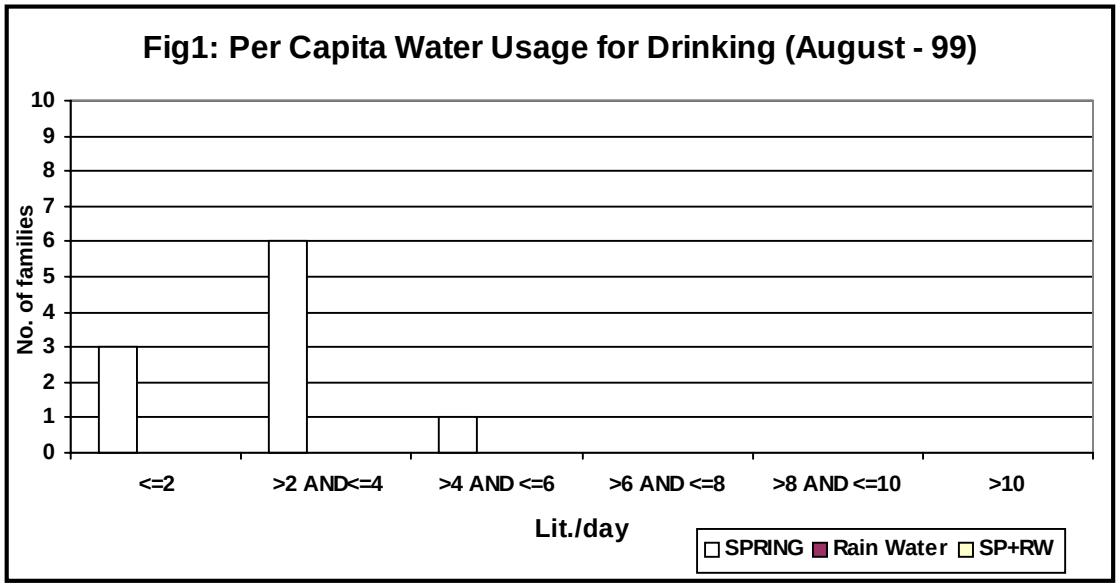
Water use for cooking also indicates an increase during December with availability of adequate water. Figure 2.1 shows an increasing trend in rain water use for cooking along with spring water.

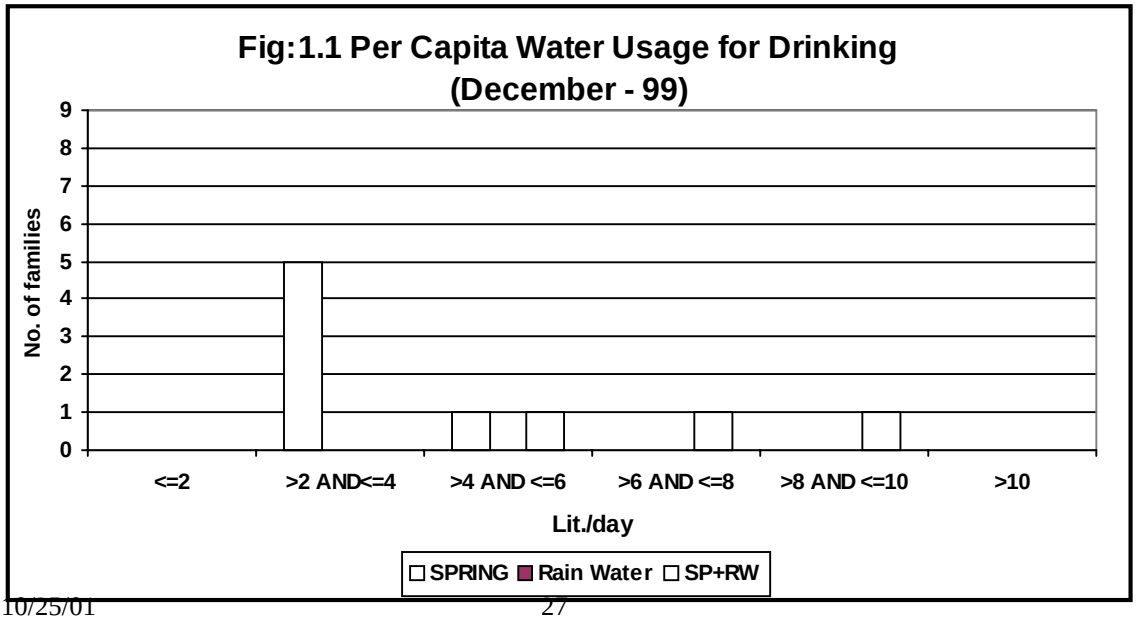
Figure 3 and 3.1 indicate that people have been using more rain water for washing cloths. Incidentally, use of rain water for non-premium activities increase with availability of water. During the month of December more households use rain water for washing cloths thereby reducing the time spent on washing cloths at rivers or dug wells. During the month of August washing cloths using rain water is limited to infants/old and invalids cloths. Figure 4 and 4.1 indicates a similar trend in the use of water for personal washing. While most families use rain water and spring water in combination during the dry month of August, water use pattern for the same activity in December indicates an increasing trend of total rain water use.

Water use for toilet purposes (figure 5 and 5.1) and “other” activities specially for home gardening (figure 6 and 6.1) indicates an increase use of rain water either totally or in combination with waters from other sources. Incidentally, toilet use and home gardening are two activities where some households use rain water as the only source of water.

This illustration indicates that people have been using rain water for household activities needing non-premium quality water. This trend has been on the increase since the commencement of the rain water harvesting programme. Using rain water for drinking and cooking is also on the increase though people restrict this use mainly to the wet season. However, even during the dry season, people have been using rain water to wash vegetables and rice prior to cooking.

The shift in water use trend towards rain water have reduced the time and energy spent for collecting water. Hence they now spend less time and energy to collect water this has improved their household water security situation.





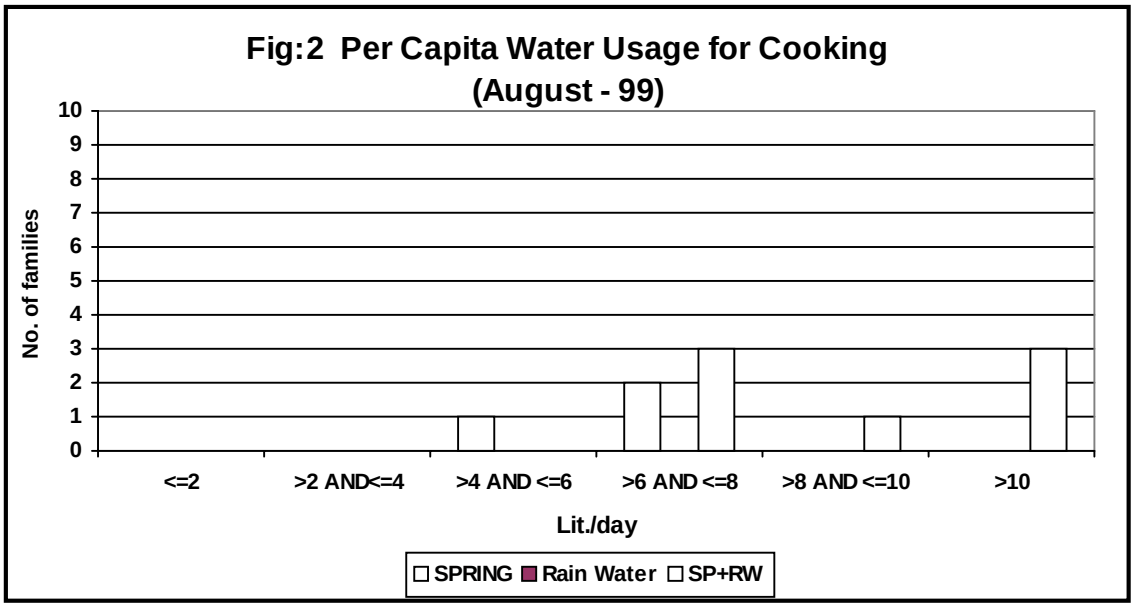


Fig:2 Per Capita Water Usage for Cooking
(August - 99)
No. of families
10
9
8
7
6
5
4
3
2
1
0
<=2
>2 AND<=4
>4 AND <=6
>6 AND <=8
>8 AND <=10
>10
Lit./day
SPRING
Rain Water
SP+RW

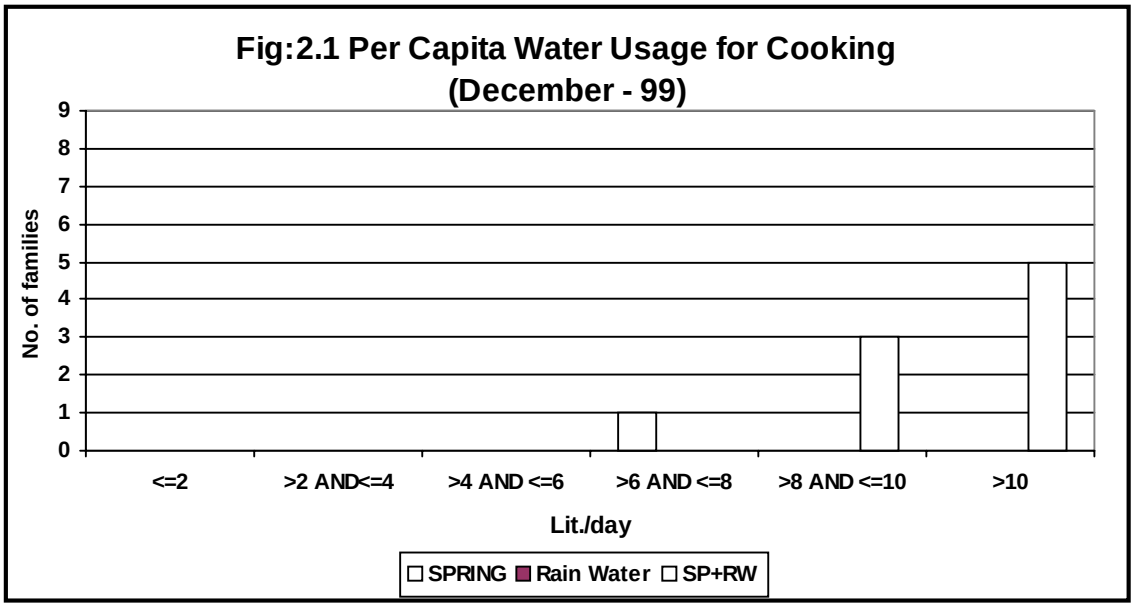


Fig:2.1 Per Capita Water Usage for Cooking
(December - 99)
No. of families
9
8
7
6
5
4
3
2
1
0
<=2
>2 AND<=4
>4 AND <=6
>6 AND <=8
>8 AND <=10
>10
Lit./day
SPRING
Rain Water
SP+RW

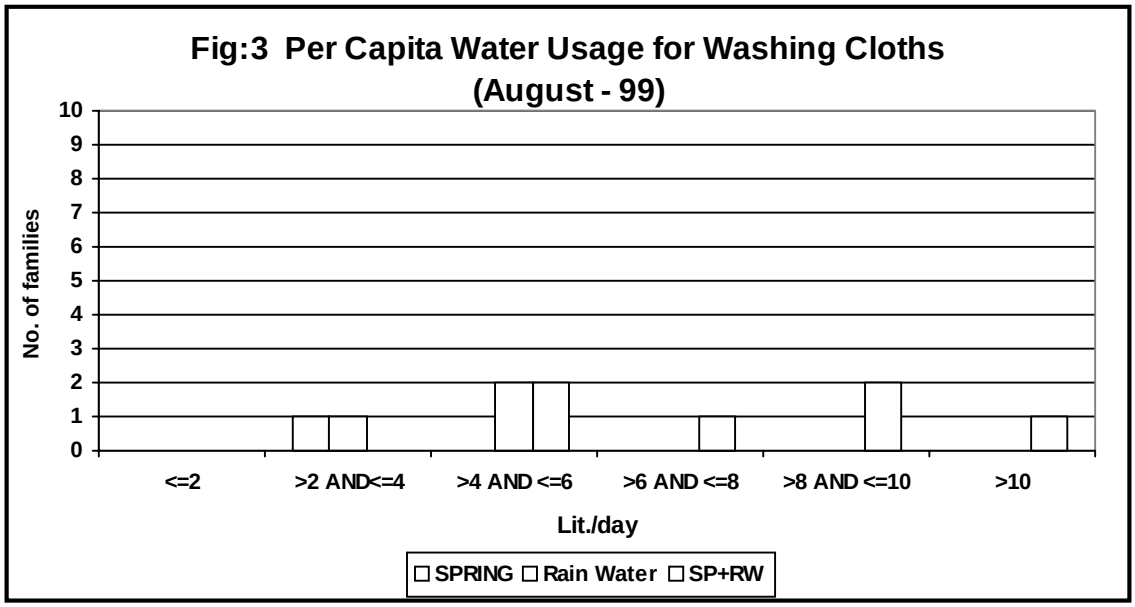


Fig:3 Per Capita Water Usage for Washing Cloths
(August - 99)
No. of families
10
9
8
7
6
5
4
3
2
1
0
<=2
>2 AND<=4
>4 AND <=6
>6 AND <=8
>8 AND <=10
>10
Lit./day
SPRING
Rain Water
SP+RW

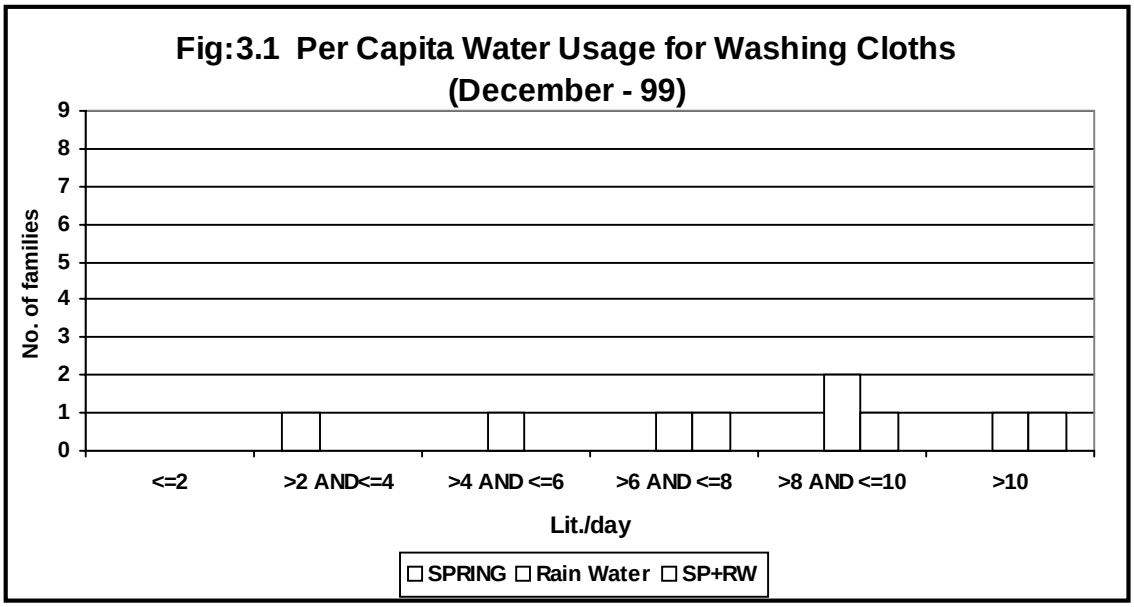


Fig:3.1 Per Capita Water Usage for Washing Cloths
(December - 99)
No. of families
9
8
7
6
5
4
3
2
1
0
<=2
>2 AND<=4
>4 AND <=6
>6 AND <=8
>8 AND <=10
>10
Lit./day
SPRING
Rain Water
SP+RW

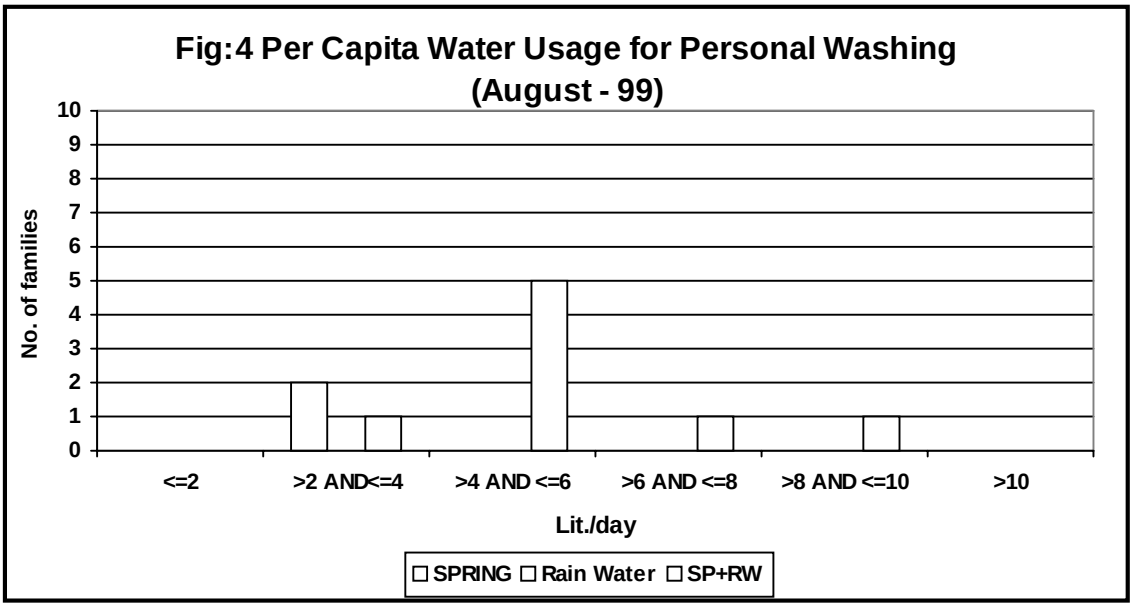


Fig:4 Per Capita Water Usage for Personal Washing
(August - 99)
No. of families
10
9
8
7
6
5
4
3
2
1
0
<=2
>2 AND<=4
>4 AND <=6
>6 AND <=8
>8 AND <=10
>10
Lit./day
SPRING
Rain Water
SP+RW

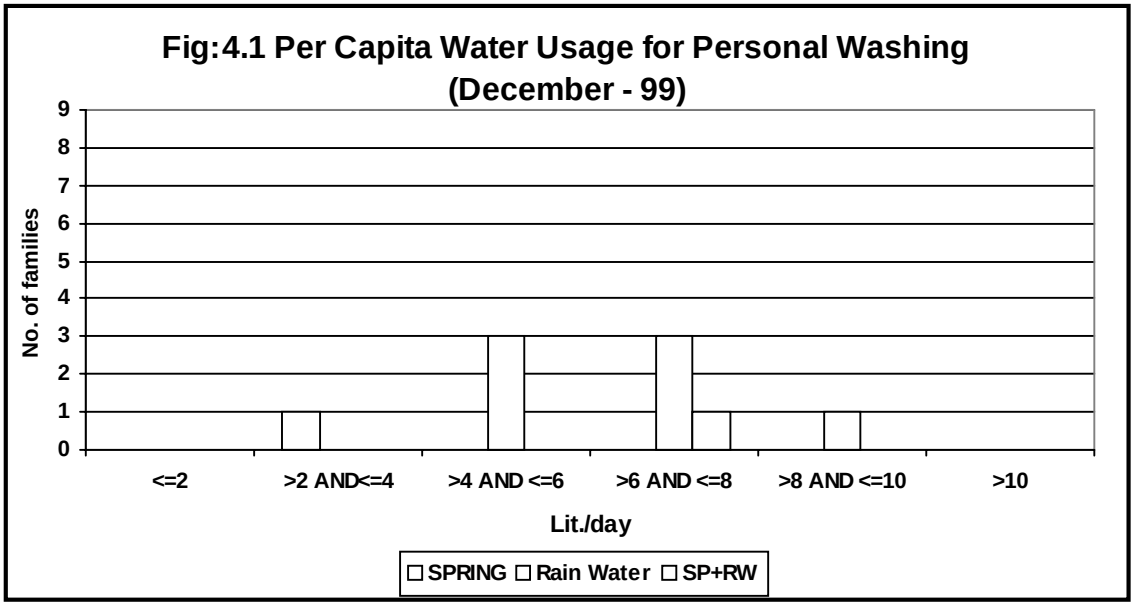


Fig:4.1 Per Capita Water Usage for Personal Washing
(December - 99)
No. of families
9
8
7
6
5
4
3
2
1
0
<=2
>2 AND<=4
>4 AND <=6
>6 AND <=8
>8 AND <=10
>10
Lit./day
SPRING
Rain Water
SP+RW

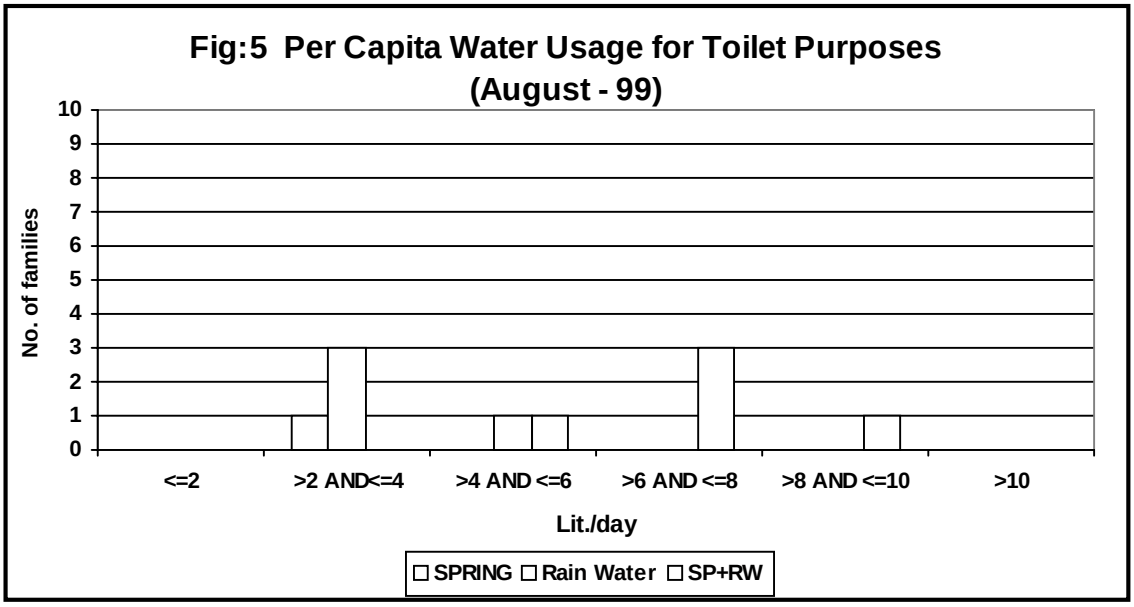


Fig:5 Per Capita Water Usage for Toilet Purposes
(August - 99)
No. of families
10
9
8
7
6
5
4
3
2
1
0
<=2
>2 AND<=4
>4 AND <=6
>6 AND <=8
>8 AND <=10
>10
Lit./day
SPRING
Rain Water
SP+RW

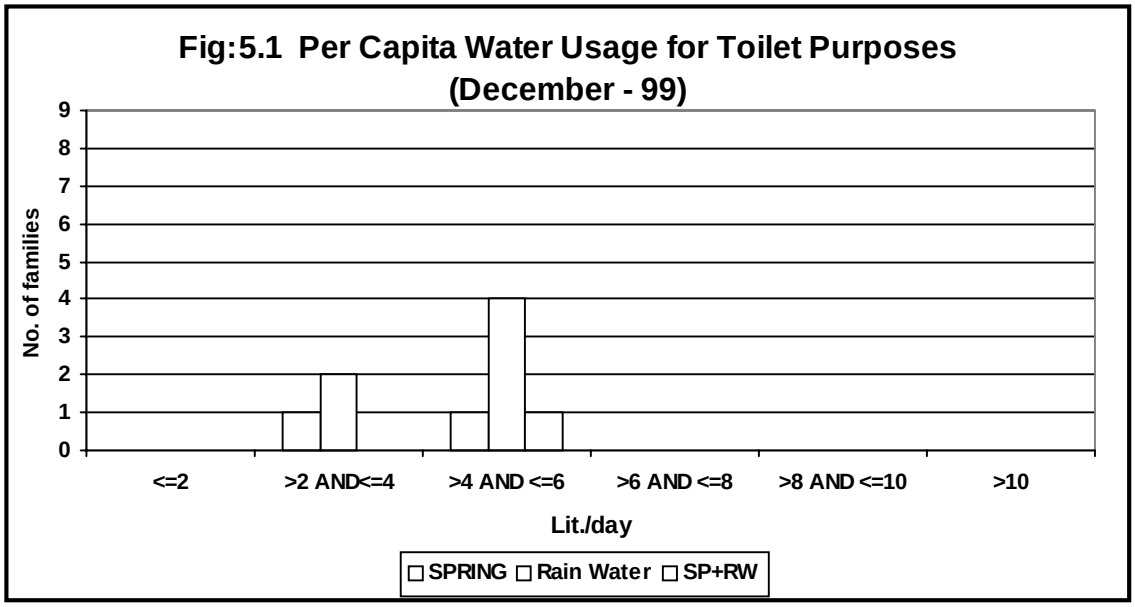


Fig:5.1 Per Capita Water Usage for Toilet Purposes
(December - 99)
No. of families
9
8
7
6
5
4
3
2
1
0
<=2
>2 AND<=4
>4 AND <=6
>6 AND <=8
>8 AND <=10
>10
Lit./day
SPRING
Rain Water
SP+RW

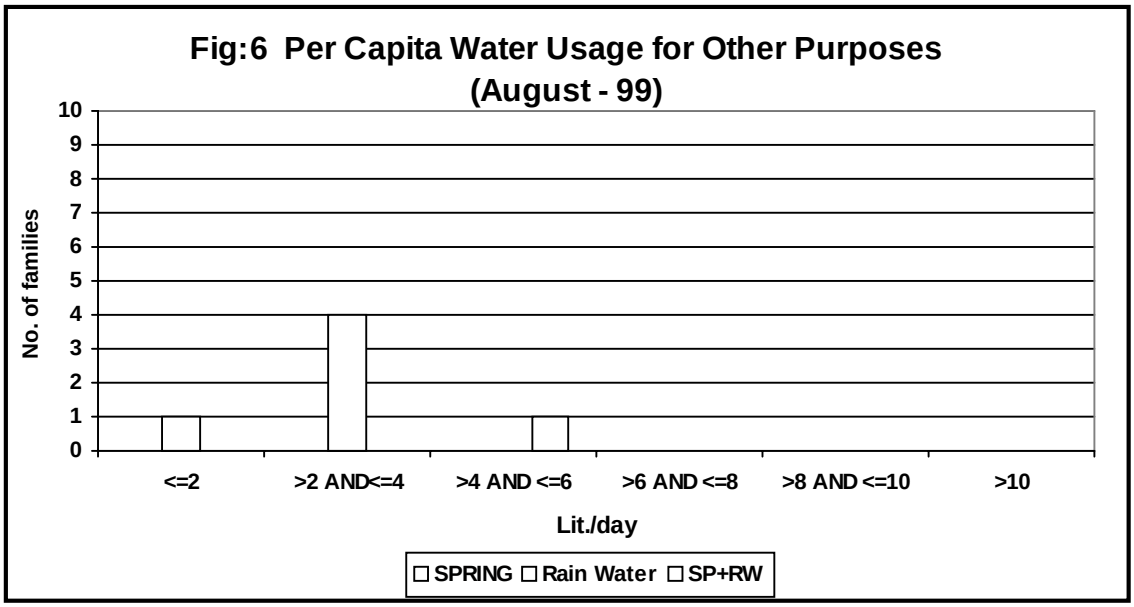


Fig:6 Per Capita Water Usage for Other Purposes
(August - 99)
No. of families
10
9
8
7
6
5
4
3
2
1
0
<=2
>2 AND<=4
>4 AND <=6
>6 AND <=8
>8 AND <=10
>10
Lit./day
SPRING
Rain Water
SP+RW

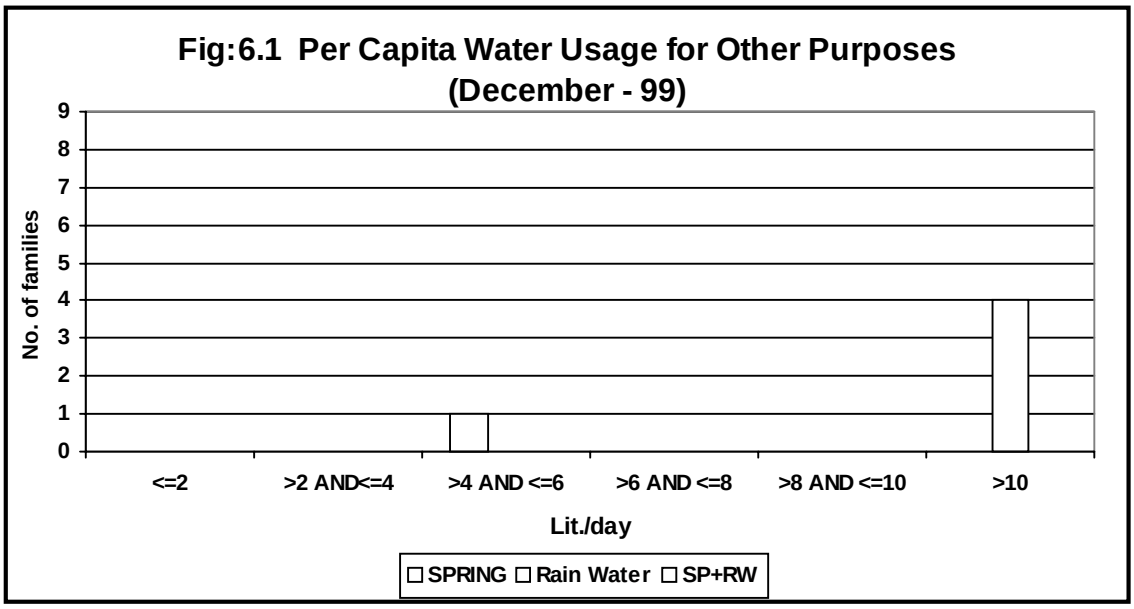


Fig:6.1 Per Capita Water Usage for Other Purposes
(December - 99)
No. of families
9
8
7
6
5
4
3
2
1
0
<=2
>2 AND<=4
>4 AND <=6
>6 AND <=8
>8 AND <=10
>10
Lit./day
SPRING
Rain Water
SP+RW

3. Household Water Security Model

Work on the household security model has been in progress since August 1999. The Lanka Rainwater Harvesting Forum has been collecting quantitative water use data from approximately 40 beneficiary households in two villages.

The matrix presented here is the first approximation of how this model would be applied to determine the household water security.

3.1 Primary Factors

Primary factors are those household activities that uses water in varying quantities. In the matrix primary factors are presented in an order of priority depending on the quality of water and its associated use. Hence, one would observe a priority sequence from "drinking" to "other uses" of water . For each of these categories a rating can be assigned depending on their quantity and preferential use by the household. In this matrix ratings vary from A to C.

3.2 Secondary Factors

Secondary factors are the quantities of water used for each primary factor. In this matrix secondary factors vary from "very high" use to "very low" use. This categorization can vary depending on the water use activity. As an example, washing has only three categories while drinking has five categories. Secondary factors are also given a rating depending on the quantity of water used under each category.

3.3 Tertiary Factors

Tertiary factors are those that effect the degree of water use in a household. These factors can be of four categories as expressed in the matrix. However, the categories can vary depending on each tertiary factor. Each category can be assigned a weight depending on the user preference and convenience in obtaining water for different water use activities.

3.4 Quaternary Factors

These factors determine in detail the convenience or quality preference (depending on perceptions) for each tertiary category. The quaternary factors are also assigned weights depending on the ascending degree of convenience or preferability.

Total Rural Household Water Security will be a summation of all primary factors. Each factor will be raised to its power depending on the weight or rating its qualified to obtain. The weight and ratings will depend on the environment and water user behavior of rain water tank beneficiaries.

In determining the household water security each household will be assessed for its water use behavior using this matrix. Once the household water security is determined, an attempt will be made to assess the village water security using the same model.

Primary Factor	Rt.	Secondary Factor	Rt.	Tertiary Factor	Wt.	Quaternary Factor	Wt.
Drinking	A	Very High	A	Distance travelled	A	D=1-50m and h=0-10m	A
						D=50-100m and h=0-10m; D=1-50m and h=10-50m	B
						D=100-200m and h=0-10m; D=50-100m and h=10-50m	C
						D=200-800m and h=0-10m; D=100-200m and h=10-50m; D=0-50m and h>50m	D
						D>800m and h=0-10m; D>200 and h=10-50m; D>50m and h>50m	E
				Taste	A	Ordinary water	A
						Harvested rainwater	C
						Brackish water, Saline water	E
				Purity / Processing	B	Pure and clear water	A
						with plant matter; dust - needs filtering	B
						needs boilding and/or filtering	C
						cement dust, bird droppings, worms / eggs	E
				Emergency	C	Neighbours provide the required amount	A
						Reduce consumption	B
						use stored rainwater	C
						use water used for cooking	D
		High	B	Distance travelled	A	D=1-50m and h=0-10m	A
						D=50-100m and h=0-10m; D=1-50m and h=10-50m	B
						D=100-200m and h=0-10m; D=50-100m and h=10-50m	C
						D=200-800m and h=0-10m; D=100-200m and h=10-50m; D=0-50m and h>50m	D
						D>800m and h=0-10m; D>200 and h=10-50m; D>50m and h>50m	E
				Taste	A	Ordinary water	A
						Harvested rainwater	C
						Brackish water, Saline water	E
				Purity / Processing	B	Pure and clear water	A
						with plant matter; dust - needs filtering	B
						needs boilding and/or filtering	C
						cement dust, bird droppings, worms / eggs	E
				Emergency	C	Neighbours provide the required amount	A
						Reduce consumption	B
						use stored rainwater	C
						use water used for cooking	D
		Medium	C	Distance travelled	A	D=1-50m and h=0-10m	A
						D=50-100m and h=0-10m; D=1-50m and h=10-50m	B
						D=100-200m and h=0-10m; D=50-100m and h=10-50m	C
						D=200-800m and h=0-10m; D=100-200m and h=10-50m; D=0-50m and h>50m	D
						D>800m and h=0-10m; D>200 and h=10-50m; D>50m and h>50m	E
				Taste	A	Ordinary water	A
						Harvested rainwater	C
						Brackish water, Saline water	E
				Purity / Processing	B	Pure and clear water	A
						with plant matter; dust - needs filtering	B
						needs boilding and/or filtering	C
						cement dust, bird droppings, worms / eggs	E
				Emergency	C	Neighbours provide the required amount	A
						Reduce consumption	B
						use stored rainwater	C
						use water used for cooking	D

		Low	D	Distance travelled	A	D=1-50m and h=0-10m A
						D=50-100m and h=0-10m; D=1-50m and h=10-50m B
						D=100-200m and h=0-10m; D=50-100m and h=10-50m C
						D=200-800m and h=0-10m; D=100-200m and h=10-50m; D=0-50m and h>50m D
						D>800m and h=0-10m; D>200 and h=10-50m; D>50m and h>50m E
				Taste	A	Ordinary water A
						Harvested rainwater C
						Brackish water, Saline water E
				Purity / Processing	B	Pure and clear water A
						with plant matter; dust - needs filtering B
						needs boilding and/or filtering C
						cement dust, bird droppings, worms / eggs E
				Emergency	C	Neighbours provide the required amount A
						Reduce consumption B
						use stored rainwater C
						use water used for cooking D
		Very Low	E	Distance travelled	A	D=1-50m and h=0-10m A
						D=50-100m and h=0-10m; D=1-50m and h=10-50m B
						D=100-200m and h=0-10m; D=50-100m and h=10-50m C
						D=200-800m and h=0-10m; D=100-200m and h=10-50m; D=0-50m and h>50m D
						D>800m and h=0-10m; D>200 and h=10-50m; D>50m and h>50m E
				Taste	A	Ordinary water A
						Harvested rainwater C
						Brackish water, Saline water E
				Purity / Processing	B	Pure and clear water A
						with plant matter; dust - needs filtering B
						needs boilding and/or filtering C
						cement dust, bird droppings, worms / eggs E
				Emergency	C	Neighbours provide the required amount A
						Reduce consumption B
						use stored rainwater C
						use water used for cooking D
Cooking	A	Very High	A	Distance travelled	A	D=1-50m and h=0-10m A
						D=50-100m and h=0-10m; D=1-50m and h=10-50m B
						D=100-200m and h=0-10m; D=50-100m and h=10-50m C
						D=200-800m and h=0-10m; D=100-200m and h=10-50m; D=0-50m and h>50m D
						D>800m and h=0-10m; D>200 and h=10-50m; D>50m and h>50m E
				Taste	A	Ordinary water A
						Harvested rainwater B
						Brackish water, Saline water E
				Purity - cooking	B	Pure and clear water A
						with plant matter; dust - needs filtering B
						cement dust, bird droppings, worms / eggs E
				Purity - washing	B	Pure and clear water; with plant matter, dust -needs filtering A
						cement dust, bird droppings, worms / eggs E
				Emergency	C	Neighbours provide the required amount; use stored rainwater A
						Reduce consumption B
		High	A	Distance travelled	A	D=1-50m and h=0-10m A
						D=50-100m and h=0-10m; D=1-50m and h=10-50m B
						D=100-200m and h=0-10m; D=50-100m and h=10-50m C
						D=200-800m and h=0-10m; D=100-200m and h=10-50m; D=0-50m and h>50m D
						D>800m and h=0-10m; D>200 and h=10-50m; D>50m and h>50m E

		Taste	A	Ordinary water	A
				Harvested rainwater	B
				Brackish water, Saline water	E
		Purity - cooking	B	Pure and clear water	A
				with plant matter; dust - needs filtering	B
				cement dust, bird droppings, worms / eggs	E
		Purity - washing	B	Pure and clear water; with plant matter, dust -needs filtering	A
				cement dust, bird droppings, worms / eggs	E
		Emergency	C	Neighbours provide the required amount; use stored rainwater	A
				Reduce consumption	B
	Medium A	Distance travelled	A	D=1-50m and h=0-10m	A
				D=50-100m and h=0-10m; D=1-50m and h=10-50m	B
				D=100-200m and h=0-10m; D=50-100m and h=10-50m	C
				D=200-800m and h=0-10m; D=100-200m and h=10-50m; D=0-50m and h>50m	D
				D>800m and h=0-10m; D>200 and h=10-50m; D>50m and h>50m	E
		Taste	A	Ordinary water	A
				Harvested rainwater	B
				Brackish water, Saline water	E
		Purity - cooking	B	Pure and clear water	A
				with plant matter; dust - needs filtering	B
				cement dust, bird droppings, worms / eggs	E
		Purity - washing	B	Pure and clear water; with plant matter, dust -needs filtering	A
				cement dust, bird droppings, worms / eggs	E
		Emergency	C	Neighbours provide the required amount; use stored rainwater	A
				Reduce consumption	B
	Low A	Distance travelled	A	D=1-50m and h=0-10m	A
				D=50-100m and h=0-10m; D=1-50m and h=10-50m	B
				D=100-200m and h=0-10m; D=50-100m and h=10-50m	C
				D=200-800m and h=0-10m; D=100-200m and h=10-50m; D=0-50m and h>50m	D
				D>800m and h=0-10m; D>200 and h=10-50m; D>50m and h>50m	E
		Taste	A	Ordinary water	A
				Harvested rainwater	B
				Brackish water, Saline water	E
		Purity - cooking	B	Pure and clear water	A
				with plant matter; dust - needs filtering	B
				cement dust, bird droppings, worms / eggs	E
		Purity - washing	B	Pure and clear water; with plant matter, dust -needs filtering	A
				cement dust, bird droppings, worms / eggs	E
		Emergency	C	Neighbours provide the required amount; use stored rainwater	A
				Reduce consumption	B
	Very low A	Distance travelled	A	D=1-50m and h=0-10m	A
				D=50-100m and h=0-10m; D=1-50m and h=10-50m	B
				D=100-200m and h=0-10m; D=50-100m and h=10-50m	C
				D=200-800m and h=0-10m; D=100-200m and h=10-50m; D=0-50m and h>50m	D
				D>800m and h=0-10m; D>200 and h=10-50m; D>50m and h>50m	E
		Taste	A	Ordinary water	A
				Harvested rainwater	B
				Brackish water, Saline water	E
		Purity - cooking	B	Pure and clear water	A
				with plant matter; dust - needs filtering	B
				cement dust, bird droppings, worms / eggs	E

		Purity - washing	B	Pure and clear water; with plant matter, dust -needs filtering	A
				cement dust, bird droppings, worms / eggs	E
		Emergency	C	Neighbours provide the required amount; use stored rainwater	A
				Reduce consumption	B
Washing face	B	Very High	A	Distance travelled A	D=1-50m and h=0-10m A
					D=50-100m and h=0-10m; D=1-50m and h=10-50m B
					D=100-200m and h=0-10m; D=50-100m and h=10-50m C
					D=200-800m and h=0-10m; D=100-200m and h=10-50m; D=0-50m and h>50m D
					D>800m and h=0-10m; D>200 and h=10-50m; D>50m and h>50m E
				Taste A	Ordinary water, Harvested rainwater A
					Brackish water, Saline water E
				Purity B	Pure and clear water; with plant matter, dust -needs filtering A
					cement dust, bird droppings, worms / eggs E
				Emergency C	Neighbours provide the required amount; use stored rainwater A
					Reduce consumption B
		Medium	A	Distance travelled A	D=1-50m and h=0-10m A
					D=50-100m and h=0-10m; D=1-50m and h=10-50m B
					D=100-200m and h=0-10m; D=50-100m and h=10-50m C
					D=200-800m and h=0-10m; D=100-200m and h=10-50m; D=0-50m and h>50m D
					D>800m and h=0-10m; D>200 and h=10-50m; D>50m and h>50m E
				Taste A	Ordinary water, Harvested rainwater A
					Brackish water, Saline water E
				Purity B	Pure and clear water; with plant matter, dust -needs filtering A
					cement dust, bird droppings, worms / eggs E
				Emergency C	Neighbours provide the required amount; use stored rainwater A
					Reduce consumption B
		Very low	A	Distance travelled A	D=1-50m and h=0-10m A
					D=50-100m and h=0-10m; D=1-50m and h=10-50m B
					D=100-200m and h=0-10m; D=50-100m and h=10-50m C
					D=200-800m and h=0-10m; D=100-200m and h=10-50m; D=0-50m and h>50m D
					D>800m and h=0-10m; D>200 and h=10-50m; D>50m and h>50m E
				Taste A	Ordinary water, Harvested rainwater A
					Brackish water, Saline water E
				Purity B	Pure and clear water; with plant matter, dust -needs filtering A
					cement dust, bird droppings, worms / eggs E
				Emergency C	Neighbours provide the required amount; use stored rainwater A
					Reduce consumption B
Washing clothes	B	Very High	A	Distance travelled A	D=1-50m and h=0-10m A
					D=50-100m and h=0-10m; D=1-50m and h=10-50m B
					D=100-200m and h=0-10m; D=50-100m and h=10-50m C
					D=200-800m and h=0-10m; D=100-200m and h=10-50m; D=0-50m and h>50m D
					D>800m and h=0-10m; D>200 and h=10-50m; D>50m and h>50m E
				Emergency C	Neighbours provide the required amount; use stored rainwater A
					Reduce consumption B
		Medium	C	Distance travelled A	D=1-50m and h=0-10m A
					D=50-100m and h=0-10m; D=1-50m and h=10-50m B
					D=100-200m and h=0-10m; D=50-100m and h=10-50m C
					D=200-800m and h=0-10m; D=100-200m and h=10-50m; D=0-50m and h>50m D
					D>800m and h=0-10m; D>200 and h=10-50m; D>50m and h>50m E
				Emergency C	Neighbours provide the required amount; use stored rainwater A
					Reduce consumption B
		Very low	E	Distance travelled A	D=1-50m and h=0-10m A

		travelled		D=50-100m and h=0-10m; D=1-50m and h=10-50m	B
				D=100-200m and h=0-10m; D=50-100m and h=10-50m	C
				D=200-800m and h=0-10m; D=100-200m and h=10-50m; D=0-50m and h>50m	D
				D>800m and h=0-10m; D>200 and h=10-50m; D>50m and h>50m	E
		Emergency	C	Neighbours provide the required amount; use stored rainwater	A
				Reduce consumption	B
Toilet purposes	B	Very High	A	Distance travelled	A	D=1-50m and h=0-10m	A
						D=50-100m and h=0-10m; D=1-50m and h=10-50m	B
						D=100-200m and h=0-10m; D=50-100m and h=10-50m	C
						D=200-800m and h=0-10m; D=100-200m and h=10-50m; D=0-50m and h>50m	D
						D>800m and h=0-10m; D>200 and h=10-50m; D>50m and h>50m	E
		Medium	A	Distance travelled	A	D=1-50m and h=0-10m	A
						D=50-100m and h=0-10m; D=1-50m and h=10-50m	B
						D=100-200m and h=0-10m; D=50-100m and h=10-50m	C
						D=200-800m and h=0-10m; D=100-200m and h=10-50m; D=0-50m and h>50m	D
						D>800m and h=0-10m; D>200 and h=10-50m; D>50m and h>50m	E
		Very low	A	Distance travelled	A	D=1-50m and h=0-10m	A
						D=50-100m and h=0-10m; D=1-50m and h=10-50m	B
						D=100-200m and h=0-10m; D=50-100m and h=10-50m	C
						D=200-800m and h=0-10m; D=100-200m and h=10-50m; D=0-50m and h>50m	D
						D>800m and h=0-10m; D>200 and h=10-50m; D>50m and h>50m	E
Other uses	C	Very High	A	Distance travelled	A	D=1-50m and h=0-10m	A
						D=50-100m and h=0-10m; D=1-50m and h=10-50m	B
						D=100-200m and h=0-10m; D=50-100m and h=10-50m	C
						D=200-800m and h=0-10m; D=100-200m and h=10-50m; D=0-50m and h>50m	D
						D>800m and h=0-10m; D>200 and h=10-50m; D>50m and h>50m	E
		Medium	A	Distance travelled	A	D=1-50m and h=0-10m	A
						D=50-100m and h=0-10m; D=1-50m and h=10-50m	B
						D=100-200m and h=0-10m; D=50-100m and h=10-50m	C
						D=200-800m and h=0-10m; D=100-200m and h=10-50m; D=0-50m and h>50m	D
						D>800m and h=0-10m; D>200 and h=10-50m; D>50m and h>50m	E
		Very low	A	Distance travelled	A	D=1-50m and h=0-10m	A
						D=50-100m and h=0-10m; D=1-50m and h=10-50m	B
						D=100-200m and h=0-10m; D=50-100m and h=10-50m	C
						D=200-800m and h=0-10m; D=100-200m and h=10-50m; D=0-50m and h>50m	D
						D>800m and h=0-10m; D>200 and h=10-50m; D>50m and h>50m	E

4. Rain water user studies: water quality

A Water Quality survey was conducted in the same two locations as for the water security study at Matara and Badulla district. The survey looks at the quality of rain water collected in various tanks (Brick and Ferrocement) in the two locations and compares it with the other available water sources within the locality. The water quality parameters tested are pH, Conductivity, temperature, hardness, turbidity and E. Coli per 100 ml.

4.1 Location Dehiyandara (Matara)

All the tanks in Dehiyandara are underground brick dome tanks built by CWSSP project and have been in operation since 1996. None of the tanks are fitted with filters or first flush systems. Most tanks have tank covers and extract water through a tap but some tanks have no cover and use a bucket through the tank mouth to extract water.

Water Quality test Results from Matara District

	Rainwater				Well water			
Month	**pH**	**Conductivity (µC / cm)**	**Turbidity (NTU)**	***E. Coli* per 100 ml**	**pH**	**Conductivity (µC / cm)**	**Turbidity (NTU)**	***E. Coli* per 100 ml**
Jun-99	7.8-8.2		5	0-1000	6.8-8.2		5	16-70
Aug-99	7.7-9.2	20-70	5	65-228	5.5-8	40-70	5	190-1000
Sep-99	8.5-9.5	20-110	5	0-2000	5.5-5.8	70-90	5	136-5000
Nov-99	7.3-9.3		5	37-1000	5.2-6.7		5	20-400
Dec-99	6-9.3	40-160	5	4 -- 37	4.5-6.5	40-170	5	6-400
Jan-00	7-11.2*	40-1290*	5	0	5.3-6.8	40-60	5	200
Feb-00	5.4-9.3	20-140	5	0-400	4.7-6.1	60	5	400
WHO standards	6.5-8.5	500	5	0	6.5-8.5	500	5	0

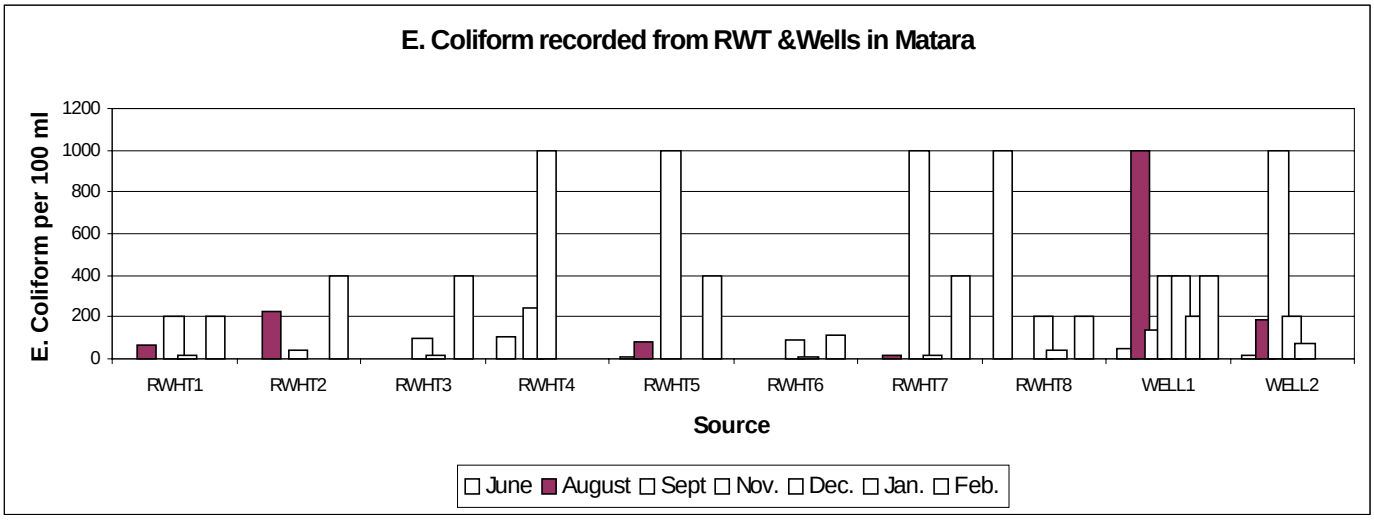
* newly build tank, pH and Conductivity was high due to cement dissolving

pH of some rain water tanks are slightly more alkaline than the WHO standards. The reason for this could be due to

1. Decomposition of leaf litter and other debris falling into the tank from the roof.
2. Algae growth in the tank causing an increase in pH due to photosynthesis action.

Conductivity and turbidity is well within the WHO standards, except in one tank which was newly built - the conductivity was high due to cement dissolving.

Most tanks recorded high counts of *E.Coli* in November just after the rain. Similar pattern were seen in February. This indicate since first flush systems are not fitted to the rain water



tanks in this location, that all the material on the roof gets washed into the tank and contaminates it.
All tanks were free of bacterial contamination in January, this was after a long dry spell, indicating that long storage time in tanks kills the bacteria.

Both wells sampled at this location used for drinking water are unprotected. pH values recorded are low and do not meet the WHO standard, the reason could be due to high use of fertilizers in the area for the tea and cinnamon plantations. *E. coli* counts were high on all occasions except for the dry months June and December.

4.2 Location Wawethenna and Kotawera (Badulla District)

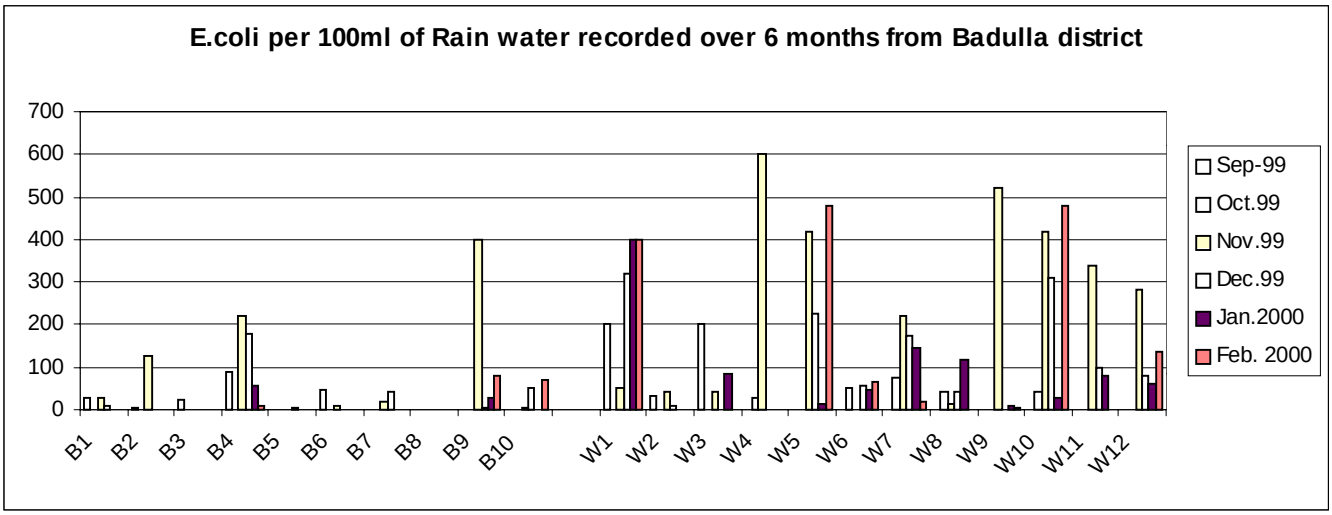
Wawethenna is located in the Bandarawella Province in the Badulla district. Most tanks sampled here are CWSSP build underground brick dome tanks of $5m^3$ volume and few tanks of above ground ferrocement of the same volume. All of them have filters tanks containing small pebbles and sand, fitted into the rain water collection system. All tanks have tank covers and water is extracted through a tap. However, non of them have a first flush system fitted or practice washing the roof before collecting into a tank.

Kotawera is located in the Wellimada Province in the Badulla district. All tanks sampled were CWSSP underground brick dome tanks of 5 m^3, non of them has a filter tanks, most of them have a tank cover, but most of them makeshift and not adequate. In all tanks the water is taken out by using a bucket lowered into the tanks from the tank mouth.

Water Quality Test Results of Rain water tanks from Badulla District

Location								
	Bandarawella				**Welimada**			
	pH	**Conductivity ((µC / cm)**	**Turbidity (NTU)**	**E. Coliform per 100 ml**	**pH**	**Conductivity ((µC / cm)**	**Turbidity (NTU)**	**E. Coliform per 100 ml**
Sep-99	7.2-9.5	30-80	5	4 -- 90	7.8-9.2	60-120	5	33-200
Oct.99	8.7-11.5		5		8.5-10.6		5	1--75
Nov.99	7.5-10.2		5	0-400	7.9-10.7		5	1-600
Dec.99	7.1-10.7	50-170	5	0-177	7-9.5	70-160	5	11-312
Jan.2000	6.9-10.4	30-120	5	0-56	6.9-9.8	40-230	5	2-400
Feb. 2000	6.2-9.8	30-140	5	0-80	6.4-9.2	50-120	5	0-480
WHO standards	**6.5-8.5**	**500**	**5**	**0**	**6.5-8.5**	**500**	**5**	**0**

pH values are higher in the rain water from both location than the WHO standards for drinking water in some tanks. Conductivity and turbidity is within the range of WHO standards.



B-Bandarwella (Wewathana) Tanks with filters
W- Welimada (Kotawara) Tanks without filters

There is significantly less *E. coli* recorded from Wewathana tanks with filter than Kotawara tanks with out filters. This indicated filter play a major role in reducing the amount of debris getting into the tanks, therefore amount of bacteria in the tanks. Also after the on set of rain in November the *E. Coli* counts in the tanks increased significantly at both locations, this is continued throughout to February. Badulla district has experienced a unusual rain fall this year in January and February where as usual these are dry months.