Small Tank Cascade Systems in Walawe River Basin

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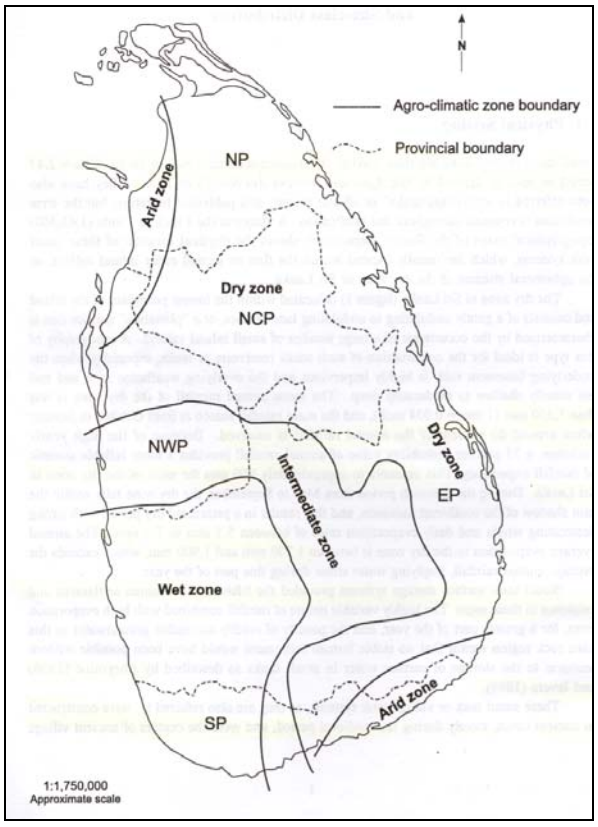
Introduction

This report on small tank cascade systems is based on a study conducted in seven tank cascades of the Walawe river basin, one of the three main river basins in the Ruhuna benchmark basins[1] selected for the benchmark basin study of the International Water Management (IWMI). The overall objective of this study is to document the situation of small tank cascade systems in the basin, paying special attention to their evolution under agro-ecological, socio-economic and institutional changes of unprecedented scale in the country after the introduction of open market economic policies in 1970s, and thereby to contribute to the existing knowledge on small tank cascades, a key feature of water resources in the Dry zone parts[2] of Sri Lanka **(**Figure 1**)** since time immemorial.

Figure 1. Main agro-climatic zones of Sri Lanka



A cascade is defined here as "a connected series of tanks (irrigation reservoirs) organized within a micro-catchment of the Dry Zone landscape, storing, conveying and utilizing water from an ephemeral rivulet" and is considered as "one of the traditional land water management systems which has obviously been developed on the basis of catchment ecosystems" (Maddumabandara 1989). The irrigation reservoirs can either exist independently or be connected to a chain of tanks within a cascade. Tanks with command areas less than 80 ha are referred as minor tanks or village tanks in Sri Lanka (Agrarian Service Act of Sri Lanka). They are more or less managed by the farmer

[1] IWMI has named basin areas between Kachchigal Ara to Menikganaga as Ruhunu benchmark basins. Walawe, Menik and Kirindi Oya are the main rivers in the Ruhunu Benchmark basins.

[2] Areas receiving an average annual rainfall below 1,905 mm in Sri Lanka is identified as the Dry zone.

communities themselves even though the support of the government and external agencies like foreign donors and NGOs is sought for major rehabilitation and improvement activities. The general feature of an irrigation tank is as follows: "tank irrigation utilizes storage of water created by throwing an earth bund or dam across a seasonal or perennial stream at a suitable point. The volume of water stored in such reservoir depends on the capacity of tank and the amount of water it receives from its catchment area. Excess water in the tank is allowed to spill over at one or two points on the tank bund specially designed to release of necessary water to flood the rice fields" (Tennakoon 1974).

1.1 Brief history of small tanks in the Dry zone of Sri Lanka

Though the exact period in which the construction of irrigation reservoirs started is not known, there are historical references that they have been in existence since earliest historical times (Tennakoon 1995). It is sometimes argued that the art of reservoir construction was known by the people in the country even before the arrival of Prince Vijaya, who is believed to be the founder of Sinhalese nation: the naga (cobra) symbol that appeared in the ancient irrigation reservoirs have given rise to a belief that the reservoir construction was practiced by naga tribes, the prehistoric inhabitants of Sri Lanka living in the country by the time of the arrival of Aryans. But some argue that there are no historical references to support these views and point out that tank irrigation was introduced in the country in the 6th Century BC by the Aryan settlers (Dikshit 1986). The Mahavamsa, a historical chronicle of Sri Lanka, refers to the construction of a small tank, Basavakkulama in Anuradhapura by King Panduvasadeva, an Aryan king who ruled the country in 5th Century BC.

The Walawe basin falls within the area known in the ancient past as Ruhunu Rata, the ancient kingdom in the Southeast part of Sri Lanka. Historical monuments such as tanks, dagobas, stone pillars, stone sluices, Brahmi inscriptions, rock cave hermitages, monasteries etc. scattered over the whole Walawe basin are indicative of the existence of an ancient civilization similar to the one in Raja rata (Anuradhapura and Polonnaruwa area). Some of these monuments date back to King Mahanaga's reign in the ancient Kingdom of Magama in the 3rd century BC. The names of the Kings such as Kavantissa and Dutugamunu (2nd centuary BC) appear in the chronicles as those responsible for the construction of some of these irrigation and religious monuments. Some inscriptions attribute some of these works to King Walagamba or Watta Gamini Abhaya (1st century B.C.) who took refuge in the area. It is believed that both large scale and small scale irrigation in the area came up during the reigns of these kings, even though the involvement of kings in village irrigation work was minimal. The Uru Sita Wewa (Mahagama Wewa) with its Biso Kotuwa believed to have been constructed during the reign of the King Mahanaga and located in the lower Walawe basin is considered as a prime example of the irrigation engineering skills of the ancient civilization in this part of the country.

1.2 Previous studies on small tanks and tank cascade in Sri Lanka

Irrigation reservoirs, both small and large, have attracted the attention of scholars since the British rule in the country. For example, Cook (1951) attempts to relate the spatial patterns such as distribution and density of tanks to climatologic and ecological factors. Studies carried up later observe 'a greater preponderance of these reservoirs in the ancient kingdom of Rajarata centered around Anuradhapura and in the principality of Rohana in the Southeast part of the island. In some localities the density of tanks exceeds 15 for an area of mere 10 km2' (Maddumabandara 1985). As these tanks are numerous some scholars hesitate to believe that they were operational during the same period of history. Some believe that they were operational but were not used entirely for irrigation but for storage purposes, to support animals and to maintain higher ground water levels

(Maddumabandara 1985). It can be believed that livelihood systems of the village community depended entirely on small tanks. In dry periods they maintained vegetation, served purposes such as recharging shallow wells used by people for drinking and other domestic uses and fish in village tanks provided nutritions requirement of people.

The studies further illustrate that while 'a large number of these tanks are operational at present, a considerable proportion lies in an abandoned state under forest cover' (Maddumabandara 1985). The reasons for the continued and present abandonment of these tanks as pointed out by these scholars are explained in the following lines: 'They lack adequate catchment area, they lack suitable agricultural soils for viable settlements, they are economically and from and engineering perspective non-viable, they lack approach roads, or are located far away from human habitation, or they are situated in forest reserves and nature reserves or wild life sanctuaries' (Abayasinghe 1982). Panabokke observes that "the primary reason for the preponderance of abandoned small tanks in the semi-arid environment in some parts of SP is the occurrence of the readily dispersible sodic soils in the narrow inland valley bottoms across which these small tanks have been constructed. Tank bunds made from such soil material are unstable during the rainy period and can cause breaching of embankments and ultimately the abandonment of tanks" (Panabokke et al 2002).

Small tank systems are perceived as human adaptation to the rainfall pattern, a water harvesting system that enables, through irrigation, to change the uneven distribution of water (as moisture stored at the time of abundance can then be released later on to supply the plant). Finally, the real blessing of the tank system is that it is an ever active "risk minimization process" (Tennakoon 1986). The physical environment of the Dry Zone has also favored an intervention like small tank as pointed out by Somasiri: 'It is not surprising that tank irrigation systems became a permanent feature in the Dry Zone landscape. The climatic, geomorphologic, soil and surface hydrological conditions all favor the establishment of irrigated systems in the Dry Zone of Sri Lanka' (Somasiri 1979).

The general layout of tank villages in the Dry Zone of NCP has been described in detail by Ievers (1899), Codrington (1938), Peris (1956), Leach (1961) and Yalman (1967). As Brow (1968) points out, apart from a recent changes in house sites, Rhys Davis' description still holds: "Each village consists, firstly, of the tank and the field below it; secondly, of the huts of the shareholders hidden in the shade of their fruit trees, each under the bund or along the sides of the field; and thirdly, of all the waste land lying within the boundaries of the parish or the village" (Davis 1871).

Some studies highlight the relationship between the tank and the village settlement and the land use pattern (Tennakoon 1974). The social organizations and community aspects in tank villages in NCP have also been addressed by anthropological studies like Pul Eliya (Leach 1961) and The Vedda Villages in Anuradapura district (Brow 1968). These studies on village communities report that the agrarian economy of villages in NCP underwent massive changes after 1953. "Increased production for the market and rapid spread of wage labor, which were the most profound of the changes, seriously threatened a form of social order the fundamental features of which appear to have been continuously reproduced, with only minor modification, through many previous generations. In the absence of paddy cultivation (due to drought conditions, leasing of lands to outsiders etc.) and absence of lands with long fallow periods suitable for chena cultivation, the social relationship of production forged few economic connections among the various households. Most highland cultivation was done by households independently, while wage labor was mainly performed for outsiders" (Brow 1992).

Some of these studies highlight the changes in the management of these tanks. During the post independence period village irrigation systems were constructed by their proprietors without aid from the government and maintained by them (Groenfeldt *et al.* 1987). During this period Velvidanes (water headmen) were responsible for the management of irrigation systems. The Velvidane system continued even after independence. However, responsibility for maintaining minor irrigation systems was taken over by the Ministry of Agriculture and Food. In 1958 the Department of Agrarian Services was established with the introduction of paddy land act and with this reform the age-old Velvidane system was replaced by the Cultivation Committees. It is pointed out that the objectives of these reforms could not be achieved due to problems such as degradation of leadership, discipline and maintenance. More reforms in the organizations came in the 1960s with the introduction of cultivation officers involved in the management activities in small tanks. The post 1970 period was characterized by the intrusion of politics in rural villages of Sri Lanka as noted by many social anthropologists and sociologists: "The post-1970 era in rural Sri Lanka witnessed increased party political intervention in local village organizations. A clear indicator of this process was the move from election of office-bearers of the cultivation committee (CC) to their appointment by political leaders. This move led to further deterioration of village level irrigation leadership, as the members were appointed by politicians on the criteria of political popularity and the ability to deliver votes in an election. Property ownership, family status and social standing which constituted the traditional criteria of village leadership thus became less important, while the ability to be a good "vote bank" became more important in the appointment of CC members. The culmination of this process of politicization of rural leadership can be seen in the 1979 Agrarian Service Act" (Groenfeldt *et al.* 1987).

2 Methodology and Research Questions

2.1 Methods for data collection and analysis

Data collection methods used in this study included the following:

- Review of existing data and information
- Formal and informal interviews with key informants
- Focus group discussions, and
- Questionnaire surveys in selected sample tank systems.

Data, information and maps available at IWMI, the Department of Agrarian Services, Metrological Department and the Department of Survey were reviewed to document the physical systems of the tanks, their location and socio economic data relevant to this study. The data was further verified and complemented during interviews held with agency officials and farmers. Participatory consultative group discussions with farmers in 7 sample cascade systems selected for the study helped to have a more in-depth understanding of the present performance of the cascade systems and of their problems. Finally, a household survey was conducted in three sample cascades, Kadawarawewa, Aluthwewa and Metigathwala to validate the findings from the consultative group discussions and the interviews. The tanks selected from these cascade systems included Andarawewa, Adiyangamawewa and Bolhidawewa from Kadawarawewa cascade, Gurumadawewa, Neraluwawewa and Kukulkatuwawewa from Aluthwewa cascade and Morakanuwawewa, Higurawewa and Metigathwalawewa from Metigathwala cascade system.

2.1.1 Research Questions

The study concentrated on answering the following research questions on the physical, socio economic and institutional evolution of the sample tank cascade systems in Walawe basin.

- What are the changes that have taken place in tank cascade systems or independent tanks and associated eco-systems and have led to the present situation? What are the accompanying changes in the socio cultural and economic systems in the tank based village communities?

- What are the factors that contributed to the increase or decrease of the number of tanks and tank based communities in the cascades?

- What are the problems associated with water resources in tank systems? What are the factors contributing to increasing or decreasing of water resources in the tank systems?

- What changes are observed in the production systems under these tanks? For what purposes were they used in the past? For what purposes are they being used at present? Are they being used for agriculture alone or for domestic and other uses? What are the current production related problems faced by the communities in these tank systems?

- What changes are observed in the institutions managing (especially in operation, maintenance and seasonal cultivation plan implementation) these tank systems?

- What trends can be envisaged with regard to the changes of hydrology and the socio-economic condition of these tank systems and tank based communities in future?

2.1.2 Description of the sample cascades and rationale for their selection

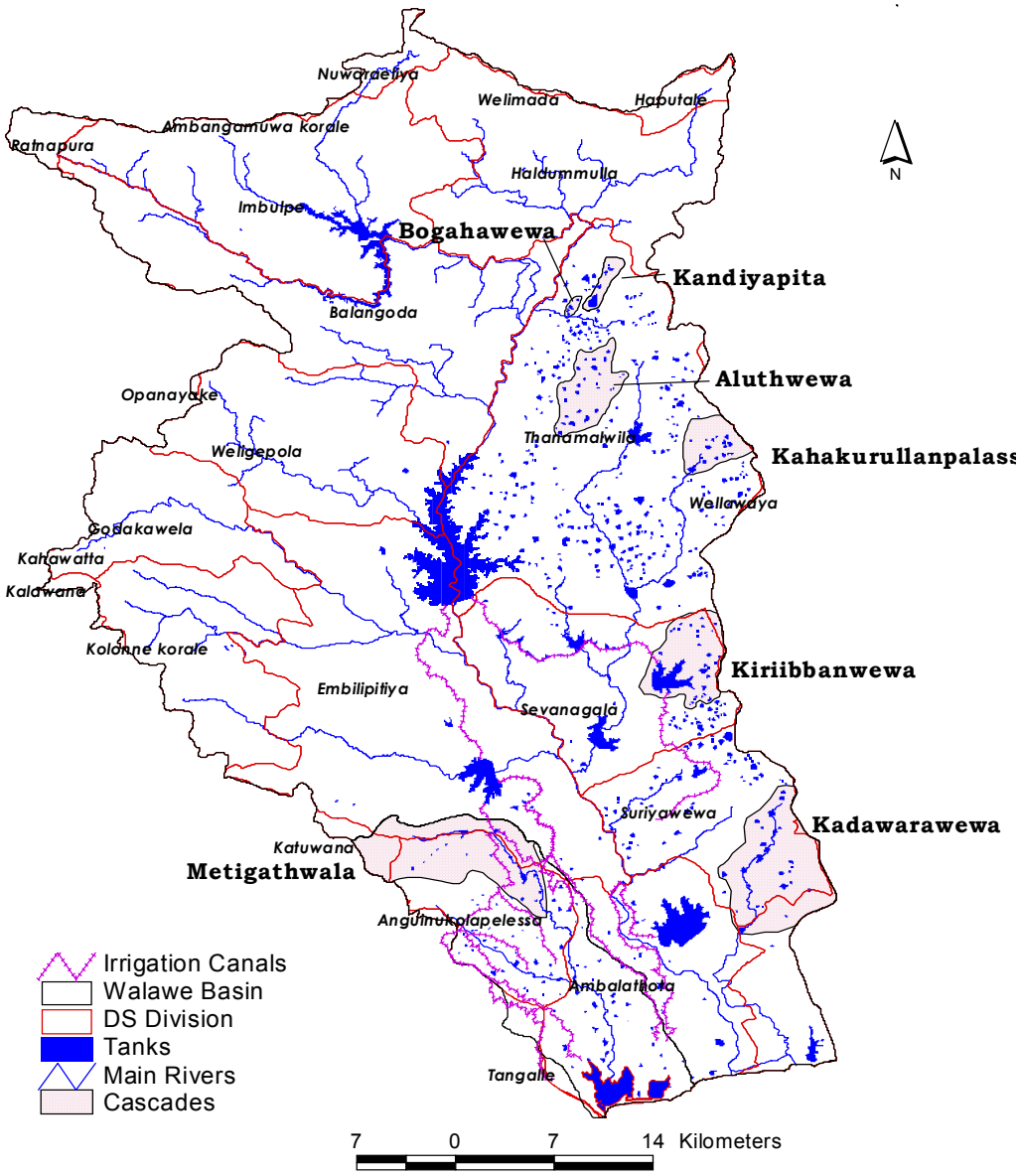
The criteria for selecting the sample cascade included their geographical location in the basin (head, middle and the tail), size of the cascade, size of the command area and number of tanks under them, and their incorporation (or not) into the major irrigation systems. Figure 2 shows the location of the seven cascade systems in the basin. The information on the cascade systems based on these criteria is presented in Table 1. Maps of the individual cascade systems are found in Figures 1 -7 in Annex 1.

Table 1. Information on the sample cascade systems.

Name of the cascade	Location in the basin	Administrative divisions (DSS)	Size (km2)	Number of tanks	Size of command (ha)	Incorporation in to major systems
Kadawarawewa	Tail	Suriyawewa and Ambalantota	56	18	115	Being partly incorporated
Metigathwala	Tail	Agunakolapalasse and Ambalantota	51	18	346	Partly incorporated
Kiriibbanwewa	Middle	Thanamalwila	30	7	621	Partly incorporated
Kahakurullanpalasse	Middle	Thanamalwila	15	4	28	Independent
Aluthwewa	Middle	Thanamalwila	21	17	62	Independent
Bogaswewa	Head	Thanamalwila	4	6	140	To be partly incorporated
Kandiyapita	Head	Thanamalwila	4	3	172	Independent

(Source: Focus group discussions and interviews)

Figure 2. Location of the selected cascades



Out of these systems, Kadawarawewa, a system undergoing massive changes under Walawe Left Bank extension project, Metigahtwala, a system partly incorporated into Walawe Right Bank system and Aluthwewa, an independent system in the middle of the basin, were selected for the household survey.

Administratively the Kadawarawewa Cascade system falls within two DS divisions, Suriyawewa and Ambalantota in Hambantota district, while Metigathwala cascade system falls within Agunakolapalessa and Ambalantota DS divisions. About 90% of the tanks in Kadawarawewa system are being incorporated in to Uda Walawe Irrigation System under the Walawe Left Bank Irrigation Upgrading and Rehabilitation Project. In Metigahthwala cascade, the tanks below Kachigala Wewa

(Metigathwala, Jadura Maha Wewa, Mahawela Wewa and Sadunkatuwa Wewa) started receiving water from Uda Walawe irrigation system after Uda Walawe Right Bank Main Canal (RBMC) was connected to Kachchigala tank in the 1960s. Kiriibbanwewa, Kahakurullanpalasse, Aluthwewa, Bogaswewa and Kandiyapita cascade systems are located in Thanamalwila DS division. Kiriibban Wewa in the tail of Kiriibanwewa cascade was incorporated into Uda Walawe irrigation scheme and started receiving water from a feeder canal from Uda Walawe Left Bank Main Canal (LBMC) in the 1960s. Some tanks in Bogaswewa cascade are to receive water from the forthcoming Weli Oya diversion scheme.

2.2 Present status of small tank systems

2.2.1 Origin and evolution of the small tank systems and tank communities

Almost all the small tank cascade systems studied in Walawe basin are ancient ruined tanks rehabilitated and renovated by the people who migrated to the area from time to time within the past 200 years or so. Except for two larger tanks, Metigahthwala and Kachchigala in Metigathwala cascade on Kachchigala ara, with legends running back to the reigns of King Dutugamunu (2nd century BC) and King Walagambahu (1st century BC), there are no references to the other small tanks in folktales, legends or chronicles. However, some of them appear in the administrative reports and diaries of colonial government officers during the British period. The process of development of communities and tank systems in the cascade differ from one cascade to the other, hence their development process is discussed separately in detail below.

Except for one tank (Weerege wewa) all the other tanks in Kadawarawewa cascade can be considered as ancient tanks renovated and rehabilitated during the British period and after independence. None of the tanks in this cascade appears in the Appendix III of the Sessional Papers (1867) indicating the names of existing irrigation systems in the Southern Province of Sri Lanka at that time. Participatory group discussions with the members of these communities reveal that these tank communities migrated to the area after 1950 in search of arable lands for chena cultivation and later settled down close to the tanks and renovated them. However, some members of the farmer community in Adiyangama claimed that they have a long settlement history extending more than 200 years back. Leonard Woolf's diaries (1908-1911) describe the situation of a village known as Andarawewa in this cascade area in 1911. "Walked to Andarawewa. This is a depopulated country which I have not seen before. There is no longer any village at Andarawewa: Inhabitants all died or left some five years ago. One old man who came with me used to live there. He owns land under the tank: its only use to him is that a year or two ago he went to jail for not doing earth work. This tank must be struck off or the lands sold to people who can restore the tank" (13 January, 1911). The farmer families in the cascade area have migrated from Beliatta, Middieniya, Kirama, Tangalle, Katuwana, Bolana, Dickwella and Baragama, all in Hambantota district. Lands under some tanks have been developed by the second generation members of families settled in the area in the 1950s.

Farmers in the headstream part of Metigathwala cascade system (up to Kachchigala) tank claim that these tanks were constructed during the reigns of the King Dutugamunu (2nd century BC). Kachchigala and Metigaltwala tanks are claimed to have been constructed during the reigns of the King Walagambahu (1st centuary BC). Metigathwala (which means clay pit) had been named as "Menik gathwala" (gem pit) in the past because there was a gem mine at that spot. The other three tanks, Jadura Maha wewa, Mahawela wewa and Hadunkatuwa are also identified as forming an ancient irrigation system with a history running back to the ancient hydraulic civilization in the

country. However there is no evidence to support that the communities have a historical continuity running back to these ancient periods. Instead, with a few exceptions, the majority of these communities can be considered to have migrated to the area during the early British period and after independence. The diaries maintained by the colonial administrators during the British period indicate the existence of small tank based village communities in this cascade system. For example, the notes of the Assistant Government Agent, Sabaragamuwa illustrates the situation in Higura wewa area in 1914 in the following lines:

"The people in this wasama are sickly and diseased and appear to live miserable life owing to the bad climate and the defective rainfall. It was the dream of late Mr. Wace (former AGA) to picture this fever-stricken spot a land of plenty when the Higure-ara wewa was restored. This tank gives an unfailing supply of water. There are over 1,000 acres[3] of irrigable land under it. The work was restored 15 or more years ago but today there is not a single paddy field under cultivation. Some years ago some 200 odd acres was sold under *the Kaltota lease system* but the purchasers only chenaed the land and then decamped. At present the lands are overgrown with thick low jungle. It has been suggested to sell the lands outright after cutting up the lots in to smaller ones but it is practically certain no villager will buy them. He has not the money and even if he had there are not Goiyas to cultivate it. Unless a wealthy capitalist comes to the rescue and imports families into the district, I am afraid this excellent work will always remain a failure" (Diary extracts, 6 April 1914).

The tanks in Metigathwala cascade system appears in the famous diary of Leonard Woolf, AGA, Hambantota from 1908 to 1911. The extracts from these diaries appended below explain the situation in the area in the early part of the 20th centaury. "I started on the Gamsabawa path to **Dabarella** and then Kiwala wewa a poor tank to Kandekatiya. Here or just past it is a fine piece of forest showing what magnificent country this must have been before chenas ruined it …… Just through the jungle is **Metigatwala** wewa, a really magnificent village tank with a bund as good as many a major work can boast. There are 45 amunus under this tank and I believe the whole extent belongs to Mulkirigala Vihare. The Kachchigala ara flows into it …".

"From **Mwetigatwala wewa** rode to Dickwewa (1 ½ miles) and Abesekaragama there doubled back through Gopalasse to Agunakolapalasse (4 miles) Gopelesse or Bopalesse is an interesting village. It too has a wonderfully good village tank but no water. The people came in a body to me and said they only wanted one thing and that was water to drink. There is however another tank here called **Mahajadura** the bund of which is badly breached. The people want to restore it as **Kachchigala ara** flows through it" (19 March, 1909).

Woolf's diaries throw light on the tank restoration activities undertaken during the British period in the tanks under Metigathwala cascade. "Rode to **Talawa** 10 miles. Inspected on way ……(2) **Kudagoda wewa**. Poor bund. A year's work should complete this too. Great want of water in **Kudagoda**. A well has been sunk 30 feet or so only to find rock. …… Inspected **Talawa** government school: fairly satisfactory.

In the evening inspected (1) **Talawa Madamalanga wewa**, (2) **Talawa Aluth wewa**, (3) **Talawa Dammana wewa**. All being well restored and should be finished next year. …. (4) **Dabarella wewa**,

[3] 1 acre = 0.40469 ha

ditto. The villagers told me they did not want a pipe sluice; they want a channel cut from the Urubokka oya 10 or 12 miles away" (29 October 1908).

Some of the tanks in the cascade appear in the Appendix III of the Sessional Papers (1867) indicating the names of existing irrigation systems in the Southern Province of Sri Lanka at that time. These tanks include Kachchigala wewa, Liyangahawewa, Dabarellewewa, Higurewewa, Dammanewewa, Madamagawawewa, Aluthwewa, Vedagewewa and Metigathwala Mahawewa.

The communities living in the small tank villages in Kiriibban wewa cascade are new migrants to the area in 1950s. They have come mainly for chena cultivation. Some of them had settled down in Sevanagala area by the time the government started a sugar factory in Sevanagala. The government allocated them new land, 3 acres of highland for each family in the cascade area after taking over their land in Sevanagala for a sugar cane farm run by the government. These re-settlers made their permanent residence in the cascade area in the 1980s. In addition, people migrating from areas like Katuwana and Middeniya in Hambantota district also settled down in this cascade. Almost all the people who have migrated to the small tank villages in this cascade came from Hambantota district. Though the area was covered with jungle at the time these new communities settled down in the area. It is evident from the ruined tanks scattered all over the cascade that there were village communities settled there in the ancient past. Almost all the existing tanks in Kiriibban wewa cascade systems are renovated or rehabilitated old tanks. Though there are some more ruined tanks in the area there is reluctance on the part of the settlers to renovate these tanks because their lands are in the water spread areas of the tanks.

The history of the settlement in Kiriibanwewa area is quite different. It is said that 637 families of the employees of the Land Development Department were settled in Kiriibbanwewa area, 101 on in the Left bank and 105 in the Right Bank after renovation of the tank in the 1960s. They were paid their salaries till they reaped their first harvest after cultivating the land under the scheme. The scheme was taken over by the River Valley Development Board in 1970, when the area was incorporated into the Uda Walawe Irrigation Scheme: the command area under the tank was expanded and new settlers were brought in.

The communities in Kahakurullanpalasse cascade live in Uruhore, Kahakurullanpalasse and Arebekema villages. They have migrated to the area in the 1960s for chena cultivation from Embilipitiya in Ratnapura district and Middeniya in Hambantota districts. They have made temporary residence in the area initially and said to have restored Uruhore and Kahakurullanpalasse tanks which were in a state of abandon in 1970. Two people who came to the area for chena cultivation settled down in Arebekema and constructed two private tanks, Rangewewa, and H.K.T tanks during the same period.

Communities cultivating under most of the small tanks in Aluthwewa cascade are settled in Aluthwewa, a fairly old village located close to Hambegamuwa. The interviews with the old villagers in this village revealed that migration into Aluthwewa started in 1850 and continued until the 1980s. People settled in Aluthwewa have migrated from Haldummulla, Bambarabedda in Balangoda area and Hambegamuwa area. The other tank villages in the cascade are Kelinbunna, Millagala and Kukulkatuwa. The communities have migrated to these villages from Balangoda area and Hambegamuwa. The discussions with them revealed that their ancestors migrated to this area during the British period in search of land for chena cultivation. The Waste Land Act implemented during the British period and the later takeover of the forest lands by planters for tea cultivation might have had

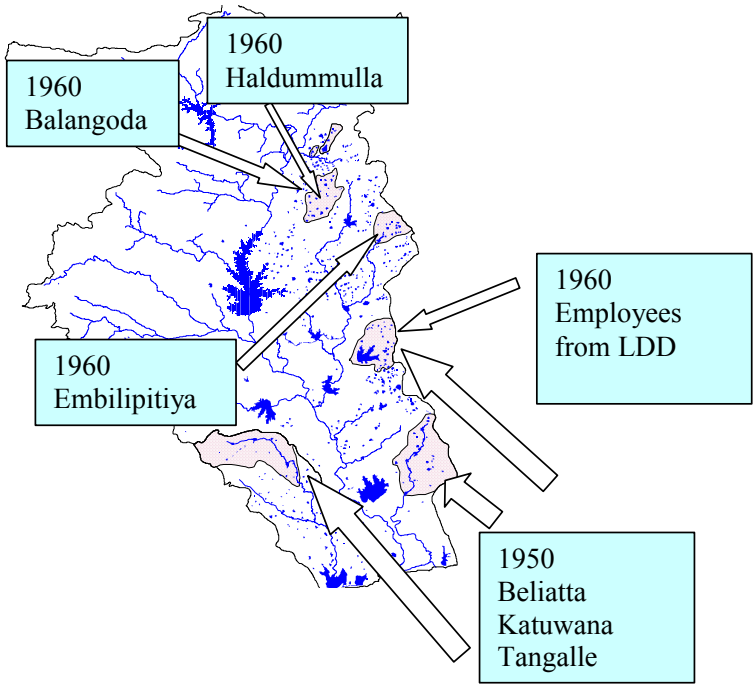
serious impacts on the peasantry in the upcountry areas, who used the forests for chena and highland crop cultivation. It might have driven them to migrate into the isolated Monaragala districts where the authority of the colonial administration was somewhat weaker. The area had also been an attraction for criminals and those who wanted to earn money by illicit means such as cultivation of hemp ('ganja'); it is said that a lot of people from Hambantota area migrated to this area for embarking on such activities through which they can become rich within a short period. There are a lot of businessmen who initially started growing hemp and gave up later after becoming rich.

The communities in Bogaswewa cascade system are settled in Mahanetula, Kudanetula, Divulana and Bogaswewa villages. They are second-generation members of the families settled in Medabedde irrigation settlement scheme and areas like Balangoda and Ellepola. Most of the families in these villages are said to have migrated to the area for chena cultivation in 1960s and settled down there permanently in 1970s after restoration of abandoned breached tanks existing in the area.

Communities cultivating under Kandiyapitiya and Mahakivula tank under Kandiyapita cascade are from Welimada and Medabedda irrigation settlement area. The people from Welimada came to this area in 1974 to start a cooperative sugar cane farm under the government youth settlement scheme for the rehabilitated youths who took part in the insurrection of the Janatha Vimukthi Peramuna (JVP) in 1971. This was a program implemented by the government to solve the unemployment problem perceived as one main reason for the insurrection. These youths renovated Kandiyapitiya tank and started paddy cultivation along with the cooperative sugar cane farm. Those who developed the Mahakivula tank are the second-generation members of the settler families in Medabedda irrigation scheme. They migrated to the area for chena cultivation and later settled down there as they do not own lands in the settlement areas (Figure 3).

The data from the household survey conducted in sample tank systems in 3 selected cascades further validate the findings from the focus group discussions that a majority of people in the upstream areas are from Badulla and Ratnapura districts while those in downstream are from Hambantota districts and they have migrated to the areas mainly for pursuing livelihood activities like chena farming; most families have no settlement history exceeding 100 years. For example, out of the 35 sample families in Aluthwewa 16 % claim that they have been living in the area for more than 100 years while only 1% of families in Kadawarawewa have such a long settlement history. In contrast to Aluthwewa and Kadawarawewa inhabited by recently migrated communities, the number of families claiming an ancestry over 100 years is significant (29%) in Metigathwala, a cascade where old villages existed even during British colonial period.

Figure 3. Migration flow in 1950 to 1960



All the families in the 3 cascades have either migrated to the area for chena cultivation or are descendents of such people. More than 90% of people migrated to Metigathwala and Kadawarawewa cascades in Hambantota district are from areas in Hambantota district while the rest are from Matara and Trincomalee districts. In Kadawarawewa migrants came from areas like Hambantota, Weeraketiya and Tangalle in Hambantota districts while in Metigathwala migrants are mainly from Ambalantota, Beliatta, Hakmana, Hambantota, Tangalle in Hambantota district. Almost all the families in Aluthwewa area are migrants from areas in Badulla, Ratnapura and Monaragala districts or their descendants. These areas include Wellawaya in Monaragala districts, Haputale in Badulla district and Balangoda in Ratnapura district.

2.3 Tank density

Tank density in the 7 cascade systems under the study are given in Table 2. It can be observed that there is one tank for 1.6 km^2 in Kadawarawewa, 4.25 km^2 in Metigathwalawewa, 0.8 km^2 in Kiriibbanwewa, 14 km^2 in Kahakurullanpelesse, 2.0 km^2 in Aluthwewa, 1.0 km^2 in Bogahawewa and 7.5 km^2 in Kandiyapita. Highest tank densities are observed in Kiriibbanwewa and Bogaswewa cascade system while the lowest tank densities are observed in Kahakurullanpalasse and Kandiyapita cascade systems. Though tank density is high in Kiriibbanwewa cascade, 60% of the tanks in this cascade system are not used for agriculture.

Table 2: Tank density in Cascade systems in Walawe basin

Name of the cascade	Number of operational tanks	Cascade area in km2	Area per tank in km2
Kadawarawewa	13	21	1.61
Metigathwala	12	51	4.25
Kiriibbanwewa	5	4	0.8
Kahakurullanpalasse	4	56	14.0
Aluthwewa	15	30	2.0
Bogahawewa	4	4	1.0
Kandiyapita	2	15	7.5

(Source: Focus group discussions and interviews)

It is also noteworthy that in the cascade systems falling within Hambantota district, tank density ranges between one tank per 0.8 km^2 to one tank per 4.25 km^2. In the basin area falling in Monaragala district tank density is higher and ranges between one tank per 1 km^2 to one tank per 14 km^2.

Table 3: Tank densities in different districts in Sri Lanka

Name of the district	Number of operational tanks	District area in km2	Area per tank in km2
Anuradhapura	2334	7205	3.0
Hambantota	446	2613	5.8
Monaragala	285	5758	20.2
Kurunagala	4188	4901	1.1

(Source: Data Books, Agrarian Services Dept.)

Comparison of tank densities in different districts is given in Table 3. The highest tank density of one tank per km^2 is observed in Kurunagala district falling within the intermediate zone. In Anuradhapura tank density is one tank per 3 km^2, against one tank per 5.8 km^2 in Hambantota and one tank per 20 km^2 in Monaragala, the two districts in which the cascade systems under this study are located. Lower tank densities are observed in Monaragala compared to Hambantota district. As Panabokke points out average tank density is one tank per 2.6 km^2 for the Northern Province (NP), North Central Province (NCP) and Southern Province (SP). For the North Western Province (NWP) the density is around one tank per 1.2 km^2'. In Panabokke *et al.*'s (2002) view, distribution pattern of small tanks in these districts "conforms to both the nature of the overall rainfall regime as well as the nature of the geomorphology of the region".

2.3.1 Functional tanks and abandoned tanks

As shown in Table 4, out of 18 tanks in Kadawarawewa cascade, 6 (33%) are in abandoned state, two of them from the time people migrated to the area some 20 years back. Three tanks which were functioning were abandoned due to water shortage and were not restored as their restoration would

have created water shortage in the main village tank, further downstream. The larger tank in the tail end was abandoned after it was incorporated into a major irrigation scheme. The command area of this tank now receives irrigation water from the irrigation system. In Metigathwala cascade too, 33% of the tanks in the upstream areas have been abandoned due to water shortage. However, comparison of the command areas of some of these tanks with those of the British period shows that the crop area increased tremendously in recent times. This may have been the main reason for water shortage in these systems and their abandonment at present. Out of the seven tanks in Kiriibbanwewa cascade, 2 are not functional now. This has happened after the construction of Mau Ara canal which disturbed the natural drainage canals flowing into these tanks. In Kahakurullanpalasse cascade one tank out of four is not functional. This is due to the breach of the tank bund after heavy rains several years back. In Aluthwewa cascade 2 tanks out of the 17 tanks are not operational. The people are not interested in restoring one tank in this system as the land area to be developed under it is marginal. The other tank in the tail end of the cascade is located in the wildlife reserve in which people are not allowed to engage in cultivation activities. Out of the 6 tanks in Bogaswewa 2 tanks are abandoned since 1975, when they breached after heavy rains. In Kandepitiya one tank out of 3 is in a state of abandonment from the time people migrated to the area.

Table 4: Functional tanks and abandoned tanks in sample cascade systems in Walawe basin

Sample cascades	Abandoned	Operational	Total	Abandoned (%)
Kadawarawewa	6	12	18	33
Metigathwala	6	12	18	33
Kiriibbanwewa	2	5	7	29
Kahakurullanpalasse	1	3	4	25
Aluthwewa	2	15	17	12
Bogahawewa	2	4	6	33
Kandiyapita	1	2	3	33

(Source: Focus group discussions and interviews)

Previous studies on small tanks in Sri Lanka reports the occurrence of tank abandonment is high in "Northern Province (NP) and Southern Province (SP), where over 50 percent of the approximately 1,400 small tanks in each province are in an abandoned state". It is pointed out that "the mean annual rainfall as well as the *maha* season rainfall is lower in the SP and NP than in the NCP and NWP. The tanks also tend to be less stable because of the sodic soils that are prevalent in the SP" (Panabokke, 2002).

The major reason for abandonment of tanks in the cascades studied may be the expansion of the command areas of these tanks under different programs from time to time without adequate attention for the hydrology of the entire cascade system. The expansion of the command area may have been required to meet the needs of the growing population. However, it has not brought expected benefits from the tank rehabilitation and improvement programs when command areas were increased without a reliable water source. Positive changes are observed in tank rehabilitation and improvements programs in tanks such as Metigathwala, Kachchigala and Kiriibbanwewa which receive irrigation supply from Uda Walawe major irrigation scheme. Also Maddumabandara's (1985) argument that the abandoned tanks in Rajarata might not have used in the past entirely for irrigation but for storage purposes and to support animals and to maintain higher ground water levels may hold true for the

abandoned tanks in Walawe basin too. Attempts at a later stage to use these tanks for irrigation purposes might have led to failures and abandonment of tanks subsequently. It is also noted that once a tank breaks after heavy rains, the tank communities have no capacity to renovate it and have to seek the assistance of the government. This takes a considerably long time, sometimes till a donor funded tank rehabilitation program comes into operation. Some tanks in these cascade systems lie in abandoned state due to this reason too.

2.4 Size of the command areas

It can be observed from the data on the size of the command area in Table 1 in Annex 2 that most of the tanks in the sample cascades are in the 6-20 ha size range. In Kadawarawewa, Metigathwala, Kahakurullanpalasse more than 70% of tanks are in this category while in Aluthwewa and Kandiyapita and Bogaswewa they are 90%, 50% and 25% respectively. Tanks in the size class of 20-40 ha are found in Kadawarawewa (23%), Metigathwala (6%), Kahakurullanpalasse (25%), Aluthwewa (6%) and Bogaswewa (25%). Larger tanks exceeding 40 ha are found in Metigathwala (22%), Kiriibbanwewa (20%), Bogaswewa (50%) and Kandiyapita (50%). In these systems larger tanks are found in the tail end of the cascade systems or upstream areas of the basin receiving water from Balangoda hilly areas. It can be observed that the dominant size class of tanks in the middle and downstream areas of the basin is 6-20 ha. These systems, Aluthwewa, Metigathwala and Kadawarawewa and Kahakurullanpalasse are in flat terrain and are characterized by low rainfall which may be the primary reasons for the preponderance of small tanks.

Table 5 shows that command areas of these tanks have changed from time to time. For example in Metigathwala system, the command area increased in the past and has now decreased in the upper reach of the cascade, which has not been incorporated into the Uda Walawe Irrigation Scheme. This decrease is mainly due to the abandonment of the command areas due to water shortage and physical system deterioration.

Table 5 : Change of the Command area in cascade systems

Sample cascades	Extent (ha)		Change (%)	
	Present	Past	Increase	Decrease
Kadawarawewa	115	127	-	9
Metigathwala	346	521	-	34
Kiriibbanwewa	621	253	145	-
Kahakurullanpalasse	28	40	-	30
Aluthwewa	62	29	114	-
Bogahawewa	140	97	44	-
Kandiyapita	172	32	437	-

(Source: Focus group discussions and interviews)

2.5 Tank capacity

With the exception of a few tanks, there are no data on tank capacity or the extent of the water holding area and the depth of the tanks at the agencies. In the focus group discussions the farmers expressed different opinions on the extent of the water holding area and the depth of the tanks and the

information appeared to be less reliable. The common view held by the farmers as well as the agency officials were that the tank capacities have been significantly reduced due to the silting and sedimentation of tank beds with the development activities in the tank catchments. Tank catchments are used by the communities for chena cultivation and residential purposes after clearing existing forests.

2.6 Physical conditions of the tanks

Physical system deterioration is a major problem in these tank systems. Based on their observations and local knowledge on the systems, the farmers pointed out at the focus group discussions that some components of the physical system have deteriorated in each tank. According to these information, bunds have deteriorated in 46% of tanks in Kadawarawewa cascade, the tank bed has been silted, reducing the tank capacity, in 92% of the tanks, sluices were damaged and not operable or leaks occur through them in 46% of the tanks, while tanks spills were damaged or not in good condition in 37% of them. The canals were physically deteriorated in 92% of the cases, as shown in Table 6. Major problems reported in all these systems are silting and sedimentation of tank bed due to soil erosion in catchments. The second major problem common to all the tank systems is the deterioration of canal systems, which are rarely addressed by tank rehabilitation programs. There is no effort on the part of farmers to improve the conditions of canals and their maintenance activities are limited to routine maintenance. In many privately owned tank systems in Aluthwewa spillways are made of clay, hence they are washed off during rainy periods creating problems for the farmers in these systems. Some tanks in these systems have no proper sluices and farmers find it difficult to manage water due to this problem.

Table 6: Physical System Deterioration in Cascades (% of tanks deteriorated)

Sample cascades	Bund	Bed	Sluice	Spill	Canals
Kadawarawewa	46	92	46	37	92
Metigathwala	92	100	67	50	67
Kiriibbanwewa	0	100	40	20	80
Kahakurullanpalasse	50	100	50	0	25
Aluthwewa	73	100	73	80	100
Bogahawewa	0	100	0	0	75
Kandiyapita	0	100	0	0	100

Source: Focus group discussions

2.7 Rehabilitation and renovations

The small tank systems in these cascades have been rehabilitated from time to time either by the farmers themselves, or government agencies and donor funded projects implemented either by NGOs or the government. For example out of the 13 functional tanks in Kadawarawewa 7 (54%) have been rehabilitated during the period from 1995 to 2001, one by a NGO, 4 by ASD, one by the National Irrigation Rehabilitation Project and one by the Samurdhi Authority. Similarly more than 90% of tanks in Matigathwala, 66% in Kahakurullanpalasse, 100% in Bogaswewa, Kiriibbanwewa, Kandiyapita and Aluthwewa have been rehabilitated from time to time by farmers or by special projects implemented by the government or NGOs. Most of these rehabilitation activities have been

implemented during the past 2 decades. Main activities attended have been tank bund strengthening, sluice and spill improvements. Improvements of canals under these programs are rarely observed. It is noted that only the tanks rehabilitated or improved during the last five years or so are in good conditions. In systems like Metigathwala most of the tanks in the upstream area are not maintained properly and are likely to deteriorate further in the near future.

2.8 Sources of water

Several main streams have been tapped to construct tanks under Kadawarawewa cascade system. They include Weerege ara (stream), Kenganga ara, Maha ara, Andara ara and Palubedda ara. These streams have not been much affected in the past due to the human interventions like chena farming and settlements because the area was little populated. With population increase these catchments have been encroached by people for chena cultivation and settlement. As a result Andara ara which drains into Andara wewa, Kengaga ara draining in to Vedi wewa, as well as other streams feeding the tanks in the cascade are silted up due to soil erosion in the catchments.

The main streams in Metigathwala cascade system are Talawa ara, Middeni ara, Kachchigal ara and Bogal ara. They drains to Higura wewa and finally to Kachchigala wewa which has been incorporated into Uda Walawe irrigation scheme in 1960s by constructing the Right Bank Main Canal (RBMC) of the scheme through this tank. In addition to drainage water tanks below Kachchigala receives a regular water supply from Uda Walawe system too.

Tanks in the Kiriibban wewa cascade system receive water from Idunilpura ara, Siyabalagas ara, Naiwala ara and Weli ara originating in Uda Walawe wildlife reservation. The cascade was severed in 2001 by the construction of Mau ara canal[4]. However, it is reported that the Mau ara canal has been constructed in such a way as not to disturb the drainage canals running into the tanks and there is no evidence to support that abandonment of tanks in the cascade is due to the construction of the canal. These tanks are believed to have been abandoned even prior to the Mau ara irrigation development project implemented from 1999 – 2001.

Uruhore ara originates in Devagiri hills and is the main stream feeding Kahakurullanpalasse cascade. After feeding Uruhore wewa it drains in to Kakurullanpalsse and from there to H.K.T. wewa and Rangawewa, two privately owned tanks in the downstream area. Rangawewa, in the tail, drains in to Galkada ara which finally flows into Galamuna wewa, recently constructed in the wildlife reservation area. The main streams feeding the tanks in Aluthwewa cascade system also drain through the National Park and empty into the Mau ara at the location of the Galamuna wewa. Kavudueliya wewa located in the Uda Walawe wildlife reserve area and Rotamada wewa have been abandoned for a long time. One main specific character of this cascade system is the existence of several tanks privately owned by farmers.[5]

The main streams in Bogahawewa cascade receive runoff from Wellankada, Mahanetula and Rankatuwa hills located in Balangoda area, and the cascade has an adequate water supply for

[4] This canal diverts water from the Mau ara to the adjacent water short Malala basin. The starting point is the Galamuna wewa.

[5] They include Heenwewa, Kelinbunna, Gerioluwa, Mawuwewa, Thanakoratuwa, Udaha Aluth wewa, Pahathwala wewa, Rakinawale wewa, Wadurangala wewa and Behethmule wewa.

cultivating paddy in Maha in almost every season and in Yala in some years. Excess water in the Bogahawewa cascade, as well as Kandiyapita cascade, drains to Weli Oya and then to Walawe river.

2.9 Water availability and cropping intensity

The farmers in these small tank systems, except those receiving water from Uda Walawe Irrigation Project, reported water shortage as the major problem for their agricultural activities. They tried to explain this situation as a new phenomenon due to shortage of rainfall. Old farmers in these systems informed that they had 100% cropping intensity both in maha (wet) and yala (dry) seasons some 20 years back. This does not really accord with historical records but is believed to illustrate the farmers' creed that water conditions were better in the past. They tried to relate the shortage of rainfall to the disappearance of forest cover due to chena farming and clearing for irrigation development under major irrigation schemes and settlements. However, Leonard Wolf's diaries report prevalence of droughts and crop failures in this part of the country even during the British period and farmers' argument may hold true for the past, when the command areas of these tanks were limited to a few acres.

Cropping intensity can be used as an indicator of water availability. It is apparent from Table 2 in Annex 2 that only one cascade has 100% cropping intensity while in many systems it is above 50% in maha seasons. A very low cropping intensity (28%) was reported from Metigathwala cascade in which a large number of tanks located in the upstream of the cascade facing acute water shortage problems. In the majority of the systems (57%) there is no cultivation during yala season. Around 20% - 28% of tanks in two cascades which receive water from Uda Walawe have 100% cropping intensity in yala. One cascade has 50% cropping intensity in yala season. The interviews with farmers and household survey data substantiate that cropping intensity in tanks incorporated into Udawalawe system has increased both in maha and yala while some increases are observed in rehabilitated and renovated tanks in maha.

2.10 Different water uses

Water in functional tanks is presently used mainly for irrigation, as shown in

Table 7. The second major use is washing and bathing, while the third major use is for livestock keeping. Fishing is pursued as an economic activity in several tanks only. It is noted that water in these tank systems is not used for drinking as water is muddy and full of sediments due to soil erosion in tank catchments. They use water in shallow wells or water provided by the authorities through water tankers. Brick-making is also carried out in these systems by farmers when water level in the tanks is low.

Table 7: Different Uses of Water in the cascades at Present (percentage of responses)

Sample cascades	Irrigation	Bathing, washing	Livestock	Fishing	Drinking	Brick making
Kadawarawewa	100	85	54	46	0	38
Metigathwala	33	17	22	22	0	28
Kiriibbanwewa	60	100	0	40	0	0
Kahakurullanpalasse	75	50	75	25	0	25
Aluthwewa	87	67	0	0	0	13
Bogahawewa	100	0	75	0	0	50
Kandiyapita	100	100	50	0	0	50

(Source: Focus group discussions and interviews)

Comparison of

Table 7 with Table 8 shows significant changes in water uses, especially in drinking and brick making over the years. Though the farmers in the cascade systems used tank water for drinking in the past, they have given up using them for drinking purposes since 1970s for the reason that the tank water was muddy, due to soil erosion in upstream areas after cleaning of the jungle for chena farming. Brick-making has emerged as a new activity in these systems at present.

Table 8: Different uses of Water in cascades before 1980s

Sample cascades	Irrigation	Bathing, washing	Livestock	Fishing	Drinking	Brick making
Kadawarawewa	100	92	54	54	54	0
Metigathwala	94	94	94	74	74	0
Kiriibbanwewa	60	100	0	40	20	0
Kahakurullanpalasse	100	50	50	50	25	0
Aluthwewa	100	73	0	0	20	0
Bogahawewa	100	100	0	100	100	0
Kandiyapita	100	100	0	100	50	0

(Source: Focus group discussions and interviews)

3 Socio economic conditions of the tank communities

3.1 Demographic data

3.1.1 Population and population increase

Population increase can be considered as a main reason for the ecological and socio economic changes taking place in the basin area at present. Vast areas of jungle have been cleared for chena, irrigated rice crop cultivation and settlements, and existing water resources have been tapped for irrigation and domestic uses to meet the basic needs of the growing population. The data collected through focus group discussions (Table 9) shows nearly a two fold increase of families in the cascade systems.

Table 9. Increase in the number of families

Name of the cascade	Families around 1980	2002	Increase (%)
Kadawarawewa	407	1283	215
Metigathwala	280	960	242
Kiriibbanwewa	1221	3224	172
Kahakurullanpalasse	122	296	142
Aluthwewa	125	275	120
Bogaswewa	170	500	194
Kandiyapita	103	248	140

(Source: Focus group discussions and interviews)

It further shows that in many cascades the increase in the number of families was nearly two fold during the past two or three decades. Around 1980, population increased mainly due to migration while after 1980s it was mainly due to natural growth. Control of malaria in the 1940s, irrigation development and land alienation activities toward the end of the British administration and after independence, and land pressure in certain areas of Hambantota for slash and burn cultivation have attracted people to these cascade systems in Walawe basin.

Population in cascade areas is presented in Table 10. It can be observed from the data that higher densities are in areas like Metigathwala and Kiriibbanwewa receiving irrigation water from a regular source like Udawalawe major irrigation system.

Table 10. Population in cascade areas (2002)

Cascade	Population			Population density
	<18	>18	Total	
Kadawarawewa	2393	3375	5768	75
Metigathwala	3889	6262	10151	315
Kiriibbanwewa	1440	1979	3419	115
Kahakurullanpalasse	592	820	1412	65
Aluthwewa	704	933	1637	21
Bogahawewa	1659	2785	4444	56
Kandiyapita				

Source: DS offices (2002)

3.1.4 Education

Table 3 in Annex 2 shows that the majority of people in these cascade systems have primary and secondary education. People with higher educational achievements are more in Kadawarawewa and Metigathwala cascade systems in Hambantota district than in Aluthwewa cascade in Monaragala district. This may be mainly due to the better educational facilities available in Hambantota district.

3.2 Economic status and poverty

Table 11 provides information on status of poverty in the cascade areas. Except in Metigathwala in which several tanks has been incorporated into Uda Walawe major irrigation system, more than 50% of households are below poverty line and receive Samurdhi assistance under the Government poverty alleviation program.

Table 11. Samurdhi recipients

DS division	Number of families		
	Samurdhi recipients	Total	Percentage
Kadawarawewa	879	1727	51
Metigathwala	1362	2824	48
Kiriibbanwewa	519	911	57
Kahakurullanpalasse	245	358	68
Aluthwewa	251	421	60
Bogahawewa	923	1256	73
Kandiyapita			

Source: DS offices (2002)

Household survey data for three sample cascade systems are presented in Table 12.

Table 12. Poverty in sample households

Status	Number of families (percentage)			
	Aluthwewa	Kadawarawewa	Metigathwala	Total
Recipient of Samurdhi	42	83	30	51
Not a recipient of Samurdhi	58	17	70	49
Total	100	100	100	100

(Source: Household survey)

A higher percentage of recipients of Samurdhi, government assistance for absolute poverty groups is observed in Kadawarawewa, mostly devoted to rain fed farming. Previous studies in the area too reports chronic poverty situation in this area (JBIC 2002).

3.2.1 Livelihood activities

The main livelihood activity of the majority of farmers in all the cascade systems is farming. The number of families with members involved in public and private sector activities is not significant in these cascades. In systems like Kadawarawewa a significant number of farmers are involved in cattle farming. There is a fear from their part to provide information on their cattle farming activities, as revealing their income might deprive them of Samurdhi assistance. Therefore, this income earning activity is not reflected in the household survey. However, interviews with farmer leaders in Andarawewa area showed that out of the of 237 families so far settled in Andarawewa unit area, 20 families are involved in cattle farming and the number of cattle owned by them (excluding calves) estimated at 60 percent of grown up animals is around 3,000. The maximum number of cattle owned by a family is around 150. In addition farmers rear goats, as in Andarawewa area, where 12 families are involved in goat rearing and have about 300 goats. The major problem faced by pastoralists is the shortage of grazing land due to the project development activities under the on-going Irrigation Rehabilitation and Upgrading project in Walawe Left Bank area. The farmers in areas like Metigathwala cascade in the developed and irrigated part of Udawalawe scheme have similar

problems over grazing their cattle. They feed their cattle in Hambegamuwa and Aluthwewa in the upstream areas of Walawe basin by hiring people to look after them. It was reported in our discussions with farmers in Aluthwewa that 90 percent of the cattle in their area belongs to farmers in Padalangala, Kachchigala and Katuwana in the downstream part of Walawe basin. Earlier these cattle herds occupied the wildlife reservation area and now the wildlife authorities fine the cattle owners if they find them grazing within the reservation. Fishing had been a main income earning activity for some families in systems like Bogahawewa and Kandiyapita in the upstream areas. This has been given up now with the reduction of fish population after a severe drought experienced some years back. Fishing is not pursued as a main income activity in the downstream area cascades. In addition to these activities, people living close to forest areas collect firewood, fruits and yams, honey etc. and are also involved mainly in wage labor and different kind of self employment activities like carpentry and masonry work.

A special case is that of the cultivation of ganja (cannabis), a very high income generating activity in the cascade system areas like Kahakurullanpalasse and Aluthwewa. Farmers never mention this as one of their main income sources because this activity is illegal. On average the expenditure involved in one acre of ganja is around Rs.100,000, while the total return is around Rs.600,000 – 800,000 (8000 U$). The return depends on the quality of the crop. The selling price of good quality ganja is around Rs. 5,000 per kilo. When it is transported to Colombo and other major towns, price is around Rs. 12,000 per kilo. Commenting on the development of ganja cultivation a resident in the area said that "prior to 1950s a few people in the area cultivated ganja on a small scale. After 1950s people migrated to the area from Katuwana, Middeniya, Walasmulla and Beliatta in Hambantota district started growing ganga on a large scale. In those days people from outside were scared to come and settle down in the area for fear of the ganja growers, many of whom were criminals. The nearest police station in Wellawaya is about 35 km away from these cascades and therefore ganja growers can operate as they wish. However, there was a huge raid on ganja growers by the police and the Department of Excise, (Government agency dealing with illicit liquor and narcotics) in 1956 which destroyed the ganga cultivation in the entire area. Ganja growers were discouraged and people started to migrate to the area for chena cultivation. Now the situation is entirely different. The majority of the people in the area grow ganja again, even in their home gardens. Rich people from outside areas invest in ganja. They hire people from the area or provide them money to grow ganja. People in the area have been able to build luxurious houses because they have a very high income. There are raids by the police but people continue to cultivate ganja".

The main livelihood activity of the families in the sample cascades in which household survey was conducted is farming as shown in Table 13. However, the number of families with members involved in public and private sector employment is high in Metigathwala. These members are employed mainly in garment factories or work as minor employees in Public sector organizations and their earnings are a major source of income for those families. It should also be noted that there is a significant number of abandoned tanks in the upstream area of Metigathwala cascade where people have to seek employment outside. More than 90% of farmers work as wage laborers in adjoining major schemes like Uda Walawe and Ridiyagama.

Table 13. Employment

Type of employment	Number of persons (percentage)			
	Aluthwewa	Kadawarawewa	Metigathwala	Total
No employment	22	9	19	17
Farming	68	81	60	69
Public sector	3	2	9	5
Private sector	0	2	6	3
Self employment	5	2	5	4
Other	2	4	2	2
Total	100	100	100	100

(Source: Household survey)

3.2.2 Family income (first source)

First and secondary sources of family income in sample cascade systems as revealed in the household survey are shown in Table 14. Paddy farming is the first or second main income source for many of the household while chena farming is the second in two sample cascades, Aluthwewa and Kadawarawewa. Public sector employment is important income source for households in Metigathwala. Self employment like carpentry, masonry and livestock keeping appear under other income sources. They, too, are a significant income source for some families.

Table 14. Sources of income

Status	Number of persons (percentage)					
	Paddy	Chena	Public/Private sector employment	Government assistance	Other	Total
Main source of income						
Aluthwewa	57	20	6	0	17	100
Kadawarawewa	57	23	6	0	14	100
Metigathwala	45	10	28	2	15	100
Secondary sources of income						
Aluthwewa	29	17	3	0	51	100
Kadawarawewa	34	26	3	0	37	100
Metigathwala	30	5	2	0	63	100

(Source: Household survey)

3.3 Land use pattern and land holdings

It can be observed from the data in Table 15 that the irrigated land is quite limited in all the DS division within which these cascade systems are located. Dominant land use categories in the cascade area are arable crop lands which include homesteads and other highland crops cultivated either under

rain fed conditions or sometimes supplemented with lift irrigation, and irrigated land used for paddy and other field crop cultivations.

Table 15. Land use in cascade areas

DS division	Land area (ha)		
	Arable crop area	Irrigated	Total
Kadawarawewa	1561	612	4496
Metigathwala	-	-	4375
Kiriibbanwewa	1187	663	2038
Kahakurullanpalasse	1375	639	2696
Aluthwewa	2449	209	4854
Bogahawewa/Kandiyapita	2145	613	8012

Source: DS offices (2002)

3.3.1 Land holdings (home gardens, highlands and chena)

Table 4 in Annex 2 shows that more than 50% in Kadawarawewa and Metigathwala cascade systems have homesteads of less than 1 acre. The reason for this situation is that both Kadawarawewa and Metigathwala are partly incorporated into Walawe irrigation system, where farmers have been allocated half an acre of land for homesteads. In Aluthwewa area where there are no such restrictions, a majority (72%) have land over 1 acre in extent. The household survey data further elucidates the fact that more than 60% of households in Metigathwala and Kadawarawewa, systems incorporated in to Udawalawe irrigation system have no highlands other than the homesteads while majority in Aluthwewa have other highlands ranging from ½ acre to more than 2 acres (Table 5 in Annex 2). The areas that have been incorporated into major irrigation and settlement schemes have no much land other than the reservations to encroach on.

A higher percentage of farmers cultivating chena lands which are government owned lands encroached by farmers is reported for the Kadawarawewa cascade, a large area of which is now being incorporated in to Udawalawe major irrigation scheme under the ongoing Walawe Left Bank Irrigation Upgrading and Extension project (Table 6 in Annex 2). This is due to the fact that irrigated lands under these tanks in this cascade system are very limited; they are cultivated only in Maha season and farmers depend mainly on chena farming in the absence of irrigated land. In Aluthwewa area remaining jungles are mainly forest reserves where there are restrictions by the government for chena cultivation. Arable land for chena is not found much in Metigathwala a larger part of which has been developed as irrigated rice fields under Uda Walawe irrigation scheme. Though farmers do not have legal rights over chena lands, they have an informal right over these lands and there is a community norm that such lands are a property of the farmers who cultivate them. These norms have come into operation in areas where chena lands are scarce.

Majority of families in these systems have more than 2 acres of highlands that include homesteads, highlands and chena lands as shown in Table 7 in Annex 2. However, a reduction of the size of holding in systems incorporated in to Udawalawe system in 1960s is observed. This is due to land fragmentation, shortage of chena lands and other highlands due to the impact of irrigation development activities under Uda Walawe scheme (Table 7 in Annex 2).

3.3.2 Paddy lands

Household surveys showed that average holding of a family differs from one system to the other based on the availability irrigated land and land distribution pattern in a given system. Average size of holding is low (0.32ha) in Kadawarawewa where irrigated lands are scarce. In Aluthwewa, a system with a large number of privately owned very small tanks, size of average holdings is around 0.36ha. The average size of holding is highest (0.44ha) in Metigathwala cascade with a larger tank (Metigatwala) where farmers are tenants of temple lands owned by Mulkirigala temple. The general observation in these systems is that more than 50% of farmers have less than 0.4ha of paddy land (Table 16).

Table 16. Paddy land holdings

Size of holding (acres)	Number of households (percentage)		
	Aluthwewa	Kadawarawewa	Metigathwala
< 0.20	37	9	30
0.21 – 0.4	20	69	23
0.4 – 0.8	29	17	23
> 0.8	14	5	24
Total	100	100	100
Average Holdings	0.91	0.8	1.1

(Source: Household survey)

3.3.4 Land tenure

The patterns of land ownership and tenure in the cascade systems have been influenced by the colonial policies and land related regulations and acts during the post independent period. The people in these systems have freehold, Swarnabhumi, Jayabhumi titles, LDO permits or are encroachers on crown lands. Freehold titles came into being during the British colonial period in which the British colonial rulers started selling government owned lands (crown lands) to the people. Issue of LDO permits started with the implementation of Land Development Ordinance in 1935 after which lands were allocated to farmers in new irrigation schemes, as well as to farmers in small tank systems and extended villages. Apart from these land ownership categories temple lands and *nidagama* lands are also found in some of the cascade systems studied. For example 300 acres of the command area under Metigathwala tank is temple land owned by Mulkirigala Vihare. Farmers cultivating these lands pay ¼ of paddy yield as land rent to the temple. Recently there was pressure from some farmers cultivating in the foreshore area of the tank to reduce the height of the spillway to avoid submergence of their paddy fields when the tank is full. The priest of the temple said that those cultivating the foreshore area are illegal farmers and he has been assured by authorities that the height of the spillway would not be reduced. The lands under this tank are identified as temple lands in administrative reports during the British colonial reports too. A similar kind of temple land is observed near Ramba Viharaya in the Right Bank system of Walawe, and near Sankapala Viharaya in the upstream of Udawalawe reservoir. Farmer holding lands under Andarawewa claimed that their lands are *nindagama* lands. However, at present the farmers cultivating these lands are the owners of the land and they are not tenants of a *nindagama* holder (a member of a feudal family).

It is also observed that lands under some tank systems are still considered as crown land encroached by people. One fine example is the land under Rangawewa in Kahakurullanpalasse cascade system. This is a privately owned tank with a command are of 16ha. The farmer has constructed the tank and developed the command area himself without any assistance from the government. He has been trying to get a long lease title (99 years lease) for the land, but the authorities are refusing to give such a long lease permit because his tank and the paddy fields are in the wildlife reservation area. However, this farmer is in the opinion that his tank and the command area under it became a part of the reservation after the government recently extended the area under the reservation. He puts the blame on the government authorities for keeping quiet till he developed the tank and the command area at his expense.

The land ownership pattern in the area differs from that in many old tank villages in Nuwarakalaviya in NCP where land often belongs to the category of *paraveni* (lands in active use when the cadastral survey was done in 1900 by the British; these lands were treated as private property from ancestral times). Absence of this type of land in Walawe cascade systems substantiates the fact that there were no communities occupying lands in this part of the country during the early parts of the British administration.

Most of the home gardens in Metigathwala (88%) and Aluthwewa (83%) and Kadawarawewa (63%), where the household survey was conducted, have permanent titles under freehold, Swarnabhumi, Jayabhumi and LDO permits, while the rest are encroachers on government lands. As discussed above most farmers, 40%, 65% and 60% respectively in Aluthwewa, Kadawarawewa and Metigathwala, have no highlands other than home gardens. In Metigathwala 25% of those with highlands other than home gardens have permanent titles, against 26% and 18% in Aluthwewa and Metigathwala respectively. Others are encroachers on government lands. It is also evident from the survey that 51% of farmers in Aluthwewa, 37% in Kadawarawewa and 75% in Metigathwala have permanent titles for their paddy lands while the rest are encroachers on government lands. Household surveys further show that majority of these paddy lands, 97% in Aluthwewa, 91% in Kadawarawewa, are owner operated. About 75% in Metigathwala are operated by tenant farmers themselves cultivating the lands owned by the temple. In Kadawarawewa 6% of the land is cultivated by legal tenants under the Agrarian Service Act. About 25% of lands under Metigathwala tank have been rented out by the farmers who are the legal tenants of the temple lands. Farmers with land mortgaged (3%) are found only in Kadawarawewa.

3.3.5 Houses and property

The survey shows that a majority of houses, 69% in Aluthwewa, 57% in Kadawarawewa, 82% in Metigathwala are permanent ones (Table 8 in Annex 2). Metigathwala area has houses of a more permanent kind than other two cascade systems. This is mainly due to the fact that Metigathwala cascade area is an established old settlement area and a part of the system receives regular irrigation water supply from Udawlawe major irrigation system.

Table 17 provides information on machinery, equipments and other household possessions. It reveals that household owning high value machinery like tractors and cars are found in Metigathwala cascade area with regular irrigation supply.

Table 17. Equipments, machinery and vehicles in possession

Equipments/machinery/vehicles	Number of households (percentage)		
	Aluthwewa	Kadawarawewa	Metigathwala
Car	0	0	5
Three wheels	3	6	3
4 wheel tractors	0	0	25
2 Wheel tractors	3	0	0
Threshers	0	0	13
Motor cycles	23	11	25
Bicycles	94	83	100
Televisions (color)	9	0	30
Televisions (black and white)	0	31	5
Radio	74	80	100
Sprayer	34	43	45
Winnowing fans	26	31	15

(Source: Household survey)

3.3.6 Infrastructure and other facilities

All the farmers in Aluthwewa cascade have drinking water either from tube wells, common wells or private dug wells, the private wells being the main source for 71% of households. In Kadawarawewa 66% of farmers depend on common wells and private wells, while 34% are supplied water by the local government agencies using water tankers. In Metigathwala, 5% have access to pipe borne water supply, 85% depend on tube wells, common wells and private wells, while 10% are supplied water through water tankers. Shortage of drinking water is a serious problems faced by the farmer communities in these cascade systems during drought periods.

A large number of households in these cascades have no access to electricity and telephone facilities. Only 14% in Aluthwewa and 5% in Metigathwala have electricity while 9% in Aluthwewa only have telephone facilities.

As for sanitation facilities 40% in Aluthwewa, 74% in Kadawarawewa and 98% in Metigathwala have water sealed toilets. The number of households using temporary toilets is high (49%) in Aluthwewa area, as shown in Table 9 in Annex 2.

3.4 Community characteristics, norms and values

As discussed in the previous section on the origin and evolution of the small tank systems and tank communities, a majority of people in the upstream cascade areas like Bogaswewa, Kandiyapita and Aluthwewa are from Badulla and Ratnapura districts while those in downstream are from Hambantota district. Except in a very few cases the families in tank villages have no settlement history exceeding 100 years. However in Kadawarawewa and Metigathwala, where villages existed even during British colonial period, people claim a history over 100 years.

It is difficult to grasp the community characteristics, norms etc. in a short study of this nature. The discussions with community members reveal that they have established close kinship ties and other social relations through marriages, shared subsistence in the same geographical area, reciprocal exchange of labor, etc. and there are no serious conflicts and contradictions among them.

One major observation made in this study is that the relationship between the tank and village community is not as strong as it is in the Dry zone villages of NCP, where village means tank and tank means village. In many of the villages in the downstream areas of Walawe, irrigated lands under the tanks are held not by the people living close to the tank, but by villagers living far away from the tank. For example most of the land under Andarawewa is owned by people living in areas like Ambalantota and the villagers call them gambarayas[6] (land owning people). In such villages the relationship between the village community and the tank is very weak. In such situations material conditions required for cooperative action is absent in the community.

In cascade systems like Kahakurullanpalasse and Aluthwewa some community members are said to be involved in cultivation of cannabis (ganja), even though it is prohibited by law. In the cascade systems studied there were no serious conflicts between people cultivating ganja and ordinary people. However, in the past there had been Mudalalis (businessmen) involved in this illegal activity. They are said to have cultivated ganja in remote jungles hiring people from outside. It is said that when a worker hired by Mudalalis left home with his salary, Mudalalis would hire men to kill him on his way home in order to prevent him from reporting to the police. There has been many such incidents in the past but they seem to be rare at present. However, we met a very rich Mudalali who had made success in life by investing in ganja cultivation. He does not cultivate ganja at present, but helps ganja cultivators to transport their produce to outside areas and makes a huge income through the transaction. He has a privately owned small tank under which he cultivates paddy and other field crops and banana.

Janatha Vimukthi Peramuna (JVP) has been active in all the cascade systems since 1970s and still there are remnants of buildings burnt and demolished during the uprisings of the 1980s. There have been incidents in which some rich people like the Mudalalis referred to above had to leave the area due to disturbances during the time of uprising. Thanamalwila and Suriyawewa areas are strongholds of JVPs even at present and JVP election offices could be observed in many villages during the general election held in April 2004.

3.4.1 Community organizations

There are a large number of community organizations in these cascade systems formed from time to time by the government and other external initiations. The Rural Development Societies formed in the past are still there in almost all the villages but they are namesake. The funeral associations, Farmer Organizations, Samurdhi associations and SANASA (Cooperative Thrift Societies) are the main organizations functioning in these villages. Out of them Funeral Associations are the strongest and most effective. They help families by providing financial and other assistance on the death of a family member. Farmer Organizations in the villages are weak, mainly due to the lack of water to cultivate crops even in Maha according to farmers. However, when cultivation activities are implemented in

[6] This term is used with different meanings according to the area.

tanks, they become active and hold cultivation meetings, attend to routine maintenance activities, manage water and even implement water rotations at times of scarcity.

While cattle farmers' organizations are very strong in areas like Lunugamwehera scheme in Tissamaharama area (Birner 1997), cattle owners in these cascades have not yet formed formal organizations for collective action. In Lunugamwehera, cattle owners organized to voice their grievances when faced with difficulties over grazing lands after Lunugamwehera project was developed. Similarly, cattle owners in WLB extension area are now organizing themselves to deal with project authorities to find solutions over shortage of grazing grounds after the area was developed for irrigation.

3.4.2 Evolution of organizations and institutions in the management of small tank systems

The institution known as Vel Vidane (water headmen) system introduced during the British period has been in force in these tank systems in the past. When selecting peope for the postion of Velvidane criterais such as economic and social status (wealth, caste status and family back ground) were considered and due to this reason most of the people selected were traditional community leaders accepted and respected by the village community. Under the Vel Vidane system, responsibilities in system operation and maintenance was implemented by the Vel Vidane on the decisions made at the cultivation meeting. Since they were well accepted people with some authority in the community, farmers tended to obey them and carry out the decisions made at the cultivation meetings. Later farmers experienced cultivation committee systems and various other reforms successively introduced by the government. With these reforms politics intruded in to the village level affairs and leaders were selected on political biases. As a result village level leadership and institutions deteriorated creating problems for operation and maintenance small tank systems. Data presented in Table 18 shows the persons responsible for these activities in the past and those responsible for them at present. Involvement of farmers and farmer representatives in system operation and maintenance in the past in some systems is due to the fact that these systems have come into operation after the abolition of Vel Vidane system. In such system farmers know only about the farmer representatives handling these responsibilities. In some very small tanks and tanks owned by farmers these activities are handled by farmers themselves. The Vel Vidane system has now been replaced with farmer representatives who take lead in routine maintenance of the irrigation systems and their operations.

Table 18. Persons responsible for O&M, past and present

Cascades	Number of households (percentage)							
	Person responsible for O&M							
	Present				Past (40 years back)			
	Vidane	President of FO	Farmer rep.	Farmers	Vidane	President of FO	Farmer rep.	Farmers
Aluthwewa	0	0	94	6	31	0	0	26
Kadawarawewa	0	3	97	0	23	0	20	57
Metigathwala	0	3	90	8	63	0	3	35
Total	0	2	94	5	40	0	7	39

(Source: Household survey)

In the past, payments were made to Vel Vidane for activities like system operation and maintenance and water management through implementation of rotations during dry periods. Now the farmer representative or the person attending to these functions is often paid by the farmers. However there are incidents of non-payment too. When a farmer representative attends to these functions properly and with commitment, farmers tend to pay him. The payment made to Vidane or farmer representative is called "uvandiram". In the past farmers had to pay ¼ of a bushel (6 kg) as uvandiram and at present it has been increased to ½ a bushel (12 kg) per acre.

Law enforcement against farmers violating decisions made at cultivation meetings and rules and regulations related to the O&M of the systems were handled in the past by Vel Vidanes and now by the farmer leaders. Law enforcement was easy in the past due to the existence of rural courts, and farmers avoided free riding and violation of decisions taken at cultivation meetings etc. because they feared punishment. With the abolition of rural courts the agency officers responsible have to sue the culprits at district courts once farmer representatives make complaints to them and it involves a long process. Therefore, there is a tendency among the farmers to violate irrigation laws and cultivation decisions at present.

3.5 Evolution of the production system and technology used

3.5.1 Crops cultivated and technologies used

The paddy varieties cultivated by farmers in the past were H 4, 34/8 and 34/6 which were high-yield varieties developed in the 1960s during the green revolution. At present BG 352 and 300, high-yield varieties are cultivated in these cascade systems. Very few farmers said that they cultivated indigenous varieties in the past.

Other field crops (OFCs)Cs were not cultivated in the paddy fields even in water short dry seasons (yala) in the past. In the 1990s OFC cultivation was introduced in minor irrigation systems in yala seasons. Farmers initially cultivated high value crops like chilies in their paddy fields, but gave it up because of high occurrence of pest attacks and marketing problems. At present a very limited number of farmers (28/110) cultivate crops such as eggplant, ladies finger, different kind of pumpkins and cowpea under several tanks. Problems such as water scarcity, marketing and problems related to crop protection from wild animals are major constraints for successful implementation of crop diversification programs in these systems.

Chena cultivation has been faced with serious problems due to degradation of forest cover. In areas like Metigathwala cascade chena farming has been totally abandoned due to shortage of arable lands. In areas like Kadawarawewa, Aluthwewa and Kahakurullanpalasse, forest areas consist mainly of bushes with short fallow not exceeding 3 – 4 years. In the past traditional chena cultivators used virgin forests or forest above 20 years fallow and are said to have followed systematic forest clearing which was less damaging to the natural vegetation. These chena under long fallow were known as "Navadeli hena" (newly burnt chena). They cultivated traditional crops like kurakkan (millet), maize, cereals like meneri and thanahal, chillies, mustard, different kind of pumpkins and a wide variety of vegetables. With population growth, the chena cycle was first reduced to 10-15 years fallow. Such chenas were known as Athdaduwawa (chena cultivated by lopping trees of the size of human arms). The same crops cultivated in "Navadeli Henas" were cultivated in them. Farmers started mono-cropping (mainly chillies) in 1968, when import of chillies into the country was restricted. At present farmers in these cascade systems cultivate hybrid tomatoes, pumpkins, water melon, eggplant, snakegourd and bittergourd etc. using seeds imported from Malaysia and Thailand. Fallow periods of

these chenas are less than 3 years in most of the cases. In some cases, the fallow period is around 8 months as they cultivate the same land in every Maha season. Their perception is that traditional crops like millet cannot be grown in chenas of short fallow periods due to soil fertility related problems. With the introduction of hybrid varieties, some traditional varieties have been lost forever. They have initially started cultivating hybrid varieties under the guidance of the government extension services as there was a high demand for such crops. Now farmers complain that input costs for these hybrid crops are very high due to the prevalence of pest attacks and diseases. In addition they have to purchase seeds at high prices every season.

Damages to crops by wild elephants is a serious problems faced by chena farmers in these systems. Human-elephant conflicts are highest in Kadawarawe system area in WLB extension area. However, damage to crops by stray cattle is not much reported in any of these systems. It is observed that the fences around the chena are strong enough to keep the cattle away.

3.5.2 Use of fertilizer

The survey data shows that only a very few farmers (5/110) used artificial fertilizer like urea, TDM or V-1 before the introduction of green revolution technologies. However, at present almost all farmers use V-1 at the time of sowing, urea (20 days after sowing) and TDM after 40 days of sowing.

Use of organic fertilizer is rare among these farmer communities. They incorporate weeds and crop residues in the field when plowing the land. However, special efforts for incorporation of straw left after threshing or organic matter such as cow dung are observed only among 5% of the farmers in the whole basin at present. The officers of the extension services now make efforts to introduce environment friendly farming practices such as Integrated Pest Management (IPM) and teach farmers how to use organic fertilizer. Some paddy farmers, especially those in Kadawarawewa cascade have a better understanding of the negative impacts of pesticide and other agrochemicals use through their experience and some of them are adopting IPM technologies.

3.5.3 Weed and pest control

It is highlighted from the survey that use of herbicide and pesticide was not known to the farmers in the area prior to the introduction of green revolution technologies and also immediately after their introduction. The methods used in the past for weed control was manual weeding and submerging weeds in water by storing water in the paddy fields to the maximum possible height. Now almost all the farmers use different kinds of herbicide for weed control. In the past the main methods used by farmers for pest control was different kind of indigenous technologies (use of adhesives from plant species etc.), magic and rituals. At present farmers have adhered to the use of pesticides. Paddy farming, in farmers' view, has become less profitable due to very high expenditure involved in weed and pest control.

3.5.4 Land preparation technologies

Land preparation technologies used by the farmers in the past were mudding with cattle, plowing with cattle or preparing the land using *mamoty*. In these systems main technology in the past for land preparation was mudding with cattle while some plowed land with cattle or prepared land with mamoty. After the green revolution, these technologies were replaced by tractors as shown in Table 10 in Annex 2. At present majority are observed using 2 wheel tractors for land preparation.

3.5.5 Yields

Paddy yield reported by farmers in these systems ranges between 4 – 7 MT per ha. These yield figures are high compared to the national averages and the averages of the dry zone parts of the country shown below in Table 19.

Table 19. Paddy yield (average) for wet and dry zones of Sri Lanka

Area	Average Yield (MT/ha)	
	Maha	
Sri Lanka	3.4	3.1
Dry zone	3.4	3.3
Wet zone	3.4	2.8
Hambantota	4.0	4.0
Monaragala	4.0	3.2

(Source: Census and Statistics Dept. Maha 2001, 2003 & Yala 2000, 2002)

The farmers in these cascade systems reported that they have higher yields compared with the situation in the past. Traditional varieties cultivated in the past gave them low yields (1.8 – 2.1 t/ha) and in addition those varieties which were 4 – 4 ½ months required more water.

4 Conclusions

This concluding section focuses on answering the research questions formulated in section 2.1.2, based on the data and information presented in this report.

- When the major changes that have been taken place in the physical system are considered, it can be observed that these tank systems which were abandoned after the fall of ancient civilizations in this part of the country were occasionally renovated and rehabilitated in recent years by people who migrated to the area in search of livelihood opportunities like chena farming. This process started 200 years ago or so. Government support for rehabilitating these systems was observed during British periods and after independence to bolster migration of people to these less populated areas as a way to alleviate poverty and curb practices like chena farming. The greater part of the settlements, however, occurred in the 50s and 60s. Tank systems from the upper part of the basin were re-colonized by people from Ratnapura and Badulla districts, while those from the south were settled by migrants from Hambantota.

  As a result in most of the cascade systems the command areas have been gradually increased. However, it is doubtful whether adequate attention was paid to hydrology of the cascade or the purpose for which these tanks were used in the past when expanding the command areas for irrigated agriculture. In cascade systems like Metigathwala, which depends on Kachchigala Ara, increase in the command area of upstream tanks resulted in water shortage and abandonment of cultivation under some tanks by the farmers. In addition to the increase in command area and related water scarcity problems, reduction in forest cover due to chena cultivation has had serious negative impacts and repercussions, such as soil erosion and sedimentation of tanks and streams and drying up of streams, and led to degradation of tank ecosystems. As a result, cultivation in yala season has declined dramatically.

- Secondly, some parts of the tank cascades like Metigathwala and Kiriibbanwewa have been incorporated into the Uda Walawe irrigation scheme, which has alleviated the water shortage problems of these tanks. However, with the development of the area for irrigation, the forest cover in the area has also been reduced and the size of holding of highlands and chena has been drastically reduced in the areas. Similarly in areas like Kadawarawewa cascade that is currently being developed for irrigation, the transformation of chena and scrub jungle into irrigated land has created a shortage of grazing lands for livestock, a main livelihood activity of the people in the area.

- Major changes in socio-economic terms include population growth in the area, which has in some place exceeded the carrying capacity of the cascade systems and the basin as a whole. Due to the lack of employment in urban areas, people in these cascade systems involve themselves in farming activities and have to depend on the limited water and land resources. As it is evident from the employment pattern, the main employment of nearly ninety percent of people in the cascades is farming.

- Except for a few old villages, the communities are comprised of people migrated to the cascade systems from different villages in the same district. Some of them were close relatives even before migrating to these villages. Those who were not close relatives have either become relatives through marriages or developed close socio economic ties through

reciprocal labor exchange and also by living as neighbors in the same villages for a long period. They have established a sense of community and solidarity in the process and also have developed formal social organizations for interactions in spheres where they need such close communication and interaction. However, there exist some villages where lands under tanks are not held by the village community, but by villagers in some other villages. In such villages people's relationship with the tank is not strong as in tank villages in the North Central Province and similar other Dry Zone areas, where tank and village are closely associated.

- The second research question examines the reason for increase or decrease of tanks under these cascade systems. Except in Aluthwewa where most of the tanks are farmer owned there is a significant number (over 25 percent) of abandoned tanks. The main reason for abandonment of these tanks is water shortage due to the decrease of rainfall in the area, according to farmers, but the major reason for water shortage in these systems, as discussed above, is that command areas of these tanks have been expanded under different rehabilitation and renovation programs implemented from time to time.. Farmers report that they cultivated the entire command areas under these tanks in both Yala and Maha seasons in the past and they had no serious problems over water. However, there are historical references to water shortages, droughts and crop failures in the area even in the past and water shortage cannot be considered a new phenomenon. This, combined with a perceived decline in rainfall, has led to imbalance between supply and demand and to the abandonment of tanks or part of the command areas under these tanks, due to inadequacy of water for the entire command areas under them.

- The third question refers to the water resources endowment of these cascade systems. Except for the tanks receiving water from Uda Walawe scheme, all others are water short and cultivation under them limited to Maha season. In some systems, the entire command area cannot be cultivated even in Maha season. This cannot be considered a new phenomenon. It cannot be assumed that the tanks in these cascade systems had been developed in the past for irrigation purposes alone. They might have been used for domestic and other purposes. However, degradation of tank catchments at present may have some impact on water resources endowment in these systems.

- Water in these tank cascade systems are used mainly for agriculture as it was in the past. In addition they are used for bathing and washing, livestock keeping and fishing. Though water in the tanks was used for drinking in the past this is no longer true as water quality has deteriorated, mainly due to soil erosions in the tank catchments after clearing the jungles for chena farming and other development activities. Though fishing was a main income activity in Bogaswewa and Kandiyapita tanks in the past, no fishing activities were observed in these systems after a severe drought diminished the fish population in the tanks. The problem is aggravated due to the fact that there are no programs for releasing fingerlings to small tanks by the government or fishing societies. Brick making has emerged as a new income earning activity in most of the tank systems studied.

- The main crop cultivated in these systems is paddy. Other Field Crops are cultivated very rarely even in water short Yala seasons. Before the Green Revolution, farmers in some of these systems are said to have cultivated traditional paddy varieties. Use of fertilizer and agro chemical was not known to them at that time. They used simple technologies such as

mudding of lands with cattle, plowing with cattle or tilling the land with *mamoty* for land preparation. They used cattle for paddy threshing too. However, most of the farmers in these systems are new migrants and they are said to have used Green Revolution technologies introduced in 1960s. Farmers have cultivated new varieties (H4) in these periods and experienced high yields compared to the traditional verities used in the past. At present they cultivate new-bred varieties using new technologies. Simple technologies used for land preparation have been totally displaced by two wheel and four wheel tractors. Pesticides and fungicides and chemical fertilizer are used intensively for paddy cultivation as well as other highland crops. Farmers report very high production costs for paddy cultivation and complain that they have low profit margins. There is a move now towards integrated pest management and also towards using organic fertilizer in response to increasing production costs, and also based on the understanding that these new technologies have negative impact on health and the environment.

- The fifth research question deals with the evolution of the institutions managing these systems. Different kinds of management are observed in different tanks in these cascade systems. Except for some major tanks like Kachchigala and Kiriibbanwewa, which are jointly managed by the Mahaweli Authority and farmer organizations in Uda Walawe scheme, all other tanks are farmer managed. Some of them are totally owned by the farmers and managed by them. There are some farmer-managed tanks in which the Department of Agrarian Services has a role in organizing cultivation meetings, system rehabilitation and improvement activities. In the past, the Vel Vidane system introduced during the British period was responsible for operation and maintenance activities as well as law enforcement. Vel Vidanes were paid by the farmers for these functions. Now the O&M activities of the tanks under the supervision of ASD are handled by a farmer representative selected by the FO. In the systems owned by individual farmers O&M is handled by the owners themselves and water management is reported to be successfully handled. A major problem observed in small tank systems is the lack of proper maintenance of tank bunds, regulatory wares and canal system by the farmer communities. In many cases their maintenance activities are limited to pre seasonal routine type of maintenance. This has led to dilapidation and deterioration of these systems. The practice in these systems is to rehabilitate them either with funds from government, donors or from lending agencies.

- The sixth question examines the future trends observed in these systems with regard to the changes of hydrology and socio-economic conditions. The trend in some systems like Kadawarawewa and Bogaswewa is to have supplementary irrigation from major irrigation systems and diversions to find solutions to water scarcity problems faced by the systems. Most of the tanks in Kadawarawewa system are being incorporated into Uda Walawe irrigation system under the ongoing Irrigation Rehabilitation and Upgrading Project implemented in Walawe LB area. Other Field Crops (OFCs) are to be promoted in WLB area as a solution to water shortage problem and socio economic development of the poor rural masses in the area. Some tanks in Bogaswewa are to receive supplementary irrigation from Weli Oya diversion and this will lead to higher cropping intensities. A trend followed by people in water short areas like upstream of Kachchigala is to find public and private sector employment outside as reflected in their employment pattern.

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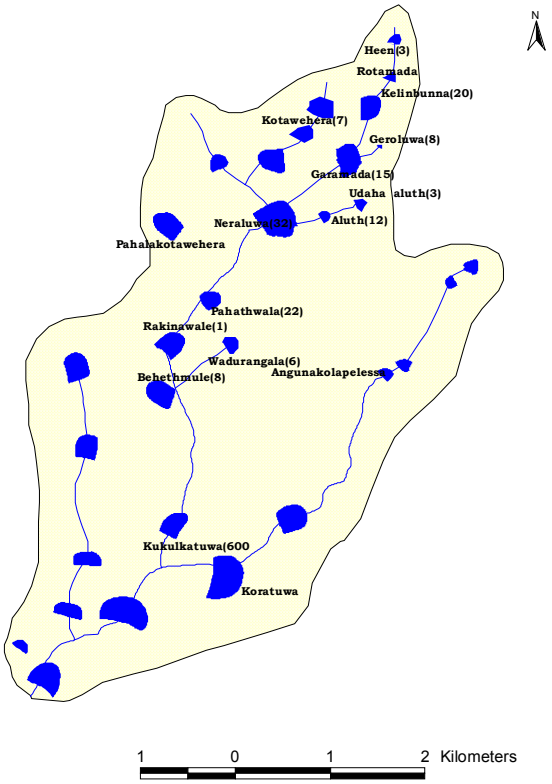
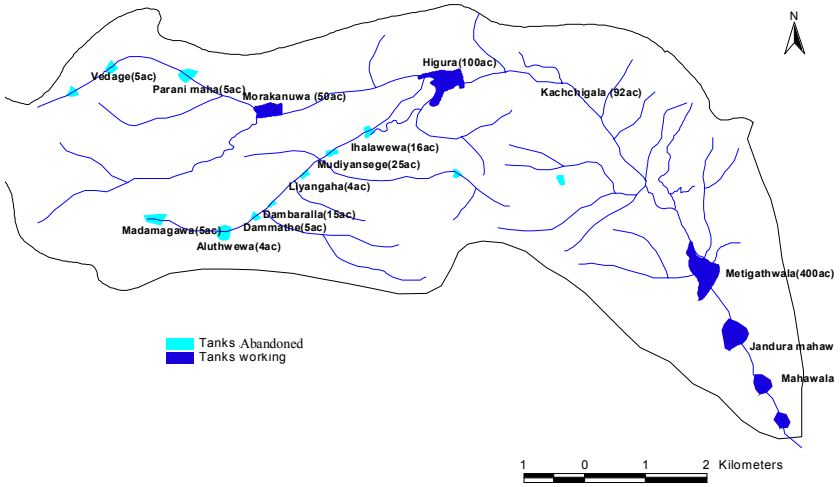
Annex 1

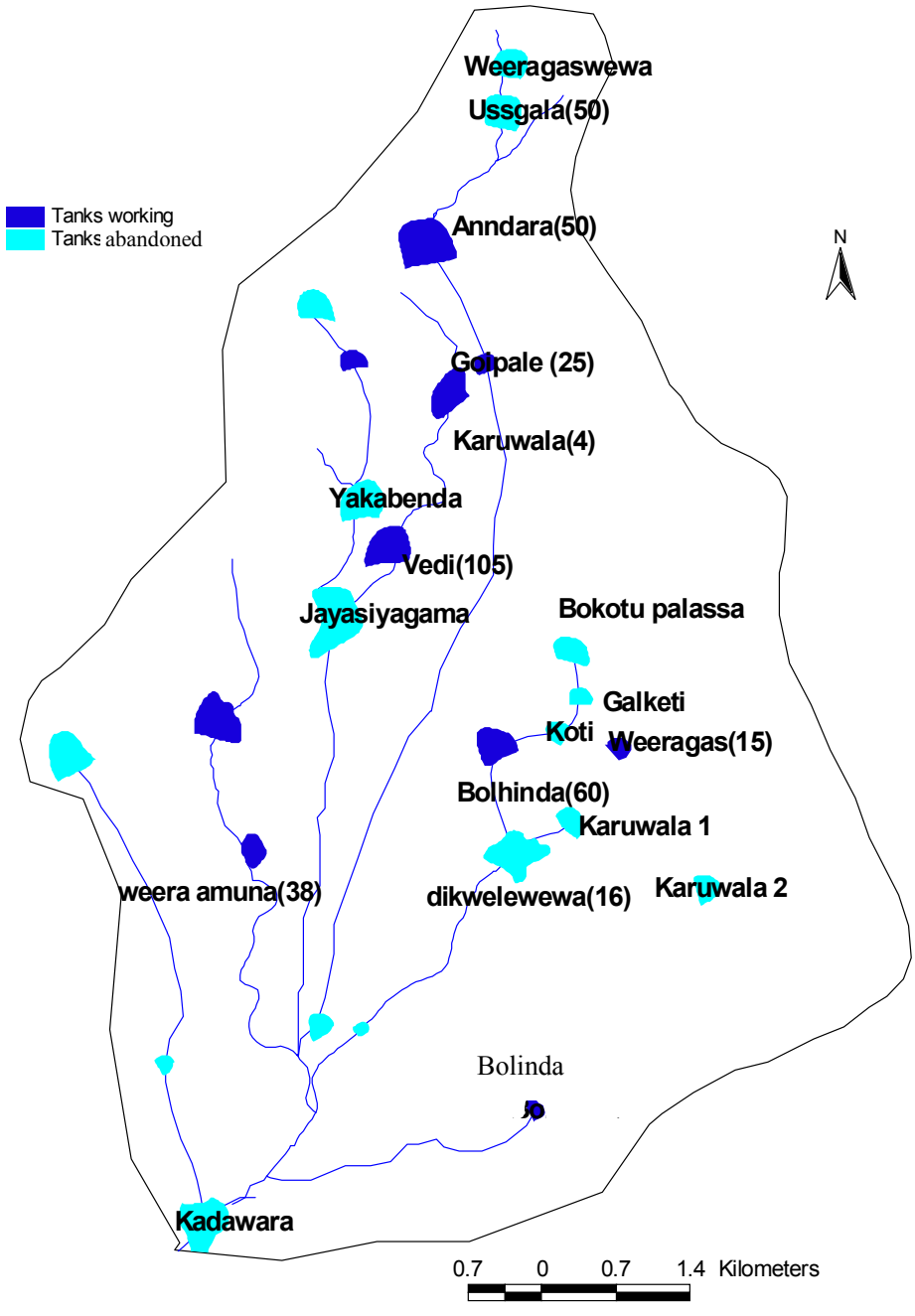
Aluthwewa cascade



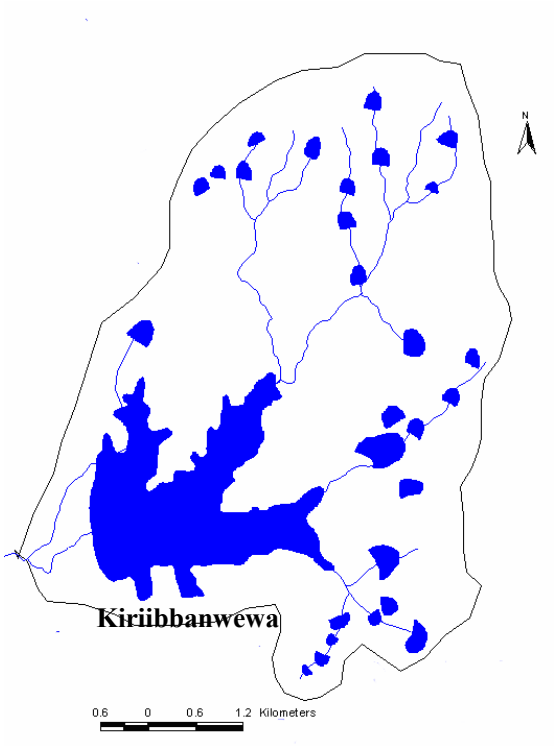
Matigathwala cascade



Kadawarawewa Cascade



Kiriibbanwewa cascade



Kahakurullan pallassa cascade

Annex 2

Table 1: Size of the command areas of small tanks in the sample cascade systems in Walawe basin

Sample cascades	Number	Command area distribution (in ha)					
	Percentage	< 6	<=6<10	<=10<20	<=20<30	<=30<40	>=40
Kadawarawewa	Number	5	3	2	3	0	0
	Percentage	39	23	15	23	0	0
Metigathwala	Number	9	3	1	0	1	4
	Percentage	50	16	6	0	6	22
Kiriibbanwewa	Number	3	0	1	0	0	1
	Percentage	60	0	20	0	0	20
Kahakurullanpalasse	Number	1	1	1	1	0	0
	Percentage	25	25	25	25	0	0
Aluthwewa	Number	10	3	1	1	0	0
	Percentage	67	21	6	6	0	0
Bogahawewa	Number	0	0	1	0	1	2
	Percentage	0	0	25	0	25	50
Kandiyapita	Number	0	0	1	0	0	1
	Percentage	0	0	50	0	0	50

(Source: Focus group discussions and interviews)

Table 2. Cropping intensity in cascade systems (% of tanks with different cropping intensities)

Cascade	Maha (% tanks)			Yala (% tanks)		
	100	~50	0	100	~50	0
Kadawarawewa	77	15	8	0	0	100
Metigathwala	28	39	33	28	0	72
Kahakurullanpalasse	75	0	25	0	50	50
Bogaswewa	100	0	0	0	0	100
Kiriibbanwewa	60	0	40	20	0	80
Kandipitiya	50	50	0	0	0	100
Aluthwewa	93	0	7	0	0	100

(Source: Focus group discussions)

Table 3. Education levels

Education level	Number of persons (percentage)			
	Aluthwewa	Kadawarawewa	Metigathwala	Total
No education	9	15	09	11
Grade 1-5	29	22	17	23
Grade 6-11	46	35	28	37
G.C.E. (Ord.L)	8	16	26	16
G.C.E.(A.L.)	6	11	17	11
Degree	2	01	03	02
Total	100	100	100	100

(Source: Household survey)

Table 4. Size of land holding (homestead)

Size of holding (acres)	Number of households (percentage)		
	Aluthwewa	Kadawarawewa	Metigathwala
> 0.50	11	31	23
0.51 – 1.00	17	20	40
1.00 – 2.00	46	29	28
< 2.00	26	20	9
Total	100	100	100

(Source: Household survey)

Table 5. Size of land holding (Other highlands)

Size of holding (acres)	Number of households (percentage)		
	Aluthwewa	Kadawarawewa	Metigathwala
No lands	40	66	60
> 0.50	3	0	15
0.51 – 1.00	23	0	13
1.00 – 2.00	28	20	12
< 2.00	6	14	0
Total	100	100	100

(Source: Household survey)

Table 6. Land holdings (chena lands)

Size of holding (acres)	Number of households (percentage)		
	Aluthwewa	Kadawarawewa	Metigathwala
No chena lands	74	54	73
> 0.50	0	0	0
0.51 – 1.00	11	14	15
1.00 – 2.00	11	26	8
< 2.00	4	6	4
Total	100	100	100

(Source: Household survey)

Table 7. Total land holdings, highlands

Size of holding (acres)	Number of households (percentage)		
	Aluthwewa	Kadawarawewa	Metigathwala
> 1.00	3	9	28
1.00 – 2.00	20	14	33
2.01 – 4.00	51	57	33
< 4.00	26	20	6
Total	100	100	100

(Source: Household survey)

Table 8. Condition of houses

Condition of houses	Number of houses (percentage)			
	Aluthwewa	Kadawarawewa	Metigathwala	Total
Permanent	69	57	82	77
Semi-permanent	20	27	18	23
Temporary	11	16	0	10
Total	100	100	100	100

(Source:Household survey)

Table 9. Sanitation facilities

Cascade	Number of persons (percentage)				
	No facilities	Water sealed	Permanent pit	Temporary pit	Total
Aluthwewa	0	40	11	49	100
Kadawarawewa	6	74	3	17	100
Metigathwala	0	98	2	0	100

(Source: Household survey)

Table 10. Land preparation technologies

Cascades	Technologies									
	Present					Past				
	1	2	3	4	5	1	2	3	4	5
Aluthwewa	0	0	6	88	57	54	11	20	0	0
Kadawarawewa	0	0	3	97	46	100	43	17	6	6
Metigathwala	0	0	0	100	48	100	33	26	5	5
Total	0	0	3	95	50	85	29	20	7	7

1. Mudding with cattle, 2. Plowing with cattle, 3. Mamotty, 4. 2-wheel tractors, 5. 4-wheel tractors

(Source: Household survey)