CHAPTER ONE

INTRODUCTION

1.0 Introduction

This dissertation discusses and analyses the restoration efforts made in the Ulpotha micro cascade. (Ulpotha is one of the micro cascades located within the Galkiriyakanda cascade). The field research mainly focused on the impacts of Ulpotha restoration on environment and rural livelihood. In early 2000, the Forest Department of Sri Lanka approached the Australian Government and requested financial support for the cascade rehabilitation. The Australian Government has accepted this Action Research and granted AUD 10 million for restoration works. The restoration of Ulpotha was started in 2004 and completed in 2011.

Prior to the restoration, Ulpotha micro cascade was badly degraded due to natural and man-made destructions. The environment was harsh, most trees have died and entire eco-system was paralysed. Lack of water was the main issue for down-stream communities and wild animals. People also encroached watershed / catchment to cultivate and earn but not in a sustainable way. Due to the encroachments, forest canopy was damaged and ground was opened for high runoff and heavy erosion. Water resistance capacity was very low in the soil. This has caused the siltation of minor tanks and irrigation network in the down-stream. Farmers could not cultivate their normal crops due to dry weather conditions and community earnings were not sufficient to feed their family members. This destructive cycle was operated in the past and final result was the increased poverty level of communities living in the area. Poor livelihood pattern was threat to the remaining resources in the cascade as communities exploited limited resources available.

This research is important to the industry as it elaborates the causes for cascade degradation and decline. At the same time research elaborates the impacts of cascade restoration on environment and rural livelihood as well. The research outcomes could be used by policy makers, administrators, professionals and other relevant authorities

to workout remedial action plans to restore other cascade systems while improving livelihood of adjacent communities.

1.1 Background

Galkiriyakanda cascade is located in Kurunegala District of North Western Province of Sri Lanka. Cascade area is agro-climatically defined as Dry Zone. The Galkiriyakanda is also situated close to the boundary of Anuradhapura district (7°C 50' -8°C 00 North 8°C 20' East) and in the northern part of Kurunegala district. In terms of local administrative boundaries, the Galkiriyakanda cascade is extended to Ehetuwewa and Polpithigama Divisional Secretariat Divisions of Kurunegala District. Studied and analysed aspects in this dissertation include cascade degradation, identifiable causes of degradation, impacts of cascade on livelihoods of cascade dependent communities and environmental benefits of cascade restoration. While focusing on Galkiriyakanda cascade, it records and analyses functional aspects of Ulpotha micro-cascade (This is called as micro-catchment as well). Ulpotha is one of the micro-catchments located in the Galkiriyakanda cascade and representative of other cascades / catchments in the area. Therefore, this dissertation analyses Ulpotha micro cascade and its functions through a case study.

As discussed in the Chapter 2, cascade is a series of tanks and water courses connected to a common water source. Generally, cascades provide multiple resources for the environment, animals, birds and downstream settlers which help to protect and promote rural livelihood. Cascade is also an invaluable resource especially as a water source and provision of livelihood opportunities for dry zone communities. The development workers correctly identified water as the main entry point to any development initiative in the dry zone (FFHC Annual Report, 1993). Cascade with its irrigation network operates as a basic and natural infrastructure on agrarian development for secured livelihood. Livelihood cannot be limited only for food and / or food security. In addition to food, it covers basic necessities such as water, fodder, shelter and medicine (R. Chambers, 1995).

A sustainable livelihood is commonly accepted as comprising: the capabilities, assets (including both material and social resources) for a means of living. “A livelihood is sustainable when it can cope with and recover from stresses and shocks and maintain

or enhance its capabilities and assets both now and in the future, while not undermining the natural resource base (Chambers and Conway, 1999)".However, there are a number of definitions developed on diverse livelihood. Following three common definitions and livelihood approaches are important for further discussion.

Livelihood. A livelihood comprises the capabilities, assets and activities required for a means of living (Chambers & Conway 1988).

Sustainable livelihood. A livelihood is sustainable when it can cope with and recover from the stresses and shocks and maintain or enhance its capabilities and assets both now and in the future without undermining the natural resource base (Chambers & Conway, 1999).

Household livelihood security. Household livelihood security is defined as adequate and sustainable access to income and resources to meet basic needs (Frankenberger 1996).

1.2 Approaches for Livelihood Development

In the development field, different agencies use different approaches to address livelihood issues. Galkiriyakanda cascade development program (Please refer page 15 for the program) was influenced by following key approaches. However, mixed approach with key elements of all definitions has been developed by project managers for better results.

1.2.1 CARE's livelihoods approach

CARE follows the Chambers and Conway definition and it recognises three fundamental attributes of livelihoods:

• the human capabilities (such as education, skills, health etc.);

• access to tangible and intangible assets; and

• the existence of economic activities.

CARE's focus is on household livelihood security and basic human needs. They believe that approach should collaborate with basic needs and a rights-based. The right-base approach provides an additional strength for stakeholder and policy

analysis. Household is not the only unit of analysis and CARE's interventions should not take place only at the household level.

1.2.2 Approach by Department of Foreign and International Development (DFID)

DFID is in the process of developing new procedures to align their approach with respective country programs, sector-wide approaches (S-wap) and right based requirements. DFID (DFID is the funding arm of the British Government) has opened up a Sustainable Livelihoods Support Office to co-ordinate activities related to lessons learned, risk management and Monitoring and Evaluation.

Core emphasis and definitions

Same as the other development agencies, DFID also adopts the Chambers and Conway definition of a livelihood. However, DFID's new version of the definition reduces the focus on the sustainability requirement at the initial level. DFID explains that there are many ways of applying livelihoods approaches but following six principles should be in place.

People-centred: sustainable poverty elimination will be achieved only if external support focuses on what matters to people, understands the differences between groups of people and works with them in a way that is congruent with their current livelihood strategies, social environment and ability to adapt.

Responsive and participatory: poor people themselves must be key actors in identifying and addressing livelihood priorities. Outsiders need processes that enable them to listen and respond to the poor.

Multi-level: poverty elimination is an enormous challenge that will only be overcome by working at multiple levels, ensuring that micro level activity informs the development of policy and an effective enabling environment, and those macro level structures and processes support people to build upon their own strengths.

Conducted in partnership: with both the public and the private sector.

Sustainable: there are four key dimensions to sustainability – economic, institutional, social and environmental sustainability. All are important – a balance must be found between them.

Dynamic: external support must recognise the dynamic nature of livelihood strategies, respond flexibly to changes in people's situation, and develop longer-term commitments. It should also be informed by an underlying commitment to poverty elimination which is the thread running through all DFID's work.

1.2.3 OXFAM Approach

Oxfam also adopted Chambers and Conway's (1992) definition on sustainable livelihood. Oxfam adopts livelihood approach in all key project management stages including planning and assessment of programs and included in their strategic aim as well. They also emphasised that sustainability could be analysed through different perspectives:

Economic opportunities (markets, credit supply etc.);

Social aspects (sociological aspects, social networks and gender equity);

Institutional strengthening (capacity building, access to services and technology, political freedom): and

Ecological (consider biodiversity and environmental resources).

1.2.4 UNDP's sustainable livelihoods approach

The sustainable livelihoods agenda is part of UNDP's overall sustainable structure including sustainable human development (SHD) mandate that has been adopted since 1995. This includes: poverty reduction, employment, gender, protection and improvement of the environment and good governance. In this context, this approach is one way of achieving poverty reduction among other strategies such as participatory development and community-based natural resource management.

Core emphasis and definitions

Conceptually, 'livelihoods' means activities, entitlements and assets by which people make a living. Assets, are defined as: natural/biological (i.e. land, water, fauna and

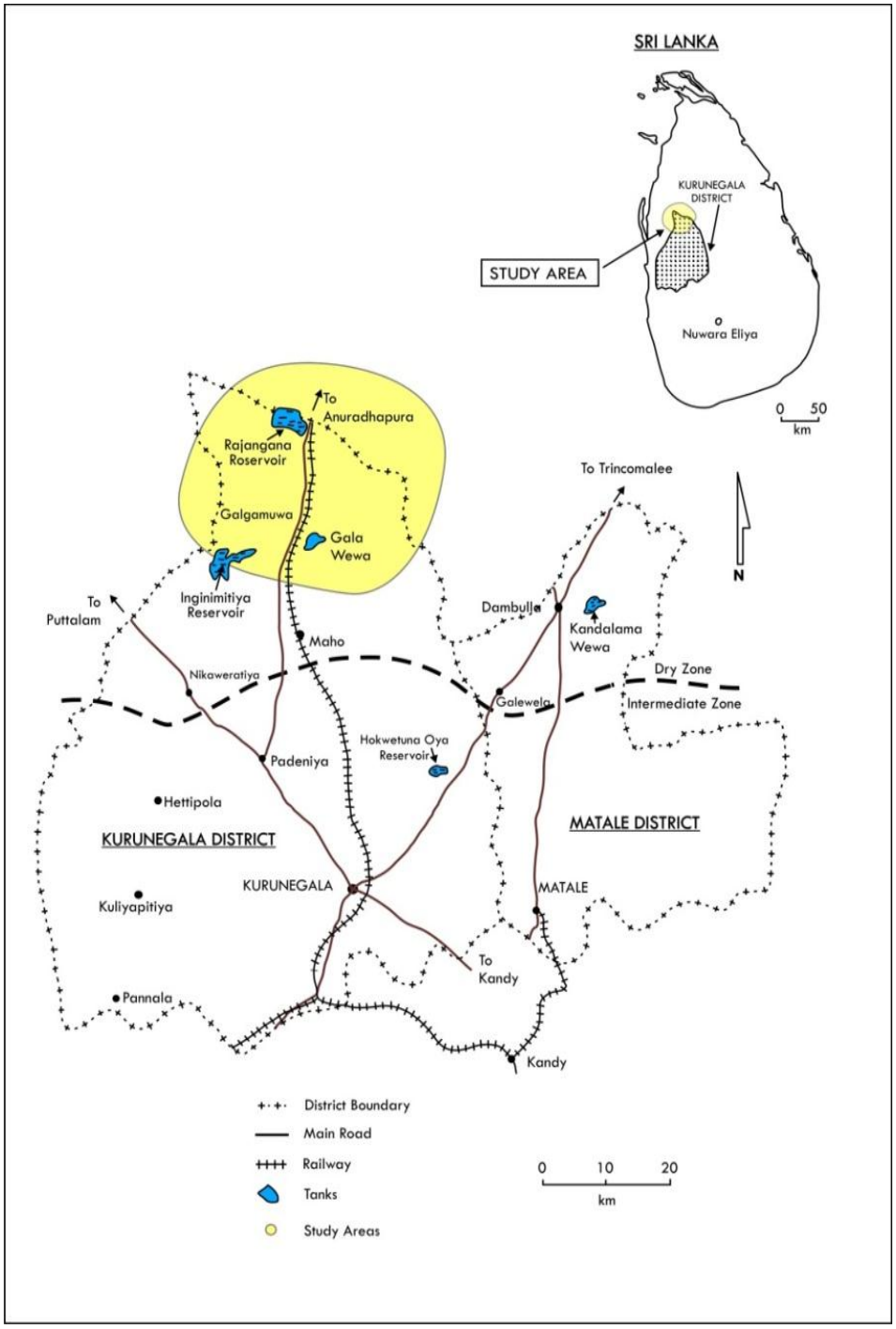
flora); social (i.e. community, family, social networks); political (i.e. participation, empowerment); human (i.e. education, labour, health, nutrition); physical (i.e. roads, clinics, markets, schools, bridges); and economic (i.e., jobs, savings, credit). The sustainability of livelihoods becomes a function of how men and women utilise asset on both a short and long-term basis. Same as other agencies, UNDP also concerns economic effectiveness, Ecological issues, social equity and cope up with external shocks.

A mixer of above livelihood development strategies have been used for the Galkiriyakanda cascade rehabilitation. Galkiriyakanda cascade and the environment provide a number of assets and resources to earn additional income and livelihoods opportunities through value additions. The best examples are reed and rush products, bee-keeping, food and fruit processing (chutney, jam & cordial etc.) and carpentry at village level. Local medicinal herbs (Bim Kohomba, Polpala etc.) are also available in plenty in the cascade.

The interdependency between cascade and livelihoods is not always positive and it operates in a negative way as well. If the cascade is degraded the environment within the cascade, eventually downstream will also be degraded. Cascade destruction will reduce the tree cover, increase soil erosion and damage the entire irrigation network. A similar situation had been observed prior to 2005 in Ulpotha micro-cascade and downstream communities were badly affected by this situation. People did not have sufficient water for their paddy cultivation and other crops. Due to lack of income and livelihood opportunities, people started cutting trees and over extraction of cascade resources for their living. The preliminary work in the area from 2003 to 2005 revealed a continued tendency for degradation of the cascade causing a decrease in livelihood opportunities for the people dependant on it and reduction of fauna and flora.Since this situation aggravated and extended to adjoining areas, government authorities decided to rehabilitate the Galkiriyakanda cascade. Due to the high cost involvement, large extent of the area and limited capacity of government agencies, it was decided to rehabilitate Ulpotha micro-cascade initially on a pilot basis. Accordingly, rehabilitation of Ulpotha micro-cascade has been commenced as a pilot program. If the rehabilitation provides positive results, replication of best practices and the model used could be sold to other donors for

financial support. The Australian government has funded AUD 10 million for this pilot rehabilitation program (Sri Lanka Australia Natural Resource Management Project – SLANRMP) to reverse the cascade destructive trend while improving environment and livelihood patterns of downstream communities.

Figure 1- Location of Study Area in Kurunegala District



Source – Government Agent's Office – Kurunegala, 2004

1.3 Objective Context and Empirical Evidence for Dissertation

Empirical evidence for cascade management and its livelihood implications that is analysed in this dissertation comes from an Action Research conducted by Sri Lanka Forestry Department (FD) with technical assistance from AUSAID. The project, namely Sri Lanka Australia Natural Resource Management Project (SLANRMP), that was implemented as a pilot project had its own goals, objectives and components. Its goals, purpose and components are briefly discussed below.

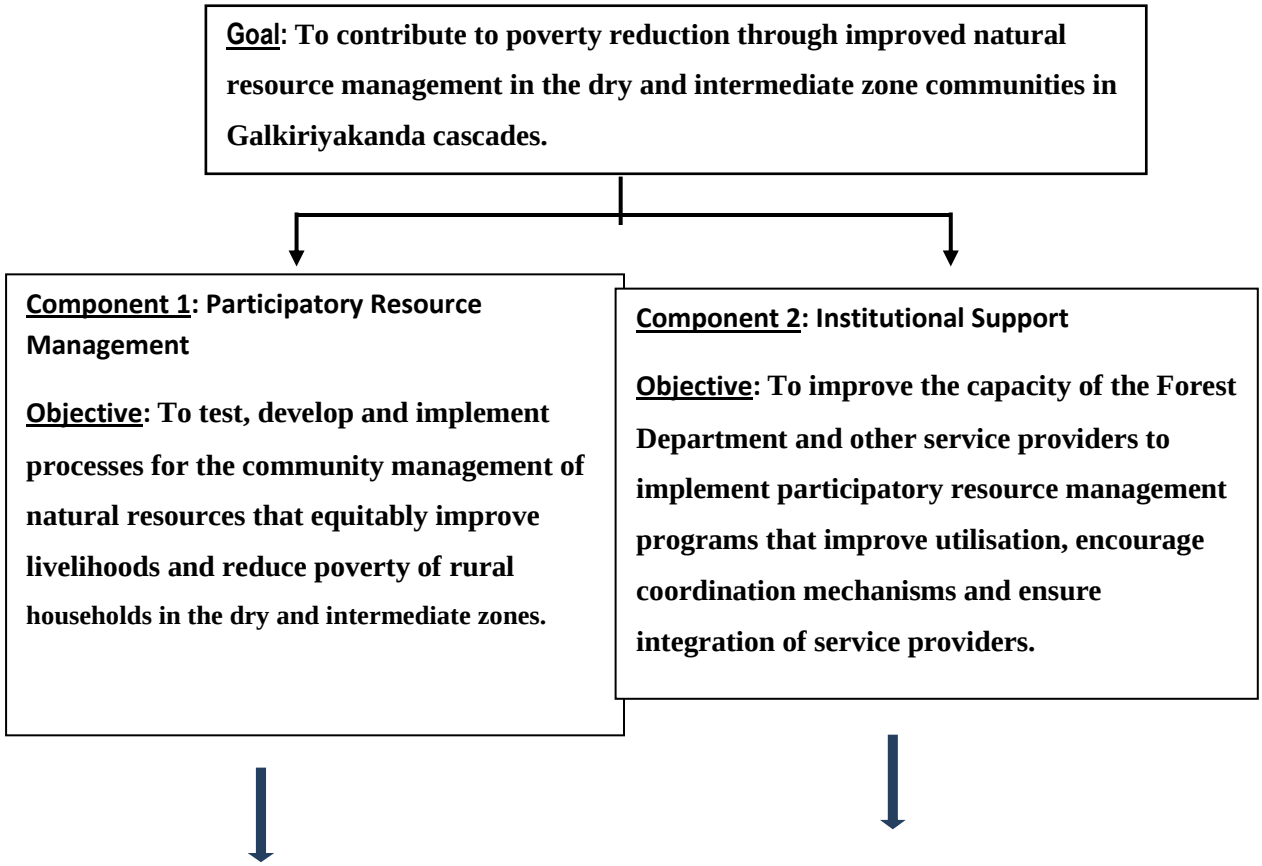
Its overall objective was to contribute to poverty reduction through improved natural resource management in the dry and intermediate zone communities in Galkiriyakanda cascades. Its overall purpose was to assist the Government of Sri Lanka (GOSL) and grassroots level agencies connected to natural resource management in order to develop and implement policy, legislation and practices to involve local communities in the participatory management of dry and intermediate zone forests and other natural resources.

Of the two (2) components, **Participatory Natural Resource Management was the first component.** Objective of this component was to test, develop and implement processes for the community management of natural resources that equitably improve livelihoods and reduce poverty of rural households in the dry and intermediate zones.

The second component was the **Institutional Support for Integrated Natural Resource Management** and its objective was to improve the capacity of the Forest Department and other service providers to implement participatory resource management programs that improve utilisation, encourage coordination mechanisms and ensure integration of service providers.

Figure 2- Program Description Chart

The program goal, components, component objectives and outputs are summarised below.



Outputs:

1.1 Suitable program sites identified
1.2 Community groups formed and capacity enhanced
1.3 Community Resource Management Plans prepared which address the leading causes of deforestation and forest degradation at each site
1.4 Community Resource Management Plans implemented in partnership with other government and potentially non-government organisations
1.5 Home garden program implemented in other/conflict affected areas, as the opportunity arises

Outputs:

2.1 Forestry regulations developed and implemented
2.2 Forest Department staff trained in community forestry approaches
2.3 Capacity to implement community forestry approaches strengthened
2.4 Capacity of the Forest Department enhanced in technical areas that will contribute to the program goal
2.5 M&E of community forestry activities undertaken on a regular basis.

1.3.1 SLANRMP Approach

The program staff believed that even poor are entrepreneurial and need small support (financial and technical) to graduate out of poverty while protecting the environment. The first step in this regard was to motivate participating communities and stakeholders. For this purpose, strengthening of village institutional (CBO) capacities was done. It was also a positive move that all poor members especially women were included in the Self Help Groups and microfinance activities. Village community also had multiple livelihood opportunities such as day labour, *chena* (slash and burned) farming and operation of small land holdings, cattle rearing, forest products, fishing, and traditional handicrafts. Project supported to improve the productivity of such livelihood activities.

Project also believed that introduction of innovative actions would help for poverty reduction of vulnerable communities while improving forest cover and other cascade resources. Therefore, a special support program has been introduced for innovations to maximise project benefits and impacts and it was successful in motivating village leaders to try out modern cultivation systems and practices. This method was named as 'Community Forestry' to improve forest cover initially and then the improvement of cascade resources subsequently. The argument was, if forest cover could be protected and promoted, it is easy to improve other cascade resources like soil, water etc.

1.3.2 Community Forestry

Similar to other Asian countries, Sri Lanka's forest cover has dwindled having direct and indirect impacts on the livelihood of the local communities and the natural environment. Various programs have been launched in the last two decades to address the issue of deforestation and forest degradation. Community Forestry approach has been introduced as one of the best models for sustainable management of forest resources and livelihood improvement of the local communities. Following are the key definitions of community forestry.

Community forestry has been defined differently by different commentators and agencies. As per the definition given by Martel & Whyte, community forestry is a

village-level forest activities done with villagers. The main issue of this definition is regarding whether community forestry as an activity that can take place only at the village-level? If forest covers entire region or district including urban area, how can we include these areas? Therefore the following two definitions could be considered as these are more applicable to SLANRMP approach.

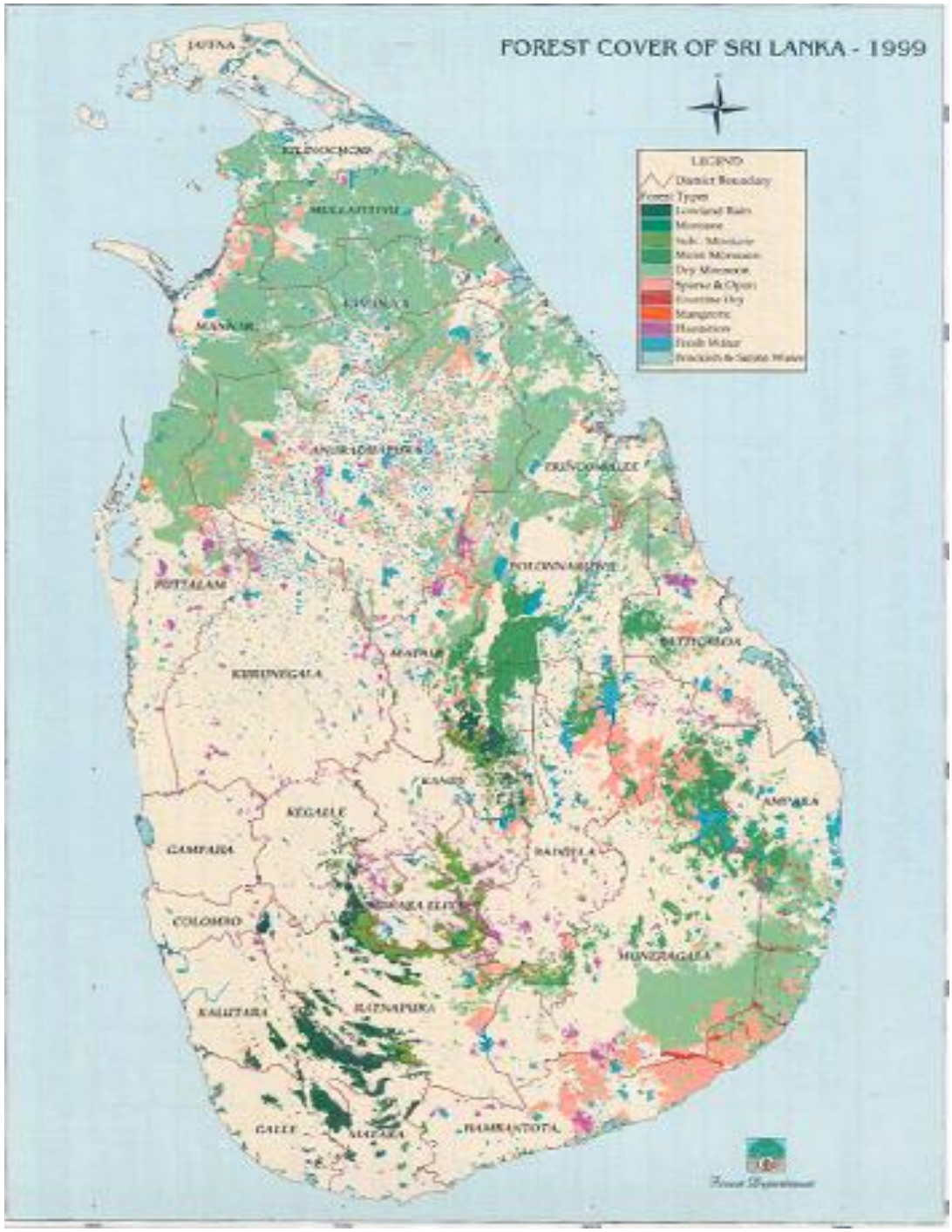
"Community forestry is an evolving branch of forestry whereby the local community plays a significant role in forest management and land use decision making by themselves in the facilitating support of government as well as change agents. It involves the participation and collaboration of various stakeholders including community, government and non-government organizations". (FAO, 1978)

Another definition is that "Community Forestry is "an approach to forest management that actively promotes the rights of the people living in & around the forests to both participate in forest management decisions and to benefit(financially and in kind) from the results of the management". "*This involves a new role for foresters for working with people rather than policing them".* (Jane Carter 2010).

As Eckholm et al, (1984) argues "Successful community forestry requires... "genuine popular participation in decision-making... Experience has proven time and again that participation is more than a development cliche; it is an absolute necessity if goals are to be met. But working with people rather than policing them is a new role for many foresters."

Revington (1992), identify few characteristics of community forestry as follows: the local community controls a clearly and legally defined area of forest; the local community is free from governmental and other outside pressure concerning the utilisation of that forest; if the forestry involves commercial sale of timber or other products, then the community is free from economic exploitation of markets or other pressure from outside forces; the community has long-term security of tenure over the forest and sees its future as being tied to the forest" (J Revington Rainforest Information Centre, 1992.)

Figure 3 – Forest Cover in Sri Lanka



Source – Forest Department, 2006

Figure 4- History of Community Forestry in Sri Lanka

- **Taungya System -** Started in Burma in 1856 – In Sri Lanka prior to 1950s.
- **In 1970s –** In1978 Eighth World Forestry Congress, which was devoted to the theme *"**Forests for People***", served to give the concept of community forestry rapid and intensive exposure.
- **In 1980** – The concept of Social Forestry was introduced to the ***"National Forest Policy of Sri Lanka".***
- **In 1980 –** Social Forestry & Extension division was started in the Forest Department
- **Since 1980–**Social/Community Forestry activities initiated in Sri Lanka.
- **In late 1980s up to now –** Several Community Forestry activities were implemented under Sinharaja and Knuckles Projects.
- **In 1990s –** Natural Resources Management Project (DFID) and Participatory Forestry Project (ADB)
- **Kanneliya Project** (Contributing to the Conservation of the Unique Biodiversity of the Threatened Rain forests of Southwest Sri Lanka) – GEF funding – 2000 – 2006
- **In 2003 -** "Sri Lanka Australia Natural Resources Management Project" (SLANRMP) (Aus AID) was started
- **2012 – (Current program)** Sri Lanka Community Forestry Program (SLCFP) (Australian Aid).

Source – Forest Department, 2011

1.3.3 Lessons Learned

SLANRMP has generated lessons which provide useful strategic guidelines for the future of community cascade and forestry management in Sri Lanka. These include:

1. The program (community) approach is the preferred instrument of cascade/forestry management in the dry and intermediate zones, and should be expanded and replicated as rapidly as possible.

2. The most suitable unit for management of program sites is one that contains the inhabitants of the selected village/s, their agricultural land resources, associated water storage and tank systems, the forested catchments of these water systems, and other natural and plantation forests.

3. Plant nursery management, enrichment planting and plantation development in degraded areas along forest margins can be successfully conducted by rural communities, with suitable capacity building, and provided suitable species are selected.

4. Community management is the only practical approach for fire protection in dry and intermediate cascades / forests. Annual fires at most sites can be virtually eliminated and this has been perhaps the most effective tool in resource protection and regeneration.

5. To encourage long-term environmental stewardship, there must be tangible short-term benefit, including the facilitation of Micro Finance (MF) /Micro Enterprise (ME) services where absent, for those who are expected to take this responsibility.

6. Rural women are valuable partners in community development and natural resource management, and every effort should be made to ensure their on-going participation / involvement, empowerment and benefit sharing.

7. Most participating communities have demonstrated a willingness to contribute increasing amounts of labour and materials to resource management initiatives as well as community infrastructure and services.

8. Once the local institutional capacity has been built, communities have confidence in dealing with other service providers and GOSL, and they have a mechanism for engagement with a large numbers of households.

9. Improved integration and coordination of agencies and stakeholders are possible at the CBO level through this program approach.

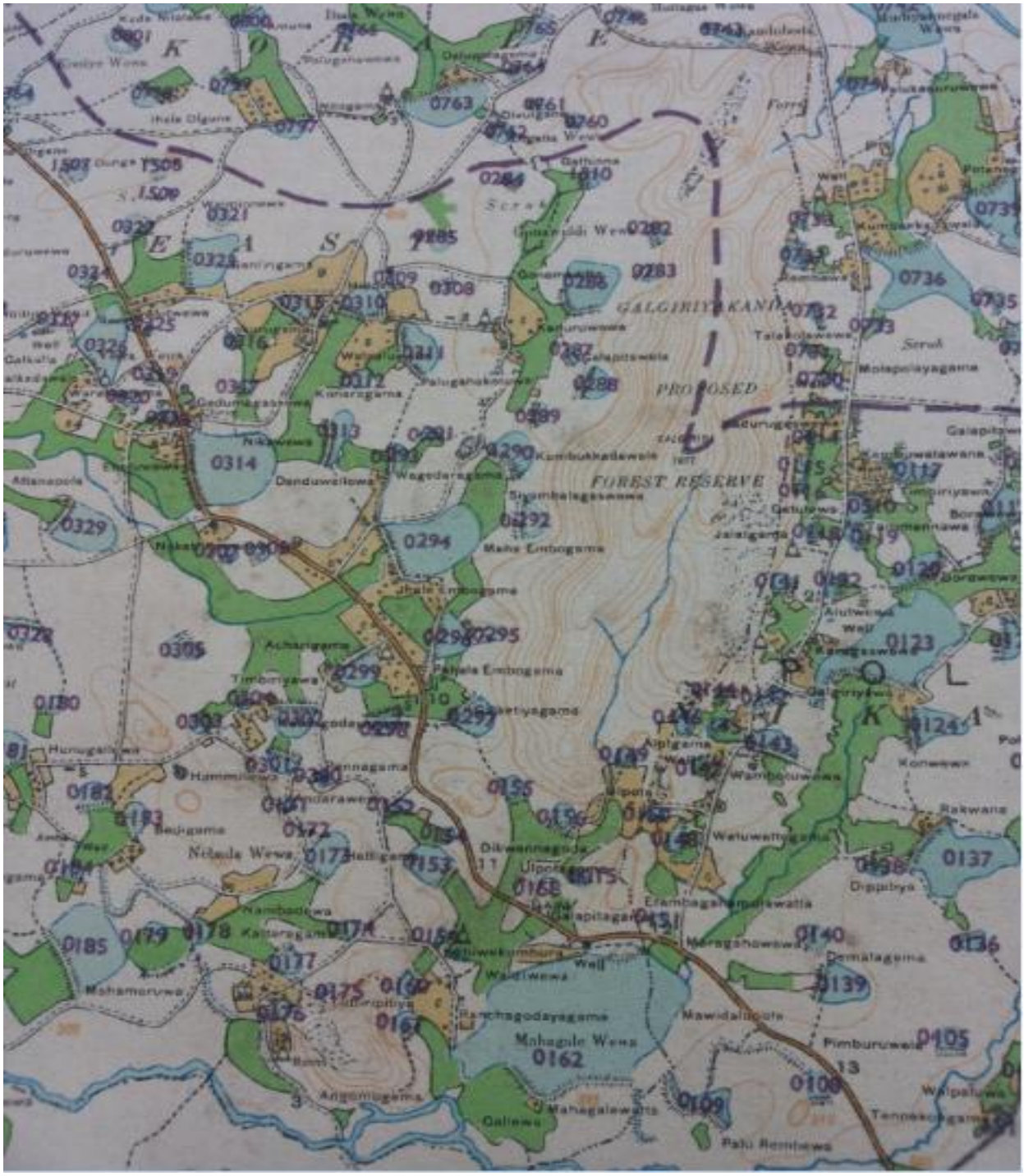
10. Facilitate the availability of non-forest benefits, including livelihood support activities offered by various agencies, especially MF and ME service providers, for individual members of communities by coordinating such agencies with CBOs;

11. Promote networks of CBOs at district, regional, and (in the future) national levels to play a role in coordination and advocacy.

1.3.4 Knowledge areas linked to the Research

This study focuses on ***'interface between cascade and livelihood'*** as the main knowledge area. However, study will further touch a number of secondary knowledge areas related to ancient hydrological architecture and rural irrigation systems.

Figure 5 – Contour Map around Galkiriyakanda Cascade



Source – Survey Department of Sri Lanka, 2000

1.4 Research Problem

The main research problem in this dissertation is to study "changes in Ulpotha micro-cascade as an ecological unit affect the livelihoods of cascade dependent communities and the environment in the area".

1.4.1 Research Questions

- **Extent to which degraded cascades are amenable for improvements?**
- **What major environmental benefits are accrued to cascade improvement?**
- **What connections are there between cascade and livelihood of cascade dependent rural communities?**
- **What are the implications of cascade improvements for policy making and practices?**

1.5 Objectives of the Study

Main objectives of this study could be categorised as general and specific. Initially, the whole area or big picture of the selected topic covered by the general objective and general it is overarching entire scope of the study.

1.5.1 General Objective:

The main objective of this dissertation is to identify and analyse impacts of restoration of Ulpotha Micro-cascade on environment and rural livelihood.

The five hypotheses were developed to support this objective and to study impacts of cascade restoration on environment and rural livelihood.

The empirical support for this analysis comes from the Sri Lanka Australia Natural Resource Management Project (SLANRMP) that implemented activities focussing environmental promotion and livelihood development of the downstream communities of Galkiriyakanda cascade and Ulpotha micro-cascade as was noted earlier. Therefore, this dissertation study, profile and analyse the impacts of

restoration efforts by SLANRMP in Ulpotha micro-cascade located within Galkiriyakanda meso-cascade on environment and rural livelihood.

The cascade resources in Ulpotha micro-cascade has been damaged and changed due to the destruction of cascade system. As a result, farming communities faced a number of hardships due to lack of water and other resources. In 2003, Government requested donor support to rehabilitate the damaged cascade. Accordingly, Australian Government extended technical assistance to Sri Lankan governments to launch a restoration program as an Action Research in collaboration with the Forest Department that included Galkiriyakanda cascade. Therefore this dissertation mainly focuses on the study of impacts of cascade restoration by SLANRMP on environment and rural livelihood.

1.5.2 Specific Objectives:

The key specific objectives of this study are:

- To analyse the strengths and weaknesses of restoration effort: and
- To identify participatory forestry implications for cascade development.
- To assess changes in livelihood opportunities in Ulpotha micro-cascade after restoration; and
- To identify the environmental, social and economic development implications of cascade development for future policy and planning.

1.6 Significance of the Study

Findings of this study is significant in many ways for dry-zone area development, improving rural livelihood support systems including ecological environment management, the role the rural community participation can play in forest regeneration and cascade development. It also highlights the ways and means of the cascade degeneration occurs in relation to Galkiriyakanda as an example and the extent of such damages with root causes. This dissertation also notes that cascade is degraded due to known and unknown reasons though with little local initiation to arrest such degradation.

This dissertation highlights and analyse the reasons for cascade degradation and lack of local level participation to arrest it. For example, during the Participatory Rural Appraisal (PRA), it was revealed that the surrounding villages were benefitted with natural resources, environment and communities collected good harvests (paddy and other crops) in every season. Degradation of water sources, soil and tree cover badly affected the rural livelihood and farmer's income has gone down. The final result was the increased poverty of adjacent communities. This situation affected the environment again as poor people were exploiting natural resource for their existences.

There is an urgent requirement to reverse the degradation of Galkiriyakanda cascade after addressing root causes. Livelihood improvement of adjacent communities is also important to reverse the degradation trend while stabilising the rural economy. Accordingly, study on inter-connections between Galkiriyakanda cascade and rural livelihood will help policy makers to develop their policies and plans for such locations.

Figure 6 – A degraded section of Ulpotha cascade

The above photograph shows that middle of the cascade is degraded and open for erosion. Siltation ends up in the downstream tanks as indicated in the below of the cascade. (Source – Field survey photo library 2011)

This study is also important in the sense that it fills a knowledge vacuum. For example, no study has been done on this cascade and very little primary or information were available until this study was undertaken. However, a number of studies and research have been conducted on other cascades and some literature are available for researchers and students on those cascades.

By noting the vacuum of knowledge on this cascade, this study attempts to fill the gap as far as possible by collecting data and analysing those in order to support the policy and planning. Accordingly, this will be the initial research paper focused on problems, issues and opportunities on the Galkiriyakanda cascade and Ulpotha micro cascade. Provincial and national planners also could field further studies and researches as per their requirements. Local communities could lobby and request national or provincial governments to consider their issues and prepare development programs to address burning issues in the locality highlighted by this research.

1.7 Limitations

Gathering all community members in to one place is the main limitation face in the village. During cultivation and harvesting seasons, all members were busy with their duties and responsibilities in paddy fields, chena and home gardens. It was extremely difficult to fix up a meeting with all community members for considerable length of period. Meetings with communities were essential to develop questionnaires and to test them with communities before fielding and commencement of field surveys.

Mostly women participate in day time meetings as men go out for day labour. During week-ends and holidays also not easy to arrange meetings as other societies (there are nearly 7 societies in the focus area) conduct their meetings during that period. The best time to meet all members (male & female) is night of a weekday. This is also difficult due to elephant threats in the night time.

The other limitation was the high expenditure or cost involvement in the entire research process including field visits and works. The researcher spent a considerable time (with his assistants) for the field work, interviews and transects walks.

1.8 Organisation of Chapters

1.8.1 Chapter 1 – Introduction

Chapter one of the dissertation, discusses the background information of the research and interface between cascade and livelihood of communities who lives around the cascade. In this study diverse livelihoods have been considered through-out the process. It also studies the geography and physical location of Galkiriyakanda area. Report also illustrates the objective of the research, research question, trends and history of Galkiriyakanda cascade definition and justification and significance of the study. The main focus of this research is to study the impacts of cascade rehabilitation through Sri Lanka Australia Natural Resource Management Project (SLANRMP) and discussions were held with communities on diverse livelihood and community forestry the and lessons learned during SLANRMP implementation.

1.8.2 Chapter 2 – Literature Survey

Chapter two covers the survey on cascade systems with literature evidence. Even though there are limited publications available on cascade systems, a considerable number of documents and web sites have been referred for the study. Practical experience of cascade origination, degradation and development aspects also discusses with graphs, photographs and maps. This chapter also describes and analyses the Ulpotha micro cascade and its special features in traditional / indigenous irrigation system. Functions, land use pattern and hydrology of Ulpotha micro cascade are the other areas discussed in this section.

1.8.3 Chapter 3 – Research Methodology

This is also an important chapter as it discusses the methodology used for this research. Case study method has been selected for the research. Two villages within the cascade have been selected for field survey. The sample size is 85 and required information collected through a Likert scale questionnaire. Independent variables and dependent variable have been developed. The cascade has been established as dependent variable and others (forest regrown, forest fire, reduce water run-off, CBO actions and additional income for poor) have been selected as independent variables. In addition to Likert scale questionnaire, focus group discussions, PRAs and

individual interviews conducted to triangulate data and information collected. In order to cover entire research area (structure), five hypotheses have been developed to study correlation between independent variables and the dependent variable (cascade). Further SPSS (Statistical package) has been applied to study correlations in a scientific way.

1.8.4 Chapter 4 – Evaluation and Analysis of Impacts on Cascade Restoration on Environment and Rural Livelihood

This section covers the analysis of information and data collected for the research. Collection of data has been done through field survey and an application of Likert scale questionnaire. Two villages namely Ihala Thimbiriyawa and Walathwewa have been selected for the field experience / application. Data collected have been analysed under two categories. Initially, socio-economic data and information collected through a general questionnaire have been analysed. Number of households and population, education level, employment groups and village economic activities have been discussed in the first category. Under the second category, data and information collected through the Likert scale questionnaire were analysed through the SPSS system. Correlation of five main hypotheses and testing of other variables were also done in this section.

1.8.5 Chapter 5 – Conclusion

Analysed data, SPSS calculation and results have been discussed in this section. Based on analysis, results and findings were reviewed and justifications were also formulated. Research recommendations were established at the end for the benefit of all sections and stakeholders including national planners. It is also recommended a further research (PhD level) on indigenous irrigation network in this cascade as this area was not covered by this research.

CHAPTER TWO

LITERATURE SURVEY

2.0 Introduction

The Galkiriyakanda cascade is situated in Ehetuwewa and Polpithigama Divisional Secretariat Divisions of Kurunegala District and Ulpotha is one of its micro-catchments. Kurunegala district is located within the North-Western Province and about 110 km northern side of Sri Lanka's capital city Colombo. It is one of the 25 districts in the country and administered by a Government Agent. It has a total land area of 481,280 hectares. Temperature in the Kurunegala district ranges from 22°C to 33°C with little diurnal or seasonal variation, and strong dry winds. In terms of the rainfall intensity, the district has been typified into three zones as dry, intermediate and wet. Relatively dryer area of the district receives around 1,100 millimetres of rainfall annually and is marked as the Dry Zone. The dry area covers nearly 1/3 of its total land area. About two third of the rains in the dry zone area occurs from October to February making it the major rainy (Maha) season. Rains in the minor (Yala) season occur from April to June. Between the Yala and Mah seasons, the climate is extremely hot and dry. Entire northern part of the district has typical dry weather conditions. Between-year and within - year variations in the rainfall are large and erratic, and seriously disrupt agricultural activities. The Dry zone in the district is inhabited by an estimated 360,000 inhabitants.

The topography of the dry zone is gently undulating, with intermittent ranges of rocky hills forming remnant (Island) forests. The potential for erosion is high, particularly when sloping soils are left with incomplete vegetative cover during periods of heavy rain, which is common on the *Chena* lands and is contributing to unsustainably high levels of soil erosion and land siltation (Steve Hunt, 2004).

Soils are generally deep, moderately fertile and easily cultivated but areas of gravely sub-horizons occur where even well managed home gardens are difficult to sustain. Water infiltration rates are generally low, so high- intensity rains (especially at the beginning of Maha season) seal the soil surface and the resulting runoff exacerbates

soil erosion. Such marginal areas are often inhabited by the poor people (Mik Nurse, 2002).

The present natural forest cover in the district is about 212,770 hectares or 44.2% of the total land area. But the forest cover in the district was around 300 hectares in 1990 and this shows the rapid deforestation in the district.

Table 1: Land use Statistics in Kurunegala

Description	Whole District	% of Total Land Area	Dry Area	% of Total Land Area
Total land area (ha)	481,280	100	160,400	33%
Area of natural forest (ha)	212,770	44.2	85,108	40%
Area cultivated (Including home gardens and chena (ha)	241,830	50.2	107,700	45%
Area of not cultivated (ha)	26,680	5.5	NA	NA

Source- Government Agent's Office, Kurunegala – 2011

Sri Lankan history is deeply connected with its hydraulic civilization with more than 100 drainage (river) basins. It is noted that the hydraulic system of Sri Lanka can-not be limited only to system of irrigation reservoirs, distribution systems and irrigated farming systems. According to D L O Mendis and Dr. Ray Wejewardene (2002), this field covers sustainable water - soil - flora fauna – human – ecosystems, which are mainly based on water cascades and their catchments including minor irrigation systems.

There is a sizeable volume of literature on hydrologic and irrigation systems and their operations in Sri Lanka. However, most such works done in relation to the indigenous knowledge of irrigation and water management. As Madduma Bandara (1985) suggests most of the above studies are descriptive than analytical.

Furthermore, it is noted that scientific assessments of ancient irrigation systems are very few in the country. This indicates a knowledge gap in this sector. On the other hand, studies on ancient irrigation / hydrologic systems often tend to highlight the glory of huge dams and reservoirs (Panapitiya, 1993). Even though some people believe that scientific analysis / assessments are not necessary in the sector, it is the duty of professionals to assess the indigenous water management knowledge in a scientific way for the use of future generation. Therefore, there exists a need for careful study and analysis of indigenous water cascade management systems and knowledge used by the people in managing those to improve their livelihood. However, current requirement is to reduce degradation of cascade while doing a scientific studies and analyses on impacts on rural livelihood.

These needs have been recognised by the modern scientists and professionals and have made efforts to study the restoration of cascade systems and impacts on rural livelihood. The environmentalists have gone further and have critically analysed the ecological and biological aspects of irrigation works and hydrological systems in cascades. They also have studied the impacts of such systems on environment as well as the communities that depend on such environments in order to protect biodiversity and minimise the adverse impacts on environment. The modern scientists focus their work beyond the traditional assessments and deep studies are being carried out on environmental, socio-economic, livelihood development, socio-technical and socio-political issues as well. They also argue that any development programs need to address the environmental issues including the climate change and agro-ecological balance of the natural environmental sphere. As Halsnaes and Verhagens (2007) aptly put "Today the issue of climate change is overshadowed by a number of immediate development priorities including poverty eradication, food and water security, health, natural resource management, energy access, transportation needs and local air and water pollution" . This shows the importance of managing cascade systems for the benefit of every aspect of the environment and people.

According to Madduma Bandara (1985), a cascade system is a "connected series of tanks organised within the meso-catchment of the dry zone landscape, storing, conveying and utilising water from an ephemeral rivulet". In 1993, Itakura and

Abernethy describe a tank cascade or a chain of tank as a “series of small reservoirs that are constructed at successive locations down are single common watercourse”. It was the practice that each individual cascade is named with the most prominent tank in the cascade (e.g. Ulpotha).

Figure 7- Dried up tank in sensitive fire areas close to the railway line

Source – Field Survey, 2011

Literature shows that poverty is a phenomenon contingent on the quality of land (Blaikie, 1981:3). This means that a poor environment is linked to poverty. By 1989, approximately 470 million (70 percent of the poorest people) in developing countries lived in ecologically fragile marginal areas characterized by arid lands, limited fertile soils and steep slopes (Leonard et al. 1989:19). Any action to arrest, reverse and manage the degradation process need identification of root causes, especially inter-phase between cascade degradation and poverty which touches by this dissertation.

2.1 Types of Cascades:

Tank cascades have been existence in South Asian countries for centuries. They are the early source of water supply systems for agriculture and human use. Apart from Sri Lanka, India and Nepal also manage their tank cascade systems. Cascades in Tamil Nadu, Andra Pradesh and some parts of Maharastra are significant in irrigation history. (Von Oppen and Sabbu Rao, 1980). Tamil Nadu itself has nearly 40,000 small tanks while Andra Pradesh has over 70,000 small systems (Maloney and Raju, 1994).

Sri Lanka cascade irrigation history goes back to over 2,000 years (Brohier, 1934). As per early records, there were more than 30,000 small tanks (in addition to large scale irrigation tanks) in dry parts of Sri Lanka (Rathnatunga, 1983). More than half of these tanks were destroyed or disappeared due to so call rural and infrastructure development. At present, more than 17,000 small tanks are operating especially in the dry zone covering nearly 500,000 hectares. (IWMI Research Paper 13). All dry zone tank irrigation systems are generally arrayed in cascades. Each small tank has its own catchments. Excess water of one tank flows to another tank in the downstream. Generally, a cascade has 2 to 25 linked tanks. (In Ulpotha cascade, more than 50 tanks can be seen). Commencement of the hydrological inter-linkage of tanks within a cascade system will be illustrated by the below diagram.

Figure 8- Initial stage of a Tank Cascade

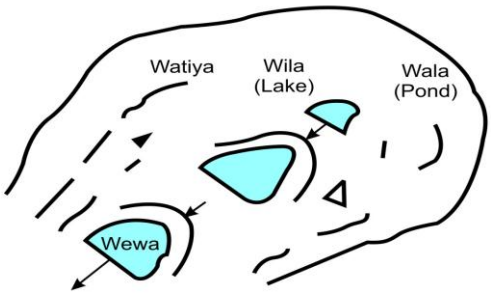
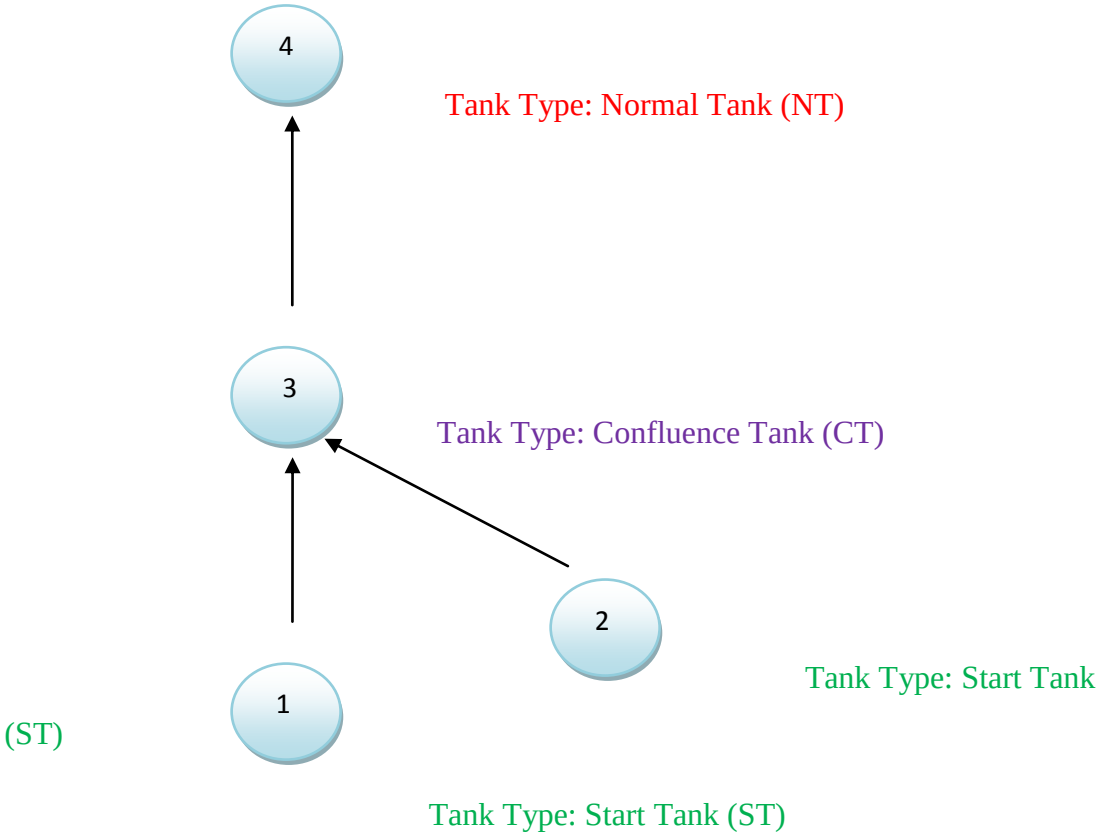


Figure 1 : Rainwater trapping structures

Figure 8 illustrates the rainwater trapping structure in an early cascade development stage. This shows how water collects in a cascade through different sources like wala (pond) and a wila (a lake). A watiya (natural protection earth-bund) also guides water flow to small tanks and then to the cascade system. This is the early stage cascade formation. Even in Ulpotha cascade, this type of situation can be seen in the western corner summit of Galkiriyakanda catchment.

Figure 9 – Tank cascade system at the early stage

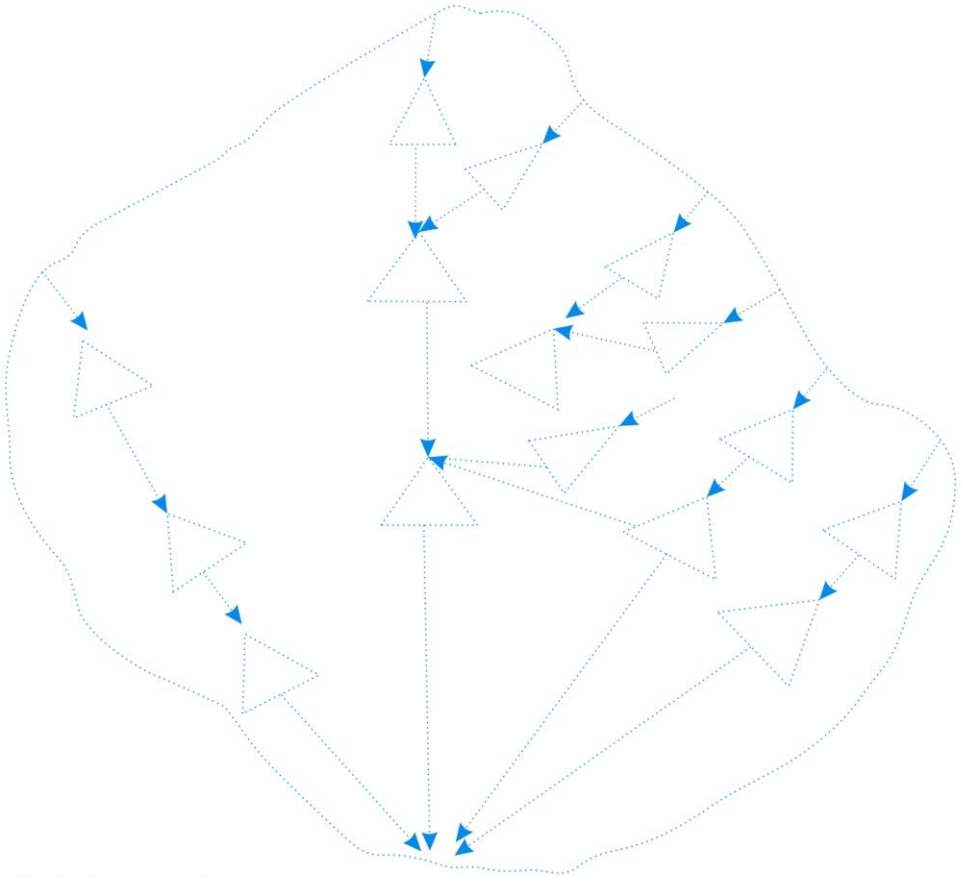


Three types of tanks are identified in the initial stage of tank cascade system and they are shown in the figure 9. Start Tank (ST) – a tank with no inflow from upstream tanks, Normal Tank (NT) – a tank with inflow from one upstream tank and Confluence Tank (CT) – a tank with inflow from more than one upstream tank. When this system developed and expanded, a comprehensive tank cascade system will create. Figure 9 and 10 show the development stages of cascade systems. A

number of examples for development of tank cascade systems could be seen in the North Central Province (NCP). Similar systems are functioning in northern corner of North Western Province (NWP) as well. Galkiriyakanda cascade with its' micro cascades and irrigation network are the good example in NWP.

Figure 10 – Schematic relationship of tanks

Schematic relationship of the tanks in the Makichchawa cascade.



Tanks in the cascade

Thimbiri	Maha Divulgaskada	Nuge
Dutu	Kuda Divulgaskada	Vedikkarayage
Etambagaskada	Palugolla	Kadawatha
Maha Meegaskada	Puhudivula	Kuda Kongollewa
Kuda Meegaskada	Makichchawa	Ratmalwetiya

Source : IWMI Research Report - 48

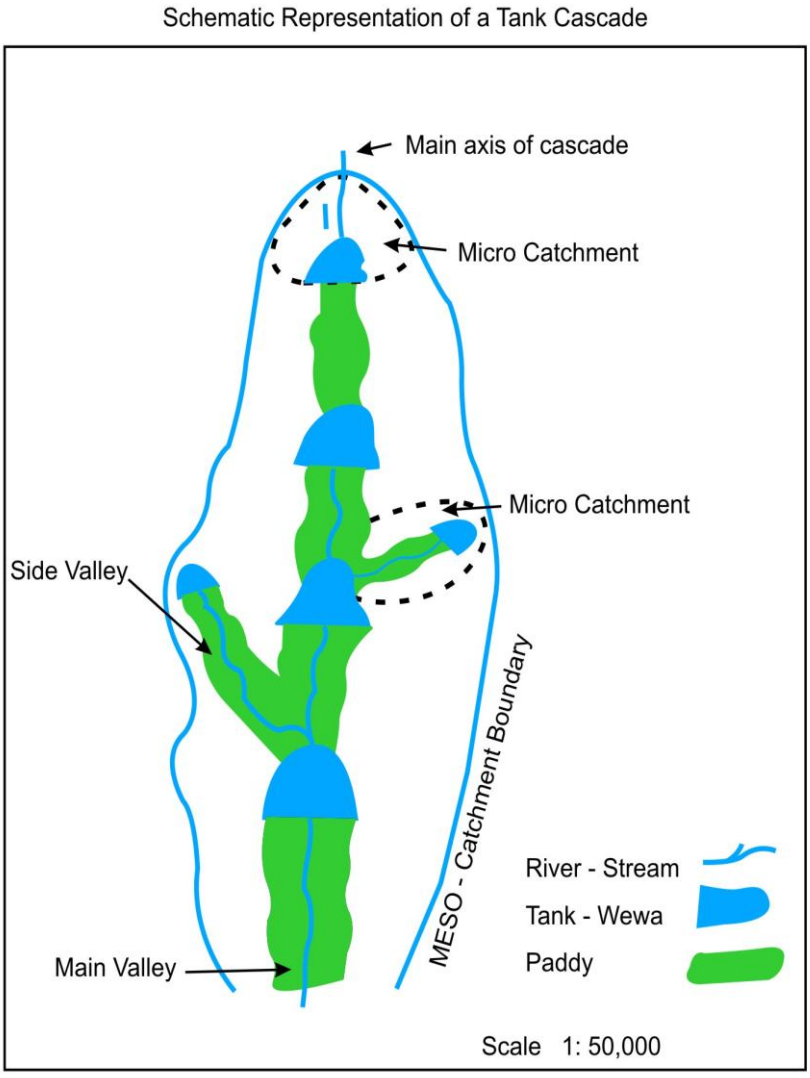
Further development of water trapping systems and tank linkages creates a comprehensive network of a cascade system. The inter-relationships of tanks create different cascade systems based on the physical or geological patterns and soil conditions. Figure 10 shows the relationships among tanks in Makichchawa cascade in North Central Province.

A number of cascade systems are visible in the North Western Province (NWP) with more than 4,000 irrigation tanks. These cascade systems have special geotechnical attributes of the landscape suitable for irrigation development. This is also a unique system for effective and productive land use as well. That is why ancient kings protected and did not allow people to exploit cascades and also educate communities about the value of cascade systems for their agricultural life. However, this traditional system was changed during the colonial ruling period. Abolishment of Rajakariya, introduction of commercial cultivations and extension of settlements to major catchment areas resulted with over-exploitation of protected areas and cascades. With the recognition of disasters due to the destruction of catchments, more studies have been started by professionals in various disciplines. The early studies of water balance were reported by Somasiri (1979) at the Walagambahu Village Tank located in Maha Illuppallama in Anuradhapura district. This Study has been concentrated on 285 acres of catchment area and 50 acres of irrigated command area with their dependents or communities. Following this study, a number of studies have been done in dry zone catchments including Willachchiya, Thirappane, Kanadarawa and Walawe in the south of Sri Lanka. However, not a single study carried out in Galkiriyakanda cascade and studying of this cascade is important at this stage due to its valuable service to the area and vulnerability with the exposure to degradation with the recent development initiatives and community actions.

However, in early studies most professionals paid their attention on single tank and its catchment and downstream works. Following Madduma Bandara's study in 1985, approach was changed and more emphasis was paid to study the entire cascade system including its ecosystems. In 1994, Thennekoon brought the traditional village know-how on cascade systems. According to him and traditional folklore, cascade named as an "Ellangava" formed with two Sinhala words. Ellan (means hanging) and gava (one after the other). Thennekoon also emphasised that cascade had been well

connected with farmer's mind and thoughts. Based on Government Agents' (GAs) notes of diaries, he further said that any development in a particular cascade systems should be done after having careful studies on adequate volume of water availability for other surrounding tanks and communities. Possible flood related disasters and dry weather conditions also need to be studied before planning and launching any development program. In 1994, Panabokke has introduced a new concept called micro-catchments and meso-catchments. Accordingly, all micro tanks' catchments are located within a meso-catchment. In one meso-catchment, there will be several micro-catchments with a number of side valleys.

Figure 11- Meso-Catchment and Micro-Catchment

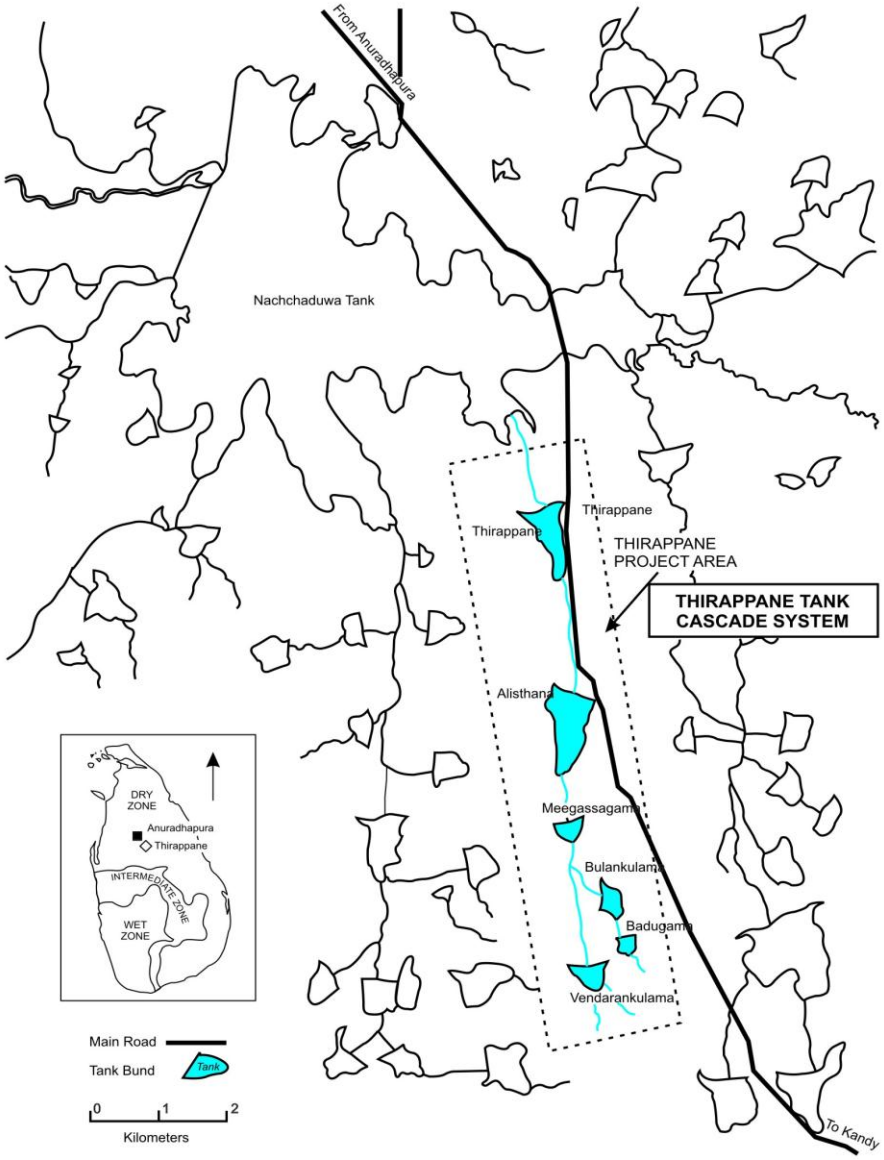


Source : Madduma Bandara

The best example for this type of catchment is the Tirappane Cascade system and it is illustrated below.

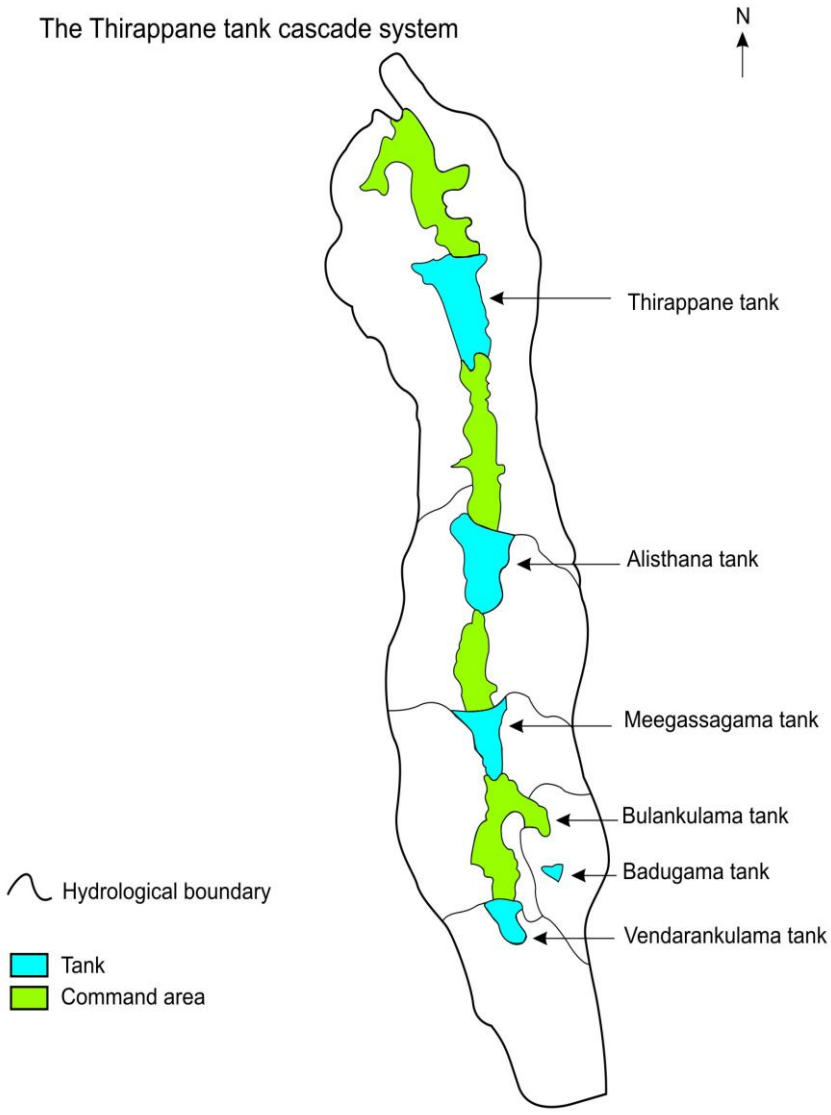
Figure 12 – Location of the Thirappana Cascade System

Location of the Thirappane tank cascade system.



Source - IWMI Research Report - 48

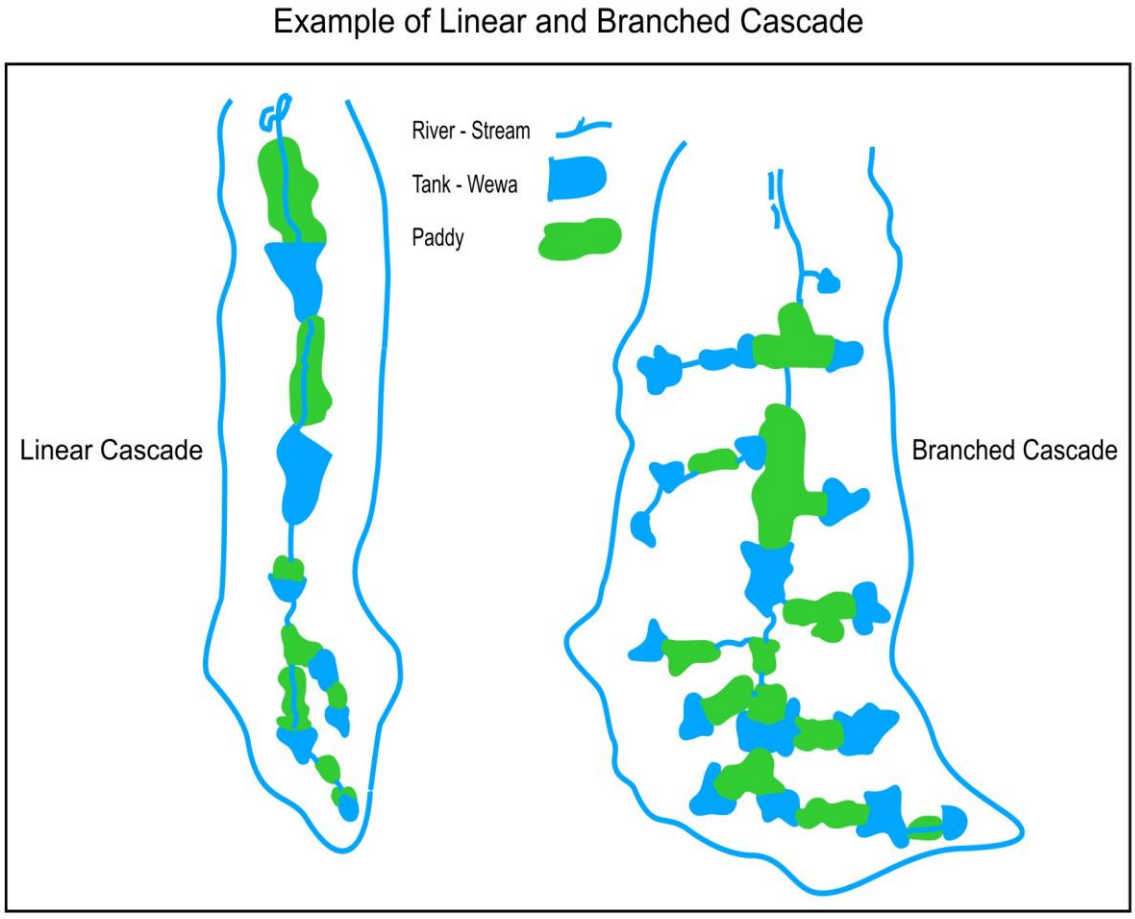
Figure 13 – A Cross-section of Thirappane Cascade



Source : IWMI Research Report - 48

This concept was further expanded by another concept called linear cascade and branched cascade. Accordingly, a number of micro-cascade will be formed due to establishment of minor tanks in different shapes. Please refer figure 14 for this style.

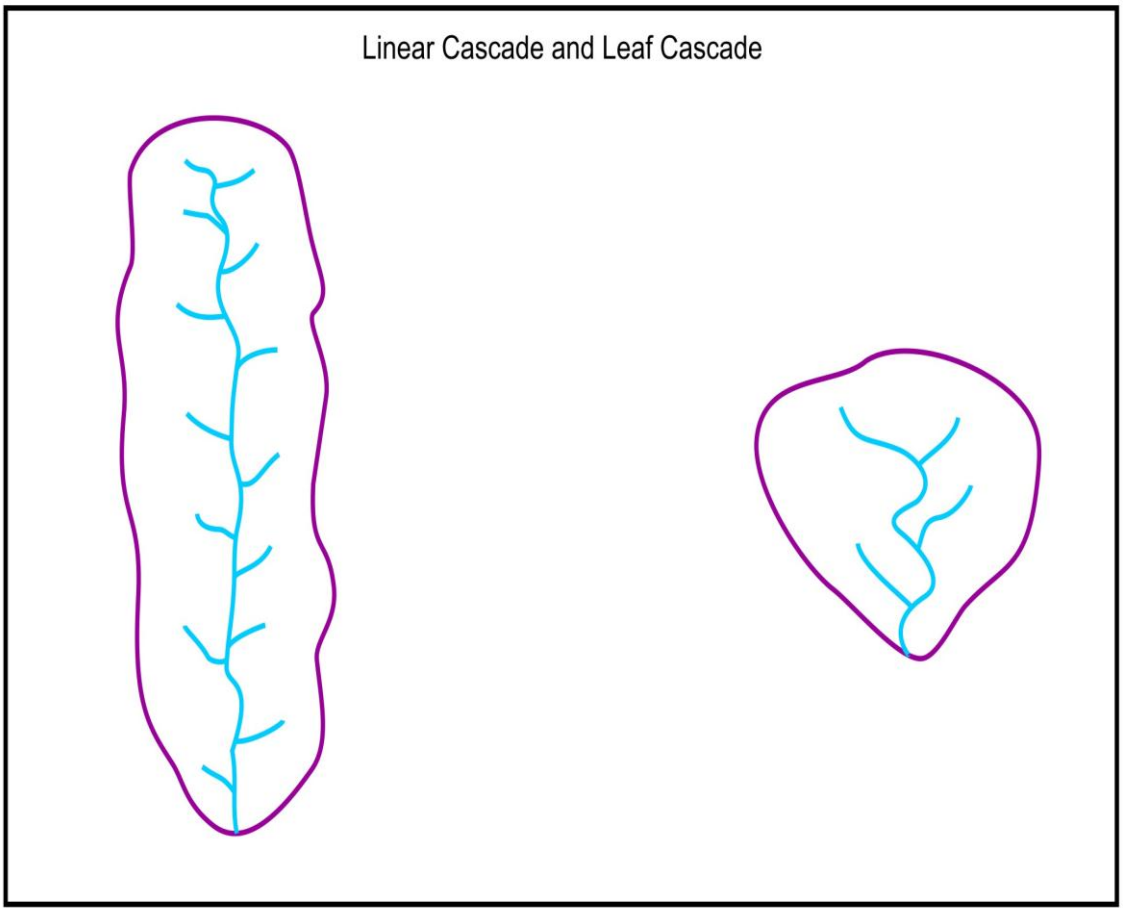
Figure 14 – Linear Cascade and Branched Cascade



Source : Madduma Bandara

Another concept was also introduced to describe linear cascade and leaf shape cascade systems. Among them, a leaf cascade system is common in many countries. Even, Ulpotha is also called as a leaf cascade. Liner cascades are common in flat and valley areas without rocks. Branch cascades are very common in hilly areas.

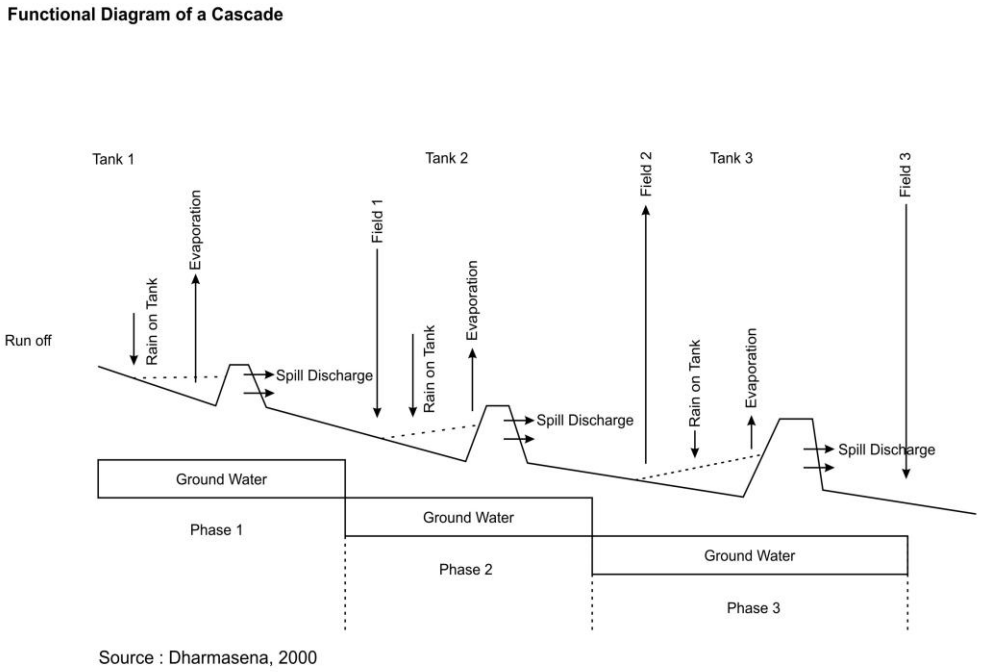
Figure 15 – Linear Cascade and Leaf Cascade



Source – Madduma Bandara, 2000

As per Dharmasena's conceptualisation, a cross-section of a cascade system is shown in the below diagram (Figure 16). This illustrates how different components work and behave in a complete cascade system. The diagram describes the ground water table functions also in various levels of the cascade stream. This will provide an idea about how tanks function under a cascade including water inflow, outflow, and cultivation areas as well. It is also noted that water streams generally end up in to a river that flows to the sea.

Figure 16 – A cross-section of a cascade



Source : Dharmasena, 2000

The above facts describe the evolution of studies on traditional cascade systems and impacts to the environment and communities. It is understood that more and more irrigation works are necessary to improve the food production for the increased population. But can all these things tolerated at the expense of environment.

There is no documented or official information regarding measures of degradation like precipitation levels, tree and grass cover, soil depth and soil erosion and water holding capacity of land in Galkiriyakanda cascade. However, even the casual observation indicates of continued degradation of entire Galkiriyakanda cascade system. Historical accounts provided by the local people, especially elderly during the focus group discussions also provide ample information to show substantial and continued degradation of Galkiriyakanda cascade. Every day discourse by the local community members also shows the abundance of forest trees, lush grass cover, reasonably and widely spread rainfall in the area, high moisture content of soils, sustained water flows from higher elevation of Galkiriyakanda cascade that fed the

land and small reservoirs of villages that the communities depended for drinking water and irrigation in the past.

More importantly, degradation found to be continued with profound implications for management of the local environmental system and rural communities that depend on those environmental resources like for drinking and irrigation water, forest resources including edible fruits, yams, medicinal herbs, timber, firewood, fodder etc.

Causes of degradation of Galkiriyakanda cascade are known and unknown. In variably, part of the degradation should occur as a natural process and this has not been investigated so far and therefore unaccounted in this dissertation. However, it is stressed that cascade degradation, like any other form of land and environmental degradation, is a natural phenomenon that occurs in differing degrees in different ecological regions. Located in Sri Lanka's dry zone, Galkiriyakanda might have degraded also due to natural causes which are not the focus of this dissertation.

Of those known causes of degradation of Galkiriyakanda cascade include human or "man-made" causes. However, large scale exploitation of cascade area and resources encompassing the area for commercial purposes by the people external to the local communities like for timber, housing and road development have not been reported so far. Therefore, it appears that considerable damages are done by the community members who live close to the Galkiriyakanda cascade. It could be found that the local community members use the cascade area for uncontrolled grazing, cutting trees for timber and firewood, land for shifting or slash and burned cultivation etc bringing pressure on the system. Especially the pressure bought by the local poor on the cascade resources found to be significant. Therefore, a clear link between environmental degradation of Galkiriyakanda cascade and Ulpotha micro cascade seems to be higher number of poor local families exploiting the cascade resources.

The major employment of the local communities that live surrounding Galkiriyakanda cascade is small-scale farming. They produce agricultural crops for home consumption as well as for sale. Agriculture, mainly the cultivation of paddy and other subsidiary food crops like non-paddy grains, yams, vegetables and fruits by the local community members in the down-stream areas mainly depend on water

sources of the cascade systems. Therefore, "***there is a paradox as to why those very people who depend on the cascade and its resources for their livelihood add to its degradation and suffer in the long run"***[1]**.** A related question is whether poor cascade resources cause higher incidence of poverty in the area or very acts of people cause cascade to degrade.

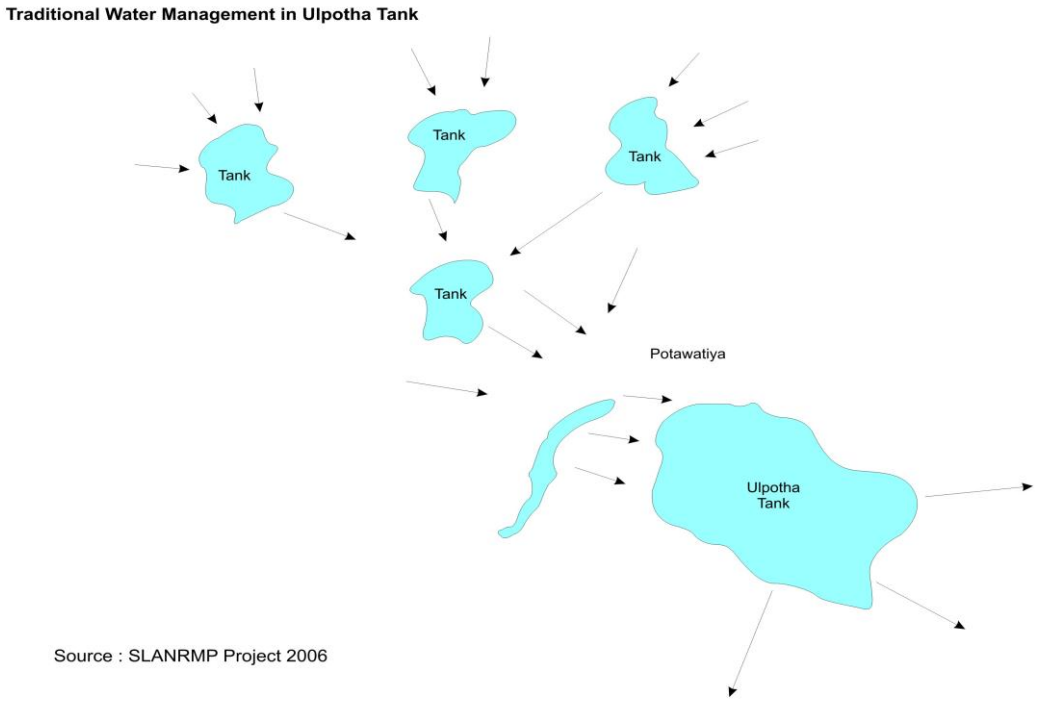
2.2 Ulpotha Micro-Cascade

The cascade has a high biological importance not only for the local area and people, but also for the entire country. There are a total of 1,500 households around this cascade. Most of these households depend on farming on smallholder basis as a major livelihood. A significant portion of the households that earn a livelihood from agriculture are irrigated paddy farmers and much dependant on water sources of cascade. Cascade also fulfils many functions as being the source of water for drinking by people and household animals like cattle, bathing and washing and home-gardening.

As we discussed earlier, Galkiriyakanda is also a meso-cascade or a catchment due to its geotechnical features. This cascade covers more than 1,100 hectares in the vicinity. Under this meso-catchment, a number of micro-cascades (catchments) are visible. Among them "Ulpotha micro cascade" has been selected for this study. According to irrigation experts, Ulpotha micro-cascade also can be named as 'Leaf Shape Cascade'.

[1] Pennington B, (2006) – Mid Term Review Report of SLANRMP, AusAID, Canberra

Figure 17 – Leaf Shape Ulpotha Cascade



Ulpotha micro-cascade enriches nearly 56 tanks from the summit of the cascade. All drainage flow water end in the middle size reservoir called 'Maha Gala Wewa'. The significant features of this micro-cascade are:

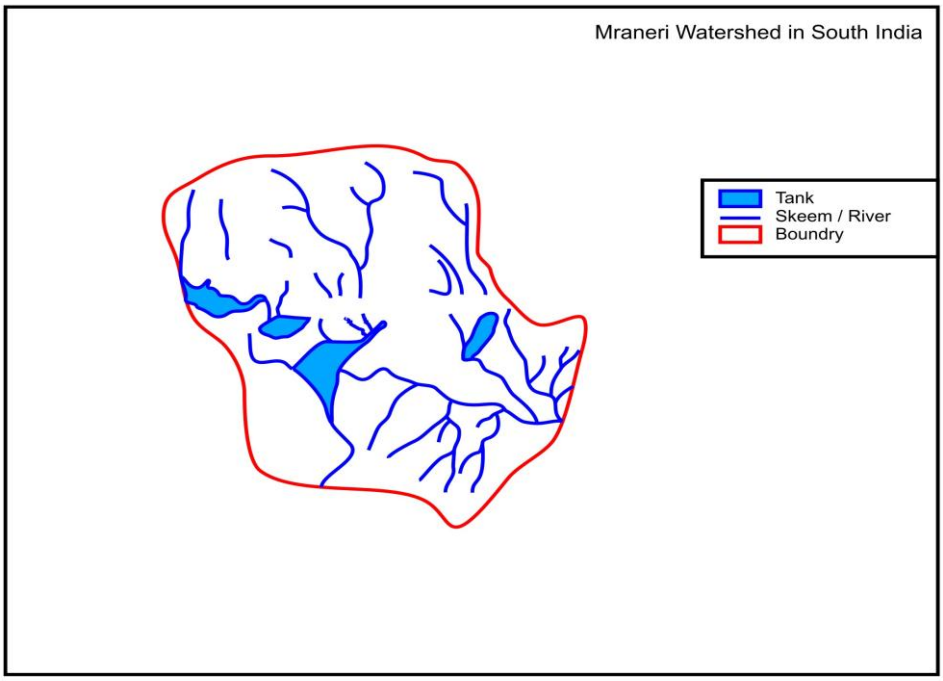
Small Tanks are being used for paddy cultivation and other crops in Maha season.

Chena cultivation also practices during the Maha season.

Small tanks will not hold sufficient water for Yala cultivation.

During Yala season, communities engage in paddy cultivation under the Maha Gala Wewa. Farmers do not cultivate any crops under this tank in Maha season and keep water or yala (season) cultivation.

Figure 18 – Example for another Leaf Shape Cascade



Source : Dr. M. Krishnaveni, Silva Sankari, A Rajeswari

If sufficient water is not available in the Maha Gala Tank, farmers practice 'Bethma System' in order to support all members of the farmer society. Bethma is our traditional system to share cultivation area equally among all farmers. This system is still in practice in rural areas.

This cascade system is suitable for ecotourism due to rich biodiversity and world famous "Ulpotha Eco-Resort" is also located within this cascade. Eco-tourism is the 'nature living' and enjoying the eco-system in the area. This is a good income source for many people and rural communities. Traditional food habits and nature living is more attractive in these places. Rural folk could sell their farm products and handicrafts to tourists who visit eco-lodges.

Figure 19 – Ulpotha Forest Eco-Resort

Source – Ulpotha Hotel photo library, 2005

Ulpotha micro-cascade is the backbone of socio-economic aspects of communities in surrounding villages. This cascade also creates various landscapes promoting King Parakramabahu's water philosophy of stop wasting water without using for any work.

This system proves that communities in this area could live comfortably if all components of cascade operate properly. Damage of the cascade system will harm the community life pattern and food security aspects as well.

As Madduma Bandara explained (1985), several types of tanks could be seen in a cascade and the same features are visible in Ulpotha cascade as well. Some of the tanks in this cascade are not for cultivation purpose. But they help irrigated agricultural works in the downstream areas by storing and releasing water at a given time. The various types of tanks operate in this cascade are as follows.

2.3 Micro-tanks in Ulpotha cascade

Sky (Ahas) Wewa in the jungle and close to the summit of the cascade.

This will collect the rain water and control the flow from the summit of the rock. Water is used by wild animals and maintains the moisture in the area.

Nagaha Wewa – Forest tank situated in the slope of the cascade.

This is also not for the irrigation purposes and provides water for wild animals. This will also reduce the wild animal damages to the village and their cultivations. This maintains the wet area suitable for a cool catchment.

Kalu Wewa – Mountain Tank

This tank built to avoid mud, soil and other silt running to downstream tanks. This is also provides water for wild animals, chena cultivation and other highland crops.

Pota Wewa – Erosion Control Tank

This is also called as 'Pota wetiya' which was designed to avoid any silt depositing in the first major tank in the chain. Villages called this as "Pota Wewa".

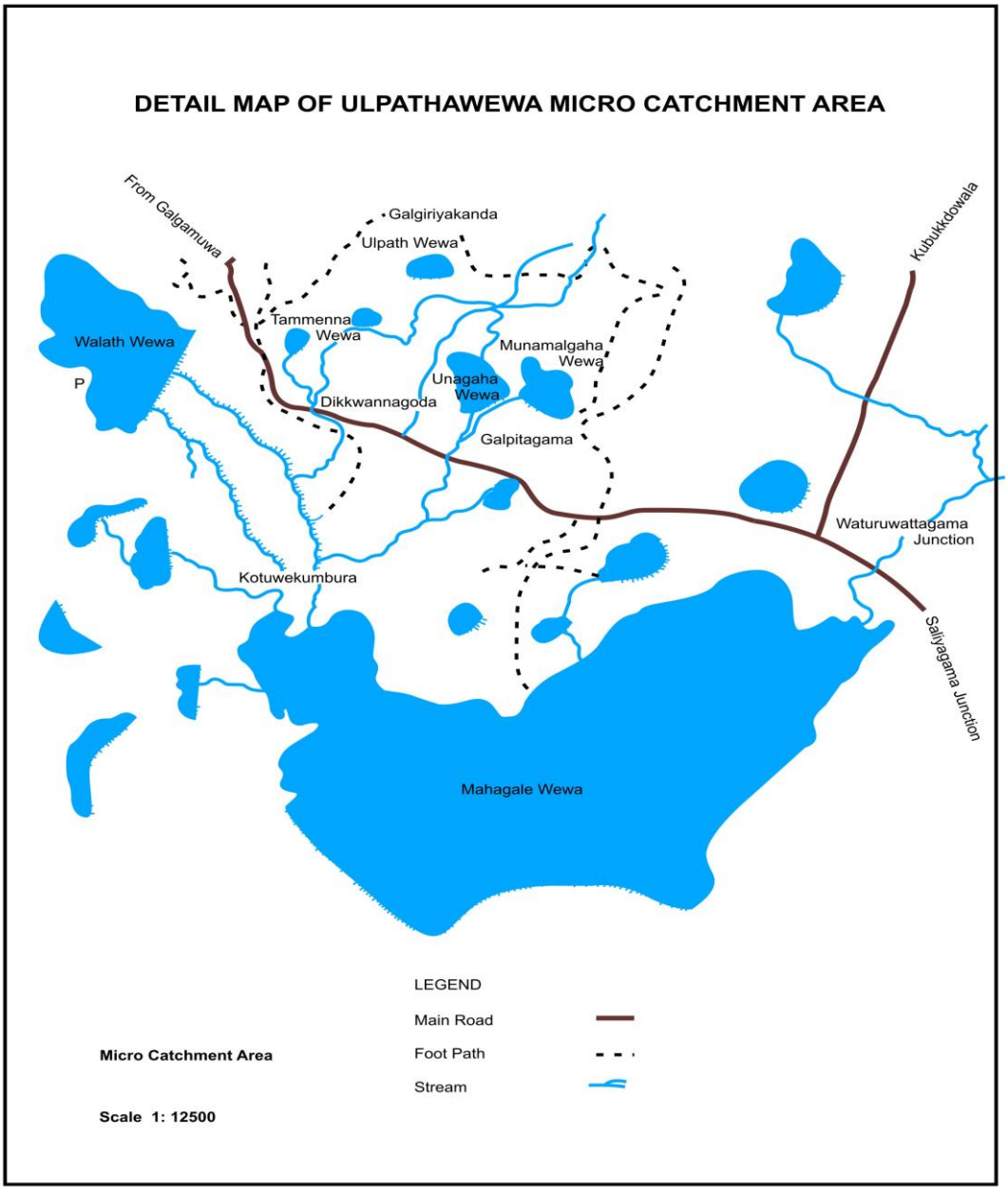
Ulpoth Wewa – Unagaha Wewa and Munamalgaha Wewa – Storage Tanks

Immediately after the erosion control tank, Storage Tanks could be seen. Traditionally, water of these tanks has been used for Maha cultivation during the main rainy season. Most cases, tank water is not sufficient for paddy cultivation in Yala. However, some farmers cultivate vegetable under the tank during the Yala.

Maha Gala Wewa – The Village Main Tank

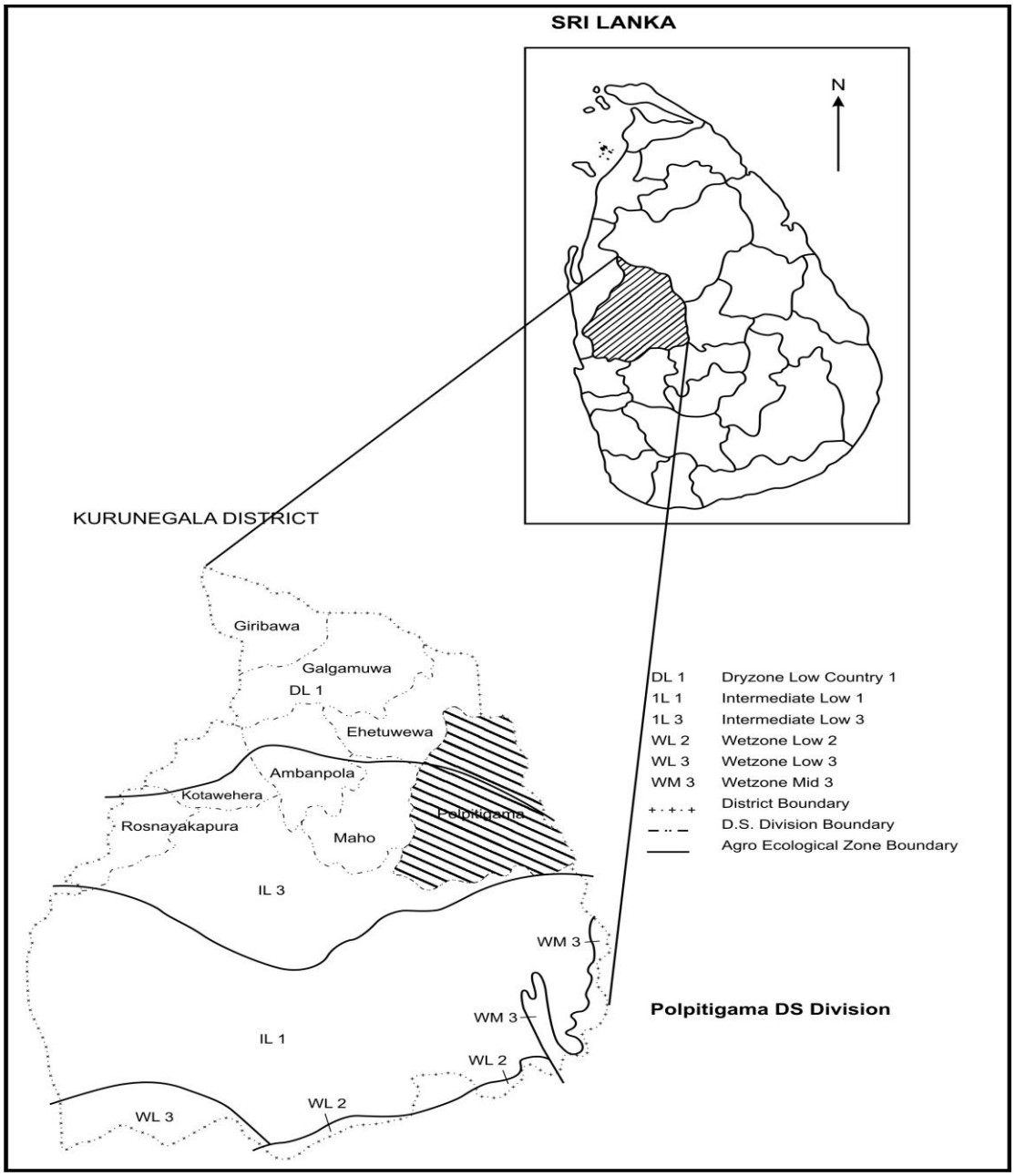
Each and every traditional village has the prominent village tank especially for irrigated agriculture. Systematic canals and other components are the main features of this tank. It is noted that all drainage water flows to this tank and collect sufficient water for both Yala and Maha. However, communities in the Ulpotha micro-catchment hardly use water from this tank for Maha season. Water in other tanks in the chain is used for Maha cultivation. Yala cultivation is mainly done under Maha Gala Tank as sufficient water is available for Yala season. Drain water from Maha Gala Wewa flows to the downstream and enrich the 'Mee Oya' which flows to the sea via Karuwalagaswewa in Puttlam district.

Figure 20 – Ulpotha Micro Catchment



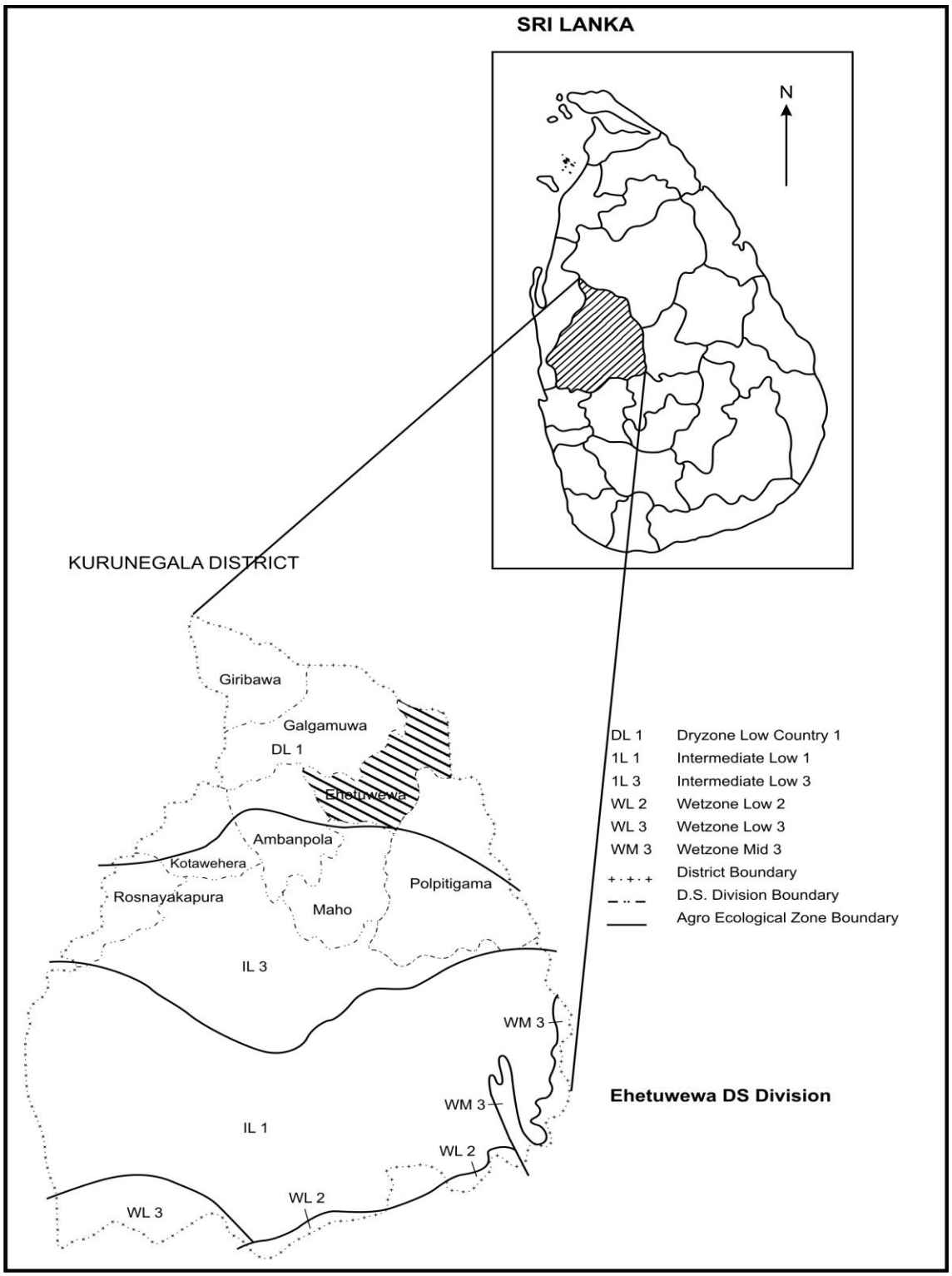
Source- Government Agent's Office, Kurunegala – 2011

Figure 21 – Polpithigama DS Division



Source- Government Agent's Office, Kurunegala – 2011

Figure 22 – Ehatuwewa DS Division



Source- Government Agent's Office, Kurunegala – 2011

2.4 Functions of Ulpotha Micro-Cascade

Galkiriyakanda cascade provides a number of functions in economic, ecological, social, hydrological and cultural terms and these can be analysed as follows:

2.4.1 Ecological function:

As this cascade is high in biodiversity, special species and ecosystem diversity, it provides a very strong ecological function. The high number of animals, plants and bird species indicates the existence of a closed and effective food chain. As in other parts of Sri Lanka this cascade provides habitat and a transport corridor for wild elephants. These elephants inhabit the buffer zone between the forest and agricultural lands. During the dry season the elephants travel towards the settlements and often destroy agricultural crops. According to the National Conservation Review Data of Forest Department (1996), apart from the common species found in the cascade, numerous endemic and threatened animals and plants exist. Four types of ecosystems are found in this cascade and describe below.

- **Forest Cover**- land including the thick and shrub forest is the main functioning natural system prevailing in the area. In addition, sparse forest areas could be seen close to the buffer zone. People are encroaching buffer zone gradually for cultivation works and for animal feeding.

- **Aquatic Resources** – Water sources like streams and tanks are also located in the in the cascade. Various types of living beings inhabit these water sources and moisture contained soils. These streams / water ways enrich the cascade with water creatures like fresh-water fish, frogs etc.

- **Grass-land** – located close to the buffer zone and grass land is important for animal feeding. But this area is vulnerable to fire as it might work as a (fire) conveyer as well. Since people are encroaching and expanding the buffer zone, forest cover is also reducing close to the buffer zone on a continuous basis.

- **Agricultural land** – Main paddy areas and home gardens are located in this section. Chena can-not be included in this section. But communities are doing chena cultivation in buffer zone and even within the forest areas as well.

2.4.2 Economic Function:

The cascade provides a range of tangible and intangible economic benefits to the communities. These include the supply of water to irrigate thousands of hectares of agricultural land, cool air and a more comfortable environment. As the cascade forest has high plant and animal biodiversity; communities have obtained a number of forest products (timber and non-timber) for many generations. The major products included timber, medicinal plants, honey, fibres and firewood. Most products were consumed within the communities rather than being marketed.

In addition to the above traditional products, communities have been engaged in production of value-added products as well. Lime drying is a good example in this regard. During the season, lime harvest is plentiful and most of this go waste as processing is lacking. Nevertheless, some farmers have started collecting lime for drying and selling. Bee honey collection, handicrafts and home-gardens also provide some income for communities.

2.4.3 Hydrological Function:

Cascade supported by forest system is the main source of water for the communities living in downstream and around it. Water flows from the cascade support downstream agriculture and enable the village tanks to be filled for use in the dry season. Cascade with forest system help recharge the village irrigation tanks and irrigation and drinking water wells. Based on the perceptions of older community members, approximately 50 years ago the cascade fed 56 ancient irrigation tanks. Currently only 31 tanks store water from the catchment. Due to soil erosion, consequent siltation, and poor maintenance of the ancient tanks are unable to function and store rain water and surface run-off. There are about of 24 streams which provide both grey water for washing, bathing, livestock and wildlife; and limited amounts of potable water to the communities. The volume of water has been observed to have reduced over the past 20 years, due to the poor management of the catchments. Ground water is generally the only source of drinking water available to

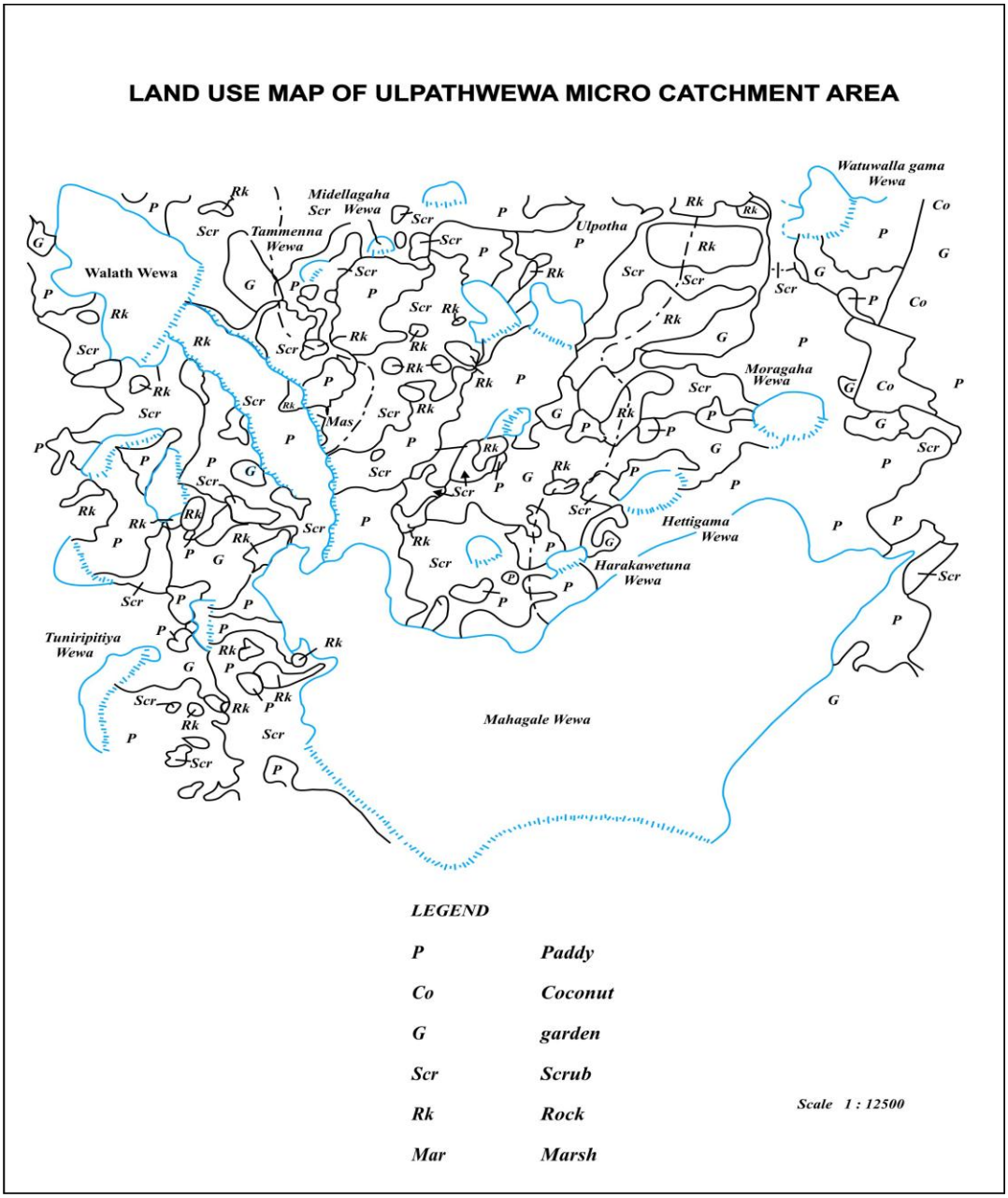
communities now. The total number of ground water wells that feed by this cascade is about 250. The clean and cool environment in and around the cascade area can easily be observed. Local people believe that due to the presence of the cascade /forest on the small mountain still the rainfall is relatively higher than surrounding areas.

Hydrological aspects of a catchment depend on rainfall, level of surface water runoff and ground water potentials (IIMI Country Paper No. 13). But in Sri Lanka, main information on hydrology is coming from farmers as they have the information on rainfall, water flow, hydrological behaviour and collection and distribution of water by small catchments and tanks. The main parameters to determine hydrological behaviour are; (a). Direct rainfall, (b). Rainfall runoff, (c) Drainage return flow and (d) spill water from upstream tanks. In some cases, supplementary diversions from another micro-catchment also can be considered as temporary water flow. However, the major problem in determination of such parameters is the collection and analysis of first-hand information and data. In order to overcome this barrier, most irrigation experts use 'Cropping Intensity' (CI) over five consecutive Maha Seasons (IIMI Country Paper No. 13).[2] This system provides more reliable and measurable data and values.

The Irrigation Department adopts a method call "Iso-Yield Method" (Ponrajah 1982) to estimate the seasonal catchment yield. One limitation of this method is that it tends to over-estimate the catchment runoff. Therefore, new models have been suggested by a number of researches. Dharmasiri (1991) and Somasiri (1992) show that no runoff is generated with the initial seasonal rainfall unless the presaturation requirement of the catchment soils have been adequately met. In respect of the runoff coefficient, the values from these studies range from 0.20 to 0.30 for the Maha season as compared with values of 0.25 to 0.35 by the Iso-Yield approach.

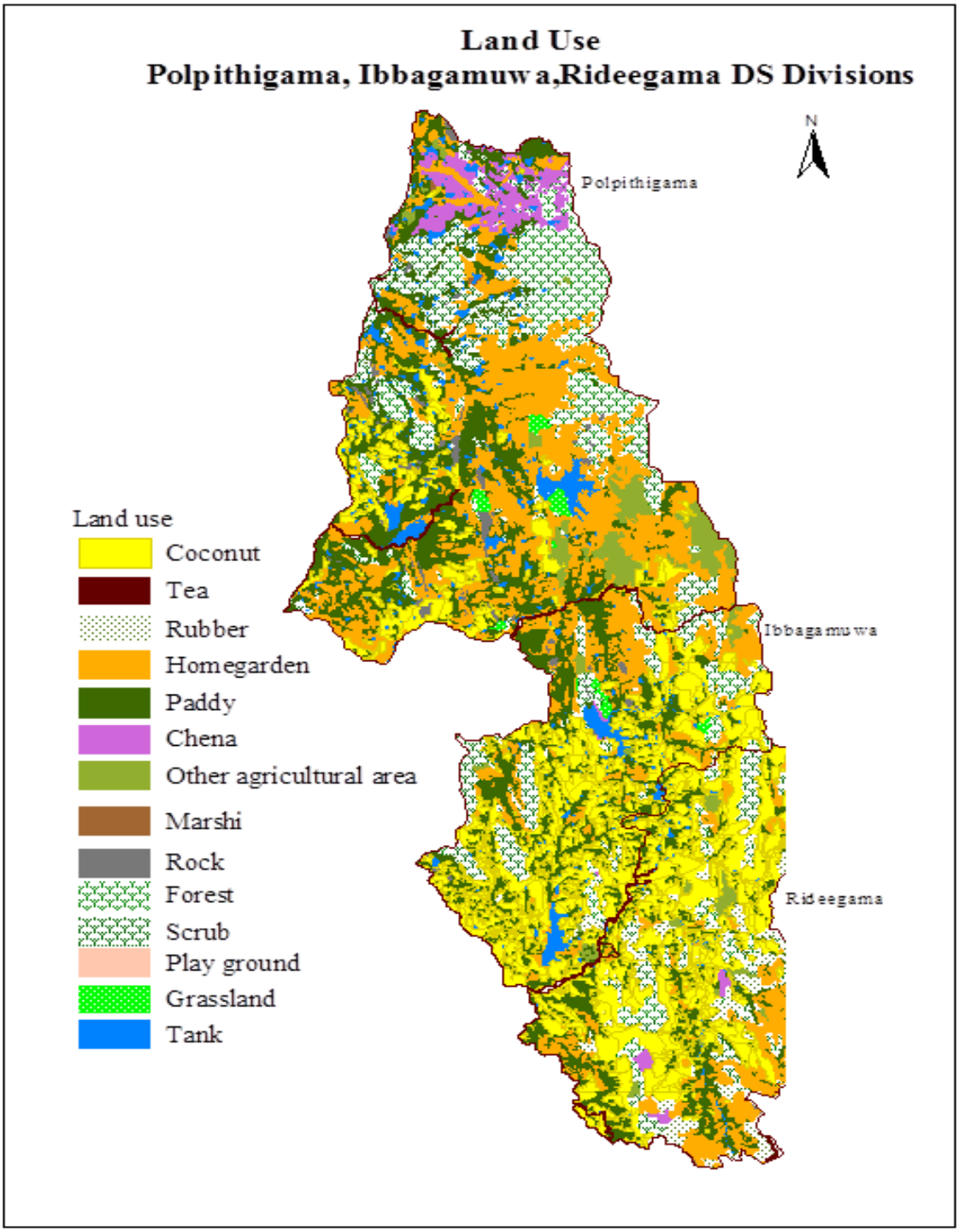
[2] The CI has been defined as "the area irrigated or cultivated during the Maha season divided by the total command area".

Figure 23 – Land Use Map in Ulpotha Micro Cascade



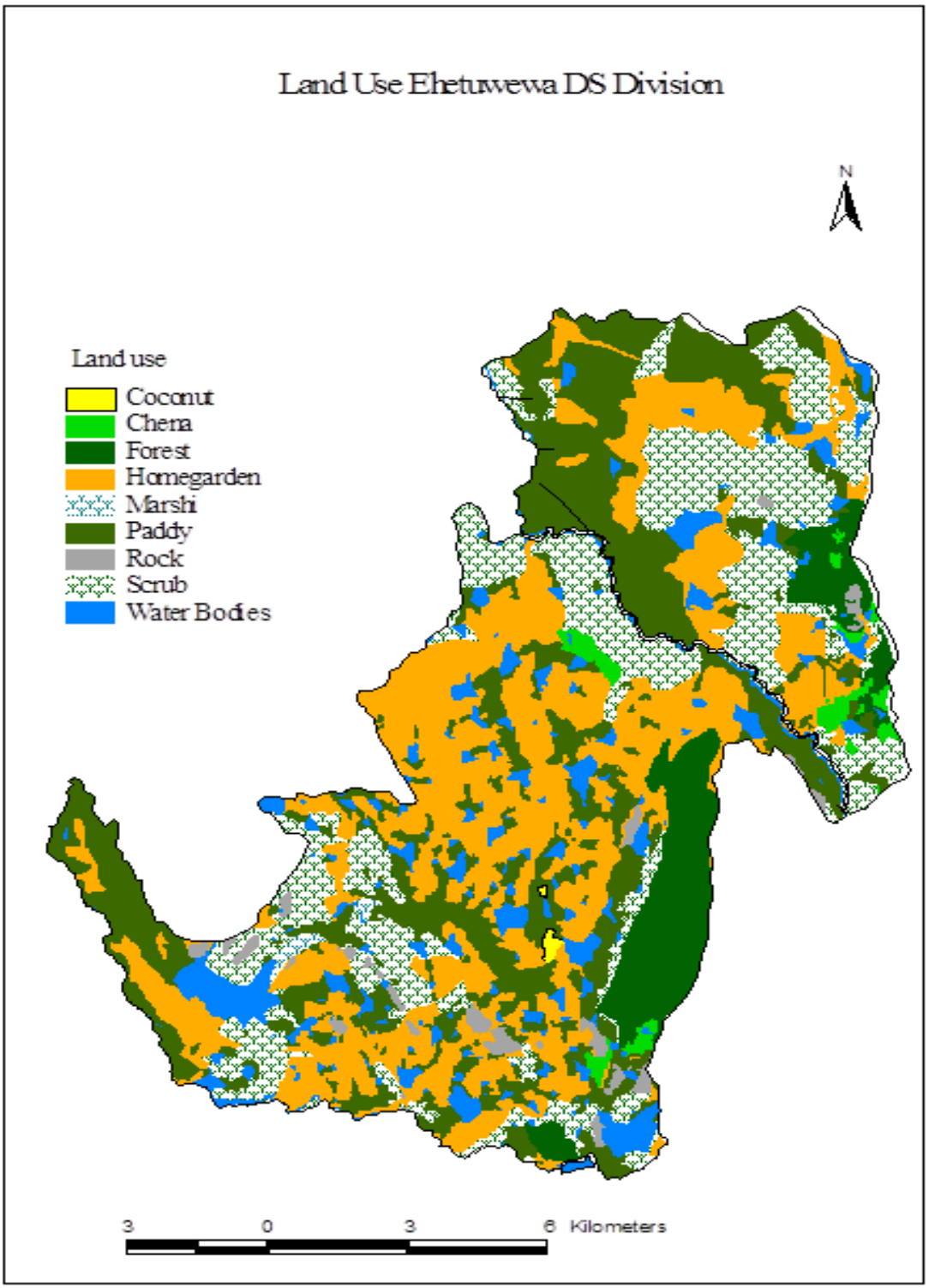
Source- Government Agent's Office, Kurunegala – 2011

Figure 24 – Land Use pattern in Polpithigama DS Division



Source- Government Agent's Office, Kurunegala – 2011

Figure 25 – Land Use pattern in Ehatuwewa DS Division



Source- Government Agent's Office, Kurunegala – 2011

CHAPTER THREE

SURVEY METHODOLOGY

3.0 Introduction

A number of tools have been used to study cascade renovation and its impacts as discussed in previous chapters. This chapter provides a detailed account of methodology used for the study. These tools have been select carefully to support objectives of the research namely to study the impacts of Galkiriyakanda cascade and Ulpotha micro-cascade renovation on rural livelihood and the environment.

3.1 Research Design and Methodological Overview

Case study is an appropriate methodology to do a holistic and in-depth investigation in an identified issue (Feagin, Orum, &Sjoberg, 1991). In order to do this, two downstream villages (namely IhalaThimbiriyawa and Walathwewa) in the Ulpotha micro-cascade have been selected as sample villages. Improvements done in Ulpotha cascade and its impacts on environment and rural livelihoods in two selected regions were the main areas to concentrate during the field survey.

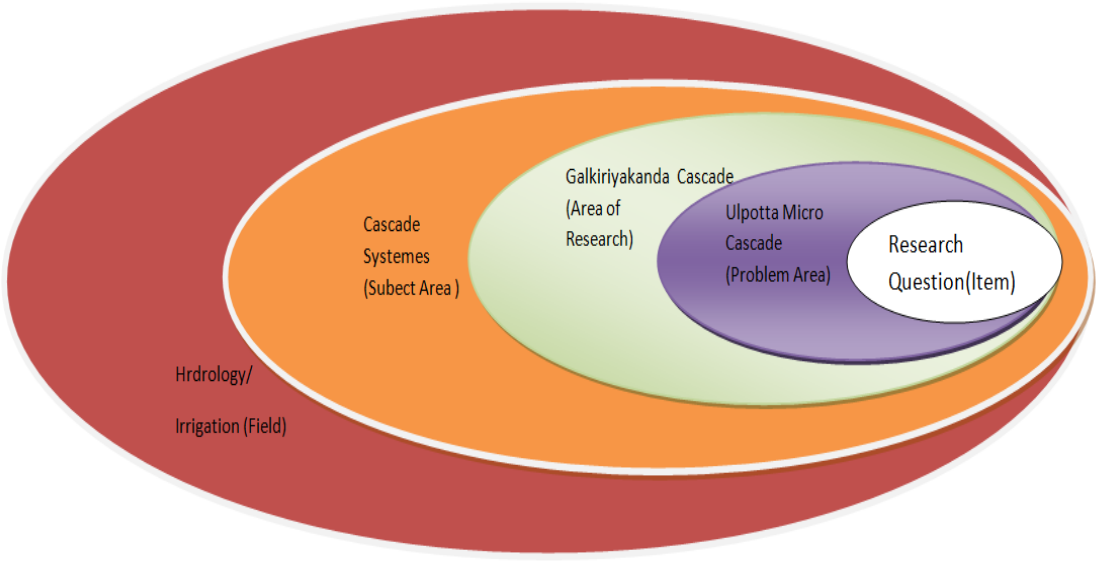
The main criticism of the case study method emphasises that a small number of cases cannot establish reliability and generality of study results. Similarly, in some instances this methodology could be biased for many reasons. These criticisms are more general and still researchers use the case study method widely with careful planning and implementation in a participatory way. In order to avoid weaknesses of the method, following steps have been followed.

The methodology selected in the case study comprised of extensive participatory field surveys (e.g. PRAs, focus group discussions, transect walks, SWOT analysis and seasonal Calendars etc). Above mentioned participatory tools were helpful to consolidate findings. In addition to above, a number of meetings have been conducted with key stakeholders to test survey tools and to measure the impacts and community acceptability of cascade restoration and its impacts.

3.2 Conceptualisation of research area:

The research area is overarched by many fields of studies. For instance, it is studied from the perspectives of hydrology, irrigation, biodiversity as well as livelihood development. From those perspectives, cascade systems (including its livelihood base) can be considered as one major area of study. Empirical basis of studying cascade system, (cascade and its livelihood pattern) is Galkiriyakanda cascade. Once the Galkiriyakanda cascade was selected as the macro physio-social domain, Ulpotha Micro Catchment was selected as physio-social domain or focus of the case study. Thus the research questions for this were formulated in relation to the Ulpotha micro-cascade rehabilitation and its impacts on livelihood opportunities of that depended on it. Figure 26 shows how the research has been conceptualised within the vast knowledge areas of hydrology and irrigation to Ulpotha restoration and community livelihood.

Figure 26 – Schematic of how the research area fits within hydrology/irrigation



Source – Field Survey, 2011

3.3 The Population and Sample Framework

The population of this study is the households who dwell in downstream areas of the Ulpotha micro-catchment. However, as it is not possible to enumerate the entire population, a section of households have been selected for the study. This sample was selected after a careful studies and analysis of village conditions households dwelling in the Ulpotha micro-catchment, their spread and livelihood systems. Of the households dwelling in the area, a sample was randomly selected to reduce any bias. Of the two villages located within Ulpothamicro-catchment, 40 from Walathwewa and balance 45 were selected from Ihala Thimbiriyawa. Differences in sample sizes was due to the number of households located the two villages. For example, Ihala Thimbiriyawa had a larger population (904) than in Walathwewa (636). The total sample was 85.

The term livelihood improvement for the purpose of this study have been defined to include improved livelihood opportunities like increased production and improved productivity, income and additional employment opportunities. Therefore, in the analysis, changes in the cascade has been considered as **'dependent variable'** while changes in forest re-grown, forest fire and water run-off etc. have been considered as **'independent variables'**.

In commencing the SLNRMP, it was noted that a range of data have been compiled at the District Secretariat and Divisional Secretariat levels as the baseline information for general planning purposes. However, the data available at the above level were limited considering the purpose of analysis in the present study. Thus, additional data needed were collected focussing on study areas. For this, local area information were collected from key informants like village leaders and village level officials like the Grama Niladharies (GNs), Samurdhi Niladharies and Cultivation Officers. Other survey tools were used, as described below, to collect and confirm the data and statistics of the case study.

There are a number of micro-catchments in the Galkiriyakanda meso-catchment and these considerably differed from each other in terms of certain geographic and socio-

economic characters. Most degraded micro-catchment (Ulpotha) has been selected as the physical context of the **Case Study** for this research.

Participatory Rural Appraisal (PRA) sessions have been conducted to collect current information and grassroots knowledge on forest degradation, traditional forest protection systems, cascade and livelihood improvements. In particular, PRAs helped to recognise and study the unique traditional protection systems functioning in different areas and villages. Discussions, interviews, transects, SWOT matrix and seasonal calendars were also done with communities and officers who worked with SLANRMP were also helpful to verify and triangulation of information collected. Community consultation was also useful to understand rural irrigation net-woks as well. A questionnaire survey was used retrieve data from sample households. Outcomes of SLANRMP were also studied through progress reports, evaluations and other project materials that were available.

3.4 Focus Group Meetings

The focus group meeting is the tool used to study stakeholders' feelings, reactions and observations on operational aspects of renovated irrigation system. Lessons learned and proposals for further improvements are the key areas discussed in these meetings. Criticisms, failures, achievements and gaps were also the key topics that covered during the discussions. The information received from various individuals has been re-checked or triangulated during the participatory Rural Appraisal (PRA) sessions with sample households. PRA sessions and tools were used to re-assess the cascade restoration and livelihood systems through resource mapping, diagrams and other PRA tools. Previous maps were used to compare the difference made through renovations.

3.5 Individual Interviews

Individual interviews with selected community members or key informants helpful to cross-check the information collected. Interviewees were conducted with members of agricultural households (both male and female), grassroots level extension officers, technical officers and provincial level planners. Such interviews were mainly focused on problems, gaps and issues identified during the field survey and during group

meetings. These interviews were structured and dwelled on deep to analyse and study the identified issues, themes or areas. Traditional cultivation and livelihood methods, indigenous knowledge and impacts of renovated cascades were the major areas covered. These interviews were two-way process to share knowledge and experience by both parties. These open and free discussions provided the opportunity to express their views and comments.

3.6 Transects

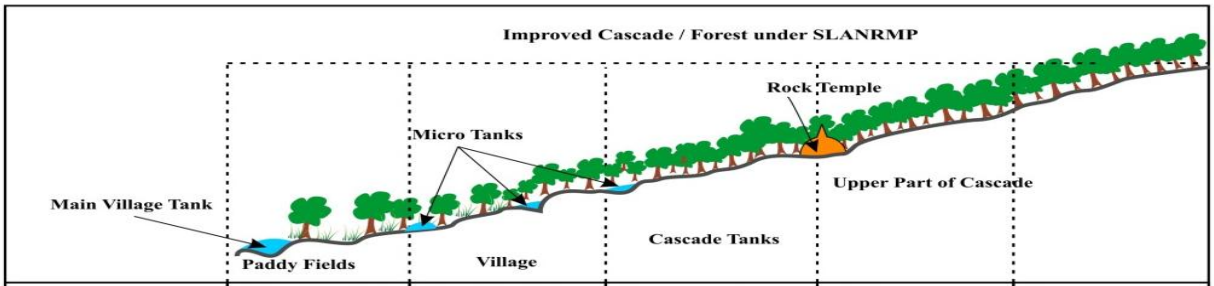
A transect is a line following a route along which a survey or observations are made (Marques T. A. Et al, 2006). A transect is a zone which functions more like an inclusive environment. Planning, implementing, mapping and finalising are the main steps of a transect study. As such transect is an important research method to study changes or improvements in physical and / or environmental (forests and eco-systems) characteristics in a study area.

The main objectives of transect in the present study were to re-visit rehabilitated areas of Ulpotha cascade to check whether the old cascade system is back in place with rural livelihood opportunities. These characteristics can be divided into two sections such as biotic (living things) and abiotic (non-living things). As Ulpotha micro-cascade is a huge area, a specific section (Nikawewa Kanda) has been selected for the transect study. Researcher conducted a line transect along with selected belt transect components to do a comprehensive survey on changes in the Ulpotha micro-cascade. Local farming community members also participated in this walk through a defined line and milestones. This took a couple of day's work and plotting, mapping and report writing took another a couple of days. Transect is also faster than surveying the entire area and it is another way of sampling. Accordingly, well planned transect has been conducted with the support of community members to recognise and note changes made in the Ulpotha cascade. Key steps followed for planning, implementing and finalising of the transect exercise are given below.

1. Discuss objectives / aims with participants (including community members);
2. Select analytical leaders and brief them about the assignment and assign duties; key roles for them to play

3. Develop criteria for observation and analysis (i.e. Howforest, cascadeand livelihood change?);
4. Develop transect line (initially in the map);
5. Walk and investigate along the transect line (Minimum three persons in one group);
6. Plotting (draft) diagrams during the field survey (group work in the field);
7. Back to the base (Field groups bring their findings)
8. Brainstorming sessions in the village;
9. Recording system (written documents – Sketches, graphs, diagrams – photographs)
10. Finalising documentations of results.

Figure 27- Transect Walk through Nikawewa- Kanda in Ulpotha Micro Cascade



Soil	Clay (Reddish Brown), sand	Clay (Reddish Brown), sand	Gravel, rocky, stones	Rocky	Rocky
Land use	Farmlands, main village tank	Farmlands, micro tanks, village forest patches	Scrub jungle, village forest patches, pasture, Cascade tanks, Village temple	Forest, forest tanks, water sources	Forest, water sources, streams
Vegetation and crops	Paddy, vegetable, other cash crops (OFC)	Paddy, vegetable, Other Field Crops (OFC) & Home Gardens	Rain-fed paddy, grassland & OFC	Forest trees, fool wood and timber - Jungle fruits	Forest trees, fool wood and timber timber, Jungle fruits
Problems	Lack of water during the dry season	Lack of water during the dry season, Low farm production	Low fertile soil, encroachments, animal damages (Elephants, monkeys etc.)	Soil erosion, forest degradation and animal damages	Soil erosion, forest degradation
Opportunities	Dry resistance farming	Dry resistance farming, dairy farming	More pasture, forest products (medicinal herbs, timber & jungle fruits etc.)	More pasture, forest products (medicinal herbs, timber & jungle fruits etc.)	Reservation forest, tourism, forest animals and other forest products

Source – Field Survey, 2011

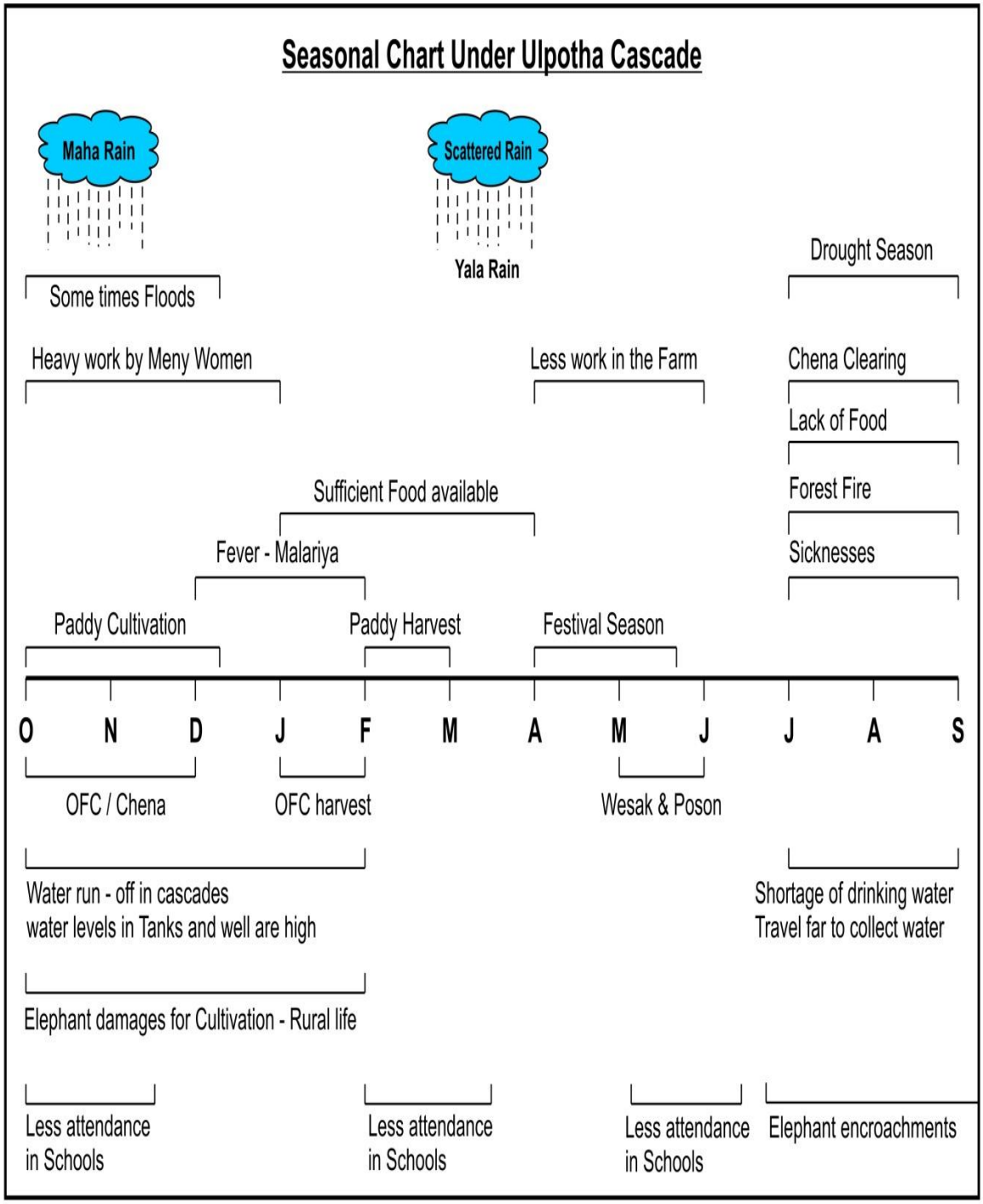
3.7 Seasonal Calendars

This is another participatory tool to study time-related seasonal changes in selected activities in selected areas. This has been used to learn changes in agricultural works, water requirements and other social requirements like food, income and expenditure and village level savings and credit of villagers. Researcher believes that this has been used effectively to study changes in cascades and livelihood patterns of villagers in Ulpotha micro-catchment as well. Comparison of water storage, irrigation, agricultural practices and other livelihood activities after the project have been done using this tool. Data collections have been done based on following key questions.

Key Questions:

1. What are the rainy months of the year in this area?
2. How much rain required (mm or inches) to fill tanks in the cascade?
3. How many months' rain-fed farmers could cultivate from rain water?
4. At what time of the year, farmers households need cultivation inputs (e.g. water, fertilizer, raw materials for micro enterprises).
5. How does water available for human consumption? (ex, streams or dug-wells)
6. When are most agricultural and other livelihood work carried out by households?
7. When is most non-agricultural work carried out by community members?
8. Do farmers have any extra water for their home garden and upland farming?
9. When the repairs needed for the cascade?

Figure 28 – Seasonal Chart of communities in Ulpotha micro-cascade



Source – Field Survey, 2011

3.8 Hypothesis to test project objectives and outcomes:

A hypothesis is a statement posited prior to a test or research describing a set of inter-connected factors or variables. It forms a background for a survey to test whether this hypothesis is true or not. For a hypothesis to be acceptable as true or not true, a scientific one, it should have been tested with available information or data and / or statistics. A scientific hypothesis could predict the outcome through an experiment or survey findings. The scientific methods involves experimentation or a testing through a survey, to validate the ability of some hypothesis to adequately answer the research question under investigation. In environment sector, the investigator will have knowledge and ability to observe some outcomes. However, the confirmation of such observations through direct beneficiaries or affected people is necessary to establish the validity of as a scientific hypothesis. In that case the hypothesis needs to be tested through various parties by providing observations, practice and experiences.

In (statistical) hypothesis testing involve two types of hypotheses. These are called the null hypothesis and the alternative hypothesis. The null hypothesis is the hypothesis that states that there is no relation between the phenomena whose relation is under investigation. The alternative hypothesis is the alternative to the null hypothesis and says that there is some kind of relationship between independent variables and the dependent variable. Sufficient data and evidence are necessary to test a hypothesis and then it becomes a working hypothesis. A fairly good size of sample population should be selected to carry out an effective survey.

When a set of hypotheses are grouped together they become a type of conceptual framework. Both independent and dependent variables are established in the conceptual framework. This framework shows the relationship between variables. Independent variable is the variable not change from external factors or effects. Meanwhile, dependent variable is influenced or changed by changes in independent variable/s. (Pl refer 3.9). The selected (five) hypotheses have direct links with the objective of the survey. All five hypotheses directly support the objective of the study and work as tools to achieve the objective of the survey. Accordingly, five hypotheses directly linked with the cascade restoration steps. At the same time, five

hypotheses represent independent variables while directly linked to the dependent variable.

3.9 Hypothesis developed for the study

H1- There is a positive relationship between Forest Regrown and cascade improvement.

H2- There is a positive relationship between reduction of forest fire and cascade improvement.

H3-There is a positive relationship between reduction of water run-off and cascade improvement.

H4- There is a positive relationship between strong CBO and cascade improvement.

H5- There is a positive relationship between increasing monthly income and cascade improvement.

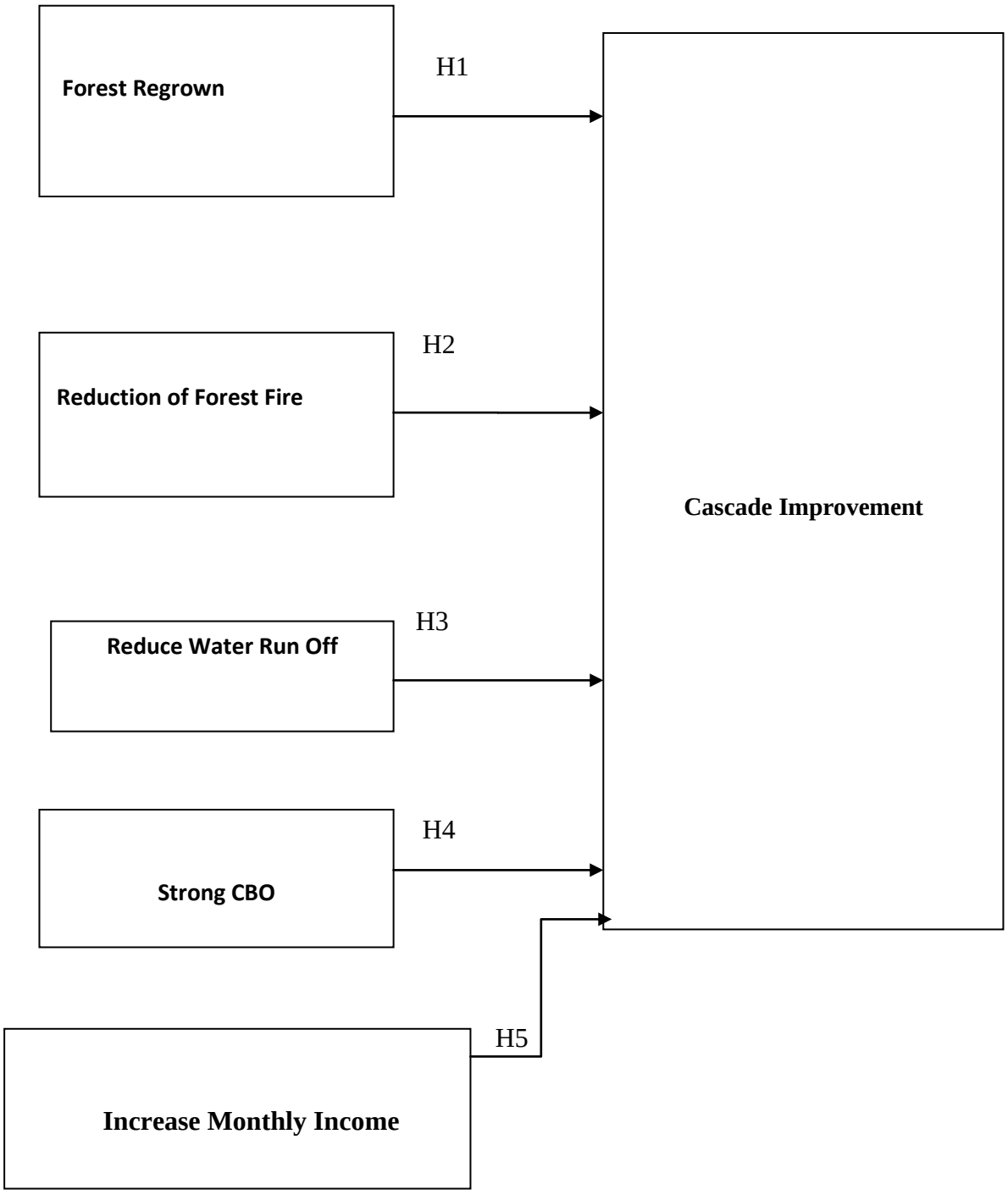
Independent and dependent variables in the survey

Independent variables
Forest re-grown
Reduction of forest fire
Reduce water run-off – (Number of days water flow from the forest after a two or more hours of rain)
Social infrastructure in working villages (CBOs etc.)
Positive changes in income due to cascade improvement

Dependent variables
Cascade Improvements (Cascade strengthened through rehabilitation)

3.10 Conceptual Framework

Independent Variables **Dependent Variable**



3.11 The Statistical Package for the Social Sciences (SPSS)

The **Statistical Package for the Social Sciences (SPSS)** commonly used in the social science and in business is comparatively more appropriate system of data analysis. For instance, SPSS system is allow for more advanced analysis than regular spreadsheets and Excel programs. SPSS is also offers a number of ways in analysing statistical data, preparing charts and graphs.

SPSS appeared to be a useful statistical package that could be used to measure impacts of different aspects on selected variables needed in the present study. In this research, Cascade systems is the dependent variable while others (like, forest regrown, reduction of forest fire and reduction of run-off) are independent variables. In order to measure impacts on dependent variable (Cascade system), five independent variables have been selected. Community response on changes measured through a Likert scale questionnaire (please refer questionnaire in Annex 1).

3.12 Likert scale questionnaire

In social science research, various types of ratings or scaling techniques are used for measuring attitudes and values. Among them, most widely used system is the Likert Scale. In 1932, psychologist Rensis Likert developed the principle of measuring attitudes by enquiring people responses on a series of statements on a selected topic. On a Likert scale questionnaire, respondents specify their level of agreement or disagreement for a series of questions. It is considered symmetric or balanced as there are equal numbers of positive and negative positions. Likert scale generally range from 2 to 10. But 5 to 7 is the most common range. Following five scales are the most favourite examples in different Likert scale formats.

Agreement	**Frequency**
• Strongly Agree	* Very Frequently
• Agree	* Frequently
• Undecided	* Occasionally
• Disagree	* Rarely
• Strongly Disagree	* Never
Importance	**Likelihood**
• Very Important	* Almost Always true
• Important	* Usually True
• Moderately Important	* Occasionally True
• Of Little Importance	* Usually Not True
• Unimportant	* Almost Never True

The analysis using attitude scales starts after completing the relevant questionnaires. Each item of the questionnaire could be analysed separately. Then the responses are summed to create a score for a group of items. For this reason Likert scales is referred to as summative scale.

A number of positive and negative aspects could be seen in the Likert Scale. Initially, this may be subject to distortion in some cases. Respondents also may avoid extreme categories in their responses.

3.13 Construction of the Questionnaire and Pre-testing

The Likert scale questionnaire was developed in several stages after consultation of various subjects focussed by the research. At the initial round, draft questionnaire was developed with the support of the study communities, social scientists, irrigation engineers and agricultural experts. This initial draft questionnaire was revised about 10 times to capture all issues, changes in cascade system and benefits of cascade renovation. The final version was tested in the field with selected individuals in two study communities and other partners like forest extension officers. The discussions and interviews conducted were mainly focused on following areas.

- Situation prior to cascade restoration?
- Land use patterns under the cascade;
- Farming practices including *chena*;
- Rain intensity;
- Irrigation water availability (number of months after the rain);
- Income patterns of communities in focused areas;
- Family expenditure in health and education;
- Indebtedness by source, purpose;
- Microfinance and micro-enterprises;
- Forest and cascade offences;
- Natural and man-made disasters;
- Water storage in cascade through forest tanks;
- Biodiversity (climate and related) differences noted;
- Village leaders;
- Village societies and CBOs;
- Available extension services;
- Village unity:
- Females participation in development activities; and
- Gender issues in the village development.

Another simple questionnaire was used to obtain socio-economic information on study farming households. The same questionnaire used during the pre-feasibility of the project (before the SLANRMP implementation) was used for this purpose as well. As this was a well-developed fielded questionnaire and testing was not necessary. Following information collected through this general questionnaire.

- Number of households;
- Statistics on men and women distribution;
- Literacy rates in households;
- School age children and school going children;
- Employment patterns;
- Community suggestions to reduce deforestation;

- Causes of forest degradation in the area;
- Perception of Forest Benefits; and
- Existing village tanks in two villages.

(Please refer Annex 1 and 2 for copies of socio-economic survey questionnaire and Likert scale questionnaire).

3.14 SWOT Analysis (Matrix)

SWOT analysis (SWOT or TOWS matrix**)** could be used to identify key internal and external factors important for a self-evaluation of an agency or a program. Generally, brainstorming sessions conduct during PRA to identify the factors in each of the four items namely Strengths, weaknesses, opportunities and threats. A SWOT analysis helped to identify positives and negatives (S - W) within the program and outside of it, while Opportunities and Threats (O - T) from the external environment.

Questions discussed During the SWOT Analysis

A set of questions has been developed and practice with some members to test community reactions and the possible outcomes.

Strengths *(positive internal factors)*

- What things project has done well?
- What resources provided by the project? Please check following:
    - *Positive attributes*, such as awareness creation, participatory processes, change of attitudes of people.
    - *Tangible assets*, such as irrigation network, credit, stakeholders/ other service providers/patents and technical know-how.
- What are the benefits received from the project?
- What services obtained from communities and other villagers?
- Were there any special benefits for women?
- What benefits received to form village organisations (e.g. CBOs)?
- Whether there is a change in the environment or climate in the cascade area?

Weaknesses *(negative internal factors)*

- What negative factors you have noticed with the cascade renovation?
- Whether the program has created new conflicts among communities.
- Whether the program has created new environmental hazards?
- Whether the new situation disturbs normal village life?
- Does your business or cultivation affected due to the renovation of cascade?

Opportunities *(positive external factors)*

- What opportunities exist in the program?
- Whether program has identified and presented options for future?
- Has project identified future links?
- Are there any opportunities to extend project benefits to more communities?

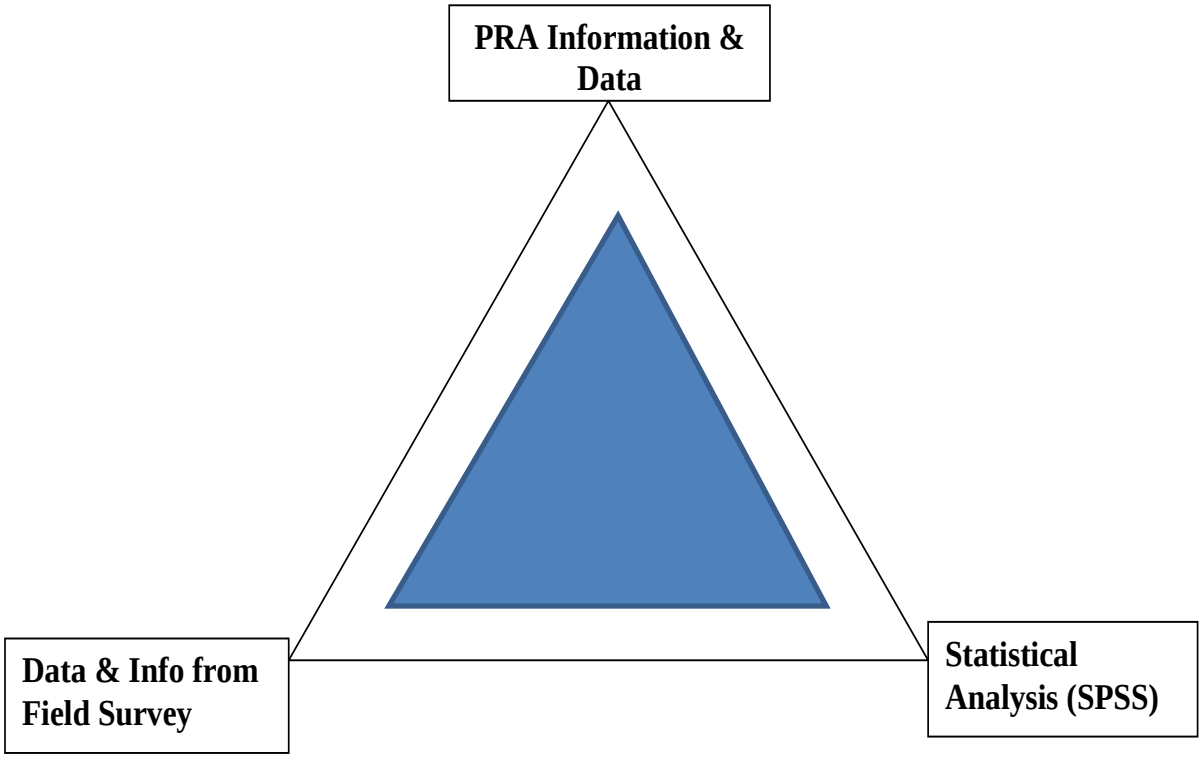
Threats *(negative external factors)*

- Whether program or renovated cascade attracts wild animals?
- Will there be any damages to cultivation or other businesses?
- What factors beyond the control of program authorities?
- Are there any challenges created by unfavourable trends?
- Has there been a significant change in business / cultivation?

Triangulation of data and information

The main reason for using several data collection tools is to triangulate the collected data and other information and it illustrates in the following diagram.

Triangulation of Data



CHAPTER FOUR

EVALUATION OF THE IMPACTS ON CASCADE RESTORATION ON ENVIRONMENT AND RURAL LIVELIHOODS OF ULPOTHA

4.0 Background

This chapter is focused on analysis of research findings. Findings are presented in two categories as indicated (A and B) below. The first category discusses the socio-economic aspects while the other one illustrates the information collected through a Likert scale questionnaire and data analysis using SPSS system.

A. Analysis of major socio-economic aspects of the study villages as a background to examine the connection between cascade improvement and livelihood expansion. This is based on information gathered through the administration of general (semi-structured) questionnaire (Annex 1).

B. Likert scale questionnaire (Annex 2) was used to collect and analyse data and information with the SPSS statistical package. The main reasons for the selection of Likert scale questionnaire and SPSS system are to study associations and relationships of major variables of the research.

Socio-Economic conditions in the study villages

The analyses in the following section which focuses on analysis of the socio-economic background and resource utilization of Walathwewa and Ihala Thimbiriyawa are based on the major findings of the socio-economic survey and PRA studies. In this chapter, village level socio-economic information including demographic situation and gender distribution of the population, social and economic conditions like employment, education etc. are viewed to portray communities and living conditions in the two study villages. Changing of cascade environment, reasons for cascade changes in the recent past and community impact of such changes and community attitude towards destruction and management are also

viewed and analysed briefly in this chapter. The findings are summarized in a series of tables below.

Main Villages Surrounding Ulpotha Micro-Cascade

Table 2: Villages located surrounding Ulpotha Micro-Cascade

Mudiyannagama	Dalupothagama	Diulgane	Kaduruwewa
Kumbukkadawela	Ambogama	Karagaswewa	Kambuwatawana
Mahakaduruwewa	Galkiriyawa	Ihala Thimbiriyawa	Walathwewa

Source: GN records

As indicated in the above table, there are 12 villages surrounding Ulpotha micro cascade. Among them most poor and high impacts of cascade villages (Ihala Thimbiriyawa and Walathwewa) have been selected for this research. These two villages also have close association with micro-cascade and its changes.

4.1 Households and population

Basic household and population data for the GN divisions (in which the two villages are located) are given in Table 3.

Table 3: Households, Families and Population (number)

GN area	Families	Population	Females	Males
Walaththwewa	175	636	298	338
Ihala Thimbiriyawa	272	904	412	492
Total	447	1,540	710	830

Source: GN records

As data in Table 3, 272 family units (904 persons) were living in a dwelling unit in Ihala Thimbiriyawa compared to 175 families (636 persons) in Walathwewa. In general, female population in Sri Lanka is higher than male population. Therefore, a

contrasting feature of the population in two study villages is a higher number of males over females as depicted by data in Table 3.

4.2 Male and Female Headed Households

Of the 85 households interviewed, 73 (or 85 %) were male headed while 12 (15%) were headed by females as is indicated from data in Table 4 below. Female headed households were smaller in the sample compared to national average of 22% recorded by household censuses. Observed situation could be due to the small sample or no direct impacts from long-term ethnic war though the villages are located outside the protracted internal struggle in the North and East. However, some youth who joined the Army from the two villages were killed in action. This does not explain gender distribution of the population. It is possible some females might have migrated out of the villages after marriage or other reasons. There is no evidence as to any impact of disaster on gender distribution of the population. Another, possibility is relatively low numbers of females in the two communities.

Table 4: Male and Female Headed Households

Village	Household (Type)		
	Male Headed	**Female Headed**	**Total**
Walathwewa	35 (82)	7 (18)	42
Ihala Thimbiriyawa	38 (88)	5 (12)	43
Both areas	73 (85)	12 (15)	85

Note: Figures within parentheses are percentages - Source: Field Survey (2011)

Source: Field Survey (2011)

4.3 Literacy

Literacy was measured in terms of the ability of the respondents to read and write in Sinhala language[3]. About 26 per cent of the survey respondents were found to be illiterate as data in Table 5 indicates. The number of illiterate respondents was higher in Ihala Thimbiriyawa compared to Walathwewa. Even-though the literacy rate is generally high in Sri Lanka, some low literate pockets could be seen in rural backward villages or lagging regions. In spite of the fact that there was a primary school in Ihala Thimbiriyawa, learning and teaching practices were not up to the desired level. In the latter village, the same issue probably affect other socio-economic conditions. Other factors influencing education levels are examined under the formal education below.

Table 5 : House hold head literacy

Village	House Hold Head Literacy		
	No. literate	No. illiterate	Total
Walathwewa	37 (88)	5 (12)	42
Ihala Thimbiriyawa	26 (59)	17 (41)	43
Both area	63 (74)	22 (26)	86

Note: Figures within parentheses are percentages

Source: Field Survey (2011)

4.4 Formal Education

In Walathwewe there is no school while there is a primary school in Ihala Thimbiriyawa. The number of school-going children was lower compared to school-age children. Walathwewa sample households had 5 school-aged female children not attending a school (Table 6). PRA also showed that the school attendance becomes low during the cultivation and harvesting seasons. Similarly, irregular attendance in schools was found to be a significant issue. It should be noted that the above phenomenon are somewhat common in relatively poorer agricultural villages in the

[3] All participants in the two villages belong to Sinhalese ethnic group.

dry zone. As the dry zone population considerably depend on dry land farming (agriculture) as a livelihood, low social and economic performance is certain in dry zone localities like the two study villages and this factors explain to a great extent by lack of assured irrigation water for crop production.

Table 6: School-age children and school-going children

Village	School-going Children (#)		School-age Children (#)	
	Males	**Females**	**Males**	**Females**
Walathwewa	11	9	11	14
Ihala Thimbiriyawa	10	11	10	11
Total	21	20	21	25

Source – Zonal Education Office (2011)

4.5 Employment

Village data on employment was obtained from the GN records. Table 10 provides employment data for the villages within the study area.

Table 7: Type of Employment in the two Study Villages

Village	Employment Category and Percentage					
	Farming	**Public Sector**	**Private Sector**	**Skilled**	**Other**	**Total**
Walathwewa	62	10	6	4	18	100
Ihala Thimbiriyawa	60	8	2	1	29	100
Total	122	18	8	5	47	200

Source – GN records (2011)

Data in Table 7 show that the major source of employment (61%) in the two study villages is farming. However, successful farming in the area largely depends on such

factors as effective monsoonal rains, irrigation water availability and favourable weather conditions. Field research indicate that prolong drought is a major problem affecting crop production in the area. Sometimes farmers receive a sufficient harvest only after three or four years due to lack of effective monsoonal rains. As a result, the farmers could not save anything after they settled their debts for previous four drought years. This necessitates them to obtain loans for cultivation in the next season. Microfinance programs have been implemented in villages from the year 2007 under the restoration project which undoubtedly reduce the indebtedness of the villagers to money lenders.

4.6 Resource Management

Information on resource management for this study was collected mainly through secondary sources and through PRA process. In PRAs, members of the community identified past and present status of resource management, current trends and reasons for changes over the years. The relevant information is presented under several categories below.

4.6.1 Forest Resource Management

Forest could be considered as the major natural and functional resource of a cascade. It is said that forest has a beneficial role in effecting rains through blocking rain clouds in elevated environments like island forests. However, most important function of forest is slowing down the downstream rain water flow and gradual release of rain water yield. In this regard, forest tree roots have an anchoring effect on surface soils allowing infiltration of rain water and enriching ground water table. Forest cover also reduces soil erosion. Effective forest cover, therefore, is very important in sustaining a healthy and natural cascade/catchment environment. In contrast, the destruction of forest cover means reduced function of the cascade to deliver almost all its functions. Therefore more attention was paid on forest and water resources aspects of the cascade during field investigation. Field research findings are discussed below.

4.6.2 Forest cover change or continuous reduction in Forest cover

The Ulpotha micro-catchment (study area) is endowed with several forest types such as the dry monsoon tropical forest, savannah and the forest system associated with village irrigation systems. All these types of forest resources were subjected to damage by human activities and natural impacts and are threatened with alarming rate of degradation.

The majority of people in meetings and discussions indicated of fast disappearance of forest cover in the area. The most alarming reduction has occurred between 1970 and 1980. The main reasons for the loss of forest cover is said to be timber extraction and chena farming in that order. With the gradual degradation of the forest cover the vacant land was invaded by grasses (*Mana*). During the dry season, people set fire to those as an easy method of clearing land, preparing land for cultivation, control reptiles, and hunt animals. Grass fire spreads to remaining forest area and annually destroys a significant portion of the forest cover. Thus forest fire has been a major contributor to reduction of the forest area in the cascade. On the other hand, the Forest Department (FD) attempts to guarantee protection of forest by adhering to laws of existing Forest Act. Adhering to laws contained in the Forest Act means catching and punishing the unlawful actors under the forest conservation regulations. This type of control mechanism have not proved much success as only now and then the illegal actors were brought under legal action. A major limitation factor in this regard is lack of resources at the Forest Department. Under existing circumstances, the rate of degradation of the existing forest resources through fire is extremely high with several catchments /forests already severely affected. Every year large areas of the Galgiriyakanda forests are reduced due to the spread of forest fire in the dry season.

A large majority of households (97%) interviewed indicated a substantial loss of forest cover within the micro catchment during the last 10 years (Table 14).

Table 8: Perception of Forest Cover Change during Last 10 Years by Villagers (% responses)

Village	Cover Changed	Not Changed	Comments
Walathwewa	94	6	Most respondents in this village are of the view that forest cover has changed over the years. On the other hand, only a few who indicated no change in the forest cover. These are likely to have contributed to forest destruction like through felling, from the point of view of the majority.
Ihala Thimbiriyawa	100	0	Not a single person says that no changes in the forest cover. It seemed no illegal fellers were living in this village. Therefore, culprits appear to be outsiders.
Both	97	3	It is interesting that 97% of the respondents were of the opinion that forest cover in the cascade has been declined in the recent past.

Source: Field Survey (2011)

The majority (97%) of those who perceived a change in forest cover said the largest reduction took place during the last 10 - 20 years.

Figure 29 – Destruction of Forest Fire due to Chena Farming

Source – Field survey 2004

Table 9: Community suggestions to reduce deforestation

Suggestions	Walathwewe	Ihala Thimbiriyawa
Strong protection by Authorities	Yes	Yes
Severe punishments to stop forest fire	Yes	Yes
Handover forest to community	Yes	Yes
Increase income of poor	Yes	Yes
Renovate all breached tanks	Yes	Yes
Improve community involvement in management	Yes	Yes
Providing awareness to children	Yes	Yes
Sign Boards for visitors to avoid fire	No	Yes
Training of youth to protect natural resources	Yes	Yes

Source – Field Survey (2011)

Information gathered through PRA regarding community views as to what action needed to protect forest cover is in Table 10. Suggestions by the PRA members were all encompassing like increased role by the government, community action, education and awareness creation. The suggestions by community members implicate a strong public-community partnership and the need for community orientation in approach by FD. Perhaps, reflected in community responses in PRA are the training and awareness programmes conducted under the rehabilitation program.

Table 10: Causes of forest degradation in the area

Reasons	Degree of Impact		
	High	**Medium**	**Low**
Poverty	Yes		
Additional Income for poor		Yes	
Lack of awareness of long-term damage		Yes	
Animal hunting			Yes
Chena cultivation		Yes	
Damage caused to forest cover by setting fire - including fire for railway line clearance	Yes		
Damage by outsiders / tourists		Yes	
Cattle feeding	Yes		
Illegal timber felling	Yes		
Week monitoring		Yes	
Major Dev. Programs		Yes	
Increased population	Yes		

Source – Field Survey (2011)

Data in Table 10 reveal several community perspectives regarding forest cover degradation of the cascade. Poverty, forest fire, illegal timber felling, cattle feeding, major development works and increased population are perceived to be the causes with a higher impact. Animal hunting found to have lower impact. However, chena cultivation which is a major factor causing decline in forest cover in the dry-zone was suggested to have a medium impact. Perhaps the reason is there is little forest land now to clear for C*hena* farming.

4.6.3 Forest Products

According to interviewees, the main benefits from forest are fuel wood, fruits and vegetables followed by collection of medicinal plants. Communities living closer to the forest also collect bee-honey from the forest. People also believe that greenery and soil improvement create a healthy environment to a formidable life same as olden days. They say that they have experienced the above benefits from newly reforested areas. People also consider water as one of the forest products as forest improves the rainfall pattern. Other benefits people perceive from the forest and the percentage people are given were shown in Table 11.

Table 11: Perception of Forest Benefits (% responses)

Benefit Type	Walathwewe	Ihala Thimbiriyawa
Fuel wood	22	30
Medicinal plants	8	10
Food & fruits	10	7
Bees honey collection	6	3
Provide rain	15	10
Soil protection	3	4
Good air (cool climate)	10	6
Timber	7	10
Water	19	20
All	100	100

Source: Field Survey (2011)

Figure 30 - Forest Materials Collected – Fuel wood and other materials

Source: Field Survey 2011

The main purpose of collection of forest resources is for own and village consumption. The only exception is bee honey and medicinal plants which are sometimes sold to outside traders. PRA revealed that people use to sell fuel wood, timber and medicine also to outsiders but in fewer quantities. A few people do this as a small scale business as well. This shows the continuous need for reforestation and conservation.

4.6.4 Cascade damages / Forest offences

The current situation in villages is quite different from early 1990s. According to forest officers, there had been so many forest offences by the community including felling and sawing trees inside the remaining forest patches. This was further confirmed by members of the community in the PRA workshops. Discussions and observations made it clear that the survey and demarcation of the two main island forests have substantially contributed to the reduction of forest offences. Community forestry concept developed and promoted under the project was contributed lot to reduce deforestation in the area. Protection and enrichment of forest and forest resources were done under SLANRMP in collaboration with communities. But we can-not ignore the present deforestation rate and shape as the danger is still open.

4.6.5 Community involvement in forest management

People living in study villages have had some informal involvement in forest management such as by participation in forest boundary demarcation, forest surveys and other community initiated activities like forest tree planting before the project. This involvement has been improved during the community forestry program under SLANRMP and now most communities contribute in different ways to protect forest and cascade to prevent forest fire, illegal timber felling and other forms of damages caused by people.

Figure 31 – Community Contribution in planting cactus to Control Forest Fire

Source – Field survey, 2007

4.7 Hydrology and Water Resources

There are 15 tanks in Ihala Thimbiriyawa and 16 tanks in Walathwewa under the Ulpotha micro-cascade. Name of the tanks and their details are given in Table 12 and 13. These tanks are said to have built by ancient kings to control the run-off and promote optimal usage of rain water for people and their livelihoods like agriculture. It was noted that Walathwewa has more paddy field than Ihala Thimbiriyawa. Tanks are important for rural life and living in many ways. Provision of drinking water, food production, improving ground water levels, maintaining biodiversity, controlling run-off are some of the benefits accrued to village tanks. Therefore the destruction of a cascade means the destruction of rural livelihoods as well as damaging the coexistence of all kinds of living beings including the human beings.

Figure 32 - Ulpotha Micro-Cascade and renovated Ulpotha tank

Source – Field survey, 2012

Table 12: Tanks in Ihala Thimbiriyawa

	Name of the Tank	Area Cultivated (Ac)
1	Kandubodagama	7
2	Vitharangama	4
3	Ranamukgama	3
4	Athaudagama Maha	12
5	Athaudagama Ulpath	8
6	Ihalathimbiriyawa	16
7	Wera	7
8	Walpaluwa Maha	13
9	Walpaluwa Kuda	3
10	Asirigama	3
11	Thennakoongama	2
12	Dematagama	12
13	Palurambewa	16
14	Maragaha	4
15	Pahalathimbriyawa*	6
	Total	116

***Abandoned**

Source – GN records and Communities in Ihala Thimbiriyawa (2011)

Table 13: Tanks in Walathwewa

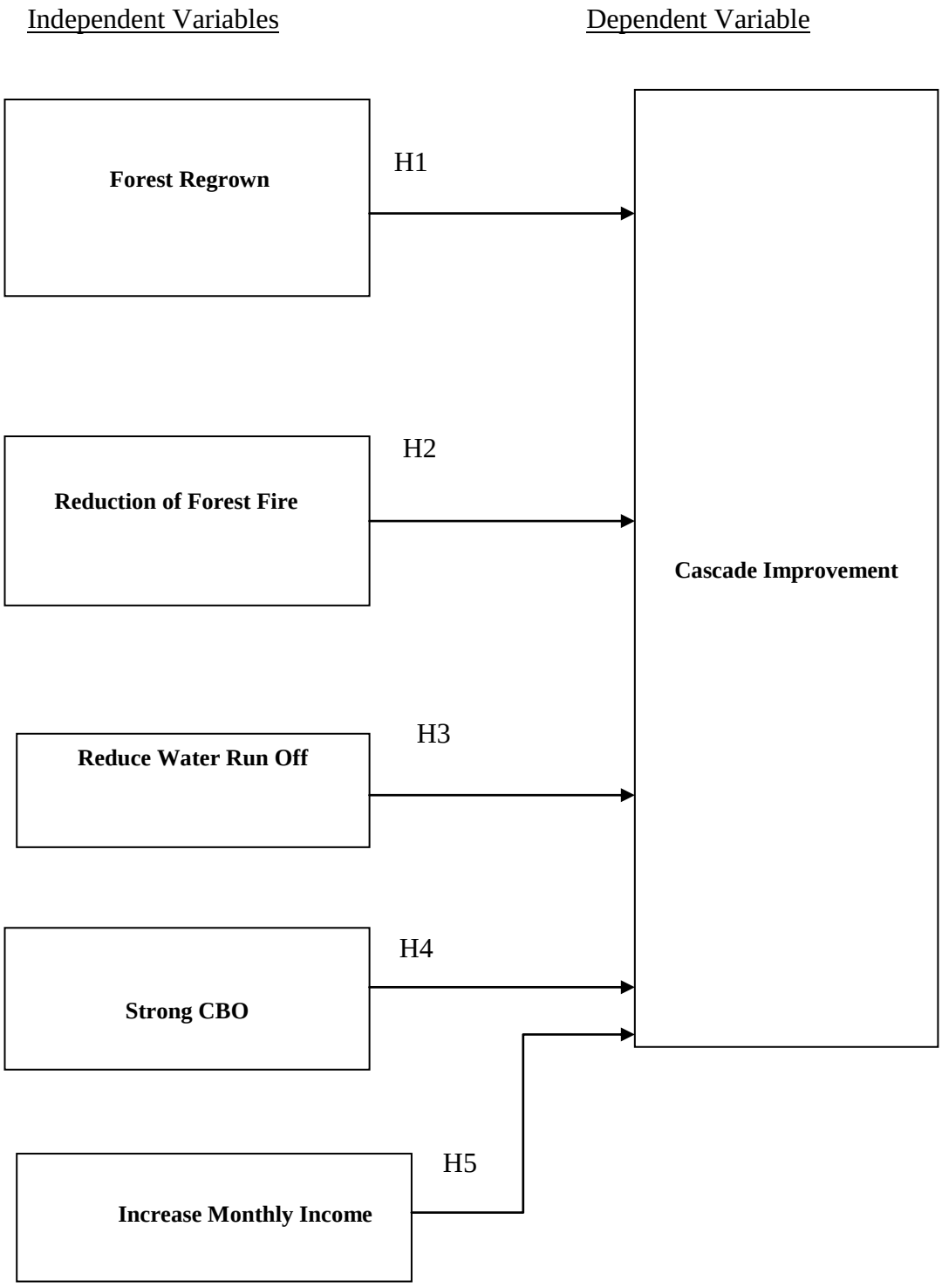
	Name of the Tank	Area Cultivated (ac)
1	Mahagalewewa	120
2	Walathwewa	47
3	Ulpothawewa	30
4	Galketikammennawewa	28
5	Rancheyagodawewa	30
6	Thuththripitiyawewa	12
7	Harakwetunawewa	4
8	Midellagahawewa	8
9	Halpangalawewa	6
10	Dambagahawewa	6
11	Unagahawewa	8
12	Munamalgahawewa	8
13	Hettigamawewa	5
14	Palugahawewa	5
15	Thuruweekotuwawewa	5
16	Kotuwakumburawewa	8
	Total	330

Source – GN Records and Communities (2011)

The catchment areas of most of the tanks are degraded. The other components of tanks are also damaged and destructed over the years. Siltation of all tanks is a recurrent problem due to the absence of proper maintenance programs.

4.8 Results of Statistical Analysis

As already noted in chapter 3, hypothesis is a logically conjectured relationship between two or more variables expressed in the form of a testable statement. Relationships are conjectured on the basis of the network of associations established in the conceptual framework formulated for the research study as given below in the following diagram. Once the researcher has identified the important variables in the phenomenon and established the relationships among them through logical reasoning in the conceptual framework as discussed in chapter 3, researcher is in the position to test whether the relationships that have been theorized do in fact hold true.



Once the important variables influencing the cascade management and establish its relationship with socio-economic conditions of cascade development through logical reasoning as was shown in the conceptual framework, a test to carry out whether the relationships that have been theorized do in fact occur and dynamic relationship

between those were undertaken. For testing purpose, a series of hypothesis were used. Hypothesis testing involves a logically conjectured relationship between two or more variables expressed in the form of a testable statement.

The hypotheses tested are briefly stated as follows:

H1- There is a positive relationship between Forest Regrown and cascade improvement

H2- There is a positive relationship between Reduction of forest fire and cascade improvement

H3-There is a positive relationship between reduction of water run-off and cascade improvement

H4- There is a positive relationship between strong CBO and cascade improvement

H5- There is a positive relationship between increasing monthly income and cascade improvement

4.9 Introduction to analysis

As already noted in the methodology chapter, a (Likert scale) questionnaire survey was administered to capture the way cascade affected communities perceive the relationships conceived in the hypotheses. As none rejected any question, the response rate for the questionnaire was 100%. The data generated through questionnaire were analysed by applying SPSS software and series of data sets were arrived for analysis. This part of the chapter focuses on presentation and analysis on data collected through the Likert scale questionnaire.

4.10 Testing hypotheses - Correlation analysis

H1- Association between forest re-grown and cascade improvement

Table 14: Association between forest re-grown and cascade improvement

Symmetric Measures

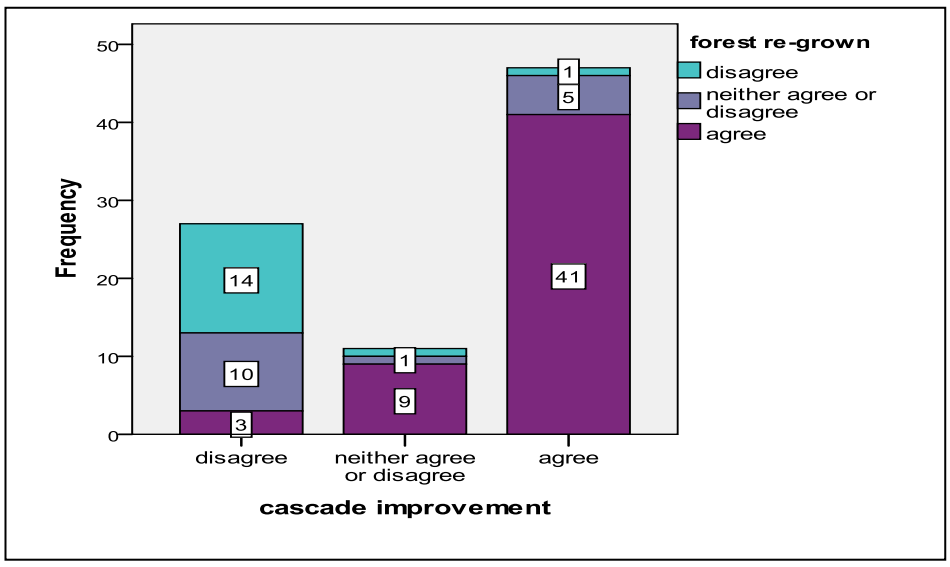
		Value	Asymp. Std. Error[a]	Approx. T[b]	Approx. Sig.
Ordinal by Ordinal	Gamma	.843	.038	13.427	.000
N of Valid Cases		85			

a. Not assuming the null hypothesis.

b. Using the asymptotic standard error assuming the null hypothesis.

The Gamma value is 0.843 with the P value 0.000 which is less than 0.05 and it is significant statistically. H0 is rejected at 0.05 level and accepted the alternative hypothesis. This means in general, Therefore that there is an association between forest re-grown and cascade improvement. Since correlation is 0.843 it has a strong relationship among two variables. This relationship is positive and the increases in one variable significantly relate to increases the other variable. This indicates that forest re-grown has a strong impact on improvement of the cascade, from the perspective of the study respondents.

Figure 33 : Descriptive statistics - Chart of forest re-grown and cascade improvement



From the data presented in figure 33, it can be seen that 41 farmers out of 85 interviewed agree with the suggestion that forest re-grown has positive consequences on casacde improvement. However, 14 farmers disagree with the forest re-grown and cascade improvement. This situation (agreement of more farmers) clearly shows that there is a relationship between forest re-grown and casacde improvement. Most farmers say that forest has regrown in the cascade and at the same time they say that the cascade has also improved. Due to less number of disagreements of forest re-grown, we can say that cascade has improved compare to year 2010. Accrding to above hypothesis analysis, we can say that forest re-grown and strong CBO involvement impacted on cascade improvement.

H2- Association between reduction of forest fire and cascade improvement

Table 15: Association between reduction of forest fire and cascade improvement

Symmetric Measures

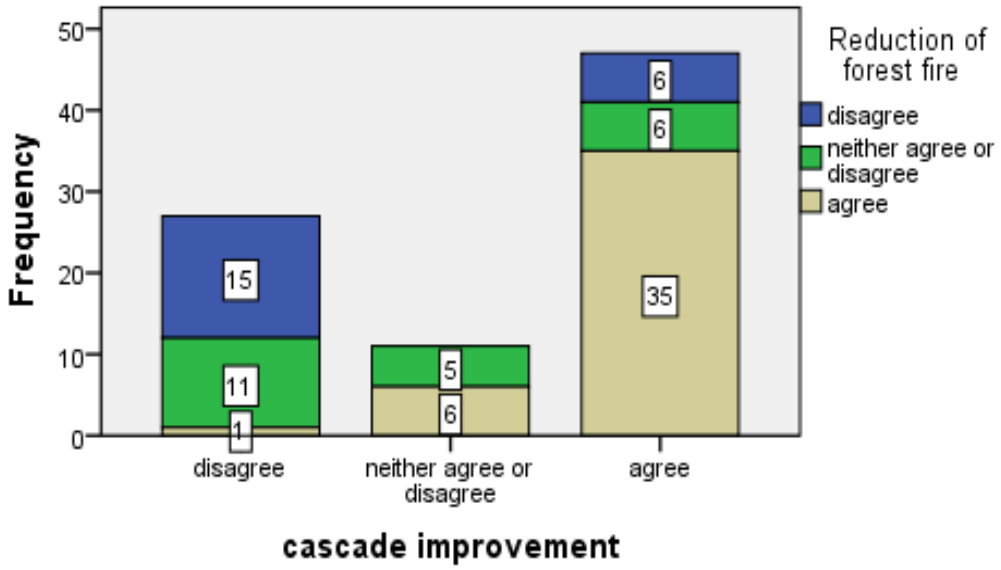
		Value	Asymp. Std. Error[a]	Approx. T[b]	Approx. Sig.
Ordinal by Ordinal	Gamma	.703	.071	8.102	.000
N of Valid Cases		85			

a. Not assuming the null hypothesis.

b. Using the asymptotic standard error assuming the null hypothesis.

The Gamma value is 0.703 with the P value 0.000 which is less than 0.05. It is significant. H0 is rejected at 0.05 level and accept the alternative hypothesis. Therefore there is an association between reduction of forest fire and cascade improvement. Since correlation is 0.703 it has a strong relationship among two variables .This indicates that reduction of forest fire has a strong impact on cascade improvements.

Figure 34: Descriptive statistics - Chart of forest fire and cascade improvement



H3- Association between reduction of water run-off and cascade improvement

Table 16: Association between reduction of water run-off and cascade improvement

Symmetric Measures

		Value	Asymp. Std. Error[a]	Approx. T[b]	Approx. Sig.
Ordinal by Ordinal	Gamma	.655	.077	7.446	.000
N of Valid Cases		85			

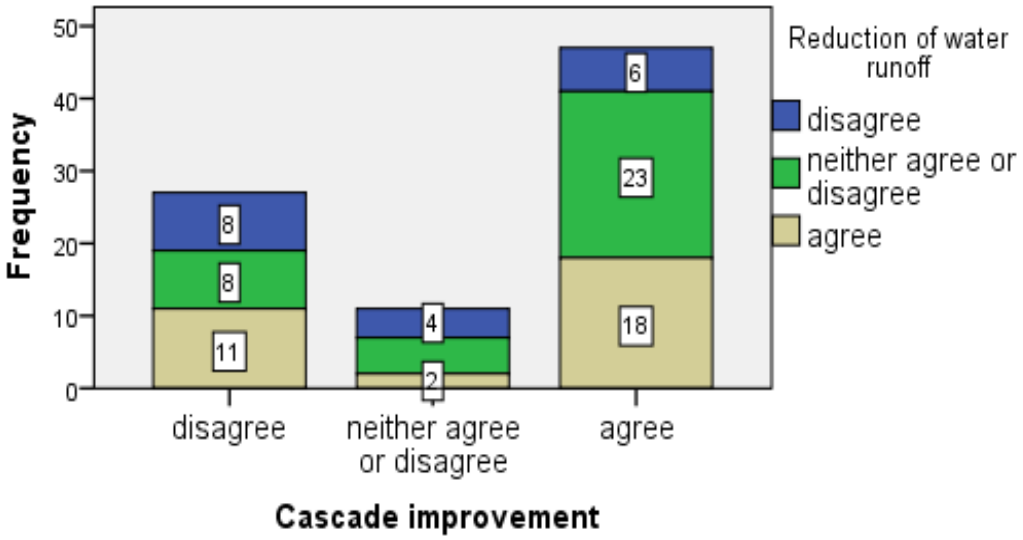
a. Not assuming the null hypothesis.

b. Using the asymptotic standard error assuming the null hypothesis.

The Gamma value is 0.655 with the P value 0.000 which is less than 0.05. It is significant. Therefore H0 is rejected at 0.05 level and accept the alternative hypothesis. There is an association between reduction of water run-off and cascade improvement. Since correlation is 0.655 it has only moderate relationship among two variables. This represents that reduction of water run-off moderately impacted on

improvement of cascade. Even under this situation, the relationship is positive under moderate impacts and the increases in one variable significantly relate to increases the other variable.

Figure 35: Descriptive statistics - Chart of reduction of run-off and cascade improvement



According to figure 35, 31 farmers among 85 have agreed with that speed of water run-off from cascade has reduced due to various reasons. That is around 37% from total sample population.

H4- Association between strong CBO and cascade improvement

Table 17: Association between strong CBO and cascade improvement

Symmetric Measures

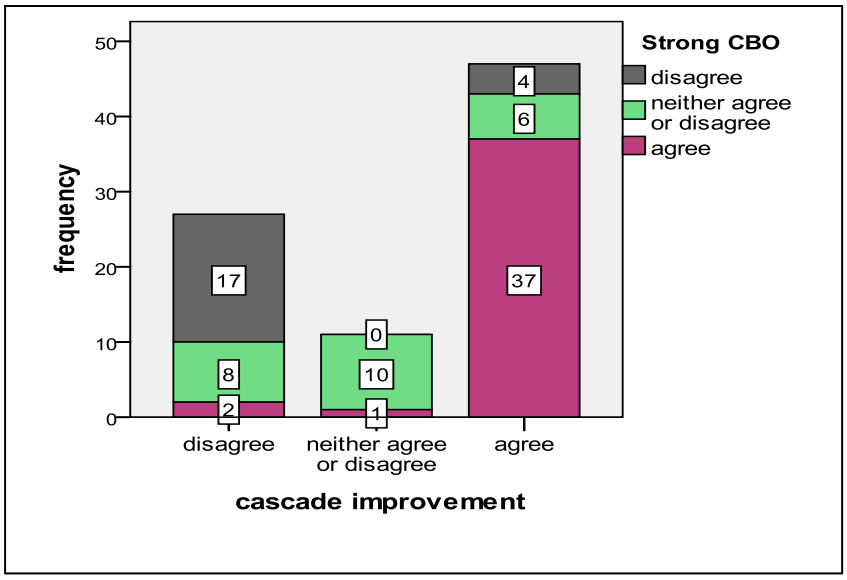
		Value	Asymp. Std. Error[a]	Approx. T[b]	Approx. Sig.
Ordinal by Ordinal	Gamma	.783	.065	9.654	.000
N of Valid Cases		85			

a. Not assuming the null hypothesis.

b. Using the asymptotic standard error assuming the null hypothesis.

The Gamma value is 0.783 with the P value 0.000 which is less than 0.05. It is significant. Therefore H0 is rejected at 0.05 level and accept the alternative hypothesis. There is an association between CBO and cascade improvement. Since correlation is 0.783 it has a strong relationship among two variables .This represents that strong CBO is strongly impacted on improvement of cascade. This relationship is positive and the increases in one variable significantly relate to increases the other variable.

Figure 36: Descriptive statistics - Chart of strong CBO and cascade improvement



Through the figure 36, it can be seen that 37 farmers among 85 agree with the forest re-grown and strong CBO and also agree with the casacde improvement. 17 farmers who disagree with the forest re-grown, disagree with the cascade improvement as well. This clearly shows that there is a relationship between strong CBO and casacde improvement. Most farmers say that there is a strong CBO in the village and most cascade improvements activities launched by CBOs. Due to less number of disagreements of strong CBO, we can say that cascade has improved compare to 2010 conditions.

H5- Association between monthly income and cascade improvement

Table 18: Association between monthly income and cascade improvement

Symmetric Measures

		Value	Asymp. Std. Error[a]	Approx. T[b]	Approx. Sig.
Ordinal by Ordinal	Gamma	.687	.077	7.456	.000
N of Valid Cases		85			

a. Not assuming the null hypothesis.

b. Using the asymptotic standard error assuming the null hypothesis.

The Gamma value is 0.687 (approximately 0.7) with the P value 0.000 which is less than 0.05. It is significant. Therefore H0 is rejected at 0.05 level and accept the alternative hypothesis. Therefore there is an association between monthly income and cascade improvement. Since correlation is 0.7 it has a strong relationship among two variables .This represents that monthly income is strongly affected for improvement of cascade. This relationship is positive and the increases in one variable significantly relate to increases the other variable.

Figure 37: Descriptive statistics - Chart of monthly income and cascade improvement

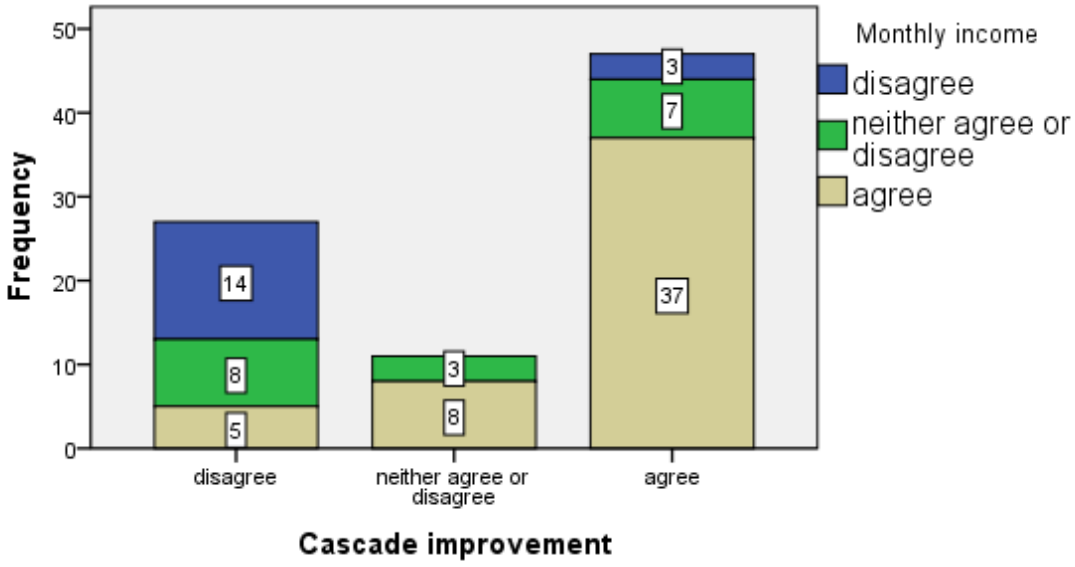
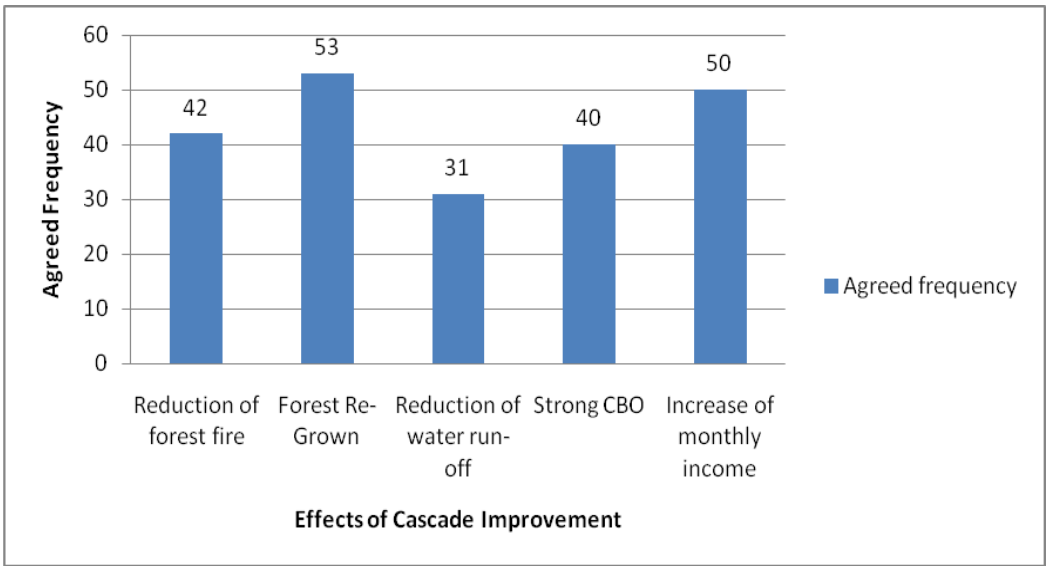


Figure 37 illustrated that around 60% farmers agree that their monthly income has improved compare to year 2010. At the same time, 40 farmers do not agree with the statement. One can argue that 21.18% did not want to commit either on a positive way or a negative way.

Figure 38: Descriptive statistics - Chart of Effects of cascade improvement



There are five issues which impact on cascade improvement.When we consider agreements of all five issues together according to figure 38, a large number of farmers (53) agree with forest re-grown. And also 50 farmers agree that their monthly income has also increased. Through the above chart, it can be seen that agreement for all these five issues are more or less equally spread.This shows between 30-50 farmers agree with these cases. That means it is around 50% of faremers agree with these effects which impact on cascade improvement.

4.11 Overall interpretation of hypotheses

As already examined, values of correlations in four hypotheses are positive and strong. Hypothesis 3 has moderate impacts but can be considered as positive. According to gamma values in H1, H2, H3, H4 and H5, one can see that strong CBO and forest re-grown have high impact on cascade improvement. Reduction of forest fire, monthly income and reduction of water run-off also helped to increase the improvement of cascade. That means cascade improves with forest regrown while existence of strong CBOs in the village, reduction of forest fire, reduction of water run-off help to promote cultivations.

4.12 Associations among other selected variables

The researcher has decided to compare the other variables in the Likert scale questionnaire to observe their associations with each variable. The analysis will provide a better picture of key questions included in the Likert scale survey. The only way to do this is the development and search of associations between each variable. Therefore, the researcher has developed another 14 sub-hypothesis to test the associations among other variables.

H6- Association between forest re-grown in the cascade and rains during seasons.

Table 19: Association between forest re-grown in the cascade and rains during seasons.

Symmetric Measures

		Value	Asymp. Std. Error[a]	Approx. T[b]	Approx. Sig.
Ordinal by Ordinal	Gamma	.707	.074	7.745	.000
N of Valid Cases		85			

a. Not assuming the null hypothesis.

b. Using the asymptotic standard error assuming the null hypothesis.

The Gamma value is 0.707 with the P value 0.000 is less than 0.05. It is significant. Therefore H0 is rejected at 0.05 level and accept the alternative hypothesis. Therefore there is an association between the forest re-grown in the cascade and rain during the seasons. Since correlation is 0.707, it has a strong relationship among two variables. This represents that forest re-grown in the cascade is strongly impact for rain during seasons. This strong relationship is positive and the increases in one variable significantly relate to increases in the other variable.

H7- Association between forests re-grown in the cascade and the arriving of wild animals and birds in to cascade

Table 20: Association between forests re-grown in the cascade and the arriving of wild animals and birds in to cascade

Symmetric Measures

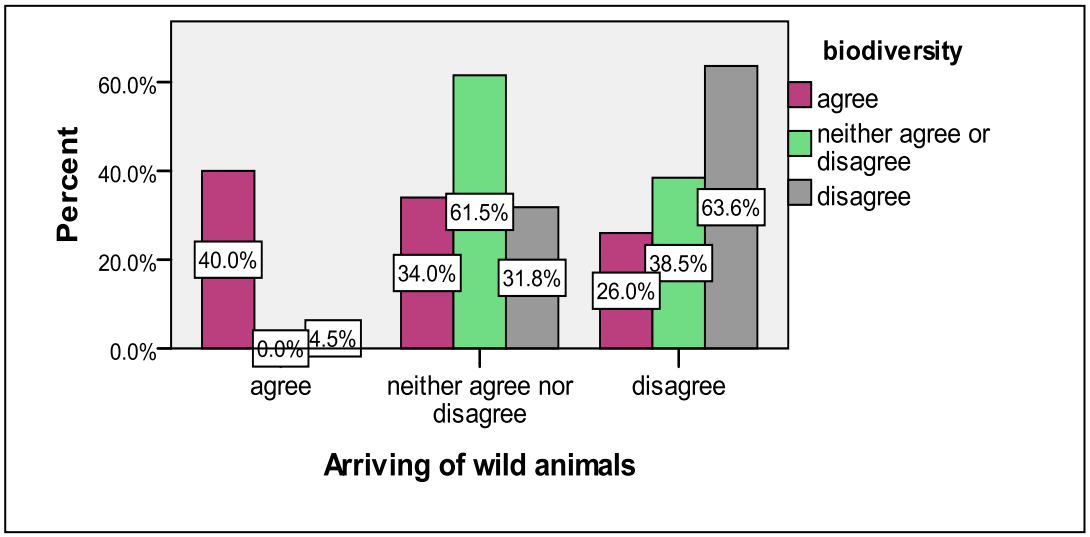
		Value	Asymp. Std. Error[a]	Approx. T[b]	Approx. Sig.
Ordinal by Ordinal	Gamma	.737	.073	7.196	.000
N of Valid Cases		85			

a. Not assuming the null hypothesis.

b. Using the asymptotic standard error assuming the null hypothesis.

The Gamma value is 0.737 with the P value 0.000 which is less than 0.05. It is significant. Therefore H0 is rejected at 0.05 level and accept the alternative hypothesis. There is an association between forest re-grown in the cascade and the arriving of wild animals and birds to cascade. Since correlation is 0.737, it has a strong relationship among two variables. This represents that forest re-grown is strongly impact for arriving of wild animals and birds. This strong relationship is positive and the increases in one variable significantly relate to increases in the other variable.

Figure 39: Descriptive statistics - Chart of bio-diversity compare with arrival of wild animals



Through the figure 39, we can observe that 40% farmers among 85 agree with the ariving of wild animals and birds. At the same time agree with the improvement of bio-diversity. And also 63.6% farmers a who disagree with the arriving of wild animals same time disagree with the improvement of bio-diversity.

This clearly shows that there is a relationship between arrriving of wild animals and birds and improvement of bio-diversity. Due to large number of agreements (60%) on bio-diversity, we can say that bio-diversity has improved compare to year 2010 because of arriving of wild animals and birds into village. Hypohesis H7 shows that birds and animals come back due to forest re-grown.

H8- Association between rains during seasons and water flow from cascad

Table 21: Association between rains during seasons and water flow from cascade

Symmetric Measures

		Value	Asymp. Std. Error[a]	Approx. T[b]	Approx. Sig.
Ordinal by Ordinal	Gamma	.592	.091	5.587	.000
N of Valid Cases		85			

a. Not assuming the null hypothesis.

b. Using the asymptotic standard error assuming the null hypothesis.

The Gamma value is 0.592 approximately 0.6 with the P value 0.000 which is less than 0.05. It is significant. Therefore H0 is rejected at 0.05 level and accept the alternative hypothesis. Therefore there is an association between water flow from cascade and rain during the seasons. Since correlation is 0.592 it has a moderate relationship among two variables. This represents that rain during seasons is moderately impact for water flow from cascade. This relationship is positive and the increases in one variable significantly relate to increases in the other variable.

H9- Association between rains during seasons and the water storage

Table 22: Association between rains during seasons and the water storage

Symmetric Measures

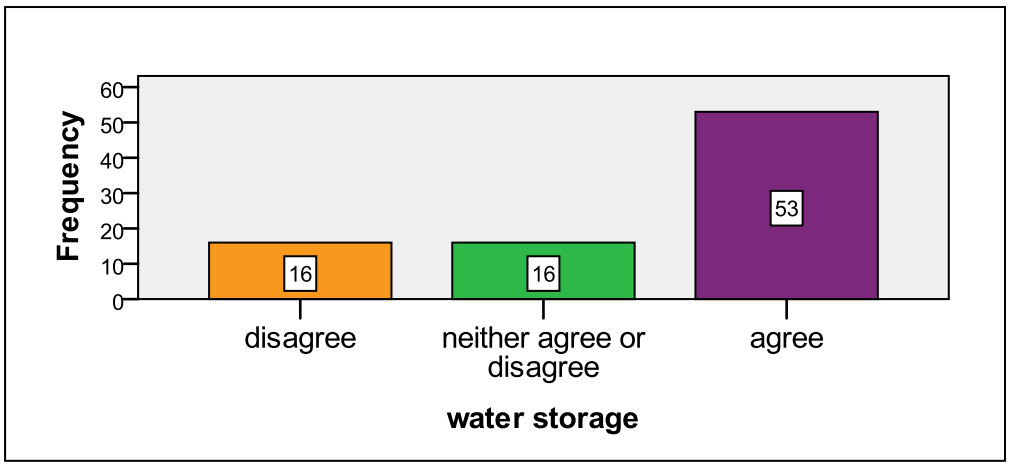
		Value	Asymp. Std. Error[a]	Approx. T[b]	Approx. Sig.
Ordinal by Ordinal	Gamma	.775	.072	7.020	.000
N of Valid Cases		85			

a. Not assuming the null hypothesis.

b. Using the asymptotic standard error assuming the null hypothesis.

The Gamma value is 0.775 with the P value 0.000 which is less than 0.05. It is significant. Therefore H0 is rejected at 0.05 level and accept the alternative hypothesis. Therefore there is an association between the rain during the seasons and water storage capacity. Since correlation is 0.775 it has a strong relationship among two variables .This represents that rain during seasons is strongly impact for water storage capacity. This relationship is positive and the increases in one variable significantly relate to increases in the other variable.

Figure 40: Descriptive statistics - Chart of water storage



According to figure 40, 53 farmers (62%) out of 85 agree that water storage capacity has improved in the tanks and dug-wells. Very few of them (18%) disagree with that statement.

H10- Association between rains during seasons and water for Yala cultivation

Table 23: Association between rains during seasons and water for Yala cultivation

Symmetric Measures

		Value	Asymp. Std. Error[a]	Approx. T[b]	Approx. Sig.
Ordinal by Ordinal	Gamma	.635	.091	6.116	.000
N of Valid Cases		85			

a. Not assuming the null hypothesis.

b. Using the asymptotic standard error assuming the null hypothesis.

The Gamma value is 0.635 approximately 0.5 with the P value 0.000 which is less than 0.05. It is significant. Therefore H0 is rejected at 0.05 level and accept the alternative hypothesis. Therefore there is an association between the rain during seasons and water for yala cultivation. Since correlation is 0.635, it has a moderate relationship among two variables .This represents that rain during seasons is moderately impact on water for yala cultivation. This relationship is positive and the increases in one variable significantly relate to increases in the other variable.

Figure 41: Descriptive Statistics - Chart of sufficient water for Yala cultivation

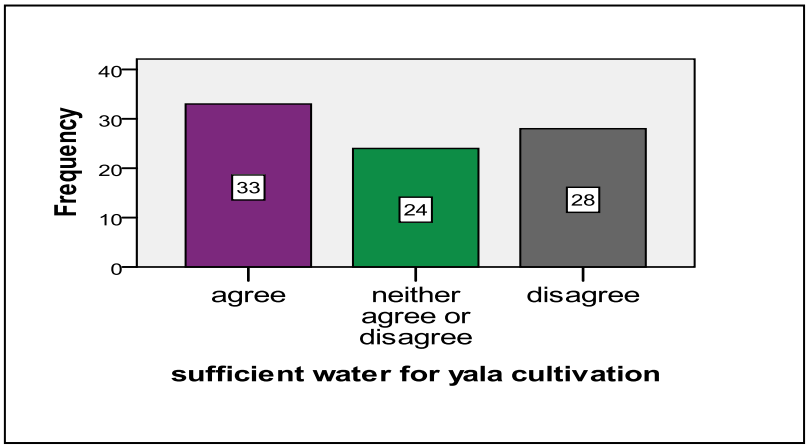


Figure 41 shows that 33 farmers agree with the statement of sufficient water for yala cultivation. But this is doubtful as 28 disagree and 24 did not agree or disagree. That means 52 did not fully agree with the statement. Therefore, availability of sufficient water in *Yala* is doubtful.

H11- Association between rains during seasons and water for Maha cultivation

Table 24: Association between rains during seasons and water for Maha cultivation

Symmetric Measures

		Value	Asymp. Std. Error[a]	Approx. T[b]	Approx. Sig.
Ordinal by Ordinal	Gamma	.696	.080	6.971	.000
N of Valid Cases		85			

a. Not assuming the null hypothesis.

b. Using the asymptotic standard error assuming the null hypothesis.

The Gamma value is 0.696 approximately 0.7 with the P value 0.000 which is less than 0.05. It is significant. Therefore H0 is rejected at 0.05 level and accept the alternative hypothesis. Therefore there is an association between the rain during seasons and water for Maha cultivation. Since correlation is 0.696, it has a moderate relationship among two variables .This represents that rain during seasons is moderately impact on water for Maha cultivation. This relationship is positive and the increases in one variable significantly relate to increases in the other variable.

Figure 42: Descriptive statistics - Chart of sufficient water for Maha cultivation

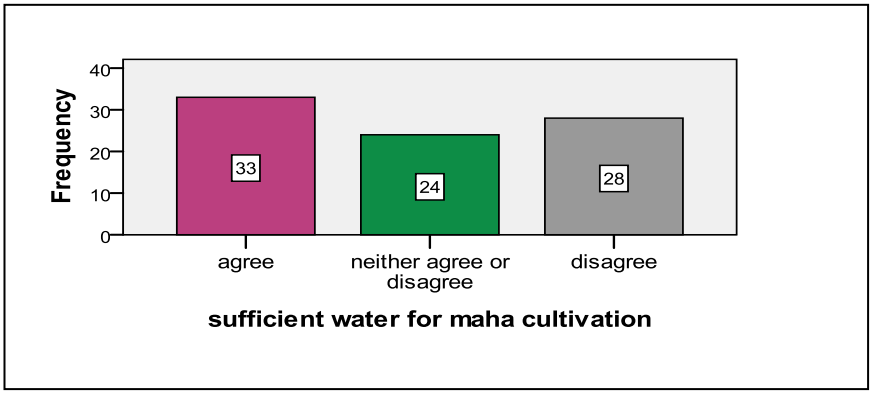


Figure 42 shows that 33 farmers agree with the statement of sufficient water available for Maha cultivation. Through figure 41 and 42, we can say that same number of farmers agree with both statements. But we need to consider that 28 were disagreeing and 24 did not responded positively. This shows the unpredictability situation of rain in both Yala and Maha.

H12- Association between supplementary water and the water storage

Table 25: Association between supplementary water and the water storage

Symmetric Measures

		Value	Asymp. Std. Error[a]	Approx. T[b]	Approx. Sig.
Ordinal by Ordinal	Gamma	.593	.112	4.174	.000
N of Valid Cases		85			

a. Not assuming the null hypothesis.

b. Using the asymptotic standard error assuming the null hypothesis.

The Gamma value is 0.593 with the P value 0.000 which is less than 0.05. It is significant. Therefore H0 is rejected at 0.05 level and accept the alternative hypothesis. Therefore there is an association between the water storage capacity and supplementary water. Since correlation is 0.593, it has a moderate relationship among two variables .This represents that water storage capacity is moderately impact for supplementary water. This relationship is positive and the increases in one variable significantly relate to increases in the other variable.

H13- Association between strong leadership in CBO and technical know-how

Table 26: Association between strong leadership in CBO and technical know-how

Symmetric Measures

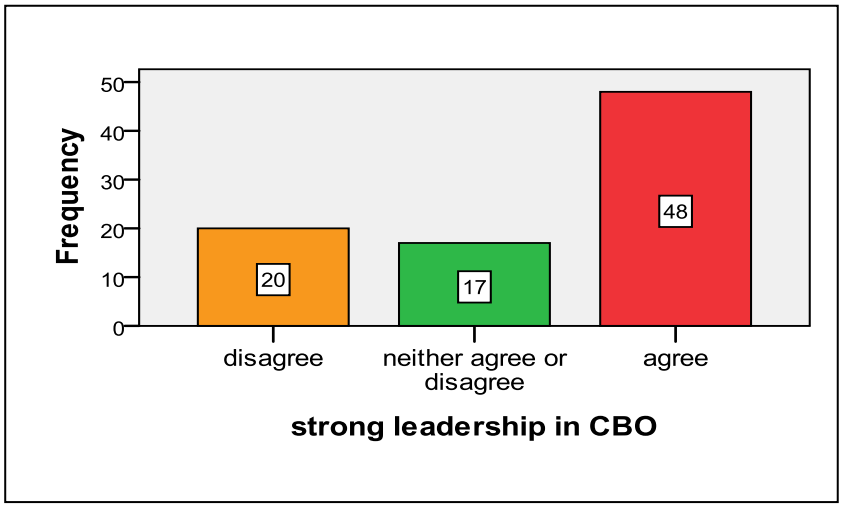
		Value	Asymp. Std. Error[a]	Approx. T[b]	Approx. Sig.
Ordinal by Ordinal	Gamma	.632	.089	5.958	.000
N of Valid Cases		85			

a. Not assuming the null hypothesis.

b. Using the asymptotic standard error assuming the null hypothesis.

The Gamma value is 0.632 with the P value 0.000 which is less than 0.05. It is significant. Therefore H0 is rejected at 0.05 level and accept the alternative hypothesis. Therefore there is an association between leadership in CBO and technical awareness. Since correlation is 0.632, it has a moderate relationship among two variables .This represents that strong leadership in CBO is moderately impact for technical awareness. This relationship is positive and the increases in one variable significantly relate to increases in the other variable.

Figure 43: Descriptive statistics - Chart of strong leadership in CBO



According to figure 43, a large number of farmers (48) agree that they have strong leadership to control forest / cascade degradation and manage CBO activities better than year 2010. It is also common to observe that some villagers are not happy with present leaders due to so many reasons.

H14- Association between strong leadership in CBO and women voice

Table 27: Association between strong leadership in CBO and women voice

Symmetric Measures

		Value	Asymp. Std. Error[a]	Approx. T[b]	Approx. Sig.
Ordinal by Ordinal	Gamma	.560	.095	5.159	.000
N of Valid Cases		85			

a. Not assuming the null hypothesis.

b. Using the asymptotic standard error assuming the null hypothesis.

The Gamma value is 0.56 with the P value 0.000 which is less than 0.05. It is significant. Therefore H0 is rejected at 0.05 level and accept the alternative hypothesis. Therefore there is an association between leadership in CBO and women voice. Since correlation is 0.56, it has a moderate relationship among two variables .This represents that strong leadership in CBO is moderately impact for women voice. This relationship is positive and the increases in one variable significantly relate to increases in the other variable.

Figure 44: Descriptive statistics - Chart of voice of women in decision making

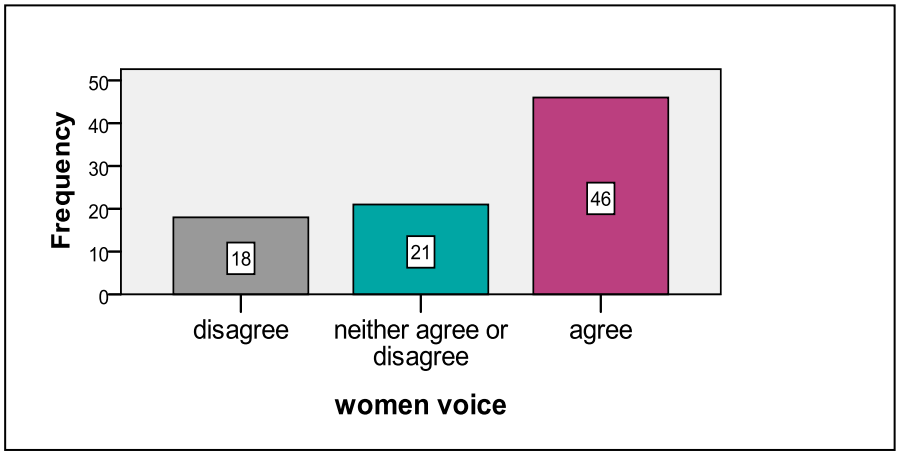


Figure 44 illustrated that 46 farmers agree that women have the voice and authority for decision making at the CBO level. When compare to year 2010, women voice in decision making has been increased as opportunities were created by CBOs. However, still 39 people believe that women did not receive the due recognition as decision makers.

H15- Association between strong leadership in CBO and unity

Table 28: Association between strong leadership in CBO and unity

Symmetric Measures

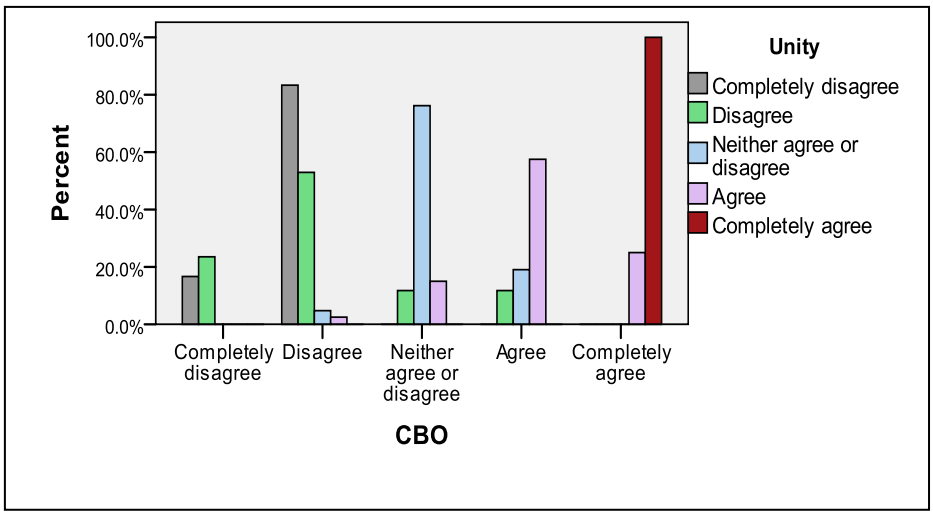
		Value	Asymp. Std. Error[a]	Approx. T[b]	Approx. Sig.
Ordinal by Ordinal	Gamma	.787	.070	7.919	.000
N of Valid Cases		85			

a. Not assuming the null hypothesis.

b. Using the asymptotic standard error assuming the null hypothesis.

The Gamma value is 0.787 with the P value 0.000 which is less than 0.05. It is significant. Therefore H0 is rejected at 0.05 level and accept the alternative hypothesis. Therefore there is an association between leadership in CBO and unity. Since correlation is 0.787, it has a strong relationship among two variables. This represents that strong leadership in CBO is strongly impact for village unity. This relationship is positive and the increases in one variable significantly relate to increases in the other variable.

Figure 45: Descriptive statistics - Chart of village unity compare to strong CBO



Through the figure 45 we can observe that farmers who completely agree with the existance of strong CBO and at the same time agree with the improvement of village unity as well.

Farmers who disagree with the strong CBO, disagree with the improvement of village unity also. This clearly shows that there is a relationship between strong CBO and vilage unity. Most of the farmers agree with that they have strong CBO therefore it can conclude that village unity has improved because of the activites conducted by CBO.

H16- Association between strong leadership in CBO and improvement of savings

Table 29: Association between strong leadership in CBO and improvement of savings

Symmetric Measures

		Value	Asymp. Std. Error[a]	Approx. T[b]	Approx. Sig.
Ordinal by Ordinal	Gamma	.802	.064	7.642	.000
N of Valid Cases		85			

a. Not assuming the null hypothesis.

b. Using the asymptotic standard error assuming the null hypothesis.

The Gamma value is 0.802 with the P value 0.000 which is less than 0.05. It is significant. Therefore H0 is rejected at 0.05 level and accept the alternative hypothesis. Therefore there is an association between leadership in CBO and improvement of savings. Since correlation is 0.802 it has a strong relationship among two variables .This represents that strong leadership in CBO is strongly impact for improvement of savings. This relationship is positive and the increases in one variable significantly relate to increases in the other variable.

Figure 46: Descriptive statistics - Chart of CBO mechanism of improving savings

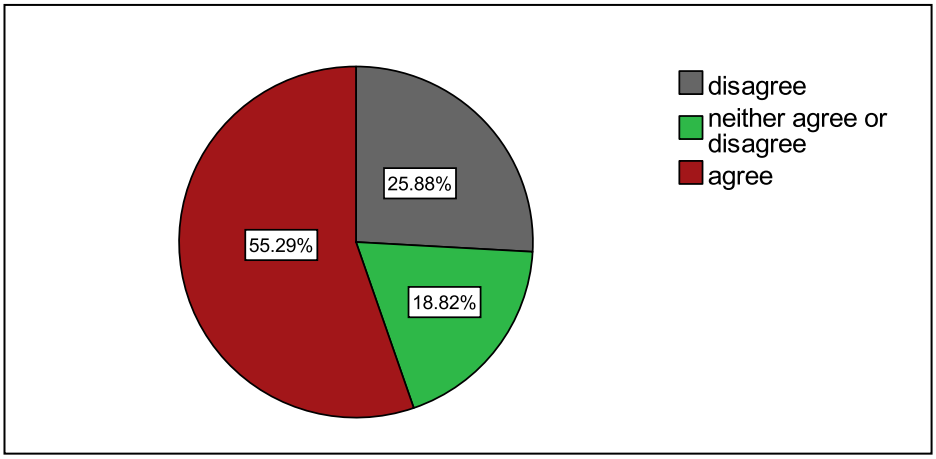


Figure 46 illustrated that most of the farmers agree that CBO has mechanisms to improve savings and saving habits. 55.29 has agreed to that as microfinance programs are working with village women for savings and credit. This system is popular among villages as money rotates among people in the village and easy access to small credit.

H17- Association between spend money on education & health and improvement of savings.

Table 30: Association between spend money on education & health and improvement of savings.

Symmetric Measures

		Value	Asymp. Std. Error[a]	Approx. T[b]	Approx. Sig.
Ordinal by Ordinal	Gamma	.579	.087	5.881	.000
N of Valid Cases		85			

a. Not assuming the null hypothesis.

b. Using the asymptotic standard error assuming the null hypothesis.

The Gamma value is 0.579 with the P value 0.000 which is less than 0.05. It is significant. Therefore H0 is rejected at 0.05 level and accept the alternative hypothesis. Therefore there is an association between spend money for education and health and improvement of savings. Since correlation is 0.579, it has a moderate relationship among two variables. This represents that improvement of savings is impact for spend money for education and health. This relationship is positive and the increases in one variable significantly relate to increases in the other variable.

Figure 47: Descriptive statistics - Chart of spend money for education and health compare with improvement of savings

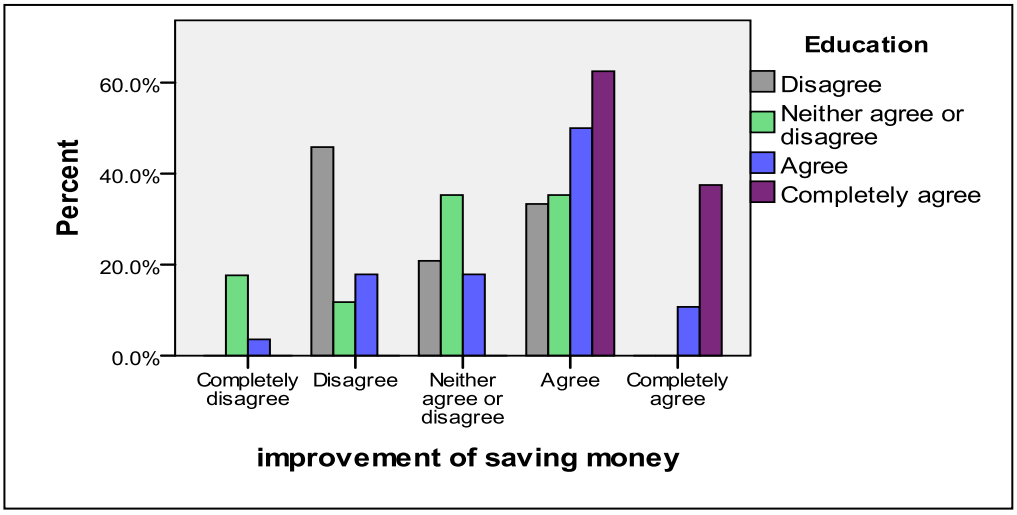


Figure 47 illustares that farmers who completely agree with that CBO has mechanisms to improve savings and savings habits and also agree with the improvement of spending money for education and health.

Farmers who disagree with that CBO has mechanisms to improve savings and savings habits also disagree with the improvement of spending money for education and health. This clearly shows that there is a relationship between these two. Most farmers agree with that CBO has mechanisms to improve savings and saving habits therefore it can conclude that they spend more money for education and health compare to year 2010.

H18- Association between strong CBO and access to market.

Table 31: Association between strong CBO and access to market.

Symmetric Measures

		Value	Asymp. Std. Error[a]	Approx. T[b]	Approx. Sig.
Ordinal by Ordinal	Gamma	.611	.097	5.098	.000
N of Valid Cases		85			

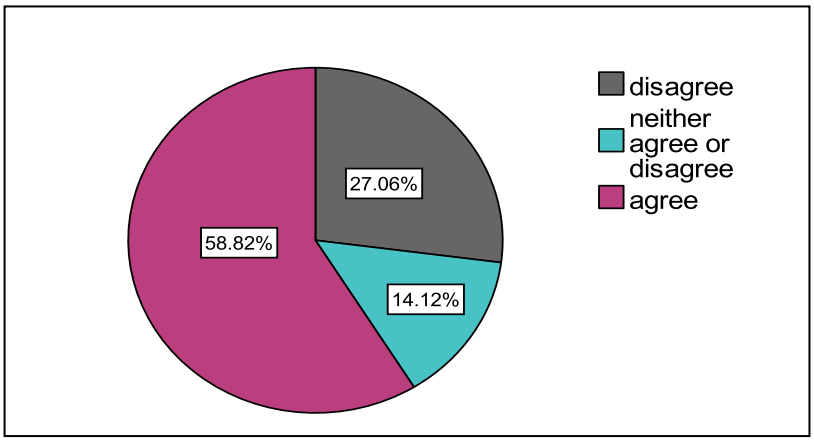
a. Not assuming the null hypothesis.

b. Using the asymptotic standard error assuming the null hypothesis.

The Gamma value is 0.611 with the P value 0.000 which is less than 0.05. It is significant. Therefore H0 is rejected at 0.05 level and accept the alternative hypothesis.

Therefore there is an association between strong CBO and access to market. Since correlation is 0.611, it has a moderate relationship among two variables .This represents that Strong CBO is moderately impact for access to market. This relationship is positive and the increases in one variable significantly relate to increases in the other variable.

Figure 48: Descriptive statistics - Chart of access to market



According to figure 48, we can see that 60% of farmers among 85 have agreed with that they have access to markets to sell their products compare to year 2010. At the same time, 41 farmers have challenged this with disagreement and neither agree or disagree.

H19- Association between reduction of forest fire and village climate

Table 32: Association between reduction of forest fire and village climate

Symmetric Measures

		Value	Asymp. Std. Error[a]	Approx. T[b]	Approx. Sig.
Ordinal by Ordinal	Gamma	.572	.098	4.997	.000
N of Valid Cases		85			

a. Not assuming the null hypothesis.

b. Using the asymptotic standard error assuming the null hypothesis.

The Gamma value is 0.572 approximately 0.6 with the P value 0.000 which is less than 0.05. It is significant. Therefore H0 is rejected at 0.05 level and accept the alternative hypothesis. Therefore there is an association between reduction of forest fire and the village climate. Since correlation is 0.572, it has a moderate relationship among two variables.

This represents that forest fire is moderately impact for village climate. This relationship is positive and the increases in one variable significantly relate to increases in the other variable.

CHAPTER FIVE

CONCLUSION

5.0 Conclusion

The research has clearly established the prevailing relationships between independent variables (such as poverty, forest fire and high water run-off) and the dependent variable (Cascade). Since almost all communities in the area live on agriculture, rehabilitation of forest cover and minor irrigation network is the most important aspect proposed to improve income levels and livelihood of communities and to ensure cascade protection. This has reduced the community dependency on forest and destructive usage of forest and other cascade resources. A strong awareness and training of communities are also influential to educate them on protection of cascade and other resources in order to maintain the eco-systems and bio-diversity of the area. Strong community organisations like CBOs have done an important work to motivate people towards a common goal of cascade improvement.

According to the tests done on research hypotheses, many benefits are visible due to cascade rehabilitation. Forest re-grown has positively impacted on rainfall improvement in the area. Sufficient rainfall promotes water storage, plant growth and arrival of wild animals to the cascade. Water storage, arrival of wild animals and well-grown tree cover improves bio-diversity. And also water quality improved due to improvement of bio-diversity and it is clear that all these aspects are inter-connected.

Well grown forest canopy and anchoring effects of tree roots reduces the speed of water flow and soil erosion in the entire cascade. Reduction of evaporation is also another benefit of forest cover. Water storage capacity influences the increase in water levels of dug-wells and other water sources including water springs. There is a positive relationship with rainfall and storage of water for Yala and Maha cultivations.

Communities enjoy a number of benefits through rehabilitated micro tanks in the cascade. Now these tanks provide sufficient water for Yala and Maha cultivations.

Increased water capacity in tanks and other water sources reduce hours spent by women and men for water collection. On the other hand, re-grown forest provides sufficient fuel wood within the village and will reduce the time spent for this purpose. These saved times and energy of women and girls and that could be spent on education or other productive and economically worth activities.

According to the associations in H10 (Association between rains during seasons and water for Yala cultivation) and H11 (Association between rains during seasons and water for Maha cultivation), when farmers have sufficient water for Yala and Maha, they cultivate all their paddy fields and highland crops and it leads to a yeld harvest. This is the main base for increased income and food security of forest communities living around the cascade. When communities have sufficient income and livelihood opportunities, they invariably stop forest destruction. This will reduce the community pressure on forest and cascade resources and improve biodiversity and environment in the cascade. However, regeneration of forest and rehabilitation of cascade takes a considerable time and authorities should promote participatory approach to obtain community support to maintain the rehabilitated forest areas and cascade during this period. Authorities also should allow communities to practice agro-forestry and intercropping of Other Field Crops (OFC) to earn considerable income during the initial years of forest plantation.

The community approaches like SLANRMP specifically addresses the leading causes of deforestation and cascade degradation in the dry and intermediate zones. The experience to date indicates that it is effective in reducing deforestation and cascade degradation. The community based approach through CBOs provides a range of benefits including livelihood improvement, poverty reduction, environmental and social benefits. The approach empowers communities and provides a mechanism for a range of government agencies to provide technical assistance and material support to help increase incomes and improve social infrastructure. At present, there is an effective social network to coordinate village activities with other stakeholders.

The return to labour provides sufficient incentive for households to participate in income-generating activities, and the increased income has reduced the poverty

levels at village level. The estimated additional income exceeds the poverty line in the dry and intermediate zones (ie. the amount of income required to meet minimal nutritional intake for a family). Accordingly, community based approaches have been successfully implemented by SLANRMP to rehabilitate rural agri-life in Ulpotha micro-cascade.

5.1 Future Actions

- Government officials and policy planners are requested to replicate the model developed and practiced by SLANRMP. The model has introduced the bottom up planning for a successful rural development and resource management. Communities themselves developed management plans to improve their village resources including forest and irrigation systems. The model also strengthened the agricultural practices which is the main economic base of rural communities. As such this is an effective development model to replicate in other rural areas.

- Rehabilitation of irrigation networks in cascades to facilitate efficient water management practices to farmers in the downstream. The importance of village irrigation systems has been established by SLANRMP. Water has been used as an entry point for all development programs in SLANRMP sites. This approach was successful and could be replicated in dry zone programs.

- There is another opportunity to conduct future researches in the Galkiriyakanda cascade but in different areas. Most appropriate area is to study the traditional irrigation system operates within the cascade. Basically, study the viability of traditional irrigation system in this cascade will be useful for policy planners, farming communities, students and professionals as well.

REFERENCES

Abeyarathna, E., (1956) Dry land Farming in Ceylon, Tropical Agriculturalist 112:191.229

Andreassion, V., (2004) Water and Forests: From Historical Controversial to Scientific Debate, Journal of Hydrology

Bohier, R. L., (1935) Ancient Irrigation Works in Ceylon, Colombo, (Translated by Piyasena L) Ceylon Government Press

Bruifnzeed, L. A., (2004) Hydrological Functions of Tropical Forests, Not Seeing the Soil for the Trees

Clder, I. R, (2000) Land Use Impacts on Water Resources, Land- Water Linkages in Rural Watersheds Electronics Workshop

Country Environment profile of Sri Lanka (2205) MWH – World Bank

FAO (2003) – Agriculture, Food and Water: A Contribution to the World Water Development Report.Rom, Italy

Gunesena, H. P. M., (2000) Food Security and Small Tanks System in Sri Lanka

Halsnaes, K., & Verhagen, J. (2007). Development based climate change adaptation and mitigation - conceptual issues and lessons learned in studies in developing countries. *Mitigation and Adaptation Strategies for Global Change*, *12*, 1573-1596. 10.1007/s11027-007-9093-6

Jayathilaka, C. J, & Sakthivaduvel, R., (1996) Pre-checking Water Availability in Irrigation Tank Cascade System; the Cascade Water Balance Model

Kawani,

Kennedy, J. S, (1933) Evaluation of Scientific Development of Village irrigation Works,Transactions of the Engineering Associate of Ceylon

Kerr, J, (2002) Watershed Development Projects in India – An Evaluation Research Report No. 127

Krishnaveni, M., & Shanker, S, (2003) Rehabilitation of Irrigation Tank Cascade Systems using Remote Sensing GIS and GPS

Leach, E. R., (1961) Pul Eliya. A Village in Ceylon - A Study of Land Tenure and Kinship. London. Cambridge University Press

Madduma Bandara, C. M., (1985) Catchment Ecosystems and Village Tanks Cascades in the Dry Zone of Sri Lanka

Marques, T.A., M. Andersen, S. Christensen-Dalsgaard, S. Belikov, A. Boltunov, Ø. Wiig, S.T. Buckland and J. Aars. 2006. Comparing distance estimation methods in a helicopter line transect survey. Wildlife Society Bulletin 34:759-763

Mathew, K., & Dietz, T., (2005) How pro-poor are Participating Watershed Management Project? An Indian Case Study, Research Report 92

Mendis, D.L.O., (2003), Environment and conflict: a Kuhnian paradigm-based approach to understanding some socio-cultural and economic causes of problems and conflicts in modern irrigation projects in southern Sri Lanka. In: Water for People and Nature. Ministry of Irrigation and Water Management, Sri Lanka, pp. 95–122.

Panabokke, C. R., & Thennakoon, M. U., a (1998) Small tank Systems in Sri Lanka: Issues and Considerations

Panabokke, C. R., (1996) The Small Tank cascade Systems of the Rajarata – Their Setting, Distribution and the Hydrology. IIMI, Colombo

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

Ponrajah, A. J. P., (1982) Designs of irrigation Water for Small Catchments (up to 20 Sq. Miles). Colombo, Sri Lanka Irrigation Department

Robert, J., & Deborch, R., (2000) , Trees and Water – Small Holder, Agro-forestry and Irrigated Tanks in Northern India

Sakthivadivel, R., Fernando, N., & Panabokke, C. M., (1996) Nature of Small Tank Cascade Systems and a Framework for Rehabilitation of Tanks within them. Sri Lanka Country Paper No 13 Colombo, IIMI

Seneviratna, A., (1989) The Springs of Sinhala Civilisation , New Delhi: Navrang Press

Shakthivadivel, R. T., Fernando, N., & Brewer, J. D., (1990) Rehabilitation Planning for Small Tank Cascades, A Methodology based as Rapid Assessment, Colombo, Sri Lanka

Somarathna, P.D.S, & Dayawansa, N. D. K, (2005) Evaluation of the Performance of Tank Cascade Systems using Multi-Temporal Satellite Data

Tennakoon, M. U. A (2005) Ellangawa (Sinhala Version), Godage and Sons, Colombo, Sri Lanka

Annex 1 – General Socio-Economic Questionnaire

UNIVERSITY OF MORATUWA

ULPOTHA MICRO-CATCHMENT

IMPACTS ON ENVIRONMENT AND RURAL LIVELIHOOD

FIELD SURVEY QUESTIONNAIRE

b. household survey schedule

District: K'gala ; DS division……; GN Division:…… ; Name of the village: …….

Date ……..Time Start: …… end …….. Name of the interviewer ……..

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1 **Household description**

Name of the Respondent: ……..M/F;
Age group (1=over 65y/ 2=18-65y)

Criterion	< 5 yr	5 to 14 years		14 to 18 years		18 to 65 years		Over 65 years	
		M	*F*	*M*	*F*	*M*	*F*	M	F
1. Total									
1.1 Reside in the HH									
2. Education									
2.1 cannot read & write									
2.2 primary									
2.3 secondary &+									
3. First Occupation									

3.1 Schooling/ education									
3.2 Farming									
3.3 Unskilled labour									
3.4 skill labour/blue collar job,									
3.5 forestry related									
3.6 unemployed.									
4. % Contribution to HH income									
5. % Contribution to the HH domestic affairs									
6. % Contribution to the HH decision making									

2. Household's living status (2.1 to 2.8 enumerator's observations)

2.1 Roof: 1. Tile 2. Corrugated asbestos 3. Cadjan 4.Tin/Al sheet 5.other specify)_____

2.2 Floor: 1. Terrazzo or tile 2. Cement 3. Earthen or Cow-Dung 5.other (specify)_ _____

2.3 Wall: 1. bricks 2. Wattle & daub 3.Wood 4.other (specify) _____

2.4 Floor area of house (sq. ft.): 1. 500 or less 2. 501-1000, 3. 1000 and higher_____

2.5 Durable Assets: 1) Radio; 2) TV; 3) Fridge; 4)Bicycle; 5) Motorbike; 6) 2W tractor; 7) 4W tractor; 8)Van/Car; 8)other _____

2.6 Toilet Facilities: availability Y/No
if yes 1.water ceiled, 2. pit; 3 other

2.7 Energy for cooking purposes?…… 2.8 Energy for lighting purposes?……

[1=Electricity, 2=Kerosene, 3= Gas, 4=Purchased firewood, 5= Collected firewood, 6= Crop residue, 7 other]

2b) Drinking water

	Wet/ rainy season	Normal dry season	Drought season
Months of the year [A]			
Source [B]			
Time spend [C]			
Person involved [D]			

Source, time spend and person involved

A month of the year, 1=January, 2=February, Etc.

B source of drinking water, 1=tube well, 2= protected well; 3= unprotected well; 4= wewa; 5=river//canal, 6=water supply by service provider; 7=others (specify……..]

C Av Time spend in hr, D Person *involved* (1=male, 2= female)

3 Present land ownership and usage

	Extent ha	Ownership	Type of the ownership(A)	Using/ own since (B)	Crops cultivated (C)		Type of Water Supply D	Soil Conservation E
					Yala	Maha		
3.1 Homestead								
3.2 Highlands								
3.3 Paddy field								
3.4.Other Agri lands								
3.5 Forestry lands								
3.6 other								

A: 1= own 2= user rights, 3= temporary/short term 4= ande or similar 5=unauthorized/encroached

B; 1= inheriting, 2= <5years, 3=>5years.

C; 1 paddy; 2 OFC; 3-fruits/ coconuts etc; 4 timbers

D: 1=Rain fed; *2=Minor tank, 3=Tank, 4=Agro well, 5=Anicut, 6=Tank connecting canal, 7=pumped, 8=others]*

E: 1= Do not use any 2=Cover crops 3= Terracing 4=Mulching 5=SALT 6.Other (specify)

type	Have your family member ever collected? Y/N	Present situation (year 2002 – 2003)						
		Quantity	Frequency (A)	Who M/F	Method of harvesting (B)	Status supply (C)	Amount selling p.a	Form of selling (D)
4.1 Timber		ft^3						
4.2 Firewood		kg						
4.3 medicinal plants		kg						
4.4 other plants/wines		kg						
4.5 honey		kg						
4.6 madu		kg						
4.7 fruits		Kg						
4.8 tourism related								

4 Benefits/ harvests form the forest

A; 1=few days once a year, 2= few days once in six months, 3= few days once in 3-4 months, 4= monthly, 5 weekly, 6= almost daily.

B; 1= after cutting the whole tree/removing the plant, 2= after cutting part of the tree/removing part the plant, 3= collecting the droppings without damaging the tree/plants, 4 other

C: 1= drastically declining 2= declining 3=constant 4=increasing 5= drastically increasing

D; 1 without any processing 2 semi processed 3 processed and sell (specify…..)

5) Livestock rearing related with the forest

	Number	Rearing system	Production	Use of inputs (B)	Amount selling
5.1 neat cattle /buffalo					
5.2 Goats & sheep					

A; 1. free grassing/range in the forest 2.controlled grassing in the forest 3. controlled grassing outside the forest 4.stall fed 6.Other (specify)

B; 1 use improved /high quality breeds. 2 Use cultivated fodder, 3 Use vaccination /health care, 4 hired labor, 5 Machinery, 6 extension /technical advise, 7 market information

6. Perception on possible income generating activities

	Relevance	Need conditions / Needs
Paddy cultivation		
Chena cultivation		
Harvests from the forest		
Livestock husbandry		
Micro enterprises 1		
Forest collection		

A; 1 very relevant, 2 marginally relevant, 3 not relevant

B, 1=capital 2=other inputs, 3=technology / training/ advise, 4=market information, 5=other specify

7. Poverty assessment

7.1 Poverty status as per the secondary info _____(1= not poor, 2= fairly poor, 3=Very poor)

7.2 perceptions on last 5 years [1=always this poor, 2=used to be less poor, 3=used to be more poor]

7.5 If deteriorated significantly, why? (List main 3 issues according to the priority)

1=crop loss due to scarcity of water for irrigation, 2= Have not been able to cultivate due to scarcity of labor, 3= Have not been able to cultivate due to scarcity of capital, 4= Income from the forest was decreased, 5=Income from

other sources decreased, 6= crop loss due to wild animals, 7=crop loss due to other reasons 8= other

8. How do you rate your environment / natural resource base

Resource	Present Status (A)	Resource	Present Status (A)
1. Wewa (Tank)		2. Soil	
3. Soil fertility		4. Water	
5. Forest		5. Other resources	

A; *1= drastically declining 2= declining 3=constant 4=increasing 5= drastically increasing*

8.1 Remedies to improve above environment / natural resource base

1= Community must involved to practice proper collective participatory NRM systems.
2= the government should be able to do that.
3=no community neither government can do, private sector mechanisms will do it
4= no idea
*5= Other*_____

9. In your opinion how do you rate the NRM services implemented by various agencies (FD, DoA etc) in the recent past?

Activity	Rating	Activity	Rating
1. Reforestation		7. Desilting /deepen of wewa	
2. Forest conservation		8. Improve water infiltration,	
3. Fire protection.		9. Improved Agro-forestry	
4. Construction of new bunds /channels of the wewa		10. Others	
5. Soil conservation - Establishing contour bunds		11.	
6. Rain water harvesting		12.	

1=very useful, 2=useful 3= not much useful, 4= not at all useful, 5=no idea

10 Source of Capital

Portfolio	Source (A)	Interest		Terms and conditions (C)
		System B	Rate per month	
shot term crops/activities (less than 6 months repayment)				
medium term crop/ livestock (less than 2years repayment)				
long term (more than 2years repayment)				
Investment – housing				
Investment – micro enterprise				
Emergency				

A; [1=Own, 2=Seettu, 3=CBO/NGO, 4=Rural moneylenders, 5=Neighbors, 6=relatives, 7=Commercial Bank 8=others]

B; 1=monthly interest as per the reducing balance, 2=flat interest without considering the balance

C; 1=repayment of total amount after harvest, 2= paying interest after harvest, 3= fixed term payment, 4=% of the products, 5= others]

11. Savings

11.1 Have your or your family member involved in informal savings system (seettu)? Y/N.

11.2 Since (1=<1year, 2=1-5 years, 3=>5 years)

11.3 Have your or your family member involved in a village banking society (CBO)? Y/N

11.4 Since (1=<1year, 2=1-5 years, 3=>5 years)

11.5 Have your or your family member a savings account in a commercial bank Y/N

11.6 Since (1=<1year, 2=1-5 years, 3=>5 years)

12. CBO involvement

12.1 Membership of the CBOs? (Please exclude funeral aid societies, Temple societies, Political parties, Sports clubs…etc.)

	Name of the CBO	Type (A)	Member since	Position held? Y/N	Objectives of being member *(exclude funeral Aid Society/ temple soc etc),*	Realization of them (B)
Respondent	1. 2.					
Family members	1. 2 3.					

A type of the organization: 2=Samurdhi, 3= Sanasa/ SEEDS, 4=Social mobilization group, 5= FO/ Producer group, 6= Marketing organization, 7=Others (specify)

B; Rating: 1=Highly satisfied, 2=Satisfied, 3=Dissatisfied, 4=highly dissatisfied

12.2 Do you expect/ see a role for CBOs in mobilizing/ empowering rural poor to articulate their needs/rights in the sectors of income generation/NRM/ activities,

1= Yes, there is a big role and it is possible in the present circumstance.

2= Yes, there is a big role but and it is not possible in the present circumstance.

3= May be…., 4= No, there is no role, 5= No idea

12.3. If yes, in your opinion what is the present situation of the existing CBO?

1= high willingness and ability, 2= marginal, 3= very limited

12.4 Possibility to improve the situation? 1= Yes 2= No 3 =No idea

……
……

Activity	Involvement Y/N	Activity	Involvement Y/N
1. Support to identify forest boundaries		5. Planting	
2. Boundary post establishment		6. Cleaning fire belts	
3. Land surveys		7. Putting up live fire belts	
4. Raising seedlings/ plants			

13. Have you involved in following activities

13.1 Benefits obtained by involved in above activities

1=no direct benefits, 2=wage/food/material/..3=long-term benefits to the society,

4= 2+3; 5= other

(specify)……
…….

13.2 Who supplied the plants & how (in above 6&8)

……

Agency	Role[A]	Agency	Role [A]
1. FD		2. Farmer organizations	
3. Agriculture dept		4. Samurdhi society	
5. Livestock dept		6. NGO	
7. Agrarian dev dept		8. Banks	
9. Divisional sec		10. Private sector – input suppliers	
11. Agrarian DC		12. Private sector – info/extension	
13. GN		14. Private sector – marketing	
15. Samurdhi officer		16. others related to production/ NRM	
17. AP&RA		18.	
19.		20.	

14. Perception on service providers

Annex 2 - MPhil - Quantitative Data Analysis – Questionnairecovered the period of 2010 to 2014.

Circle the number that represents your feelings at this particular moment best. There are no right or wrong answers. Please answer every question.

Compared to 2010, do you note the following changes and if so how intensively?

No	*Statement*	*I disagree Completely*	*Disagree*	*Neither agree or disagree*	*Agree*	*I agree completely*
A	***Environmental Impacts***					
1	Forest has re-grown in the cascade	1	2	3	4	5
2	No more forest fire in the cascade	1	2	3	4	5
3	We receive more rains during seasons	1	2	3	4	5
4	Water storage capacity improved in tanks and dug-wells	1	2	3	4	5
5	Wild animals and birds have come back to the cascade	1	2	3	4	5
6	Biodiversity has improved in the cascade (greenery with animals).	1	2	3	4	5
7	Village climate is cooler than the past	1	2	3	4	5
B	***Hydrological Impacts***	***I disagree Completely***				***I agree completely***
8	We have sufficient water for Maha cultivation	1	2	3	4	5
9	We have sufficient water for Yala cultivation	1	2	3	4	5
10	Water flow from cascade last more than three months	1	2	3	4	5
11	Speed of water run-off from cascade has been reduced	1	2	3	4	5
12	Number of hours spent for drinking water collection has been reduced (Drinking water available in the village)	1	2	3	4	5
13	Supplementary water (dug-well) use for highland crop is sufficient	1	2	3	4	5
14	Drinking water quality has improved	1	2	3	4	5
C	***Institutional Impacts***	***I disagree Completely***				***I agree completely***
15	We have a strong and registered CBO in the village	1	2	3	4	5
16	CBO has a mechanism to improve savings and saving habits	1	2	3	4	5
17	We have gained technical know-how to maintain	1	2	3	4	5

	cascade resources					
18	There is a strong leadership to control degradation and manage CBO activities	1	2	3	4	5
19	Village unity has improved through collective programs.	1	2	3	4	5
20	Women have the voice and authority for decision making at the CBO	1	2	3	4	5
D	***Financial Impacts***	***I disagree Completely***				***I agree completely***
21	Harvest from paddy and other crops has increased	1	2	3	4	5
22	We spend more money for children's education and health	1	2	3	4	5
23	We cultivate all our paddy fields	1	2	3	4	5
24	Our monthly income has improved	1	2	3	4	5
25	Now we have extra income from Microfinance and Micro-enterprises	1	2	3	4	5
26	We have collected more assets (livestock etc.)	1	2	3	4	5
27	We have access to markets to sell our products	1	2	3	4	5
		I disagree Completely				***I agree completely***
E	**Cascade Improvements (Dependent Variable)**					
28	Cascade has improved	1	2	3	4	5

28.07.14