UNEP-GEF Project:
Managing Agricultural Landscapes in Socio-Ecologically Sensitive Areas to Promote Food Security, Wellbeing and Ecosystem Health in Sri Lanka

Baseline Assessment of Biodiversity, Ecosystem services, Land Degradation, Food Security and Human Health in *Village Tank Cascade Systems of Sri Lanka*

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15 April 2021

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Table of Contents

List of Tables

List of Figures

CHAPTER ONE

INTRODUCTION

One of the prerequisites to a viable human future is restoring and maintaining healthy ecosystems. The concept of ecosystem health can be explained from biophysical, socioeconomic, and human health perspectives. Assessments of ecosystem health need to be made considering all interactive relationships of these perspectives. Both qualitative and quantitative indicators of ecosystem health are being developed for each of these dimensions. The ecosystem health may be defined as the capacity for maintaining biological and social organization, on one hand, and the ability to achieve reasonable and sustainable human goals on the other. From this perspective ecosystem health is as much about sustaining human communities, economic opportunity, and human and animal health, as it is about sustaining the biological functions of ecosystems.

At the beginning of the twentieth century, the per capita extent of land in Sri Lanka was 10.53 hectares. During last two decades with the increase in population up to 18.6 million by 2001 and 21.8 million by 2019 the per capita extent had dropped to 0.29 ha and further to 0.25 ha respectively. As the population continues to grow the per capita extent of land will further decline rapidly in the future. This trend has contributed not only the fragmentation of lands into small unproductive units but also to an acute shortage of land. With the pressure on the use of land has led to deteriorate the ecosystems in Sri Lanka, threatening the ecosystem health. Hence, solutions to these problems have to be sought through proper land use planning.

As ecosystems include the human communities, the evolving definitions of ecosystem health encompass the direct implications of biophysical changes on humans. It means that there are direct social, economic, and human health consequences associated with ecosystem health. Epidemiological studies suggest that, increasingly, human health is being affected by environmental decline. For example, cholera, malaria, dengue fever etc. are enhanced by degraded environments.

Ecosystem health is closely related to the concept of sustainability, which is defined to meet the current and future societal need for ecosystem services. The potential to continuously supply of ecosystem services for the coming generations has been highlighted as an important issue within environment justice.

Ecosystem health is essential for an ecosystem to provide services that benefit the human population in terms of social and economic value. Ecosystem services are generally divided into four categories: provisioning, regulating, supporting, and cultural services. Supply of services relies on a well-conditioned ecosystem, and the capacity of service supply will be reduced if an ecosystem is unhealthy, for example through loss of biodiversity. In order to advance human welfare through improved ecosystem services, a better understanding of the integrated social-ecological system is needed so that appropriate policies and practices can be formulated.

The integrity and functionality of cascade landscapes in recent years have been degraded significantly with major impacts on biodiversity and ecosystem service

provision. A number of drivers and threats have undermined the mixed, heterogeneous landscapes that the cascade system represents. Poor understanding on the function of this complex landscape has led to ignorance and inadvertent destruction of the ancient Village Tank Cascade System (VTCS) during recent large-scale development projects, and as a result of the spread of commercial opportunities and changes in agricultural technologies in the dry zone. During the past few decades there has been a drastic reduction in forest cover due to various development activities and population growth. Degradation of floral and faunal communities, loss of fertile lands, destruction of village ecosystems and increased severity of droughts are among the most distinct features that have affected cascade landscapes of Sri Lanka. One of the most heavily affected elements has been the areas of traditional knowledge on the conservation and sustainable utilization of biodiversity, especially agrobiodiversity, which has seen the rapid erosion and loss of many traditional varieties. Recent climate change scenarios have further fueled the situation with extreme events seriously challenging the system.

The Healthy Landscapes project will seek to showcase management strategies for strengthening the restoration and sustainable management of selected VTCSs in cascade landscapes for the enhanced provision of ecosystem services and protection of biodiversity. The project plans to develop and validate a model VTCS management system that can be used for scaling up to other cascade landscapes in the country.

The project proposes using an ecosystem/landscape approach to better understand and manage biodiversity, agriculture and health linkages (Eco-Health approach) and recognizes the concept of social-ecological resilience when considering the interdependence between people and nature in this context. This will include efforts to integrate human health and agrobiodiversity concerns into the ecosystem services framework. The growing pressure on the environment by humans increases the importance of viewing and analyzing this relationship as a linked and dynamic system.

The project consists of 4 components namely:

i. Implementation of biodiversity-based options that improve sustainable landscape management in socio-ecological sensitive areas;
ii. Strengthening institutions, policies, and integrated landscape planning of village tank cascade systems (VTCSs) in socio-ecological sensitive areas;
iii. Partnerships, awareness raising and capacity building for better sustainable integrated landscape management in support of improved ecosystem services and eco-health outcomes; and
iv. Knowledge, information management and monitoring and evaluation

For most of the project outputs identified, there is a pre-requisite to establish the baseline at the beginning to assess the project impact on aspects such as degradation of land resource, biodiversity and bio-cultural diversity, food security, human health etc. Thus, the Healthy Landscapes core project team agreed to work collaboratively on the overall baseline assessment approach and methodology to identify key actions,

TORs, identify key students and enumerators and other necessary actions to suit the establishment of the Project benchmark.

Baseline assessment covers all the key bio-physical, socio-ecological, and economic aspects and their linkages and interrelation process. During the baseline survey and study compilation of information and data inventories, assessments, mapping and network and spatial analysis were done for status and trends analysis, evaluation of strategies and guideline formulations. Data collection will be done through field data collection, key informant discussions, household surveys, field observations, brainstorming guided workshops and secondary data collections.

The assessment was carried out in five VTCSs in the *Nachchaduwa* and *Horiwila* project sites. (Table 1.1). Baseline assessment has been designed based on system approach principles. Landscape level holistic multidisciplinary and spatially integrated approaches have been adopted. The Baseline assessment survey has been planned to cover following key topics:

i. Land Degradation Assessment - development of new VTCS land use system classification, assessing and mapping land degradation and ecosystem services mapping and modelling.

ii. Biodiversity assessment including terrestrial biodiversity, agrobiodiversity, aquatic biodiversity, and medicinal plant diversity; and

iii. Food security and human health assessment including food and nutrition assessment, human health assessment, and COVID 19 impact assessment

Table 1.1. Baseline assessment project sites

Major Reservoir	Village Tank Cascade System (VTCS)	DS Divisions	No. of tanks	Extent (ha)
Nachchaduwa	Mahakanumulla	Ipalogama, Thirappane	29	4,717
	Thirappane	Thirappane, Ipalogama, Kekirawa	10	2,206
	Ulagalle	Thirappane, Kekirawa	28	5,127
Horiwila	Palugaswewa	Palugaswewa	14	2,022
	Bellankadawala	Palugaswewa, Dambulla	28	4,995
TOTAL			**109**	**19,067**

CHAPTER TWO

LAND DEGRADATION

2.1. Introduction

Healthy ecosystems are the most critical component of the biosphere that has the ability to maintain its structure, and function through time and in the face of external stresses (resilience). Sustainable ecosystems provide food, shelter, the capacity to assimilate and recycle wastes, clean air and water.

Village Tank Cascade Systems (VTCSs) of Sri Lanka with its techniques of culturing the natural surge of water for human and ecosystem needs by spatially and temporally harmonizing the multiplicity of entire ecosystem, provides an excellent model for unique sustainable ecological production landscape that feed whole life forms (flora and fauna including people) in the face of many natural and human induced challenges.

VTCS is a century old traditional wisdom of ancient skilled hydrologic genius who had in-depth knowledge of analyzing ecological functions (Madduma Bandara, 2009).

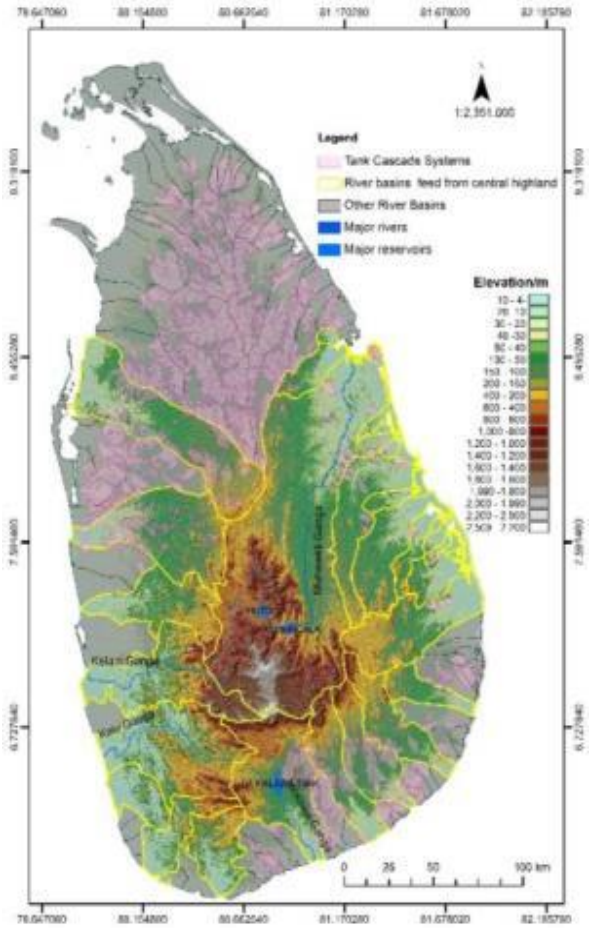

Figure 2.1. The VTCSs spread over three major zones -Northern, North Western and South-eastern parts of the country

VTCS consists with complex integration of different concepts and components to store water, feeding water for different ecological purposes and purify used water and make available for downstream tanks after purifying and filtering while sustaining all ecological components and making multifaceted livelihood for all the people including villagers, famers, fishermen, traders and even tourists. The functional components of VTCS have proved the withstanding and buffering capacity for many stresses including climate variability for centuries, even with minimum maintenance in recent decades.

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Presently, unplanned land utilization patterns have transformed lands devoted for sensitive functional components of VTCS to farmlands, human settlements and urban centers at the expense of loss of ecological functional features with many consequences indicating the exceeding of productivity threshold levels and urge the need of immediate intervention needs.

2.1.1. Objectives

The main aim is to evaluate the baseline status of land degradation in pilot study sites with novel approaches and tools to screen hotspots and identifying guiding information for planning and implementation of comprehensive holistic integrated management plans.

2.2.2. The study area

As shown in Figure 2.1, the total area under VTCS in Sri Lanka is approximately 14,800 km^2 (22.5% of Sri Lanka) and it spreads over most suitable landforms in Northern, North-central, North-western and South-eastern dry zone areas. For this study, three adjoining cascade systems from *Nachchaduwa* VTCS complex and *Horiwila* VTCS complex located in the upper part of the *Malwathu Oya* river basin (Anuradhapura District) were the pilot study landscapes (Figure 2.2).

2.2. Methods

As main approach for evaluation of land degradation related issues within pilot VTCSs, Land Use System (LUS) based LADA-WOCAT-QM approach with guided expert brainstorming sessions, key informant discussions and participatory field investigations were used with detailed local level assessment in selected sampling areas (Liniger, et al., 2013) (Annex 2.1-2.2)

Field evaluation has focused on following broad aspects;

- Land use change evaluation;
- Land degradation types and trend evaluation in each LUS;
- Evaluation of present status of tank components in relation to functional role of each tank component;
- Evaluation of direct and indirect causes for emerging issues identified in the field;
- Identifing the intensity and trends of land degradation severity; and
- Identifing the priority areas / high risk areas for rapid interventions.

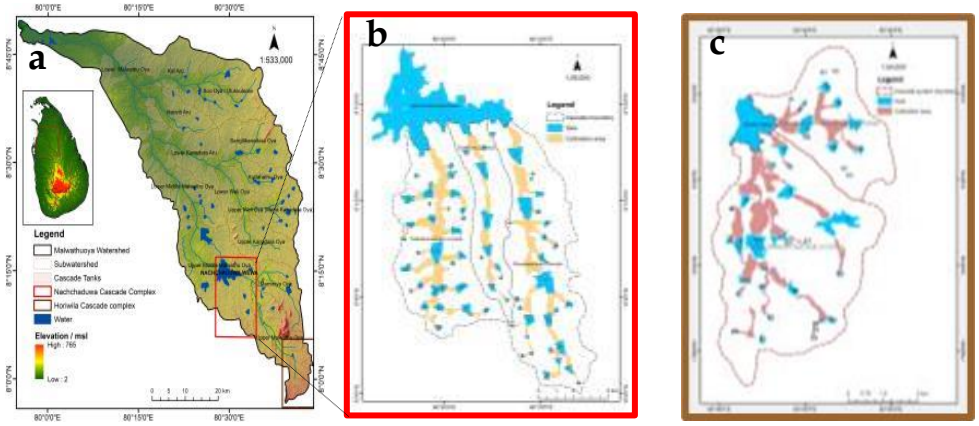

Figure 2.2. Location of pilot study sites in *Malwathuoya* river basin (a). *Nachchaduwa* landscape consisting of three adjoining VTCS namely *Mahakanumulla, Thirappane and Ulagalla (b) and Horiwila* landscape consisting with two adjoining VTCS namely *Palugaswewa and Bellankadawala* (c)

All the basic details such as land use, soil, topographic features, tank component distribution, etc. were spatially evaluated using suitable spatial analysis.

2.2.2. Sampling area selection for detailed degradation assessment

As shown in the figure 2.3, three sample zones from each pilot study cascade complexes (from *Horiwila* VTCS and *Nachchaduwa* VTCS) were taken as detailed investigating areas for baseline assessment. The sampling areas for detailed study were selected considering the similarity and homogeneity of the conditions withing each study ring as suggested at the planning meeting with all the consultants contributing baseline assessment. Main concept is sociological and ecological homogeneity of a VTCS is linked with the radial distance from the mother tank of the VTCS complex. So, the sampling zones were demarcated in *Horiwila* tank considering the radial distance from *Horiwila* tank and three sampling rings of N*achchaduwa* pilot site has been demarcated considering the radial distance from the *Nachchaduwa* Reservoir.

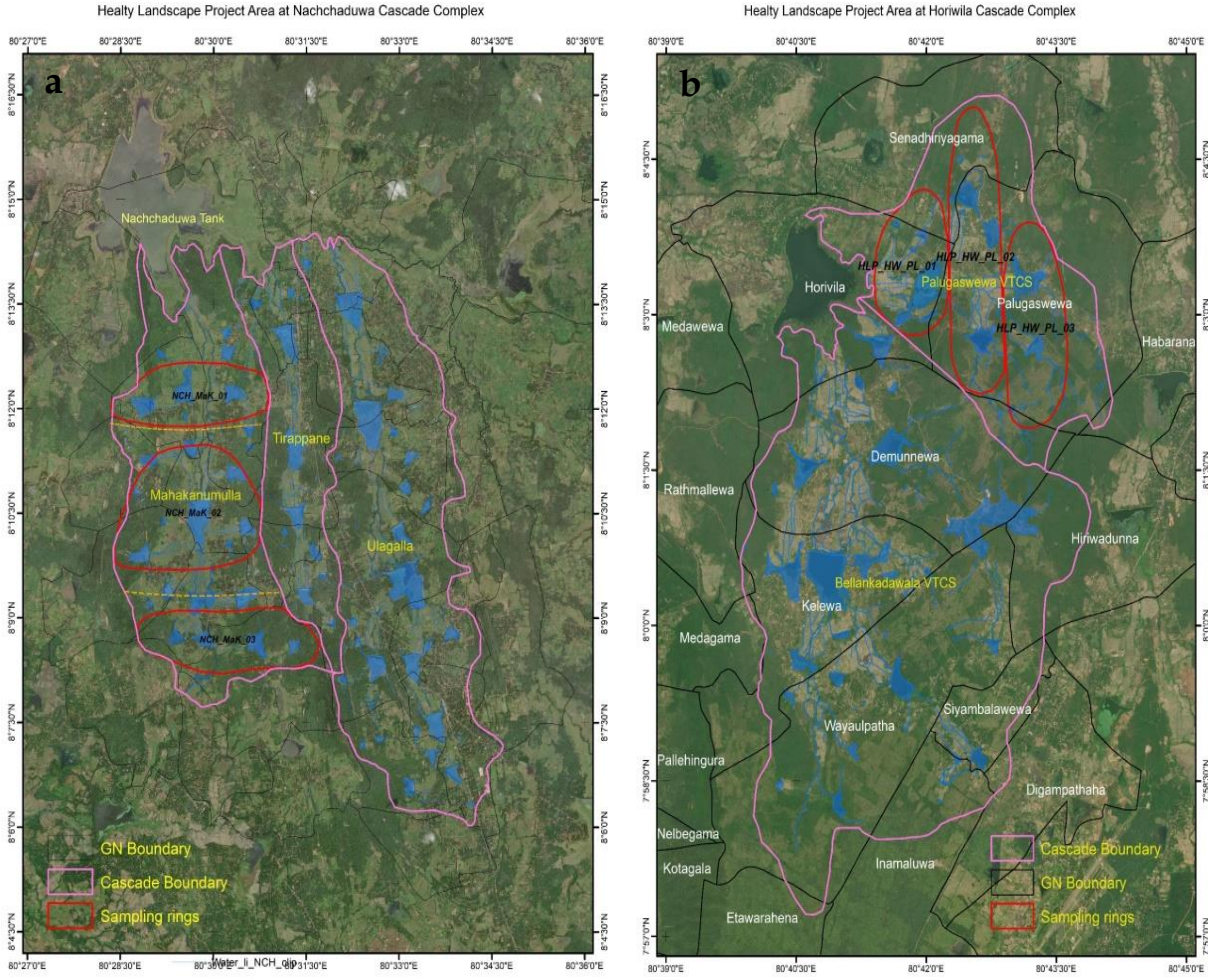

Figure 2.3. Sampling locations selected for detailed baseline assessment in Healthy Landscape Project Area. *Nachchaduwa* VTCS complex (a) and *Horiwila* VTCS complex (b)

2.2.3. Evaluation of baseline status of tank components

In addition to land use categories, tank cascade component maps were developed for evaluation of baseline status of different tank cascade components of each VTCS specific land unit or component. Major components included in the map were

1. Village tank, 2. *Kattakaduwa* (Interceptor), 3. Main streams, 4. *Perahana* (sieve or filtering strip), 5. *Godawala* (upstream water hole), 6. *Gasgommana* (wind break trees), 7. Peripheral shallow tank bed and 8. Bund. The baseline status of each cascade component of all the tanks were evaluated using standard schedule.

2.2.4. Data collection

For the baseline assessment on land degradation, LADA WOCAT methodology, a globally tested approach has been adapted. The assessment is comprising with Land Use System Based assessment mapping and local level detailed assessment with comprehensive field assessment using standard guiding data collection formats. The survey team was comprised with soil surveyor, soil conservationists, agriculture research officers, agriculture extension officers, university academics, postgraduate students, final year undergraduates, community leaders and key informants. Group discussions, field investigations with high resolution detailed field maps, key informant interviews, were used during field data collection. The field investigations were done covering all land parcels under each land use types. Information on land use changes (LUC), LUC intensity, LUC severity, degradation type, area degraded, degradation intensity causes of degradation, conservation interventions and impact of degradation were gathered during field investigation. Field investigations for degradation assessment were done in 28 days.

2.2.5. Data analysis

All the collected data were incorporated into GIS using a coding ID assigned for each land parcel unit. Spatial analysis and interpretations were deployed for developing map illustrations. Descriptive statistics on the information related to land use change, degradation and conservation status were used for evaluation of baseline status.

Plate 2.1. Field investigation for land degradation baseline assessment

Table 2.1. Field data collection summary

Sampling Area	Number of Tanks	Number of Sampling sites
Mahakanumulla R1	4	69
Mahakanumulla R2	4	59
Mahakanumulla R3	3	81
Palugaswewa R1	4	66
Palugaswewa R2	4	88
Palugaswewa R3	3	68
Total	22	431

Updating land use maps

Land use maps of the pilot study landscapes were updated with most recent available version of detailed (scale 1:10000) data sets of Land Use Policy Planning Department and comprehensive field investigations (Figure 2.4). The updated land use map has been used as the base map for developing Land Use System (LUS) maps. These have been used as the guide maps by all the experts for field data collection. The map has been reformatted for web map version to facilitate mobile phone based filed location tracking for accurate and convenient field data collection for all baseline field data collection teams.

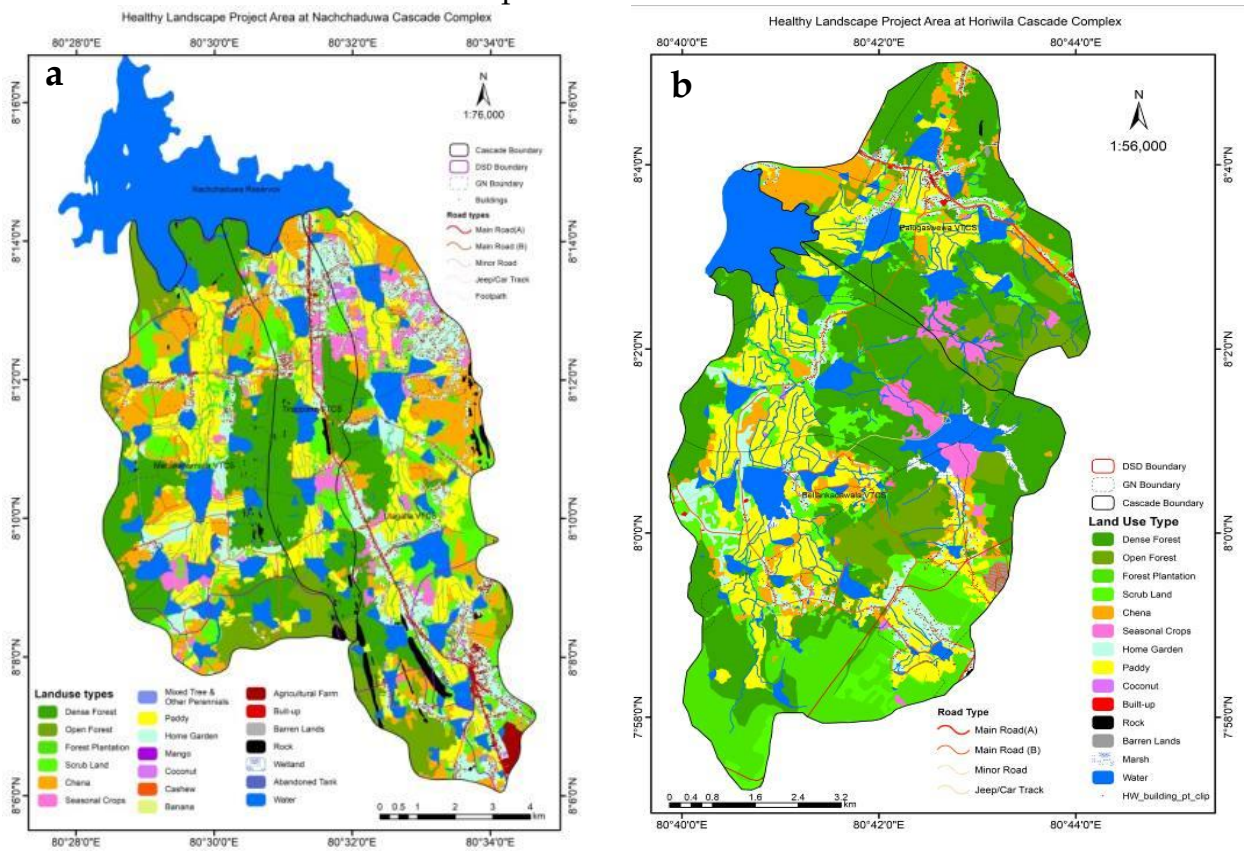

Figure 2.4. Updated land use maps of the pilot VTCS landscapes. *Nachchaduwa* (a) *Horiwila* (b)

2.3. Results: baseline status

2.3.1. Land use system mapping

The land use maps of the study landscape were updated through comprehensive field investigation and GIS during each field visit. Update land use maps are illustrated in the figure 2.4. The updated land use maps were used by all the field investigation teams as the base map.

2.3.2. Bassline status of VTCS components

As defined by Dharmasena (2004), main components of VTCS and the brief description of functional role of each component are given below. The field investigations have been done for assessment of the baseline status of each component in the detailed investigation zones. The components are shown in Figure 2.5

Perahana – It is the meadow developed under *Gasgommana* and it filters the sediment flow coming from upstream chena lands.

Iswetiya or potawetiya - An upstream soil ridge constructed at either side of the tank bund to prevent entering eroded soil from upper land slopes.

Godawala - A man-made water hole to trap sediment and it provides water to wild animals. This might had been a strategy to evade man-animal conflict.

Kuluwewa - A small tank constructed above relatively large reservoirs only to trap sediment and not for irrigation purpose. It provides water for cattle and wild animals.

Tisbambe – It is a fertile land strip found around the settlement area (*Gangoda*) and it is a common in the village. Tree species such as mee, mango, coconut etc. are grown in scattered manner. Mostly this area was used for sanitary purposes and the resting place of buffaloes. Buffaloes were used as a bio-protection mechanism from wild animals and malaria.

Kiul ela – This is the old natural stream utilized as the common drainage. Tree species such as *karanda*, *mee*, mat grass, *Ikiri, vetakeya* etc. and few rare small fish species are also found along the *Kiul ela*. Most importantly it removes salts and iron polluted water and improves the drainage condition of the paddy tract.

Kattakaduwa – This is a reserved land below the tank bund. It consists of four micro-climatic environments: water hole; marshy land; moist land; and dry upland, therefore, diverse vegetation is developed. This land phase prevents entering salts and Ferric ions into the paddy field. The water hole referred to as *Yathuruwala* minimizes bund seepage by raising the groundwater table.

Figure 2.5. Schematic diagram of main components of traditional village tank system (Source: Dharmasena, 2010)

Printed and web-based maps of main VTCS components were prepared for easy reference and used as the field guide during field investigations for baseline status evaluation (figure 2.4). Most of the field staff followed the smartphone-based location tracking approach for collecting and reporting baseline status assessment.

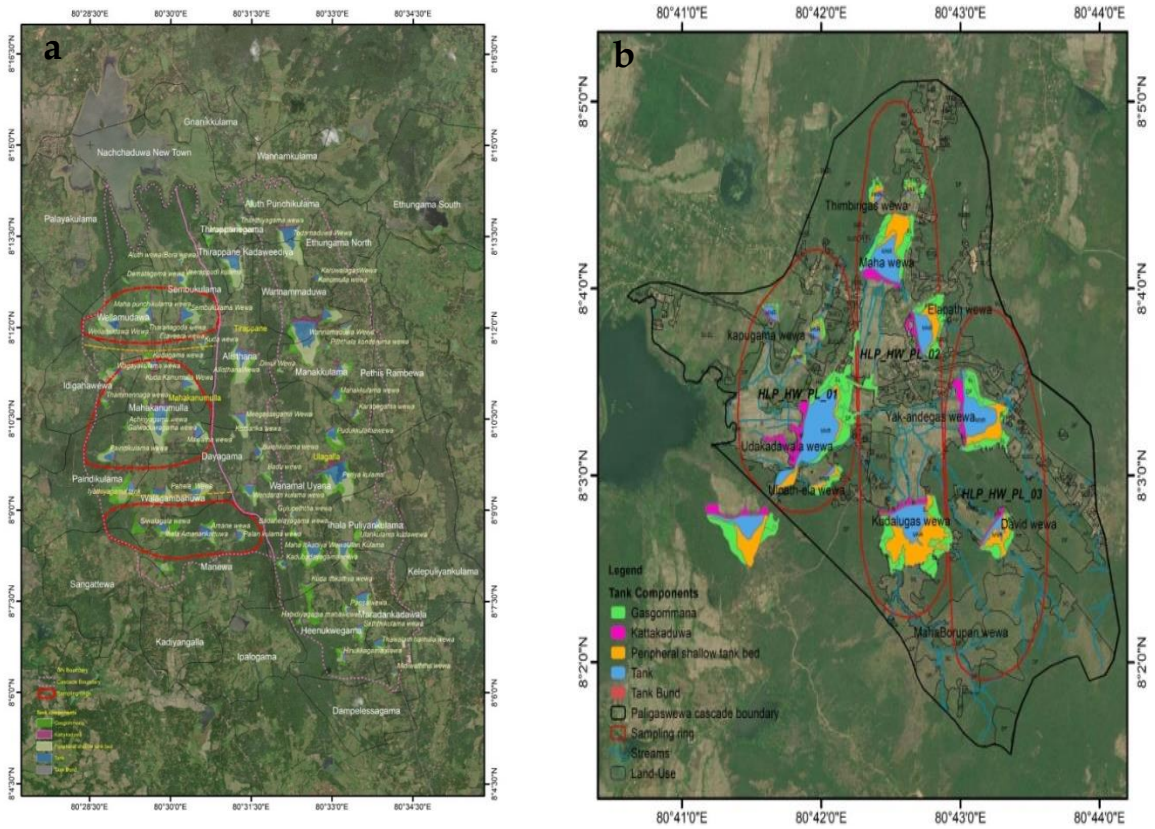

Figure 2.6: VTCS component map of the pilot study landscapes

The baseline status of each VTCS components was evaluated by comprehensive field investigations in collaboration with key informants of each village was done and the summary of collected information is given in the table 2.2

Table 2.2. Baseline status of VTCS components and identified issues during field investigations

Tank	ID	Tank status	Kattakaduwa	Gasgommana (Tree belt)	Shallow tank bed	Iswetiya	Godawala
Udakadawala	pal_1	Bush encroachments and siltation	Encroached for Paddy cultivation & Invasive species found (*Acasia and IpilIpil)*	Good condition with well covered trees	Not affected by human activities. So not degraded	Iswetiya is Panwaliyawa	Recently restored
Panweliyaya	pal_1	Former *Iswetiya* of *Udakadawala* tank as the bund	Recently rehabilitated and allow growing plants	Good condition with dense forest	Not Found	Not Found	Not Found
Kapugama	pal_1	Bush encroachments and siltation	Intensely encroached for cultivation seasonal crops and paddy	Good condition with well grown trees	Highly degraded due to the encroachment for seasonal crops and paddy	Not Found	Not Found
Dumbuluwagama	pal_1	Bush encroachments, Salvinia and siltation	Encroached for seasonal crops	Good condition with well grown trees	Not Found	Not Found	Not Found
Kudalugaswewa	pal_2	A well-maintained	A marsh with good	Good condition with	Not affected by human activities	Not Found	Not Found

		tank with conservation measures to protect the bund. Not degraded	biodiversity. Large trees not found	well grown trees	and well-functioning		
Alapathwewa	pal_2	Not degraded	Slightly degraded. Recently rehabilitated	Good condition with well grown trees	Not affected by human activities and good condition	Replanted	Restored
Palugaswewa	pal_2	Well maintained and conservation measures were taken. Not degraded	Not affected by human activities and not degraded	Encroached for home gardens	Encroached for paddy cultivation	Not affected by human activities. So not degraded	Not Found
Thimbiriwewa	pal_2	Highly degraded due to bush encroachments and silt with broken sluice and bund. Need repairing	Encroached for Paddy cultivation	Good condition with well grown trees	Not Found	Not Found	Not Found
Yakadagaswewa	pal_3	Siltation	Encroached for Paddy cultivation	Rapidly decreasing the area due to human settlements and construction of power plant	Rapidly decreasing the area due to human settlements and construction of power plant	Not Found	Not Found
David Wewa	pal_3	Bush encroachments and siltation	Encroached for Paddy cultivation	Good condition with well grown trees	Not affected by human activities. So not degraded	Not Found	Not Found

2.3.3. Baseline status of land degradation of different land categories

Land use system (LUS) based LADA-WOCAT Approach has been followed for baseline assessment of land degradation and related issues in each land unit within sampling rings. According to LUS change evaluation some of the important lands uses associated with VTCS are found rapidly changed. *Gasgommana*- the windbreak tree strip in some of the tanks has shown rapid decreased, (Plates 2.2-2.9). while areas under cultivation lands, settlements and home gardens are in the increasing trends (Figures 2.7-2.8).

Plate 2.2. *Kattakaduwa* area of some the tanks found encroached for paddy cultivation by some villagers

Plate 2.4. In some areas seasonal crop cultivation can been seen extended over *Kattakaduwa* area.

Plate 2.6. Initial stages of weed and bush encroachments into the tank can be seen in some tanks and regular maintenance needs to be scheduled

Plate 2.7. In some tanks well maintained *Gasgommana* (the Wind break tree belt) can be seen, but the area devoted for *Kattakaduwa* has been neglected.

Plate 2.3. Realizing the importance of existence of *Kattakaduwa* in some villages, rehabilitation has been started followed by demarcating the reserve belt.

Plate 2.8. Aquatic weeds seem to be a problem in several tanks and regular maintenance may be required after rehabilitation

Plate 2.5. Considerable number of tanks has well maintained *Kattakaduwa* area that should be promoted in others tanks as well

Plate 2.9. Considerable number of tanks are well functioning and properly maintained and can be considered as best models

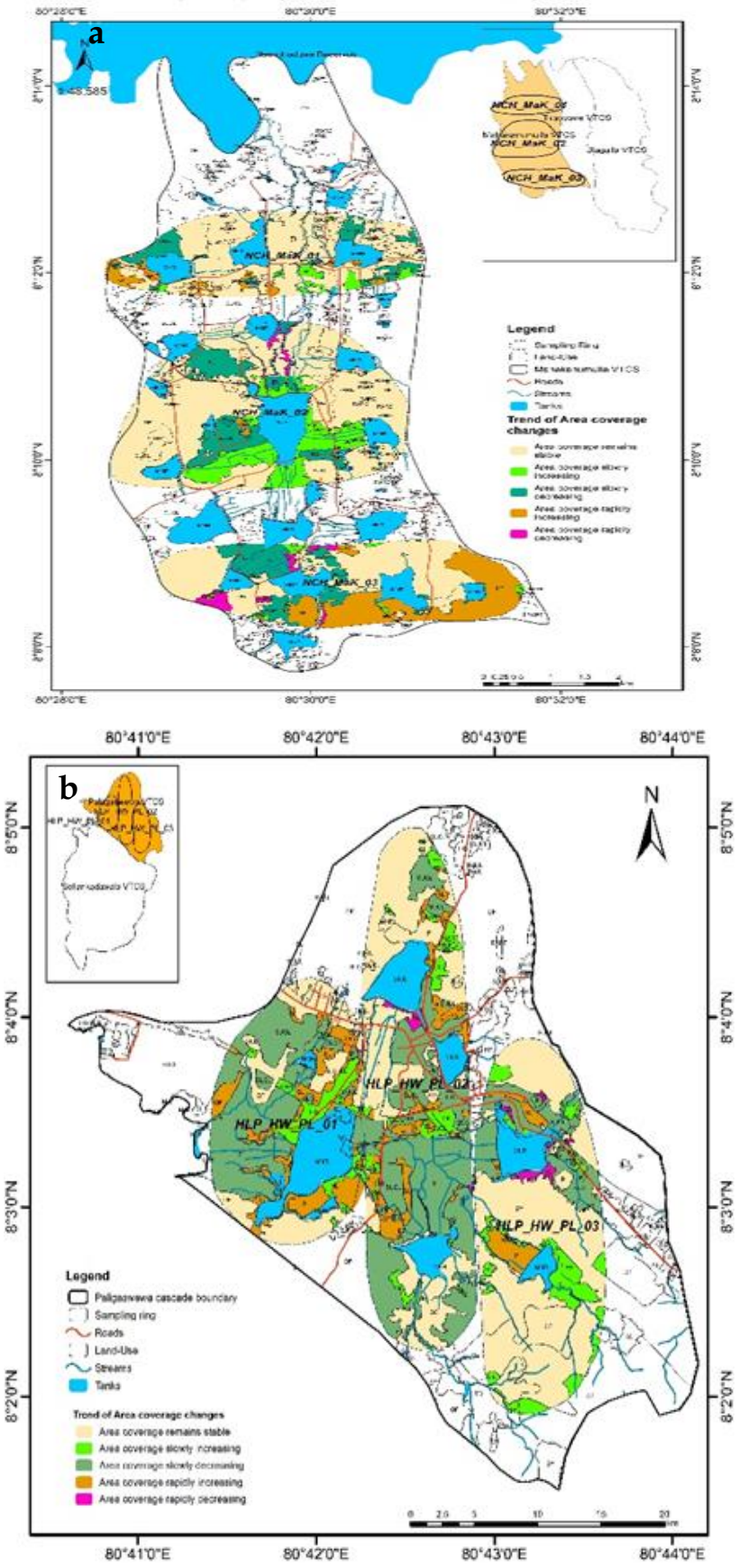

Figure 2.7. Land use system change in *Nachchaduwa* (a) and *Horiwila* (b)

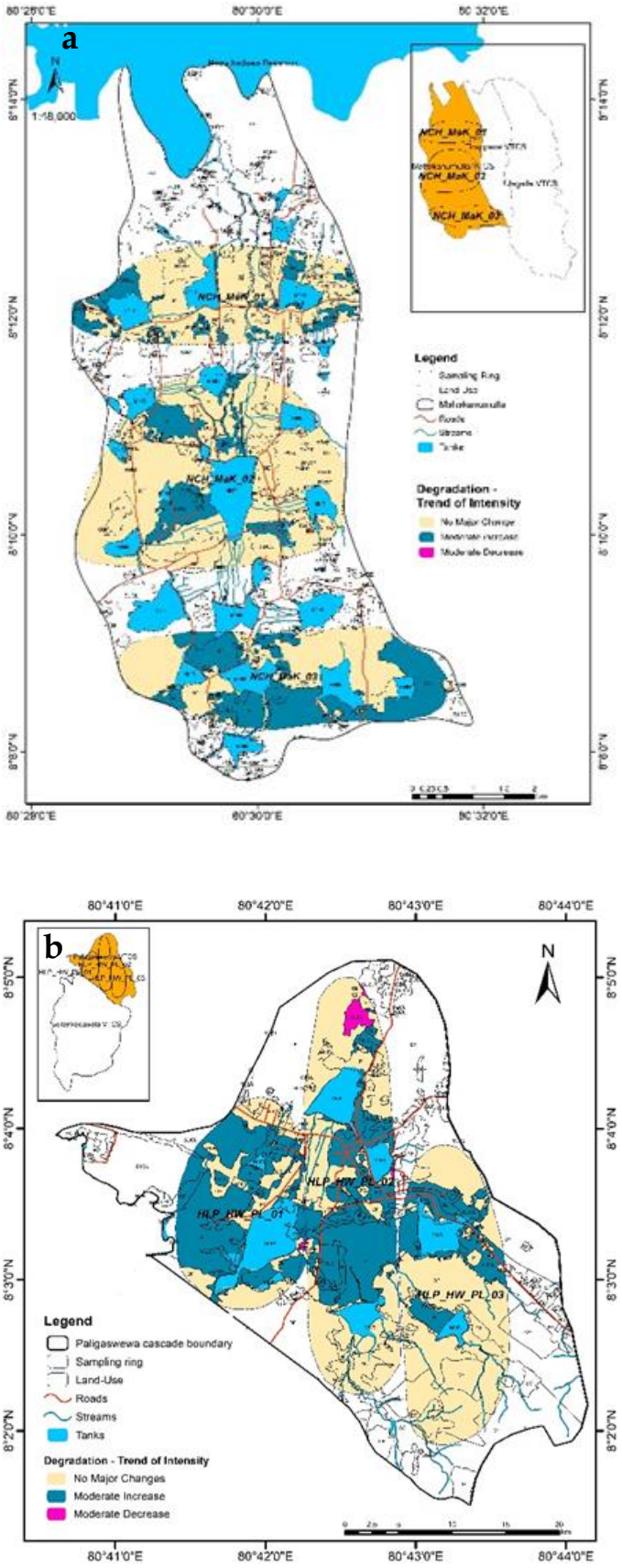

Figure 2.8. Land use system changing trends of *Nachchaduwa* (a) and *Horiwila* (b)

2.3.4. Baseline status of Land Degradation

LADA-WOCAT LUS based degradation assessment has resulted identified land use types and degradation types indicated in the table 2.3. Assessment results showed that considerable percentage of area is under influence of many land degradation types (Figure 2.9-2.14).

Table 2.3. Land-use type and degradation types

No	Land-Use Type	Prominent Degradation Types
1	Paddy	Heavy agro-chemical use with increased frequency and severity of pests/ diseases incidences
		Fertility declined and reduced organic matter content
2	Seasonal Crops	Surface erosion, topsoil loss
		Heavy agro-chemical use with increased frequency and severity of pests/ diseases incidence
		Quality and species composition/diversity decline
		Fertility declined and reduced organic matter content
		Increase of pests/diseases
3	Sparsely Used Crop Land / Chena	Surface erosion - top soil loss
		Quality and species composition/ diversity decline
		Fertility declined and reduced organic matter content
		Quantity/ biomass decline
4	Dense Forest	Reduction of vegetative cover
		Increase in invasive tree species
5	Open Forest	Reduction of vegetative cover
		Loss of habitats
		Increase in invasive tree species
6	Forest Plantation	Fertility declined and reduced organic matter content
7	Scrub Land	Surface erosion- top soil loss
		Loss of habitats
		Reduction of vegetative cover
8	Minor Reservoirs	Change in quantity of surface water
		Reduction of vegetative cover in upper watershed areas
		Fertility declined and reduced organic matter content in cultivation areas
		Quality and species composition/ diversity decline vegetative areas
		Change in quantity of surface water,
		Loss of habitats
		Offsite degradation effects
9	Stream	Riverbank erosion
10	Wet Land (Boggy Area)	Reduction of the buffering capacity of wetland areas

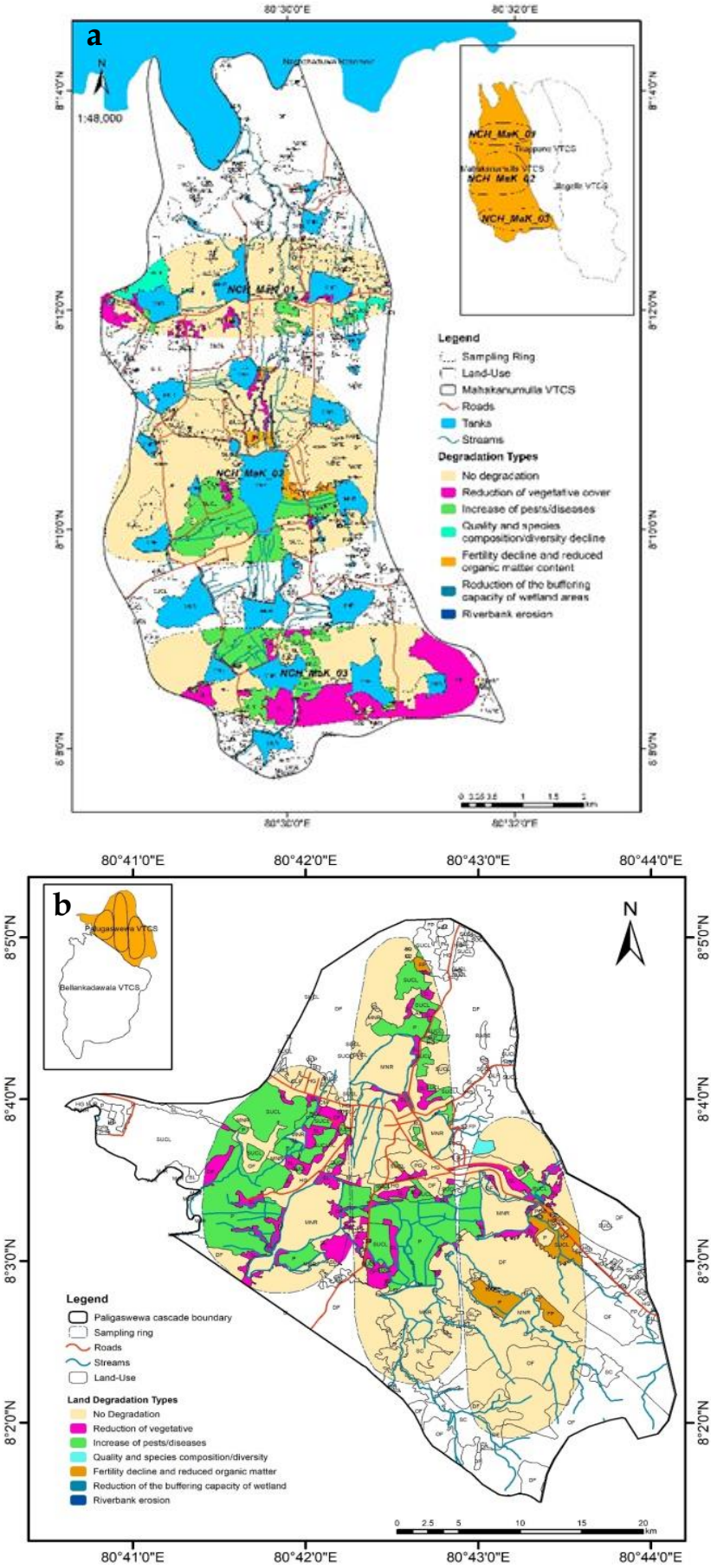

Figure 2.9. Prominent land degradation types of *Nachchaduwa* (a) and *Horiwila* (b)

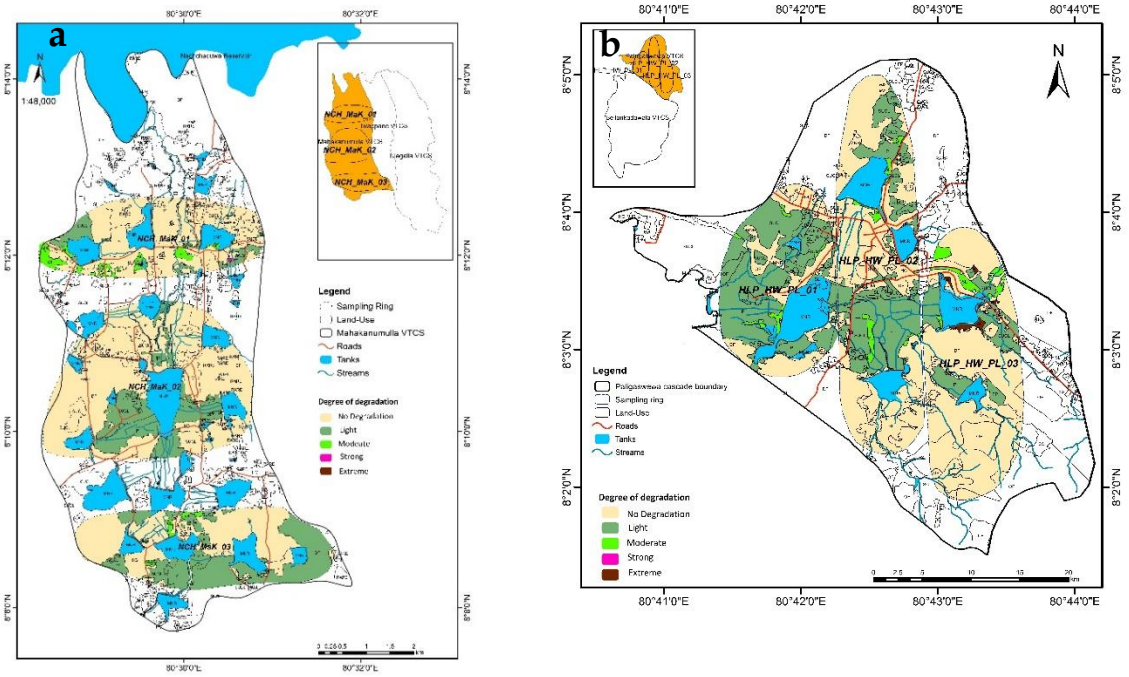

Figure 2.10. Degree of land degradation of *Nachchaduwa* (a) and *Horiwila* (b)

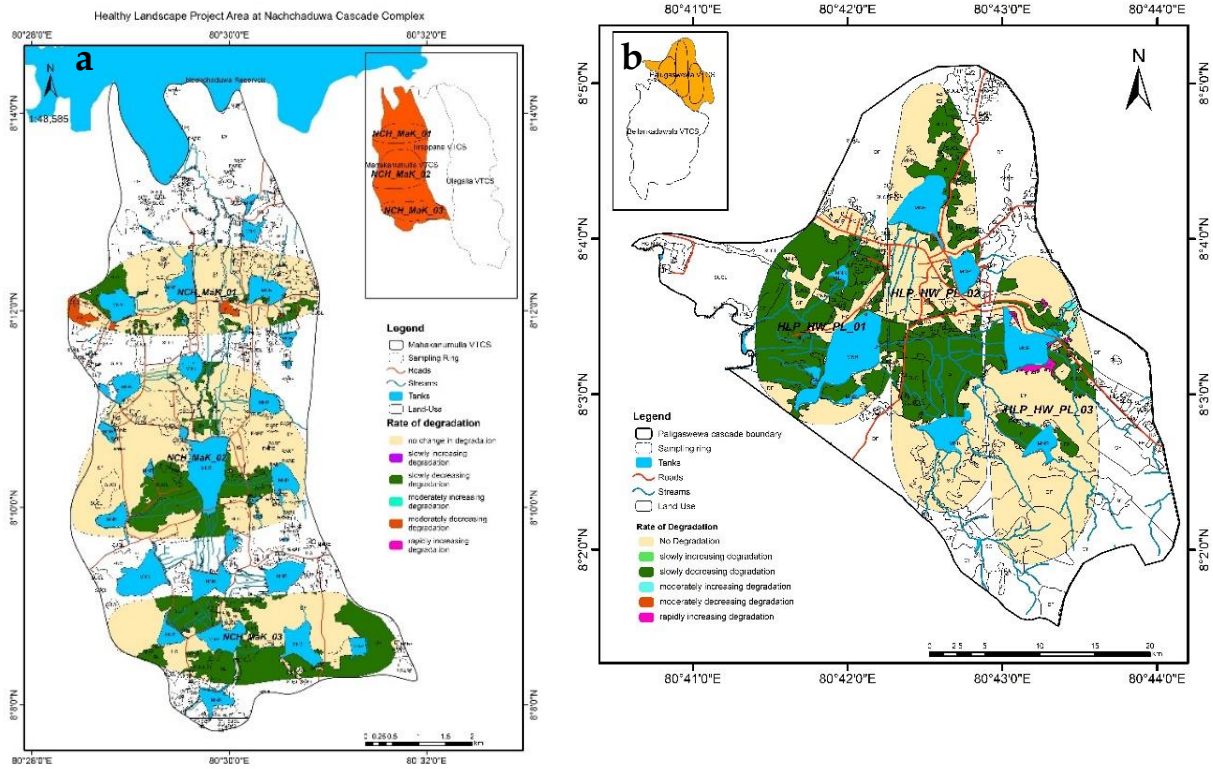

Figure 2.11. Rate of land degradation of *Nachchaduwa* (a) and *Horiwila* (b)

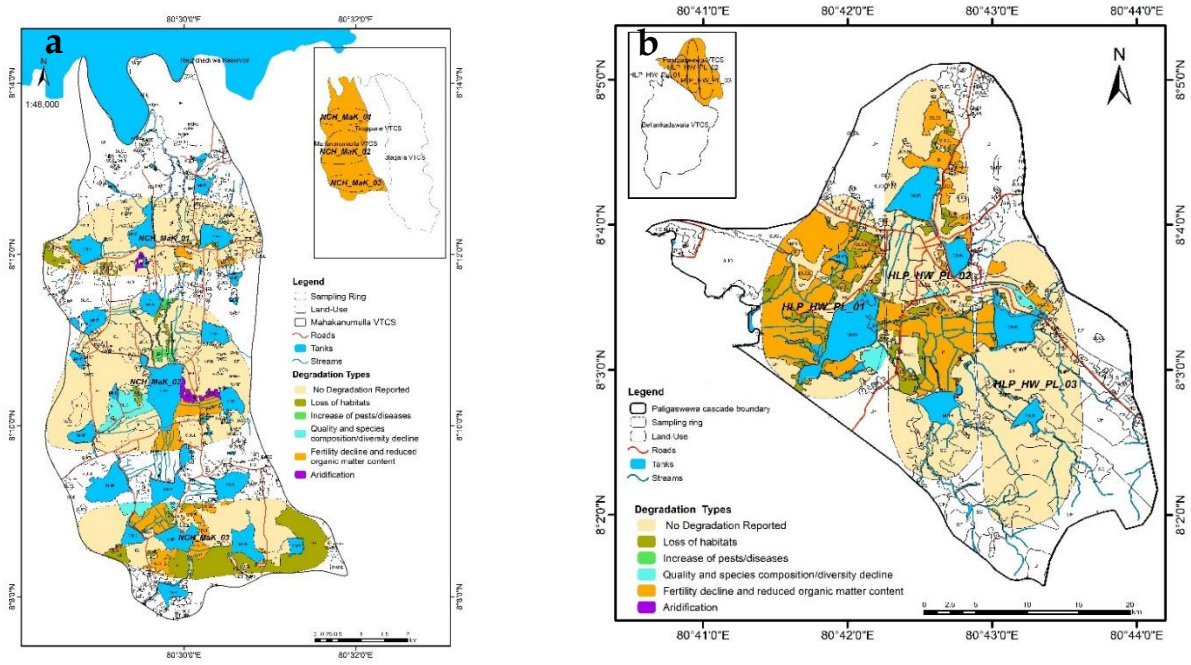

Figure 2.12. Land degradation types (second prominent) of *Nachchaduwa* (a) and *Horiwila* (b)

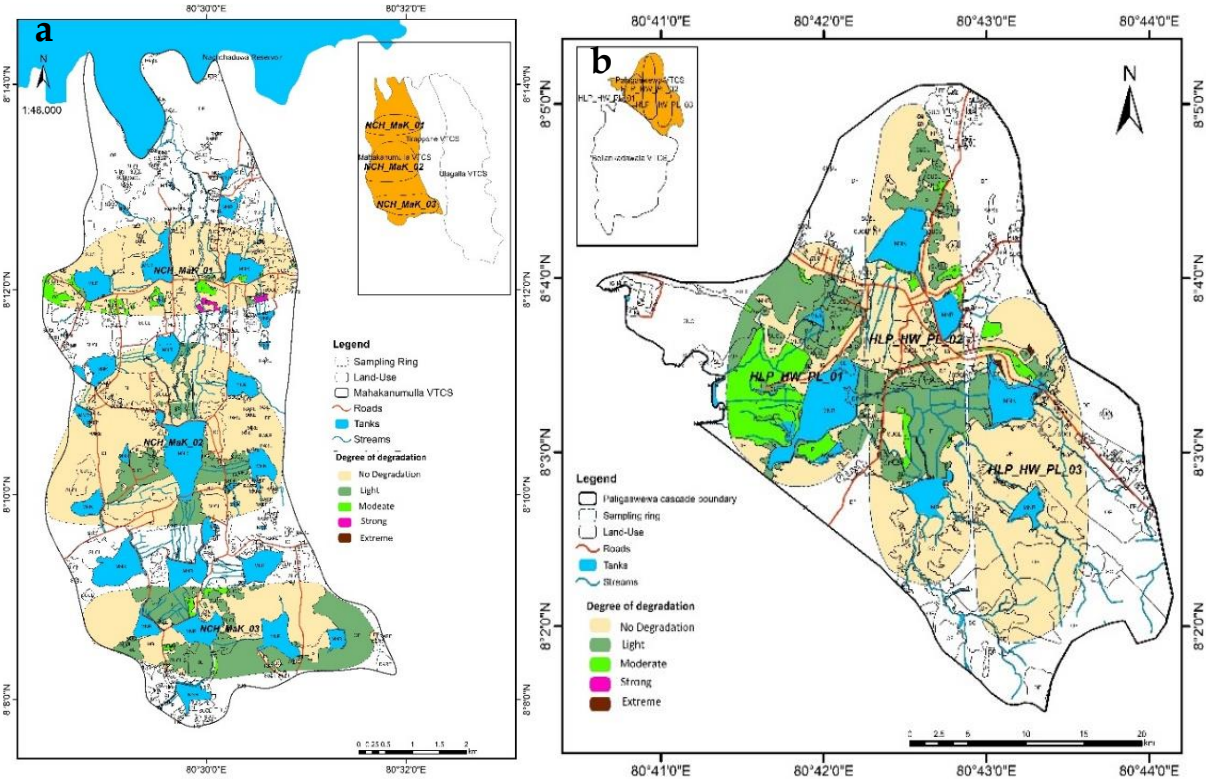

Figure 2.13. Degree of land degradation types (second prominent) of *Nachchaduwa* (a) and *Horiwila* (b)

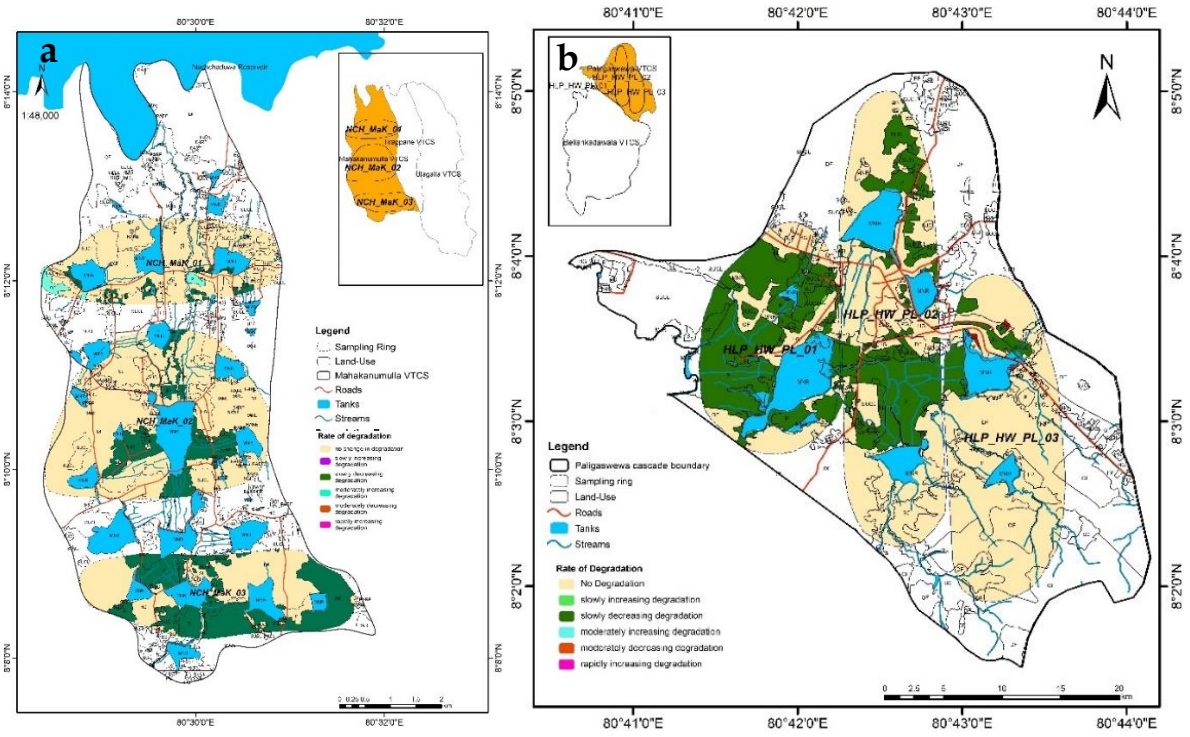

Figure 2.14. Rate of land degradation types (second prominent) of *Nachchaduwa* (a) and *Horiwila* (b)

It was revealed that the prominent degradation types prevailing in the area tested were surface erosion and topsoil loss, soil fertility decline, reduction of organic matter content, biodiversity decline, loss of habitat, diminishing vegetation cover and reduction of species diversity. Invading forest lands in critical spaces such as upper watershed feeding areas of small tanks by seasonal cultivation lands and settlements can be seen increasing in many locations. Solid waste disposal (polythene, glass bottles, etc.) in some wetlands and some areas of tank components have been reported during the field investigations.

The trend and the rate of degradation is varied with the land utilization patterns in some areas, the rate of degradation is fond in increasing trend mostly due to ignorance and lack of awareness among majority of the villagers on the importance of sustainable land management. Awareness creation, providing technological guidance, support for community-based collaborative approaches may change the present situation of the VTCS communities by self-motivation for sustainable land management

2.4 Conclusions

2.4.1 Sustainable Land Management

Although some Sustainable Land Management (SLM) technologies and approaches have been followed by some villagers, most of the areas are not managed properly and unattended for implementation of SLM practices. LADA-WOCAT approach for SLM accepts the fact that land use is the most important factor that governs the Land Degradation. Therefore, land use management systems play a key role in degradation assessments. During the baseline evaluation for SLM, we experienced the

suitability and adaptability of the present approach for VTCS. LADA-WOCAT approach which has been globally recognized and well tested, can be confidently applied for all the land categories in VTCS zones. In addition to use Land Use Systems (LUS) units, VTCS specific components have to be considered separately during each stages of LADA-WOCAT Approach. Both the LUS and VTCS components have been considered during the baseline status evaluation and all the components visited by the field investigating team with key important aspects of each village. Hotspots have been identified in entire cascade areas and detailed local level transact based field investigations were done for identified sampling rings and the works have to extended for the whole area to identify issues that have to be addressed immediately to rectify the issues with suitable interventions.

2.4.2 Training and capacity building

The LADA-WOCAT Approach combines different disciplines and skills to complete the whole process from current status detailing up to remedial intervention planning. Therefore, investigators need to develop some specific knowledge and skills for better operations. For this purpose, during the baseline assessment and evaluation, field investigating team was trained systematically and guided by training modules on GIS applications, field data collection, data incorporating into GIS and performing analysis to get integrated. The training guidelines and modules are found in LADA-WOCAT websites for this purpose and can be used for future investigation with expert's guidance.

Key deliverables

Deliverables	Description
Spatial assessment of land degradation using LADA-WOCAT-QM approach report in the selected 5 cascade systems (Task A)	Assessment methodology and results have been incorporated in the Chapter
Inventorying and mapping of ecosystem goods and services report (Task B)	Chapter 2 linked with Chapter 4. Therefore, pl see Chapter 4 for the Ecosystem Services
Land degradation and multiple ecosystem services model development report (Task C)	Land degradation model has been developed based on LADA-WOCAT-QM approached. Model results have been incorporated into the Land degradation evaluation maps Ecosystem services supply and demand modeled have been developed and results have been incorporated into the supply and demand maps in the Chapter 4
Sustainable Land Management (SLM) guidelines and practices report (Task D)	SLM guidelines and practices justified and incorporated in the Chapter and its annexes.
Socio-economic baseline report including socio-cultural and economic valuation of ecosystem services provided by VTCS landscapes (Task E)	During the planning meetings experts decided to be conducted one household socio-economic survey to gather demographic data instead of conducting by each thematic group. However socio-economic data required for specific technical assessments relevant to LADA-WOCAT, Biodiversity indices, Ecosystem Services Metrics have been gathered and incorporated into the results of relevant chapters Household demographic survey results have been incorporated in the Chapter 5
Planned scientific papers drafted based on the above	All contents of the Chapter 4 have been designed, formatted and developed following the scientific writing guideline. Mr. Sujith Ratnayake, chief technical coordinator, and currently PhD student at UNE has been given responsibility for the development of scientific (draft) paper in collaboration with Dr. H. K. Kadupitiya and other matter specialists of the baseline assessment. He will coordinate with Dr. Kadupitiya and Authorities for the final outcome.

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CHAPTER THREE

BIODIVERSITY

3.1. Terrestrial Biodiversity

3.1.1. Introduction

Purpose of this exercise is to document baseline information necessary for project planning and monitoring through collection of data on terrestrial biological aspect of the selected VTCS areas of the Project, particularly focusing fauna & flora, agrobiodiversity and community perceived ecosystem values. The cascade ecosystem is rich in biodiversity resources, harbouring many economically, ecologically and socially high value species and habitats. The local community depends upon these resources for the tangible and intangible needs of their social life cycle. Continual over-exploitation of cascade ecosystem components, with its high utility species, has resulted in the accelerated decline in the abundance of a wide range of species and habitats. Better understanding on the fauna, flora, agrobiodiversity and community perceived ecosystem values are fundamental to the management decision making process in uplifting a cascade landscape which consists of a mosaic of agroecosystems and natural ecosystems.

Study Locations: The project sites are *Nachchaduwa* and *Horiwila* cascade system complexes in the Anuradhapura District within the Dry Zone of Sri Lanka.

Study Objectives:

The present investigation of cascade ecosystem aspects and species diversity has the following objectives.

a. To document ecological features of the cascade ecosystem with species therein, as a part of understanding species sensitivities, ecological services, and habitat degradation and remediation actions.

b. To document ecosystem values as perceived by the local community that shed light on the human dimension of cascade ecosystems, opening avenues for more socially relevant ecosystem restoration actions.

c. To make recommendations to enhance the ecological sustainability of the cascade, while advancing the well-being of local communities.

3.1.2. Methodology

The baseline situation was assessed using rapid techniques in line with available resources, project time frame and ground circumstances. The basic methodological components are as follows.

Reconnaissance

The documentation of biodiversity commenced with a reconnaissance visit to understand the present situation of the cascade.

The reconnaissance helped for:

a. Familiarization of the territory and biodiversity using pertinent references viz; road maps, aerial photographs, geological and geographical maps, previous knowledge of the biodiversity, climate data etc.;

b. Ground survey of the territory; for this much of the area that was approachable was traversed to:

i. Familiarize with the territory and accessibility;
ii. Get the knowledge of biodiversity in general and its status; and

c. Engage local community and develop social contacts necessary for the survey.

The detail survey was planned according to the ground situation examined.

Flora sampling

The species diversity of higher plants in diverse vegetation types, found in traditional cascade system were studied using standard scientific techniques, with appropriate modifications to suit field conditions. A total number of 36 sampling sites spread over two cascades were sampled. GPS locations were noted using GPS enabled site photographs (Plate 3.1.1).

Plate 3.1.1. GPS enabled photograph showing the tank ecosystem

The floral survey was focused on documenting flowering plant species in terrestrial habitats within the cascade. Several distinct major vegetation categories observed in two cascades included; Tank catchment forest (*Gasgommana*), Interception (*Kattakaduwa*), Scrublands, Home gardens, Chena & Forest plantations (Teak or Acacia). Vegetation was sampled using 400 m^2 sampling areas as per Luttmerding et al. (1990) with minor variation of methodology to accommodate local circumstances. Abundance of plants was noted as visually assessed percentage foliage cover of trees, shrubs & herbs using cover categories from Terry & Chillinger (1955) cited in Luttmerding et al (1990). Abundance parameters were used in calculating Shanon diversity index.

The Simpson Diversity Index is defined as the sum of squares of proportion abundance of each species. As D increases, diversity decreases. Therefore, the Simpson Diversity Index is usually expressed as 1 -D or 1/D. Where 1 - D is used as the index, it ranges from 0 to 1, with values close to 1 showing a community of many species with equally low abundances while numbers close to 0 express fewer species with one of them clearly dominant.

Working definitions of plant groups observed within 400 m^2 plots were;

Tree flora: Woody plants above 3m height.
Shrub flora: Woody plants of 1.5m-3m height.
Small plants: Small plants including young stages of trees and shrubs below 1.5m height.

Altogether, 36 plot samples were observed for recording flora and their foliage cover abundance. Annex 3.1.1 gives the details of sampling sites in two cascades and different ecosystem types. Key ecosystem types identified and sampled include; Acacia forest, Chena, Home garden, *Kattakaduwa*, Natural forest, Scrubland, Teak forest, Medicinal forest. Among them medicinal forest is a special type of forest maintained by a private party within *Palugaswewa* cascade.

Visual estimation of foliage % cover categories as per Luttmerding et al. (1990) comparison charts included 1%, 2%, 3%, 5%, 7%, 10%, 15%, 20%, 25%, 30%, 40% and 50%. In case, when foliage cover of a particular species exceeded 50% value, it was recorded as 10% incremental additions up to 90% maximum to accommodate site specific circumstances considering local situation. Those cover abundance vales and respective species numbers were used in calculating Simpson diversity index through a web-based application. Floral species were identified and classified using the latest standard published guides and keys available in Sri Lanka. A list of key references used in the floral survey is presented in Table 3.1.1.

Fauna sampling

As with the floral survey, the same 400 m^2 area was used to sample the fauna of the cascade system. Key groups of animals' terrestrial habitats; Land snails, Butterflies, Dragonflies, Amphibians, Reptiles, Birds and Mammals encountered at the site were identified, and documented. All attempts were made to document the animals in a non-destructive manner. Details of the specific techniques used to sample different faunal taxa are presented in the table below (Table 3.1.2). Faunal species were identified and classified using the latest standard published guides and keys available in Sri Lanka. A list of key references used in the faunal survey is presented in the table 3.1.3 below.

Table 3.1.1. Key references used in the floral survey

Subject	Source
Taxonomic identification	Ashton et al. (1997); Dassanayake and Fosberg (1980 - 1991); Dassanayake et al. (1994 - 1995); Dassanayake and Clayton (1996 - 1999); de Vlas & Jong (2008)
Nomenclature	Senaratne (2001)
Conservation status	MOE (2012)

Table 3.1.2. Fauna sampling techniques

Taxon	Method	Technique
Land snails	Direct and indirect	Visual encounter survey and observation of shells
Dragonflies and butterflies	Direct	Visual encounter survey.
Amphibians	Direct	Visual encounter survey and nocturnal survey.
Reptiles	Direct and indirect	Visual encounter survey within transects. Communication with local community.
Birds	Direct and indirect	Visual and auditory observations and indirect signs of presence including tracks, feathers, nests and vocalizations.
Mammals	Direct and indirect	Visual observations and indirect signs of presence including tracks, scats, faecal matter, feeding signs and vocalizations. Communication with local community.

Table 3.1.3. Key references used in the faunal survey

Taxon	Source
Land snails	Naggs and Raheem (2000)

Dragonflies	Bedjanic et al. (2007)
Butterflies	D' Abrera (1998)
Amphibians	Manamendra-arachchi & Pethiyagoda (2006)
Reptiles	Somaweera (2006); Somaweera & Somaweera (2009)
Birds	Harrison (1999); Warakagoda et al. (2012)
Mammals	Phillips (1935); Kotagama & Goonatilake (2013)

Nomenclature and conservation status are based on MOE (2012)

Plate 3.1.2. Documenting agrobiodiversity

Study of species:

During this rapid assessment event, Visual Encounter Survey (VES) method was used to document fauna and flora in different habitat types. There are three standard sampling designs for visual encounter surveys: opportunistic or

randomized walk, transects, or a quadrat design (Crump and Scott, 1994), and the present survey was carried out through opportunistic or randomized walks in 400 m^2 plots. Visual encounter surveys can determine species richness; be applied in long term monitoring projects; provide information for compilation of a species list; and provide data used to estimate the proportion of area surveyed that is occupied by target species. Photographic records were made to identify less familiar plants and animals, and standard taxonomic keys and other scientific literature mentioned in the list of references were used in the process of species identification. Sensitive species (endemic & threatened) were especially noted as high risk biodiversity.

Species attributes:

Plants and animals were categorized to understand sensitivity using IUCN Sri Lanka and Ministry of Environment and Natural Resources (2012), The 2012 Red List of Threatened Fauna and Flora of Sri Lanka, Ministry of Environment and Natural Resources, Colombo, Sri Lanka. Based on this National conservation status (NCS) and global conservation status (GCS) species were evaluated. Accordingly, level of threat in descending order includes CR (PE), CR, EN & VU.

Documentation of agrobiodiversity

The agrobiodiversity study was conducted within the cascade villages to understand the dynamic relationships among people, biota and environments. Field observations as well as community interviews and focus group discussions were used in documenting edible agrobiodiversity reference to following parameters.

- Agrobiodiversity species or locally adapted cultural variety breed or heritage crops/breeds.
- Sources of agrobiodiversity.
- Habitat used in cascade to sustain specific agrobiodiversity component.
- Part used as food.

(Please see details in Annex 3.1.8 on Participatory agrobiodiversity (edible) assessment chart for VTCS Landscapes).

Plate 3.1.3. Knowledge sharing with a key informant**.**

Documentation of community perceived ecosystem values

Assessment of community perceived ecosystem services was carried out using the Community Score Card (CSC) tool (CARE, 2013), which originally was developed as a monitoring tool that enables citizens to voice their assessment of a priority public service. In the present case, the CSC was adopted to assess ecosystem services, which turned out to be a powerful tool enabling community to voice their assessment of cascade ecosystems too. The generic approach was;

- Convene community members.

- Ask each to identify performance/quality indicators for the ecosystem services (please see Annex 3.1.9 for indicators and field chart).
- Ask the group to score each indicator and give reasons for the scores. This approach was relatively easy to use and flexible in application. Also, it strengthens citizen voice and promotes dialogue and consensus building as well as information gathering.

3.1.3. Results and Discussion

Ecosystem diversity of terrestrial biodiversity

The entire cascade area and its associated habitats are reflective of the harshness of the physical environment in the Dry Zone of Sri Lanka, and the entire landscape has experienced anthropogenic impacts that have been taking place since the historical Dry Zone civilization. The tank cascade is a conglomeration of different types of vegetation cover brought about by the influence of water regimes, soils, human actions and other biotic interactions. These include semi-natural and managed habitat types. The key components of cascade terrestrial ecosystem include; Acacia forest plantations, Teak forest plantations, *Chena* lands, *Gasgommana* forests, Home gardens, *Kattakaduwa* forest and Scrubland. In addition, recently established private sector Medicinal woodland is also a unique plantation area. Characteristic features of the main terrestrial habitat types are as follows.

Acacia forest plantations

Acacia auriculiformis dominated planted forest stands up to 30m height and this type is not widespread. This vegetation represents lands that were historically

cleared or degraded, and later exotic

Plate 3.1.4. Plantation forest of *Acacia auriculiformis*.

tree cover was established by Forest Department. Structurally well-developed these kinds of forests play a significant role in soil and water conservation in the area, though currently they are still under human pressure. However, established native flora is poor in this ecosystem and local community is not in favor of these type of plantation forests. The forest structure is usually developed into a three strata system; canopy (25m-30m) and shrubs (2m-3m) and herbs (below 1m). However, the species composition is not yet closer to natural forests. Common species include; Canopy - *Acaia auriculiformis* as main species; Shrubs-

Ficus hispida, *Lantana camara* and *Zizyphus oenoplia*; Herbs - *Panicum maximum*.

Teak forest plantations

Plate3.1.5. Teak plantation in *Tirappane*

This is also a monoculture area of Teak (*Tectona grandis*) planted by Forest Department. Previous degraded state lands have been converted into Teak areas. Dense growth of teak trees (15m-25m) forms the main canopy layer with almost 90% canopy cover. Undergrowth is extremely poor and native species recruitment is almost absent. Often, about 80% ground area is exposed soil and the balance is covered with invasive species like *Lantana camara*.

Medicinal woodland area

Plate 3.1.6. Medicinal woodland at *Palugaswewa*

There is a cultivated medicinal woodland in *Horiwila* cascade. Various types of medicinal woody plants; trees, shrubs and few herbs are found in this woodland. There is a continuous canopy at 10m-15m level and shrubs (2m-3m) and herbs below 1m are randomly distributed. Names of trees are displayed for identification and education value. The site is a leased-out state land for a local NGO and managed as a law income commercial activity while serving the local indigenous medical practitioners.

***Gasgommana* forests**

Immediately upper forest areas of high ground surrounding the village tank is locally called *Gasgommana* forest, which are more or less similar to typical dry zone climax forests. They comprise of four recognizable vegetation strata; 20m-30m high continuous tree canopy, sub canopy up to 15 m, shrubs up to 5m and herbaceous plants below 1m.

Plate 3.1.7. *Gasgommana* forest on far side of village tank.

The common woody elements include; *Albizia odoratissima* (Kabal mara), *Bauhinia racemosa* (Maila), *Bridelia retusa* (Ketakela), *Cassia roxburghii* (Wa), *Chloroxylon swietenia* (Burutha), *Drypetes sepiaria* (Weera), *Manilkara hexandra* (Palu), *Memecylon umbellatum* (Kayan), *Nothopegia beddomei* (Bala), *Pterospermum suberifolium* (Welan) and *Schleichera oleosa* (Kon). Trees are densely assembled in well-developed sites, where poor growth of shrubby and herbaceous forms is found in the ground layers. Exposed ground is common and forest regeneration can be observed in many

places. However, it is regrettable that forest patches in the vicinity of settlements, cultivation or access roads, are severely under forest exploitation pressure. Valuable timber trees such as *Chloroxylon swietenia* (Burutha), *Manilkara hexandra* (Palu) and *Diospyros ebenum* (Kaluwara) are selectively removed illegally, affecting the forest structure and watershed properties.

Kattakaduwa forest

This is a small, forested strip at dam toe. Several tanks have well developed *Kattakaduwa* forest vegetation, while that of others is highly degraded or not present at all. *Kattakaduwa* is always a linear habitat running parallel to the tank bund. The ponding effect of the *Yathuruwala* and year-round high moisture level due to seepage has given rise to a forest that is closely related to riverine forests.

Plate 3.1.8. A well-developed Kattakaduwa forest

This vegetation type can be as narrow as 5m in some locations and as wide as 20m in others. The forest height is about 20m-30m with almost a closed canopy. Sub-canopy (10m) and shrub/herb (0.5m-3m) layers can also be distinguished. General luxuriance due to high moisture conditions compared to other nearby forests makes it visibly healthy and akin to a rain forest patch. Lianas are also an important constituent of this forest framework and constitute considerable floristic richness. Common tree species in this patch of small forest include; *Borassus flabellifer* (Thal), *Diospyros malabarica* (Thimbiri), *Ficus benghalensis* (Nuga), *Ficus racemosa* (Aththikka), *Hibiscus tiliaceus* (Belipatta), *Madhuca longifolia* (Mee), *Margaritaria indicus* (Karau), *Nauclea orientalis* (Bakmee), *Pongamia pinnata* (Karanda) and *Terminalia arjuna* (Kumbuk). The evergreen character of these species can be attributed to the unlimited availability of groundwater throughout the year. The *Kattakaduwa* forest is a natural bio filter that traps pollutants in the water, before it irrigates the low lying paddy tracts. The thick root system of trees and shrubs act as a protective cushion for the sloping land. Well-developed *Kattakaduwa* forests provide convenient resting sites for birds, bats, reptiles, amphibians etc.

Chena

Chena (Slash and burn cultivation) is a highly manipulated system dominated by agricultural crops. A good number of weedy plants also occur here.

Plate 3.1.9. *Chena* cultivated area

Chena is dominated by shrubby and herbaceous crop species like *Abelmoschus esculentus* (Bandakka), *Solanum melongena* (Batu), *Vigna cylindrica* (Me) and *Zea mays* (Badairingu) growing up to 1.5m. Some scattered trees are found in almost every *chena* land; *Bauhinia racemosa* (Maila), *Borassus flabellifer* (Thal), *Bridelia retusa* (Ketakela), *Cassia fistula* (Ehela), *Chloroxylon swietenia* (Burutha), *Chukrasia tabularis* (Hik),

Drypetes sepiaria (Weera), *Limonia acidissima* (Divul), *Manilkara hexandra* (Palu), *Pterospermum suberifolium* (Welan), *Schleichera oleosa* (Kon) and *Vitex altissima* (Milla). Plant biomass of the system is highly variable due to the traditional agricultural practices spread over the year. Months of the wet season (November-January) are marked by the abundance of vegetation cover. Once the harvesting season is over, the land is left to fallow. Abandoned *chena* lands are more common than cultivated *chena*. Abandoned *chena* lands are structurally more closely related to scrublands but differ on account of relatively sparse vegetation and the presence of some perennial crop species abandoned after *chena* cultivation. Abandoned *chena* differs from cultivated *chena* lands by the abundance of weedy species and the presence of a few unmanaged crop species, which are in decline under the threat of weeds. The plant assemblage is about 1m in height and consists mostly of fast-growing weedy species that have structural and functional adaptations to adverse conditions. Similarly, to scrublands, the plants produce seeds that can successfully remain dormant until the rainy season commences. The vegetation has the ability to withstand heavy structural damage from herbivores, drought or wind, and can recover in the wet season opportunistically. Depending on the site-specific circumstances such as the length of fallow period, disturbance by fire or herbivores, the structure may not be uniform.

Home gardens

Home garden vegetation is found immediately around homesteads and is the result of long-term manipulations. This is really a semi-natural system by account of the deliberate manipulation by man, and at the same time the natural incorporation of wild species and their co-habitation. The effective area of the Home Garden unit is approximately 0.25 acres but larger units are not uncommon. Home gardens are for both commercial produces (timber and fruits) and subsistence produces (wood and vegetables).

Plate 3.1.10. A well-managed home garden.

The existing home gardens in the cascade are poorly managed and do not receive the full potential benefits economically as well as ecologically. General structure shows that multi-purpose trees, shrubs, herbs and climbers are deliberately intermixed. The appearance varies depending on the farming practices employed. Well-developed home gardens have a structure that mimic a near natural forest. Generally, there are several poorly developed plant layers: a canopy (20 m), a sub canopy (15 m) and a shrub/herb layer (2 m). Many crop species are found in this habitat; *Annona reticulata* (Anoda), *Areca catechu* (Puwak), *Artocarpus heterophyllus* (Kos), *Carica papaya* (Pepol), *Citrus medica* (Dehi), *Cocos nucifera* (Pol), *Mangifera indica* (Amba), *Moringa pterygosperma* (Murunga), *Musa x paradisica* (Kesel), *Punica granatum* (Delum), *Sesbania grandiflora* (kathurumurunga) and *Tectona grandis* (Thekka). The home garden is also an important faunal

habitat providing animals with feeding and nesting sites. It provides people with fruits, spices, nuts, yams, flowers, vegetables, medicines, firewood, timber etc. throughout the year. Visibly, the home gardens gradually mix with forests or scrublands at the periphery. In these cases, it takes the form of an unmanaged orchard - sometimes barely recognizable as a component of the home gardens.

Scrublands

Scrublands are thick, impenetrable thorny or spiny and woody vegetation growing up to 2m-3m in height. Two major strata can be recognized; the shrub canopy and the herbaceous (up to 0.5m) plants growing underneath. Scattered trees could be located.

Plate 3.1.11. Scrubland area

The ground layer abounds with herbaceous life forms since it receives intense sunlight. Since the commencement of prevailing dry climatic conditions, the plants show xerophytic adaptations e.g. leaves are thick with well-developed surface structures to protect them from strong sunlight and minimize evaporation, plants produce seeds that can successfully remain dormant until the rainy season commences, vegetation can withstand heavy structural damage from herbivores, drought or wind, and can recover in the wet season opportunistically. Most of the scrubland areas were chena areas or other cultivated lands in the distant past. The common shrub species in scrublands include; *Carissa spinarum* (Karamba), *Dichrostachys cinerea* (Katuandara), *Flueggea leucopyrus* (Katupila), *Phyllanthus polyphyllus* (Kuratiya), *Trema orientalis* (Geduma), *Benkara malabarica Glycosmis mauritiana* (Dodampana), *Hugonia mystax* (Bokere), *Lantana camara* (Hinguru), *Maba buxifolia* (Jabara), *Memecylon umbellatum* (Kayan), *Scutia myrtina*, *Streblus asper* (Nithul), *Tarenna asiatica* (Tharana), *Toddalia asiatica* (Kudumiris) and *Ziziphus oenoplia* (Eraminiya).

Flora

The survey enabled documenting 376 plant species in two cascades. Among them 8 species are endemic; *Vernonia zeylanica* (Pupula), *Argyreia populifolia* (Girithilla), *Diospyros ferrea* (Jabara), *Erythroxylum zeylanicum, Premna procumbens* (Le-Kola-Pala), *Cinnamomum verum* (Kurundu), *Artocarpus nobilis* (Bedi-Del) and *Lepisanthes tetraphylla.* The threatened flora included 22 species, both in endangered category and vulnerable category. Details have been given in Annex 3.1.2. Sampling details indicate that natural forest and *Kattakaduwa* are acting as superior store houses for many threatened plants (sensitive plants) and therefore of high conservation concern (see Annex 3.1.3). As far as considered the occurrence of those 376 total species recorded, 276 species are in *Nachchaduwa* cascade while 291 species are in *Palugaswewa* cascade. Many species are common to both the cascades; 189 species (see Annex 3.1.4. for details). Analysis of occurrence of plant species in different ecosystem types in both cascades shows that home garden records the largest number of

plant species 170, followed by *Kattakaduwa* 141, scrub lands 116, natural forest 106, teak forest 55, medicinal forest 39 and Acacia forest 23. *Azadirachta indica* (Kohomba) and *Chromolaena odorata* (Podisinnomaran) are the most frequent species occurring in all ecosystem types (details are given in Annex 3.1.3). Dominance of species based on foliage cover abundance (km^2) in different ecosystem types in cascades shows that following species are dominant in respective ecosystems.

Dominant tree species in tree dominant systems based on foliage cover

Acacia forest - *Acacia auriculiformis*
Home garden - *Cocos nucifera* (Coconut)
Kattakaduwa - *Terminalia arjuna* (*Kumbk*)
Medicinal forest - *Acronychia pedunculata* (*Ankenda*)
Natural forest - *Drypetes sepiaria* (*Weer*a)

Dominant shrub species in shrub dominant systems based on foliage cover

Scrubland-*Phyllanthes polypylus* (Kuratiya)
Chena - *Zea maiz* (Maiz). Details on variations of different levels of canopy cover / foliage cover (cover dominance levels) of species representing each habitat are given in Annex 3.1.3.

Diversity indices
Average values of Simpson diversity indices, in descending order, calculated for different habitats are as follows.

Home garden: 0.92745
Natural Forest: 0.9144
Chena: 0.87397
Kattakaduwa: 0.8678
Scrubland: 0.8632
Medicinal Forest: 0.7921
Acacia Forest: 0.6073
Teak Forest: 0.5687

As indicated by diversity indices home gardens and natural forests have high floral diversity while Acacia and Teak plantations are floristically poor. *Kattakaduwa* takes a moderate level of flora diversity and this is likely due to human disturbance in those ecosystems, and few *Kattakaduwa* systems are found as well-developed systems.

Agrobiodiversity of crops

Both the cascades are rich with crop diversity amounting to 150 species of actively managed food crops (see Annex 3.1.8 for details). The farmers source their propagules through commercial purchasing, community exchange and on-site live gene bank maintained by them. Most of edible crop diversity managed by the community is concentrated in *Chena* lands or in their home gardens. Much of the crop diversity consists of ancestral crop cultivars maintained by the community and include 110 crop types or cultural varieties out of 150 crop plants recorded, despite such ancestral crop cultivars have less occupied land area compared to commercial crops. Developed crop varieties which are results of modern technology are used for income generation through commercial planting.

Plate 3.1.12. *Polonme*, an ancient variety of long bean maintained by local farmers in family gene banks

Plate 3.1.13. *Landesi - Amaranthus cruentus.* ***Note:*** *This is an ancestral crop plant now totally disappeared from cascade areas. According to the verbal description of plant features by village elders of Nachchaduwa cascade, Landesi is most likely Amaranthus cruentus cultivated in Chena lands. Old people still have high regard for its food value despite its unfortunate disappearance from traditional Chena lands. The crop was widely used as a subsistence food crop in 1970's and before. Various food preparations have done using the starch of the grains. This seed-producing pseudocereals are characterized by their excellent nutritional profile as reported elsewhere and now in other countries it is ranked as a super food on account of that they are good sources of carbohydrates, good quality proteins, lipids, vitamins, minerals, and bioactive compounds. There is an increasing interest in their utilization for the formulation of healthy food products with improved nutritional value. In future, such plants can be reintroduced to cascade landscape considering nutrition value, low water consumption, climate change adaptation and premium food market.*

Fauna

The faunal assessment documented 202 animal species belonging to amphibians, birds, butterflies, dragonflies, land snails, mammals and reptiles animal groups. The quantitative summery is amphibians - 7, birds - 70, butterflies - 59, dragonflies - 19, land snails - 6, mammals - 22 and reptiles - 19. *Nachchaduwa* cascade recorded 191 species while *Horiwila* cascade recorded 178 species (Annex 3.1.5).

Faunal species (aggregated) in different ecosystem types in *Nachchaduwa* cascade in detailed in Annex 3.1.6 while the same of *Horiwila* cascade is given in Annex 3.1.7

Lowest number of animal species was recorded in plantation forests; Nachchaduwa cascade Acacia forest (33), Teak forest (36); Horivila cacade Medicinal forest (38) & Teak forest (33).

In both the site *Kattakaduwa* area recorded the largest number of animal species; *Nachchaduwa* cascade *Kattakaduwa* (129) and *Horiwila* cascade (115). This is likely due to diversity of microenvironments within *Kattakaduwa* system. Summary of occurrence of quantity of animal species are as follows (Table 3.1.4).

Table 3.1.4 Number faunal species found in each land use type.

Nachachaduwa	***Horiwila***
Acacia forest (33)	Chena (52)
chena (62)	Home garden (61)
home garden (78)	*Kattakaduwa* (115)
Kattakaduwa (129)	Medicinal woodland (38
Natural forest (43)	Natural forest (58)
scrubland (105)	Scrubland (87)
teak forest (36).	Teak forest (33)

Agrobiodiversity of animal genetic resources

Community managed animal genetic resources in two cascades include chicken, cattle and buffaloes. In addition, bee (*Apis cerana*) keeping is also done by few people. Livestock farming is taking place as a very low-level activity. Poultry (*Gallus gallus domesticus*) farming include both village chickens and improved chicken breeds. Cattle farming is always free grazing type and almost all cattle population is locally adapted breeds; indigenous cattle, Zebu cattle types and their crosses common in dry zone of Sri Lanka. The native cattle (*Bos indicus var.ceylonicus*) called "Lankan Cattle" or "Batu Haraka" are well adapted to hot, dry and saline environment. Apparently, all cattle are now of mixed nature due to introduction of high yielding cattle breeds some decades back, and people call them '*Bangaliharak*'.

A small population of buffaloes is found in some locations where wetland grazing lands with wallowing sites are used by those animals. The Murrah buffalo breed of water buffalo *(Bubalus bubalis)* is kept for milk production. The colour of this breed is usually jet black with white markings on tail and forehead. The tightly curved horn is an important character of this breed.

Plate 3.1.14. Locally common cattle type

Plate 3.1.15. Bee keeping in a hollow tree trunk.

Community perception of ecosystem services values

Analysis of scores (average values) shows that ecosystem services of different ecosystem components of the cascade as valued by the community, falls in descending order of Natural Forest (2.724) > Homegarden (2.664) > *Kattakaduwa* (2.3) > Scrubland (1.168) > Chena (0.844) > Acacia Forest (0.188) > Teak Forest (0.168). Higher values of natural forest and home garden are indicative of perceived superior beneficial influence of those ecosystems (Medicinal woodland in *Horivila* cascade did not consider in this study since it is privately managed and less interactive ecosystem with local community).

Monoculture plantations like Acacia and Teak forests are not in good terms with the local community as far as considered the community sensitive ecosystem services. They are considered as least valued ecosystems with regard to various problems created by such alien ecosystems. Killing of bees, promotion of human-elephant conflict, spread of fire, impact on water table and absence of non-timber forest products for community use are main attributes to downgrade such ecosystems. Scrub

lands are considered as medium value ecosystems in account of moderate level availability of wild products and soil conservation values.

Although *Chena* is a highly interactive system with the local community, its ecological benefits are inferior in comparison to economic values. The findings highlight the importance of Natural Forest, Home garden and *Kattakaduwa* as high-quality ecosystem service points and need for enhancing those systems. At the same time, the need is there to improve the ecosystem service potential of Scrubland, *Chena,* Acacia Forest and Teak forests.

Conclusions

Ecosystem diversity in cascades range from near natural systems to man-made agricultural systems. They include Natural Forests, *Kattakaduwa* forest, Home gardens, Scrublands, *Chena*, Acacia Forest plantations and Teak Forest plantations as key landscape elements. Each ecosystem has characteristic structure, species composition, functions and values. Diversity indices of flora indicate that species diversity is in decreasing order of home gardens, natural forests, *Chena, Kattakaduwa,* scrub lands, medicinal forest plantation, Acacia forest plantation and Teak forest plantations. By co-incidence, more or less, the same order is followed by ecosystem service values perceived by the community. Planted forests are not only species poor but also less valued ecosystem units. As a general rule, home gardens and natural forests of the cascades are superior systems sustaining more biodiversity and yielding better ecosystem services. *Kattakaduawa* takes the lead in sustaining high animal diversity in both cascades since it harbors both terrestrial and wetland animals. As far as considered the agrobiodiversity of cultivated food plants, home gardens and *Chena* lands are prime areas and support cash income and human nutrition based on varietal and crop species diversity. Livestock animals (breeds and species diversity) are less important component in present day cascades.

Recommendations

1. Ecosystem and biodiversity-based approach for enhancing the well-being of people and environment of the cascades is a potential solution for many present day problems in these agricultural landscapes. Livelihoods of cascades rely on ecosystem services including pollination, biological pest control, maintenance of soil fertility and hydro logical services. The value of these ecosystem services to agriculture is enormous and often underappreciated. Depending on management practices, cascade agriculture can be the source of numerous pressures, including loss of wildlife habitat, sedimentation of tanks, greenhouse gas emissions, and pesticide poisoning of humans and non-target species. The tradeoffs that may occur between ecosystem services and problematic practices should be evaluated in terms of spatial scale, temporal scale and reversibility. Application of modern environmental economic tools for valuing ecosystems services can shed light on potential 'win–win' scenarios, especially in relation to appropriate agricultural management practices focused on climate responses.

2. Tree dominated and biologically diverse superior ecosystems like natural forests, *Kattakaduwa* and home gardens are capable of better delivering

combined ecological and social functions contributing to added ecosystem goods and services and values for local community at large. Therefore, actions for betterment those systems striking a right balance, are essential for gaining multiple benefits like conserving national biodiversity assets including managed and unmanaged agrobiodiversity, climate proofing the landscapes, water security, erosion control and livelihood dependability. Attempts for better implementing of cascade related legal provisions under the Department of Agrarian Services can mitigate many such issues.

3. The existing single species plantations (Acacia or Teak forests) have negative impacts on biodiversity, communities, and local economies which includes, loss of community used biodiversity, depletion of bees, dwindling water sources, fire and soil erosion. Gradual enrichment of those plantations with native plants can lead to complex forests which are biodiversity-rich, self-regenerating ecosystems, support soil & water system, enhance microclimate, and sustain wide variety of plants and animals in mutual coexistence. Multi species forest is made up of many layers and each layer has a different set of flora and fauna. Such forests sequester more carbon.

4. Strategies for agrobiodiversity conservation and promotion need to be put in place for promising species. In this regard, habitat protection of wild populations, maintenance of native crop species and varieties in traditional agroecosystems, establishment of living collections and germplasm banks, and introduction of species and varieties into agroecosystems for agricultural practice and sustainable uses are actions in right direction. For example, ancestral crop cultivars of *Cucurbita maxima, Musa x paradisaca, Amaranthus cruentus, Sorghum bicolor* and *Oryza sativa* are some potential crops for premium product development. Establishment of an ethnobotanical garden in a cascade can showcase most of the agrobiodiversity for wider awareness.

5. Present day practice of *Chena* cultivation plays a significant role in sustaining rural livelihoods in water deficit landscapes while its ill effects are harassing the wellbeing of cascade biodiversity and people. Now Chena is more or less sedentary form of agriculture unlike former times when land pressure is not severe. Excessive use of agrochemicals, ever expanding seasonal cropping areas and loss of multi species tree cover are starting points of many ills of current *Chena* system. Introduction of techniques that provide increased crop harvest from small land area, e.g., low-cost controlled environment agriculture, can be a part of the solution to stop encroachment of natural areas set aside for ecosystem services. Such approaches are potential solutions for ongoing human-wildlife conflict too and some enterprising farmers are already gaining benefits of similar techniques. As an initial step, low input *Chena* cultivation can be attempted. Tree cover can be increased in sedentary *Chena* areas through introduction of high income developed crops like mango, guava, sour sops, coconut etc.

6. Traditional knowledge is at the core of cascade identity, agriculture, heritage and livelihoods. Its transmission from one generation to the next must be protected, preserved and encouraged. Knowledge of cultivated and non-

cultivate food plants, food processing, culinary practices are now at the brink of extinction and most of the existing knowledge system is trapped within few village elders. Useful practices can be explored and mainstreamed through appropriate avenues such as eco-tourism, premium marketing of super foods and cultural events. That would be an opportunity to share innovations and practices developed in indigenous communities over centuries and millennia. Moreover, traditional knowledge occupies a pivotal place in the range of actions needed to respond climate change. Transferring this information across generations is vital, as is harnessing the potential of youth and women.

7. A pilot project on cascade ecotourism can be initiated for visiting natural areas in order to learn, to study, or to carry out activities in environmentally friendly manner. Focusing primarily on experiencing and learning about nature, cascade landscape, water environment, archaeological heritage, flora, fauna and their habitats; especially elephants and birds. Carefully planned and operated ecotourism sites, especially if it is village-based and includes local participation, is able to provide direct benefits that might offset pressure from other less sustainable activities.

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3.2. Aquatic Biodiversity

3.2.1. Introduction

From the ancient times, Sri Lanka is a well-known Asian country that ensures agriculturally based civilization with high food security. The island's dry zone that covers a greater part of the country and receives a low annual rainfall < 2,000 mm is credited for its known high food security. This is due to vast dry low-lying plains irrigated using traditional micro or meso watershed management system referred to as the Village Tank Cascade System (VTCS). Thus, particular zone is famous as "The state of Lakes" means presence of an array of ancient irrigation tanks, has substituted a natural wetland type. These man-made wetlands depict the rich cultural heritage and biological diversity and provide indirect benefits and numerous environmental services (Geekiyanage & Pushpakumara, 2013). This indicates that the VTCSs of Sri Lanka evolved over two millennia, are now naturalized and bound to the dry zone landscape in Sri Lanka. Despite the non-natural nature VTCSs are known as rich biological resources, harbour many economically and ecologically high value species. Therefore, local communities largely depended up on such resources for their tangible and intangible needs. In addition to providing irrigation water, VTCSs have impacted the microclimate by creating cooler habitats, enhanced the biodiversity and agro biodiversity, and paved the way for a unique decentralized social system in Sri Lanka, where farmers have held the highest social rank (Marambe et al., 2012).

The particular agro-bio-ecosystems in VTCS which, are home to a large number of aquatic and semi aquatic edible species are reported as deteriorating systems due to many of reasons. Therefore, country's food security that is greatly connected with such mosaics of man-made VTCSs is threatened. At present those systems are not well functioning and even their ecosystem services are continuing to low-down, many of them abandoned, and their functions are hindering. Over-reliance on agricultural pesticide and fertilizer inputs that has significant negative impacts on the health of farmers and rural dwellers, finally on country's biodiversity. Some chronic health issues are persistently reporting in the dry zone, largely hit lives of the VTCS dependant people. Thus, restoration of VTCS is a great need to seek possibility in re-establishing the early self-sustained agricultural economy as the country is now depending up on many of imported food stuffs and commodities for food security.

The UNDP funded project "Healthy Landscapes Project" has been developed and designed to seek possibility in furnishing proper management strategies to strengthen the restoration and sustainable management of selected village tank cascade systems (VTCSs) in Sri Lanka. This project has several end targets *viz.* enhanced provision of ecosystem services, protection of biodiversity and ensuring the food & nutrition security. The project also plans to develop and validate a model VTCS management system that can be used for scaling up to other cascade landscapes in the country. On the other hand, improvement of the livelihoods in VTCSs is a big challenge for which it is required to mainstream VTCS's biodiversity. Prior to all it is essential to document the information on the species richness, usages, challenges faced by the people in VTCSs and already acquired impacts and future prospects as those are in neonate stage. For baseline data

collection, two VTCSs in *Malwathu Oya* River lower catchments in Anuradhapura district have been selected.

The scope of aquatic biodiversity assessment was restricted to:

- Survey and inventory of the Aquatic Bio Resources (ABR) in two cascade systems namely; *Horiwila* and *Nachchaduwa* VTCS complexes in Anuradhapura district;
- Organize the collected ABR data in taxonomic categories and construct a database;
- Identify different ABR ecosystem services; and
- Assess community perceptions on benefits/impacts of ABR ecological services; and

Based on two on-site field visits and subsequent meetings had with project management unit and each subject expert, two VTCS ecosystems in Anuradhapura district *viz. Horiwila* and *Nachchaduwa* VTCS systems were selected for the present baseline survey on the aquatic biodiversity. In the past, these two VTCSs have been built by crossing ephemeral streams in lower reaches of the *Malwathu Oya* River, which is the second longest and largest river in Sri Lanka. The *Nachchaduwa* VTCS consists of 29 village tanks whereas the *Horiwila* VTCS has a total of 14 small tanks. Therefore, the objectives of present study were to:

- Assessment of aquatic biodiversity and ecology in VTCS landscapes i.e. *Horiwila* and *Nachchaduwa;*
- Inventory of the aquatic life with habitats and local distribution;
- Compilation of services and functions of aquatic life of VTCS landscapes; and
- Assessment of impact of biodiversity deterioration on aquatic system in VTCS landscapes.

3.2.2. Survey Methods

The survey area was confined only to tank itself and 100 m peripheral area within the water's edges of each tank (this is dynamic; depends up on the water inundating area of each tank). However, survey area included all accessible aquatic and semi aquatic habitats mainly the upper and down reaches of relevant ephemeral streams, tanks, adjacent paddy fields and inter-connected waterlogged/supplying canals, and other water holes etc. These selected tank systems get water mainly from Northeast monsoon rain, store themselves in and act as a heart of each area ensuring water demand of village people. They are agroecosystems enclose with paddy fields, irrigation canals, water holes and etc. and have become semi natural ecosystems.

The assessment was initiated referring to satellite images of the selected VTCS to get a consensus of the distribution of tanks and their assemblages with natural waterways. A total of seven tanks i.e. five for *Nachchaduwa* VTCS and Two from *Horiwila* VTCS with their respective catchments representing different aquatic and semi-aquatic habitats *viz.* all sub sections within each VTCS, riverine/irrigation canals, water holes, paddy lands and associated natural/man–made wetlands etc. were surveyed. Although it was supposed to survey *Ola-gam* tanks if present in each VTCS was unable to carry out due to inaccessibility and time constraint. The

study site selection was depended highly on the quality, types of habitats present, eases of access and visual biological values.

The detailed biodiversity assessment of each site was done during four field visits conducted from February to March 2021. Adequate information on each site, their inhabitants and importance were gathered through a questionnaire survey which was carried out amongst the local villagers, different stakeholders and through referring different published data.

Assessment of aquatic life in different habitats was done by using line transect method employed at each 50 m point along the tank bund. Thorough visual observations were made regarding main visual features and any visible animals and plants. A special emphasis was given to study attached flora, submerged flora and riparian vegetation. Presence of any special locations such as waterlogged places with submerged roots of large tree, swamp and reed beds and fragmented habitats were noticed and then study thoroughly. The detailed description on each survey method is described below.

Plankton sampling and analysis

Plankton samples were collected from each tank using a 50 µ mesh plankton net, one sample was collected to a plastic bottle, preserved in Lugol's solution for phytoplankton analysis in the laboratory. Another sample was also preserved in 5% formalin for zooplankton analysis. In the laboratory, the plankton species in the samples collected from each site were identified as much as possible using Needham & Needham (1962), Mendis & Fernando (1962), Abewickrama (1979). The relative volumes of major taxa of plankton were estimated using a cell of *Spirogyra* as an arbitrary unit.

Other aquatic macro fauna sampling and analysis

This was done by various non-quantitative sampling methods, including visual observation and digital photographing to assess the aquatic life in water area, banks, and peripheral area. The aquatic macro fauna such as crabs, snails, damselfly and dragonfly larvae were sampled with a hand net/butterfly net and a scoop net. The free-living nymphs and larvae of aquatic insects, live attached to substrates (caddis flies) or other stuffs in the water area were dislodged with fine meshed hand net, subsequently collected into a tray. Some animals were picked up with a fine tip forceps. They were identified *in situ* to possible lowest taxa using Needham and Needham (1962) and Mendis and Fernando (1962).

Fish sampling

At each study site, fishes were caught using cast nets of 2.5 cm stretched mesh. The small hand nets, which made up of the mosquito netting was used as drag nets or scoop nets to catch fish in water's edges. The fishes were identified up to species level *in situ*. Their abundance was assessed as Catch Per Unit Effort (CPUF). The extra information in earlier occurred fish fauna was gathered through a questionnaire survey that was carried out amongst the different tanks users and aged-old village people. This was further refined and validated by referring the ichthyofaunal zones of Sri Lanka.

Assess occurrence of other vertebrates

Survey work was supplemented by direct visual observation where possible, and this included investigations of animals or plants, including callings (to

assess birds), pugmarks (to assess mammals), scat (to assess carnivorous mammals), dung (to assess herbivorous mammals), egg masses (to assess amphibians), discarded fur, seeds, flowers and fruit. In addition, local people were interviewed to gather information on presence of certain species and habitats. Every possible attempts were taken to quantitative assess of each faunal taxa. The conservation status of each taxon was determined referring to The Freshwater Fish National Red List, 2020 and National Red list 2012 of Sri Lanka (MOE, 2012, IUCN, 2020).

Data interpretation (Diversity indices, ABR ecosystem services and their relationships)

The species recorded in each tank site were listed in taxonomic categories and was used as ABR databases. The different ABR user groups identified during the survey as well as preferring to available literature were given in the separated column in each appendix. We also included the existing practices in ABR utilization in brief, which data are largely based on informal discussions we had with the village people at each sampling occasion. We also provided the matrices on identified opportunities, threats and constraints which are largely based on different databases and the information provided by village people.

Identification of hotspots (biotopes) of aquatic diversity

Finally, the site-vise *alpha* (species) scale aquatic species richness of the vertebrates, aquatic plant and plankton densities and generic richness of aquatic invertebrates are given describing different aspects such as richness and dominance.

The procedure proposed for identification of indicators

Firstly, we identified natural drivers for biological indicators in each VTCS and records of the diversity indices/measurements were kept that indicate, disturbance/ impairment/ stressor signal embedded at each tank. We identified anthropogenic stressors, which are needed to provide an adequate suite of "stressor" indicators for surveys. We ranked all indices for habitat quality and species diversity indices for each dimension of habitat condition. We evaluated the overall invasive species index and rank them. Finally, we assessed the spatial variations in each indicator.

Ecologically important habitat assessment

The Sensitive Landscapes & Ecological Sensitivity assessment was be done referring to Young & Potschin (2009) using the information gathered through desktop studies as well as from the present field investigations. Ecological sensitivity was quantified by subjectively assessing two factors; the ecological function and the conservation importance described the below;

i. ***Ecological function***

Functional status refers to an indication of the services provided by an area and includes both ecological and human related services. It depends on the degree to which the area or system still provides a noticeable service and ecological function is rated as high, medium and low.

ii. ***Conservation importance***

Ecological health is an indication of carrying capacity of an ecosystem and therefore, its ability to perform ecological services. In order to adequately gauge the ecological health of the study site it is important to give a qualitative definition of the 'perceived biodiversity value' of the land. This is done at a broad level to simply categorize the total area of land owned based on potential biodiversity value. Biodiversity Value (BV) is understood as being a combination of the conservation status and the functional status of the area.

Table 3.2.1 Ecological Sensitivity Assessment Criteria – Ecological Function (Source: Young & Potschin 2009).

Ecological function level	Description
High	Sensitive ecosystems with either low inherent resistance or resilience towards disturbance factors or highly dynamic systems considered to be stable and important for the maintenance of ecosystem integrity (e.g. pristine grasslands, pristine wetlands and pristine ridges)
Medium	Relatively important ecosystems at gradients of intermediate disturbances. An area may be considered of medium ecological function if it is directly adjacent to sensitive/pristine ecosystem
Low	Degraded and highly disturbed systems with little or no ecological function

Assessment of community perceptions on benefits/impacts of aquatic biodiversity and its habitats

The assessment was done referring to the Millennium Ecosystem Assessment Conceptual Framework which describes interactions between biodiversity, ecosystem services, human well-being, and drivers of change. The goal of the Millennium Ecosystem Assessment is to establish the scientific basis for actions needed to enhance the conservation and sustainable use of ecosystems and their contributions to meeting human needs.
As it helps to recognize the interactions exist between people, biodiversity and ecosystems present data interpretation was solely based on this concept.

Ecosystem Services Evaluation

Ecosystem system services are the benefits people obtain from ecosystems. An ecosystem services assessment was conducted to establish the supply and demand of ecosystem services within the context of the proposed project. This is essentially an exploratory process to better understand the following;

- The key ecosystem services generated by the natural assets or land cover types.
- The demand for these services based on numbers of users and their dependence on the supply of these services
- The potential changes in the supply of services with development of the project and the implications for the

users in terms of service level changes.

The demand for ecosystem services within the study area was established through consultation with local community members during cultural and heritage as well as the field studies. Discussions involved identifying provisioning services such as the supply of water, energy/fuel, building materials and food amongst others and establishing the supply of and. dependence on regulatory and cultural services.

Plate 3.2.1. Aquatic plant found in the paddy fields

3.2.3. Results and discussion

Details of the Aquatic Bio Resources (ABR) collected through literature survey, by interviewing the people in each VTCS and baseline survey conducted in March 2021 are given in tabulate forms in Annexes 3.2.1- 3.2.4.

In general, disperse and colonization of the aquatic lives in lentic water bodies are depended up on the water in fluxes, which very often result in more or less comparable biodiversity among different water bodies of same catchment. This nature is highly linked with interconnecting nature of the VTCSs and also, they are fed by the same irrigation The existing practices in ABR utilization are largely based on informal discussions had with the village people in respective VTCSs. The species distribution, a scaled-up abundance and habitat of each ABR are also given as aid material. The identified opportunities, impact to biodiversity, and ecosystems, threats and constraints given in this report are largely based on different databases and the information provided by village people. Finally, the site vice *alpha* (species) and *gamma* (eco-region) scale canals which facilitate to supply seeds and propagules of all sympatric species. This scenario is well exampled by surveyed VTCSs that are of more comparable micro catchments, thus baseline survey has come out with non-disparity databases in *alpha* scale species richness. The data of tanks in each VTCS were pooled together to get a precise idea, are listed in taxonomic categories, and developed as databases. Different ABR user groups identified during the survey as well as preferring to available literature are also given in a separated column.

aquatic species richness of the vertebrates, invertebrates, plants and phytoplankton densities are given.

According to databases developed for the *Nachchaduwa* VTCS and *Horiwila* VTCs systems indicate more or less comparable species richness values but vary in their species composition. Of them the *Mahakanumulla* tank has high species richness in almost all taxa, indicating rich ecological integrity compared to others. It is a semi-naturalized ecosystem that supplies

rainfed water for rice and crops culture at least for two crop seasons. Although extreme dry climate conditions are frequent in the area, it harbours a diverse ABR indicating its ability to host for a higher number of aquatic biodiversity providing a range of ecosystem services.

This tank is managed by a committee headed by the "*Wew Vidane Mahatha*". There is a prescheduled calendar for each activity in tank management such as cleaning, catching and auction of fish, lotus and water lilies and removal and control of unwanted noxious aquatic plant species, bund restoration etc. There is a waste removal method, collecting non-biodegradable waste into the bags and then disposing. Cleaning of tank surroundings thereby reduces the possible contamination with micro plastics and other wastes. Therefore, it is a logical example on which the application of ecological knowledge and best management practices are in line to get high ecological services from a VTCS.

However, fishing activity in particular system is highly seasonal. But this VTCS is of high surplus fish yield which can grant the protein and nutrient demands and requirement of the area people. At present this resource is partially underutilized.

Ecological Value/Environmental services

The ecological services provided by the aquatic ecosystems of the VTCS are numerous. Among the ecological services, water purification is the most important one. This is done through the ecological function of the interceptor, which is basically built for purification of the water flowing into the paddy fields from pollutants from seepage water across the embankment. Moreover, the lager trees such as *Terminalia arjuna* in the tree belt located in upper inundation area of the almost all VTCS also act as a wind barrier and reduce the occurrence of waves in the tank. Consequently, it helps to prevent evaporation.

Further, water filter (*perahana*), which is dominated by sedges such as *Cyperus* spp, *Schoenoplectus grossus*, reeds mainly *Typha angustifolia*, shrubs and grasses retain sediments in runoff water between tank and tree belt so that the main function is purification of water.

The environmental services provided by the floral types for the farming communities and used only for the sustainable extraction of some non-timber forest products such as medicinal herbs for Ayurveda. Many of the species have various medicinal properties which could be used for curing variety of human ailments in traditional way. In spite of that many aquatic plants could be extracted for the edible purpose although there was no such satisfactory utilization recorded from the area. Flowers of *Nymphea* spp. are mainly used for sale. Other potential uses would be selling for ornamental plants and use as bio-fertilizer.

Presence of endemic species *Phoenix zeylanica* also carries a significant conservation priority of the plants. Villagers use to extract leaves of the plant for hand crafting. Also, sedges viz *Cyperus corymbosus, Schoenoplectus grossus* are used for weaving baskets, mats etc. which have an attractive traditional value and source of additional income for women.

Riparian zones in VTCS are habitats of critical conservation concern, as they are known to filter agricultural contaminants, buffer landscapes against erosion, and provide habitat for high numbers of species. The riparian areas are habitats for a large number of faunal species including many of the rare

species that depend on water. The floral habitats have been functioned to increase the groundwater table through infiltration and slow discharge of water to the tank during the dry season.

Streams associated in VTCS are essentially dynamic systems, their path and flow can change with time. But bank vegetation plays an important role in the maintenance of stream and foreshore stability. The presence of vegetation in riparian areas acts to reduce the rate of change and therefore maintain a level of stability. Proper management of riparian areas together with vegetation is therefore essential as it helps to maintain the biodiversity of the area.

Threats and Indicators

Vacate niches

The species composition of invertebrates is an indicator of ecological function groups in the ecosystems. Present survey showed a relatively lower diversity in particular small insects such as Mayfly larvae (order Ephemeroptera), Crane fly larvae. They are common members in the ecological function group known as shredders. They play major role in converting coarse particles to fine particles.

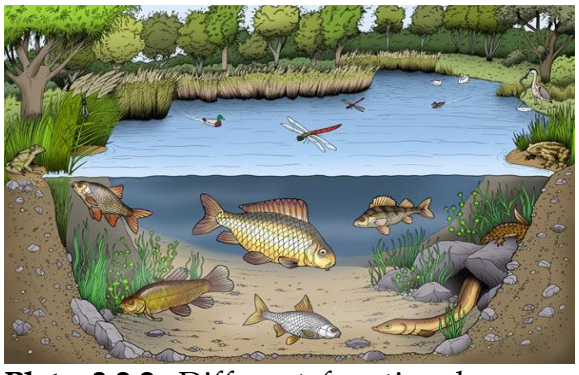

Plate 3.2.2. Different functional groups and respective micro habitats in a tank system

However, presence of accumulated coarse particles in the tank beds indicates that most of VTCS do not harbour adequate numbers of them hence their ecological role is insufficient and hindering well-functioned food chains. The condition seems to be severe in the *Sembukulama* tank and *Amane* tank, which represent lower and upper catchment of *Nachchaduwa* VTCS. Low down of shredders number in such systems might be due to presence of large number of individuals of carnivore fish species such as Catfishes and beetle larvae which is a threat to VTCSs.When considering fish species diversity, it is clear that there are some vacate niches in these VTCSs. They are lacking functional service of large herbivore fish species such as *Systomus sarana.* This vacate niche has to be filled by introducing suitable large herbivore fish spp. such as grass carp and Silver carp who entirely feed on aquatic macrophytes. It also helps to minimize the invasion of most of aquatic macrophytes and bring them to manageable levels.

Floral invasion

Salvinia molesta and *Eichornia crassipes* were the most common species encountered in all VTCS in particularly

Plate 3.2.3. *Monochoria hastata* at a drainage canal

in the tank open water area. They have occupied > 30% of the water area in all studied systems. Canals and spill areas

are also occupied with dominant aquatic species; tall reed *Typha angustifolia, Cyprus* spp., *Schoenoplectus grossus.* Existing environment provides conditions to proliferate invasive species in the water area as well as the surroundings. The encountering of dense patches of recently naturalized alien invasive aquatic ornamental plant species namely *Ludwigia sediogia* (Debarawatta et al. 2016) in upper catchments of *Nachchaduwa* VTCS in particular *Amane* tank should be taken into much consideration. It can increase the populations drastically at the expense of the existing flora including indigenous root floating plants species such as *Nymphoidea* spp.

Plate 3.2.4. Dense patches of *Ottelia alismoides* in *Punchikulama* tank

In many instances most of invasive aquatic species are non-edible and not consumed by wild herbivores and therefore their commitment in food chain is devoid. Then the habitats of many species would be degraded and reduced thereby having an adverse impact on VTCS.

Assessment of stress factors

As shown in Table 3.2.2, it reveals that *Mahakanumulla* tank in *Nachchaduwa* VTCS is under less stress condition whereas *Wellamudawa* tank in same system is under severe stress condition. The good govern practices by the Farmer Organization has succeeded to maintain the integrity. Ecological sensitivity assessment indicates low to medium ecological service provide by these VTCSs and major area under stress due to many of human induced factors. All these tanks can be considered as relatively important ecosystems at gradients of intermediate disturbances thus may be considered of medium ecological function.

Plate 3.2.5. Aquatic plant invasion - *Palugaswewa*

Best management practices- an existing model

According to databases developed for *Nachchaduwa* and *Horiwila* systems indicate more or less comparable species richness values but they slightly vary in species composition. of them *Mahakanumulla* tank has high species richness in almost all taxa groups indicating rich ecological integrity compare to others. It is a semi-naturalized ecosystem, supplies rain fed water for rice and crops culture at least in two crop seasons. Although extreme dry climate conditions are frequent in the area, it harbours a diverse ABR indicating its ability to host for a higher number of aquatic biodiversity providing a range of ecosystem services. This tank is managed by a committee headed by the "Wew-Vidane-Mahatha".

There is a prescheduled calendar for each activity in tank management such as cleaning, catching and auction of fish, lotus and water lilies and for removal and control of unwanted noxious plant species, bund restoration and etc. There is a waste removal method, collect non-bio-degradable waste into the bags hug near to bathing site and then disposal. This cleans tank surroundings thereby minimize possible contamination with micro plastics and other wastes. It is a logical example on which the application of ecological knowledge and best management practices are in lined to get high ecological services from a VTCS. However, fishing activity in particular system is highly seasonal. But this VTCS is of high surplus fish yield which can grants the protein and nutrient demands requirement for the local people. At present this resource is underutilized.

Table 3.2.2. Assessment of stress factors

Anthropogenic stressor	**Nachchaduwa VTCS**					**Horiwila VTCS**		
	SK	**PK**	**WM**	**MK**	**AW**	**PW**	**UK**	**KG**
Dumping of rapping materials	+	+++	+	-	-	+	++	+
Excess use of detergents	+	++	+	+	-	+	+	+
Over exploitation for food	-	-	+	+	++	-	-	-
Over exploitation for small scale enterprises	_	+	-	-	+	+	+	+
Excess use of agro chemicals	+	+	+	+	+	++	++	++
Harmful collecting methods	_	-	+	+	+	+	_	-
Cleaning and cultivating in interceptor	+	+	+++	_ _	+	+	-	+
Encroachment	+	-	+	_	+	-	-	++
Total	5+3-=2+	8+2-=6+	9+1-=8+	5+4-=1+	7+2-=5	7+2-=5+	6+3-=3+	7+2-=5+
Invasion severity	+++=3+	+++=3+	++=2+	-=1-	+++=3+	++=2+	++=2+	++=2+
Cumulative severity	5+	9+	10+	0	8+	7+	5+	7+
Rank (habitat quality)	2	5	6	1	4	3	2	3
Average	7.20					6.33		

(Key: SK-Sembukulama, PK-Punchi Kulama, WM-Wellamudawa, MK-Mahakanumulla, AW-Amane, PW-Palugaswewa, UK-Udakadawala and KG-Kudalugama Wewa)

3.2.4 Conclusions

The assessment showed that indirect and direct drivers of change in ecosystems and their services are changing in both VTCSs, thus services have affected human wellbeing and negatively influence on income and date-to-date material needs, good social relations and food security. Conservation of biological diversity in these two tank systems is timely required from which local people

can benefit. It seems that **s**hort-term targets are not sufficient for the conservation and sustainable use of biodiversity in VTCSs. In the sense of political, socio-economic and ecological aspects, policy frame for long term goals and targets of these hereditary eco-systems are needed to take.

Recommendations

1. Restoration of tank VTCSs with proper policy formulation, planning and implementation.
2. To enhance surface water storage capacity, efficient water conveyance, and groundwater recharge that ensure water availability throughout the year.
3. To secure biodiversity therein granting food security with minimized siltation and improved water quality.
4. Monitoring of water quality in VTCS for better nutrient management to safeguard soil and water quality.
5. Proper management of riparian areas together with vegetation to maintain the biodiversity.
6. Apply best management practices such as home garden improvement, traditional rice farming, crop diversification and fisheries & livestock development to ensure healthy food and to minimize adding of excess nutrition load into water.
7. Frequent records of information, data and analysis to improve databases on biodiversity and knowledge sharing among different tank cascade systems.
8. Documentation of traditional wisdom associated with VTCS in particular to develop resilience for climate change.

Plate 3.2.6. *Lymnophylla* at *Mahakanumulla* tank spill

Plate 3.2.7. *Ludwigia spendes* invasion in *Amane* tank

Plate 3.2.8. *Potomogeton petinus* invasion in *Wellamudawa* tank

Plate 3.2.9. *Nymphoidea indica* patches in *Palugaswewa* tank

Plate 3.2.10 Healthy reed bed at *Sembukulama* tank

Plate 3.2.11. Severe aquatic weed invasion in bund side-*Sembukulama* tank

Plate 3.2.12. Non-biodegradable waste dumped at a bathing site at *Nachcaduwa VTCS*

Plate 3.2.13. Value added products- Reed crafts by *Udakadawala* tank community

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3.3. Medicinal Plant Diversity

3.3.1. Introduction

In the North-central dry zone of Sri Lanka, rainfall and surface runoff have been stored in human-made reservoirs since ancient times and today continue to provide water for irrigation. These large-scale tanks are managed and maintained by local villagers. The tanks are arranged in a cascade-like fashion along shallow valley courses. They are connected by canals and spillways and build a complex system of floodwater harvesting, water storage and water distribution. Besides irrigation, the stored water is used for domestic purposes, desiccated tank beds serve as pasture for the cattle and deposited sediments are used as raw material for brick production. Thus, the tanks have characterized the cultural landscape of north-central Sri Lanka for 2000 years, and have become an identity-generating factor for the rural everyday culture. Some distinctive areas can be identified in a Village Tank Cascade System (VTCS) such as tank bund (TB), Peripheral Tank Bund (PTB), *Kattakaduwa* (KK), *Gasgomman*a (GG) and in addition, there are adjacent thorny bushes and dense forest in the catchment area, which play a unique role in maintaining VTCS and its sustainability. These are ecologically important for the protection of the ecosystem as well as for water catchment. It also provides social support for the health and well-being of the community living in and dependent on this ecosystem, as well as for food and other needs. Economically, the service rendered to the community for the creation of lakes and adjacent area is invaluable.

Village Tank Cascade Systems found in Anuradhapura District, which is considered as the center of ancient irrigation systems and there are a number of unique tank systems found in the *Horiwila* and *Nachchaduwa* Divisional Secretariats in the Anuradhapura District. As the VTCSs are man-made, diverse groups of flora and fauna have adapted to these ecosystems over centuries and these species create high diversity in the VTC systems. These have created a biodiversity for that ecosystem consisting of a number of animal and plant species. Among the plants grown in any climatic zone as well as in the ecosystems of Sri Lanka, medicinal plants do a great service to the environment and as well as life of all living forms. Among them, the medicinal plant that grows in associated with the VTCS , which is a unique ecosystem, is of great environmental as well as social and economic importance. Medicinal plants are used not only for medicinal purposes but also for food, wood and firewood, for various purposes such as the production of essential oils, and other products etc.

Sri Lanka has over 3700 flowering plant species native to it. The number of medicinal plants used in Sri Lanka, endemic, indigenous and introduced has been variously put at between 1370-1400 species of higher plants. The check list of medicinal plants are to be found in Sri Lanka has listed 1430 plants belongs to 181 families, 842 genera and 1430 species of medicinal plants.

Surveys on medicinal plants have revealed that 1370 species of medicinal plants are to be found in Sri Lanka, some common, some rare and valuable and some endemic. Out of the total number of species 173 are endemic, 208 of commonly used are distributed among

the dry zone area and equal percentage are spread over the wet as well as intermediate zone.

Study Objectives

1. Assessment of traditional medicines and traditional medical practice and multiple medicinal products in VTCS landscapes;
2. Preparation of an inventory of medicinal plants available and traditional uses in VTCS landscape; and
3. Assessment of the impact of biodiversity deterioration on traditional medicine in VTCS landscapes

3.3.2. Methodology

Study sites

Major/medium Reservoir	Village Tanks Cascade system (VTCS)
Nachchaduwa	*Mahakanumulla*
	Wellamudawa
	Punchikulama
Horiwila	*Palugaswewa*
	Bellankadawala

Sampling

Randomly selected 30 home gardens of traditional practitioners and knowledgeable people were visited to collect information on Medicinal Plants (MPs) and Medicinal Edible Plants (MEPs) availability, usage and threat found in each VTCS with the help of field assistants working at *Horiwila* and *Nachchaduwa* VTCS landscapes.

Survey techniques

Desk review was done to prepare MPs and MEPs lists based on the existing institutional records on past studies, research, national inventories and herbarium etc. The list prepared was short listing and prioritized based on local expert knowledge and experience on subject (Annexes 3.3.1-3.3.2).

Interview technique

Following two techniques were practiced depending on the situation and time availability to collect maximum information.

a. Unstructured interviews (allow informant to talk freely on topic and gather information)

b. Applied interviews (talk about selected plants showing to informant by the observer and gather information)

1. Data entered in excel sheets based on habitat type (using habitat code) for each VTCS separately and prioritized habitat type using habitat scoring values.
2. Information gathered through the interviews on MPs & MEPs usage, traditional practices, other uses, threats on MPs & MEPs etc. were also recorded.
3. For medicinal plants that are difficult to identify in the field plant specimens were collected and herbarium specimens were prepared for correct botanical identification.

Study tools

Questionnaires, voice recorders, data sheets

3.3.2 Results and Discussion

VTCS is a socio-ecological system and has a large variety of medicinal plants found in various regions such as the tank, the bund of the tank, *kattakaduwa, gasgommana* and the dense forest. The tank bund is restricted to small herbs, shrubs and vines, the scrubland is covered with thorny shrubs as well as large arboreal vegetation found in forested areas characteristic of dry zone forests.

Considering the number of medicinal plants found in the VTCS and the number of the MEP plants, species diversity can be observed. Although vines, herbs and small shrubs can often be seen on the tank bund and, water-loving plants and shrubs can be found at Peripheral Tank Bund (PTB). Large trees such as Ehela (*Cassia fistula*), Karanda (*Pongamia pinnata*), Kumbuk (*Terminalia arjuna*), Kone (*Schleichera oleosa*), Mee (*Madhuca longifolia*) were common on the banks of the tank. Most of these are the plants that grow in dry zone reservoir areas. Very old valuable medicinal plants were conserved in the forests found in the *Nachchaduwa* VTCS system.

Among the medicinal plants that grow on the water of the tank, stamens of the Lotus flowers (*Nelumbo nucifera*), seeds of Egyptian lotus (*Nymphaea pubescense*) and Water lily tubers (*Nymphaea nouchali*) are used medicinally and their collection is also a threat to the survival of those plants. Due to this over collection of medicinal plants such as "Diyahabarala" (*Monochoria vaginalis*), which form in the wetland around the tank, they could not be found in these ecosystems at present. Many of the VTCS surveyed were full of water and minimum number of invasive aquatic plants could be seen.

The main findings of the home garden survey were that the team identified as indigenous physicians had also grown wet zone medicinal plant species to increase the medicinal plant collection and reported a large number of medicinal plants in the home garden. The number of medicinal plants reported in other home gardens was very low because they are increasingly using home gardens to grow food crops.

Physicians who are living in these areas well aware in medicinal plants and their uses and the knowledge of medicinal plants in the elderly are vast. Diseases such as snake bites and fractures and dislocations are common conditions, and many of the villagers are well aware of the usage of medicinal plants and its medicinal properties in such conditions (Table 3.3.1).

Selected VTCS landscapes of *Horiwila* and *Nachchduwa* DS Divisions belongs to dry zone area of the country. Interest to develop home gardens using annual herbs affected by rain fall pattern and the long dry spell that they experience during a year. Most of the medicinal plants recorded are perennial herbs, shrubs, small, medium and large trees. Normally people in this area used to collect medicinal plants for food and medicinal needs from the nearby VTCS area. The results of the survey reveal that with compared to the *Nachchaduwa* VTCS landscape *Horiwila* recorded higher number of medicinal plants and medicinal edible plants in most of the habitat type (Table 3.3.1).

Table 3.3.1. Occurrence & importance of Medicinal Plants (MPs) and Medicinal Edible Plants (MEPs) in each habitat type in VTCS at *Horiwila* and *Nachchaduwa* DS Divisions

Habitat code	Number of medicinal plants (MPs) and medicinal edible plants (MEPs) found in *Horiwila* (HW) and *Nachchaduwa* (NH) sites							
	MPs (HW.)		MEPs (HW.)		MPs (NH.)		MEPs (NH.)	
	C	R	C	R	C	R	C	R
HG	48	15	40	01	29	10	21	06
TB	25	01	15	-	15	-	10	01
PTB	27	-	12	-	26	02	17	-
TW	02	-	03	-	1	-	03	-
KK	37	-	16	-	30	03	27	03
SC	06	-	05	-	07	-	09	-
GG	29	-	08	-				
DF	21	01	04	-	25	-	08	-
Other (Osu uyan)	29	09	11	01	07	01	08	01
Total	224	26	114	2	140	16	103	11

MPs- Medicinal Plants, MEPs – Medicinal Edible Plants

Table 3.3.2. Degree of importance for providing Medicinal Plants (MPs) and Medicinal Edible Plants (MEPs) services in each habitat types in VTCS at *Horiwila* DS Division.

No.	Habitat Type	Degree of importance for providing MP and MEP services {Scale 1-10}	
		MPs	MEPs
1	Home Garden {HG}	8	5
2	Tank water {TW}	5	6
3	Tank bund {TB}	7	6
4	Peripheral shallow tank bed {PTB}	6	5
5	Kattakatduwa vegetation {KK}	8	6
6	Gasgommana vegetation {GG}	7	4
7	Scrublands {SC}	4	4
8	Dense Forest {DF}	6	4
9	Other {Osu uyana}	8	7

MPs- Medicinal Plants, MEPs – Medicinal Edible Plants

Table 3.3.3. Degree of importance for providing Medicinal Plants (MPs) and Medicinal Edible Plants (MEPs) services in habitat types in VTCS at *Nachchaduwa* DS Division.

No.	Habitat Type	Degree of importance for providing MPs and MEPs services {Scale 1-10}	
		MPs	**MEPs**
1	Home Garden {HG}	7	6
2	Tank water {TW}	4	4
3	Tank bund {TB}	6	5
4	Peripheral shallow tank bed {PTB}	6	7
5	Kattakatduwa vegetation {KK}	7	6
6	Gasgommana vegetation {GG}	-	-
7	Scrublands {SC}	5	6
8	Dense Forest {DF}	7	4
9	Other {Osu uyana}	3	4

MP- Medicinal Plants, MEP – Medicinal Edible Plants

Table 3.3.4. Most influential environmental factors on Medicinal Plants (MPs) and Medicinal Edible Plants (MEPs) in two VTCS landscapes at *Horiwila* and *Nachchaduwa* DS Divisions.

No.	Habitat type (code)	Influential factor (Environmental or social)	Impact on MPs and MEPs	Outcome	Parameter: Indicator or decision space	Effect score
1	HG	Drought	Water stress Heat stress	Yield loss Quality loss Species loss	Rain fall temperature	(-1)
2.	TW	Drought Eutrophication Introduction of new fish species Soil erosion Community participation	Water stress Heat stress Increase salinity Water pollution Species decline Habitat conservation	Yield loss Quality loss Species loss Loss of Germination of seeds Yield & water quality increase	Rain fall Temperature pH, RP Turbidity	(-5) (+8)
3.	TB	Drought Soil erosion	Water stress Heat stress Species decline	Yield loss Species loss	Rainfall Temperature RP	(-4)
4.	PTB	Drought Soil erosion	Water stress Heat stress Species decline	Yield loss Species loss	Rainfall Temperature RP	(-4)
5.	KK	Drought Soil erosion Encroachment	Water stress Heat stress Increase salinity	Yield loss Quality loss Species loss Space loss	Rainfall Temperature TDS, EC Density	(-7)
6.	GG	Drought Encroachment, Flodding	Heat stress Water stress Species reduction	Space loss Species loss Yield loss	Rainfall Temperature Area/Density	(-7)
7.	Sc	Drought Habitat conversion	Water stress Heat stress	Yield loss Quality loss Species loss Space loss	Rainfall Temperature Area/Density Species richness	(-6)
8.	DF	Drought Habitat conversion Wildlife conflict Policy & legislations	Water stress Heat stress Biodiversity conservation	Yield loss Quality loss Species loss Space loss Biodiversity increase	Rainfall Temperature Area/Density Species richness	(-8) (+8)
9.	Other (Osu uyana)	Drought	Water stress Heat stress	Yield loss Quality loss Species loss	Rainfall Temperature Species richness	(-3)

3.3.4. Conclusions

Home gardens belong to indigenous practitioners in two VTCS landscapes containing multiple crops including large number of medicinal and medicinal edible plants. It acts as a unit of ex-situ conservation of medicinal plants as well as providing medicine, variety of nutritious foods and other uses for households and in some instant for income generator.

Cultivation of cash crops instead of food crops with high medicinal value does not much practice at home garden level. Promoting cultivation of medicinal edible plants with high demand and market value in home garden level can make substantial contribution to family's income.

Limited extension advices cause serious drawback of knowledge on medicinal plants. Awareness and education on conservation, cultivation and value of medicinal plants is essential for younger generation in these areas. At the village level people should establish community-based organization to protect and enhance their environment as well as faunal and floral diversity

Key deliverables

Deliverables	Description
Inventory of biodiversity (species and intra-species level) in the selected 5 cascade systems (Task A)	Inventories provided for terrestrial flora and fauna, aquatic flora and fauna, medicinal plants and crop genetic resources. Please see relevant chapters and annexes
Flora-fauna interaction assessment (Task A)	Interactions of flora, fauna with habitats and socio-ecological have been presented in relevant chapter tables and annexes
Condition assessment report of ecological components in VTCS (including impacts to VTCS sustainability) (Task A)	Conditional assessment of habit quality has been presented terrestrial biodiversity, aquatic biodiversity and medicinal plants habitats. In addition, quantitative conditional assessment for land use and cover types provided in the Chapter 02 and Chapter 04.
Qualitative assessment report of the role of VTCS ecosystem services in VTCS community health, food security and wellbeing (Task B)	Community perception of ecosystem services values quantified in the section terrestrial biodiversity section. Qualitative ecosystem services importance for aquatic habited presented in the relevant annexes More detailed qualitative and quantitative ecosystem services assessment presented in the Chapter 4
Qualitative assessment of traditional medicines and traditional medical practice and multiple medicinal products in VTCS landscapes (Task D) Impact assessment report of biodiversity deterioration on traditional medicine and food	This has been presented in the medicinal plant section and Chapter 05

Planned scientific papers drafted based on the above	All contents of the Chapter 3 have been designed, formatted and developed following the scientific writing guideline. Mr. Sujith Ratnayake, chief technical coordinator, and currently PhD student at UNE has been given responsibility for the development of scientific (draft) paper with Dr. P. B. Dharmasena and other authors of the chapter. He will coordinate with the relevant Authors and Authorities for the final outcome.

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CHAPTER FOUR

ECOSYSTEM SERVICES

4.1. Introduction:

Village Tank Cascade System (VTCS) is a world heritage which is a unique agricultural system to Sri Lanka. It is mainly located in the Dry Zone of the country which has been sustained over 2,500 years according to the written history. Madduma Bandara, 1985 defines a 'cascade' as a connected series of village irrigation tanks organized within a micro-(or meso) catchment of the dry zone landscape, storing, conveying and utilizing water from an ephemeral rivulet.

However, the functionality and concept of cascade go beyond it's definition. Rather than it's provisional services and water use, VTCS provides numerous goods and services to the mankind and the environment becoming an agricultural ecosystem. Consequently, Dhrmasena, 2017 stressed the need of a comprehensive definition for VTCS considering it's ecology (cascade ecology). Thus, the tank cascade definition can be improved as 'an ecosystem, where land and water resources are organized within the micro-catchments of the dry zone landscape, providing basic needs to human, floral and faunal communities through water, soil, air and vegetation with human intervention on sustainable basis (Dhrmasena, 2020).

The VTCS is a manmade system with the goal of making the man self-sufficient with food. It is managed with a collective and a collaborative effort over the years beginning from ancient time in a sustainable manner. Not only the tangible benefits but also numerous intangible benefits are provided by VTCS. The resilience of VTCS to climate change, it's capacity to mitigate and adopt the adverse impact of climate change is well highlighted in the literature (Kekulandala, et al., 2020; Imbulana and Manoharan, 2020; Melles and Perera, 2020,). Cascade system regulated the water floor and provide sufficient water for mainly paddy cultivation meanwhile controlling the floods taking place in the Dry Zone (Perera, et al., 2020)

The provisional services arising from VTCS are the mostly tangible benefits which is being mainly counted by community at present. The contribution of VTCS for the hydrological balance in the Dry Zone of the country is immense and has been the key driving force on sustainable agriculture in the area. However, due to various human interference the system has been seriously disturbed and consequently the hydrological balance in VTCSs has got seriously disrupted (Panabokke, et al., 2002). There are many more intangible benefits of VTCS some of them have been identified and valued by Vidanage, 2019.

At present more emphasis is given to centralize the irrigation system with large reservoirs rather than

decentralizing it as such the VTCS which has been a success story in the history. The real functions of VTCS have been ignored and it is being continuously deteriorated with the time. The provisional services are mostly valued at present while other Ecosystem Services (ESs) of the system have not been valued and ignored and thus the sustainable management of the system is a question.

A 22% of the agricultural lands of the country are under VTCSs and thus managing VTCSs sustainably is of paramount importance. However, sustainable management of the system will not be feasible if it's ecology and ecosystem services are not well known. The climate change and its impact are the most threat on agriculture and it's sustainable development today. In this context, VTCS can play a major role being is a highly resilient system and as an adaptation measure to climate change. However, it is not now feasible to adopt the same land use that has been in traditional TCSs. So, the challenge is to bring some elementary changes in planning, designing, and managing VTCSs to sustain the ecosystem services provided (Geekiyanage and Pushpakumara, 2013).

In this context understanding the ecology of VTCS and it's ecosystem system services with respective to land use and lance cover are very important and useful in various aspects including better decision making at different institutional level. Identification of the capacity of landscapes for providing ES and mapping it would facilitate the decision making by different instructions when an ecosystem is managed sustainably (Brukhard, et al., 2009). However, no such efforts are reported in the literature which are to understand fully the cascade ecology, ecosystem services of VTCS and the capacity of different landscapes in VTCS to provide ESs. Consequently, this study focusses on fully identifying and inventorying the ecosystem services of VTCSs while the capacities of different landscapes in the system for providing ESs.

4.2. Methods

4.2.1. Study area

The study area has been identified by the proposal writing team, for which a description is given in Table 1.1. During the site selection, it has been identified that the selected sites represents adequately the VTCSs in the country. Two major/medium reservoirs were *Nachchaduwa* and *Horiwila.* There are three VTCSs connected to *Nachchaduwa* reservoir while two other VTCSs connected to *Horiwila* reservoir. There are 109 tanks under five selected VTCSs which covers an area of 190.67 Square kilometers.

4.2.2. Sample and sampling

The baseline survey was planned to conduct using a sample of the study area due to several reasons viz. Covid 19 pandemic and limited resources including budget limitations. Based on the available information and its gaps *Mahakanumulla* and *Palugaswewa* VTCSs were selected on a purposive approach. During the field visits and expert consultative meetings, it was confirmed that these cascades can reasonably represents study site and population of VTCSs. It was decided to follow a stratified sampling approach to cover the variability apparent in the system from upper cascade to lower cascade. Consequently, the three strata were identified as upper cascade, middle

cascade and lower cascade which were specially demarcated by a GIS map as depicted in Figure 4.1. Data collection in other sections of the baseline survey was carried out in the areas demarcated by read lines (Figure 4.1).

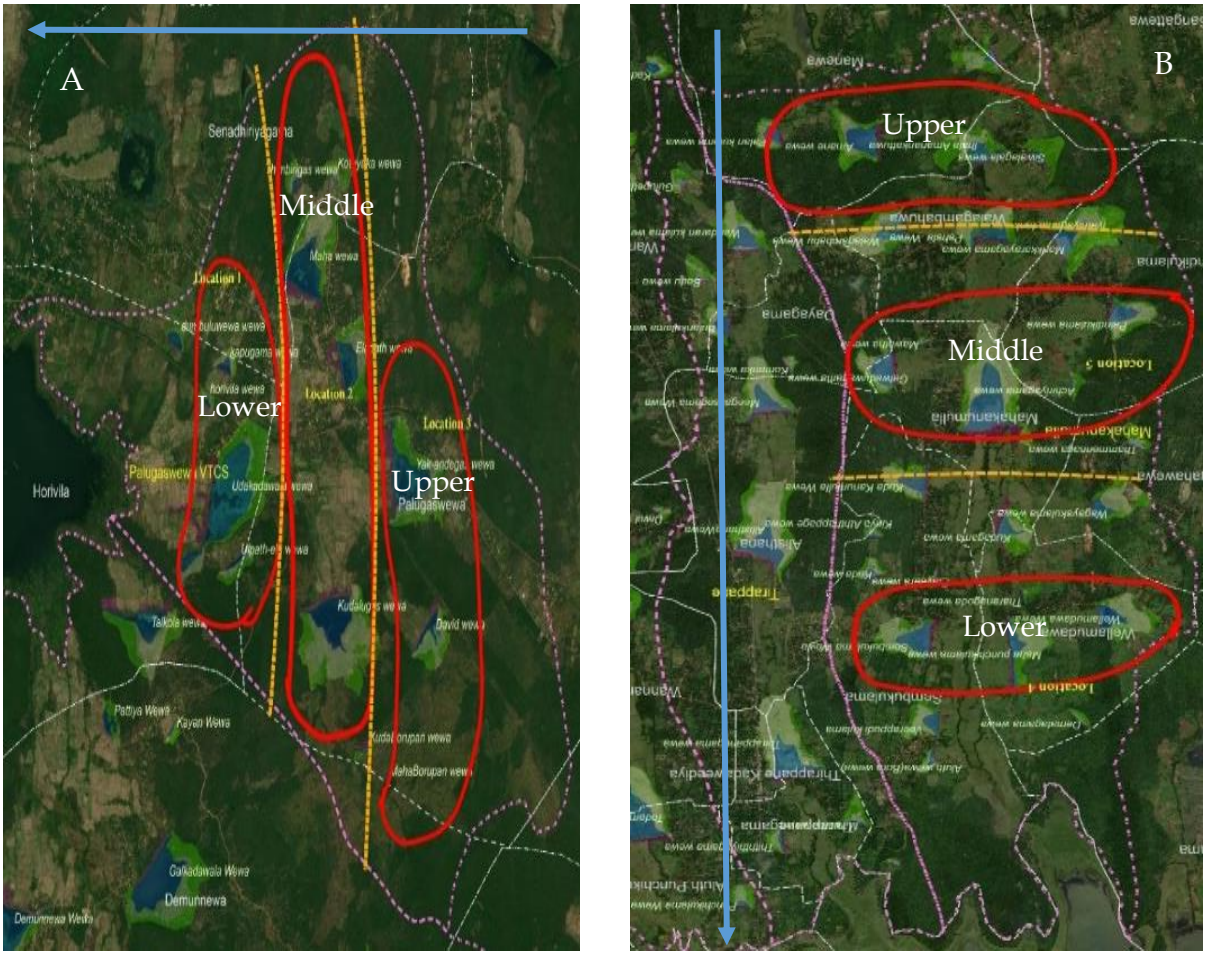

Figure 4.1. Sampled areas; *Horiwila* (A) and *Nachchaduwa* (B) VTCS landscapes

4.2.3. Identification and inventorying ecosystem services

A rapid literature survey was done to identify ecosystem services arising from VTCSs and list them. The community living in VTCS are the people who has firsthand information about the ESs of VTCSs. They are the direct uses of VTC who actually experience and aware about the ESs over generations. Consequently, identification, inventorying and prioritizing ESs of VTCSs were done through a PRA had with the community in both cascades. ESs were identified and prioritized under four main categories viz. Provisional services, Regulatory services, Support services and Cultural services. The prioritization was done through a participatory ranking which is a PRA tool. The results of PRAs were further validated in focus group discussions had with other stakeholders and experts of VTCSs.

Plate 4.1. During PRA Exercise at *Horiwila* site

Plate 4.3. During PRA Exercise at *Nachchaduwa* site

Plate 4.2. During PRA Exercise at *Horiwila* site

Plate 4.4. During PRA Exercise at *Nachchaduwa* site

4.2.4. Estimation of ecosystem services demand and supply

Demand for ESs is the amount of all ecosystem goods and services currently consumed or used in a certain area over a given period of time. Usually, demand is assed not considering where ESs are actually provided (Burkhard et al., 2012). However, the demand for ESs is connected with the land use and land cover (LULC) which would be taken into granted in quantification of the demand of ESs. There are various approaches found in literature used for estimation of demand for ESs out of which a LULC based participatory approach (Burkhard et al., 2012; Palomo et al., 2013 and Casado et al., 2013) will be used for quantification of ESs in the baseline survey. The stakeholders participate in the process of participatory assessment include experts, managers and direct users of VTCS. A scale from zero to five will be used for the quantification of demand for ESs where higher the value the higher the demand.

Supply of ESs refers to the capacity of a particular area to provide a specific bundle of ecosystem goods and services within a given time period. The capacity here refers to generation of the actually used set of natural resources and services (Burkhard et al., 2012). A participatory LULC based assessment will be carried out to estimate the supply of ES by the

VTCS where the stakeholders participate in the assessment will be expects, managers and direct users of VTCS (Brukhard et al., 2009). The supply will be assessed on a 0 – 5 scale where higher the value the higher the supply.

4.2.5. Mapping ecosystem services

The mapping exercise of demand and supply will be carried out by linking the matrix of ESs supply and demand to appropriate spatial data in GIS. The matrices of ESs supply and demand will be prepared based on the outcome of part 4.3. Estimates of ESs supply and demand can be mapped in spatially explicit units of similar biophysically units which in this study is the LULC. The ecosystem supply and demand matrices will be joined with the polygon attributes using the LULC code field as common identifier field. The LULC map will be obtained from the Survey Department of Sri Lanka. This procedure has been commonly used in the literature of mapping demand and supple of ES (Brukyard et al., 2009; Brukyard et al., 2012; Mukul et al., 2017 and Geange et al., 2019).

4.3. Results: Baseline Status

4.3.1 Identification and inventorying ecosystem services of VTCS

An inventory of ESs arising from VTCSs are provided in Table 3 together with probable indicators of them. We have identified eleven provisional services, eight regulatory services, three main support services and four cultural services from VTCS during this exercise. These can be used for different purposes and in future exercises under the Healthy Landscape Project. However, there may be some other important ESs that have been missed in this quick baseline survey and the inventory is open for further revisions.

Table 4.1. An inventory of Ecosystem Services arising from VTCSs

Ecosystem service	Rationale	Probable Indicators
Provisional services		
1. Paddy and other cereals	Main produce of VTCSs is Paddy. Apart from this, many other cereals (finger millets, corn etc.) are grown in paddy lands and other land use classes (Chena, home gardens etc.)	Production, productivity (Yield) and prevalence
2. Lentils and other seed crop	A variety of lentils and other seed crops are grown in different Land Use Classes (LUC) of VTCS during different periods in a year.	Production, productivity (Yield) and prevalence
3. Leafy vegetables, vegetables and tuber crops	A variety of Vegetables, tuber crops and leafy vegetables are grown in different LUCs in VTCSs which are sometimes specific to the LUC and the system.	Production, productivity (Yield) and prevalence
4. Clean/ fresh water for drinking and domestic use	Availability/ presence of fresh water for drinking, washing, bathing	Amount of fresh water, number of sources with fresh water

5.	Irrigation water	Availability/ presence of water for irrigation throughout the year	Amount of water, Capacity of tanks, Number of seasons cultivate in a year
6.	Inland fisheries	Presence/ availability of edible fish	No of edible species, the catch of fish (Kg/Month), Auction value
7.	Livestock	Keeping edible animals and animal products	Number of species, Production (Kg/Year, Nos/Year, Litters/ Year)
8.	Fodder and grasses	Presence/ availability of fodder and grasses	Kinds of fodder plants, Production (Kg/ Ha)
9.	Sedges and other alternative plants	Availability/ presence of sedges with potential use for weaving reeds and other utilities	Number of sedges kinds, Plant density, number of products, number of cottage industries
10.	Herbals/ medicinal plans and materials	Presence of plants, herbs and materials with potential use for medicine/ medical production	Site specific species, Types of herbs and medicinal plants, Number of products
11.	Ecotourism	The potential for ecotourism for local and foreign people viz. Bird watching, adventures, home stay etc.	Number of people engage in ecotourism, Number of local and foreign visitors, Number of ventures
Regulatory services			
12.	Control floods/ Flood protection	Elements of VTCS dampening extreme flood events	Number of floods causing damages
13.	Ground water recharge and maintain the flow	The timing and magnitude of runoff, flooding, and aquifer recharge can be strongly influenced by changes in land use and land cover, including, in particular, alterations that change the water storage potential of VTCS, such as the conversion of components of tanks into cropping lands, conversion of forests into cropping lands and other developmental activities.	Groundwater recharge rates, Stream flow, water levels in wells during droughts
14.	Water purification	VTCS has specific components and the capacity to purify water.	Water quality and quantity
15.	Local climate regulation	Changes in land use and land cover can locally affect temperature, wind, radiation and precipitation.	Temperature, albedo, precipitation, wind; Temperature amplitudes; Evapotranspiration
16.	Global climate regulation	VTCS can play an important role in climate by either sequestering or emitting greenhouse gases.	Source-sink of water vapor, methane, CO2
17.	Pollination	Changes in the VTCS affect the distribution, abundance, and effectiveness of pollinators. Wind and bees are the key actors of the reproduction of a lot of culture plants.	Amount of plant products; Distribution of plants; Availability of pollinators
18.	Soil Nutrient regulation	The capacity of VTCS to carry out (re)cycling of, e.g. N, P or others; organic matter.	Amount of soil carbon; N, P or other nutrient turnover rates
19.	Erosion regulation	Vegetative cover in VTCS plays an important role in soil retention and Water flow and runoff controlee also reduces soil erosion	Loss of soil particles by water; vegetation cover; availability of components that controls runoff.
Support services			
20.	Food security	The role of VTCS assuring food availability, accessibility, utilization and Stability	Household food production, Food crop diversity, percentage household expenditure on food, Household dilatory diversity and Degree of access to utilities and services etc.
21.	Nutrient security	The role of VTCS assuring nutrient security	Stunting, Wasting, BMI, presence of malnutrition etc.
22.	Conserve and maintain biodiversity	The presence or absence of selected species, (functional) groups of species, biotic habitat components or species composition.	Indicator species representative for a certain phenomenon or sensitive to distinct changes
Cultural services			

23.	Recreational and aesthetic value	VTCS provides beautiful land escapes and has elements with recreational potential.	Recreational and esthetic value (non-market value), No elements that has reactional and aesthetic value
24.	Traditional knowledge and values	Traditional knowledge on various aspects viz. farming system, engineering technology, irrigation technology, farming practices etc. uniquely connected with VTCS that has a bequest value	Specific knowledge, awareness, use of such knowledge in the system
25.	Culture, traditions, customs and practices	There is a specific culture, traditions and customs are connected with VTCS	Specific cultural events, traditions and customs being practice, awareness
26.	peace, harmony and corporation	VTCS has components and activities the that creates peace, harmony and corporation among the community	Existence of specific activities leading to peace, harmony and corporation

4.3.2. Prioritizing ecosystem services, a perspective of the community of VTCS

Provisional services from VTCS ranked by the community in two cascades under investigation are given in Table 4.2. Two communities have ranked the provisional services more or less in a similar manner. Same ranks have been given to first six provisional services while the rest have been ranked slightly differently. The community identifies Paddy and other cereal crops, water for drinking, domestic purpose and irrigation as the first-hand provisional services from VTCS being in line with it's original function.

Regulatory services from VTCS ranked by two communities are given in Table 4.3. They were found to be in different perceptions on prioritizing the regulatory services. Community in *Palugaswewa* cascade identified local climate regulation as the most important regulatory service while community of *Mahakanumulla* cascade identify water purification as the most important regulatory service from VTCS. Based on the results in Table 4.3., it can be concluded that some communities in VTCS identify climate regulation as the most important regulatory service from VTCS. The other communities identify water regulation as the most important regulatory service from VTCS. The place a significant weight on pollination and soil nutrient regulations as important regularity services from VTCS. However, they have kept the role of VTCS in global climate regulation in the bottom of the list.

Support services from VTCS ranked by the community in two VTCSs are illustrated in Table 4.4. The key support services identified during the baseline study are food security, nutrient security and conservation and maintenance of biodiversity. Two communities prioritize them in the same fashion where food security is mostly valued by them. They place nutrient security and biodiversity in second and third places respectively.

Cultural services from an ecosystem are the most unrevealed kind of services which place an important role in connection to VTCS. The connection of VTCS to the culture of the community in the DZ of Sri Lanka is immense which could have been one of the driving forces on the sustainability of the system beginning form the ancient time. There has been a unique culture to VCTS of the country according to written historical sources. The cultural services from VTCS ranked by the community in the study area is listed in Table 4.5. Cultural services

respectively are recreational and aesthetic value; traditional knowledge and values; culture, traditions customs and practices and peace, harmony and corporation. Those who are in *Palugaswewa* cascade place culture, traditions, customs and practices as the most important cultural service from VTCS. However, community in *Mahakanumulla* cascade identifies recreational and aesthetic value as the most important cultural service from VTCS which has been least valued by the community in *Palugaswewa* cascade. Both communities have ranked traditional knowledge and values as the second important cultural service from VTCS.

Table 4.2. Provisional services from VTCS ranked by the community

Provisional service	**Rank given by the community**	
	***Horiwila* Site**	***Nachchaduwa* site**
1. Paddy and other cereals	1	1
2. Lentils and other seed crop	5	5
3. Leafy vegetables, vegetables and tuber crops	4	4
4. Clean/ fresh water for drinking and domestic use	2	2
5. Irrigation water	3	3
6. Inland fisheries	7	7
7. Livestock	8	6
8. Fodder and grasses	7	10
9. Sedges and other alternative plants	10	11
10. Herbals/ medicinal plans and materials	9	8
11. Ecotourism	11	9

Table 4.3. Regulatory services from VTCS ranked by the community

Regulatory service	**Rank given by the community**	
	***Horiwila* Site**	***Nachchaduwa* site**
12. Control floods/ Flood protection	5	4
13. Ground water recharge and maintain the flow	3	2
14. Water purification	2	1
15. Local climate regulation	1	3
16. Global climate regulation	8	8
17. Pollination	4	6
18. Soil Nutrient regulation	6	5
19. Erosion regulation	7	7

Table 4.4. Support services from VTCS ranked by the community

Support service	**Rank given by the community**	
	Horiwila Site	**Nachchaduwa site**
20. Food security	1	1
21. Nutrient security	2	2
22. Conserve and maintain biodiversity	3	3

Table 4.5. Cultural services from VTCS ranked by the community

Cultural service	Rank given by the community	
	Horiwila Site	Nachchaduwa site
23. Recreational and aesthetic value	4	1
24. Traditional knowledge and values	2	2
25. Culture, traditions, customs and practices	1	3
26. Peace, harmony and corporation	3	4

4.3.3. Ecosystem services demand and supply

The ESs identified in 4.3.1 was used in the participatory assessment of demand and supply. The assessments were carried out in six areas demarcated in Figure 1 where there were there were eleven tanka in *Mahakanumulla* cascade and ten tanks in the *Palugaswewa* cascade. A list of tanks and number of Land Use (LU) segments are given in Table 8. There were 422 Land Use (LU) segments; 216 in *Mahakanumulla* and 206 in *Palugaswewa* which were belong to various LUCs. Each LU segment were evaluated for demand and supply under all ES identified in the previous section.

Table 4.6. The tanks and number of land use segments under each tank in two cascades under the investigation

Cascade	Sample Number	Name of the tank	No of land segments
Mahakanumulla	1	Amane	15
		Ihala Amanankattuwa	23
		Palankulama	14
		Sivalagala	18
	2	Achariyakulama	9
		Mahakanumulla	24
		Mawathawewa	21
		Paindikulama	12
	3	Punchikulama	19
		Sembukulama	42
		Wellamudawa	19
Palugaswewa	1	Dumbuluwagama	12
		Kapugama	19
		Panweliyaya	13
		Udakadawala	21
	2	Alapathwewa	14
		Kudalugaswewa	39
		Palugaswewa	13
		Thimbiriwewa	24
	3	David Wewa	19
		Yakadagaswewa	32

4.3.4. Profile of the informants participated in the evaluation

There were 60 members (*Mahakanumulla* – 47 and *Palugaswewa* – 13) from the community who had different interactions with village tanks were participated in the assessment. Number of participants from *Palugaswewa* were comparatively less since area and number of tanks under this cascade was significantly lower than *Mahakanumulla* (Table 1.1). Moreover, there were only two farmer organizations in the area. About 90% of them were males and the other 10% females. An 88% of the informants were members of the Farmer Organization which is the village level key institution directly involving in the management of village tanks. Out of them 57% were office bearers of the farmer organization who directly involving in the management and hold the responsibility and the accountability.

Education status of the informants participates in the evaluation of ES demand and supply is given in Table 9. About 76% of informants have been schooling at least up to GCE(O/L) examination. This indicated that education level of them is considerably high evidencing that their judgements and evaluations will be fair and accurate.

The age distribution and the distribution of number of generations that they have been in this are depicted in Figure 4.2. The age ranges from 30 years to 85 years with a mean and standard deviation of 58 years and 11 years respectively. Number of generation that they have been in this area ranges from one to six with a mean value of 3 generations and a standard deviation of 1.5 generations. The majority of them were elderly and have been in the area several generations which indicates their knowhow about VTCS can be expected as high. They have firsthand information the usefulness of VTCS and ESs arising from it.

All participants engage in paddy cultivation under VTCS while 76% of them were found to be engaged in upland farming including *chena* cultivation and home gardening. Eventually we can conclude that they are rich with the knowledge/ information about VTCSs and its ecosystem services.

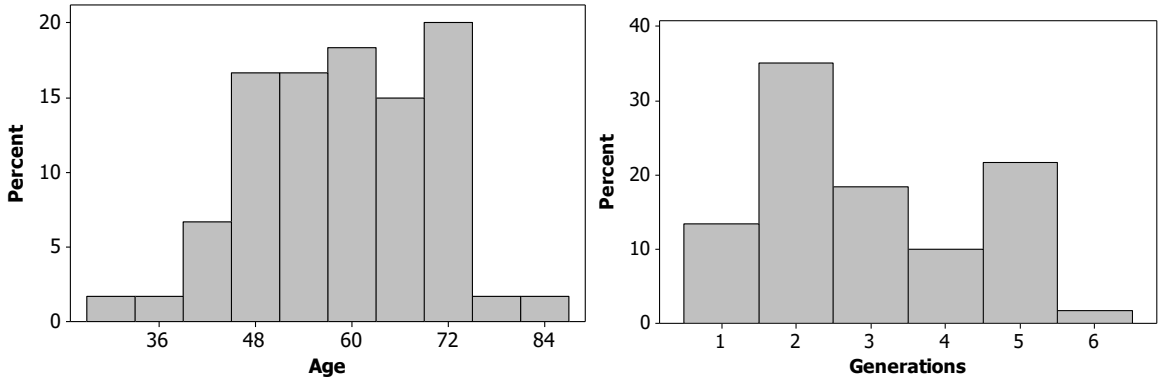

Figure 4.2. Age distribution and distribution of number of generations the informants have been living in the area.

Table 4.7. Education status of the informant participated in the evaluation

Education level	Frequency	Relative frequency (RF)	Cumulative RF
No Education	0	0%	0%
Primary Education	7	12%	12%
Upto Grade 8	7	12%	24%
Upto GCE(O/L)	24	40%	64%
Upto GCE(A/L)	7	12%	76%
Pass GCE(A/L)	13	21%	97%
Above GCE(A/L)	2	3%	100%

Ecosystem services supply

In the baseline assessed the capacity of different landscapes in two VTCS to supply different ESs identified under four classes viz., provisional services, regulatory services, support services and cultural services and recorded in Table 10 and Table 4.8. The quantification of supply has been done on a scale from 0 to 5 (0 – no relevant capacity, 1 – low relevant capacity, 2 – moderate relevant capacity, 3 – relevant capacity, 4 – High relevant capacity and 5 – very high relevant capacity) where higher the value the higher the supply.

In both cascade the capacity to supply provisional services ranges from 0 to 4 where 4 is recoded only in two occasions; one with paddy lands for paddy, the other with Tanks for Irrigation water. It can be seen that supply of provisional service of *Mahakanumulla* cascade is less that of the *Palugaswewa* cascade. As far as the tank component is concerned, it has still some relevant capacity to supply water for cultivations. There is a reduction in its capacity to provide fisheries and clean water for drinking and domestic use. In *Mahakanumulla* home gardens have some relevant capacity to supply vegetables, lentils and other seed crops which is less in *Palugaswewa* cascade. Community in *Mahakanumulla* cascade identify that there is some relevant capacity in their cascade to supply ecotourism while the community in *Palugaswewa* say that there is no capacity in their cascade for ecotourism. The supply of respective services by *Chena* in both locations were found to be low which may be due to changes in the land use. During the field visits we have observed that they cultivate mostly fruit crops in chena with some irrigation facilities for commercial purpose.

As far as regulatory services are concerned, community say that *Mahakanumulla* cascade has more capacity supply regulatory services compared to that of *Palugaswewa* cascade. *Mahakanumulla* cascade has comparatively a high capacity to control floods while *Palugaswewa* cascade has more capacity to recharge groundwater level and maintain the floor rather than controlling flood. It can be seen that both VTCS has comparatively relevant capacity to supply support services, food security, nutrient security and maintain and conservation of biodiversity. Most of the landscapes in both cascades have at least relevant capacity to conserve and maintain the biodiversity.

Table 4.8. Ecosystem services supply by different land use in *Mahakanumulla* VTCS

Ecosystem Services	Tank	Diyagilma	Gas Gommana	Kattakaduwa	Godawala	Isvetiya	HG	DF	OF	P	RARE	SC	SL	SUCL
Paddy and other cereals	0	0	0	1	0	0	2	0	0	4	0	2	0	2
Lentils and other seed crop	0	0	0	0	0	0	3	0	0	1	0	2	0	2
Leafy vegetables, vegetables and tuber crops	0	1	1	1	0	1	3	1	1	1	0	2	1	2
Clean/ fresh water for drinking and domestic use	2	1	0	0	0	1	2	0	0	0	1	0	0	0
Irrigation water	4	2	0	0	1	0	3	1	1	2	0	2	0	2
Inland fisheries	3	1	0	1	1	0	0	0	0	3	0	0	0	0
Livestock	2	1	2	2	0	0	2	1	1	3	0	2	2	1
Fodder and grasses	1	1	2	1	0	0	2	1	2	3	0	2	2	2
Sedges and other alternative plants	2	2	2	1	0	1	1	0	1	1	0	0	1	0
Herbals/ medicinal plans and materials	2	2	3	2	0	1	2	3	2	2	1	2	2	2
Ecotourism	3	3	3	2	1	3	2	3	2	2	1	2	2	2
Control floods/ Flood protection	2	2	3	2	1	2	1	2	2	1	2	0	1	0
Ground water recharge and maintain the flow	1	1	0	0	0	0	0	0	0	0	0	0	0	0
Water purification	3	2	3	2	2	3	2	3	2	2	0	2	2	2
Local climate regulation	2	1	3	2	0	3	2	3	2	2	0	2	2	2
Global climate regulation	3	2	3	2	0	2	3	3	3	3	0	3	2	3
Pollination	3	3	2	1	1	3	2	1	2	2	0	3	2	2
Soil Nutrient regulation	0	0	0	0	0	1	0	0	0	0	2	0	0	0
Erosion regulation	1	0	0	0	0	0	0	0	0	0	0	0	0	0
Food security	3	2	3	2	1	2	4	3	2	3	0	3	2	3
Nutrient security	3	2	2	2	1	2	3	3	2	3	0	3	2	3
Conserve and maintain biodiversity	3	3	3	3	1	3	3	3	3	3	1	2	3	3
Recreational and aesthetic value	4	3	3	2	0	3	3	3	3	4	4	2	2	2
Traditional knowledge and values	3	2	2	2	0	2	2	3	2	3	1	2	1	2
Culture, traditions, customs and practices	3	2	2	1	0	2	2	1	2	3	1	1	1	2
peace, harmony and corporation	3	1	1	1	0	0	3	1	1	3	0	2	1	2

0	No relevant capacity	1	Low relevant capacity	2	Medium relevant capacity
3	Relevant capacity	4	High relevant capacity	5	Very high relevant capacity

Ecosystem services demand

Similar matrices depicted in Table 4.8 and Table 4.9 for supply of ESs have been derived for the demand of ESs by different land uses in two VTCSs and are given in Table 4.10 and Table 4.11. In the matrix, landscapes found in particular VTCS has been taken in to x-axis while relevant ESs are taken into y-axis. Demand for each ES were assed for various landscapes in VTCS on a scale range from 0 to 5. The higher the value the higher the demand. Demand for ESs were found to be more or less similar in both locations. There was a high demand for irrigation water from Tanks and

Paddy lands in both places and from home gardens in *Palugaswewa*. Apart from the Tank, farmers used to get irrigation water from agrowells which are mostly located in their home gardens, near paddy lands and Chena. There were some issues reported among the community regarding sharing irrigation water from village tanks. For most of the cases demand for ESs were found to be low and moderately low while there were few cases with relevant demand. No relevant demand was observed for provision of ecotourism for VTCSs. Compared to demand for provisional services, a fairly high demand for regulatory services can be observed in both locations.

Table 4.9. Ecosystem service supply by different land uses in *Palugaswewa* VTCS

Ecosystem Services	Tank	Diyagilma	Gas gommana	Kattakaduwa	Godawala	Isvetiya	HG	DF	OF	P	RARE	C	SL	SUCL	LAK	M	FP
Paddy and other cereals	0	1	0	1	0	0	2	0	0	4	0	0	0	3	0	0	0
Lentils and other seed crop	0	1	0	0	0	0	2	0	0	2	0	0	0	2	0	0	0
Leafy vegetables, vegetables and tuber crops	1	1	0	1	0	1	1	1	0	1	0	0	1	2	0	0	0
Clean/ fresh water for drinking and domestic use	3	0	0	0	1	2	0	0	0	0	0	0	0	0	2	0	0
Irrigation water	4	2	1	1	2	0	2	1	1	3	0	3	1	3	3	1	2
Inland fisheries	3	1	0	1	0	0	0	0	0	2	0	0	0	0	1	1	0
Livestock	0	2	1	1	1	2	3	1	0	3	0	2	2	2	0	1	2
Fodder and grasses	0	2	1	1	0	1	1	1	1	2	0	1	2	2	0	2	1
Sedges and other alternative plants	1	1	0	1	1	2	0	0	0	2	0	0	1	1	1	2	1
Herbals/ medicinal plans and materials	2	2	3	2	1	3	3	3	3	2	3	1	2	2	2	2	2
Ecotourism	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Control floods/ Flood protection	0	2	0	1	1	0	0	0	0	0	0	0	0	0	0	2	0
Ground water recharge and maintain the flow	3	2	3	2	3	2	1	3	3	3	0	2	2	2	2	2	1
Water purification	2	2	3	2	3	3	1	3	2	2	1	0	1	0	0	2	0
Local climate regulation	3	2	2	2	2	2	1	3	3	2	0	1	2	2	2	2	1
Global climate regulation	1	1	2	1	1	2	1	2	2	1	0	1	1	1	1	2	1
Pollination	2	2	3	2	0	2	2	3	3	3	0	2	2	3	2	1	3
Soil Nutrient regulation	2	3	2	1	0	2	2	2	2	2	0	2	2	2	2	2	2
Erosion regulation	0	0	0	1	0	0	0	0	0	0	4	0	0	0	0	0	0
Food security	3	2	2	2	1	2	2	3	3	4	0	2	2	3	3	1	1
Nutrient security	2	2	2	1	1	2	2	3	2	3	0	2	1	3	2	1	1
Conserve and maintain biodiversity	4	3	3	2	2	2	2	3	3	3	3	2	3	3	3	3	1
Recreational and aesthetic value	3	3	3	2	1	2	2	3	3	4	1	2	2	3	3	2	2
Traditional knowledge and values	3	2	2	1	1	1	3	2	1	3	1	2	1	2	3	1	2
Culture, traditions, customs and practices	2	1	2	1	1	1	2	2	0	3	0	1	0	2	3	1	2
peace, harmony and corporation	2	1	1	1	1	1	2	2	0	3	0	2	0	2	2	1	1

0	No relevant capacity	1	Low relevant capacity	2	Medium relevant capacity
3	Relevant capacity	4	High relevant capacity	5	Very high relevant capacity

Compared to other service types, there is more relevant demand for support services; food security, nutrient security and conservation and maintenance of biodiversity from most of the landscape types in VTCS. It both sites, the community identifies comparatively a more demand for conservation and maintenance of biodiversity. Out of four cultural services, most demanding cultural service is the recreational and aesthetic value arising from landscapes in VTCS.

Table 4.10. Ecosystem services Demand by different land use in *Mahakanumulla* VTCS

Ecosystem Services	Tank	Diyagilma	Gas Gommana	Kattakaduwa	Godawala	Isvetiya	HG	DF	OF	P	RARE	SC	SL	SUCL
Paddy and other cereals	0	1	0	1	0	0	2	0	0	4	0	2	0	2
Lentils and other seed crop	0	1	0	0	0	0	3	0	0	1	0	3	0	2
Leafy vegetables, vegetables and tuber crops	1	1	0	1	0	1	3	1	1	1	0	2	1	2
Clean/ fresh water for drinking and domestic use	2	1	0	0	1	1	2	0	0	0	1	0	0	0
Irrigation water	4	2	0	0	1	0	3	1	1	3	0	3	1	3
Inland fisheries	3	1	0	2	2	0	0	0	0	3	0	0	1	0
Livestock	2	1	2	2	0	0	3	1	1	3	0	2	2	2
Fodder and grasses	1	1	1	2	0	0	2	1	2	3	0	3	2	2
Sedges and other alternative plants	2	2	1	2	0	1	1	0	1	2	0	0	1	0
Herbals/ medicinal plans and materials	2	2	2	2	0	2	2	2	2	2	1	2	2	2
Ecotourism	1	0	0	0	0	0	0	0	0	0	0	0	0	0
Control floods/ Flood protection	1	2	0	0	0	0	0	0	0	0	0	0	0	0
Ground water recharge and maintain the flow	3	3	3	2	2	4	2	3	2	2	1	2	2	2
Water purification	3	2	3	3	1	3	1	3	2	2	2	1	1	0
Local climate regulation	3	2	3	2	2	4	2	3	2	2	0	3	2	2
Global climate regulation	2	2	2	2	0	4	2	3	2	2	0	3	2	2
Pollination	3	2	2	2	0	4	3	3	3	3	0	3	2	3
Soil Nutrient regulation	3	3	2	2	2	4	3	2	3	3	0	3	3	3
Erosion regulation	0	0	0	1	0	2	1	0	0	0	2	1	0	0
Food security	3	2	2	2	2	3	3	3	2	3	0	3	2	3
Nutrient security	3	2	2	2	2	3	3	3	3	3	0	3	2	3
Conserve and maintain biodiversity	4	3	3	3	1	3	3	3	3	3	1	3	3	3
Recreational and aesthetic value	4	3	3	3	0	3	3	4	3	3	4	2	2	3
Traditional knowledge and values	3	2	2	2	0	3	2	2	1	2	2	2	1	2
Culture, traditions, customs and practices	3	1	1	1	0	2	2	1	2	2	1	1	1	2
Peace, harmony and corporation	3	1	1	1	0	0	3	1	1	2	0	2	1	2

0	No relevant demand	1	Low relevant demand	2	Medium relevant demand
3	Relevant demand	4	High relevant demand	5	Very high relevant demand

Table 4.11. Ecosystem services Demand by different land use in *Palugaswewa* VTCS

Ecosystem Services	Tank	Diyagilma	Gas gommana	Kattakaduwa	Godawala	Isvetiya	HG	DF	OF	P	RARE	C	SL	SUCL	LAK	M	FP
Paddy and other cereals	0	1	0	1	0	0	2	0	0	4	0	0	0	3	0	0	0
Lentils and other seed crop	0	1	0	0	0	0	2	0	0	3	0	0	0	3	0	0	0
Leafy vegetables, vegetables and tuber crops	0	1	0	1	0	1	1	1	0	2	0	0	1	2	0	0	0
Clean/ fresh water for drinking and domestic use	2	0	0	0	2	2	0	0	0	0	0	1	0	0	2	0	0
Irrigation water	4	2	1	1	2	0	4	1	0	3	0	3	0	3	3	1	2
Inland fisheries	3	1	0	1	1	0	0	0	0	2	0	0	0	0	1	1	0
Livestock	0	2	1	1	0	2	3	1	0	3	0	2	2	2	0	1	2
Fodder and grasses	0	2	1	1	0	1	1	1	1	3	0	2	2	2	0	1	1
Sedges and other alternative plants	1	1	1	2	1	1	0	0	0	2	0	0	1	1	2	2	1
Herbals/ medicinal plans and materials	1	1	2	2	1	2	2	2	2	2	1	1	2	2	1	1	2
Ecotourism	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Control floods/ Flood protection	0	2	0	1	1	0	0	0	0	0	0	0	0	0	0	2	0
Ground water recharge and maintain the flow	3	2	3	3	3	2	3	3	3	3	0	2	2	2	3	2	1
Water purification	2	2	3	3	3	3	3	3	2	2	1	0	1	1	0	2	0
Local climate regulation	3	2	2	2	2	2	1	3	3	2	0	1	2	2	2	2	1
Global climate regulation	2	1	2	2	1	2	1	2	2	1	0	1	1	1	1	2	1
Pollination	2	2	3	2	0	2	4	3	3	3	0	2	2	3	2	1	3
Soil Nutrient regulation	2	3	2	1	0	2	4	2	2	3	0	3	2	3	2	2	2
Erosion regulation	0	0	0	1	0	0	0	0	0	0	4	0	0	0	0	0	0
Food security	3	2	2	2	1	2	4	3	2	4	0	2	2	3	3	1	1
Nutrient security	2	2	3	2	1	2	4	3	1	3	0	2	1	3	2	1	1
Conserve and maintain biodiversity	4	3	4	3	2	2	4	4	3	3	3	2	3	4	3	3	1
Recreational and aesthetic value	4	3	3	2	1	2	4	4	3	4	1	3	2	3	3	2	3
Traditional knowledge and values	3	1	2	1	1	1	2	2	1	2	1	2	1	2	2	1	2
Culture, traditions, customs and practices	2	1	1	1	1	1	2	2	0	2	0	1	0	2	2	1	2
peace, harmony and corporation	3	1	1	2	1	2	2	2	0	3	0	2	0	2	2	1	1

0	No relevant demand	1	Low relevant demand	2	Medium relevant demand
3	Relevant demand	4	High relevant demand	5	Very high relevant demand

4.3.4. Present status of the components of village tanks

Present condition of the components of village tanks were studied during the baseline survey and reported in Table 4.12. The condition of the tank and its components were evaluated on a scale range from 0 to 5. Status would be zero if the component is missing. One indicates high level of degradation while 5 stands for no degradation. Then lower the value the higher the level of degradation. In all tanks except very few, *Godawala* and *Iswetiya* are missing. We can notice that *Kattakaduwa* and *Diyagilma* are also missing in some of the tanks. None of the *Kattakaduwa* were

found in good condition. Their condition ranged from slightly degraded to fully degraded. One tank in the upper cascade in both *Mahakanumulla* and *Palugaswewa* had an undegraded *Gasgommana* as per the evaluation done by the community. *Diyagilma* in some of the tank found undegraded while the rest were at lease slightly degraded. Based on the assessment done by the community, there were three tanks ranked as undegraded. However, during the field visits we observed that these tanks were also filled with invasive plant species and were some issues with their capacities. Rest of the tanks were at least slightly degraded.

Summary statistics of the rank-based assessment is reported in Table 16. Based on their mean and median level of degradation, different components can be ordered in descending order respectively as *Iswetiya, Godawala, Kattakaduwa*, Tank, *Diyagilma* and *Gasgommana.* Their mean and median ranks ranged from 0 to 4. Thus, on the average, village tanks have been at least slightly degraded at present.

Table 4.12. Present status of the components of village tanks in *Mahakanumulla* and *Palugaswewa* VTCSs

			Component of the tank					
Cascade	**Location**	**Name of the tank**	**Tank**	**Diyagilma**	**Gasgommana**	**Kattakaduwa**	**Godawala**	**Isvetiya**
Mahakanumulla	Upper	Amane	2	4	4	3	0	0
		Ihala Amanankattuwa	1	4	3	2	0	0
		Palankulama	3	4	2	2	0	0
		Sivalagala	2	5	5	2	0	3
	Middle	Achariyakulama	4	0	4	0	0	0
		Mahakanumulla	2	4	4	4	0	0
		Mawathawewa	3	4	4	0	0	0
		Paindikulama	2	4	4	3	0	0
	Lower	Punchikulama	2	2	4	2	0	0
		Sembukulama	3	2	4	4	0	0
		Wellamudawa	2	2	2	1	0	0
Palugaswewa	Upper	Dumbuluwagama	3	0	2	2	0	0
		Kapugama	2	1	4	1	0	0
		Panweliyaya	2	0	5	0	0	0
		Udakadawala	4	5	3	2	2	0
	Middle	Alapathwewa	5	4	4	3	2	2
		Kudalugaswewa	5	4	4	4	0	0
		Palugaswewa	5	2	2	4	4	0
		Thimbiriwewa	1	0	4	2	0	0
	Lower	David Wewa	3	5	5	2	0	0
		Yakadagaswewa	3	2	2	2	0	0

Scale: 0 – No component, 1 – Highly degraded, 2 – Degraded, 3 – Moderately degraded, 4 – Slightly degraded, 5 – not degraded

Table 4.13. Summary statistics of rank-based assessments on different components of village tanks

Statistic	Tank	Diyagilma	Gas gommana	Kattakaduwa	Godawala	Isvetiya
Mean	3	3	4	2	0	0
Median	3	4	4	2	0	0
Minimum	1	0	2	0	0	0
Maximum	5	5	5	4	5	3

4.3.4. Mapping ES demand, supply

Mapping is a powerful tool that helps to understand complex phenomenon and thus facilitate the decision-making process. We have mapped demand, supply and budgets of ESs for both cascades and made available for using different activities in the Healthy Landscape Project. For an example we present the map of regulatory services budgets in *Mahakanumulla* VTCS in Figure 4.3. This is the difference between average supply and average demand of regulatory services from respective VTCS. In some areas demand and supply of regulatory services in the cascade in its natural balance while in rest of the areas there is an undersupply of regulatory service on the average.

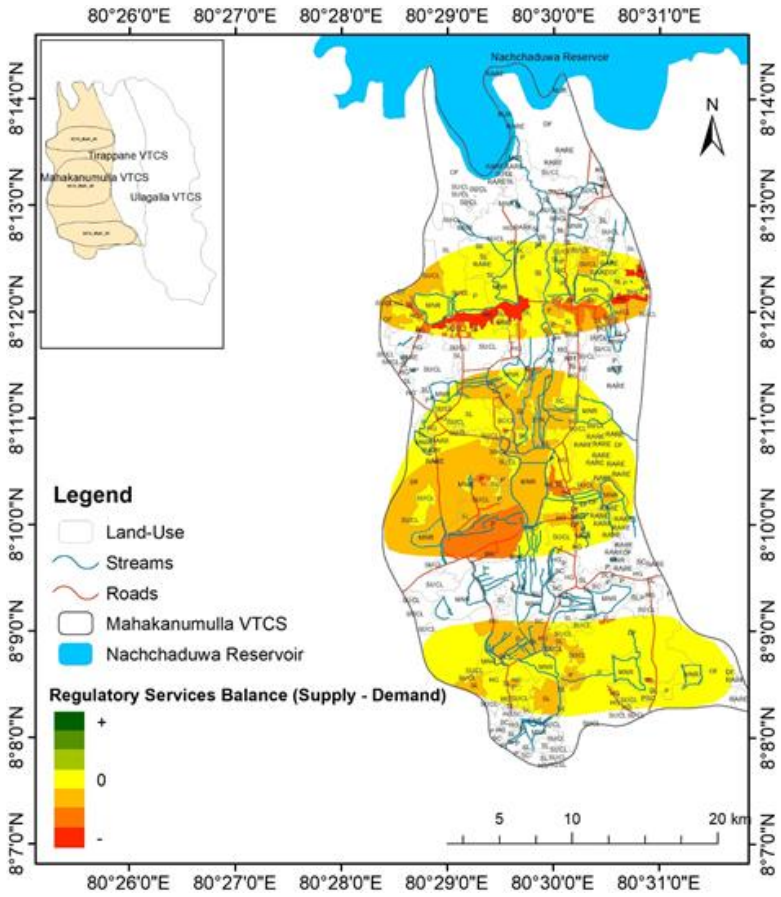

Figure 4.3. Provisional services provided across different landscapes in *Mahakanumulla* VTCS

4.4. Conclusion and recommendations

A comprehensive list of ESs arising from VTCSs has been prepared based on the perception of the community and other stakeholders. It is made available for using various purposes in the healthy landscape project as well as for any other purpose outside the project. There may be additions and omissions to this list meanwhile the main project is progressing.

We have further identified how the community in VTCSs prioritize ESs of VTCS and reported which might have various implications in the project. Paddy and other serial production, water for drinking, domestic use and irrigation were the most valued provisional services. Water balance and regulation and local climate regulations were tanked in the first place among the other regulatory services. Food security was the most valued support service arising from VTCS. Recreational and aesthetic value and culture, traditions, customs and practices in VTCS were the top ranked cultural services.

The capacity to supply ES, demand for ES and ES budgets are important elements in decision making for sustainable management of VTCSs. If ESs are not benefited to the community then it won't be a service to them any longer and thus suitability of the ecosystem would be under threat. The capacity of VTCS to supply ESs would be variable depending on the condition of its landscapes. We have assessed the capacity to supply and demand of ESs across various landscapes found in VTCS.

High and vary high relevant capacities were barely reported for supplying support services across landscapes in VTCS. The capacity to supply mostly range from 0 to 2 which indicate that there is comparatively a low capacity to supply provisional services expected from VTCS. The same situation was observed with respect to other service; regulatory services, support services and cultural services. Land degradation and changes land cover and land use and other changed in cascade ecology may be the causes of this. However, further studies are required to model and identify how changes in cascade ecology impacts on the capacity of the system to supply ESs.

The demand for ESs across landscapes were observed somewhat different between two VTCS under investigation which is not unrealistic because needs and perceptions can be variable among different communities. However, demand for provisions services were not observed significantly different between two VTCSs. There was still a high demand for paddy production, irrigation water in both systems. For rest of ESs the demand mostly ranged from 0 to 2 indicating available low demand for provisional services. There was a high demand for some regulatory services (pollination, nutrient regulation) and

support services from home gardens in *Palugaswewa* cascade which is not so in *Mahakanumulla* cascade. In both cascade, there is either relevant demand or high demand for cultural services associated with the village tank. In general, demand for ESs we not either high or very high across the landscapes in VTCS which mostly remained at a very low level to relevant level at present. Further studies are suggested (similar to what was suggested for supply side) carry out during the project to model and understand dynamics of ES demand together with it's determinants.

We have mapped ES supply, demand and budgets using Arc GIS and made available for using for various activities done int the Healthy Landscape Project. Mapping is a very powerful tool that is used to understand and explain complex phenomenon. Other information from different sources viz. modeling, statistics, remote sensing can be incorporated with demand supply and budgets of ESs both specially and temporally to visualize and understand complex phenomenon in the cascade ecology. This further facilitate decision making process towards sustainable management of VTCS. We recommend a comprehensive mapping study using GIS and remote sensing where the input from baseline can be incorporated with other indicators of demand, supply and budgets together with their determinant.

Key deliverables

Deliverables	Description
Comprehensive assessment on ecosystem services and functions in VTCS (Task B)	Ecosystem services prioritization, supply and demand, and tradeoff analysis presented Chapter 02 also provide impact of land degradation to the ecosystem services
Qualitative assessment of the role of VTCS ecosystem services in VTCS community health, food security and wellbeing (Task B)	This has been linked with above deliverable as well as Chapter 3 assessment of ecological values in both VTCS
Planned scientific papers drafted based on the above	All contents of the Chapter 04 have been designed, formatted and developed following the scientific writing guideline. Mr. Sujith Ratnayake, chief technical coordinator, and currently PhD student at UNE will be coordinated with Prof. Keminda Hearth and Dr H. K. Kadupitiya for the development of scientific (draft) paper in collaboration with relevant authorities of the baseline assessment. He will coordinate with the relevant Authors and Authorities for the final outcome.

CHAPTER FIVE

FOOD SECURITY AND HUMAN HEALTH

Summary

A Sri Lankan agrarian system, the "ellanga gammana" or Cascaded Tank-Village system in the Dry Zone, was designated as a Globally Important Agricultural Heritage System (GIAHS) by the Food and Agriculture Organization of the United Nations (FAO). The village tanks host a significant agro-biodiversity and wild biodiversity and constitute a unique buffer against natural disasters and climate change. The Cascaded Tank-Village System also contributes to efficient water management with water from one tank flowing to another, through a network of tanks and streams.

However, the continuation of the Cascaded Tank-Village System is threatened by the poor income of farmers, rural-urban migration of the youth, deforestation, and the degradation of the tank eco-system. Although ecological and agricultural importance was investigated, the impact of this system on human nutrition and health as well as food security yet to be evaluated. A baseline assessment on human nutrition, food security and health was carried out in *Horiwila* and *Thirappane* Village Tank Cascade System (VTCS) under the UNEP-GEF funded 'Healthy Landscapes: Managing Agricultural Landscapes in Socio-Ecologically Sensitive Areas to Promote Food Security, Wellbeing and Ecosystem Health'.

The objectives of the study were: (1) to assess human health, food security, nutrition issues, wellbeing, and impacts; (2) to characterize and identify locally available nutrient-rich/ healthy foods; (3) to find out information gaps in relation to nutrition and health and constraints to healthy food consumption; (4) to assess the impact of the current pandemic (Covid19). Qualitative and quantitative data were collected from 100 participants from villages situated in two cascade complexes in January 2021.

Nutritionally inadequate diet, especially low in calories and deficient in almost all micronutrients were observed in the study sites. The consumption of fruits and animal sources of foods was low. The variety of foods consumed was not satisfactory. Household food insecurity in the study population was 43%, which shows lesser access to nutritious and desired foods by the households.

Undernutrition as well as overnutrition, especially central obesity was prominent in the study population. High prevalence of non-communicable diseases and psychological distress was found in the study population. The participants of the study perceived that they have a food system which has the potential to provide nutritious and healthy foods and food security, but they admitted that the system is not utilized optimally due to socio-economic reasons. Although the food system in the village tank cascade system is highly vulnerable with current socioeconomic and nutrition transition in these rural communities, the food and ecosystem still show potential of building resilience at the farm/household level.

1. *Based on the findings of the baseline assessment, several recommendations are made.* Advocacy to the policy and law makers (Department of Agriculture, Environment, Forestry etc) is needed for the biodiversity conservation and sustainable use interventions.
2. Interventions should be done to conserve and restore the village tanks with the involvement of multi-stakeholders.
3. Farmer awareness and provision of necessary technical and infrastructure support.
4. Plan and implement programmes which promote the traditional and indigenous knowledge in their food production systems.
5. Conduct research to mainstream indigenous knowledge in conserving and popularizing the traditional landraces that will result in implementing effective adaptation action on the ground.
6. Provide farmers necessary awareness and inputs to enhanced popularity of organic and locally grown food.
7. Programmes should be carried out to build knowledge and understanding of native agriculture and food systems and help promote native communities' innovative ideas and best practices.
8. Programmes should be conducted to transfer the traditional knowledge in food culture using novel behavioural communication techniques.
9. Promotion of local traditional agriculture and local cuisines can be used to promote agro-tourism, eco-tourism and cultural activities.
10. Action has to be taken to provide access to better medical facilities to vulnerable groups such as elderly, adults and school children and awareness and behavioural change communication actions must be taken.

5.1. Introduction

Sri Lanka is a unique country which has a long tradition of agriculture for more than 2500 years. One of the significant features of the dry zone agriculture system is cascaded village tank system. A tank cascade is defined as a 'connected series of tanks organized within the micro-catchments of the dry zone landscape, storing, conveying and utilizing water from an ephemeral rivulet' (Madduma Bandara, 1985).

An improved definition was given later as 'an ecosystem, where land and water resources are organized within the micro-catchments of the dry zone landscape, providing basic needs to human, floral and faunal communities through water, soil, air and vegetation with human intervention on sustainable basis (Dharmasena, 2017).

The main feature of the Tank Cascade Systems is recycling and reuse of water through a network of small to large scale tanks. These irrigation systems with large number of interconnected reservoirs are believed to have evolved since the third century BC. The primary function of a village tank is to provide irrigation water to dry low-land plains for paddy farming during main cultivation seasons. In addition, water tank systems are complex man-made ecosystems involving many natural resources and providing a wide diversity of functions and services. The water tank ecosystems are comprised with economic (i.e., agriculture, livestock, fishing,), ecological (i.e., groundwater recharge, prevention of soil erosion and floods), and socio-cultural (i.e., domestic, leisure, festivals) and these functions are not independent from one another (Dharmasena, 2017). Considering the tank cascade system as a food ecosystem, the services provided by the system includes providing safe water for drinking, cooking and eating, washing and cleaning; source of water and food for livestock and wildlife; source of nutrition and quality food; providing a pleasant and cool microclimate and biodiverse environment that can be conducive to good mental and psycho-social well-being and places that enrich people's lives.

Four distinctive zones can be identified in a TCS such as (i) tank bund and tank bed, (ii) associated irrigation channels and paddy fields, (iii) protected forest in the catchment and rainfed uplands and, (iv) gangoda, (hamlet or high elevation household area) (Dharmasena 2010) as shown in Figure 5.1. Each zone had one or several components of ecological significance.

The strong association between people, tank and its environs has ensured the system sustainability in the past, but ignorance of this interactive association has threatened the functions of the biological components including the human being. However, in the last few decades, improper land utilization, poor crop diversity is prominently visible in this landscape. Sustainable Land Management measures are currently implemented on a less than 10% of the agricultural landscape. Intensive cultivation taken place in some areas has led to land degradation and consequent deterioration of the landscape health. Continual overexploitation of cascade ecosystem components, misuse of chemicals in agricultural lands and destructive human activities are believed to be affected globally important biodiversity as well as the human nutrition and health.

The UNEP-GEF funded 'Healthy Landscapes: Managing Agricultural

Landscapes in Socio-Ecologically Sensitive Areas to Promote Food Security, Wellbeing and Ecosystem Health' project seeks to address these problems by implementing management strategies for strengthening the restoration and sustainable management of selected village tank cascade systems (VTCS) in cascade landscapes for the enhanced provision of ecosystem services and protection of biodiversity. A comprehensive baseline assessment has been planned to consider the key elements related to land degradation, vegetation cover and biodiversity (including plant and animal genetic resources) and water quality. Other related issues of much interest to the project including human health and nutrition and diets, indigenous knowledge, gender, spiritual dimensions and wellbeing will also be addressed by the baseline assessment. Additionally, the baseline assessment also aims to make a rapid assessment of the direct and indirect impacts of the covid-19 pandemic in project locations.

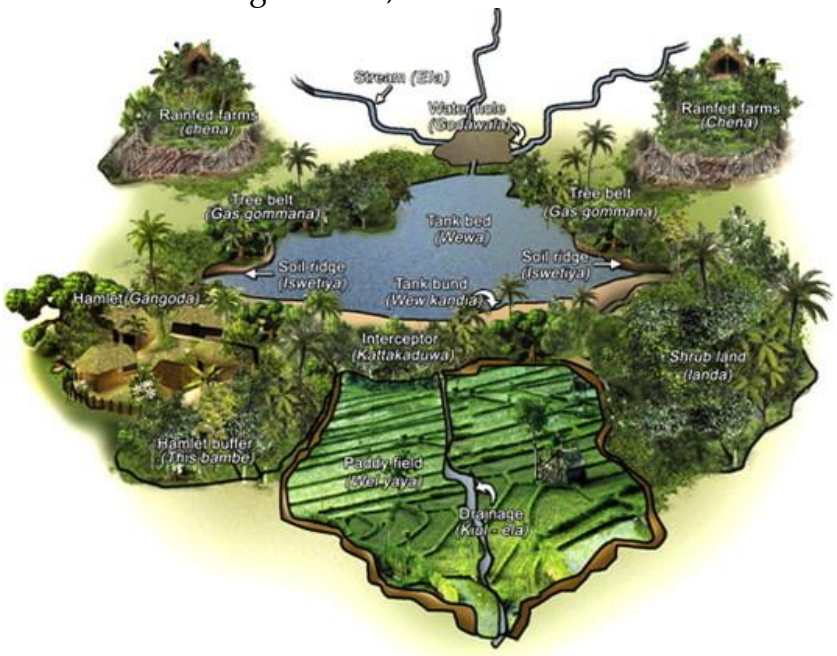

Figure 5.1. Components and their relative positions in the small tank system in Sri Lanka (Dharmasena 2010)

Objectives

The objective of the baselines assessment of the current socio-ecological and biophysical context in the Nachchaduwa Village Tank Cascade System (which includes the Mahakanumulla – Thirappane – Ulagalle triple VTCS complex) and the Horiwila Village Tank Cascade System (Palugaswewa-Bellankadawala double VTCS complex) project selected landscapes.

Specific objectives of the baseline assessment relevant to the thematic area: Human health and wellbeing, including assessment of diet and nutrition were to;

1. assess human health, food security, nutrition issues, wellbeing, and impacts
2. characterize and identify locally available nutrient-rich / healthy foods.

3. find out information gaps in relation to nutrition and health and constraints to healthy food consumption

4. assess the impact of the current pandemic (Covid19)

5.2. Methods

Setting

Baseline assessment sites include five VTCS belong to two landscapes; Nachchaduwa and Horiwila (tank cascade complexes), which consisted of 109 tanks spreading over total land area of 19,067ha. Figure 2 and 3 illustrate the selected locations demarcated by the research team representing the agroecological factors as well as socioeconomic factors associated with these locations, in the upper, middle and lower parts of the cascade system. Three geographical areas from Horiwila and two areas from Nachchaduwa tank cascade complexes were selected for the study. In this baseline assessment, a sample of 20 households were randomly selected from each study location. All households selected were primarily engaged in farming.

The participants were selected by the field officers based on the village they live and one member (an adult male or a female) participated in the study as the respondents. The selected participants were requested to gather at the common location (a village temple, farmer society building, or a common place) and all meetings and data collection interviews were conducted following the health regulations and guidelines for Covid-19 provided by the health authorities.

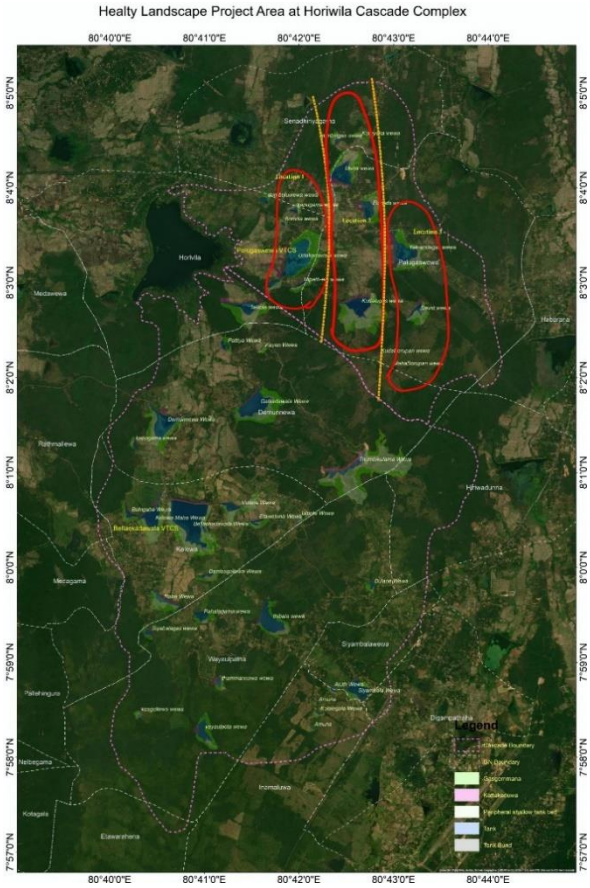

Figure 5.2. Sampling rings of the *Horiwila* landscape

At the beginning of the study, the study protocol was explained to the participants and written consent was obtained. The study protocol was approved by the Ethics Review Committee of the Faculty of Livestock, Fisheries & Nutrition, Wayamba University of Sri Lanka.

A total of 95 individuals (50 males and 45 females) participated in the study and completed the assessment of nutritional status, wellbeing, and physical activity level. Fasting blood glucose was measured from 85 participants and blood pressure was measured from all 95 participants. Only 89 (44 males and 45 females) participants completed dietary assessment and household food security assessment and provided

sociodemographic information. Data collection was done in January 2021.

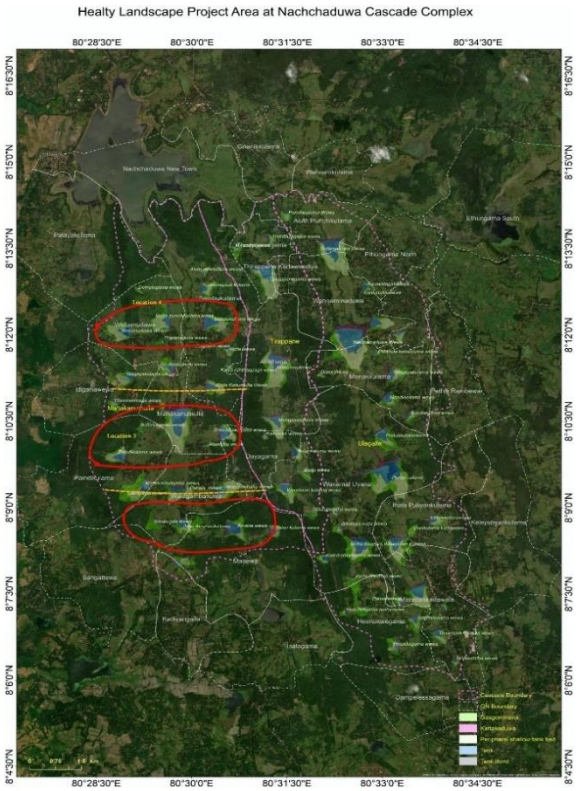

Figure 5.3. Sampling rings of the *Nachchaduwa* landscape

Plate 5.1. A section of participants – Horiwila

5.2.1. Approach of data collection:

Quantitative data

General information

The participants' socio-demographic data were collected using a questionnaire which consisted of questions about their education level and type of farming practices (Annex 5.1).

Plate 5.2. Data collection from participants of the study

Household food security

Food security status of the households were determined using Household Food Insecurity Access Scale (HFIAS) (Coates, et al 2007). The set of questions in this tool have been used in several countries and appear to distinguish the food secure from the insecure households across different cultural contexts (Annex 5.2).

These questions represent apparently universal domains of the household food insecurity (access) experience and can be used to assign households and populations along a continuum of severity, from food secure to severely food insecure. The questions of the HFIAS attempt to capture the household's perception of the quality of their diet regardless of the diet's objective nutritional composition. The information generated by the HFIAS was used to determine the prevalence of household food insecurity (access).

Plate 5.3: 24-hour dietary recall – interviewing

Dietary intakes and dietary diversity

All participants were individually interviewed by a trained interviewer regarding their past 24-hour dietary intake. The interviewer questioned the participants about all the foods and beverages consumed by them during the past 24 hours (24-hour recall). First the participants listed all the food items they consumed and then they were asked to quantify the portion sizes using household measures such as cups (eg. Tea, coffee etc), spoons (eg. Rice, vegetable curries, milk powder etc), glasses (eg. milk, herbal beverages etc.), numbers (e.g roti, eggs, banana etc) and sizes (eg. Size of a piece of fish, meat etc). The food preparation details were also asked by the interviewer (eg. Boiled, fried, mixed with other ingredients). The leftover food was also determined by the participants using the same household measures. The actual amount of food consumed by the participants were quantified into grams or milliliters using the portion size data available at the Department of Applied Nutrition, Wayamba University of Sri Lanka. The energy, macronutrients and selected individual micronutrient intakes of the participants were calculated using Food base 2000 software (Institute of Brain Chemistry, UK), which is updated with food compositions of Sri Lankan foods and dishes (Thamilini et al. 2014). Intake of energy and nutrients were compared with Estimated Average Requirement (EAR) and recommended dietary allowance (RDA) (World Health Organization, 2005, 2006, 2007; FAO/WHO/UNU, 2001).

Dietary diversity score (DDS) was calculated by summing the number of unique food groups consumed during last 24 hours using the information collected by 24 hour recalls. Food groups considered were: (i) cereals, (ii) white tubers and roots, (iii) vegetables, (iv) fruits, (v) meat, (vi) eggs, (vii) fish and other seafood, (viii) legumes, (ix) nuts and seeds, (x) milk and milk products, (xi) oils and fats, (xii) sweets, spices, condiments and beverages .

Food variety score (FVS) was calculated by summing the number of unique food items consumed during last 24 hours.

Nutritional status

The nutritional status of the participants was determined by measuring weight and height using standard methods. Body Mass Index (BMI) was determined by dividing the weight in kg by square of height in meters. The participants were categorized as underweight (<18.5 kgm^{-2}), normal (18.5 – 23 kgm^{-2}), overweight (>23 - 24.99 kgm^{-2}) or obese (>25 kgm^{-2}) based on the BMI cut-off values recommended for Asian populations. Waist circumference of the subjects were also measured taking the body circumference around umbilicus. The participants were categorized as centrally obese (> 90 cm and > 80 cm waist circumference for males and females, respectively) and having greater non-communicable disease risk and normal.

Health and wellbeing

Blood pressure (systolic and diastolic) was measured using a digital sphygmomanometer by a Medical Officer. Fasting or random blood glucose level of the participants were measured using a blood glucose meter.

Plate 5.4: Taking blood samples

The participants who were at risk of hypertension and diabetes were determined based on the measurement data obtained. Kessler Psychological Distress Scale (K10), which is a 10-item questionnaire intended to yield a global measure of distress based on questions about anxiety and depressive symptoms that a person has experienced in the most recent 4-week period (Kessler et al, 2002) was administered by a trained interviewer (Annex 5.3). The participants answered the questions as 'None of the time' (score of 1), 'A little of the time' (score of 2), 'Some of the time' (score of 3), 'Most of the time' (score of 4) and 'All of the time' (score of 5) and the scores were assigned. The numbers attached to the participant's 10 responses are added up and the total score was calculated as the score on the Kessler Psychological

Distress Scale (K10). Scores range from 10 to 50. The participants' psychological wellbeing was determined as likely to be well (score under 20), likely to have a mild mental disorder (score 20-24), likely to have moderate mental disorder (score 25-29) and likely to have a severe mental disorder (score over 30).

Plate 5.5. Health assessment

Physical activity level of the participants was assessed using the short version of International Physical Activity Questionnaire (IPAQ) (Annex 5.3).

Qualitative data

Focus group discussions

A focus group discussions (FGDs) guide was developed by the investigators based on the objectives of the study (Annex 5.4). The guide included three modules: Perceptions on healthy diet, Perceptions on food security and Physical, socioeconomic and institutional evolution of the village tank cascade systems. Each module has 4-5 questions with probing questions.

The focus groups were conducted by a trained moderator assisted by another investigator. All questions were asked in Sinhala language. Focus group discussion norms such as using pauses, probes and creating a friendly environment were maintained to have effective and attractive discussions with particular participant groups. Further, the moderators were trained to use subtle group control like making shy participants to talk by controlling the dominant speaker. The assistant moderator was trained in taking notes,

recording nonverbal behavior and audio recording of the conversations.

Plate 5.6. Focus group discussion

Five separate groups of participants from selected five different sites participated for FGD. Each FGD included 8-10 participants. The moderator explained the importance of contribution of all participants in the discussion and emphasized that there are no "correct" answers. FGD lasted approximately 45–60 minutes per focus group. At the end of each question, the moderator verified the discussion points, summarized responses using themes identified throughout the discussion, and welcomed input from participants on any missed points.

Key Informant Interviews

Five (5) key informants, one from each site selected for the baseline survey, were interviewed. Key Informant Interview (KII) guide was developed based on the objectives of the study which comprised 10 questions (Annex 5.5). KII were lasted approximately 45-60 minutes. While the moderator conducted the interviews, the assistant moderator took notes of participants' comments and nonverbal behavior.

All the discussions and interviews were conducted until the information get saturated.

Analysis of qualitative study data

All the FGDs and KII were audio recorded with the permission of the participants. A verbatim, written transcription of the focus groups and individual interviews in the local languages was made from the audio recordings. They were transcribed verbatim including questions, answers and probes. Transcripts were reviewed by two investigators against audio recordings for accuracy. The transcripts were then translated to English. Using the content analysis procedure, data were coded manually, and then codes were organized into subcategories and categories. All the responses of the participants were grouped based on the similarities. The themes were developed from those similar responses. The themes described the responses. Some of the responses were further grouped into subgroup within the responses. Those subgroups within the group were described by the subthemes. Quotes were extracted from the transcripts to illustrate participants' responses relevant to the categories which were found.

5.3. Results

5.3.1. Sociodemographic characteristics

Table 5.1 shows the sociodemographic characteristics of the participants. Both males and females in approximately equal proportions attended the study. Majority had educated up to General Certificate in Education (Ordinary Level). Majority engaged in crop farming as the main income source. Household income of the majority of the households were reported to be less than LKR 20,000 per month.

5.3.2. Household food security (access) status

Figure 5.4 illustrates the household food security status. Majority (57%) of the households were food secure whereas 43% of the households were food insecure. Severely food insecure households (8%) were also fund in the study sample.

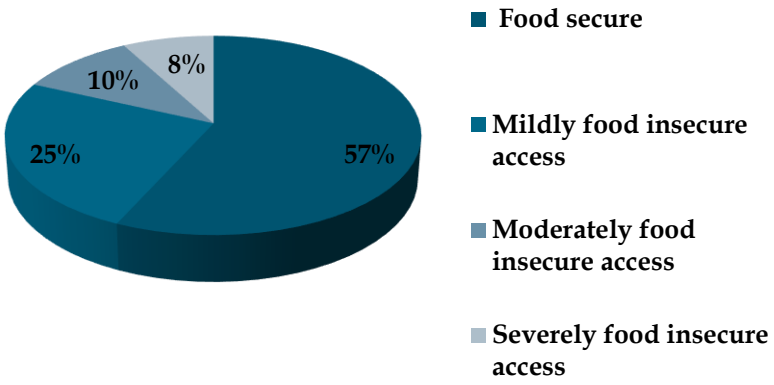

Figure 5.4. Food security status of households (n=89)

Table 5.1. Socio-demographic characteristics of the study population

	Male (n=40)		Female (n=49)		Total (n=89)	
	n	%	n	%	n	%
Age category (years)						
18-60	22	55.0	27	55.1	49	55.0
>60	18	45.0	22	44.9	40	45.0
Educational level						
Never gone to school	0	0.0	2	4.1	2	2.2
Primary Education	10	25.0	18	36.7	28	31.5
Junior Secondary Education	23	57.5	17	34.7	40	44.9
Senior Secondary Education	7	17.5	12	24.5	19	21.3
Higher Education	0	0.0	0	0.0	0	0.0
Monthly income of households (LKR)						
< 20000	-		-		46	51.7
20001 - 30000	-		-		16	18.0
30001 - 40000	-		-		11	12.4
40001 - 50000	-		-		9	10.1

>50000	-	-	7	7.9
Primary type of income				
Crop farming	-	-	77	86.5
Livestock farming	-	-	0	0.0
Aquaculture farming	-	-	3	3.4
Other occupation	-	-	4	4.5
No specific income source	-	-	5	5.6

5.3.3. Dietary intake of nutrients

Table 5.2 shows the energy and macronutrient intakes of the adult males and females. Mean energy consumption was lower than the daily amount of energy recommended for Sri Lankans.

Table 5.2. Mean energy and macronutrient intake of adult males and females

	Male (n=40)		Female (n=49)	
	Mean	**SD**	**Mean**	**SD**
Energy(kcal)	1703	558	1159	417
Protein (g)	43	13	30	10
Fat (g)	44	19	33	13
Carbohydrates (g)	302	110	197	83

More than 55% of the energy (recommendation) came from carbohydrates, whereas contribution of energy from protein and fats was lower than the recommended level (15% and 25-30%, respectively) showing imbalance in the macronutrient intakes (Table 5.3).

Table 5.3. Percent energy consumption from macronutrients

	Male (n=40)		Female (n=49)		Total (n=89)	
	Mean	**SD**	**Mean**	**SD**	**Mean**	**SD**
% energy from carbohydrate	66.5	7.2	63.0	6.9	64.8	7.3
% energy from protein	11.3	6.3	11.4	6.9	11.4	6.6
% energy from fat	23.1	7.1	25.6	6.7	24.7	7.0

Table 5.4 shows the intake of micronutrients. The intake of all selected micronutrients given in the table were lower than the RDA values. Especially, calcium, thiamine, riboflavin, vitamin B6, vitamin B12,

folate, vitamin C and vitamin A provided less than 50% of the recommendation (NAR). The mean adequacy ratio was 0.42 (48%).

Table 5.4. Mean intakes (SD) of selected micronutrients, nutrient adequacy ratio (NAR) and mean adequacy ratio (MAR)

Nutrient	Mean intake	SD	RDA	Mean NAR
Calcium (mg)	351.2	203.1	1000	0.35
Iron (mg)	7.9	3.9	13.7	0.60
Zinc (mg)	6.1	2.9	7	0.87
Thiamine (mg)	0.5	0.5	1.2	0.48
Riboflavin (mg)	0.4	0.7	1.3	0.33
Niacin equivalent (mg)	13.4	6.7	16	0.87
Vitamin B6 (mg)	0.6	0.4	1.5	0.43
Vitamin B12 (mg)	1.0	1.1	2.4	0.43
Folate (μg)	131	65	400	0.32
Vitamin C	15	11	45	0.34
Retinol equivalent (μg)	162	129	600	0.28
MAR (SD)				**0.42 (0.13)**

5.3.4. Dietary diversity

Table 5. 5 shows the mean DDS and FVS, which indicates the dietary diversity of the participants. Mean DDS indicates that the study group consumed 6 to 7 food groups out of 12. The mean number of foods consumed by the study group (FVS) is around 9 per day.

Table 5.5. Dietary diversity indicators

Dietary diversity indicator	Mean	SD
DDS	6.7	1.3
FVS	9.4	2.7

All households consumed cereals in the previous day of the survey (Figure 5.5). Fats and oils and sugars (sweets) were consumed by nearly 99% of the households. Vegetables are the other food group mostly consumed (96%) followed by legumes, fish and sea foods. Fruits were consumed by only 52% of the participants. Consumption of milk and milk products, tubers and roots, meat and egg consumption was observed in lesser proportion of participants.

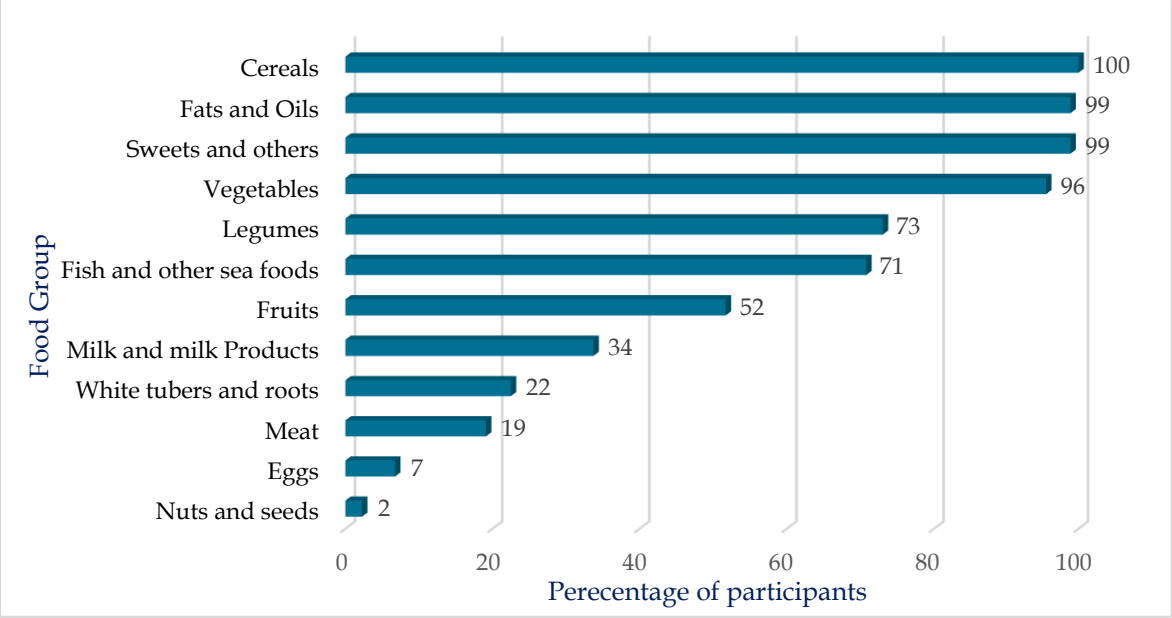

Figure 5.5. Percentage consumption of different food groups on the previous day of the survey

5.3.5. Nutritional status

The nutritional status of the participants is given in the Table 5. 6. Of the participants, nearly 17% were underweight. In contrast, 27.4% and 18% were overweight or obese. Central obesity was reported in 41% of the participants and the majority of them were women.

Table 5.6. Nutritional status and prevalence of central obesity

	Male (n=50)		**Female (n=45)**		**Total (n=95)**	
Nutritional status (BMI kgm^{-2})	n	%	n	%	n	%
Underweight (BMI <18.5)	10	20.0	6	13.3	16	16.8
Normal (BMI 18.5 - 22.9)	19	38.0	17	37.8	36	37.9
Overweight (BMI 23 - 24.9)	15	30.0	11	24.4	26	27.4
Obese (BMI 25<)	6	12.0	11	24.4	17	17.9

Central obesity (waist circumference cm)						
Obese:	7	24.0	32	71.1	39	41.1
>90 (males); >80 (females)						
Normal:	43	86.0	13	28.9	56	58.9
<90 (males); <80 (females)						

5.3.6. Physical activity level

Figure 5. 6 shows the physical activity level of the participants. Majority of the males and females were physically active.

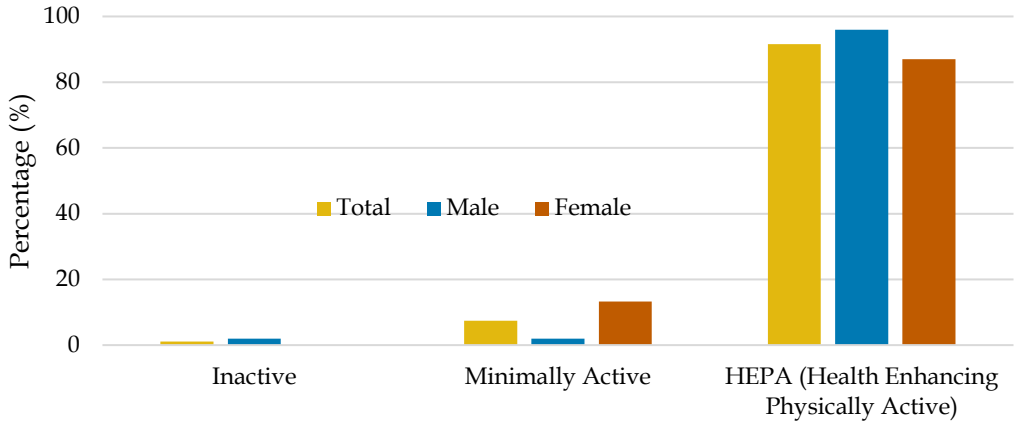

Figure 5.6. Physical activity level

5.3.7. Prevalence of diabetes, hypertension and level of psychological wellbeing

Table 5.7 presents the prevalence of diabetes and hypertension of the participants of the study.

Health status	**Male**		**Female**		**Total**	
	n	**%**	**n**	**%**	**n**	**%**
Diabetes (n=85)	24	53.3	21	52.5	45	52.9
Blood pressure (BP) (n=95)						
Hypertension stage 2	18	36.0	22	48.9	40	42.1
Hypertension stage 1	17	34.0	10	22.2	27	28.4
Ideal blood pressure	14	28.0	13	28.9	27	28.4
Low blood pressure	1	2.0	0	0.0	1	1.1

Nearly 53% of the study participants had blood glucose values greater than the normal, or previously diagnosed as type 2 diabetics. Hypertension was reported in nearly 70% of the participants. Since the study group was not a representative sample of the studied villages, we are uncertain whether higher participation of individual who seek medical assistance from the researchers had any impact on the results. However, results showed alarmingly higher rate for a small population group of the selected villages.

Figure 5.7 shows the participants categorized according to their status of psychological wellbeing. Only 47% of the participants had normal psychological wellbeing status whereas 53% shows mild, moderate or severe psychological distress.

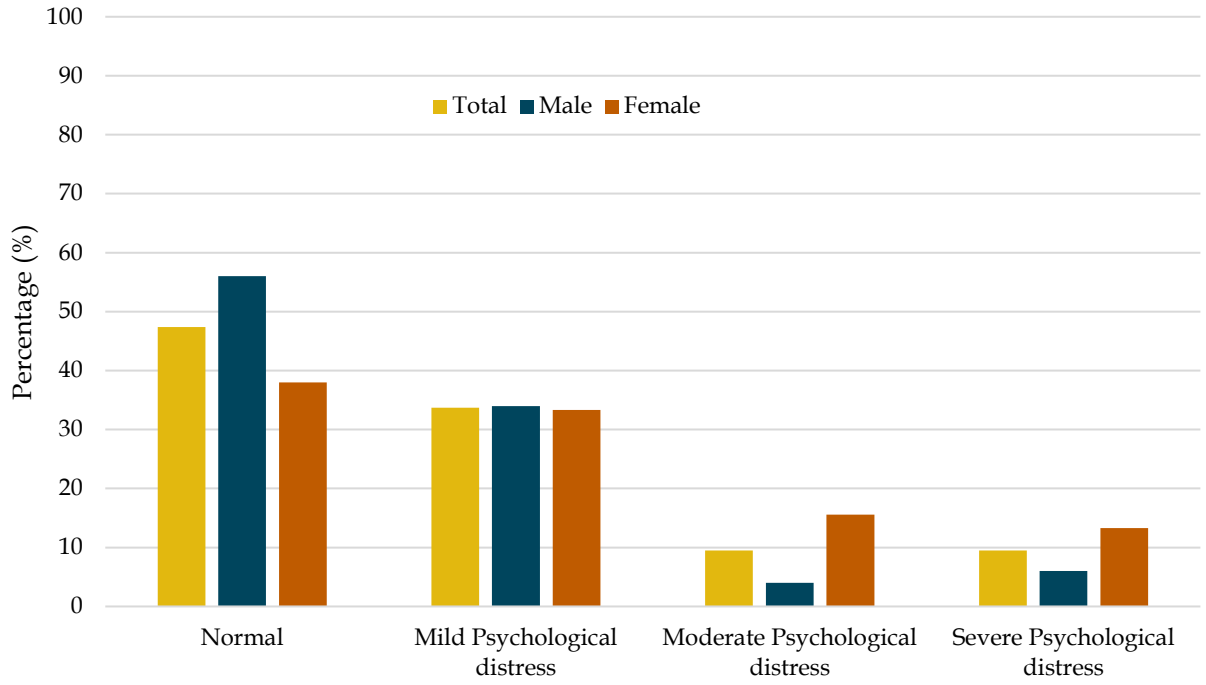

Figure 5.7. Psychological wellbeing

5.3.8. Qualitative study findings

Focus group discussions.

- **Theme 1: Perceptions on healthy diet**

Rice is the major staple food item consumed by the participants for all three major meals.

> "Usually, in our village rice is the major food consumed as the breakfast"
> "What we all get used to eat as a main meal is rice"
> "Our main food is rice"

In addition, flour-based food items and pulses are consumed in major meals by the villagers.

> "Once or twice per week we eat foods like bread, string hoppers"
> "For the breakfast we eat string hoppers, roti, cowpea, green gram and chickpeas"

The participants listed a variety of foods under different food groups claiming that they consumed them frequently.

Food group	Food items
Fruits	mango, papaya, guava, wood apple, banana, seasonal fruits (*Damba*, Ceylon olives, *Palu*, *Veera, Nelli, Kon*)
Vegetables	Green leafy vegetables, long beans, brinjal, winged beans, *kekiri*, pumpkin, drumstick, ridge gourd, ladies' fingers
Cereals/Grains	Rice, corn, finger millet
Legumes	Cowpea, mung beans, chickpea
Milk products	Milk powder, curd, yoghurt
Fish and meat	Tank fish, sea fish, chicken, wild animal meat

When asked about what they mean by a healthy/nutritious diet and its characteristics, most of them recognized it as a diet which goes along with the concept of balanced diet. They said it should have foods from major food groups.

"It should have varieties of Green leafy vegetables, grains, fruits, meat fish, milk, eggs"

Furthermore, they mentioned that a balanced diet should have vitamins and such a diet gives energy and maintains body functions

"Foods give much calories to the body"
"In order to maintain our body and to get energy, should eat three complete major meals"
"Meal contains energetic and foods help to stimulate the growth, balanced diet is called as nutritious food"

They get their food from several sources such as paddy fields, chena, tank and home gardens. Participants reported that the Maha season as the season which gives relatively higher harvest, therefore the availability and accessibility of foods are greater in this season.

"Higher availability is in Maha season"
"Relatively higher quantities are available in Maha season"

The major crops cultivated during Maha season is rice. In addition to paddy cultivation, growing vegetables and other grains is commonly practiced.

"Now this is Maha season. Now we are targeting mostly Capsicum, Ridge gourd, Brinjal, Chili… etc. Paddy cultivation is over now"
"In Maha season – we grow corn as a land crop and also finger millet"
"……..also, vegetables, mustard, cowpea, mung beans, mango……."

"In Maha season – we grow corn as a land crop and also finger millet"
"……..also, vegetables, mustard, cowpea, mung beans, mango……."

They said Yala and the intermediate seasons have several fruits and vegetables. Mainly they grow those crops in Yala seasonal in chena.

"In Yala…we grow onions like things in large scale, and also rice and vegetables"
"Vegetables and fruits are common in Yala and intermediate seasons"

"In Yala…we grow onions like things in large scale, and also rice and vegetables"
"Vegetables and fruits are common in Yala and intermediate seasons"

We asked the villagers about the foods that they get from different parts of the village. The following table shows the summary of the responses given by the participants.

Sources	Food items
Below the tank bund	Fruits - *himbutu* Green leafy veg - *Mukunuwenna, gotukola, kankun, kara kola, lee kola*
From the tank	Tank fish – *theppili, lula, hunga, magura* Other foods - *Olu,* lotus stem, *kekatiya*
Paddy field	*Kiri handa kola, thal kola, monara kudumbiya*
Village forest	Green leafy vegetables - *Kowakka, anguna kola* *elabatu*, Bitter gourd, *thumba karawila, gon karapincha, paaliya, damba, wal batu, nelum batu, karamba, palu, weera, eraminiya, kothala himbutu, gal siyambala*, tamarind, Ceylon olives, *Nelli, Kon*, wood apple
Homegarden	Fruits - Sweet orange, guava, papaya, jack fruit, *ambarella*, pomegranate, mango, papaya, guava Root vegetables – *kiri ala*, cassava

Tank fish species (*wew malu*) are the most common food type they obtain from the tank. They have the perception that compared to the past, most of the fish species have become unavailable due to introduction of new fish species to the tanks.

> ”Now, the tank fish varieties we had in the past are not widely available”
> “Most of the fish types are not available now, which were there in the past”
> “*Lullu, Kavaiya, Hunga* are the only varieties available from the past times. Kokassu like species are not available anymore now”

The amounts of fish consumed from the tank is also becoming lower than in the past due to religious beliefs and less availability may have also affected the consumption patterns.

"Now our population is higher. Fishery is practicing in a limited number of tanks and that small amount is distributed among large number of people"
"People are not catching fish as previously as it is a sin."
"The thing is this is a village and a temple. Temple becomes the most important. Monks are here in the temple. Due to the advice of monks, all the fish catchers stopped their activities."
"Previously we used hook and catch the fish. Now we prevent that practice even among our children. We do not let them catch fish using even hook. They don't get into the lake now".
"Due to village and temple concept, people are less likely to practice those things."

Food supply from village forest has become limited to a few numbers of vegetables and fruit varieties. Due to changes in the land use pattern and clearance of more land for increasing population, previous food sources are not available. We questioned the participants regarding their perceived health and nutritional benefits of locally available foods. The villagers believe that several food items traditionally grown in their villages give nutritional/health benefits. Most of the ideas ate linked with Ayurvedic views. The generally

"When we are doing a chena, after cultivating it for 2 or 3 times, we abandon it. Thereafter weeds are growing naturally in those lands. In chena, we grew everything like brinjal, green leafy vegetables etc. and we went there with our parents. Green leafy and other all vegetables are taken from the village forest. Now such things are vanished or destroyed".

"In the past, there were lands with several trees full of *karamba, eraminiya, indi* in bunches. Now they are not available. Now those lands are cleared for chena and then abandoned. That's why mostly these consumption patterns have been changed."

believe that certain foods are categorized as 'cold' or 'hot', which are not suitable to consume sometimes.

The benefits of consuming specific food items are well explained by the elders.

> "What we all know is these foods are cold foods and these foods are hot foods. As I know foods are consist with 80% of water. Jack fruit, breadfruit like foods give relatively higher energy to our body than other foods. Breadfruit like foods are considered as a hot food. The energy absorbed to the body is lower when it comes to cold foods. That kind of fruits and vegetables are considered as foods important to boost the immunity against disease"

Most of the knowledge came from the family and as a tradition. The participants were able to name food items which are good sources of nutrients.

> "It is said that *Gotukola* is good for the blood circulation. *Mukunuwenna* is good for the vision. Also, it is said that those are cold foods. If we eat spinach, iron will absorb to our body as far as we know."
> "If we eat sprats, calcium is there. Protein is present in the dried fish"
> "Vitamin C is there in the fruits. Carbohydrate is present in the root vegetables"
> "Fat is present in the dairy"
> "Dairy is good for the bone formation"
> "Vitamins are good for the vision"
> "Green leafy vegetables are good for the hair, vision, skin"
> "Some foods are good for the prevention of diseases"

It seems that the food preference of the villagers has been changed with time. Some younger family members do not like to eat the foods traditionally being eaten.

> "To tell you the truth, our children do not eat these foods we mentioned. They get used to meatballs, sausages, fish, meat… etc."
> "They don't eat foods like finger millet flour roti"
> "Some are not eating freshwater fish…..especially children"

Physical characteristics like appearance and texture of the foods are the major reasons for the less preference of younger generations. Also, such foods are not preferred due to availability of instant foods (means…it takes time to prepare village grown foods).

> "The color may be a problem. They don't like the color of finger millet flour"
> "Now children got used to instant foods like noodles from very young age"
> "They don't like the taste of finger millets"
> "When considering vegetables also, they don't like to eat winged beans, bitter gourd, ladies' fingers like vegetables, due to bitter taste, roughness/rough texture etc."

- **Theme 2: Perceptions on food security**

Villagers believe that they can produce foods in sufficient quantities for their own consumption except the foods which are not grown in the country. Foods like potato, cabbage, carrot, leeks which cannot be grown in the dry zone and other essentials like dhal and sugar have to be imported.

They had mixed thoughts about the safety and the nutritional values of the foods they grow in their own lands. They assured the safety of the foods that they grow for their consumption only in their home gardens as they are free of chemicals, pesticides and weedicides.

> "Nutrition quality is also higher. We do not add any pesticides and fertilizer. We were advised to put compost. We were advised to grow what we need at least in a polythene bag in order to get the foods we need. Therefore, almost all are practicing it. Something we need to prepare a meal is there, at least grown in a small plot or pot. If we have an *ambarella* tree or *kekiri* or cucumber, we pluck it and prepare as a meal"

But they believe that the foods grown in large scale (mostly in paddy fields and chena) are not safe, as they add fertilizers and chemicals for that crops.

> "Nutrition wise quality is lower because we add fertilizer and pesticides. Even for the lime"

The participants had the perception that most of villagers eat somewhat balanced diet.

"Not successful in 100%.....but we take some kind of balanced diet"

"When preparing meals, sometimes it may not be achievable. But it's not due to unavailability of foods……. food is available. But there are some situations we couldn't think about the balancing of our diets. Sometimes due to hurry/busy lifestyle"

There seems to be some barriers to consume their own food. The elder men and women think that people's negative attitudes affect the food habits.

"Let's take sweet orange……. it's a nutritious food. But now they import oranges from another countries. Our one is only Rs.10 and the imported one is Rs.30. but our people buy the imported one"

"What I am saying to our people is, every day they buy flowerpots and grow some flowers. Rather than that, they can grow a vegetable like long beans or brinjal etc. and put some water to it. It's worth rather than spending money for a flower plant. Along with the fences they grow some flowers. That's not the thing should be done. They can grow bitter gourd or any other twines. Then we can get foods to eat which are free from toxic substances. This kind of practices should be changed. Rather than flowers what we need is vegetables, to consume. They can grow at least a long beans twine, and it will last many months without getting damaged from rain or whatever".

Economic issues such as low income, wild animal attacks which destroyed the crops and lack of government support in particularly related to land policies are some of the obstacles they face.

"There were some situations that ¼ of the paddy field destroyed due to wild animal attacks"

"The other major problem we are facing is the damage due to wild animals, and that's the reason we are getting lesser income. As we think more than 50% loss. Farmers are depressed due to this. Please inform the media and higher government authorities about the damages caused by wild animals. That means we are really in a bad condition due to damages from wild animals".

"Recently, government provided 25 kg onion seeds. We prepared nursery beds and finally monkeys destroyed whole 25 kg"

The villagers showed strong dissatisfaction and concerns regarding allocation of land to the people and expressed their view about problems related to agriculture.

> "Now our village forests have been also converted into reservation areas - *rakshithaya*. Previously the farmers did their cultivation and we have our paddy fields in that area. But now we do not have land for cultivation and for the chena because it all converted as a conservation area"
>
> "……other thing is that they provide 10-15 acres lands to people who have some ability or income. Poor people who don't get lands. The land that I have been cultivating since 1968, has not legally owned by me. Although if we cultivate a chena there, those who have the power will take over those lands after some time. It's because of the politics."
>
> "Government can reduce taxes for tractors, spare parts of the tractors, agro chemicals etc, they can impose some regulations or have some programmes for that"

Adverse weather conditions also affect the farming. Unexpected weather changes experienced in the last few years gave low yield. Drought or excessive rain was experienced by them.

> "Due to heavy rain, there will shortage of vegetable stocks in the shops. Therefore, will need to buy it on higher prices"
>
> "The major problem all of the villagers are having is water shortage if lake is dried off"
>
> "Sometimes, rain is also not there when we are expecting"

The participants were asked whether they think that the households in the village are able to get all the foods (safe and nutritious) they prefer in adequate quantities, all the time. They generally accepted that the food is available.

However, the answers of the participants showed that accessibility to the food that they want is an issue due to poor economy of the families. They admitted that some families are unable to get nutritious food s hence unable to have a balanced diet. According to the participants, they give their priority for the convenience and the price of the food items when selecting foods for the consumption.

"Yes, food is available in shops or in town"

"If money is there, goods are available in enough quantities"

"Now our society has been changed and therefore the food consumption patterns also changed. We all are searching for some convenience methods……therefore mostly use instant and artificial (meaning processed) foods"

"To tell the truth, due to current economic situation and higher prices of commodities, some people in our village are unable to consume a nutritious diet. We don't have foods to eat what they show via advertisements in the television."

The participants were asked about the coping strategies they adapted when there is a food shortage. The participants however had not faced such kind of food shortage recently. Even during temporary lockdown period due to recent Covid19 pandemic, the villages were able to maintain their livelihood and food consumption as they utilized the foods available in their surrounding food system. They anticipate that they have ability of consuming what is available in the village if such situation arises. Exchanging foods, preservation of food or food aids from the government help them to cope up with the situation. Restricting their choices and contained to the foods available in the village is the most common option

"The thing is we, villagers have a habit of consuming meals as a villager. As urban dwellers, we do not need to eat foods like sausages. Therefore, we can find or buy foods what are available in the village and from the surrounding"
"Some are having more space to grow vegetables in relatively large scale. So we exchange our foods among ourselves."

"If foods are not available in households, we purchase them from the market. Foods like instant foods, dhal, soya, potato etc."

"If vegetables are unavailable, we tend to find something like *Elabatu* from our home gardens and make some dishes which can consume."

"During some seasons, we are drying foods like brinjal and preserve them for later consumption…. another example, jack fruit is preserved after boiling and drying".

The participants suggested some strategies to overcome food shortages or related issues in their area. They prefer self-employment opportunities, more awareness about food preservation techniques and better training on food production practices.

"Vegetables grown in Maha season cannot keep remained until Yala season. Therefore, we sell the whole lot. We can consume it in Yala season if preservation methods are available"

"It's also better if someone can educate us about new fish cultivating methods"

- **Theme 3: Physical, socioeconomic and institutional evolution of the village tank cascade systems**

When asked about the problems associated with water resources in tank systems and associated ecosystems, they told that the tank system is slowly destructing.

"Yes, have a huge problem. Our lake becomes like a forest due to formation of mosses. All the dirty things have accumulated there"

They mainly have an understanding that the rain pattern is the main factor which affect the increasing or decreasing water resources in the tank systems, but generally have no deeper understanding on destruction of the surrounding environment has an effect on it. Rather than understanding the root causes of the problems associated with tank cascade system, they expressed their views regarding the problems they face in the day-to-day life. The water unavailability in adequate quantities has affected the paddy cultivation.

We asked the suggestions of the participants to promote the food that are

"……. if the tank is not filled, we couldn't eat rice. It's totally destroying"

available in the village. The participants suggested to promote the cultivation

"Nowadays finger millet like crops are not even cultivated in our villages. Previously it's not like that. These all people were had a finger millet Chena. Corn, finger millet, *kekiri*, green leafy etc, all were there previously. I mean we ate those in that times. But nowadays children are not (doing it)."

of minor crop varieties. Need for better quality seeds, especially the seeds of traditional varieties, which cannot be found at present.

Provision of infrastructure facilities such as irrigation and rehabilitation of tanks were emphasized by the participants. Also, they expect a solution for wild animal destruction of their crops.

"Last year they finished the reconstructions. Now the remaining is to remove the mud. If it's also removed, we can utilize tank water productively".

Although, the interviewers focused the questions on tank cascade system and how its present situation affect the food consumption, the participants were not very sensitive on the food system. They just focused on the problems they face but not the strategies of exploiting the food system and optimize their family food, nutrition and health

Theme 4: Food patterns connected with the village tank and agriculture (KII).

Six (6) key informants were interviewed to get specific information regarding the food patterns of the villagers. They explained the typical meal patters of the villages as follows:

- Breakfast – mostly rice (but lazy to cook rice), with vegetables or pol sambol or bread or string hoppers (mostly from shops)
- Lunch – rice with vegetables (pumpkin, long beans, cucumber, ridge gourd, bitter gourd, snake gourd etc. and sometimes with fish)
- Dinner – rice with vegetables and fish (t*heppili* as tank fish or sea fish) or chicken

The villages consume most frequently banana, guava and pineapple as fruits

A variety of green leafy vegetables are consumed for lunch – e.g *kowakka, thampala, polkudupala*, moringa, *kathurumuranga*, *mukunuwenna, gotukola*

In addition to rice, finger millet is also consumed. Cowpea and mung bean are the major pulses grown in the village.

The KIIs reported that following food items were consumed by them in their childhood (at least 5 decades ago).

Food group	**Food item**	**Where were they grown? (around the tank; inside the tank; paddy fields; chena; homegarden; wild (bare lands and forest)**
Cereals	Rice – *heenati, pachchaperumal, suwandal*	Paddy fields
	Finger millet	Chena
	Maize	Chena
Vegetables	Long beans	Chena

	Ridge gourd (*niyan wetakolu*) Ladies' fingers (*hen bandakka, athdala bandakka*) *Elabatu* *Thibbatu* *Kekatiya* *Herala* *Nelum, manel ala*	From the tank
Green leafy vegetables / herbs / flowers	*Lee kola* *Kara kola* *Gandapana* *Kowakka* *Girithilla* *Kuppameniya* *Wel Gotukola* *Mukunuwenna* *Udaththana kola*	Wild Around the tank
Fruits	*Mora* *Maadan* *Katukaaliya* Tamarind *Kothala himbutu* *Thimbiri* *Goda weralu* *Weera* *Palu* *Karamba* *Eraminiya*	Wild
Pulses	Black gram Mung beans *Meneri* Horse gram *Boo maa*	Chena
Fish	*Lula* *Magura* *Eel* *Theliya* *Pethiya* *Kokassa* (Note: rarely ate sea fish)	Tank
Meat/Eggs/Milk	Curd	
Beverages	*Ranawara* *Ikiriya* *Beli mal* *Pol pala*	Wild/Homegarden

The health and nutritional benefits of the food items perceived by the KIIs are as follows:

- Kowakka, finger millet – sugar control
- Mango – good for digestion
- Kohila – good for stomach
- Green leafy vegetables – good for vision, skin, immunity
- Vegetables (ridge gourd, snake gourd, cucumber) – good for immunity
- Rice – good for fractures

They also had the opinion that the foods can be classified as hot and cold. Some foods were not consumed by people if doctors said not to eat these specific foods because they are unhealthy or bad for a specific health/disease condition.

KIIs said most of the foods they consumed a few decades ago are now not consumed as the present generation do not prefer them or due to lifestyle changes (i.e. busy life, convenience etc).

When specifically asked about how people coped with recent covid19 lockdown or restrictions, they had the opinion that food availability was relatively higher during that period. Mobile retailers delivered foods to doorstep. If money is available and the economic situation is good, villagers were able to cope with the situation well. Also, they said that people found foods from their surrounding and grow many crop varieties than previously.

When asked about the changes happened in the village tank ecosystem in the past decades, they mentioned that deforestation and development projects took place due to political influences. Furthermore, the people changed their attitudes and perceptions towards the environment and adverse weather changes occurred due to climate changes.

Such transitions had caused unavailability of some food items – olu ata, honey etc. and people's preferences had been shifted to more convenient processed foods. These have contributed to under nutrition of children (underweight) and NCDs, particularly kidney disease and diabetes.

They suggested following actions to **preserve** and **promote** the healthy foods that are available in the village.

- Environment conservation
- Systematic land allocation for crop production
- Re-forestation
- Awareness about nutrition and health benefits of foods
- Strengthening local farmers – buying harvest by government or private sector
- Controlling prices of instant foods, bakery products

5.4 Conclusions

- The participants of the study had an overall nutritionally inadequate diet, especially low in calories and deficient in almost all micronutrients. They

consumed relatively low amount and frequency of fruits and animal sources of foods.

- The variety of foods consumed was not satisfactory. On average, only 6-7 food groups out of 12 food groups and around 9 individual food items were consumed by the participants on a normal day.
- Household food insecurity in the study population was 43%, which shows lesser access to nutritious and desired foods by the households.
- Undernutrition as well as overnutrition, especially central obesity was prominent in the study population. This shows the consequences of imbalanced diet. Also, we speculate that this population may have some other lifestyle factors or genetic predisposition to obesity, which may have a root in their childhood nutrition.
- High prevalence of non-communicable diseases and psychological distress was found in the study population.
- The participants perceived that they have a food system which has the potential to provide nutritious and healthy foods and food security, but they admitted that the system is not utilized optimally due to socio-economic reasons (low income, lack of food literacy, nutrition transition and issues related to their agricultural practices). Although the food system in the village tank cascade system is highly vulnerable with current socioeconomic and nutrition transition in these rural communities, the food and ecosystem still show potential of building resilience at the farm/household level.

5.5. Recommendations

Based on the findings of the baseline assessment of food and nutrient intakes, nutritional and health status assessment and household food security status, the following recommendations are made for planning future activities of the project.

1. Traditional farming communities in the present study consider that institutional support towards conserving their rich farm and off-farm biodiversity has not been enough. Despite the many laws in place, the native communities openly expressed that there is a lack of effective enforcement of the laws to protect and sustainably use biodiversity.

   Therefore, advocacy to the policy and law makers (Department of Agriculture, Environment, Forestry etc) is needed for the biodiversity conservation and sustainable use interventions.

2. The entire ecosystem of the village depends on the village tank. The restoration and conservation of the tank and its components are very much essential to promote the benefits of the food system. Dynamic conservation relies on the active
   participation of all core stakeholder groups in particular local communities in the traditional agricultural systems.

Therefore, programmes should be planned to conserve and restore the village tanks with the involvement of multi-stakeholders (including local communities). Monitoring and evaluation of the progress and the effect of the implementation of the action plan should also be undertaken.

3. The communities in VTCS are particularly exposed to climate change impacts on their agricultural production and livelihoods. Maintaining species and genetic diversity in fields provide a low-risk buffer in uncertain weather and the diversity in production landscapes is considered a necessity.

   Therefore, farmer awareness and provision of necessary technical and infrastructure support will help the farming communities to shift from current monocropping unsustainable agriculture system to more diverse agriculture production.

4. The need of a new knowledge base is being strongly felt for transition towards more sustainable agriculture. Farmers greatly value local experiential knowledge as they see it as having practical and local relevance. The potential of farmers' experiential knowledge, however, is not being optimally used and a better strategy to integrate various forms of knowledge is needed.

   Therefore, it is recommended to plan and implement programmes which promote the traditional and indigenous knowledge in their food production systems.

5. The traditional landraces differing in morphological characters have been effectively used by farmers as markers for taste, texture, cooking quality, resistance to biotic/abiotic stresses, etc., besides yield *per se*. Farmers are the sole custodians of the genetic wealth of the landraces they use. Conservation is especially important in the case of disappearing of traditionally, adapted crop varieties.

   Therefore, it is recommended to conduct research to mainstream indigenous knowledge in conserving and popularizing the traditional landraces that will result in implementing effective adaptation action on the ground.

6. Organic farming is important for Sri Lanka as we spend a huge amount of money on the inputs, especially fertilizer. Further, the health concerns are also important as farmers exposed to agrochemicals have high cancer risks and kidney disorders unabated use of antibiotics in livestock rearing is a major cause for drug-, although not proved. The consumers also have concerns regarding the safety of the agricultural production. The environmentally sustainable advances in the productivity and profitability of the organic production system and good agricultural practices (GAP) will help to generate both livelihoods and income.

   Therefore, it is recommended to provide farmers necessary awareness and inputs to enhanced popularity of organic and locally grown food

7. In traditional Sri Lankan agroecology, without any formal interventions, food sovereignty existed. Reintroduction of indigenous food production practices will

help restore food sovereignty to rural communities. Traditionally, these farming communities had enough cultivated and wild-sourced food available. However, the forces of globalization, ignorance to traditional farming and outmigration of village youths to urban areas, loss of traditional knowledge, loss of farm and natural diversity due to habitat degradation, urbanization and climate change, etc., are negatively impacting indigenous food sovereignty efforts. Food sovereignty initiatives will empower traditional farming communities grow and consume their own healthy food that would contribute to enhanced human health and wellbeing.

Hence, the programmes should be carried out to build knowledge and understanding of native agriculture and food systems and help promote native communities' innovative ideas and best practices.

8. The traditional food consumption pattern in the studied villages has been changed drastically in the last few decades due to globalization, ignorance of traditional dishes, unavailability of traditionally grown crop landraces, loss of traditional knowledge etc. The younger generations in the village prefer to consume processed foods or else, due to poor economic management and irrational and uninformed decision-making eats nutritionally imbalanced foods. The agricultural systems in these villages have been developed over time, so did the social organizations, value systems and cultural practices that became part of the resource management practices and food production technologies used in the agricultural systems. This has led to the close association of social organizations and cultural values with the entire management of agricultural resources and the operation of agricultural systems. Although, the link between these social organizations and the community has been weakened due to socio-political and economic reasons in the recent past, still these organizations embedded in rural communities can also contributed to the transfer of traditional knowledge to the next generation. Thus, programmes should be conducted to transfer the traditional knowledge in food culture using novel behavioural communication techniques.

   The following activities are recommended to promote healthy eating of the population, which will directly improve the nutritional and health status of the community as well as indirectly promote sustainable agriculture.

   - Popularize the traditional culinary practices through cooking demonstrations, food festivals, food exhibitions, recipe collection and dissemination, awareness of the nutritional and health aspects of the local food varieties. The schools, religious institutes, youth organizations and other community organizations should be the partners in organizing and implementing such activities.
   - Support home gardening providing knowledge, inputs and sensitizing the households on health and nutritional benefits of such activities.
   - Special programmes should be conducted for school children and targeting the youth and women who play a major role in taking the food culture to the next generations.

- Food processing and preservation technology as well as marketing facilities for the surplus home-base agricultural production should be provided.

9. Promotion of local traditional agriculture and local cuisines can be used to promote agro-tourism, eco-tourism and cultural activities. There is a great potential to promote these activities as the villages are located near already developed tourist zones (Habarana, Dambulla, Sigiriya and Anuradapura).

   Therefore, the programmes have to be planned to incorporate tourism related activities to the promotion of agriculture and food in these villages.

10. Health status of the communities has been deteriorated as the study found high prevalence of non-communicable diseases and psychological distress.
    Special emphasis must be paid on this and action has to be taken to provide access to better medical facilities to vulnerable groups such as elderly, adults and school children who are usually not prioritized in the present public health services. Awareness and behavioural change communication actions must be taken with the assistance of the health authorities.

Key deliverables

Deliverables	Description
Qualitative assessment report of human health food security and nutrition problems in VTCS landscapes including impact of the current pandemic (COVIO 19) in VTCS landscapes and the communities (Task D)	Presented in the Chapter 05
VTCS landscapes food diversity and ethno-botanical assessment (Task D)	Presented in the Chapter 05
Planned scientific papers drafted based on the above	Mr. Sujith Ratnayake, chief technical coordinator, and currently PhD student at UNE has discussed with prof. Renuka Silva and Prof. Danny Hunter to developed this into a PhD chapter and a journal article that will give more credit to the project

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CHAPTER SIX

TRADITIONAL KNOWLEDGE AND BIO-CULTURAL DIVERSITY

6.1. Introduction: Study conducted in *Palugaswewa* VTCS

There are 12 VTCSs in the *Palugaswewa* Divisional Secretariat Division in the Anuradhapura District. *Palugaswewa* and *Bellankadawala* are two of them draining to *Horiwila* medium reservoir within the *Malwathuoya* river basin. A village has one main tank for various purposes including irrigation and one or few other tanks such as *olagam wewa* (tank without village), *kulu wewa* (forest tank), *kayan wewa* (sediment filtering tank) etc. Most of the *kuluwew* and *kayanwew* are now at abandoned state.

6.2. General Description of the *Palugaswewa* VTCS

There are 3 tank series in the studied VTCS.

i. *Maha Borupanwewa – Kuda Borupanwewa – Kudalugaswewa* tank series:

Maha Borupanwewa and *Kuda Borupanwewa* are forest tanks (*kuluwewa*), which act as water sources to Kudalugaswewa (an *olagama* – irrigation tank without village). These *kuluwewas* prevent eroded materials entering into the *olagama* tank, serve as water sources for wildlife, maintain the groundwater table for natural vegetation and provide feeding for cattle and buffalo.

i. *David wewa – Diyamalan wewa* tank series:

David wewa is a recently developed irrigation tank and this must had been a *gabada wewa* (storage tank) in the past. No archeological remnants are found around to indicate any human settlement. Water is flowing into tank even during dry periods indicating the possibility of being a stock tank for the tank cascade system. *Diyamalan wewa* is a small depression to trap sediment to protect paddy fields of *Yakandagaswewa.*

ii. *Koteyaka wewa, Thimbirigas wewa, Palugaswewa Mahawewa* and *Udakadawalatank* series*:*

Water collected in Koteyakawewa (*kuluwewa*) moves to Thimbirigas wewa (*olagama*) without debris and eroded materials transported from *chena* lands. Thimbirigas wewa is an irrigation tank, but paddy fields are at abandoned state at present. Water storage in this tank (if rehabilitated) can be shared with Palugaswewa *maha wewa* in any urgent situation.

In addition to above three series, Yakandagaswewa and Elapath wewa tanks are found standalone in the upper area of the cascade system. The catchment of the tank must had been a thick forest (*maha mukalana*) and do not show any evidence for *kuluwew* above them. A *kuluwewa* is needed if *chena* cultivation is taking place. However,

recent removal of forest for *chena* cultivation can be observed in the catchment.

The cascade consists of three villages namely, *Palugaswewa, Udakadawala* and *Horiwila*, which cover an area of nearly 2 800 ha. The three villages consist of a population of around 2 300 (745 families) living around. The details of the tank capacities, extent of paddy lands under the tanks and farming community are given in Table 6.1.

Table 6.1: Tanks and their status in the *Horiwila* VTCS

No	Name of the tank/ Location coordinates	Tank capacity (ha.m)	Paddy land extent (ha)	No. of farmers	Remarks
1	*Kudalugas wewa* N 80 2′ 49.7″ E 800 42′ 35.2″	43.2	21	22	Working tank with a good storage. Ecosystem components are restorable. It is a tank without village (*olagama*) belongs to Udakadawala
2	*Kudaborupan wewa* N 80 2′ 11.2″E 800 42′ 37.7″	-	-	-	This is a forest tank (*kuluwewa*) meant to trap sediment and serve as a water source for wildlife.
3	*Mahaborupan wewa* N 80 2′ 3.5″ E 800 42′ 52.0″	-	-	-	This is also a forest tank (*kuluwewa*) meant to trap sediment and serve as a water source for wildlife. Feeding area for cattle and buffalo.
4	*David wewa* N 80 2′ 47.5″ E 800 43′ 18.1″	11.8	9	11	A relatively large abandoned storage tank, but can be restored. Water is flowing into tank even during dry periods. The ecosystem components are neglected and need restoration. The old name of the tank could not be traced.
5	*Ulpath-ela wewa or Diyamalan wewa* N 80 3′ 1.2″ E 800 42′ 48.6″	-	-	-	This is a sediment trapping structure (*Godawala*) serving Udakadawala tank.
6	*Yakandagas wewa* N 80 3′ 14.1″E 800 43′ 1.8″	42.6	36	60	*Olagama*tank operational at present. Tank and its ecosystem need to be restored. No evidence for old settlement closer to the tank.
7	*Alapath wewa* N 80 3′ 44.4″E 800 42′ 41.5″	18.5	8	35	Working tank. Ecosystem components are in existence, but need improvement. No evidence could be traced for an old settlement closer to the tank.
8	*Koteyaka wewa* N 80 4′ 43.6″E 800 42′ 49.3″	-	-	-	A *kuluwewa* to protect *Palugaswewa* tank from sedimentation. The entire area is covered with a dense vegetation. Ecosystem components could not be observed.

9	*Thimbirigas wewa* N 80 4′ 29.4′′E 80042′ 25.5′′	-	-	-	The tank is an *olagama* tank and has an abandoned paddy field. Tank water is available during rainy seasons. There is a good potential to rehabilitate the tank and restore the ecosystem.
10	*Palugaswewa mahawewa* N 80 4′ 1.9′′ E 800 42′ 31.2′′	48.1	31	35	Relatively medium size old working tank with a settlement. Tank bed is heavily sedimented and needs to be desilted. Ecosystem components are in good condition but need improvement.
11	*Udakadawala wewa* N 80 3′ 20.8′′E 800 41′ 53.7′′	77.1	51	81	The last tank of the tank cascade system. Working tank, heavily infested with aquatic weeds. A settlement is found around the tank. Tank ecosystem is in existence but needs to be improved.

6.3. Food and livelihood security

The farming systems have evolved based on the natural seasons. The *maha* season (October to February with Northeast Monsoon rains) is the main season where lowland paddy is cultivated in the paddy fields under the tank (Plate 7.1). If the water is left in the tank after the harvest of *maha* crop and *yala* rains are received as usual to collect sufficient water in the tank, paddy is also grown during *yala* season. Average paddy yield under the VTCS is around 3.2 tons per ha. The communities are self-sufficient in rice though most of the produce are no longer the traditional varieties but improved and hybrids. In recent times, well-drained paddy fields are used for cultivation of onion, chili, corn and pulses due to the shortage of water in the *yala* season.

Plate 6.1. Paddy cultivation irrigated by the tank - *Udakadawala*

These crops bring additional income to the farmers.

Chena cultivation (shifting cultivation) was practiced in the *maha* season in forest area of the tank catchment (which was allocated for that purpose) until the nineteen eighties in the last century. However, at present, the fallowing period required for regeneration of forest is not possible due to a shortage of land. Therefore, most *chena* lands have been converted to land of continuous cultivation. Found mostly in the uplands, chena lands are used for growing other coarse grains, pulses, yams, spices and vegetables. Some of the traditional practices such as plant protection, moisture conservation, mixed cropping etc. are still taking place in these lands. Wild animals were chased away by watching the crop day and night using a multi-storey watch hut (Plate 62). In the *yala* season, as rainfall is limited to a shorter duration of 1-2 months, sesame is grown in uplands. Recent

Plate 6.2. A traditional multi- story watch out for protecting crops from wild life – *Udakadawala*

analyses have shown that income from chena per season per hectare varied between Rs. 25,000 and 100,000. Sesame, kurakkan, cowpea and maize were recorded as major cultivated crops. The income variation is due to the variation of the crops, soil fertility, farmer ability, price of the product and other socio-economic factors. Perennial fruit and timber trees mostly occupy the home gardens. Beli, wood apple, orange, banana, jak, and mango are the common fruit trees while teak is the dominant timber tree species. The coconut tree is also very common in all home gardens. The home gardens supply most of the wood, firewood and other forest products for the district (in fact a substantive portion of forest products in Sri Lanka come mostly from the home gardens). Fruits produced are used for family consumption and excess if any, are sold. A recent survey in the area of the proposed site has shown that annual income from a home garden was around Rs. 67,000 per ha per year.

The tank is used to produce fish. Fish is enriched with health proteins and the villagers use fish as a main protein source. Sri Lanka has 82 species of indigenous freshwater fish belonging to 11 families. Forty-four species or 55 percent are endemic to the island. Some of these species have yet to be described and recorded scientifically. Unfortunately, several species are already extinct mainly due to habitat degradation. With the ongoing research, soon there will be a better and fuller understanding of our freshwater fish. Traditional fish catching methods are still being practiced (Plate 6.3-6.4).

Plate 6.3. Karaka – a fish catching device - *Palugaswewa* area (2003)

Plate 6. 4. *Kemana* – a fish catching device - *Palugaswewa*

The villagers, who depend on the VTCS predominantly consume rice. Lunch and dinner essentially consist of rice with curry. For breakfast, they use rice or food produced from rice flour, *kurrakkan, meneri, thanahaal,* green gram, cowpea or yams. All these food items are produced by the farmers themselves in their paddy land, rain fed upland and home garden. All vegetables as well as spices and medicinal plants important for primary health care are also produced in the home garden, upland or harvested from the locality. The milk, fish and fish products, and meat products are not produced in all households and they have to purchase from the local market.

The forest is an integral part of villagers' livelihood strategies. A number of non-timber forest products are in common use. The most important of these are medicinal products, fuel wood, bee honey, some food products, fibers, and wild game (mainly wild boar). However, forests in the cascade are not a significant source of income.

The production system of the *Palugaswewa* cascade yet maintains the traditional components namely paddy field, home garden, highland crop field/*chena*, tank, forest and the *kattakaduwa*. However, their use has been relatively changed. Irrigated paddy cultivation is the main farming practice. Chena cultivation has been changed to a settled cultivation by some farmers. In some places slash and burn cultivation is practiced with very short fallow period. Corn and sesame are the popular crops under rainfall in the *Maha* season (rainy season) in these lands at present. In the *Yala* season (dry season) paddy or other field crops are cultivated in the paddy field under irrigation by the tanks. In some highlands, crops are irrigated from shallow wells. These are some recent developments. Coconut, wood apple, orange, banana, jack, and mango mainly occupy the home gardens in the *Palugaswewa* cascade. Teak is grown in home gardens as a timber tree species.

6.4. Bio-cultural diversity and ecosystems functions

The VTCS greatly contributes to high biodiversity due to the fact that the system combines a large number of ecosystems such as wetlands, seasonally wet and dry lands, paddy fields, uplands, forests, scrublands, tank beds, home gardens, rocky lands and water streams.

The study in the *Palugaswewa* cascade has shown that in the *kattakaduwa*, the tank bund, and the tree belt alone there are 226 plant species. They belong to 51 families. These plants species include fruit, timber, medicinal, ornamental and forage trees. Many species are found in more than one ecological segment showing their adaptability to different ecological conditions. Undoubtedly the CTVS is fully endowed with globally significant biodiversity and genetic

resources for food and agriculture. This is further validated by the below described globally significant plant species, home gardens, livestock, forages and pastures, diversity of forests etc.

Significant Plant Species

Some plant species found in this system are land races adaptable to dry zone and can be considered as globally significant genetic resources. Among them traditional fruit trees and vegetables are of particular importance and adaptable to dry and extremely dry climatic conditions. Most of them are rare and disappearing.

Wild fruit species

Mora (*Dimocarpus longan*), Damba (*Syzygium assimile*), Palu (*Manikara hexandra*), Koan (*Schleichera oleosa*), Weera (*Dryptes sepiaria*), Karamba (*Carissa spinarum*), Indi (*Phoenix pusilla*)

Wild fruit trees (domesticated)

Divul (*Feronia limonia*), Mee amba (honey mango), Beli (*Aegle marmelos*), Siyambala (*Tamarindus indica*), Veli anoda (*Annona squamosa*)

Wild vegetable species (domesticated)

Kiri dambala (*Dolichos kiblab Linn*), *Niyan vetakolu* (*Luffa cylindrica*), *Thumba karavila* (*Momordica dioica*), *Batu-karawila* (*Momordica charantia*), *Ela batu (Solanum melongena), Thibbatu thakkali, Goraka thakkali, Wanni miris, Nayi miris (Capsicum chinense)*

Many traditional rice varieties have been lost during last few decades. However, with the current trend of global awareness of the benefits of consuming organic food and the dangers of using chemical fertilizer and pesticides both to human health and the environment, traditional rice is gradually making a come-back. Farmers had many rice varieties, which they developed using natural selection by observing the adaptive ability of tolerance to water scarcity, resistance to pest and disease, impact on soil fertility as well as for various social needs such as health, cultural functions and religious needs. Among them, are many varieties found for specific purposes.

Farmers in the VTCS still cultivate few traditional rice varieties such as *Suwandel*, *Rathdel*, *Kaluheenati*, *Kuruluthuda*, *Kuru wee*, *Suduru samba*, *Kahata wee*, *Pachchaperumal*, *Elankalian, Madathawalu*, *Hetadha Wee*, *Hondarawalu*, *Girisa*, and *Heenati*.

Vegetables grown in the *chena*(rain-fed upland)include pumpkin, luffa, snake gourd, long beans, *labu* (bottle gourd), e*labatu* (*Solanummelongena*), *kekiri*(*Cucumismelo*), *thibbatu* (*Solanumtorvum*), *batu-karawila* (*Momordicacharantia*) (Plate 6.5) etc. In addition, *Cowpea, kurakkan (*Finger millet*), bada-iringu (*Maize*), thana haal (foxtail millet), meneri (*Proso millet) (Plate. 6.6), Chillie, Mustard, *kollu* (Horse gram), Sorghum were also cultivated before. Now growing of *thanahaal, meneri, chillie,* Mustard, *kollu,* sorghum is not very common.

Plate 6.5. Batu-karawila (Momordicacharantia)

Plate 6.6*: Meneri (Panicummiliaceum)*

The home gardens consist of fruit, timber, medicinal plants, vegetables and ornamental plant species as seen commonly in the lands under the VTCS. Common fruit trees include: mango, jack, lime, wood apple, banana, papaya, guava, anoda, *Beli*, Orange, Cashew, and Pomegranates. Common timber species in home gardens are: margosa, jak, *Lunumidellea* (Bead tree) and *halmilla* (*Berrya cordifolia*). *Ahu* (Indian mulberry), *ehela* (Pudding pipe), *ingini* (*Strychno spotatorum*), *kaduru* (nux-vomica), *karapincha* (Curry tree), Lime, Tamarind and Margosa are the common medicinal species. Vegetable species such as *murunga* (drumstick tree), *ambarella* (*Spondi ascytherea*), Jak and Coconut are very common in the home gardens of the VTCS.

Aquatic biodiversity is found in the tank and the paddy fields. tank and the paddy fields act as wetlands. Hence, their biodiversity is very high. The produce of vegetation in the tank and the paddy fields serve as: 1) food; 2) ornamental material (flowers for religious offerings and decorations); 3) medicinal plants; and 4) material for handicrafts (weaving of baskets, mats, bags, etc.).

Kattakaduwa (Downstream Interceptor)

The land reservation between tank bund and paddy field is known as *kattakaduwa*. It consists of a water hole (*yathuruwala*), marshy land, wet land and the dry land showing a wide spectrum of floral vegetation.

A field survey conducted in the *Udakadawala* tank showed that there are 226 plant species within the *kattakaduwa* and downstream side of the tank bund. Of them 171 plant species are found in the *kattakaduwa* area. Spread of *kattakaduwa* in the *Udkadawala* tank is shown in Figure. 6.1.

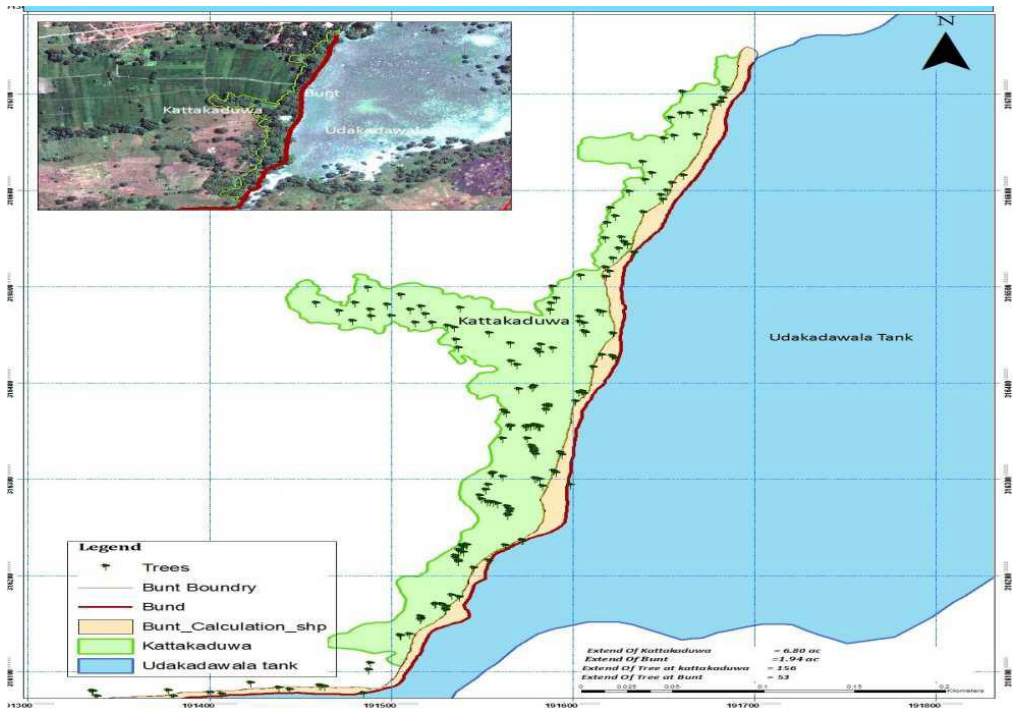

Figure 6.1: Spread of *Kattakaduwa* in *Udakadawala* tank (Source: Piyadasa et al, 2012)

Of total vegetation in the *kattakaduwa*, 68 percent of the trees are kumbuk (*Terminalia arjuna*), damunu (*Grewiadamine*), helamba(*Mitragynaparvifolia*) and karanda (Indian beach) plants at different ages. Among 55 plant species found in the *Udakadawala* tank bund, most prominent species are *thotila*, *maila* and ipil-ipil. Villagers use these plant species found in *Kattakaduwa* for different purposes. Table 6.2 shows the uses of those in rural villages.

Table 6.2. Uses and functions of plant species in *Kattakaduwa* (Dharmasena, 1995)

Name of the plant	Botanical name	Uses and functions
Margosa (neem)	*Azadirachtaindica*	Oil, pesticides, timber, medicine
Mee	*Madhucalongifoia*	Honey, oil, habitat for bats
Damba	*Syzygiumassimfle*	Mortar and pestle, timber, fruit
Kumbuk	*Terminaflaarjuna*	Lime, timber
Tamerind	*Tamerindusindica*	Fruit, soft drinks, sweets, chutney, medicine
Koon	*Schleicheria*	Fruit, chutney,
Ebony	*Diospyrosebenum*	Wood carvings, furniture
Kotta	*Ciba pentandra*	Pillows, toys
Indi	*Phoenix zeylanica*	Fruit, hats, bags, baskets, broom etc.
Palmyra	*Borassusflabellifer*	Timber, mats, bags, baskets, honey, sweets, toddy.
Bamboo	*Bambusa vulgaris*	Wood carvings, handicrafts, building materials etc.

Kithul	*Caryotaurens*	Honey, jaggery, toddy, timber, household implements
Patabeli	*Hibiscus tfliaceus*	ropes
Vetakeya	*Pandanuskaida*	Bags, baskets, mats
Rattan	*Calamus spp.*	Baskets, furniture
Reed	*Cyperuspangoreil*	Mats, baskets, trays
Wood apple	*Feronialimonia*	Jam, juice, soft drinks, medicine

Gasgommana (Upstream Tree Belt)

Gasgommana is the temporary flooding area between tank water levels of Full Supply Level (FSL) and High Flood Level (HFL). There are 396 trees and bushes belong to 25 plant species found within the *Udakadawala gasgommana*. Many trees have already been removed by villagers and at present trees are found in a scattered manner (Figure. 6.2).

Most abundant species in the *Udakadawala gasgommana* area are kumbuk (*Terminafiaarjuna*), nabada (*Vitexleucoxylon*) and karamba (*Carissa spinarum*). Abundance of plant species in the Udakadawala *gasgommana* is given in Table 6.3.

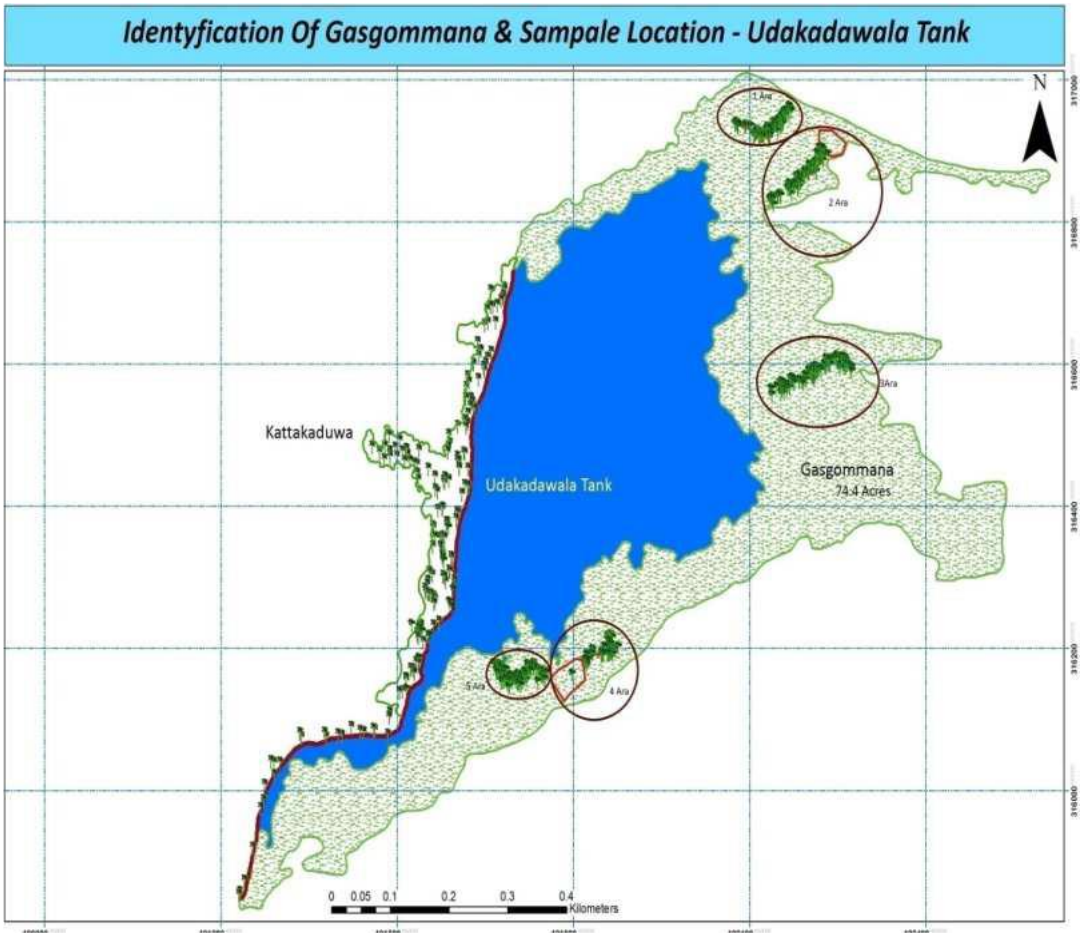

Figure 6.2. Spread of *Gasgommana* in *Udakadawala* tank (Source: Piyadasa et al, 2012)

Table 6. 3. Relative abundance of tree species in *Udakadawala Gasgommana*

Plant species	Abundance		Medicinal value	Other uses
	#	%		
Kumbuk(*Terminalia arjuna*)	124	33	To balance the three "humors": *kapha, pitta,* and *vata*. It has also been used for asthma, bile duct disorders, scorpion stings, poisonings and for heart disease	Traditional lime production, timber
Nabada (*Vitexleucoxylon*)	87	23	To cure diabetics, inflammatory diseases, liver disorders and free radical mediated diseases.	
Karamba (*Carissa spinarum*)	61	16	Known for its therapeutic effects against liver disease, epileptic disease, microbial disease, cytotoxic, viral diseases. It has antioxidant, antimicrobial, antiviral, anticonvulsant, anticancer, antiarthritic, antihelmintic, cytotoxic value.	for use as fruit and medicine, fruit is of potential commercial interest.
Helamba (*Mitragynaparvifolia*)	29	8	To treat fever, colic, muscular pain, burning sensation, poisoning, gynecological disorders, cough, edema and as an aphrodisiac	
Bokalawel (*Derris scandens*)	21	6	Good antibacterial (*Escherichia coli*, and *Bacillus megaterium*), antialgal (*Chlorella fusca*), and antifungal (*Microbotryumviolaceum*) medicine	In preparation of Bio-pesticides
Rathmal (*Ixoracoccinea*)	20	5	It has antioxidative, antibacterial, gastroprotective, hepatoprotective, antidiarrhoeal, antinociceptive, antimutagenic, antineoplastic and chemopreventive effects	
Kaila (*Breyniavitis-idaea*)	10	3	Roots decoction is used as mouthwash, for the treatment of chronic bronchitis and wounds	For the control of mosquitoes
Kothalahimbutu (*Salacia reticulate*)	9	2	It helps normalize blood sugar and insulin levels, and supports healthy blood lipids. Traditionally used in Ayurvedic medicine to treat diabetes, and a potential antioxidant for human use against toxins that cause damage to the liver	
Palu (*Manikarahexandra*)	5	1	Used for treatment of various diseases such as ulcer, bronchitis, jaundice, ulitis, fever, hyper dyspepsia, arthritis and alimentary disorders.	Used as timber, edible and nutritive fruit, useful wood, latex and bark and it provides substantial livelihood

				support to local inhabitants.
Nithul (*Streblusasper)*	4	1	Treatment for filariasis, leprosy, toothache, diarrhea, dysentery and cancer.	Fodder source for buffalo calves
Total	370			

Data source: Piyadasa et al, 2012

Home gardens

In the year 2012, 300 home gardens were surveyed in *Palugaswewa* and *Udakadawla* by Piyadasa et al. and results revealed that a complete canopy cover has occurred in 8 and 18 home gardens in *Udakadawala* and *Palugaswewa* respectively. Villagers have planted 58 plant species in their home gardens. Most abundant plant species are coconut, mango, jak, guava, banana and orange.

Livestock, forage and pastures

Cattle and Buffalo are the dominant livestock in the system. Goat and Poultry are not very common. Some farmers practice backyard poultry. Cattle and Buffalo were reared by almost all households until 1960s. However, due to the decreasing grazing lands, only few households rear cattle and buffalo at present. Cattle breeds, which are common in the villages are: *Zebu* (local breed), *Jersey, Sindhi, Sahiwal* and crosses of local breeds with Indian and European breeds. Buffalo is comprised of *Niravi* and *Murrah* breeds. Goat includes *Jamnapari, Saanen* and local breeds.

Utilization of the forest by the community

The contribution of fruits, nuts, seeds, leafy vegetables to the local diet, products to the native medical practices and condiments to flavor and supplement food, nuts, roots, barks and seeds to extract edible oils, resins, latex, honey, raw materials for industries, construction materials and others to the survival maintenance, are increasingly recognized in the interest of managing the forest resources for the betterment of life.

The forest was used for *chena* cultivation, bee honey extraction, timber needs of the villagers, extraction of wild fruits (Eg: *gal syambala*) until mid-1980s. *Chena* cultivation was practiced by obtaining a permit from the Forest Department (FD). After 1981, FD discontinued issuance of permits to use forests for *chena* cultivation. However, village communities are allowed to use non-timber forests products. Eco-functions are the important services provided by the forests in the tank cascades at present. Forests serve as watersheds of tanks and provide habitats for fauna and flora. In some cases, Buddhist hermitages are located in the village forests. Forests in the cascade are not a significant source of income.

Forests legally owned by the Government are widely used by almost all fringe communities for their multiple products. The usufruct rights of the communities have been maintained without recognition. Although the level of dependence of the households vary, the service functions of the forests are considered a condition that helps them to maintain the non-forest activities, primarily agriculture. The forest is

equally considered as a source of multiple products, which include a large number of non-timber forest products. For those who depend heavily on agriculture for a living, the forest is the next most important source of survival. A study carried out in *Ritigala* SNR shows that throughput the year the forest is a source of survival needs and these include food, fuel wood, medicinal products, binding and fencing materials etc. The well marked seasonal nature of other forest products, the varieties sold in the market, primarily 'gal-siymabala' (*Dialium ovoideum*), Honey and 'bin kohomba' (*Munroniapumila*) help smooth the seasonal difficulties in getting an income. The gathering groups are formed for better harvesting within a given periods in which these products are available. Community interaction with the forests for cultivation has resulted in their heavy dependence on cultivated crop in the forest reducing the complementary nature of subsistence farming and non-timber forest products. The concerns of the fringe dwellers over the forest has been driven away from the gathering of non-timber forest products.

6.5. Indigenous knowledge systems and adapted technologies

Indigenous knowledge evolved for centuries in traditional agriculture is a mixture of many aspects derived from religious and spiritual origins, cosmic influence (astrology) and natural phenomena. Beauty of the traditional agriculture is that it has followed at many instances the rules, principles and phenomena of nature. This is the vital reason for the sustainability and the environmental compatibility of these systems, which prevailed for centuries under very harsh climatic conditions tolerating sudden shocks of natural events (Dharmasena, 2007).

Knowledge gained by these communities has transmitted through generations and it is still available with them. Some of them have been documented in ola leaves and still can be traced in the Palugaswewa area (Plate 6.7).

Plate 6.7. Ola books, which store their traditional knowledge – *Palugaswewa*

One example for their traditional knowledge is that the rural people understand the salinity status of soil by observing the plants found in an area. Diwul (*Feronia limonia*), keeriya (*Acacia chundra*), indi (*Phoenix zeylanica*), ikiriya (*Hygrophila spinosa*), pothu-pan (*Scleria poaeformis*), vetakeya (*Pandanus kaida*), illuk (*Imperata cylindrical*) are grown in saline soils. They believe that Many plant species are known to be salt absorbing such as Vetakeya (*Pandanus thwaitesii*), Matgrass(*Cyperus pangore*), Ratton (*Calamus spp*), Palmyra *(Borassus flebelfifer*), Karanda (*Pongamia pinnata*), Thimbiri (*Diospyros malabarica*), Damba (*Syzygium assimile*), Areconut (*Areca catechu*), Milla (*Vitex pinnata*), Tamarind (*Tamarindus indica*), Beli (*Aegle marmelos*), Margosa (*Azadericta indica*), Kumbuk (*Terminalia arjuna*), Wood apple (*Feronia fimonia*) and Mee (*Madhauca longifolia*). Hence these plant species can be used for water purification in the bio-remediation process. Families had become experts and specialists for different purposes.

Some examples are *Wedadura* (physician), *Yakadura* (healer), *Kammalkararaya* (blacksmith), *Dadayakkaraya* (hunter) and *Gamarala* (village headman). They gave their education to next generation through instructions, apprenticeships and learning through observation.

Martial arts

One of the reflections of our heritage system is the martial arts, which are still prevalent in its dynamic form (Plate 6.8). ***Vishuddi haramba***is a form of martial art from the VTCS site that combines combat techniques, self-defense, sport, exercise, and meditation. A key component of *vishuddi haramba* is the *angam*, which incorporates hand-to-hand fighting, and *illangam*, involving the use of indigenous weapons such as the *ethunu kaduwa*, staves, knives and swords. Another component known as *maya angam*, which uses spells and incantations for combat, is also said to have existed. The *Angampora's* distinct feature lies in the use of pressure point attacks to inflict pain or permanently paralyze the opponent. Fighters usually make use of both striking and grappling techniques, and fight until the opponent is caught in a submission lock that they cannot escape.

Plate 6.8. *Ritigala Vishuddi Haramba* (Martial Art)

Usage of weapons is discretionary. Perimeters of fighting are defined in advance, and in some of the cases is a pit. With the advent of colonialism over the entirety of the island in 1815, *Angampora* fell into disuse and was very nearly lost as a part of the country's heritage. The British administration prohibited its practice due to the dangers posed by a civilian populace versed in a martial art, burning down any *angan madu* (practice huts devoted to the martial art) found: flouting of the law was punished by a gunshot to the knee, effectively crippling practitioners; *Angampora* nevertheless survived within a few families, allowing it to emerge into mainstream Sri Lankan culture post-independence.

Local medicine (Horiwila Wedagedara)

The village *Horiwila i*s located with the tank just below the *Palugaswewa* tank cascade system. The *Horiwila* indigenous medical tradition commences from King *Dhathusena* era (455 AD) and Dr *Herathhamy's* reputation expanded beyond the shores of Sri Lanka. Lived in a remote village in Anuradhapura District, he had thousands of miraculous treatments for his credit derived from recipes, which are of confidential hereditary by the family tradition (Plate 6.9).

Plate 6.9. *Horiwila Wedagedara* (medical center)

The family is a repository of vast traditional knowledge in Sri Lanka Ayurvedic herbal medicines handed over through centuries within the family

and from the clinical and pharmacological experience gained from years of intensive and dedicated practice of Ayurveda.

All his medicinal secrets were relayed to his son *Sena Banda*, who later became a prominent member of the Ayurvedic Medical Council of Sri Lanka for the past two decades and is doing a yeoman service for the preservation and development of Sri Lankan indigenous medicine, apart from treating thousands of patients – both local and foreign.

Evolution of the VTCS

The historical evidence suggests that the VTCS has been evolved over a period of two millennia. The dry zone of Sri Lanka where this system has been evolved, experiences a protracted dry period which occurs every year from May to late September. Life is not possible during this period without a reliable source of water for domestic use. Panabokke (2010) reported that the early settlers in this part made rudimentary ponds by damming across valleys to store run off water during the rainy season for use in the dry period. They took the advantage of the heavy run off during the rainy period and the undulating landscape for this purpose. Lately they have invented the *ketahorowwa,* the sluice made of terracotta pipes to take the water out of the ponds and the ponds were transformed into irrigation tanks. In the valleys, lowland rice was cultivated as soils were essentially hydromorphic and suitable for retaining water after puddling the soil. The dendritic drainage pattern on the undulating landscape made it possible to develop cascading system of small tanks in the valleys where ephemeral streams drained rainwater to the main river systems. As time passed, probably by trial and error they have learned how to manage the water in the cascade system by proper catchment management and developing various components in the system such as *kattakaduwa* and *gasgommana* etc. In order to assure that the paddy crop is raised without subjecting to water stress, the cultivation of paddy under the tank commenced only after an assured storage is accumulated in the tank. This practice gave them sufficient time to complete chena cultivation before they come to the paddy field.

Basic problems faced by farmers were shortage of water in less rainy seasons, development of salinity in certain part of the field, and damage from wild animals, pest, and diseases. Strategies adapted to address these problems were not specific to a certain problem but collective. The following strategies were adapted to minimize the water shortage problem in the VTCSs (Dharmasena, 2010 a).

a. '*Bethma'* practice—It is a practice that temporarily redistributes plots of land among shareholders (paddy landowners) in part of the command area (territory) of a tank (reservoir) during drought periods.
b. '*Pangu'* method—The tank had to be maintained properly to avoid breach, leak, and excess seepage. Repair and desiltation of tanks and cleaning of canals during dry periods are shared tasks assigned to each farmer proportionately to land ownership.
c. '*Kekulama'*—Farmers advance the cultivation time using early seasonal rains whenever they feel that tanks would not get enough water to cultivate the command area. They have the experience that if September (2nd inter-monsoonal) rains are high,

the total seasonal rainfall is not adequate to fill the tank.

d. '*Karahana*'—This is a water distribution device fixed across the canal made up of log with two weir-shape cuts. The size and bottom level of these cuts are made according to flow requirements of the two canals below, and the *karahana* is fixed by the village head (*Gamarala*).
e. Village commons—micro-landscapes are utilized to reduce tank water losses, mitigate salinity effects, prevent tank sedimentation and so on.

Maintenance of the System

The tank and the forests were considered as sacred by ancestors of the system as those were the basic sources that helped providing water. These resources were considered belong to gods and deities. This belief was passed from generation to generation. Hence, it was the responsibility of all individuals lived in the community to protect and maintain them. Maintenance of the tanks, irrigation canals, roads and other common property was carried out by community participation under the leadership of village headman until this was transferred to the state institutions at recent times.

Soil fertility management in the paddy fields

Unlike the chena where upland crops are cultivated in rotation, the soil fertility tends to decline by continuous cultivation of the paddy fields. This problem has been tackled by allowing cattle and buffalo to graze during fallow period, by adding green manure, promoting leguminous weeds to grow in the fallow period and by fallowing the field for several years when poor growth is noticed. Grazing cattle add sufficient quantities of urine and dung to restore the soil fertility. (Nayakekorala, 2010)

Equitable sharing of land and water

Water availability to a plot of land in the paddy field depends on the proximity of the land to the tank. The paddy plots which are closer to the tank can get water easily and those that are far away get less water. In order to minimize inequalities of water distribution to lands under a tank, a system of land allocation is practiced in the villages. In this system, lands were grouped into three based on the proximity to the tank namely: upper section (*upayapotha*), middle section (*heranapotha*) and lower section (*aswdduma*). Each farmer has allocated land in each section so each person enjoyed the same benefit of water allocation. This also reduced any disparity that may arise from differences of fertility of the soil due to fertility gradient along the paddy tract. In order to deliver the correct amount of water in each channel, depending on the extent of land under each channel, a device called "*karahankota*" is used. *Karahankota* is a kind of weir made of wood and placed in the main channel to divide the water flow.

Crop management and protection

Traditional agriculture is based on certain strategies aiming to adjust for climate variability and conservation of resources. Main strategies are as follows (Dharmasena, 2010 b).

- Land for chena cultivation was selected from middle part of the land catena with gentle slopes, where soil is

relatively deep. Paddy is cultivated in valley bottoms, where groundwater influence is high during longer period of the year.

- Risks of farming due to factors such as rainfall, drought, pest and diseases, and damages from wild animals were reduced by adjusting the cultivation to the best times through long experience.
- Favorable environment for crops was maintained by adoption of various soil and moisture conservation practices and through shade management.
- Land productivity was maintained by posing least disturbance to soil and using high amounts of biomass through fallowing.
- Diverse crop combinations were adopted to cope with variation of climate, soil, and other biotic as well as abiotic stresses.
- Simple farm implements were used with lesser energy consumption. Shallow tillage with '*sinhala nagula*' does not penetrate the hard crust, which prevent percolation of water with nutrients
- Land races were improved as family secrets to utilize as most suitable crop varieties for the area.

Paddy Crop is protected from birds and pest damage leaving a small portion of land (*kurulu paluwa*) to attract birds for pest management and if necessary supplement these actions with use of plants or plant extracts (bio-pesticides). There are three spiritual categories of traditional practices also to protect crops from pest damage. The first group is based on astrology, the second on the powers of the spirits and Gods, and the third involves the chanting of verses and the use of specific symbols. Often these different practices are combined (Upawansa, 2000).

Management of animals, pastures and forage

At present, the livestock farming in the system is not a major activity as compared to the old days. There are some limitations. Shortage of grazing lands has been the main reason. Some farmers in the system keep a few cows of cattle/buffalo for milk production. These animals are managed in extensive manner, feeding on communal grazing ground during daytime, brought back home in the evening, and kept in paddocks. The usual grazing lands are paddy fields after harvest, catchment areas of the village tanks, tank bed during dry period, tank bund, shrub jungle and other open areas. There are number of forage species, which are naturally grown in grazing lands such as *maila* and *ipil-ipil*. *Gliricidia* is a common tree species, which is grown in fences of land and grazed by cattle and buffalo. The grazing lands are generally not managed. They are naturally regenerated. In a village there can be one or two herdsman who keep a larger herd.

Management of forests and water bodies

Forests serve as the main catchment area for the tank. The village community understands well the importance of forestland in the cascade and takes communal responsibility in protecting it. Forests are traditionally classified according to its importance namely: "*landu kela*" (shrub jungle), "*mukalana*" (forest)" and *maha mukalana*" (thick forest). By tradition use of "*mukalana*"

was prohibited so that nobody dared to clear this forest for *chena* or any other purposes. The village forests are also protected by the forest ordinance of Sri Lanka. Home gardens are sources of nuts and fruits and wood. Farmers know the combinations of species to plant to minimize competition for light and soil nutrients. Farmers also maintain forests for medicinal plants apart from forest trees. Apart from the culture of medicinal plants, certain members of the family also know how to formulate a range of concoctions and decoctions for application to cure common ailments.

The village tanks with a command area of less than 80 ha are designated as minor tanks and they become under the jurisdiction of the Department of Agrarian Development. Historically, these tanks were managed by the community under community leadership. A person designated as "*Vel vidane*" (to oversee the paddy cultivation and water management) was elected by the farmers from the farming community. He was paid with a certain quantity of paddy depending on the paddy extent one has under the tank. The *Vel vidane* used to visit each farm and ensured that there is a supply of water during the season. However, this system was abolished by the government after the introduction of Paddy Land Act in 1958 and the water management and farming responsibility were entrusted to the cultivation committees appointed under the act. With several rounds of amendment of the act, now, the cultivation committees have been replaced by the farmer organizations. Farmer organizations meet yearly to agree on the nature and timing of cropping based on water availability and for water allocation. Relevant government officials joined the said meetings as resource persons.

The community was previously responsible for the maintenance of the tank bund and irrigation channels under the village leadership of the village headman. This responsibility has now been entrusted to the farmer organization.

At the moment, there is no formal or informally organized system for passing the knowledge associated with the agricultural heritage of managing CTVS and is its land uses. Children observe their parents practice the remaining few practices or recite and chant songs during special events. Families are left on their own initiative to seriously pass on certain practices, particularly those that remains to be relevant to economic livelihoods.

Sharing paddy land during water short seasons – Bethma

There are unique systems of sharing resources in the village community. One important aspect is the sharing of the paddy tract during seasons of water shortage. Paddy lands are individually owned. But during the seasons of water shortage, as cultivation of the full extent under the tank in not possible, one portion of the command area (paddy fields) is left out while the other portion is distributed among all the farmers under the tank equally. This system is known as "*bethma*" cultivation. The decision is taken during a meeting attended by farmers and officials collectively. This arrangement is only for that season.

Sharing of fish harvest in the tank

There was a tradition of distributing the fish harvest among the households under the tank. This was done by the village headman during the dry period when tank is dried-up. All the fish are

harvested and distributed among the farmers depending on their share of land under the tank.

Village commons

Various micro-landscapes such as *kattakaduwa*, *gasgommana*, *thisbambe*, *kiul-ela* etc. are maintained by villagers to ensure the system sustainability. These village commons are described in section 1.8. The commons are of multi-purpose and multi-functions, and many services are rendered for the benefit of human and wildlife.

6.6. Culture, value systems and social organizations

Culture

Sri Lanka's rich cultural heritage has been nourished by characteristics, challenges and opportunities provided by the landscape and the resultant values, knowledge systems associated with the agrarian society and refined by the Buddhist teachings. The culture in the VTCS has been developed centered on inter linkages among the village, the temple, tank and the stupa as stated before. The cultural aspects such as livelihood, knowledge, belief, art, law, morals, custom, and other capabilities and habits are developed to lead a simple and happy life while sustaining the natural resource base in the village and in surrounding area.

Social structure in the VTCS

The present social structure in the VTCS has been transitioned from ancient feudal system under which the agrarian society thrived for centuries. The feudal society was characterized by a cast system based on the occupation that the people were engaged in. The occupations ranged from farming, blacksmiths work, laundering, dancing and drumming, goldsmith work etc. There was a hierarchical system prevalent among these castes. However, this caste system has been gradually diminished starting from the time of colonial administration in the country. The present village society consists of farmers, carpenters, government and private sector officials, soldiers in the armies, traders and laborers. They are formed into upper middle, middle, lower middle and poor classes based on the economic status. The majority is farmers and fall in the poor class.

Value system

The agrarian life in the VTCS essentially depends on sharing of common resources, mutual help and dedicated work. This needed to cultivate values such as integrity, respect, loyalty and responsibility among the villagers. The villagers are honest in their behavior, respect the leadership and elders, loyal to the village community and the family and ready to discharge their responsibility to the common causes at any time. These values prompted villagers to protect their natural resources, volunteer to common causes such as maintenance of tank, wells, channels and other common property and sharing of labor. However, some of these values are not much respected at present due to changing social status in the village life. Further, the villages are 'invaded' by out siders who to some extent do not appreciate very much the traditional norms and values. Although some erosion of these values and norms is happening due to social change and modernization, substantive portions of

the community still observe many of these values and practices. Community leaders are conscious of the gradual loss of values and practices. They have begun to identify actions that can arrest rapid loss of local heritage and make adaptation to modern times possible through a participatory process. Among the remaining values are conservation of traditional forests and biodiversity and sharing of natural resources.

Under the section on knowledge systems above, the practices related to sharing of water resources, paddy and fishery products from the tank are discussed. The traditional management systems practiced by the community has been superseded by the modern governance structures and processes. However, VTCS management is considered a joint responsibility of both government and community; regular annual meetings are conduced to decide on priority actions for the maintenance of VTCS and sustainability of its ecosystem services.

Performing arts

Traditional dancing, folklore, folksong, folk poems, folk music, rituals, traditional festivals, and folk drama, have been evolved in the village tank farming culture during its long existence .Some examples are:

1. *Pal kavi* (The poems recited in the night at watch hut to protect fields from wild animals)
2. *NelunKavi* (Poems recited by women when weeding and filling in vacancies in paddy fields)
3. *Andahera* (Verses recited at ploughing and threshing)
4. Folk dance *such as* Reaping dance, *Kalagedinatuma* and Winnowing dance (*Kulunatuma*)
5. *Sokeri dance* (A dramatic dance performed after harvesting paddy in villages)
6. *Hevisi and berawaadana*

Folk dances in the area depict activities related to agrarian life, such as *kalagedinatuma* (depicting fetching water in the pots), *Kulunatuma* (depicting winnowing of rice in the threshing floor), and dance depicting harvesting of paddy. Often, these dances are performed in the open air in celebration of community events. These dances are performed to the beat of the drums and tune of the music and are very colorful and attractive. Other traditional dancing are performed by descendants from dancing families of the feudal society of the past. In the *Palugaswewa* DS division there are several families who are very reputed for their performances. They have won national and international awards for their excellent performances. These families run their own training centers for passing the dancing traditions of them. Some performance arts are twined with the rituals such as *bali* and *thovil* (healing methods by chanting and dancing to the beat of drums). There are many traditional instruments that they play in these performances.

Believes, faith and rituals.

The dwellers of CTVS believe in gods, deities and devil spirits. They believe that some powerful kings who lived in the past have become gods after their death and they can help the people when they are in desperate situations. Some such gods they believe are *Minnerideviyo, Aiyanayakedeviyo and Bissobandaradeviyo.*

They believe that through various ritual these gods support them to get through bad times. Most prominent rituals include: *Muttinameememangallaya*, *Kiriithirimmangallaya, Kohombakankariya*and *Pideni. Muttinameememangallaya (*Ceremony of pot overturn*)*

Before commencing the cultivation when the tank is full of water, the elders of the village, chiefly *gamaralas,* go to the tank and at the *muttinamana*tree, the chief *gamarala* addresses the god (of the area), announces that the tank was filled and that cultivation will begin and that the *muttimangallaya* (a ceremony) will be performed after the harvest.

He would also request the god and deities to protect their crops and livestock from evil and natural disasters. As a token, they would tie a copper coin wrapped in a piece of cloth on a branch of the tree. Once the harvesting is over, the villagers then perform this festival. This is a ceremony where all village communities participate. Milk rice, oil cake, rice and curry are offered to the gods and deities on a platform erected on the tank bund. Food is also served to all who were assembled. This is followed by dancing ceremony with *tom-tom* beating.

Kiriithirimmangallaya (Festival of milk boiling)

After reaping of each crop *kiriithirimmangallaya* is performed to thank the gods and deities for protecting their crops and cattle from evil and natural disasters. This is performed collectively by contribution and participation of all villagers. In the tank bund, they cook rice milk, offer the first portion to the gods and invoke their blessings. Then the remaining rice milk is served to all assembled. In disastrous situations such as drought, floods, epidemics, etc. also this activity is performed.

Kohombakankariya

KohombaKankariya, one of the most venerated and elaborate traditional dance rituals in Sri Lanka is held to invoke the blessings of the twelve deities (*KohombaYakka, IrugalBandara, KandeBandara, ViramundaYakka, MeleyiYakka, VadiYakka, KadavaraYakka, ValiYakka, Kadu Guru, Maha Guru, Ambrapati and Kalu Kumara*). The *KohombaKankariya* is a *Shanthi Karma* (a traditional art of healing) demonstrating the pre-Buddhist worship of *Yakshas* (demons) who are regarded as deities. It is an all-night event that commences in the evening and continues until the early hours of the following morning. This is also an event usually performed by the villagers after harvesting of the paddy crop.

Aluthsahalmangallaya (Festival of fresh rice)

This is a festival to offer milk-rice cooked with the first portion of the paddy harvest to the Buddha collectively at the village temple. After offering of milk-rice to Lord Budhdha, the merit that they earned through this act is offered to the gods and deities invoking blessing from them. In order to protect their cultivations from wild animals and natural disasters

Ritualistic plant protection methods

Various ritual are performed in farming for protection of crops from pests and diseases and wild life. These include carrying out various farming activities

such as ploughing, seeding, planting at auspicious times based on astrology, use of method called *Kem* and chanting of religious verses and charming of *mantra.* Astrology plays a dominant role in agriculture as most activities are based on the astrological calendar. 'Kem' practices demand complete faith from those who practice them. These practices vary from elaborate, time consuming rituals to simple, instantaneous methods. These methods are mostly carried out in secret, hence most of they are not in public knowledge.

Traditional crafts

Common traditional crafts of VTCS include the handicrafts made out of reeds, other cured leaves of palm trees, and rattan, wood carving, rock carving, and pottery. There are a variety of produce such as mats, hats, handbags and purse made out of reeds and cured palm leaves. These are traditionally woven by women in villages. Reeds used are *Gallaha, Havan, Vetakeiya, Borupang, Thunhiriya* which grow in wetlands found around the tanks and the paddy fields. Of these, *Gallaha* is the most expensive. Leaves of Palmyra tress and *Vetakeiya* are also used. Wood carvings include statues religious leaders, images various animals, various sceneries and ornaments. Similarly, the rock carvings and pottery also include articles of ornamental value.

Traditional foods and food habits

The traditional food consists mainly of rice which is the staple food of the nation. However, other cereals such as finger millet, *thanahaal, and meneri* and pulses such as mung bean and black gram and various types of yams supplement rice in these traditional villages. The seeds of water lilies (oolu seeds) which grow in the tanks also make a special food item in these villages. It is used as a substitute for rice. Rice and curry are the well-known regular meals as in other parts of the country. Curries are full of spices and other tasty ingredients used which are specific to each village and housewife. The recipes may change from village to village. The flour of rice are used to make various preparations such as *roti, pittu, hoppers, kavum, kokis, and aggala* etc. *Kavum, kokis* and *aggala*are sweets which go as snacks. *Thalapa* is a special preparation made of flour of finger millets. Special curry is made to go with thalapa. The curries mainly consist of vegetable which are grown in the home gardens or in the chena. There are several types of wild yams such as *katuala* and *gonala* naturally grown in the forests and road reservations. People collect them for breakfast.

The fish and dried fish are also cooked with spice. Previously local fish species such as *Loola, Aanda, Kanaya and Hirikanaya* were the common fish species in the village tanks. However, after introduction of foreign fish species such as *Thilapia*, the local fish species have been disappeared from village tanks.
A complete rice and curry meal includes a meat or fish curry, two or three different vegetable curries, curry of pulse seed or dhal (lentil), and a *'mallum'* made of chopped green leaves and grated coconut. For special occasions, especially religious occasions, rice is boiled in thick coconut milk to make a creamy textured rice pudding called *'kiri-bath'* which is very delicious preparation. Dairy products such as curd, ghee, whey etc. were very common in these villages until 1960s of the last century, but now they are rare due reduction of cattle population as a result of shortage of

grazing lands. Milk (neat cattle) is produced in some villages as a house-hold activity for sale to companies which produce milk powder.
There are many herbs used as herbal tea called "*osupan*"with very high health benefits. Some of the herbs in the villages are used to make herbal porridge. Herbal porridge are recommended for a range of ailments and to improve the nutrition of people.

Food habits are different in these villagers compared to urban community. Villagers take three meals- breakfast, lunch and dinner- a day as usual. Dinner is the main meal, which consists of rice and curry. Breakfast includes boiled cassava, yams, mung bean, cowpea etc and preparations from rice / wheat/ finger millet flour. Lunch also consists of rice and curry.

Traditional healing methods

Traditional healing system focuses on mental and physical health simultaneously. This is by using herbal medicine for the physical component and "*yanthra* and *manthra*" for the mental aspects. This indigenous medical practice descends from old generations. The prescriptions are handed from generation to generations and there are families known as *"vedaparampara"* (generation of medical practice). In the *Palugaswewa* DS division there are several such families. In local language these practitioners are known as "*vedamaththaya*' or "vedarala". There are specialists such as General Physician (*Sarvangavedamahattaya*), Eye specialist (as *vedamattaya*) Snake-bite treating specialist (*Sarpavishavedamahattaya*) and Orthopedic specialist (*Kadum-bindum Vedamahattaya*). The medical family of orthopedic practice in the division is renowned for their practice nationally and internationally. Known as *"Horiwilakadumbidumvedaparamparawa"* has established their own hospital in the *Horiwila* village (Plate 6.10).

Sorcerers and exorcists also are part of the mental healing system. They too descends from old generations. Sorcerers carry out rituals afflicting misfortune on people and they also carry out ritual to eliminate such bad effects. The exorcists treat mental ailments which are considered to be caused by devilish activities. Rituals include, tying of amulets in the body, cutting of lime while chanting *manthra*, tying of threads subjected to chanting of *manthra,* making offers of foods and fruits to gods and demons (*pideni*) etc. There are several families who treat for devilish afflictions. Fortune tellers and horoscope readers are also part and parcel of the traditional system in these villages (Plate 6.11).

Plate 6.10. *Horiwila* local medicine practitioner

Plate 6.11.`*Yanthra Manthra practitioners and horoscope readers – Palugaswewa*

Festivals

There are no specific festivals confined to VTCS. These villages also celebrate national "Sinhala and Tamil new year which fall in the mid-April each year and the "Vesak" festival on the full- moon day in May. The New Year celebration marks the ending of one year and beginning of the New Year according to Astrological calendar.

Social organization in the villages

Traditionally *Gam Sabhas* (Village Councils) administered local affairs, addressed people's grievances & needs and settled minor disputes in villages. In 1818, the Village Councils were abolished by the British rulers. After colonial administration different organizations were introduced for local administration and at present *Pradeshiya Sabhas* represent the local government system. The administration is represented by locally elected members from villagers. The *Palugaswewa* DS division falls in the administrative division of *Kekirawa pradeshiyasabha*. The other social organizations in the DS division includes official organizations such as Farmer organizations (FO), Rural development societies, *Samurdhi* societies and voluntary organization such as Womens' societies, Death and welfare societies. The FOs are linked to the Agrarian Development Department, which is officially responsible for VTCS. The office bearers are elected from the membership. The holders of the paddy fields under the village tanks become members of the organization. The farmer organizations attend to maintenance of tanks & canals, irrigation water management, fertilizer distribution, making of crop calendar and collection of fees from the farmers. The activities of the FO are governed by the Agrarian Development Act No. 46 of 2011.

Key deliverables

Deliverables	Description
Indigenous knowledge and bio-cultural diversity data base (Biodiversity ToR-Task C)	Qualitative assessment of Indigenous knowledge and bio-cultural diversity has been provided in the Chapter 6. Due to the pandemic restriction quantitative assessment was not done

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CHAPTER SEVEN

Synthesis of Conclusions and Recommendations

The baseline assessment of the UNEP-GEF Healthy Landscape project provides the information about the initial reference levels of selected indicators to monitor the project progress special reference for the achievement of Global Environment Benefits (GEB) identified in the project GEF Tracking Tool (GTT). GEF tracking tool to be applied in the stage of CEO approval and project mid-term and project completion stages.

Baseline assessment also provides information on the status of the information model facility at the beginning of the project and provides written texts, databases, analysis, maps and photographic documentation as result of systematic assessment based on the scoping document and Terms of References (ToRs) in line with GTTs and the national policies and programmes. More importantly it provides information to National Project Coordinator (NPC), National Steering Committee (NSC), Technical Consultants (TCs), Global Coordination Unit (GCU), to monitor the project progress based on the GTT

The baseline assessments focused broad objective areas based on the GTT as indicated in the Table 7.1. However due to various limitation and restriction, this baseline assessment has not touched all the specific objective and indicators areas mentioned in the overall GTT but only identified indicators for the project. Nevertheless, this assessment has been managed provide necessary information (i) to establish an initial reference points for assessing key GEF tracking tool areas (ii) to identify performance indicators and compare with existing national and global indicators and averages (iii) to describe current status and impacts for key tracking tools areas (iv) identify potential gaps and provide directions to further assessment areas (v) to help define goals, objectives and scope of the project activities identified in the project workplan.

Village tank cascade system is recognized as a complex socio-ecological system established in the rural landscape setting of the Dry Zone of Sri Lanka. In the face of future climate change, VTCSs are nationally, important for sustainable food production though they are vulnerable to both droughts and floods. Globally, as a landscape VTCSs are important as it was identified as Globally, Important Agricultural Heritage Systems (GIAHSs) declared by the FAO. Therefore, the identification of socio-ecological context and principles behind the development of VTCS is vital.

Table 7.2 analyzed information collected in this baseline study in the context of GTT to identify information gaps for future assessments. Stakeholder opportunities for major interventions based on the recommendations are presented in Table 7.3.

Table 7.1. GEF tracking tool, main context and objectives

Main context and broad objectives	Specific objectives
Ecological: To measure the project progress in achieving the impacts and outcomes established at the GEF VI portfolio level under the biodiversity and land degradation focal areas.	Characterization of project pilot landscape in the context of nationally and globally important **Biodiversity** status and impacts
	Characterization of project pilot landscape in the context of nationally and globally important **Agrobiodiversity** (Crop/Livestock genetic resources) status and impacts
	Characterization of project pilot landscape in the context of nationally and globally important **Landscape/Habitat** level status and impacts
	Characterization of project pilot landscape in the context of nationally and globally important **Ecosystem Services** status and impacts
	Characterization of project pilot landscape in the context of **Land Degradation** status and impacts
Social: To measure the project progress in achieving the impacts and outcomes established at the GEF VI portfolio level under the Socio-economic and socio-ecological context	Characterization of project pilot landscape in the context of **Food Security and Human Health** status and impacts
	Characterization of project pilot landscape in the context of **Socio-Ecological Knowledge** status and impacts

Table 7.2. Socio-ecological contextual issues, baseline information and gaps

Socio-ecological contextual issues of the VTCS	Chapter 1	Chapter 2	Chapter 3	Chapter 4	Chapter 5	Chapter 6	Chapter 7	Inventory	Database	Maps	Spatial analysis	Trend analysis	Pattern analysis	Gap analysis	Perceptions	Annexes
Loss of vegetative (land) cover	0	2	0	0	0	0	x	0	0	3	3	1	2	3	3	0
Degradation of vegetation (biomass, health, damage, age structure)	0	3	2	1	1	0	x	2	0	3	3	1	1	3	3	3
Degradation of soil properties (chemical, physical and biological)	0	2	0	1	0	0	x	0	0	0	1	0	0	1	2	1
Soil loss by water erosion	0	0	0	0	1	0	x	0	0	0	0	0	0	0	1	2
Loss of tank capacity by siltation	0	0	0	0	0	0	x	0	0	0	0	0	0	1	3	2
Loss of above-ground carbon	0	0	0	0	0	0	x	0	0	0	0	0	0	0	0	0
Loss of soil carbon	0	0	0	0	0	0	x	0	0	0	0	0	0	0	0	0
Declining land productivity – based on Net Primary Productivity	1	2	1	1	0	0	x	0	0	0	0	0	0	2	3	3
Loss of biodiversity characterized at habitat level	1	2	3	1	1	0	x	3	3	0	2	1	1	3	3	3
Loss of biodiversity characterized at species level	1	0	3	1	2	0	x	3	3	0	3	3	3	3	3	3
Loss of agrobiodiversity at species/genetic level	0	0	3	2	3	0	x	2	1	0	2	1	1	1	2	1
Loss of livestock diversity at genetic level	0	0	2	1	1	0	x	0	0	0	0	0	0	0	1	1
Impact of invasive species	0	0	1	0	0	0	x	0	0	0	0	0	0	0	1	0
Loss/reduced water supply (surface and ground water)	1	0	1	1	0	0	x	0	0	0	0	0	0	0	2	2
Lowering of groundwater table / reduced aquifer	0	0	0	0	0	0	x	0	0	0	0	0	0	0	1	2
Loss/reduced water quality (surface and ground water)	1	2	2	0	0	0	x	0	0	0	0	0	0	0	3	3
Loss of VTCS aquatic habitats and their functions/services	1	2	3	3	2	0	x	0	0	0	2	2	0	2	3	2
Increased extent and severity of drought, flood, storm damage	1	0	0	1	1	0	x	0	0	0	0	0	0	0	1	1
Avoided emissions- Carbon stocks, other GHG gases	0	0	0	0	0	0	x	0	0	0	0	0	0	0	0	0
Carbon sequestration- Above ground biomass, Soil Carbon	0	0	0	0	0	0	x	0	0	0	0	0	0	0	0	0
Loss of ecosystem services in farming landscapes	1	2	2	3	1	0	x	2	2	3	2	2	2	2	3	1
Loss of ecosystem services in catchment forest landscapes	0	2	2	3	0	0	x	0	0	2	4	2	2	2	3	2

Loss of ecosystem services in ecological commons	1	3	3	3	1	0	x	2	0	3	2	0	2	2	3	2
SLM in wider landscape level	0	3	1	1	1	0	x	0	0	0	2	0	0	0	3	3
Affected community within the landscape	1	1	2	2	3	0	x	0	0	0	3	3	3	2	3	3
Income and poverty issues of the community	0	0	0	1	2	0	x	0	0	0	2	1	2	2	3	2
Food and nutrition security awareness and issues of the community	3	2	2	1	3	0	x	3	3	0	3	2	3	2	3	2
Status of human health and impacts	0	0	1	0	3	0	x	3	3	0	3	2	3	2	3	2
Loss of traditional knowledge and practises	0	0	2	0	0	3	x	0	0	0	1	1	2	1	1	1
Level of community awareness on climate variability	0	0	1	0	0	1	x	0	0	0	0	0	0	0	0	0
Level of community awareness on adaptation	0	1	1	1	1	1	x	0	0	0	0	0	0	0	1	0
Level of community awareness on resilience and restoration	0	0	0	0	0	2	x	0	0	0	0	0	0	0	1	1
Socio-ecological impacts of governance	0	0	1	0	0	1	x	0	0	0	0	0	0	0	0	2

Based on the GEF COE approval document, indicators identified in the GEF Tracking Tool are indicated in highlighted text

0	No relevant information (major gaps)	1	Low relevant information	2	Moderate relevant information
3	Adequate relevant information	4	More than adequate	X	Not relevant

Opportunities for major interventions

Based on the gap analysis in line with GTT indicators and analyses of recommendation from all chapters, editors identified opportunities for key interventions to implement programmes and activities in different stakeholder levels are presented in Table 7.3.

Table 7.3. Recommendations for major interventions

Gaps in knowledge, current constraints and development interventions that could provide opportunities/niches for project stakeholders and partners	**Development and Research Partners**					
	GOSL National Level	GOSL Local Level	NGOs Level	Research Level	Community Level	Intel. Level
Support for implementation of Sustainable Land Management (SLM) technologies	X		X	X	X	
Training and capacity building for land degradation assessment and prevention measures	X		X	X		X
Understanding the value of biodiversity of the VTCS and ecosystem services in the context of VTCS sustainability	X	X	X	X	X	X
Restoration of biodiversity in species and habitat level		X	X	X	X	X
Pilot project on VTCS eco-tourism	X	X				

	Strategies to preserve, protect and utilization of traditional knowledge. Promote the traditional knowledge in VTCS food production systems.			X	X	X	X
	Strategies for agrobiodiversity conservation and promotion	X	X		X	X	
	Discourage monoculture planation improve the multi species home gardens	X		X		X	
	Monitoring water quality and strategies to improve water quality and prevent water pollution		X		X	X	
	Invasive species control and management programmes	X	X		X		
	Encourage medicinal plant cultivation home garden level	X	X		X	X	
	Improve extension services	X	X				
	Comprehensive assessment and mapping of VTCS ecosystem services				X		X
	Conserve and restore the village tanks with the involvement of multi-stakeholders	X	X		X	X	X
	Farmers and community awareness and provision of necessary technical and infrastructure support to understand food security, human health issues	X	X		X		
	Provide farmers necessary awareness and inputs to enhanced popularity of organic and locally grown food	X	X		X		
	Build knowledge and understanding of native agriculture and food systems and help promote native communities' innovative ideas and best practices.	X	X			X	
	Promote healthy eating of the population, which will directly improve the nutritional and health status of the community as well as indirectly promote sustainable agriculture	X	X		X		
	Promote awareness on farmers and community to	X	X	X	X		

	understand climate change, climate variability and its impacts.				
	Promote programmes to understand farmers and community about adaptation practices	X	X	X	X
	Provide access to better medical facilities to vulnerable groups such as elderly, adults and school children who are usually not prioritized in the present public health services.	X	X		
	Strategies to improve efficiency and effectiveness of VTCS governance	X	X		

Key deliverables

Deliverables	Description
Gap analysis for major interventions	Editors decided to analyses of recommendation from all chapters and provide comparative analysis of information and data presented in the baseline assessment with GTT indicators. Further identified opportunities for interventions based on recommendations. Baseline assessment information dedicated to the selected GTT indicators identified in the GEF COE approval document.

Annexes – Chapter 2

Annex 2.1 Code sheet – LADA WOCAT Assessment

i. Type of degradation

Code	Type of Degradation	Main types
Bc	Reduction of vegetative cover	Biological degradation
Bf	Detrimental effects of fires	
Bh	Loss of habitats	
Bl	Loss of soil life	
Bp	Increase of pests/diseases*: reduction of biological control*	
Bq	Quantity/biomass decline*: reduced vegetative production for different land use*	
Bs	Quality and species composition/diversity decline	
Ca	Acidification	Chemical Soil deterioration
Cn	Fertility decline and reduced organic matter content	
Cp	Soil pollution	
Cs	Salinization/alkalinisation	
Ed	Deflation and deposition : *uneven removal of soil material*	Soil erosion by wind
Eo	Offsite degradation effects	
Et	Loss of topsoil : *uniform displacement*	
Ha	Aridification: *decrease of average soil moisture content*	Water degradation
Hg	Change in groundwater/aquifer level	
Hp	Decline of surface water quality	
Hq	Decline of groundwater quality	
Hs	Change in quantity of surface water: *change of the flow regime (flood, low flow, drying up of rivers and lakes)*	
Hw	Reduction of the buffering capacity of wetland areas	
Pc	Compaction	Physical soil degradation
Pk	Sealing and crusting	
Ps	Subsidence of organic soils, setting of soils	
Pu	Loss of bio-productive function due to other activities	
Pw	Waterlogging	
Wg	Gully erosion/gullying	Soil erosion by water
Wm	Mass movements/landslides	
Wo	Offsite degradation effects: *deposition of sediments, downstream flooding, siltation of reservoirs and waterways, and pollution of water bodies with eroded sediments*	
Wr	Riverbank erosion	
Wt	Loss of topsoil/surface erosion	

ii. Direct causes

Code	Direct causes	Main Types
c1	Reduction of plant cover and residues	Crop and rangeland management
c2	Inappropriate application of manure, fertilizer, herbicides, pesticides and other agro-chemicals or waste	
c3	Nutrient mining: excessive removal without appropriate replacement of nutrients	
c4	Shortening of the fallow period in shifting cultivation	
c5	Inappropriate irrigation (full and supplementary): inefficient irrigation method, over-irrigation, insufficient drainage	
c6	Inappropriate use of water in rainfed agriculture (eg excessive soil evaporation and runoff	
c7	Bush encroachment and bush thickening	
c8	Occurrence and spread of weeds and invader plants	
c9	Others (specify)	
e1	Excessive gathering of fuel wood, (local) timber, fencing materials	Over-exploitation of vegetation for domestic use
e2	Removal of fodder	
e3	Others (specify)	
f	Deforestation and removal of natural vegetation	Deforestation and removal of natural vegetation
f1	Large-scale commercial forestry	
f2	Expansion of urban / settlement areas and industry	
f3	Conversion to agriculture	
f4	Forest / grassland fires	
f5	Road and rail construction	
f6	Others (specify)	
g1	Excessive numbers of livestock	Overgrazing
g2	Trampling along animal paths	
g3	Overgrazing and trampling around or near feeding, watering and shelter points	
g4	Too long or extensive grazing periods in a specific area or camp leading to overutilization of palatable species	
g5	Change in livestock composition: from large to small stock; from grazers to browsers; from livestock to game and vice versa	
g6	Others (specify)	
i1	Industry	Industrial activities and mining
i2	Mining	
i3	Waste deposition	
i4	Others (specify)	
n1	Change in temperature	Natural causes
n2	Change of seasonal rainfall	
n3	Heavy/ extreme rainfall (intensity and amounts)	
n4	Windstorms / dust storms	
n5	Floods	
n6	Drought	
n7	Topography	
n8	Others	
Code	Direct causes	Main Types
o1	Irrigation	Over abstraction of water / excessive withdrawal of water
o2	Industrial use	
o3	Domestic use	
o4	Mining activities	
o5	Decreasing water use efficiency	
o6	Others (specify)	
p1	Sanitary sewage disposal	Discharges
p2	Waste water discharge	
p3	Excessive runoff	
p4	Poor and insufficient infrastructure to deal with urban waste	
p5	Others (specify)	
q1	Contamination of vegetation/ crops and soil	Release of airborne pollutants
q2	Contamination of surface and ground water resources	
q3	Others	
s1	Cultivation of highly unsuitable soils	Soil Management
s2	Missing or insufficient soil conservation / runoff and erosion control measures	
s3	Heavy machinery	
s4	Tillage practice (ploughing, harrowing, etc.)	
s5	Others (specify)	
u1	Settlements and roads	Urbanization and infrastructure development
u2	Recreation (urban)	
u3	Others	
w1	Lower infiltration rates/increased surface runoff	Disturbance of water cycle
w2	Others (specify)	

(iii) Indirect Causes

c	Consumption pattern and individual demand
e	Education, awareness raising and access to knowledge and support services and loss of knowledge
g	Governance, institutions and politics
h	Poverty
l	Labour availability
o	Others (specify)
p	Population pressure
r	Inputs and infrastructure
t	Land tenure
w	War and conflict

Annex 2.2. Land Use Type grouping system definition sheet

***Land use**: human activities which are directly related to land, making use of its resources or having an impact on it.*

***Land cover**: vegetation (natural or planted) or man-made structures (buildings, etc.) that cover the earth's surface.*

Land use types

Main categories	*Subcategories*
Cropland: land used for cultivation of crops (field crops, orchards)	• *Ca: Annual cropping: land under temporary/ annual crops usually harvested within one, maximally two years (e.g. maize, paddy rice, wheat, vegetables, fodder crops).* • *Cp: Perennial (non-woody) cropping: land under permanent (not woody) crops that may be harvested after 2 or more years, or where only part of the plants are harvested (e.g. sugar cane, banana, sisal, pineapple).* • *Ct: Tree and shrub cropping: permanent woody plants with crops harvested more than once after planting and usually lasting for more than 5 years (e.g. orchard/ fruit trees, coffee, tea, grapevines, oil palm, cacao, coconut, fodder trees).*

Grazing land: land used for animal production	• *Ge: Extensive grazing land: grazing on natural or semi-natural grasslands, grasslands with trees/ shrubs (savannah vegetation) or open woodlands for livestock and wildlife. Includes the following subcategories:*
	  • *Nomadism: people move with animals.*
	  • *Semi-nomadic pastoralism: animal owners have a permanent place of residence where supplementary cultivation is practiced. Herds are moved to distant grazing grounds.*
	  • *Ranching: grazing within well-defined boundaries, movements cover smaller distances and management inputs are higher compared to semi-nomadism.*
	  • *Transhumant pastoralism: regular movements of herds between fixed areas in order to benefit from the seasonal variability of climates and pastures.*
	• *Gi: Intensive grazing/ fodder production: improved or planted pastures for grazing/ production of fodder (for cutting and carrying: hay, leguminous species, silage etc.) not including fodder crops such as maize, cereals. These are classified as annual crops (see above). Intensive grazing can be subclassified into:*
	  • *Cut-and-carry/ zero grazing: carrying fodder to animals confined to a stall/ shed or another restricted area; in zero-grazing systems the livestock are not permitted to graze at any time.*
	  • *Improved pastures: pasture that is sown with a mixture of introduced grasses and legumes (can be fertilized and/ or inoculated with rhizobia to fix nitrogen).*

Forests/ woodlands: land used mainly for wood production, other forest products, recreation, protection.	• *Fn: Natural or semi-natural: forests mainly composed of indigenous trees, not planted by man.*
	  • *Selective felling.*
	  • *Clear felling: felling the whole forest at one time.*
	  • *Shifting cultivation: felling (harvesting) only certain valuable trees within a forest.*
	  • *Dead wood/ prunings removal (no cutting of trees).*
	  • *Non-wood forest use (e.g. fruit, nuts, mushrooms, honey, medicinal plants, etc.) .*
	• *Fp: Plantations, afforestations: forest stands established by planting or/ and seeding in the process. of afforestation or reforestation.*
	  • *Monoculture local variety.*
	  • *Monoculture exotic variety.*
	  • *Mixed varieties.*
	• *Fo: Other: e.g. selective cutting of natural forests and incorporating planted species.*

Settlements, infrastructure	• *Ss: Settlements, buildings* • *St: Traffic lines: roads, railways* • *Se: Energy lines: pipe lines, power lines* • *So: Other infrastructure*
Waterways, waterbodies, wetlands	• *Wd: Drainage lines waterways* • *Wp: Ponds, dams* • *Ws: Swamps, wetlands* • *Wo: Other waterways*
Mines, extractive industries	• *I: Mines, extractive industries*
Unproductive land	• *U: Wastelands, deserts, glaciers, etc.*

SLM group to which the Technology belongs

Natural and semi-natural forest management: encompasses administrative, legal, technical, economic, social, and environmental aspects of the conservation and use of forests.

Forest plantation management: plantation forests comprise even-aged monocultures and are established primarily for wood and fibre production. They are usually intensively managed and have relatively high growth rates and productivity.

Agroforestry: integrates the use of woody perennials with agricultural crops and/ or animals for a variety of benefits and services including better use of soil and water resources; multiple fuel, fodder, and food products; and habitat for associated species.

Windbreak: or shelterbelt is a plantation usually made up of one or more rows of trees or shrubs planted in such a manner as to provide shelter from the wind and to protect soil from erosion. They are commonly planted around the edges of fields on farms.

Area closure (stop use, support restoration): enclosing and protecting an area of degraded land from human use and animal interference, to permit natural rehabilitation, enhanced by additional vegetative and structural conservation measures.

Rotational systems (crop rotation, fallows, shifting cultivation): is the practice of growing a series of dissimilar/ different types of crops/ plants in the same area in sequenced season, letting it fallow for a period of time, shifting cultivation is an agricultural system in which plots of land are cultivated temporarily, then abandoned and allowed to revert to their natural vegetation while the cultivator moves on to another plot.

Pastoralism and grazing land management: is the grazing of animals on natural or semi-natural grassland, grassland with trees, and/ or open woodlands. Animal owners may have a permanent residence while livestock is moved to distant grazing areas, according to the availability of resources

Integrated crop–livestock management: optimizes the uses of crop and livestock resources through interaction and the creation of synergies.

Improved ground/ vegetation cover: any measures that aim to improve the ground cover be it by dead material/ mulch or vegetation

Minimal soil disturbance refers to no-tillage or low soil disturbance only in small strips and/ or shallow depth and direct seeding.

Integrated soil fertility management (IFSM) aims at managing soil by combining different methods of soil fertility amendment together with soil and water conservation. ISFM is based on three principles: maximizing the use of organic sources of fertilizer (e.g. manure and compost application, nitrogen-fixing green manure and cover crops); minimizing the loss of nutrients; and judiciously using inorganic fertilizer according to needs and economic availability.

Cross-slope measures: are constructed on sloping lands in the form of earth or soil bunds, stone lines, or vegetative strips, etc. for reducing runoff velocity and soil erosion.

Integrated pest and disease management (incl. organic agriculture): Integrated pest and disease management is a process to solve pest and disease problems while minimizing risks to people and the environment.

Improved plant varieties/ animal breeds: refers to the development of new plant varieties or animal breeds that offer benefits such as improved production, resistance to pests and diseases, or drought tolerance, in response to changing environmental conditions and land users' needs.

Water harvesting: is the collection and management of floodwater or rainwater runoff to increase water availability for domestic and agricultural use as well as ecosystem sustenance.

Irrigation management (incl. water supply, drainage) aims to achieve higher water use efficiency through more efficient water collection and abstraction, water storage, distribution, and water application.

Water diversion and drainage: is the natural or artificial diversion or removal of surface and sub-surface water from an area

Surface water management (spring, river, lakes, sea): involves the protection of springs, rivers, and lakes from pollution, high water flows(floods), or over-abstraction of water, as well as protection measures against damage from waterbodies (e.g. river bank erosion, floods, tidal erosion)

Groundwater management: involves securing the recharge of groundwater reserves and their protection from pollution, overexploitation/ overuse, and rising groundwater levels leading to salinization.

Wetland protection/ management: managing wetland typically involves manipulating water levels and vegetation in the wetland, and providing an upland buffer.

Waste management/ waste water management: is a set of activities that include collection, transport, treatment and disposal of waste, prevention of waste production, and modification and reuse/ recycling of waste.

Energy efficiency technologies: reduce the amount of energy required to provide products and services, e.g. for cooking and heating, reducing the demand for fuel (fossil, wood).

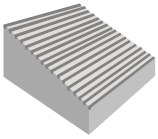
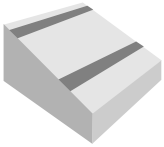
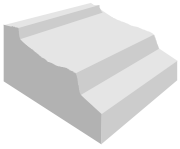
Beekeeping, aquaculture, poultry, rabbit farming, silkworm farming, etc.: allow food production and agricultural products requiring small surfaces of the land.

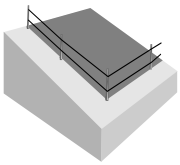
Home gardens (also called backyard or kitchen gardens): are a traditional multifunctional farming system applied on a small area of land around the family home. They have the potential to supply most of the non-staple foods (including vegetables, fruits, herbs, animals and fish). They also provide a space for recreation, leisure, and relaxation.

Ecosystem-based Disaster Risk Reduction: is the sustainable management, conservation, and restoration of ecosystems with the aim of enabling these ecosystems to provide services that mitigate hazards, reduce vulnerability, and increase livelihood resilience.

Post-harvest measures: encompasses activities to deliver a crop from harvest to consumption with minimum loss, maximum efficiency, and maximum return for all involved – such as drying, storage, cooling, cleaning, sorting, and packing.

SLM measures – the constituents of a Technology

Type of measure	Subcategories	Examples
Agronomic measures  • are usually associated with annual crops • are repeated routinely each season or in a rotational sequence • are of short duration and not permanent • do not lead to changes in slope profile • are normally independent of slope	A1: Vegetation/ soil cover	Mixed cropping, intercropping, relay cropping, cover cropping
	A2: Organic matter/ soil fertility	Conservation agriculture, production and application of compost/ manure, mulching, trash lines, green manure, crop rotations
	A3: Soil surface treatment	Zero tillage (no-till), minimum tillage, contour tillage Differentiate tillage systems: No tillage, reduced tillage (>30% soil cover), full tillage (>30% soil cover).
	A4: Subsurface treatment	Breaking compacted subsoil (hard pans), deep ripping, double digging
	A5: Seed management, improved varieties	Production of seeds and seedlings, seed selection, seed banks, development/ production of improved varieties
	A6: Residue management A7: Others	Specification required: burned, grazed, collected, retained.
Vegetative measures  • involve the use of perennial grasses, shrubs, or trees • are of long duration • often lead to a change in slope profile • are often aligned along the contour or against the prevailing wind direction • are often spaced according to slope	V1: Tree and shrub cover	Agroforestry, windbreaks, afforestation, hedges, live fences
	V2: Grasses and perennial herbaceous plants	Grass strips along the contour, vegetation strips along riverbanks
	V3: Clearing of vegetation	Fire breaks, reduced fuel for forest fires
	V4: Replacement or removal of alien/ invasive species	Cutting of undesired trees and bushes
	V5: Others	Tree nurseries
Structural measures  • are of long duration or permanent • often require substantial inputs of labour or money when first installed • involve major earth movements and/ or construction with wood, stone, concrete, etc. are often carried out to control runoff, erosion, and wind velocity, and to harvest rainwater • often lead to a change in slope profile	S1: Terraces	Bench terraces (slope of terrace bed <6%); Forward-sloping terraces (slope of terrace bed >6%
	S2: Bunds, banks	Earth bunds, stone bunds (along the contour or graded), semi-circular bunds ("demi-lunes")
	S3: Graded ditches, channels, waterways	Diversion/ drainage ditch, waterways to drain and convey water
	S4: Level ditches, pits	Retention / infiltration ditches, planting holes, micro-catchments
	S5: Dams, pans, ponds	Dams for flood control, dams for irrigation, sand dams
	S6: Walls, barriers, palisades, fences	Sand dune stabilization, rotational grazing (using fences), area closure, gully plugs (check dams)
	S7: Water harvesting/ supply/ irrigation equipment	Rooftop water harvesting, water intakes, pipes, tanks, etc.
	S8: Sanitation/ waste water structures	Compost toilet, septic tanks, constructed treatment wetlands
	S9: Shelters for plants and animals	Greenhouses, stables, shelters for plant nurseries

• are often aligned along the contour/ against prevailing wind direction • are often spaced according to slope If structures are stabilized by means of vegetation, also select relevant vegetative measures!	S10: Energy saving measures	Wood-saving stoves, insulation of buildings, renewable energy sources (solar, biogas, wind, hydropower)
	S11: Others	Compost production pits; reshaping of surface (slope reduction)
Management measures  • *involve a fundamental change in land use* • *usually involve no agronomic and structural measures* • *often result in improved vegetative cover* • *often reduce the intensity of use*	M1: Change of land use type	*Area closure/ resting, protection, change from cropland to grazing land, from forest to agroforestry, afforestation*
	M2: Change of management/ intensity level	*Change from grazing to cutting (for stall feeding), farm enterprise selection (degree of mechanization, inputs, commercialization), vegetable production in greenhouses, irrigation; from mono-cropping to rotational cropping; from continuous cropping to managed fallow; from open access to controlled access (grazing land, forests); from herding to fencing, adjusting stocking rates, rotational grazing*
	M3: Layout according to natural and human environment	*Exclusion of natural waterways and hazardous areas, separation of grazing types, distribution of water points, salt licks, livestock pens, dips (grazing land); increase of landscape diversity, forest aisle*
	M4: Major change in timing of activities	*Land preparation, planting, cutting of vegetation*
	M5: Control/ change of species composition (if annually or in a rotational sequence as done e.g. on cropland → A1)	*Reduction of invasive species, selective clearing, encouragement of desired/ introduction of new species, controlled burning (e.g. prescribed fires in forests/ on grazing land)/ residue burning*
	M6: Waste management (recycling, re-use or reduce)	*Includes both artificial and natural methods for waste management*
	M7: Others	
Other measures • *comprises any measures which do not fit into the above categories*		*Beekeeping, small stock farming (e.g. poultry, rabbits), fish ponds; food storage and processing (including post-harvest loss reduction)*
Combinations • *occur where different measures complement each other and thus enhance each other's effectiveness* • *may comprise any two or more of the above measures*		*Terrace (S1) + Grass strips and trees along riser (V2, V1) + Contour tillage (A3)* *Zero grazing/ stall feeding (M2) + Construction of stables and fence (S10) + Compost/ manure production pits (S12) + Application of manure and compost on cropland (A2)*

Annexes – Chapter 3

Annex 3.1.1. Distribution of samples in two cascades

	CASCADE													
	NACHCHADUWA CASCADE							**HORIVILA CASCADE**						
SAMPLE NO.	ACACIA FOREST	CHENA	HOMEGARDEN	KATTAKADUWA	NATURAL FOREST	SCRUBLAND	TEAK FOREST	CHENA	HOMEGARDEN	KATTAKADUWA	MEDICINAL FOREST	NATURAL FOREST	SCRUBLAND	TEAK FOREST
Sample_1			1											
Sample_1.1		1												
Sample_10					1									
Sample_11			1											
Sample_12										1				
Sample_13												1		
Sample_14									1					
Sample_15													1	
Sample_16								1						
Sample_17											1			
Sample_18														1
Sample_19												1		
Sample_2				1										
Sample_20										1				
Sample_21		1												
Sample_22						1								
Sample_23					1									
Sample_24			1											
Sample_25				1										
Sample_26							1							
Sample_27								1						
Sample_28													1	
Sample_29									1					
Sample_3							1							
Sample_30												1		
Sample_31													1	
Sample_32										1				
Sample_33								1						
Sample_34														1
Sample_35									1					
Sample_4						1								
Sample_5	1													
Sample_6					1									
Sample_7				1										
Sample_8						1								
Sample_9		1												
Total > (36)	1	3	3	3	3	3	2	3	3	3	1	3	3	2

Annex 3.1.2 List of plants in two cascades

	Family	Species	Local Name	Endemic	Threatened
1	Acanthaceae	*Blepharis maderaspatensis*			
2	Acanthaceae	*Crossandra infundibuliformis*			
3	Acanthaceae	*Ecbolium ligustrinum*	Kawu Thumba		
4	Acanthaceae	*Hygrophila schulli*	Neeramulliya		
5	Acanthaceae	*Justicia adhatoda*	Adathoda		
6	Aizoaceae	*Trianthema portulacastrum*	Heen Sarana		
7	Amarallidaceae	*Allium cepa*	Rathu Lunu		
8	Amaranthaceae	*Achyranthes aspera*	Karal Haba		
9	Amaranthaceae	*Aerva lanata*	Polpala		
10	Amaranthaceae	*Alternanthera sessilis*	Mukunuwenna		
11	Amaranthaceae	*Amaranthus sp.*	Rathuthampala		
12	Amaranthaceae	*Amaranthus spinosus*	Katu Thampala		
13	Amaranthaceae	*Amaranthus viridis*	Kura Thampala		
14	Amaranthaceae	*Celosia argentea*	Kiri Henda		
15	Amaranthaceae	*Gomphrena celosioides*			
16	Amaryllidaceae	*Crinum defixum*	Heen Tolabo		
17	Amaryllidaceae	*Crinum latifolium*	Goda Manel		(T-VU)
18	Anacardiaceae	*Anacardium occidentale*	Kaju		
19	Anacardiaceae	*Mangifera indica*	Amba		
20	Annonaceae	*Annona muricata*	Katu Anoda		
21	Annonaceae	*Annona reticulata*	Sini Anoda		
22	Annonaceae	*Annona sp.*	Seenianoda		
23	Annonaceae	*Annona squamosa*	Anoda		
24	Annonaceae	*Miliusa indica*	Kekili Messa		
25	Annonaceae	*Polyalthia korinti*	Miwenna, Ul Kenda		
26	Annonaceae	*Polyalthia longifolia*	Owila		
27	Apiaceae	*Centella asiatica*	Gotukola		
28	Apiaceae	*Trachyspermum involucratum*	Asamodagam		
29	Apocynaceae	*Allamanda cathartica*	Wal-Ruk-Attana		
30	Apocynaceae	*Alstonia scholaris*	Ruk-Attana		
31	Apocynaceae	*Calotropis gigantea*	Wara		
32	Apocynaceae	*Carissa spinarum*	Karamba		
33	Apocynaceae	*Dregea volubilis*	Anguna		
34	Apocynaceae	*Hemidesmus indicus*	Iramusu		
35	Apocynaceae	*Ichnocarpus frutescens*	Kiri-Wel		
36	Apocynaceae	*Nerium oleander*	Kaneru		
37	Apocynaceae	*Tabernaemontana divaricata*	Wathusudda		
38	Apocynaceae	*Tylophora pauciflora*			(T-EN)
39	Aponogetonaceae	*Aponogeton crispus*	Kekatiya		(T-VU)
40	Araceae	*Alocasia macrorrhizos*	Habarala		
41	Araceae	*Anthurium andraeanum*	Anthurium		
42	Araceae	*Colocasia esculenta*	Gahala		
43	Araceae	*Lasia spinosa*	Kohila		
44	Araceae	*Pothos scandens*	Pota-Wel		
45	Arecaceae	*Areca catechu*	Puwak		
46	Arecaceae	*Borassus flabellifer*	Thal		
47	Arecaceae	*Caryota urens*	Kithul		

48	Arecaceae	*Cocos nucifera*	Pol	
49	Arecaceae	*Corypha umbraculifera*	Thala	
50	Arecaceae	*Dypsis lutesence*	Dothuru	
51	Arecaceae	*Phonix pusilla*	Wal Indi	
52	Asparagaceae	*Asparagus racemosus*	Hatawariya	
53	Aspliniaceae	*Asplenium sp.*	Meewana	
54	Asteraceae	*Ageratum conyzoides*	Hulantala	
55	Asteraceae	*Bidens pilosa*		
56	Asteraceae	*Chromolaena odorata*	Podi Singno Maran	
57	Asteraceae	*Dahlia coccinea*	Delia	
58	Asteraceae	*Eleutheranthera ruderalis*		
59	Asteraceae	*Gerbera jamesonii*	Barbandesia	
60	Asteraceae	*Mikania cordata*	Gam Palu	
61	Asteraceae	*Sphaeranthus indicus*	Mudu-Mahana	
62	Asteraceae	*Tagetes erecta*	Dahaspethiya	
63	Asteraceae	*Tridax procumbens*	Wasu Suda	
64	Asteraceae	*Vernonia cinerea*	Monorakudumbiya	
65	Asteraceae	*Vernonia zeylanica*	Papula	(E)
66	Asteraceae	*Vicoa indica*	Ran-Hiriya	
67	Asteraceae	*Xanthium indicum*	Uru-Kossa	
68	Bignoniaceae	*Oroxylum indicum*	Totila	
69	Bignoniaceae	*Tecoma stans*	Kelani Tissa	
70	Boraginaceae	*Cordia curassavica*		
71	Boraginaceae	*Cordia dichotoma*	Lolu	
72	Boraginaceae	*Ehretia laevis*		
73	Boraginaceae	*Ehretia microphylla*	Hin-Thambala	
74	Boraginaceae	*Heliotropium indicum*	Et-Honda	
75	Brassicaceae	*Brassica juncea*	Aba	
76	Bromeliaceae	*Ananas comosus*	Annasi	
77	Cactaceae	*Portulaca oleracea*	Genda-Kola	
78	Cactaceae	*Talinum paniculatum*	Gas-Niviti	
79	Calophyllaceae	*Mesua ferrea*	Na	
80	Cannabaceae	*Trema orientalis*	Gadumba	
81	Cannaceae	*Canna indica*	Buthsarana	
82	Capparaceae	*Capparis zeylanica*	Wellangiriya	
83	Caricaceae	*Carica papaya*	Gas-Labu	
84	Celastraceae	*Maytenus emarginata*		
85	Celastraceae	*Reissantia indica*		
86	Celastraceae	*Salacia chinensis*	Heen-Himbutu-Wel	
87	Celastraceae	*Salacia oblonga*	Gal Himbutu	(T-EN)
88	Cleomaceae	*Cleome rutidosperma*		
89	Clusiaceae	*Garcinia morella*	Gokatu	
90	Combretaceae	*Combretum albidum / ovalifolium ?*	Kaduru-Ketiya Wel	
91	Combretaceae	*Terminalia arjuna*	Kumbuk	
92	Combretaceae	*Terminalia catappa*	Kottamba	
93	Commelinaceae	*Commelina benghalensis*	Diya-Meneriya	
94	Commelinaceae	*Commelina diffusa*	Gira-Pala, Tanapala	
95	Commelinaceae	*Commelina ensifolia*		
96	Commelinaceae	*Murdannia nudiflora*		
97	Connvolvulaceae	*Argyreia osyrensis*	Dumbada	
98	Connvolvulaceae	*Argyreia populifolia*	Girithilla	(E)

99	Connvolvulaceae	*Hewittia sublobata*	Wal-Trastawalu		
100	Connvolvulaceae	*Ipomoea aquatica*	Kankun		
101	Connvolvulaceae	*Ipomoea cairica*			
102	Connvolvulaceae	*Ipomoea indica*			
103	Connvolvulaceae	*Ipomoea marginata*	Rasa-Tel-Kola		
104	Connvolvulaceae	*Ipomoea obscura*	Tel Kola		
105	Connvolvulaceae	*Jatropa spicata*	Visahkumba		
106	Connvolvulaceae	*Merremia cissoides*			
107	Costaceae	*Costus speciosus*	Tebu		
108	Cucurbitaceae	*Coccinia grandis*	Kowakka		
109	Cucurbitaceae	*Cucurbita maxima*	Wattakka		
110	Cucurbitaceae	*Diplocyclos palmatus*	Pasengilla		
111	Cucurbitaceae	*Luffa cylindrica*	Niyan-Vetakolu		
112	Cucurbitaceae	*Momodica charantia*	Batu Karavila		
113	Cucurbitaceae	*Trichosanthes cucumerina*	Dum-Mella		
114	Cycadaceae	*Cycas nathorstii*	Madu		(T-VU)
115	Cyperaceae	*Cyperus brevifolius*			
116	Cyperaceae	*Cyperus compressus*	Pidalithana		
117	Cyperaceae	*Cyperus haspan*	Hal-Pan		
118	Cyperaceae	*Cyperus iria*	Thunessa		
119	Cyperaceae	*Cyperus rotundus*	Kaladuru		
120	Cyperaceae	*Cyperus triceps*			
121	Cyperaceae	*Fimbristylis dichotoma*			
122	Cyperaceae	*Fimbristylis falcata*			
123	Cyperaceae	*Fimbristylis miliacea*	Mudu-Hal-Pan		
124	Cyperaceae	*Fimbristylis triflora*			
125	Cyperaceae	*Scleria lithosperma*			
126	Dioscoreaceae	*Dioscorea pentaphylla*	Katu-Ala		
127	Ebenaceae	*Diospyros cordifolia*	Elakaruwala		
128	Ebenaceae	*Diospyros ebenum*	Kaluwara		(T-EN)
129	Ebenaceae	*Diospyros ferrea*	Jabara	(E)	
130	Ebenaceae	*Diospyros malabarica*	Thimbiri		
131	Ebenaceae	*Diospyros ovalifolia*	Habara, Kunumella		
132	Erythroxylaceae	*Erythroxylum zeylanicum*		(E)	
133	Euphorbiaceae	*Acalypha paniculata*			
134	Euphorbiaceae	*Codiaeum variegatum*	Croton Mal		
135	Euphorbiaceae	*Croton aromaticus*	Wel-Keppetiya		
136	Euphorbiaceae	*Croton hirtus*	Val-Tippili		
137	Euphorbiaceae	*Euphorbia hirta*	Bu-Dada-Kiriya		
138	Euphorbiaceae	*Macaranga peltata*	Kenda		
139	Euphorbiaceae	*Mallotus philippensis*	Hamparilla		
140	Euphorbiaceae	*Mallotus rhamnifolius*	Bulu-Hulu-Keppetiya		
141	Euphorbiaceae	*Manihot esculenta*	Maiokka		
142	Euphorbiaceae	*Ricinus communis*	Endaru		
143	Euphorbiaceae	*Suregada lanceolata*			
144	Fabaceae	*Acacia auriculiformis*			
145	Fabaceae	*Acacia caesia*	Hinguru-Wel		
146	Fabaceae	*Acacia leucophloea*	Maha-Andara		
147	Fabaceae	*Adenanthera pavonina*	Madithiya		
148	Fabaceae	*Albizia odoratissima*	Suriya-Mara		
149	Fabaceae	*Alysicarpus vaginalis*	Aswenna		

150	Fabaceae	*Arachis hypogaea*	Rata-Kaju		
151	Fabaceae	*Atylosia scarabaeoides*	Wal-Kollu		
152	Fabaceae	*Bauhinia racemosa*	Maila		
153	Fabaceae	*Bauhinia tomentosa*	Kaha-Petan		
154	Fabaceae	*Butea monosperma*	Gas-Kela		(T-VU)
155	Fabaceae	*Cassia fistula*	Ehela		
156	Fabaceae	*Cassia roxburghii*	Ratu-Wa		
157	Fabaceae	*Clitoria ternatea*	Nilkatarodu		
158	Fabaceae	*Crotalaria lunulata*			
159	Fabaceae	*Dalbergia lanceolaria*	Bol-Mara		(T-VU)
160	Fabaceae	*Desmodium heterophyllum*	Maha-Undupiyaliya		
161	Fabaceae	*Desmodium triflorum*	Heen-Undupiyaliya		
162	Fabaceae	*Dichostachys cinerea*	Katu Andara		
163	Fabaceae	*Gliricidia sepium*	Vetamara		
164	Fabaceae	*Leucaena leucocephala*	Ipil-Ipil		
165	Fabaceae	*Mimosa invisa*	Wel Nidikumba		
166	Fabaceae	*Mimosa pudica*	Nidi-Kumba		
167	Fabaceae	*Phaseolus vulgaris*	Bonchi		
168	Fabaceae	*Pithecellobium dulce*	Pinikaral		
169	Fabaceae	*Pongamia pinnata*	Karanda		
170	Fabaceae	*Psophocarpus tetragonolous*	Dara-Dambala		
171	Fabaceae	*Pterocarpus marsupium*	Gammalu		(T-VU)
172	Fabaceae	*Samanea saman*	Maara		
173	Fabaceae	*Saraca asoka*	Ashoka		(T-VU)
174	Fabaceae	*Senna auriculata*	Ranawara		(T-VU)
175	Fabaceae	*Tamarindus indica*	Siyambala		
176	Fabaceae	*Tephrosia maxima*			
177	Fabaceae	*Vigna mungo*	Undu		
178	Fabaceae	*Vigna unguiculata*	Mekaral		
179	Hydrocharitaceae	*Ottelia alismoides*			
180	Hypoxidaceae	*Curculigo orchioides*	Bim Thal		
181	Lamiaceae	*Anisomeles indica*	Yak-Wanassa		
182	Lamiaceae	*Gmelina asiatica*	Demata		
183	Lamiaceae	*Hyptis capitata*			
184	Lamiaceae	*Ocimum gratissimum*	Gas-Tala		
185	Lamiaceae	*Ocimum tenuiflorum (old name ?)*	Maduru-Tala		
186	Lamiaceae	*Orthosiphon thymiflorus*			
187	Lamiaceae	*Premna procumbens*	Le-Kola-Pala	(E)	
188	Lamiaceae	*Premna tomentosa*	Bu-Sera		
189	Lamiaceae	*Vitex altissima*	Milla		
190	Lamiaceae	*Vitex leucoxylon*	Nabada		
191	Lamiaceae	*Vitex negundo*	Nika		
192	Lauraceae	*Alseodaphne semecarpifolia*	Wewarana		(T-VU)
193	Lauraceae	*Cinnamomum verum*	Kurundu	(E)	(T-VU)
194	Lauraceae	*Litsea glutinosa*	Bomi		
195	Lauraceae	*Persea americana*	Aligeta-Pera		
196	Linaceae	*Hugonia mystax*	Bu-Getiya		
197	Loganiaceae	*Spigelia anthelmia*			
198	Loganiaceae	*Strychnos nux-vomica*	Goda-Kaduru		(T-VU)
199	Loganiaceae	*Strychnos potatorum*	Ingini		(T-VU)
200	Malpighiaceae	*Hiptage benghalensis*	Puwak-Gediya-Wel		

201	Malvaceae	*Abelmoschus esculentus*	Bandakka	
202	Malvaceae	*Abutolon indicum*	Beth Anoda	
203	Malvaceae	*Abutolon pannosum*		
204	Malvaceae	*Berrya coridifolia*	Halmilla	
205	Malvaceae	*Bombax ceiba*	Katu-Imbul	
206	Malvaceae	*Corchorus aestuans*	Jaladara	
207	Malvaceae	*Grewia damine*	Damunu	
208	Malvaceae	*Grewia helicterifolia*	Bora-Daminiya	
209	Malvaceae	*Grewia orientalis*	Wel-Keliya	
210	Malvaceae	*Hibiscus micranthus*	Siriwedi Babila	
211	Malvaceae	*Hibiscus rosa-sinensis*	Wada	
212	Malvaceae	*Hibiscus tiliaceus*	Belipatta	
213	Malvaceae	*Hibiscus vitifolius*	Maha-Epala	
214	Malvaceae	*Melochia corchorifolia*	Gal Kura	
215	Malvaceae	*Pterospermum suberifolium*	Welang	
216	Malvaceae	*Sida acuta*	Gas-Bevila	
217	Malvaceae	*Sida cordifolia*	Sulubu Bebila	
218	Malvaceae	*Triumfetta pentandra*	Epala	
219	Malvaceae	*Urena lobata*	Patta-Epala	
220	Malvaceae	*Urena sinuata*	Heen-Epala	
221	Malvaceae	*Waltheria indica*		
222	Marsiliaceae	*Marsilia quadrifolia*		
223	Melastomataceae	*Memecylon umbellatum*	Kora-Kaha	
224	Meliaceae	*Azadirachta indica*	Kohomba	
225	Meliaceae	*Chukrasia tabularis*	Hulanhik	
226	Meliaceae	*Khaya senegalensis*	Kaya	
227	Meliaceae	*Walsura trifoliolata*	Kiri Koan	
228	Menispermaceae	*Cissampelos pareira*	Diya-Mitta	
229	Molluginaceae	*Glinus oppositifolius*	Heen-Ala	
230	Moraceae	*Artocarpus heterophyllus*	Kos	
231	Moraceae	*Artocarpus nobilis*	Bedi-Del	(E)
232	Moraceae	*Ficus benghalensis*	Gotu Nuga	
233	Moraceae	*Ficus hispida*	Kota-Dimbula	
234	Moraceae	*Ficus racemosa*	Attikka	
235	Moraceae	*Plecospermum spinosum*	Katu-Timbol	(T-VU)
236	Moraceae	*Streblus asper*	Geta-Netul	
237	Moraceae	*Artocarpus altilis*	Del	
238	Moringaceae	*Moringa oleifera*	Murunga	
239	Muscaceae	*Musa x paradisaca*	Kehel	
240	Myrtaceae	*Eugenia bracteata*	Tembiliya	
241	Myrtaceae	*Psidium guajava*	Pera	
242	Myrtaceae	*Syzygium cumini*	Ma-Dan, Dan	
243	Myrtaceae	*Syzygium jambos*	Seeni-Jambo	
244	Nelumbonaceae	*Nelumbo nucifera*	Nelum, Sudu Nelum	
245	Ochnaceae	*Ochna lanceolata*	Bo-Kere	
246	Oleaceae	*Chionanthus zeylanicus*	Geratiya	
247	Oleaceae	*Jasminum angustifolium*	Wlapichcha	
248	Oleaceae	*Jasminum multiflorum*	Pichcha	
249	Oleaceae	*Jasminum officinale*	Samanpichcha	
250	Oleaceae	*Jasminum rottlerianum*	Getapichch	

251	Oleaceae	*Jasminum sambac*	Geta Pichcha	
252	Oleaceae	*Nyctanthes arbor-tristis*	Sepalica	
253	Onagraceae	*Ludwigia adscendens*	Beru-Diyanilla	
254	Orchidaceae	*Cymbidium aloifolium*	Orchid	
255	Orchidaceae	*Vanda tessellata*	Orchid	(T-VU)
256	Oxalidaceae	*Averrhoa carambola*	Kamaranga	
257	Pandanaceae	*Pandanus amaryllifolius*	Rampe	
258	Pandanaceae	*Pandanus sp.*		
259	Passifloraceae	*Passiflora edulis*	Weldodan	
260	Passifloraceae	*Passiflora foetida*	Pada Gedi	
261	Phyllanthaceae	*Bridelia retusa*	Keta-Kela	
262	Phyllanthaceae	*Flueggea leucopyrus*	Heen Katu Pila	
263	Phyllanthaceae	*Margaritaria indicus*	Karau	(T-VU)
264	Phyllanthaceae	*Phyllanthus acidus*	Rata Nelli	
265	Phyllanthaceae	*Phyllanthus amarus*	Pitawakka	
266	Phyllanthaceae	*Phyllanthus debilis*	Ela Pitawakka	
267	Phyllanthaceae	*Phyllanthus polyphyllus*	Kuratiya	
268	Phyllanthaceae	*Phyllanthus reticulatus*	Wel-Kaliya	
269	Phyllanthaceae	*Phyllanthus urinaria*	Rat-Pitawakka	
270	Piperaceae	*Piper betle*	Bulath	
271	Piperaceae	*Piper nigrum*	Gam-Miris	
272	Plantaginaceae	*Bacopa monnieri*	Lunuwila	
273	Plantaginaceae	*Scoparia dulcis*	Wal Koththamalli	
274	Poaceae	*Alloteropsis cimicina*	Bundeni-Tana	
275	Poaceae	*Apluda mutica*	Kuru Kuda Tana	
276	Poaceae	*Aristida setacea*	Et-Tuttiri	
277	Poaceae	*Axonopus compressus*	Potu-Tana	
278	Poaceae	*Bothriochloa pertusa*		
279	Poaceae	*Chloris barbata*	Mayuru-Tana	
280	Poaceae	*Chrysopogon aciculatus*	Tuttiri	
281	Poaceae	*Cynodon dactylon*	Eethana	
282	Poaceae	*Cyrtococcum trigonium*		
283	Poaceae	*Dactyloctenium aegyptium*	Putu-Tana	
284	Poaceae	*Dichaetaria wightii*		(T-VU)
285	Poaceae	*Digitaria longiflora*		
286	Poaceae	*Echinochloa colona*	Giri-Tana	
287	Poaceae	*Echinochloa crusgalli*	Wel-Marukk	
288	Poaceae	*Eleusine coracana*	Kurakkan	
289	Poaceae	*Eleusine indica*	Bela-Tana	
290	Poaceae	*Eragrostis ciliaris*		
291	Poaceae	*Eragrostis unioloides*		
292	Poaceae	*Heteropogon contortus*	E-Tana	
293	Poaceae	*Imperata cylindrica*	Iluk	
294	Poaceae	*Ischaemum rugosum*	Kudu-Kedu	
295	Poaceae	*Leptochloa chinensis*		
296	Poaceae	*Leptochloa neesii*		
297	Poaceae	*Oplismenus compositus*		
298	Poaceae	*Oryza rufipogon*	Uruwee	(T-EN)
299	Poaceae	*Panicum maximum*	Gini Tana	
300	Poaceae	*Panicum repens*	Etora	
301	Poaceae	*Paspalum conjugatum*		

302	Poaceae	*Paspalum scrobiculatum*	Amu	
303	Poaceae	*Paspalum vaginatum*		
304	Poaceae	*Perotis indica*		
305	Poaceae	*Saccharum officinarum*	Uk	
306	Poaceae	*Stenotaphrum dimidiatum*		
307	Poaceae	*Zea mays*	Bada Iringu	
308	Poaceae	*Zoysia matrella*		
309	Pteridaceae	*Acrostichum aureum*		
310	Punicaceae	*Punica granatum*	Delum	
311	Putranjiavaceae	*Drypetes sepiaria*	Weera	
312	Rhamnaceae	*Scutia myrtina*		
313	Rhamnaceae	*Ventilago maderaspatana*	Yakkada Wel	
314	Rhamnaceae	*Zizyphus oenopila*	Hin-Eraminia	
315	Rosaceae	*Rosa sp.*		
316	Rubiaceae	*Benkara malabarica*	Pudan	
317	Rubiaceae	*Canthium coromandelicum*	Kara	
318	Rubiaceae	*Catunaregam spinosa*	Kukurumanna	
319	Rubiaceae	*Coffea arabica*	Kopi	
320	Rubiaceae	*Discospermum sphaerocarpum*		
321	Rubiaceae	*Haldina cordifolia*	Kolon	
322	Rubiaceae	*Ixora coccinea*	Rathmal	
323	Rubiaceae	*Ixora pavetta*	Maha-Rathambala	
324	Rubiaceae	*Mitracarpus hirtus*		
325	Rubiaceae	*Mitragyna parvifolia*	Helamba	
326	Rubiaceae	*Morinda coreia*	Ahu	
327	Rubiaceae	*Mussaenda frondosa*	Mussenda	
328	Rubiaceae	*Spermacoce hispida*	Hin-Geta-Kola	
329	Rubiaceae	*Spermacoce latifolia*		
330	Rubiaceae	*Tarenna asiatica*	Tarana	
331	Rutaceae	*Acronychia pedunculata*	Ankenda	
332	Rutaceae	*Aegle marmelos*	Beli	
333	Rutaceae	*Atalantia ceylanica*	Yakinaran	
334	Rutaceae	*Atalantia racemosa*	Yakinaran	
335	Rutaceae	*Chloroxyclon swietania*	Burutha	(T-VU)
336	Rutaceae	*Citrus hystrix*	Goda-Dehi	
337	Rutaceae	*Citrus medica*	Dehi	
338	Rutaceae	*Clausena indica*	Migon-Karapincha	
339	Rutaceae	*Glycosmis mauritiana*	Dodan-Pana	
340	Rutaceae	*Glycosmis pentaphylla*	Dodan-Pana	
341	Rutaceae	*Limonia acidissima*	Divul	
342	Rutaceae	*Murraya koenigii*	Karapincha	
343	Rutaceae	*Murraya paniculata*	Etteriya	
344	Rutaceae	*Paramignya monophylla*	Yaka Bendi Wel	
345	Rutaceae	*Pleiospermium alatum*	Tunpath-Kurundu	
346	Rutaceae	*Toddalia asiatica*	Kudu-Miris	
347	Salviniaceae	*Azolla pinnata*	Asolla	
348	Salviniaceae	*Salvinia molesta d.mitch.*	Salvinea	
349	Sapindaceae	*Allophylus cobbe*	Kobbe	
350	Sapindaceae	*Cardiospermum halicacabum*	Penela-Wel	
351	Sapindaceae	*Dimocarpus longan*	Mora	

352	Sapindaceae	*Lepisanthes senegalensis*	Gal-Kuma		
353	Sapindaceae	*Lepisanthes tetraphylla*		(E)	
354	Sapindaceae	*Sapindus trifoliata*	Gas Penela		
355	Sapindaceae	*Schleichera oleosa*	Kon		
356	Sapotaceae	*Madhuca longifolia*	Mi		
357	Sapotaceae	*Manilkara hexandra*	Palu		(T-VU)
358	Sapotaceae	*Pouteria campechiana*	Kaha Laulu		
359	Solanaceae	*Capsicum annuum*	Miris		
360	Solanaceae	*Capsicum chinensis*	Naimiris		
361	Solanaceae	*Capsicum frutescens*	Kochchi		
362	Solanaceae	*Lycopersicon esculentum*	Takkali		
363	Solanaceae	*Solanum melongena*	Ela-Batu		
364	Typhaceae	*Typha agustifolia*	Hambu-Pan		
365	Verbanaceae	*Clerodendron sp.*	Pinnamal		
366	Verbanaceae	*Duranta repens*	Durantha		
367	Verbenaceae	*Lantana camera*	Hinguru		
368	Verbenaceae	*Tectona grandis*	Tekka		
369	Vitaceae	*Cissus latifolia*	Wal Diya Labu		
370	Vitaceae	*Cissus quadrangularis*	Heeressa		
371	Vitaceae	*Leea indica*	Burulla		
372	Xanthorrhoeaceae	*Aloe vera*	Komarica		
373	Zingiberaceae	*Curcuma domestica*	Kaha		
374	Zingiberaceae	*Zingiber officinale*	Inguru		
375	Zingiberaceae	*Zingiber wightianum*	Wlinguru		
376	Zingiberaceae	*Zingiber zerumbet*	Aran Kaha		

Annex 3.1.3. Foliage cover (cumulative) of species in different habitats

PLANT FORM	Species	ACACIA FOREST	CHENA	HOMEGARDEN	KATTAKADUWA	MEDICINAL FOREST	NATURAL FOREST	SCRUBLAND	TEAK FOREST	
SHRUBS	*Abutolon indicum*							4		
SHRUBS	*Acacia auriculiformis*	20						12		
SHRUBS	*Acacia caesia*				40					
SHRUBS	*Acronychia pedunculata*					12	4			
SHRUBS	*Aegle marmelos*					4				
SHRUBS	*Allamanda cathartica*			16						
SHRUBS	*Allophylus cobbe*							4		
SHRUBS	*Alseodaphne semecarpifolia*						4			
SHRUBS	*Anacardium occidentale*		12							
SHRUBS	*Annona muricata*			4						
SHRUBS	*Annona reticulata*			8						
SHRUBS	*Annona sp.*			12						
SHRUBS	*Annona squamosa*			16						
SHRUBS	*Areca catechu*			12						
SHRUBS	*Argyreia osyrensis*							4		
SHRUBS	*Argyreia populifolia*				12					
SHRUBS	*Artocarpus altilis*			4						
SHRUBS	*Artocarpus heterophyllus*		4	4						
SHRUBS	*Artocarpus nobilis*					4				
SHRUBS	*Atalantia ceylanica*							4		
SHRUBS	*Atalantia racemosa*						4			
SHRUBS	*Averrhoa carambola*			8						
SHRUBS	*Azadirachta indica*	4	8	4	4			16	4	
SHRUBS	*Bauhinia racemosa*	20						24		
SHRUBS	*Bauhinia tomentosa*						4			
SHRUBS	*Benkara malabarica*						40			
SHRUBS	*Bombax ceiba*				4					
SHRUBS	*Borassus flabellifer*				12					
SHRUBS	*Bridelia retusa*							20		
SHRUBS	*Butea monosperma*				40					
SHRUBS	*Calotropis gigantea*				4					
SHRUBS	*Canthium coromandelicum*							4		
SHRUBS	*Capparis zeylanica*						4			
SHRUBS	*Carica papaya*			4						
SHRUBS	*Carissa spinarum*						8			
SHRUBS	*Caryota urens*				4					
SHRUBS	*Cassia fistula*	12			4	4	16	4	8	
SHRUBS	*Cassia roxburghii*							20		
SHRUBS	*Catunaregam spinosa*						92			

SHRUBS	*Chionanthus zeylanicus*						4	12	
SHRUBS	*Chloroxyclon swietania*							8	
SHRUBS	*Chromolaena odorata*							240	
SHRUBS	*Chrysopogon aciculatus*							8	
SHRUBS	*Chukrasia tabularis*						4	4	
SHRUBS	*Cinnamomum verum*			8					
SHRUBS	*Cissampelos pareira*							8	
SHRUBS	*Cissus quadrangularis*			4					
SHRUBS	*Citrus hystrix*			8					
SHRUBS	*Citrus medica*		12	24					
SHRUBS	*Clausena indica*						128		
SHRUBS	*Clerodendron sp.*							12	
SHRUBS	*Cocos nucifera*		8	36					
SHRUBS	*Coffea arabica*			8					
SHRUBS	*Combretum albidum / ovalifolium ?*				28		12		
SHRUBS	*Cordia curassavica*							20	
SHRUBS	*Cordia dichotoma*								20
SHRUBS	*Corypha umbraculifera*				20				
SHRUBS	*Croton aromaticus*						36	12	
SHRUBS	*Cycas nathorstii*					8			
SHRUBS	*Dalbergia lanceolaria*				4				
SHRUBS	*Derris scandens*				192		12	12	
SHRUBS	*Desmodium triflorum*							4	
SHRUBS	*Dichostachys cinerea*				12			88	8
SHRUBS	*Diospyros ferrea*			4					
SHRUBS	*Diospyros malabarica*				12				
SHRUBS	*Discospermum sphaerocarpum*						8		
SHRUBS	*Drypetes sepiaria*						24		
SHRUBS	*Duranta repens*			4					
SHRUBS	*Dypsis lutesence*			8					
SHRUBS	*Ehretia laevis*							8	
SHRUBS	*Ehretia microphylla*						28		
SHRUBS	*Erythroxylum zeylanicum*						8		
SHRUBS	*Eugenia bracteata*						12	8	
SHRUBS	*Ficus hispida*				136				
SHRUBS	*Ficus racemosa*				4				
SHRUBS	*Flueggea leucopyrus*				8		28	220	
SHRUBS	*Garcinia morella*						4		
SHRUBS	*Gliricidia sepium*			52	124				8
SHRUBS	*Glycosmis mauritiana*						440		
SHRUBS	*Glycosmis pentaphylla*						4		
SHRUBS	*Gmelina asiatica*							8	
SHRUBS	*Grewia damine*	12			4		60	68	
SHRUBS	*Grewia orientalis*						4	28	
SHRUBS	*Haldina cordifolia*							4	
SHRUBS	*Hibiscus micranthus*				4			240	
SHRUBS	*Hibiscus rosa-sinensis*			12					
SHRUBS	*Hiptage benghalensis*				4				
SHRUBS	*Holoptelea integrifolia*				12			4	
SHRUBS	*Hugonia mystax*						40		
SHRUBS	*Ichnocarpus frutescens*							36	

SHRUBS	*Imperata cylindrica*						40		
SHRUBS	*Ipomoea indica*						4		
SHRUBS	*Ipomoea marginata*						8		
SHRUBS	*Ixora pavetta*					8	8		
SHRUBS	*Jasminum sambac*		12						
SHRUBS	*Justicia adhatoda*				20				
SHRUBS	*Lantana camera*	12		40		24	172		
SHRUBS	*Lepisanthes senegalensis*					4			
SHRUBS	*Lepisanthes tetraphylla*					120			
SHRUBS	*Leucaena leucocephala*		12	4			8		
SHRUBS	*Litsea glutinosa*							4	
SHRUBS	*Macaranga peltata*			4					
SHRUBS	*Madhuca longifolia*			8	4				
SHRUBS	*Mallotus philippensis*					4			
SHRUBS	*Mallotus rhamnifolius*					48			
SHRUBS	*Mangifera indica*		60	4	4				
SHRUBS	*Manihot esculenta*	12	24						
SHRUBS	*Manilkara hexandra*					28			
SHRUBS	*Margaritaria indicus*					4			
SHRUBS	*Maytenus emarginata*					12			
SHRUBS	*Memecylon umbellatum*					60	8	4	
SHRUBS	*Mesua ferrea*				4				
SHRUBS	*Miliusa indica*					4			
SHRUBS	*Mitragyna parvifolia*		4						
SHRUBS	*Morinda coreia*						4		
SHRUBS	*Moringa oleifera*	8	24		4		8		
SHRUBS	*Murraya koenigii*	4			12		68		
SHRUBS	*Musa x paradisaca*		72						
SHRUBS	*Mussaenda frondosa*			8		4			
SHRUBS	*Myristica ceylanica*			160					
SHRUBS	*Nerium oleander*			8					
SHRUBS	*Nyctanthes arbor-tristis*		12						
SHRUBS	*Ochna lanceolata*					12	4		
SHRUBS	*Ocimum gratissimum*						4		
SHRUBS	*Oroxylum indicum*					4			
SHRUBS	*Pandanus sp.*			40					
SHRUBS	*Panicum maximum*						96		
SHRUBS	*Persea americana*		8						
SHRUBS	*Phonix pusilla*			8					
SHRUBS	*Phyllanthus acidus*		12						
SHRUBS	*Phyllanthus polyphyllus*				4	68	248		
SHRUBS	*Phyllanthus reticulatus*			32					
SHRUBS	*Piper nigrum*		8						
SHRUBS	*Pithecellobium dulce*					40			
SHRUBS	*Plecospermum spinosum*			4					
SHRUBS	*Pleiospermium alatum*					4	4		
SHRUBS	*Polyalthia korinti*					32			
SHRUBS	*Polyalthia longifolia*					4			
SHRUBS	*Pongamia pinnata*			80	8				
SHRUBS	*Pouteria campechiana*		8						
SHRUBS	*Premna procumbens*			140			4		

SHRUBS	*Premna tomentosa*							32	
SHRUBS	*Psidium guajava*			80					
SHRUBS	*Pterospermum suberifolium*						8	24	12
SHRUBS	*Punica granatum*			16		4			
SHRUBS	*Reissantia indica*						8		
SHRUBS	*Ricinus communis*		8						
SHRUBS	*Salacia oblonga*						8		
SHRUBS	*Samanea saman*				4				
SHRUBS	*Saraca asoka*					4			
SHRUBS	*Schleichera oleosa*	4			4		4	20	
SHRUBS	*Scleria lithosperma*						8		
SHRUBS	*Scutia myrtina*							4	
SHRUBS	*Senna auriculata*	4							
SHRUBS	*Solanum melongena*		28	12					
SHRUBS	*Streblus asper*			20	20	12	68	88	12
SHRUBS	*Strychnos nux-vomica*						12	4	
SHRUBS	*Strychnos potatorum*				4				
SHRUBS	*Suregada lanceolata*						20		
SHRUBS	*Syzygium cumini*				4				
SHRUBS	*Syzygium jambos*			20					
SHRUBS	*Tabernaemontana divaricata*			8					
SHRUBS	*Tamarindus indica*						12		
SHRUBS	*Tarenna asiatica*						8		
SHRUBS	*Tecoma stans*			8					
SHRUBS	*Tectona grandis*							40	100
SHRUBS	*Tephrosia maxima*							20	
SHRUBS	*Terminalia catappa*				4				
SHRUBS	*Toddalia asiatica*						4	4	
SHRUBS	*Trema orientalis*							16	
SHRUBS	*Ventilago maderaspatana*						24	20	
SHRUBS	*Vernonia zeylanica*							80	
SHRUBS	*Vitex altissima*						20	20	
SHRUBS	*Vitex leucoxylon*				8				
SHRUBS	*Vitex negundo*			8		8			
SHRUBS	*Walsura trifoliolata*						32		
SHRUBS	*Zizyphus oenopila*	20					124	40	
SMALL PLANTS	*Abelmoschus esculentus*			4					
SMALL PLANTS	*Abutolon indicum*		4	8				4	
SMALL PLANTS	*Abutolon pannosum*			4	4			4	4
SMALL PLANTS	*Acalypha paniculata*		4		4		4	8	
SMALL PLANTS	*Achyranthes aspera*		8	20	4				
SMALL PLANTS	*Acronychia pedunculata*						4		
SMALL PLANTS	*Acrostichum aureum*				4				
SMALL PLANTS	*Aegle marmelos*			4					
SMALL PLANTS	*Aerva lanata*		8	8					
SMALL PLANTS	*Ageratum conyzoides*		28	12				180	104
SMALL PLANTS	*Allium cepa*		20						
SMALL PLANTS	*Allophylus cobbe*							4	
SMALL PLANTS	*Alloteropsis cimicina*			12	8				8
SMALL PLANTS	*Alocasia macrorrhizos*				64				
SMALL PLANTS	*Aloe vera*			8					

SMALL PLANTS	*Alternanthera sessilis*			16					
SMALL PLANTS	*Alysicarpus vaginalis*			4					
SMALL PLANTS	*Amaranthus sp.*		8	4					
SMALL PLANTS	*Amaranthus spinosus*		4	4					
SMALL PLANTS	*Amaranthus viridis*			8					
SMALL PLANTS	*Ananas comosus*			4					
SMALL PLANTS	*Anisomeles indica*				4			12	
SMALL PLANTS	*Annona reticulata*			4					
SMALL PLANTS	*Anthurium andraeanum*			36					
SMALL PLANTS	*Apluda mutica*		8	4	4			4	4
SMALL PLANTS	*Aponogeton crispus*				4				
SMALL PLANTS	*Arachis hypogaea*		164						
SMALL PLANTS	*Argyreia osyrensis*						8		
SMALL PLANTS	*Argyreia populifolia*			4		8			
SMALL PLANTS	*Aristida setacea*						4		
SMALL PLANTS	*Asparagus racemosus*								4
SMALL PLANTS	*Asplenium sp.*						4		
SMALL PLANTS	*Atylosia scarabaeoides*		8	4				4	
SMALL PLANTS	*Averrhoa carambola*			4					
SMALL PLANTS	*Axonopus compressus*			360					
SMALL PLANTS	*Azadirachta indica*			4					8
SMALL PLANTS	*Azolla pinnata*				20				
SMALL PLANTS	*Bacopa monnieri*				4				
SMALL PLANTS	*Bidens pilosa*		24	16	8		4	4	4
SMALL PLANTS	*Blepharis maderaspatensis*							4	
SMALL PLANTS	*Bothriochloa pertusa*		8	8					4
SMALL PLANTS	*Brassica juncea*		28						
SMALL PLANTS	*Bridelia retusa*								4
SMALL PLANTS	*Calotropis gigantea*							4	
SMALL PLANTS	*Canna indica*			4					
SMALL PLANTS	*Canthium coromandelicum*			4		4			
SMALL PLANTS	*Capparis zeylanica*						8		
SMALL PLANTS	*Capsicum annuum*		20	28					
SMALL PLANTS	*Capsicum chinensis*		4	4					
SMALL PLANTS	*Capsicum frutescens*		20	4					
SMALL PLANTS	*Cardiospermum halicacabum*				12				
SMALL PLANTS	*Carica papaya*		8						
SMALL PLANTS	*Carissa spinarum*						8		16
SMALL PLANTS	*Cassia fistula*						4		
SMALL PLANTS	*Celosia argentea*		8	4					
SMALL PLANTS	*Centella asiatica*			36	8				
SMALL PLANTS	*Chloris barbata*			8	4			4	
SMALL PLANTS	*Chloroxyclon swietania*	12				4	8		
SMALL PLANTS	*Chromolaena odorata*	60	4	4	8	4	44	44	152
SMALL PLANTS	*Cissampelos pareira*				4	4		4	
SMALL PLANTS	*Cissus latifolia*						4		
SMALL PLANTS	*Citrus medica*			8					
SMALL PLANTS	*Clausena indica*						28		
SMALL PLANTS	*Cleome rutidosperma*		4	4	4			4	
SMALL PLANTS	*Clitoria ternatea*			16					
SMALL PLANTS	*Coccinia grandis*			8					

SMALL PLANTS	*Cocos nucifera*			12						
SMALL PLANTS	*Codiaeum variegatum*			12						
SMALL PLANTS	*Colocasia esculenta*			28	80					
SMALL PLANTS	*Commelina benghalensis*				8					
SMALL PLANTS	*Commelina diffusa*				12					
SMALL PLANTS	*Commelina ensifolia*		4	8	4					
SMALL PLANTS	*Corchorus aestuans*							4		
SMALL PLANTS	*Costus speciosus*			4						
SMALL PLANTS	*Crinum defixum*						4			
SMALL PLANTS	*Crinum latifolium*				20					
SMALL PLANTS	*Crossandra infundibuliformis*				4					
SMALL PLANTS	*Crotalaria lunulata*							4		
SMALL PLANTS	*Croton hirtus*		8	20				4	4	
SMALL PLANTS	*Cucurbita maxima*			20						
SMALL PLANTS	*Curculigo orchioides*						8		4	
SMALL PLANTS	*Curcuma domestica*		8	8						
SMALL PLANTS	*Cymbidium aloifolium*			4						
SMALL PLANTS	*Cynodon dactylon*		8	12	4		4	4		
SMALL PLANTS	*Cyperus brevifolius*				4					
SMALL PLANTS	*Cyperus compressus*		4	4	12		4			
SMALL PLANTS	*Cyperus haspan*						80			
SMALL PLANTS	*Cyperus iria*		4		12					
SMALL PLANTS	*Cyperus rotundus*		12	16	12		8		4	
SMALL PLANTS	*Cyperus triceps*			4						
SMALL PLANTS	*Cyrtococcum trigonium*			188	12	160	248		120	
SMALL PLANTS	*Dactyloctenium aegyptium*		12	16	12			4	8	
SMALL PLANTS	*Dahlia coccinea*			4						
SMALL PLANTS	*Derris scandens*							20	8	
SMALL PLANTS	*Desmodium heterophyllum*						4			
SMALL PLANTS	*Desmodium triflorum*			44					4	
SMALL PLANTS	*Dichaetaria wightii*				4		4			
SMALL PLANTS	*Digitaria longiflora*	4		16	8		4			
SMALL PLANTS	*Dioscorea pentaphylla*							4		
SMALL PLANTS	*Diospyros cordifolia*						12			
SMALL PLANTS	*Diospyros malabarica*				4					
SMALL PLANTS	*Diospyros ovalifolia*						4			
SMALL PLANTS	*Diplocyclos palmatus*			4						
SMALL PLANTS	*Discospermum sphaerocarpum*						4			
SMALL PLANTS	*Dregea volubilis*		4							
SMALL PLANTS	*Duranta repens*			4						
SMALL PLANTS	*Ecbolium ligustrinum*				4	4				
SMALL PLANTS	*Echinochloa colona*			4	16		4			
SMALL PLANTS	*Echinochloa crusgalli*				4					
SMALL PLANTS	*Ehretia laevis*	4								
SMALL PLANTS	*Ehretia microphylla*						8			
SMALL PLANTS	*Eleusine coracana*		20	12						
SMALL PLANTS	*Eleusine indica*		16	16	4			4	4	
SMALL PLANTS	*Eleutheranthera ruderalis*		4	80						
SMALL PLANTS	*Eragrostis ciliaris*		4		4				4	
SMALL PLANTS	*Eragrostis unioloides*							4		
SMALL PLANTS	*Eugenia bracteata*						12			

SMALL PLANTS	*Euphorbia hirta*		8	12				8	
SMALL PLANTS	*Ficus hispida*				20				
SMALL PLANTS	*Fimbristylis dichotoma*			8	8				
SMALL PLANTS	*Fimbristylis falcata*		4	4	4			4	
SMALL PLANTS	*Fimbristylis miliacea*		4	8	4				
SMALL PLANTS	*Fimbristylis triflora*				12				
SMALL PLANTS	*Flueggea leucopyrus*	4			4		4		20
SMALL PLANTS	*Gerbera jamesonii*			4					
SMALL PLANTS	*Glinus oppositifolius*							4	
SMALL PLANTS	*Glycosmis mauritiana*						72		
SMALL PLANTS	*Gomphrena celosioides*			8				4	
SMALL PLANTS	*Grewia damine*						4		
SMALL PLANTS	*Grewia helicterifolia*						4		
SMALL PLANTS	*Grewia orientalis*						4		
SMALL PLANTS	*Heliotropium indicum*		4	4	8			4	
SMALL PLANTS	*Hemidesmus indicus*			4					4
SMALL PLANTS	*Heteropogon contortus*		4		4			8	
SMALL PLANTS	*Hewittia sublobata*				4				
SMALL PLANTS	*Hibiscus micranthus*		12	4	4			12	
SMALL PLANTS	*Hibiscus vitifolius*			4					4
SMALL PLANTS	*Hiptage benghalensis*							4	
SMALL PLANTS	*Hugonia mystax*						4		
SMALL PLANTS	*Hygrophila schulli*				4				
SMALL PLANTS	*Hyptis capitata*		12	4				24	4
SMALL PLANTS	*Ichnocarpus frutescens*					4		28	
SMALL PLANTS	*Imperata cylindrica*								72
SMALL PLANTS	*Ipomoea aquatica*				8				
SMALL PLANTS	*Ipomoea cairica*			8				4	
SMALL PLANTS	*Ipomoea indica*			4	4				
SMALL PLANTS	*Ipomoea marginata*	4			12			4	
SMALL PLANTS	*Ipomoea obscura*				4				
SMALL PLANTS	*Ischaemum rugosum*		4	12	16		4		
SMALL PLANTS	*Ixora coccinea*			8					
SMALL PLANTS	*Jasminum angustifolium*						4	4	
SMALL PLANTS	*Jasminum multiflorum*			8					
SMALL PLANTS	*Jasminum officinale*			4					
SMALL PLANTS	*Jasminum rottlerianum*			4					
SMALL PLANTS	*Jasminum sambac*			4					
SMALL PLANTS	*Jatropa spicata*			4					
SMALL PLANTS	*Lantana camera*	8			4			8	
SMALL PLANTS	*Lasia spinosa*				4				
SMALL PLANTS	*Leea indica*				8				
SMALL PLANTS	*Lepisanthes tetraphylla*						4		
SMALL PLANTS	*Leptochloa chinensis*				4				
SMALL PLANTS	*Leptochloa neesii*				4				
SMALL PLANTS	*Leucaena leucocephala*			4					
SMALL PLANTS	*Ludwigia adscendens*				4				
SMALL PLANTS	*Luffa cylindrica*			4					
SMALL PLANTS	*Lycopersicon esculentum*		40	8					
SMALL PLANTS	*Madhuca longifolia*				8		4		
SMALL PLANTS	*Mallotus philippensis*					4			

SMALL PLANTS	*Mangifera indica*			4					
SMALL PLANTS	*Manihot esculenta*			20					
SMALL PLANTS	*Manilkara hexandra*					4			
SMALL PLANTS	*Marsilia quadrifolia*				4				
SMALL PLANTS	*Melochia corchorifolia*		4	12	4		12	4	
SMALL PLANTS	*Memecylon umbellatum*					12		8	
SMALL PLANTS	*Merremia cissoides*		4	4			4		
SMALL PLANTS	*Mikania cordata*			20	168				
SMALL PLANTS	*Mimosa invisa*						8		
SMALL PLANTS	*Mimosa pudica*	4	20	20	12	4	28	36	
SMALL PLANTS	*Mitracarpus hirtus*		8	8	4		12	4	
SMALL PLANTS	*Mitragyna parvifolia*			4			4		
SMALL PLANTS	*Momodica charantia*		4	4					
SMALL PLANTS	*Moringa oleifera*							8	
SMALL PLANTS	*Murdannia nudiflora*			4	4				
SMALL PLANTS	*Murraya koenigii*	4		4		4	4	24	
SMALL PLANTS	*Musa x paradisaca*			16					
SMALL PLANTS	*Nelumbo nucifera*				32				
SMALL PLANTS	*Nerium oleander*			4					
SMALL PLANTS	*Ochna lanceolata*				4		4		
SMALL PLANTS	*Ocimum gratissimum*						4		
SMALL PLANTS	*Ocimum tenuiflorum (old name ?)*		4				44		
SMALL PLANTS	*Oplismenus compositus*			8	8				
SMALL PLANTS	*Orthosiphon thymiflorus*							4	
SMALL PLANTS	*Oryza rufipogon*				4				
SMALL PLANTS	*Ottelia alismoides*				4				
SMALL PLANTS	*Pandanus amaryllifolius*			16					
SMALL PLANTS	*Panicum maximum*	240		12	408	12	320	460	
SMALL PLANTS	*Panicum repens*				40				
SMALL PLANTS	*Paramignya monophylla*							4	
SMALL PLANTS	*Paspalum conjugatum*				12				
SMALL PLANTS	*Paspalum scrobiculatum*		4		8				
SMALL PLANTS	*Paspalum vaginatum*			16	4				
SMALL PLANTS	*Passiflora edulis*			4					
SMALL PLANTS	*Passiflora foetida*						12		
SMALL PLANTS	*Perotis indica*		8	12			4		
SMALL PLANTS	*Phaseolus vulgaris*		60						
SMALL PLANTS	*Phonix pusilla*				8				
SMALL PLANTS	*Phyllanthus amarus*		8	8	4		8		
SMALL PLANTS	*Phyllanthus debilis*			16	4				
SMALL PLANTS	*Phyllanthus polyphyllus*	4				20	4	8	
SMALL PLANTS	*Phyllanthus reticulatus*						4	4	
SMALL PLANTS	*Phyllanthus urinaria*			20	4				
SMALL PLANTS	*Piper betle*		4	4					
SMALL PLANTS	*Polyalthia korinti*					12			
SMALL PLANTS	*Portulaca oleracea*		4						
SMALL PLANTS	*Pothos scandens*				4				
SMALL PLANTS	*Premna procumbens*				20				
SMALL PLANTS	*Psophocarpus tetragonolous*		4	12					
SMALL PLANTS	*Pterospermum suberifolium*					16		16	
SMALL PLANTS	*Punica granatum*			4					

SMALL PLANTS	*Rosa sp.*			8					
SMALL PLANTS	*Saccharum officinarum*			4					
SMALL PLANTS	*Salacia chinensis*						4		
SMALL PLANTS	*Salvinia molesta D.Mitch.*				40				
SMALL PLANTS	*Samanea saman*				4				
SMALL PLANTS	*Sapindus trifoliata*								4
SMALL PLANTS	*Schleichera oleosa*						4		8
SMALL PLANTS	*Scleria lithosperma*						160		
SMALL PLANTS	*Scoparia dulcis*		8	8	4			28	4
SMALL PLANTS	*Scutia myrtina*						4		
SMALL PLANTS	*Sida acuta*							4	
SMALL PLANTS	*Sida cordifolia*		4					20	
SMALL PLANTS	*Solanum melongena*		260	20					
SMALL PLANTS	*Spermacoce hispida*		4					4	
SMALL PLANTS	*Spermacoce latifolia*			12	4			4	4
SMALL PLANTS	*Sphaeranthus indicus*		12						
SMALL PLANTS	*Spigelia anthelmia*		4		4			8	
SMALL PLANTS	*Stenotaphrum dimidiatum*				268		200		
SMALL PLANTS	*Streblus asper*	4		4	4	12	12		
SMALL PLANTS	*Strychnos potatorum*			4					
SMALL PLANTS	*Tabernaemontana divaricata*			40					
SMALL PLANTS	*Tagetes erecta*			92					
SMALL PLANTS	*Talinum paniculatum*			4					
SMALL PLANTS	*Toddalia asiatica*						4		
SMALL PLANTS	*Trachyspermum involucratum*			4					
SMALL PLANTS	*Trianthema portulacastrum*		4						
SMALL PLANTS	*Trichosanthes cucumerina*				4				
SMALL PLANTS	*Tridax procumbens*		32	24	12			16	4
SMALL PLANTS	*Triumfetta pentandra*		12	12	4			8	
SMALL PLANTS	*Tylophora pauciflora*			4					
SMALL PLANTS	*Typha agustifolia*				12				
SMALL PLANTS	*Urena lobata*				20				
SMALL PLANTS	*Urena sinuata*			4	4				
SMALL PLANTS	*Vanda tessellata*				4				
SMALL PLANTS	*Ventilago maderaspatana*				24				
SMALL PLANTS	*Vernonia cinerea*		4	4					
SMALL PLANTS	*Vicoa indica*		4	4				4	
SMALL PLANTS	*Vigna mungo*		240	4					
SMALL PLANTS	*Vigna unguiculata*		320	12					
SMALL PLANTS	*Waltheria indica*		8	12	4			12	
SMALL PLANTS	*Xanthium indicum*				12			4	
SMALL PLANTS	*Zea mays*		700	12					
SMALL PLANTS	*Zingiber officinale*		4	4		12			
SMALL PLANTS	*Zingiber wightianum*						8		
SMALL PLANTS	*Zingiber zerumbet*				4				
SMALL PLANTS	*Zizyphus oenopila*	4			4		12		4
SMALL PLANTS	*Zoysia matrella*			20					
TREES	*Acacia auriculiformis*	160							
TREES	*Acacia leucophloea*	20							
TREES	*Acronychia pedunculata*					40			
TREES	*Adenanthera pavonina*					28			

TREES	*Aegle marmelos*		8	28					
TREES	*Albizia odoratissima*			80					
TREES	*Allophylus cobbe*					28			
TREES	*Alseodaphne semecarpifolia*					20			
TREES	*Alstonia scholaris*				8				
TREES	*Anacardium occidentale*		20	36					
TREES	*Areca catechu*			52	4				
TREES	*Artocarpus altilis*			8					
TREES	*Artocarpus heterophyllus*			156					
TREES	*Atalantia racemosa*						4		
TREES	*Azadirachta indica*		40	52	12	20	12	20	
TREES	*Bauhinia racemosa*					20	20		12
TREES	*Berrya coridifolia*			196					
TREES	*Borassus flabellifer*				8				
TREES	*Bridelia retusa*		28	48		28		52	12
TREES	*Butea monosperma*				80				
TREES	*Caryota urens*				8				
TREES	*Cassia fistula*				28		12		12
TREES	*Cassia roxburghii*						20		
TREES	*Chloroxyclon swietania*	12	44	12		20	192		48
TREES	*Chukrasia tabularis*						8		
TREES	*Cocos nucifera*			368		28			
TREES	*Combretum albidum / ovalifolium ?*				28				
TREES	*Cordia dichotoma*						4		4
TREES	*Corypha umbraculifera*				60				
TREES	*Derris scandens*						20		
TREES	*Dimocarpus longan*						12		
TREES	*Diospyros cordifolia*			28			12		
TREES	*Diospyros ebenum*						20		
TREES	*Diospyros ferrea*						12		
TREES	*Diospyros malabarica*				12				
TREES	*Drypetes sepiaria*						208		
TREES	*Ficus benghalensis*						40		
TREES	*Ficus hispida*				20				
TREES	*Ficus racemosa*				32				
TREES	*Gliricidia sepium*							20	
TREES	*Grewia damine*	4			12		100	4	32
TREES	*Grewia helicterifolia*						40		
TREES	*Hibiscus tiliaceus*				20				
TREES	*Holoptelea integrifolia*			40			60		
TREES	*Hugonia mystax*						12		
TREES	*Ixora pavetta*						4		
TREES	*Khaya senegalensis*		12						
TREES	*Lepisanthes senegalensis*						20		
TREES	*Lepisanthes tetraphylla*						112		
TREES	*Leucaena leucocephala*			16					
TREES	*Limonia acidissima*			80					
TREES	*Macaranga peltata*				12				
TREES	*Madhuca longifolia*				260				
TREES	*Mangifera indica*		4	280	96				
TREES	*Manilkara hexandra*		20				100		

TREES	*Mesua ferrea*					12				
TREES	*Mitragyna parvifolia*	8		76			4			
TREES	*Morinda coreia*	4				8				
TREES	*Moringa oleifera*		4	12						
TREES	*Murraya paniculata*						12			
TREES	*Oroxylum indicum*					8				
TREES	*Pongamia pinnata*				8					
TREES	*Premna procumbens*						8			
TREES	*Premna tomentosa*					12	20			
TREES	*Pterocarpus marsupium*					20				
TREES	*Pterospermum suberifolium*						80			
TREES	*Sapindus trifoliata*								4	
TREES	*Schleichera oleosa*				60		8		20	
TREES	*Senna auriculata*						12			
TREES	*Streblus asper*						32			
TREES	*Syzygium cumini*			4	80		120	20	20	
TREES	*Tamarindus indica*						40			
TREES	*Tectona grandis*		24	60					1240	
TREES	*Terminalia arjuna*				700					
TREES	*Terminalia catappa*				8					
TREES	*Trema orientalis*							28	12	
TREES	*Ventilago maderaspatana*						32			
TREES	*Vitex altissima*		12	12			140			
TREES	*Vitex leucoxylon*				72					
TREES	*Walsura trifoliolata*						20			

Annex 3.1.4. Occurrence plant species in different habitats

Species	ACACIA FOREST	CHENA	HOMEGARDEN	KATTAKADUWA	MEDICINAL FOREST	NATURAL FOREST	SCRUBLAND	TEAK FOREST	Row total
Abelmoschus esculentus			1						1
Abutolon indicum		1	1				1		3
Abutolon pannosum			1	1			1	1	4
Acacia auriculiformis	1						1		2
Acacia caesia				1					1
Acacia leucophloea	1								1
Acalypha paniculata		1		1		1	1		4
Achyranthes aspera		1	1	1					3
Acronychia pedunculata					1	1			2
Acrostichum aureum				1					1
Adenanthera pavonina					1				1
Aegle marmelos		1	1		1				3
Aerva lanata		1	1						2
Ageratum conyzoides		1	1				1	1	4
Albizia odoratissima			1						1
Allamanda cathartica			1						1
Allium cepa		1							1
Allophylus cobbe					1		1		2
Alloteropsis cimicina			1	1				1	3
Alocasia macrorrhizos				1					1
Aloe vera			1						1
Alseodaphne semecarpifolia					1	1			2
Alstonia scholaris				1					1
Alternanthera sessilis			1						1
Alysicarpus vaginalis			1						1
Amaranthus sp.		1	1						2
Amaranthus spinosus		1	1						2
Amaranthus viridis			1						1
Anacardium occidentale		1	1						2
Ananas comosus			1						1
Anisomeles indica				1			1		2
Annona muricata			1						1
Annona reticulata			1						1
Annona sp.			1						1
Annona squamosa			1						1
Anthurium andraeanum			1						1
Apluda mutica		1	1	1			1	1	5
Aponogeton crispus				1					1
Arachis hypogaea		1							1
Areca catechu			1	1					2

Argyreia osyrensis						1	1		2
Argyreia populifolia			1	1	1				3
Aristida setacea						1			1
Artocarpus altilis			1						1
Artocarpus heterophyllus		1	1						2
Artocarpus nobilis					1				1
Asparagus racemosus								1	1
Asplenium sp.						1			1
Atalantia ceylanica							1		1
Atalantia racemosa						1			1
Atylosia scarabaeoides		1	1				1		3
Averrhoa carambola			1						1
Axonopus compressus			1						1
Azadirachta indica	1	1	1	1	1	1	1	1	8
Azolla pinnata				1					1
Bacopa monnieri				1					1
Bauhinia racemosa	1				1	1	1	1	5
Bauhinia tomentosa						1			1
Benkara malabarica						1			1
Berrya coridifolia			1						1
Bidens pilosa		1	1	1		1	1	1	6
Blepharis maderaspatensis							1		1
Bombax ceiba				1					1
Borassus flabellifer				1					1
Bothriochloa pertusa		1	1					1	3
Brassica juncea		1							1
Bridelia retusa		1	1		1		1	1	5
Butea monosperma				1					1
Calotropis gigantea				1			1		2
Canna indica			1						1
Canthium coromandelicum			1		1		1		3
Capparis zeylanica						1			1
Capsicum annuum		1	1						2
Capsicum chinensis		1	1						2
Capsicum frutescens		1	1						2
Cardiospermum halicacabum				1					1
Carica papaya		1	1						2
Carissa spinarum						1		1	2
Caryota urens				1					1
Cassia fistula	1			1	1	1	1	1	6
Cassia roxburghii						1	1		2
Catunaregam spinosa						1			1
Celosia argentea		1	1						2
Centella asiatica			1	1					2
Chionanthus zeylanicus						1	1		2
Chloris barbata			1	1			1		3
Chloroxyclon swietania	1	1	1		1	1	1	1	7
Chromolaena odorata	1	1	1	1	1	1	1	1	8
Chrysopogon aciculatus							1		1
Chukrasia tabularis						1	1		2
Cinnamomum verum			1						1
Cissampelos pareira				1	1		1		3
Cissus latifolia						1			1

Cissus quadrangularis			1						1
Citrus hystrix			1						1
Citrus medica		1	1						2
Clausena indica						1			1
Cleome rutidosperma		1	1	1			1		4
Clerodendron sp.							1		1
Clitoria ternatea			1						1
Coccinia grandis			1						1
Cocos nucifera		1	1		1				3
Codiaeum variegatum			1						1
Coffea arabica			1						1
Colocasia esculenta			1	1					2
Combretum albidum / ovalifolium ?				1		1			2
Commelina benghalensis				1					1
Commelina diffusa				1					1
Commelina ensifolia		1	1	1					3
Corchorus aestuans							1		1
Cordia curassavica							1		1
Cordia dichotoma						1		1	2
Corypha umbraculifera				1					1
Costus speciosus			1						1
Crinum defixum						1			1
Crinum latifolium				1					1
Crossandra infundibuliformis				1					1
Crotalaria lunulata							1		1
Croton aromaticus						1	1		2
Croton hirtus		1	1				1	1	4
Cucurbita maxima			1						1
Curculigo orchioides						1		1	2
Curcuma domestica		1	1						2
Cycas nathorstii					1				1
Cymbidium aloifolium			1						1
Cynodon dactylon		1	1	1		1	1		5
Cyperus brevifolius				1					1
Cyperus compressus		1	1	1		1			4
Cyperus haspan						1			1
Cyperus iria		1		1					2
Cyperus rotundus		1	1	1		1		1	5
Cyperus triceps			1						1
Cyrtococcum trigonium			1	1	1	1		1	5
Dactyloctenium aegyptium		1	1	1			1	1	5
Dahlia coccinea			1						1
Dalbergia lanceolaria				1					1
Derris scandens				1		1	1	1	4
Desmodium heterophyllum						1			1
Desmodium triflorum			1				1	1	3
Dichaetaria wightii				1		1			2
Dichostachys cinerea				1			1	1	3
Digitaria longiflora	1		1	1		1			4
Dimocarpus longan						1			1
Dioscorea pentaphylla							1		1
Diospyros cordifolia			1			1			2
Diospyros ebenum						1			1

Diospyros ferrea			1			1				2
Diospyros malabarica				1						1
Diospyros ovalifolia						1				1
Diplocyclos palmatus			1							1
Discospermum sphaerocarpum						1				1
Dregea volubilis		1								1
Drypetes sepiaria						1				1
Duranta repens			1							1
Dypsis lutesence			1							1
Ecbolium ligustrinum				1	1					2
Echinochloa colona			1	1		1				3
Echinochloa crusgalli				1						1
Ehretia laevis	1						1			2
Ehretia microphylla						1				1
Eleusine coracana		1	1							2
Eleusine indica		1	1	1			1	1		5
Eleutheranthera ruderalis		1	1							2
Eragrostis ciliaris		1		1				1		3
Eragrostis unioloides							1			1
Erythroxylum zeylanicum						1				1
Eugenia bracteata						1	1			2
Euphorbia hirta		1	1				1			3
Ficus benghalensis						1				1
Ficus hispida				1						1
Ficus racemosa				1						1
Fimbristylis dichotoma			1	1						2
Fimbristylis falcata		1	1	1			1			4
Fimbristylis miliacea		1	1	1						3
Fimbristylis triflora				1						1
Flueggea leucopyrus	1			1		1	1	1		5
Garcinia morella						1				1
Gerbera jamesonii			1							1
Glinus oppositifolius							1			1
Gliricidia sepium			1	1			1	1		4
Glycosmis mauritiana						1				1
Glycosmis pentaphylla						1				1
Gmelina asiatica							1			1
Gomphrena celosioides			1				1			2
Grewia damine	1			1		1	1	1		5
Grewia helicterifolia						1				1
Grewia orientalis						1	1			2
Haldina cordifolia							1			1
Heliotropium indicum		1	1	1			1			4
Hemidesmus indicus			1					1		2
Heteropogon contortus		1		1			1			3
Hewittia sublobata				1						1
Hibiscus micranthus		1	1	1			1			4
Hibiscus rosa-sinensis			1							1
Hibiscus tiliaceus				1						1
Hibiscus vitifolius			1					1		2
Hiptage benghalensis				1			1			2
Holoptelea integrifolia			1	1		1	1			4
Hugonia mystax						1				1

Hygrophila schulli				1						1
Hyptis capitata		1	1				1	1		4
Ichnocarpus frutescens					1		1			2
Imperata cylindrica							1	1		2
Ipomoea aquatica				1						1
Ipomoea cairica			1				1			2
Ipomoea indica			1	1			1			3
Ipomoea marginata	1			1			1			3
Ipomoea obscura				1						1
Ischaemum rugosum		1	1	1		1				4
Ixora coccinea			1							1
Ixora pavetta						1	1			2
Jasminum angustifolium						1	1			2
Jasminum multiflorum			1							1
Jasminum officinale			1							1
Jasminum rottlerianum			1							1
Jasminum sambac			1							1
Jatropa spicata			1							1
Justicia adhatoda					1					1
Khaya senegalensis		1								1
Lantana camera	1	1		1		1	1			5
Lasia spinosa				1						1
Leea indica				1						1
Lepisanthes senegalensis						1				1
Lepisanthes tetraphylla						1				1
Leptochloa chinensis				1						1
Leptochloa neesii				1						1
Leucaena leucocephala			1	1			1			3
Limonia acidissima			1							1
Litsea glutinosa									1	1
Ludwigia adscendens				1						1
Luffa cylindrica			1							1
Lycopersicon esculentum		1	1							2
Macaranga peltata				1						1
Madhuca longifolia				1	1	1				3
Mallotus philippensis					1	1				2
Mallotus rhamnifolius						1				1
Mangifera indica		1	1	1	1					4
Manihot esculenta		1	1							2
Manilkara hexandra		1				1				2
Margaritaria indicus						1				1
Marsilia quadrifolia				1						1
Maytenus emarginata						1				1
Melochia corchorifolia		1	1	1			1	1		5
Memecylon umbellatum						1	1	1		3
Merremia cissoides		1	1				1			3
Mesua ferrea					1					1
Mikania cordata			1	1						2
Miliusa indica						1				1
Mimosa invisa							1			1
Mimosa pudica	1	1	1	1		1	1	1		7
Mitracarpus hirtus		1	1	1			1	1		5
Mitragyna parvifolia	1		1			1	1			4

Momodica charantia		1	1						2
Morinda coreia	1				1		1		3
Moringa oleifera		1	1		1		1	1	5
Murdannia nudiflora			1	1					2
Murraya koenigii	1	1	1		1		1	1	6
Murraya paniculata						1			1
Musa x paradisaca			1						1
Mussaenda frondosa				1		1			2
Myristica ceylanica				1					1
Nelumbo nucifera				1					1
Nerium oleander			1	1					2
Nyctanthes arbor-tristis			1						1
Ochna lanceolata				1		1	1		3
Ocimum gratissimum							1		1
Ocimum tenuiflorum (old name ?)		1					1		2
Oplismenus compositus			1	1					2
Oroxylum indicum					1	1			2
Orthosiphon thymiflorus								1	1
Oryza rufipogon				1					1
Ottelia alismoides				1					1
Pandanus amaryllifolius			1						1
Pandanus sp.				1					1
Panicum maximum	1		1	1	1		1	1	6
Panicum repens				1					1
Paramignya monophylla								1	1
Paspalum conjugatum				1					1
Paspalum scrobiculatum		1		1					2
Paspalum vaginatum			1	1					2
Passiflora edulis			1						1
Passiflora foetida							1		1
Perotis indica		1	1				1		3
Persea americana			1						1
Phaseolus vulgaris		1							1
Phonix pusilla				1					1
Phyllanthus acidus			1						1
Phyllanthus amarus		1	1	1			1		4
Phyllanthus debilis			1	1					2
Phyllanthus polyphyllus	1				1	1	1	1	5
Phyllanthus reticulatus				1			1	1	3
Phyllanthus urinaria			1	1					2
Piper betle		1	1						2
Piper nigrum			1						1
Pithecellobium dulce						1			1
Plecospermum spinosum				1					1
Pleiospermium alatum						1	1		2
Polyalthia korinti						1			1
Polyalthia longifolia						1			1
Pongamia pinnata				1	1				2
Portulaca oleracea		1							1
Pothos scandens				1					1
Pouteria campechiana			1						1
Premna procumbens				1		1	1		3
Premna tomentosa					1	1	1		3

Psidium guajava			1						1
Psophocarpus tetragonolous		1	1						2
Pterocarpus marsupium					1				1
Pterospermum suberifolium						1	1	1	3
Punica granatum			1		1				2
Reissantia indica						1			1
Ricinus communis		1							1
Rosa sp.			1						1
Saccharum officinarum			1						1
Salacia chinensis						1			1
Salacia oblonga						1			1
Salvinia molesta D.Mitch.				1					1
Samanea saman				1					1
Sapindus trifoliata								1	1
Saraca asoka					1				1
Schleichera oleosa	1			1		1	1	1	5
Scleria lithosperma						1			1
Scoparia dulcis		1	1	1			1	1	5
Scutia myrtina						1	1		2
Senna auriculata	1					1			2
Sida acuta							1		1
Sida cordifolia		1					1		2
Solanum melongena		1	1						2
Spermacoce hispida		1					1		2
Spermacoce latifolia			1	1			1	1	4
Sphaeranthus indicus		1							1
Spigelia anthelmia		1		1			1		3
Stenotaphrum dimidiatum				1		1			2
Streblus asper	1		1	1	1	1	1	1	7
Strychnos nux-vomica						1	1		2
Strychnos potatorum			1	1					2
Suregada lanceolata						1			1
Syzygium cumini			1	1		1	1	1	5
Syzygium jambos			1						1
Tabernaemontana divaricata			1						1
Tagetes erecta			1						1
Talinum paniculatum			1						1
Tamarindus indica						1			1
Tarenna asiatica						1			1
Tecoma stans			1						1
Tectona grandis		1	1				1	1	4
Tephrosia maxima							1		1
Terminalia arjuna				1					1
Terminalia catappa				1					1
Toddalia asiatica						1	1		2
Trachyspermum involucratum			1						1
Trema orientalis							1	1	2
Trianthema portulacastrum		1							1
Trichosanthes cucumerina				1					1
Tridax procumbens		1	1	1			1	1	5
Triumfetta pentandra		1	1	1			1		4
Tylophora pauciflora			1						1
Typha agustifolia				1					1

Urena lobata				1					1
Urena sinuata			1	1					2
Vanda tessellata				1					1
Ventilago maderaspatana				1		1	1		3
Vernonia cinerea		1	1						2
Vernonia zeylanica							1		1
Vicoa indica		1	1				1		3
Vigna mungo		1	1						2
Vigna unguiculata		1	1						2
Vitex altissima		1	1			1	1		4
Vitex leucoxylon				1					1
Vitex negundo			1		1				2
Walsura trifoliolata						1			1
Waltheria indica		1	1	1			1		4
Xanthium indicum				1			1		2
Zea mays		1	1						2
Zingiber officinale		1	1		1				3
Zingiber wightianum						1			1
Zingiber zerumbet				1					1
Zizyphus oenopila	1			1		1	1	1	5
Zoysia matrella			1						1
TOTAL	23	90	170	141	39	106	116	55	

Annex 3.1.5. Presence of fauna in different cascades

		CASCADE	
		NACHCHADUWA CASCADE	HORIVILA CASCADE
	FAUNA SPECIES		
1	*AMPHIBIANS_Duttaphrynus melanostictus_Common toad*	1	1
2	*AMPHIBIANS_Euphlyctis hexadactylus_Indian green frog*	1	1
3	*AMPHIBIANS_Euphlyctis mudigere_Indian skipper frog*	1	1
4	*AMPHIBIANS_Hoplobatrachus crassus _Jerdon's bull frog*	1	1
5	*AMPHIBIANS_Minervarya agricola_Common paddy field frog*	1	1
6	*AMPHIBIANS_Polypedates maculatus _Spotted tree frog*	1	1
7	*AMPHIBIANS_Uperodon taprobanicus_Sri Lankan bull frog*	1	
8	*BIRDS_Accipiter badius _Shikra*	1	1
9	*BIRDS_Acridotheres tristis _Common Myna*	1	1
10	*BIRDS_Aegithina tiphia _Common Iora*	1	1
11	*BIRDS_Alcedo atthis _Common Kingfisher*	1	1
12	*BIRDS_Anthus rufulus _Paddyfield Pipit*		1
13	*BIRDS_Ardea intermedia _Intermediate Egret*		1
14	*BIRDS_Centropus sinensis _Greater Coucal*	1	1
15	*BIRDS_Chloropsis jerdoni_Jerdon's Leafbird*	1	1
16	*BIRDS_Chrysomma sinense _Yellow-eyed Babbler*	1	
17	*BIRDS_Cinnyris asiaticus_Purple Sunbird*	1	1
18	*BIRDS_Cinnyris lotenius_Loten's Sunbird*	1	1
19	*BIRDS_Cisticola juncidis _Zitting Cisticola*	1	1
20	*BIRDS_Clamator jacobinus _Jacobin Cuckoo*	1	
21	*BIRDS_Copsychus fulicatus_Indian Robin*	1	1
22	*BIRDS_Copsychus malabaricus _White-rumped Shama*		1
23	*BIRDS_Copsychus saularis _Oriental Magpie Robin*	1	1
24	*BIRDS_Coracina melanoptera _Black-headed Cuckooshrike*	1	
25	*BIRDS_Corvus levaillantii_Eastern Jungle Crow*	1	1
26	*BIRDS_Cuculus micropterus_Indian Cuckoo*		1
27	*BIRDS_Cyornis tickelliae _Tickell's Blue Flycatcher*	1	1
28	*BIRDS_Cypsiurus balasiensis _Asian Palm Swift*	1	1
29	*BIRDS_Dicaeum erythrorhynchos _Pale-billed Flowerpecker*	1	1
30	*BIRDS_Dicrurus caerulescens _White-bellied Drongo*	1	1
31	*BIRDS_Dinopium psarodes*_Lesser Sri Lanka Flameback*	1	1
32	*BIRDS_Dumetia hyperythra _Tawny-bellied Babbler*	1	1
33	*BIRDS_Egretta garzetta _Little Egret*	1	1

34	*BIRDS_Eudynamys scolopacea _Asian Koel*	1	1
35	*BIRDS_Gallus lafayetii* _Sri Lanka Junglefowl*	1	1
36	*BIRDS_Halcyon smyrnensis _White-throated Kingfisher*	1	1
37	*BIRDS_Haliaeetus ichthyaetus _Grey-headed Fish-eagle*	1	1
38	*BIRDS_Haliastur indus _Brahminy Kite*	1	1
39	*BIRDS_Hemiprocne coronata _Crested Treeswift*	1	1
40	*BIRDS_Hirundo rustica _Barn Swallow*	1	1
41	*BIRDS_Lanius cristatus _Brown Shrike*	1	1
42	*BIRDS_Leptocoma zeylonica _Purple-rumped Sunbird*	1	1
43	*BIRDS_Lonchura malacca _Tricolored Munia*	1	1
44	*BIRDS_Lonchura punctulata _Scaly-breasted Munia*	1	1
45	*BIRDS_Lonchura striata _White-rumped Munia*	1	1
46	*BIRDS_Merops leschenaulti _Chestnut-headed Bee-eater*	1	
47	*BIRDS_Merops orientalis _Green Bee-eater*	1	1
48	*BIRDS_Merops philippinus _Blue-tailed Bee-eater*	1	1
49	*BIRDS_Microcarbo niger _Little Cormorant*	1	1
50	*BIRDS_Mirafra affinis_Jerdon's Bush Lark*	1	
51	*BIRDS_Ninox scutulata _Brown Hawk Owl*		1
52	*BIRDS_Nisaetus cirrhatus _Changeable Hawk Eagle*		1
53	*BIRDS_Oriolus xanthornus _Black-hooded Oriole*	1	1
54	*BIRDS_Orthotomus sutorius _Common Tailorbird*	1	1
55	*BIRDS_Pavo cristatus_Indian Peafowl*	1	1
56	*BIRDS_Pelargopsis capensis_Stork-billed Kingfisher*	1	1
57	*BIRDS_Pellorneum fuscocapillum*_Sri Lanka Brown-capped Babbler*	1	
58	*BIRDS_Pericrocotus cinnamomeus _Small Minivet*	1	1
59	*BIRDS_Pericrocotus flammeus _Scarlet Minivet*	1	1
60	*BIRDS_Phaenicophaeus viridirostris _Blue-faced Malkoha*	1	1
61	*BIRDS_Pitta brachyura _Indian Pitta*	1	1
62	*BIRDS_Prinia hodgsonii _Grey-breasted Prinia*	1	1
63	*BIRDS_Prinia inornata _Plain Prinia*	1	1
64	*BIRDS_Prinia sylvatica _Jungle Prinia*	1	1
65	*BIRDS_Psilopogon haemacephalus_Coppersmith Barbet*	1	1
66	*BIRDS_Psilopogon zeylanicus_Brown-headed Barbet*	1	1
67	*BIRDS_Psittacula krameri _Rose-ringed Parakeet*	1	1
68	*BIRDS_Pycnonotus cafer _Red-vented Bulbul*	1	1
69	*BIRDS_Pycnonotus luteolus _White-browed Bulbul*	1	1
70	*BIRDS_Pycnonotus melanicterus* _Sri Lanka Black-capped Bulbul*	1	1
71	*BIRDS_Rhipidura aureola _White-browed Fantail*	1	1
72	*BIRDS_Spilopelia chinensis _Spotted Dove*	1	1
73	*BIRDS_Tephrodornis affinis*_Sri Lanka Woodshrike*	1	1
74	*BIRDS_Terpsiphone paradisi _Asian Paradise- flycathcher*	1	1
75	*BIRDS_Treron bicinctus_Orange-breasted Green-pigeon*	1	1
76	*BIRDS_Treron pompadora*_Sri Lanka Green-pigeon*	1	1
77	*BIRDS_Turdoides affinis _Yellow-billed Babbler*	1	1
78	*BUTTERFLIES_Acraea violae_Tawny Coster*	1	1
79	*BUTTERFLIES_Appias albina_Common Albatross*	1	1
80	*BUTTERFLIES_Appias galene*_Sri Lanka Lesser Albatross*	1	1
81	*BUTTERFLIES_Ariadne ariadne_Angled Castor*	1	1
82	*BUTTERFLIES_Belenois aurota_Pioneer*	1	1
83	*BUTTERFLIES_Castalius rosimon_Common Pierrot*	1	1
84	*BUTTERFLIES_Catochrysops strabo_Forget-me-not*	1	1
85	*BUTTERFLIES_Catopsilia pomona_Lemon Emigrant*	1	1
86	*BUTTERFLIES_Catopsilia pyranthe_Mottled Emigrant*	1	1

87	*BUTTERFLIES_Charaxes solon_Black Rajah*	1	
88	*BUTTERFLIES_Chilades lajus_Lime Blue*	1	1
89	*BUTTERFLIES_Chilades pandava_Plains Cupid*	1	1
90	*BUTTERFLIES_Colotis amata_Small Salmon Arab*	1	
91	*BUTTERFLIES_Danaus chrysippus_Plain Tiger*	1	1
92	*BUTTERFLIES_Danaus genutia_Common Tiger*	1	1
93	*BUTTERFLIES_Delias eucharis_Jezebel*	1	1
94	*BUTTERFLIES_Elymnias hypermnestra_Common Palmfly*	1	1
95	*BUTTERFLIES_Euploea core_Common Indian Crow*	1	1
96	*BUTTERFLIES_Euploea klugii_Brown King Crow*	1	1
97	*BUTTERFLIES_Eurema blanda_Three-spot Grass Yellow*	1	1
98	*BUTTERFLIES_Eurema hecabe_Common Grass Yellow*	1	1
99	*BUTTERFLIES_Euthalia aconthea_Baron*	1	
100	*BUTTERFLIES_Everes lacturnus_Indian Cupid*		1
101	*BUTTERFLIES_Hebomoia glaucippe_Great Orange Tip*	1	
102	*BUTTERFLIES_Iambrix salsala_Chestnut Bob*	1	1
103	*BUTTERFLIES_Jamides bochus_Dark Cerulean*	1	1
104	*BUTTERFLIES_Jamides celeno_Common Cerulean*	1	1
105	*BUTTERFLIES_Junonia almana_Peacock Pansy*	1	1
106	*BUTTERFLIES_Junonia atlites_Grey Pansy*	1	1
107	*BUTTERFLIES_Junonia iphita_Chocolate Soldier*	1	1
108	*BUTTERFLIES_Junonia lemonias_Lemon Pansy*	1	1
109	*BUTTERFLIES_Lampides boeticus_Pea Blue*	1	1
110	*BUTTERFLIES_Leptosia nina_Psyche*	1	1
111	*BUTTERFLIES_Melanitis leda_Common Evening Brown*	1	1
112	*BUTTERFLIES_Mycalesis patnia_Gladeye Bushbrown*	1	1
113	*BUTTERFLIES_Mycalesis perseus_Common Bushbrown*	1	1
114	*BUTTERFLIES_Neptis hylas_Common Sailor*	1	1
115	*BUTTERFLIES_Orsotriaena medus_Medus Brown*	1	1
116	*BUTTERFLIES_Pachliopta aristolochiae_Common Rose*	1	1
117	*BUTTERFLIES_Pachliopta hector_Crimson Rose*	1	1
118	*BUTTERFLIES_Papilio crino _Banded peacock_VU(N)*	1	1
119	*BUTTERFLIES_Papilio domoleus _Lime butterfly*	1	1
120	*BUTTERFLIES_Papilio polymnestor_Blue Mormon*	1	1
121	*BUTTERFLIES_Papilio polytes_Common Mormon*	1	1
122	*BUTTERFLIES_Parantica aglea_Glassy Tiger*	1	1
123	*BUTTERFLIES_Phalanta phalantha_Leopard*	1	1
124	*BUTTERFLIES_Potanthus confuscius_Tropic Dart*	1	1
125	*BUTTERFLIES_Prosotas nora_Common Lineblue*	1	1
126	*BUTTERFLIES_Spalgis epeus_Apefly*		1
127	*BUTTERFLIES_Spindasis schistacea_Plumbeous Silverline_VU(N)*	1	
128	*BUTTERFLIES_Tagiades litigiosa_Water Snow Flat_VU(N)*	1	
129	*BUTTERFLIES_Talicada nyseus_Red Pierrot*	1	
130	*BUTTERFLIES_Taractrocera maevius_Common Grass Dart*	1	1
131	*BUTTERFLIES_Tirumala limniace_Blue Tiger*	1	1
132	*BUTTERFLIES_Virachola perse_Large Guava Blue_VU(N)*	1	
133	*BUTTERFLIES_Ypthima ceylonica_White Four-ring*	1	1
134	*BUTTERFLIES_Zizeeria karsandra_Dark Grass Blue*	1	1
135	*BUTTERFLIES_Zizina otis_Lesser Grass Blue*	1	1
136	*BUTTERFLIES_Zizula hylax_Tiny Grass Blue*	1	1
137	*DRAGONFLIES_Acisoma panorpoides_Asian Pintail*	1	1
138	*DRAGONFLIES_Agriocnemis pygmaea_Wandering Wisp*	1	1
139	*DRAGONFLIES_Brachydiplax sobrina_Sombre Lieutenant*	1	1

140	*DRAGONFLIES_Brachythemis contaminata_Asian Groundling*	1	1
141	*DRAGONFLIES_Ceriagrion coromandelianum_Yellow Waxtail*	1	1
142	*DRAGONFLIES_Crocothemis servilia_Oriental Scarlet*	1	1
143	*DRAGONFLIES_Diplacodes trivialis_Blue Percher*	1	1
144	*DRAGONFLIES_Indothemis limbata_Restless Demon*	1	1
145	*DRAGONFLIES_Ischnura aurora_Dawn Bluetail*	1	1
146	*DRAGONFLIES_Lestes elatus_White Tipped Spreadwing*	1	1
147	*DRAGONFLIES_Neurothemis intermedia_Paddyfield Parasol*	1	1
148	*DRAGONFLIES_Neurothemis tullia_Pied parasol*	1	1
149	*DRAGONFLIES_Orthetrum sabina_Green Skimmer*	1	1
150	*DRAGONFLIES_Pantala flavescens_Wandering Glider*	1	1
151	*DRAGONFLIES_Potamarcha congener_Blue Pursuer*	1	1
152	*DRAGONFLIES_Rhyothemis variegata_Variegate Flutterer*	1	1
153	*DRAGONFLIES_Tramea limbata_Sociable Glider*	1	1
154	*DRAGONFLIES_Trithemis aurora_Crimson dropwing*	1	1
155	*DRAGONFLIES_Urothemis signata_Scarlet Basker*	1	1
156	*LAND SNAILS_Aulopoma itieri*_Itier's Operculate Snail_EN(N)*	1	1
157	*LAND SNAILS_Beddomea trifasciatus*__VU(N)*	1	1
158	*LAND SNAILS_Cryptozona bistrialis_Common Translucent Snail*	1	1
159	*LAND SNAILS_Cyclophorus sp.*	1	1
160	*LAND SNAILS_Euplecta sp.*	1	1
161	*LAND SNAILS_Lissachatina fulicaEX_Giant African Snail*	1	1
162	*MAMMALS_Axis axis+_Spotted deer*		1
163	*MAMMALS_Bos sp.*	1	1
164	*MAMMALS_Canis aureus+_Jackal*		1
165	*MAMMALS_Canis familiaris_Domestic dog*	1	1
166	*MAMMALS_Elephas maximus_Elephant_EN(N)_EN(G)*	1	1
167	*MAMMALS_Felis catus_Domestic cat*	1	1
168	*MAMMALS_Funambulus palmarum_Palm squirrel*	1	1
169	*MAMMALS_Herpestes smithii_Ruddy mongoose*	1	1
170	*MAMMALS_Hipposideros speoris_Schneider's leaf-nosed bat*	1	
171	*MAMMALS_Hystrix indica+_Porcupine*	1	1
172	*MAMMALS_Lepus nigricollis_Black-naped hare*	1	1
173	*MAMMALS_Lutra lutra+_Otter_VU(N)*	1	
174	*MAMMALS_Macaca sinica* _Sri Lanka toque monkey_EN(G)*	1	1
175	*MAMMALS_Moschiola meminna*_Sri Lanka mouse-deer*	1	1
176	*MAMMALS_Muntiacus malabaricus_Barking deer*	1	1
177	*MAMMALS_Paradoxurus hermaphroditus_Palm cat*	1	1
178	*MAMMALS_Pteropus medius_Flying fox*	1	
179	*MAMMALS_Rattus rattus_Common rat*	1	1
180	*MAMMALS_Ratufa macroura+_Giant squirrel*	1	1
181	*MAMMALS_Sus scrofa_Wild boar*	1	1
182	*MAMMALS_Tatera indica_Indian gerbil\Antelope rat*	1	
183	*MAMMALS_Viverricula indica_Ring-tailed civet*	1	1
184	*REPTILES_Ahaetulla nasuta*_Green vine snake*	1	1
185	*REPTILES_Calotes calotes_Green garden lizard*	1	
186	*REPTILES_Calotes versicolor_Common garden lizard*	1	1
187	*REPTILES_Chrysopelea taprobanica _Striped flying snake*		1
188	*REPTILES_Dendrelaphis schokari*_Schokari's bronze back*	1	
189	*REPTILES_Dendrelaphis tristis _Common bronze back*	1	1
190	*REPTILES_Eutropis madaraszi*_Spotted skink_VU(N)*	1	
191	*REPTILES_Eutropis sp.*	1	1
192	*REPTILES_Fowlea asperrimus*_Sri Lanka keelback*	1	

193	*REPTILES_Fowlea cf. piscator _Checkered Keelback*		1	1
194	*REPTILES_Gehyra mutilata _Four-claw gecko*		1	1
195	*REPTILES_Geochelone elegans_Star tortoise*		1	1
196	*REPTILES_Hemidactylus depressus* _Kandyan gecko*		1	1
197	*REPTILES_Hemidactylus frenatus _Common house-gecko*		1	1
198	*REPTILES_Hemidactylus parvimaculatus_Spotted housegecko*		1	1
199	*REPTILES_Hypnale hypnale_Merrem's Hump nose viper*		1	
200	*REPTILES_Lankascincus fallax*_Common lankaskink*		1	1
201	*REPTILES_Ptyas mucosa_Rat snake*		1	1
202	*REPTILES_Varanus bengalensis_Land monitor*		1	1
		Total	191	178

Annex 3.1.6. Species present (aggregated) in different ecosystems in *Nachchaduwa* cascade

	ACACIA FOREST	CHENA	HOMEGARDEN	KATTAKADUWA	NATURAL FOREST	SCRUBLAND	TEAK FOREST
FAUNA SPECIES							
AMPHIBIANS_Duttaphrynus melanostictus_Common toad			1				
AMPHIBIANS_Euphlyctis hexadactylus_Indian green frog				1			
AMPHIBIANS_Euphlyctis mudigere_Indian skipper frog				1			
AMPHIBIANS_Hoplobatrachus crassus _Jerdon's bull frog				1			
AMPHIBIANS_Minervarya agricola_Common paddy field frog				1			
AMPHIBIANS_Polypedates maculatus _Spotted tree frog			1		1		
AMPHIBIANS_Uperodon taprobanicus_Sri Lankan bull frog				1			
BIRDS_Accipiter badius _Shikra		1		1			
BIRDS_Acridotheres tristis _Common Myna	1	1	1	1			1
BIRDS_Aegithina tiphia _Common Iora	1		1	1		1	
BIRDS_Alcedo atthis _Common Kingfisher				1			
BIRDS_Centropus sinensis _Greater Coucal			1			1	
BIRDS_Chloropsis jerdoni_Jerdon's Leafbird			1		1	1	
BIRDS_Chrysomma sinense _Yellow-eyed Babbler		1					
BIRDS_Cinnyris asiaticus_Purple Sunbird						1	
BIRDS_Cinnyris lotenius_Loten's Sunbird			1	1		1	
BIRDS_Cisticola juncidis _Zitting Cisticola		1				1	
BIRDS_Clamator jacobinus _Jacobin Cuckoo					1	1	
BIRDS_Copsychus fulicatus_Indian Robin		1	1			1	
BIRDS_Copsychus saularis _Oriental Magpie Robin			1				
BIRDS_Coracina melanoptera _Black-headed Cuckooshrike				1			
BIRDS_Corvus levaillantii_Eastern Jungle Crow				1			
BIRDS_Cyornis tickelliae _Tickell's Blue Flycatcher			1	1	1		
BIRDS_Cypsiurus balasiensis _Asian Palm Swift		1	1	1		1	1
BIRDS_Dicaeum erythrorhynchos _Pale-billed Flowerpecker	1	1	1	1	1	1	1
BIRDS_Dicrurus caerulescens _White-bellied Drongo		1	1	1		1	1
*BIRDS_Dinopium psarodes*_Lesser Sri Lanka Flameback*	1		1	1			
BIRDS_Dumetia hyperythra _Tawny-bellied Babbler		1				1	
BIRDS_Egretta garzetta _Little Egret				1			
BIRDS_Eudynamys scolopacea _Asian Koel			1	1			
BIRDS_Gallus lafayetii _Sri Lanka Junglefowl*					1	1	1
BIRDS_Halcyon smyrnensis _White-throated Kingfisher				1		1	
BIRDS_Haliaeetus ichthyaetus _Grey-headed Fish-eagle				1			
BIRDS_Haliastur indus _Brahminy Kite	1			1		1	
BIRDS_Hemiprocne coronata _Crested Treeswift				1			
BIRDS_Hirundo rustica _Barn Swallow				1			
BIRDS_Lanius cristatus _Brown Shrike			1	1		1	
BIRDS_Leptocoma zeylonica _Purple-rumped Sunbird	1		1	1		1	
BIRDS_Lonchura malacca _Tricolored Munia				1			

BIRDS_Lonchura punctulata _Scaly-breasted Munia		1		1		1	1
BIRDS_Lonchura striata _White-rumped Munia		1		1		1	1
BIRDS_Merops leschenaulti _Chestnut-headed Bee-eater			1	1		1	
BIRDS_Merops orientalis _Green Bee-eater	1	1	1	1		1	
BIRDS_Merops philippinus _Blue-tailed Bee-eater		1		1		1	1
BIRDS_Microcarbo niger _Little Cormorant				1			
BIRDS_Mirafra affinis_Jerdon's Bush Lark		1		1			
BIRDS_Oriolus xanthornus _Black-hooded Oriole			1	1		1	
BIRDS_Orthotomus sutorius _Common Tailorbird	1	1	1	1		1	1
BIRDS_Pavo cristatus_Indian Peafowl				1		1	
BIRDS_Pelargopsis capensis_Stork-billed Kingfisher				1			
*BIRDS_Pellorneum fuscocapillum*_Sri Lanka Brown-capped Babbler*			1		1	1	
BIRDS_Pericrocotus cinnamomeus _Small Minivet				1		1	
BIRDS_Pericrocotus flammeus _Scarlet Minivet						1	
BIRDS_Phaenicophaeus viridirostris _Blue-faced Malkoha						1	
BIRDS_Pitta brachyura _Indian Pitta					1		
BIRDS_Prinia hodgsonii _Grey-breasted Prinia	1			1			
BIRDS_Prinia inornata _Plain Prinia		1		1		1	
BIRDS_Prinia sylvatica _Jungle Prinia				1		1	
BIRDS_Psilopogon haemacephalus_Coppersmith Barbet			1	1		1	
BIRDS_Psilopogon zeylanicus_Brown-headed Barbet	1	1	1	1	1	1	1
BIRDS_Psittacula krameri _Rose-ringed Parakeet	1	1	1	1		1	
BIRDS_Pycnonotus cafer _Red-vented Bulbul		1	1	1		1	1
BIRDS_Pycnonotus luteolus _White-browed Bulbul	1	1		1		1	
BIRDS_Pycnonotus melanicterus _Sri Lanka Black-capped Bulbul*				1			
BIRDS_Rhipidura aureola _White-browed Fantail		1	1	1	1	1	1
BIRDS_Spilopelia chinensis _Spotted Dove	1	1	1	1	1	1	1
*BIRDS_Tephrodornis affinis*_Sri Lanka Woodshrike*				1	1	1	
BIRDS_Terpsiphone paradisi _Asian Paradise- flycathcher			1	1		1	1
BIRDS_Treron bicinctus_Orange-breasted Green-pigeon				1		1	1
*BIRDS_Treron pompadora*_Sri Lanka Green-pigeon*				1			
BIRDS_Turdoides affinis _Yellow-billed Babbler			1				
BUTTERFLIES_Acraea violae_Tawny Coster		1	1	1			
BUTTERFLIES_Appias albina_Common Albatross		1		1		1	
*BUTTERFLIES_Appias galene*_Sri Lanka Lesser Albatross*				1		1	1
BUTTERFLIES_Ariadne ariadne_Angled Castor	1		1	1		1	
BUTTERFLIES_Belenois aurota_Pioneer						1	
BUTTERFLIES_Castalius rosimon_Common Pierrot				1		1	
BUTTERFLIES_Catochrysops strabo_Forget-me-not				1		1	
BUTTERFLIES_Catopsilia pomona_Lemon Emigrant	1	1	1	1	1	1	1
BUTTERFLIES_Catopsilia pyranthe_Mottled Emigrant		1		1			
BUTTERFLIES_Charaxes solon_Black Rajah				1			
BUTTERFLIES_Chilades lajus_Lime Blue			1			1	
BUTTERFLIES_Chilades pandava_Plains Cupid				1		1	
BUTTERFLIES_Colotis amata_Small Salmon Arab						1	
BUTTERFLIES_Danaus chrysippus_Plain Tiger		1					
BUTTERFLIES_Danaus genutia_Common Tiger		1		1		1	
BUTTERFLIES_Delias eucharis_Jezebel	1	1	1	1	1	1	1
BUTTERFLIES_Elymnias hypermnestra_Common Palmfly			1			1	
BUTTERFLIES_Euploea core_Common Indian Crow	1	1	1	1	1	1	1
BUTTERFLIES_Euploea klugii_Brown King Crow					1	1	
BUTTERFLIES_Eurema blanda_Three-spot Grass Yellow		1	1	1		1	
BUTTERFLIES_Eurema hecabe_Common Grass Yellow	1	1	1	1	1	1	1

BUTTERFLIES_Euthalia aconthea_Baron			1	1			
BUTTERFLIES_Hebomoia glaucippe_Great Orange Tip					1	1	
BUTTERFLIES_Iambrix salsala_Chestnut Bob	1		1	1		1	
BUTTERFLIES_Jamides bochus_Dark Cerulean		1		1			
BUTTERFLIES_Jamides celeno_Common Cerulean	1	1	1	1		1	
BUTTERFLIES_Junonia almana_Peacock Pansy				1		1	
BUTTERFLIES_Junonia atlites_Grey Pansy	1	1	1	1		1	
BUTTERFLIES_Junonia iphita_Chocolate Soldier	1	1	1	1	1	1	
BUTTERFLIES_Junonia lemonias_Lemon Pansy			1	1		1	
BUTTERFLIES_Lampides boeticus_Pea Blue		1				1	
BUTTERFLIES_Leptosia nina_Psyche		1	1	1		1	1
BUTTERFLIES_Melanitis leda_Common Evening Brown			1				
BUTTERFLIES_Mycalesis patnia_Gladeye Bushbrown				1			
BUTTERFLIES_Mycalesis perseus_Common Bushbrown		1	1	1		1	1
BUTTERFLIES_Neptis hylas_Common Sailor	1	1	1	1		1	
BUTTERFLIES_Orsotriaena medus_Medus Brown			1	1	1	1	1
BUTTERFLIES_Pachliopta aristolochiae_Common Rose						1	
BUTTERFLIES_Pachliopta hector_Crimson Rose			1	1	1	1	1
BUTTERFLIES_Papilio crino _Banded peacock_VU(N)						1	
BUTTERFLIES_Papilio domoleus _Lime butterfly		1	1	1	1	1	
BUTTERFLIES_Papilio polymnestor_Blue Mormon				1	1	1	
BUTTERFLIES_Papilio polytes_Common Mormon	1	1	1	1	1	1	1
BUTTERFLIES_Parantica aglea_Glassy Tiger		1					
BUTTERFLIES_Phalanta phalantha_Leopard				1		1	
BUTTERFLIES_Potanthus confuscius_Tropic Dart				1			
BUTTERFLIES_Prosotas nora_Common Lineblue				1	1		
BUTTERFLIES_Spindasis schistacea_Plumbeous Silverline_VU(N)					1	1	1
BUTTERFLIES_Tagiades litigiosa_Water Snow Flat_VU(N)						1	
BUTTERFLIES_Talicada nyseus_Red Pierrot			1				
BUTTERFLIES_Taractrocera maevius_Common Grass Dart				1			
BUTTERFLIES_Tirumala limniace_Blue Tiger						1	
BUTTERFLIES_Virachola perse_Large Guava Blue_VU(N)						1	
BUTTERFLIES_Ypthima ceylonica_White Four-ring	1	1	1	1		1	
BUTTERFLIES_Zizeeria karsandra_Dark Grass Blue	1	1	1	1		1	
BUTTERFLIES_Zizina otis_Lesser Grass Blue			1	1		1	1
BUTTERFLIES_Zizula hylax_Tiny Grass Blue		1	1	1		1	1
DRAGONFLIES_Acisoma panorpoides_Asian Pintail		1					
DRAGONFLIES_Agriocnemis pygmaea_Wandering Wisp				1			
DRAGONFLIES_Brachydiplax sobrina_Sombre Lieutenant				1			
DRAGONFLIES_Brachythemis contaminata_Asian Groundling				1			
DRAGONFLIES_Ceriagrion coromandelianum_Yellow Waxtail		1	1	1	1	1	
DRAGONFLIES_Crocothemis servilia_Oriental Scarlet				1			
DRAGONFLIES_Diplacodes trivialis_Blue Percher		1		1		1	
DRAGONFLIES_Indothemis limbata_Restless Demon				1			
DRAGONFLIES_Ischnura aurora_Dawn Bluetail				1			
DRAGONFLIES_Lestes elatus_White Tipped Spreadwing				1			
DRAGONFLIES_Neurothemis intermedia_Paddyfield Parasol		1		1		1	
DRAGONFLIES_Neurothemis tullia_Pied parasol		1	1				
DRAGONFLIES_Orthetrum sabina_Green Skimmer		1	1			1	
DRAGONFLIES_Pantala flavescens_Wandering Glider				1		1	
DRAGONFLIES_Potamarcha congener_Blue Pursuer				1			
DRAGONFLIES_Rhyothemis variegata_Variegate Flutterer		1	1	1		1	
DRAGONFLIES_Tramea limbata_Sociable Glider				1		1	

DRAGONFLIES_Trithemis aurora_Crimson dropwing					1			
DRAGONFLIES_Urothemis signata_Scarlet Basker					1			
*LAND SNAILS_Aulopoma itieri*_Itier's Operculate Snail_EN(N)*						1	1	1
*LAND SNAILS_Beddomea trifasciatus*__VU(N)*						1		
LAND SNAILS_Cryptozona bistrialis_Common Translucent Snail	1	1	1	1	1	1		
LAND SNAILS_Cyclophorus sp.				1	1			
LAND SNAILS_Euplecta sp.					1			
LAND SNAILS_Lissachatina fulicaEX_Giant African Snail			1					
MAMMALS_Bos sp.								1
MAMMALS_Canis familiaris_Domestic dog		1	1	1				
MAMMALS_Elephas maximus_Elephant_EN(N)_EN(G)	1	1		1	1	1	1	
MAMMALS_Felis catus_Domestic cat			1					
MAMMALS_Funambulus palmarum_Palm squirrel			1	1				
MAMMALS_Herpestes smithii_Ruddy mongoose								1
MAMMALS_Hipposideros speoris_Schneider's leaf-nosed bat					1			
MAMMALS_Hystrix indica+_Porcupine		1						
MAMMALS_Lepus nigricollis_Black-naped hare	1	1		1		1	1	
MAMMALS_Lutra lutra+_Otter_VU(N)				1				
MAMMALS_Macaca sinica _Sri Lanka toque monkey_EN(G)*	1	1	1	1	1	1	1	
*MAMMALS_Moschiola meminna*_Sri Lanka mouse-deer*					1	1		
MAMMALS_Muntiacus malabaricus_Barking deer		1			1			
MAMMALS_Paradoxurus hermaphroditus_Palm cat			1					
MAMMALS_Pteropus medius_Flying fox				1	1			
MAMMALS_Rattus rattus_Common rat			1					
MAMMALS_Ratufa macroura+_Giant squirrel				1	1			
MAMMALS_Sus scrofa_Wild boar	1	1		1	1	1	1	
MAMMALS_Tatera indica_Indian gerbil\Antelope rat						1		
MAMMALS_Viverricula indica_Ring-tailed civet						1		
*REPTILES_Ahaetulla nasuta*_Green vine snake*				1		1		
REPTILES_Calotes calotes_Green garden lizard			1			1		
REPTILES_Calotes versicolor_Common garden lizard	1	1	1	1		1		
*REPTILES_Dendrelaphis schokari*_Schokari's bronze back*					1			
REPTILES_Dendrelaphis tristis _Common bronze back					1			
*REPTILES_Eutropis madaraszi*_Spotted skink_VU(N)*				1				
REPTILES_Eutropis sp.			1	1				
*REPTILES_Fowlea asperrimus*_Sri Lanka keelback*				1				
REPTILES_Fowlea cf. piscator _Checkered Keelback				1				
REPTILES_Gehyra mutilata _Four-claw gecko			1					
REPTILES_Geochelone elegans_Star tortoise				1				
REPTILES_Hemidactylus depressus _Kandyan gecko*			1					
REPTILES_Hemidactylus frenatus _Common house-gecko				1				
REPTILES_Hemidactylus parvimaculatus_Spotted housegecko			1					
REPTILES_Hypnale hypnale_Merrem's Hump nose viper			1					
*REPTILES_Lankascincus fallax*_Common lankaskink*					1			1
REPTILES_Ptyas mucosa_Rat snake	1		1					
REPTILES_Varanus bengalensis_Land monitor						1		
Total	33	62	78	129	43	105	36	

Annex 3.1.7. Species present (aggregated) in different ecosystems in *Nachchaduwa* cascade

	CHENA	HOMEGARDEN	KATTAKADUWA	MEDICINAL FOREST	NATURAL FOREST	SCRUBLAND	TEAK FOREST
FAUNA SPECIES PRESENT							
AMPHIBIANS_Duttaphrynus melanostictus_Common toad	1	1					
AMPHIBIANS_Euphlyctis hexadactylus_Indian green frog			1				
AMPHIBIANS_Euphlyctis mudigere_Indian skipper frog			1				
AMPHIBIANS_Hoplobatrachus crassus _Jerdon's bull frog			1				
AMPHIBIANS_Minervarya agricola_Common paddy field frog			1				
AMPHIBIANS_Polypedates maculatus _Spotted tree frog		1					
BIRDS_Accipiter badius _Shikra			1		1		
BIRDS_Acridotheres tristis _Common Myna	1	1	1				
BIRDS_Aegithina tiphia _Common Iora		1			1	1	1
BIRDS_Alcedo atthis _Common Kingfisher			1				
BIRDS_Anthus rufulus _Paddyfield Pipit			1			1	
BIRDS_Ardea intermedia _Intermediate Egret			1				
BIRDS_Centropus sinensis _Greater Coucal		1		1			
BIRDS_Chloropsis jerdoni_Jerdon's Leafbird		1		1			
BIRDS_Cinnyris asiaticus_Purple Sunbird						1	
BIRDS_Cinnyris lotenius_Loten's Sunbird		1	1			1	
BIRDS_Cisticola juncidis _Zitting Cisticola						1	
BIRDS_Copsychus fulicatus_Indian Robin	1	1	1			1	
BIRDS_Copsychus malabaricus _White-rumped Shama					1		
BIRDS_Copsychus saularis _Oriental Magpie Robin	1	1					
BIRDS_Corous levaillantii_Eastern Jungle Crow					1		
BIRDS_Cuculus micropterus_Indian Cuckoo						1	
BIRDS_Cyornis tickelliae _Tickell's Blue Flycatcher		1		1			
BIRDS_Cypsiurus balasiensis _Asian Palm Swift	1		1			1	
BIRDS_Dicaeum erythrorhynchos _Pale-billed Flowerpecker	1	1	1	1	1	1	1
BIRDS_Dicrurus caerulescens _White-bellied Drongo	1	1	1			1	1
*BIRDS_Dinopium psarodes*_Lesser Sri Lanka Flameback*							1
BIRDS_Dumetia hyperythra _Tawny-bellied Babbler			1			1	
BIRDS_Egretta garzetta _Little Egret			1				
BIRDS_Eudynamys scolopacea _Asian Koel				1			
BIRDS_Gallus lafayetii _Sri Lanka Junglefowl*					1	1	
BIRDS_Halcyon smyrnensis _White-throated Kingfisher			1		1	1	
BIRDS_Haliaeetus ichthyaetus _Grey-headed Fish-eagle			1				
BIRDS_Haliastur indus _Brahminy Kite			1				
BIRDS_Hemiprocne coronata _Crested Treeswift			1				
BIRDS_Hirundo rustica _Barn Swallow			1				
BIRDS_Lanius cristatus _Brown Shrike						1	
BIRDS_Leptocoma zeylonica _Purple-rumped Sunbird		1	1	1		1	
BIRDS_Lonchura malacca _Tricolored Munia			1			1	

BIRDS_Lonchura punctulata _Scaly-breasted Munia	1		1		1		1
BIRDS_Lonchura striata _White-rumped Munia	1	1	1	1		1	1
BIRDS_Merops orientalis _Green Bee-eater	1		1		1	1	
BIRDS_Merops philippinus _Blue-tailed Bee-eater	1		1			1	
BIRDS_Microcarbo niger _Little Cormorant			1				
BIRDS_Ninox scutulata _Brown Hawk Owl					1	1	
BIRDS_Nisaetus cirrhatus _Changeable Hawk Eagle			1		1		
BIRDS_Oriolus xanthornus _Black-hooded Oriole		1					1
BIRDS_Orthotomus sutorius _Common Tailorbird	1	1	1	1		1	1
BIRDS_Pavo cristatus_Indian Peafowl			1				1
BIRDS_Pelargopsis capensis_Stork-billed Kingfisher			1				
BIRDS_Pericrocotus cinnamomeus _Small Minivet	1	1					
BIRDS_Pericrocotus flammeus _Scarlet Minivet			1			1	
BIRDS_Phaenicophaeus viridirostris _Blue-faced Malkoha						1	
BIRDS_Pitta brachyura _Indian Pitta		1			1		
BIRDS_Prinia hodgsonii _Grey-breasted Prinia			1			1	
BIRDS_Prinia inornata _Plain Prinia			1			1	
BIRDS_Prinia sylvatica _Jungle Prinia			1		1	1	
BIRDS_Psilopogon haemacephalus_Coppersmith Barbet			1	1	1		
BIRDS_Psilopogon zeylanicus_Brown-headed Barbet	1	1	1	1		1	1
BIRDS_Psittacula krameri _Rose-ringed Parakeet	1	1	1		1	1	1
BIRDS_Pycnonotus cafer _Red-vented Bulbul	1	1	1			1	
BIRDS_Pycnonotus luteolus _White-browed Bulbul			1		1	1	1
BIRDS_Pycnonotus melanicterus _Sri Lanka Black-capped Bulbul*			1				
BIRDS_Rhipidura aureola _White-browed Fantail	1		1			1	1
BIRDS_Spilopelia chinensis _Spotted Dove	1	1	1	1	1	1	1
*BIRDS_Tephrodornis affinis*_Sri Lanka Woodshrike*			1	1	1	1	
BIRDS_Terpsiphone paradisi _Asian Paradise- flycathcher				1	1		
BIRDS_Treron bicinctus_Orange-breasted Green-pigeon			1		1		
*BIRDS_Treron pompadora*_Sri Lanka Green-pigeon*		1				1	
BIRDS_Turdoides affinis _Yellow-billed Babbler	1	1	1				
BUTTERFLIES_Acraea violae_Tawny Coster						1	
BUTTERFLIES_Appias albina_Common Albatross			1			1	
*BUTTERFLIES_Appias galene*_Sri Lanka Lesser Albatross*					1	1	
BUTTERFLIES_Ariadne ariadne_Angled Castor			1				
BUTTERFLIES_Belenois aurota_Pioneer						1	
BUTTERFLIES_Castalius rosimon_Common Pierrot				1	1	1	
BUTTERFLIES_Catochrysops strabo_Forget-me-not			1			1	
BUTTERFLIES_Catopsilia pomona_Lemon Emigrant	1	1	1	1	1	1	1
BUTTERFLIES_Catopsilia pyranthe_Mottled Emigrant		1	1				
BUTTERFLIES_Chilades lajus_Lime Blue		1	1	1	1	1	
BUTTERFLIES_Chilades pandava_Plains Cupid			1			1	
BUTTERFLIES_Danaus chrysippus_Plain Tiger			1				
BUTTERFLIES_Danaus genutia_Common Tiger	1		1			1	1
BUTTERFLIES_Delias eucharis_Jezebel		1	1	1	1	1	1
BUTTERFLIES_Elymnias hypermnestra_Common Palmfly		1					
BUTTERFLIES_Euploea core_Common Indian Crow	1	1	1	1	1	1	1
BUTTERFLIES_Euploea klugii_Brown King Crow					1		
BUTTERFLIES_Eurema blanda_Three-spot Grass Yellow			1			1	
BUTTERFLIES_Eurema hecabe_Common Grass Yellow	1	1	1	1	1	1	1
BUTTERFLIES_Everes lacturnus_Indian Cupid		1	1			1	
BUTTERFLIES_Iambrix salsala_Chestnut Bob	1	1	1	1		1	
BUTTERFLIES_Jamides bochus_Dark Cerulean			1		1		

BUTTERFLIES_Jamides celeno_Common Cerulean	1	1	1			1	
BUTTERFLIES_Junonia almana_Peacock Pansy			1			1	
BUTTERFLIES_Junonia atlites_Grey Pansy	1	1	1			1	
BUTTERFLIES_Junonia iphita_Chocolate Soldier	1	1	1	1	1	1	1
BUTTERFLIES_Junonia lemonias_Lemon Pansy	1		1			1	
BUTTERFLIES_Lampides boeticus_Pea Blue	1			1	1		
BUTTERFLIES_Leptosia nina_Psyche	1	1	1	1	1	1	1
BUTTERFLIES_Melanitis leda_Common Evening Brown		1	1	1		1	
BUTTERFLIES_Mycalesis patnia_Gladeye Bushbrown			1	1		1	
BUTTERFLIES_Mycalesis perseus_Common Bushbrown	1	1	1	1	1	1	1
BUTTERFLIES_Neptis hylas_Common Sailor	1	1	1	1	1	1	
BUTTERFLIES_Orsotriaena medus_Medus Brown		1	1	1		1	
BUTTERFLIES_Pachliopta aristolochiae_Common Rose			1				
BUTTERFLIES_Pachliopta hector_Crimson Rose		1	1			1	1
BUTTERFLIES_Papilio crino _Banded peacock_VU(N)					1		
BUTTERFLIES_Papilio domoleus _Lime butterfly	1		1		1	1	
BUTTERFLIES_Papilio polymnestor_Blue Mormon			1				
BUTTERFLIES_Papilio polytes_Common Mormon	1	1	1	1	1	1	1
BUTTERFLIES_Parantica aglea_Glassy Tiger			1			1	1
BUTTERFLIES_Phalanta phalantha_Leopard			1			1	
BUTTERFLIES_Potanthus confuscius_Tropic Dart			1				
BUTTERFLIES_Prosotas nora_Common Lineblue			1				
BUTTERFLIES_Spalgis epeus_Apefly					1		
BUTTERFLIES_Taractrocera maevius_Common Grass Dart	1					1	
BUTTERFLIES_Tirumala limniace_Blue Tiger				1	1	1	
BUTTERFLIES_Ypthima ceylonica_White Four-ring	1	1	1	1		1	
BUTTERFLIES_Zizeeria karsandra_Dark Grass Blue			1	1			
BUTTERFLIES_Zizina otis_Lesser Grass Blue		1	1			1	
BUTTERFLIES_Zizula hylax_Tiny Grass Blue	1		1			1	
DRAGONFLIES_Acisoma panorpoides_Asian Pintail	1	1			1	1	
DRAGONFLIES_Agriocnemis pygmaea_Wandering Wisp			1				
DRAGONFLIES_Brachydiplax sobrina_Sombre Lieutenant			1				
DRAGONFLIES_Brachythemis contaminata_Asian Groundling			1				
DRAGONFLIES_Ceriagrion coromandelianum_Yellow Waxtail	1	1	1			1	
DRAGONFLIES_Crocothemis servilia_Oriental Scarlet			1				
DRAGONFLIES_Diplacodes trivialis_Blue Percher			1				
DRAGONFLIES_Indothemis limbata_Restless Demon			1				
DRAGONFLIES_Ischnura aurora_Dawn Bluetail			1				
DRAGONFLIES_Lestes elatus_White Tipped Spreadwing			1				
DRAGONFLIES_Neurothemis intermedia_Paddyfield Parasol			1				
DRAGONFLIES_Neurothemis tullia_Pied parasol						1	
DRAGONFLIES_Orthetrum sabina_Green Skimmer	1	1				1	
DRAGONFLIES_Pantala flavescens_Wandering Glider			1				
DRAGONFLIES_Potamarcha congener_Blue Pursuer			1				
DRAGONFLIES_Rhyothemis variegata_Variegate Flutterer	1	1	1			1	
DRAGONFLIES_Tramea limbata_Sociable Glider			1			1	
DRAGONFLIES_Trithemis aurora_Crimson dropwing			1				
DRAGONFLIES_Urothemis signata_Scarlet Basker			1				
*LAND SNAILS_Aulopoma itieri*_Itier's Operculate Snail_EN(N)*				1	1	1	
*LAND SNAILS_Beddomea trifasciatus*__VU(N)*					1		
LAND SNAILS_Cryptozona bistrialis_Common Translucent Snail	1	1	1	1	1	1	
LAND SNAILS_Cyclophorus sp.					1		1
LAND SNAILS_Euplecta sp.					1		

LAND SNAILS_Lissachatina fulicaEX_Giant African Snail		1	1	1				
MAMMALS_Axis axis+_Spotted deer		1					1	1
MAMMALS_Bos sp.				1				
MAMMALS_Canis aureus+_Jackal							1	
MAMMALS_Canis familiaris_Domestic dog			1					
MAMMALS_Elephas maximus_Elephant_EN(N)_EN(G)		1		1		1	1	1
MAMMALS_Felis catus_Domestic cat			1					
MAMMALS_Funambulus palmarum_Palm squirrel		1	1	1	1			
MAMMALS_Herpestes smithii_Ruddy mongoose				1				
MAMMALS_Hystrix indica+_Porcupine		1				1	1	1
MAMMALS_Lepus nigricollis_Black-naped hare		1		1		1	1	1
MAMMALS_Macaca sinica _Sri Lanka toque monkey_EN(G)*		1	1	1		1		1
*MAMMALS_Moschiola meminna*_Sri Lanka mouse-deer*						1		
MAMMALS_Muntiacus malabaricus_Barking deer						1		
MAMMALS_Paradoxurus hermaphroditus_Palm cat		1						
MAMMALS_Rattus rattus_Common rat			1					
MAMMALS_Ratufa macroura+_Giant squirrel						1		
MAMMALS_Sus scrofa_Wild boar		1			1	1	1	1
MAMMALS_Viverricula indica_Ring-tailed civet							1	
*REPTILES_Ahaetulla nasuta*_Green vine snake*						1		
REPTILES_Calotes versicolor_Common garden lizard		1	1	1			1	
REPTILES_Chrysopelea taprobanica _Striped flying snake						1		
REPTILES_Dendrelaphis tristis _Common bronze back						1		
REPTILES_Eutropis sp.								1
REPTILES_Fowlea cf. piscator _Checkered Keelback				1				
REPTILES_Gehyra mutilata _Four-claw gecko			1					
REPTILES_Geochelone elegans_Star tortoise				1				
REPTILES_Hemidactylus depressus _Kandyan gecko*			1					
REPTILES_Hemidactylus frenatus _Common house-gecko						1		
REPTILES_Hemidactylus parvimaculatus_Spotted housegecko			1					
*REPTILES_Lankascincus fallax*_Common lankaskink*					1	1		
REPTILES_Ptyas mucosa_Rat snake			1		1			
REPTILES_Varanus bengalensis_Land monitor				1				
	Total	52	61	115	38	58	87	33

Annex 3.1.8. Agrobiodiversity of crops in two cascades

a. Commercial purchasing

b. Community exchange

c. On-site live gene bank

*Historical crops now rare

	Species	Source of proprgule	Edible component	Local Name & Cultural Variety	Main planting zone	Remarks
1	*Abelmoschus esculentus*	bc	Fruit	Ethdalabandakka	Chena	Ancestral crop cultivar
2	*Abelmoschus esculentus*	abc	Fruit	Bandakka	Chena	Developed variety
3	*Abelmoschus sp.*	bc	Fruit	Thumbabandakka	Chena	Ancestral crop cultivar
4	*Abelmoschus sp.*	bc	Fruit	Rathubandakka	Chena	Ancestral crop cultivar
5	*Aegle marmelos*	c	Fruit	Beli	Home garden	Ancestral crop cultivar
6	*Allium cepa*	a	Leaf	Rathu Lunu	Chena	Developed variety
7	*Allium cepa*	a	Leaf	Lokuloonu	Chena	Developed variety
8	*Amaranthus cruentus*	bc	Leaf	Landesi*	Chena	Ancestral crop cultivar
9	*Amaranthus tricolor var.*	c	Leaf	Rathuthampala	Chena	Ancestral crop cultivar
10	*Amaranthus tricolor var.*	c	Leaf	Kolathampala	Chena	Ancestral crop cultivar
11	*Amorphophallus paeoniifolius*	c	Yam	Kidaran*	Home garden	Ancestral crop cultivar
12	*Anacardium occidentale*	bc	Fruit	Kaju	Home garden	Ancestral crop cultivar
13	*Ananas comosus*	bc	Fruit	Annasi	Home garden	Ancestral crop cultivar
14	*Annona muricata*	bc	Fruit	Katu Anoda	Home garden	Ancestral crop cultivar
15	*Annona reticulata*	bc	Fruit	Welianoda	Home garden	Ancestral crop cultivar
16	*Annona squamosa*	bc	Fruit	Sini Anoda	Home garden	Ancestral crop cultivar
17	*Arachis hypogaea*	a	Seeds	Rata-Kaju	Chena	Developed variety
18	*Artocarpus altilis*	bc	Fruit	Del	Home garden	Ancestral crop cultivar
19	*Artocarpus heterophyllus*	c	Fruit	Kos	Home garden	Ancestral crop cultivar
20	*Artocarpus nobilis*	b	Fruit	Bedi-Del	Home garden	Ancestral crop cultivar
21	*Basella alba*	c	Leaf	Nivithi	Home garden	Ancestral crop cultivar
22	*Benincasa hispida*	bc	Fruit	Sinhalapuhul*	Chena	Ancestral crop cultivar
23	*Benincasa hispida*	bc	Fruit	Puhul	Chena	Ancestral crop cultivar
24	*Brassica juncea*	bc	Seeds	Aba	Chena	Ancestral crop cultivar
25	*Brassica oleracea var.*	a	Leaf	Malgowa	Chena	Developed variety
26	*Brassica oleracea var. Capitata*	a	Leaf	Gedigowa	Chena	Developed variety
27	*Canavalia ensiformis*	bc	Fruit	Avara*	Home garden	Ancestral crop cultivar
28	*Canna indica*	c	Yam	Buthsarana*	Home garden	Ancestral crop cultivar
29	*Capsicum annuum*	abc	Fruit	Miris	Chena	Developed variety
30	*Capsicum annuum var.*	a	Fruit	Maalumiris	Chena	Developed variety
31	*Capsicum chinensis*	bc	Fruit	Naimiris	Chena	Ancestral crop cultivar
32	*Capsicum frutescens*	bc	Fruit	Wannimirs	Chena	Ancestral crop cultivar
33	*Capsicum frutescens*	bc	Fruit	Sudukochchi	Chena	Ancestral crop cultivar
34	*Capsicum frutescens*	bc	Fruit	Kochchi	Chena	Ancestral crop cultivar
35	*Carica papaya*	bc	Fruit	Kahapepol*	Home garden	Ancestral crop cultivar
36	*Carica papaya*	a	Fruit	Gas-Labu	Chena	Developed variety
37	*Centella asiatica*	bc	Leaf	Gotukola	Home garden	Developed variety
38	*Cinnamomum verum*	bc	Bark	Kurundu	Home garden	Ancestral crop cultivar
39	*Citrullus lanatus*	a	Fruit	Komadu	Chena	Developed variety
40	*Citrus aurantium*	bc	Fruit	Embuldodam	Home garden	Ancestral crop cultivar
41	*Citrus hystrix*	bc	Fruit	Goda-Dehi	Home garden	Ancestral crop cultivar
42	*Citrus medica*	c	Fruit	Dehi	Chena	Ancestral crop cultivar
43	*Cocos nucifera*	bc	Fruit	Kundira*	Home garden	Ancestral crop cultivar
44	*Cocos nucifera*	bc	Fruit	Pol	Home garden	Developed variety
45	*Coffea arabica*	bc	Seeds	Kopi	Home garden	Ancestral crop cultivar
46	*Colacasia sp.*	bc	Yam	Diyahabarala*	Home garden	Ancestral crop cultivar
47	*Colacasia sp.*	bc	Yam	Kaluhabarala*	Home garden	Ancestral crop cultivar

48	*Coleus rotundifolius*	bc	Yam	Innala*	Home garden	Ancestral crop cultivar
49	*Colocasia esculenta*	c	Yam	Kiriala	Home garden	Ancestral crop cultivar
50	*Colocasia esculenta*	c	Yam	Gahala	Home garden	Ancestral crop cultivar
51	*Cucumis sativus*	bc	Fruit	Malkekiri*	Chena	Ancestral crop cultivar
52	*Cucumis sativus*	bc	Fruit	Thiyambara*	Chena	Ancestral crop cultivar
53	*Cucumis sativus*	abc	Fruit	Kekiri	Chena	Developed variety
54	*Cucurbita maxima*	bc	Fruit	Henwattakka*	Chena	Ancestral crop cultivar
55	*Cucurbita maxima*	bc	Fruit	Pettiwattakka*	Chena	Ancestral crop cultivar
56	*Cucurbita maxima*	bc	Fruit	Rajaratawattakka*	Chena	Ancestral crop cultivar
57	*Cucurbita maxima*	abc	Fruit	Wattakka	Chena	Ancestral crop cultivar
58	*Cucurbita moshchata*	a	Fruit	Malsian Wattlkka	Chena	Developed variety
59	*Curcuma domestica*	bc	Fruit	Kaha	Home garden	Ancestral crop cultivar
60	*Dioscorea alata*	bc	Yam	Engiliala*	Home garden	Ancestral crop cultivar
61	*Dioscorea sp.*	bc	Yam	Serala*	Home garden	Ancestral crop cultivar
62	*Eleusine coracana*	bc	Seeds	Kurakkan	Chena	Ancestral crop cultivar
63	*Glycine max*	a	Seeds	Soya	Chena	Developed variety
64	*Ipomoea batatus*	bc	Yam	Pandurubathala*	Chena	Ancestral crop cultivar
65	*Ipomoea batatus*	bc	Yam	Rathubathala	Chena	Ancestral crop cultivar
66	*Ipomoea batatus*	bc	Yam	Sudubatala	Chena	Ancestral crop cultivar
67	*Labla purpureus*	bc	Fruit	Haalmehidambala*	Home garden	Ancestral crop cultivar
68	*Labla purpureus*	bc	Fruit	Kiridambala*	Home garden	Ancestral crop cultivar
69	*Lagenaria siceraria var.*	bc	Fruit	Diklabu*	Chena	Ancestral crop cultivar
70	*Lagenaria siceraria var.*	bc	Fruit	Nailabu*	Chena	Ancestral crop cultivar
71	*Lagenaria siceraria var.*	bc	Fruit	Labu	Chena	Ancestral crop cultivar
72	*Luffa acutangula*	abc	Fruit	Wetakolu	Chena	Developed variety
73	*Luffa cylindrica*	bc	Fruit	Niyan-Vetakolu	Chena	Ancestral crop cultivar
74	*Lycopersicon esculentum*	bc	Fruit	Batuthkkali*	Chena	Ancestral crop cultivar
75	*Lycopersicon esculentum*	bc	Fruit	Gorakathakkali	Chena	Ancestral crop cultivar
76	*Lycopersicon esculentum*	a	Fruit	Takkali	Chena	Developed variety
77	*Macrotyloma uniflorum*	abc	Seeds	Kollu	Chena	Ancestral crop cultivar
78	*Mangifera indica*	abc	Fruit	Karthakolomban	Home garden	Ancestral crop cultivar
79	*Mangifera indica*	bc	Fruit	Pettiamba	Home garden	Ancestral crop cultivar
80	*Mangifera indica*	a	Fruit	Tom Jc Amba	Home garden	Developed variety
81	*Mangifera indica*	a	Fruit	Vilad	Home garden	Developed variety
82	*Mangifera indica*	c	Fruit	Amba	Home garden	Ancestral crop cultivar
83	*Manihot esculenta*	bc	Yam	Kirikawadi*	Chena	Developed variety
84	*Manihot esculenta*	bc	Yam	Rathumyokka	Chena	Ancestral crop cultivar
85	*Manihot esculenta*	bc	Yam	Maiokka	Chena	Ancestral crop cultivar
86	*Maranta arundinacea*	bc	Yam	Hulankeeriya*	Home garden	Ancestral crop cultivar
87	*Momodica charantia*	bc	Fruit	Batu Karavila	Chena	Ancestral crop cultivar
88	*Momordica charanta*	bc	Fruit	Urukarawila*	Chena	Ancestral crop cultivar
89	*Moringa oleifera*	c	Fruit	Murunga	Chena	Ancestral crop cultivar
90	*Murraya koenigii*	c	Leaf	Karapincha	Home garden	Ancestral crop cultivar
91	*Musa x paradisaca*	bc	Fruit	Rathkehel*	Home garden	Ancestral crop cultivar
92	*Musa x paradisaca*	bc	Fruit	Embulkesel	Home garden	Ancestral crop cultivar
93	*Musa x paradisaca*	bc	Fruit	Kolikuttu	Home garden	Ancestral crop cultivar
94	*Musa x paradisaca*	ab	Fruit	Cic Kehel	Home garden	Developed variety
95	*Musa x paradisaca*	bc	Fruit	Seenikehel	Home garden	Ancestral crop cultivar
96	*Oryza sativa*	bc	Seeds	Anepoda Wee*	Wetlands	Ancestral crop cultivar
97	*Oryza sativa*	bc	Seeds	Heenati*	Wetlands	Ancestral crop cultivar
98	*Oryza sativa*	bc	Seeds	Kaluheenati*	Wetlands	Ancestral crop cultivar
99	*Oryza sativa*	bc	Seeds	Mahawee*	Wetlands	Ancestral crop cultivar
100	*Oryza sativa*	bc	Seeds	Murungakaayam*	Wetlands	Ancestral crop cultivar

101	*Oryza sativa*	bc	Seeds	Pachachaperumal*	Wetlands	Ancestral crop cultivar
102	*Oryza sativa*	bc	Seeds	Rathdel Wee*	Wetlands	Ancestral crop cultivar
103	*Oryza sativa*	bc	Seeds	Suwadel Wee*	Wetlands	Ancestral crop cultivar
104	*Oryza sativa*	bc	Seeds	1/400 Wee*	Wetlands	Developed variety
105	*Oryza sativa*	bc	Seeds	379 Wee*	Wetlands	Developed variety
106	*Oryza sativa*	bc	Seeds	Bankokwee*	Wetlands	Developed variety
107	*Oryza sativa*	bc	Seeds	H4Wee*	Wetlands	Developed variety
108	*Oryza sativa*	bc	Seeds	Ir8Wee*	Wetlands	Developed variety
109	*Oryza sativa*	bc	Seeds	Keerisamba	Wetlands	Ancestral crop cultivar
110	*Oryza sativa*	bc	Seeds	Sudurusamba	Wetlands	Ancestral crop cultivar
111	*Pandanus amaryllifolius*	bc	Leaf	Rampe	Home garden	Ancestral crop cultivar
112	*Panicum miliaceum*	bc	Seeds	Meneri*	Chena	Ancestral crop cultivar
113	*Paspalum scrobiculatum*	bc	Seeds	Amu*	Chena	Ancestral crop cultivar
114	*Passiflora edulis*	bc	Fruit	Weldodan	Home garden	Developed variety
115	*Persea americana*	bc	Fruit	Aligeta-Pera	Home garden	Ancestral crop cultivar
116	*Phaseolus aureus*	abc	Seeds	Mung	Chena	Developed variety
117	*Phaseolus mungo*	abc	Seeds	Undu	Chena	Developed variety
118	*Phaseolus vulgaris*	a	Fruit	Bonchi	Chena	Developed variety
119	*Phyllanthus acidus*	bc	Fruit	Rata Nelli	Home garden	Developed variety
120	*Piper nigrum*	bc	Fruit	Gam-Miris	Home garden	Developed variety
121	*Pouteria campechiana*	bc	Fruit	Kaha Laulu	Home garden	Ancestral crop cultivar
122	*Psidium guajava*	bc	Fruit	Rathuratapera*	Home garden	Ancestral crop cultivar
123	*Psidium guajava*	abc	Fruit	Pera	Home garden	Developed variety
124	*Psophocarpus tetragonolous*	abc	Fruit	Dara-Dambala	Chena	Developed variety
125	*Punica granatum*	bc	Fruit	Delum	Home garden	Ancestral crop cultivar
126	*Saccharum officinarum*	bc	Stem	Uk	Home garden	Ancestral crop cultivar
127	*Sesamum indicum*	bc	Seeds	Suduthala*	Chena	Ancestral crop cultivar
128	*Sesamum indicum*	a	Seeds	Thala	Chena	Ancestral crop cultivar
129	*Sesamum indicum*	bc	Seeds	Kaluthala	Chena	Ancestral crop cultivar
130	*Solanum indicum*	bc	Fruit	Thiththathibbatu	Chena	Ancestral crop cultivar
131	*Solanum melongena*	bc	Fruit	Thalanabatu	Chena	Ancestral crop cultivar
132	*Solanum melongena*	a	Fruit	Batu	Chena	Developed variety
133	*Solanum melongena*	a	Fruit	Ela-Batu	Chena	Developed variety
134	*Sorghum bicolor*	bc	Seeds	Kirisorgam*	Chena	Ancestral crop cultivar
135	*Sorghum bicolor*	bc	Seeds	Sorgam*	Chena	Ancestral crop cultivar
136	*Syzygium jambos*	bc	Fruit	Seeni-Jambo	Home garden	Ancestral crop cultivar
137	*Trachyspermum involucratum*	bc	Leaf	Asamodagam*	Chena	Ancestral crop cultivar
138	*Trichosanthes cucumerina*	abc	Fruit	Pathola	Chena	Developed variety
139	*Vigna mungo*	a	Seeds	Undu	Chena	Developed variety
140	*Vigna unguiculata*	bc	Fruit	Bambame*	Chena	Ancestral crop cultivar
141	*Vigna unguiculata*	bc	Fruit	Bonchime*	Chena	Ancestral crop cultivar
142	*Vigna unguiculata*	bc	Fruit	Boome*	Chena	Ancestral crop cultivar
143	*Vigna unguiculata*	bc	Fruit	Hawarime	Chena	Ancestral crop cultivar
144	*Vigna unguiculata*	bc	Fruit	Polonme	Chena	Ancestral crop cultivar
145	*Vigna unguiculata*	bc	Fruit	Rathume	Chena	Ancestral crop cultivar
146	*Vigna unguiculata*	abc	Fruit	Mekaral	Chena	Developed variety
147	*Vigna unguiculata*	abc	Seeds	Cow Pea	Chena	Ancestral crop cultivar
148	*Zea mays*	bc	Seeds	Kiribadairingu*	Chena	Ancestral crop cultivar
149	*Zea mays*	a	Seeds	Bada Iringu	Chena	Developed variety
150	*Zingiber officinale*	bc	Yam	Inguru	Home garden	Ancestral crop cultivar

Annex 3.2.1. List of the phytoplankton taxa (Key: SK-Sembukulama, PK-Punchi Kulama, WM-Wellamudawa, MK-Mahakanumulla, AW-Amane, PW-Palugaswewa, UK-Udakadawala and KG-Kudalugama Wewa)

Taxa	Location							
	SK	PK	WM	MK	AW	PW	UK	KG
Cyanophyceae								
Lyngya	+	+	+	+	+	+	+	
Rivularia	+	+	+	+	+	+	+	+
Scytonema			+	+	+	+	+	
Bacillariophyceae								
Achnanthes	+			+	+	+	+	+
Asterionella	+	+		+	+	+	+	+
Coscinodiscus	+			+	+	+	+	+
Cymbella		+		+	+	+	+	+
Diatoma		+	+	+	+	+	+	+
Pinnularia	+	+	+	+	+	+	+	+
Stauroneis	+		+		+	+	+	+
Chlorophyceae								
Bulbochaete	+		+					
Chaetophora	+	+	+	+	+	+	+	+
Cosmarium	+	+		+	+	+	+	
Costerium	+	+	+	+	+	+	+	+
Desmidium	+	+	+	+	+	+	+	+
Euastrum	+			+	+	+	+	+
Micraterias	+							+
Microspora	+		+		+		+	
Netrium		+			+		+	
Oedogonium		+			+	+	+	+
Pediastrum	+	+	+		+	+	+	+
Sorastrum	+	+	+		+	+	+	+
Spirogyra	+	+	+		+	+	+	+
Generic richness	**18**	**15**	**14**	**14**	**21**	**19**	**21**	**17**

Annex 3.2.2. List of the zooplankton taxa (Key: SK-Sembukulama, PK-Punchi Kulama, WM-Wellamudawa, MK-Mahakanumulla, AW-Amane, PW-Palugaswewa, UK-Udakadawala and KG-Kudalugama Wewa)

Taxa	Location							
	SK	PK	WM	MK	AW	PW	UK	KG
Phylum Protozoa								
Actinosphaeriu		+	+					
Paramecium	+	+			+			
Phylum Rotifera								
Conochilus	+	+	+	+	+	+	+	+
Kellicittia	+		+					
Lecane	+		+		+			
Rotaria	+	+	+		+			
Phylum Arthropoda								
Class Crustacea								
Brachiopoda	+	+	+	+	+	+	+	+
Malacostraca	+	+	+	+	+	+	+	+
Copepoda	+	+	+	+	+	+	+	+
Class Insecta								
Dipteran larvae	+	+	+	+	+	+	+	+
Coleopteran larvae	+	+	+	+	+	+	+	+
Total taxa	**10**	**10**	**10**	**06**	**09**	**06**	**06**	**06**

Annex 3.2.3. List of Different taxonomic groups of fauna (Key: SK-Sembukulama, PK-Punchi Kulama, WM-Wellamudawa, MK-Mahakanumulla, AW-Amane, PW-Palugaswewa, UK-Udakadawala and KG-Kudalugama Wewa)

Taxonomic group	Common English name	SK	PK	WM	MK	AW	PW	UK	KG
Phylum Platyhelminthes	Flatworms								
Turbellaria		+			+	+	+	+	+
Phylum Nematoda	Roundworms								
Anguina trutici		+	+						
Phylum Annelida	Earthworms and leeches								
Class Oligochaeta	Aquatic earthworms								
Family Aeolosomatidae									
Aeolosoma ternarium		+	+	+				+	+ +
Family Naididae									
Dero sp.		+	+	+	+	+	+	+	+ +
Class Hirudinea									
Placobdella emydae		+		+	+	+	+	+	+ +
Phylum Mollusca									
Class Gastropoda	Snails and Mussels								
Family Thiaridae									
Paludomus chilinoides		+	+	+	+	+	+	+	+ +

P. loricatus				+	+	+	+	+	+	+	
Melanoides turculata			+	+	+	+	+	+			
Family Paludestrinidae				+							
Bithynia sp.			+	+	+	+					
Family Pilidae											
Pila globosa			+	+		+	+	+	+	+	
Family Lymnaeidae											
Lymnaea sp.			+	+							
Family Panorbiddae			+								
Indoplanorbis sp.			+	+	+	+	+	+	+	+	+
Family Unionidae											
Lamellidens sp.				+							
Class Crustacea			+	+	+	+	+	+	+	+	+
Sub class Cladocera				+							
Diaphanosoma sp.			+	+	+	+	+	+	+	+	+
Leptodora kindti				+							
Sub-class Copepoda											
Diaptomus sp.			+	+	+	+	+	+	+	+	+
Cyclops sp.			+	+		+					
Order Decapoda											
Cardina sp.			+	+	+	+	+	+	+	+	
Macrobrachium rosenbergii				+		+					
Perbrinkia sp.						+					
Class Insecta											
Family Nepidae		Water Scorpions									
Laccotrephes grossus			+			+					
Family Belostomatidae		Giant Water Bug									
Lethocerus sp.			+			+					
Family Naucoridae		Creeping Water bug									
Naucoris scutellaris			+			+	+		+	+	+
Family Helotrephidae		Backswimmers									
Tiphorephes indicus						+			+	+	+
Family Notonectidae											
Anisops barbata						+					
Family Corixidae	Water Boatmen										
Micronecta sp.			+			+					
Order Coleoptera	**Beetles**										
Family Dytiscidae		Diving beetles									
Copelatus sp.						+					
Hydraticus facificus			+			+	+				
Cybister confusus			+	+	+	+	+	+	+		
Family Gyrinidae		Whirligig Beetles				+					
Gyrinus convexiusculus			+	+	+	+	+	+			
Dipteran larvae		True mosquitoes	+	+	+	+	+	+	+		

Annex 3.2.4. List of Odonate species (Dragonflies and Damselflies) recorded from the study area in 2020/21 (Key: G/status: Geological status, CS/NRL: Conservation Status in National Red List 2012 & GRL: IUCN Global Red List 2019; EN: Endangered, VU -Vulnerable, LC-Least Concerned, NT-Near Threatened and NE-Not Evaluated).

Family	Scientific name	Common English Name	G/Status	Cs/NRL 2012
Lestidae	*Lestes elatus*	White-tipped Spreadwing	Indigenous	LC
Coenagrionidae	*Agriocnemis pygmaea*	Wandering Wisp	Indigenous	LC
	Aciagrion occidentale	Asian Slim	Indigenous	VU
	Ischnura aurora rubilio	Dawn Bluetail	Indigenous	NT
Aeshnidae	*Anax guttatus*	Pale-spotted Emperor	Indigenous	LC
Gomphidae	*Ictinogomphus rapax*	Rapacious Flangetail	Indigenous	LC
Libellulidae	*Cratilla lineata calverti*	Sombre Lieutenant	Indigenous	EN
	Lathrecista asiatica asiatica	Pruinosed Bloodtail	Indigenous	NT
	Orthetrum sabina sabina	Green Skimmer	Indigenous	LC
	Acisoma panorpoides	Asian Pintail	Indigenous	LC
	Brachythemis contaminate	Asian Groundling	Indigenous	LC
	Crocothemis servilia servilia	Oriental Scarlet	Indigenous	LC
	Neurothemis tullia tullia	Pied Parasol	Indigenous	LC
	Rhodothemis rufa	Spine-legged Redbolt	Indigenous	NT
	Trithemis aurora	Crimson Dropwing	Indigenous	LC
	Trithemis pallidinervis	Dancing Dropwing	Indigenous	NT

Medicinal Plants Diversity

Annex 3.3.1: Medicinal Plants (MP) & Medicinal Edible Plants (MEP) recorded in each habitat type at *Horiwila* VTCS landscapes

Habitat (LULC) code: Tank bund

Family & Scientific name	Local name	MP/ MEP in the selected habitat	Occurrence of MP/MEP species in the selected habitat Common (C) Rare (R)	Degree of importance of species (Scale 1-10)
Morinda citrifolia L. RUBIACEAE	Ahu	MP	C	2
Alysicarpus vaginalis (L.) DC. FABACEAE	Aswenna	MP	C	2
Sida acuta Burm. f. MALVACEAE	Babila	MP	C	2
Stachytarpheta indica (L.) Vahl VERBENACEAE	Balunaguta	MP	C	2
Abutilon indicum (L.) Sweet ssp. guineense MALVACEAE	Beheth anoda/Killotagas	MP	C	2
Derris scandens (Roxb.) Benth. FABACEAE	Bokala wel	MP	C	2
Cissampelos pareira L. var. hirsuta (Buch. ex DC.) Forman MENISPERMACEAE	Deekirimudawanna/Diyamitta	MEP	C	3
Limonia acidissima L. RUTACEAE	Divul	MEP	C	3
Ficus trimenii King. MORACEAE	Ehatu	MP	C	2
Cassia fistula L. FABACEAE	Ehela	MP	C	2
Argyreia populifolia Choisy CONVOLVULACEAE	Girithilla	MEP	C	3
Cucumis melo L. CUCURBITACEAE	Gon kekiri	MP	C	2
Cissus quadrangularis L. VITACEAE	Heeressa	MP	C	2
Achyranthes aspera L. AMARANTHACEAE	Karalheba	MP	C	2
Carissa carandas L. APOCYNACEAE	Karamba	MEP	C	3
Pongamia pinnata (L.) Pierre FABACEAE	Karanda	MP	C	2
Allophylus cobbe (L.) Rausch. SAPINDACEAE	Kobbe	MP	C	2
Schleichera oleosa (Lour.) Oken SAPINDACEAE	kone	MEP	C	3
Cartunaregam spinosa	Kukuruman	MP	C	2
Terminalia arjuna (Roxb.) Wight & Arn. COMBRETACEAE	Kumbuk	MP	C	2
Cordia dichotoma Forst.f. BORAGINACEAE	Lolu	MEP	C	3
Syzygium cumini Skeels MYRTACEAE	Madan	MEP	C	3
Ocimum tenuiflorum L. LAMIACEAE	Maduruthala	MP	C	2
Madhuca longifolia (L.) Macbride SAPOTACEAE	Mee	MEP	C	3
Vernonia cinerea (L.) Less. ASTERACEAE	Monarakudumbiya	MEP	C	3
Hygrophila schulli (Buch. - Ham.) M. R. & S. N. Alme. ACANTHACEAE	Neeramulliya	MEP	C	3
Strebles aspera	Nithulla	MP	C	2
Passiflora foetida L. PASSIFLORACEAE	Padawel/Nottuwel	MEP	C	3
Cassia tora L. FABACEAE	Pethithora	MEP	C	3
Aerva lanata (L.) Juss. Ex Schult AMARABTHACEAE	Polpala	MEP	C	3
Vernonia zeylanica (L.) Lees. ASTERACEAE	Pupula	MP	C	2
Premna tomentosa Willd.f. tomentosa VERBENACEAE	Seru	MP	C	2
Tamarindus indica L. FABACEAE	Siyambala	MEP	C	3
Rungia repens (L.) ACANTHACEAE	Sulu nai	MP	C	2
Ipomoea littoralis Blume CONVOLVULACEAE	Thal kola	MEP	C	3

Tarenna asiatica (L.) Kuntze ex Schumann RUBIACEAE	Tharana	MP	C	2
Oroxylum indicum (L.) Vent. BIGNONIACEAE	Thotila	MP	C	2
Vitis spp.	Wal midi	MP	C	2
Calotropis gigantea (L.) R.Br. ASCLEPIADACEAE	Wara	MP	C	2
Pterospermum suberifolium (L.) Willd. STERCULIACEAE	Welan	MP	C	2
Ficus benghalensis L. var. benghalensis MORACEAE	Nuga	MP	R	2

Habitat (LULC) code: Peripheral Tank Bund

Scientific name	Family	Local name	MP/ MEP in the selected habitat	Occurrence of MP/MEP species in the selected habitat Common (C) Rare (R)	Degree of importance of species (Scale 1-10)
Morinda citrifolia L.	RUBIACEAE	Ahu	MP	C	2
Sida acuta Burm. f.	MALVACEAE	Babila	MP	C	2
Grewia carpinifolia Juss.	TILIACEAE	Damunu	MP	C	2
Cassia fistula L.	FABACEAE	Ehela	MP	C	2
Ficus trimenii	MORACEAE	Ehatu	MP	C	2
Ziziphus rugosa Lam.	RHAMNACEAE	Eraminiya	MEP	C	3
Argyreia populifolia Choisy	CONVOLVULACEAE	Girithilla	MEP	C	3
Strychnos nux-vomica L.	LOGANIACEAE	Goda Kaduru	MP	C	2
Crinum latifolium L.	AMARYLLIDACEAE	Goda manel	MP	C	2
Alocasia macrorrhizos	ARACEAE	Habarala	MP	C	2
Mitragyna tubulosa (Arn.) Havil.	RUBIACEAE	Helamba/He kolon	MP	C	2
Lannea coromandelica (Houtt.) Merr.	ANACARDIACEAE	Hik	MP	C	2
Albizia amara (Roxb.) Boivin	FABACEAE	Iha	MP	C	2
Strychnos potatorum L. f.	LOGANIACEAE	Ingini	MP	C	2
Derris parviflora Benth.	FABACEAE	Kalawel	MP	C	2
Carissa carandas L.	APOCYNACEAE	Karamba	MEP	C	3
Murraya koenigii (L.) Spreng.	RUTACEAE	Karapincha	MEP	C	3
Syzygium rubicundum Wight & Arn.	MYRTACEAE	Karaw	MP	C	2
Colocasia esculenta (L.) Schott	ARACEAE	Kalu habarala	MP	C	2
Celosia argentina	AMARANTHACEAE	Kirihanda	MEP	C	3
Phyllanthus reticulatus Poir.	EUPHORBIACEAE	Kaila	MP	C	2
Macaranga peltata (Roxb.) Muell. Arg.	EUPHORBIACEAE	Kenda	MP	C	2
Bridelia retusa (L.) A.	EUPHORBIACEAE	Ketakela	MP	C	2
Ichnocarpus frutescens (L.)R. Br.	APOCYNACEAE	Kiriwel	MP	C	2
Azadirachta indica A. Juss.	MELIACEAE	Kohomba	MP	C	2
Coccinia grandis (L.) J. Voigt	CUCURBITACEAE	Kowakka	MEP	C	3
Terminalia arjuna (Roxb.) Wight & Arn.	COMBRETACEAE	Kumbuk	MP	C	2
Ocimum tenuiflorum L.	LAMIACEAE	Maduruthala	MP	C	2
Bauhinia racemosa Lam.	FABACEAE	Maila	MEP	C	3
Madhuca longifolia (L.) Macbride	SAPOTACEAE	Mee	MEP	C	3
Vernonia cinerea (L.) Less.	ASTERACEAE	Monarakudumbiya	MEP	C	3
Mussada frondosa	RUBIACEAE	Mussanna	MEP	C	3
Passiflora foetida L.	PASSIFLORACEAE	Padawel/Nottuwel	MEP	C	3
Aerva lanata (L.) Juss. Ex Schult	AMARABTHACEAE	Polpala	MEP	C	3
Operculina turpethum (L.) S. Manso	CONVOLVULACEAE	Thirasthawalu	MP	C	2
Ipomoea triloba L.	CONVOLVULACEAE	Wahu keliya	MP	C	2
Solanum macrocarpon L.	SOLANACEAE	Wara	MP	C	2
Sida cordata	MALVACEAE	Wel keppetiya	MP	C	2
Crotalaria laburnifolia L.	FABACEAE	Yakberiya	MP	C	2

Habitat (LULC) type: Kattakaduwa

Family	Scientific name	Local name	MP/ MEP in the selected habitat	Occurrence of MP/MEP species in the selected habitat Common (C) Rare (R)	Degree of importance of species (Scale 1-10)
MALVACEAE	*Sida acuta Burm. f.*	Babila	MP	C	2
TILIACEAE	*Grewia carpinifolia Juss.*	Damunu	MP	C	2
CONVOLVULACEAE	*Argyreia populifolia Choisy*	Girithilla	MEP	C	3
RUBIACEAE	*Mitragyna tubulosa (Arn.) Havil.*	Helamba/He kolon	MP	C	2
ANACARDIACEAE	*Lannea coromandelica (Houtt.) Merr.*	hik	MP	C	2
FABACEAE	*Albizia amara (Roxb.) Boivin*	Iha	MP	C	2
LOGANIACEAE	*Strychnos potatorum L. f.*	Ingini	MP	C	2
RUTACEAE	*Murraya koenigii (L.) Spreng.*	Karapincha	MEP	C	3
MYRTACEAE	*Syzygium rubicundum Wight & Arn.*	Karaw	MP	C	2
EUPHORBIACEAE	*Phyllanthus reticulatus Poir.*	Kaila	MP	C	2
EUPHORBIACEAE	*Bridelia retusa (L.) A.*	Ketakela	MP	C	2
APOCYNACEAE	*Ichnocarpus frutescens (L.)R. Br.*	Kiriwel	MP	C	2
MELIACEAE	*Azadirachta indica A. Juss.*	Kohomba	MP	C	2
MORACEAE	*Ficus hispida L. f.*	Kotadimbula	MP	C	2
CUCURBITACEAE	*Coccinia grandis (L.) J. Voigt*	Kowakka	MEP	C	3
COMBRETACEAE	*Terminalia arjuna (Roxb.) Wight & Arn.*	Kumbuk	MP	C	2
CAPPARACEAE	*Crateva adansonii DC ssp. odora (Buch. - Ham.) Jacobs*	Lunuwarana	MP	C	2
MYRTACEAE	*Syzygium cumini Skeels*	Madan	MEP	C	3
FABACEAE	*Bauhinia racemosa Lam.*	Maila	MEP	C	3
RUBIACEAE	*Mussada frondosa*	Mussanna	MEP	C	3
PASSIFLORACEAE	*Passiflora foetida L.*	Padawel/Nottuwel	MEP	C	3
AMARABTHACEAE	*Aerva lanata (L.) Juss. Ex Schult*	Polpala	MEP	C	3
CAPPARACEAE	*Capparis moonii Wight*	Sudu wellangiriya	MP	C	2
CONVOLVULACEAE	*Ipomoea littoralis Blume*	Thal kola	MEP	C	3
CONVOLVULACEAE	*Operculina turpethum (L.) S. Manso*	Thirasthawalu	MP	C	2
BIGNONIACEAE	*Oroxylum indicum*	Thotila	MP	C	2
FABACEAE	*Cassia siamea*	Wa	MP	C	2
TILIACEAE	*Grewia carpinifolia Juss.*	Wahu keliya	MP	C	3
VITACEAE	*Vitis spp.*	Wal midi	MP	C	2
ZINGIBERACEAE	*Zingiber zerumbet*	Wal inguru	MP	C	2
PANDANACEAE	*Pandanus kaida*	Wetakeiya	MP	C	2
RUTACEAE	*Atalantia ceylanica*	Yakinaran	MEP	C	2
ASTERACEAE	*Elephantopus scaber*	Aththadi	MP	C	2
VERBENACEAE	*Stachytarpheta indica (L.) Vahl*	Balunaguta	MP	C	2
FABACEAE	*Cassia fistula L.*	Ehela	MP	C	2
LEEACEAE	*Leea indica*	Gurulla	MP	C	2
VERBENACEAE	*Lantana camara L.*	Gandapana	MEP	C	3
ULMACEAE	*Trema orientalis (L.) Blume*	Gedumba	MP	C	3

CLUSIACEAE	*Garcinia spicata*	Gonapana	MP	C	2
MYRTACEAE	*Syzygium cylindricum*	Ilapaththa	MP	C	2
COMBRETACEAE	*Combretum albidum*	Kanduruketiya wel	MP	C	2
AMARANTHACEAE	*Achyranthes aspera L.*	Karalheba	MP	C	2
EUPHORBIACEAE	*Macaranga peltata (Roxb.) Muell. Arg.*	Kenda	MP	C	2
SAPOTACEAE	*Madhuca longifolia (L.) Macbride*	Mee	MEP	C	3
MALVACEAE	*Hibiscus furcatus Roxb.*	Napiriththa	MP	C	2
FABACEAE	*Mimosa pudica L.*	Nidikumba	MP	C	2
MORACEAE	*Strebles aspera*	Nithulla	MP	C	2
PASSIFLORACEAE	*Passiflora foetida L.*	Padawel/Nottuwel	MEP	C	3
SAPINDACEAE	*Cardiospermum halicacabum L.*	Penala	MEP	C	3
FABACEAE	*Cassia tora L.*	Pethithora	MEP	C	3
CONVOLVULACEAE	*Operculina turpethum (L.) S. Manso*	Thirasthawalu	MP	C	2
RUTACEAE	*Pleiospermium alatum*	Tunpath kurundu	MP	C	2
SAPINDACEAE	*Cardiospermum halicacabum L.*	Wel penala	MEP	C	2

Habitat (LULC) type Tank Water

Scientific name	Family	Local name	MP/ MEP in the selected habitat	Occurrence of MP/MEP species in the selected habitat Common (C) Rare (R)	Degree of importance of species (Scale 1-10)
Nelumbo nucifera	NELUMBONACEAE	Nelum	MEP	C	3
Nymphaea pubescens Willd.	NYMPHAEACEAE	Ou	MEP	C	3
Nymphoidea indica	MENYANTHACEAE	Kumudu	MP	C	2
Aponogeton crispus	APONOGETONACEAE	Kekatiya	MEP	C	3

Habitat (LULC) type: Scrublands

Family	Scientific name	Local name	MP/ MEP in the selected habitat	Occurrence of MP/MEP species in the selected habitat Common (C) Rare (R)	Degree of importance of species (Scale 1-10)
RUBIACEAE	*Morinda citrifolia L.*	Ahu	MP	C	2
BORAGINACEAE	*Carmona retusa (Vahl)Masamune*	Heen thambala	MEP	C	3
VITACEAE	*Cissus quadrangularis L.*	Heeressa	MP	C	2
PERIPLOCACEAE	*Hemidesmus indicus (L.) R. Br.*	Iramusu	MEP	C	3
APOCYNACEAE	*Carissa carandas L.*	Karamba	MEP	C	3
RUTACEAE	*Murraya koenigii (L.) Spreng.*	Karapincha	MEP	C	3
EUPHORBIACEAE	*Flueggea leucopyrus*	Katupila	MP	C	2
MELIACEAE	*Azadirachta indica A. Juss.*	Kohomba	MP	C	2
SAPINDACEAE	*Schleichera oleosa (Lour.) Oken*	Kone	MEP	C	3
RUTACEAE	*Toddalia asiatica (L.) Lam.*	Kudumirissa	MP	C	2
FABACEAE	*Bauhinia racemosa Lam.*	Maila	MEP	C	3
FABACEAE	*Cassia auriculata L.*	Ranawara	MEP	C	3
ACANTHACEAE	*Rungia repens (L.)*	Sulu nai	MP	C	2
RUTACEAE	*Pleiospermium alatum*	Tunpath kurundu	MP	C	2
TILIACEAE	*Grewia carpinifolia Juss.*	Wahu keliya	MEP	C	3
RUTACEAE	*Atalantia ceylanica*	Yakinaran	MEP	C	3

Habitat (LULC) type: Gasgommana					
Family	**Scientific name**	**Local name**	**MP/ MEP in the selected habitat**	**Occurrence of MP/MEP species in the selected habitat Common (C) Rare (R)**	**Degree of importance of species (Scale 1-10)**
TILIACEAE	*Grewia carpinifolia Juss.*	Damunu	MP	C	2
LOGANIACEAE	*Strychnos nux-vomica L.*	Goda Kaduru	MP	C	2
RUBIACEAE	*Mitragyna tubulosa (Arn.) Havil.*	Helamba/He kolon	MP	C	2
ANACARDIACEAE	*Lannea coromandelica (Houtt.) Merr.*	Hik	MP	C	2
LOGANIACEAE	*Strychnos potatorum L. f.*	Ingini	MP	C	2
MELIACEAE	*Azadirachta indica A. Juss.*	Kohomba	MP	C	2
RUBIACEAE	*Haldina cordifolia (Roxb.) Ridsd.*	Kolon	MP	C	2
MORACEAE	*Ficus hispida L. f.*	Kotadimbula	MP	C	2
MYRTACEAE	*Syzygium cumini Skeels*	Madan	MEP	C	3
FABACEAE	*Bauhinia racemosa Lam.*	Maila	MEP	C	3
FABACEAE	*Tamarindus indica L.*	Siyambala	MEP	C	3
EBENACEAE	*Diospyros malabarica (Desr.) Kostel.*	Thimbiri	MP	C	2
BIGNONIACEAE	*Oroxylum indicum*	Thotila	MP	C	2
FABACEAE	*Cassia siamea*	Wa	MP	C	2
		Ataweera	MP	C	2
ASTERACEAE	*Elephantopus scaber*	Aththadi	MP	C	2
RUTACEAE	*Giycosmis angustifolia*	Bolpana	MP	C	2
ASTERACEAE	*Eupatorium odoratum L.*	Bosa/ podisingnomaran	MP	C	2
RUTACEAE	*Chloroxylon swietenia DC.*	Burutha	MP	C	2
MYRTACEAE	*Eugenia rotundata*	Danduwaha	MP	C	2
RHAMNACEAE	*Ziziphus rugosa Lam.*	Eraminiya	MEP	C	3
VERBENACEAE	*Lantana camara L.*	Gandapana	MEP	C	3
EUPHORBIACEAE	*Croton laccifer*	Gas keppetiya	MP	C	2
RUTACEAE	*Clausena indica (Dalz.) Oliver*	Gon karapincha	MEP	C	3
BORAGINACEAE	*Carmona retusa (Vahl)Masamune*	Heen thambala	MP	C	2
		Je karal	MP	C	2
		Keeriya	MP	C	2
MELIACEAE	*Walsura trifoliolata*	Kiri kone	MP	C	2
RUTACEAE	*Toddalia asiatica (L.) Lam.*	Kudumirissa	MEP	C	2
VERBENACEAE	*Vitex pinnata L.*	Milla	MP	C	2
SAPOTACEAE	*Manilkara hexandra (Roxb.) Dubard*	Palu	MP	C	2
RUTACEAE	*Pamburus missionis (Wight) Swingle*	Pamburu	MP	C	2
RUTACEAE	*Micromelum minutum*	Wal karapincha	MEP	C	3
STERCULIACEAE	*Pterygota thwaitesii*	Welan	MP	C	2
EUPHORBIACEAE	*Tragia hispida*	Wel kahambiliya	MP	C	2
EUPHORBIACEAE	*Dimorphocalyx glabellus*	Weli wanna	MP	C	2
LAURACEAE	*Alseodaphne semecarpifolia*	Wewarana	MP	C	2

Habitat (LULC) type Dense Forest :					
Family	**Scientific name**	**Local name**	**MP/ MEP in the selected habitat**	**Occurrence of MP/MEP species in the selected habitat Common (C) Rare (R)**	**Degree of importance of species (Scale 1-10)**
MORACEAE	*Strebles aspera*	Nithulla	MP	C	2
RUTACEAE	*Giycosmis angustifolia*	Bolpana	MP	C	2
RUTACEAE	*Chloroxylon swietenia DC.*	Burutha	MP	C	2
HYPOXIDACEAE	*Curculigo orchioides Gaertn.*	Binthal	MP	C	2
MENISPERMACEAE	*Cissampelos pareira L. var.hirsuta*	Deekirimudawanna/Diyamitta	MEP	C	3
MALVACEAE	*Sida acuta Burm. f.*	Gas babila	MP	C	2
RUBIACEAE	*Knoxia zeylanica L.*	Goda rathmal	MP	C	2
RUBIACEAE	*Mitragyna tubulosa (Arn.) Havil.*	Halamba	MP	C	2
ANNONACEAE	*Xylopia nigricans*	Heen kenda	MP	C	2
SMILACACEAE	*Smilax zeylanica*	Heen kabarossa	MP	C	2
APOCYNACEAE	*Carissa spinarum*	Heen karamba	MP	C	2
BORAGINACEAE	*Carmona retusa (Vahl)Masamune*	Heen thambala	MP	C	2
MYRTACEAE	*Syzygium cylindricum*	Ilapaththa	MP	C	2
CAPPARACEAE	*Capparis zeylanica*	Kalu wellangiriya	MP	C	2
EUPHORBIACEAE	*Croton laccifercus*	Kappetiya	MP	C	2
SAPINDACEAE	*Allophylus cobbe (L.) Rausch.*	Kobbe	MP	C	2
SAPINDACEAE	*Schleichera oleosa (Lour.) Oken*	Kone	MEP	C	3
MELASTOMACEAE	*Memocylon spp.*	Korakaha	MP	C	2
EUPHORBIACEAE	*Phyllanthus polyphyllus Willd.*	Kuratiya	MP	C	2
RUTACEAE	*Clausena indica (Dalz.) Oliver*	Meegon karapincha	MEP	C	3
FABACEAE	*Bauhinia tomentosa L.*	Pethan	MP	C	2
RUBIACEAE	*Tarenna asiatica (L.) Kuntze ex Schumann*	Tharana	MP	C	2
ANNONACEAE	*Polyalthia korinti*	Ulkenda	MP	C	2
RUTACEAE	*Micromelum minutum*	Wal karapincha	MEP	C	3
MALVACEAE	*Sida cordata*	Wel babila	MP	C	2
ACANTHACEAE	*Blepharis integrifolia (L.f.) E. Meyer ex Krauss*	Samadana	MP	R	2

Habitat (LULC) type: Home garden

Family	Scientific name	Local name	MP/ MEP in the selected habitat	Occurrence of MP/MEP species in the selected habitat Common (C) Rare (R)	Degree of importance of species (Scale 1-10)
CRASSULACEAE	*Kalanchoe pinnata*	Akkapana	MEP	C	2
SOLANACAE	*Withania somnifera.*	Amukkara	MP	C	2
ANNONACEAE	*Annona muricata L.*	Anoda	MEP	C	3
RUTACEAE	*Citrus aurantifolia*	Dehi	MEP	C	3
RUTACEAE	*Citrus aurantium L.*	Dodam	MEP	C	3
CUCURBITACEAE	*Trichosanthus cucumerina*	Dummalla/meeminna	MP	C	2
EUPHORBIACEAE	*Ricinus communis L.*	Endaru	MP	C	2
LAMIACEAE	*Leucas zeylanica*	Gatathumba	MP	C	2
LEEACEAE	*Leea indica*	Gurulla	MP	C	2
CONVOLVULACEAE	*Argyreia populifolia Choisy*	Girithilla	MEP	C	3
APIACEAE	*Centella asiatica (L.) Urban*	Gotukola	MEP	C	3
ASPARAGACEAE	*Asparagus gonoclados Baker*	Hatawariya	MEP	C	3
ZINGIBERACEAE	*Zingiber officinale Roscoe*	Inguru	MEP	C	3
LAMIACEAE	*Plectranthus zatarhendi var. tomentosa (Benth.) Codd*	Iriweriya	MP	C	2
ZINGIBERACEAE	*Curcuma longa L.*	Kaha	MEP	C	3
AMARANTHACEAE	*Achyranthes aspera L.*	Karalheba	MP	C	2
RUTACEAE	*Murraya koenigii (L.) Spreng.*	Karapincha	MEP	C	3
FABACEAE	*Clitoria ternatea L.*	Katarolu(nil)	MEP	C	3
ALOACEAE	*Aloe vera (L.) Burm.f.*	Komarika	MEP	C	3
LAURACEAE	*Cinnamomum verum J. Presl*	Kurundu	MEP	C	3
LAMIACEAE	*Ocimum tenuiflorum L.*	Maduruthala	MP	C	2
EUPHORBIACEAE	*Jatropha multifida L.*	Mayurapada	MP	C	2
MORINGACEAE	*Moringa oleifera Lam.*	Murunga	MEP	C	3
CUCURBITACEAE	*Diplocyclos palmatus (L.) C. Jeffrey*	Pasangilla	MP	C	2
RUBIACEAE	*Ixora coccinea L.*	Rathmal	MP	C	2
RUBIACEAE	*Tarenna asiatica (L.) Kuntze ex Schumann*	Tharana	MP	C	2
EUPHORBIACEAE	*Ricinus communis L.*	Thel endaru	MP	C	2
SCROPHULARIACEAE	*Scoparia dulcis L.*	Wal koththamalli	MP	C	2
EUPHORBIACEAE	*Drypetes sepiaria*	Weera	MP	C	2
ANACARDIACEAE	*Mangifera indica L.*	Amba	MEP	C	3
BROMELIACEAE	*Ananas comosus (L.) Merr.*	Annasi	MEP	C	3
CONVOLVULACEAE	*Ipoomea asarifolia*	Bin thamburu	MP	C	2
RUTACEAE	*Chloroxylon swietenia DC.*	Burutha	MP	C	2
ASTERACEAE	*Tagetes erecta L.*	Daspethiya	MP	C	2
PUNICACEAE	*Punica granatum L.*	Delum	MEP	C	3
FABACEAE	*Cassia fistula L.*	Ehela	MP	C	2

PIPERACEAE	*Piper nigrum L.*	Gammiris	MEP	C	3
FABACEAE	*Gliricidia sepium (Jacq.) Walp.*	Glirisidia	MP	C	2
FABACEAE	*Vigna spp.*	Halmassan dambala	MEP	C	3
TILIACEAE	*Berrya cordifolia (Willd.) Burret*	Halmilla	MP	C	2
ASPARAGACEAE	*Asparagus racemosus Willd.*	Hathawariya	MEP	C	3
VERBENACEAE	*Gmelina asiatica*	Heen demata	MP	C	2
BORAGINACEAE	*Carmona retusa (Vahl)Masamune*	Heen thambala	MEP	C	3
RUBIACEAE	*Mitragyna tubulosa (Arn.) Havil.*	Helamba/He kolon	MP	C	2
ANACARDIACEAE	*Lannea coromandelica (Houtt.) Merr.*	Hk (bath)	MP	C	2
MELIACEAE	*Chukrasia tabularis A. Juss.*	Hulan hik	MP	C	3
ARECACEAE	*Phoenix pusilla Gaertn.*	Indi	MEP	C	3
FABACEAE	*Sauropus androgynous*	Japan batu	MEP	C	3
		Je karal	MP	C	2
SOLANACEAE	*Solanum americanum*	Kalukamberiya	MEP	C	3
RUBIACEAE	*Canthium coromandelicum (Burm. f.) Alston*	Kara	MEP	C	3
FABACEAE	*Pongamia pinnata (L.) Pierre*	Karanda	MP	C	2
ANNONACEAE	*Annona muricata L.*	Katu anoda	MEP	C	3
MUSACEAE	*Musa paradisiaca L.*	Kesel	MEP	C	3
EUPHORBIACEAE	*Bridelia retusa (L.) A.*	Ketakela	MP	C	2
		Kiri thambala	MEP	C	3
APOCYNACEAE	*Ichnocarpus frutescens (L.)R. Br.*	kiriwel	MP	C	2
ARACEAE	*Lasia spinosa (L.) Thw.*	Kohila	MEP	C	3
MORACEAE	*Artocarpus heterophyllus Lam.*	Kos	MEP	C	3
COMBRETACEAE	*Terminalia arjuna (Roxb.) Wight & Arn.*	Kumbuk	MP	C	2
EUPHORBIACEAE	*Phyllanthus polyphyllus Willd.*	Kuratiya	MP	C	2
MYRTACEAE	*Syzygium cumini Skeels*	Madan	MEP	C	3
FABACEAE	*Vigna unguiculata (L.) Walp. ssp. cylindrical*	Mae	MEP	C	3
FABACEAE	*Bauhinia racemosa Lam.*	Maila	MEP	C	3
SAPOTACEAE	*Madhuca longifolia (L.) Macbride*	Mee	MEP	C	3
VERBENACEAE	*Vitex pinnata L.*	Milla	MP	C	2
SOLANACEAE	*Capsicum annuum L.*	Miris	MEP	C	3
ASTERACEAE	*Vernonia cinerea (L.) Less.*	Monarakudumbiya	MEP	C	3
BASELLACEAE	*Basella alba L.*	Niwithi	MEP	C	3
FABACEAE	*Abrus precatorius L.*	Olinda	MP	C	2
SAPOTACEAE	*Manilkara hexandra (Roxb.) Dubard*	Palu	MP	C	2
ASTERACEAE	*Vernonia zeylanica (L.) Lees.*	Pupula	MP	C	2
.PANDANACEAE	*Pandanus amaryllifolius Roxb*	Rampe	MEP	C	3
ACANTHACEAE	*Blepharis integrifolia (L.f.) E. Meyer ex Krauss*	Samadana	MP	C	
VERBENACEAE	*Premna tomentosa Willd.f. tomentosa*	Seru	MP	C	2
MALVACEAE	*Hibiscus micranthus L.*	Siriwadi babila	MP	C	2
ACANTHACEAE	*Rungia repens (L.)*	Sulu nai	MP	C	2
SOLANACEAE	*Lycopersicon esculentum Miller*	Thakkali	MEP	C	3
RUBIACEAE	*Tarenna asiatica (L.) Kuntze ex Schumann*	Tharana	MP	C	2
ANNONACEAE	*Polyalthia korinti*	Ulkenda	MP	C	2
FABACEAE	*Cassia siamea*	Waa	MP	C	2

ASTERACEAE	*Tithonia diversifolia*	Wal sooriyakantha	MP	C	2
MALVACEAE	*Sida cordata*	Wel babila	MP	C	2
EUPHORBIACEAE	*Drypetes sepiaria*	Weera	MP	C	2
PASSIFLORACEAE	*Passiflora edulis Sims*	Wel dodam	MEP	C	3
APOCYNACEAE	*Allamanda cathartica L.*	Wel rukaththana	MP	C	2
LAURACEAE	*Alseodaphne semecarpifolia*	Wewarana	MP	C	2
MALVACEAE	*Hibiscus rosa-sinensis L.*	Pokuruwada	MP	C	2
RUTACEAE	*Aegle marmelos (L.) Correa*	Beli	MEP	R	3
EUPHORBIACEAE	*Mallotus rhamnifolius (Willd.)*	Bulu hulu keppetiya	MP	R	2
HYPOXIDACEAE	*Curculigo orchioides Gaertn.*	Binthal	MP	R	2
CLUSIACEAE	*Calophyllum inophyllum*	Domba	MP	R	2
HYPOXIDACEAE	*Curculigo orchioides Gaertn.*	Heen binthal	MP	R	2
ACANTHACEAE	*Barleria prionitis L.*	Katu karandu	MP	R	2
ARACEAE	*Amorphophallus paeoniifolius*	Kidaram	MP	R	2
CACTACEAE	*Rhipsalis baccifera*	Nawahandi	MP	R	2
FABACEAE	*Abrus precatorius L.*	Olinda	MP	R	2
ACANTHACEAE	*Barleria lupulina Lindl.*	Ranwan katukarandu	MP	R	2
OLEACEAE	*Jasminum officinale L.*	Samanpichcha	MP	R	2
EUPHORBIACEAE	*Euphorbia tortilis Rottl. ex Ainslie*	Seenuk	MP	R	2
PIPERACEAE	*Piper longum L.*	Thippili	MP	R	2
EUPHORBIACEAE	*Jatropha podagrica Hook.*	Vishakumba	MP	R	2
CONVOLVULACEAE	*Evolvulus alsinoides (L.) L.*	Vishnukranthi	MP	R	2
ACORACEAE	*Acorus calamus L.*	Wadakaha	MP	R	2

Habitat (LULC) type: Osu uyana				
Family & Scientific name	Local name	MP/MEP in the selected habitat	**Occurrence of MP/MEP species in the selected habitat Common (C) Rare (R)**	**Degree of importance of species (Scale 1-10)**
Justicia adhathoda L. ACANTHACEAE	Adathoda	MP	C	2
Acronychia pedunculata (L.) Miq. RUTACEAE	Ankenda	MP	C	2
Alysicarpus vaginalis (L.) DC. FABACEAE	Aswenna	MP	C	2
Terminalia chebula. COMBRETACEAE	Aralu	MP	C	2
Elephantopus scaber ASTERACEAE	Aththadi	MP	C	2
Stachytarpheta indica (L.) Vahl VERBENACEAE	Balunaguta	MP	C	2
Cissampelos pareira L. var.hirsuta (Buch. ex DC.)Forman MENISPERMACEAE	Deekirimudawanna/Diyamitta	MEP	C	3
Citrus aurantifolia (Christm. & Panzer) Swingle RUTACEAE	Dehi	MEP	C	3
Grewia carpinifolia Juss. TILIACEAE	Damunu	MP	C	2
Cassia fistula L. FABACEAE	Ehela	MP	C	2
Erythrina variegata L. FABACEAE	Erabadu	MEP	C	3
Fimbristylis ovata CYPERACEAE	Ethana	MP	C	2
Thespesia populnea (L.) MALVACEAE	Gansooriya	MP	C	2
Pterocarpus marsupium FABACEAE	Gammalu	MP	C	2
Asparagus gonoclados Baker ASPARAGACEAE	Hatawariya	MEP	C	3
Carmona retusa (Vahl)Masamune BORAGINACEAE	Heen thambala	MP	C	2
Strychnos potatorum L. f. LOGANIACEAE	Ingini	MP	C	2
Emilia exserta Fosberg ASTERACEAE	Kadupahara	MP	C	2
Derris parviflora Benth. FABACEAE	Kalawel	MP	C	2
Flueggea leucopyrus EUPHORBIACEAE	Katupila	MP	C	2
Croton laccifercus EUPHORBIACEAE	Kappetiya	MP	C	2
Macaranga peltata (Roxb.) Muell. Arg. EUPHORBIACEAE	Kenda	MP	C	2
Wattakaka volubilis (L.f.)Stapf ASCLEPIADACEAE	Kirianguna	MEP	C	3
Allophylus cobbe (L.) Rausch. SAPINDACEAE	Kobbe	MP	C	2
Azadirachta indica A. Juss. MELIACEAE	Kohomba	MP	C	2
Schleichera oleosa (Lour.) Oken SAPINDACEAE	Kone	MEP	C	3
Toddalia asiatica (L.) Lam. RUTACEAE	Kudumirissa	MP	C	2
Cyclea peltata MENISPERMACEAE	Kehipiththan	MP	C	2
Cordia dichotoma Forst.f. BORAGINACEAE	Lolu	MEP	C	3
Madhuca longifolia (L.) Macbride SAPOTACEAE	Mee	MEP	C	3
Premna latifolia VERBENACEAE	Mahamidi	MP	C	2
Catunargegam spinosa RUBIACEAE	Kukuruman	MP	C	2
Mussada frondosa	Mussanna	MEP	C	3
Aerva lanata (L.) Juss. Ex Schult AMARABTHACEAE	Polpala	MEP	C	3
Ixora coccinea L. RUBIACEAE	Rathmal	MP	C	2

Oroxylum indicum (L.) Vent. BIGNONIACEAE	Thotila	MP	C	2
Pleiospermium alatum (Wight & Arn.) Swingle RUTACEAE	Tunpath kurundu	MP	C	2
Grewia carpinifolia Juss. TILIACEAE	Wahu keliya	MP	C	2
Micromelum minutum (Forst. f.) W. & A. var. ceylanicum B. C. Stone RUTACEAE	Wal karapincha	MP	C	2
Atalantia ceylanica (Arn.)Oliver RUTACEAE	Yakinaran	MEP	C	3
Barleria prionitis L. ACANTHACEAE	Katu karandu	MP	R	2
Vitex negundo L. VERBENACEAE	Nika	MP	R	2
Abrus precatorius L. FABACEAE	Olinda	MP	R	2
Pamburus missionis (Wight) SwingleRUTACEAE	Pamburu	MP	R	2
Cassia auriculata L. FABACEAE	Ranawara	MP	R	2
Alstonia scholaris (L.) R. Br. APOCYNACEAE	Gas rukaththana	MP	R	2
Jasminum officinale L. OLEACEAE	Samanpichcha	MP	R	2
Piper longum L. PIPERACEAE	Thippili	MP	R	2
Desmodium triflorum (L.)DC. FABACEAE	Undupiyali	MP	R	2
Syngonium angustatum Schott ARACEAE	Wel Kohila	MEP	R	3

Annex 3.3.2. Medicinal Plants (MPs) & Medicinal Edible Plants (MEPs) recorded in each habitat type at *Nachchaduwa* VTCS landscapes

Habitat (LULC) type: Tank Bund					
Family	**Scientific name**	**Local name**	**MP/ MEP in the selected habitat**	**Occurrence of MP/MEP species in the selected habitat Common (C) Rare (R)**	**Degree of importance of species (Scale 1-10)**
RUBIACEAE	*Morinda citrifolia L.*	Ahu	MP	C	2
MORACEAE	*Ficus rasimosa*	Attikka	MEP	C	3
VERBENACEAE	*Stachytarpheta indica (L.) Vahl*	Balunaguta	MP	C	2
RUTACEAE	*Limonia acidissima L.*	Divul	MEP	C	3
LEEACEAE	*Leea indica*	Gurulla	MP	C	2
RUBIACEAE	*Mitragyna tubulosa (Arn.) Havil.*	Helamba/He kolon	MP	C	2
EUPHORBIACEAE	*Flueggea leucopyrus*	Katupila	MP	C	2
ARACEAE	*Colocasia esculenta (L.) Schott*	Kaluhabarala	MP	C	2
MORACEAE	*Ficus hispida L. f.*	Kotadimbula	MP	C	2
CUCURBITACEAE	*Coccinia grandis (L.) J. Voigt*	Kowakka	MEP	C	3
LAMIACEAE	*Ocimum tenuiflorum L.*	Maduruthala	MEP	C	3
FABACEAE	*Bauhinia racemosa Lam.*	Maila	MEP	C	3
SAPOTACEAE	*Madhuca longifolia (L.) Macbride*	Mee	MEP	C	3
MORACEAE	*Ficus benghalensis L. var. benghalensis*	Nuga	MP	C	2
FABACEAE	*Cassia tora L.*	Pethi thora	MEP	C	3
ASTERACEAE	*Vernonia zeylanica (L.) Lees.*	Pupula	MP	C	2
FABACEAE	*Cassia auriculata L.*	Ranawara	MEP	C	3
EUPHOBRIACEAE	*Jatropha glandulifera Roxb.*	Rath endaru	MP	C	2
MALVACEAE	*Hibiscus micranthus L.*	Siriwadi babila	MP	C	2
FABACEAE	*Tamarindus indica L.*	Siyambala	MEP	C	3
PEDALIACEAE	*Sesamum indicum L.*	Thala	MEP	C	3
CONVOLVULACEAE	*Operculina turpethum (L.) S. Manso*	Thirasthawalu	MP	C	2
ASCLEPIADACEAE	*Calotropis gigantea (L.) R.Br.*	Wara	MP	C	2
EUPHORBIACEAE	*Croton aromaticus L.*	Wel keppetiya	MP	C	2
FABACEAE	*Crotalaria laburnifolia L.*	Yakberiya	MP	C	2
PALMAE	*Caryota urens*	Kithul	MEP	R	3

Habitat (LULC) type: Peripheral **Tank Bund**

Family	Scientific name	Local name	MP/ MEP in the selected habitat	Occurrence of MP/MEP species in the selected habitat Common (C) Rare (R)	Degree of importance of species (Scale 1-10)
RUBIACEAE	Morinda citrifolia L.	Ahu	MP	C	2
FABACEAE	Crotalaria retusa L.	Andanahiriya	MP	C	2
FABACEAE	Alysicarpus vaginalis (L.) DC.	Aswenna	MP	C	2
RUTACEAE	Murraya paniculata (L.) Jack	Atteriya	MP	C	2
FABACEAE	Derris scandens (Roxb.) Benth.	Bokala wel	MP	C	2
MENISPERMACEAE	Cissampelos pareira L. var.hirsuta	Deekirimudawanna/ Diyamitta	MEP	C	3
TILIACEAE	Grewia carpinifolia Juss.	Damunu	MP	C	2
EUPHORBIACEAE	Ricinus communis L.	Endaru	MP	C	2
RHAMNACEAE	Ziziphus rugosa Lam.	Eraminiya	MEP	C	3
MALVACEAE	Sida acuta Burm. f.	Gas babila	MP	C	2
CONVOLVULACEAE	Argyreia populifolia Choisy	Girithilla	MEP	C	3
ULMACEAE	Holoptelea integrifolia (Roxb.) Planch.	Goda kirilla	MP	C	2
RUBIACEAE	Mitragyna tubulosa (Arn.) Havil.	Helamba/He kolon	MP	C	2
ANACARDIACEAE	Lannea coromandelica (Houtt.) Merr.	Hik	MP	C	2
ARECACEAE	Phoenix pusilla Gaertn.	Indi	MEP	C	3
LOGANIACEAE	Strychnos potatorum L. f.	Ingini	MP	C	2
FABACEAE	Bauhinia tomentosa Lam.	Kaha pethan	MP	C	2
AMARANTHACEAE	Achyranthes aspera L.	Karalheba	MP	C	2
FABACEAE	Pongamia pinnata (L.) Pierre	Karanda	MP	C	2
EUPHORBIACEAE	Flueggea leucopyrus	Katupila	MP	C	2
EUPHORBIACEAE	Phyllanthus reticulatus Poir.	Kaila	MP	C	2
SAPINDACEAE	Allophylus cobbe (L.) Rausch.	Kobbe	MP	C	2
MELIACEAE	Azadirachta indica A. Juss.	Kohomba	MP	C	2
SAPINDACEAE	Schleichera oleosa (Lour.) Oken	Kone	MEP	C	3
MORACEAE	Ficus hispida L. f.	Kotadimbula	MP	C	2
CUCURBITACEAE	Coccinia grandis (L.) J. Voigt	Kowakka	MEP	C	3
RUTACEAE	Toddalia asiatica (L.) Lam.	Kudumirissa	MP	C	2
MYRTACEAE	Syzygium cumini Skeels	Madan	MEP	C	3
LAMIACEAE	Ocimum tenuiflorum L.	Maduruthala	MEP	C	3
FABACEAE	Bauhinia racemosa Lam.	Maila	MEP	C	3
SAPOTACEAE	Madhuca longifolia (L.) Macbride	Mee	MEP	C	3
EUPHORBIACEAE	Phyllanthus emblica L.	Nabada	MP	C	2
SAPOTACEAE	Manilkara hexandra (Roxb.) Dubard	Palu	MP	C	2
FABACEAE	Cassia tora L.	Pethi thora	MEP	C	3
AMARABTHACEAE	Aerva lanata (L.) Juss. Ex Schult	Polpala	MEP	C	3
ASTERACEAE	Vernonia zeylanica (L.) Lees.	Pupula	MP	C	2

FABACEAE	Tamarindus indica L.	Siyambala	MEP	C	3
CONVOLVULACEAE	Ipomoea littoralis Blume	Thal kola	MEP	C	3
ASCLEPIADACEAE	Wattakaka volubilis (L.f.)Stapf	Thiktha anguna	MEP	C	3
TILIACEAE	Grewia carpinifolia Juss.	Wel keliya	MEP	C	3
EUPHORBIACEAE	Croton aromaticus L.	Wel keppetiya	MP	C	2
FABACEAE	Crotalaria laburnifolia L.	Yakberiya	MP	C	2
RUTACEAE	Atalantia ceylanica	Yakinaran	MEP	C	3
LOGANIACEAE	Strychnos nux-vomica L.	Goda Kaduru	MP	R	2
RUBIACEAE	Catunaregam spinosa	Kukuruman	MP	R	2

Habitat (LULC) type: Kattakaduwa

Family	Scientific name	Local name	MP/ MEP in the selected habitat	Occurrence of MP/MEP species in the selected habitat Common (C) Rare (R)	Degree of importance of species (Scale 1-10)
RUBIACEAE	*Morinda citrifolia L.*	Ahu	MEP	C	3
FABACEAE	*Alysicarpus vaginalis (L.) DC.*	Aswenna	MEP	C	3
MORACEAE	*Ficus rasimosa*	Attikka	MEP	C	3
VERBENACEAE	*Stachytarpheta indica (L.) Vahl*	Balunaguta	MEP	C	3
MALVACEAE	*Abutilon indicum (L.) Sweet ssp. guineense*	Beheth anoda/Killotagas	MP	C	2
RUTACEAE	*Giycosmis angustifolia*	Bolpana	MP	C	2
RUTACEAE	*Limonia acidissima L.*	Divul	MEP	C	3
TILIACEAE	*Grewia carpinifolia Juss.*	Damunu	MP	C	2
FABACEAE	*Cassia fistula L.*	Ehela	MP	C	2
LEEACEAE	*Leea indica*	Gurulla	MP	C	2
MALVACEAE	*Sida acuta Burm. f.*	Gas babila	MP	C	2
FAbaCEAE	*Butea monosperma*	Gas kaela	MP	C	2
		Gas nerenchi	MP	C	2
CONVOLVULACEAE	*Argyreia populifolia Choisy*	Girithilla	MEP	C	3
RUBIACEAE	*Mitragyna tubulosa (Arn.) Havil.*	Helamba/He kolon	MP	C	2
AMARANTHACEAE	*Achyranthes aspera L.*	karal heba	MEP	C	3
MYRTACEAE	*Syzygium rubicundum Wight & Arn.*	karaw	MP	C	2
EUPHORBIACEAE	*Flueggea leucopyrus*	Katupila	MEP	C	3
ARACEAE	*Colocasia esculenta (L.) Schott*	Kalu habarala	MP	C	2
EUPHORBIACEAE	*Bridelia retusa (L.) A.*	Ketakela	MP	C	2
CONVOLVULACEAE	*Merremia umbellata L.*	Kiri madu wel	MP	C	2
SAPINDACEAE	*Allophylus cobbe (L.) Rausch.*	Kobbe	MP	C	2
MELIACEAE	*Azadirachta indica A. Juss.*	Kohomba	MEP	C	3
SAPINDACEAE	*Schleichera oleosa (Lour.) Oken*	Kone	MEP	C	3
MORACEAE	*Ficus hispida L. f.*	Kotadimbula	MP	C	2
CUCURBITACEAE	*Coccinia grandis (L.) J. Voigt*	Kowakka	MEP	C	3
RUTACEAE	*Toddalia asiatica (L.) Lam.*	Kudumirissa	MP	C	2
COMBRETACEAE	*Terminalia arjuna (Roxb.) Wight & Arn.*	Kumbuk	MP	C	2
BORAGINACEAE	*Cordia dichotoma Forst.f.*	Lolu	MEP	C	3
MYRTACEAE	*Syzygium cumini Skeels*	Madan	MEP	C	3
LAMIACEAE	*Ocimum tenuiflorum L.*	Maduruthala	MEP	C	3
LAMIACEAE	*Ocimum gratissimum L.*	Maha maduruthala	MP	C	2
FABACEAE	*Bauhinia racemosa Lam.*	Maila	MEP	C	3
SAPOTACEAE	*Madhuca longifolia (L.) Macbride*	Mee	MEP	C	3
ASTERACEAE	*Vernonia cinerea (L.) Less.*	Monarakudumbiya	MEP	C	3
ACANTHACEAE	*Hygrophila schulli (Buch. - Ham.) M. R. & S. N. Alme.*	Neeramulliya	MEP	C	3
MORACEAE	*Strebles aspera*	Nithulla	MP	C	2

MORACEAE	*Ficus benghalensis L. var. benghalensis*	Nuga	MP	C	2
PASSIFLORACEAE	*Passiflora foetida L.*	Padawel/Nottuwel	MEP	C	3
FABACEAE	*Cassia occidentalis L.*	Panithora/ kathuru thora	MP	C	2
FABACEAE	*Cassia tora L.*	Pethithora	MEP	C	3
ARACEAE	*Pothos scandens*	Pota wel (Ath)	MP	C	2
ASTERACEAE	*Vernonia zeylanica (L.) Lees.*	Pupula	MEP	C	3
FABACEAE	*Cassia auriculata L.*	Ranawara	MEP	C	3
EUPHOBRIACEAE	*Jatropha glandulifera Roxb.*	Rath endaru	MP	C	2
MALVACEAE	*Hibiscus micranthus L.*	Siriwadi babila	MP	C	2
FABACEAE	*Tamarindus indica L.*	Siyambala	MEP	C	3
CONVOLVULACEAE	*Ipomoea littoralis Blume*	Tal kola	MEP	C	3
ASCLEPIADACEAE	*Wattakaka volubilis (L.f.)Stapf*	Thiktha anguna	MEP	C	3
PIPERACEAE	*Piper longum L.*	Thippili	MP	C	2
CONVOLVULACEAE	*Operculina turpethum (L.) S. Manso*	Thirasthawalu	MP	C	2
RUTACEAE	*Pleiospermium alatum*	Tunpath kurundu	MP	C	2
FABACEAE	*Desmodium triflorum (L.)DC.*	Undupiyali	MEP	C	3
ASCLEPIADACEAE	*Calotropis gigantea (L.) R.Br.*	wara	MP	C	2
EUPHORBIACEAE	*Croton aromaticus L.*	Wel keppetiya	MP	C	2
SAPINDACEAE	*Cardiospermum halicacabum L.*	Wel penala	MEP	C	2
FABACEAE	*Crotalaria laburnifolia L.*	Yakberiya	MP	C	3
ACANTHACEAE	*Justicia adhathoda L.*	Adathoda	MEP	R	3
PLUMBAGINACEAE	*Plumbago zeylanica L.*	Elanitul	MP	R	2
PALMAE	*Caryota urens*	Kithul	MEP	R	3
FABACEAE	*Tephrosia purpurea (L.) Pers.*	Pila	MP	R	2
ARECACEAE	*Borassus flabellifer L.*	Thal	MEP	R	3
LAMIACEAE	*Anisomeles indica (L.) Kuntze*	Yakwanassa	MP	R	2

Habitat (LULC) type: Tank water

Scientific name	Family	Local name	MP/ MEP in the selected habitat	Occurrence of MP/MEP species in the selected habitat Common (C) Rare (R)	Degree of importance of species (Scale 1-10)
Nelumbo nucifera	NELUMBONACEAE	Nelum	MEP	C	3
Nymphaea pubescens Willd.	NYMPHAEACEAE	Ou	MEP	C	3
Nymphoidea indica	MENYANTHACEAE	Kumudu	MP	C	2
Aponogeton crispus	APONOGETONACEAE	Kekatiya	MEP	C	3

Habitat (LULC) type: Scrubland					
Family	**Scientific name**	**Local name**	**MP/ MEP in the selected habitat**	**Occurrence of MP/MEP species in the selected habitat Common (C) Rare (R)**	**Degree of importance of species (Scale 1-10)**
RUBIACEAE	*Morinda citrifolia L.*	Ahu	MP	C	2
BORAGINACEAE	*Carmona retusa (Vahl)Masamune*	Heen thambala	MEP	C	3
VITACEAE	*Cissus quadrangularis L.*	Heeressa	MP	C	2
PERIPLOCACEAE	*Hemidesmus indicus (L.) R. Br.*	Iramusu	MEP	C	3
APOCYNACEAE	*Carissa carandas L.*	Karamba	MEP	C	3
RUTACEAE	*Murraya koenigii (L.) Spreng.*	Karapincha	MEP	C	3
EUPHORBIACEAE	*Flueggea leucopyrus*	Katupila	MP	C	2
MELIACEAE	*Azadirachta indica A. Juss.*	Kohomba	MP	C	2
SAPINDACEAE	*Schleichera oleosa (Lour.) Oken*	Kone	MEP	C	3
RUTACEAE	*Toddalia asiatica (L.) Lam.*	Kudumirissa	MP	C	2
FABACEAE	*Bauhinia racemosa Lam.*	Maila	MEP	C	3
FABACEAE	*Cassia auriculata L.*	Ranawara	MEP	C	3
ACANTHACEAE	*Rungia repens (L.)*	Sulu nai	MP	C	2
RUTACEAE	*Pleiospermium alatum*	Tunpath kurundu	MP	C	2
TILIACEAE	*Grewia carpinifolia Juss.*	Wahu keliya	MEP	C	3
RUTACEAE	*Atalantia ceylanica*	Yakinaran	MEP	C	3

Habitat (LULC) type: Dense forest

Family	Scientific name	Local name	MP/ MEP in the selected habitat	Occurrence of MP/MEP species in the selected habitat Common (C) Rare (R)	Degree of importance of species (Scale 1-10)
RUBIACEAE	*Morinda citrifolia L.*	Ahu	MP	C	2
RUTACEAE	*Murraya paniculata (L.) Jack*	Atteriya	MP	C	2
MENISPERMACEAE	*Cissampelos pareira L. var.hirsuta*	Deekirimudawanna/ Diyamitta	MEP	C	3
FABACEAE	*Cassia fistula L.*	Ehela	MP	C	2
RHAMNACEAE	*Ziziphus rugosa Lam.*	Eraminiya	MEP	C	3
ULMACEAE	*Holoptelea integrifolia (Roxb.) Planch.*	Goda kirilla	MP	C	2
LOGANIACEAE	*Strychnos potatorum L. f.*	Ingini	MP	C	2
VERBENACEAE	*Vitex spp.*	Kalu nika	MP	C	2
SAPINDACEAE	*Allophylus cobbe (L.) Rausch.*	Kobbe	MP	C	2
SAPINDACEAE	*Schleichera oleosa (Lour.) Oken*	Kone	MEP	C	3
RUTACEAE	*Toddalia asiatica (L.) Lam.*	Kudumirissa	MP	C	2
RUBIACEAE	*Catunaregam spinosa*	Kukuruman	MP	C	2
LAMIACEAE	*Ocimum gratissimum L.*	Maha maduruthala	MP	C	2
ACANTHACEAE	*Rungia repens (L.)*	Sulu nai	MP	C	2
RUTACEAE	*Pleiospermium alatum*	Tunpath kurundu	MP	C	2
TILIACEAE	*Grewia carpinifolia Juss.*	Wel keliya	MEP	C	3
EUPHORBIACEAE	*Croton aromaticus L.*	Wel keppetiya	MP	C	2
RUTACEAE	*Atalantia ceylanica*	Yakinaran	MEP	C	3
		Araa lolu	MP	C	2
RUTACEAE	*Giycosmis angustifolia*	Bolpana	MP	C	2
TILIACEAE	*Grewia helicterifolia*	Bora damunu	MP	C	2
RUBIACEAE	*Knoxia zeylanica L.*	Goda rathmal	MP	C	2
FABACEAE	*Derris parviflora Benth.*	Kalawel	MP	C	2
ANNONACEAE	*Polyalthia spp.*	Kalu ulkenda	MP	C	2
EUPHORBIACEAE	*Flueggea leucopyrus*	Katupila	MP	C	2
EUPHORBIACEAE	*Bridelia retusa (L.) A.*	Ketakela	MP	C	2
AMARANTHACEAE	*Amaranthus viridis L.*	Kura thampala	MP	C	2
RUTACEAE	*Clausena indica (Dalz.) Oliver*	Meegon karapincha	MEP	C	3
SAPOTACEAE	*Manilkara hexandra (Roxb.) Dubard*	Palu	MEP	C	3
CAPPARACEAE	*Capparis moonii Wight*	Sudu wellangiriya	MP	C	2
		Webadanga wel	MP	C	2
EUPHORBIACEAE	*Drypetes sepiaria*	Weera	MEP	C	3
LAURACEAE	*Alseodaphne semecarpifolia*	Wewarana	MP	C	2

Habitat (LULC type: Home gardens

Family	Scientific name	Local name	MP/ MEP in the selected habitat	Occurrence of MP/MEP species in the selected habitat Common (C) Rare (R)	Degree of importance of species (Scale 1-10)
EUPHORBIACEAE	*Euphorbia indica Lam.*	Dadakeeriya	MP	C	2
RUTACEAE	*Citrus aurantifolia*	Dehi	MEP	C	3
PUNICACEAE	*Punica granatum L.*	Delum	MEP	C	3
RUTACEAE	*Limonia acidissima L.*	Divul	MEP	C	3
RUTACEAE	*Citrus aurantium L.*	Dodam	MEP	C	3
PIPERACEAE	*Piper samentosum*	Gas Thippili	MP	C	2
ULMACEAE	*Holoptelea integrifolia (Roxb.) Planch.*	Goda kirilla	MP	C	2
ZINGIBERACEAE	*Alpinia calcarata Roscoe*	Heen araththa	MP	C	2
VITACEAE	*Cissus quadrangularis L.*	Heeressa	MP	C	2
ZINGIBERACEAE	*Kempferia galanga*	Ingurupiyali	MEP	C	3
ZINGIBERACEAE	*Curcuma longa L.*	Kaha	MEP	C	3
ANNONACEAE	*Annona muricata L.*	Katu anoda	MEP	C	3
EUPHORBIACEAE	*Bridelia retusa (L.) A.*	Ketakela	MP	C	2
SAPINDACEAE	*Allophylus cobbe (L.) Rausch.*	Kobbe	MP	C	2
MELIACEAE	*Azadirachta indica A. Juss.*	Kohomba	MP	C	2
SAPINDACEAE	*Schleichera oleosa (Lour.) Oken*	Kone	MEP	C	3
MYRTACEAE	*Syzygium cumini Skeels*	Madan	MEP	C	3
MORINGACEAE	*Moringa oleifera Lam.*	Murunga	MEP	C	3
VERBINACEAE	*Vitex leucocylon*	Nabada	MP	C	2
MORACEAE	*Strebles aspera*	Nithulla	MP	C	2
SAPOTACEAE	*Manilkara hexandra (Roxb.) Dubard*	Palu	MP	C	2
NYCTAGINACEAE	*Boerhavia diffusa L.*	Pitasudu sarana	MEP	C	3
EUPHORBIACEAE	*Phyllanthus amarus Schum.*	Pitawakka	MP	C	2
OLEACEAE	*Jasminum officinale L.*	Saman pichcha	MP	C	2
FABACEAE	*Tamarindus indica L.*	Siyambala	MEP	C	2
ZINGEBERACEAE	*Costus speciosus*	Thebu	MEP	C	3
ASCLEPIADACEAE	*Wattakaka volubilis (L.f.)Stapf*	Thiktha anguna	MEP	C	3
FABACEAE	*Desmodium triflorum (L.)DC.*	Undupiyali	MP	C	2
ACORACEAE	*Acorus calamus L.*	Wadakaha	MP	C	2
ZINGIBERACEAE	*Zingiber zerumbet*	Wal inguru	MP	C	2
PANDANACEAE	*Pandanus kaida Kurz.*	Wetakeiya	MP	C	2
ACANTHACEAE	*Rungia repens (L.)*	Sulu nai	MP	C	2
RUBIACEAE	*Nauclea orientalis*	Bakmee	MP	C	2
ASTERACEAE	*Tagetes erecta L.*	Daspethiya	MP	C	2
MENISPERMACEAE	*Cissampelos pareira L. var.hirsuta*	Deekirimudawanna/ Diyamitta	MEP	C	3
FABACEAE	*Cassia fistula L.*	Ehela	MP	C	2

	Sida acuta Burm. f. MALVACEAE	Gas babila	MP	C	2
CONVOLVULACEAE	*Argyreia populifolia Choisy*	Girithilla	MEP	C	3
NICTAGINACEAE	*Milabiris jalapa*	Hendirikka	MP	C	2
ASTERACEAE	*Emilia exserta Fosberg*	Kadupahara	MP	C	2
CUCURBITACEAE	*Coccinia grandis (L.) J. Voigt*	Kowakka	MEP	C	2
ASTERACEAE	*Vernonia cinerea (L.) Less.*	Monarakudumbiya	MEP	C	3
MALVACEAE	*Hibiscus furcatus Roxb.*	Napiriththa	MP	C	2
AMARABTHACEAE	*Aerva lanata (L.) Juss. Ex Schult*	Polpala	MEP	C	3
MALVACEAE	*Hibiscus micranthus L.*	Siriwadi babila	MP	C	2
	Tamarindus indica L.	Siyambala	MEP	C	2
CAPPARACEAE	*Cleome gynandra L*	Wela	MP	C	2
SAPINDACEAE	*Cardiospermum halicacabum L.*	Wel penala	MEP	C	3
FABACEAE	*Crotalaria laburnifolia L.*	Yakberiya	MP	C	2
RUTACEAE	*Acronychia pedunculata (L.) Miq.*	Ankenda	MP	R	2
MORACEAE	*Ficus rasimosa*	Attikka	MEP	R	3
LAURACEAE	*Litsea glutinosa (Lour.) C. B. Ro.*	Bo mee	MP	R	2
COMBRETACEAE	*Terminalia belarika*	Bulu	MP	R	2
URTICACEAE	*Boehmeria nivea*	Datta	MP	R	2
LEEACEAE	*Leea indica*	Gurulla	MP	R	2
ARECACEAE	*Phoenix pusilla Gaertn.*	Indi	MEP	R	3
ZINGIBERACEAE	*Zingiber officinale Roscoe*	Inguru	MEP	R	3
EUPHORBIACEAE	*Sauropus androgynus*	Japanbatu	MEP	R	3
MORACEAE	*Ficus hispida L. f.*	Kotadimbula	MP	R	2
LORACEAE	*Cenamomum verum*	Kurundu	MEP	R	3
FABACEAE	*Caesalpinia bonduc (L.) Roxb.*	Kumburu wel	MP	R	2
CACTACEAE	*Rhipsalis baccifera*	Nawahandi	MP	R	2
MENISPERMACEAE	*Tinospora cordifolia (Willd.) Hook.f. & Thoms.*	Rasakinda	MP	R	2
STERCULIACEAE	*Sterculia spp.*	Ran thelambu	MP	R	2
RAMNACEAE	*Ziziphus mauritiana*	Masan	MEP	R	3

Habitat (LULC) type: Osu Uyana

Family	Scientific name	Local name	MP/ MEP in the selected habitat	Occurrence of MP/MEP species in the selected habitat Common (C) Rare (R)	Degree of importance of species (Scale 1-10)
RUBIACEAE	*Morinda coreia Buch-Ham*	Ahu	MP	C	2
COMBRETACEAE	*Terminalia belarika*	Bulu	MP	C	2
RUBIACEAE	*Mitragyna tubulosa (Arn.) Havil.*	Helamba/He kolon	MP	C	2
ANACARDIACEAE	*Lannea coromandelica (Houtt.) Merr.*	hik	MP	C	2
ARECACEAE	*Phoenix pusilla Gaertn.*	Indi	MEP	C	3
RUTACEAE	*Murraya koenigii (L.) Spreng.*	Karapincha	MEP	C	3
EUPHORBIACEAE	*Bridelia retusa (L.) A.*	Ketakela	MP	C	2
MELIACEAE	*Azadirachta indica A. Juss.*	Kohomba	MEP	C	3
MYRTACEAE	*Syzygium cumini Skeels*	Madan	MEP	C	3
FABACEAE	*Bauhinia racemosa Lam.*	Maila	MEP	C	3
EUPHORBIACEAE	*Phyllanthus emblica L.*	Nelli	MEP	C	3
RUTACEAE	*Pamburus missionis (Wight) Swingle*	Pamburu	MP	C	2
ACANTHACEAE	*Rungia repens (L.)*	Sulu nai	MP	C	2
SOLANACEAE	*Solanum violaceum Ortega*	Thiththa thibbatu	MEP	C	3
TILIACEAE	*Grewia carpinifolia Juss.*	Wahu keliya	MEP	C	3
MORACEAE	*Ficus benghalensis L. var. benghalensis*	Nuga	MP	R	2
SANTALACEAE	*Santalum album L.*	Suduhandun	MEP	R	3

Annexes – Chapter 5

Annexure 5.1

Date:

Ref No:

General information Questionnaire

(Interviewer Administered)

Height	_____cm	Fasting/Random blood sugar	_____mg/dl
Weight	_____kg	Blood pressure	_____Hgmm
Waist circumference	_____cm		

1. Name: ……

2. Gender: Male ☐ Female ☐

3. Date of birth: …… 1.4. Age: …….

4. Address: ……

5. Contact Number: ……..

6. Ethnicity: a)Sinhala ☐ b)Tamil c)Muslim ☐

7. Religion : a)Buddhist ☐ b) Hindu c)Islam d)Christian/Catholic ☐

8. Educational level

   a) Never gone to school ☐ c) Up to O/L ☐ e) Diploma or higher ☐

   b) Primary education ☐ d) Up to A/L ☐

9. Monthly income of the family? (Mark only one) Rs.

   a) Less than 20000 ☐ c) 40001 – 60000 ☐ e) More than 80000 ☐

   b) 20001 – 40000 ☐ d) 60001-80000 ☐

10. What type of farming you do?

    a) Crop farming ☐ c) Inland fisheries ☐

    b) Livestock faring ☐ d) Other occupation ☐

11. What type of crops you cultivate?

    a) Paddy ☐

    b) Vegetables ☐

    c) Fruits ☐

    d) Pulses ☐

12. What foods you cultivate for ‘Maha’ season?

    ……

13. What foods you cultivate for ‘Yala’ season

    ……

    ……

Annexure 5.2

Date:

Ref No:

Name: ……..

Sri Lanka Food Security Assessment: Household Questionnaire

Food insecurity experience scale (FIES)

Enumerator: Now I would like to ask you some questions about food. During the last 30 DAYS, was there a time when:			
1	You or others in your household worried about not having enough food to eat because of a lack of money or other resources?	1 = Yes 2 = No 98 = Don't know	| __ |
2	Still thinking about the last 30 DAYS, was there a time when you or others in your household were unable to eat healthy and nutritious food because of a lack of money or other resources?	1 = Yes 2 = No 98 = Don't know	| __ |
B_3	Was there a time when you or others in your household ate only a few kinds of foods because of a lack of money or other resources?	1 = Yes 2 = No 98 = Don't know	| __ |
B_4	Was there a time when you or others in your household had to skip a meal because there was not enough money or other resources to get food?	1 = Yes 2 = No 98 = Don't know	| __ |
B_5	Still thinking about the last 30 DAYS, was there a time when you or others in your household ate less than you thought you should because of a lack of money or other resources?	1 = Yes 2 = No 98 = Don't know	| __ |
B_6	Was there a time when your household ran out of food because of a lack of money or other resources?	1 = Yes 2 = No 98 = Don't know	| __ |
B_7	Was there a time when you or others in your household were hungry but did not eat because there was not enough money or other resources for food?	1 = Yes 2 = No 98 = Don't know	| __ |
B_8	Was there a time when you or others in your household went without eating for a whole day because of a lack of money or other resources?	1 = Yes 2 = No 98 = Don't know	| __ |

Annexure 5.3

HEALTH ASSESSMENT QUESTIONNAIRE

Preferred Name:	Age:
Telephone (if preferred):	

MODULE 01: MENTAL HEALTH ASSESSMENT QUESTIONNAIRE

- Rate yourself on these statements on a scale from 1 to 10. (1 - not true; 10 - most true)

Statements	Response -Rate 1-10
I wake up full of energy every day.	
I can maintain a peaceful, stress-free state.	
Body pains and headaches are rare for me.	
I have no sleeping issues	
Overall, I am happy with my health.	

1. During the last 30 days, about how often did you feel tired out for no good reason?

i. None of the time ☐

ii. A little of the time ☐

iii. Some of the time ☐

iv. Most of the time ☐

v. All of the time ☐

2. During the last 30 days, about how often did you feel nervous?

i. None of the time ☐

ii. A little of the time ☐

iii. Some of the time ☐

iv. Most of the time ☐

v. All of the time ☐

3. During the last 30 days, about how often did you feel so nervous that nothing could calm you down?

i. None of the time ☐

ii. A little of the time ☐

iii. Some of the time ☐

iv. Most of the time ☐

v. All of the time ☐

4. During the last 30 days, about how often did you feel hopeless?

i. None of the time ☐

ii. A little of the time ☐

iii. Some of the time ☐

iv. Most of the time ☐

v. All of the time ☐

5. During the last 30 days, about how often did you feel restless or uneasy?

i. None of the time ☐

ii. A little of the time ☐

iii. Some of the time ☐

iv. Most of the time ☐

v. All of the time ☐

6. During the last 30 days, about how often did you feel so restless you could not sit still?

i. None of the time ☐

ii. A little of the time ☐

iii. Some of the time ☐

iv. Most of the time ☐

v. All of the time ☐

7. During the last 30 days, about how often did you feel depressed?

i. None of the time ☐

ii. A little of the time ☐

iii. Some of the time ☐

iv. Most of the time ☐

v. All of the time ☐

8. During the last 30 days, about how often did you feel that everything was an effort?

i. None of the time ☐

ii. A little of the time ☐

iii. Some of the time ☐

iv. Most of the time ☐

v. All of the time ☐

9. During the last 30 days, about how often did you feel so sad that nothing could cheer you up?

i. None of the time

ii. A little of the time ☐

iii. Some of the time ☐

iv. Most of the time ☐

v. All of the time ☐

10. During the last 30 days, about how often did you feel worthless?

i. None of the time ☐

ii. A little of the time ☐

iii. Some of the time ☐

iv. Most of the time ☐

v. All of the time ☐

MODULE 02: PHYSICAL ACTIVITY QUESTIONNAIRE

Only those physical activities that you did for at **least 10 minutes** at a time

1. Do you currently have a job or do any work outside your home (including farming)?

   i) Yes ☐

   ii) No ☐

2. During the **last 7 days**, on how many days did you do **vigorous** physical activities?

   i) Number of days per week ☐

   ii) No vigorous physical activity ☐

3. How much time did you usually spend on one of those days doing **vigorous** physical activities?

   i) _____hours per day

   ii) _____minutes per day

4. During the **last 7 days**, on how many days did you do **moderate** physical activities?

   i) Number of days per week ☐

   ii) No moderate physical activity ☐

5. How much time did you usually spend on one of those days doing **moderate** physical. activities?

   i) _____hours per day

   ii) _____minutes per day

6. During the **last 7 days**, how many days did you **bicycle** for at least 10 minutes at a time to go **from place to place**.

   i) Number of days per week ☐

   ii) No bicycling from place to place ☐

7. How much time did you did you usually spend **bicycling** on one of those days?

i) _____hours per day

ii) _____minutes per day

8. During the **last 7 days**, how many days did you **walk** for at least 10 minutes at a time to go **from place to place**?

i) Number of days per week ☐

ii) No walking from place to place ☐

9. How much time did you did you usually spend **walking** on one of those days?

i) _____hours per day

ii) _____minutes per day

10. During the last 7 days, how much time did you spend sitting on a week day?

i) _____hours per day

ii) _____minutes per day

11. How much time did you usually spend on one of those days doing **vigorous** physical. activities in the home garden or paddy field?

i) _____hours per day

ii) _____minutes per day

MODULE 03: MEDICAL HISTORY DETAILS

(Please answer the questions below by placing a tick. If yes, please give details in the space provided).

Do you have any medical condition?	**Yes**	**No**	**Details including Medication**
Diabetes			
High Cholesterol			
High Blood Pressure			
Heart Disease			
Kidney disease			
Underweight			
Overweight			
Obesity			
Fatty Liver			
Cancer (specify List)			
Arthritis /Joint issues			
Mental issues			
Epilepsy/Fits			
Sleeping problems			
Stomach problems			
Any other (List)			
PHYSICAL ASSESMENTS			
Weight in Kg			
Height in cm			
Calculated BMI (Kg/m^2)			
Waist circumference in cm			
BIA Measurement (Body fat %)			
Blood Pressure (mmHg)			
Fasting Blood Sugar (mg/Dl)			

BEHAVIORAL HABITS

- Do you have a condition affecting sleep? Yes/No

- Are you satisfied with your dietary habits? Yes/No
- Do you smoke? Yes/No

If Yes, please state how many per day.

- Do you drink alcohol? Yes/No

If Yes, please state how much and how often per week.

Annexure 5.4

"Healthy Landscapes: Managing Agricultural Landscapes in Socio-Ecologically Sensitive Areas to Promote Food Security, Well-Being and Ecosystem Health"

Assessment of food security, human health and community wellbeing – Baseline survey

Focus group discussion guide

Module 1: Perceptions on healthy diet

1. What are the food items mainly consumed at your household diets?
   Ask for breakfast, lunch, dinner and snacks.
   Categorize them to food groups Fruits, Vegetables, Cereals/Grains, Legumes, Milk products, Fish and meat

   Probe:
   - Why do households eat the mentioned foods/diet?

2. What do you mean by a healthy/nutritious diet? What are the characteristics?

   Probe:
   - Do you think you can provide / eat a healthy diet?
   - What are the nutrition-related issues in your village?
   - How do you get those nutrition/health-related information? Are they reliable?

3. What are the sources of food?

   Probes:
   - Which time of the year (Yala/Maha) you get those food from mentioned sources?
   - When do you have food in abundance or not?
   - Where are you get those foods from?

Sources	Food items
Below the tank bund	
Above the tank	
Inside the tank	
Paddy field	
Village forest	
Homegarden	

4. What are the nutritional/health importance/benefits of those food items?

5. Do all members of your family like/prefer to eat those foods?

   Probes:
   If yes, why?
   If no, why?

Module 2: Perceptions on food security

6. Do you think you can produce foods by yourselves?

Probes:

- What do you think about the foods that you produce in your farm/homegarden or in your village? (ask about the safety / nutrition and health)
- What are the barriers to produce your own food?
- What are the foods that you purchase? Why?

7. What are the barriers / factors influencing village community's and households' access to food?

8. Do you think that the households in your village are able to get all the foods (safe and nutritious) you prefer in adequate quantities, all the time?

   Probes:

   - If yes, explain whether they are the foods you prefer
   - What kind of families who cannot get all of the food requirements?
   - What are the reasons for not getting the required food in required amounts?

9. When you are unable to get the foods that you want and in adequate amounts what do you do?

10. What do you suggest to overcome food shortages or related issues in your area?

Module 3: Physical, socioeconomic and institutional evolution of the village tank cascade systems

11. What are the problems associated with water resources in tank systems and associated ecosystems?

    Probe:

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

12. How do those changes in tank cascade systems or your village tank and associated ecosystems which have led to the present situation regarding food production / availability and access?

13. Are there any other changes (probe: socio-cultural and economic systems) affected the food consumption pattern in your village?

14. What suggestions that you can make to promote the food that are available in the village?

15. **Closing:** Do you have any other comments about current food habits in the community/villagers?

Annexure 5.5

"Healthy Landscapes: Managing Agricultural Landscapes in Socio-Ecologically Sensitive Areas to Promote Food Security, Well-Being and Ecosystem Health"

Assessment of food security, human health and community wellbeing – Baseline survey

Key Informant Interview Guide

The purpose of interview is to talk about the food patterns connected with the village tank and agriculture.

1. How would you describe the common (standard) diet in the area at present?
2. What were the food items that were consumed by the villagers in the past (childhood)?
   (Ask about different food groups. Fruits, green leaves, vegetables, pulses and cereals, fish species)

Food group	Food item	Where were they grown? (around the tank; inside the tank; paddy fields; chena; homegarden; wild (bare lands and forest)
Cereals – Rice, Maize, Millets		
Vegetables		
Green leafy vegetables / herbs / flowers		
Fruits		
Pulses		
Nuts		
Fish		
Meat/Eggs/Milk		
Beverages		

3. What are the nutritional/health importance/benefits of those food items?
   (Ask separately about different foods/groups – functions or disease prevention)
4. Did people think that some foods **should not be consumed** in certain situations?
   (perceptions regarding food items)
5. What are the foods that you consumed during your childhood but no longer consumed by you or your family at all or consumed rarely at present? – Read the foods listed in Q2 by the interviewee and check.
   Probe: Why are such foods no longer consumed? (not available or cultivated / not preferred by present generation/ other problems in accessing and preparing / lifestyle changes / traditional knowledge loss)

6. How did villagers cope with the recent Covid19 lockdown/curfew period in relation to food?
7. What changes have occurred to village tank system/village environment compared to your childhood time? ***(Probe: physical/social/political environment and climate change and associated weather pattern changes)***
8. How does it affect the dietary patterns of villagers?
9. How does it affect the nutrition and health of the villagers? ***(probe about NCDs, undernutrition of children and pregnant women)***
10. What suggestions can you make to **preserve** and **promote** the healthy foods that are available in the village? ***(Probe: refer to the answers given in the Q5 and Q7 and ask them to make suggestions)***

Annex: Desk Review of VTCS Publications

	Title	Key words	Author/s name/s Editor/s name/s	No of citations	type of publication and year of publication	Main focus areas and findings
1	Analysis of return flows in a tank cascade system in Sri Lanka	Irrigation reservoir · Paddy rice · Water balance · Water management	Yutaka Matsuno · Masahiro Tasumi		Journal Article, Paddy Water Environ (2003) 1:173–181 DOI 10.1007/s10333-003-0029-9	Hydrological aspects - Water balance
2	Nature of small tank cascade systems and a framework for rehabilitation of tanks within them	Irrigated farming Hydrology, Surface water, Groundwater,	Sakthivadivel, R.; Fernando, N.; Panabokke, C. R.; Wijayaratna, C. M. 1996. Nature of small tank cascade systems and a framework for rehabilitation of tanks within them. Colombo, Sri Lanka: International Irrigation Management Institute (IIMI). 54p. (IIMI Country Paper Sri Lanka 13)	32	Book, International Irrigation Management Institute (IIMI). 54p. (IIMI Country Paper Sri Lanka 13, 1996)	Water basin characteristics Hydrology of the system Water uses of the system (Presenting a methodology for planning the rehabilitation and improvement of small-scale irrigation systems within the context of the water basin when information on hydrology and water use is inadequate).
3	Integrated management of surface and groundwater resources in tank cascade systems	Not given	Author/s P B Dharmasena Editor: S. Pathmarajah	11	Article of conference proceeding book Proceedings of symposium "Use of groundwater for agriculture in Sri Lanka," Peradeniya, Sri Lanka (2003)	Integrated surface and groundwater management model of Runoff, percolation, evaporation, groundwater availability, crop water use assessment (The paper discusses the pre-requisites for and the process of integrated water resource management planning)
4	Agro-well Development and its Impact on Groundwater Table Depletion in Tank Cascades in the Dry Zone of Sri Lanka	Agro-wells, Tank Cascades, Groundwater Table, GIS maps	Muditha Prasannajith Perera K.W.G. Rekha Nianthi C.M. Madduma Bandara		International Journal of Arts and Commerce (2016) www.ijac.org.uk	Ground water Agro-well development (Identifying the impacts on groundwater table due to Agro-well development in tank cascades in the Dry Zone)
5	Seasonal and Spatial Variations of N, P, K and Cd Concentrations in Water of the Mahakanumulla Cascade in the Dry zone of Sri Lanka	Seasonal changes, plant nutrients, heavy metal, tank cascade system	W.M.G.D. Wijesundara K.A. Nandasena	11	Tropical Agricultural Research Vol. 24 (3): 279 – 288 (2013)	Water pollution assessment of VTCS. Spatial accumulation of agrochemicals and heavy metal in the system (Systematic work on water quality aspects, particularly on the accumulation and fluctuation of plant nutrients and heavy metals, in the Mahakanumulla tank cascade in the dry zone of Sri Lanka).
6	Interpolation methods for groundwater quality Assessment in tank cascade landscape: a study of Ulagalla cascade, Sri Lanka	deterministic interpolation, empirical Bayesian kriging (EBK), geostatistical methods, root mean square error (RMSE), spatial variability	KUMARI, M. K. N.1,2* – SAKAI, K. 3* – KIMURA, S. 3 – NAKAMURA, S.3 – YUGE, K. 4 – GUNARATHNA, M. H. J. P.1,2 – RANAGALAGE, M. 5 – DUMINDA, D. M. S.	5	Journal Article, Applied Ecology and Environmental Research (2018) 5:5359--5380	Ground water quality assessment Water quality assessment parameters/indices (Groundwater quality Assessment in a VTCS (Ulagalla) usisng Geostatistical interpolation. Water quality parameters/indices in the VTCS used as variables or indicators
7	Spatial and Temporal Changes in Nitrogen, Phosphorus and Potassium Concentration in Water in the	Plant nutrients, Thirappane tank cascade system, Surface water	W. M. G. D. Wijesundara# , K. A. Nandasena and A. N. Jayakody	5	Journal Article, Journal of Environmental Professionals Sri Lanka (2012)	Spatial temporal Soil and water pollution assessment (N, P, K concentrations in soil and water. Highest concentration of nutrients was observed in Yala compared to the Maha

	Thirappane Tank Cascade in Dry Zone of Sri Lanka					season. Low nutrients concentration in the Maha period could be due to dilution effect caused by comparatively high volume of tank water. The chemical fertilizer may be applied based on-site specific characteristics relating to soils and water as well.)
8	A review on the qanats in Iran and the tank cascade System (tcs) in Sri Lanka –	Iran, Tank cascade system, Qanats, Total environment, Hydraulic civilization	H.A.H. Jayasena K.R. Gangadhara	1	Journal Article, Geological Society of Sri Lanka (2014) 16:75--91	Evolution of the system Environment, social and procuration characteristics of the system (Assessment of evolution of Qqunata (Iran) and VTCS (sri Lanka) based on integrated environment criteria)
9	Geochemical characteristics of sediments from a reservoir (tank) ecosystem in Sri Lanka	Tank sediments, High field strength Elements, Malagane Tank Cascade (Daduru Oya basin), Principal component analysis, Enrichment factors	Rohana Chandrajith Kushani Mahatantila H. A. H. Jayasena & H. J. Tobschall	23	Journal Article, Paddy and Water Environment (2008) 6:363--371	Tank sediment Geochemistry study Analysis of sediments sample for geochemistry Water pollution study
10	Rainwater harvest by tank cascades in Sri Lanka -was it a technically adapted methodology by the Ancients?	Rain water harvest, cascade tanks, sequence, dry zone, Deduru Oya, Sri Lanka, sustainable, water management, ancient, sociotechnical	K.R. Gangadhara H.A.H. Jayasena	3	Journal Article, Proceedings of the twelfth international conference on rainwater catchment systems, New Delhi, India (2005)	Study on Spatial distribution and evolution of tanks system based on rail fall regime (Towards the drier part of the dry zone of Sri Lanka the tank density and their respective water surface area are increasing. Very low number of tanks are representing from the high rainfall area. Construction of tanks and settlements of human habitats had been conducted in a technical manner, considering pure socio technical criteria. Placing a new tank in the environment was done with accepted procedures but not by random selections)
11	Resilience Thinking and Strategies to Reclaim Sustainable Rural Livelihoods: Cascade Tank-Village System (CTVS) in Sri Lanka	cascading tank village system, sustainable livelihoods, resilience thinking, Sri Lanka, rural dry zone, community rural development	Gavin Melles Ethmadalage Dineth Perera		Journal Article, MDPI, Challenges (2020)	Resilience Sustainability Application of sustainable livelihood framework and resilience assessment framework Discussed sustainable livelihood and resilience indicators
12	Village Tank Cascade Systems: A Traditional Approach to Drought Mitigation and Rural Well-being in the Purana Villages of Sri Lanka	Cascade tank village system, Purana Village, ecological sustainability	C.M. Madduma Bandara		Journal Article Indigenous Knowledge for Disaster Risk Reduction (2018)	VTCS as climate change adaptation solution .
13	Evolution of Tank Cascade Studies of Sri Lanka	Small Tanks, Cascade Systems, Catchments, Command Area, Food Security, Water Flow, Groundwater, Hydro-ecology.	Dr. Muditha Prasannajith Perera		Journal Article Saudi Journal of Humanities and Social Sciences (2017) 2:597-610 DOI: 10.21276/sjhss	Assessment of VTVS studies by categorizing into 12 …. thematic areas, such as historical/, engineering, geography, hydrology, ecology, biodiversity etc etc.
4	Spillway Modernization for Improving Robustness of Village Tank Cascades for Floods, Sri Lanka	flood analysis, ungauged catchments, peak discharge, natural spillways, piano key weir	K.T.N. Perera Nimal Wijayaratna		Proceedings, Moratuwa Engineering Research Conference (MERCon,2020) 360--365	
15	Indigenous Agricultural Systems in the Dry Zone of Sri Lanka: Management Transformation Assessment and Sustainability	agricultural systems; community based; irrigated agriculture; irrigation landscape; participatory; traditional	Nuwan Abeywardana , Brigitta Schütt , Thusitha Wagalawatta and Wiebke Bebermeier 1,*	14	Journal Article, Sustainability (2018) 11:910	Sustainability of the indigenous agricultural system This is vulnerable to rapid changes due to modernization, market changes, education levels, and inconsistent management decisions.

		knowledge; water harvesting; water management				Farmers' perceptions of the management of their irrigated landscape and its indigenous aspects captured
16	Spatial and temporal changes of hydro geochemistry in ancient tank cascade systems in Sri Lanka: evidence for a constructed wetland	ancient irrigation, constructed wetland, dry and wet zone. Fe and Mn hydro geochemistry, man-made tanks, nutrients	Mahatantila, Kushani and Chandrajith, Rohana and Jayasena, HAH and Ranawana, KB		Journal article, Water and Environment Journal 2008 22(1):17-24. https://doi.org/10.1111/j.1747-6593.2007.00077.x	Temporal and spatial variations of the hydro geochemistry of a small cascade system Water pollution,
17	Ecology of ancient tank cascade systems in island Sri Lanka	Tank Cascade System Watershed management	Geekiyanage, Nalaka and Pushpakumara, DKNG	28	Journal article Journal of Marine and Island Cultures 2013 1;2(2):93-101 https://doi.org/10.1016/j.imic.2013.11.001	Ecological implications of the Tank Cascade Systems
18	A simple water balance modelling approach for determining water availability in an irrigation tank cascade system	Water balance Modelling Sri Lanka Irrigation Water storage Simulation	Jayatilaka, CJ and Sakthivadivel, Ramaswamy and Shinogi, Y and Makin, Ian W and Witharana, P	48	Journal article Journal of Hydrology 2003 (1-4):81-102 https://doi.org/10.1016/S0022-1694(02)00360-8	Hydrology Water balance model *Cascade* formulated to account for the dynamic hydrologic components of an irrigation tank cascade system in Anuradhapura, Sri Lanka
19	Analysis of return flows in a tank cascade system in Sri Lanka	Irrigation reservoir Paddy rice Water balance Water management	Matsuno, Yutaka and Tasumi, Masahiro and van der Hoek, Wim and Sakthivadivel, Ramaswamy and Otsuki, Kyoichi		Journal article Paddy and water environment 2003 1(4):173-81 https://doi.org/10.1007/s10333-003-0029-9	Hydrological aspects - Water balance
20	Characterization of the Rota Wewa tank cascade system in the vicinity of Anuradhapura, Sri Lanka	Watershed management Water harvesting Sediment characters Sustainability Traditional knowledge	Sch{\"u}tt, Brigitta and Bebermeier, Wiebke and Meister, Julia and Withanachchi, Chandana Rohana	13	Journal article DIE ERDE--Journal of the Geographical Society of Berlin 2013 144(1):51-68. https://doi.org/10.12854/erde-144-4	Sediment analysis for reconstruct the palaeoenvironmental history
21	Tank cascade systems as a sustainable measure of watershed management in South Asia	Water harvesting Water storage Water control Traditional knowledge Tank siltation	Bebermeier, Wiebke and Meister, Julia and Withanachchi, Chandana Rohana and Middelhaufe, Ingo and Sch{\"u}tt, Brigitta		Journal article Water (MDPI) 2017 9(3):231 https://doi.org/10.3390/w9030231	Investigate sediment characteristics relates Functions and characteristics of VTCS
22	Water management in ancient Tank Cascade Systems (TCS) in Sri Lanka: Evidence for systematic tank distribution		Jayasena, HAH and Chandrajith, Rohana and Gangadhara, KR	12	Journal article J Geol Soc Sri Lanka 2011 14: 29--34	Spatial distribution pattern analysis of tanks in cascades in the Deduru Oya river basin
23	Management of small irrigation tank cascade systems (STCS) in Sri Lanka: past, present and future	Small tanks Community Sri Lanka Small Tank Cascade Systems Governance Climate adaptation	Kekulandala, Bhathiya and Jacobs, Brent and Cunningham, Rebecca	1	Journal article Climate and Development 2020 https://doi.org/10.1080/17565529.2020.1772709	Governance of VTCS (The management of STCS through history and identifies major issues in the current governance model and the challenges and opportunities associated with renewed interest in small tank cascade systems (STCS) to support adaptation to climate change)
24	Classification of Groundwater Suitability for Irrigation in the Ulagalla Tank Cascade Landscape by GIS and the Analytic Hierarchy Process	Dry zone Empirical Bayesian kriging Maha season Sri Lanka Tank cascade system Yala season	Kumari, MKN and Sakai, Kazuhito and Kimura, Sho and Yuge, Kozue and Gunarathna, MHJP		Journal article, Agronomy (MDPI) 2019 9(7), 351 https://doi.org/10.3390/agronomy9070351	Assessment of ground water suitability of irrigation Ground water quality parameters Agro-wells (The suitability of groundwater for irrigation using the analytic hierarchy process and geographical information system.)
25	Will restoration of ecological functions of tank cascade system contribute to reduce CKDu in Sri Lanka? A review	Chronic kidney disease Heavy metals Tank cascade system Ecology Water Quality	Abeysingha, NS and Dassanayake, KB and Weerarathna, CS	3	Journal article Environ. Manag. Sustain. Dev 7: 60--81 2018	Water Pollution Restoration Ecology of VTCS componenets Human Health

					doi:10.5296/emsd.v7i3.13129	(The issues and gaps in understanding the ecological functioning of Globally Important Agricultural Heritage System. It is suggested that reconstruction of ecofriendly structural components of tanks and reestablishment of tank cascade system in the area would help to combat the spreading of CKDu in dry and intermediate zone of the country)
26	Optimal water management in pihimbiyagollawa tank cascade system		Hettiarachchi, HASM and Basnayake, BMLA		Booktitle:Proceedings of the Undergraduate Research Symposium on Recent Advances in Civil Engineering 2016	Water balance study for optimal water management Development of an optimization model for the Pihimbiyagollawa TCS using "WEAP" software tool
27	Applicability of Water Level Monitoring System and Water Level Estimation System to Tank Cascade in Sri Lanka	Agricultural Engineering Disaster prevention Heavy rainfall Small earth dam Storage function method Flood	IZUMI, Akira and HORI, Toshikazu		JARQ 55 2021 (1), 35-43 Japan International Research Center for Agricultural Sciences	The water level monitoring system and water level estimation system in tank cascades in Sri Lanka to improve disaster prevention measures.
28	System Dynamics Based Model for the Nachchaduwa Reservoir in the Malwathu Oya Basin, Sri Lanka	System Dynamics Simulation, Vensim Software, Nachchaduwa Reservoir	R.D.T. Kaushalya and K.D.W. Nandalal		Journal Article ENGINEER - Vol. L, No. 04, pp. [31-40], 2017 © The Institution of Engineers, Sri Lanka	System approach or system dynamics application (study) to VTCS Using system dynamics modelling show most optimum cropping pattern for the Nachchaduwa Reservoir System is to grow
29	Water Quality Assessment of a Tank Cascade System using CCME Water Quality Index	-CCME WQI, cascade, drinking, fish & aquatic life, irrigation & agriculture, recreational use	MHJP Gunarathna, MKN Kumari		International Journal of Research and Innovation in Applied Science (IJRIAS) |Volume I, Issue III, June 2016|ISSN 2454-6194	Assess the water quality of Malwathu Oya cascade-I in tropical Sri Lanka for drinking, fish & aquatic life, irrigation & agriculture and recreational use by applying CCME Water Quality Index (WQI). CCME WQI showed that water quality is poor for drinking, fish & aquatic life and irrigation & agriculture in tanks of Malwathu Oya cascade- I while, marginal for recreational use. However, it showed high spatial and temporal variation of water quality for all kind of water use
30	Rehabilitation of Irrigation Tank Cascade System Using Remote Sensing GIS and GPS	Tank Cascade, Rehabilitation, GIS, GPS	M.Krishnaveni1 ,Siva.Sankari2, A. Rajeswari	5	International Journal of Engineering Science and Technology (IJEST)	The prediction of water availability for the purpose of improving productive use of the water resources in a tank cascade system Using GIS, GPS and RS The land use/land covers are Agricultural, Nonagricultural, barren land, forest and settlements. The drainage courses problems are identified in the tank cascade system by GPS tracking. The land use/land cover map was prepared using Cartosat imagery This study is conducted towards rehabilitation of irrigation tank cascade system. It was found that most of the irrigation tanks do not receive the surplus from the upstream tanks. Rehabilitation of irrigation tank cascade system is very essential, and GIS and GPS are the most effective tools.

31	The importance of the small-tank cascade system for the sustainable production of water in the dry zone of Sri Lanka	sustainable production, management, cascade system, spatial modeling, scenarios, GIS = Geographical Information Systems]	S. Shanmuganathan1 , M. Manobavan1 , and, G.W.A.R. Fernando2	1	Journal article 2010	Assessment and evaluate of potentiality of sustainable production of groundwater resources (A GIS based spatial modeling approach was adopted to understand the state of the small-tank cascade system at present.)
32	Water Quality Variation in a Tank Cascade Irrigation System: A Case Study from Malagane Cascade, Sri Lanka	Hydrophytes · Irrigation · Water quality	Kushani Mahatantila, Rohana Chandrajith, H.A.H. Jayasena, and Sampath Marasinghe		Journal article, Environmental Earth Sciences, 2010	Water quality Water pollution (Investigate the water quality variation in a tank cascade system and study the role of hydrophytes found in the upper periphery (Thaulla). The Malagane Tank in the northwestern intermediate zone of Sri Lanka was selected for the study Fairly high levels of nutrients and metal concentrations were recorded in the upstream paddy fields and main inflow of the tank. Concentrations of most of the chemical parameters were showed a decreasing trend while passing the thaulla area which is one of the most important hydrologic regimes in a tank system.)
33	Village Tank Cascade Systems of Sri Lanka A Traditional Technology of Water and Drought Management	Cascades, Principles and Substance, Current Relevance	C.M. Madduma Bandara		Book, 2005	Sustainability study of analyzing VTCS characteristics and features Traditional technologies cannot be adequately comprehended in isolation without reference to the ecological and social systems in which they prevail. This may be approached through a systems approach, than through a sectoral or piecemeal approach.

	Title	Key words	Author/s name/s Editor/s name/s	Number of citations	type of publication and year of publication	Main focus areas and findings
34	Environmental Problems Faced by the Ancient Village Wewa (Tank) Cascade System: A Case Study at Kappriggama in the Dry Zone of Sri Lanka	Cascade system Water Environment Kappirigama	Dewaraj, KE		2017 Publisher: Rajarata University of Sri Lanka	Identify the major environmental problems faced by Kappirigama Wewa cascade system and work out appropriate solutions. (This study applied the framework of the ecosystem components and functions constructed by Jayasundara for comparison of model with actual conditions.)
35	Alternative approaches to small tank/cascade rehabilitation: Socio-economic and institutional perspective		Aheeyar, MMM	4	2013 Book Publisher: Hector Kobbekaduwa Agrarian Research and Training Institute}	Review different approaches adopted by three different organizations in rehabilitating small tanks/cascade systems. Identify the best practices and success and failure aspects of these rehabilitation models. Propose recommendations for future rehabilitation strategies
36	The Existence of Multiple Hydro-Mentalities and their Implications for Water Governance: A Case Study from Sri Lanka	hydro-mentality; irrigation; Sri Lanka; water; water management	Paranage, Kavindra and Yang, Nancy	1	Journal Article Water. 2020 Jul;12(7):2043	How different social and cultural groups construct diverse philosophies of water that heavily influence their unique water management patterns and styles. The possibility of multiple hydro-mentalities that exist in regard to water and how these different hydro-mentalities have a very real effect in shaping water management practices across various socio-cultural groups.
37	Tank cascade characteristics of the small tank systems in Sri Lanka: a comparative study of Rajarata, Uva-Wellassa and Ruhuna-Magama regions	Small tanks, Tank cascade system, Tank regions, Topography	Perera, MP and Priyadarshanee, KSGS		Sri Lankan J. Agric. Sci. Vol. 51 – 2014, 34 - 43	Identify the nature of tank systems in terms of emergence of "Tank Cascades" and to understand the differences of basic tank cascade characteristics among the different tank regions of the dry zone. (Thirty tank cascades that covered three ancient tank regions were used in this study. Data were collected using 1: 50,000 topographic maps of Anuradhapura, Pallegama and Hambantota representing the Rajarata, Uva-wellassa and Ruhuna-magama area respectively. Google Earth was used to identify the specific cascade boundaries, and actual water surface areas of the tanks. ArcGIS 10.3 software and digitizing maps were used for area calculations.)
38	How the Ancient Cascade System Functioned and Current issues; A case study at Kappiriggamain Dry zone in Sri lankka	Cascade system Irrigation tanks Kappirigama Water	Lakmini, DNN and Subhasinghe, PMGSS		2018 Publisher: Rajarata University of Sri Lanka	Examine how the ancient cascade system functioned and current issues in Kappiriggama cascade system.
39	A study of identifying the potential for improving rainwater harvesting systems in a village tank cascade system-a Case study of Kappiriggama Village tank system in Anuradhapura District	Kappiriggama Rainwater tanks Development potential Usable water scarcity	Herath, NSK and Dilanjani, HUK		2016 Publisher: Rajarata University of Sri Lanka	Assess the availability of rainwater harvesting tanks in Kappirigama tank cascade system area. Identify the present usage of rainwater tanks and the reasons for why people are reluctant to use rainwater harvesting tanks.
40	Drinking Water Quality on Chronic Kidney Disease of Unknown Aetiology (CKDu) in Ulagalla Cascade, Sri Lanka	Chronic Kidney Disease of unknown aetiology, Surface water, Ground water, Drinking water quality, Drinking water quality standards	Wanasinghe, WCS and Gunarathna, MHJP and Herath, HMPIK and Jayasinghe, GY	7	2018 Publisher: Belihuloya, Sabaragamuwa University of Sri Lanka http://repo.lib.sab.ac.lk:8080/xmlui/handle/123456789/632	Evaluate the drinking water quality of Ulagalla cascade in Anuradhapura district with admiration to CKDu. (Once the input data was imported as a point layer into ArcGIS 10.1, geo-database was created to generate the maps of spatial distribution of selected ground water quality parameters. Point based Inverse Distance Weighted (IDW) interpolation method was used to produce spatial distribution of GW quality variables. To evaluate measured drinking water quality parameters of GW and SW t test (one sample t test

						and two sample t test) was performed by using Minitab statistical software package)
41	Optimal Water Management-Case Study of Tank Cascade System.		Shinogi, Y.		IRCAS International Symposium Series (Japan). 2002	the optimal water management of a tank cascade system (TCS), mainly in the dry (Yala) season. Investigate the potential of optimization of water management and the introduction of OFC (Other Field Crops) for crop diversification to raise productivity and stabilize farmers' incomes even during the dry season. Determining a cropping strategy to cope with the variations in annual rainfall and surface water inflows in the Meegassagama command area through the use of an optimization model.
42	Implications of storage state behaviour of village tanks in adaptation to climate change, Sri Lanka	climate change adaptation, reliability, resilience, storage states, transition probability, village tanks	K. T. N. Perera T. M. N. Wijayaratna H. M. Jayatillake Tilak Priyadarshana J. M. A. Manatunge		Journal Article Journal of Water and Climate Change (2020) https://doi.org/10.2166 /wcc.2020.285	Understanding of the near real-time storage behavior of village tanks in a given region to be aware of and prepared for the times of water shortages to apply remedial measures and to facilitate the planning of cropping patterns, improving water management and identification of modernization needs of the tank systems.
44	Public Preferences for Cascade Development		Lakmali, IMT and Rajapakshe, PSK		2017 Organization: Sri Lanka Forum of University Economists (SLFUE)	Estimate the benefits of cascade system by examining the public willingness to pay for cascade development (Rambewa Division of the North Central Province). (Primary data(by structured questionnaire,interviews and field observations),secondery data(from the internet and books)were analyzed by spread sheet applications (MS Excel) and statistical software's (SPSS).)
45	"Identification of cascade systems and assessment of the performance of village tanks in Kovilkulam Agrarian Centre Area" ICSBE 2016	cascade systems; cropping intensity; hydrological endowmentrehab ilitation, tank performance	Sudusinghe, SA and Nanthakumaran, A and Kadupitiya, HK			Identify the cascade systems among the tanks in Kovilkulam Agrarian Centre using GIS and to assess the tank performance.
46	Identification of cascade systems and assessment of the performance of village tanks at Madukanda agrarian service centre	Cascades, Cropping intensity, Hydrological endowmentReha bilitation, Tank performance	W.E.P.Athukorala A.Nanthakumaran H.K.Kadupitiya		Article of conference proceedings South Eastern University of Sri Lanka, University Park, Oluvil, Sri Lanka (2018)	Cropping intensity and hydrological endowment were used to assess the performance of the tanks. Results revealed that 64% of the tanks were with good hydrological endowment whereas 36% of the tanks were with poor hydrological endowment. (GIS software platforms were used to identify the cascades among the minor irrigation tanks)
47	Progress of research on cascade irrigation systems in the dry zones of Sri Lanka		Nianthi, KWG Rekha and Jayakumara, MAS	4	Book title :Water communities 2010	The progress of cascade concept during the past few years.
48	Characterization of agro-well water in Malwathu Oya Cascade-I in Anuradhapura district of Sri Lanka	Agro-wells, groundwater potential, irrigation water quality, Malwathu Oya cascade	Kumari, MKN and Pathmarajah, S and Dayawansa, NDK and others	8	Journal Article Tropical agricultural research 2013;25(1):46-55	The characterization of agro-well water for its suitability for irrigation in the Malwathu Oya cascade based on its quality and availability.
49	Computation of runoff on tank cascade system using GIS	Tank, catchment, GIS, runoff, land use, soil	Nagarajan, M and Thiyagarajan, G and Kannan, Balaji and Manikandan, M		Journal Article Journal of Pharmacognosy and Phytochemistry 2019;8(4):613-20	Computation of the runoff in tank catchment using GIS databases. For the study 10 tank cascade system was selected in upper Noyyal river basin, Coimbatore region of Tamil Nadu.
50	Are geostatistical interpolation techniques better than deterministic interpolation methods? A study in ulagalla tank cascade, Sri Lanka	Spatial variation, groundwater quality, empirical bayesian kriging	Kumari, MKN and Sakai, Kazuhito and Gunarathna, MHJP			The predictive performances of deterministic (inverse distance weighted, global polynomial interpolation, local polynomial interpolation, radial basis function) and geostatistical interpolation methods (universal kriging, ordinary kriging, and empirical Bayesian kriging) to interpolate the spatial variation of groundwater

						quality in the Ulagalla cascade, Sri Lanka
51	A Geographical Analysis of Positioning and Functionality of the Tank Cascade Systems of the North Central Province Sri Lanka	Cascades, Water efficiency, catchment dryness, Water yield, Water surplus, Tank water intake	Bandaranayake, Ganthihe Mudiyanselage		2009 Phd thesis Doctoral dissertation, University of Sri Jayewardenepura, Nugegoda DOI : 10.31357/fhssphd.2009.00709	Comparative analyzation the 'water efficiency of tank cascade systems' using remote sensing, and topographical maps interpretation together with field verifications (by observing the distribution and positioning of the tank cascades with emphasize on the physical setup to enable an analysis of water efficiency.)
52	Small tank cascade systems: their relevance for minor irrigation rehabilitation		Bandara, CM Madduma	1	Journal Article (2004): 43 Small Tank Settlements in	A properly planned 'cascade-based' approach to development of small irrigation systems, fed and nurtured by large scale irrigation projects would prove to be a more enduring solution to the acute water stress in such areas. A fundamental change in land use towards less water consuming and more economically attractive crop and livestock combinations, has a better chance of assuring stability in these rural areas.
53	Hydrological principle behind the development of series of bunds in ancient tank cascades in small catchments, Sri Lanka	development principle, peak inflow, routing, runoff harvesting, village tank cascade	Perera, KTN and Wijayaratna, TMN and Jayatillake, HM and Manatunge, JMA and Priyadarshana, Tilak		Journal Article Water Practice \& Technology 2020 Dec;15(4):1174-89	• Village tanks are important though they are vulnerable to both floods and droughts. • Identification of development principles assists in improving their robustness. • Historical evidence, studies and routing mechanism using a HEC-HMS model verified the hypothesis developed. • The suggested definition of the tank cascade indicates its hydrologically dependent and interlinked nature. • Development principles should be considered during the restoration. The layout of the bund series identified in the 1: 50,000 topographical maps was further investigated using the STRM30 (NASA 2015) Digital Elevation Model (DEM) of 30 m resolution and satellite images available in Google Earth. The cascade parameters and catchment characteristics were determined using the tools available in Arc GIS 10.3.1 software. Flow accumulation paths, gross and net catchments at each bund were delineated using the software, which determines the contributing area above a set of cells in a raster map.
54	Water resource assessment of a cascade system in the intermediate zone of Sri Lanka for the past fifty two years through hydrological modeling	Water resources, modeling, cascade system, intermediate zone	B M C N Kularathne and M M M Najim		Journal article Year 2014, Sri Lanka Association of the Advancement of Science	Evaluating the suitability of the HEC-HMS model for water resources assessment in a cascade system together with a water balance approach under a cascade system Among the three tanks in the cascade system Karangamuwa tank has the lowest number of days on which the reservoir is empty. The crops affected include the sum of totally as well as partially affected percentages of cropping seasons.
55	Agro-well Development and its Impact on Groundwater Table Depletion in Tank Cascades in the Dry Zone of Sri Lanka	Agro-wells, Tank Cascades, Groundwater Table, GIS maps	Muditha Prasannajith Perera, K.W.G. Rekha Nianthi, C.M. Madduma Bandara	5	International Journal of Arts and Commerce ISSN 1929-7106, volume 5, pages 66-77, year 2016	Compare the status and the behavior of the groundwater table between different Agro-well density cascades. Elevation points of Agro-wells were taken from a GPS receiver. An analysis was based on GIS maps and "Kriging Interpolation Method" that was used to assume the un-sample points to create groundwater elevation contours differences of water table depletion using "groundwater table maps" (below ground level) within a year. groundwater table has normally declined with or without groundwater extraction through Agro-wells. This means, that the main factor for the groundwater fluctuations in all tank cascades was the rainfall pattern

56	Evaluation of Groundwater Quality for Irrigation in Malwathu Oya Cascade-I in Anuradhapura District of Sri Lanka	Agro-well, dry season, irrigation, Malwathu Oya cascade-I, water quality	M.K.N. Kumari* , S. Pathmarajah1 , N.D.K. Dayawansa1 and K.G.S. Nirmanee	4	Tropical Agricultural Research Vol. 27 (4):310–324 (2016)	Point based inverse distance weighted interpolation method available in GIS was used to produce maps of spatial distribution of water quality parameters. Malwathu Oya Cascade-I has a good groundwater potential for agriculture. It was observed that almost all the chemical parameters monitored except nitrate and ammonium tends to concentrate towards the lower part of the cascade during the premonsoon period.
57	Importance of cascade systems (ancient irrigation systems) in sustainable development of rural communities in the dry zone of Sri Lanka (a review of the previous studies)	Cascade Systems, Sustainable Development	Saseeka Wijesekera,			Field as essential elements of water management for agriculture in the dry zone of Sri Lanka. The main principle behind the Tank Cascade Systems (TCSs) is recycling and reuse of water through a network of small to large scale tanks (Geekiyanage & Pushpakumara, 2013). TCSs are playing a marvelous role of community sustainable development in the dry zone of Sri Lanka
58	Variation in Soil Quality Parameters in the Thaulla Area of a Small Reservoir – A Case Study of Ulankulama Tank at Anuradhapura, Sri Lanka	Constructed wetland, Thaulla area, Tank cascade system, Ulankulama tank, Soil parameters	N.S. abeysingha1*, J.P.H.U. jayaneththi1, E.J. kosgollegedara1 and samuel hammer2	4	Vol. 16, No. 1&2, pp. 1-8 (2016) Journal of Agricultural Physics ISSN 0973-032X	Investigated the role of the Thaulla area in one tank (Ulankulama Tank) by observing the variation in several soil parameters including pH, EC, N, P, K, Ca, Mg, Na, sand, silt and clay content in soils tudy could be helpful in rehabilitation and management of tank ecosystems. Ulankulama Tank acts approximately as a wetland as evidenced by the accumulation of P and recorded lower N content in Thaulla area. Moreover, the Thaulla area of this tank trapped elements such as Mg, Na, and Ca as shown by decreasing concentration in Thaulla area towards the water spread area The reasons for this trapping may be the abundance of aquatic grasses and trees in the Thaulla area. These findings reconfirm the importance of ecological functions of Thaulla area of tanks. This study is useful in future land use planning in tank based agricultural areas and in taking the policy decisions to restore the Thaulla area where Thaulla is used for some other activities and degraded
59	Are geostatistical interpolation techniques better than deterministic interpolation methods? a study in ulagalla tank cascade, sri lanka	Spatial variation, groundwater quality, Empirical Bayesian kriging	M.K.N. Kumari, Kazuhito Sakai, M.H.J.P. Gunarathna		Journal article	Deterministic and geostatistical interpolation techniques in ArcGIS is used to understand the spatial variation of natural resources and related environmental concerns including groundwater Based on the results, local polynomial interpolation method showed better performances compared to other deterministic methods. Empirical Bayesian kriging method outperformed all the other geostatistical and deterministic interpolation methods in interpolating the spatial variation of groundwater quality parameters/indices in the Ulagalla cascade.
60	Economic Valuation of Village Tank Systems of Hambantota District: Towards Development of an Incentive Mechanism for their Continuity	Contingency valuation, TEV, cascade system	E.B.I. Dayananda		Journal article, 2007	The Total Economic Value (TEV) concept was the basis for the valuation of tank benefits. To measure the direct use values, residual imputation approach, market price approach. opportunity cost method and contingent valuation method were used The results of contingent valuation method indicated that respondents are willing to pay I % of their average annual income for the recreational benefits of the tank the non-irrigation value of a village tank is greater than the irrigation value. In the case of cascade tanks that is 81% and in the case of isolated tanks that is 86%. The estimated tank benefits were then compared with tank rehabilitation cost in order to derive relevant policy implications. Results of the cost-benefit analysis indicated that rehabilitation of village tanks is economically feasible if multiple benefits are generated.