A PROPOSAL FOR DECLARATION AS A GIAHS THE CASCADED TANK–VILLAGE SYSTEM (CTVS) IN THE DRY ZONE OF SRI LANKA

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A PROPOSAL FOR DECLARATION AS A GIAHS

THE CASCADED TANK-VILLAGE SYSTEM (CTVS) IN THE DRY ZONE OF SRI LANKA

SUBMITTED TO
FOOD AND AGRICULTURE ORGANIZATION
OF THE UNITED NATIONS, SRI LANKA

P.B. Dharmasena, National Consultant, FAO

AUGUST 2016

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ACRONYMS

BD	Biodiversity
CCF	Climate Change Fund
CGIAR	The Consultative Group for International Agricultural Research
CoSOP	Country Strategy Operations Plan
DA	Department of Agriculture
DAD	Department of Agrarian Development
DL	Low Country Dry Zone
DS	Divisional Secretariat
DZ	Dry Zone
FAO	Food and Agriculture Organization
FD	Forest Department
FIM	First Inter-Monsoon
FO	Farmer Organization
GIAHS	Globally Important Agricultural Heritage System
IFAD	Internal Fund for Agricultural Development
IWMI	International Water Management Institute
LHG	Low Humic Gley
NGO	Non-Governmental Organization
RBE	Reddish Brown Earth
SIM	Second Inter-Monsoon
SL	Sri Lanka
SNR	Strict Nature Reserve
SWM	South West Monsoon
UNDP	United Nations Development Programme
UNESCO	United Nations Educational, Scientific and Cultural Organization
CTVS	Cascaded Tank-Village System

SUMMARY INFORMATION

Name of the Agricultural Heritage System: The Cascaded Tank-Village System (CTVS) in the dry zone of Sri Lanka

Local Name: Ellanga Wev Gammana

Requesting Agency: Ministry of Agriculture

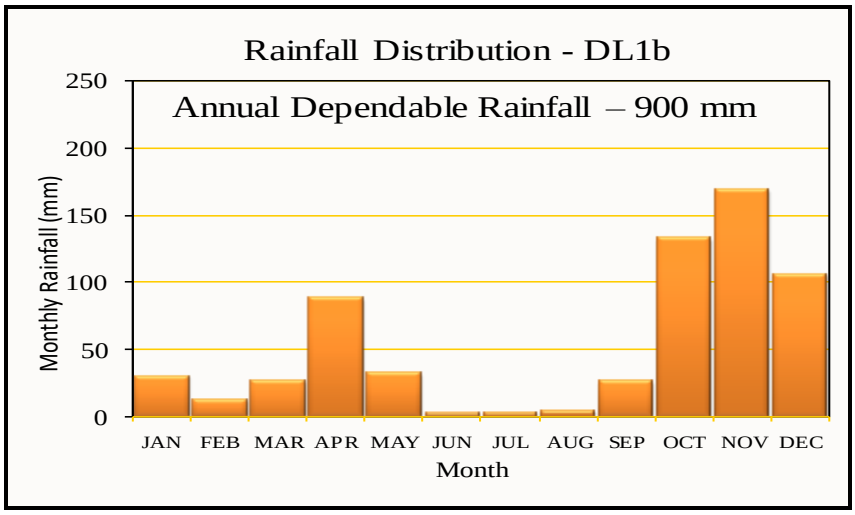
Country/location/Site: ThePalugaswewa Cascaded Tank-Village Ssystem (CTVS) is located in the Palugaswewa Divisional Secretariat Division in the Anuradhapura District of Sri Lanka. The site is located on N 08^0 25' 12'' and E 80^0 21' 36''.

The site is within the Malwathuoya river basin, which is the home for original settlers, who developed ancient irrigation systems in Sri Lanka. The site falls within the "Cultural Triangle" of Sri Lanka, where ancient cultural monuments are conserved under the UNESCO support.

Accessibility of the site to capital city or major cities: The site is located approximately 175km away from Colombo, the capital and 40 km from Anuradhapura, a sacred city in Sri Lanka. Further, the distances to local cities with tourist attraction, Habarana and Dambulla are10km and 30km respectively from the Palugasweva CTVS.

Approximate Surface Area: The site approximately covers an area of 1,450 ha.

Agro-Ecological Zone: The site falls within the agro-ecological zone DL1b, which is characterized by undulating terrain and bimodal rainfall pattern with 75 percent expectancy annual rainfall of about 900 mm.



Topographic Features: The site is located in an area of nearly 165-175m above mean sea level. The undulating terrain has developed well defined drainage ways in dendritic form, which is a unic feature to form cascaded tank systems. Valley bottoms are more or less flat and formed floor for irrigated terraced paddy farming. Often the crest positions of the terrain are occupied by forest vegetation on rock out crops and mid-aspect of the land catena is generally utilized for *chena* (shifting cultivation).

Climate Type: The climate of the area as well as the entire dry zone is mainly decided by the Northeast and Southwest monsoons. The annual mean rainfall in the area is about 1,400 mm. There is a distinct dry period, which extends from May to September. Depending on the monsoons there are four climatic phases or seasons namely: First Inter-Monsoon - FIM (March to April), South-West Monsoon - SWM (May to September), Second Inter-Monsoon - SIM (October to November) and North-East Monsoon - NEM (November to February). The rainfalls received during each season vary making a bimodal distribution pattern and give rise to two distinct growing seasons namely *yala* (minor) season and *maha* (major) season. *Yala* season includes FIM and SWM periods. As SWM rains are not very effective in the dry zone the *yala* season rains confine to one month showing a subsequent longer dry period. The *maha* season is the main growing season with sufficient rainfall extending from October to January.

Potential evapotranspiration varies from 42 to 122 mm/month during the year. Maximum monthly mean temperature varies from 29^0C to 35^0C, while mininmum value is in the range of 20^0C - 26^0C. Relative Humidity in the morning ranges from 77% to 91%, while in the evening it varies from 46% to 75%. The periods March – April and August – October are having the warmest climate. Average wind velocity is in the range of 3 – 10 km/hr.

Approximate Population: There are about 400 families with approximate population of 1,500 people.

Main Source of Livelihoods: Agriculture is the main livelihood of the people in the proposed site. Almost all people engage in tank irrigated lowland paddy cultivation, while some are engaged in rain-fed upland cultivation with crops such as legumes, coarse grains, vegetables etc. and few in livestockfarming. Very few people work in private and public organizations.

*Ethnicity/Indigenous population:*Sinhala majority with traditional *wanni* dialect and Tamil and Muslim minority

Summary Information of the Agricultural Heritage System:

The Palugaswewa CTVS consists of 11 tanks, of which 5 irrigation tanks are operational and others are abandoned at present. Two tank-villages namely Udakadawala and Palugaswewa are located at the lower part of the cascade. The upper part is covered with dense forest and shrub jungle, where the wildlife is secured.

The two village communities are self-sufficient in rice. All food items are produced by the farmers themselves. Well-drained paddy fields are used for cultivation of onion, chili, corn and pulses during minor season. Legumes, coarsegrains, fruits and vegetables are cultivated in uplands and home gardens. These crops bring significant income to the farmers. The tank itself is a basket of food including fish and aquatic food sources.

Village commons, forest and the tank ecosystems enhance the bio-diversity. Upstream tree belt (*gasgommana*) and downstream *kattakaduwa* of the main tanks, while conserving water, provide wild fruit and food, local medicine and habitat to many predators.

Some of the practices evolved for centuries and the knowledge passed through generations are still with the community and practicing in agriculture and natural disasters.

The agriculture being practiced in the CTVS is well knitted and inseparable with their century old culture. Specific folklore, folk song, beliefs, rituals, traditional festivals, practices and traditional crafts are stillin existence with this community.

The tank cascade itself is an evidence of the long practiced land and water conservation and management practices. The current state of the CTVS is no longer in pristine form, butthe system is very much serviceable and restorable. Since the site is located in the midst of the cultural triangle of Sri Lanka, it will definitely become an attractive destination for tourists. The CTVS once restored would exhibit the agricultural heritage with its unique features to demonstrate the sustainable agro-society, once flourished over the dry zone of Sri lanka.

I. CHARACTERISTICS OF THE PROPOSED GIAHS

A. General Description

i. The Dry Zone

The CTVS is widely found in the dry zone of Sri Lanka.The Dry Zone (DZ) is the area, which receives a mean annual rainfall of less than 1,750mm with a distinct dry season from May to September. The mean minimum temperature in the DZ ranges between 20 – 26^0C while maximum temperature varries between 29- 38^0C. The DZ is confined to the low-country, which is the area below 300m elevation. The rainfall pattern is a significant limiting factor in crop production.

The terrain in the DZ of Sri Lanka changes from flat to undulating to rolling when moving from ocean towards the interior. There are broad valleys in the undulating terrain and well-defined drainage ways in the terrain due to the high rainfall received in the *maha* (wet) season. The terrain condition and the rainfall are the two significant factors which enabled construction of tanks in the DZ that augment water supply for crop production. The construction of tanks has changed the landscape of the DZ to form a land use mosaic of water bodies (tanks), paddy tracts, forests, uplands and hamlets (figure 1).

Figure 1: A Village tank in the proposed CTVS–Yakandagaswewa

There are several great soil groups found in the DZ. The dominant soil types in Anuradhapura District are Reddish Brown Earth (RBE) and Low Humic Gley (LHG) soils (figure 2). The LHG is found in the valleys of the terrain where paddy lands are formed under the CTVS. The proposed CTVS site also consists of Reddish Brown Earth soil on upper aspects of the land catena associated with Low Humic Gley soils found in the valley bottom.

ii. The Cascaded Tank-Village System (CTVS)

The Cascaded tank-village system is an ancient, widely used and unique traditional agriculture systemmainly found in the DZ of Sri Lanka. The system has evolved over a period of nearly two millennia. It provides water for irrigation, domestic purposes, animals and ecosystems. CTVS is a dominant feature in the DZ of Sri Lanka. In a broader sense, the system can be considered as a sustainable ecosystem.

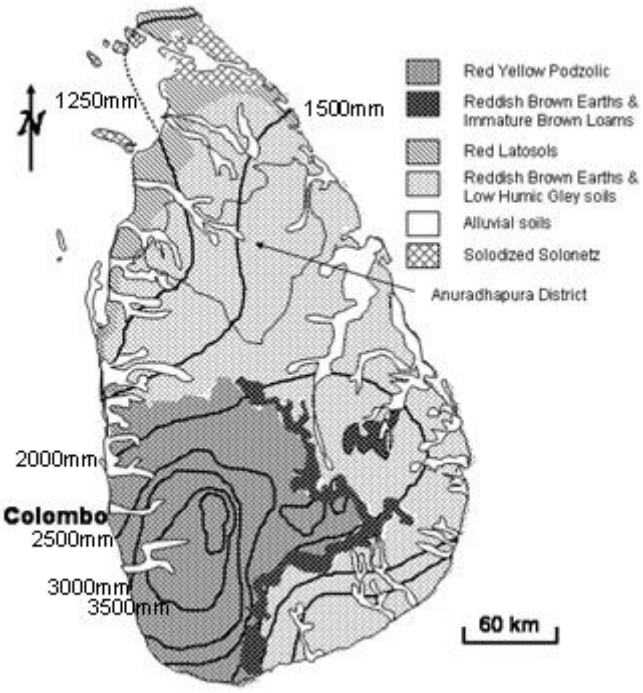


Figure 2: Soil type distribution with annual rainfall isohytes in Sri Lanka
(Source: Dharmasena, 2010a)

A cascade is a connected series of tanks organized within a meso-catchment of the dry zone landscape, for storing, conveying, and utilizing water from an ephemeral rivulet (Madduma Bandara, 1985) (figure 3). According to local terminology, this system is known as *"ellangawa"*. A tank on the other hand is a minor water reservoir formed by constructing an earthen dam across a natural waterway or a depression.

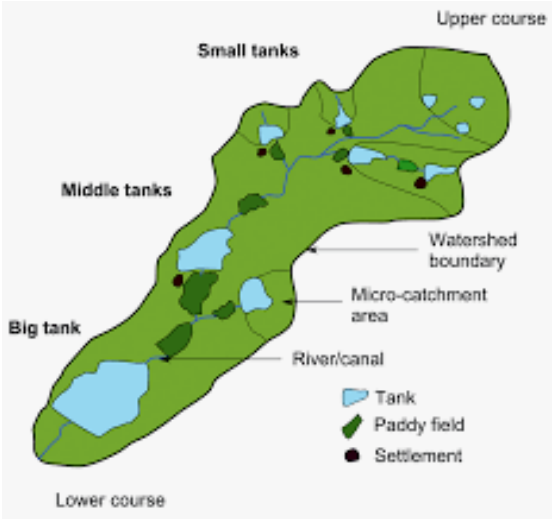


Figure 3: Schematic representation of a tank cascade system
(Source: Brigitta Schütt et. al. 2013)

A cascade in the dry zone is made up of about 4 to 10 individual small tanks with each tank having its own micro-catchment, but all of the tanks are situated within a single meso-catchment basin. These meso-catchment basins could vary in extent from 6 to 10 sq. miles,

with a modal value of 8 sq. miles in the North Central Province(Panabokke et al, 2002).Existence of tank cascade systems is shown in figure 4. The advantage of such a system is that excess water flowing from a reservoir along with the water used in its command area is captured by the next downstream reservoir and is thus, put to use again in the command area of the second reservoir. This water is continuously filtered and recycled in subsequent tanks.

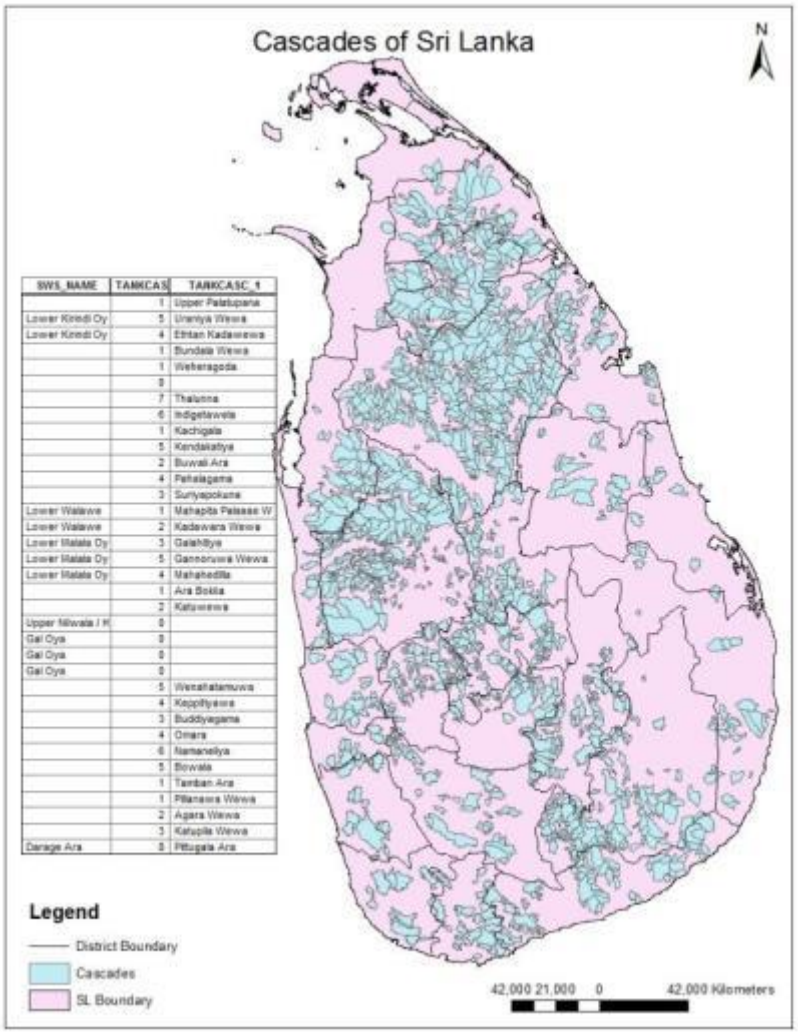


Figure 4: Map showing tank cascade systems in Sri lanka
(Source: Department of Agrarian Development)

iii. Geographical Distributionof Village Tanks

As stated before, this system is predominantly found in the dry zone of Sri Lanka. The density of village tank distribution in Sri Lanka is shown in figure 5. The highest density is found in part of Kurunegala District followed by central part of Anuradhapura District. In general, the average tank density is one tank per 2.6 km^2 for the Northern, North Central and Southern provinces. For the Northwestern province, the density is around one tank per 1.2 km^2.

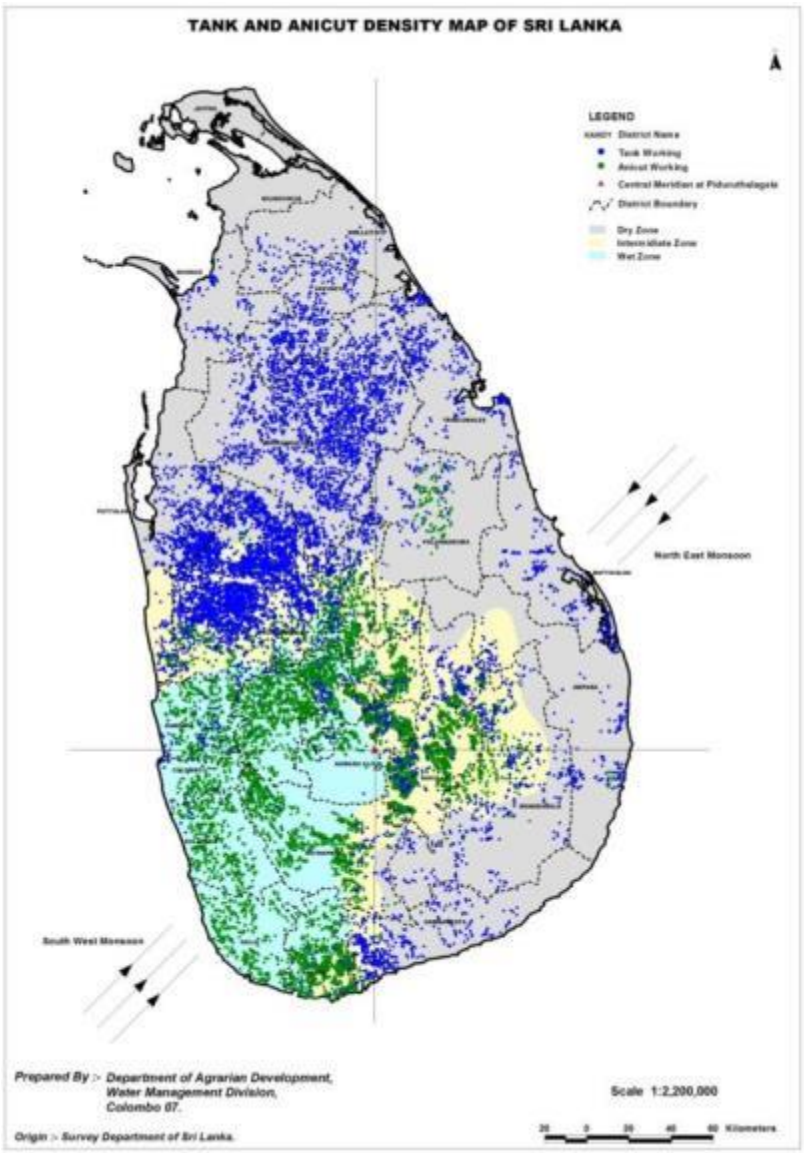


Figure 5: Map showing density distribution of village tanks (tanks in blue and anicuts in green)
(Source: Department of Agrarian Development)

iv. Traditional Agriculture in the Dry Zone

Traditional agriculture is based on more realistic principles. People observed natural phenomena operating around them and studied how it could be manipulated for their needs. They could see the forest, its anatomy, association of different species for coexistence, regeneration after fire, spatial variations etc. The farming system, which includes *chena*, paddy and home garden cultivation has been evolved with interaction of man with the environment and developed in harmony with natural ecosystems (Dharmasena, 1993). Their experience and observations on rainfall pattern, wind, temperature, humidity and soil behaviours have used to adjust their cultivation activities. When they found that some of the tragedies they faced in farming as reasons beyond their control, they appealed the support from the religion and spiritual and cosmic influences. Most important fact they realized on top of others that without giving due respect to the resources using for farming they could not expect the sustainability of their food sources.

A three-fold farming system was evolved in the tank-villagesof the dry zone: rain-fed upland cultivation, lowlandpaddy cultivation (‘wela’), and dwelling gardens(‘gangoda’).As in many countries of the world, shifting cultivationis the oldest way of farming in Sri Lanka. Manysimilarities are found in these countries such as clearingof forest or savannas, burning, sowing a mixtureof seeds with onset of rains, cultivation under rain fedcondition for few seasons, and moving to other landsonce the cultivated land becomes less fertile. However,chena cultivation in Sri Lanka evolved on undulatingterrains with variable soil and rainfall conditions, hencespecific practices as given below were developed (Dharmasena, 2010a).

a. Land for chena cultivation was selected from middle part of the land catena with gentle slopes, where soil is relatively deep;
b. 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;
c. Favourable environment for crops was maintained by adoption of various soil and moisture conservation practices and through shade management;
d. Land productivity was maintained by posing least disturbance to soil and using high amounts of burnt biomass;
e. Diverse crop combinations were adopted to cope with variation of climate, soil, and other biotic as well as abiotic stresses;
f. Simple farm implements were used with lesser energy consumption;
g. Land races were improved as family secrets to utilize as most suitable crop varieties for the area.

v. Key Components of the System

The system consists of a series of tanks (minor water reservoirs) set one after the other on a natural drainage line in a watershed. These tanks are built by constructing an earthen dam across the water stream in the valley. Rainwater is collected in the tanks. Excess water, from tank at the higher elevation, spills over to the one below. Paddy fields are located in the valley of the drainage line below the tank. A *sluice* releases water for irrigating the paddy.

The drainage also passes to the tank below. The watershed of the tank comprises of several land uses such as forest, village hamlets, paddy fields and uplands of crop fields (former *chena* lands) and the tanks. The sustainability of this irrigation system has been secured through associated land use segments. These land uses are: natural tree strip (g*as gommana*), upstream medow (*perahana*),soil ridge (*potawetiya*), seepage interceptor (*kattakaduwa*), natural drainage (*kiul ela*) and hamlet buffer (*thisbambe*) (figure 6). The purposes of these components are briefly described below (Dharmasena, 2010a).

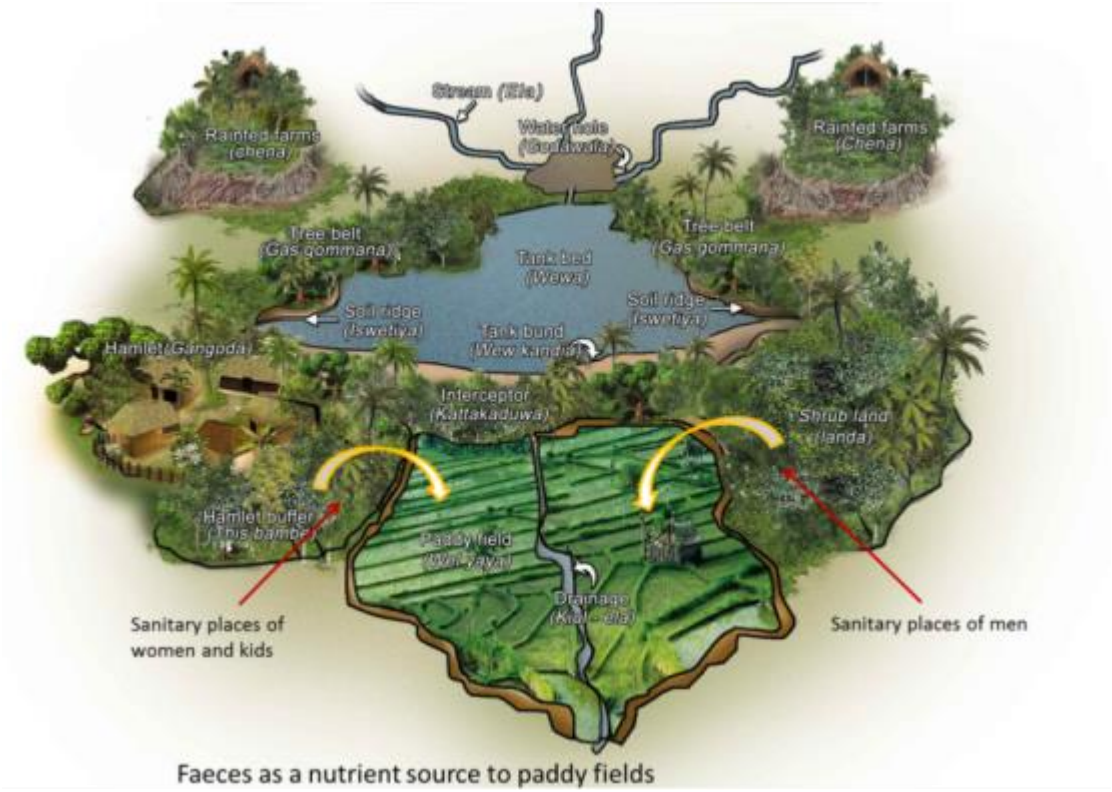


Figure 6: Various components of a village tank (Dharmasena, 2010b)

Upstream tree belt (*Gasgommana*) - This is thenaturally grown vegetation in the upstream land stripabove the tank bed, flooded only when spilling occursfrom the reservoir (figure 7). Large trees and climbers are foundin this area. The gasgommana acts as a wind barrierreducing adverse effects of strong winds, minimizingevaporation from the tank, and lowering water temperature.It extends up to the bund (embankments)where roots of large trees create watery conditionssuitable for breeding and living places for some fishspecies. This strip of trees demarcates the territoryseparating somewhat the human and wild animaldomains.

Figure 7: Gas gommana (Tree belt) in tank – Palugaswewa

Upstream meadow (*Perahana*)—This meadowdeveloped below the *gasgommana* filters out the sedimentflowing from upstream chena lands. It helpsin maintaining the tank capacity reducing the threatsof floods and droughts.

Upstream soil ridge (*Iswetiya* or *Potawetiya*)—This is an upstream bund constructed to prevent enteringeroded soil from upper land slopes.

Upstream water hole (*Godawala*)—A manmadewater hole to trap sediment and. It also provides waterto wild animals.

Hamlet buffer (*This-bambe*)—A fertile land stripfound around the settlement area (*gangoda*) that is notprivately owned. Tree species such as *Maduka longifolia*,mango, coconut are grown in scattered manner.This area was mostly used for sanitary purposes and asthe resting place of buffaloes. Buffaloes were used as aprotection mechanism from wild animals and malaria.

Downstream drainage (*Kiul-ela*)—This is the oldnatural stream utilized as the common drainage. Treespecies, which could absorb salts, and a few rare speciesof small fish are also found in water holes alongthe kiul-ela. Most importantly it filters salts and ironpolluted water, and improves the drainage condition ofthe paddy tract.

Interceptor (*Kattakaduwa*)—This is a reservedarea of land below the tank bund. Its micro-landscapeconsists of three micro-climatic environments: waterhole, wetland, and dry upland, therefore, diverse vegetationis developed. This land prevents soluble saltsand ferrous iron entering the paddy field. The water hole referred to as ‘yathuruwala’ minimizes bund seepageby raising the groundwater table. Villagers plant*Pandanus kaida* along the toe of the bund to strengthenthe bund stability. It appears to be a village garden,where people utilize various parts of the vegetation forpurposes such as fuel wood, medicine, timber, fencingmaterials, household and farm implements, food,fruits, vegetables. Specifically they harvest raw materialsfrom this vegetation for cottage industries.

vi. Production system

The production system of the CTVS involves production from the: paddy field, home garden, upland crop field/*chena*, tank, forest and the *kattakaduwa*. The paddy fields produce paddy; uplands produce other cereals, vegetable, spices and oil crops; tanks produce fish and some edible plants; forests produce timber and medicinal plants; home garden produces nuts and fruits; *kattakaduwa* produces medicinal plants, material for making mats and some handicrafts (rattan, reed) (figure 8). The tank bed during dry season, the scrublands, and the paddy fields during off season, serve as grazing lands for the cattle and buffalo.

Figure 8: Kattakaduwa of Udakadawala tank

vii. Goods and Services provided by the system

The main livelihood of the people is farming while a few engaged in raising cattle and fishing. Women have the tradition of weaving mats, bags, hats etc. from raw materials collecting from village commons (Figure 9). The system provides water and food for human as well as for animals and a series of other ecological functions such as habitats and biodiversity.

The collection and storage of rainfall runoff is the primary function of the CTVS. The water provides a number of ecosystem services such as rice irrigation, domestic water needs and environmental water needs. The tank storage recharges the groundwater table, which helps the villagers to have drinking water from their wells.

The other components of the system also provide habitat for many faunal populations including predators, fish and birds. The tank creates a wetland condition, making it possible to have a very high biodiversity situation in its surrounding and in the paddy fields. The forest, *chena*, scrublands, tank bed and other components (*kattakaduwa*, *gasgommana*) also contribute to a very high biodiversity owing to their varying ecological conditions. The tank bund, tank bed (when water level falls), scrublands and paddy fields after harvest serve as the grazing land for cattle and buffalo. The forests are the sources of timber needs of the villagers. The tank and the vegetation around it create a comfortable micro-environment and aesthetic view.

Figure 9: Handicrafts production in Palugaswewa Junction (2003)

B. The Proposed GIAHS Site

i. Introduction

The Ministry of Agriculture proposes the Palugaswewa cascade in the Palugaswewa Divisional Secretariat Division in the Anuradhapura District as the GIAHS site (figure 10). The site is within the Malwathuoya river basin, which is the home for original settlers who developed cascaded tank-village systems. At present, there are over 3,000 village tanks found in the Anuradhapura district out of total 11,260 village tanks in Sri Lanka. Further, the site falls within the "Cultural Triangle" of Sri Lanka, where ancient cultural monuments are conserved under the UNESCO support. The site is located closer to the popular tourist destination, namely Habarana and easily approached from any part of the country.

There are 11 tanks of varying sizes found within the GIAHS (figure 11). The cascade consists of two villages namely, Palugaswewa and Udakadawala which cover an area of nearly 1,300 ha. The two villages consist of a population of around 1,500 (400 families) living around (figure 12). The details of the tank capacities, extent of paddy lands under the tanks and farming community are given in table 1. There are two tanks renovated recently from their abandoned state. Provision is kept for development of traditional components such as *kattakaduwa*, *gasgommana* and *kiulela*(drainage way) in these tanks.The other tanks had been in existence in working condition for a long time. They have been improved in recent time by the Government. Some tanks are very small, most probably must have been constructed to trap sediment. The dominant land uses of the site include, tanks (including bund, *kattakaduwa* and *gasgommana)*, streams, lowland paddy fields, home gardens, chena, forests and scrublands (annex 1).

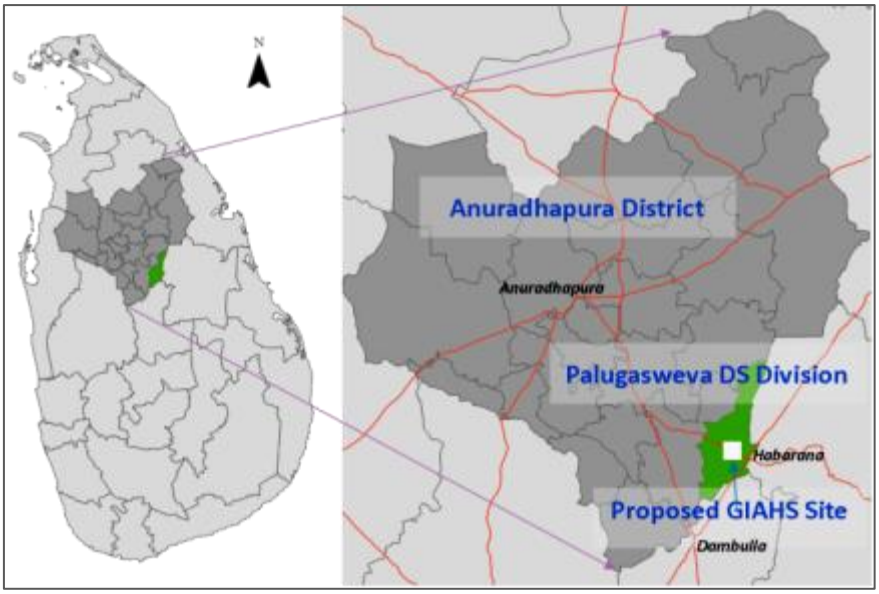


Figure 10: Location map of the proposed GIAHS site

Figure 11 Detailed location map of the proposed site
Prepared by S. Suthakaran, GIS Specialist

Most of the forest lands belongs to the Government. One important aspect of this cascade system is that there is considerable proportion of the cachments of the tanks are still under forest cover. Further, the catchment area of each tank is less disturbed by constructions and other activiites.

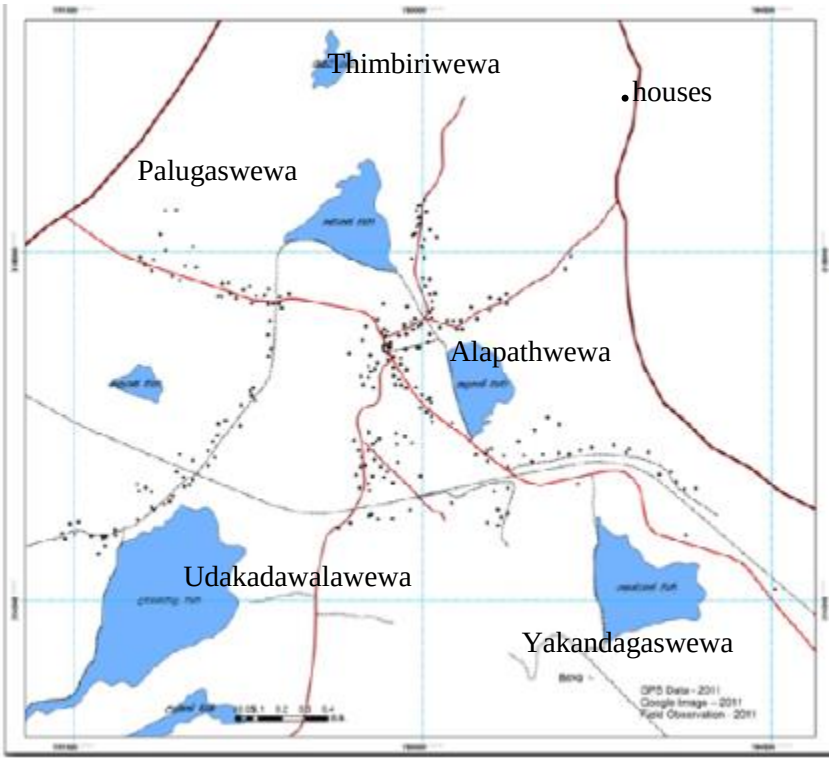


Figure 12: Distribution of houses within the GIAHS
Source: Piyadasa et al, 2012

The tank cascade in this DS Division was selected from a number of candidate sites as reviewed by a technical working group, which was formed by the Ministry of Agriculture. The technical working group used the 5 GIAHS criteria and at the same time added other criteria such as the level of social capital in the site. Palugaswewa is one of the several sites, where the system is still partially maintained and where there is great potential to restore a few more of the traditional practices that can be adapted to modern times.

Table 1: Tanks and their status in the Palugaswewa CTVS

#	Name of the tank	Location coordinates		Tank capacity (ha.m)	Paddy land extent (ha)	No. of farmers	Remarks (Photographical illustrations for tanks are given in anneture 3)
1	Kundalugas wewa	N 8^0 2' 49.7''	E 80^0 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 8^0 2' 11.2''	E 80^0 42' 37.7''	-	-	-	This is a forest tank (*kuluwewa*) meant to trap sediment and serve as a water source for wildlife.

#	Name of the tank	Location coordinates		Tank capacity (ha.m)	Paddy land extent (ha)	No. of farmers	Remarks (Photographical illustrations for tanks are given in anneture 3)
3	Mahaborupan wewa	N 8^0 2' 3.5''	E 80^0 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	Davidge wewa	N 8^0 2' 47.5''	E 80^0 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	N 8^0 3' 1.2''	E 80^0 42' 48.6''	-	-	-	This is a sediment trapping structure (*Godawala*) serving Udakadawala tank.
6	Yakandagas wewa	N 8^0 3' 14.1''	E 80^0 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 8^0 3' 44.4''	E 80^0 42' 41.5''	18.5	8	35	Working tank. Ecosystem components are in existence, but need impovement. No evidence could be traced for an old settlement closer to the tank.
8	Koteyaka wewa	N 8^0 4' 43.6''	E 80^0 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	N 8^0 4'	E $80^0$42'	-	-	-	The tank is an olagama

#	Name of the tank	Location coordinates		Tank capacity (ha.m)	Paddy land extent (ha)	No. of farmers	Remarks (Photographical illustrations for tanks are given in anneture 3)
	wewa	29.4''	25.5''				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 8^0 4' 1.9''	E 80^0 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 8^0 3' 20.8''	E 80^0 41' 53.7''	77.1	51	81	The last tank of the tank cascade system. Working tank, hevily infested with aquatic weeds. A settlement is found around the tank. Tank ecosystem is in existence but needs to be improved.

Sources:Field observations in 2016 and Piyadasa et al, 2012

ii. Topography, Climate and Soil

The landforms of this area are described as a 'mantled plain undulating', 'mantled plain gently undulating' and 'mantled plain level', i.e. level valley floors associated with low order valleys, rock knob plains and ersion remnants. The term "mantled plain" is used to designate the planation surfaces having a mantle of residual material derived from the weathering of underlying basement rocks. The whole area is underlain by rock formations of the Khondalite complex. All land forms in this land system are developed from in-situ weathering of basement rocks, surface erosion and the process of slope recession. The flat or level narrow valleys have developed from the deposition of slope colluviums and alluvium brought down by streams (Somasiri, 2010). The drainage pattern is parallel to sub parellel forming a dendritic feature which indicates strong bed rock control on the drainage. The dominant land elements are moderately broad convex crests of uplands, upland slopes in the mantled plains, and level valley floors, bare rock exposures within the rock knob plain and long narrow quartzite ridges crest and dissected ridge slopes. **These specific features of land system has led to develop the unique cascaded tank-village systems in this part of the dry zone.**

Palugaswewa DS division is in the DL 1b agro-ecological region and the closest meteorological station is at Mahailluppallama,23 km away from the GIAHS site. Monthly rainfall data averaged over the period from 2003 to 2012 is shown in figure 13. It indicates that the annual mean rainfall in the area is about 1,400 mm. All traditional agricultural practices such as selection of varieties, land preparation, time of cultivation to minimize pest damage, water management etc. have been adjusted to this rainfall pattern, therefore crop failure occurred is very much a rare event. Table 2.Shows monthly climate data observed for the period September 2013 – August 2014 at Mahailluppallama.Potential evapotranspiration varies from 42 to 122 mm/month during the year. Maximum monthly mean temperature varies from 29^0C to 35^0C, while mininmum value is in the range of 20^0C - 26^0C. Relative Humidity in the morning ranges from 77% to 91%, while in the evening it varies from 46% to 75%. The periods March – April and August – October are having the warmest climate. Average wind velocity is in the range of 3 – 10 km/hr.

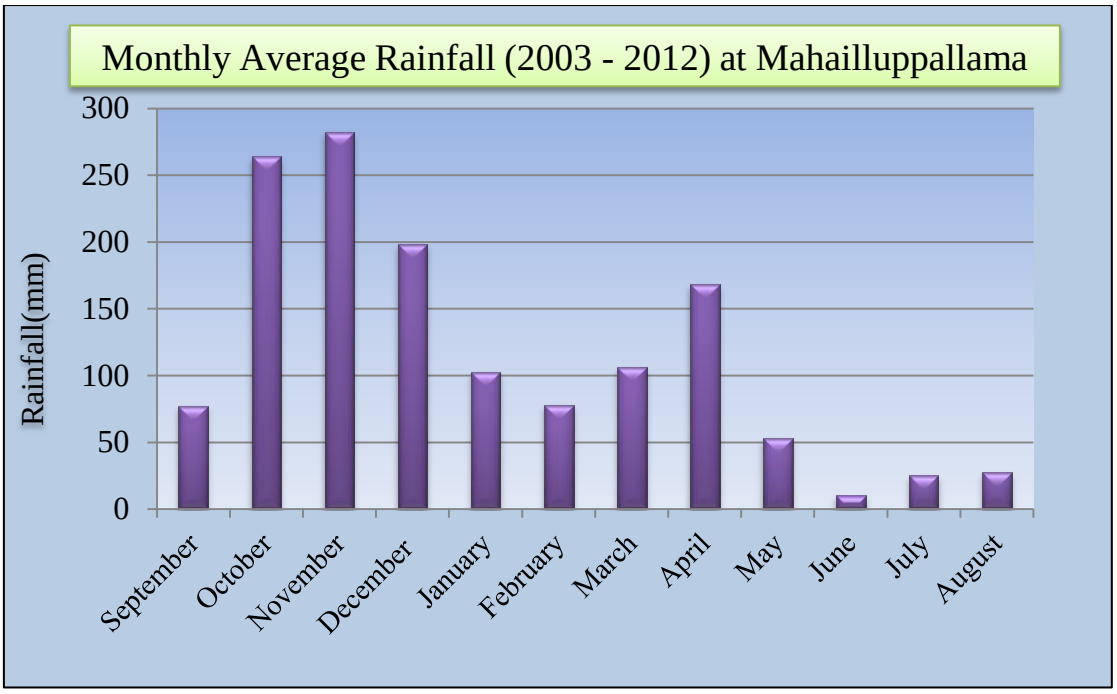


Figure 13: Monthly rainfall distribution at Mahailluppallama

Data source: Annual Performane Report (2014), Department of Agriculture

Table 2: Average monthly climate data (2013/14) at Mahailluppallama

	Sep	**Oct**	**Nov**	**Dec**	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**
Rainfall (mm)	21.7	228.8	189.7	70.0	134.1	10.4	0.0	322.9	195.2	2.0	0.0	25.8
PET (mm)	91.2	99.2	57.6	42.2	54.6	69.4	111.6	91.2	86.8	105.6	121.5	106.5
Temp. max. ^{0}C	31.9	32.9	31.2	29.0	29.2	31.6	34.6	34.8	32.7	32.5	32.7	32.7
Temp. min. ^{0}C	24.0	23.6	22.4	21.4	21.3	20.2	22.2	23.5	24.8	25.6	25.3	24.4
RH % (M)	80	77	89	90	91	87	79	83	81	79	78	79
RH % (E)	62	58	72	75	72	51	46	54	67	63	59	59
Sunshine(hrs.)	7.1	8.4	5.9	4.1	5.5	8.4	9.1	9.1	8.5	8.3	8.1	7.5
Wind velocity (km/hr	8.0	6.2	3.5	4.6	5.4	4.9	6.1	3.1	5.6	9.3	9.8	8.1

Source: Annual Performance Report (2014), Department of Agriculture, Peradeniya
PET – Potential Evapo-Transpiration,
RH – Relative Humidity, M - Morining at 8.30 hrs., E – Evening at 15.30 hrs.

Two soil types are dominant in this area. The Reddish Brown Earth (RBE) soil (well or imperfectly drained) occupies on upper aspects of the land catena and Low Humic Gley (LHG) soil is found in the valley bottom (figure 14). The RBE well drained soil observed in this area is classified as *Aluthwewa* series and described as follows.

The *Aluthwewa* series is a well drained RBE soil with a deep soil profile. The distribution is confined to the crest, upper slopes and mid slopes of the undulating terrain and developed on coarse grained gneisses and migmatites of the Khondalite series. The colour of soil varies from dark brown to brown in the surface. The sub surface soil colour ranges from reddish brown to dark reddish brown. Texture of the soil ranges from sandy loam to sandy clay loamwith the increase of soil depth. Quartz and ironstone gravel can be observed at depth greater than 100 cm. However, depth to the gravel layer and thickness of the gravel vary according to the physiographic position within undulating topography.

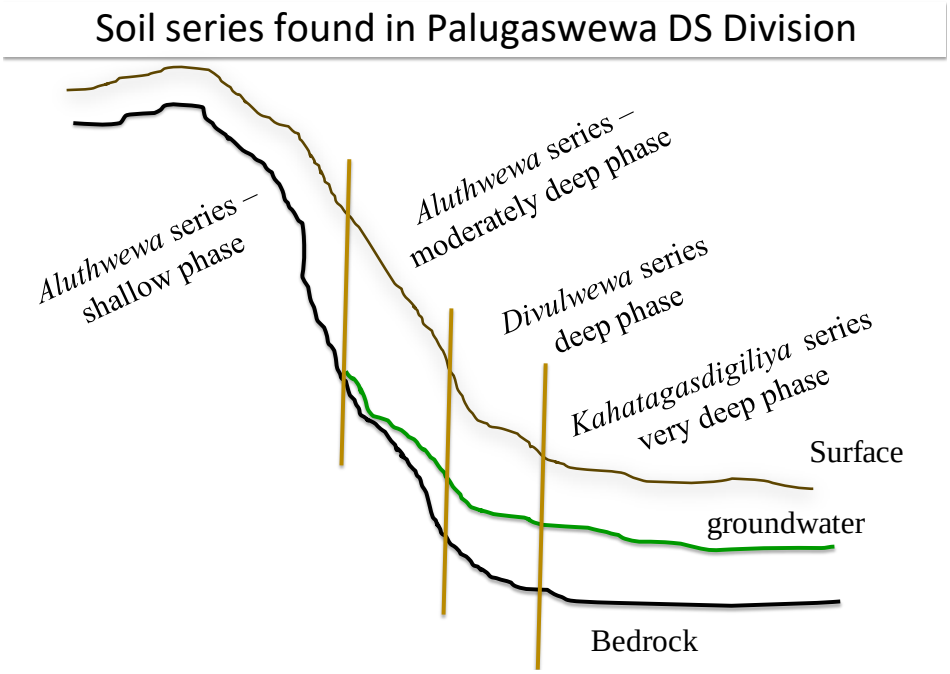


Figure 14: Position of soil series on the landscape - Palugaswewa

The other soil associated with *Aluthwewa* series is RBE imperfectly drained soil classified as *Divulwewa* series, which is briefly described below.

The *Divulwewa* series is a deep imperfectly drained soil. Texture varies from sandy loam to sandy clay loam with the increase of soil depth. The colour of soil varies from dark brown to brown in the surface. The sub surface soil colour varies from very dark brown to dark brown. Distinct mottles are visible in the lower part of the swub surface as the soils are confined to lower aspects of the undulating topography. Presence of black colour iron-manganese nodules indicate the fluctuation of groundwater level within lower part of soil profile. Surface soil is slightly sticky and plastic when wet, friable when moist and slightly hard when dry.

The LHG soil found in the valley bottoms of the CTVS is classified as the *Kahatagasdigiliya* series and briefly described below.

The *Kahatagasdigiliya* series is a deep, poorly drained LHG soiloccurring within valley bottoms of the undulatingto rolling terrain found in the proposed GIAHS site. Teaxture is sandy loam and therefore low in moisture holding capacity in the absence of organic matter. The soil is susceptible to drought condition, thus, the dominant rice cultivation depends on irrigation water. Traditionally farmers cultivate these lands under tank irrigation, wher the groundwater table is maintained at a shallow depth. The soil is naturally low in organic matter content and poor in available nutrients. **Traditional agriculture with their good practices (fallowing, green manuring, shallow tillage, bio-fertilizer etc.) for nutrient and moisture management people obtain a successful harvest from paddy. Due to the fact that the soil is high in sodium content traditional farmers have adopted good drainage practices (*kiwul ela*) in paddy fields.**

iii. 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 (figure 15). 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 proposed CTVS 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. These crops bring additional income to the farmers.

Figure 15: Paddy cultivation irrigated by the tank - Udakadawala

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 (Figure 16). In the *yala* season, as rainfall is limited to a shorter duration of 1-2 months, sesame is grown in uplands. Recent 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(Sandika and Withana, 2010). The income variation is due to the variation of the crops, soil fertility, farmer ability, price of the product and other socio-economic factors.

Figure 16: A traditional multi- storey watch hut for protecting crops from wild life – Udakadawala

The home gardens are mostly occupied by perennial fruit and timber trees. 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. 67,000.00 per ha per year.

The tank is used to produce fish. Traditional fish catching methods are still being practiced (figure 17). Lotus (*Nelumbo nucifera*) seed and tubers, Olu (*Lymphaea pubescens*) seeds andsome green vegetable leaves which are naturally grown in the tank are harvested for home consumption and for sale (figure 18).

Figure 17: Karaka – a fish catching device - Palugaswewa area (2003)

Figure 18: A tank with lotus and water lilies – Udakadawala

The villagers, who depend on the CTVS 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, rainfed 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, uplandor 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 (table 3).

Table 3: Egg and milk production in the CTVS

Type of livestock	Type of produce	Production per month	
		Palugaswewa	Horiwila (including Udakadawala)
Poultry	Eggs	84,000	4,500
Cattle	Cattle milk (lits)	1,200	12,840

Source: Resource profile - 2015, DS Office, Palugaswewa

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. The home gardens in the Palugaswewa cascade are mainly occupied by coconut wood apple, orange, banana, jack, and mango. Teak is grown in home gardens as a timber tree species.

The main livelihood of the people is farming which include cultivation of lowland paddy & other field crops, animal husbandry (dairy) and home gardening (table 4). Average family income in Udakadawala village approximate to Rs 32,400.00 while that in Palugaswewa is about Rs. 40,000.00. Men are engaged in part time work outside the village. A very few number engaged in self-employment activitiesother than farming. Majority of women are engaged in farming and domestic activities.

Table 4: Percentage of population engaged in various livelihood in Palugaswewa and Udakadawala villages

Sector	Palugaswewa	Udakadawala
Agriculture (including Animal Husbandary and inland fishery)	73.3%	89.5%
Rural industry	8.6%	6.8%
Services	12.0	3.7%
Other	6.1	0

Source: Resource Profile 2015, Divisinal Secretariat, Palugaswewa

iv. Biodiversity and Ecosystems Functions

Sri Lanka's biodiversity is significantly important both at the regional and global scale. Sri Lanka has the highest species density for flowering plants, amphibians, reptiles, and mammals in the Asian region (NARESA, 1991). The CTVSs greatly contribute to this high biodiversity in the country 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.

A recent study in the Palugaswewa cascade (GIAHS) has shown that in the kattakaduwa and the tank bund and the tree belt alone there are 226 plant species. They belonged to 51 families. These plants species included fruit, timber, medicinal, ornamental and forage trees. Mostly agricultural crops wich are popular in the site consists of new improved varieties. However, people still tend to cultivate 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, lufa, snake gourd, long beans,*labu* (bottle guord), e*labatu*(*Solanum melongena*),*kekiri*(*Cucumis melo*),*thibbatu*(*Solanum torvum*),*batu-karawila*(*Momordica charantia*) (figure 19)etc.In addition, cowpea, *kurakkan* (finger millet), *bada-iringu* (maize), *thanahaal* (foxtail millet), *meneri* (proso millet) (figure 20), chillie, mustard, *kollu* (horse gram), sorghum were als cultivated before. Now growing of *thanahaal*, *meneri*, *chillie*, mustard, *kollu*, sorghum is not very common.

Figure 19: Batu-karawila (Momordica charantia)

*Figure 20: Meneri (*Panicum miliaceum*)*

The home gardens consist of fruit, timber, medicinal plants, vegetables and ornamental plant species as seen commonly in the lands under CTVS. 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*). and*Halmilla*(*Berrya cordifolia*).*Ahu* (Indian mulberry), *ehela* (pudding pipe), *ingini* (*Strychnos potatorum*), *kaduru* (nux-vomica), *karapincha* (curry tree), lime, tamarind and margosa are the common medicinal species. Vegetable species such as *murunga* (drumstick tree), *ambarella* (*Spondias cytherea*), jak and coconut are very common in the home gardens in the CTVS.

Aquatic biodiversity is found in the tank and the paddy fields. The 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 (Piyadasa et al, 2012) 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 21.

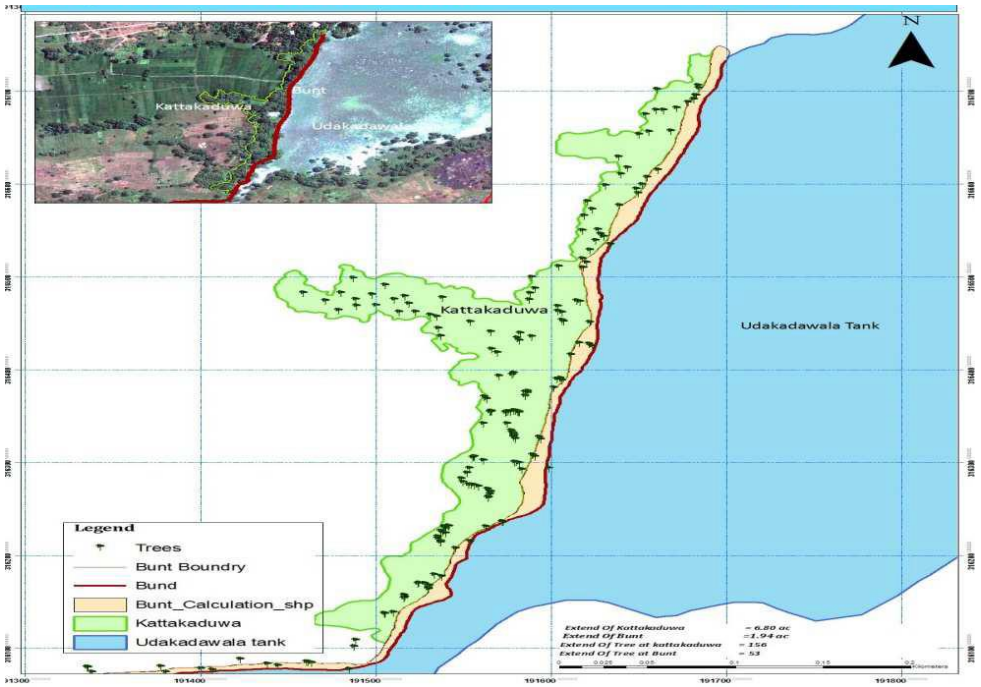


Figure 21: Spread of kattakaduwa in Udakadawala tank

Source: Piyadasa et al, 2012

Of total vegetation in the kattakaduwa, 68 percent of the trees are kumbuk (*Terminalia arjuna*), damunu (*Grewia damine*), helamba(*Mitragyna parvifolia*) and karanda (Indian beach) plants at different ages. Among 55 plant species fund 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 5 shows the uses of them in rural villages.

Table 5: Uses and functions of plant species in kattakaduwa (Dharmasena, 1995)

Name of the plant	Botanical name	Uses and functions
Margosa (neem)	*Azadirachta indica*	Oil, pesticides, timber, medicine
Mee	*Madhuca longifoia*	Honey, oil, habitat for bats
Damba	*Syzygium assimfle*	Mortar and pestle, timber, fruit
Kumbuk	*Terminafla arjuna*	Lime, timber
Tamerind	*Tamerindus indica*	Fruit, soft drinks, sweets, chutney, medicine
Koon	*Schlei cheria*	Fruit, chutney,
Ebony	*Diospyros ebenum*	Wood carvings, furniture
Kotta	*Ciba pentandra*	Pillows, toys
Indi	*Phoenix zeylanica*	Fruit, hats, bags, baskets, broom etc.
Palmyra	*Borassus flabellifer*	Timber, mats, bags, baskets, honey, sweets, toddy.
Bamboo	*Bambusa vulgaris*	Wood carvings, handicrafts, building materials etc.
Kithul	*Caryota urens*	Honey, jaggery, toddy, timber, household implements
Patabeli	*Hibiscus tfliaceus*	ropes
Vetakeya	*Pandanus kaida*	Bags, baskets, mats
Rattan	*Calamus spp.*	Baskets, furniture
Reed	*Cyperus pangoreil*	Mats, baskets, trays
Wood apple	*Feronia limonia*	Jam, juice, soft drinks, medicine

Gasgommana (Upsteam 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 22).

Most abundant species in the Udakadawala gasgommana area are kumbuk (*Terminafia arjuna*), nabada (*Vitex leucoxylon*) and karamba (*Carissa spinarum*) . Abundance of plant species in the Udakadawala gasgommana is given in Table 6.

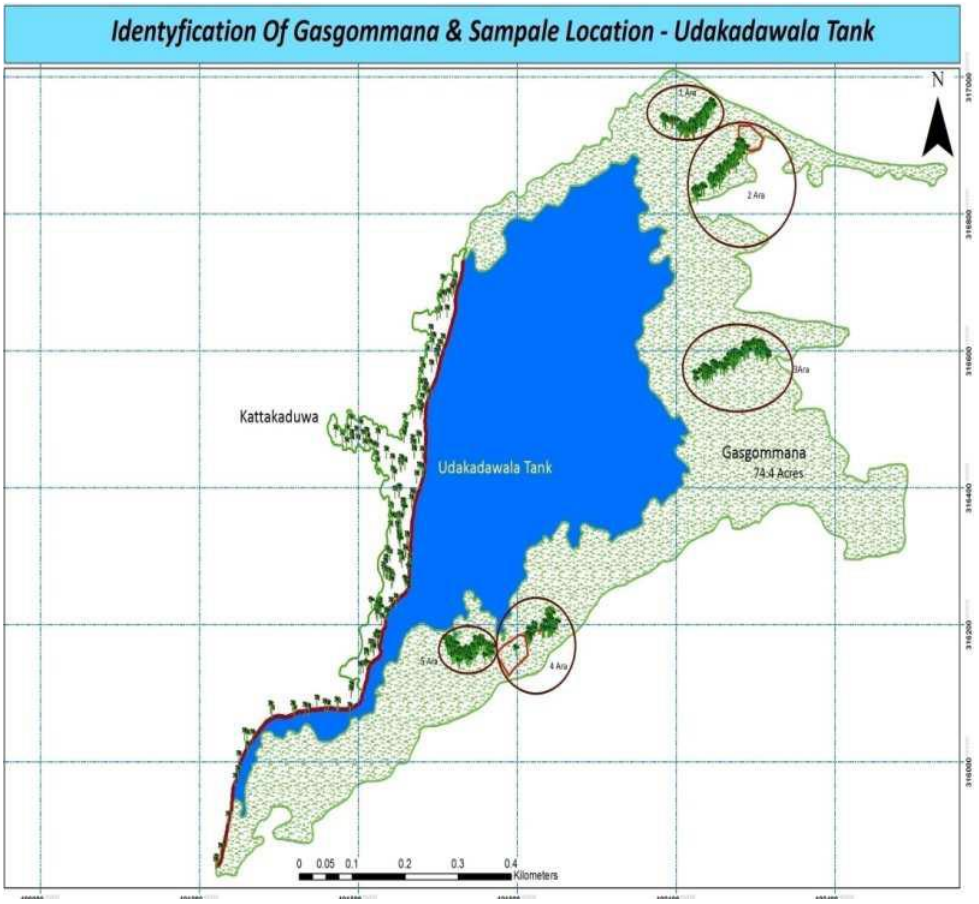


Figure 22: Spread of gasgommana in Udakadawala tank
Source: Piyadasa et al, 2012

Table 6: 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 (*Vitex leucoxylon*)	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 (*Mitragyna*	29	8	To treat fever, colic, muscular pain, burning sensation,	

Plant species	Abundance		Medicinal value	Other uses
	#	%		
parvifolia)			poisoning, gynecological disorders, cough, edema and as an aphrodisiac	
Bokala wel (*Derris scandens*)	21	6	Good antibacterial (*Escherichia coli*, and *Bacillus megaterium*), antialgal (*Chlorella fusca*), and antifungal (*Microbotryum violaceum*) medicine	In preparation of Bio-pesticides
Rathmal (*Ixora coccinea*)	20	5	It has antioxidative, antibacterial, gastroprotective, hepatoprotective, antidiarrhoeal, antinociceptive, antimutagenic, antineoplastic and chemopreventive effects	
Kaila (*Breynia vitis-idaea*)	10	3	Roots decoction is used as mouthwash, for the treatment of chronic bronchitis and wounds	For the control of mosquitoes
Kothala himbutu (*Salacia reticulate*)	9	2	It helps normalize blood sugar and insulin levels, and supports helthy 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 (*Manikara hexandra*)	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 (*Streblus asper)*	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. Table 7 shows the canopy cover in the home gardens of the GIAHS site.

Table 7: Canopy cover in Udakadawala and Palugaswewa village home gardens (Piyadasa et al, 2012)

Canopy cover	# of home gardens	%
> 75 %	26	8.7
74 – 50 %	101	33.6
49 – 25 %	110	36.6
< 25 %	63	21.0
Total	300	

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.

Diversity of Forest

A total of 93 wildlife protected areas have been declared in Sri Lanka. It includes 21 nature parks, three Strict Nature Reserves (SNR), five nature reserves, three jungle corridors and 61 sanctuaries. The total area covered is 14 percent of the country. Some of the cascades fall within the declared protected areas or close proximity to them. *Ritigala* is an SNR with high biodiversity and located about 7km North-West of the selected pilot site.

The vegetation of the Ritigala SNR shows a clear pattern of altitudinal zonation. Most of the Wet Zonespecies are found at higher elevations and some of them are strictly confined to the summit areas ofRitigala. Some species occur within more or less sharp altitudinal zones. Most of the Dry Zonespecies are restricted to lowerelevations. A Short-Stature Forest occurs on the summits and upperslopes of Ritigala.

Rock out crops and associated vegetation are commonthroughout Ritigala (figure 23). Tree species associated with rock outcrops include: *Commiphora caudate, Ficus arnottiana,Ficus mollis, Givotia moluccana, Lannea coromandelica,Memecylon petiolatum, Euphorbia antiquorum, Bambusabambos, Sapium insigne* and *Wrightia angustifolia.* Shrubspecies include *Carmona retusa, Croton laccifer, Munduleasericea, Ochna lanceolata, Osbeckia aspera* and*Cassipourea ceylanica.*

Scrub forms in places of chena (shifting cultivation). Soonafter chena is abandoned, various herbaceous pioneerspecies appear and they are followed by successions ofwoody species, culminating in the appearance of secondaryforest. Characteristic species include *Azadirachta indica,Bauhinia racemosa, Carissa spinarum, Catunaregamspinosa, Dichrostachys cinerea, Flueggea leucopyrus,Gmelina asiatica, Grewia orientalis, Hugonia mystax,Ichnocarpus frutescens, Lantana camara, Limoniaacidissima, Memecylon umbellatum, Phyllanthuspolyphyllus, Scutia myrtina, Syzygium cumini, Toddaliaasiatica* and *Ziziphus oenoplia*

Figure 23: Ritigala Strict Nature Reserve (SNR)

Another forest reserve found closer to the proposed GIAHS is 'Hurulu Forest Reserve' found just about 5 km North East of Palugaswewa (N 8^0 12' 36", E 80^0 50' 59"). The reserve was designated as a biosphere reserve in January 1977. Initially it was declared as a forest reserve in 1942. It comprises 25,500 hectares within the tropical dry evergreen forest in Sri Lanka.
The forest reserve contains Dry Monsoon Forest (Dry Mix Evergreen Forest) with a typically layered structure comprising an upper canopy of moderately large trees, a sub canopy of smaller pole-sized species and a distinct herb layer. The upper canopy is dense about 15-20m height and interrupted by emergents of which Satin and Palu are typical. The sub canopy is characterized by species such as *Korakaha, Kunumella*, *Weliwenna*. The orchid *Dendrobium maccarthiae* in bloom is a colorful sight. Dominant plant species are Setinwood (*Chloroxylon swietenia*) and Palu (*Manilkara hexandra*) together with the ebony tree (*Diospyros ebenum*). Among the most endangered animal species are the turtle (*Testudo elegans*), Ceylon Junglefowl (*Gallus lafayettii*), the elephant (*Elephas maximus*), the leopard (*Panthera pardus*) and the rusty-spotted cat (Felis rubiginosa).

Mammals include endemic torque macaque, loris, wild boar, sloth bear, spotted deer, pangolin, bandicoot rat, porcupine, rabbit, jackal, leopard, rusty spotted cat, mongoose, water buffalo and elephant. The avifauna includes a variety of endemic birds. Endemic birds such as Sri Lankan jungle fowl, spurfowl, and blue faced *malkoha*. and rare rufous woodpecker can be observed.

Forest were 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.

Forest found in the dry zone cascades belong to the following categories: dry monsoon forest, shrub and riverine dry forests. They show very high biodiversity. Dry monsoon and riverine forests are dominated by species such as *Manilkara hexandra* (Palu- use for timber), *Chloroxylon sweitenia* (Satin-Burutha-use for timber), Diospyros ebenum (Ebony for timber), *Drypetes sepiaria* (Weera-use for firewood), *Feronia elephantum* (Wood apple-use for fruit), *Vitis altissima* (milla-use for timber), *Syzygium spp.,Chukrasia tabularis* (hulanhith- use for timber), *Madhuca longifolia* (mee- use for timber and medicine), *Berryya cordifolia* (halmilla- use for timber), and *Alseodaphne semecarpifolia* (wewarana-use for timber). The shrub and regenerating forests are characterized by *Bauhinia racemosa* (maila-use for medicine and forage), *Pterospermum suberifolium* (velang-use for soft timber), *Cassia fistula* (ehala- use for medicine), and *Dichrostachys cineria* (andara). The biodiversity in the forests is at risk due to selective felling of trees for timber. Some of the species are listed as threatened species.Chloroxylon sweitenia (Satin) and Diospyros ebenum are two nationally important timber species listed as threatened species.

Monoculture forest plantations (predominantly teak) have been established in some areas of the catchments by the Forest Department since 1970s. In recent times, farmers have also grown teak and *Halmilla* (a local species) in their home gardens under the support programs of the Forest Department.

v. 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 (figure 24).

Figure 24: 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*), Woodapple (*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.

Evolution of the CTVS

The historical evidence suggests that the CTVS 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 pipesto 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 dendretic drainage pattern on the undulating landscape made it possible to develop cascading system of small tanks in the valleys where ephemeral streams drained rain water 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 shortageof water in less rainy seasons, development ofsalinity in certain part of the field, and damage fromwild animals, pest, and diseases. Strategies adapted to address these problems were not specific to a certainproblem but collective. The following strategies were adapted to minimize the water shortage problem in the CTVSs (Dharmasena, 2010a).

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 (2^{nd} 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.

<u>Maintenance of the System</u>

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 (figure 25), 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)

Figure 25: Cattle and buffalo to graze paddy field during fallow period

Equitable Sharing of Land & 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.

Cropping Systems

The cropping calendar is based on the rainfall pattern. There are two seasons of cultivation based on rainfall pattern, these are: *maha* and *yala* seasons. There are two farming components important in the system namely: upland crop cultivation and lowland paddy cultivation. The lowland paddy is grown with irrigation water. The upland crops grown during *maha* season are rain-fed. Generally, farmers give priority to upland crop cultivation as crops have to be established at the onset of rainfall. Paddy cultivation is based on the

availability of the water in the tank. Therefore, lowland paddy cultivation begins later in the season. The general crop calendar adapted in the CTVS is shown in figure 26.

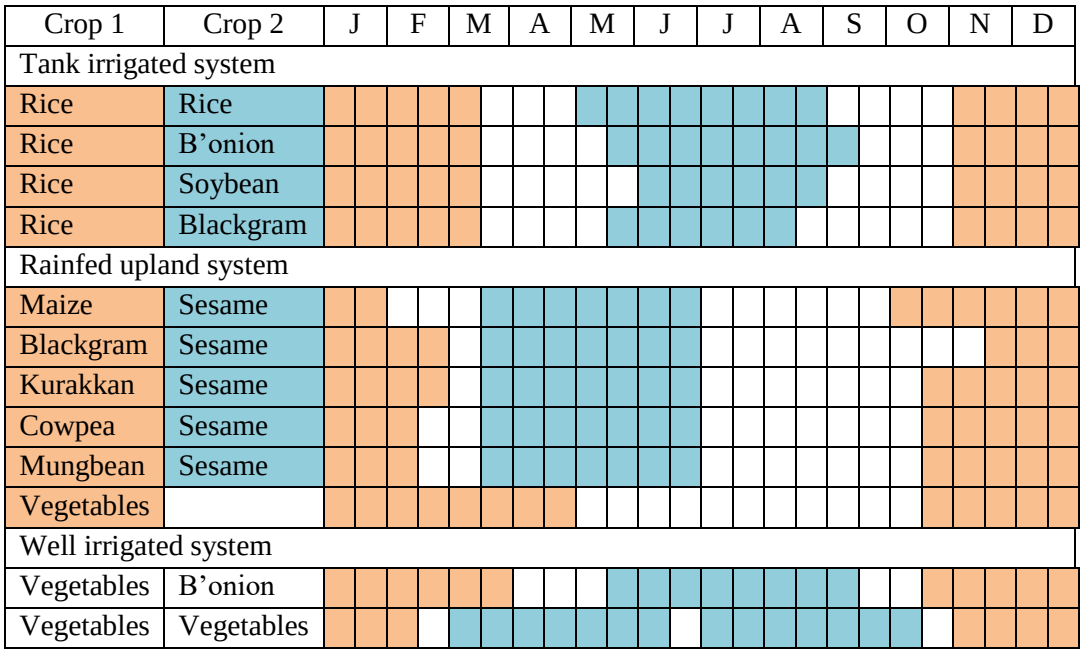


Figure 26: Cropping calendar of the CTVS

Vegetables – Pumpkin, water melon, longbean, tomato, luffa, brinjal,elabatu (Solanum melongena), kekiri (Cucumis melo), thibbatu(Solanum torvum),batu-karawila (Momordica charantia)

Source: Mrs. Janaki Ariyadasa, Agriculture Instructor, ASC, Palugaswewa

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, 2010a).

- 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.
- Favourable environment for crops was maintained by adoption of various soil and moisture conservationpractices 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 day time and 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 decribed in section I.D. The commons are of multi-purpose and multi-functions, and many services are rendered for the benefit of human and wildlife.

vi. Culture, Value Systems and Social Organizations

Sri Lanka's rich cultural heritage has been nourished by characteristics and challenges and opportunities provided by the landscape and the resultant values, knowledge systems associated with the agrarian society. Although some erosion of 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 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 tankare discussed.
The traditional management systems practiced by the community has been superseded by the modern governance structures and processes. However,CTVS 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 CTVS and sustainability of its ecosystem services.

Specific folklore, folksong, folk poems, folk music, beliefs, rituals, traditional festivals, practices, folk drama, performing art and traditional crafts are related to the village tank farming culture. Examples are:

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

<u>Heritage Reflected in Art Forms Such as Folk Dances</u>
Folk dances in the area depict activities related to agrarian life, such as kalagedi natuma (depicting fetching water in the pots), Kulu natuma (depicting winnowing of rice in the threshing floor)(figure 27), 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.

Figure 27: Traditional winnowing dance (kulunetuma)

Rituals

Most prominent rituals include:*Mutti nameeme mangallaya*, *Kiri ithirim mangallaya* and *Kohombakankariya*.

Mutti nameeme mangallaya (Ceremony of pot)

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 communitiesparticipate. 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.

Kiri ithirim mangallaya

After reaping of each crop *kiriithirim mangallaya* 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.

Kohombakankariya

Kohomba Kankariya, one of the most venerated and elaborate traditional dance rituals in Sri Lanka is held to invoke the blessings of the twelve deities (*Kohomba Yakka, Irugal Bandara, Kande Bandara, Viramunda Yakka, Meleyi Yakka, Vadi Yakka, Kadavara Yakka, Vali Yakka, Kadu Guru, Maha Guru, Ambrapati and Kalu Kumara*). The *Kohomba Kankariya* is a *Shanthi Karma* (a traditional art of healing) demonstrating the pre-Buddhist worship of *Yakshas* (demons) who are regarded as deities (figure 28). 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.

Figure 28: A scene from Kohomba Kankariya

Other rituals and related practices include:

- *Aluth sahal mangallaya* - performed to offer milk-rice cooked with the first portion of the paddy harvest to the Buddha collectively at the village temple.
- *Praying for gods for protection of cultivations* - performed when there are disastrous situations such as drought, floods, epidemics, etc. (figure 29).
- Ritualistic plant protection method - use of *Kem* - *adoption of various ritualistic methods for controlling various pests in the paddy fields.*

Figure 29: A ritual invoking blessing from deities and gods

Traditional Crafts

Common traditional crafts include the handicrafts made out of reeds and other cured leaves of palm trees. There are a variety of produce such as mats, hats, handbags and purse. Theseare traditionallywoven 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 (figure 30). Leaves of Palmyra tress and Vetakeiya are also used

Figure 30: Weaving mats with numbers embedded using Gallaha reeds by village women, Palugaswewa

vii. Remarkable Landscapes, Land and Water Resource Management Features

The dry zone (DZ) landscape has been completely changed to give rise to a panoramic view with the development of the village tanks in the cascading system. The tanks make water bodies here and there in the undulating landscape, giving an attractive view. These water bodies located one after the other are associated with various vegetation, including lotus, water lilies, many other flowering plants and trees. Due to long existence, these tanks have become almost like natural wetlands creating a unique ecosystem that attract various types of birds. The paddy fields, forest patches and home gardens combined with the tanks make a mosaic of beautiful scenery. This mosaic changes its color and appearance all year round as the cultivation progress and seasons change (figure 31).

Figure 31: Crossectional view of paddy field and home garden

The proposed CTVS consists of several land uses within a single tank catchment. These land uses make a unique land management system aiming a long-term sustainability of lands. The forest reservation in the catchment makes the main watershed area of the tank. It is used for *chena*/upland crop cultivation. Even if the *chena* cultivation is not practiced in its real sense at present, fallowing is done for short durations in order to maintain the soil productivity. In the tank, a soil ridge called *isvetiya* or *potavetiya* is constructed just below the lands used for *chena*/upland cultivation and above the tank water level to prevent eroded soil coming in to the tank bed.

In the main natural drains, which carry runoff water from the catchment, a pit locally known as *godawala* is dug before reaching the tank bed to collect all soil and debris with water. This pit is periodically cleaned when filled by communal action. In some cascades, tanks have

been built in the forest which serves only for environmental services such as groundwater recharge and use of wildlife. They also serve as additional storage tanks in the cascade.

The tank cascade itself is an evidence of the long practiced land and water conservation and management practice. The current state of the cascade and CTVS in Palugaswewa is no longer in pristine form, but overall the system is still very much serviceable in terms of its main objective of water conservation for the agricultural communities in this part of the Cultural Triangle. The fact that the system is located in the midst of the Cultural Triangle of Sri Lanka makes the system a very attractive destination by both Sri Lankans and foreigners alike who want to understand this particular gem of a heritage in the country's dry zone.

In section I.D, the components of the CTVS are described together with their intricate set of ecological functions. Each tank cascade system in the dry zone must have been in existence for more than at least over a thousand years.

Udakadawalawewa has the largest reservoir capacity because it receives drainage and spill water from 5 tanks. This cascade system is described as "branched" sytem. The maintenance of tanks and irrigation canals and water management are carried out by two farmer organizations under the supervision of the Department of Agrarian Development. Palugaswewa Farmer Organization manages four tanks namely Palugaswewa, Alapathwewa, Davidwewaand Kundalugaswewa. The Udakadawala Farmer organization manges the restof the tanks.As generally practiced in the other CTVSs the cropping calendar and the crops are decided at the "Seosonal Meeting", which is held with participation of farmers.The seasons and the cropping system of the Palugaswewacacade follows the general pattern that of the CTVS.

II. OTHER SOCIAL AND CULTURAL CHARACTERISTICS

A. Relevant Structures, Architecture

The culture in the dry zone villages is based on the concept of "*Wewai, Dagabai, Gamai, Pansalai*" which means the culture is based on the relationship of the components, namely: "The Tank, Stupa, Hamlet and the Temple" which are common to any village (figure 32). The Traditional village consisted of houses built with *wattle* and *daub* walls thatched with straw or a grassy weed called '*illuk*' (*Imperata cyylindrica)*These houses are eco-friendly and ideally suited to the local climate. The houses have one or two rooms with a large verandah. The verandah consists of a pila, a raised bed attached to the back wall of the verandah. The verandah is open on three sides where visitors were entertained.

Figure 32: Tank, stupa, village and the temple as the main elements of the community

Keta sorowwa (Traditional sluice in the tank): This has two components. One is the linear horizontal layer of burnt clay (*terracotta*) pipes laid under the tank bund extending from inner side to the outer side. The other component is the set of similar pipes arranged vertically fitted to the opening of the horizontal pipe in the inner side of the tank (figure 33). The pipes are about 2 ft in length and can be removed to the water level of the tank so that water can be released from the tank.

Figure 33: Ketasorrowwa
Source: Department of Agrarian Development

Vee Bissa(Rice bin)*:* This is a traditional structure built with wattle and daub wall for storing paddy in the villages. This is erected outside, near the house and thatched with straw (figure 34).

Atuwa: This is a large box made of wood to store paddy inside the house not very common as the vee bissa

Figure 34: Vee Bissa (rice bin)

B. Traditional Agricultural and Domestic Implements

Tank-village communities in the dry zone of Sri lanka have developed their own tools and implements for agriculture and domestic purposes. Energy conserving simple devices were made by them using raw materials that can be found from their surrounding. However, basic principles they used in making these devices contribute to the traditional wisdom they had in the past. Some of them are listed below;

- *Pas pattalaya* (for extracting oil from mee seeds) (figure 35),
- *Kurahan gala (*grinding stone device of finger millet*) (f*igure 36*),*
- *Mmirisgala (*grinding stone device of chili*),*
- *Kemana (*cage for trapping fish in the tank*),*
- Bags - *Karaththa malla, kata palal malla (*bags made of reed for carrying things*),*
- Grain measuring devices - *laha, kuruniya,busala*(figure 37)
- *Killotaya (*bowl for keeping lime as an ingredient of chewing beetle*),*
- Land preparation implements - *Mada poruwa, nagula.*

Figure 35: Pas pattalaya (for extracting oil from mee seeds), Palugaswewa

Figure 36: Kurahan gala (grinding stone device of finger millet), Palugaswewa

Figure 37: Grain measuring devices - Kuruniya and Busala, Palugaswewa

C. Gender Roles

As per the traditional culture in the villages in CTVS, the men and women work in harmony under a reasonable division of labour among them. The women manage tasks related to the home garden, household jobs of cooking, washing clothes, cleaning the house, looking after children while helping in nursery preparation, transplanting , weeding and harvesting. Men engage in work such as land preparation, irrigation, crop care, marketing, labour supervision and farmer organization activities. Children also help in the farming activities, house keeping and home gardening when ever, they have free time from their educational activities.

III. HISTORIC RELEVANCE

A. Age of the Practice as Reported By Studies

Village tanks gained reference in inscriptions, especially during reigns of King Walagambahu (104 – 77 BC), King Bhathikabhaya (21 – 7 BC) and king Washabha (67-105 AD), all those locatyed at mid-points of cascades. One of the examples is Horiwila in the palugaswewa cascade in the Maminiya sub-watershed (Thennakoon, 2000).

There are a few reported studies that have been carried out on the historical aspects of the small tanks in the country. Some references indicate that these small tank systems have been in existence since era of B.C. Nicholas (1959) reported that "The village tank was a well-established feature in the dry zone by the beginning of the second century B.C." According to *Siriweera* (2005), the stone inscriptions of first, second and third A.D. centuries refer to about 150 tanks.

Panabokke et.al. (2002), who studied the village tank cascade system reported that they observed that majority of the small tanks were hydrologically well-endowed and were also less susceptible to breaching during major rainfall events. According to oral village tradition, they had been in continuous existence and had been used from the period of *King Valagambahu* (approximately 300-400 B.C.). This would have started as small village settlements around small tanks, which gradually increased in size in response to increasing population (Panabokke et. al. (2002). Robert Knox (1681), who lived in the country in captivity during the period 1660-1679, reported that "Every town (village) has one of these ponds (tanks) of which there is a great number, the banks of which are in length above a mile, some less - –ot all of a size". These evidences suggest that the tank systems have been there during the long history of the country.

B. The Extent to Which the System has been Maintained

The system has proved its excellent technology for collection, storing and use of rainwater that fall within the catchment for domestic, irrigation and environmental needs of the village. Therefore, the basic features of the system are preserved despite heavy pressure on the lands

due to population increase and other social and economic changes. The main components such as tank, paddy field, hamlet are yet intact. However, the tank catchment management has been disturbed due to changes of land uses. There is no more chena cultivation in its traditional form. The *kattakaduwa* is maintained in most tanks. However, due attention is not paid to other components such as *gasgommana, iswetiya*, etc. This has resulted in siltation of tank bed causing a range of other problems. Villagers have understood the importance of maintaining the historically perfected system and are trying hard to rectify what has gone wrong.

C. Unique Contribution of the Practice to the History and Socio Political Evolution of the Nation

It is well established that the history of Sri Lanka has evolved with the progress of irrigation development in the country. Development of irrigation work commenced with development of village tank systems. Panabokke (2010) described how evolution of small village tanks cascade systems took place in the North Central Province of Sri Lanka. The technology of village tank systems later expanded to the construction of large scale tanks. With such development of irrigation works, Sri Lanka earned a prestigious name "Granary of the east" during ancient times. The CTVS were managed by the villagers. It was not a burden to the state. The country was self-sufficient in food and excess labor was used for construction of Stupas and large irrigation work by the kings under "*rajakariya*" (free labor for the king) system. As the nation was self-sufficient in food and kings were strong, they could pay more attention on development of other areas such as art, culture, religion etc.

The village irrigation system in the dry zone helped to keep the people in villages even when administration in the area collapsed due to foreign invasions. During these periods, the major irrigation works collapsed as heavy maintenance was not possible without the support of the central administration. However, the villagers managed to carry on the repairs and maintenance of village tanks by themselves. Further, the system has high resilience to natural hazards such as drought and floods. The villagers even survived the severe destruction caused to irrigation systems, paddy fields and property by invading foreign forces several occasions in the history.

IV. CONTEMPORARY RELEVANCE

The tank cascade irrigation system is a valuable, historically tested technology, which is based on scientific principles in harmony with the ecology. Therefore, even in the modern day, nobody can challenge its sustainability. However, haphazard development taking place at present without proper understanding of the system results in destruction of the system. Silting of the tanks, eutrophication of water, loss of biodiversity, salinity development in the paddy fields, water shortage, loss of livelihood are some of the implications. This situation gradually leads the farmers who were once self-sufficient in food in the villages become

totally dependent on the government. Also the contribution of the village tank irrigation systems to the total food production is decreasing.

Therefore, the conservation of the ecological foundations of the system while using the modern technology to improve the efficiency is vital for Sri Lanka. This implies improvements in the production system, introduction of new products out of available resources in the villages;, improving the quality of produce; new markets and development of skills of the community. Conservation of forests and watersheds, de-silting of tank bed, regularization of agrochemical use, increasing the efficiency of water application and use, and proper land use, maintenance of tank system are important aspects with respect to the production system.

The use of traditional crop varieties and organic farming will support agro biodiversity conservation and production of quality food. This will generate new experience on management of this vital system of the economy which can set an example for the development of thousands of CTVS in the country. Restoration of Tank Cascade System has a wider implication from the point of view of climate change. The system has proved its resilience to extreme weather events so far and the restoration of the system will be useful as an adaptation strategy as the effects of climate change escalate further. Further this will also preserve our unique agricultural heritage.

V. THREATS AND CHALLENGES

There are several possible threats for the conservation and restoration of cascade system in the changing social, political and economic scenario.

The water holding capacity of the CTVS has been affected through time – there is lesser volume available and shorter duration of water available to irrigate farms depending on the CTVS. Farm productivity, resiliency and profitability of farming is locally perceived to have declined, hence, the integrity of CTVS and sustained practice of farming revolving around CTVS is threatened.

A. Challenges in Natural Resources and Water Management

The water holding capacity of CTVS is largely affected by siltation, which in turn has been caused by encroachment of forested catchment areas (whether government or village owned) by upland farming, which does not adequately incorporate soil erosion control strategies. The stability of bunds and their water filtering functions are affected by the encroachment of the kattakaduwa for farming purposes.

Traditional community-based land and water management of CTVS has given way to a government-driven approach to management. This has been partly supported through the participation of Farmers Organizations (FOs) who play a major role in the annual village

water utilization planning. However, the current management system could not adequately absorb all traditional functions for natural resources management. Among the crucial functions that are no longer consistently practiced is the maintenance of buffer zones important for water quality management (kattakaduwa, Iswetiya, Gas gommana) and wildlife control. The loss of natural sanctuaries for birds has reduced natural capacities for crop protection. Lands supposed to serve as buffer for wildlife have been encroached thus, abetting human – animal conflict.

Since the tank system is rather old, occasional renovations are inevitable. Physical modifications and engineering works of the CTVS have been done on a tank by tank basis. Planning has not been done on cascade wide basis or on the basis of the hydrology of the meso-catchment upon which the CTVS has been embedded. As such, the effects of physical improvements are occasionally short lived.

B. Challenges in Agricultural Productivity, Resiliency and Profitability

The reduced supply of water combined with the high cost of farm inputs and limited access to markets, have made farming less productive and less resilient while profitability is no longer stable. The mainstream agricultural program promotes farm modernization through the use of higher yielding varieties and adequate fertilization and pest control, which imply higher production costs. The promotion of new crops and varieties has caused a decline in agro biodiversity, thereby, making the cropping systems more vulnerable to pest and disease outbreaks.

Usually, farming villages have inadequate access to mainstream markets for their products, They usually end up indebted due to loans for seeds and chemical inputs. In recent years, the government has piloted organic agriculture and promoted traditional varieties. The idea has been successful in some pilot areas. Most areas covered by CTVS await the opportunity for widespread implementation of this approach as an alternative to current agricultural approaches.

The questionable profitability of farming practices and the attraction of less physically demanding off-farm labor among the younger, generation has led to serious labor shortage for farming. This means that more cost effective agricultural innovations such as organic agriculture cannot be readily tried out.

C. Access to Agricultural Land

There is an acute agricultural land shortage and farm lands are increasingly fragmented. This is due to population increase and the drive towards putting back areas into forest and/or protected area status. The dwindling land: man ratio and resulting land fragmentation is also one of the challenges to both the integrity of buffer lands that stabilize the CTVS as well as to farm productivity. For instance, encroachment of lands traditionally allocated for animal grazing has reduced the livestock population of villages. Farm mechanization has also

reduced the need for livestock. Lesser availability of livestock has reduced availability of livestock manure important for soil fertility and farm productivity.

D. Appreciation of the Value of CTVS

The physical manifestation of the CTVS, which is the tank, has been regarded as an important part of history. However, the system of agro-ecological practices that is embedded in the CTVS and has formed part of the day to day culture in the dry zones is not yet recognized by the general public, as part of the country's cultural heritage. Thus, there is inadequate effort yet to document the traditional practices. Within the village, the younger people observe a few remaining traditional practice sustained by their parents but do not have the chance to discuss or reflect upon their significance.

VI. PRACTICAL CONSIDERATIONS

A. Ongoing Efforts (National and Local) to Promote Dynamic Conservation

There are a number of programs that if fully tapped, can support promotion of cascade conservation program. In recent times, a separate ministry, the Ministry of Environment has been established to monitor and address environmental issues arising from development activities. Recently, the ministry of Environment updated the National Action Plan for combating land degradation in the country. The plan has considered the conservation of village tanks. In order to conserve the Sri Lanka CTVS heritage, relevant concerned are included in the mandate of the Ministry of Agriculture. This ministry will support the conservation of tank cascade irrigation system through the Agrarian Development Department which has the authority on management of tank cascade irrigation systems and promotes development of village tanks.

There are other sectoral programs that would support the cascade conservation program. For example, the government policy on dairy development is aimed at increasing country's milk production which is only 17 percent of the national requirement up to 50 percent off by the year 2015.This is an opportunity that can be tapped in the tank dependent villages. The national biodiversity program facilitated by the Biodiversity Secretariat encourages the conservation of agro- biodiversity through active use. The traditional varieties that have been grown in the cropping systems and home gardens can help achieve this. The Ministry of Agriculture through Plant Genetic Resource Center maintains a wide collection of accessions of traditional varieties and the more desirable varieties can be reintroduced to the system if needed. The Forest department's present policy is to increase the forest cover up to 35 percent that would involve community participation such as through community forestry and Agroforestry. Climate Change Secretariat of Sri Lanka promotes the CTVS as this system has been recognized to show high resilience to extreme weather conditions.

B. Potentials and Opportunities for Sustainability and Management

The CTVS provides multiple windows of opportunities for improving food security, agriculture and livelihoods in the villages where the CTVS reside, thereby helping reducing poverty and enhancing socio-economic development. As a basic first step, food security and agriculture can be further enhanced through improved natural resources management and tank improvement to arrest the decline of water supply that supports the production of paddy rice. Through improved agronomic practices such as soil moisture management, some farmers may be able to plant an additional cash crop (pulse) in the paddy fields to augment plant protein and cash supplemental cash income.

Arresting the decline of yields through better water management can be complemented by improved access to markets. Farming communities may also wish to assess if it is worthwhile to compete with other more established suppliers for mainstream agricultural markets. Alternatively, the farm community may instead aim for engaging emerging niche markets who put premium to organically grown products as well as wellness products. Organizations that assist CTVS communities may help the latter transition to less chemically dependent products and link the same to these niche markets. Linking may involve identifying and understanding the needs of emerging markets and helping communities produce, package and market their products for these markets in ways that enhance competitiveness (organically grown, certification and labeling).

In addition to improving agriculture, eco- agri-ecotourism that is designed and managed with communities represents a new source of livelihood. This would be likely possible if the agricultural heritage practices are recognized and sustained while the existing biodiversity (ecosystems and species) associated with the CTVS are protected and promoted. Improving water management and agriculture through ecologically sound strategies, improved markets and enabling locally managed eco-agritourism provide incentives for improved management and sustainability of the system.

C. Expected Impacts of GIAHS on Society and Ecology

There are four key impacts expected as a result of declaration of the CTVS as a GIAHS. They are:

1 Sustainable conservation of the cascaded tank-village system;
2 Increase in income of the community in the declared site;
3 The potential replication of the good practices to be developed in areas declared as GIAHS in other cascades in the dry zone as well as formulation of policies that would enable such spread; and
4 Improved global awareness of the natural and man-made attraction in Sri Lanka.

D. Motivation (Interest) of the Community, Local Authorities and Other Relevant Stakeholders

The local authorities and farming communities are very interested in the prospect of dynamic conservation as a means to help conserve heritage that is fast dwindling and at the same time, a means for livelihood enhancement.

The various Ministries are interested with the potential value as model for good practices in the areas declared as GIAHS along their respective lines of interest. For instance, the Department of Agriculture (DA) is interested to develop and pilot approaches for agri-tourism, which would be based on agricultural heritage as a new form of agriculture-based income generation. Also of interest is to develop approaches for natural farming that utilize suitable indigenous species of cereals and vegetables that cater to emerging niche markets for safe food and wellness products. Both the DA and local authorities also want to provide alternative farming practices that rely on less chemical inputs partly because of emerging concerns on the increased frequency of renal (kidney) ailments among the populace.
The Department of Agrarian Development is particularly interested to be part of an effort for a holistic cascade wide approach to improve the hydrology of the CTVS while at the same time strengthening CTVS governance through improved capacities of FOs. International partner agencies such as the International Water Management Institute (IWMI) are likewise interested to provide R&D for developing the said approach.

VII. DYNAMIC CONSERVATION PLAN FOR THE PROPOSED GIAHS

A. Ongoing Efforts at National and Local Levels and a Preliminary Gap Analysis

The following is a preliminary list of ongoing efforts, subject to further study, that have potential relevance to dynamic conservation and from which future actions might build upon. The 3rd column indicates the possible gap in the current effort, which can be a possible area of concern for future plans.

Table 8: List of ongoing eforts

Constraint	Relevant On-going Work and Opportunities	Potential Gap
Catchment degradation and lessened capacity of tanks	Some of the tanks in the Palugaswewa cascade (the proposed GIAHS site) have been identified for rehabilitation by the Department of Agrarian Development Rain-water harvesting and soil	Tank bed surveys have already been completed in the tanks identified. Restoration of other small tanks, removal of sediments and tank ecosystem development are not included in the programme;

Constraint	Relevant On-going Work and Opportunities	Potential Gap
	conservation demonstrations by the Department of Agriculture in the highlands (uplands)	Total Catchment Management (TCM) approach through a multi-discuplinary team needs to be promoted as a Government policy to ensure the system sustainability
Limited availability of agricultural lands resulting in agricultural land fragmentation, and encroachment of land use zones reserved for ecological functions that protect the tank's integrity, etc.	Promotion of Ecotourism by the Forest Department under Community Forestry program Promotion of Agroforestry within Forest lands under the Community Forestry Program of the Forest Department	Capacity of communities may to plan and co-manage ecotourism may be limited at the moment Lack of opportunity and capacity for the community to fully avail the potential incentives and support for Agroforestry under the Community Forestry Program
Declining productivity resiliency and profitability of farming in some tank villages	Promotion of Traditional Rice cultivation by the Agriculture ministry through NGOs Promotion of organic farming by the Agriculture Department Promotion of home gardening by the community forestry management project (UNDP project) and Department of Agriculture Agro-biodiversity conservation program by the Biodiversity Secretariat	Application of generic extension programs does not consider the unique characteristics of heritage agriculture associated with the CTVS (e.g. maintenance of biodiversity etc.) Lack of seed production support program for traditional varieties Lack of access to niche markets by the community Lack of an organization to access the available opportunities

Constraint	Relevant On-going Work and Opportunities	Potential Gap
Wildlife damage to crops	Electric fencing program by the Wildlife Conservation Department for Human Elephant conflict areas	Adoption of biological barriers such as palmyra, cactus, sisal or combination of them is essential due to difficulty of maintaining electric fence on long run. Need of restoring wild tanks (*kuluwew*) for wildlife has not been recognized
Lack of Interest in agriculture by youth	No program currently documents agri-cultural heritage associated with the CTVS	Agricultural heritage related income generation opportunities for youth aiming tourism are not recognized
Farmer concerns related to CTVS are not adequately reflected in local development plans	Existing active Farmer organizations participate in local consultations	Inadequate measures in place to promote awareness by the local political leaders on natural resource and heritage management issues associated with the CTVS

B. Description of Key Strategies that Need to be Undertaken to Address the Threats and Challenges Cited in Chapter V

A series of multi-sectoral review and planning workshops were conducted during August to October 2015 to identify key challenges and threats and the priority actions that need to be considered to address them. A more detailed Dynamic Conservation Plan will be prepared for this purpose.

One of the key concepts contemplated by the foregoing dialogue is the development of the 'happy village' that involves proactive resolution of key structural constraints that the modern tank village is now confronted with, while at the same time encourage the sustainability of beneficial community practices that enhances both individual and social development.
Two levels of work are suggested. The first would be in the pilot sites to be declared as representatives of the system as a GIAHS. The second would be national level effort to establish policies that would help enable the dynamic conservation of heritage agriculture. In both levels, a Multi-sectoral approach would be crucial because we are not simply dealing with regular agricultural needs, but also cultural pride and conservation. Both young and old should be involved in preparing plans.

Site level work would include:

- Restoration of tank ecosystem and village commons to revitalize the heritage;
- Promote practicing traditional irrigation and agricultural practices, which are in harmony with present context;
- Encourage villagers to practice and preserve the traditional healthy food habits and local medicines;
- Establish a cultural centre with a folk museum to enlighten the indigenous technology;
- Heritage mapping, documentation of agri–culture; and communication thereof including the incorporation of cultural aspects in the formal education curriculum;
- Enhance access to both mainstream and niche market support through interventions guided by the value chain approach such as post-harvest handling, value addition and processing;
- Tap the community ecotourism potential of the tank and associated forest and agricultural biodiversity and cultural practices.

National level work would include the following:

- Review and amend policies that tend to constrain dynamic conservation of agri–cultural heritage. Such policies include those that inadvertently removed incentives for localized seed supply systems, natural methods for soil fertility enhancement and the maintenance of ecological buffer systems etc;
- Prepare a Compendium of agricultural heritage systems in Sri Lanka; such compendium would aim to inventory and identify the essential features of remarkable systems as sources of biodiversity, as well as lessons on strategies for climate change adaptation;
- Establish a national system for official recognition and support to agricultural heritage as a part of the overall cultural heritage of the country (both tangible (tanks) intangible heritage (agricultural practices);
- Launching of information campaigns that would incorporate a discussion of heritage agriculture and CTVS as part of public discourse on innovations in agriculture, biodiversity conservation, climate change adaptation, cultural heritage and ecotourism.

In both site and national level actions, the participation of women and youth in the decision making processes, implementation, monitoring and learning will be given optimum emphasis.

C. Resource Mobilization Plans To Support the Strategies Including Leveraging Actions with Other National and International Funding

Ideally, this can be a combination of the following sources in support of the Dynamic Conservation Plan:

a) Internal financing (national Government and local authorities);
b) External financing (small grants, loans from bilateral and multilateral partners, etc.);
c) Innovative financing (e.g. private sector, voluntary sector).

Financing will also need to be consisted of short term and long term financing Support from national and local sources;

- Based on dynamic conservation plan, introduce the concept of GIAHS into proposed plans and budgets of agencies for the succeeding years.
- Obtain immediate "in-kind" technical support from agencies based on their mandates and using available resources. Examples are:
    - Ministry of Culture - –upport to conduct cultural mapping in pilot site
    - Plant Genetic Resources Centre - –dentify germplasm in the gene banks (Plant Genetic Resources Center) that are coming from the site and reintroduce selected varieties
- Conduct studies and investigations on indigenous knowledge system disappearing at present

Support from external sources

- Short term grants from Grant Facilities and Scientific Institutions can provide small but immediate funding to support small scale piloting of concepts. Examples are :
    - GEF SGP (they are supporting cascade level work on biodiversity)
    - Small Startup Technical Assistance Grants from Donors (IFAD, FAO, etc.)
    - Research Grants from National and Global Scientific Institutions (CGIAR)
- Long term funding. The strategy is to be part of ongoing project preparation of relevant projects by key Ministries. Examples are:
    - Ministry of Agriculture –Department/Division on International Projects
    - IFAD and other donors – Identify relevant projects under preparation and be part of this project ; Also contribute to the development of their CoSOP (e.g. IFAD Country Strategy Operations Plan)
- Long term funding from the Climate Change Fund (CCF) is an example
    - There is a need to assemble information on Carbon sequestration potential, vulnerability assessments and CC adaptation potential
    - Partnerships with Department of Agrarian Department of Irrigation Ministry and IWMI will provide greater leverage

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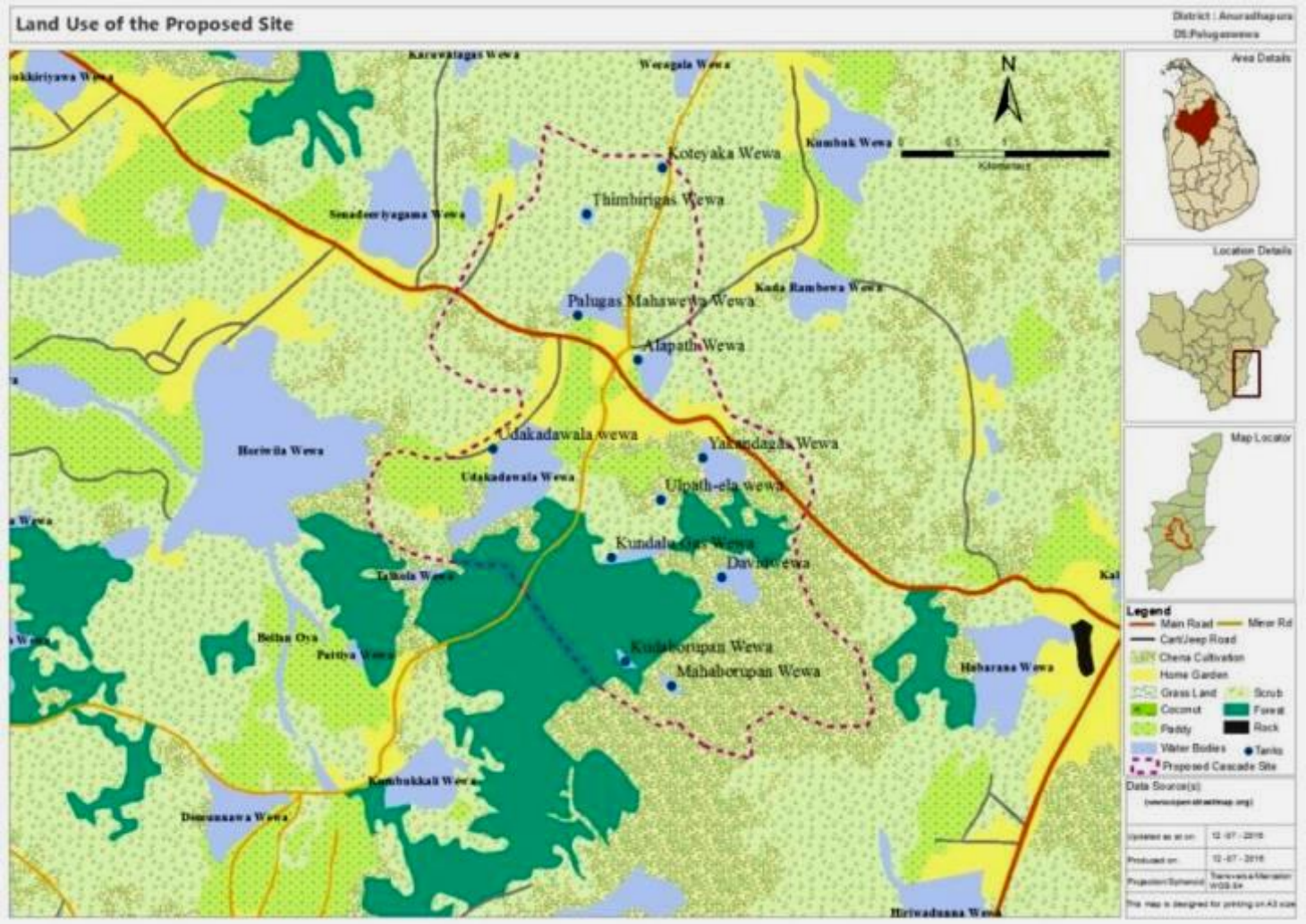
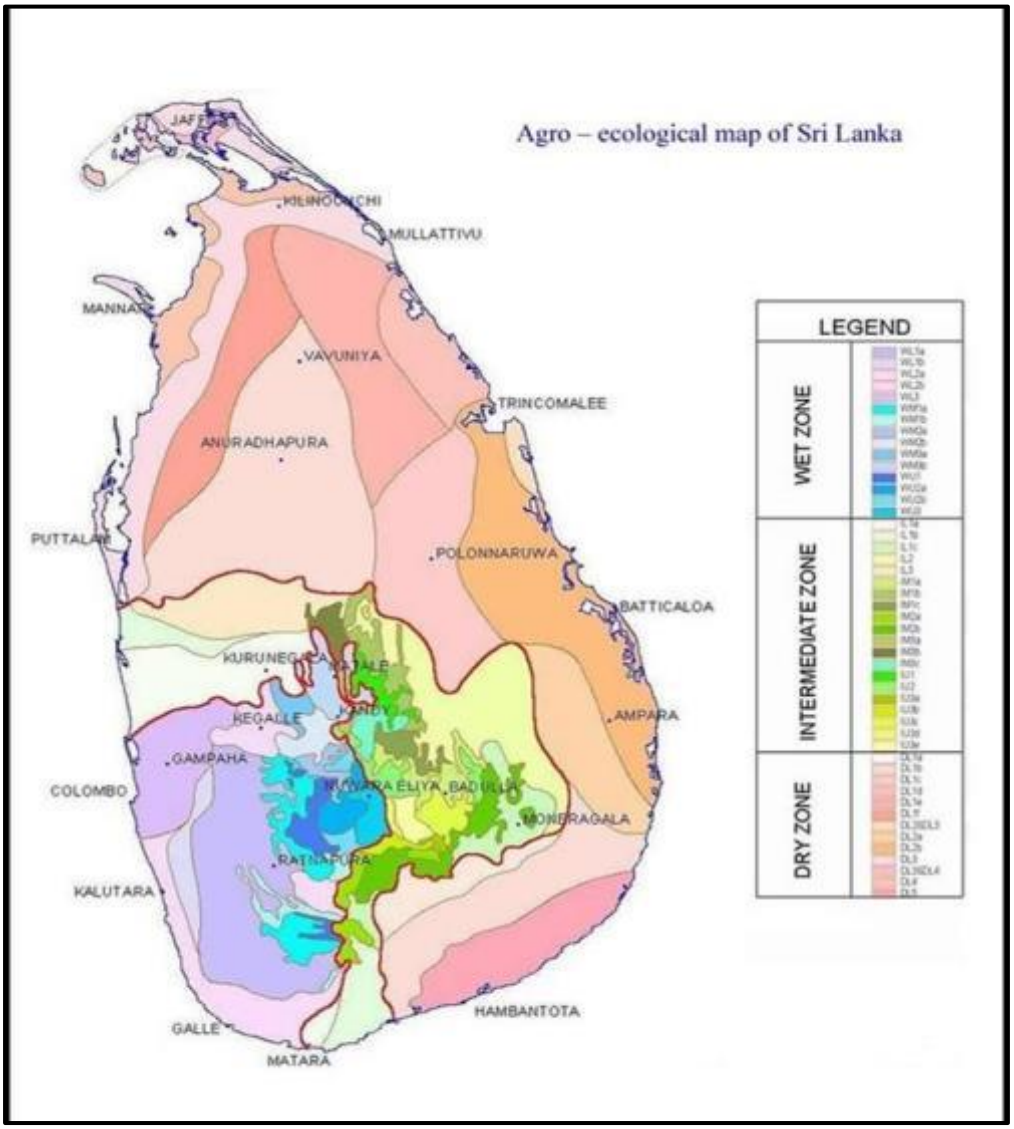
ANNEXES

Annex 1: Land use map of the proposed GIAHS site



Prepared by S. Suthakaran, GIS Specialist

Annex 2. Agro-ecological map of Sri Lanka



Source: Natural Resources Management Centre, Department of Agriculture, Sri Lanka

Annex 3. Present status of village tanks in the proposed GIAHS

Source: Piyadasa et al, 2012 and field photos

Kundalugas wewa(N 8^0 2’ 49.7’’, E 80^0 42’ 35.2’’)

Kudaborupan wewa (N 8^0 2’ 11.2’’, E 80^0 42’ 37.7’’)

Mahaborupan wewa (N 8^0 2’ 3.5’’, E 80^0 42’ 52.0’’)

Davidge wewa (N 8^0 2’ 47.5’’, E 80^0 43’ 18.1’’)

Ulpath-ela wewa (N 8^0 3’ 1.2’’, E 80^0 42’ 48.6’’)

Yakandagaswewa (N 8^0 3’ 14.1’’, E 80^0 43’ 1.8’’)

Alapath wewa (N 8^0 3’ 44.4’’, E 80^0 42’ 41.5’’)

Koteyaka wewa (N 8^0 4’ 43.6’’, E 80^0 42’ 49.3’’)

Thimbirigas wewa (N 8^0 4’ 29.4’’, E 80^0 42’ 25.5’’)

Palugaswewa Mahawewa (N 8^0 4’ 1.9’’, E 80^0 42’ 31.2’’)

Udakadawala wewa (N 8^0 3’ 20.8’’, E 80^0 41’ 53.7’’)