Perceptions of Tank Cascade Systems in Sri Lanka

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Cascade Ecology

By

P. B. Dharmasena

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‘Cascade Ecology is the study of the interactive relationships between living organisms (flora and fauna), including humans, and their physical environment (soil, water and geo-morphology) within the cascade boundary as well as its surrounding area of influence’.

- Dharmasena (2021)

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PREFACE

Scholars from various institutes have shown their interest on advancement of the knowledge of tank cascade systems scattered in the dry and intermediate zones of Sri Lanka. Early writers have mentioned about the well-organized water resources management systems including reservoirs, linked canals and small tanks and their land utilization patterns. The first definition of the village tank cascade systems emerged in 1985, when Prof. C.M. Madduma Bandara discovered the formation of systematic structure of these small tank clusters and named them as tank cascade systems. At present, after passing almost 4 decades, many scientists need to understand clear insight of the system and its functions with ecological factors. This book is a result of the collective effort of all such persons, who devoted time to probe deep into the real perception of this sustainable ecological system.

The book contains 16 short Chapters. As Ecology means the study of the relationships among living organisms, including humans, and their physical environment, it consists of various aspects of the whole environment where the humans are living and the interactions among these aspects. Thus, the cascade ecology needs due consideration of all these drives functioning in the system to get an insight of the perception.

Chapter one attempts to explore the historical perspective of the subject and Chapters 3, 4 and 5 bring the geography, geology, soil and climate prevailing in the region and how they create a favourable environment for the creation of this marvelous formation. Then the book moves on explaining water behavior in Chapter 5, traditional rice cultivation under these tanks in Chapter 6 and water resources management within the system in Chapters 7 and 8. Floral and faunal communities and their interactions with humans are discussed in Chapters 9 and 10 respectively. Chapters 11 and 12 are devoted to discuss about planning and management of cascade systems. The remaining Chapters (13, 14, 15 and 16) review the present knowledge on tank cascade systems extracting from various recent academic studies.

P.B. Dharmasena
(B.Sc., M.Sc., P.G. Dip., PhD), Independent Consultant
9th January 2024.

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CHAPTER ONE

HISTORICAL PERSPECTIVE

1.1. Introduction

Throughout the history, a large number of communities developed their own cultures and lifestyles that are intricately tied to nature and the local landscapes. The ancient civilization of Sri Lanka is not an exception, but its' social, political, and economic interactions with neighbouring countries have interfered during the entire process of evolution. The known history of Sri Lankan civilization records two main discontinuities due to external invasions taking place in 3000 BC and 1200 AD. This chapter attempts to describe the evolutionary process of the ancient hydraulic civilization of Sri Lanka, leading to the establishment of the cascaded tank-village communities. Available evidence from such a long period is also reviewed in this chapter to explore the evolutionary process of the dry zone civilization influenced by landscape and other factors.

The dry zone civilization might have first emerged around natural lakes ('vil') and streams ('oya') in varying sizes. Subsequently, human beings developed rainwater-harvesting methods to make living possible in other areas of the dry zone. Intrinsic networks of minor tanks and streams evolved with the formation of organized communities. More logical water-use systems were used when farming societies developed. Culture, customs, agriculture, traditions, and all sorts of lifestyles have evolved on this landscape with the influence of migration and invasion from the northern side of the island. These external factors might have accelerated or sometimes disrupted this evolutionary process of civilization. Two main types of supportive factors of the evolutionary process of this ancient civilization can be identified as the needs-based and the problem-based. The basic needs were water, food, fiber, shelter, and protection. The problem-based driving forces of the evolution of our human community were strategies to address natural disasters such as droughts, epidemics, floods, cyclones, and external invasions. Strategies adopted to face these challenges were infiltrated into the social systems in the form of their lifestyle and as accepted facts in their traditions. The pre-historic evolution that took place in Sri Lanka and India shows great similarities due to the continuous interaction between the two countries.

1.2. Paleolithic (Old Stone Age)

During the last one million years, when the human population is known to have existed in various parts of India, Sri Lanka was connected to the sub-continent on numerous occasions. The rise and fall of sea level (due to temperature fluctuations in the global climate) determined the periodicities of these connections, the last separation having occurred at 7000 years BP (Deraniyagala, 1992). Hence, it is impossible to view Sri Lankan prehistory in isolation from India. By about 125,000 years BP it is certain that there were prehistoric settlements in Sri Lanka. It is estimated that during certain subsequent pluvial episodes, the population density in the dry zone of northern, eastern, and southern Sri Lanka could have ranged between 1.5 and 0.8 individuals/km^2, whereas the wet zone in the west would have had densities of 0.1 or less.

1.3. Mesolithic (Middle Stone Age)

From about 34,000 years BP onwards the prehistoric record is much more complete. It appears to have been a remarkably static situation over so long a period, relatively undisturbed by the arrival of new populations with diverse physical traits. Their lifestyle could not have been too different from that described for the Veddas of Sri Lanka, the Kadar, Malapantaram, and Chenchus of India, the Andaman Islanders, and the Semang of Malaysia. They would have been moving from place to place on an annual cycle of foraging for food.

1.4. Neolithic (New Stone Age)

The transition from the Mesolithic Culture to the proto-historic Early Iron Age has been inadequately documented in Sri Lanka as the relevant transitional deposits have been disturbed by the extraction of fertilizer (guano) from prehistoric cave habitations. However, at a site, there are indications of pottery excavated for the cultivation of cereal. The discovery of a few pieces of copper-working slag from the Mesolithic context could signify the first identification of a Chalcolithic horizon in Sri Lanka.

1.5. Early Iron Age

The Early Iron Age settlement at Anuradhapura does not have a Megalithic cemetery to which it can even remotely be linked. The Megalithic mortuary complex could have been associated with just a special group of people, such as pastoralists, on the periphery of those who occupied Anuradhapura. Migration from the North to the island could have occurred primarily before 500 BC. What attracted these people who intruded on the scene at this early date? It is probable that the agricultural potential of Sri Lanka, notably its abundant supplies of water, with iron technology capable of subjugating the dense equatorial rainforest and heavy soils, was a major factor. Thereafter, Sri Lanka's attraction for settlers from further afield than South India appears to have gained rapidly. This swell coincided with the so-called Second Urbanization of the Indo-Gangetic Plain. The settlement at Anuradhapura spread over more than 10 ha by 800 BC. By then prehistoric stone tool technology had been completely superseded by that of iron at this site. Other advanced traits were the manufacture of copper-alloy artefacts, high-quality pottery (notably Black and Red Ware), the breeding of cattle and horses, and the cultivation of rice. By 700–500 BC Anuradhapura exceeded over 50 ha (Prematilleke, 2007).

1.6. Historic Period

The evolution of a great civilization in the north-central part of Sri Lanka was principally driven by the process of collecting water from rainfall for people and agriculture. It is somewhat of a sacrifice made to form societies around small sources of water in a water-scarce area and not move to water-rich areas found in the central highlands of the island. This is debatable and difficult to understand unless one deeply probes the interactive process of historic evolution. One might conclude that although the apparent problem in this area was water, the historic fate of the country nonetheless had enabled the erection of the civilization through skillful management of the available water due to regard for with the particular landscape features of the region.

With the progressive acceleration of cognitive abilities and technology in the later prehistoric period (30000–1000 BC), the stage was set for a radical transformation in the interactive balance between man and the environment. People steadily proceeded to dominate nature and bend it to the collective will. The advent of iron technology in Sri Lanka around

1000 BC is witness to this ascendance of man. Excavations in the citadel of Anuradhapura have produced important evidence of iron technology, the breeding of horses and cattle, and paddy cultivation, from cultural horizons nearly ten meters below the present ground surface. There is incidental evidence (faunal, sedimentological) for water management associated with paddy cultivation. Agriculture would undoubtedly have been dominated by paddy, which can only be intensified in the Sri Lanka dry zone, where Anuradhapura is situated, by the adoption of water management measures to control supplies from seasonal rainfall, streams, and perennial rivers (Deraniyagala, 2002).

The history and cultural heritage of Sri Lanka extends over more than 5000 years. The great King Ravana ruled the land of Lanka, which covered also part of India, around 3000 BC as mentioned in the popular Indian epic 'Ramayana' (The Epic of Lord Rama) thought to have been written in 500 BC. The capital of the Asura King Ravana is said in the epic Ramayana to be situated in Anuradhapura. The invasion of Vijaya through the Princess Kuweni (Princess of Land) occurred in 600 BC. Princess Kuweni ruled the area 'Chalaka' (western region), which was one of the ten divisions at that time. The cities of these local kings were said to be on mountains and four of them were around the Anuradhapura city, which was built 250 years later.

Although according to historical records, the city was founded in the fifth century BC, the archaeological data put the date as far back as the tenth century BC (Proto-historic period). Excavations in Anuradhapura have uncovered information about the existence of a Proto-historic habitation of humans in the citadel. The Lower Early Historic period spanning from 500–250 BC is studied on the lines of the chronicles. During this time King Pandukabhaya formally planned the city, with gates and quarters for traders. The city at the time would have covered an area of 1 km^2, which makes it one of the largest in the continent at the time (Prematilleke, 2007).

The legendary story of civilization in Sri Lanka begins when the island was inhabited by people of the original tribes Yakka, Raksa, and Naga. These early people gradually developed systems of sedentary agriculture based on irrigation, and folklore maintains that the Yakka built some ancient irrigation tanks. By the arrival of Vijaya around 500 BC, small-scale irrigation systems were already operational. The first extensive Sinhalese settlements were along rivers in the dry northern zone of the island. Because of early agricultural activity, primarily because the cultivation of wet rice was dependent on unreliable monsoon rains, the Sinhalese constructed canals, channels, water-storage tanks, and reservoirs to provide an elaborate irrigation system to counter the risks posed by periodic droughts. Such early engineering attempts reveal the brilliant understanding these ancient people had of hydraulic principles and trigonometry. The discovery of the principle of the valve tower, or valve pit (bisokotuwa), for regulating the escape of water is credited to Sinhalese ingenuity more than 2000 years ago. By the first century AD, several large-scale irrigation works had been completed.

The mastery of hydraulic engineering and irrigated agriculture facilitated the concentration of large numbers of people in the northern dry zone, where early settlements appeared to be under the control of semi-independent rulers. In time, the mechanisms for political control became more refined, and the city-state of Anuradhapura emerged and attempted to gain sovereignty over the entire island. The state-sponsored flowering of Buddhist art and architecture and the construction of complex and extensive hydraulic works exemplify Sri Lanka's classical age, which roughly parallels the period between the rise and fall of Anuradhapura (from 437 BC to 1040 AD).

After King Pandukabhaya (437–367 BC) founder of the Anuradhapura city, 122 kings reigned for 1477 years up to 1040 AD, until the kingdom was moved to Polonnnaruwa (80 km to the west). The establishment of forests and construction of ponds, reservoirs, and irrigation systems were considered great meritorious acts by popular Buddhism, the faith of the leaders, and the large majority of the people.

Sri Lanka's history is full of achievements of kings who contributed to the development of water resources. Since the first century AD, kings such as Vasabha (67–111 AD), Mahasena (276–303 AD), Dhatusena (455–473 AD), Agbo II (575–608 AD), and Parakrambahu (1153–1186 AD) built numerous reservoirs and irrigation systems that fed vast expanses of paddy field in the dry zone. Construction and upkeep of these irrigation systems became massive undertakings. An indigenous expertise developed over the centuries appears to have been called upon by other countries of South Asia.

This ancient hydraulic civilization of the dry zone disappeared after the twelfth century AD. Climate change, malaria, depletion of soil fertility, foreign invasions, and famine are some of the reasons cited. The breakdown of the efficient irrigation management system may have resulted from the annihilation of the 'kulinas' (the dry zone nobility who possessed irrigation expertise) by invading South Indian forces (Paranavithana, 1960).

The ancient water–soil conservation systems of Sri Lanka are a classic example of human adaptation to landscape. They include river diversion and water storage systems consisting of small, medium, and large reservoirs. These systems have been constructed over a long period, beginning about the mid-first millennium BC.

Hence, one may reasonably postulate that the distinct water management systems of Sri Lanka had their origins in the technological development that occurred during its proto-historic Early Iron Age from 1000 to 500 BC. It constituted the springboard for what followed during the Early and Middle Historic periods up to the end of the first millennium AD: the development of a water management system that in its technology and organization is one of the most sophisticated in the world (Deraniyagala, 2002).

This civilization evolved through millennia as a result of trying to find solutions to basic needs (food, water, and protection) and basic problems (drought, flood, cyclone, epidemics, and invasions). It is difficult to trace specifically the timing of the special strategies adopted to mitigate such disasters or to what degree these approaches were indigenous or influenced by invading/migrating foreigners (Dharmasena, 2010b).

Three main factors were most responsible for the evolution of the water resources management system in the dry zone. They are the morphology of the landscape, the amount and distribution of the rainfall, and the nature of the substratum (in terms of pedology and geology).

Water was managed by sharing between river basins through diversion or feeder canals to avoid excess or shortage. Some examples are the Dambulu Oya–Malwathu Oya diversion canal (860 AD), the Malwathu Oya–Kanadara Oya diversion canal (860 AD), and the Yoda Ela–Nachchaduwa feeder canal (540 AD). Within some river basins, water flow had been also regulated through link canals to avoid an imbalance of water. Examples are the feeder canals of Kalawewa–Thisawewa Yodha Ela (470 AD), Nachchaduwa–Nuwarawewa (290 AD), Balaluwewa–Siyambalangamuwa feeder canal (290 AD), and Basawakkulama–Maha Vilachchiya (470 AD).

A cascading form of small tanks and streams was developed to manage the water resources within river sub-basins. These tank cascades are mostly rain-fed but locally they may be supplied by feeder or diversion canals. Those people developed the knowledge to construct long canals with extremely low gradients, such as the Yoda Ela, which carried water from Kalawewa to the city tanks of Anuradhapura (Thisawewa) along a canal 87 km long. This 'Yoda Ela', which had a gradient of less than 10 cm/km within its first 27 km continued to maintain itself as a natural stream. It feeds numerous tank cascade systems found along its way, at the same time receiving excess drainage waters dispersed on the land from upstream tank cascades.

Indigenous agriculture is mostly based on inborn principles. People observed natural phenomena operating around them and studied how they could be manipulated for their needs. This included management of the forest by observing its anatomy, association of coexistent species, regeneration after fire, spatial variations, and so on. The farming system, which includes chena (shifting cultivation), paddy, and home garden cultivation, evolved through the interaction of man with the environment and developed in harmony with the natural landscape. Their experience and observations of rainfall patterns, wind, temperature, humidity, and landscape have been used to adjust their cultivation activities.

To reduce the risks of natural disasters they developed the tank-village community system that spread all over the dry zone. When they found that some of the disasters they faced in farming were beyond their control, they appealed to the support of religion and spiritual and cosmic influences. The most important fact they realized was that the sustainability of their food sources was not possible without giving due respect to the resources used in farming.

1.7. Evolution of Tank Cascade Ecology

The farming system of the dry zone communities is characterized by its three-fold pattern of land use. Rice, Sri Lankan's staple food crop is grown in the irrigable lowland mainly in the maha season and perhaps in the yala season depending upon the water availability in the village tank. The village hamlet (*gan-goda*) is on either side of the rice-grown area (*wel-yaya*) usually below the tank with perennial crops and vegetables. With the influence of tank water and because of lower elevation and imperfectly drained soils, most of the fruit crops such as mango, jackfruit, coconut, and some vegetables are easily grown in the home garden. '*Chena*' the third component, is the oldest farming practice of dry zone villagers, a form of shifting cultivation in the upland using direct rainfall.

Traditional wisdom in agriculture and the living has not been developed within a few decades. It is a long-time-tested knowledge, which created an environmentally adapted, disaster-tolerant, and sustainable living system. Their agriculture had been adjusted to absorb any weather vagaries by shifting the cultivation time and selecting farming practices. They cultivated chena and paddy lands according to the seasonality of rains thus; at least they could get a successful harvest from one of two cultivation types. '*Kekulama*' (dry sowing), '*Bethma*' (shared cultivation), *'Thaulu govithena*' (tank bed cultivation), etc. are the best examples showing how they could avert the drought effects on their farming. Traditional communities made every attempt to conserve soil, water, and natural habitat. Food security was one of the in-built aspects of their culture. The use of groundwater for agriculture was never practiced by them, and it ensured water security. Adequate dead storage was found in tanks to be utilized during dry periods for all purposes and had been the only source of water for cattle and wild animals. There was a broad diversity of flora and fauna in and around and the availability of water in the tank during the dry period assured their survival. Sharing resources equally and the equity of ownership were the most striking features of their culture, which led to building up a peaceful and sustainable rural society. Environmental pollution was not a topic for discussion. With the disappearance of the features discussed above, the whole system was subjected to deteriorate socially, physically, ecologically, and economically leaving vulnerability to disasters.

The sustainability of the traditional tank-village irrigation system had been maintained in the past simply not only from structural maintenance. Every component of the ecosystem was given due consideration. The attention was paid not only to macro-land uses such as paddy land, settlement area, chena lands, tank bed, etc. but also to micro-land uses such as *goda wala, iswetiya, gasgommana, perahana, kattakaduwa, tisbambe, kiul-ela* etc. (Dharmasena, 2010a). The geographical setting of these land uses, and descriptions and importance of them are discussed below (Fig. 1.1).

Gasgommana **(tree belt)** - It is the upstream land strip above the tank bed, accommodating water only when spilling. Large trees such as *Kumbuk, nabada, maila, damba* etc. and climbers such as *kaila, elipaththa, katukeliya, kalawel, bokalawel* etc. are found in this area. This vegetation is natural and seeds are floating on water. The *gasgommana* acts as a wind barrier reducing evaporation from the tank and lowering water temperature. It gets closure to the bund from either side where the roots of large trees make water cages creating breeding and living places for some fish species. This strip of tree demarcates the territory between humans and wild animals.

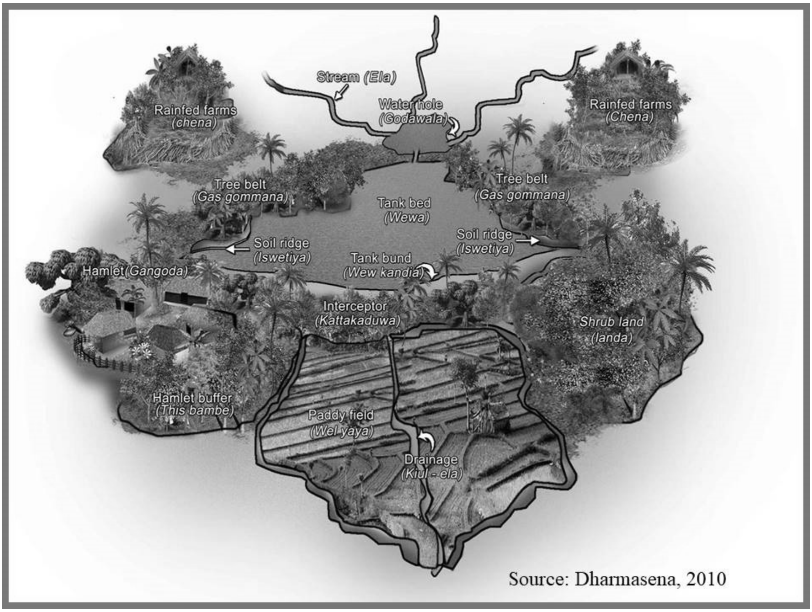
Perahana **(meadow)** – It is the meadow developed under *gasgommana* and filters the sediment flow coming from upstream *chena* lands.

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

Godawala **(water hole)** - A manmade water hole to trap sediment and it provides water to wild animals. This might have been a strategy to evade man-animal conflict.

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

Tisbambe – It is a fertile land strip found around the settlement area (gangoda) and does not belong to anybody. Tree species such as *mee*, mango, coconut, etc. are grown in a scattered manner. Mostly this area was used for sanitary purposes and as the resting place of buffaloes. Buffaloes were used as a protection mechanism from wild animals and malaria.



Source: Dharmasena, 2010

Fig. 1.1. Tank-village ecosystem

***Kattakaduwa* (downstream reservation)** – This is a reserved land below the tank bund. It consists of three micro-climatic environments: water hole; wetland; and dry upland, therefore, the vegetation developed is rich in diversity. This land phase prevents entering salts and Ferric ions into the paddy field. The water hole referred to as '*yathuruwala*' minimizes bund seepage by raising the groundwater table. Villagers plant *vetakeya* along the toe of the bund to strengthen the bund's stability. It is a common village garden, where people utilize various parts of the vegetation for purposes such as fuel wood, medicine, timber, fencing materials, household and farm implements, food, fruits, vegetables, etc. Specifically, they harvest raw materials from this vegetation for cottage industries.

Small irrigation tanks do not exist as individuals. Natural drainage system in a watershed is blocked by earth bunds in appropriate locations to store water forming a series of tanks along the drainage. The drainage pattern formed in the undulating topographic formation in the dry zone landscape can be classified as a dendritic drainage pattern. This ramifying nature of the drainage system has led to form clusters of small tanks found in series, which are connected to form a system known as 'tank cascades' (Fig. 1.2).

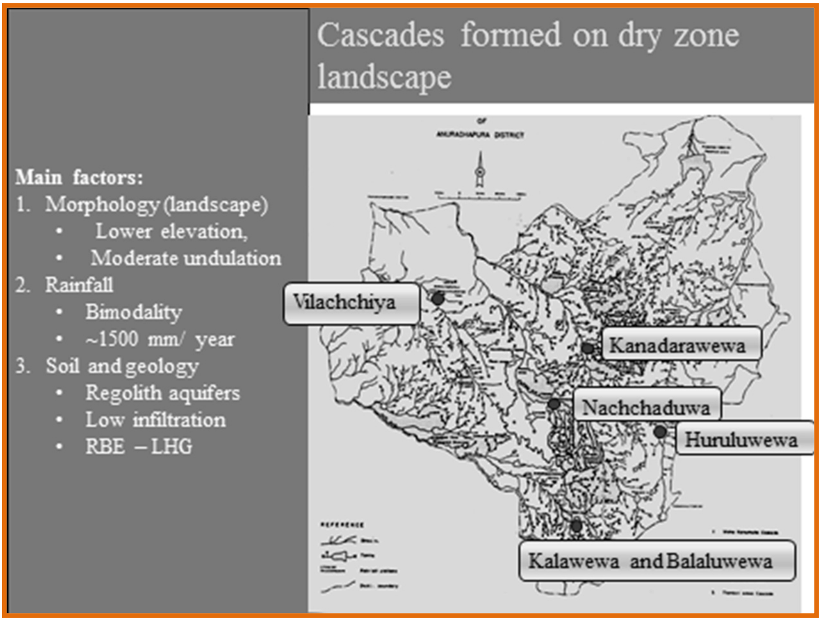


Fig. 1.2. Tank cascade systems in the dry zone

The existence of small tanks in a cascade pattern is an advantageous feature in many ways. Surface water bodies spread over an area can maintain the groundwater level closer to the land surface at least in lower portions of the minor basins. It can be stipulated that the absence of such a branched system of tanks could lead to rapid depletion of groundwater due to the natural gradient of the drainage system. Therefore, in the absence of tank cascade systems natural vegetation seen now would have not been in the same composition with deep-rooted large tree species found in the various positions along the catenary slope.

Upper tanks in a tank cascade system act as buffer reservoirs to absorb flood-generating rainfall, which would otherwise bring the risk of breaching lower tanks. Similarly, these upper tanks are buffer reservoirs to supply water to the lower tanks when they are in short of water to save the crop. Since the tanks exist not in isolation but as clusters, and they are hydrologically interrelated, planning for individual tanks could create conflicts in water resource management among them.

The setting of the small tank village from the point of view of its position in the landscape and the principles of land and water use that had been understood and practiced by the early settlers are best brought out by Abeyratne, 1956 in his description and discussion of some of the basic features of traditional dry zone agricultural systems.

A shift in emphasis from the single small tank to the cascade took place following Madduma Bandara's 1985 approach to the study of catchment ecosystems and village tank cascades in the dry zone of Sri Lanka. His approach emphasized the treatment of the total tank cascade rather than the individual tanks within a cascade as the more logical focus for any study of small tank systems.

Study of the water balance of a small tank was reported by Somasiri, 1979 at the Walagambahuwa village tank located in the Mahakanumulla cascade. This tank has a water spread area of 30 ha at full supply level and a storage capacity of 36 ha.m. Its catchment area is 115 ha and the irrigated command area is 13 ha. The water balance of this small tank was studied for four consecutive seasons and it was observed that the percentage catchment runoff during the maha season varies widely, with a high value of 25.4% of seasonal rainfall in a very wet maha season compared to 5.2% in an average maha season.

Dharmasena (1991) reports that the catchment area of a tank absorbs a significant amount of rainfall for initial soil saturation before it generates any productive or useful runoff and that, on average, around 150 mm of rainfall is required during the early part of the maha season before runoff commences. This value conforms with the moisture-holding capacity of the reddish brown earth soils that require around 150 mm of rain to moisten a 1.5 m depth of the soil profile to the field capacity moisture level. The first water balance study to be conducted on a whole cascade was by Itakura (1994) in the Thirappane cascade located adjoining to Mahakanumulla cascade. The Thirappane cascade is made up of four minor tanks along the main valley and two minor tanks on a side valley. A water balance study reports that for two successive maha seasons, the average percent runoff was 30 and 12, and for the two successive yala seasons it was 10 and 2.5.

Having studied the size, form, shape, and general alignment of 280 tank cascade systems in Anuradhapura District, Sakthivadivel et al 1996 have proposed two levels of classification for tank cascades. The first level is based on form and the size class and the second level is based on the configuration of the main valley, its main axis, and the side valleys.

The main components of the first level are:
Form – Linear or branched and form index;
Size (based on the total micro-watershed area) as

Small (< 1,000 ha)
Medium (1,000-2,000 ha)
Large (2,000- 3,000 ha)
Very large (> 3,000 ha)

Examples of linear and branched cascades are Thirappane and Mahakanumulla tank cascade systems respectively (Figure 1.3).

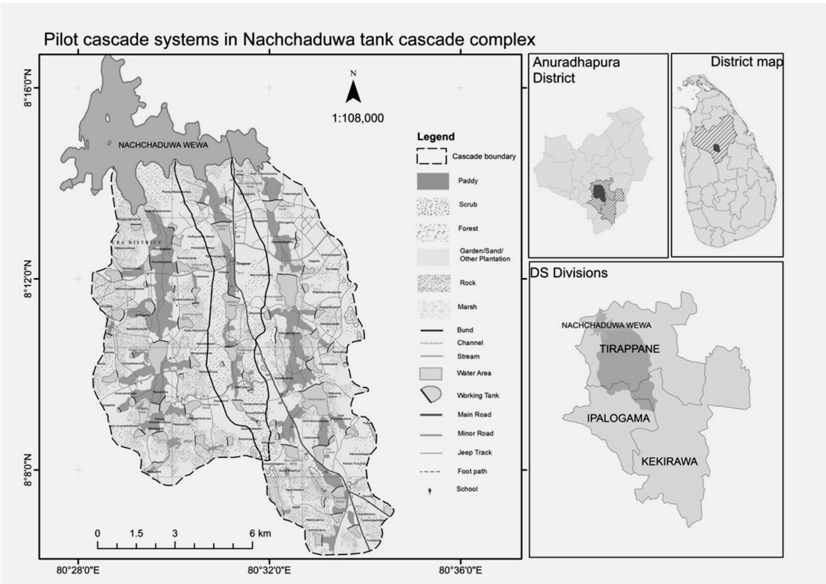


Fig. 1.3. A cascade system complex in Nachchaduwa watershed

The two parameters used for the proposed typology are the form index and the size class. The form index is the ratio of the overall area of the cascade to its overall length. This value could range from 1.15 to 2.55 and gives a measure of its general shape. The size class refers to the total area enclosed by the watershed or catchment boundary of the micro-watershed within which the cascade is located. The foregoing terms could be considered under the broad terminology of 'descriptors' that are commonly used in characterizing natural land systems. At the second level, the main features considered are the nature of the main valley and main axis; and the number of side valleys that enter and join the main valley.

The main valley of a cascade could be long, medium or short, according to the size class of the individual cascade and its form index. However, the more significant property of the main valley and its main axis is the overall slope class of the main axis because this has a close bearing on the hydrology of the cascade. Where the slope class of the axis is gently sloping (0-2% slope) there is a better retentivity of the water table within the cascade than where the slope class is moderately sloping (2-4% slope).

In sum, it could be stated that hydrologically better endowed cascades would be those that have: (i) a linear or slightly branched form with a form index of more than 1.5; and those that have (ii) a gently sloping gradient of the main axis. Table 1.1 shows the typology of some selected small tank cascades (Sakthivadivel et al, 1996).

Table 1.1. Typology of selected small tank cascades

Name of cascade	Level 1			Level 2	
	Form	Form index	Size	Main valley and axis	Side valleys
Thirappane	Linear	1.3	Medium	Moderately straight Moderately sloping	Few
Mahakanumulla	Branched	2.35	Large	Non-uniform Moderately sloping	Many
Ulagalla	Linear	2.08	Very large	Straight to wavy Moderately sloping	Many
Gangurewa	Branched	2.05	Large	Non-uniform Gently sloping	Few
Thimbiriwewa	Linear	1.70	Medium	Curved Gently sloping	Few