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Nāgānanda International Journal of Humanities & Social Sciences

Vol: 1 , No. 2021, 1, pp. 45-71

http://www.niibs.lk

H.H.A. Karunarathna

Lecturer, Department of Applied Archaeology, Faculty of Humanities and Social Sciences, Nāgānanda International Institute for Buddhist Studies, Sri Lanka.

Abstract:

The settlements existed before the creation of irrigation works, fulfilled their requirements of water through natural resources which were arranged according to the natural landscape settings. Anuradhapura old Yodha Ela coming under this study and well before its creation, the settlements spread in the Kala Oya Valley upper lands, fulfilled their water requirements through cascade systems right from the early historical period. According to the sloping of the terrain from the uppermost lands up to the lowermost lands, the cascade is a system made up of a network of village tanks. The problem of this research study is to establish as to why Yodha Ela was constructed later on through this zone although the *Kala Oya* valley uppermost lands received water from the cascade. The objective of the research study, is to examine the cascade which existed before the construction of the Yodha Ela, and the environmental and physiological factors that caused their structural changes. In order to justify the research objective, and during the data collection, GPS, study of aerial photographs, drawing up of plans, earth coring methods, and during data analysis the use of GIS, examination of soil profiles, calculation of the mean sea levels, and the like research methodologies were followed. As the result of this research, establishment of the spread of the village tanks in this zonal area before construction of the Yodha Ela, physical grouping of the cascade, establishment of the topographical landscape pattern of the cascade system, to build up the case that Yodha Ela is a facilitating component of the cascade systems, and the establishment of the functionality of the Yodha Ela and the cascade, was done. Even though in the previous researches, the originating water resources of the cascade system was done, their functionality, and classification of topographical patterns have not been done. But the manner in which the activities of the cascade changed with the early historic irrigation works have not been covered those previous studies. In this research, the structural pattern of cascade as an early water management methodology of the zonal area through which the Yodha Ela flowed and an understanding of the topographical landscape pattern accordingly, variations in the climatic factors, population density, agricultural works, and changes due to the variations in those factors, through the cascade and as a facilitating component the construction of the Yodha Ela during the early historic period, and parallel to those water management methodologies, migration of settlements from the uppermost to the lowermost zonal areas, which factors were established in this research study.

Keywords: ***Water Management, cascade, Soil moisture, Groundwater, Topographical Pattern, Settlements***

Received : 15 September 2020
Revised : 02 January 2021
Accepted : 03 May 2021
Published : 01 June 2021

TO CITE THIS ARTICLE:
H. H. Ashoka Karunarathna. Cascading Systems fed by the ancient Yodha ela canal of Anuradhapura in Sri Lanka. Nāgānanda International Journal of Humanities and Social Science.1:1, Pp.45-71

Introduction

According to the Sri Lanka district plan, bordering kekirawa and Anuradhapura districts which are within the North Central Province, Yodha Ela had been constructed. Its total linear elongation is 54 miles, and the width is 40 feet. Within the irrigation construction field, it can be cited as an exceptional quality creation. During the prehistoric period and the early historic period water management methods, and also the water management methods even after the construction of the Yodha Ela have together been networked from historical times, and with it functioning as such, altogether considered as a single Yodha Ela irrigation system. In this research, the cascade systems before the construction of the Yodha Ela, had to be introduced as a conceptual approach to the social background which was influential in the creation of Yodha Ela. As such, the water management methods used prior to the construction of Yodha Ela, and also the water requirements due to the complexities of issues in those contemporary settlements, leading to the factors in the construction of Yodha Ela, are the objectives of this research.

Applicable only to the Rajarata dry zone, and that can be identified only within one topographical environment, the concept of cascade system has been a subject of research receiving attention of both the local and foreign researchers. The conceptual research approach to the name ‘cascade' has been received from following the functioning of the rapidly cascading streams in the rocky's mountain slope range of North America (Bandara, 1985). With a similar functionality found in the cascade system in the North Central Province of Sri Lanka, starting from the top of an undulating mountainous range, slowly but gradually growing in size flowing down a valley feeding the tank further downstream, and traversing a considerable distance, connecting a large pond or a tank or even smaller rivers in the lower elevations. In here, the functionality of the main waterfall is quite similar to the above mentioned cascading system, has been shown (Bandara, 1985). Dharmasena has tried to illustrate the cascade system from quite a different view point. “Based on a sustainable human intervention, water, soil, air, plant lives etc. in fulfilling the basic requirements of human and animal lives, become an organized biological resource base set within the dry zone geographical arena" (Dharmasenam, 2017: 01). What is apprehended from this approach is that the cascade has operated as a multi-faceted functionality.

Analysing of the human corporations from the systems theory point of view, the origination of sub-cultures like technology, societal culture, manufacturing processes, habits and rituals, the village tanks have been the basis for their formations. Centred on the tank, food security can be identified as one of the main production activities. This has been an activity paying due consideration on factors like the water, soil, technology, landscape, and agricultural products. After the prior historic period and as a result of man's entry into the agricultural period, an irrigation cultural society associated with a societal culture trend can be identified. The term “cascade" at academic level, first came into use in the book “**Small Tank and Food Security**" printed in the year 2000. In here,

the manner in which the village tank technology has influenced the water management in the food production process, traditional methodologies adopted in the agricultural works, present day village tank related issues and in order to control them, the sectors that also need to be developed, have been considered (Panabokke, 2000). The whole background formation in the development of the total irrigational culture cantering the village tanks, has functioned as protecting the entire cascade system. The main purpose of these activities is food security. Since centring on the village tank is built up the entire cultural activities, they have human interventions both as tangible and intangible heritages. In later years, this term has been subjected to a much broader study in the book “Ellangavas for Environmentally based Development" (Tennakone, 2005). Also through the book “Urbanization in the Dry Zone of Sri Lanka", the Principles related to cascade have been analysed. In here, the topographical picture in the distribution of the cascade system, water flow, soil, and the influence of rainwater fall, have been analysed (Tennakone, 2005). Along with this principle of approach, within the eighties of the 20th century the functionality and the environmental friendliness of the cascade systems, a number of historic studies related to water management are cited among others (Ponnraja, 1982; Madduma Bandara, 1982, 1985; Abeysinghe 1982; Fernando, 1982; Karunanayake, 1983; Kariyawasam, 1984; Dharmasena, 1985; Tennakone, 1986; Alwis, 1986; Mendis, 1986 – 1989; Thilakasiri, 1986; Weerawardena, 1986) are important.

In the nineteen of the 20th Century, cascade with an international inclination has been studied, the International Water Management Institute has shown an interest in the scientific background of the tanks belonging to cascade for the development of the agricultural sector. Accordingly the establishment of the tanks, profile and nature of the tank, trends in their distribution have been studied at length (Panabokke, 1999). In this research on Rajarata, nine river clusters have been identified, and those water clusters have been grouped into 50 clusters, and have exposed 457 river valleys with cascades. Among these, the cascade belonging to river valleys, *Kala Oya*, *Moderagam Aaru*, *Malwathu Oya*, *Parangi Aaru*, *Maa Oya*, *Mii Oya*, *Yaan Oya*, *Koddikkaddu Aaru*, *Pankuulam Aaru* are important (Panabokke, 1999). Since the cascades between *Malwathu Oya* upper Valley and *Kala Oya* upper Valley have been exposed, and those facts have been included in this research study as a principle of approach. The said research study, although has drawn attention on the cascade, no attention has been paid on the sub-cascades. In this study however, sub-cascade between *kala Oya* and *Malwathu Oya* through which the Yodha Ela flows down, were exposed.

As the earliest period research on *Rajarata* cascades, research carried out on *Kadiragaama* and *Thoruwa* cascades are important. This study is a systematic research done on the tank systems that evolved parallel to the study on *Maaminiya Oya* and *Malwathu Oya* valley (Madduma Bandara, 1991). Cascade that originate from *Malwathu Oya* upper valley are boardering the *Kala Oya*, while cascades starting from the upper *Malwathu* valley are bordering the *Malwathu Oya* (Karunarathna, 2020). In here, the research approach is that when Yodha Ela is flowing through *Kala Oya* valley, construction of the

right embankment and when the same is flowing across *Malwathu Oya*, the construction of the left embankment. The two embankment's change of one and the same stream path when traversing through two valleys and the spread of the contour lines through revealing the pattern of the cascade profiles, the gradient of the terrain was established here.

Through the research paper titled "Scientific Background on some Traditional Methodologies of Lands and Water Management which were within the village tank system", the purpose and their functionality of built tanks/joined tanks or the associated tanks have been subjected to study (Bandara; Yatigammana; Paranavithana, 2010:1-10). The distribution of water in these cascades take place not only from across the upper lands to the lower lands, but take place also parallel to the associated tanks (Built tanks), has been shown by Brohier (Brohier, 1937). Cross or associated cascades are originated from a river or a tank or a hilltop. Much more has been subjected to study than the functionality of a cascade originated from a tank than the Yodha Ela cascade which is so special, since it is connected to a stream fed by a *mother tank* (first water). These cascade systems which were there even long before the Yodha Ela was created, although originated from a canal in the upper valley, construction of the Yodha Ela through this valley has been done in the ancient times as a step taken, in view of strengthening the functionality of the tanks in the system. Although the networking of a system of tanks has been introduced through a common concept of cascade, these village tanks at that times were considered as a show-piece that each of these tanks can be identified in a settlement zone. Dharmasena has illustrated this component as "*Tisbambe"* situated within the uppermost terrain of a tank with a higher gradient (Dharmasena, 2004:05).

In the settlements distribution where created irrigation works are functioning as a secondary system, some factors like the climate, water, and the environment are important (Bandaranayake, 2002:147-156). In the water management techniques associated with the water supply requirements of human settlements of the early historical period or that of the historical period prior to the construction of Yodha Ela, inefficiency of the water supply too may have been instrumental. For this, the climatic change, increase in the demand for land utilization, trends in the spread of settlements, and population density may have been instrumental. Through the research "Cascade Tank System and the Cultural Landscape of Sri Lanka", it has been shown that factors responsible in the spread of settlements in the topographical landscape pattern, and the related cultural landscape pattern, and human settlements around village tanks have been subjected to study (Bandaranayake, 2018:27). In here the scientific geographical landscape pattern that has been instrumental in the distribution of the tanks has been highlighted, and that the geo-pattern of the terrain where tanks in Sri Lanka have been constructed, is of crystalline granite, has been shown (*ibid*, 2018:27). This research which is drawing attention on the study of cascade cultural geo-landscape pattern, has classified the structural features into four categories. Viz. tanks constructed associating one stream path (single type), branched form stream paths (branch type), those connected with one or more connected in a linear way (linear type), single or cluster cascades (cluster type), those concentration around

a single epicentre (nucleous type) as cascades, could be identified (*ibid*, 2018:47).The spread of the cascade can be identified accordingly with the profile pattern of the water stream as a linear networking. The internal geophysical arrangement of those cascades built based on the Yodha Ela can be illustrated in two ways. That is, a linear networking distribution taking into consideration the horizontal spreading patterns, and the vertical spreading pattern according to the contours, epicentre, clusters, and linear cascades, can be established.

Attention has been paid to the steps that need to be taken in order to conserve the catchment areas among the cascade distribution zones and the feeder zones. Among them, the surface water flow control, evaporation control, ground water changes, agri water utilization methodologies are important (Dharmasena, 2002:10). As an important research in the study of cascades of the dry zone, Small Village Tank Systems of Sri Lanka: Their Evaluation Settings, Distribution and Essential Functions, is important (Panabokke, 2009). Village tank construction has started in the iron era (1500 - 500 BC), while in the historical period (500 - 300 BC) foundation for the large tank culture has been laid. Before the large tank culture, that the water management and settlements were in existence in the dry zone centred on village tanks, has been shown by Tennakone (Tennakone, 2005). Through the research paper "Small tank settlement in Sri Lanka" multipurpose activities which are the activities connected with the terrain variations and the like, and taking them into consideration, a classification as a village tank heritage, have been studied (Tennakone, 2000:03). The components of the activities connected to a village tank, and some factors in their utilization have been shown. Accordingly, the water catchment areas, *Kattakaduwa, Gasgommana*, canal pathways, human settlement terrain (*Tisbambe*), groundwater pathways, *Wev Pitiya*, tank forest, and the like are important (Tennakone, 2004:05). In studying the spread of the human settlements and their water requirement before the construction of the *Anuradhapura* Yodha Ela, this zone had been a human settlement ground and their water requirements had been fulfilled through cascades. The settlement spread of the downstream cascades which are fed by the Yodha Ela, and the upstream cascades which are separated from the primary activities, have been studied.

Nicholas shows that the human settlements first appeared in the B.C era in association with the village tanks in the dry zone areas (Nicholas, 1959: 75). During the 2nd century, increasing the water capacity of the existing village tanks centralizing on the household activities, they had to construct larger tanks sufficient for their agricultural works (Panabokke, 2004:22). In addition to this practice, the migration of settlements into lowland areas has occurred along with the distribution of water to different areas largely through the network of canal pathways of the agri technology. As a result of this, even though Yodha Ela up to the capital city was created due to the migration of human settlements existent during the early historic era in the inter zonal areas, and that in order to reveal this fact, inter-zonal settlements and intercity settlements, could be revealed, only through physical cultural factors.

Methodology

In order to reveal the cascades that are fed by the old Yodha Ela in Anuradhapura, the methodologies engaged primarily are; field visits, calculation of the contour lines, and obtaining of GPS data. In order to establish the distribution of cascades in the study area, maps showing the village tank distribution has been studied. Study areas were divided into two major categories. Viz. the zonal area through which Yodha Ela is flowing as the core area, and the middle area which is 45 km from each side of the river bank, that is in total about 90 km of ground area, was explored. In here, when dividing the ground areas, while a straight line distance measure was not done, but a measurement following the curvy nature of the Yodha Ela.

Since exploring the entire ground area was rather a difficult task, in the protected area portion of the Yodha Ela from *Kala Weva* to *Mahailluppalama* with 45 km on either side or covering a total area of 90 km was explored. The 2nd Portion from *MahaIlluppalama* up to *Batuwatta*, and the 3rd portion from *Batuwatta* to *Thisaweva* following the earlier measurements, were explored. For the correction of the distances a Dhumpy leveller had to be utilized, while for the topographical positioning, GPS equipment has to be utilized. Because the survey maps and plans were used, the activities of the respective cascade could be revealed quite conveniently.

The activities of the tank systems in the study area as the Yodha Ela fed lower land and upper land cascade as separate notes, has been done in the zonal classification. Thereafter, in order to rectify the accuracy of those activities, and also to establish their connection with Yodha Ela, Tracing of the geographical positioning of those tanks on a contour map prepared using the ArcGIS software has been done. While naming of the tank systems was done based on the name of the largest tank in that location, and the study was carried out in cascade where at least 05 tanks were included.

In collecting the data associated with the tank systems fed by the ancient Anuradhapura Yodha Ela, an important aspect where attention was paid had been the settlement factors. While collecting data on the tanks in the systems, data collection on the settlements too has been done. In here, from the tanks in the uppermost systems to the lowermost systems in revealing the true activities of the tank system, tools such as GPS instruments, one inch maps, and compass had to be used in the explorations, while the irrigation components of the tanks in the zone were established through ground surface explorations. Accordingly for each and every tank the settlement ground of the relevant tank system distribution trend as to how they occurred, had to be established. All factors related to the settlements connected to the tanks have been recorded both in the written form and non-written methodologies.

In the study of the tank systems fed by the Yodha Ela and the sector exploration in collecting the data, one inch maps, survey plans, data collection issued by the agricultural department on the tank systems, and GPS scientific tools have been used. Revealing

through the sector exploration of the cascade tank system and using GPS location information, analysis of the data was done using the GIS Software. In here, the activities of the tank system in the study area, as to how it was instrumental in the distribution of the settlements was established through data analysis. As such in the establishment of data on the tank, how those tanks influenced the distribution of the settlements, attention was paid to reveal the methodologies engaged by the canal pathways and their connections with the tanks.

According to the ground arrangement pattern in the Yodha Ela Sector exploration, the site information of the cascade system tanks, with the help of the GIS software, the topographical plans of the relevant study zonal area, establishment of the information gathered during the site explorations and placing them onto a single map, was carried out. Thereafter, in order to establish the correctness and accuracy of the information, the complete data base on the entire rajarata tank system distribution, extracting the corresponding information as per the relevant zone, by tracing on the earlier map, correctness of the activities of the system tanks could be done. Then by tracing those cascade on the map where the corrected pathway of Yodha Ela was established, Yodha Ela upper cascade and the lower cascade system, and the establishment of their activities could be done. The originating tank of the cascade could be either be from a rain fed upper zone tank or a catchment area, most of the tank systems subjected to this study are distributed taking into consideration the tank connected to Yodha Ela, as the origin of tank in their distribution. By using GIS software, how much of those cascades are covering the feeder areas could be established.

The second factor is the establishment of the trends in human settlements in the related cascade of the zonal areas. In here, while basing on the field explorations data gathered connected to the cascade system has been important, incorporating such data in the topographical map prepared using GIS Software, a clear understanding on the trends in the settlements distribution could be obtained. Through this, the manner in which the human settlement trends have been associated with the cascade system could be comprehended by this methodology, during the data analysis. This is a fact that can be cleared from the organization of the Archaeological remains recovered from those settlement excavations.

Results

Cascade system can be identified as a water management medium identified in relation to the old Yodha Ela of Anuradhapura. Bofore the Yodha Ela was constructed (prehistoric or the megalithic culture) from the discovery of human settlements in this zone, it can be presumed that the origin of the village tanks would have happened here. Fed only by the rainwater, the village tanks are connected like the links of a chain starting from uppermost tank up to the lowermost tank according to the topographical pattern. 12 Cascades built in this manner have been identified from the Yodha Ela uppermost zones and lowermost zones, and confirmed. within the entire cultural geographical landscape,

irrigational construction features, and developed over different stages, could be identified. They are;

-Village tanks

- Cascade systems before the construction of Yodha Ela

- Activities of cascades after the construction of Yodha Ela

Under the 1st category which are the tanks that belong to the *"Mother tanks" (first water)* of the uppermost cascades that appeared, and concluded to have occurred with the Earliest distribution of the human settlements. It is quite clear that these tanks have been spreading over a distribution period from prehistoric (1000-500 BC) times, up to early historic (500-100 BC) times. Before the construction of the Yodha Ela, tanks that belong to the cascades have been fed only with rain water. Due to increase in complexities of the settlements, and the increase in demand for land and insufficiency of water requirements, Yodha Ela has been constructed through this province. Taking into consideration this increase in the social complexity, Yodha Ela has been constructed, and through this a further strengthening of the early irrigation system network, the Yodha Ela irrigation works have able to further improve their inter-relationship. Meanwhile, the cascade system is operating as two differentiated sections as the uppermost and the lowermost. The uppermost cascade fed only through rainwater or spring-water, while the lowermost cascade tanks are fed by the Yodha Ela. The spill-over water from the uppermost cascades are again directed to be collected at the Yodha Ela through arrangements in the ground pattern (Map No. 01).

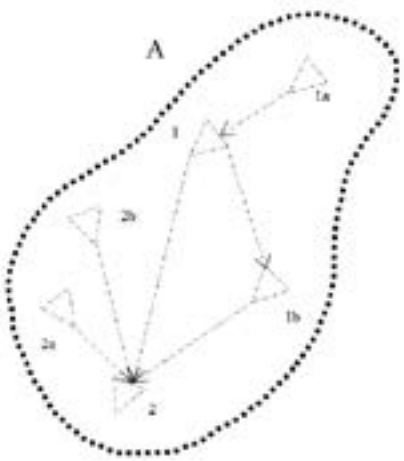
Uppermost cascade Systems

From *Kalaweva* which belongs to the uppermost zone of the Yodha Ela, up to *MahaIlluppalama* was first explored, where five (05) cascade systems were revealed. The uppermost zone was studied. Those cascades systems are as given below.

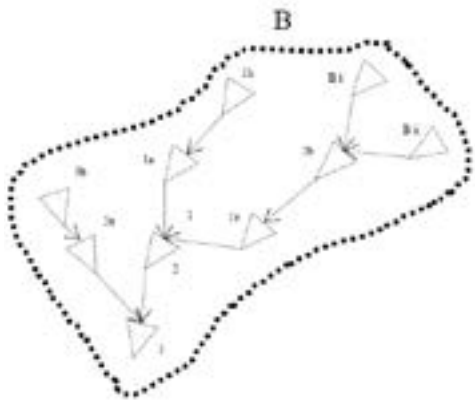
Table 01: Uppermost cascade systems from *Kalaweva* up to *MahaIlluppalama*

Serial No.	Main tank	Sub-tank- i	Sub-tank- ii	Sub-tank- iii
01	*Mudaperumagama*	*Aluth Ihalagama Ihalawewa Maelaperumawa*	*Karabewa Gokarellagama*	*Mudaperumagama Radagama*
02	*Pallekagama*	*Halmillewa Karabewa*	*Ihalakagama*	*Pallekagama Hiripitiyagama*
03	*Aththikulama*	*Kelekarabewa Katuwellagama*	*Aththikulama*	*Nellikulama*
04	*Goonapathirawa*	*Ihalagama Machchagama Manewa*	*Kadiyangalla Lokgama*	*Goonapathirawa*
05	*Maradankadawala*	*Walagambahuwa Paankulama*	*Amane*	*Ihalagama Maradankadawala*

Source: From Sector Studies



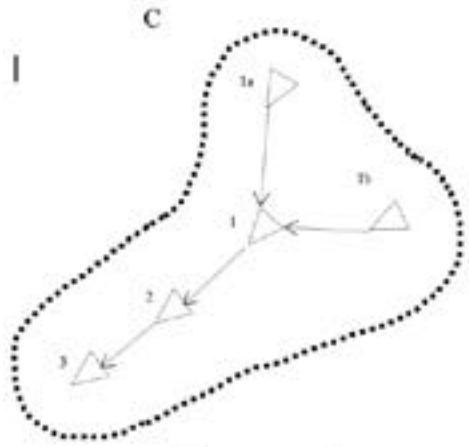
Plan No. 01, *Gonapathirava* Cascade



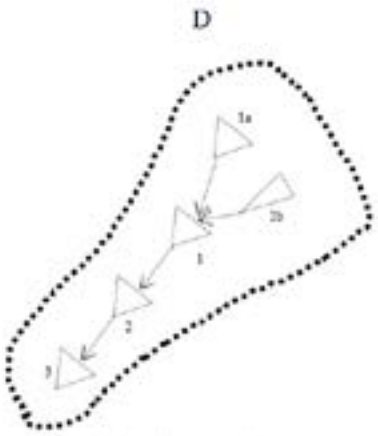
Plan No. 02, *Pallekagama* Cascade

Among the cascade systems that belong to the uppermost zone of the Yodha Ela, *Gonapathirava* and *Pallekagama* cascades are important. The *Gonapathirava* cascade is connected to the *Ihalagamavewa* (1a) which originates from Cascade of *Maaneva Kanda*, upto *Machchagama*, and is also connected to *Maanawavewa* (1b). Water from Loggama (2b) and *Kadiyangalla* (2a) tank which are situated towards the left side of the feeder zone, and water from *Majjhagama* and *Maanewavewa* while connecting to the *Gonapathiravewa* (2), before the construction of the Yodha Ela, and though this cascade is spreading from *Gonapathirava weva* to lowermost zone, at present, due to construction technologies used in Yodha Ela, the lower zone area is functioning as a separate cascade. Since prehistoric human settlements could be discovered in this cascade uppermost zone, that this zone right from the early days had been subjected to human habitation, was confirmed.

The water catchment areas of some of the tanks originating from the uppermost zones of Yodha Ela, *Halmmillewa* (bi) and *Karambawattaweva* (bii) are important as originating tanks based on natural scrub forests and natural water springs. Thereafter the "*Drainage water"* from those tanks join the tanks *Ihalakagamaweva* (1a) and *Pallekagamaweva* (1). Originating from the uppermost zone of the left side of this chain of tanks, water from the *Indunugalaweva* (1b), *Dampellessaweva* (1a) getting collected also to *Pallekagamaweva* (2), and thereafter join the tank *Hiripitiyagama* (3). Spreading in a horizontal manner from the left side of those tanks system, Hiriyapitiyagamaweva is fed also from waters of (*Dampellessa* 3a), and *Kammalathpalliya* (3b).cascade system below the *Hiripitiyagamaweva*, since they are divided by the Yodha Ela, could be identified as operating as a separate system.



Plan No. 03, *Aatthikulama* Cascade



Plan No. 04, *Maradankadawala* Cascade

Aatthikulama (C) cascade is originating from the Yodha Ela uppermost zone natural forest area, and the tank *Kelekarambewa* (1a) and *Katuwellagama* (1b) could be identified as the twin original tanks. The water from these tanks, join the main *Aatthikulama* (1) tanke, and thereafter join the *Nellikulamaweva* (2) and *Ganthiriyagamaweva* (3) tanks. The *Ganthiriyagama* lower cascade system, due to the construction of the Yodha Ela, is now separated.

Parallel to the *Aatthikulama* cascade, the origination of *Maradankadawala* Cascade has occurred from *Walagambahuwa* (1a) and *Paalankulama* (1b) tanks. *Walagambahuweva* is an active tank of the *Mahakanumulla* cascade, and with the *"Drainage water"* from lowermost area feeder zone are fed to the *Amanankattuwaweva*. Although the contour lines of the topographical area where this cascade is spread do not decline towards Yodha Ela, it is connected to the *Naachchaduwaweva* across the uppermost area of the Yodha Ela. Thereafter, has joined the tanks *Ihalagamaweva* (2) and *Maradankadawalaweva (3)*, situated below the *Manewa wewa* (1).

Table No. 02, Uppermost system tanks from *MahaIlluppalama* up to *Batuwatta*

Serial No	Main tank	Sub-tank-i	Sub-tank-ii	Sub-tank-iii
01	In ithis Zone only Kulu-Lakes could be found.			

Source: through Sector Studies

Table No. 03, Uppermost settlements from *Batuwatta* up to *Thisaweva*

Serial No	Main tank	Sub-tank-i	Sub-tank-ii	Sub-tank-iii
01	In this zone village-tank could be found.			

Source: through Sector Studies

According to the information revealed during the sector study of Yodha Ela, from *Kalaweva* up to *MahaIlluppalama* of the uppermost zone, although the spread of the cascades can be identified, from *MahaIlluppalama* up to *battuwatta*, from *Batuwatta* up to *Thisaweva*, no any such spread of the cascade system in the uppermost zones could be identified. What was revealed in here is that the main water catchment areas of the uppermost zone from *Kalaweva* up to *MahaIlluppalama* could not be identified. But the agricultural activities in those zones have been carried out based on rain water and on tanks fed through natural spring water sources. According to the human settlement factors, the settlements which have spread associated with these tanks is a clear fact that from historic periods these irrigation works must have been on an active scale. But, from *MahaIlluppalama* up to *Thisaweva*, and within the uppermost zones of the main resources *Naachchaduuwa*, *Thuruwila*, *Nuwara Weva*, due to the supply of water to the uppermost zones, the functionality of the cascades have been slowed down. Yet, during the historical periods, before the development of large irrigation works, centralizing on cascades in this zone, water supply activities had taken place, could be established through the distribution study of the marginalized tanks. As such, due to the development of the irrigation works, the water management methodologies before the construction of Yodha Ela, and over a period of time have made them obsolete. Due to this reason, even though human settlement factors within that zone could be identified, it is quite reasonable to think that some of the tanks in the cascade system have been rendered dormant, as a result of some later on activities.

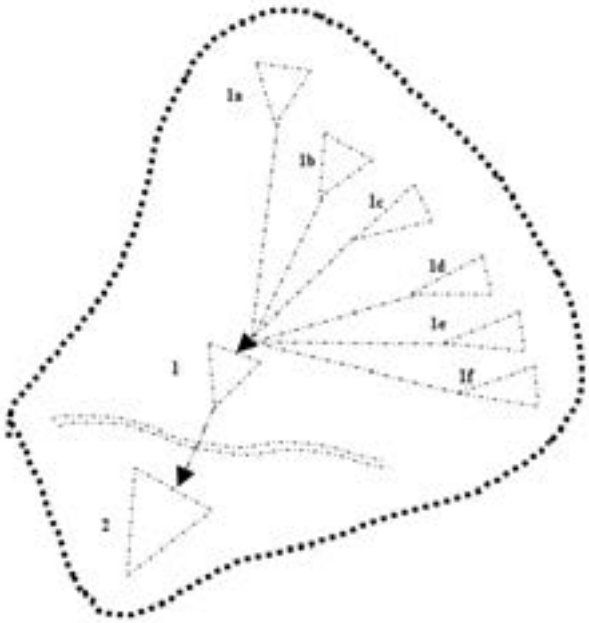
Lowermost cascade system (from *Kalaweva* up to *MahaIlluppalama*)

Yodha Ela has been constructed not only for the purpose of fulfilling the water requirements of the Capital City, but also as an irrigation work for the purpose of fulfilling the Inter zonal water requirements. Although the construction of the Yodha Ela across *Kala oya* and *Malwathu oya* could be identified as a complete irrigation work, during the early phase Yodha Ela has been constructed to some extent, only for supplying water to tanks in the intermediate zone and the settlements. Although the Yodha Ela flowed in an inter-zonal area between two main *oyas*, no suitable landscape setting is there, for obtaining water to Yodha Ela from those sources. This fact was revealed from an examination of the elevations of the contour lines in the study area. Taking these factors into consideration, with the aim of expediting the water utilization of the cascade system, and the supply of the water requirement of the lowermost settlements, Yodha Ela has been constructed. Due to this reason, it is clear that even at present the cascade system of the lowermost zone has been able to remain active and quite unaffected by the influence of those activities.

Table No. 04, The lowermost system tanks from *Kalaweva* upto *MahaIlluppalama*.

Serial No	Main tank	Sub tank- i	Sub tank- ii	Sub Tank- iii
01	*Mahailluppallama*	*Sangettewa Sirikkulama Maha- Mii gassegama Kuda-Mii gassegama Maradankadawala*	*Koniththi ela -Kattiyawa wewa*	*Katiyawa ela- ^Nawagala* Settlement&

Source: through Sector Studies



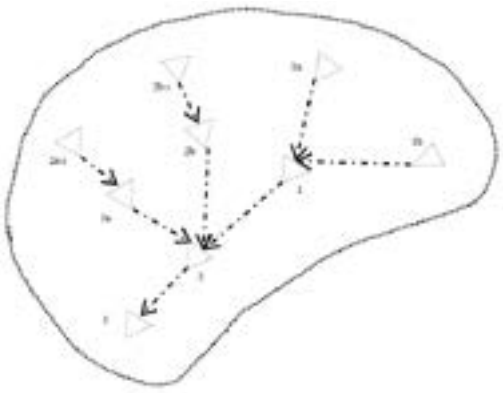
Plan No. 05, *MahaIlluppalama* Cascade

MahaIlluppalama cascade which can be identified in the form of a fan, is fed by a number of tanks in the uppermost zone. Those tanks have later been found to be fed from Yodha Ela, was revealed during the research study. Water from *Maradankadawala* (1a), *Sungettawa* (1b), *Sirikkulama* (1c), *Miigessagama* (1d), *KudaMiigessagama* (1e), feed the *MahaIlluppalama* tank. According to the large extent of the spread of the catchment area, this tank can be identified as a large tank. Water from *MahaIlluppalama* is feeding the *Kattiyaweva* (1) through *Konnitthi* Ela. Within this zone, historic period human settlements could be found, and accordingly can be identified as human settlements after the construction of the Yodha Ela.

Table No. 05, lowermost tanks from *MahaIlluppalama* up to Batuwatta

Serial No	Main tank	Sub tank-I	Sub tank-ii	Sub tank- iii	Sub tank- vi
01	*Kuttikulama*	*Ihalagama Galmaduwa Nabadewa Katiyawa*	-	-	-
	Aluthwewa	*Poththegama Galmaduwa*	-	-	-
02	*Eppawala*	*Koonwewa Mahaganewewa Kudagane wewa Eppawala Katiyawa Madiyawa*	*Madiyawa ela- Veheragala Ruins*	-	-
03	*Kaduru wewa*	*Palugaswewa Meegahagama wewa Makule wewa*	*Eliyadiuwlwewa*	*Rajjallegama Hurigaswewa*	*Pahala halmillewa*
	Halmillewa	*Pahala halmillewa*	*Ipalogama*	*Achiriyagama*	*Veheragala Settlement*
04	*Getakela*	*Kudagama Paindikulama*	-	-	-
	Kiralogama	*Kubukwewa Paindikulama*	*Mahabellan-kadawala*	*Kudabellankadawala thalakolawewa Rajapakshayagama*	
	Galnewa	*Meegassegama Paindikulama*	-	-	-

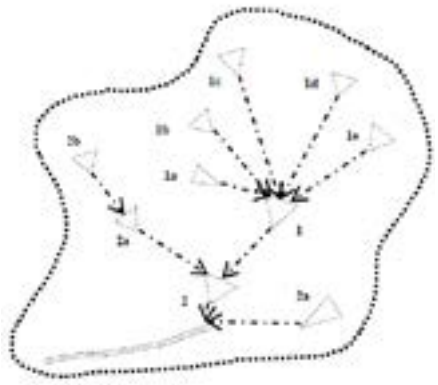
Source: through Sector Studies



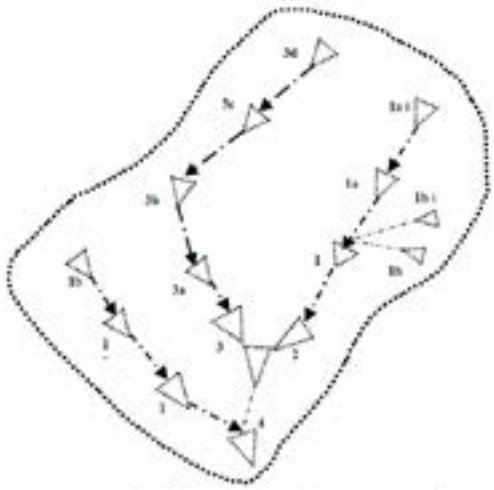
Plan No. 06, Galmaduwa Cascade

Taking the spread in the form of a fan, *Galmaduwa* cascade could be identified as an irrigation work fed by the Yodha Ela. In here two main networks of tanks could be identified, while *Kuttikulamaweva* (1a) is fed by the Yodha Ela and the “Drainage water" from the feeder area, join the *Ihalagama* (2), and then the *Galmaduwaweva* (3). Starting

from the left side, the highest tank of this network is *Aluthweva* (2bii), while the *"Drainage water"* from here has joined the *Potthegamaweva* (2bi). Joining from the Left side, the water from the *Medagamaweva* water too, join the Galmaduweva. Joining vertically to *Galmaduweva*, the *Ihalaweva* (2ai), and the *Siyambalaweva* (2a), join the *Galmaduweva* and the manner in which it has joined with the *Katiyaweva*, could be revealed.



Plan No. 07, *Eppawala* cascade

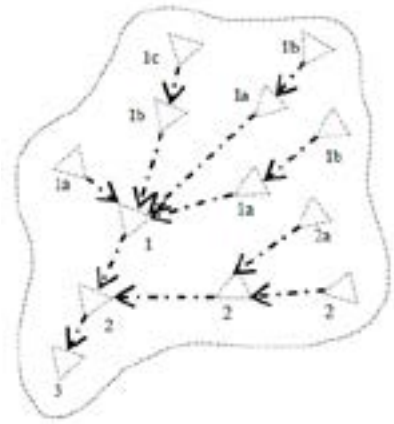


Plan No. 08, *Rajjalegama* cascade

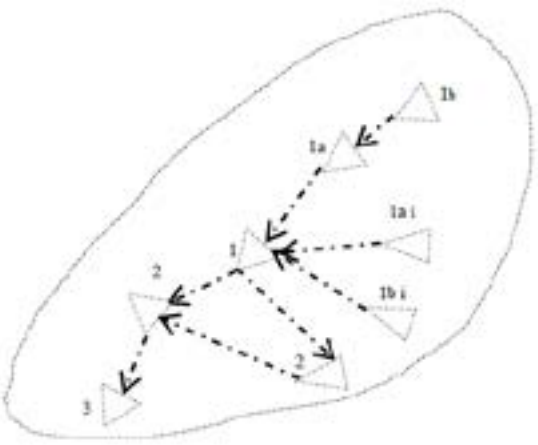
According to sector divisions, the old pathway of Yodha Ela feeding the lowermost zone from *MahaIlluppalama* up to *Batuwatta* fed by *Eppawala* cascade, is fed by a number of tanks. As tanks fed from Yodha Ela, *Kudaganeweva* (1a), *Mahaganeweva* (1b), *Konweva* (1c), and *Ammunukolayaweva* (1d), the *"Drainage water"* from those feeder areas, has fed *Eppawalaweva* (1). Historic period human settlements can be widely found within this zone (*Katiyava, Ambagasweva* human settlement). Towards the left side of *Eppawala* tank joining horizontally are a number of other tanks. Waters from *Kudagamaweva* (2b), *Thammettawa* (2a) also feed *Mediyaweva* (2). Water of *Mediyaweva*, through *Mediyawa Ela* feeding a number of terrains (*Veheragodella*), join Kala oya.

In the zones where Yodha Ela flows down from *MahaIlluppalama* up to *Batuwatta*, the *Rajjallegama* cascade is built up of an organized number of cascades. The creation of the main cascade, has taken place with the combination of triple small cascades. This is a cluster cascade discovered during the research study. The first of these system tank supply water to lowermost tanks of the Yodha Ela, *Ihalaweva* (1b i), *Ihalagamaweva* (1a), and *Eliyadivulweva* (1). *Eliyadivulweva* (2b), *Kudagama* (1bi), and *Pahala Siyambalawa* (1b) *"Drainage water*" is received by the *Divulweva* (1), these tanks are recognized as "*Olagam Weva*". *Eliyadivulweva* water also joins *Huriyagasweva* (2) which is situated further down. A tank system feeding the *Huriyagasweva* cascade has been discovered from a feeder zone to the left of Yodha Ela. They are, in a serial order as; *Kaduruweva* (3d), to *Palugasweva* (3c), thereafter joining *Miigahaweva* (3b), out of which to *Makuluweva* (3a), from there to Rajjalegamaweva (3), through which the excess water gets collected

in the *Huriyagasweva*. From the feeder zone of *sooriyagasweva*, water is received to *Halmilleweva* (4) feeder zone, out of which the excess after feeding Mediya Ela and *Katiyawa Ela*, and it flows through *Weragala*, *Nawagala* join Kala oya. Within the latter half of that cascade system, it is quite clear are also fed by *Halmillewa* (1a), *Ipalogama* (1b), and *Aachariyagama* (1) tanks.



Plan No. 09, *Paindikulama* cascade



Plan No. 10, *Hoorigasweva* cascade

Paindikulama cascade is a cluster cascade identified in the lowermost zone of Yodha Ela. What is special in here is that this cascade is being fed by a couple of other cascades. Before the Yodha Ela was constructed these tanks would have been in an active state. There are three pairs of main feeder tanks to these cascades, viz; *Galneva* (1c) *Miigassegama* (1b) tanks, *Kiralogama* (1b) *Kumbukweva* (1a) tanks, and *Ketakala* (1b) *Kudagama* (1a) tanks are feeding the main tank which is *Paindikulamaweva*. Water from *paindikulama* is received by the *Mahabellankadawala* (2), while *Mahabellankadawalaweva* is fed by *Thalakolaweva* (2a). *Thalakolaweva* (2a) is also fed by tanks *Delnegama* (2ai), and *Akuranayagama* (2bi) which also feeds *Mahabellankadawalaweva*.

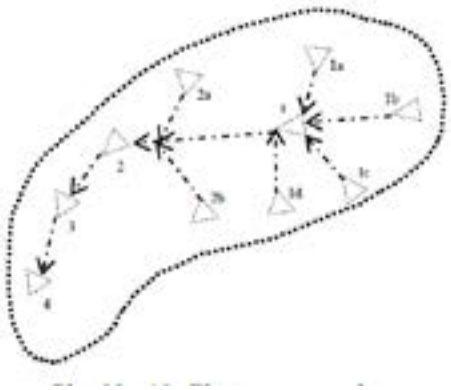
Identified as *Hoorigasweva* belonging to Yodha Ela zone from *MahaIlluppalama* up to *Batuwatta*, "*Drainage waters*" from the *Kudagama* (1a), *Ihalasiyambalawa* (1b) tanks feed the Eliyadivulweva (2b). Towards the left of *Eliyadivulweva*, connecting from vertically above, receive water also from *Ihalaweva* (1b), *Ihalagama* (1a) tanks. While water from *Eliyadivulweva* (1) supplies water to *Hoorigasweva* (2a) and also to *Rajjallegamaweva* (2), thereafter join also with the *Halmillavetiyaweva* (3). *Rajjallegama* and *Hoorigasweva* are joined together spreading from the uppermost zone to the lowermost zone as a chain of tanks, they are grouped and studied separately in here.

Table No. 06, lowermost cascade from *Batuwatta* upto *Thisaweva*

Serial No	Main Tank	Sub- Tank-I	Sub tank-II	Sub tank-III	Sub tank-IV
01	*Tirappanaya Nabadewa*	*Kaduruwewa Kudagama Kadahagaha wewa*	*Ihala thalawa wewa Kudagaha wewa*	*Kumbukgaha wewa*	*Wehera godella*
02	*Ekiriya wewa*	*Miigahawewa Mandagaha wewa Waduressagama Maddhumagama*	*Ekiriya wewa Galayagama*	*Illuppankadawala Ulukkulama Kudagama wewa*	

Source: through Sector Studies

Plan No. 11, *Thirappanaya* cascade



Plan No. 12, *Ekiriweva* cascade

For the purpose of sector studies, and according to the arrangements of the terrain, from *Batuwatta* up to *Thisaweva* and Fed by Yodha Ela, a twin cascade system could be revealed. *Ethiriyaweva* cascade whilst spreading in a vertical direction, and taking into consideration their spread, arriving at any decision on the topographical landscape of those zones, is quite a clear fact. Accordingly, the terrain in that zone could be identified as spreading with an inclination towards *Kala oya*, which was confirmed by the calculation of the mean sea levels of that zone. The beginning of the *Thirappanaya* cascade takes place from twin tanks. viz; *Kudalama* (1a), *Thirappanaya* (1b), and *Waragoda* (1c) tanks. The *"Drainage water"* from the tanks fed by the Yodha Ela waters, also join the *Ihalathalaweva* (1). *Kaduruweva* (1d), which is on the left side, and the *Gambirisweva* tanks, and from *Moragoda* (2a i) and *Kadagaha* (2) tanks, *Kumbukgahaweva* (3) and *Katiyaweva* (4) tanks are fed. The water from *Katiyaweva*, after distributing to the settlements, flows down to *Kala oya*.

The uppermost tanks of *Ekiriweva* cascade are a triplet. They are, *Miigahaweva* (1a), *Mandagamaweva* (1b), and *Wandurassagamaweva* (1c), while their *"Drainage waters"* get collected to *Maddumagamaweva* (1). This cascade for the reason that it is spread in a vertical direction, waters from tanks in the uppermost zones, which

are the *Galayagamaweva* (2a) and *ullukkulamaweva* (3a) tanks, join together and feed *Illuppankadawalaweva* (3), and *Kudagamaweva* (4).

The cascades which existed before the construction of the old Anuradhapura Yodha Ela, have operated in a new fashion along with the construction of the old Yodha Ela. Although before the construction of the Yodha Ela, a large number of Village tanks could be found in this Zone, later on that when the water requirement from there was insufficient for the settlements, agricultural needs, Yodha Ela was constructed in the related zone, has been a fact revealed through this scientific study. That the creation of Yodha Ela is an extension of the settlements development, could be confirmed through the analysis of the relevant information gathered conforming to the objectives.

Early period *Kalaweva* and *Thisaweva* intermediate zone, were fed only with rainwater, and over a period the changes that occurred with the climatic conditions, and due to the increase in complexities of the settlements, Yodha Ela may have been constructed through this Zone. In mobilizing the Yodha Ela construction technology, creating the flow traversing the uppermost terrain around each tank, is a speciality. From MahaIlluppalama upto Batuwatta, with the associated tanks which are; *Medagama, Kuttikulama, Aluthweva, Ihalaweva, Maradankadawala, Amunukolaya, Kiriamunukolaya, Konweva, Kiralogama*, the Physical bank portions, and although the remnants of which can be identified even today along the path taken by this canal, because of the *Mahaweli* development project, have come to an inactive state. Another important factor which can confirm the above fact is the creation of Yodha Ela to circulate around each and every tank, but also the Anicuts deployed to supply water to each and every tank, from Yodha Ela, remain as remnants today. Even in the water management of the last tank of the lowermost cascade so discovered, the irrigation works planner has utilized diverse methodologies. The water from these tank, while it is not allowed to be just drained down directly to *Kala Oya*, but have also acted deploying canals in between tank as well as among the settlements, making it possible for the inter-exchange of water.

When taking into consideration of all these factors, what is clearly understood is that in the study area, well before the construction of the Yodha Ela has had an organized water management methodology, and due to changes in weather pattern and climate, later on Yodha Ela may have been created. Although, before construction of Yodha Ela, the early cascade systems as from the uppermost up to lowermost that may have existed, remained intact even after the construction of Yodha Ela, the uppermost and the lowermost cascade systems have now come to function as two differentiated systems. However, through this it can be shown that it is a complete irrigation work done in order to fulfil the water requirements of the capital city, and those of the inter-zonal settlements of the *Kala Oya* uppermost valley.

Discussion

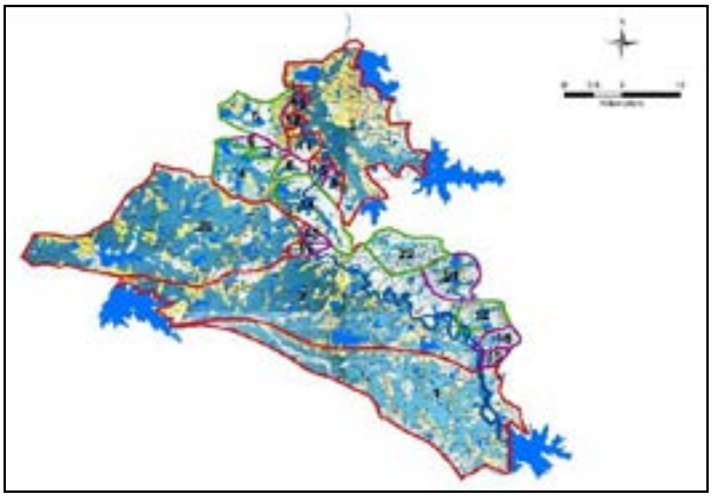
The spreading of the cascade according to the topographical landscape from the uppermost to the lowermost, is the result of the settlement incremental approach, has been

shown in the research study. Before the Yodha Ela was constructed, the water requirements of the *Kala Oya* valley uppermost area settlements was fulfilled by the cascade system which can be identified as the principal water managemnt methodology. The cascade system which was networked from the uppermost areas up to the lowermost areas, can now be identified as acting in isolation, along with the construction of *Yodha Ela*. In here, to what extent the distribution trends of the established cascades, topographical landscape, water management methodologies, can be justified in the early researches done, has been subjected to scrutiny.

Functionality of cascades before construction of the Yodha Ela

The cascade Systems in the *Kala Oya* valley uppermost zone, before the construction of Yodha Ela, were identified. Among them, the vertically disposed *maradankadawala, Ganthiriyagama, Kuttikulama, Kon weva, Kele Divulweva, Thirappanaya, Aatthikulama, Pallekagama, Karabewa* and the like are important. Four principal ways in which the topographical functionality of these cascades, have been illustrated (Bandaranayake, 2018). Out of which, in the study area, cluster cascades with two or more associated tanks, and single cascades, have been identified. Cascades that are spread in an angular direction too have been an important discovery in the research. Among them, *Maaneva, Aamane, Thirappanaya, Aatthikulama* cascades, and *Nallamudawa, Mahaganeweva, Nambadeva* as cluster cascades, are important.

As a research done within the country; “Scientific foundation on some of the traditional practices in the land and water management of village lake cascades", is important (Madduma Bandara, Yatigammana, Paranavithana, 2010). In this research, as some of the associated tanks, *Ethidathkella, Millawetiya, Sandamaleliya* and others are important among the cascades. This is important as an environmental factor in understanding about topographical landscape of the relevant study zone.



Map No.01 Map showing the division of the uppermost and the lowermost cascades.

During the study of the water management methodologies in the associated village tanks that belonged to cascades, a complete understanding of the irrigational components has been acquired. As tanks connected to the uppermost zone cascades; *Kurundan Kulama, Wellamudawa, Wagayakulama, Halmillewa, Kurundu Weva, Dikweva, Rota Weva, Kuda Weva*, and as the irrigation components identified in those lakes; *Perahana, Iswetiya, Godawala, Kuluweva, Tisbambe, Kivul Ela, Kattakaduwa* and their features are important. As a research carried out in this connection, "Traditional tank systems for conservation and effective use of water" the research paper has illustrated the utility features of the irrigational components, in an old tank which are; *Godawala, Gasgommana, Iswetiya* and the like (Dharmasena, 2005). Likewise, in the research paper "Kattakaduwa: Potential land for agro-forestry system development in Sri Lanka", Dharmasena has illustrated, that by conservation of forests how the features of a village tank could be developed. In here, it has been shown that forests, scrub Jungles, *Henas*, Village, *Paddy Fields*, *GasGommana*, *Tisbambe* as components that belong to the uppermost region, and *Kattakaduwa*, to the lowermost region of a tank. Herein, it has been shown that by protecting the uppermost components, the *Kattakaduwa* too was protected (Dharmasena, 2005). *Tisbambe*, which is situated in a somewhat raised landscape above the Tank, and that in here the Community Settlements were spread, has been revealed in the research. Centralized on *tisbambe* associated with the village tank that the settlements may have spread, is shown by Dharmasena (2005) and Brohier (1975), and in here *Mii*, *Amba*, *Coconut* like tree varieties which require only a minimum soil water condition, that the settlements may have spread centralizing on these zonal areas. Chandana Rohana Vithanachchi in his research on old irrigation works of some components of an old village tank, revealed in his study that among the components discovered included facts on *Iswetiya, Denikada, Kattakaduwa,* and how their utility values could be established.

Even before the Yodha Ela was constructed, it is quite clear that the water management methodologies which existed centralizing on the tanks in order to safeguard the environmental balance, have been more appropriate methodologies. That the distribution of settlements in the study zone has had a direct link with the irrigation works, has been established. Although the early settlements which were centralizing on the uppermost areas, later on taking into consideration of the efficacy in the agriculture and water management methodologies, those settlements may have spread towards the lower flat land areas. Along with the increase in the complexities of the settlements and due to the lowering of the efficacy of the irrigation facilities along with the diminishing in productivity of the water catchment areas, and as an alternative to it, Yodha Ela may have been created during the historic period. However, even before the creation of Yodha Ela, settlements had been spread in this zone, and that later on as an extension to the development of settlements, Yodha Ela may have been constructed, is also quite clear.

The origin of the water resources of these cascade has found in this research, to be either a natural stream or a scrub jungle. From the uppermost up to the lowermost, the excess waters from these cascades finally get collected at the Kala Oya. Before the

construction of Yodha Ela in this area, and since associated with the Kala Oya uppermost valley areas, original and prehistoric human settlements could be identified, the origin of the cascades too must have been those uppermost valley areas, has been shown in this research. During the early historic period, and in the middle or later time periods, with the construction of Yodha Ela right across the cascades, the functionality of the cascades has been sub-divided into two sections.

Plan No. 13, Katiyava cascade

Plan No. 14, Mediyava cascate

According to the topographical pattern of the cascades discovered from this zone, they had to be shown as cluster cascades, linear cascades, and angular cascades. The geographical formations of the cascades have been influenced by the topographical landscape pattern of the relevant zone. Although the origination of the cascades identified in the uppermost area was either a natural stream or a water shed area, after the construction of Yodha Ela, the originating tank of the lowermost cascade was found to be a tank connected to Yodha Ela, has been revealed.

Table No.07, Water Catchment Areas

Catchment area	**Village tank**	**Fertilize area**
Shrub jungle	*Kadiyangalla*	*Yodha ela*
Shrub jungle	*Ihala wewa*	*Yodha ela*
Thick jungle	*Ulankulama wewa*	*Yodha ela*
Thick jungle	*Puliyankulama wewa*	*Yodha ela*
Thick jungle of *Kiri amunukolaya*	*Tammennagala*	*Yodha ela*
Thick jungle	*Dikwewa, Aliyawatunu wewa, Gatadiula*	*Yodha ela*
Thick jungle	*Kalekubuk wewa*	*Yodha ela*

Sourse, Field visit

For the convenience of study of the Yodha Ela, the terrain was sub-divided into three portions. Accordingly, within areas from *Kalaweva* up to *MahaIlluppalama, MahaIlluppala upto Batuwatta,* and *Batuwatta* to *Thisaweva*, 12 cascade could be established. A conceptual approach regarding the term cascade “Mother Tank" is clear from the interpretation given by Madduma Bandara. That it is “Collected from short term water ways and transported while being made use of and feeding the living beings within the dry zone geographical landscape, and an organized and interconnected chain of tanks", is said by him (Madduma Bandara, 1985). As shown in the research and before the construction of Yodha Ela, the cascade mother tank has been a tank connected to the uppermost water ways or a scrub jungle area, and after the construction of Yodha Ela the *mother Tank* of the lowermost cascades is fed by the Yodha Ela (Table No. 02). The main reason for this is the fact that depending on the functionality of the cascade tanks, the concept of appearance of the catchment areas. The uppermost uascades are fed only from rain water or the natural spring water, and over a period of time or due to climatic reasons made the changing movements. But, since the lowermost cascades are now fed by the Yodha Ela, through those cascades an active supply of water is now received throughout the year.

Due to the influence of the ground water and in comparison to the uppermost zone, the lowermost zone soil developed into more suitable terrain for agricultural works, and the spread of the settlements to this zone too may have been influenced by this irrigation work. Compared to the external geophysical factors, the internal geophysical arrangement too have an influence on the functionality of the cascade, is explained in the analysis given by Dharmasena on the cascades. “On a sustainable basis with the interference of man, water, soil, air and vegetation fulfilling the fundamental requirements of man, vegetation, and animals, in the dry zone geographical landscape within the feeder zone areas for the living, consisting of ground and water resources rich environmental system", by which it is made clear (Dharmasena, 2017:10). What is understood from this is that there is a strong networking in the representation of the entire social system which is displayed through cascade. In order to maintain the social balance and as some of the factors shown by binford, which are the climate, weather, soil, vegetations, water and the like physical factors are important, while in the identification of building up of the external environmental culture which is formed corresponding to the internal functionality of an cascade, this is important. The variations in those factors mentioned above may also have influenced the settlements spread, has been a fact that could be identified.

The study of the rajarata cascades from a scientific research point of view was first initiated during the decade of eighties in the 20th Century. Through these research, attention has been paid only towards the functionality of the cascades systems in the uppermost zone originating from short waterways. As such, some of the cascades which originate from a tank, are the *Thirappana* starting from *Naachchaduwa weva*, and *Horiwila* cascades, *Kadiragama*, *Thoruwa Ellanga*, *Maaminiya Oya*, and the tanks that spread parallel to *Malwathu Oya*, are important (Madduma Bandara, 1991). Centralized on *divulweva*, the

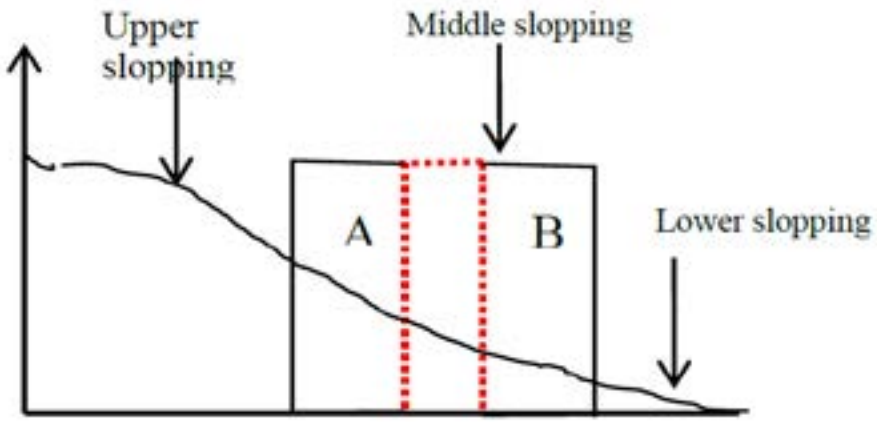
Rathmale Cascade, (Madduma Bandara, 1985), the *Kapiriggama* cascade, too have been originated from a tank (Panabokke, 2000). But, to develop the water capacity of these tanks, cross canals from other water resources have been connected, although in those earlier researches only a minimum attention has been paid on this. Use of such alternative methods for system tanks may have been followed also due to incremental results of the settlements and climatic changes, is also clear.

As some of the major factors that contributed towards the functionality of the cascades; rain (Weather), landscape pattern, soil conditions, environment, and temperature can be identified. That from the middle of the Iron Age up to the historic period, the climatic and weather factors have not been stable, is clear from the variations in the cultural and historical landscape changes. Over a period of time along with the variations in the rain and climate changes, due to complexities in the requirements, and the water movement activity of the village tanks may not have been sufficient. The remedy adopted in such situations had been the construction of a horizontal canal pathway across the vertically spread cascades and feeding them. This can be considered as an awakening stage of an irrigation culture trend, though no attention on such trends have been shown through any of the earlier researches carried out. The old Yodha Ela of Anuradhapura which connects with the main cascades identified in the intermediate zone is a cascade system originating from a tank connected to Yodha Ela. As a result of the climatic and seasonal variations, the census carried out by Panabokke on Rajarata Tanks, has shown that out of the Total of 4017 tanks, nearly half of it had become inactive (Panabokke, 1999). Accordingly, it is clear that even the Yodha Ela may have been constructed across this zone, as an alternative solution corresponding to the situations prevalent during that period, due to changes in the climatic conditions. During the early stages, the spread of the settlements and to fulfil their requirement of water received from the cascade, and in order to expedite the water flow and to feed cascades with external resources of water has been done through the construction of intermediate canals. What is understood from this is that in this zone, even before the construction of the Yodha Ela, their Water Requirements may have been fulfilled through prevalent tanks system, and the construction technology of the Yodha Ela by allowing the water to flow also around the highest tank of the tank system, it is quite clear from the study of the construction technology, that it was a recuperation measure that had been undertaken.

Discovered as a cascade connected result can be shown the water movement affected by the *Kattakaduwa*, and centralizing on the lowermost lake of the cascade, the establishment of the spread of the settlements could be realized. These settlements which belong to a historic period, and from the times the cascades were active and the migration happened quite after the construction of the Yodha Ela, has been shown and for this to happen, that an appropriate terrain with suitable soil, or internally suitable environmental factors, and a proper active movement of water in the lakes would have caused them. An important research paper done in this regard, “Scientific foundation on the traditional knowledge in the water management of the village tank cascade system" is important.

Through this, that the water movement within the cascades as well as in the uppermost, are quite different from one another, has been identified, and the variations in the water quality under the surveillance of the electrical conductivity, and the introduction of water immersions for the protection of the *Kattakaduwas* of the cascades as the objective, this study has been carried out (Bandara; Yatigammana; Paranavithana, 2010). Regarding the accuracy of results on the facts revealed in this research, it is reasonable to show that there is a connection between the functionality of the *Kattakaduwas* of the tanks belonging to cascades originating from Yodha Ela. According to this decision, activity of the ground water of the cascade had been caused by the water movement of the *Kattakaduwa*, from the uppermost to the lowermost. From the said research, destruction of the *Kattakaduwas* of the village tanks, and due to not affecting maintenance works, and by identifying the differences in the electrical conductivity, this fact has been confirmed. Accordingly, salts and iron which are two of the main twin polluting components in that water showing a higher concentration within the cascades from the uppermost up to the lowermost, the electrical conductivity at the *Kattakaduwa* right below the tank bund increasing by a few folds, and along with the *Kattakaduwa* Water too flowing into the lowermost, how the conductivity of that water has gone up, is shown. In order to regulate this situation exercised through the Yodha Ela bund construction technology can be thought of, since the cascade system of the lowermost is fed by Yodha Ela, establishment of sluice gates in order to provide water to the tanks, and Water from the Village Tanks situated in the uppermost were connected to Yodha Ela through ground water, and the like features. In that research, it has been shown that in order to allow the flow of surface rain water to the tank, by establishing anicuts at a higher elevation, thus allowing accumulation of only a lower concentration of salts in the Paddy Fields, and this task has been accomplished by the ancient Irrigation canal technicians through the use of '*Ketasorrowva*' (Bandara, Yatigammana, Paranavithana, 2010). This is made clear from the manner in which the Anicuts are placed at a higher elevation on the Left bank in supplying water from Yodha Ela to the cascades. Quite apart from this, the fact that by allowing the flow of water in the canal to flow covering a large area encircling the tanks, infiltration of water with a low concentration of salts and irons to the Tanks through the right bank are allowed to get connected to the tank after getting infiltrated through the left bank. From the citing of the sluice gates, it is clear that in order to obtain water they have been established at a much higher elevation, and by citing the Sluices at a higher elevation, thus preventing these salt mixed water from getting accumulated in the cascade as a precautionary technological measure undertaken. Accordingly the irrigation technician may have had a prior understanding not only on the citing of irrigational components corresponding to the landscape pattern, but also on the consequences of such actions. The aim of the research paper titled: **Kattakaduwa: A potential land for agro-forestry development in Sri Lanka** had been undertaken to study that through *Kattakaduwa* during the water movement of the cascades, the Water seepage through the lake bund is minimized, and that along with the Water the collection and the mixing of salts and iron which pollute the soil and the agricultural Products is controlled (Dharmasena, 1995: 1-10). As sample tanks

used in this research are some of those Tanks that bear a connection to the Uppermost Study Area, those results were subjected to this discussion (Dharmasena, 1995: 1-10). What is so special here is that not only through the environmental conservation, and the water movement activity of the cascades, but also through the connected technological studies done on the canal waterways during later periods, this fact was further established. Through the Yodha Ela canal bank construction technology, the efforts taken in safeguarding the activity of the *Kattakaduwas* in the Tanks" of cascades connected to the Yodha Ela, and the supply of water to the lakes based on the topographical landscape distribution of both the lowermost and the uppermost lands of Yodha Ela, were taken into consideration. While Yodha Ela does not supply water to cascades in the uppermost region, those systems are fed by *Kuluwev* and *Olagamwev*, is shown in the study. Although the supply of water to cascades originating from the Yodha Ela had been done through two sluice gates, water management methodology of the Yodha Ela canal system is of a more complex nature. Yodha Ela has been made to circulate around the tanks covering a large area, and this has acted to make it possible the maintenance of the ground water table at a higher level. As an object of those earlier studies, through the *DiyaGilma*, Protection of the *Kattakaduwa*, that the protection of the ground water Level, can be sustained. That the Yodha Ela though quite indirectly has accomplished these tasks, is confirmed by the fact that in order to facilitate *DiyaGilma* on the canal right bank, conforming to the sloping of the terrain, construction of the canal pathway has been done. This technological procedure is not confined only to the tank concerned, but has been able to protect the ground water level of almost 54 miles of terrain. As such this creative technology may have been used with the aim of developing the ground water level of all the cascade systems spread on to both sides, is quite clear. In the construction of the Yodha Ela, a special attention has been paid to the elevation of the geographical landscape of the terrain. When the elevation of the terrain is of mid-sloping or low-sloping nature, that it has been possible to maintain the ground water table at a higher level, could be confirmed.



Plan No. 15, for purposes of water management the nature of the terrain sloping situation

The supply of water requirements for the settlements and agricultural grounds situated below the mid or large capacity tanks is done through sluice gates established, taking into consideration the altitude of the tank. But in the village tanks which are built up through a networking of cascades, the movement of water is taking place through ground water activity. Interchange of water among these tanks which have been created taking into consideration the topographical Landscape, and since the water movement between these tanks takes place underground, the tendency of silt getting accumulated in the tanks below, is at a minimum.

The direct influence of the ground water from the highest lake of the cascade is received in the zone called *'Purana Wela'*, Asweddumization is first carried out in the corresponding paddy field of that tank called the *Purana Wela*, which is situated in the lowest topographical landscapes of the tank. Secondly, Asweddumization is done in the other paddy fields taking into account, the water capacity of the tank. The connection between the tank and the *purana Wela* is decided upon by the size of the tank, and the Feeder Area of the *Purana Wela* is decided on the water capacity of the uppermost tank, has been shown (Dharmasena, 2009). What becomes clear in here is that the functionality of the cascades has happened according to an Activity of the Ground Water movement, and that may have influenced the building up of the relationship between the tank and the associated village community.

Conclusions

During the early historic period, taking into consideration the environmental and topographical factor requirements for agricultural needs, and as a result of networking of the Village Tanks so constructed from the upper lands up to the low lands, cascades have originated. Even before the construction of the Yodha Ela, the settlements in the *Kala Oya* uppermost zonal valley have fulfilled their requirements of water through cascades. As an example, *Konapathirana* Cascade spreading from uppermost early historical settlements of *Ihala Weva* (Maaneva) up to lowermost *MahaIlluppalama*, uppermost *Kiriamunukolaya* originating from the highland where the *Muukalas* are situated, and the *Ulankulama* is the highest Lake of *Kuttikulama* cascade, while the lowermost (Lowest) lake is the Katyawa Weva. During the early historic period, construction of the Yodha Ela has been done by allowing the water flow to cover the centre portion of each cascade. As irrigation components used in the water management of lakes connected to cascades; *Perahana, Iswetiya, Godawala,Kuluweva, Tisbambe, Kivulela, Kattakaduwa* and the like, were revealed in the research. In order to manage the natural rainwater and fountain waters, each and every irrigational component has been cited according to the ground elevation. through this methodology, the control of silt in the water, and to make it suitable for consumption and in agriculture, in filtering off of toxic water polluting elements *Godawala, Iswetiya, Kiwul ela, Kulu weva* have contributed, while the supply of ground water is accomplished by *Kattakaduwa*. Even before the construction of the Yodha Ela, cascades had been made use of as environmental concepts in water management, is quite clear.

Cascade which became active right from the uppermost zones, after the construction of the Yodha Ela, its lowermost portion only had a continuous water movement activity. As a current need, along with the construction of Yodha Ela, the migration of the settlements from the uppermost towards the lowermost zone, may have happened as an influence of this irrigation works. But, as a result of the climatic changes in this zone, that the migration of the communities towards the lowermost zone has happened, is also quite clear. While centralizing on the tanks in the lowermost zones settlements were revealed, no human settlements were discovered in the cascade mid-zones. What becomes clear by this is that, connected to this zone, that settlements spread was not there, but due to the over-utilization of land, and the settlement areas called the ' *Tisbambe*', were later on converted to agricultural lands.

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