

## **Village Tank Cascade Systems of Sri Lanka** A Traditional Technology of Water and Drought Management

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### **Abstract**

‘Village tank Cascade Systems’ - an ancient, small scale irrigation technology is examined as it could be observed in the North Central Dry Zone of Sri Lanka. A ‘cascade’ is defined as ‘a connected series of village irrigation tanks organized within a micro-(or meso-) catchment of the dry zone landscape, storing, conveying and utilizing water from an ephemeral rivulet’ (Madduma Bandara 1985). The underlying argument developed from this case study is that, traditional technologies cannot be adequately comprehended in isolation without reference to the ecological and social systems in which they prevail. With changes in the latter elements, some traditional technologies may become anachronistic and often unusable or even face disappearance. Therefore, it is prudent to look for their substance than their form and the principles that governed their perpetuity over long periods of time.

(Key Words: Cascades, Principles and Substance, Current Relevance)

### **INTRODUCTION**

In academic research, it is often more promising and profitable to search for new paths than trying to follow the already ‘beaten tracks’. In this regard the words of the classical poet Robert Frost may prove highly inspiring :

‘Two Roads diverged in a yellow wood  
And sorry, I could not travel both  
And be one traveler, long I stood  
And looked down one as far as I could  
To where it bent in the under growth

Then took the other, just as fair,  
Because, it was grassy and want of wear  
In leaves no step had trodden back  
I doubted if I should ever come back

Two roads diverged in a wood, and I –  
Took the one less traveled by,  
and that has made all the difference

(Robert Frost (1874-1963))

As I recall, towards the latter parts of my own academic career, I was also beginning to discover that, there is much potential for identifying new path ways in interdisciplinary areas than in mono-disciplinary pursuits. This may partly explain my interest in the search for traditional wisdom in some time-tested technologies hailing from the past, particularly in countries of long history and human civilization.

## **TRADITIONAL WISDOM DEFINED**

The UN Convention to Combat Desertification (UNCCD) adopts the following definition of Traditional knowledge, particularly in relation to drought management: “Traditional knowledge consists of practical and normative knowledge concerning the ecological, socio-economic and cultural environment. Traditional knowledge originates from people and is transmitted by recognizable and experienced actors. It is systematic, experimental and handed down from generation to generation and culturally enhanced. Such a kind of knowledge supports diversity and enhances and reproduces local resources”

Under that definition it appears that, traditional knowledge and wisdom are considered similar and interchangeable. A further refinement may perhaps show that, ‘wisdom’ connotes both knowledge as well as experience gained from long periods of trial and error. However, at present both expressions are often used as inter-changeable.

The UNESCO and ICSU seem to promote traditional knowledge due to following reasons: “ The local and traditional knowledge system, as the dynamic expression of perceiving and understanding the world, can give, and historically has given, a valuable contribution to science and technology. For this reason there is a need to preserve, protect, and research this cultural heritage and empirical knowledge”

It may be understood that, using traditional knowledge does not mean to reapply directly the techniques of the past as they were, but rather to understand the logic, substance and principles behind them. Such wisdom ‘allowed societies in the past to manage ecosystems in balance, to carry out outstanding technical, artistic and architectural feats which are universally admired’. Traditional knowledge is also a dynamic and time-tested system of understanding that is able to incorporate innovation, and achieve local and environmental sustainability. However, in adopting traditional knowledge, one has to exercise some caution to avoid any tendency towards over-romanticizing the events and creations of the past

## **APPLICABILITY IN DISASTER MANAGEMENT**

The appreciation, protection and promotion of traditional knowledge or traditional wisdom for nature conservation, art, architecture and agriculture had been progressively advanced during the last few decades. This is reflected in attempts towards creating traditional knowledge ‘world banks’ at international level and the moves towards the provision of legal protection for local repositories of such knowledge. However, the present initiative towards the application of traditional wisdom in seeking solutions for disaster management is relatively a new direction with much potential for the future. In this process, it may prove easier to understand the forms of technologies available in different parts of the world. But the actual substance and principles behind them may defy comprehension for some time unless research efforts are focused on such aspects in the future.

## **THE SRI LANKA CONTEXT**

Sri Lanka, as an Island located near the southern tip of India and the Asian Continent and in the core area of the South Asian Monsoon, has developed its own endemic forms of hydraulic civilization. The rainfall is seasonal as governed by the monsoons and on the average in the Dry Zone where the cascade systems prevail, annual rainfall exceeds 1000mm. However, due to high evaporation rates, serious seasonal water deficiencies occur, and therefore the term ‘Dry Zone’ had come into usage. The natural vegetation is largely deciduous in consonance with the marked seasonality of rainfall. The rolling topography of the terrain in most areas creating a myriad of small watersheds, provided the necessary natural background for the evolution of cascade-based agriculture.

In general, the culture of the Island, and particularly that of the North Central Region was primarily dominated by Indian influences. However, due to its insular nature, it has also developed its own unique forms of indigenous language, custom, attire, agriculture, irrigation, architecture and culture. Thus the North Central Dry Zone, became the cradle of Island’s civilization with the national capital city of Anuradhapura, established there from the 3<sup>rd</sup> Century BC. Civilizations whose agriculture and culture were

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dependent upon minor as well as large-scale waterworks for irrigation, flood control and water supply are referred to as "hydraulic civilizations" by many writers (Leach, 1959, 1976). The conditions that prevailed in the Dry Zone fitted into this description quite well.

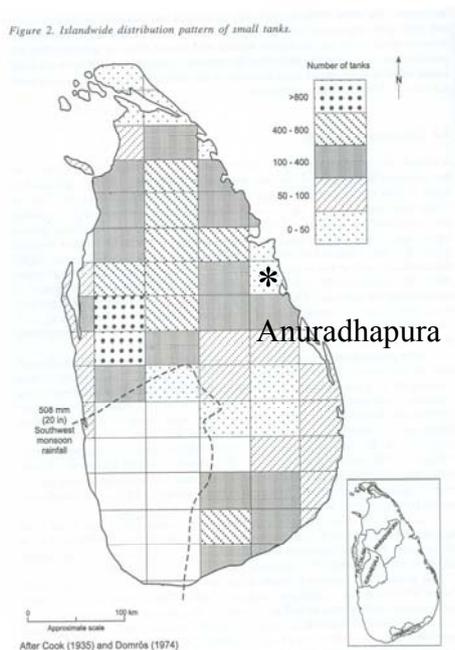


Fig. 1 Distribution of ancient Village Irrigation Tanks in Sri Lanka



Fig. 2 A Satellite Image of the area of tank cascade systems around Anuradhapura, in North Central Sri Lanka

In addition to its large-scale irrigation works, the drier areas of Sri Lanka are also covered with thousands of man-made lakes and ponds, known locally as 'tanks' (after 'tanque', the Portuguese word for 'reservoir' (Figs.1 & 2). Some are truly massive; many are as old as thousands of years, and almost all show a high degree of sophistication in their construction and design (Tennent, 1860). Tennent was fulsome in his admiration of those who built them. A symbol of a multi-hooded cobra occasionally discovered in many sites of ancient irrigation and water works, provides some clue. Some believe that it was an insignia of a *Naga* (early people) line of royalty that was well-versed in the hydraulic arts and sciences, or a totem of an early *naga* tribe skilled in hydraulic engineering.

Traditionally, several different types of tanks were built - some of which had nothing to do with irrigation *per se* but all of which had a critical role to play in the practice of irrigation agriculture. It was, for example, traditional to build a forest tank in the jungle above the village. That tank, however, was not used to irrigate land. On the contrary, its express purpose was to provide water to wild animals and, hence, to reduce the likelihood that they would descend into the cultivation areas and destroy the crops in the search for water. Other types of tanks included the mountain tanks, that were built to provide water for '*chena*' or slash-and-burn agriculture in the more hilly areas.

The erosion control tank, or '*pota wetiye*', which was so designed that any silt from the upper slopes was deposited in it, before entering the main water storage tanks. Several erosion control tanks were associated with each village irrigation system. All were built in such a way that they could easily be de-silted. The storage tank, of which, traditionally, there were two types - one being used whilst the other was being repaired. For that reason, such tanks were known as 'twin tanks'.

Village tank settlements, have always been the back-bone of the Hydraulic Civilization from ancient times. These small tanks find their best expression across the various landscapes of the North Central, North Western and Southern Regions (Figs. 3a and 3b) reflecting the essence of traditional irrigation technology. At the same time, the small tank systems have always occupied a special place in the national consciousness and heritage of Sri Lanka. They represented some of the earliest sedentary human settlements

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with its well known cultural trinity - the *Wewa* ( tank), *Wela* (Rice Field) and the *Dagaba* (religious monument).



Fig. 3 (a)Village tank landscape and (b) a close-up of a tank

### VILLAGE TANK SYSTEMS – THEIR FORM AND SUBSTANCE

As a reputed Director of Irrigation during the colonial period in Sri Lanka (Kennedy, 1936), observed, ‘Every village irrigation work has an individuality of its own, and when located on the topographic map, the engineer has .... to acquire the sense and substance of that individuality’. In other words Kennedy was searching for that elusive **sense and substance** in order to better grasp and understand the essential nature of a small tank systems (Panabokke, 2000). The cascade concept had obviously advanced this thinking further, as could be seen in the definition itself. ‘A ‘cascade’ is a connected series of tanks organized within a micro-(or meso-) catment of the dry zone landscape, storing, conveying and utilizing water from an ephemeral rivulet’. (Madduma Bandara 1985).

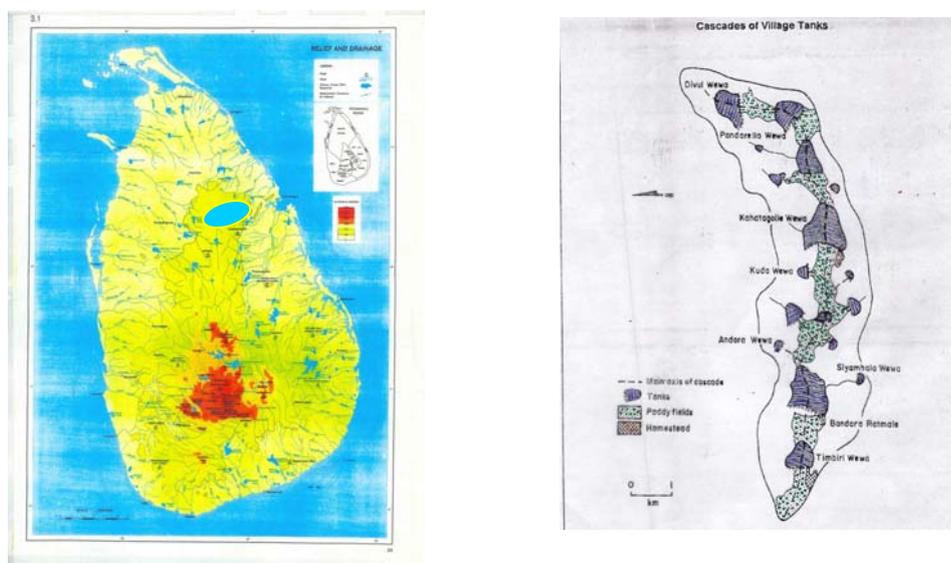


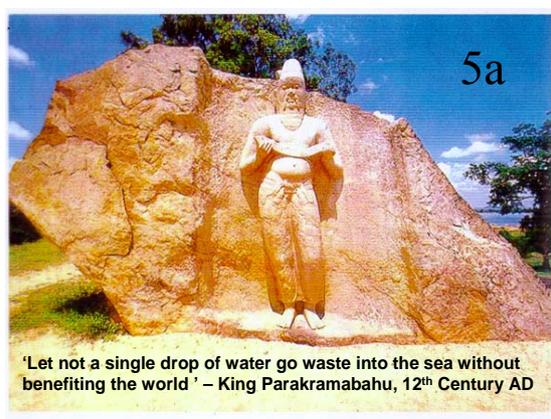
Fig.4 A Village Tank Cascade and its Location

It appears that, the *rai-son d’et-re* for the emergence and continued existence of village tank cascade systems was the need for a sustainable irrigation and water management technology to meet the challenge of recurrent water shortages and drought conditions in a seasonally dry environment. Therefore, it was the need for more economical and rational use of water that lead to the development of the **recycling or re-use** principle (Figs.5a and 5b). Water from the upper parts of the cascade was used and re-used several times before it reached the outlet. It may therefore, be argued that the village tank cascade systems only gave expression to the famous royal dictum that ‘Let not a single drop of water go waste into the sea without benefiting the world ’ ( King Parakramabahu, 12 Century AD).

The tank cascade systems are associated with a variety of ecological and socio-economic subsystems that include (a) The ecological system with catchment forests, aquatic habitats, and the commons (b) Land use

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zoning systems (c) Various Crop combination systems (d) Elaborate water management systems including, sluices, spills, water control weirs (*Karahankota*) with rotational water distribution systems (e) Management systems such as *Velvidane* (Irrigation Headman) system that dates back to pre-colonial times.



The Recycling Principle Behind the Tank Cascade Systems

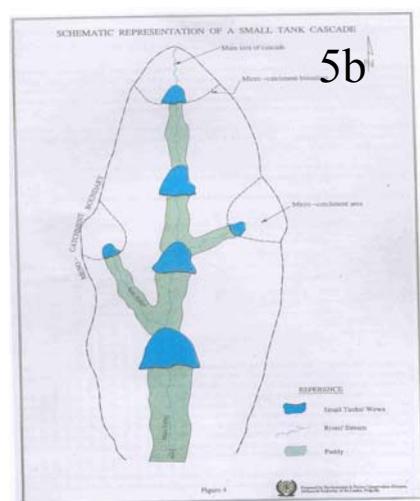
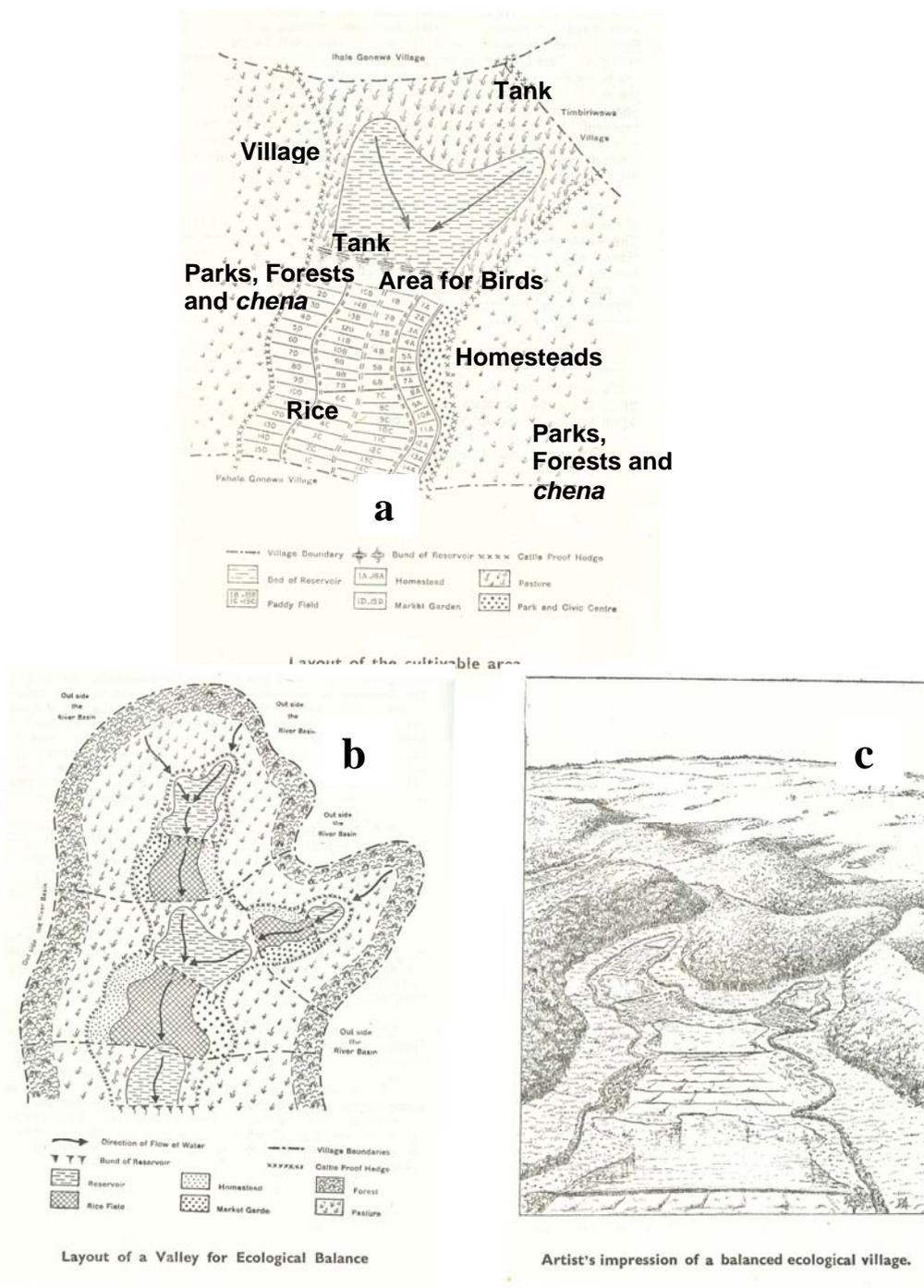


Fig. 5 (a) A Statue of the King and 5(b) Recycling Principle of cascades

Another principle that would have ensured the sustainability of cascade systems, would have been the **ecological harmony**. An impression of a tank village system is given in Figs. 6a, 6b and 6c. By trial and error the people would have discovered that they have to adhere to the laws of nature if they are to survive in a challenging environment. Therefore, the land use system became adjusted in such a way that the richer alluvial humic gley soils were used for rice fields, while the sloping areas of reddish brown earths in the upper segments of the catena, were devoted to shifting cultivation that allowed the soils to recuperate after several years of fallow. The most infertile areas of the watersheds were left intact under rocks and forests, except for being used for spiritual purposes.

A third principle that may have governed the sustainability of cascade systems was the **socio-economic harmony** where the village society and its economy evolved and thrived on the wise utilization of the local resource base. The communities that inhabited the tank villages were largely homogenous often confining to a single *caste or clan*. Therefore, the community spirit had been high, fostering the practices of sharing as reflected in the *bethma* (share) system. In the village rice field, tail-enders of the irrigation ditches were related to those of the top-end either by descent or by marriage. This resulted in scattering of land parcels insuring them against severe droughts or damage from wild life. The rice fields were laid out as elongated strips parallel to the tank bund so that water management would be more rational. With increasing family size, some strips became narrower and narrower due to sub-division. Whatever produced from the local resource base was sufficient for an egalitarian life style, with rice for all meals supplemented with finger millets and vegetables from *chena* (swidden) farming and freshwater fish from the tanks. The village had been virtually self-sufficient except in a few items like salt.

The above account would demonstrate that, most traditional technologies cannot be treated in isolation. They often form part of a wider ecological and social system that nurtures them and sustains them over long periods of time. Once the changes began to occur in the socio-economic setting (eg. increased individualism and break down of social harmony), ecological environment (e.g. deforestation and reduced length of *chena* farming cycles) and the economic environment (e.g. greater dependence on external inputs), the cascading systems have also begun to weaken and mal-function. However, since the natural setting of the micro-catchments was more enduring, the cascading systems seem to have continued to function with less vigour and dynamism.



Figs. 6a,b, and c: Impressions of an 'Eco-Village' (Adapted from unpublished manuscript material by P.U. Ratnatunge, the late Chairman Freedom from Hunger Campaign Board, Colombo, Sri Lanka.

### CULTIVATION PRACTICES UNDER VILLAGE IRRIGATION SYSTEMS

In different times in history, when the central government was disrupted and the major irrigation tanks fell into disrepair, village life could still carry on quite adequately under the small tanks. Each village possessed its own small-scale irrigation system which was maintained by the villagers themselves. In early descriptions of the 19<sup>th</sup> Century, several different cultivation systems were observed under village tanks. Under the *bethma* system, 'a portion of the field of suitable size is selected and all the rest is abandoned. The selected portion is then divided into the same number of shares in the whole field.... The persons whose land is thus selected do not get larger allotments than others... Each *bethma* arrangement is binding only for one crop, and when it has been removed, matters revert to their original position'. Quite often the paddy tract selected for *bethma* was that lying close to the tank bund or to the irrigation ditch, thus helping to

minimize conveyance losses and to conserve the available irrigation water. The division of paddy lands into *baga* (*narrow parcels*) and the scattered and fragmented nature of blocks made the land allocation under *bethma* easy. Despite various changes in the macro-environment, *bethma* continues to be practiced in the tank villages as observed by the writer during the *yala* (minor or drier) cultivation season of 2006.

*Kurulu paluwa* (or the bird damage area), formed another important component of man-made agro-ecosystem types found in the old fields (*Purana Wel*). This means a strip of cultivated rice land adjacent to a tank bund or at the downstream end of the rice tract

abutting the next tank, is primarily dedicated to birds. Although its exact function in the past remains unclear, it was probably left without harvesting, for birds to feed on as a bird damage area. This would have somewhat minimized avian crop damage in the main tracts. It would have also minimized rice plant pests as birds feed on them, too. This presents an interesting example that shows how the early people knew through experience, the importance of biodiversity and how to harness it while conserving it. However, in most villages, the *kurulu paluwa* had disappeared all together in the recent past, due to a variety of reasons both social and economic.

### MANAGEMENT OF CASCADE SYSTEMS

As already noted, the management of Village Irrigation Systems was intimately associated with their sociological setting and the evolution of rural settlements. The early management systems buried in the historical past still remain poorly understood. There is only sketchy and rudimentary evidence indicating the ownership, maintenance obligations, sanctions, penalties and taxation. There are some references to the effect that private ownership of tanks existed in the distant past, as reflected in the use of the term *vapihamika* (owner of the tank), where the management was performed privately.

During the pre-colonial era, community owned minor irrigation systems were operated and managed by the rural community through the *Rajakariya System* (a system of compulsory labour; literal meaning 'duty by the king'). The primary management responsibility rested with the chieftain of the village (*Gamarala*) and the *Gamsabhawa* – the Village Council. The abolition of the *Rajakariya System* by the British in 1832 AD, has resulted in the neglect of village irrigation systems as well as the upkeep of rural infrastructure. Realizing the adverse consequences of abolishing *Rajakariya*, colonial government enacted the Paddy Lands Irrigation Ordinance in 1856 to rectify some mistakes. However, the damage already caused by that time was irreparable both in the physical infrastructure as well as in the psyche of the farming communities. Even today, many years after the introduction of more democratic forms of control, village irrigation systems continue to suffer from poor maintenance and management.

The management of individual tanks is more readily comprehensible than that of a whole cascade of tanks. Truly, each tank in the cascade had to be maintained with due care and attention. In an exceptionally high rainfall season, if the top-most tank in the cascade collapsed due to negligence or some other reason, the large volume of water that gushes out would exert much pressure on the next tank bund often leading to its breach and even total collapse. Then the combined volume of water in both tanks would have generated a 'dominoes' effect, leading to a collapse of all tanks in the cascade, one after another. This had been witnessed to some extent during the exceptionally high rainfall conditions that prevailed in 1957, when widespread floods occurred in the North Central Dry Zone.

Similarly, the commencement dates of paddy cultivation under each tank would have taken place sequentially from one end of the cascade to the other resulting in more rational and economical water use. Sociologically, as some preliminary studies indicated, villages with higher social status in terms of *caste* surprisingly tend to occupy the lower end of the cascade, possibly due to its richer resources base. Therefore, they would have had some control in the past over the top-enders in maintaining irrigation structures under good condition. Nevertheless, how the management of cascades was achieved historically, remains hardly understood. At present, there is a real need to develop management structures that can embrace the entirety of a cascade, if best results are to be obtained in water management. Some studies in this direction have been undertaken by the International Water Management Institute in recent years.

## **DECLINE OF THE HYDRAULIC SOCIETY**

Historically, the hydraulic civilization that developed to its zenith during the first millennium began to diffuse around the twelfth Century. The reasons for this catastrophe remain still poorly understood. While the major irrigation works fell into disuse, village irrigation systems continued to survive. However, this still represents an area where many imaginations have wandered. Some attribute it to foreign invasions, but others to malaria, climate change, depletion of soil fertility, and even to a combination of factors and a “pull and push” mechanism that eventually attracted the people to the wet zone and the hill country. There are hardly any scientific investigations into this phenomenon. It is the historian and the archaeologist who provide qualitative interpretations of events. During the colonial period as indicated earlier, the demolition of traditional institutional structures have undoubtedly had some lasting adverse impacts.

## **CASCADING SYSTEMS: AN ANSWER TO DROUGHTS?**

On the basis of their form and appearance, the cascading systems would have operated as an ideal rainwater harvesting technology; a soil moisture and groundwater maintaining technology; a soil erosion and siltation control technology; a technology that ensured the maintenance of ecological balance; a technology that promoted social cohesion and need for community leadership; a system that accommodated spiritual development which promoted egalitarian attitudes, that helped the community in passing through the difficult times during the droughts; a system that nurtured the development of drought insurance through animal husbandry and fragmented land ownership; and that provided opportunities for inland fishing and human and animal nutrition.

Despite all these inherent advantages, why the cascading systems are so poorly functioning in the present times, remains an open question to be grappled with by the research community. A study of the severe drought that prevailed 1981, indicated that the worst drought damage is reported from areas under minor irrigation systems (Madduma Bandara, 1982). Some of these village irrigation areas also continue to remain as poorest areas of the country. Therefore, there is a real need to harness the beneficial aspects of cascading systems for combating the droughts as well for alleviating poverty.

The current relevance of restoring the ancient cascade irrigation technology is felt due to several reasons. Among the foreseeable adverse impacts of global climate change is the exacerbation of extreme climatic events such as droughts and floods. Therefore, in a situation of increasing drought proneness or flood proneness, improvement of cascade systems may prove beneficial in view of its time-tested buffering capacity. At present in the areas of cascade systems, there is a higher prevalence of poverty and as a consequence some out-migration from the affected rural areas to cities. These tendencies may be checked to some extent through enhancing the potential for improving productivity. The higher prevalence of malnutrition among the rural communities can also be mitigated through improved tank fishing and animal husbandry. However, health issues related to drinking water, eating tank-fish contaminated by agrochemicals (e.g. Cadmium) received by tanks, including kidney failure and malaria would have to be monitored and remedied. The ecological issues related to the clearance of village forests and unsustainable land use, may be addressed through better planning based on the cascade principle. The break-down of old social order (cohesion, kinship, leadership, norms and values) may not be easily restored. However, the situation may be improved with innovative approaches that suits modern living conditions. In the place of traditional institutional arrangements new robust but flexible structures may have to be nurtured.

Among the possible areas of further improvement, the first and foremost is the general recognition of the cascade concept in rural development planning. The increasing recognition of the cascade principle by modern civil engineers and regional planners is encouraging and promising. Just as the engineers deal with whole cascades than individual tanks, planners will be called upon to develop management structure not only covering individual villages but also whole system of villages nestled within a cascade system. Re-adjustment of land use and land tenure to suit current socio-economic realities without destroying the cascade bases presents another area of possible improvement. Above all, there is a need for preserving the ecological system that sustained the cascade technology for many generations.

However, as long as the external market forces tend to determine the fate of the villages, no amount of *in situ* improvement may prove productive. In this regard, there is a challenge for developing modern forms of market oriented agriculture through the assimilation of modern technologies such as drip-and sprinkler irrigation into cascade systems. This may be accompanied by the revival of some traditional varieties of rice, vegetables and fruits that are believed to be beneficial for human health.

## CONCLUSIONS

In conclusion, it may be stated that, cascading system as a traditional irrigation technology, due to a variety of its positive features, is worthy preservation, enhancement and popularization. This may be approached through a systems approach, than through a sectoral or piecemeal approach. It is the principles than the form of the cascading systems that deserve understanding, emulation and propagation. Therefore, the cascading systems may be perceived as flexible and evolving entities than antique objects. There is much scope for improvement and adoption of less harmful modern technologies. In order to face the challenges of modern times new shoots have to be developed from the ancient roots. In this context what Jonathan Swift (1167-1745) exhorted a few centuries ago, appears still valid: “.....And gave it for his opinion, that.... who ever could make two ears of corn, or two blades of grass, to grow upon a spot of ground where only one grew before, would deserve the better of mankind, and do more essential service to his country, than a whole race of politicians put together”.

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