<u>Format for Proposals of Candidate Systems</u>

For The Globally-important Ingenious Agricultural Heritage Systems (GIAHS) Programme

SUMMARY INFORMATION

a.	Country and location Sri Lanka North Central Province
b.	Project title / name of the system Protection and revival of Ancient Irrigation Systems in Sri Lanka
c.	Requesting agency Central Engineering Consultancy Bureau
d.	Governmental counterparts and other partners Irrigation Department Department of Agriculture, Rice research Institute University of Peradeniya United Nations University State Development and Construction Corporation Institute for Fundamental Studies
e.	Summary of objectives and activities (max. 200 words) The ancient irrigation systems of Sri Lanka consist of intricate networks of small to gigantic reservoirs called tanks connected through a series of feeder canals that brought water for yearlong rice cultivation in the dry zone. The majority of tanks that numbers around 30,000 have been constructed from 3rd century BC to 12th century AD and some of them have been in operation continuously for more than 2000 years. The project aims to recognize and promote the multiple services provided by these sustainable systems in agriculture, ecology and social sectors. Through the development of a series of demonstration pilot system it aims to revive the systems in the context of present day needs as an ecologically sound development alternative. The specific activities are; • Document the technology and practices related to environmental, social and economic perspectives of ancient irrigation systems • Choosing demonstration sites as pilot systems to highlight the multiple values of irrigation tank systems through multi-stake holder consultation process • Develop a framework for reviving the tank based village system as a modern day residential unit though the partnership of local communities, NGO, government and educational institutes by exploring benefits in food security, poverty reduction, bio-diversity and eco-tourism. • Develop a framework for systematic research and dissemination of sustainable practices and experiences or the ‘water heritage’ of Sri Lanka achieved through the perfection of ancient irrigation systems.

DESCRIPTION OF THE SYSTEM

1. Description of GIAHS

The rainfall of the low dry lands, the most significant climatic zone for the rice production of Sri Lanka, is concentrated in a rainy season of 3 months. Intricate irrigation systems consisting of large number of interconnected reservoirs (*weva* or tanks) evolved in response to this climatology, during the period from 3 century B.C. to 12 century A.D. The ancient irrigation systems in Sri Lanka still function as a crucial element in agricultural water supply in the dry zone. These systems also constitute one of the richest sources of wetland biodiversity in the country.

One of the intriguing features of the tank systems is their sheer density: There are about 30,000 tanks which have been built in the land area of about 40,000 sq.km of the dry zone, resulting in nearly a tank for every square kilometer (Mendis, 2003). This large density of tanks and their long-term existence (more than 1000 years in many cases) make them an important component in the environment and ecosystems of the region. Figure 1 shows the distribution of ancient tanks in the North Central region of Sri Lanka.

Brohier (1934) identified that there is a chain like structure in organization of small tanks in Sri Lanka and their relationship with large ancient reservoirs and waterways (Brohier, 1937) . Madduma Bandara (1994) coined the term *cascades* to identify this pattern where water from upstream tanks was successively stored in those of downstream (figure 2). These small cascades are linked to large reservoirs and giant feeder canals to form extremely complex large irrigation systems (figure 3).

The technical breakthrough that enabled the construction of large irrigation systems in Sri Lanka is the invention of the 'valve tower' or the 'valve-pit'. Sir Henry Parker, a British Engineer with the irrigation department who was entrusted with rehabilitation of ancient irrigation systems in mid 1800 describe the skills and inventions that went to the development of ancient tanks as follows. *"It may be assumed, that the formation of all reservoirs of a class with embankments much higher than those of simple village tasks was originally due to the constructive genius of the Sinhalese themselves. …. Since about the middle of last century, open wells, called 'valve-towers' when they stand clear of the embankment and 'valve-pits' when they are in it, have been built at numerous reservoirs in Europe. Their duty is to hold the valves, and the lifting –gear for working them, by means of which the outward flow of the water is regulated or totally stopped. Such also was the function of the* ***bisokotuwa*** *of the Sinhalese engineers; they were the first inventors of the valve-pit, more than 2100 years ago.(Parker, 1909)"*

Figures 4 and 5 show the short valve pit or 'short-sluice' used to control the outflow of small tanks. This construction made it possible to use a single sluice gate to distribute water to paddy fields at any reservoir water level. However, it cannot accommodate high volumes associated with large reservoirs. The 'bisokotuwa' has been developed for this purpose (Avsadahamy, 2003). The figures 6-8 shows the details of 'bisokotuwa' used in large reservoirs. Sir Henry Parker (1909) describes the still intact bisokotuwa of 'Pawatikulam tank' which had performed its duties continuously for over 2100 years.

A tank system in a cascade has a small reservation catchment, the reservoir, a strip of trees downstream of the reservoir that act as a wind breaking barrier, paddy fields, and the village. The reservation of the next tank of the cascade starts immediately below the paddy fields of the upper tank. The system of tanks, paddy fields and canals are so much integrated and inter woven with the natural environment, it is difficult to identify tank systems as man made structures. The primary service provided by the tanks was the storage of rainfall that comes in 3 months to enable year long rice growing with two seasonal crops. In addition to irrigation water, the tanks provided a number of other services. They made the microclimate pleasant and cool, enabled bio and agro diversity. The tanks also served as the common bathing place for the village and the meeting point for the village. (Photos 1 – 5). Most importantly the independence provided the ancient tanks through to each village has paved the way for a unique decentralized social system in Sri Lanka, where farmers had the highest social rank.

2. Goods and Services Provided by the System

About 40% of annual rice production in Sri Lanka originates from the dry-zone, where majority of farmlands depend on the ancient irrigation systems for a sustained water supply. There are two rice cultivation seasons, *yala*, October-March and *maha*, April-September. The *maha* land preparation and planting is generally started with the arrival of North-West monsoon rains, but needs irrigation for managing the crops until harvesting during February-March. During the *yala* season, the heavy rains of southwestern monsoon are limited to the south-western plans and central mountains (collectively known as wet-zone). Therefore the possibility of farming a second season almost entirely depends on irrigation.

In addition to the ancient irrigation systems, several large-scale irrigation projects (e.g. *Mahaveli* Development Project during 70s and 80s) involving diversions and big dams contribute to the irrigation water in the dry-zone in Sri Lanka However, these schemes also are designed to depend on and to supplement to the function of some of the major components of the ancient systems.

The development of tank irrigation system was a crucial element in the social organization and cultural traditions in the dry-zone. Numerous villages in dry zone are having names synonymous with the name of the village tank. The highly distributed nature of this 'water resource' and the sheer number density had no doubt contributed to the shaping of the social structures of people that built, managed and reaped benefits of them. The nature of the system encourages a much decentralized mode of water governance at the same time emphasizing the importance of inter-relationships and co-operation at larger scales.

Sri Lanka's low land also features a number of very large historical reservoirs that are believed to be the products of a centralized state bureaucracy. When the states that supported them collapsed (after 13th century), these works were also ruined. However, the village tanks (the subject of this proposal) did not undergo the same destiny, because they were constructed, managed and maintained by the respective villagers. It is believed that there had been a sophisticated system of shared responsibility and social equity developed around the village tank system (Traces of which still remains in remote parts of Sri Lanka). Until the colonial government instated irrigation department in 1860s in fact, the management of village tanks completely remained on the hands of the locals.

Sri Lanka's ancient history provides several examples of cases where the state's authority was effectively challenged and sometimes overrun by the common opinion. In addition to cultural and religious factors, historians increasingly see a contribution from the very decentralized and independent nature of the village tanks systems towards the freedom of thinking. In fact, in the ancient history of Sri Lanka (particularly the early period of the 2nd millennium) there are occasions showing a competition between the independent, self-sufficient villages and the desire of central authorities to consolidate them in to state. One example is the King Parakramabahu the great who reigned in Pollonaruwa from 1164 to 1197. The king was responsible for the construction of a number of monumental tanks among which the famous *parakrama samudra* takes a prime place.

Study of the history of Sri Lanka does not reveal evidence that a centralized bureaucracy ever even existed to run the country's irrigation works (Leach, 1959). The necessary maintenance work was organized by the villagers themselves: there was never a centralized bureaucracy to direct such work or to ensure that it was carried out. (Goldsmith and Hildyard, 1984).

It is reasonable to assume that the social system organized around the village tanks in ancient Sri

Lanka was significantly different from the feudalism in the medieval Europe and many others elsewhere in the world. Understanding this unique and sustainable way of life is also as important as the scientific, economical and ecological aspects of the ancient tanks systems.

3. Threats and Challenges

It is widely accepted that the ancient irrigation system in the dry-zone of Sri Lanka was largely developed during the period up to 12th century. The system faced a decline from 13th century to 19th century (Panabokke, 1999) due to numerous reasons including poor soil conditions, malaria epidemic, political instability, etc., although the system did not completely collapse.

During the early 19th century the colonial government of the time did not allow the people to restore or repair their sluices or tanks, but later identified the importance of the tank system for the human livelihood in the dry-zone (Levers 1890). However, the poor knowledge on the function of the systems had lead to either ignorance or unplanned disruption of the ancient tank systems during large-scale irrigation development projects during 20th century. As the centralized large-scale schemes were considered to be more efficient than the decentralized small systems, a number of small tank cascades were replaced by large reservoirs and high capacity feeder channels.

However the modern development has not been able to capture the harmony between local and regional hydrological characteristics that the older small cascade tank systems and ancient large reservoirs could capture so admirably. One of the examples is the function of the giant feeder canals, which Brohier (1937b) describes in relation to one such canal, as "*The Jayaganga, indeed an ingenious memorial of ancient irrigation, which was undoubtedly designed to serve as a combined irrigation and water supply canal, was not entirely dependent on its feeder reservoir, Kalaweva, for the water it carried. The length of the bund between Kalaweva and Anuradhapura intercepted all the drainage from the high ground to the east which otherwise would have run to waste. Thus the Jayaganga adapted itself to a wide field of irrigation by feeding little village tanks in each subsidiary valley, which lay below its bund. Not infrequently it fed a chain of village tanks down these valleys – the tank lower down receiving the overflow from the tank higher up on each chain*". The photo 6 shows a modern feeder canal that is entirely dependent on the feeder reservoir as it shuts off the valley drainage by the high embankments. In contrast the Photo 7 shows the ancient feeder canal, which is now located a few tens of meters below the modern construction, having one embankment open to catch the runoff and following the contour lines that result in very low velocity and minimum loss of command area. The multifaceted functionality of ancient systems has given rise to a renewed interest to scientifically understand the function of the tank systems in recent times. The ancient irrigation systems have been developed and constructed over 1600 years, and the collective wisdom of those long years, in addition to the natural selection process that must have eliminated the unsustainable practices should be embedded in the remaining systems. It is therefore, very important to rehabilitate and scientifically understand their functions and services adequately. There have been a number of large-scale development projects involving reservoirs and diversions providing irrigation to the dry-zone recently (most rapid developments during 70s and 80s), making it difficult to ascertain their long-term impact on ecosystems, biodiversity and man-made habitats associated with tanks. The ancient systems could provide valuable insights to make them sustainable and attractive.

On another aspect, recent research has indicated that the abandoned ancient tanks in the dry-zone plays a large role as breeding media for malaria vectors (Amerasinghe et al. 2001). It was recommended that the rehabilitation, use and proper maintenance of village tanks is important to the reduction of malaria epidemic in the dry-zone.

The Minneriya Tank, build in 227 A.D. with a circumference of 32 km with a capacity of 136 million cubic meters has been irrigating farms un-interrupted till present. The operation and maintenance know-how of such reservoirs were lost in the wars in when the families entrusted with the maintenance of large tanks were killed in 16th and 17th centuries. What ever remained was lost during the colonization and modernization of the last couple of centuries. It is a great challenge as well as a national priority to search, un-cover and combine whatever knowledge that remain with isolated individuals to document this great heritage and to inform the future generations.

4. Policy and Development Relevance

Sri Lanka's per capita rice consumption is about 150 kg/year, out of which only less than 10% is imported. Hence, a stable rice production remains an important requirement for sustainable development and alleviation of poverty and hunger in the country. Additionally, each effort in securing reliable water supplies is extremely important to reduce the widespread poverty in the rural agricultural areas in the dry zone. Towards this goal, the ancient irrigation works in Sri Lanka is a crucial component. The government of Sri Lanka launched a project to rehabilitate 1000 village tanks during the year 2004. Now the project is in its 2nd phase, targeting the reconstruction of another 1500 tanks at an estimated cost of 70 million Sri Lankan Rupees. The proper understanding of the function of small tank systems would make it possible to contribute scientifically for such development attempts.

5. Global Importance

The ancient irrigation systems of Sri Lanka are a unique system that have been perfected through consistent improvements and construction over 1600 years. The systems consist of many of the features now we have come to realize as imperative for sustainable utilization. They have bridged the micro and macro with small village cascades linked up with massive reservoirs in intricate hydraulic systems. They have succeeded in developing social systems for the management and operation of the systems where the villagers managed small village tanks and large reservoirs were managed and operated by designated families. The management systems encompassed the water management as well as social harmony where collective decisions have been taken to accommodate high climate variability characteristic of the tropics.

The tank irrigation systems also had the unique feature of blending seamlessly to the natural environment. It is nearly impossible to separate the man-made tank based agricultural environment from that of the natural environment. This has been carefully maintained through the preservation of a diverse array of plants and trees that occupied the surrounding land with paddy. The lessons and experiences from these systems can be very useful in the quest of various development alternatives, especially for eco-development pursuits.

The sustainable development challenges lie in understanding the human and social needs and meeting them through the co-existence with nature. In this context, reviving the ancient irrigation systems in modern day social context by expanding their services to accommodate current societal needs while designing norms and procedures for community based management of these systems to be sustainable eco-systems would be a worthy endeavour that identify closesly with the objectives of GHIAS.

References:

Amerasinghe, F.P. et al. (2001) Small Irrigation Tanks as a Source of Malaria Mosquito Vectors: A Study in North-Central Sri Lanka, Report 57. International Irrigation Management Institute, Colombo, Sri Lanka.

Avsadahamy, U. B. (2003) Wewa, Siri printers, ISBN-955-96820-0-8

FAO (2000) Riceinfo*, Crop and Grassland Commission of Internatinal Rice Commision. Food and Agriculture Organization of the United Nations.*

*Brohier R. L. (1934), "*Ancient Irrigation Works of Ceylon*" – Vol 1, 2 and 3, Ceylon Government Press.*

Brohier R. L. (1937a), Inter-Relation of groups of ancient reservoirs and channels in Ceylon. Journal of Royal Asiatic Society, Ceylon Branch, 34 (90), pp 64-85.

Brohier R. L. (1937b), Interconnected large reservoirs and channels in ancient Rajarata, Journal of Royal Asiatic Society, Ceylon Branch .

Goldsmith, E. and N. Hildyard (1984), Chap. 24 The Social and Environmental Effects of Large Dams*: Volume 1. Overview. Wadebridge Ecological Center, Worthyvale Manor Camelford, Cornwall PL32 9TT, UK*

Kennady, J.S. (1933), Evolution of scientific development of village irrigation works in Ceylon, Proc: Engineering association of Ceylon, pp.229-320.

Leach, E. A. (1959), "Hydraulic Society in Ceylon". Past and Present *No 15.*

Levers, R.W. (1890) Irrigation, Chapter 11 of Manual of the North Central Province, pp. 132-169

Madduma Bandara, C. M. (1994) Tank cascades in Sri Lanka. In. K .Asharul Haq. ed. Proceedings of IRMU Seminar Series. Colombo: Irrigation Research and Management Unit/Irrigation Department Sri Lanka

Mendis, D.L.O. (2003), Environment and Conflict: A Kuhnian Paradigm-based approach to understanding some socio-cultural and economic causes of problems and conflicts in modern irrigation projects in southern Sri Lanka, in Water for people and nature, Ministry of Irrigation and Water Management, Sri Lanka, pp.95-122.

Needham, J., Science and civilization in China (1956). Volume IV part 3: Civil Engineering and nautics.

Panabokke, C. R. 1999. The small tank cascade systems of the Rajarata: Their setting, distribution patterns, and hydrography. *Colombo, Sri Lanka: Mahaweli Authority of Sri Lanka.*

Parker, H. (1909). Ancient Ceylon, London-Luzca & Co., Published by the India Office.

Sakthivadivel, R., Fernando, N. and Brewer, J.D. (1997), Rehabilitation Planning for Small Tanks in Cascades: A Methodology Based on Rapid Assessment, Report 13: International Irrigation Management Institute, Colombo, Sri Lanka.

<u>Figures and Maps</u>

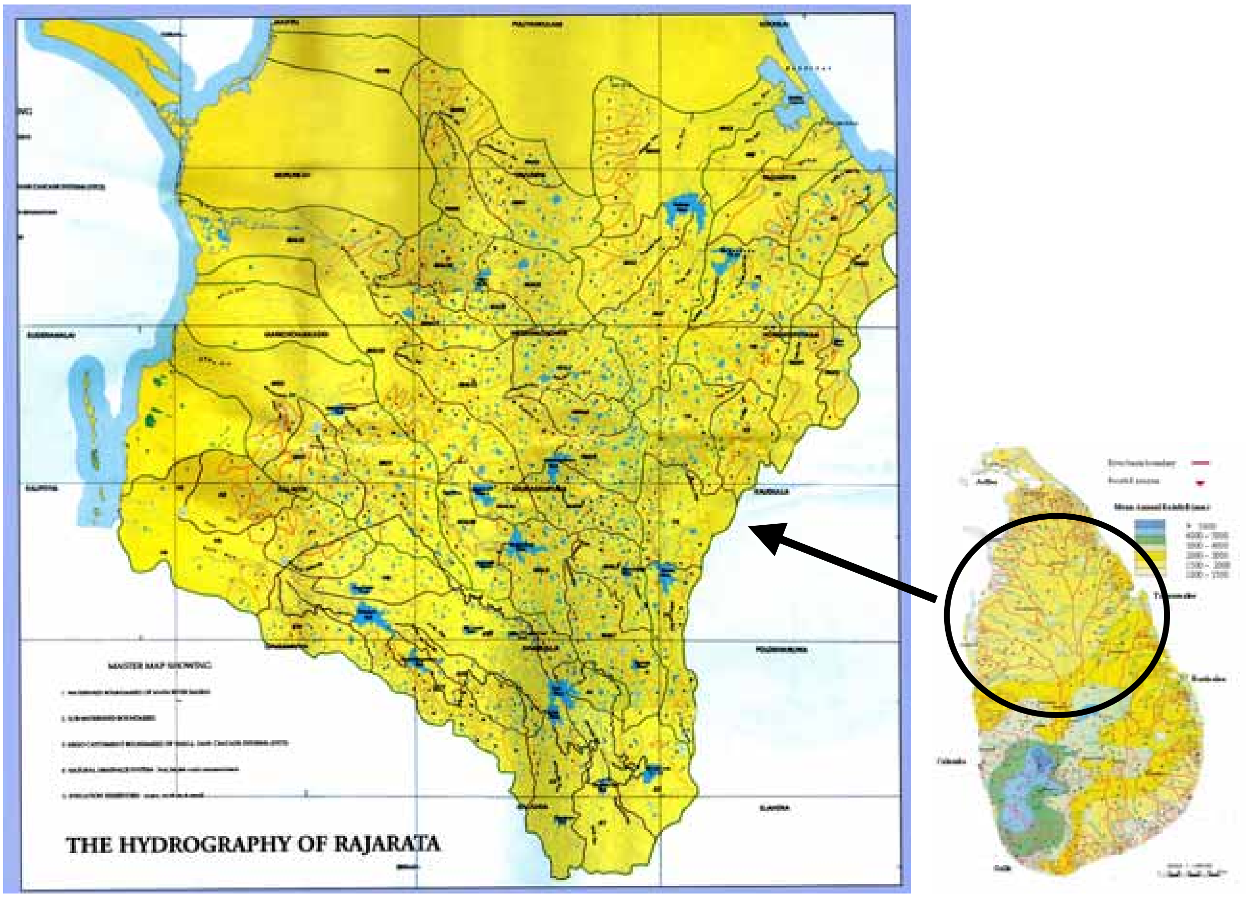

Figure 1 Distribution of ancient irrigation systems in the North Central Province

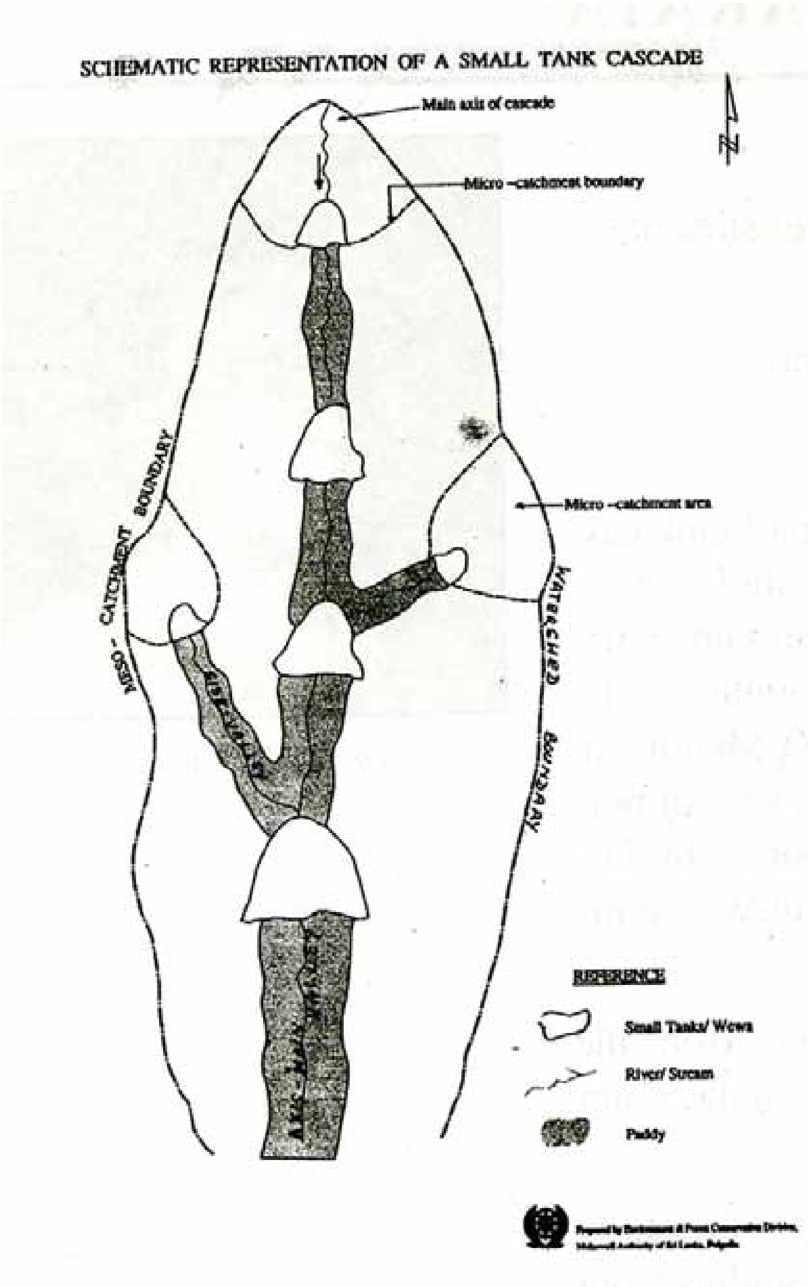

Figure 2: A cascade system and the micro-watersheds associated with it. (Source: Madduma Bandara1994)

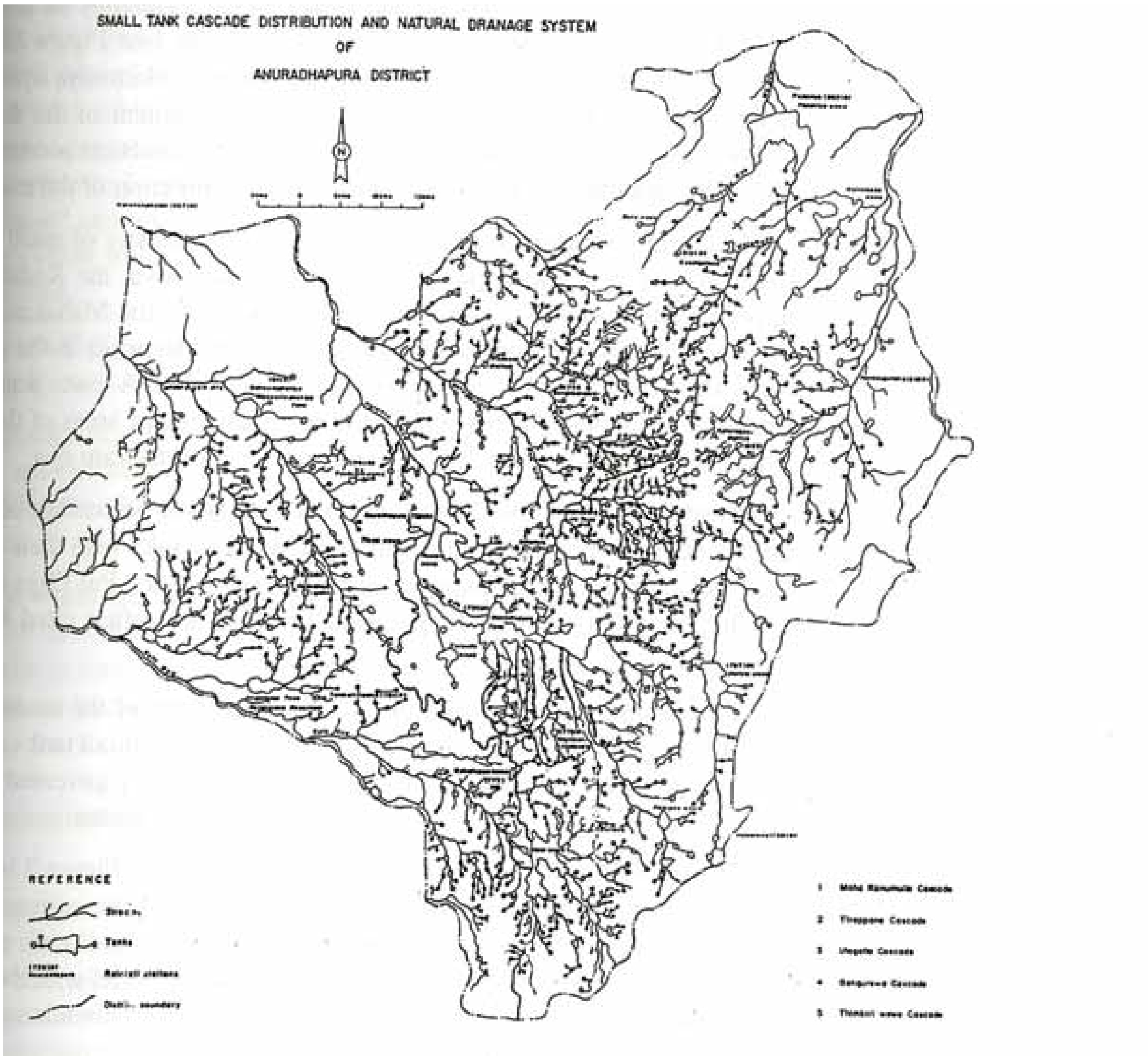

Figure 3: Interconnected tanlk cascades and large reservoirs on Natural Drainage System in Anuradhapura District, North-central province, Sri Lanka (Source:

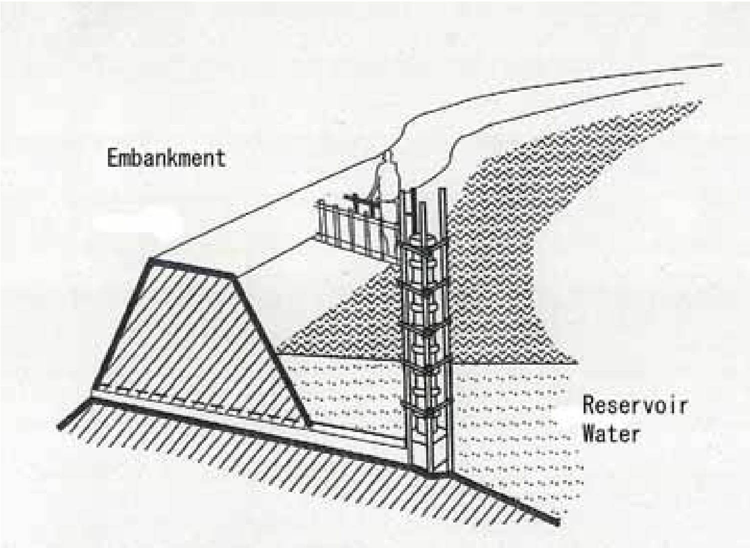

Figure 4 short sluice perspective (source: Udula Bandara Awsadahamy, 2003)

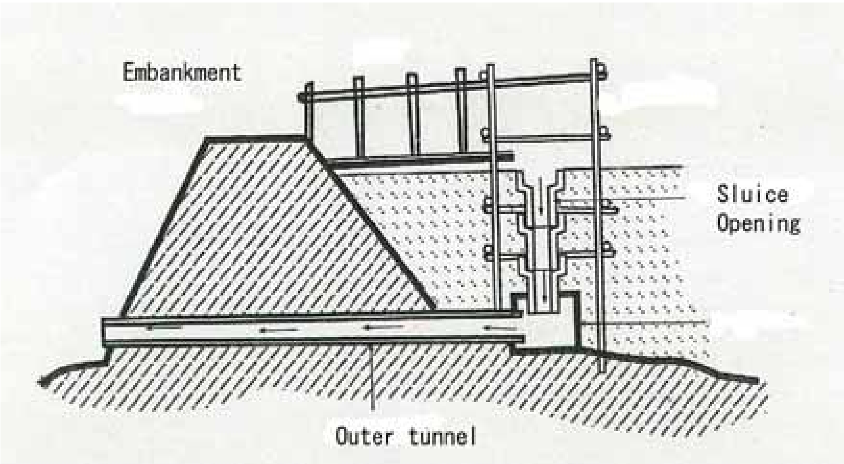

Figure 5 short sluice – cross section (source: Udula Bandara Awsadahamy, 2003)

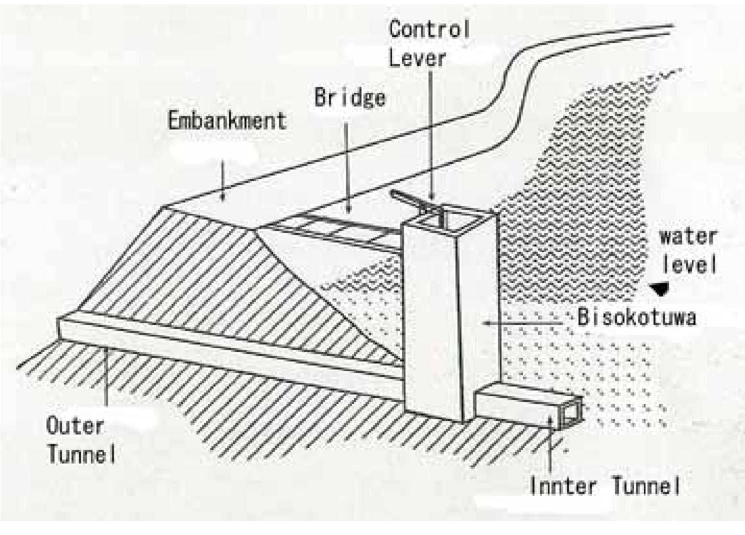

Figure 6. Bisokotuwa – the sluice used in large reservoirs (source: Udula Bandara Awsadahamy, 2003)

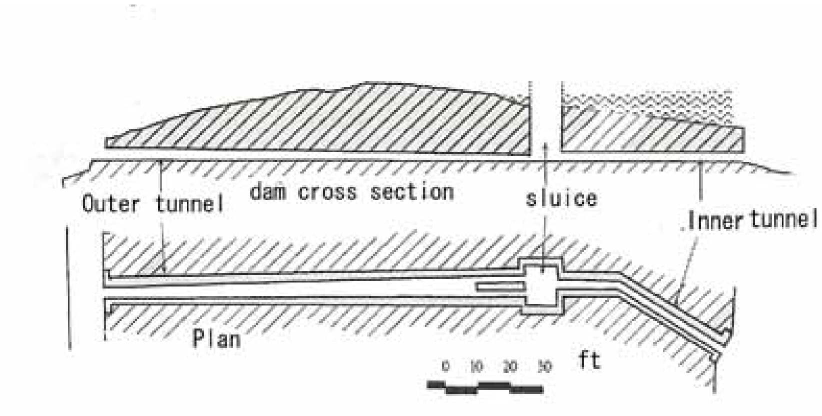

Figure 7 Plan view of Bisokotuwa (source: Udula Bandara Awsadahamy, 2003)

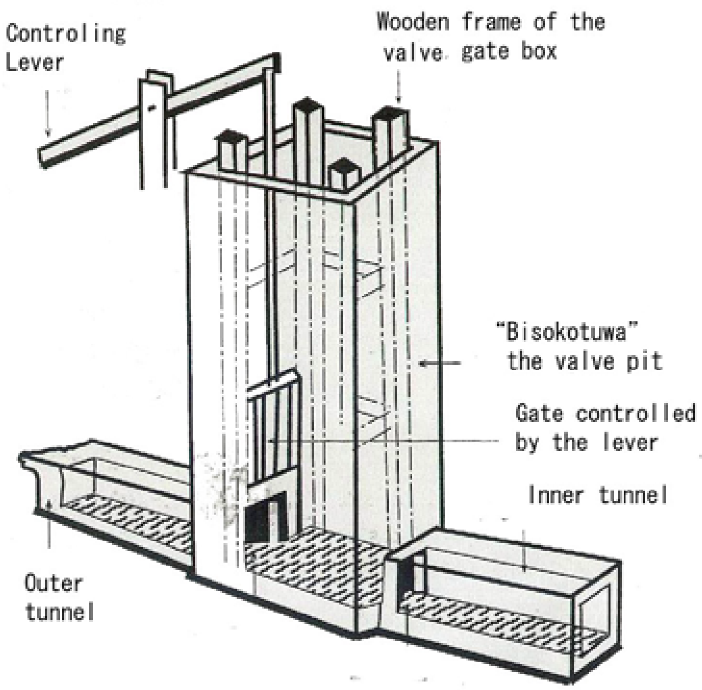

Figure 8 Details of Bisokotuwa (source: Udula Bandara Awsadahamy, 2003)

Table 1. Sizes of some reservoir bunds (source: Henry Parker)

Name	Region	Length (km)	Height (m)
Panga	north-western	2560	10.4
Kanadara	North-Central	1801	10.4
Tisa	North-Central	3353	11.8
Wannikulama	North	4069	11.3
Pavatikulama	North	2957	13.2
Sangili Kanadarawa	North-Central	2469	8.3
Batalagoda	north-western	1829	14.2
Nuwara wewa	North-Central	4828	17.5
Nachchaduwa	North-Central	1692	17.0
Yoda Wewa	North West	11265	

Photos

Photo 1 The ancient irrigation tanks not only provided much needed irrigation water to the but were aesthetically pleasing structures that fit seamlessly with the nature

Photo 2 There are over 30,000 tanks of various sizes built over 1600 years with majority being constructed from 3 century BC to about 12 century AD

Photo 3 The length of a an embankment of a tank could vary from few 100 s of meters to 10s of kilometres .

Photo 4. Sluice gates provided the water to irrigation distribution canals that fed the rice fields.

Photo 5. The village tank also serves as the community bathing place and plays an important role as a place for social gatherings.

Photo 6 A recent feeder canal that runs close to the ancient feeder canal. The velocity is much higher in the recent construction compared to the ancient one. The high embankments isolate the canal from the intermediate runoff.

Photo 7 An ancient feeder canal that lies just below the recent replacement shown in Photo 6. Note the almost stationary flow, due to construction along the contours. The embankment is only on the lower side, enabling the canal to trap surface runoff along its way.