ANCIENT WISDOM IN DEVELOPMENT AND MANAGEMENT OF IRRIGATION TANKS

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ABSTRACT

Observations of Great Civilizations show that their development was directly related to the extent to which they could control and manage water resources. The hydrological characteristic of the Indian monsoon necessitated the creation of storage facilities to hold the rainwater of the monsoon and utilize the same at a later date. With extraordinary engineering, managerial and social skills, an extensive system of rainwater harvesting structures like tanks and ponds had been built and maintained by the people for centuries. The community had the complete control over water. The village organizations had well laid out rules and fixed responsibilities to manage water efficiently. Traditional system of water allocation and sharing was based on custom, belief, and the concept of equity, as they perceived. This ensured smooth sharing and minimized conflicts. The structures built with the technology then available also contributed the efficient management. Behind these existing indigenous systems of irrigation, there thousands of years of tradition. A closer examination of the technology behind these structures indicates that the design that the design principles developed thousands of years ago still hold good and applicable in future also. This paper documents some of the ancient technologies in building tanks and water management principles followed in ancient period. The methodology adopted is to collect information available in literatures, epigraphs, inscriptions, and interpretation of the features of the ancient structures still in use and discussions with villagers. The antiquities of the tanks were established by the archeological dating principles.

INTRODUCTION

The Tamilnadu state is in the southern part of India. Irrigation development in Tamilnadu dates back to several centuries BC. Archeological discoveries on the banks of the Thamiravaruni River in Tamilnadu indicate a civilized life in the area around 1000 BC. Iron tools are found in the sepulchral urns excavated in Adhichanallur on the banks of Thamiravaruni. The evidence in the form of epigraphs appear from 200 BC. An epigraph dating 200 BC mentions that *" the assembly of Vembiurar constructed a*

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large tank" (ARE B.265 / 1978-79, IAR 1978-79 p.83). The tank is still in use. There are evidences of well-developed irrigation systems in Sangam literatures, epigraphs and also remnants of structures. Some of the irrigation structures described in *Sangam* literatures are still functioning and they are the standing monuments of indigenous irrigation technology. Behind these existing indigenous systems of irrigation, there are thousands of years of tradition. The water management techniques had thus an opportunity to be perfected over time. This paper attempts to rediscover and study the techniques adopted by the ancient Tamils in building and managing irrigation systems with a special focus on Tank Irrigation.

IMPORTANCE OF TANKS

Though Irrigation works are found everywhere in the world, nowhere are those as important as in monsoon Asia, stretching from India to Japan. Its unique rainfall pattern distinguishes the monsoon Asia from the rest of the world. Hence the course of development of agriculture has been different in monsoon Asia and the rest of the world. To attenuate temporal variability of rainfall, these countries had followed from time immemorial, a policy of conserving rainwater for subsequent use through innumerable tanks and small storage structures like ponds, built owned and managed by the local people through community organizations. Tank systems developed ingeniously and maintained over the centuries, have provided insulation from recurring droughts and floods and vagaries of monsoon, and provided the much needed livelihood security to the poor living in the fragile semi-arid regions.

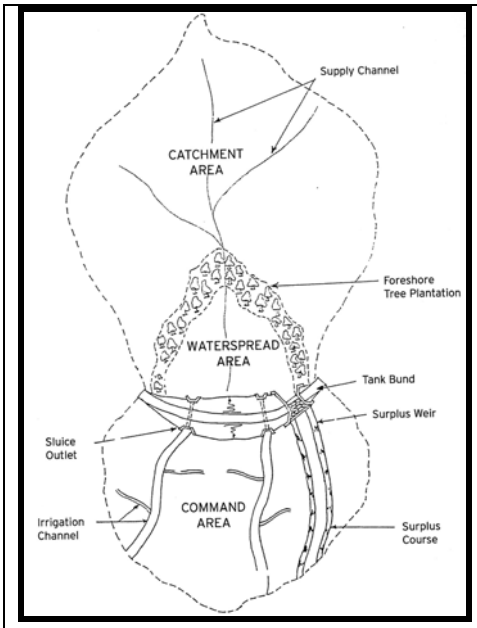


Figure 1 Components of Tank Irrigation System

COMPONENTS OF TANK IRRIGATION SYSTEM

The tank irrigation system has three major components as depicted in Figure 1. They are:

1. The source - Supply channels,
2. The tank proper with its surplus works and irrigation sluices
3. Irrigation channels

SOURCE

In Tamilnadu, there are about 39,000 tanks all over the State. These tanks are either system tanks that get supply from nearby rivers and may have their own catchment

source or Non-system tanks that depend mainly on their own catchment. As the tanks are of shallow storages, formed across the existing contours and as the contours themselves fall gradually towards eastern plains, they lie one below the other. The lower one gets the benefit of the spills from the higher. These tanks are called a 'Chain of Tanks' and the last in the chain spills out to a drain. In system tanks the chains are linked to a supply channel excavated from a diversion weir on the nearby stream or river. This additional facility greatly enhances the stability and sustainability of the tank's source.

TANK PROPER

The Tank proper has three components, tank bund, surplus arrangements and irrigation sluices. The tank bund sizes and cross section vary depending up on need. But in each of them, suitable surplus arrangements exist. The surplus arrangements are designed to carry the maximum flood discharge. A unique feature in the surplus weir construction is that, invariably one or more vents are provided to release water to a lower down tank in the chain even before this tank gets filled up and spills. This also helps to lead the flood flows in the river through the supply channel to reach the tail end tank in a short time. The irrigation sluices are also provided at different elevations depending upon the contours.

IRRIGATION CHANNELS

The tanks serve their ayacut through a distribution system consisting of channels taking off from the sluices. They have, depending upon the size, branches, minors and watercourses. They supply tank water to the fields and they also act as a drainage channel when ever the water is surplus than the demand. This enable the applied water to reuse many time within the command area.

ANTIQUITY OF TANKS IN TAMIL NADU

The literatures belonging to the third *Sangam* (300 B.C. to 200 A.D.) are the earliest records of history of Tamilnadu. The Socio-economic conditions of Tamilnadu in first millennium B.C. are portrayed well in *Sangam* literatures. Another source is *"Periplus of the Erythrean Sea*" (AD 81-96) which informs about the trade between the Roman Empire and Tamil kingdoms. The most important development of this period is the spread of irrigated rice cultivation. Some of the irrigation structures described in *Sangam* literatures are still functioning and they are the standing monuments of indigenous irrigation technology.

A possible way to identify the antiquity of tanks could be from the artifacts and other remnants found during archaeological excavations. During the megalithic age, there was a practice of burying the dead in an urn near a watercourse, either in the banks of rivers or near a tank (either in the foreshore or out in the bund). If a Sepulchral urn is found near a tank, we can conclude that the tank probably belongs to the Sangam period (300 B.C to 200 AD). All the dead were not always put into urns in the above period; many

were burnt also. Hence we have to be cautious in using this method to identify tanks of Sangam age. In addition, many tanks have been referred in the epigraphs and copper plate inscriptions found in different parts of Tamilnadu. However these epigraphs and inscriptions could not provide the clues to the exact date of formation of these tanks.

EVOLUTION OF SLUICES

A Sluice is the water drawing structure from the tank to the command area. The sill levels of various sluices in a tank could be same or different. The sill level is fixed based on the commandability of the ayacut lands (command area).

TYPES OF SLUICES

PULIKKAN MADAI

The *Pulikkan Madai* (Tiger's Eye Sluice) has three circular holes of roughly 2" diameter in a triangular shape on the masonry head wall of the sluice. The head wall will be of cut stone place on the tank side of the sluice. This arrangement of holes in this way resembles the eye of a Tiger and hence this name. During early period of cultivation when more water is required all the three holes will be opened. When the demand reduces the number of holes to be operated will be reduced. Water flow in the holes will be in relation to the depth in the tank. The discharge through an orifice (hole) will be equal to C_d x A x $\sqrt{}$ 2gh. When, the depth reduces, the bottom two holes will be opened to maintain the same discharge. This design indicates that the traditional knowledge of hydraulics compares well with present principles.

KARKUMILI

The off-take sluices of the tanks were located in the deepest portion. In the case of deep sluices, the sluice barrels got extended to the deepest bed of the water spread to ensure maximum drawl of storage. Even now one can observe that two vertical stone pillars protruding in the waters connected by two or more horizontal stone slabs with a central hole. They are referred as *"KARKUMILI*" in inscriptions. These are the "Plug and Socket" type sluices called *Kumili* in Tamil. A person has to swim to the pillars and operate the sluice. There will be two inlets for water. One on top is the socket in which plugs will be used to open or close the sluice. The top shaped plug provides an annular ring opening for partial lift and is capable of allowing varying discharges in accordance with the fluctuations in water level in the tank as well as for varying water demand. If the water level goes down the socket level, the second opening, usually closed with Clay or wooden piece, will be opened. This is called *Setthumadai.* The arrangement is

shown in Figure 2. In this type of arrangement there will be minimum or no dead storage.

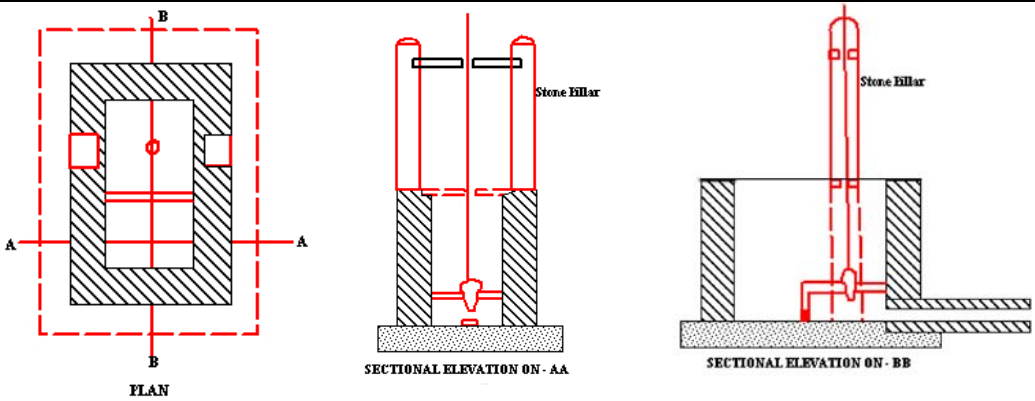


Figure 2 *Kumili* – Plug and Socket

REAR CISTERN

A cistern is provided on the rear side of the sluice barrel. When the tank is at FTL (Full Tank Level), the velocity with which the water rushes through the barrel will be very high causing erosion and damage to the field channels in the command area. To reduce this force, the cisterns are provided that will store and release water dissipating all the energy. The cisterns are in different shapes – Square, Rectangle and Semi-circular. They divide the water into two, three and more, sometimes up to 7 parts and distribute to various areas of tank command through field channels. Photo 15 shows the rear cistern of Srivilliputhur tank where 7 vents are provided. The inscription found in the tank indicates that the tank was built by Raja Raja Chola in his 12th year of reign (997 AD). The inscription mentions as *Perumadai* (big sluice) and elaborates the arrangement, seven channels distributing water equally in seven different directions.

Figure 3 Rear cisterns with 7 distribution channels

When the water rushes through the sluice, the velocity makes the water flow towards the vent directly in line with the flow. Hence a stone barrier acting as energy dissipater is placed just behind the vent as seen in the Figure 3. To see that no one disturbs or removes the stone, an image of God is carved on the stone. The figure of God Vinayaka is carved on this stone.

ARRANGEMENT FOR SURPLUS WATER DISPOSAL

SURPLUS WEIR OR *CALINGULA*

The *Calingu* or Surplus Weir is the most important component of a tank acting as the safety valve for the tank. They were constructed with care and its protection and maintenance received special attention of the villagers. The surplus weir is sometimes referred as *Kodu*. The people use the word *Kodi Paythal* indicating that the tank surpluses. The word *Kodu / Kodi* is used in Tamil to indicate 'one end'. Usually the escape was located on the extreme end of a tank. In a tank formed across a stream, the weir will be high if located on the stream and will also be costlier.

Providing dam stones in the surplus weir was a common practice followed for centuries till recently in Tamilnadu. These stones were generally of 6 inches. X 6 inches square and 2 to 3ft long. They are built into the crest of the *Calingu.* The top of the dam stones would be at Full Tank Level (FTL) of the Tank. The dam stones would be fixed at 2ft to 3ft interval. Figure 4 gives the Dam stone arrangements in a Calingu.

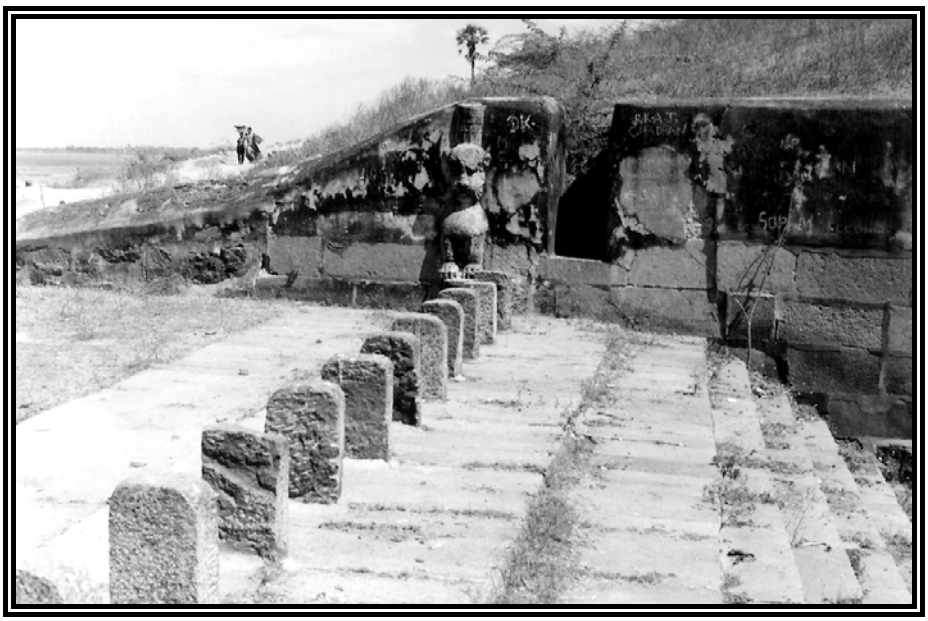


Figure 4 Dam stones in a *Calingula*

The spaces between the dam stones were blocked up with clay and turf so that water could be held up to FTL. In the normal time, when the first tank in the chain receives water, it will be allowed to fill up and start to surplus. This will be followed in all the tanks in chain. The last tank will not have dam stones but the crest of weir itself will be at FTL. When the last tank fills up to FTL, the farmers will start closing the dam stones and store water up to FTL in the upper tanks. Then, the immediate upper tank will be filled up to FTL and so on till the first tank stores up to FTL. Only after the first tank thus gets filled up, all the farmers in other tanks can start opening their sluices for

irrigation. During flood time, when the water level rises and overtops the turf bund, it would be washed away rapidly and the surplus weir surpluses the flood water quickly.

ANICUTS

Construction of anicuts or weirs on the bed of a river/stream raises the water level sufficiently and ensures gravity flow in the channels to irrigate lands, which are at higher elevation and feeds tanks. The anicuts across Thamiravaruni River are the classic examples of technical ingenuity. They are built on the riverbed as elongated and at an inclined angle and irregular "Horse Shoe" shape. This shape was interpreted as that they have been aligned to suit the rock out crop. However there are two reasons. The First one is that, these alignments ensure the waters to flow into the channels even during low flows. The second important reason is that by increasing the length of anicut, the affluxes during floods are contained within the river. In Thamiravaruni system, the command area of each channels (Contour canals) lies between the channel and river and the excess water drains back to the River (A method of reuse). So if any increase in water level of the river will submerge the cropped land adjoining. Though at these anicut sites rock out crop is everywhere, they have followed this shape.

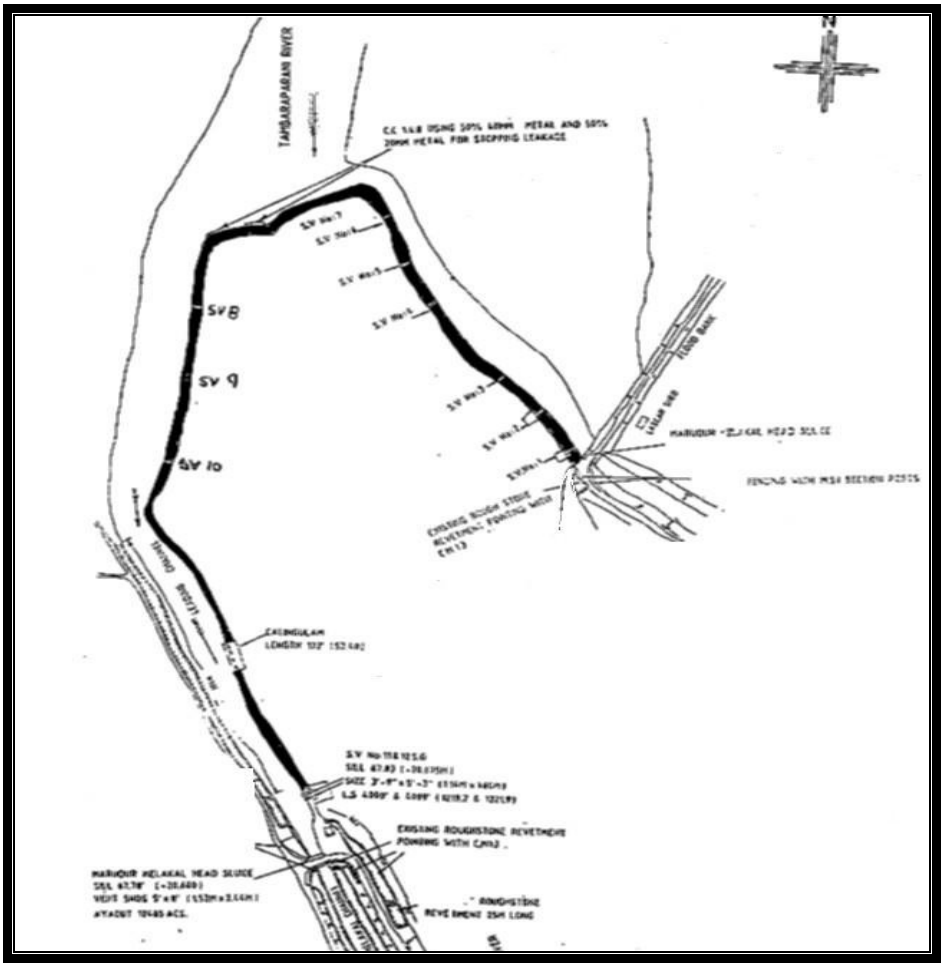


Figure 5. Plan of Marudur Anicut

The Marudur Anicut built by Maravarman Sundara Pandyan (1238-1258 AD), has almost a length more than three times the straight width of the river (Figure 5). When the British came, they built the first straight anicut across Thamiravaruni at Srivaikundam during 1858. The historical flood records show that the height of water over the Srivaikundam anicut was more than double that of Marudur anicut. This forced the British to build flood banks on both sides upstream of Srivaikundam anicut for 3 km. This not only increased the cost but also created water logging and drainage problem in the ayacut behind the tanks.

WATER MANAGEMENT

IRRIGATION INSTITUTIONS OF SANGAM AGE

The earliest form of peasant organization was the *Ur* a settlement of people who pursued agriculture. The *Ur* encompassed one or more villages. The agricultural settlements *Ur* also had their own assemblies to administer their settlement. The members of the assembly of *Ur* were the *Urar. Nadu* is a collection of *Ur*s and a bigger administrative unit. Historians agree that *Nadu* is the fundamental building block of rural organizations. The assembly of *Nadu* looked after the administration of *Nadu*. The members of the assembly of *Nadu* were called *Nattar.* Similarly *the* settlements of traders were the *Nagaram* and its assembly members were the *Nagarathars.*

"Karai" is the word used to denote the land unit along with right to the land. There are many epigraphs mentioning the *Karaiolai* or *Karaicheetu* used to the periodical redistribution of land by lot (Picking at random). Notable feature in the early Tamil kingdoms was that there was little or no (probably) private property in land. All land being held nominally under the authority of *Urar* with the "owners" holding merely the right of possession at the Urar's pleasure. The produce of all arable land was divided into two main parts Melvaram (Upper share) belong to the state and the Kilvaram (lower share) belonging to the local villagers. So there is a need to redistribute the lands each year among the cultivators. The names of all cultivators was written in separate palm leaves and put in a pot. One child would pick one leaf and corresponding land unit is allocated to him for cultivation during that year.

BRAHMADEYA AND *ERI VARIYAMS*

The settlements of Brahmins (Priests) were called *Brahmadeyas.* The *Pallava* period (600 AD to 900 AD) epigraphs extensively mention the *Sabha*, the village assemblies of Brahmadeya villages. Village Sabha consisted of all the male inhabitants of the area. They had complete control of the rural administration and acted on their own initiative independent of any directive from kings.The Brahmadeya villages had a local self-governing institution called **"Village Sabha".** For the purpose of administration, the Sabha created committees called *"Variyams".* The word *Varam* means Share and a committee of shareholder is the *Variyam.* The following committees for the various purposes are mentioned in inscriptions and copper plates.

Samvathsara Variyam	General Administration
Thotta Variyam	Garden Crops
Eri Variyam	Tanks and Irrigation
Calingula Variyam	Surplus weirs
Kazhani Variyam	Land development
Thadivazhi Variyam	Roads and paths leading to farms
Pancha Variyam	Tax collection

The Management of tanks was entrusted to a committee called "Eri Variyam" and its members were known as *Erivariyapperumakkal* (Honourable Members of tank committee). The members of the committee were elected every year, which enabled fresh members to get in and serve the committee. The electoral process was picking by lot. Similar to *Ur* But the Brahmadeya Sabha had excluded Non-Brahmins from contesting and stipulated conditions like land holding size, education, wealth etc for eligible candidates. The disqualifications have also been elaborated. Who had misappropriated the common funds, his family members and relatives cannot contest the elections. The sabha had the right to recall its elected representatives.

Kings, noblemen or the villagers for the purpose of maintenance of tanks made endowments in the form of gold or land. The income from these endowments was utlised for the maintenance of tanks. The *Erivariyam* took up the responsibility of regular maintenance, failing which the members of the assembly were liable for fine and punishment. The committee employed persons to operate sluices (*Madaiyaans*), distribution of water (Neerani, *Neerkatti or Kanduvetti*). There were village accountants, village watchmen (*Kaval*). All these persons and the village artisans were paid from the total produce of the village. The remaining was shared between state and villagers.

WATER MANAGEMENT

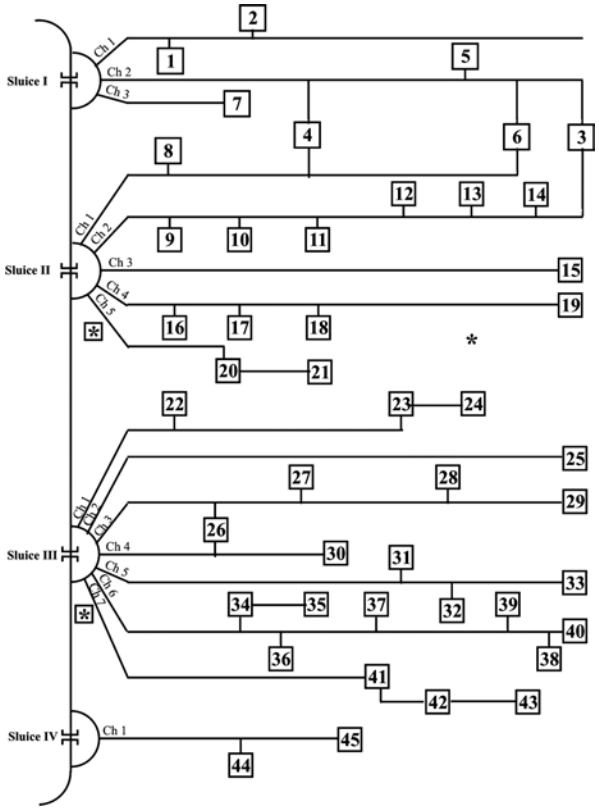
Inscriptions contain wealth of information on water sharing, distribution, water rights and responsibilities that are the elements of water management. The words *Nazhigai Vattam* (Time cycle) and *Nazhigai Kanankkan* (Time keeper) found in epigraphs and sangam literature point out that a turn system based on time and a persons who calculates the time allocations were in existence. There was a cycle of turns (Vattam) and an order in turns (Murai) adopted for irrigating the lands.

The Ur and Urar had the authority to allocate and distribute water from irrigation sources. Thus gradually the rights to water came to be attached to the land. The inscription of Maran Sendan in 770AD is the earliest describing the water right. The message is that the urar had sold land to one *Velsendil* along with water right specified for a time duration (S.I.I.No17) Similar messages are found in many inscriptions. One inscription giving this information was found in Pudukkottai district.

" When the Urar of Alattur sold in auction to a dancing girl of the temple 12 ma(1.6 ha) of land they also sold with the lands 16 naligais (6.4 hrs) of water out of 180 naligais(3 days) for which Perunkumili (Big sluice) was drawing water from tank."

- Pudukkottai Inscription No.666

The *Kasagudi* Copper plates mention that any tapping from or obstruction to the feeder channels was a punishable offence. The inscription found in *Kuruvithurai Peumal Temple* states that **"**When a channel is drawing water for irrigation from river, no channel should be excavated in the upstream". Such excavation will affect the flows in the old channel; this inscription protects their first right to water. The globally accepted concept of water rights "Prior Appropriation Right" and Riparian Right" have been in existence in the early Tamilnadu.



Case study of Muthunadu tank (Based on interview with farmers and Govt. record)

Muthunadu tank is unique in its construction and function. The tank is a balancing reservoir to 45 yendals (baby tanks) below it, through which only irrigation is made to its ayacut. The tank is not supplying directly to any ayacut (command area). Water supply to the 45 tanks is made through 4 sluices with an intelligent distribution from the rear cisterns of the sluices. 16 channels are taking off from the rear cisterns and 45 tanks are supplied. Vents are provided in the rear cistern to distribute water proportionally to the distribution channels.

The informal institution, which manages the tank system, is the UR constituting all farmers at *yendal* tanks. Before the commencement of the irrigation season, every year, all the farmers of each *yendal* tanks meet in any one of the villages where the farmers live, in a rotation. In this meeting they select the farmers who have to act as water distributors for each *yendal*. The selections are made randomly through lot. The names of the farmers are written in separate ballot paper, rolled and put into a pot or box. One child will be asked to take a few papers ranging from 1 to 5 for each tank according to its requirement. Such persons elected are called *Sethakkarar* If the farmers selected by lot as *Sethakkarar* are not residing in the villages, then they are permitted to employ others at their cost and responsibility. If they are not working to the satisfaction of other farmers the non-resident farmer is answerable for the misconduct. The appointments of the *Sethakkarar* are valid for only one year. When the selection processes are made for

the successive years, the names of farmers worked in the previous years will be deleted. In this system only farmers or their representatives alone are employed, the distribution will be better as the name itself indicates as *Sethakkarar*. They are paid wages fixed by the urar.

The duty and responsibility of *Sethakkarar's* is to bring the water from Muthunadu tank to their *yendal* tank without loss and as per the time schedule according to the customary rights. And below the yendal they should distribute the water in such a way there is no loss of crop productivity. Even though they are selected before the crop season, they start distribution of water below the *yendal* only after transplantation or broad casting, which is predominant, is completed in the command area. Till then farmers themselves operate the sluices according to the requirement and convenience of individual farmer. There is no rigid scheduling below the tank.

Muthunadu tank has a customary operation plan indigenously developed many centuries. The channel flows are distributed to *yendal* tanks according to a fixed time schedule in units of *Velai* (a unit of time of 12 hours). Each yendal tank get the supply varying from 1 *Velai* to 6 *Velais* in each turn till all the tanks got filled. During the period of a turn, if there is no flow to Muthunadu tank, the rotation of supply to *yendal* tanks will be disrupted. But, if the flow resumes within 7 days then, the supply to *yendals* will be continued as per the schedule. If the disruption is more than 7 days, the supply has to be resumed from the first tank in the channel and a fresh turn / rotation has to be followed. When all the *yendals* are filled to their full storage capacity or when the flow to the Muthunadu tank is higher than the drawing capacity of all supply channels, the excess water will be stored in the Muthunadu tank. Adequate surplus arrangements are available to dispose surplus floodwater when the tank got filled in. The time allocation called *Velai* in distribution of irrigation supply in this tank system is still followed.

The time schedule may present an unequal distribution of supply when compared to the command area. The sluice sill levels are at different levels and when there are low flows, the channels in the elevated sluice may not draw any water. Further the slopes of the channel bed vary under sluices. But to rectify these anomalies, the widths of the channels are designed in such a way the supply to yendal are equal to their requirement. And the sill level of the vents in the rear cistern of sluice III are raised so that the flow in the channel starts uniformly with that of sluice II.Yet another inequality in supply occurs when the flow in the channel is varying as the flow is not controlled. However the flow pattern itself may minimize the variation. There may be low flows at the start of the rotation and higher flow at the end and vise-versa Further, preference is given to the first tank whenever there is a break in supply for more than a week. The lower down tanks are in an advantage position to receive return flows from the upper command area and surplus water from upper tanks. Even if there are variations in supply in some rotation, such variation will not affect the crop as the storage in the *yendal* will compensate the short supply. Thus the double storage system provides more flexibility in operation and ensures equity and equality in irrigation supply between the total supply to these tanks. During drought years, the farmers postpone the starting of cultivation till the end of Tamil month *Purattasi* (15^{th} October to 15^{th} November). The farmers meet and decide to what extent the area of cultivation could be done by each farmers, generally proportionate to the total land holding.

CONCLUSION

1. Tanks constructed / existed during the Third Sangam period (300 B.C to 200 A.D) are still functioning.
2. The earliest inscription dated to 200 B.C describes about the construction of a tank by the community itself.
3. The literature provides / contains valuable information about the components of tank complex, its preferred location and shape.
4. Inscriptional evidences throw light on formation of institutions and their functions.
5. Number of inscriptional evidences are available on water management, farmers' water rights and responsibilities.
6. Inscriptional evidences are available about the periodical maintenance works carried out and the ways of raising funds for such works.
7. The modern technology being undertaken in construction and management of tanks is nothing but the revival of our ancient wisdom.

ABBREVIATION

ARE - Annual Report on Indian Epigraph

IAR - Indian Archeology, Review

SII - South Indian Inscription

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