27 January 2007 Daily News 08P

Ancient Marvels: The reservoirs and the irrigation canals of Sri Lanka

P. L. N. de Silva

(Formerly of the Sri Lanka Administrative Service)

IRRIGATION: The greatness of the irrigation systems of Sri Lanka is summed up in the University History of Ceylon: "the construction of reservoirs originated from the meagre knowledge the Indo-Aryan settlers had. From this basic elementary knowledge, there developed later the greatest engineering skill exhibited in the ancient Sinhalese Kingdom namely the progressive building up of a colossal and complex system of interrelated dams, canals and tanks, mingling the waters of rivers flowing in different directions; no parallel system of the same magnitude or intricacy existed in contemporary India."

Irrigation and Civil Engineers

Three examples from Indian and Sri Lankan history would be adequate to illustrate the abilities of our ancient civil as well as irrigation engineers.

The king of Kashmir was aware of the achievements of Sri Lanka in the sphere of irrigation engineering. He wanted to build similar irrigation works to help his country. He sent a delegation to Sri Lanka and got down irrigation engineers to build the required facilities in his country.

Sri Lankan King Megawarna sent a mission to the Court of Chandragupta requesting permission to build a huge facility at Buddhagaya for pilgrims from Sri Lanka and other countries to rest when they visit Buddhagaya. Chandragupta was the most powerful king in India in the 4th C BC. He was extremely pleased and acceded to our king's request. A grand monastery was built at Buddhagaya by our civil engineers. 300 years later, the famous Chinese monk, Hsiian Tsang, had recorded that this building was giving accommodation to thousands of monks and he was impressed with the construction of that great facility.

The Dhagoba is a symbol of Theravada Buddhism. King Mahasen , the irrigation genius of our country who was deified by a grateful people as 'Minneri Deviyo' built in the 4th C AD , a 110 metre Jethavanarama Dagoba which is said to be the tallest brick construction in the world even now.

Yodha Ela

Anyone going from Colombo to Anuradhapura will see the Yodha Ela along the main road, a canal that goes the distance of 54 miles mostly on flat land between two reservoirs ("tanks"), from the Kala Weva to the Tissa Weva in Anuradapura. On the way through small anicuts on the Yodha Ela bund, water is supplied to a number of small village cultivations. The engineers had maintained a gradient of six to 12 inches per mile in taking this water from one reservoir to the other. The bottom of the canal is not paved. The water flows over ordinary ground. How the Sri Lankan engineers maintained the fantastic gradient of six to 12 inches per mile for 54 miles is really unknown.

Another feature of the Yodha Ela is that the canal has only one bund. The successful construction of a canal of considerable length meant that in the first Century that Sinhalese had developed high degree of instrumental accuracy in contouring and leveling and had achieved success in building permanent stone dams across large rivers. The Sri Lankan engineers achieved this competence and took water along a contour with one bund instead of two. In this way, they reduced the cost by half. Another advantage was that during a sudden influx of water where the presence of two bunds would have increased the pressure causing damage, with one bund the water spreads on the upper side and releases the pressure so that there is no danger to the bund.

King Wasaba's engineers are credited with a notable achievement. They conducted water to the bathing tanks at Anuradhapura through a system of underground pipes doing away with surface channels.

Kawantissa of Kaleniya had ten clever men to function as his leaders of the army. The Dasa Maha Yodhayas (the ten great army officers) of king Kawantissa were the first *Yodhayas* in our literature. People began to think that the Yodha Ela was built by some unknown *Yodhayas* and that a Yodhaya was a superman.

Dr. Harishchandra Wijethunga's Practical Sinhala Dictionary records the following for the Sinhala word *Yodha: Yodha* = big, massive, large and brave, a strong soldier, *Yodhaya*= a military man , fighting soldier, committed man , a person with a huge body. (Mr. D.G.A. Perera of Kandy, a place names specialist, concurs that in Sinhalese the word Yodha has a military sense. The Yodha Ela was not built by some mythical *Yodhaya* but by able bodied soldiers in peace time.

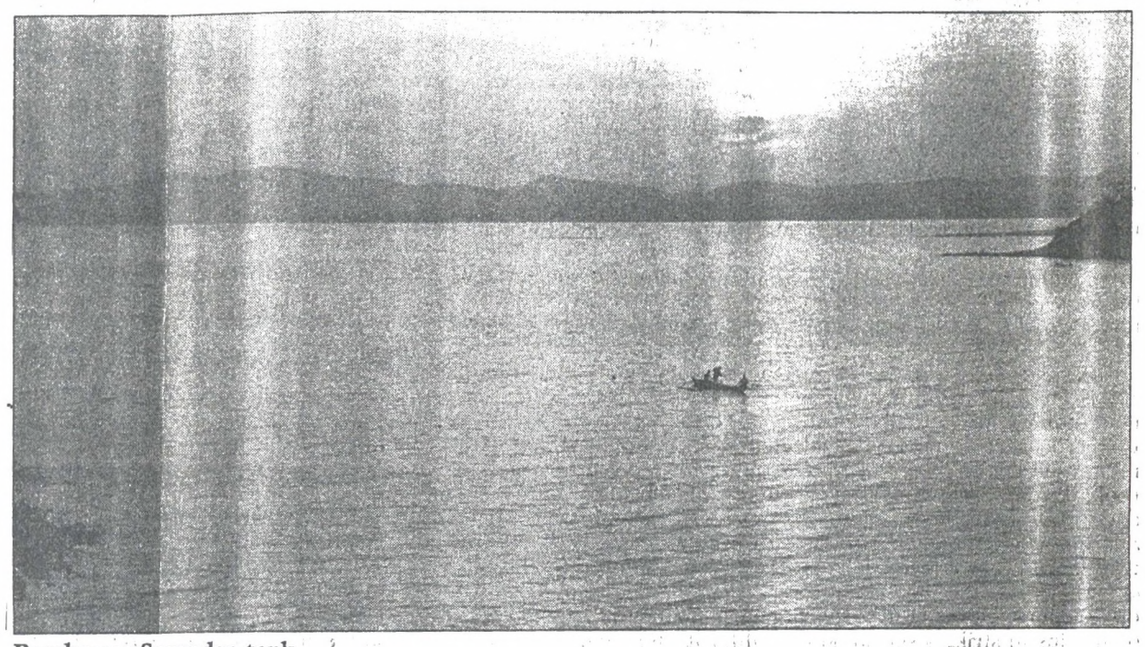
The Construction of small and large tanks

In Sri Lanka some of the village tanks were privately owned, some by women. In due course our engineers learnt to build permanent dams across rivers to make their irrigation tanks.

Various aspects have to be investigated before the proper tank can be constructed:

The catchment area: The area that permits the rainfall to flow into one particular place, which could be transformed into a tank., The rainfall in a particular catchment area must be adequate to fill a tank. A tank is normally made by building a dam across a flowing stream. Adequacy of any catchment area is determined by a study of the rainfall figures.

Seepage: The tank is by definition a place where water is stored for a long time. Such a situation can cause problems to the tank bund. The main problem is that of seepage. The massive bunds are made of earth and therefore when water is stored for a long time there is every likelihood of it seeping through the bund and ultimately destroying the bund. The Sinhalese engineers found a method to prevent this. They dug a trench at suitable places horizontal to the bund and filled it with clay, mostly from ant-hills (puddle clay) or Kiri Meti and got elephants to trample the clay into a thick mass effectively preventing any seepage.



Parakrama Samudra tank

The Shape: The shape of the bund had to be determined. The top of the bund was a flat area, which allowed the people to use it as a convenient roadway. The inside of the bund as well as the out side of the bund had to maintain the gradient of under 45 degrees as a preventive measure. The outside area of the tank bund and some other areas where necessary were covered with grass to prevent damage by heavy rain. In some large tanks wave formations occur and at times waves keep beating the inside of the tank bund. To prevent this, bunds were strengthened with stone masonry. *(Ralapanawa)*

The spillway (Vana): A tank must have provision to manage excess water as that would cause pressure on the tank bund and destroy it. Therefore, a spillway was built, so that the excess water could continuously flow out of the tank without causing any danger to the tank bund.

The sluice gate: This is, perhaps, the most important aspect of a large tank. Village tanks and somewhat bigger tanks could be used without danger to the bund by making use of other devices that were available e.g. Ketasorowwa and Rajamohol *Sorowwa.* However, when the volume of water within the tank increases, it builds up severe pressure that a normal sluice gate cannot handle safely. Then other measures become necessary to safeguard the tank bund. The earlier sluice gate has to be strengthened with a novel device. Large tanks in Sri Lanka would not have been possible but for the invention of a new device called the *Bisokotuwa,* which is an original concept of Sri Lankan engineering.

Secret of the *Bisokotuwa*

As one of the greatest authors on Sri Lankan irrigation, Dr. R. L. Brohier describes:

"*Bisokotuwa* is inside the Dam. The water from the reservoir flows into the *Bisokotuwa* with very high pressure through strong tubes made of stone. These tubes are generally 2-4 feet wide. The bottom 2-6 feet of the *Bisokotuwa,* into which the high-pressure water flows in, is generally made of stone. The top is generally made of high quality bricks, about one foot large, strong enough to withstand the relatively low pressure water at the top. While the water is forced to move upwards inside the *Bisokotuwa,* the pressure reduces. Then the water exits the *Bisokotuwa* through 2 or 3 stone tubes.

Generally, this water is directed to a second *Bisokotuwa,* where the same process is repeated further reducing the water pressure. Finally the water, unbelievably disciplined and calm, flows out through a larger tube to the outside of the Dam. This tube is normally six feet wide at the beginning and then widens to about 14 feet at the exit point of the Dam. That reduces the water pressure further. This was an outstanding idea, which was based on precise mathematics. Such were the skills, and the talents of the Sinhalese engineers. It can't be said that we have found enough of ancient irrigation works around the great-buried cities. Yet it leads to a higher estimate of the state of enlightenment of the old Sinhalese than that of all their works."

Thus we see that the *Bisokotuwa* was one of the greatest and original inventions of the Sinhala irrigation engineers. The massive reservoirs built by our great kings like Wasaba, Mahasen and Parakramabahu would not have been possible, if not for this great invention.

There are many other explanations given for this *Bisokotuwa.* Some authorities considered it as a silt trap. This view strangely lasted for over a 100 years. That view is no longer accepted. (According to D. G. A. Perera it is impossible for any silt to be trapped in the *Bisokotuwa)* Many described it as a successful device to control the issue of water from the tank to the fields below. That definition can be accepted because it described the purpose, but does not explain how it works.

Mr. Perera hypothesizes that this system is similar to that provided by hydraulic surge chamber used in the production of hydro-electricity. (Dr. D. H. Lewitt in a textbook says, "another method of overcoming the inertia effect of the water column in the supply pipe is to fit a vertical pipe and tank known as the Surge Tank on the supply pipe as neat to the turbine as possible." (Hydraulics, Page 294.) There is surprising similarity between the systems. The hydraulic surge chamber was used by European science in the 20th century, but the *Bisokotuwa* was built over 2100 years ago. I am in complete agreement with Mr. Perera's suggestion that it would be instructive to build working models of the *Bisokotuwa.*

Management of Water Resources

The astonishing effort needed to plan, design, build and use the intricate network of reservoirs and canals would have been of limited value unless the water so collected was rationally used for the benefit of the community.

Fortunately, Ven. Buddhagosha, the famous Buddhist commentator who wrote in the 5th century AD gives an example of the regulations that guided agricultural practice of the time. In seasons of drought, when the supply of water in the reservoir was reduced, water was distributed to each field in turn. Where a person diverts the water into his own channel with dishonest intention he has committed an offence. Detailed rules as decided at the *Kanna* (harvest) meeting have to be followed. Even today, at the Kala Weva *Kanna* meeting very serious decisions are made by the cultivators, and those decisions are sincerely honoured by the cultivators. Therefore, as a Cornell University Professor said after participating in one of the *Kanna* meetings with me, "there is refreshingly direct democracy in this agrarian community and as Ven. Buddagosha has recorded all these in details, we may accept the position that these regulations were valid from the 5th century AD." The Alahara-Minneri-Kawdulu scheme completed in Mahasen's reign was an epoch-making event in the history of irrigation in Ceylon and its successful operation to the great benefit of his subjects inspired them to deify him as *'Minneri Deviyo'.*

The artificial canals taken from the main rivers e.g. Mahaweli Ganga, Amban Ganga and Kala Oya etc., constructed by the ancient Sinhala engineers is about 506 miles in length. The capacity in acre-feet of these three major tanks is as follows: Giant's Tank: 26,596, Kantale Tank: 37,124, Kala Weva: 72,687. These statistics of the tanks and canals that were functioning in the 10th Century should convey to anyone the magnitude of the achievements of the ancient Sinhalese engineers in the sphere of irrigation.

There is nothing to compare with this achievement in irrigation anywhere in the world. For a moment one can imagine what Anuradhapura would look like without the glory infused into its environment by the irrigation tanks and canal system. It would have the hot dehydrated appearance of the dry zone during the Yala season. To enjoy the fabulous view from the Tissa Weva tank bund in the early hours of the morning or in the late evening with the cool breeze blowing across the wide expanse of water, is an experience that no Sri Lankan should miss.

Isn't it strange that the greatest achievement of the Sinhala irrigation engineers is buried in the middle of a tank bund, so that no one can see it and therefore very few can understand it?