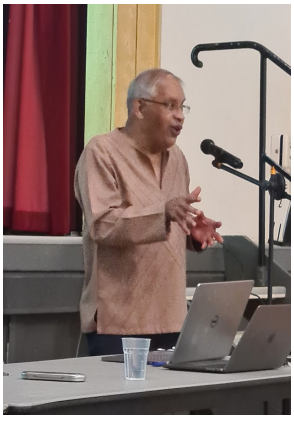
CSA
Reports of Meetings
February 2024

CSA General Meeting and Social

Sunday 25th February 2024 at 6.30pm at the Pennant Hills Community Centre Ramsay Road, Pennant Hills NSW

SPEAKER: Palitha Manchanayake

TOPIC: Ancient Irrigation Systems of Sri Lanka



Engineer Palitha Manchanayake had his education at Royal College, Colombo. He entered the Faculty of Engineering of the University of Ceylon, Peradeniya, and graduated with Honours in Civil Engineering in 1972. He then joined the Irrigation Department as an Irrigation Engineer. Palitha served as a construction engineer at the Wahalkadawewa Reservoir Project in Anuradhapura District in restoring the abandoned Tank. In 1976, he got his professional qualifications M.I.C.E (London), C.Eng. In 1981 Palitha obtained his M.Eng.Sc. Degree in Hydrology from the University of New South Wales, Australia.

From 1983 to 1987, Palitha served as Assistant Director at the Water Management Secretariat of the Mahaweli Authority of Sri Lanka, and was a Visiting Lecturer in Hydrology at the University of Moratuwa from 1981 to 1987. He served as a Consultant and Unit Author in Hydrology and Irrigation Engineering at the Open University, Nawala. Also, Palitha worked as a National Consultant in Water and Environmental Engineering for the ILO / UNDP from 1985 to 1987 in the formation and the setting up of the Technical Training Institute (TTI) at Katunayake.

He won the Ceylon Development Engineering (CDE) Award for the Best Paper published in '*Engineer*', the journal of the Institution of Engineers, Sri Lanka, during 1984-85. He is a Fellow of the Institution of Engineers (F.I.E), Sri Lanka.

After migrating to Australia in 1987, he served as a Hydrologist at the Flood Forecasting Centre of the Commonwealth Bureau of Meteorology, Sydney, until retirement.

Ancient Irrigation Systems of Sri Lanka - Transcript of Talk

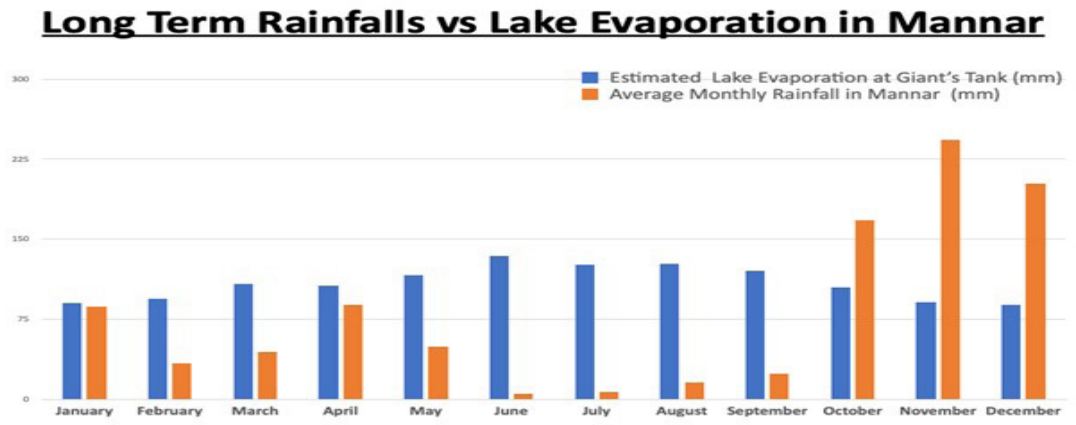
With the arrival of Prince Vijaya at Thammenna Beach on the North-West Coast of Sri Lanka, and the subsequent establishment of his kingdom in that area, the earliest irrigation work had centred around the Malwathu Oya Basin.

Prince Vijaya came in boats with 700 people from India and they were thirsty for water after travelling for hours, if not for days in the sea. Prince Vijaya wanted his men to find a fresh water source in the new country which they landed in. As they could not find a source easily, Prince Vijaya himself went in search, and found a lake beside which there was a tribal queen by the name of Kuweni sitting down there knitting. He got friendly with her, and subsequently with her help Vijaya became the King of Sri Lanka and he reigned for 38 years. It is the view of the late Mr. H. De. S. Manamperi, former Director of Irrigation and the Chairman of Mahaweli Development Board, that this particular lake was not a natural one, but a man-made lake. I wanted to investigate it and do some research into it.

I studied the Long-term Rainfall Records and the Evaporation Records of Mannar, which is quite close to the Thammenna Beach. The name '*Thammenna Beach*' does not exist these days, though it was used some 2600 years ago. It showed mostly with 3 months of rainfall from October to December, the people of the locality survived in managing the dry weather for the rest of the nine months of the year. The monthly evaporations are found to be extremely high with values exceeding 100 mm from March to September, while the monthly rainfalls remain to be very low.

Figure 1 (see over) gives a plot of monthly rainfall and the lake evaporation over the year at Mannar.

Figure 1



This fact helps us to conclude that the Yakshasa Tribe, which Kuweni belonged to, would have had a really good knowledge of water conservation techniques to survive in the area. The Figure 1 illustrates the fact quite convincingly. King Vijaya's kingdom in Sri Lanka lasted from 483 - 445 BC and during that period he had constructed a number of small ponds and small diversions for irrigation.

As Malwathu Oya originates from the Ritigala mountain and flows past the city of Anuradhapura, most of the ancient kings opted to retain their kingdom at Anuradhapura, and a lot of reservoir development took place in and around the area from about 500 BC to about 700 AD. From there onwards, it shifted to Polonnaruwa and continued there until about 1200 AD.

All of the ancient dams of Sri Lanka are essentially Earthen Dams. The names of the kings who built the individual reservoirs and their period of construction are given in **Table 1**.

Table 1

Name of Reservoir	Name of the King	Period of Construction
Basawakkulama Wewa	King Abhaya	400 BC (1st Ever Tank)
Thisaa Wewa	King Devanampiyatissa	200 BC
Maha Villachchiya Wewa	King Vasabha	100 AD
Nuwara Wewa	King Gajabahu-I	125 AD
Hurulu Wewa	King Mahasen	300 AD
Minneriya Wewa	King Mahasen	300 AD
Kaudulla Wewa	King Mahasen	300 AD
Padaviya Wewa	King Mahasen	300 AD
Kalaa Wewa	King Dhathusena	470 AD
Nachchaduwa Wewa	King Moggallaana-II	550 AD
Kanthale Wewa	King Aggabodhi-II	610 AD
Parakrama Samudraya	King Parakrama Bahu-I	1170 AD

The first reservoir to be constructed in Sri Lanka was Basawakkulama Wewa in Anuradhapura. It was built by King Abhaya around 400 BC. It could most likely be the first ever tank constructed in the world.

Table 2 gives their individual lengths of each of the bund and their operational heights of water. You may notice the reservoirs such as Nuwara Wewa, Hurulu Wewa, Kaudulla Wewa and Parakrama Samudraya have quite long earth bunds specifically 4.5 miles, 6 miles, 6 miles and 9 miles respectively. The Parakrama Samudraya has an operational height of water close to 52 feet.

Table 2

Name of Reservoir	Length of Bund (in Miles)	Height of Water (in Feet)
Basawakkulama Wewa	0.75	16.5
Thisaa Wewa	1.75	17.5
Maha Villachchiya Wewa	1.5	37
Nuwara Wewa	4.5	23
Hurulu Wewa	6.0	25
Minneriya Wewa	1.5	38
Kaudulla Wewa	6.0	25
Padaviya Wewa	2.75	22
Kalaa Wewa	2.7	30
Nachchaduwa Wewa	1.0	25
Kanthale Wewa	1.0	41
Parakrama Samudraya	9.0	52

The Irrigation Department of Sri Lanka was started by the British around 1900 as part of the then Public Works Department, and subsequently grew up into a major department of the country. During the British rule, they have restored a good number of these reservoirs which have been breached over the past floods, thereby acting defunct and growing out to be as part of the jungle. The British only reconstructed the 'breached section' of the dam which could be, say 400 metres in length and 10 metres in height. Once the reservoir is impounded after its restoration, the soil mechanics of the old reservoir bunds is under check, as certain parts of the old bund could collapse if proper quality control was not made in tamping of soil at that time.

In modern-day earth dam construction, we will have to select the correct type of soil, particularly the type of clay especially for the core trench of the dam etc. In order to find the correct soil type, the soil testers generally have to do a 'Borrow Area Survey' and find the appropriate soil. This would be transported to the dam site by way of push-cats, bulldozers and other earth moving equipment. After dumping the soil there, it has to be properly compacted as mere tamping would not help. It has to be consolidated by adding the necessary amount of water in order to arrive at the 'maximum dry density'. This could be achieved in arriving at the 'optimum soil-moisture content' which is determined by doing the in-situ measurements, while the construction work was going on. This is the method adopted in modern-day soil mechanics. But hardly any information exists about the king's soil mechan-

ics and the techniques they adopted in those days. We only know that several proportions of the many miles long reservoir bund were allocated to certain villages, and the construction would have been supervised by a village headman or his representative. So, if poor quality had been maintained for a certain reach due to lack of proper supervision, then once the reservoir is operating at full capacity, this particular reach could fail and cause a breach of the dam that could result in a disaster. But generally, they have done a superb job and it lasted for very many centuries.

So much so, the Minneriya Tank built by King Mahasen around 300 AD has never been breached. It had served the nation for 1700 years feeding them for every Maha and Yala Seasons. As such, the people in Minneriya are treating King Mahasen as a Deity, a God and they refer to him as "*Mahasen Deviyo*". There is a *devaale* built in his name along the Minneriya Tank Bund, and the locals make offerings to him on each and every Wednesday and Saturday.

In continuing with the topic of Ancient Irrigation Systems, I would like to make mention of 'Sorobora Wewa' in Mahiyangana. According to legend, it was built by a Giant named '*Bulatha*' during King Dutugemunu's reign around 102 BC. It has a capacity of 11,800 ac.ft and it caters for 1700 acres of paddy cultivation. What is noteworthy in Sorobora Wewa is its unique style adopted to issue water from the reservoir through a 'rock cut deep canal'. This canal is being operated by a gate covering its 2 ft diameter opening. It has existed for over 2000 years and is still working fine. As such, this reservoir and the structure had been identified and declared as an 'archeologically protected monument'.

The next topic is '**Keta Sorowwa**' (pictured). It is a masterpiece of innovation by ancient Sri Lankan irrigators, and it has been in good use for the past 20 centuries. It was invented around 400 - 300 BC. In the 19th century the British, while roaming around Sri Lanka, found this '*Keta Sorowwa*' in rural tanks throughout the country, and they named it as 'Morning Glory Spill cum Sluice'. Keta Sorowwa is a cylindrical clay pipe of 1 foot in diameter and running across the tank bund at the bottom. From inside the tank, it is fitted with a number of Ketayas which are small cylindrical clay pipes of the same diameter of about 1.5 ft in height and is with a thick collar. As the water level rises, the extra Ketayas are added up to a height where a human could operate. Once the water level recedes, the top most Ketaya is removed from it. Then the water would spill over and act as a sluice for the waters to run into the paddy lots. This could operate only for small rural tanks with smaller heads of water.

Preserved Biso Kotuwa of Maduru Oya Reservoir

But for higher heads of water, the local engineers at that time invented the '**Biso Kotuwa**' or the 'Sluice Tower'. In the ancient days, it was referred to as the '*Biso Kotuwa*', and in the present day it is being named the 'Sluice Tower'. The Biso Kotuwa is the apparatus that was to function in regulating the outflow from the tank. It is a square chamber fitted with an inlet to bring-in water from inside the tank, and an outlet on the opposite side of the chamber to dispatch the water from it. All the management and operation of the sluice tower would be done through this square chamber. The operation of the Biso Kotuwa in the ancient days is not available to us now, and one could only guess how it had functioned at that time.

The next topic is the '**Yodha Elas**' of Sri Lanka. When talking about the Yodha Ela of Sri Lanka one could talk about at least of 5 Yodha Elas, namely Kalawewa Yodha Ela (KYE), Elahera-Minneriya Yodha Ela (EMYE), Minneriya-Kanthale Yodha Ela (MKYE), Angamedilla Yodha Ela (AYE) and Minipe Yodha Ela (MYE).

The Kalawewa Yoda Ela (KYE) was built by King Dhathusena around 470 AD, and it was a canal joining Kalawewa to Thissaa-wewa in Anuradhapura. It had a length of 52 miles, and it is said that in the first 17 miles of this KYE canal, the drop in the water level was only 6 inches per river mile, which amounts to a gradient of 0.0001. The gradient which could be achieved with the present day levelling equipments is only 0.01. The KYE is a single banking channel travelling on a contour line, and it accommodates the intermediate flows from the forest cover on its way, and it was expected even to feed the small tanks nearby. This KYE is supposed have been built by adopting a series of "*Amunu Gilma*" techniques. It is done by connecting the Kalawewa to the closest village tank by a single banking bund, where it ends up in a single pool.

Kalawewa Yodha Ela (KYE)

These days this pool is connected to the next village tank by the same technique of '*Amunu Gilma*' resulting in the continuation of a single banking bund in making a continued single pool.

The Elahera-Minneriya Yodha Ela (EMYE) starts from an old anicut built across Amban Ganga and takes water for a distance of 20 miles where it ends up at a bifurcation structure at Diyabeduma. This EMYE was built by King Vasabha around 100 AD.

The Minneriya-Kanthale Yodha Ela (MKYE) starts from the bifurcation structure at Yabeduma and runs for 20 miles to feed the Kanthale Wewa and then to the Vendrasan Wewa, which is located beyond the Kanthale Wewa. This MKYE was built by King Aggabodhi-I around 600 AD.

Elahera-Minneriya Yodha Ela (EMYE)

The Angamedilla Yodha Ela (AYE) starts off from another anicut built across Amban Ganga, and the AYE feeds Parakrama Samudraya reservoir in addition to its own catchment area. The AYE is only 4 miles long, and it was built by King Parakrama Bahu-I around 1170 AD.

The Bifurcation Structure at Diyabeduma located at the end of EMYE

The Minipe Yodha Ela (MYE) originates from an anicut built across the main Mahaweli Ganga at Minipe, and it supplies water for 21,500 acres of paddy cultivation located on the Left Bank of the River Mahaweli. MYE was constructed by King Aggabodhi-I during 575 - 608 AD and it ran for 17 miles. Later it was extended to a length of 47 miles by King Sena-II during 853 - 887 AD.

References:

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2. Manchanayake P. (2022), *Memoirs of a Water Engineer (Stories from Sri Lanka and Australia)*, Owner Publication, Sri Lanka

3. Parker H. (1909), *Ancient Ceylon*, 4th Edition, Asian Educational Services, New Delhi, India

4. Arumugam S. (1969), *Water Resources of Ceylon its Utilisation and Development*, A Water Resources Board Publication, Colombo, Sri Lanka

Some photos from the evening