DAMS IN ANCIENT INDIA

ANANDAKRISHNAN KUNHOLATHILLATH
Department of Sanskrit
Government Brennen College, Thalassery

Introduction

Water is recognized as an important resource without which life in earth cannot exist. According to ancient Indian texts, water is one among the basic five elements called '*Pancabhūtas*' with which the universe, the cosmic world comprises of; earth, light/heat, air and ether/space being the other four elements. Ancient people depended more on agriculture and they realized that water is an essential resource for their existence and subsequently they developed water harvesting methods in myriad forms for storing monsoon water for the dry months. They used the then available empirical knowledge and techniques for construction of water works. Ancient Sanskrit texts and inscriptions provide interesting information on water storage structures and their management. Here the word 'ancient' is not limited to the period in history as defined by historians but it signifies the period of human civilization in India till the western colonial invasion. In this paper, an attempt has been made to bring out some details on dams and embankments constructed in ancient India. The indigenous technology used for construction of these water storage structures is also examined here.

Dams

A dam is a barrier that is constructed across a river or stream so that water can be held back or impounded to supply water for drinking or irrigation and to control flooding. Dam technology is a very ancient one. The earliest recorded dam is believed to have been built across the river Nile about 2900 BC to supply water to Memphic, the capital of King Menes[1]. The history of construction of dams in India goes back to pre-Harappan period. In the Indian sub-continent, the earliest dam is believed to have been built of stone rubbles by Zoroastrians in Baluchistan. Dams built of stone rubbles called *Gabarbands* are seen in Kutch and Brick bunds have been found in Karachi. The dating of these dams is said to be very difficult. However, on the evidence of pottery found in that area, archeologists assigned the date to pre-Harappan period. About the construction of *Gabarbands*, M.K. Dhavalikar says:

> There are several methods of construction, the most common being a series of platforms which are about 60-120 cm high. They rise in successively receding steps, gradually narrowing towards the top. Dams of this type are common in the Hab valley while some of these dams are small, there are others which are as long as 1 km or even longer. The construction of these dams involved immense skill in labour and engineering. These dams were probably used for the controlling flood water and for retaining the alluvium coming from the hills.[2]

The Arthaçästra

With many other subjects that are suitable for a 'Welfare Country', Kautilya deals the subject of water works and agriculture in the *Arthaçästra* written in 300 B.C. He says that the King should construct reservoirs (*setu*) , and fill them with water , either perennial or from some other source. Or he should provide with sites, roads, timber, and other

[1] *Water Management Traditions in India* , p.14

[2] *The Dying Wisdom* , p.21.

necessary things to those who construct reservoirs of their own accord. Whoever stays away from such kind of cooperative construction should send his servants and bullocks to carry on his work and should share the expenditure, but he should have no claim to the profit[3]. Kautilya says that the state should not only construct reservoirs of water but also should give necessary support for private contractors who undertake to build such reservoirs. The *Nāgaraka* (Govt. Superintendent of City) shall make daily inspection of water reservoirs[4]. Though private ownership of water works were encouraged, the ownership of a tank will be lost if it is not used for five years, except in times of distress, and it was possible for a person to sell or mortgage his tank[5]. Kautilya suggests not to destroy the disused tanks and waterless tanks.

Kautilya used the term *setu* primarily to refer an embankment or dam which is built for holding water. According to him, two types of *setu* are constructed [6]. They are:

1. *Sahodakasetu* – It refers to tanks, wells etc. which are fed by natural springs of water.
2. *Ahäryodakasetu* – It is an embankment between two hills and diverts river water through a canal.

Among these two types of reservoirs, according to Kautilya, the former is preferable. He says that among the *sahodaka* type of *setu,* one which irrigates a larger area is better[7]. From this we can infer that before building a dam, the engineers were directed to learn about the maximum benefit of the reservoir.

The *Räjatarangiëi*

The Räjatarangiëi is a chronicle of ancient Kashmir written by Kalhana in 1148-1150 AD. In this book he has given a detailed account of well concieved and maintained dams and irrigation canals during 8-12th

[3] *Arthaçästra* 2.1.22-23 [4]Ibid. 3.36.27 [5] Ibid. 3.9.32,34 [6] Ibid. *2.1.20*
[7] Ibid. *7.12.4-5*

century AD which played a significant role in the development of Kashmir. M.A. Stein, who translated the book into English with an introduction, commentary and appendices, could identify such few canals which Kalhana claimed were constructed during the tenure of different rulers of Kashmir. Apart from the irrigation canals from rivers and lakes, dams were also constructed with a network of canals and series of *arghat* (water wheels) and they distributed water in different regions of the country. It is said that the town of Damodara-suda was entirely in scarcity of water and an artificial irrigation canal named Guddasetu[8] was constructed. There is a reference to diverting a river called Candrakulya by the King Mihirakula[9] .The King Pravarasena II built a bridge called Great Bridge (*Brhat Setu*) in Vitasta (now called Jhelum) river. It was made of wood and later numerous permanent wooden bridges (also called boat-bridges) were built over the river Vitasta[10].

During the reign of King Avanthivarman in the 9th century AD, a learned man of great vision called Suyya drained the flood water of Vitasta and locked the entire river for a week. In the meantime, he organized hundreds of men to clear the bed of the Vitasta and the boulders were removed where the river rolled down between precipices. He constructed a stone embankment for a length of 13Km to construct a dam. It is called Mahāpadma (now called Wular Lake) and now it is the largest fresh water lake in India - into which the Vitasta flows. Wherever the banks of the Vitasta were vulnerable, strong stone embankments were constructed. It is recorded that Suyya could make a drastic change in the topology of Kashmir as well as he could make surplus earning for the treasury and could help to rise the living condition of people.

Inscriptions

The Sanskrit Junagadh inscription engraved on a rock dated back to 150 A.D, credits Rudradaman I who repaired the embankment of

[8] *Rajatarangini* Vol. I. p:156 [9] Ibid. Vol. I.318

[10] Ibid. Vol III.354

the lake Sudarçana, which was constructed by Pushyagupta, who was the Governor of Chandragupta Maurya of 4th century B.C. for checking floods. This lake was created by an embankment across the river Palasini and Suvarna-sikata[11]. Another inscription at Junagadh which is dated back to Skandagupta (455-467 AD) proves the restoration of the lake Sudarçana by Chakrapalita. He restored the embankment of the lake as it was burst as a consequence of excessive rain in 455-456 AD[12]. B.M. Pande opines as follows[13].

> The two inscriptions have several common features. Both mention the name of the lake as Sudarçana *taṭäka* or *taḍäka*. The inscriptions also mention that the lake was created by *Setubandhana* or embankment across the river Palasini (Rudradaman's inscription also mentions Suvarnasikata) and other streams. The term *setu* or *setubandhana* which means embankment is commonly found in several Sanskrit texts. Each of these inscriptions gave detailed measurements of the breach caused and the time taken to repair and restore the embankment which originally had an earthen core and stone facings on both sides. This time-tested method of construction was followed throughout the country until cement and concrete started replacing it.

During the course of his work on the Sudarçana lake, eminent historian R.N. Mehta, located the waste weir which had been cut across the Joganiyo hill, locally called the Dungar. It is still possible to see similar waste weirs cut across the hills in the construction of several artificial lakes.[14]

A number of dams or embankments were built in early India which exemplified the ancient merit of engineering feats. The Grand Anicut, built by the Chola King Karikalan around Ist century AD, also known as the *Kallanai* is an ancient dam built on the river Kāveri. It is considered one of the oldest water diversion and regulation structure in the world. It is a

[11] *A History of Water Management and Hydraulic Technology in India*, p:54
[12] *The Dying Wisdom* p:17 [13] Ibid. [14] Ibid.

massive dam of stone, 329 m long, 13 to 19 m wide and about 6 m high across the river. The purpose of the dam was to divert the waters of the Kāveri across the region for irrigation. It was greatly improved by the British Government and is functioning even today[15].

The construction of Bhopal Lake[16] is another example. The Paramara ruler Bhoja of Bhopal constructed an embankment across two hills in 11th century A.D and created a huge artificial lake called Bhojapāla. It was a huge lake which was fed by 365 streams. It is said that this lake was the largest artificially created lake in Indian Peninsula before the introduction of modern technology, which covered nearly 65,000 hectares of land, and in places, more than 30 m deep and was surrounding by high hills on all sides. The myth behind the construction of the lake goes as follows. The King Bhoja was stricken with a severe illness which the court physician failed to cure. A holy prophet predicted that he would die unless he was able to construct a huge lake which is fed by 365 streams. The efficient engineers of the King went to the valley of Vindhyan range in search of such a place. A valley was ultimately discovered, and subsequently enclosed, which included the headwaters of the river Vetrāvatī (Betwa). But the engineers were disappointed to find that only 356 streams could be fed into such a lake. The requisite number to made up 365 streams were then pointed out by Kalia, a Gond Chief, by whose name the river is still known today as Kaliasot or Kalia's river. He proposed to redirect the missing river and its tributaries to this lake. Historian and archeologist W. Kincaid, who surveyed the lake appraises the ability of those engineers who skillfully redirected another river, which rises 32 km to the west into Betwa valley. According to him, the legend preserves two important facts: That the drainage area of the source of Betwa was insufficient to fill the lake, and that the lake thus formed was of an unusual size. It is said that the rules followed in the construction of this dam, ie, tanks on the higher and lower levels, was as mentioned in the *Arthaçästra*.[17]

[15] *Water Management Traditions in India* , p.84,85 [16]*The Dying isdom*, p.17.
[17]Ibid. p.18

B.M. Pande says:

> The waste weir cuts through the solid rock of one of the lower hills. It is situated at the apex of a triangular valley, and is probably 3 km from the great dam in a direct line. Its position, so far from the dam, according to Kincaid, provides further proof of the practical ability of the engineers of that time. Any error in levels would have quickly destroyed the dam which, though stone- faced on both sides, was filled in by earth and could not have withstood heavy overflows for long. The second bund was thrown across the only other opening of the valley, which turned the Kaliasot off its course at right angle into the Betwa.[18]

In 1434 AD, this embankment was destructed by Hoshang Shah.It is recorded by contemporary historian Sahib Haleim in *Ma'asir-e-Mahmud Shahi*. It is said that the destruction of the embankment and drying up of the lake caused a drastic change in the climate of Malva and the town of Vidisa became more prone to floods.

During the first half of the 13th century a tank called Dharmakirti - Mail-Samudra was constructed by Mailamba, in Khammam district of Andhra Pradesh by throwing a strong bund of earth and stone across a valley between two hillocks. In 14th century AD, under the patronship of King Bhaskara Bavadura constructed a huge tank in Andhra Pradesh with many sluices and created an artificial lake called Anant-rāj-Sāgar [19]. An inscription, which is dated back to 1369 AD, throws light to the construction of the dam. It took a period of two years to complete the work and one thousand labourers were working every day. One hundred carts were employed to get stones for the walls. The bund consists of four natural hills connected by three earthen dams riveted by Cudappah slabs. The lake is 12 km in length and 4 km in breadth. The total length of the artificial bund is 1370m and 10.5 m high. At the deepest section, the bund is 46 m wide at the bottom and gradually become reduced as about

[18]Ibid. p.18. [19]*Water Management and Hydraulic Technology in India* p: 58

4 m at the top. Improved version of this lake stands today near the Porumamilla village[20]. Rana Uday Sing of Rajasthasn is credited to create the lake Udayasgar by building a dam between two hills at the Udaipur valley. He completed this work on 1565 and irrigated about 600 hectares of land. The embarkment of the lake had about 55 m width and the lake was about 3.5 km long. King Rajasimha of Rasjasthan built a dam in river Gomati near Kankroli and created an artitificial lake called Rajsamand[21]. The work was started in 1662 and was completed after 14 years. The embankment was 183 m in length and 64 m in width. The side towards the lake is fronted by ghats with a flight of steps built of marbles. On the upper most level of these ghats had pillared pavilians of remarkable elegance. Krishna Deva constructed the great dam and channel at Korragal, and the Basavanna channel in 1521. Another great work of his was the construction of an enormous tank or dammed-up lake which he carried out with the aid of Joao de la Ponte, a Portuguese engineer. It was intended partly for irrigation purpose, and partly for the supply of water to the new city of Nagalapur. It was built at the mouth of two hills, and in order to this end he broke down a hill. Innumerable people worked on the dam and it is recorded that sixty human beings were offered in sacrifice to ensure the security of the dam[22].

The tank structures[23] provided multiple purposes and the ancient society was well aware of them.

· *Nadi*, *Tanka*, *Kund* or *Kui* are different local names for ancient water tanks made for conserving water for drinking purposes. *Nadis* are used to store water for drinking purpose in Jodhpur. They were used for irrigation in Ajmer. *Nadi* is also called *Johad*.

· *Eri*, *Cheruvu*, *Kalvai*, *Kunta*, *Ahar*, *Pokhar* , *Beel* etc. are water tanks or embankments made in ancient India for both drinking and irrigation

[20] *The Dying Wisdom* p: 290

[21] *Water Management and Hydraulic Technology in India* p: 59

[22] *A Forgotten Empire: Vijayanagar; A Contribution to the History of India* , Ch.12

[23] *Water Management Traditions in India* , p.90-95

purposes. *Ahars* were indigenously developed tanks used for irrigation in South Bihar .

· Certain other water tanks like *Khadin* in Rajasthan, *Bundhies* in Madhyapradesh and *Rapats* in Rajasthan were built for improving soil moisture, and to induce deep percolation to ground water apart from satisfying irrigation requirements.

The ancient technology behind Dam Construction

In ancient India, Dams and big earthern embankments appear to have been designed not only with a sophisticated knowledge of dam engineering but also with an understanding of the principles of basin water balance. The systematized practice of irrigation engineering was known as Päthaçästra in ancient texts. Engineers specialized in water works were known as Päthaçästravid.

The ancient method of dam construction built earthen embankments[24]. After the site selection, two strong stone walls are built and then it is filled with earth. Stones and earth were dumped and trodden to make the bund firm and as a result the width of the bund was increased. The proportion of height to width was one to four. To make the stone veneer water proof, lime mortar or some mixture of lime was used. The use of lime in construction of dams is also ascertained by the Sanskrit term '*Sudha-jivin*' where *sudha* means lime and *jivin* means one who lives by. These embankments were provided with sluices or outlets in order to release the water stored in lake. The type and nature of sluices were varied; however, the most common was use of strong timber shutters which were slide down grooves made in stone wall.

Components of dams or embankments were[25]:

1. Catchment area : It is the area from which run off water is collected. The volume of inflow of water depends on rainfall and runoff potential of catchment area. In case of steeper slopes, the embankment had low ratio

[24]*Water Management and Hydraulic Technology in India* p: 68

[25]Ibid. p.58

of submergence to catchment area. In case of gentle slopes, this ratio was high owing to cultivation in the catchment area. In case of *Khadins*, sufficient run off was to be ensured and the ratio of submergence to catchment was 1:10 to 1:15.

2. Submergence area: It is the area under the stored water. The physical and chemical properties of soil under the submergence area of tanks were investigated. The area is strengthened with hard clay. The elevation of the bed at the middle of the dam should be avoided so that the storage capacity of the dam is increased.

3. Bund : It is a physical structure to retain water and withstand water pressure. The size and shape of bund will differ according to the location, soil type and topography of the tank. In the case of *Ahars*, the bund follows the contours of the land as far as possible. The bund is usually not more than 27 feet high and extends up to several kilometers. *Khadin* bund is usually 4 to 10 feet deep. Length of the bund is usually between 300 to 500 meters. In the case of *Bundhies*, the height of the bund is about 6 feet. Waste weir is provided to discharge the surplus water without causing any damage to the bund.

4. Sluice : It consists of mechanical devices to control water let out from the dam upstream end to the canal branches. Regulating arrangements are installed to control water out flow for irrigation. Sluices were constructed with stone and sometimes palmera planks joined together by ropes were used as sluice shutters.

5. Sluice location indicator : One *Stambha* is located in the middle of each tank in line with the sluice. It is also used to know the quantum of silt accumulated in the tank bed.

6. Distribution system : It is used to convey water to command area. Canals and channels are used to convey water to the fields for irrigation.

7. Command Area : The area cultivated by the stored water is called command area.

[26]*The Dying Wisdom* p.18 [27] *Water Management and Hydraulic Technology in India* p:57

It is said that the rules followed in the construction of tanks on the higher and lower levels, was as mentioned in the Arthasāstra[26]. The Porumamilla inscriptions[27] in Andhra Pradesh dated 1369 AD describe the construction of dams in Sanskrit verses. It lists the twelve constituents which were essential for construction of dams. 1) The first and foremost is the King who can understand the needs of the people as well as he should be rich and righteous to undertake the construction of dam. 2) Service of experts in hydrology or Päthaçästra. 3) A group of skilled masons and craftsmen to assist the irrigation engineers. 4) The location should have strong hills on either side of the river so that the dam could be well supported by them. 5) It is said that the river should provide sweet water and the dam should be constructed at least three *yojanas* downstream from the source of the river. 6) The dam should be constructed between the hills and the bunds should be built with compact stone wall which should not be too long but should be firm. 7) The raw materials used in dam construction were mainly strong and long stones and mud. 8) A quarry of strong and long stones should be available as close as possible to the site of the dam. 9) A water course (sluice) having strong eddies (*Bhrama*) on account of portion of mountain 10) The land around the dam should be fertile, rich in fruits and not sandy or rocky. 11) The ground should be firm and adorned with hard clay and 12) The river bed should be extensive and deep.

The six faults of a dam or *dosas* are as follows[28]. 1)Water leaking from the dam 2) Salinity of soil 3) Location of dam at the boundary of two kingdoms 4) Elevation (*Kurma*) at the middle of the bed of the dam. 5) Lack of enough supply of water and presence of large area to be irrigated. 6) Small river bed and excess of water.

[28] Ibid. p: 58

Conclusion

The dams constructed in ancient times were not very big but they could satisfy the purpose for which they were built. One cannot envisage any use of highly evolved technical knowledge in dam construction during ancient ages. The traditional systems were created out of sheer empirical knowledge, experience and folk wisdom. Most of the traditional water storage systems were managed and maintained by rules and procedures commonly agreed upon by the village community and not by individuals. Finding solutions to water management problems were also the collective responsibility of the society. The study of traditional systems in totality apart from only considering their technological side will certainly give answers to our current problems related with water shortage and water pollution.

References

1. Anil Agarwal and Sunita Narain, *The Dying Wisdom*.
2. M.A Stein, *Kalhana's* Rājataranginī.
3. L.N Rangarajan, Arthaśāstra.
4. M.S Mate, *A History of Water Management and Hydraulic Technology in India.*
5. Robert Sewell, *A Forgotten Empire: Vijayanagar; A Contribution to the History of India.*
6. T.M Srinivasan, *A Brief Account of the Ancient Irrigation Systems Prevalent in South India.*
7. Uma Shankari, Esha Shah, *Water Management Traditions in India*.