Wells, Tanks, and Canals: Indigenous Traditions of Irrigation in Ancient India

DOI: https://doi.org/10.63345/ijrsml.v13.i8.8

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ABSTRACT

The history of water management in India illustrates the deep interconnection between society, ecology, and hydraulic knowledge across ancient and medieval times. From the urbanized Harappan civilization (3000–1500 BCE) to the Chola Empire (9th–13th century CE), communities developed diverse and innovative techniques for sustaining agriculture, ensuring urban sanitation, and meeting socio-cultural needs. Archaeological and literary evidence demonstrates how civilizations such as the Harappans built elaborate drainage networks, reservoirs, and wells; the Mauryans institutionalized hydraulic governance through state-managed dams, canals, and water pricing systems; the Guptas emphasized localized, community-driven irrigation via tanks and guild initiatives; and the Cholas perfected large-scale irrigation networks, including the Grand Anicut and interconnected tank systems, supported by village assemblies and temple patronage. Each of these periods highlights the sophisticated understanding of hydrological principles and the integration of governance, technology, and community participation in water management. The continuity and adaptability of these systems underscore India's long-standing legacy as a hydraulic civilization. This study traces the evolution of ancient and medieval Indian water systems to reveal how engineering knowledge, administrative structures, and cultural practices shaped enduring models of sustainable resource management.

KEYWORDS

Water management, Ancient India, Harappan civilization, Mauryan Empire, Gupta period, Chola dynasty, irrigation systems, hydraulic water management, community-based governance, sustainable water practices.

INTRODUCTION

For several thousand years the history of hydrologic knowledge in India has been extending, linking and related with the Harappan civilization (circa 3000-1500 BC) and the Vedic period (from about 1500 to 500 BC). It might have been in other ancient civilizations that the quest for efficient water management had a catalyst role in shaping the hydrologic science development during early India. Our ancient scriptures especially the Rigveda, Yajurveda, and Atharvaveda contain basic hydrologic concepts about the water cycle and water quality together with hydraulic engineering methods for water control. Archaeological evidence shows that during the time of the urbanized Harappan civilization they implemented superior water management practices by creating draining networks and reservoir systems and centralized and

decentralized water operations . The Mauryan Empire, which thrived from 322 to 185 BCE, marks a pivotal chapter in the evolution of hydraulic infrastructure, often referred to as India's first "hydraulic civilization." During this time, the Mauryan government adopted control over massive dam construction which included spillways along with reservoirs and the building of Pynes and Ahars irrigation channels during this period. They progressed in hydrologic measurement alongside establishing water pricing systems and acquired knowledge of water balance. This legacy of hydraulic engineering and effective water management carried on into ancient and medieval times, especially during the Gupta empire (4th to 6th century CE) and the Chola dynasty (9th to 13th century CE). The Cholas, for example, created vast irrigation systems, including the Grand Anicut, which is one of the oldest water diversion structures still in use today. Likewise, during the Delhi Sultanate (13th to 16th century CE) and the Mughal era (16th to 18th century CE), remarkable innovations emerged, such as stepwells (baolis), extensive canal networks, and advanced water-lifting devices to meet the needs of both urban areas and agriculture. These historical occurrences highlight India's long history of managing water resources, which reflects a range of indigenous hydrological knowledge that developed in response to social and ecological demands. The intricacy of these systems, which range from the first urban drainage networks to the innovations in irrigation during the Middle Ages, shows a remarkable understanding of hydrologic principles that were both sophisticated for their time and flexible over centuries.

Objectives of the study

This study aims to understand how water shaped the growth of civilizations in ancient and medieval India by tracing the evolution of water management systems over time. It looks at how different societies—from the Harappans to the Cholas—developed innovative techniques such as tanks, canals, dams, and reservoirs to sustain agriculture, urban life, It also explores how governance and administration played a role, whether through the highly centralized control of the Mauryan state, the community-based efforts of the Gupta period, or the democratic village assemblies of the Cholas.

Harappan civilization

Among the earliest urban societies of ancient times the Indus Valley Civilization (c. 3000–1500 BCE) displayed a highly developed system of water management that directly supported its town planning schemes and controlled its public sanitation systems and agricultural cultivation methods. The northwestern regions of the Indian subcontinent became home to this Bronze Age civilization which needed efficient water resource management to sustain its large urban Centers in its semi-arid ecological zone. The inhabitants of Indus Valley Civilization understood that water was essential for human survival. Harappan farmers depended on Gabarbands and Canals to direct water for irrigation of their agricultural lands during dry seasons. The urban centres received state-of-the-art civil and architectural designs together with sophisticated drainage and water management systems (Singh et al., 2020). Dholavira and Mohenjo-Daro, the two major cities are best example of water management in Harappans civilization. In Dholavira the artificial ponds are best example for water conservation. The people of Dholavira take water from two seasonal rivers name Mansar and Manhar. The local residents construct dams to control the higher water levels in rivers during rainy seasons which is then directed to ponds built along canals for creating artificial water reservoirs. This fundamental technique ensures their survival and success. The pond discovered at

Dholavira measures 263 feet in length with 39 feet width and reaches a depth of 24 feet. The discovered drinkable well exists with a circular shape of 4–25 meters. The Great Bath of Mohenjo Daro of the Indus Valley is considered the "earliest public water tank of the ancient world", More than 700 wells are located throughout Mohenjo-Daro which belongs to this civilization. Harappans have deep awareness about seasonal rainfall because they know how to use their knowledge of flood and drainage systems. People within the Harappan culture demonstrated strong proficiency when it comes to natural resource preservation and water resource management (Pant & Dubey, 2024).

Mauryan empire

Figure 1.1 Ahar-Pyne system

During the Mauryan empire (322-185BCE) they constructed their first dams while simultaneously developing water balance measurement techniques for rainfall alongside a water pricing system and multiple water management approaches. A dedicated department under Mauryan rule managed the creation and upkeep of an advanced water management system including wells along with canals and lakes and tanks. The Mauryan state recognized water as a fundamental economic resource which led to the creation of administrative systems for its control. According to Kautilya's Arthashastra there was a reference for managing water resources in detail. The Superintendent of Water Works (Udakabhaga) and the Superintendent of Agriculture (Sitadhyaksha) held executive positions to oversee the development and upkeep of water infrastructure and canal systems and water reservoirs (Karpagaselvi, 2014).

During the Mauryan era the Ahar (storage tanks)-pyne (small canals) system demonstrates a superior approach to rainwater harvesting and participatory irrigation management. Archaeological survey of India conducted research during 1951-1955 which revealed a 45-foot-wide and 10-foot-deep 450-foot-long water canal from the Mauryan period in Kumhrar (Singh et al., 2020). King Chandragupta Maurya built Sudarsana dam in Girnar, Gujrat, around this time Pushyagupta Vaishya was the head of the Girnar region Pushyagupta is credited with constructing the Sudarshan Lake. Major hydraulic infrastructure projects emerged for agricultural productivity growth along with food supply stabilization purposes (Chaturvedi, 2020). The construction of hydroengineering structures which consisted of bandhas (embankments) across rivers and streams created sarovaras and pushkarinis as reservoirs for irrigation and drinking water. "The Mauryan Empire was first and foremost a great hydraulic civilization". Megasthenes mentions that "more than half of the arable land was irrigated and was in agriculture and produced two harvests in a year". The Mauryan administration created an assessment method to understand both water quantity and its economic worth. Rates for water utilization depended on which irrigation method people used: rates were higher for state canal irrigation and lower for manual irrigation and rainfed crops (Singh et al., 2020). The state adopted a system where water rates increased from manually irrigated lands to state-built canal systems to promote water efficiency and generate financial gains. The Mauryan

Empire had established water pricing systems as central features of their water management administration. Water rate (udakabhágam) required people to pay one fifth of their agricultural produce if they irrigated their land through manual labor (hastaprávartimam) and one-fourth of their produce for using water carried on shoulders (skandhaprávartimam) and one-third for utilizing water lifts (srotoyantraprávartimam) and one-third or one-fourth of their produce for raising water from rivers, lakes, tanks, and wells

Figure 1.2 Sudarsana Lake

(nadisarastatákakúpodghátam) (Kautilya, 1915). According to Arthashastra. The existence of these regulatory systems demonstrated early hydrological scientific understanding about water movement together with rainfall patterns and agricultural cycle effects. The development of water management in Mauryan period marked a significant milestone in South Asian hydraulic governance because of its centralized and technological administration (Singh et al., 2020).

Gupta empire

The Gupta Empire (c. 320–550 CE) was called the "Golden Age" of Indian civilization and was marked by achievements in art, science, administration and economic growth. The agrarian base of the empire was central to its prosperity and depended heavily on water management. Unlike the Mauryan period which had a strong central bureaucracy in water governance, the Gupta period had a more decentralized system. Local guilds (srenis), village assemblies (sabhas) and landholding communities played a bigger role in construction, maintenance and administration of water structures. Epigraphic evidence especially land grant inscriptions like Copper Plate Charters often mention donation of land for construction of tanks (taṭaka), wells (kuṇḍa) and irrigation channels (nalika) often under the patronage of local elites or religious institutions (Pandey, 2016).

The Gupta period is famous for the use of artificial tanks and reservoirs as the main method of irrigation and water storage. These were built by damming seasonal streams or capturing monsoon runoff and served both practical and ritual purposes. Emperor Skanda Gupta led the Gupta Empire, and there's a record of an incident when the dam at Sudarsana Lake, Girnar broke. It was fixed in 455 A.D. by Chakrapalit, the local city governor and son of Skanda Gupta's provincial governor, Parnadatta. Later on, in the 9th century AD, the large dam, which was more than 100 feet thick at the base, finally gave way and was never repaired again. They used devices called "sweeps" (lever-based water-lifting device) to lift water from the lakes and send it into smaller channels that brought water to the fields (Chaturvedi, 2020). These old methods are still seen in Indian farming today., an artificial reservoir built during the Mauryan period and maintained by the Shaka rulers. Agricultural growth under the Guptas depended on efficient irrigation. In areas where rainfall was seasonal and unpredictable, irrigation tanks and canals enabled double cropping and expansion of cultivable land. Construction of sluice gates, embankments and channels allowed for controlled water distribution and soil moisture. This enabled

cultivation in semi-arid areas and increased yields in fertile riverine areas. Gupta period agrarian manuals and treatises like Bṛhaspati Smṛti and later dharmashastra literature occasionally talk of water distribution, land fertility and agrarian rights. Not technical texts per se, but reflect growing awareness of water as a managed resource embedded in the legal, economic and religious life of the society. The Gupta period lacked numerous surviving technical treatises yet hydraulic knowledge remained active during this time. The presence of levees together with diversion weirs and stepped embankments demonstrates the implementation of hydrologic and civil engineering knowledge. Tax and water measurement systems operated actively during this time based on available inscriptions. The administrative authorities understood the economic

Figure 1.3 Kallanai (Grand Anicut)

value of irrigation so they taxed fields irrigated with artificial methods at higher rates than those completely dependent on rainfall (Pandey, 2016).

Chola empire

Rulers Karikala, Rajaraja I and Rajendra I established the Chola Empire (c. 850–1279 CE) as the dominant power in the Indian peninsula through their strategic advancements in state governance while promoting exceptional temple construction and maritime business ventures along with improving agricultural systems. The Kaveri delta served as a central agricultural region in South India while showcasing an innovative system of water management which drove the empire's prosperity. A Chola King initiated the water diversion of the Cauvery for drought relief when he observed his nation experiencing a dry spell. He became among the first leaders to recognize that river water should be used for land irrigation. The Chola rulers, particularly Karikala Chola (a legendary early Chola king) and later imperial Cholas, invested heavily in irrigation infrastructure, including anicuts (weirs), stone embankments, tanks (eri), and canals (vaykkal). karikala Chola constructed the Kallanai(Grand Anicut) in 1st A.D. across Cauvery and closed the major breach due to unprecedented floods in the river Cauvery and restored adequate supply to Thanjavur Cauvery delta besides making Kallanai as an escape to divert the excess floods in to it ("Water Harvesting- Our Age-Old Tradition," 2012). King Kochengkannan built 108 Siva temples with domestic Theppakulams(temple tanks or sacred reservoirs,) inside each sacred structure alongside his effort to maintain appropriate depths of water in drinking water sources. He established water connection canals running between the river course to maintain clean usable water for public use. These canals were called as Rajavoikals and in the names of the Kings.

Table- 1.1 Welfare Projects and Irrigation Works of Ancient Kings (Karpagaselvi, 2014).

Veeranam Tank	South Arcot District
Kandiratheertham Tank	Tiruchirappalli District

Gangaikonda Cholapuram	Tiruchirappalli District
Cauverypakkam Tank	Kanchipuram
Pameswarar Thadagam	Chengalpattu District
Samuthiram Tank	Thanjavur

The Cholas established a vast canal distribution system known as vaykkals through community collaboration with assistance from royal and temple support. Various delta inscriptions document how main river branch canals received their names either from kings (e.g., Rajendra Chola vāykkāl) or deities (e.g., Porantalarkilli). The canals contained different water-control features including sluices (madhagu) and stone spillways together with regulators to manage water flow and safeguard against floods. Tens of thousands of irrigation tanks existed in the Tamil region throughout the Chola period and numerous tanks still function to this day. The design of tanks permitted rainwater collection during monsoons for agricultural usage in the dry season. Multiple tanks were linked through a circular design so that water overflowed from an upper tank gradually moved to successive lower tanks downstream. One renowned tank service date to 10th-century CE Rajaditya Chola and is known as Veeranam tank. The irrigation facility covering 15 km of ground area served thousands of agricultural properties in the Kadalur district of present-day Madras state (Karpagaselvi, 2014).

A unique characteristic of Chola water management involved institutional involvement at the village level for controlling water resources. The inscription records from Uttaramerur and Thanjavur areas show how local sabhas (village assemblies) together with ur (common assemblies) controlled irrigation system repair and distribution and upkeep responsibilities. The local assembly units maintained full control of their nearby tanks and canals by keeping comprehensive records on land mapping and irrigation privileges and water station schedules and service requirements. Through its system of Eri-variyam the committee exercised both election and accountability to the local body therefore creating a democratic structure of administration for rural water governance and Panchavara-variyam the Committee for general public works and irrigation (Karpagaselvi, 2014).

Conclusion

So, the way water was handled in Ancient and Medieval India reflects the depth of understanding people had about their surroundings and the importance of water for their lives. The ancient Indian civilizations made sure their water systems were effective at managing resources. Water was vital to the society's success in almost every area. These methods changed and improved due to the landscape and the customs and beliefs of the peoples. Every era developed different methods for managing water resources. The Mauryan Empire depended on government-led works, but in the Gupta era, most irrigation was handled by local groups. The Cholas were famous for their beautiful and intricate water storage systems. These techniques demonstrate how both the government and engineering expertise combined efforts to make water a key resource for both society and the economy. These approaches shaped the region's water security for years to come and even has examples surviving into modern times.

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