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Identifying the Role of Water Through the Study of Water-Storage Architecture in Óc Eo Urban Settlement (Vietnam)

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Abstract
This study focuses on analyzing the system of water conveyance and storage architecture in the urban center of Óc Eo (Vietnam) in comparison with the ancient cities of Mohenjo-daro (Pakistan) and Varanasi (India). The article aims to clarify the differences in the ways water was exploited and utilized, as well as how human communities adapted to natural conditions during the first seven centuries CE in southern Vietnam. The research results indicate that in Óc Eo there was a clear distinction between domestic water and sacred water. While the network of canals functioned as a form of "transportation system" facilitating trade and connecting communities, the stepped wells discovered at Gò Cây Me, Nền Chùa, and Giồng Cát appear to have had a highly symbolic character closely associated with temple spaces. Ultimately, water played a dual role: it served both as a material resource sustaining the economy and as a symbolic instrument for constructing social power. In particular, at Óc Eo, the adoption and localization of Indian models of water architecture demonstrate a distinctive synthesis between imported religious beliefs and local practices within a riverine environment. These conclusions open up new approaches for studying ancient urban centers in southern Vietnam and Southeast Asia from a geo-cultural perspective.

Keywords: Óc Eo Urban settlement, Water-strorage architecture, Funan state, Canals, Hinduism

1. Introduction

Water plays a critical role in the formation and development of civilizations, serving not only daily life but also being closely intertwined with economic, cultural, and religious activities. Historically, ancient cities were often established near water sources or networks of canals. Beyond its material value, water also holds profound spiritual significance, revered as a "sacred" element with supernatural properties in many religious traditions.

Research into water use in ancient civilizations not only sheds light on cultural practices; it also provides profound insights into human adaptation and creativity in the face of natural conditions. Óc Eo (Vietnam) is an ancient city planned and built according to the standards of its contemporary inhabitants, where water played a crucial role in the formation and development of ancient communities. From its original role of merely sustaining life, water gradually became sanctified with the emergence and spread of Hinduism as it moved eastward, giving rise to ancient cities in India from the 15th century BCE and influencing Óc Eo—a site that deeply absorbed Indian traditions as early as the beginning of the Common Era. From West to East, each region developed distinctive methods of water management and utilization that reflected its living environment; in the Óc Eo city—through its system of canals and related structures—these clearly reflect the cultural synthesis characteristic of the area [1, 2]. This article focuses on the study of water use in the Óc Eo urban center through a comparative analysis with several ancient Indian cities, aiming to clarify how ancient people harnessed and utilized water in their daily lives. The study does not attempt

to establish chronological connections; instead, it treats water use as a point of reference to examine the sacred role of water in each city. From this, it highlights how ancient residents adapted to the natural context of each region.

2. Materials and Methods

The content presented in this article is based on research employing comparative archaeological methods and the analysis of historical sources to examine water storage systems at Óc Eo Urban settlement in compare with two other sites in ancient India. This study involves comparing artifacts and archaeological remains across a chronological span from the 1st to the 6th century AD to identify similarities and differences among them, while incorporating Hindu scriptures to clarify the role of water. The study utilizes excavation findings from the Gò Cây Me, Nền Chùa, and Giồng Cát sites, as well as the Lung Lớn canal system (1st–7th centuries AD). It also references ethical guidelines in archaeology and field measurement tools previously published by other research groups.

Smith's theory of urban order was applied in the study [3] to identify water usage patterns at three locations. In Smith's view, urban order is a state in which residents enjoy a degree of property security, a predictable daily social life, and the absence of violence or physical attacks. This order is not a given constant but must be continuously constructed and maintained through two distinct driving forces in society. Here, the theory of urban order explains "why" and "how" water becomes a tool of governance and a symbol.

Steward is renowned for his cultural ecology theory, which posits that cultural change does not occur randomly but is the result of humans adapting to the environment through technology and the economy. He divides cultural structure into two parts: the cultural core and secondary characteristics; the core is the component most strongly influenced by the natural environment [4]. Applying Julian Steward's Cultural Ecology theory, the water infrastructure system at Óc Eo can be identified as components of the cultural core. While the network of canals serves as the primary adaptive technology for survival, the emergence of sacred water storage structures represents the refinement of secondary characteristics to reinforce urban order.

3. Results And Discussion

3.1. Óc Eo site's background

Located in the lower reaches and delta of the Mekong River, the ancient city of Óc Eo once stood on the site of the Óc Eo Plain in present-day an Giang Province. Archaeological excavations and research indicate that the ancient city of Óc Eo was not merely a simple settlement but a sophisticated urban-irrigation complex, demonstrating the planning capabilities and adaptability of ancient residents to the riverine environment. The city's geometric layout, intentionally aligned with the Lung Lớn River, was both practical and reflected the urban planners' understanding of nature.

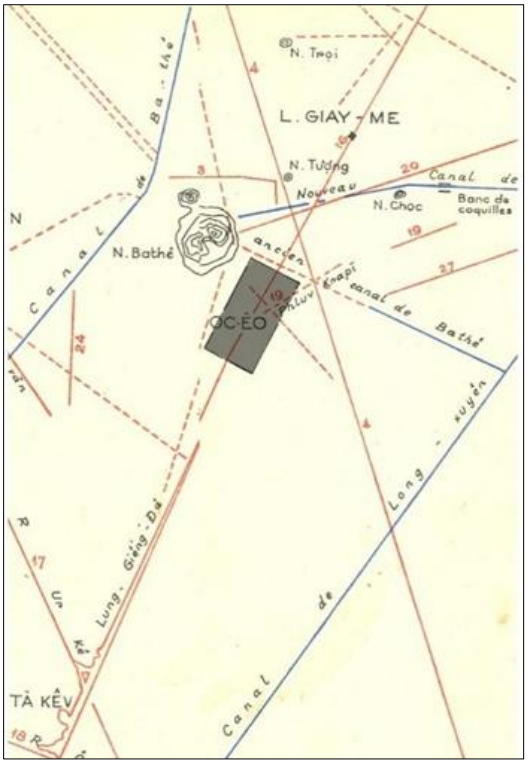

Fig 1: Canals distribution around Óc Eo Urban settlement (blacken rectangle) [2]

This city was first studied and documented by Louis Malleret in his works. According to his findings, the city had a rectangular layout, bisected by the Lung Lớn River, and was divided into distinct functional zones. Since the 1940s, through excavations and aerial surveys, L. Malleret estimated the city's area to be approximately 450 hectares, surrounded by layers of moats and ramparts. Although it was identified as early as the 20th century, it was only recently recognized as a genuine ancient city in archaeological studies. This city existed from approximately the 1st–2nd centuries CE to the 7th century CE, with some remains indicating continuity into later centuries. However, archaeological excavations suggest

that the city's peak period occurred between the 4th and 7th centuries CE.

Following L. Malleret, the war situation made research on this ancient city difficult. After 1975, Vietnamese scholars continued the study of this city. Many issues regarding this ancient city were raised and discussed; verification excavations and new discoveries have clarified the cultural context of Óc Eo in general and this city in particular. Notably, the Óc Eo Culture Research Project for the 2017–2020 period—featuring archaeological excavations, the application of multidisciplinary and interdisciplinary research, and new technologies— the results once again confirm the actual existence of the ancient city; the diverse types of archaeological sites and artifacts discovered help shed further light on the functions, chronology, and developmental trajectory of this city in relation to the Óc Eo culture and the Funan Kingdom. Within the city limits, the findings reveal various types of archaeological sites: residential sites, religious architectural sites, workshops… along with artifacts originating from outside regions such as India and China, which help demonstrate the city's extensive network of exchanges with the outside world.

3.2. Water Supply and Storage Systems in ÓcEo Culture as Documented in Historical Records

The Southern Delta is where the Óc Eo culture left its mark. Traces of human habitation have been found in this low-lying, marshy delta region since the early Common Era. Over time, they developed a vibrant way of life, and archaeological evidence has revealed a number of distinctive features. Research on the Óc Eo culture, beginning with Malleret, has suggested that it took the form of an organized state with a full set of institutions modeled after those of India [1, 2]. The presence of numerous canals clearly reflects a collective approach to action and purposeful planning… Additionally, the canal system reveals how residents adapted to an environment frequently affected by floodwaters.

Current information points to an understanding of sites such as Óc Eo, Nền Chùa, and Giồng Cát as areas with dense populations [5, 6, 2]. A common feature in the distribution of these sites is their proximity to waterways. Over 20 watercourses have been identified by L. Malleret; they form a network around the Óc Eo–Ba Thê plain and radiate out to neighboring areas (Figure 1).

Similar to the cities of Mohenjo-Daro on the Indus River and Varanasi on the Ganges River, the ancient city of Óc Eo in the Óc Eo–Ba Thê region was planned in close association with the Lung Lớn flow. During the early phase (1st–3rd centuries), numerous settlements were identified along the banks of the Lung Lớn [7, 6]. In the subsequent phase (4th–7th centuries), the urban landscape of Óc Eo was transformed by the widespread use of brick structures throughout the region. Brick architecture appeared at existing settlement sites (Óc Eo Mound, Giồng Cát Mound, Giồng Trôm Mound, and Nền Chùa) and expanded to higher-elevation areas around the foothills of Ba Thê Mountain. These structures formed complexes comprising multiple distinct structural components. Within these complexes, structures related to water storage and supply played a crucial role in the daily lives of the residents.

At Gò Cây Me (also known as Gò Sáu Thuận), at the foot of Ba Thê Mountain (located east of Linh Sơn Ancient Temple), excavations have confirmed the existence of an architectural complex featuring a gate and an access road extending all the way up the slope of Ba Thê Mountain. This architectural complex existed through several consecutive developmental phases from the 4th to the 7th centuries and continued into the 10th century [5]. In the early phase (4th–5th centuries), a combined brick-and-stone structure existed beneath the approach path. The plan was nearly square; the exterior was surrounded by stone, while at the very center of the structure was a square brick structure stacked high into a block (Figure 2). According to the excavators, the main structure served as a religious site (shrine) of the stone mound type, common in Hinduism [8]. Adjacent to the shrine, to the southwest, there is a square brick-well constructed with bricks stepped evenly inward toward the center. The well's construction date, based on charcoal samples found inside, is estimated to be from the early 5th century [9]. It is evident that both the temple and the well date to an early phase and demonstrate a close connection. It is highly likely that the water used for the temple's rituals was drawn from this well.

The Nền Chùa site (An Giang) is a major settlement within the Óc Eo culture [5, 10, 2], featuring a full range of structures from residential dwellings to religious temples [7]. Here, the residential structures along the riverbanks and their close proximity to the temple architecture present a notable connection. Although situated right next to the Lung Lớn flow, the Nền Chùa site features water features such as ponds and wells… Two rectangular ponds lie adjacent to each other, oriented in the same direction (North-East 20°–22°), with uneven areas (one pond measures 502 m², the other approximately 482 m², with an average depth of 1.15 m–1.25 m) (Figure 4). Not far from the two ponds, in a southwesterly direction, is a brick well structure with a rectangular plan (dimensions 4.4 m × 4.8 m, depth 2.2 m); the well is constructed with stepped walls receding inward, forming a funnel-shaped well shaft (Figure 5). According to the excavation team: "*These water pond and well sites are associated with religious rituals rather than daily life, and the two ponds and the well can be referred to as sacred water ponds and a sacred well*" [10]. The findings regarding the ponds and wells at Nền Chùa have revealed a new aspect of water use among the Óc Eo people, indicating that there was a clear distinction in the functions of each water source.

Fig 2: Temple architecture at Gò Cây Me. [5]

Fig 3: Square well at Gò Cây Me. [5]

Located along the western bank of Lung Lớn, Gò Giồng Cát has been confirmed through archaeological evidence to contain numerous significant structures. The main structure at Giồng Cát, situated at the very center (the highest point), has been identified as a Hindu temple featuring a construction style that combines brick and stone [11]. Adjacent to the temple structure are the following structures: Structure K (northeast corner), a square well (west-southwest corner), and a round well (south corner) (Figures 6-7). The cluster of these structures within the mound's space reflects the daily life of the contemporary inhabitants. The core element of this practice lies in the unified use and management of water resources. Here, there are two wells surrounding the temple: a square well located 8 meters southwest of the temple (with sides of nearly equal length, each 2.5 meters); and a round well situated 33.8 meters south of the temple (with a diameter of 5.9 meters). Both wells are primarily constructed of brick and incorporate other materials (wood, stone) for their underlying structures. The construction dates of the wells differ: the square well was built in the early 4th century, while the round well was built later in the 5th century [9]. What is particularly interesting is that both wells are located very close to the Lung Lớn stream (about 20–30 meters away).

Fig 4: Wells and ponds distribution at Nền Chùa [5]

Fig 5: Well at Nền Chùa [5]

The similarities in water storage and usage at the Giồng Cát, Gò Cây Me, and Nền Chùa sites reveal common features in the urban planning of the Óc Eo people. Alongside religious architecture, there were water storage and supply structures (wells, ponds), and, more significantly, a clear distinction in the functions of each type of water source. Water was stored in specialized structures (wells, ponds, reservoirs, etc.) and was integrated into the overall urban planning. The research team suggests that the wells at Óc Eo serve a role similar to the cylindrical wells at Mohenjo Daro and the stepped wells at Varanasi (stepped wells). However, the wells at Óc Eo demonstrate an influence from afar, likely resulting from the transmission of Hindu traditions rather than direct environmental conditions.

Fig 6: Trace of round well at Gò Giồng Cát [5]

Fig 7: Square well at Giồng Cát [5]

3.3. Water Management Practices in the Óc Eo City (Vietnam) in Comparison with Ancient Indian Cities

3.3.1. Methods of water exploitation by the inhabitants of Mohenjo-daro

The Harappan civilization consisted of a network of sites distributed along the Indus River basin (in present-day Pakistan) that existed between 3500 and 1800 BCE. Its peak period, around 2900–1900 BCE, marked the rise of major cities such as Harappa, Rakhigarhi, Mohenjo Daro, and Dholavira. Mohenjo Daro was built on a high mound to avoid flooding from the Indus River and was dubbed the "city of wells," with an estimated 700 wells throughout the city. The Great Bath, situated within a complex featuring structures such as a stupa, bathhouses, and a large reservoir, has led many researchers to conclude that it served a ritual purification function within Hinduism [12]. The Great Bath is the only standalone structure in Mohenjo Daro surrounded by four avenues. The entire structure is a rectangular block-oriented north-south, measuring 30x60m. At the center of this architectural complex is a large rectangular pool measuring 12x7m, 2.5m deeper than the surrounding surface [13]. The separate wells and bathing rooms reveal another aspect of water management at Mohenjo-Daro.

In larger homes, the well and shower area are typically arranged within a spacious layout alongside other functional areas, while in smaller homes, they are allocated their own separate room. This room is always located on an upper floor, with the shower area positioned against the wall adjacent to the drainage channel to facilitate water drainage. The shower area in a house is easily identifiable because it is typically lower than the floor, slopes toward the drainage area, is paved with tiles cut to uniform sizes, and is grouted with mortar to prevent water penetration; the base of the walls is also lined with an additional row of tiles to prevent water from seeping through the wall joints. Since the floor is used frequently, the tiles always have a certain degree of shine at the points of contact.

3.3.2. The City of Varanasi and Its Relationship to Water Resources

During the Aryan period (1500 BCE), Hindu legends and scriptures frequently referred to the role of water in society as well as the power of the Water God within the Hindu pantheon. From its origins in the beliefs of the Harappan people, water became deeply intertwined with the spiritual lives of the ancient Indian people through a system of religious texts. Both rivers (the Indus and the Ganges) were important and sacred, closely tied to religious activities in daily life. Varanasi is located on the west bank of the Ganges in northern India and is the confluence of the Ganges and its tributaries, the Varuna and Assi rivers. Archaeological excavations in this region indicate that the first settlements of ancient Indian inhabitants emerged around the 8th century BCE. The name Varanasi is believed to date back to the 1st century CE, referring to the city bounded by the Varuna (or Varana) River to the north and the Assi River to the south from the 1st century CE [14].

The oldest water source in Varanasi is associated with Ishana, who dug this well here as an offering to Avimukteshvara. Shiva resided in this well in liquid form to destroy ignorance and bestow wisdom upon humanity, hence it is called Jnana Vapi or Gyaan Vapi—the Well of Wisdom. This is the first and most important pilgrimage site for Hindu devotees visiting Varanasi. They drink water from this well as a vow to complete their pilgrimage, and take a second sip after the pilgrimage has ended. According to the Kashi Khanda, this water source has existed in Varanasi for a very long time, even before the Ganges River reached humanity; in fact, it appears to be an underground spring existing independently of the Ganges. Another sacred water source that has been present in Varanasi since ancient times is known as the Manikarnika Well or Chakrapushkarini. Today, the well has a rectangular floor plan and features a stepped design that tapers downward, with an area of approximately 60 square feet at the top and narrowing to about 20 square feet at the bottom [15]. The water here is believed to have been formed from the sweat of Lord Vishnu, independent of the Ganges River (which originates in the Himalayas). The footprint on the stone slab at this well is regarded as the physical manifestation of Lord Vishnu and is deeply intertwined with the region's history due to the cremation rituals of royal family members that take place beside it.

4. Conclusion

The planning and use of water resources in the ancient Óc Eo city demonstrate a harmonious balance and symbolic significance, reflected in the clear distinction between utilitarian water (Lung Lớn) and sacred water (wells associated with the temple). From an ancient urban perspective, the system of archaeological sites at Óc Eo–Ba Thê clearly demonstrates meticulous planning from the initial design phase through to the construction of architectural structures. The planning intent is exceptionally clear, as the Óc Eo city is bisected right down the middle by the Lung Lớn. It is precisely this waterway that connected numerous settlements across a vast expanse and indirectly influenced the flourishing of Óc Eo culture. Most notably, viewing the ancient city of Óc Eo as a trading port facilitating commerce highlights its dynamic nature within the cultural context. Exchange activities brought many groups of people to this region, laying the groundwork for the introduction of various technical and religious characteristics. Indeed, the influence of Indian communities is evident in the architectural structures from the Óc Eo development period (4th–7th centuries). The research team believes that the Lung Lớn served as the key link connecting Óc Eo to the outside world. In addition, the Lung Lớn flow served as a conduit for introducing new cultural and religious elements to the residents of Óc Eo. The local inhabitants adopted these new religious elements from Indian groups. History shows that Hinduism and other religions successively arrived in Óc Eo, selectively adopting features compatible with the local culture. Evidence of this selection is clearly evident in the arrangement of architectural elements within the temples. The archaeological sites of Nền Chùa, Giồng Cát, and Gò Cây Me provide clear evidence of the sacred role of water in religious practices. According to Hindu scriptures, the west is the domain of the god Varuṇa (वरुण), who symbolizes the water deity (one of the eight guardian deities of the eight directions). In the architectural layout of Hindu temples (the Óc Eo–Ba Thê region), the main temple structure is always surrounded by auxiliary structures designed to support it, where the guardian deities are arranged in a standardized manner. Hindu temples in Óc Eo culture, in addition to the

principal deities (Shiva, Brahma, Vishnu), also feature other architectural units representing the guardian deities. At the three archaeological sites (Gò Cây Me, Giồng Cát, and Nền Chùa), the presence of wells situated clearly to the west–southwest of the temple can be interpreted as a sign of the water deity Varuṇa. This implies two significant implications: on one hand, it demonstrates the influence of Hinduism within Óc Eo society; on the other, it highlights the sacred nature of water and its role in religious rituals at the temples.

It must be noted that for the residents of Óc Eo, fresh water was not a luxury; an abundant network of freshwater sources surrounded the mounds. The presence of wells right on the edge of the Lung Lớn may seem illogical at first glance, but it makes perfect sense when viewed within the context of the urban landscape. Wells were always associated with temple architecture, and although they were located near the flow of the Lung Lớn, they were always separated from this water source. In fact, the architecture of Óc Eo cultural wells in relation to the Lung Lớn waterway demonstrates a perception of water as sacred. Water from the wells was used in the temples and likely served this purpose exclusively. In contrast, the water of the Lung Lớn served the transportation of goods and connected settlements. The sacred water in Óc Eo culture was restricted in access and tied to the temple. Meanwhile, the natural water from the Lung Lớn, viewed as ordinary, reflects a communal aspect in its accessibility.

In contrast, the architectural differences reflect the varying significance of water at the sites of Mohenjo-daro and Varanasi. For the inhabitants of Mohenjo-daro, water symbolized administrative power and hygiene. The water storage system (as well as the drainage and irrigation systems) in each structure at Mohenjo Daro is considered unique and unparalleled in the ancient world [16], highlighting the importance of water to the lives of the local residents. Moreover, the city's well-organized infrastructure reveals a high degree of centralized power within the municipal government. Most notably, the political power of the ruling class was demonstrated through the construction of a massive infrastructure system and the control, management, and distribution of water from the Great Bath via an aqueduct system to the residential areas below. The people of Mohenjo-daro developed public sanitation systems as well as systems within individual households, and it is evident that bathing was an important part of their culture, gradually evolving into a systematic practice; this may have served as a precursor to the purification rituals in Hinduism later on [17]. In Varanasi, social order and the caste system are manifested through the ritual sanctification of water. In Varanasi, water is thoroughly sanctified to uphold the Varna caste system. The Brahman caste uses the sacredness of water to demonstrate their authority and enforce regulations regarding spiritual purity. Varanasi is a city closely associated with natural water sources, and the Ganges River, which flows through the city, is considered the holiest of all. The presence of this sacred water in Varanasi, dating back to before the Common Era and continuing to the present day, partly explains the enduring existence of the Varna caste system in Indian society.

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