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Dholavira's Hydraulic Mastery and Urban Design: Insights from R.S. Bisht's Excavation Reports

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"Most guides also resent that all credit for the discovery of Dholavira went to J.P. Joshi of the ASI, with no mention at all of two villagers, Shambhudan Gadhavi, master clerk and amateur geologist, and Velubha Sodha, former sarpanch, who had earlier found the site, picked out some beads and pottery shards, and sent them to the Kutch Museum in 1967….Joshi recognized the artefacts from Dholavira at once, and was immortalized by history, even before turning up on site, allege the guides."[1]

Such was the story of discovery of Dholavira, or the '*smart village*' as designated by the Gujarat government, and true to its name, this Harappan site was able to mesmerise J.P. Joshi, its alleged discoverer and then subsequently R.S. Bisht, and his team from Archaeological survey of India (ASI), when it was excavated for the first time in 1990, and continued till as recently as 2005. As asserted by Chakraborti, Dholavira along with sites of Harappa and Kunal showcase the point where the *'transformation was taking place at a certain point in the sequence related to the emergence of Indus Valley Civilization.'* (Chakrabarti, 1999: 160) However, something that caught the attention of archaeologists was that it was a city unlike any other in the Harappan world, built not along a river but in an arid wasteland. What had emerged from the dust was not just another Harappan settlement, but a 'hydraulic masterpiece'. This extensive and accomplished water management system gives Dholavira its unique place among the Indus civilization sites. (Chakrabarti, 1999: 320) Arora, in his book, *Indians: A Brief History of a Civilization,* lines out other features among Dholavira's water management system, that according to him, attempted to save every water droplet as though it was gold:

"For instance, Dholavira lay in an arid zone and, compared to northern sites, focused a lot more on water harvesting and storage; its trade and material culture was more maritime than riverine; its funerary structures took many forms and differed from other regions' Harappan sites."[2]

[1] Namit Arora, *Indians: A Brief History of a Civilization* (Gurugram: Penguin Books, 2021), 34
[2] Arora, *Indians*, 23.

The extensive archaeological excavation that enabled historians and searchers to study this marvel would not have been possible without Bisht. R.S. Bisht's excavations at Dholavira between 1990 and 2005 transformed our understanding of Harappan urban planning, water management, and socio-economic organization. His fieldwork identified seven major cultural stages, documenting both the rise and decline of the settlement. Unlike other Harappan cities, Dholavira was structured into a three-tiered layout consisting of a citadel, middle town, and lower town, each fortified with massive stone walls.

Bisht noted, "*The city was configured like a large parallelogram, boldly outlined by a massive wall, with its longer axis being east to west*" (Bisht, 1994:10). Unlike Harappa and Mohenjo-daro, where baked bricks were dominant, Dholavira's use of locally available stone ensured superior durability. A key revelation from Bisht's work was Dholavira's advanced water conservation system, which sustained life in an arid environment. He discovered 16 reservoirs, ingeniously designed to capture and store monsoon runoff. "*On a most conservative estimate, the reservoirs within the city walls covered an area of at least 17 hectares containing not less than 250,000 metric meters of water*," he remarked. (Bisht, 1994:18). Additionally, satellite imagery suggested a large buried reservoir, indicating even greater water storage capacity.

One of Bisht's most enigmatic discoveries was a ten-sign inscription of the Indus script, the longest known from civilization. He described it as "*an inscription made up of ten (not nine, as previously reported) large-sized signs of the Indus script*". (Bisht, 2000:5) The purpose of this inscription remains uncertain but suggests significant administrative or public communication. Bisht also found compelling evidence that Dholavira's decline was triggered by a major earthquake. Following this disaster, the city underwent de-urbanization, with later inhabitants resorting to crude, circular dwellings. (Bisht, 1994:8)

Dholavira's reservoirs, dams, and underground channels suggest an advanced understanding of hydraulic engineering, crucial for sustaining urban life in an environment with erratic rainfall. This paper examines how these strategies reflect the settlement's resilience and long-term planning. Furthermore, the city's imposing citadel, monumental structures, and the enigmatic ten-sign inscription hint at a well-defined socio-political hierarchy, raising questions about governance, administration, and power dynamics within Harappan society. By primarily relying on R.S. Bisht's excavation reports and engaging with secondary critiques of his

interpretations, this research seeks to explore how Dholavira's urban design and infrastructure offer deeper insights into the civilization's technological ingenuity and social organization.

Water Conservation & Hydraulic Engineering

Dholavira, located on Khadir Island in the Rann of Kachchh, presents a unique case of human settlement in an extreme environment. The climate of Kutch is harsh, with erratic monsoon rainfall averaging between 262 mm and 400 mm per annum, and no perennial rivers or lakes to support sustained human habitation (Bisht, 2000:40). Additionally, the groundwater in most parts of Kutch is brackish or saline, making it unsuitable for direct consumption or irrigation (Chitalwala, 1988:341). The ephemeral nature of Kutch's rivers, which flow only during the monsoon, posed a major challenge to water availability throughout the year (Bisht, 2000:42). Due to these conditions, Kutch has historically not been suitable for large-scale agriculture, and in many instances, its inhabitants have relied on seasonal migration and livestock farming to sustain themselves (Bisht, 1988:266).

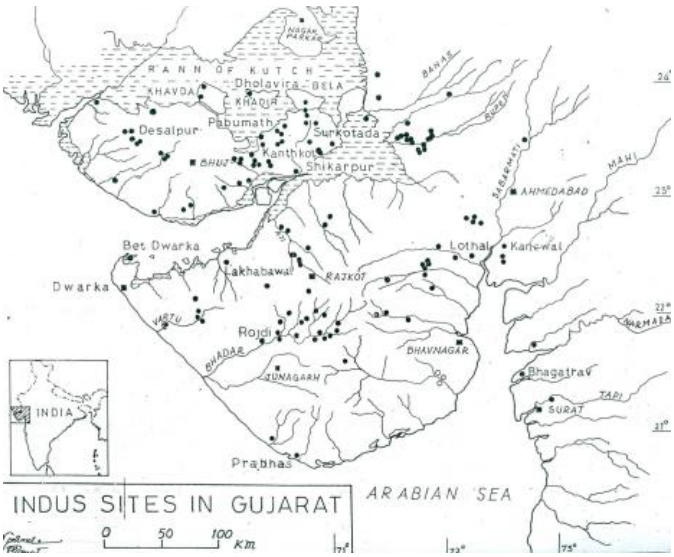

***Fig 1**: Map showing indus sites located in Kutch, Gujrat*[3]

Despite these challenges, Harappan settlers transformed Kutch into a major urban center, demonstrating extraordinary adaptation to the region's semi-arid conditions. Unlike the river-fed civilizations of the Indus Valley, the Harappans in Kutch could not depend on annual flooding to replenish agricultural lands (Chitalwala, 1988:341). Scholars suggest that their

[3] Illustration Figure 1, '*Map showing Indus sites in Gujarat"*', Bisht, R.S., *The Harappan Colonisation of the Kutch: An Ergonomic Study with Reference to Dholavira and Surkotada*. 10

survival in this region was made possible by a highly sophisticated water conservation system, which collected and stored rainwater through a series of reservoirs, dams, and channels (Gaur et al., 2013:1485). These water management techniques ensured a continuous supply of water, even in years of poor monsoon rainfall, allowing the city to support a large and complex population over a millennium (Bisht, 2000:45).

Geological and archaeological evidence indicates that the Rann of Kachchh may have been a navigable waterbody during the Harappan period, which would have facilitated trade and connectivity (Gaur et al., 2013:1486). Some scholars propose that a palaeo-river system once connected the region to the Indus Delta, offering a crucial water source for settlements like Dholavira (Chitalwala, 1988:342). However, the gradual aridification of Kutch over millennia, coupled with tectonic activity, may have contributed to the decline of water availability, making Dholavira's hydraulic engineering even more essential for survival (Gaur et al., 2013:1488).

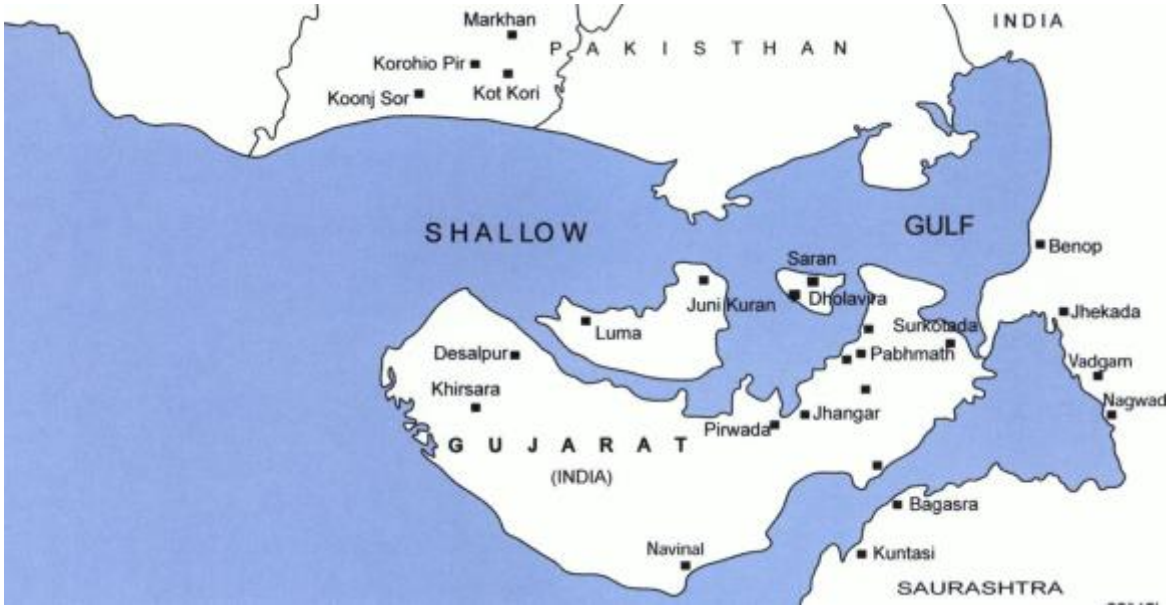

Fig. 2: *Proposed Map of how Kutch would have been in 3000 BC.*[4]

The Harappans' extensive investment in water storage infrastructure suggests that they were fully aware of the region's climatic vulnerabilities. Unlike other Harappan cities like Mohenjo-daro, which relied on well-based systems, or Lothal, which managed tidal inflows for its

[4] Figure 2., '*Proposed Map of Rann of Kutch during the 3rd Millenium BC*.', Gaur, A. S., K. H. Vora, Sundaresh, R. Mani Murali, and S. Jayakumar. "*Was The Rann of Kachchh Navigable During the Harappan Times (Mid-Holocene)? An Archaeological Perspective.*", 2013. 5

dockyard, Dholavira depended on massive reservoirs and a gradient-based drainage system to capture and store rainwater efficiently. (Bisht, 1994:40) This unique approach to water management highlights the ingenuity and resilience of the Harappans in adapting to an inhospitable environment. (Chitalwala, 1988:341)

While some researchers argue that the climate of Kutch may have been wetter during the Harappan period, others suggest that aridity was already an established feature by 3000 BCE (Bisht, 2000:47). Palaeoenvironmental studies indicate that if the monsoon shifted westward even slightly, Kutch could have experienced significantly higher rainfall, creating conditions more conducive to settlement (Chitalwala, 1988:342). However, even if conditions were more favorable in the past, the absence of a perennial river system meant that water conservation was always a priority for the inhabitants of Dholavira (Bisht, 1994:50).

Dholavira's water conservation system is one of the most advanced examples of hydraulic engineering from the Harappan civilization. The city's inhabitants developed a complex network of 16 reservoirs, carefully designed and strategically placed to ensure maximum rainwater harvesting and storage. The reservoirs occupied approximately 10 hectares, or 20% of the city's total area, and were integrated within the fortifications, making water management a core aspect of urban planning (Bisht, 2000:40). "*The Harappans created within the city walls sixteen or more reservoirs of varying size, shape, and depth*," demonstrating an "*amazing efficiency in water harvesting and management*" (Bisht, 2000:41).

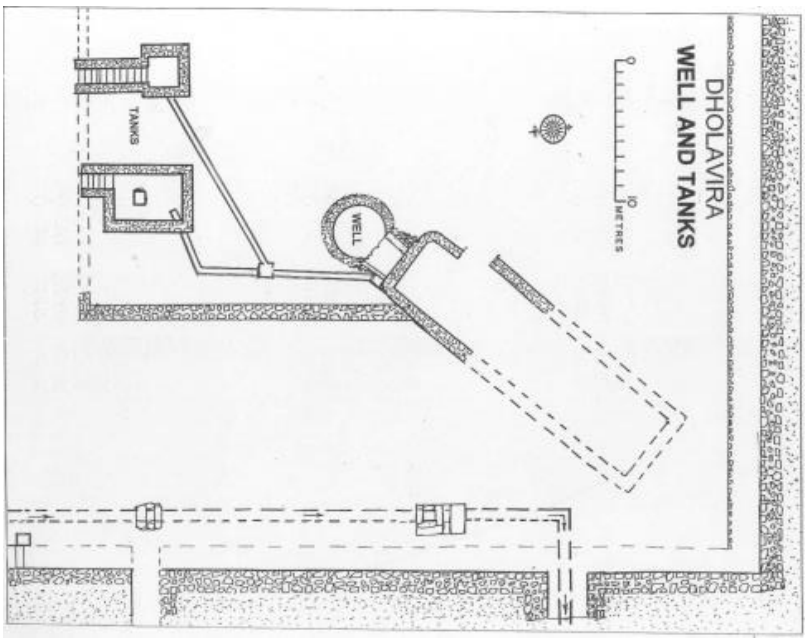

Fig. 3: *Plan of tanks and well in the castle, Dholavira*[5]

The city's gradient-based drainage system utilized the 13-meter natural slope between its higher northeast and lower southwest sections, allowing for a cascade-style arrangement of reservoirs (Bisht, 2000:42). The reservoirs were separated by strong bunds made of earth and stone, which prevented uncontrolled water flow while also serving as pathways for movement within the city (Bisht, 2000:45). The largest reservoir, measuring 73.5m in length and 29.3m in width, was positioned near the citadel and was accessed through three staircases, ensuring easy water retrieval at different levels during dry periods (Bisht, 2000:46). "*These reservoirs were not just passive storage tanks but actively regulated water flow*," allowing Dholavira's inhabitants to store excess water during the monsoon and release it gradually as needed (Bisht, 2000:47).

Beyond reservoirs, Dholavira's stormwater management system efficiently directed rainfall and runoff toward storage tanks. Rainwater from buildings and streets was funneled through an intricate network of stone-lined drains, preventing wastage and ensuring that every drop was captured (Bisht, 1994:45). Additionally, the city's two primary water channels, the Manhar and Mansar, were dammed at strategic locations to divert water into reservoirs (Bisht, 1994:43). "*The Manhar has provided evidence of three and the Mansar of two dams raised across their beds*," indicating the Harappans' ability to control seasonal floods and utilize water to its maximum potential (Bisht, 2000:48).

Unlike other Harappan cities, which relied on different water management strategies, Dholavira's reservoir-based model was unique. In Mohenjo-daro, for example, water supply was largely dependent on hundreds of private and public wells, supplemented by an advanced drainage system (Bisht, 1994:40). In contrast, Dholavira's design prioritized collective water conservation, with large reservoirs ensuring equitable distribution among its inhabitants (Bisht, 2000:47). Meanwhile, Lothal's dockyard featured tidal inflow regulation, designed for maritime trade rather than long-term storage, highlighting the distinct environmental adaptations seen in different Harappan sites (Bisht, 2000:49). "*The Harappans were not bound by a single approach to water management but adapted their engineering solutions to suit the*

[5] Fig. 6.32, '*Plan of the tanks and well along with drains, castle, Dholavira*', Bisht, R.S., Excavations at Dholavira (1990–2005): An Archaeological Report.2015., 144

local environment," making each site a reflection of its unique geographic constraints. (Bisht, 2000:50)

Dholavira's sophisticated water conservation system, with its extensive reservoir network, embankments, and stormwater management structures, suggests a high degree of centralized planning and control. The scale, complexity, and integration of hydraulic infrastructure into the city's urban fabric indicate that water management was likely overseen by a centralized authority, rather than being purely a decentralized, community-managed effort (Bisht, 2000:45). The presence of monumental structures, such as the citadel and large reservoirs, implies that an elite ruling or administrative class played a role in organizing labor and maintaining these water systems (Bisht, 2000:47).

Evidence from the site suggests that the construction and maintenance of water structures required significant resources, specialized knowledge, and labor mobilization, which points toward an organized administrative system (Bisht, 2000:50). The city's reservoir-centric model meant that water collection and distribution had to be carefully coordinated, ensuring fair access while preventing disputes over this crucial resource. The integration of public pathways along reservoir embankments further suggests that access may have been regulated and supervised (Bisht, 1994:45).

However, some scholars propose that while initial construction and planning may have been state-driven, daily operations and maintenance could have involved community participation (Bisht, 2000:48). The large-scale infrastructure may have been built by a centralized governing body, but upkeep and usage may have relied on collective, localized efforts, similar to traditional water-sharing systems in arid regions (Gaur et al., 2013:1487).

Urban Planning

Dholavira's layout represents one of the most meticulously planned urban structures of the Harappan civilization, featuring a three-tiered division consisting of the citadel, middle town, and lower town. The entire city was enclosed within a fortified parallelogram, with its longer axis running east to west. The strategic placement of these divisions within the city suggests a clear hierarchical organization, both in terms of administrative control and social stratification (Bisht, 1999:400).

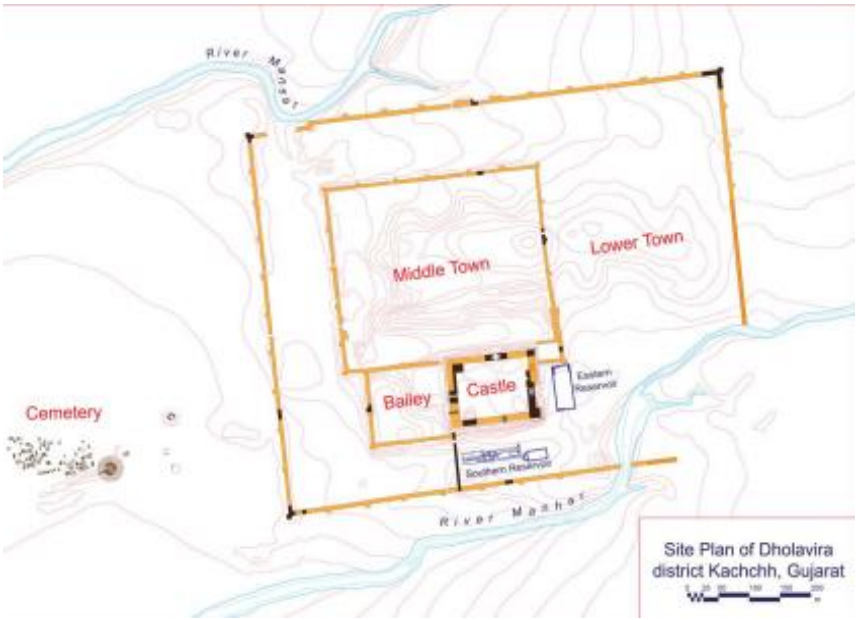

Fig. 4: *Site Division of Dholavira*[6]

At the heart of the city lay the citadel, which was further subdivided into two sections: the castle on the east and the bailey on the west. The castle was the most fortified structure in Dholavira, with massive walls up to 15 meters thick, suggesting it housed the elite or ruling authority (Bisht, 2000:45). The bailey, while still fortified, was lower in elevation and enclosed by comparatively thinner walls, indicating that it may have served as the residence for high-ranking officials or administrators (Bisht, 1999:400). The citadel also contained gateways with guardrooms, towers, and bastions, reinforcing its strategic and administrative importance. "*The towering 'castle' stands majestically in fair insulation and is splendidly defended by double ramparts.*" (Bisht, 2000:47)

Directly north of the citadel lay the middle town, a well-planned area that included broad streets, planned housing clusters, and public spaces (Bisht, 2000:46). This section of the city was fortified with its own defensive walls, albeit less massive than those of the citadel. Archaeological evidence indicates that the middle town featured a grid-like street pattern, with an east-west arterial road dividing the settlement into smaller blocks. The structures here were more standardized, suggesting that this section housed the merchant and artisan classes (Bisht, 1999:401). "The middle town contained a series of well-aligned streets, with houses laid out in an orderly fashion, indicating a planned settlement" (Bisht, 2000:49).

[6] Fig. 4.7, '*Site plan showing the city planning and layout of the prominent divisions of Dholavira*,' Bisht, R.S., Excavations at Dholavira (1990–2005): An Archaeological Report.2015., 93

The lower town, located in the eastern part of the city, was the largest residential section and contained densely packed structures, likely housing the laboring population (Bisht, 2000:50). Unlike the citadel and middle town, the lower town did not have its own separate fortifications but was enclosed within the broader peripheral walls of the city. This suggests that while it was an integral part of the settlement, it was less strategically significant in terms of defense. The architectural layout indicates that this area was likely home to skilled laborers, craftsmen, and lower-ranking officials, providing essential services to the rest of the city (Bisht, 2000:52).

The use of construction materials varied across different sections of the city, reflecting both functional and socio-political considerations. The citadel, being the most fortified and strategically important section, was predominantly built using stone masonry, a material that provided superior durability (Bisht, 2000:54). "Unlike Harappa and Mohenjo-daro, where baked bricks were widely used, Dholavira's reliance on locally available stone ensured that its structures withstood the test of time" (Bisht, 2000:54). The middle town also utilized stone for public buildings, while private residences incorporated a mix of stone and mudbrick. In contrast, the lower town was primarily constructed with mudbrick, suggesting a lower status and fewer resources allocated to its development (Bisht, 2000:55).

The city's planning and architectural execution highlight an advanced understanding of geometry and proportionality. Studies indicate that the dimensions of Dholavira’s enclosures followed precise ratios, suggesting that Harappan architects employed a standardized system of measurements (Bisht, 2000:56). "Dholavira’s plan was not arbitrary but followed a well-thought-out proportional system, with key structures adhering to a consistent modular framework" (Bisht, 2000:58). This careful planning, combined with its elaborate water conservation system, reinforces the notion that Dholavira was a highly organized and efficiently governed city, capable of sustaining a large population in a semi-arid environment.

Michel Danino draws connections between Dholavira’s town planning and ancient Indian religious and architectural traditions. He discusses the use of proportions and geometric principles found in Hindu architectural texts. For instance, he notes that the Manasara, a treatise on Hindu architecture, prescribes ratios such as 5:4, 3:2, and 7:4, which are found in Dholavira's layout (Danino, 2008: 21). Danino also suggests that Dholavira’s use of recursive geometry, where proportions repeat across different city divisions, is reminiscent of sacred architectural traditions in India, such as temple layouts that follow similar proportional systems (Danino, 2008: 21). He further highlights that the Harappan use of a decimal system in weights and

measures aligns with later Indian mathematical traditions, reinforcing a continuum between Harappan and post-Vedic urban planning (Danino, 2008: 21)

The urban layout of Dholavira was distinct compared to other major Harappan cities like Mohenjo-daro and Lothal. While Mohenjo-daro featured a dual division of an acropolis and lower town, Dholavira's three-tiered model suggests a more complex social hierarchy (Bisht, 2000:60). Additionally, whereas Lothal was designed with maritime trade in mind, featuring a large dockyard and tidal control mechanisms, Dholavira's focus was on internal water conservation, with its network of reservoirs and drainage systems playing a central role in sustaining its urban life (Bisht, 2000:62).

Political Organization

The castle complex at Dholavira, situated within the fortified citadel suggesting it housed an administrative or religious elite. The structure was heavily fortified with thick stone walls, distinguishing it from other sections of the city. Its location at the highest point provided both visibility and security, reinforcing its status as a seat of governance or ritual center. The presence of large halls, pillared chambers, and elaborate gateways suggests that the space could have functioned as an assembly hall or administrative headquarters. Some scholars argue that certain structures within the castle, such as raised platforms and water channels, indicate possible ritualistic or ceremonial usage, akin to later Indic temple traditions (Bisht, 2000:50). It is possible that the organization of the pre-dholavira levels were done away with to make space for the new one, as mentioned by Bisht in this report when referring to the transition of Stage III to Stage IV in Dholavira, with the latter depicting the mature harappan level at the site.

"There is a great variety of fabrics, forms and painted motifs. Besides the fabric, forms and painting traditions of Stage III also persists alongside. The use of coloured clays, white, off-white, pink, deep pink, plastering of structures and flooring of houses, was almost like signature phenomenon, but, as soon as Harappans arrived, the use of these coloured clays was totally done away with. This phenomenon leads to believe as if there was a change in power structure, i.e. political authority with a different ideological orientation."[7]

[7] Bisht, R.S., Excavations at Dholavira (1990–2005): An Archaeological Report. 2015. 100

A unique and remarkable discovery at Dholavira is the large Indus script signboard, which remains one of the longest inscriptions in the Indus Valley civilization. This ten-sign inscription, composed of large-sized Indus characters, was strategically placed above the northern gateway of the citadel, indicating that it was intended for public visibility (Bisht, 2000:49). "*This inscription is the longest known Indus text and is composed of large-sized signs, possibly serving as an emblem of authority or a public message.*" (Bisht, 2000:51). Some scholars speculate that similar signboards might have existed in other Harappan cities, but their remains have not survived due to the perishable nature of materials like wood. The survival of Dholavira's signboard is considered a rare stroke of luck, as the material used for the inscriptions—white crystalline stone—helped preserve it over time (McIntosh, 2008: 359). McIntosh suggests that its placement at a major entrance to the city's elite area indicates an ideological or ritual function, marking a boundary between the ruling administrative space and the outer settlement (McIntosh, 2008: 359).

R.S. Bisht also argues that the diversity in funerary architecture at Dholavira reflects a complex and stratified social structure. The presence of elaborate memorial structures, cenotaphs, and tumuli suggests differentiation in status and authority, with more prominent and resource-intensive burials likely belonging to the elite or ruling class (Bisht, 2005: 252) Bisht further emphasizes that Dholavira's funerary practices suggest a non-centralized form of political organization, possibly governed by local elites rather than a singular monarch. The presence of a necropolis with large and highly symbolic structures, such as Tumulus-1, which contained valuable offerings like gold bangles and a complete necklace of steatite beads, indicates that high-ranking individuals or leaders were honored in death with significant architectural investment (Bisht, 2005: 280)

Moreover, the orientation and placement of these burials hint at ritualistic and ideological considerations, reinforcing the role of the elite in maintaining social and religious order. Bisht notes that "*the monumental tumuli surrounding an ancient reservoir suggest that the ruling elites had both economic and ritual authority over the city*," further pointing to a leadership structure where power was legitimized through religious symbolism and public display (Bisht, 2005: 276). The presence of simpler memorials and inhumations in contrast to these grand structures suggests a hierarchical distinction in burial customs. Bisht argues that this disparity reflects social stratification, where different classes within the city had varying levels of access to resources even in death (Bisht, 2005: 268)

Decline

Stage V out of seven identified cultural layers of Dholavira has been associated with a general decline in maintenance of the city, whereas previous stage items like pottery, seals, and weights remained in use with minor ceramic changes. Local wares showed pyrotechnological deficiencies, making them brittle. Architectural repairs were poorly executed, reflecting a brief occupation. An earthquake ended this phase, but financial decline was evident earlier as flood-damaged water structures were never restored due to resource scarcity. The site was temporarily deserted before Stage VI began. Bisht hence supports the climate-change explanation, noting that Dholavira's elaborate water conservation system, including massive reservoirs and channels, was no longer sufficient as rainfall decreased significantly. A study on oxygen isotope records suggests that Dholavira was initially supported by a humid fluvial landscape, but "a catastrophic drought drove the final collapse of the settlement at the onset of the Meghalayan Stage" (Sengupta et al., 2019: 1)

Apart from climate change, scholars argue that economic decline played a significant role in the fall of Dholavira. Y. M. Chitalwala argues that Harappan settlements, including Dholavira, were economically interdependent with coastal and riverine trade networks. As trade declined due to environmental changes, urban centers struggled to sustain themselves. He suggests that "*Dholavira, like other major Harappan settlements, occupied nodal points in an extensive trading network, and its decline was linked to the disruption of these networks.*" (Chitalwala, 1988-89: 341)

The Rann of Kachchh, which once facilitated navigation and trade, became increasingly inhospitable due to changing sea levels and sedimentation. Gaur et al. propose that "*the decline of Dholavira may be linked to the loss of navigable routes, which previously allowed trade with regions such as Mesopotamia and the Persian Gulf.*" (Gaur et al., 2013: 1485) The final phase of Dholavira saw a drastic decline in population, with archaeological evidence indicating a shift from urban living to rural or nomadic lifestyles.

Conclusion

Interpretations of Dholavira's political organization vary due to the absence of deciphered records, relying instead on material evidence and settlement patterns. McIntosh identifies a lack of conventional state features, suggesting a decentralized system where cities functioned as administrative and economic centers rather than political capitals (McIntosh, 2008: 256,

261), while Bisht points to bureaucratic structure as evidence of administrative oversight (Bisht, 1994: 119). Ratnagar argues for an economy-driven model of governance, where trade networks, rather than military control, structured power (Ratnagar, 1991). The available evidence indicates that Dholavira operated within a complex administrative framework which still requires an extensive study to reach to a concrete conclusion regarding Dholavira in particular and Harappan civilization in general.

References

Arora, Namit. *Indians: A Brief History of a Civilization.* Gurugram: Penguin Books, 2021.

Bisht, R. S. *A New Model of Harappan Town Planning as Revealed at Dholavira in Kutch.* Accessed February 1, 2025. https://www.academia.edu/10188007.

———. *Dholavira Excavations 1990-1994.* Accessed February 3, 2025. https://www.academia.edu/10187605.

———. *Dholavira: New Horizons of the Indus Civilization.* Accessed February 8, 2025. https://www.academia.edu/10187616.

———. *Excavations at Dholavira (1990–2005): An Archaeological Report.* New Delhi: Archaeological Survey of India, 2015.

———. *How the Harappans Honoured Death at Dholavira.* Accessed January 27, 2025. https://www.academia.edu/10187944.

———. *Paradigms of Harappan Hydraulic Engineering at Dholavira.* Accessed February 6, 2025. https://www.academia.edu/10187799.

———. *Recently Excavated Site: Dholavira.* Accessed February 9, 2025. https://www.academia.edu/10188186.

———. *The Harappan Colonisation of the Kutch: An Ergonomic Study with Reference to Dholavira and Surkotada.* Accessed January 31, 2025. https://www.academia.edu/10187778.

———. *The Harappan Water Structures at Dholavira.* Accessed February 11, 2025. https://www.academia.edu/10187827.

———. *The Water Structures and Engineering of the Harappans at Dholavira, India.* Accessed February 4, 2025. https://www.academia.edu/10188795.

———. *Urban Planning at Dholavira: A Harappan City.* Accessed January 29, 2025. https://www.academia.edu/10188608.

Chakrabarti, Dilip K. *India: An Archaeological History.* Oxford: Oxford University Press, 1999.

Chitalwala, Y. M. "Harappan Settlements in Kutch and Saurashtra: Problems and Perspectives." *Bulletin of the Deccan College Post-Graduate and Research Institute* 47–48 (1988): 341–52. Vice Chancellor, Deccan College Post-Graduate and Research Institute (Deemed University), Pune. https://www.jstor.org/stable/42930238.

Danino, Michel, and Indian Institute of Technology Gandhinagar. "New Insights Into Harappan Town-Planning, Proportions and Units, With Special Reference to Dholavira." *Man and Environment* 33, no. 1 (2008): 66–78.

Gaur, A. S., K. H. Vora, Sundaresh, R. Mani Murali, and S. Jayakumar. "Was The Rann of Kachchh Navigable During the Harappan Times (Mid-Holocene)? An Archaeological Perspective." *Current Science* 105, no. 11 (December 10, 2013): 1510–16. https://www.jstor.org/stable/24098848.

McIntosh, Jane R. *The Ancient Indus Valley: New Perspectives.* Santa Barbara, CA: ABC-CLIO, 2008.

Sengupta, Torsa, Arati Deshpande Mukherjee, Ravi Bhushan, F. Ram, M. K. Bera, Harsh Raj, Ankur J. Dabhi, et al. "Did The Harappan Settlement of Dholavira (India) Collapse During the Onset of Meghalayan Stage Drought?" *Journal of Quaternary Science* 35, no. 3 (December 26, 2019): 382–95. https://doi.org/10.1002/jqs.3178.