

Ancient shorelines of Gujarat, India, during the Indus civilization (Late Mid-Holocene): A study based on archaeological evidences

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Changes in the shoreline at any point could be due to various reasons such as tectonic disturbance or shift in sedimentological regime causing erosion or deposition. Many scientific investigations, focusing on the palaeo-shoreline vis-à-vis sea level fluctuations in India based on numerous geological techniques, have indicated that at about 6000 BP, the sea level was approximately 6 m higher than at present and about 4000 years BP it stabilized at the present one with minor fluctuations.

We use archaeological data suggesting maritime practices, as an indication for palaeo-shoreline of Gujarat. Examples from archaeological sites belonging to the Harappan period such as Lothal, Padri, Bet Dwarka and others have been cited to indicate shoreline movement in relation to the last 4500 years. Excavations at Lothal have brought to light a Persian Gulf seal, terracotta models of African mummy, guerrilla and boat model, demonstrating the maritime practices and relations with Mesopotamia and Egypt between 5000 and 4000 years BP. There is a massive brick structure identified as dockyard, and some stone anchors found in the vicinity suggesting that Lothal, was an important maritime Harappan trading centre. Lothal, therefore, can be considered a clear evidence of offshoreward movement of shoreline. Indications from other archaeological sites are also discussed to configure shoreline movements during the last 4000 years or so.

The study of former shorelines is of considerable importance to a variety of disciplines. The changes in shoreline directly affect the dawn and devolution of civilization along the coast. Archaeologists have long been aware that in the past the coastline had been a focus for man's activities and thus archaeological sites can be one of the most promising indicators of former shorelines, particularly of the late Quaternary period. Several submerged prehistoric sites off the coastline of France¹, California², Israel³ and Greece⁴ have been useful in tracing the shoreline. In India, particularly on the Tamil Nadu coast, several Palaeolithic sites are situated on the terraces at 73 m, 45 m, 30 m and 17 m above MSL formed by fluctuations of the sea-level⁵. Early Palaeolithic tools were found at 45 and 30 m while middle Palaeolithic tools were noticed on 17 m terrace. Several Mesolithic and Neolithic sites are located along the coastal belt of India and there are ample evidences of the exploitation of marine resources. Similarly, Gujarat on the west coast of India has several sites which witnessed extensive maritime activity during the Harappan period (3000–1500 BC). There are several direct and indirect references in Ancient Indian literature about the behaviour of shoreline which significantly affected the coastal human settlement.

It is now generally agreed that glacio-eustatic sea-level stood higher than the present in and around 6000 years BP^{6–8}. During the mid-Holocene, the Indian Ocean witnessed the rise of three major civilizations of the world namely, Mesopotamian, Egyptian and Indus Valley. One of them emerged in the Indus–Saraswati Valley (popularly known as the Harappan civilization) and developed full scale. Archaeological evidences such as

settlements on the islands and exploitation of marine resources from Kachchh suggest that the maritime activities began a little earlier than the Harappan civilization. A group of people migrated from the Sind area called Amari culture, to Kachchh around 3000 BC and settled in northern Kachchh area. Several sites of Indus Valley Civilization are within 20 km from the present shoreline. These are believed to be the ancient ports or centres busy in exploiting the marine resources and clearly suggest migration of shoreline. Several studies have reported changes in sea-levels and shoreline migration with special reference to the Gujarat and Maharashtra coasts⁹⁻¹², and suggested a sea-level during mid-Holocene period between 2 and 6 m which is higher than the present. Much of the evidence has been based on ¹⁴C dating and morphological features and lithologies. The present study is an attempt to trace the ancient shoreline of Gujarat, using archaeological sites as the indicator of past shoreline. The archaeological data have also been corroborated with sea-level changes, sedimentation and tectonic activity from the Gujarat coast.

A few archaeological sites showing direct or indirect connection with shorelines have been selected and examined in detail with respect to the present shoreline. Explorations in Okhamandal were undertaken to collect information on the submergence of Bet Dwarka island. A few sites were located in intertidal zone. Apart from Okhamandal a few other Harappan period sites on Gujarat coast have also been selected (Figure 1) which show evidence of port installation, exploitation of marine resources like conch shells, marine fishes or production of salt, etc. as indicators of palaeo-shorelines. As of today, these sites are located away from the present shoreline.

Lothal, believed to be the oldest dockyard in the world, is located at the head of the Gulf of Khambhat, now situated about 23 km away from the shoreline and about 12 m above the mean sea-level, on the left bank of river Bhogawa. The discovery of Persian Gulf seal¹³, terracotta models of African mummy, guerrilla, and boat model clearly demonstrate Lothal's maritime connection and its relation with Mesopotamia and Egypt. A massive brick structure measuring 213 m × 36 m at Lothal is identified as a dockyard and some stone anchors in the vicinity suggest that Lothal was an important maritime trading centre. Moreover there are evidences of marine salinity in the soil of the tank¹⁴. Boats might have been reaching the dockyard through a channel of the river Bhogawa and Lothal must have been one of the major Harappan trading centres. Lothal thus provides a clear evidence of southward shifting of shoreline by about 23 km. A recent study¹⁵ in the valley of Mahi river suggests that seismic events had taken place between 3320 ± 90 and 2850 ± 90 year BP which may have played a major role in the evolution of the Mahi Basin in particular and Gujarat alluvial plains in general.

Padri is another recently excavated site by the Deccan College, Pune. It is located in the Gulf of Khambhat about 60 km south of the Bhavnagar port and just 1 km away from the shoreline. According to the excavating team, the site belongs to a fairly mature Harappan period, datable to 2200 BC¹⁶. There are numerous evidences of exploitation of marine resources at this site. One of the major findings is a large Harappan copper fish hook, which is 14 cm long with barbed point and loop on the other end¹⁷ and weighs 45 g. It is in a very good state of preservation. Such large fish-hooks were probably used to catch large marine fish weighing more than 50 kg. This indicates that the Harappans of Padri had perhaps mastered the technique of deep sea fishing. It is logical to presume that, for

this purpose, they also used a big boat. The excavator of Padri site also inferred that the people there were producing salt and supplying it to the surrounding Harappan settlements¹⁸.

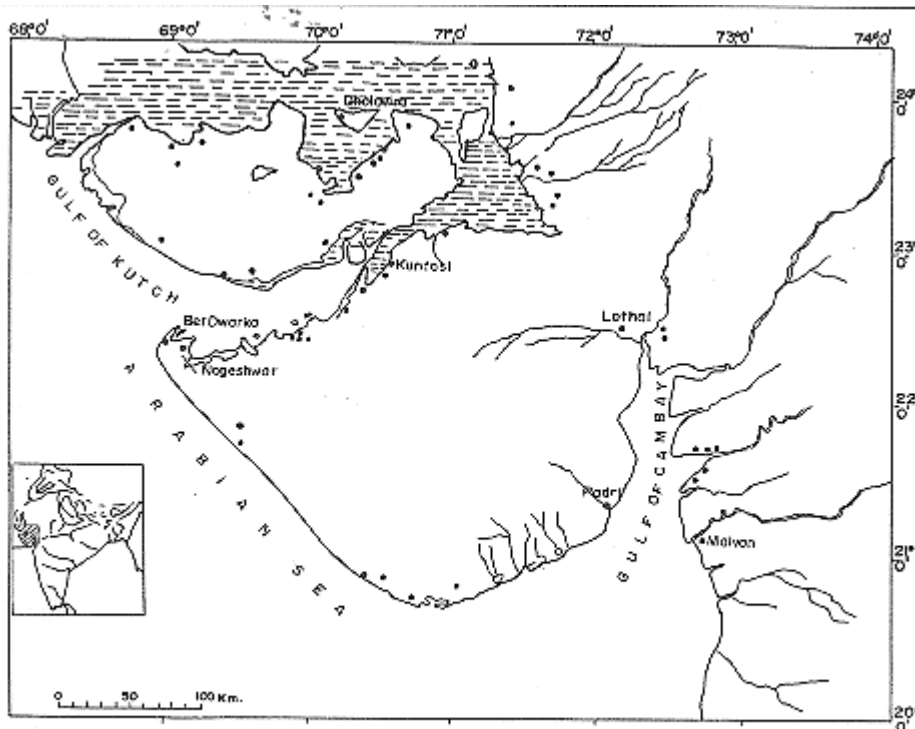


Figure 1. Harappan and Late Harappan coastal sites in Gujarat.

Dholavira is yet another Harappan site located in the Great Rann of Kachchh on a Khadir Bet. At present the Rann is a dry area but during good monsoon it gets flooded. Dholavira is supposed to have witnessed the earliest habitation of protohistoric period in Gujarat. Excavation has revealed a long cultural sequence which commences from the beginning of the third millennium BC, when perhaps a group of people from Makran coast arrived on the island through Kori creek. This assumption is based on the ceramic feature resembling those from the Amerian culture (datable to 3000 BC). Similar pottery has also been reported from other Harappan sites of Kachchh. The base of Rann of Kachchh might have been under 10 m deep water for 3000 years¹⁹ and the Khadir Bet could have served as an island in the shallow sea. It is not clear why people settled on an island rather than on the mainland, where agriculture and other commodities, including marine resources could be better exploited. The inference is that Dholavira was an active port and the Harappans must have found that this port was a safe harbour for anchoring boats. The long habitation history of the area highlights the importance of the location and of maritime activities. The location of the site seems to be favourable even for riverine navigation, in case one is not inclined to consider this a port site.

Kuntasi is another site locally known as *Bibino Timbo* located about 3 km south-east of the Kuntasi village. It is about 5 km inlandward from the present shoreline. A large stone structure measuring 9.5 m × 4.1 m outside the fortification, according to Dhavalikar *et al.*²⁰ was used as landing platform for going down to the creek for loading-unloading cargo in boats. They further suggested that it was not an agricultural settlement but was a

centre for acquiring and processing raw materials for manufacturing articles for export. Discovery of two cylindrical stone anchors with tapering sides, and large holes bored vertically throughout the length and the overall geomorphology of the area corroborate that Kuntasi could have been a port situated at the creek mouth during the Harappan period.



Figure 3. An early historical site on the western coast of Bet Dwarka island, exposed during low tide (scale: 50 cm with 10 cm division).

Table 1. A few ^{14}C dates from Saurashtra coast of Gujarat²⁶

Site	District	Material	Sample	Dates (years BP)	Height from highwater line (m)
Bhimrana	Saurashtra	Shells	TF-908	5430 ± 100	+ 1
Salaya	-do-	Coral	TF-911	5220 ± 105	+ 4
Warawala	-do-	-do-	TF-1014	6185 ± 115	+ 4.2
Warawala	-do-	-do-	TF-1015	4575 ± 105	+ 4.5
Gadhula	-do-	Shell	TF-1044	6670 ± 280	+ 1.0
Rahalmata	-do-	-do-	TF-1045	6320 ± 270	+ 2.8
Mangral	-do-	-do-	TF-1051	4700 ± 245	+ 3.0
Sil	-do-	-do-	TF-1052	5820 ± 300	+ 1.9

Table 2. Details of a few important archaeological sites along the coastal belt of Gujarat

Site	District	Distance from shoreline	Direction from shore line	Elevation	Remark
Lothal	Ahmedabad	26 km	North	12 m	Dockyard was found
Padri	Bhavnagar	1 km	North	At present MSL	Centre of salt production
Kuntasi	Rajkot	5 km	South		Jetty was found
Dholavira	Kachchh	1 km	East		One of the biggest sites in India
Shikarpur	-do-	3 km	North		Located near Gandhidham
Bet Dwarka	Jamnagar	Harappan artifacts are lying in intertidal zone	South and west coast of the island	1 m	At least three small sites were found near the shoreline
Bhagatrav	Bharuch	1.5 km	East	2 m	Small late Harappan site
Nageswar	Jamnagar	4 km	East		Shell industry centre
Malvan	Bharuch	1 km	East	1.5 m	Post Harappan site

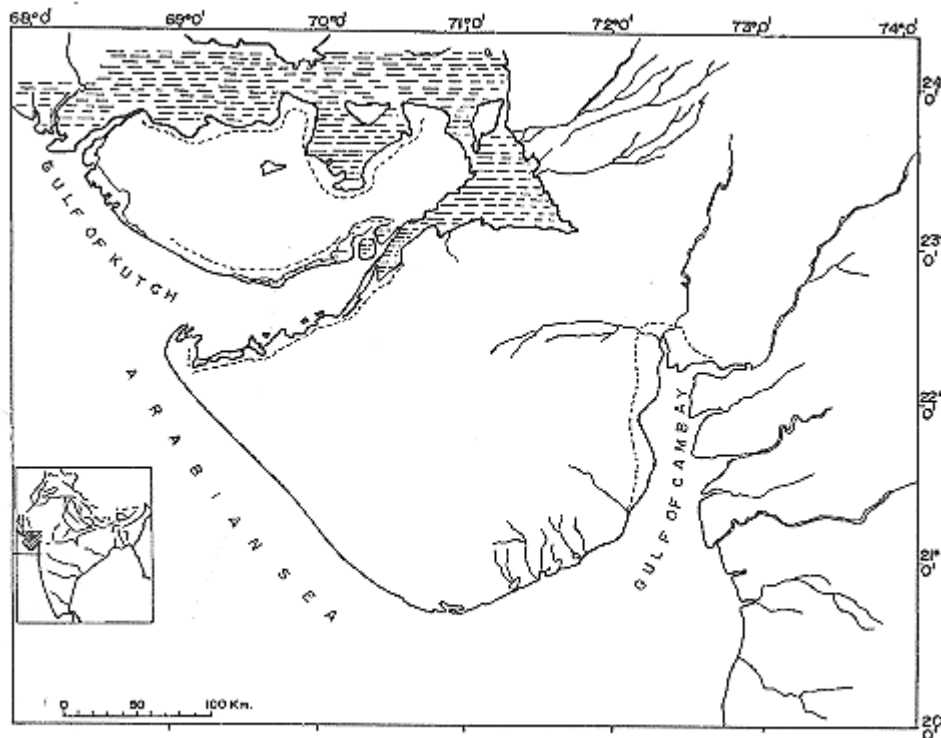


Figure 4. Proposed shorelines of Gujarat during the Indus Valley civilization.

The protohistoric site is located at Bet Dwarka, Okhamandal, Jamnagar located south-east of the island near Siddi Pir Baba²¹. Onshore explorations in and around this site since 1979 have yielded a large quantity of protohistoric pottery including perforated jar, sharp carinated dish, dish on stand and bowls. Other important findings include two inscriptions, one seal and a few chert blades. These antiquities enable us to assume that Bet Dwarka was established at the beginning of the second millennium BC. Discovery of a large number of conch shell collumela and shell bangles in the region suggests that this site was a small port during the Harappan period. It is observed that the protohistoric habitation in the cliff section of Bet Dwarka-I (Figure 2) is being destroyed by the sea. Similarly, in the past the protohistoric habitation was destroyed near Balapur BDK-VI by an advancing sea. A historical period²² site located in intertidal zone (Figure 3) gets submerged during high tide. Obviously, the shoreline has been advancing since the Harappan Period.

Excavations at Malvan in south Gujarat²³ suggest that this was a post-Harappan estuarine port, dating back to 1400 BC. The site was located on the banks of an oxbow lake formed by the Dumas branch of the Tapti river. Studies of sediment samples from this lake suggest that during the post-Harappan time tides would have been two and a half m above the dark grey clay bed. Hegde²⁴, after analysing the sediment samples, reported that during the post-glacial climatic optimum (between 5000 BP and 3000 BP) the warmest period since the ice age, the eustatic sea-level was higher than the present. It was probably during this period that barges were floated into the lake with the tide. This established the point that Malvan was a port. Since silting was sufficiently advanced and the sea-level retreated, the site could not have functioned as a port.

Shifting of shoreline due to one or other reason is not a new phenomena. Dales²⁵, who discovered a few Harappan sites along the Makran coast, believes that these sites must have served as a sea port during the third millennium BC and now these sites are located as far as 30 miles inland. These displaced ports reveal that the coastline in this part of Pakistan had risen considerably during the past 4000 years. Similarly, several workers have demonstrated that the sea-level was higher than the present around 6000 BP (4000 BC) at the Saurashtra coast^{10,26} (Table 1) as well. In view of this, it can be surmised that the above-mentioned archaeological sites on Kachchh and Saurashtra coast, which happened to be contemporary, had been connected with maritime activities, and therefore, can also be used as indicators of palaeo-shorelines for the region between 3000 BC and 1500 BC. However, it is also necessary to discuss other geological aspects connected with this.

Archaeological evidences suggest that the behaviour of shoreline was different at different places. Lothal is located about 26 km from the present shoreline and about 12 m above the MSL (Table 2). The gulf is narrow and a few major rivers debauch here such as Narmada, Tapti, Mahi, Luni, etc. Offshore currents are also responsible for depositing the sand in the Gulf, ultimately resulting in the shallowing of the Gulf. Earlier studies mentioned that the Gulf of Khambhat and the Gulf of Kachchh were connected during the early mid-Holocene period¹⁰. Bruckner²⁷ had suggested that the river-generated sediments may have played a vital role in the seaward movement of the shoreline.

The Great Rann and Little Rann are unique examples of Holocene sedimentation. The two Ranns represent filled-up gulf and mark the site of accumulation in an estuarine delta environment that was marked by a fluctuating strandline since the advent of Holocene. Gupta²⁸ mentioned that 'Holocene sediments of the Little Rann and Nal Lake were contemporaneous'. The lowermost sandy clay horizon extends from about 9000 BP to about 4200 BP overlain by the silty clay horizon dating from 4200 to 1500 BP and then again by the most recent silty clay horizon'. He further suggested that even as late as 2000 years ago, Little Rann was about 4 m deep and thus was inundated throughout the year.

Another important factor of shifting of the shoreline may be due to tectonic effect. Recent studies on sea-level changes clearly suggest that neotectonic activity had also played a vital role in sea-level fluctuations, particularly in Saurashtra and Kachchh region, during the Late Pleistocene/ Holocene. Studies on sea-level along the Mumbai coast²⁹ suggest that until 8300 BP shallow sea-level conditions prevailed on the carbonate platform located at about 80–90 m depth off Bombay. This is in contrast with the glacial eustatic sea-level position which was at about 22 m at 8300 years BP.

There are also evidences of earthquake from phase III of Dholavira in Khadir Bet of Rann of Kachchh³⁰ which may be datable to around 2200 BC. Perhaps the effect of earthquake such as collapse of houses and diversion of drainage system, and finally the uplift of Rann were responsible for the decline of Harappans at Dholavira. There are evidences of navigation in the Rann of Kachchh during the historical period. The author of *Periplus of Erythraean Sea* writes 'Beyond the river Sinthus there is another gulf, not navigable, running in towards the north; it is called Eirinon; its parts are called separately the small gulf and the great; in both parts the water is shallow, with shifting sand-banks occurring continually and a great way from shore; so that often when the shore is not

even in sight, ships run aground, and if they attempt to hold their course they are wrecked³¹.

In the case of Bet Dwarka, one can observe that archaeological material is spread all over the intertidal zone of BDK-I and II. The earliest date of Bet Dwarka could be put around the beginning of second millennium BC on the basis of archaeological findings. Remains of perforated jar, two inscriptions and one unique seal clearly indicate the settlement during the Harappan period in the area. A settlement of second century BC at Dwarka (about 15 km south of Bet Dwarka by sea route) was destroyed by the sea³², which again is an indication of sea-level rise in the past.

Archaeological sites provide evidences on shoreline fluctuation along the Gujarat coast at about 5000–4000 years BP. If a possible shoreline (Figure 4) of Harappan period is drawn touching the Harappan ports, the following conclusions can be arrived at:

(i) The evidences indicate that in the Gulf of Khambhat, a distinct shifting of shoreline offshoreward is observed. On the other hand, south and western Saurashtra coasts appear to be stable, at least for the last 4000 years. (ii) If Dholavira is established as a port by more convincing findings than what is presented here, it will have significant importance in the palaeoclimatic study as well as archaeology and anthropology of the region. It would then mean that the Great Rann was navigable during the Harappan period (4500 years BP) and its subsequent siltation may have even triggered the decline of Harappan civilization in the area. (iii) The study clearly demonstrates the use of archaeology in establishing palaeo-shoreline. While the tectono-eustasy can only indicate the possibility of occurring of an event, evidences like this clearly support it.

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