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## Maritime heritage in and around Chilika Lake, Orissa: Geological evidences for its decline

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**Chilika (also Chilka) lake is the largest brackish water body in India. Archaeological explorations and excavations around the Chilika lake region have brought to light the habitational remains of the Neolithic–Chalcolithic period onwards, datable to the 3rd millennium BC. The archaeological findings embody the fact that well-known ports of the bygone era such as Manikapatna on Chilika coast, Palur on the extreme south and Che-li-ta-lo had close contacts with Africa, Ceylon, China and Southeast Asian countries. Further, a text of the 10th century AD mentions about the maritime activities of the lake and ships, which used to ply to the Southeast Asian countries from Chilika. Similarly, Soran, Nairi, Pathara and other villages around the lake have had glorious navigational traditions. The ports located around Chilika lake had played a significant role in spreading the Indian culture to other countries. However, subsequent changes in the hydrodynamic regime caused the formation of sand bars, spits and altered sedimentation pattern, which**

**eventually caused a decline in maritime activities in the Chilika region.**

THE relationship between man and sea is as old as the evolution of culture on this earth. Since prehistoric times, man realized that waterways are the easiest and cheapest mode of transport. Centuries after, man used boats for trade and commerce, warfare, ferrying, etc. In the early historical period, India had several ports, trade centres, dockyards, wharves, lighthouses and boat-building centres all along the east and west coasts of India. However, during subsequent periods, ports and trade centres started declining and were being deserted due to various geological processes such as coastal erosion, tectonic activities, formation of sand bars and sea-level changes. On the other hand, historians believe that weak successors, weak economy and attack by neighbouring kingdoms attributed to the decline of maritime activities in Chilika. In maritime history, Orissa has played a great role since the early historical period.

In maritime trade, Kalinga (ancient Orissa) had a prominent place on the east coast of India. Kalidas has referred to the king of Kalinga as ‘Mahodadhipati’, the lord of ocean in the *Raghuvamsa*<sup>1</sup>. The *Araya Manjusri Mulakalpa*, a Mahayana text refers to the Bay of Bengal as the Kalinga Sea<sup>2</sup>. The history of Orissa is inter-twined with the Chilika lake. Earlier studies suggest that port towns around Chilika lake had established their cultural and commercial contacts with Ceylon, Java, Sumatra, Borneo, China, Rome and African countries during the early centuries of the Christian era. During the past, people from South India used to travel to Puri by ships, which were anchored in Chilika lake. The people of Orissa have been drawing inspiration from the lake and a number of local legends are associated with it.

Archaeological findings, literary sources, epigraphic evidences, art and sculptural remains of Orissa emphasize on the ports, ship-building activities and their trade and cultural contacts with other countries. Several research works have been published on the ports<sup>3,4</sup>, boat-building technology<sup>5,6</sup>, cultural contacts<sup>7,8</sup>, trade and commerce of Orissa<sup>9</sup>. However, the maritime activities of Chilika lake and causes for their decline, remain unexplored.

This communication is the outcome of explorations carried out by the National Institute of Oceanography, Goa, around Chilika and adjoining regions to trace its earliest archaeological remains in relation with human activity. Maritime traditions and their contacts with other parts of the world are also described. Taking into consideration the importance of maritime activities in the Chilika lake, a systematic onshore survey was conducted in and around Manikapatna, Palur and adjoining regions of Chilika (Figure 1). The findings of the exploration include several terracotta ringwells, pottery and stone mould at Manikapatna. The early historical and medieval sites adjoining areas of Palur, namely Bardhayakuda, Raghunathpur, Arunapur, Podaghar and Jhatipadara were also explored and the remains were studied. Factors responsible for the decline in maritime activities

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around the lake and its impact on the navigational techniques of the region are also discussed.

Chilika lake dates back to the later stages of the Pleistocene period<sup>10</sup>. It was a part of the Bay of Bengal; a shallow, brackish-water inshore lake connected to the Bay of Bengal through a narrow mouth. The lake is about 64 km long and 13.5 km wide. It extends from the southeast corner of the Khurda district into the adjoining district of Ganjam. The progression of the littoral drift formed a barrier spit near Palur and sand bar along the eastern shore; hence the lake gradually has become a shallow lagoon. The lake is separated from the Bay of Bengal through more than 8 km long tidal inlet. Chilika is hemmed between mountains and the sea. The presence of numerous shoals, sand spits, shallow depth and narrow channel through the sand bar connect the lake with the sea between Satapada. The inlet mouth of the lake considerably induces hydraulic loss and thereby reduces the tidal flow in and out of the lake. The sand ridges adjacent to the spit have been built in part by constructive waves, tidal currents, storms and wind<sup>11</sup>. Chilika lake has experienced

both submergence and emergence. The discharge of sediment by the tributaries of river Mahanadi made it shallow and subsequently it separated after the formation of the spit<sup>12</sup>.

In some places on the southwest side of the lake, a rocky projection extends up to the water edge. To the north, the lake loses itself in endless shallows, sand banks and islands peeping just above the surface, formed year by year from the silt which the rivers Daya, Bhargavi and Makra along with other tributaries of the river Mahanadi and other small streams discharge into the lake (Figure 2). A number of rocky islands of different sizes exist within the lake. There is a 10 km wide belt of lowland, consisting of a number of small islands, 3–4 m in height, which are separated by creeks. It appears that these islands originally belonged to the headlands and were subsequently detached from them by marine erosion<sup>13</sup>.

The water level in the lake fluctuates with seasons in terms of size and depth, with the intensity and duration of annual river floods, and during high and low tides. The area of the lake varies during dry weather and floods between 560 and 800 km<sup>2</sup> respectively. The average depth is from 1.5 to 2 m and scarcely exceeds 5 m, except in the southwest side of the lake. The channel entrance to the sea is narrow and its width is of the order of 150 m, which keeps the lake distinctly salty during the dry months from December to June. Once the rains set in and the rivers debouch upon its northern extremity, the seawater is gradually driven out and Chilika becomes a freshwater lake.

Excavations at Golbai on the bank of Chilika revealed two-fold habitational evidences of protohistoric period datable to the 3rd millennium BC, which includes the remains of Neolithic and Chalcolithic period. The early habitation belongs to the Neolithic period (2300–2100 BC) and includes hand-made pottery, structural remains and bone tools. Subsequent habitation belongs to the Chalcolithic period (2100–900 BC) and the remains include bone and polished stone tools, copper tools, ceramics and structures for settlements. Further findings indicate that fishing was an important aspect of livelihood, which is confirmed from the findings of fish bone, fish hook, barbed spear, harpoon and two teeth of shark from the early and middle levels (2100–1100 BC) of the Chalcolithic period<sup>14</sup>.

The 10th century AD text, the *Brahmanda Purana*, describes that the Chilika lake itself was an important centre of trade and commerce. Ships having a number of masts and sails were often sheltered in the lake. Some of the ships had curvilinear towers with three to five stories and used to go to Java, Malaya and Ceylon from Chilika<sup>15</sup>. The lake was very deep and through a wide-opening mouth was connected with the sea, which provided easy berthing for boats and ships bound for Southeast Asian countries in ancient times<sup>16</sup>.

Ptolemy (AD 150), the Greek geographer referred to Palur port as Paloura, the point of departure for ships bound for Southeast Asian countries<sup>17</sup>. Hiuen Tsang (6th century AD), the Chinese pilgrim who visited Orissa in AD 638 referred to the Che-li-ta-lo port<sup>18</sup>. These two ports were located on

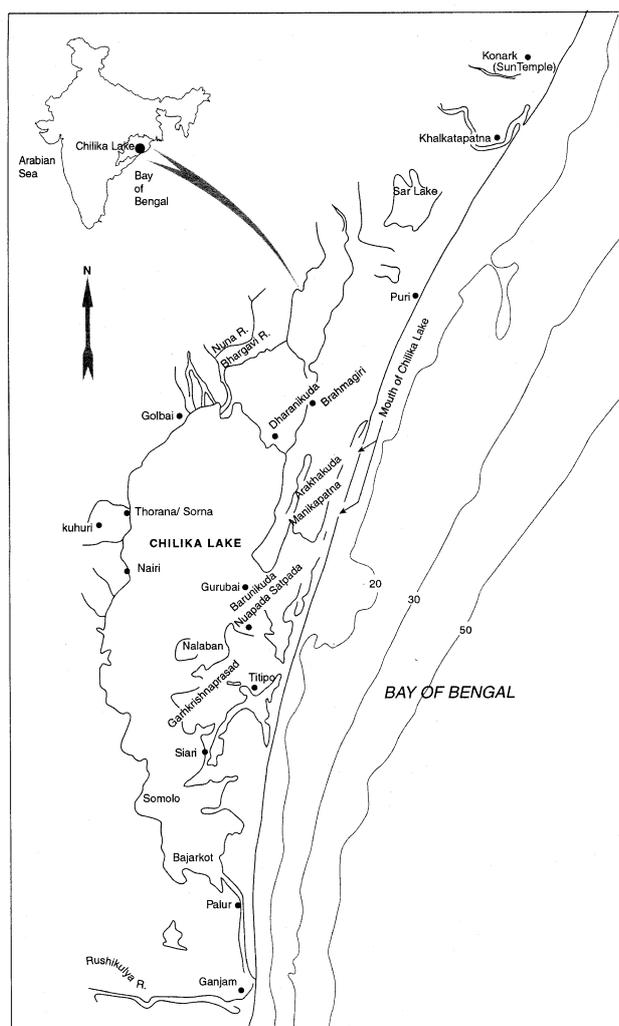


Figure 1. Map showing Chilika lake and other study sites.

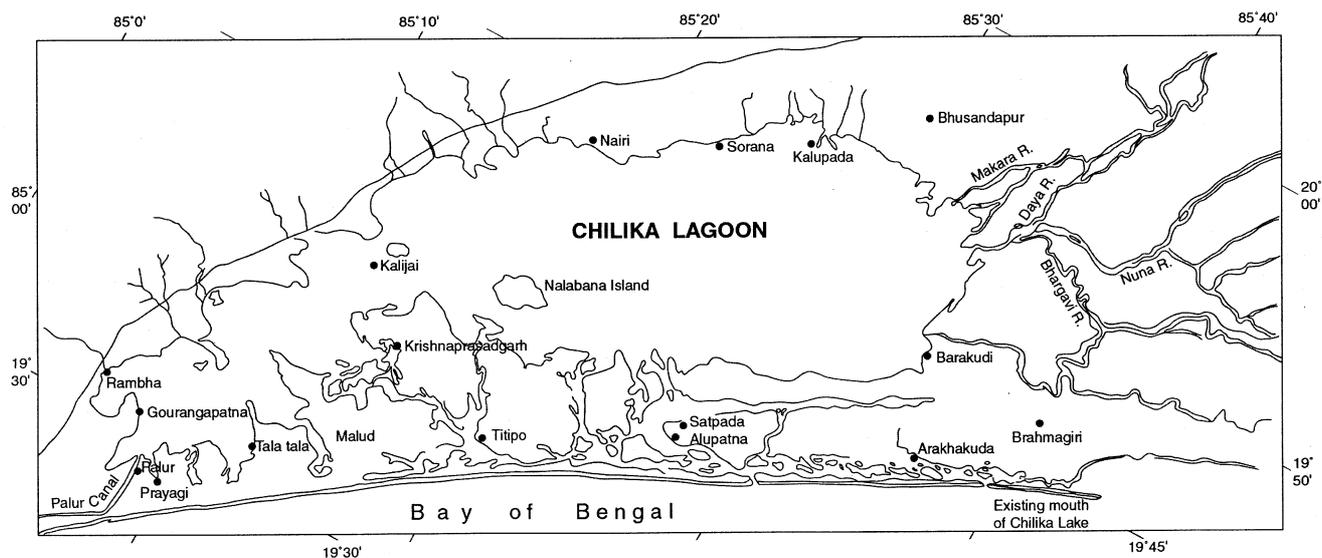


Figure 2. Map showing rivers, shoals and sand spits in Chilika lake.

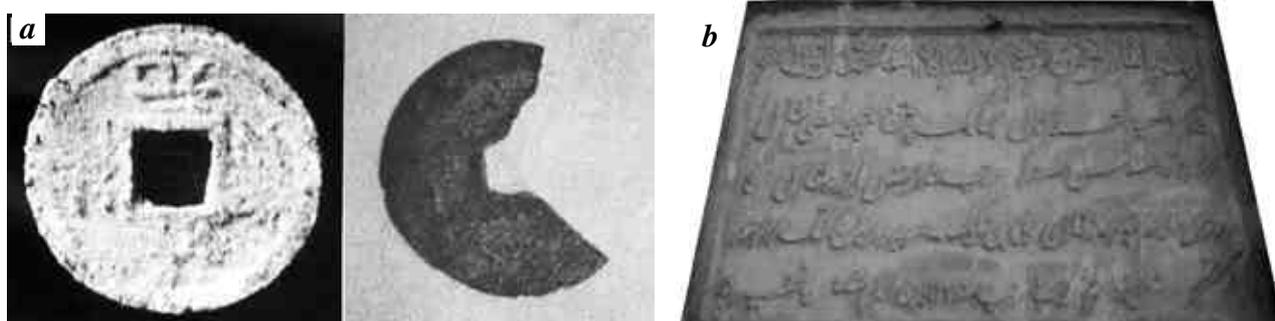


Figure 3. *a*, Coin of King Sahasamalla, Sri Lanka found during excavations at Manikapatna. *b*, Arabic inscription found on a mosque at Manikapatna.

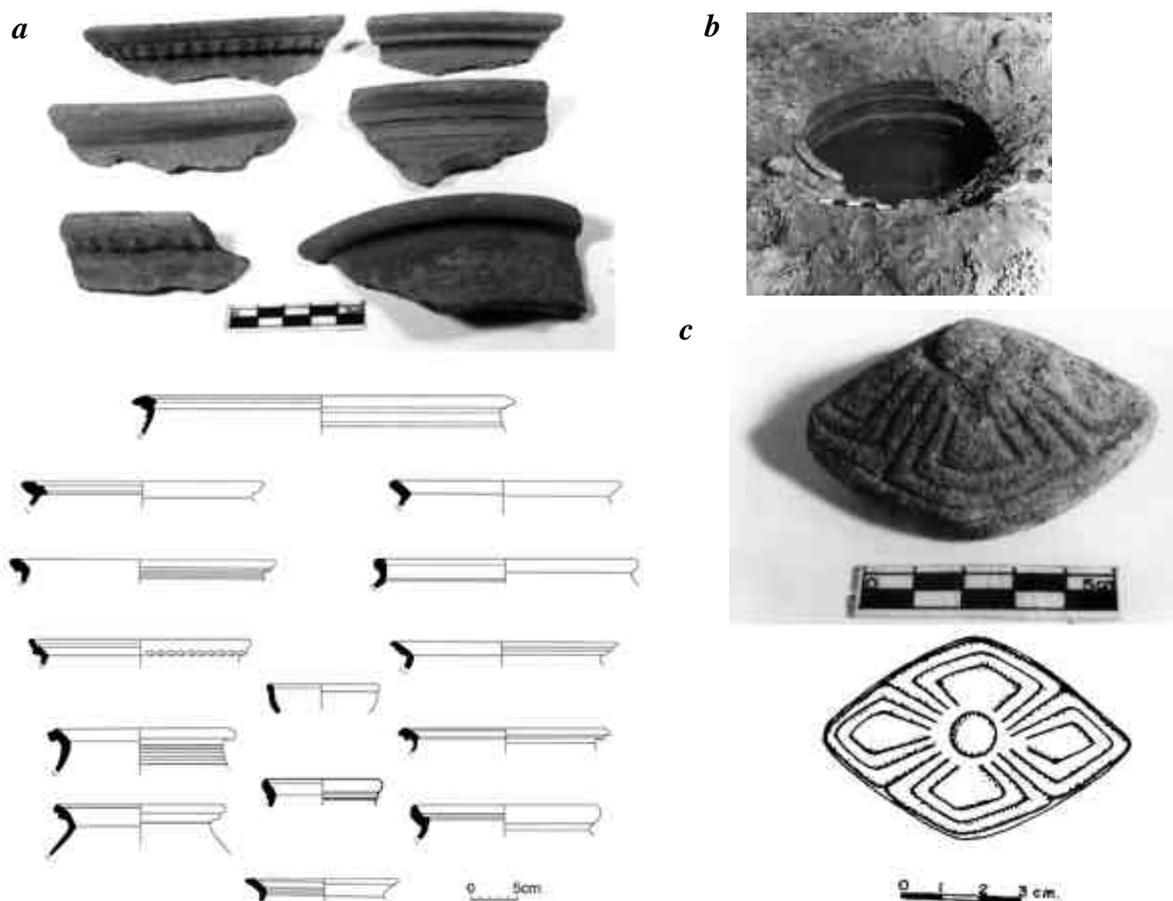
the banks of Chilika, but Ptolemy and Hiuen Tsang did not refer to the lake; however, they described the ports, cities, towns and religious centres of Orissa. It appears that during the time of their visit, the mouth of the lake was either wider or the lake was part of the sea, so that the travellers did not consider Chilika as a lake.

Like the above-mentioned two ports, Manikapatna on the bank of Chilika, was a flourishing port from the early historic period to the 19th century AD. Abul Fazal described Manikapatna as a seaport where taxes on salt were collected. There was a gate named 'samudrakara bandha' on the bank of Chilika, where taxes were collected from the sea traders. Excavations at Manikapatna in 1989–93 yielded twofold habitational remains datable between 2nd century BC and 6th century AD and 9th and 19th century AD. The findings include Indian rouletted ware, knobbed ware, stamped ware, kaolin ware, fragments of amphora, red glazed ware, a Kharosthi inscription on a potsherd, Puri-Kushana coins, Ceylonese coin (Figure 3 *a*), Chinese, Mughal and East India Company coins. In the upper levels, Chinese celadon and

porcelain ware made of jade green celadon occurred in large numbers as also egg-white Arabic glazed ware, black ware, red ware, etc. These findings indicate that Manikapatna had close interactions with Ceylon and China<sup>19</sup>. A mosque of the 18th century located close to Manikapatna and having an Arabic inscription (Figure 3 *b*), indicates that traders and sailors paid homage here before they set sail overseas.

Archaeological explorations and excavations provide detailed information about the cultural deposit of sites and the period of the findings. Keeping this in view, explorations were carried out at Bardhayakuda, Podaghar, Jhatipadara, Gourangapatana, Arunapur, Manikapatna and Palur.

Explorations were carried out at Manikapatna to understand its location, environment and maritime contacts with other countries. The explorations brought to light black and red ware (Figure 4 *a*), which are similar to those found at Sisupalgarh near Bhubaneswar. The other pottery remains are glazed ware, red ware and red glazed ware. Four terracotta ringwells were noticed at Manikapatna on the shore of Chilika, which submerged during high-tide and are exposed during



**Figure 4.** Pottery collected (a), Terracotta ringwells (b) and diamond-shaped stone artefact (c) found during explorations at Manikapatna.

low water (Figure 4b). A diamond-shaped, sandstone artefact ( $7 \times 5 \times 4$  cm) having a plain base, with a little portion of its lower side broken and appearing like a mould was found during explorations at Manikapatna (Figure 4c). It has linear designs and appears like a stylized lotus flower motif datable to 2nd–3rd to 7th–8th centuries AD. It was possibly in the central position in a wall decoration or used for making decorations on pottery.

Explorations at Palur and adjacent areas yielded fine red ware with flaring rim and bowls having a ledge on the exterior grey ware and local imitation of northern black polished ware. Over an area of half a square kilometre, sherds of red ware were extensively scattered in the midst of sand dunes. On the basis of a comparative analysis, the pottery noticed at Palur was assigned from the early historic period to the 12th–14th century AD.

Remains of habitational sites brought to light at Bardhayakuda, Podaghar, Jhatipadara and Arunapur were datable to the early historic period to the medieval period. Bardhayakuda has yielded black and red wares, bifacial bone points, local imitation of northern black polished ware and red ware. The sherds belong to jars, bowls and dishes. Arunapur lies close to Bardhayakuda and the archaeological remains are spread over 30–40 ha. The early historic pottery

such as black and red ware, red polished ware, local imitation of northern black polished ware, red ware and medieval pottery were noticed at Arunapur. Raghunathpur, Podaghar and Jhatipadara are medieval sites located close to each other and are surrounded by Palur hill.

The remains of a 2 m high monolithic stone pillar on a hilltop of 70 m height near Raghunathpur and Podaghar is worth mentioning. On the top portion of the monolithic pillar there is a hollow rectangular depression, which was probably meant for keeping fire. The stone pillar might have served as a lighthouse for seafarers in ancient times (Figure 5). The hillock on the shore of Chilika was referred to as ‘Deepa-Adia Pahad’ (Hill of Light), and had a stone pillar lighthouse to guide mariners during navigation at night.

Two stone alignments on the foothills of Ghantasila and Nandighar near Rambha on the bank of Chilika were noticed, which might have served as breakwaters. Chilika separates these stone alignments from each other through a narrow land mass for about 700–800 m. The length of both the breakwaters is 650–675 m, about 9 m in height and are in 1 m water depth. Stone structures of similar kind have not been noticed on the east coast of India. The location of hills and backwaters suggests that ships were protected from both

SW and NE monsoon, and the wind and area were conducive for safe anchorage.

Earlier explorations at Gourangapatana at the foothill of Ghantasila yielded red slipped ware and dull red ware. Turquoise-glazed glassy ware was recovered from Gourangapatana, which is believed to be imported from the Mediterranean–Persian Gulf region<sup>20</sup>. Explorations at Gourangapatana brought to light varieties of pottery which include red slipped ware, coarse black and red ware, dull red ware and Chinese ceramics. The people of the village suggested that there was a dockyard on the eastern side of the village and the hill (Deepa Dandi) on the southern side of Gourangapatana served as a lighthouse.

Orissa coast has experienced complex geological processes combined with natural factors like littoral currents, severe cyclones, storms, wave action, flood and wind since long, which has given rise to various landforms both erosional and depositional, ultimately compounding shoreline changes along with sea-level fluctuations. During the rainy season, tributaries of the Mahanadi, namely Daya, Bhargavi, Nuna and Makra and many other small streams drain 3400 million m<sup>3</sup> of water into the Chilika lake. These rivers deposit huge quantity of sediment in the lake, which makes it shallow. This has resulted in a decrease in salinity of the lake.

A comparative study of recent satellite imagery and topographic maps of the last 60 years shows that the lake is shrinking in area. In 1929, its water-spread area was 860 km<sup>2</sup>, which reduced to 605 km<sup>2</sup> in 1988. It appears that the lake is reducing in area at an average of more than 4 km<sup>2</sup>/yr. Even the rate of sedimentation has increased in recent years<sup>13</sup>. The growth of the barrier spit near Palur separated Chilika lake from the sea. The occurrence of estuarine shells at 7 m height above the present high water line and corals at Ghantasila attests to this fact<sup>11</sup>.

Further, there is a long history in shifting of the inlet of the lake and its depth, size and shape. The width of the inlet was 1.6 km in 1780, which decreased to 60 m in 1907. The inlet was located 6 km northeast of Arakhakuda<sup>21</sup> in 1914, while in 1965 the inlet was located 8 km northeast

of Arakhakuda. Similarly, in 1965 the width was 1913 m; however, it reduced to 400 m in 1968. The landsat imagery shows three inlets in 1975, two inlets in 1985 and only one since 1986, which is 4 km away from Arakhakuda<sup>11</sup>. The study suggests that the deposit of sediment at the mouth of the lake brings about drastic changes in the width and location of the inlet (Table 1).

Orissa coast is in general prone to cyclones. Between 1891 and 1970, there were 1036 cyclonic depressions reported in the Bay of Bengal, out of which 360 intensified into moderate to severe storms<sup>22</sup>. These cyclonic waves might have washed out spits, migrated or opened new ones. A storm wave breached the spit and was opened opposite to Arakhakuda in later years.

Bathymetry survey at the inlet channels and currents has been carried out in the lake to understand the depth and flow of water. The results of the survey show littoral drift more at the mouth and migration of the inlet mouth northward<sup>23</sup>. Formation of large sandy shoals was noticed along the channel near Satapada, Gabakund and Arakhakuda; these reduce the tidal flow. The formation of a number of spits in the lake obstructed the movement of water and caused deposition of sediment into the lake. Even monsoon winds have led to the formation of sand spits across its mouth. Deposits of estuarine shell at 6 to 9 m above the high-tide level have been noticed near the southwestern end of the spit. The shells include *Meretrix costa* and *Acra granosa*, neither of which lives in Chilika lake at present; but the former is known in the estuary connecting the lake with the sea. The occurrence of shell bed may be due to the minor tectonic uplift along the eastern margin of the lake. The tectonic activity might have raised the growth of barrier across the eastern side of the lagoon, thus separating the lake from the Bay of Bengal<sup>24</sup>. In the subsequent years, coastal progradation due to sea-level changes or deposition of sediment by longshore currents has resulted in widening of the barrier spit<sup>25</sup>.

The Chilika lake is situated on the northern end of the Bay of Bengal and waves approaching from north are limited. Data on daily littoral current observation show that the longshore sediment transport is northward throughout the year along the shorefront of the Chilika lake<sup>26</sup>. The major rivers such as Krishna, Godavari and Mahanadi supply a large quantity of sediment to the Bay of Bengal. The discharge of freshwater during the southwest monsoon by the rivers flushes out a part of the sediment deposited in the inlet mouth



**Figure 5.** Monolithic stone pillar lighthouse on the bank of Chilika lake.

**Table 1.** Width of inlet and its location with change in time

Year	Width of the inlet (m)	Location of the inlet (km)
1780	1600	–
1907	60	–
1914	–	6
1965	1913	8
1968	400	–

and migration rate of the inlet mouth is higher during the southwest monsoon period. In the fair weather season, the inlet mouth gets silted.

Along the east coast of India, longshore sediment transport is northward during March to October and southward during November to January. It is also observed that annual longshore transport rate increases northward along this coast<sup>27</sup>. The northern part of the lake is seriously affected by siltation and subsequently freshwater flora started growing inside the lake. The large quantity of littoral sediment movement across the mouth of the inlet of Chilika lake causes instability, by which the migration of the inlet takes place in the northern direction and reduces tidal flow to the lake<sup>23</sup>. Under the influence of wave action and littoral drift the inlet on the coast shifts progressively towards northeast.

Historians believe that weak successors, weak economy, attack by neighbouring kingdoms, etc. contributed to the decline of maritime activities in Chilika lake. On the other hand, geological processes such as coastal erosion, sea-level changes, tectonic activities, sedimentation, formation of sand bars and spits also seem to have been responsible for the decline in the number of ports of Orissa, including Chilika lake<sup>28</sup>. Historical evidences indicate that Balasore and Konark were the ancient ports of Orissa. Presently, Balasore and Konark which are 15 and 4.8 km away from the coast and ports became inoperable due to the upliftment of land<sup>29</sup>. Similarly, formation of sand dunes made Palur port inoperable.

Satellite imagery and topographic maps show the shrinking of the lake due to siltation; the depth of the lake has also reduced due to siltation. Deposition of sediment at the mouth of lake by the longshore sediment transport prevented contact between the sea and the lake. Moreover, rapid migration of inlet channel towards the north caused problems for movement of ships in the lake. The study shows that the above-mentioned natural factors are the main causes for the decline in the maritime heritage of Chilika lake.

It appears that during the 3rd millennium BC, Chilika extended up to Golbai. Presently, Golbai is located 20 km NW of Chilika, on a low-lying area. The present location of Golbai suggests the extent of recession of the lake, which might have caused the migration of people from Golbai to other suitable places. The discovery of harpoons, barbed spear, fish bones and shark teeth indicates that the people of Golbai were not only fishing in Chilika, but might have ventured into the Bay of Bengal for the same.

Excavations at Manikapatna have brought to light both indigenous and foreign pottery. Manikapatna is the only site along the east coast of India from where varieties of ceramics have so far been reported. The presence of pottery, artifacts and coins indicates the impact of early sea trade between Orissa and the Mediterranean world. Findings of Rouletted ware, Kharosthi scripts, semi-precious stone beads, etc. along the east coast of India, suggest that the regional contact between Orissa, Bengal, Assam and Tamil Nadu dates back to the early historic period. Manikapatna played a vital role

in the internal trade of the east coast of India. The formation of the sand bars and sedimentation in the lake caused the decline of Manikapatna port.

The findings of ringwells at Manikapatna on the bank of the lake suggest that these wells were in use when the lake was away from the site, while subsequent seepage of marine water into the ringwells made them inoperable.

The reasons for the decline of maritime heritage in the Chilika lake is twofold: (i) sediment transported by the distributaries of Mahanadi in the northern end of the lake reduced the depth and area of the lake and (ii) deposition of sediment in the inlet mouth by littoral current. Due to these reasons Chilika was gradually transformed into a shallow lagoon. These two factors also prevented the movement of large ships in the lake, which caused a decline in the maritime heritage. In later periods, to retain their tradition mariners of the region constructed flat-bottom small boats known as 'nauka', suitable for movement in shallow waters inside the lake for trade and commerce, and these are still in use<sup>30</sup>. Coastal surveys and offshore explorations at other port sites in Orissa and the east coast of India may shed new light on the factors responsible for their decline and their present status.

The archaeological findings and descriptions mentioned in the literature show that Chilika lake provided good shelter and easy handling of cargo to the ships bound to Southeast Asian countries and other parts of the world during ancient times. The ecology and environment of Chilika region helped human habitation since 3rd millennium BC onwards. However, subsequent fluctuations in environmental variables changed the area, depth, location of the mouth of the lake, etc. and ultimately ensued decline in the maritime heritage of the lake and adjoining regions.

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