

High-Resolution Topographic Mapping Using Remote Sensing and GIS to Identify Geomorphic Controls on the Location of Ancient Civilization Sites in the Indian Sundarban Delta**Submitted by** Sanjibani Banerjee

Early human settlement in the lower Ganga delta, commonly known as the Sundarban delta, has occurred over the past 7,000 to 6,000 years up to the colonial times, with archaeological evidence dating back to 500 BCE (2,000 Y.B.P). This offers a fresh perspective on the reinterpretation of ancient historical development, taking into account the changing climate, river avulsion, and changing geomorphic patterns, which align with the development of the Sundarban region of upper Holocene delta of Bengal.

The first objective of this study to attempts to collate and map the already established archaeological sites in the lower Ganga delta plain using a state of art Remote Sensing and GIS techniques. Study of palaeochannel and palaeo- levees is one of the main objectives to estimate the palaeo-riverine environment and impact of changing river course on ancient civilization. Beside this, it is felt necessary to find the distributional pattern of ancient civilization, if any to make a link with existing known archaeological site with surface elevation. The study of geomorphic features, changing course of rivers and paleogeography and palaeoenvironment from available secondary data and aps of the lower Bengal delta lain is another objective of present study. Several techniques of digital elevation modelling, mapping of palaeo- channels, estimation of relative water saturation, landcover mapping have been employed to understand the distribution of archaeological remains of historic settlements and their relation with geomorphic features and changes. This study assesses the influence of ancient river on early historic civilization especially on Chandraketugarh on the delta, an early historic port city connected with European and Asian countries with trade. This study also assesses the sequence of palaeochannel development of Padma nala and river Bidyadhari that would flow in an around Chandraketugarh to find out the main connecting channel with port city. Modern remote sensing data analysis techniques like NDVI and PCA have also been applied in present study to find out the sequence of palaeochannel development. Details of archaeological artifacts and nature of findings were collected from the State Museums and nearest site museum of Chandraketugarh and also from private collections. Besides, some expert opinions have also been taken to assume knowledge about the stylistic age of artifacts. As the southern part of

Sanjibani Banerjee
19/02/2025

D.H. [Signature]
19.02.2025

Lower Bengal Delta has been bestowed with rich assemblages of archaeological artefacts, terracotta figurines, seals, beads, utensils of grey, black, and red potteries and stone carvings belonging to different historical periods and dynasties, finding out of new sites also been emphasized and explored in this study. To reach this goal some image processing techniques have been applied in this study by which some new probable archaeological sites have been successfully identified in this deltaic area especially in the mangrove cover part of delta which is not easily approachable. The influence of the now-relict courses of the Bidyadhari River and its distributaries on the location of early historic sites, such as Chandraketugarh, Tilpi, Dhosa, and those near the Adi Ganga River, as well as early medieval sites like Atghara, Kankandighi, Monir Tat, and Jatar Deul in the North and South 24 Parganas, has been examined through high-resolution mapping of known archaeological sites. It has been observed that during the Roman Warm Period, higher solar insolation and stronger monsoon, early historic sites thrived along the northern Bidyadhari and Piyali Rivers. In contrast, during the 'Medieval Cold Period', early medieval sites developed further sea ward along the emergent Adi Ganga River and its distributaries, including the Mani River. A significant shift in the location of settlements from early historic to early medieval periods is interpreted as a response to changes in the river system, particularly the main flow moving from Bhagirathi-Bidyadhari to Bhagirathi-Adi Ganga. These changes are believed to have been driven by variations in solar insolation, declining monsoon activity, and changes in sea levels. Additionally, the connectivity between the early historic delta port city of Chandraketugarh and the renowned Mauryan port of Tamralipta on the Rupnarayan River has been mapped. This route was likely controlled by the now-relict 'Proto-Bhagirathi River; linked to the ancient Bhagirathi River via the NNE-SSW "Chinsura-Krishnanagar" lineament. This waterway served as a vital trade and travel route, facilitating visits by travellers such as Fa Hien in the early historic period and Hiuen Tsang in the early medieval period to the capital city of Pataliputra on the Ganga in Bihar. Although various works have been done by different scholar to find out the evidences of ancient livelihood from early historic time period, but the application of state of art remote sensing techniques and geoarchaeological studies together was the main research gap in this field. Contrary to the common beliefs of no human presence in the Sundarban region before the colonial rulers, the present study spatially analysed evidences and sites of historical settlement in the lower Ganga delta to suggest existence of human civilisation during early historic, early and late medieval times with changing pattern of settlement and trade depending on possible climatogenic and geomorphic changes.

The present research, through a comprehensive review of various archaeological studies and reports, coupled with field observations of artifacts in both local sites and museums, aims to establish the existence of an extensive early history and early medieval civilization in the Sundarban delta, covering an area of nearly 100 km². This was made possible by applying high-resolution elevation mapping using Coastal DEM data, alongside advanced NDVI and PCA analyses from high spatial resolution Sentinel 1 data. These findings suggest that the civilization's spread may have been influenced by shifts in climatic patterns, sea levels, neotectonic movements, and delta dynamics.

Through contour and elevation mapping using Coastal DEM data, along with local archaeological evidence, several new potential archaeological sites have been identified for future exploration. It is recognized that systematic paleoenvironmental studies, incorporating palynological evidence, precise radiometric dating using AMS, and subsurface structural imaging using Ground Penetrating Radar, will be crucial for further understanding the historical context of this deltaic wetland before large-scale excavation efforts are undertaken in the future.

Sanjibani Bandyopadhyay
19/02/2025


19-02-2025