

Paleoclimatic reconstruction of Chilika Lake, India since the Last Glacial Maximum

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The Indian Summer Monsoon (ISM) is a major driver of hydroclimatic variability in the Indian subcontinent. It influences agriculture, water resources, and socio-economic stability. Deciphering the temporal dynamics of ISM variability is an important component of past tropical climatic regimes. Despite recent advancements in lake sediment studies, high-resolution, long-term geochemical records from the Chilika Lake located in Core Monsoon Zone (CMZ), are scanty and poorly constrained. This study presents a high-resolution multi-proxy record of a 14.64 m sediment core retrieved from Chilika Lake, the largest brackish water lagoon in Asia and second largest in the world. It is a dynamic coastal system sensitive to monsoonal precipitation, riverine discharge, sedimentation processes, and sea-level fluctuations. The radiocarbon dates indicate that the core spans ~ 28,000 cal yr BP. Geochemical and particle size data provide a critical insight into the hydroclimatic evolution of the lake. Variations in TiO₂, ZrO₂ and coarse-grain fraction (sand %) suggest that Chilika Lake was connected to the waters of the Bay of Bengal (BoB) until ~25,000 cal yr BP. The free connectivity between Chilika Lake and BoB waters was disrupted or completely shut down at the onset of the LGM when the sea level was lower by about 120 m. This change in the Chilika hydrology is characterized by an abrupt cessation of the previously increasing trend in Fe₂O₃ and MgO, along with sudden drop in sand size fraction. The End Member Modelling (EMM) coupled with fluctuations in the Fe/Mn ratio suggests that Chilika Lake remained in a transitional phase between ~25,000 and ~ 9,000 cal yr BP. The onset of Holocene is characterised by a sharp increase in MgO and K₂O, a decline in the Fe/Mn ratio, and the initiation of an upward trend of clay size fraction. The lake attained hydrodynamic stability as a brackish water system around 9,000 cal yr BP as indicated by elevated K₂O and MgO and clay content. This study for the first time presents the longest record on climate and hydrological variability in the Chilika Lake linking it with the dynamics of sea level change since the LGM.