



Holocene climate events and associated land use changes in the eastern coast of India: Inferences from the Chilika Lagoon

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Abstract

The Holocene arid events and related societal responses are important scientific inquiries due to concerns about their reoccurrences in the future. In the Indian subcontinent, significant number of studies have focussed on understanding the Holocene aridification events at 8.2 and 4.2 ka. Despite these studies, high resolution palaeoclimatic records from the eastern India during Holocene, particularly around the above-mentioned aridification events are lacking. In this study, we present high resolution Holocene palaeoclimate records reconstructed based on geochemical and isotopic data from the Chilika Lagoon located in the east coast of India. A 130 cm long sediment core, retrieved from the southern end of the lagoon, revealed a continuous sedimentation history between 8.49 and 0.99 ka. The variations in organic carbon isotopic compositions, total organic carbon contents, along with major and trace element abundances suggested a strong effect of 8.2 dry event and a shift in chemical weathering at around 4.2 ka in the eastern coast of India. Additionally, a strong warm climate anomaly was observed at 1.2 ka. Interestingly, higher sedimentation rates were observed post 4.2 ka, which potentially indicated a significant change in settlement dynamics and human interventions. It appears that the eastern coast of India experienced human migration and surge in agricultural practices similar to that in northwest India after the 4.2 ka climatic event. It is likely that people relocated themselves, which eventually increased the pastoral activities in newly occupied lands. Consequently, enhanced land use and land cover changes accelerated soil erosion in the region leading to higher sedimentation rate in the lagoon.

Keywords

Chilika Lagoon, Indian summer monsoon, palaeoclimate, sediment geochemistry, stable isotopes

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Introduction

The Holocene extreme climate events are being robustly investigated due to concerns of possible recurrence of similar rapid and abrupt events in the future (Alley et al., 2003; Holmes et al., 2011). The Holocene interglacial warm climate was punctuated by a number of dry climate events, globally known as Bond events, which were largely caused due to ice rafting in the North Atlantic Ocean (Bond et al., 1997, 2001). Two of these cold and dry events (8.2 and 4.2 ka) were prominently reported in the Northern Hemisphere during the Holocene. The North Atlantic cooling was considered an influencing factor for 8.2 ka aridification, whereas large-scale tropical ocean-atmosphere dynamics was correlated with 4.2 ka event (Head et al., 2021; Walker et al., 2018, 2019). Further, these dry events correlated to the societal collapse worldwide by impacting and altering the ancient agricultural practices. Recently, Giosan et al. (2018) evaluated the role of the Indian summer monsoon (ISM) along with the Indian winter monsoon (IWM) precipitation during the Holocene time using drill core sediments from the Arabian Sea. They proposed that the combined changes in the ISM and IWM hydroclimate triggered transformation of urban culture into rural society, possibly leading to deurbanization of the Harappan (Indus Valley) Civilisation. Moreover, the shift in temperature and climate over the Indian subcontinent and subsequent weakening of the ISM, at around 4.2 ka (e.g. Archer and Fowler, 2004; Berkelhammer et al., 2012;

Ponton et al., 2012), has also been projected as possible factor for the collapse or deurbanization of the Indus Valley Civilisation (Dutt et al., 2019; Valdiya, 2017). Similarly, the 4.2 ka drought event has been documented based on the $\delta^{18}\text{O}$ records of speleothem (Dongge Cave, south China) and subsequently linked to the downfall of extensive agriculture in the central China (Dykoski et al., 2005; Wang et al., 2005; Yuan et al., 2004). Since global warming is accelerating rapidly, it has been argued that the augmented melting of the Greenland ice sheet could result in yet another dry/cold climate event in the Northern Hemisphere (Liu et al., 2017; Srokosz and Bryden, 2015).

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