



Holocene palaeoenvironmental records from the high-altitude Wular Lake, Western Himalayas

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Abstract

We present a comprehensive record of Holocene (11,590–628 cal. yr BP) climate and hydrographic changes around the Wular Lake located in Kashmir Valley, India. Based on the multi-proxy investigations, we have identified three phases of wet climate conditions that prevailed from the commencement of the Holocene Epoch – 9000 cal. yr BP, 8100–6650 cal. yr BP and 6350–5000 cal. yr BP, whereas periods of dry climate were observed during 9000–8100 cal. yr BP, 6650–6350 cal. yr BP and ~5000 to 4000 cal. yr BP. The results also suggested that the lake widened and deepened significantly around 6350–5000 cal. yr BP. The results indicated desiccation and the exposure of the lake margin around 5000–4500 cal. yr BP. The sedimentation rate since 4500–628 cal. yr BP was quite low for detailed paleoclimate interpretations. Oscillations in lake extension and deepening appear to be due to changing intensity of westerly moisture in the region, and we correlate several of the low lake-level phases to the Bond events caused by North Atlantic ice rafting events.

Keywords

bond events, carbon dating, Holocene climate, Kashmir Valley, lake desiccation, palaeolimnology

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Introduction

The Holocene Epoch started around 11,700 yr BP, marking the end of the Upper Pleistocene (Cohen et al., 2013; Walker et al., 2018, 2019). Although it is considered a warm interglacial Epoch, about eight cold climate events, also known as Bond events, caused by North Atlantic ice rafting, are proposed to have occurred during the Holocene (Bond and Lotti, 1995; Bond et al., 1997, 2001; Obrochta et al., 2012). These abrupt climatic events are thought to have impacted large regions around the world, altering agricultural practices by ancient civilizations established along the river banks and fertile valleys, often bringing a shift to pastoral activities during drier times (Calvin, 2002; Parmesan and Yohe, 2003; Root et al., 2003). While the impact of Bond events is not evident in climate records everywhere, they do correspond with the episodes of dry/cold climate, causing low lake levels in areas such as the northeastern USA (Li et al., 2007), a weaker Asian monsoon (Gupta et al., 2003; Wang et al., 2005), and aridification in the Middle east (Parker et al., 2006). Since the Early Holocene (11,700–7000 yr BP), the northern hemisphere has gradually warmed (Wanner et al., 2015), with a temperature rise of up to 4°C near the North Pole and 2–6°C and 3–9°C warming during summer and winter, respectively, in the northern Central Siberia (Koshkarova and Koshkarov, 2004). The northwest region of the Europe experienced warming from 11,700–7000 yr BP, while the southern Europe cooled (Davis et al., 2003). The tropical ocean surface of the Great Barrier Reef was 1°C warmer around ~5350 yr BP (Gagan et al., 1988). During this period,

warm climate phases such as Holocene Climate Optimum (HCO; ~6000 yr BP), the Roman Warm Period (RWP; 2200–1550 yr BP), and the Medieval Warm Period (MWP; 1000–700 yr BP; Mann et al., 2009) coincided with rapid deglaciation and spread of forest area (Riser, 1999).

During the Holocene, climate varied in the northwest Himalayas (Das et al., 2010; Lone et al., 2019). Lesser Himalaya experienced warm and wet climate regime during the Early Holocene and dry and cold during the Late-Holocene (Das et al., 2010). Significant summer monsoon moisture is recorded in the Tso Kar Lake (Ladakh, India) around 12,500 yr BP and from 11,500 to 8600 yr BP with low precipitation around 4200 yr BP (Wünnemann et al., 2010). The presence of sparse vegetation confirmed cool

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