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Late Holocene paleoenvironmental changes inferred from Manasbal Lake sediments, Kashmir Valley, India

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ABSTRACT

Paleoclimate investigations and reconstruction using the lake sediment cores of Kashmir Valley have been rarely attempted. The basin is influenced by Indian Summer Monsoon, Westerlies and the local katabatic winds. In the present study, an 80 cm undisturbed sediment core was retrieved from the Manasbal Lake situated in North western Himalaya. Sediments were dated using ^{14}C method, and the age-depth model indicated a depositional history extending from ~3345 yrs BP to the present. Grain size, major and trace elements, TOC, OM contents C/N ratio and diatom assemblages were applied to reconstruct the paleoenvironmental changes around the area. The A-CN-K diagram displays that the weathering intensity of the Manasbal lake sediments are moderate to highly weathered and the sediments have been derived from nearby and mixed source origin. Several wet and cold phases were identified during ~3300 yrs BP to ~2500 yrs BP and ~1800 yrs BP to ~1300 yrs BP due to intense precipitation reflect high lake level. These wet phases are marked by higher sand and silt content, C/N ratio and high allochthonous input with less abundance of diatom species, clay, OM, TOC contents and high CIA values. Consequently, low lake level and dry and cold period from ~3345 yrs BP to ~3300 yrs BP and ~2500 yrs BP to ~1800 yrs BP is observed. These inferences are corroborated with the trace elemental ratios CIA and CWI data. Our data indicate that the Westerlies and localised katabtic winds rather than the Indian summer monsoons played a major role in controlling the past climate around the Manasbal lake, Kashmir Valley.

1. Introduction

The Himalayan region, particularly the Western Himalaya and Tibetan Plateau is influenced/fed by both Indian Summer Monsoon (ISM) and the Mid-Latitude Westerlies (MLW) (Fig. 1; Benn and Owen, 1998; Ali and Juyal, 2013: Ali et al., 2013; Sati et al., 2014; Bali et al., 2016). Multi-proxy records have often been used to understand the late Holocene climate change in several parts of the globe. In order to reconstruct the past monsoon fluctuations, the Holocene history of the Himalayan Lakes has been investigated by several researchers (Laat and Lelieveld, 2002; Yadav et al., 2013; Dimri, 2013; Kotlia et al., 2017). Till date, all the well-dated Holocene paleoclimate records from the Himalayan lakes have been reconstructed in relation to the variable intensity of the ISM. Both the variations of the westerlies and the Asian monsoons are regarded as the potential drivers of the climatic changes in Kashmir Valley. In addition, other forcing factors such as the high temperature causing increased evaporation, decreased effective moisture (Chen et al., 2003; Mason et al., 2009), snowmelt (Herzschuh, 2006; Zhao et al., 2007) as well as the regional differences in the uplift and descent of air masses leading to the different moisture situation in the core monsoon area and monsoon margin (Herzschuh, 2006; Zhao et al., 2007), were also proposed to explain the complex patterns of climatic evolution in this area although the area is controlled by localised katabatic winds.

Herzschuh (2006) argued that the Holocene moisture history of the westerlies-dominated central Asia is similar to that of the region dominated by the Indian and East Asian Summer Monsoons. Chen et al. (2006, 2008) suggested that the moisture variations in arid central Asia are out-of-phase with that in the monsoon dominated regions. Several factors such as the low-latitude summer monsoon, the mid-latitude westerly winds and the orographic influence of the Tibetan Plateau control the regional climate in the North-Western Himalaya (Chen et al., 2008) particularly in Kashmir Valley. Recent work by Wulf et al. (2010) stated that the northern slopes of the Pir-Panjal Range act as an orographic barrier, ranging in altitude between 4000 and 6600 m is mainly responsible for the existence of entirely two different precipitation regimes in the Kashmir valley. Moreover, the MLW and the ISM contribute to the average annual precipitation with the north face of the orographic barrier that receives nearly 80% of winter precipitation from the northern

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