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Analysis of vegetation and climate change during Late Pleistocene from Ziro Valley, Arunachal Pradesh, Eastern Himalaya region

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ABSTRACT

Vegetation and climate during later part of Late Pleistocene have been reconstructed from Ziro valley, Arunachal Pradesh, Eastern Himalaya based on pollen data along with carbon isotope and magnetic susceptibility data The study reveals that the area and the vicinity is occupied by mixed broad leaved – conifer forest and pine grass savanah at variable densities at least since 66,000yr BP. The phases of expansions and declines of Oaks with decline and increase of Pines and grasses probably occurred under increase (warm–moist) and decrease (cool–dry) of S.W. monsoon precipitation respectively. The increasing trend of S.W. monsoon and temperature is recorded during ~44,000 to 34,000 cal yr BP synchronizing with the peat development, and which peaked at around 35,000 cal yr BP. This may link to the interstadial phase during the last major glacial cycle in the Himalayan region. It is also reflected in the decline of $\delta^{13}C$ value indicating dominance of C-3 type of vegetation. The increased values of χFD%, and lower values χLF magnetic susceptibility, recorded during the phase of the peat deposit, further advocate's higher monsoon intensity. Impact of expansion of glacier felt with peak (LGM) around 20,000 cal yr BP is perceived. Tree line had moved to lower altitudes due to increased aridity and low temperature. During this time existence of savannah type of vegetation is also evident by the increase of C4 taxa. Decreased FD% and increased χLF susceptibility also indicate reduced S.W. monsoon intensity.

1. Introduction

Analysis of climate of the Himalaya is important not only in understanding the monsoon dynamics of the Indian subcontinent (Prell and Kutzbach, 1992; Li and Yanai, 1996; Boos and Kuang, 2010, 2013) but also for the whole Southeast Asia, and to know its tele–connection with other global climate systems (Bhattacharyya, 1989; Gupta et al., 2003, 2005; Cane, 2010; Molnar et al., 2010). In the Himalaya itself a great variability in climate exists from one region to other (Mani, 1981; Kumar and Pant, 1997). The eastern part is under the extreme influence of South–West Monsoon, due to closeness to the Bay Bengal and as a result climate in eastern part is considerably more humid than in the western part. Thus, it is crucial to understand cause, timing and spatial extent of millennial scale climate events of this region for understanding the tele–connections among various climate systems. Analysis of various proxy records (viz. pollen, tree rings, lake and marine sediments etc) are indispensable to retrieve long–term paleoclimate data (Bradley, 1999). It has been recorded that pollen and carbon isotope as proxy data have broader perspective towards climatic reconstruction through analysis of vegetation change. In addition magnetic susceptibility data in sediments also provide clue for the climatic change. The records of Quaternary palaeoclimate vis–à–vis palaeo–vegetation analysis based on varied proxy data are sparse from the Eastern Himalaya (Chauhan and Sharma, 1996; Bhattacharyya et al., 2007). However, such records are available in good numbers from the Western Himalaya (Krishnamurthy and DeNiro, 1982; Bhattacharyya, 1983, 1988, 1989; Dodia et al., 1985; Kotlia et al., 2000, 2010). On the contrary from the Eastern Himalaya (except one viz., from Jore–Pokhari, Darjeeling (Chauhan and Sharma, 1996), the climate records are mainly from early Holocene (Sharma and Chauhan, 2001; Bhattacharyya

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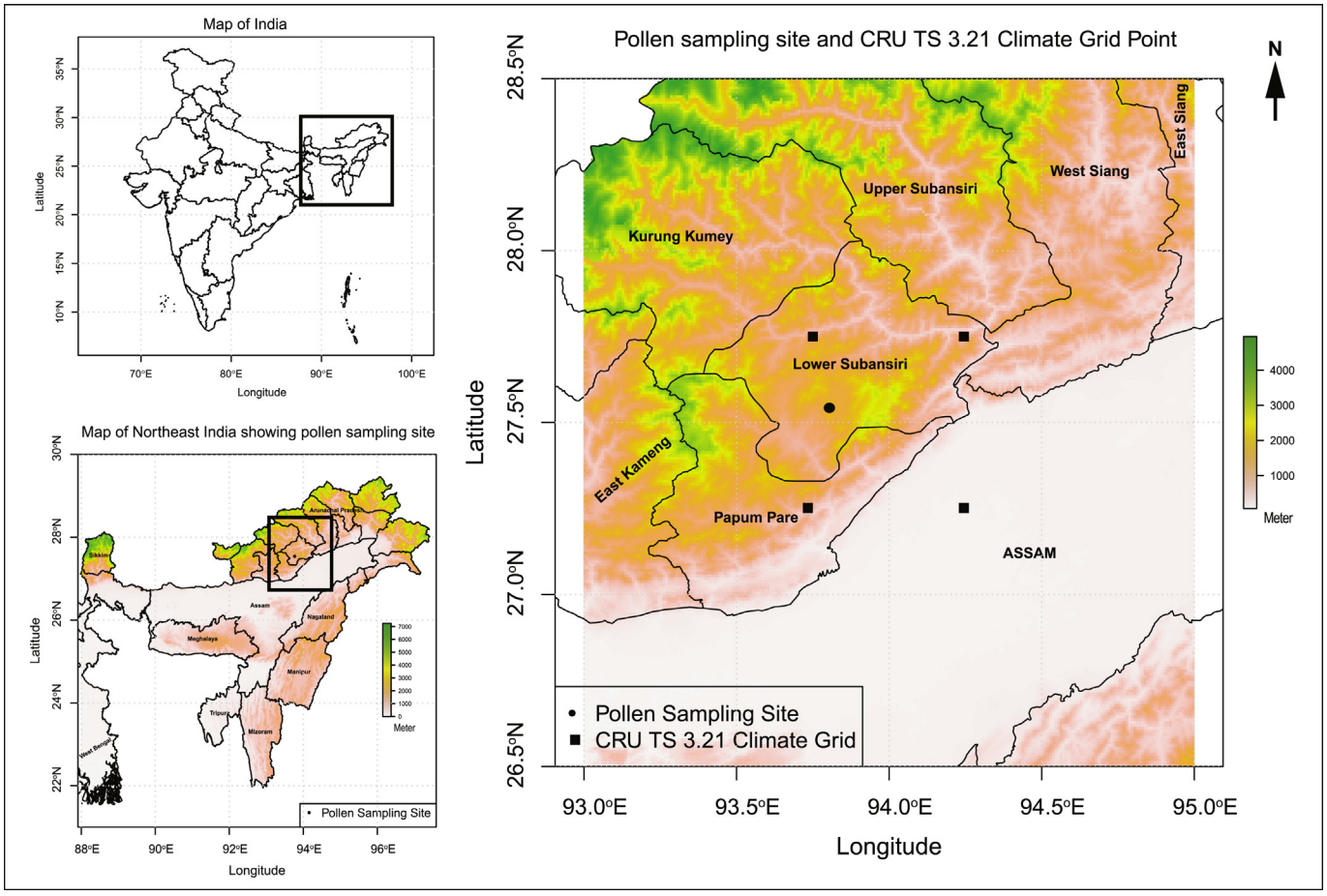

Fig. 1. Site Map showing location of sampling site in Ziro Valley, Arunachal Pradesh, NE India and nearest climate grid points used to represent modern regional climate.

et al., 2007). Even paleoclimatic scenario from the low elevation sites of north east part of India beyond Holocene are scarce (Bhattacharyya et al., 2011; Mehrotra et al., 2014).

This study attempts to reconstruct the changes in vegetation vis-à-vis climate during the Late Quaternary period based on palynological analysis supplemented with environmental geomagnetic and isotopic studies from subsurface sediments from the Ziro valley, Lower Subansari District in the state of Arunachal Pradesh, Eastern Himalaya.

2. Temporal record of Himalayan past vegetation and climate change

Paleoenvironmental studies commenced since the early part of 20th century with pioneering work from Western Himalaya (Wodehouse and De Terra, 1935; Deevey, 1937). Subsequent work, except for a few (Bhattacharyya, 1989; Kotlia et al., 2000, 2010) mostly was concerned vegetational changes vis–à–vis climate covering Holocene time (Bhattacharyya, 1988; Ranhotra et al., 2001; Bhattacharyya et al., 2006 and others). Some of the longest records of climate change from this region are from the Tsokar lake (4572 m amsl) in Ladakh, based on pollen analysis of 23 m core of about 30,000 yr BP–9000 yr BP, revealed phases of increase in *Junperus* communities in the continued alpine steppe vegetation cover. Four phases at 28,000 yr BP–30,000 yr BP, 21,000 yr BP–18,375 yr BP, before 15,800 yr BP and 10,000 yr BP were considered as climate amelioration events during the last glaciations in the Trans– Himalayan region (Bhattacharyya, 1989). Later from the same lake, Demske et al. (2009) reported Lateglacial and Holocene vegetation covering time span since 15.2 BP. Ranhotra et al. (2007) studied a palaeolake profile in the semi arid climate of Lamayuru, Ladakh, and provide a broad idea of temporal succession of vegetation vis–à–vis climatic changes during major part of the Last Glacial period. Paleoclimate record from Bhimtal–Naukuchiatal Lake basin in south–central Kumaun in western Himalaya indicated at least two phases of arid climate and one phase of humid climate in Late Pleistocene–Holocene period (Kotlia et al., 1997). Palynological records from another sediment profile from Wadda Lake in western Himalaya preserve three temperate humid and two arid climate phases during 36,000–10,000 yr BP (Kotlia et al., 2000). In the eastern Himalaya, longest pollen record is from the Mirik lake, Darjeeling which extends up to about 20,000 yr BP (Sharma and Chauhan, 1994). Vegetation vis-à-vis climate of Late Holocene (since 1800 yr BP) was made based on pollen and carbon isotope from a sediment profile in Paradise Lake near Sela Pass, Arunachal Pradesh (Bhattacharyya et al., 2009). This review of palynological analysis shows that except some stray reports, a detailed palaeoclimate records covering even major part of the Last Glacial period from the diversified geographical regions of the Himalaya especially from its eastern part are yet to come.

3. Ziro valley, Arunachal Pradesh, Eastern Himalaya

3.1. Physiognomy, modern environment

Arunachal Pradesh, is a state in the northeastern extremities of the Eastern Himalaya extending from the southern ends of snow