



Late Quaternary climate variability and civilization history of Belan valley, India

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Late-Paleolithic to Neolithic fluvial sequences of Belan river situated in north-central India have received notable attention owing to its well preserved early human artifacts and first known evidence of domesticated rice (*Oryza sativa*) from the Indian subcontinent. The human settlement and associated agricultural activities in the Belan valley were perceived to be controlled by climate changes. However, the climate-culture linkages from Belan valley lack proxy based quantitative dataset. To establish a climate-culture linkage, we have analysed climatic proxies such as $\delta^{18}\text{O}_{SC}$ and $\delta^{13}\text{C}_{sc}$ of soil carbonates and $\delta\text{D}_{C_{29}}$ and $\delta^{13}\text{C}_{C_{29}}$ of *n*-alkanes from the paleosols of Belan archaeological sites.

Based on average $\delta\text{D}_{C_{29}}$ and $\delta^{18}\text{O}_{SC}$ values from six archaeological sites of similar time windows, three phases of isotopic depletion were observed. During ca. 72 to 53 ka, the $\delta\text{D}_{C_{29}}$ and $\delta^{18}\text{O}_{SC}$ values are $-151.1 \pm 34.2\text{‰}$ and $-6.4 \pm 1.2\text{‰}$ respectively. In time window ca. 45 to 31 ka, the $\delta\text{D}_{C_{29}}$ and $\delta^{18}\text{O}_{SC}$ values are $-143.9 \pm 29.7\text{‰}$ and $-6.1 \pm 0.8\text{‰}$ respectively, and for ca. 10 to 6 ka the values are $-173.9 \pm 27.8\text{‰}$ and $-7.2 \pm 1.4\text{‰}$ respectively. The lower values indicate the period of intense monsoonal rainfall. During ca. 30 to 21 ka with higher $\delta\text{D}_{C_{29}}$ and $\delta^{18}\text{O}_{SC}$ values of $-143.3 \pm 31.5\text{‰}$ and $-5.0 \pm 1.4\text{‰}$ respectively indicate weakest monsoon phase and correspond to Last Glacial Maxima (LGM). The time span ca. 30 to 6 ka has experienced most dramatic oscillations in monsoonal rainfall. The $\delta^{13}\text{C}$ values of *n*-alkane and soil carbonate show vegetation were characterized by mixed C_3 - C_4 plants throughout the last ca. 100 ka. The C_4 plants dominated in the ecosystem during the ca. 52 to 21 ka and sharply decreased during the early Holocene period. In the present study, we compared the climatic events and the vegetational shift to the civilization history of Belan valley and established a climate-culture linkage. Our data indicate that climatic fluctuations lead to the human migration during late Mesolithic-early Neolithic as well as affected the early human population.