Climate, vegetation and fire history of the last ~100 ka from archaeological sites of Belan valley, north-central India

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Late-Paleolithic to Neolithic archaeological sites situated in north-central India is known for its well-preserved artifacts and the first evidence of domesticated rice (*Oryza sativa*) from the Indian subcontinent. Therefore, these archaeological sites provide an ideal platform to understand the linkage of hominins with climate, vegetation and fire events during the late Quaternary period. As the fire disturbance in the modern ecosystem appears to be one of the important processes in shaping vegetation and landscape dynamics, its identification in paleo-records would enhance our understanding of the past environment. However, climate, as well as human, can equally induce the fire at the stand. Therefore, unraveling the natural and hominin induced factor is equally important to comprehend the paleoclimatic and paleovegetation conditions at a regional and global scale.

In this study, 49 paleosols sampled from six archaeological sites of Belan River. Paleosols were analyzed for *n*-alkane distribution, $dD_{n\text{-}alkane}$, $d^{13}C_{n\text{-}alkane}$ value and Charcoal count to reconstruct the climate, vegetation and fire events. *n*-Alkane distribution pattern, carbon preference index ($CPI_{25\text{-}33}$) and average chain length ($ACL_{15\text{-}33}$) used to delineate the source of organic matter (OM) in the paleosols which suggest a dominant contribution from terrestrial plants. Three samples of lower $CPI_{25\text{-}33}$ (~1.0) and $ACL_{15\text{-}33}$ (~23.0) observed that indicate enhanced degradation of OM. The lower $CPI_{25\text{-}33}$ sample showed a prevalence of mid to short-chain even-numbered carbon (maximum at *n*-C_{16} or n-C_{18}) which was also observed in the previous study from the archaeological site for fire events (Eckmeier et al., 2009). Additionally, macro-charcoal analyses (n=40) showed degraded paleosols exhibits higher charcoal which endorses its exposure to fire. The macro-charcoal analysis suggests paleofire events in the Belan valley at i) ~58ka BP, ii) ~26ka BP and iii) ~8ka BP. $dD_{n\text{-}alkane}$ values suggested lower rainfall condition during Large Glacial Maximum (LGM; ~20-25ka BP) and during the early-Holocene (~11ka BP). The intensification in rainfall observed at i) ~60ka BP, ii) ~26ka BP and iii) ~10-3ka BP which corresponds to observed fire events. The $d^{13}C_{n\text{-}alkane}$ values showed the dominance of grassland between ~30-25ka BP with the cool and dry environment due to LGM which was favorable for wildfires. Further, the fire event at ~26ka BP identified at Main Belan temporarily overlaps with Mahagara and Koldihwa archaeological site. The absence of any major sign of thermal alteration of paleosols (supported by *n*-alkanes) in Koldihwa and Mahagara with indicates the local nature of the paleofire events. Similarly, fire events observed in this study coincides with the high rainfall condition which is unconducive to natural wildfires. Further, fire disturbance increases in the early Holocene to mid-Holocene overlaps with the timing of domestication of agriculture in the Belan valley. Therefore, this study postulate that the paleofire events were mostly induced by hominin groups living in the Belan valley.

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