The role of short-term disturbances in paleovegetation dynamics in a montane forest-grassland vegetation mosaic, Western Ghats, India

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November 23, 2022

Abstract

The Sandynallah valley (Western Ghats, India) features one of the oldest peat accumulations in the world at >50 kyr and has been central to the reconstruction of late Quaternary paleoclimate using paleovegetation changes in the forest-grassland vegetation mosaic that coexist here. It is well-known that short-term disturbances (fire, frost, intense drought) can also cause vegetation switches when multiple stable states exist, but this framework has seldom been considered in paleoecology investigations. Using stable carbon isotope signatures (relative C3-C4 vegetation abundance) on the cellulose fraction from two well-dated peat cores ˜170 m apart - Core 1 closer to the hillslope (32000 years old) and Core 2 from the centre of the valley floor (45,000 years old) - we looked at paleovegetation changes and the implications for paleoclimate reconstruction within the alternative stable states framework. Charcoal data from another sediment profile from the same valley was used to correlate with paleofires. We propose that the valley floor is bistable, switching between peat-forming vegetation 'sedgeland' and montane stunted evergreen forest 'shola', maintained by level of waterlogging. Core 1 shows shola-sedgeland dynamics with vegetation switching at c.22ka from shola (possibly due to fires) to a prolonged unstable state until 13 ka sustained by low waterlogging. Following a hiatus c.13-7 ka, sedgeland dominates, with a shift into shola at 3.75 ka driven by increasing aridity. Core 2 shows a relatively stable signature, enriched in C3-vegetation in the last glacial (45-20 ka) compared to the Holocene. Given temperature is the primary driver of abundance in C3-C4 mixed-grasslands, C4 dominance beginning c.18.5 ka followed by C4 enrichment is indicative of deglacial warming that continues into the Holocene except for a departure at ˜10 ka. The record at Core 2 is indicative of changing climate while Core 1 shows disturbance-based vegetation dynamics. The simultaneously distinctive vegetation states in Cores 1 and 2 within the same valley is the first record of alternative stable states in the past in the montane tropics. Our results point to the need to account for short-term disturbances and site attributes before ascribing vegetation changes to changing climate in alternative stable states landscapes.

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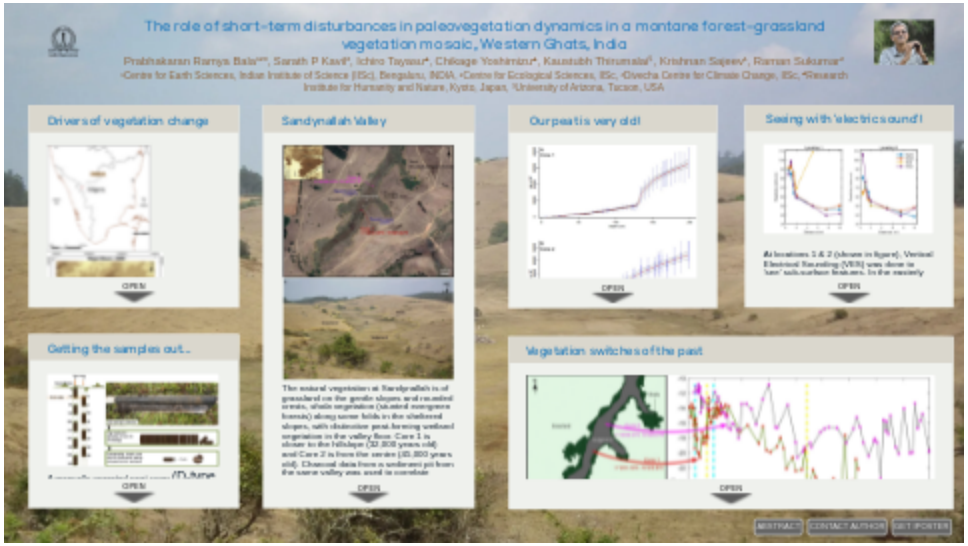

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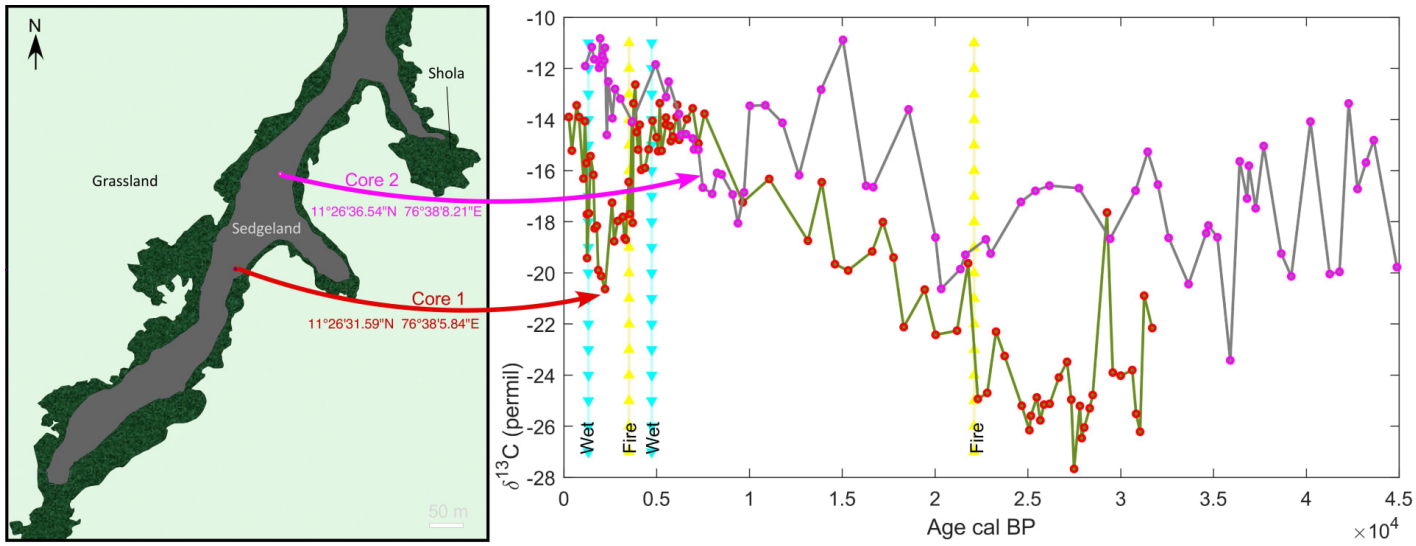
VEGETATION SWITCHES OF THE PAST



- Core 1 is an ecotone showing *shola*-sedgeland dynamics with vegetation switching at c.22ka from *shola forest* (C3 signature), possibly due to fire, to a prolonged unstable state until 13 ka sustained by low waterlogging.
- Following a hiatus c.13-7 ka, sedgeland (mixed C3-C4) dominates, with a shift into *shola forest* at 3.75 ka driven by increasing aridity.
- Core 2 shows a stable sedgeland signature responding to temperature, enriched in C3-vegetation in the last glacial with C4-dominance beginning c.18.5 ka, indicative of deglacial warming.

The distinctive vegetation states in Cores 1 and 2 within the same valley, responding independently to disturbances and climate, respectively, is the first paleo-record of alternative stable states in the montane tropics. Our results point to the need to account for short-term disturbances and site attributes before ascribing vegetation changes to changing climate in alternative stable states landscapes. For more details on our results please check out our preprint now accepted for publication in The Holocene - doi.org/10.1002/essoar.10504188.1