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Identifying drivers of near-surface reactivation in semi-arid landscapes using luminescence profiles and novel applications of modern analytical techniques

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Two billion people living in drylands are affected by land degradation. Sediment erosion by wind and water removes fertile soil and destabilises landscapes. A quantified understanding of vegetation cover sensitivities and resultant surface change to forcing factors is needed if the vegetation and landscape response to future climate change and human pressure are to be better predicted.

Using quartz luminescence-dated near-surface sediment profiles and records of climate change, land use history and wildfire frequency, this study attempts to identify drivers of sediment movement and near-surface reactivation. Luminescence ages, measuring the date since deposition, of near-surface profiles produce reactivation histories of aeolian sediments across dryland geomorphological features in the Niobrara Valley Preserve of the Nebraska Sandhills. Data on natural and anthropogenic driving forces, including precipitation, wildfire history and land use pressure, are taken from a range of instrumental and archival datasets from the local region, spanning the last two hundred years. Using a range of data analytical techniques, including machine learning, the relationship between sediment reactivation ages and corresponding driving parameters is explored to help identify and quantify the level of disturbance required to induce landscape reactivation. Identifying episodes of surface deposition and comparing with records of disturbances allows us to assess the future sensitivity, stability and thresholds of the landscape to a range of forcing factors, including climate change.