

EGU22-10759

<https://doi.org/10.5194/egusphere-egu22-10759>

EGU General Assembly 2022

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Insidious Retreat of the Holderness Coastline: Capturing Spatial and Temporal Patterns of Failure using Terrestrial Laser Scanning (TLS)

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The Holderness coastline of Eastern England is the fastest eroding coastline in Europe. The coast is characterised by 'soft sediment' tills, which make it distinctly susceptible to cliff retreat, in turn, these pose a socio-economic threat to local communities. The controls and future projections of the rates and patterns of retreat rely upon robust monitoring and process-based understanding of the geomorphological processes. Herein, we report on a 12-month monitoring study (June 2019 to May 2020) along a 220 m stretch of the Holderness coastline (Withernsea), whereby the spatial and temporal patterns of failure were captured using terrestrial LiDAR. Failure footprint, volumetric change and total eroded volume of the cliffs were estimated and compared against local hydrodynamic and meteorological records. The results reveal that >36% of individual failure events occurred solely in the upper portions (upper 75% vertical height) of the cliff, with a further >38% over the central section of the cliff face, with <26% occurring solely at the cliff toe (lower 25% cliff height). These findings disprove the widely accepted assumption that failure is primarily driven by wave attack, and we instead propose that instability in soft cliffs occurs as a result of moisture-driven 'structural weakening' with the influence of wave action primarily acting to remove failed material.