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Evaluation of resolution-precision relationships when using Structure-from-Motion to measure low intensity erosion processes, within a laboratory setting.

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The accessibility of Structure-from-Motion Multi-Stereo View (SfM) and the potential for multi-temporal applications, offers an exciting opportunity to quantify soil erosion spatially. Accordingly, published research provides examples of the successful quantification of large erosion features and events, to centimetre accuracy. Through rigorous control of the camera and image network geometry, the centimetre accuracy achievable at the field scale, can translate to sub-millimetre accuracies within a laboratory environment. The broad aim of this study, therefore, was to understand how ultra-high-resolution spatial information on soil surface topography, derived from SfM, can be utilised to develop a spatially explicit, mechanistic understanding of rill and inter-rill erosion, under experimental conditions. A rainfall simulator was used to create three soil surface conditions; compaction and rainsplash erosion, inter-rill erosion, and rill erosion. Total sediment capture was the primary validation for the experiments, allowing the comparison between structurally and volumetrically derived change, and true soil loss. A Terrestrial Laser Scanner (resolution of ca. 0.8mm) was employed to assess spatial discrepancies within the SfM datasets and to provide an alternative measure of volumetric change. The body of work will present the workflow that has been developed for the laboratory-scale studies and provide information on the importance of DTM resolution for volumetric calculations of soil loss, under different soil surface conditions. To-date, using the methodology presented, point clouds with ca. 3.38 x 10^7 points per m^2, and RMSE values of 0.17 to 0.43 mm (relative precision 1:2023-5117), were constructed. Preliminary results suggest a decrease in DTM resolution from 0.5 to 10 mm does not result in a significant change in volumetric calculations ($p = 0.088$), while affording a 24-fold decrease in processing times, but may impact negatively on mechanistic understanding of patterns of erosion. It is argued that the approach can be an invaluable tool for the spatially-explicit evaluation of soil erosion models.