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Using Structure from Motion to measure micro-topographic changes due to soil erosion by water

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Being able to parameterise the surface roughness, so as to predict the hydraulics of overland flow, is crucial for understanding the probability of soil detachment. Surface roughness is dictated by the complex, micro-topography of the soil surface. Existing methods to characterize the surface roughness are unable to accurately measure the small-scale surface changes that occur due to soil erosion. Furthermore, these methods are expensive both in terms of cost and labour time. In this study, an image-based three-dimensional reconstruction method known as 'Structure from Motion' (SfM) is adopted to acquire a high quality elevation model (DEM) at an exceptionally low cost. The study was carried out using flume experiments to simulate overland flow by water and by acquiring images of changing surface conditions to reconstruct the micro-topographic changes. The experiments reveal that the ability of SfM is substantial. Over an area of 250 x 250 mm the method is able to produce a dense point cloud of bed elevations at an error level of less than 0.8 mm. This reveals that we can measure the micro-topographic changes due to sediment detachment and subsequent rill formation at a resolution and error level that far exceeds the standards of existing methods. Thus SfM is an exciting method for examining flow-bed interactions in soil-erosion research.