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Investigation into the momentum transfer between an impacting raindrop and a granular bed using 3-dimensional particle tracking

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The transportation of soil particles through the process of raindrop impact is a significant mechanism within the process of soil erosion. However, even though splash transport has received considerable attention over the years, little is still known about the transfer of momentum between raindrops and soil particles, with only a few recent studies investigating the fundamental interactions involved. The work presented in this study examines the interaction that occurs between an impacting water droplet and a bed of loose, graded sand, with the aim of providing further insight into the transfer of energy between them. The study focuses on quantifying the ejection of particles from the bed through momentum transfer and the resultant change in the morphology of the bed caused by the impact. The nature of the interaction that occurs between the water and the sand is defined by a large number of variables such as droplet size, impact velocity, fluid viscosity, surface tension, grain size, grain shape and packing density. However, for this study, all of these variables are kept as constant as possible, with multiple runs made of the same individual interaction, in order to examine the complexity and variability of the event. To investigate the interaction that occurs, three different techniques are used: i) High speed imaging of the interaction, looking at the dynamics of both the water and the sand ii) Three dimensional, time resolved particle tracking of the grains ejected from the sand bed during the event iii) Surface profiling of the crater produced by the impact and the large clumps of sand transported from the crater edge. The data produced demonstrates that, for example, for a 3.7–mm raindrop impacting a 150-160 μm sand bed at 6.2 m/s, only approximately 2% of the momentum of the rain drop gets transferred to the ballistic ejection of dry sand particles from the crater edge. The small amount of momentum transferred explains why the large amounts of energy present in rainstorms cause only a small proportion of total soil erosion by water processes.