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The role of particle wettability in splash detachment behaviour: a simulation study using hydrophobic and hydrophilic glass beads

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Water repellent soil is often more susceptible to erosion compared with wettable soil. Many studies have suggested that reduced infiltration and the resulting increase in overland flow is one of the main indirect causes of the enhanced erosion on a water repellent soil surface. However, there has been relatively little research on how soil water repellency directly affects soil erosion. Apparent differences in splashing behaviour between water repellent and wettable soil surfaces have been reported in a study using cumulative drop impacts (Terry, 1992), where bigger ejection droplets and lower and shorter trajectories of splash ejections were found for the water repellent soil. However, these findings have not been confirmed in any follow-up study. In order to understand the mechanism underlying the different splashing patterns between water repellent and wettable soils, examination of the effects of the initial drop impact on splash erosion is warranted. This study aims to investigate the splash behaviour following impact of a single water drop on arrays of water repellent and wettable particle surfaces.

Acid-washed and chemically hydrophobized glass beads were used as hydrophilic and hydrophobic particles. The beads were held in an array within a circular holder of 1.5 cm diameter on the centre of a 20 cm diameter disk. A de-ionized water drop (20 μL) was dropped from a height of 40 cm into the centre of the array. A black paper disk covered with adhesive captured ejected particles. The populations of, and distances travelled by, the particles were compared for four arrays of size fractions within the range (180-850 μm). The trajectories of ejections were recorded with a resolution of 3000 frames per second by high-speed video. Three replications were made for each test. More splash detachment was observed for hydrophobic particles compared with hydrophilic ones in agreement with Terry (1992) and Fox (2007). In contrast to those studies, however, we observed that a single drop impact resulted mainly in dispersion (splash saltation), with few ejections (splashing) of particles, and the trajectories of ejections from hydrophobic particle arrays were higher than those from the hydrophilic arrays. The details of these phenomena are analysed based on high-speed video records and discussed in this contribution.

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