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Can changes in soil surface characteristics be related to sediment dynamics?

Alona Armstrong and John Quinton
Lancaster University, Lancaster Environment Centre, Lancaster, United Kingdom (alona.armstrong@lancaster.ac.uk)

Progressing the fundamental understanding of soil erosion processes is of increasing importance given the need to reduce diffuse pollution as a result of its impact on aquatic ecosystems and the introduction of legislation such as the European Water Framework Directive. The Hairsine-Rose soil erosion model suggests that a surface shield develops which protects the underlying soil from erosion and reduces the availability of the preferentially transported finer sediment, which is also enriched in nutrients and contaminants. However, there is no validation data from natural soils. In addition, understanding the breakdown of surface aggregates is a key challenge when considering sediment transfer from the soil surface. In order to further our understanding of both the development of surface shields and aggregate breakdown we undertook factorial experiments, in triplicate, examining the impact of soil type, slope, infiltration and water ponding on the soil surface. The experiments were carried out using a drip-type rainfall simulator at a rainfall intensity of 45 mm hr-1 for two hours onto soil packed into 25 cm by 25 cm soil boxes. A silt loam and a sandy loam soil were used, the slope was set at 2% or 10%, infiltration was free-flowing or impeded and the ponding depth was 0, 0.3 or 0.7 cm. After rainfall the soil surface was assessed by measuring the size of aggregates and particles at the intersections of a grid overlaid on a high resolution photograph and by laser particle size analysis of surface scrape samples. Furthermore, the runoff was collected at ten minute intervals during the experiments and analysed for sediment concentration and particle size. Soil type, slope, ponding depth, and to a lesser extent infiltration, were found to affect the particle size distribution of the soil surface and runoff samples. Comparison of the dominant controls over the surface and runoff samples allows inferences to be made about the mechanisms controlling the breakdown and movement of sediment.