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Deriving hydraulic roughness from camera-based high resolution topography in field and laboratory experiments

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The hydraulic roughness, represented by Manning's n, is an essential input parameter in physically based soil erosion modeling. In order to acquire the roughness values for certain areas, on-site flow experiments have to be carried out. These results are influenced by the selection of the location of the test plot and are thereby based on the subjectiveness of the researchers. The study aims on the methodological development to acquire Manning's n by creating very high-resolution surface models with structure-from-motion approaches.
Data acquisition took place during several field experiments in the Lainbach valley, southern Germany, and on agricultural sites in Saxony, eastern Germany, and in central Brazil. Rill and interrill conditions were simulated by flow experiments. In order to validate our findings stream velocity as an input for the manning equation was measured with coloured dye. Grain and aggregate sizes were derived by measuring distances from a best fit line to the reconstructed soil surface. Several diameters from D50 to D90 were tested with D90 showing best correlation between tracer experiments and photogrammetrically acquired data. A variety of roughness parameters were tested (standard deviation, random roughness, Garbrecht's n and D90). Best agreement in between the particle size and the hydraulic roughness was achieved with a non-linear sigmoid function and D90 rather than with the Garbrecht equation or statistical parameters. To consolidate these findings a laboratory setup was created to reproduce field data under controlled conditions, excluding unknown influences like infiltration and changes in surface morphology by erosion.