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Photogrammetric measurement of soil surface properties after splash erosion under natural and artificial rainfall

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Splash erosion is the initial stage of the soil erosion caused by rainfall and it results in significant changes of the soil surface. One of the efficient techniques for measuring soil surface changes is close range photogrammetry („Structure from Motion“). It provides satisfactory results even with mid-range customer cameras.
The photogrammetric method was used in splash experiments with modified Morgan splash cups. The experiments were performed on three different locations, the Czech Republic (Prague) and two sites in Austria (Mistelbach and Petzenkirchen). The monitoring was conducted during year 2017 under natural rainfall and tested soil samples from all three sites. Additional measurements were done during winter of the same year with the laboratory rainfall simulator at CTU in Prague. In this case, only the soil samples from the Czech Republic were tested.Photogrammetic monitoring included acquisition of 12 pictures of the soil surface of every soil sample prior and after the rainfall. Each shot was taken from different angle but overlapping the others with about 90 %. For reference purposes, the splash cup is provided with a ring containing 16 reference targets, keeping identical coordinate system for each splash cup. In addition, due to the low light level in the laboratory, LED lighting was designed for the laboratory testing to ensure a sufficient and uniform sample illumination in the 360° range.
The photogrammetric monitoring results in sets of digital elevation models. The DEMs were evaluated, the properties of the soil surface and its changes due to the impact of rain drops were analyzed. These values were further compared with the rainfall parameters and measured splash erosion. Data from the laboratory measurements shows less variability due to steady and controlled conditions compared to natural rainfall. Relationship between rainfall intensity and average surface roughness variation from 5 experiments (each with 12 samples) can be described by linear regression function with an acceptable coefficient of determination of 0.76. The linear relationship between the surface roughness change and the rainfall kinetic energy results in the coefficient of determination of 0.62. The relation between average volume of splash and average surface consolidation results in the R2 of 0.54, whereas the volume of splash and surface roughness change relation results in R2 of 0.65.

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