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SfM photogrammetry with a smartphone camera in the evaluation of two soil roughness indices

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A preliminary evaluation of two soil surface roughness indices derived from a SfM photogrammetry survey was performed. Two experiments of rainfall simulation on replicated micro-plots (1 m x 0.92 m, slope 16%) were carried out in a silty-clay loam soil at Masse experimental station (central Italy). Each experiment started from seedbed conditions and included a sequence of three simulated rainfalls. Each rainfall included two phases: a wetting phase of about 30 min with intensity of about 40 mm/h (kinetic energy 9.5 J·mm-1·m-2), followed by a rainfall event with intensity of about 70 mm/h and duration between 60-75min (kinetic energy 14.5 J·mm-1·m-2). An iPhone6sPlus was used for SfM photogrammetry survey. Three surveys were carried out for each simulated rainfall: before the wetting phase, at the beginning and at the end of the event. For each survey about 100 frames were taken vertically from a height of approximately 2m around the perimeter of the plots and then were processed using AgiSoftPhotoScan to obtain the point cloud and the 0.002 m x 0.002 m DEM.
From each point cloud a roughness index R, was evaluated using the software CloudCompare: for each point a roughness value, Rc, is calculated as the absolute distance between this point and the best fitting plane computed on its nearest neighbors, which are identified giving in input a “kernel size” (i.e. the radius of the sphere centered on each point). The R index was evaluated as the standard deviation of the Rc assuming the mean equal to 0. Three kernel size of 0.01m (R1), 0.05m (R5),0.1m (R10) were used.
From each DEM a roughness index-elevation, RI, was calculated by the method described in Cavalli et al.(2008). The software SedInConnect was used to obtain the RI maps (0.002m x 0.002m) using a moving window of 5-cells (0.0001m2), 25-cells (0.0025m2) and 50-cells (0.01m2). The indices RI5, RI25 and RI50 were computed as the mean value of the corresponding RI maps.
R1 resulted significantly correlated with RI5, RI25 and RI50 (r=0.67, r=0.83, r=0.75), while R5 and R10 resulted significantly correlated only with RI25 (r=0.87 and r=0.81) and RI50 (r=0.83 and r=0.8).
The two indices R and RI were used to assess the exponentially decrease of the roughness ratio with the cumulated precipitation, P and rainfall kinetic energy, E. The higher values of the determination coefficient R2 were obtained for R5 (R2= 0.62 and 0.73) and for RI25 (R2= 0.43 and 0.4) for P and E respectively.
The slope coefficient obtained for RI25 and R5 resulted similar or equal to that proposed by other authors.
Furthermore the RI index resulted to be the more efficient in estimating the maximum depression storage quantified with a DEM-derived procedure.

References

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