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Using airborne LiDAR to estimate vegetation's influence on throughfall kinetic energy

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Enormous social and economic impacts can be caused by soil loss from erosion. Splash effects from drop impacts are known to be a major driver of erosion processes, however it is not fully understood how vegetation affects splash erosion. Throughfall kinetic energy (TKE) is a widely used parameter to assess vegetation influences on splash erosion and can be measured in situ (e.g. by splash cups). However, most previous studies on TKE remained on plant- or plot-level measuring a heterogenous set of parameters to characterize vegetation. The present study aims for the development of new methodology for large-scale and area wide estimation of the influence of vegetation on TKE by utilizing remote sensing methods. We identified the key vegetation variables affecting splash erosion in an extensive literature review and derived a conceptual model describing the interaction of vegetation and rainfall. Our model emphasizes the distinction between amplifying and the protecting effects of vegetation layers according to their height above the ground and aggregates them into a new indicator: The Vegetation Splash Factor (VSF). The VSF is based on the leaf area density (LAD), derived from an airborne LiDAR dataset and a dynamic weighting factor. The straightforward implementation of VSF allows simple integration in future studies on splash erosion adding consistent means of comparison. To prove our concept, we conducted a case study for which we calculated the VSF using airborne LiDAR data from the La Campana National Parc in central Chile. The studied catchment comprises a heterogeneous mosaic of layer combinations and vegetation types and is hence ideal to test the approach. The resulting VSF raster map shows increased values in areas with high vegetation without understory, whereas ground cover results in negative values. It is thus consistent with the model. We calculated a mean VSF of 0.98 (median: 0.76), which indicates an amplifying overall effect of vegetation on TKE. Negative values (protective effect) were calculated for 27 % of the area. The discrete return LiDAR dataset did not allow a reliable separation of the point cloud into ground and low vegetation returns, thus returns from bare soil were not removed from the vegetation. Full waveform LiDAR data would allow to exclude returns from bare soil based on their shorter echo amplitude in the last return and should thus be utilized in future studies. Furthermore, we recommend the refinement of the weighting factor by calibrating it to local conditions using field-reference data and comparing the VSF with erosion measurements in the field.