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Time for 3D: UAV-based lidar for modelling splash erosion under vegetation

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Rain throughfall under vegetation is determined by characteristics of the vertical structure and the associated plant traits. It goes both ways: A protective layer of ground covering vegetation or leaf litter can decrease throughfall kinetic energy (TKE), whereas the formation of large drips in the canopy layers has been found to increase TKE. Abstracting the three-dimensional vegetation structure into usable quantitative metrics is challenging, and therefore these processes have not yet been sufficiently integrated into spatial erosion models. The vegetation splash factor (VSF) was designed to close this gap (Senn et al. 2020, DOI: 10.1002/esp.4820). The VSF quantifies the influence of vegetation on TKE and can be calculated from aerial lidar point clouds. In the first step, we derive the vegetation cover in a voxel space, which then allows modelling the proportional contribution of drips per layer to reach the ground. Hence, the approach is strictly based on the 3D structure rather than conventional forestry parameters, e.g. crown diameter or leaf sizes. Here, we present the result of the first application of the VSF in a small scale field study using splash cup measurements to validate and refine the concept.

We implemented the experiment in a mixed-broadleaf forest near Bretten, Germany with a beech and an oak-dominated plot to cover a variety of vertical forest structure configurations and a diverse composition of species. Each plot comprised two transects of ten splash cups to measure sand loss - as a proxy for TKE - during six individual rainfall events. In addition, we used micro-scale runoff plots to determine the effect of soil covering layers such as leaf litter or biological soil crusts in comparison to bare soil. The VSF was calculated in R with a voxel resolution of 0.5 x 0.5 x 0.25 m using a UAV lidar dataset.

Initial results from the splash cup measurements showed that young oak induced about 70 % higher TKE than adult beech trees. Among the individual cup positions, the lowest energy values were measured without canopy influence as freefall kinetic energy (FKE), TKE at positions with an intermediate young growth and shrub layer showed medium values. In near-trunk and mid-positions without intermediate layers, we measured TKE values more than twice as high as FKE. This resulted in significant sediment removal beneath the tree layer when the ground covering

vegetation layer was removed, which is in accordance with studies from other ecosystems. Grouped according to these conventional vegetation structural criteria, we found that the calculated VSF values clustered around similar values and correlated with sand loss from splash cups. From these initial results, we assume general suitability of the VSF to reflect the influence of vegetation structure on TKE. Further, more detailed analysis will now be done to adjust and calibrate the VSF model to produce more indicative results. The preliminary findings presented here will be further expanded to be presented at vEGU21.