Time for 3D

UAV-based lidar for modelling splash erosion under vegetation

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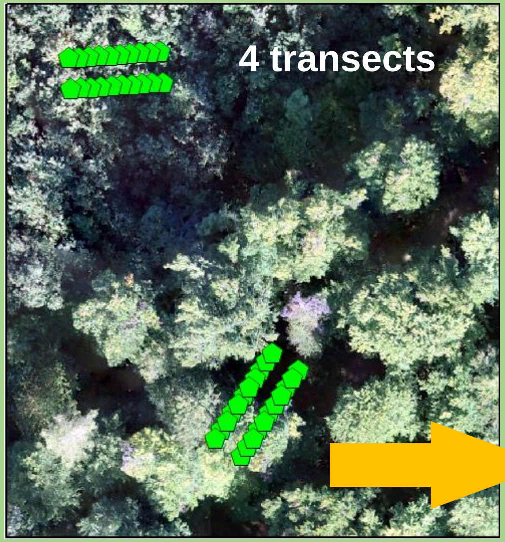
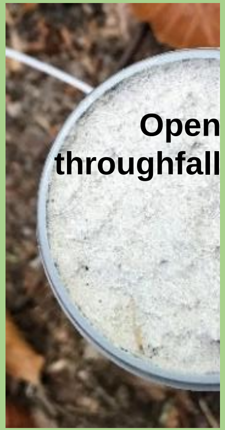
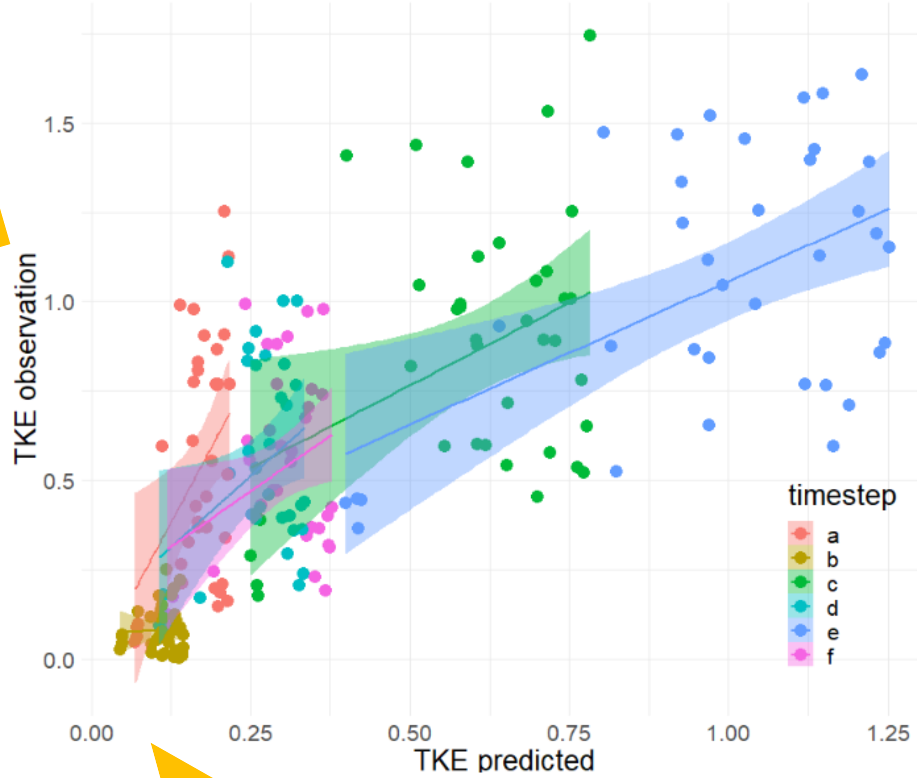
Observations

TKE measured for 6 precipitation events

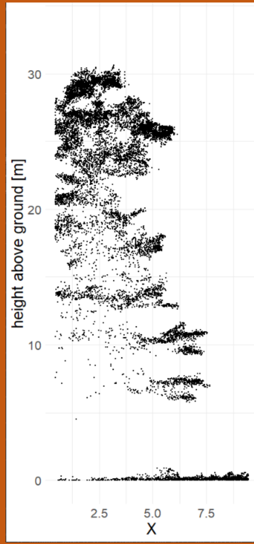




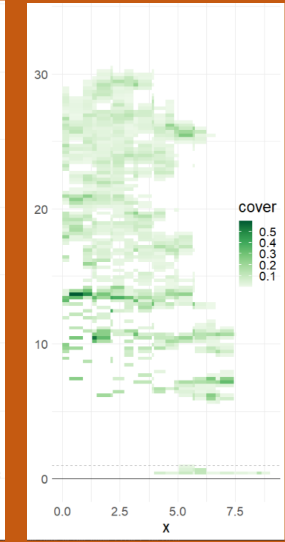


Model

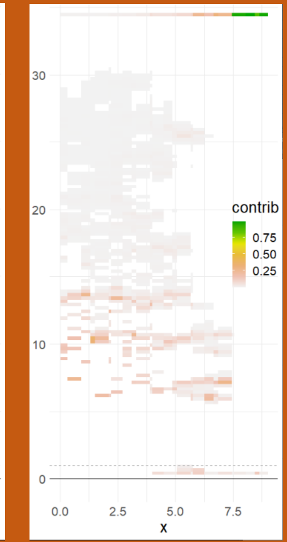
Illustrated along transect



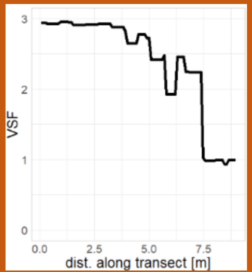
Point cloud



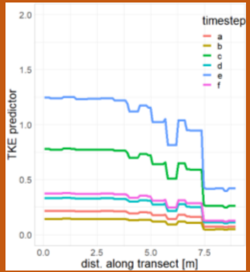
Vegetation cover 3D



Drip contribution



Vegetation splash factor



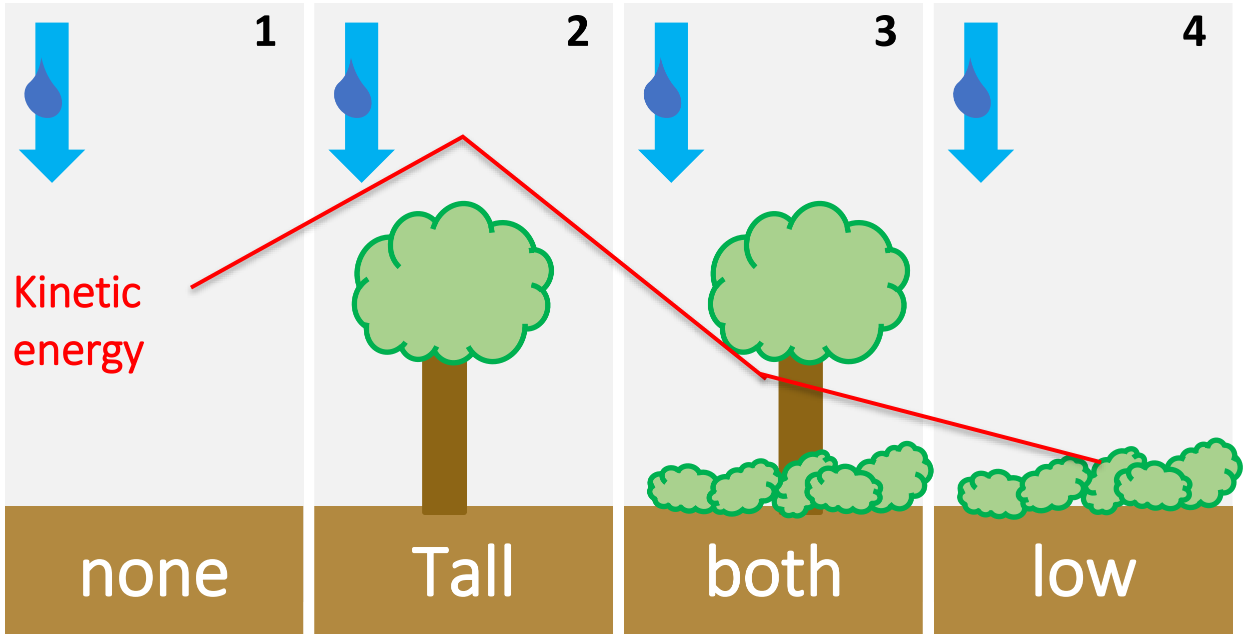
TKE predictor

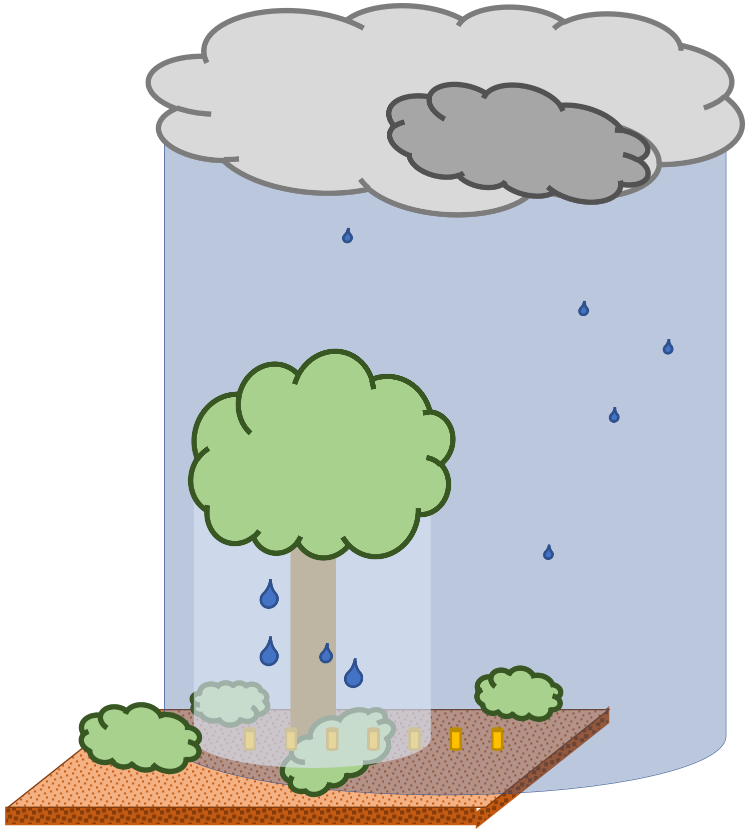
Sharing is encouraged

@remotesennsing

The Idea

- Throughfall Kinetic Energy (TKE) under vegetation is determined by characteristics of the vertical structure (canopy) and plant traits

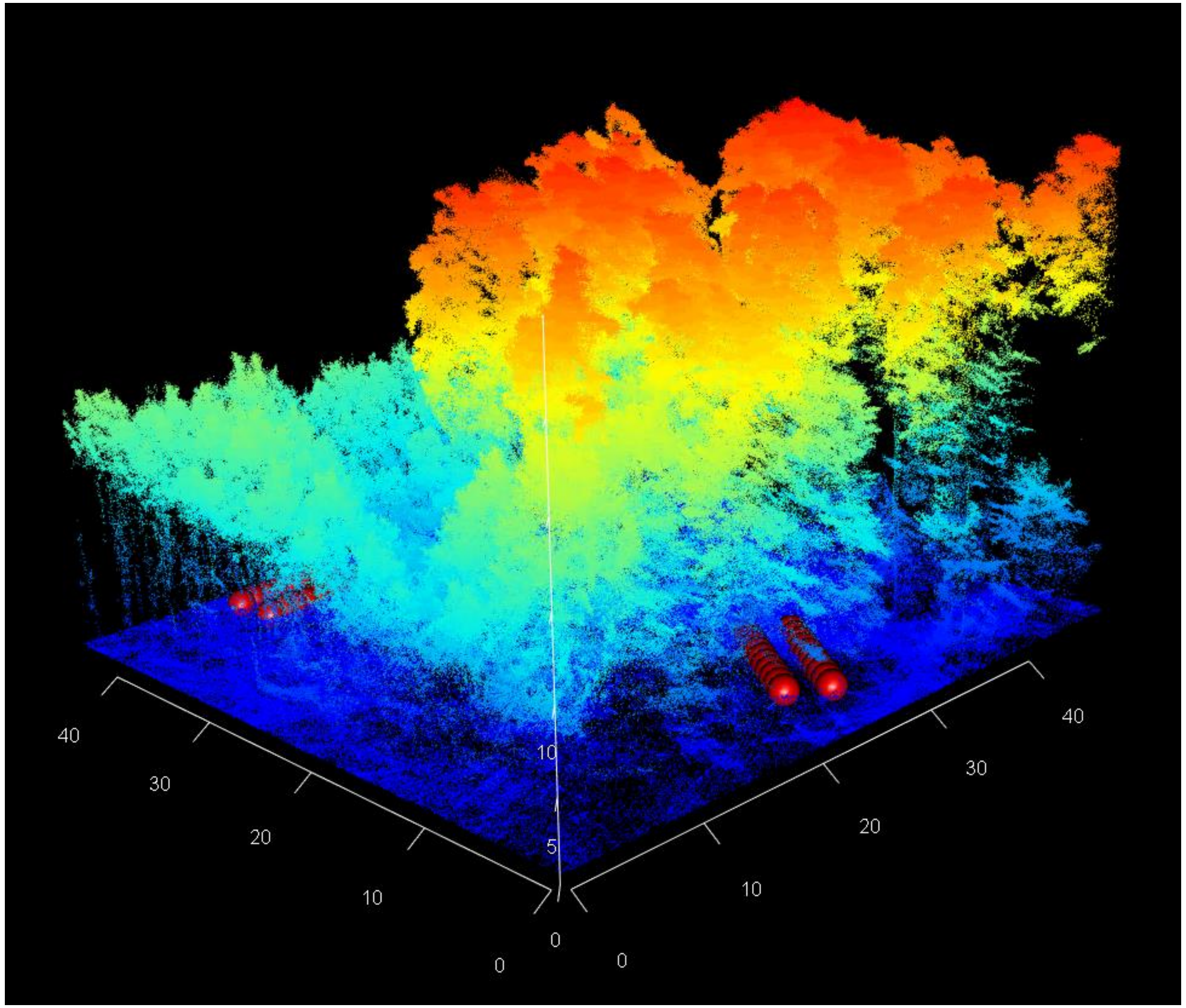




It goes both ways:

- A protective layer of ground covering vegetation can decrease TKE
- The formation of large drips in the canopy layers has been found to increase TKE

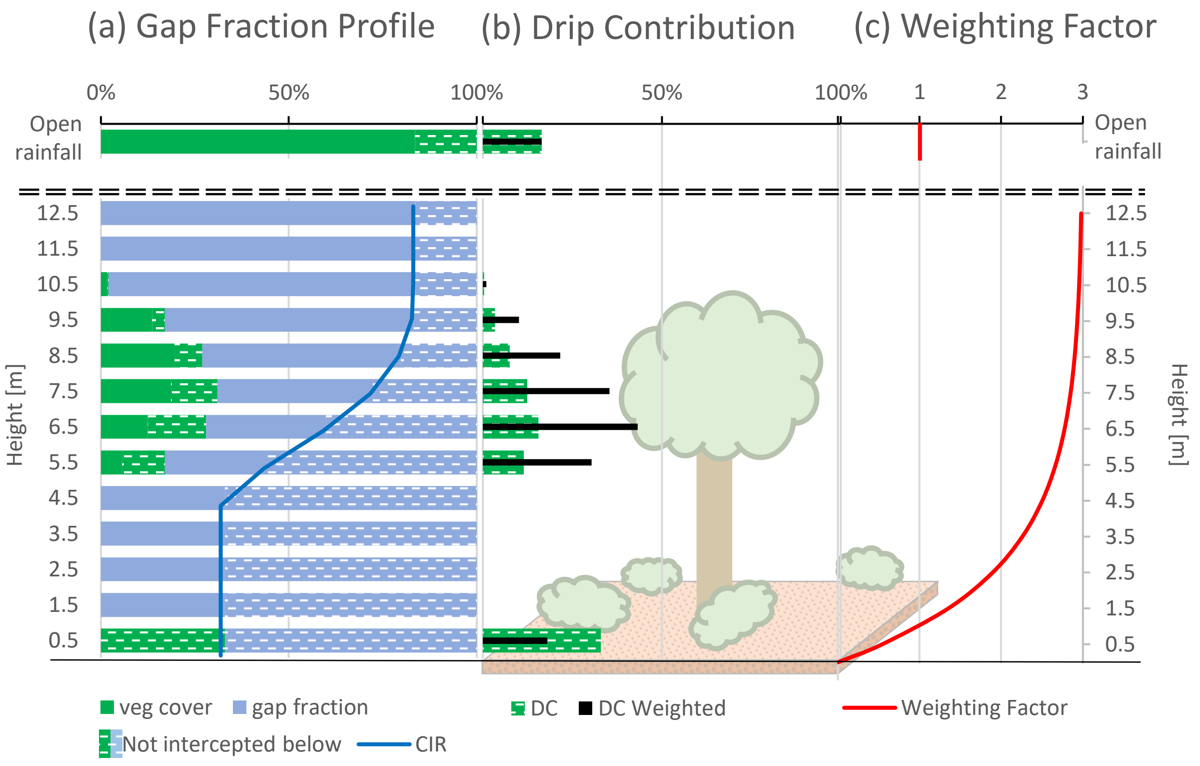
A spatially continuous representation



- Previous research has focused on the relationship between TKE and manually determined tree parameters such as crown diameters or leaf sizes
- The vegetation splash factor (VSF) aims at spatially continuous modelling of TKE
- It is strictly based on 3D vegetation structure and calculated from aerial lidar point clouds (UAV/airborne)
- The VSF represents the influence of vegetation on TKE relative to freefall kinetic energy (FKE) of open rainfall

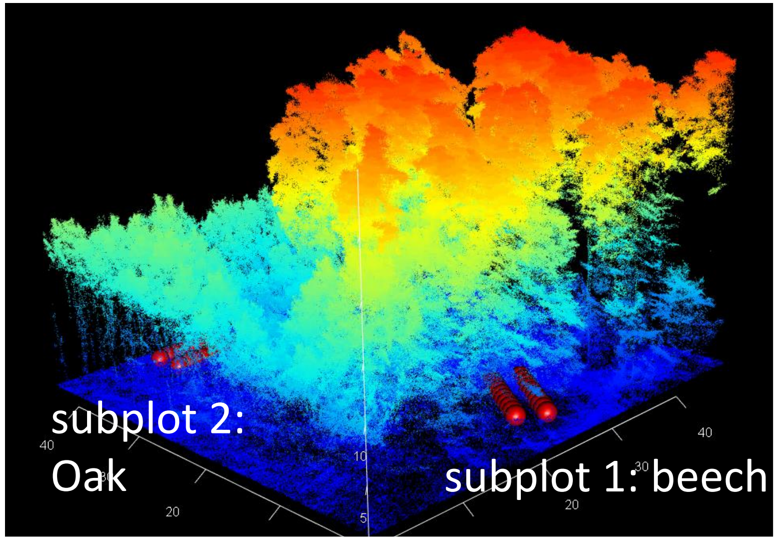
The concept

- 3D gap fraction / vegetation cover calculated from the point cloud.
- Cover = statistical probability of interception in a layer
- Drip contribution: Per layer percentage of drip / throughfall to reach the ground without interception below
- Weighting factor represents protective / amplifying effect depending on the height above ground
- VSF: vertical sum of weighted drip contribution
- TKE predictor: multiply VSF with FKE measurement / prediction based on precipitation / disdrometer



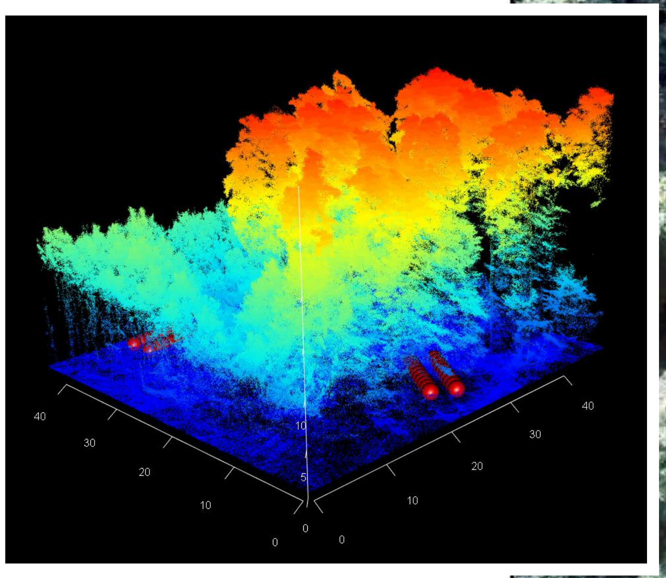
The pilot study

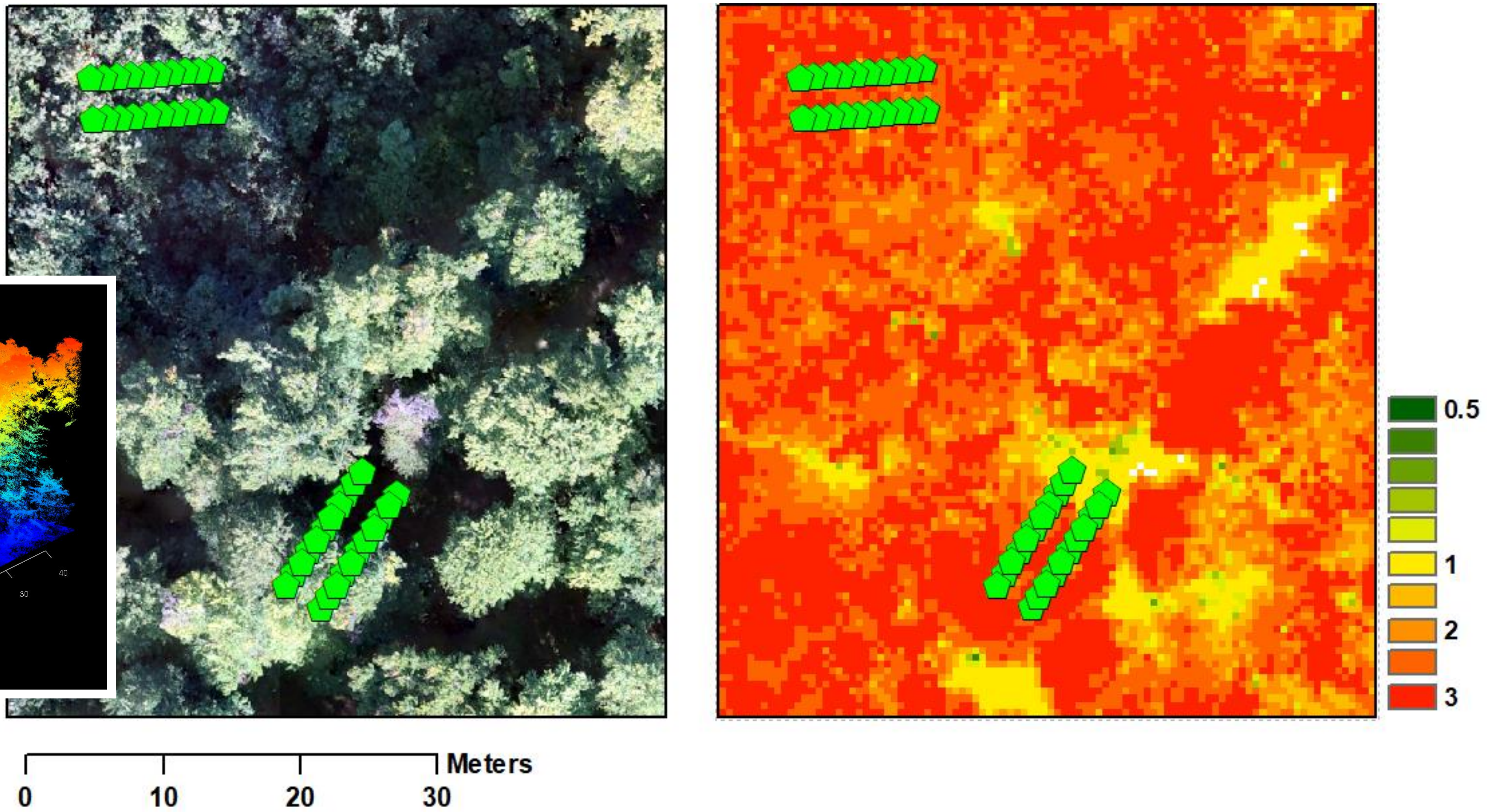
- ULS point cloud
- Field site: Bretten, Germany
- 2 subplots of different vegetation structure (Tall beech trees no understory / Young oak trees some understory)
- 2 transects per subplot (10 splash cups per transect)
- 6 time steps of measurements between July – October 2020



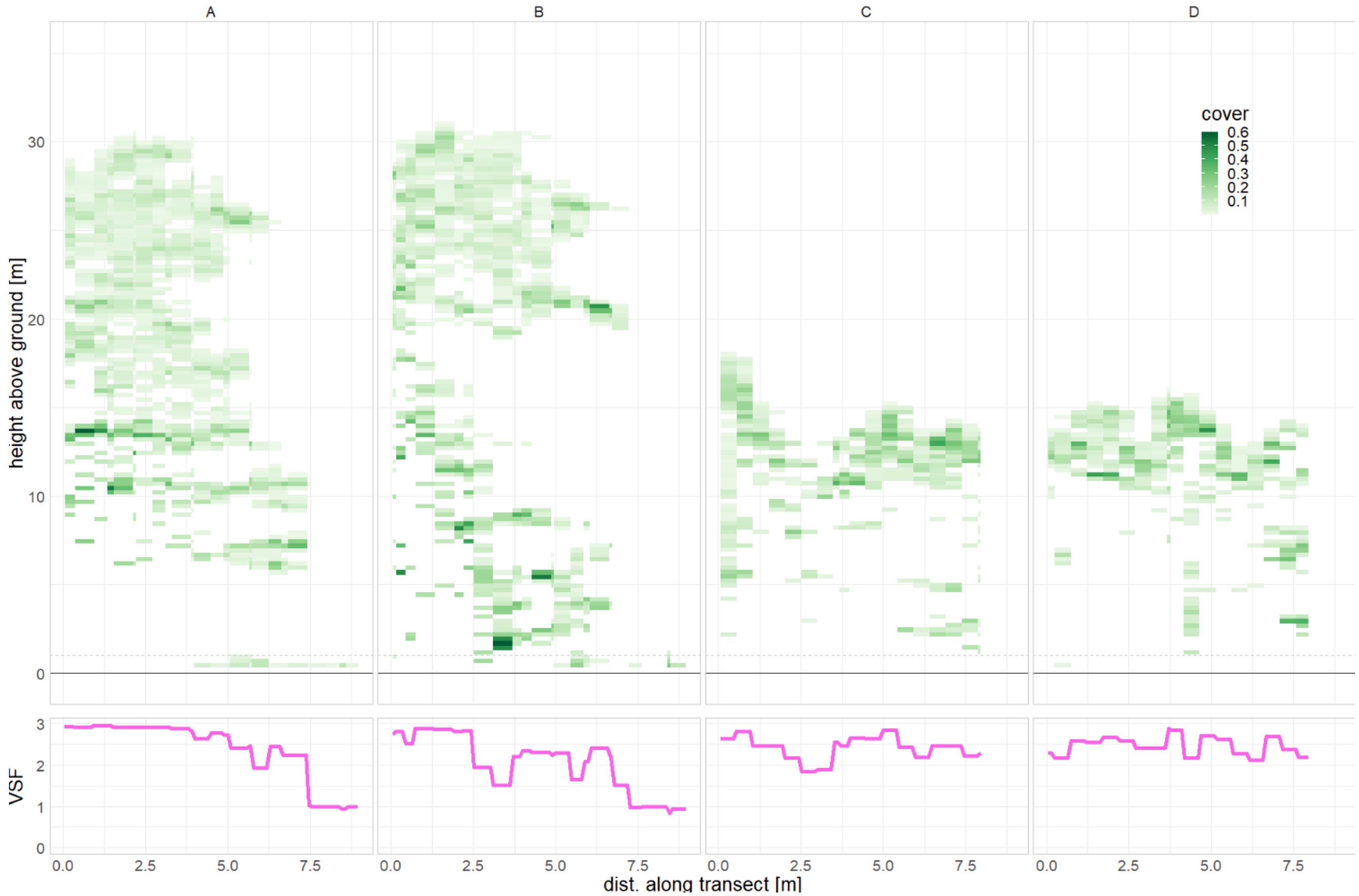
Splash Cups measure sand loss from drop impacts as proxy for TKE

Results: VSF Map





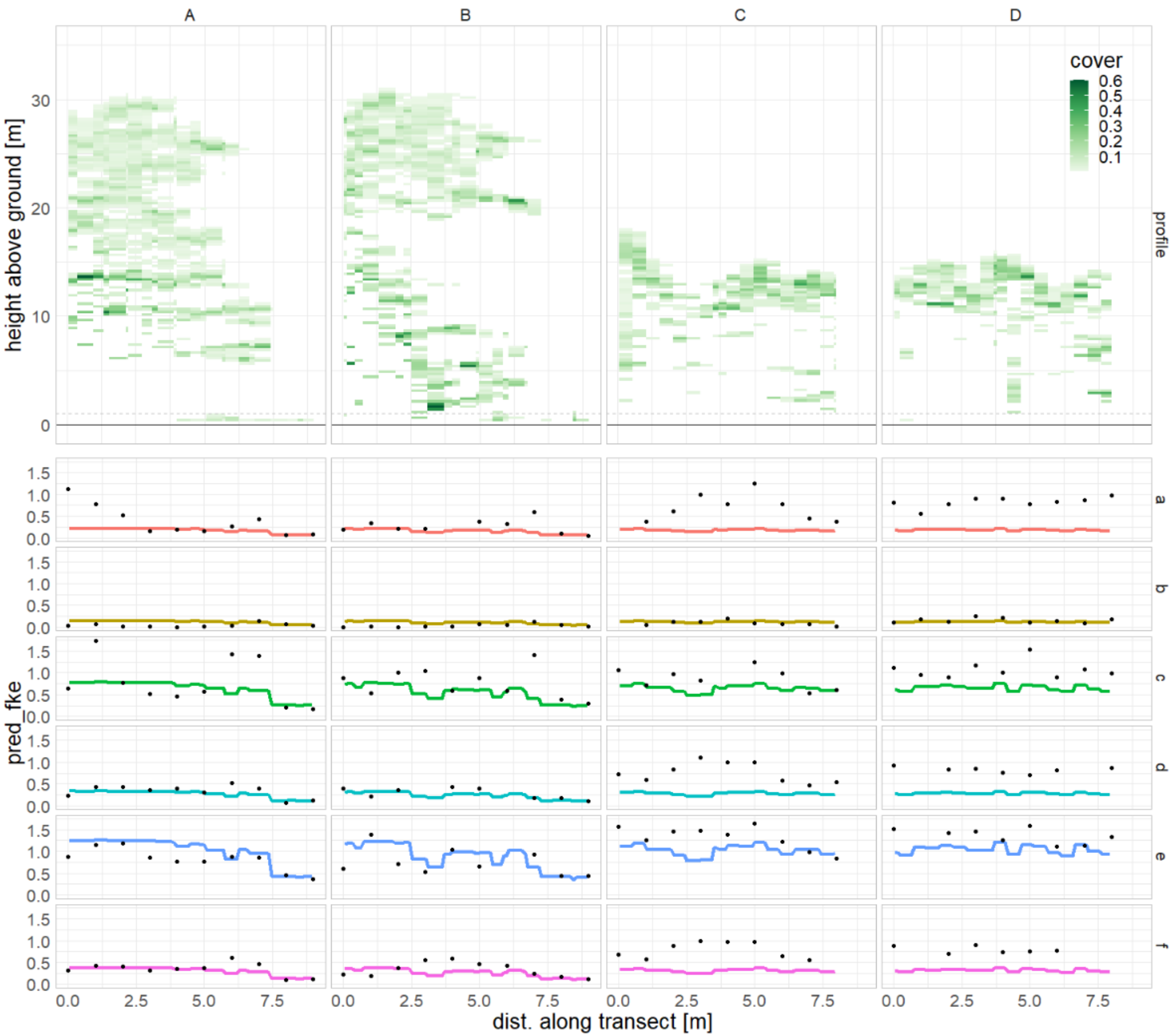
Results: Vegetation cover profiles and VSF

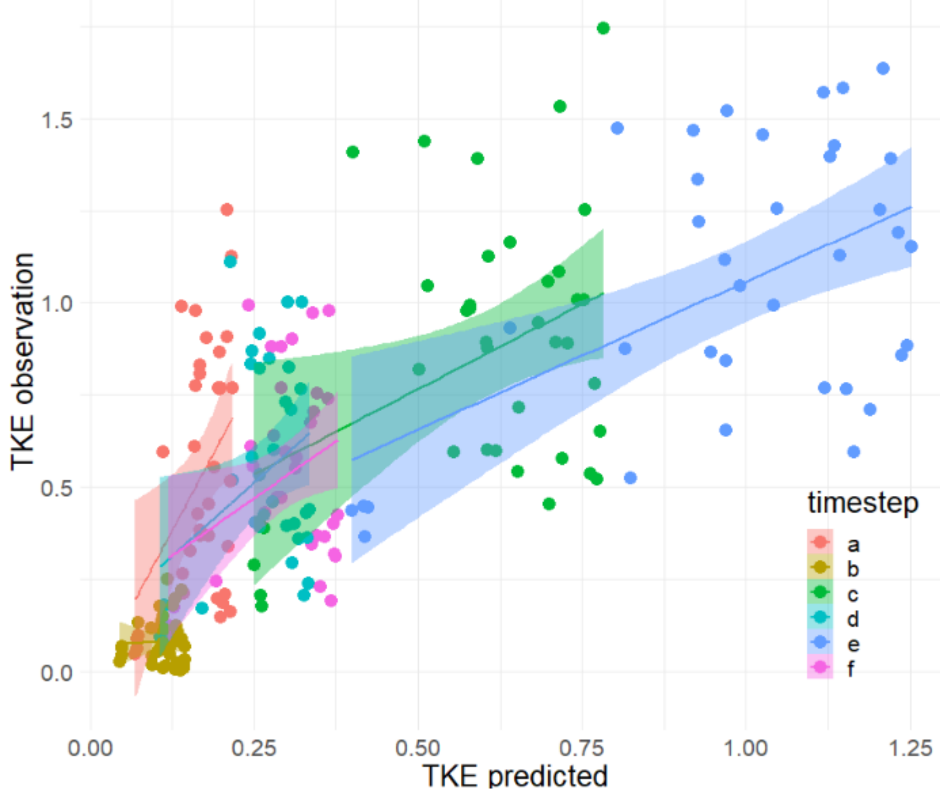


The four transects through the vegetation cover voxel space and the calculated VSF values below.

The TKE predictor is calculated by multiplying the mean freefall kinetic energy (FKE) with the VSF (see next slide)

Results: TKE observation vs. predictor



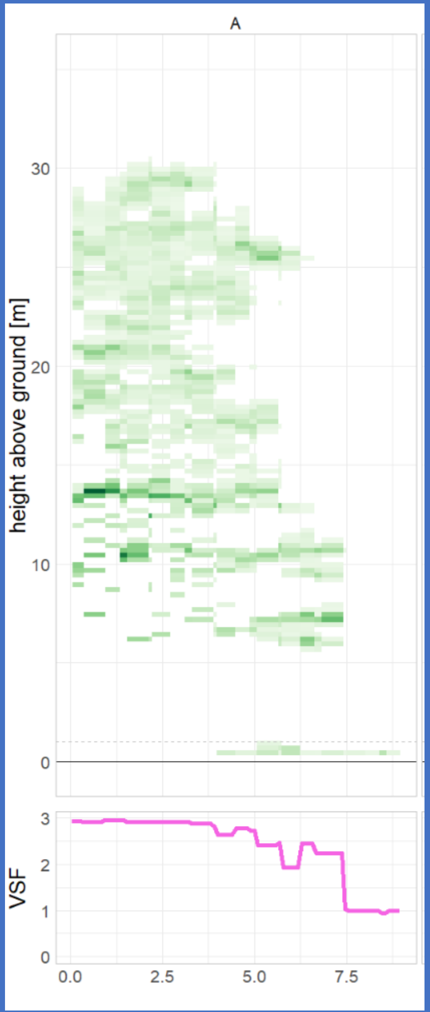


- Profiles: The TKE observations (black points) and the predicted TKE (rainbow lines) along the transects
- Or as Scatterplot: predictions / observations coloured by timestep

Vegetation Runoff plots

Site 1

Tall beech trees
no understory

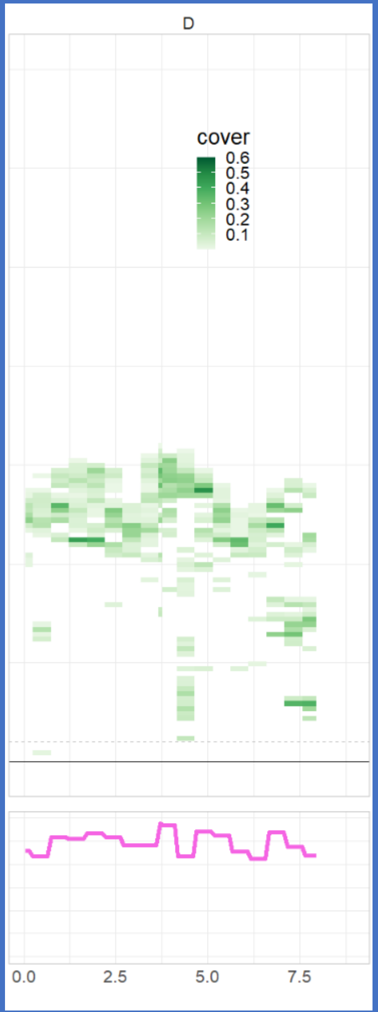


Plot 1: Bare soil	Plot 2: Leaf litter
2.8g	0.1g
430 ml	840 ml

Site 2

Young oak trees
Some understory

Plot 3: Bare soil	Plot 4: biocrust
1.5g	<0.1g
1350 ml	190 ml



Start	End	mm total timestep	mm daily peak	mean loss	KE
07.07.	21.07.	23	14,40	3,65	319,25
21.07.	05.08.	2,8	2,40	0,55	48,07
05.08.	26.08.	25,9	15,50	5,97	522,82
26.08.	18.09.	21,5	13,10	3,66	320,17
18.09.	28.09.	39,5	19,50	7,17	627,80
28.09.	22.10.	22,1	3,40	3,61	315,98

Future improvements

- Sample size in this pilot study too small for advanced statistics (ideally 2000+ splash cups)
- Splash cup measurements at 30 cm above ground (to avoid interference)

  -> incomplete representation of understory vegetation

  -> cut off vegetation cover dataset (simulate absence of 0-25 cm vegetation layer)

  -> future research requires to sample under low vegetation
- GNSS location of cup position (to be improved e.g. with registered TLS point cloud)

Previous publication

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A new concept for estimating the influence of vegetation on throughfall kinetic energy using aerial laser scanning

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ESPL
Earth Surface Processes and Landforms

ABSTRACT: Soil loss caused by erosion has enormous economic and social impacts. Splash effects of rainfall are an important driver of erosion processes; however, effects of vegetation on splash erosion are still not fully understood. Splash erosion processes under vegetation are investigated by means of throughfall kinetic energy (TKE). Previous studies on TKE utilized a heterogeneous set of plant and canopy parameters to assess vegetation's influence on erosion by rain splash but remained on individual plant- or plot-levels. In the present study we developed a method for the area-wide estimation of the influence of vegetation on TKE using remote