Disentangling Plant-Induced Soil Effects on Runoff: Experiments and Modeling of *Miscanthus*

Florian Bucher [1], Mark Tuschen [2], Mariele Evers [2], Markus Weiler [1]

HYDROLOGY

Soil Effects of *Miscanthus*

The cultivation of perennial crops such as *Miscanthus* leads to long-term changes in soil physical properties. These effects are primarily driven by:

Permanent Root Clumps
- Less Erosion
- High and Persistent Surface Roughness

Permanent Mulch Layer
- Reduced Soil Evaporation
- Improved Soil Moisture Retention
- Cover and Nutrition for Soil Organisms

Low Management Intensities
- Lower Soil Compaction
- Preservations of Soil Structure

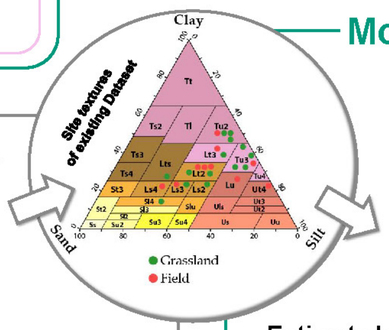
Positive effect on runoff formation and retention during heavy rainfall events?

Hypothesis 1: *Miscanthus* reduces surface runoff formation.

Hypothesis 2: *Miscanthus* has a significant retention effect.

Existing Dataset & RoGeR

Ries et al. (2020) conducted 132 sprinkler rainfall experiments across a range of soil types using a comparable experimental setup. This dataset was used to validate the RoGeR model. (Steinbrich et al., 2016)



RoGeR – Runoff Generation Research Model
- Physically based, parameterized with local soil properites (no calibration required)
- Includes preferential flow processes to analyze runoff formation mechanism

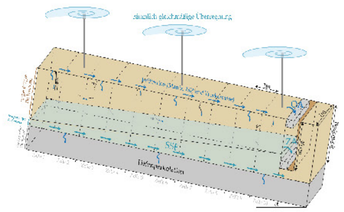
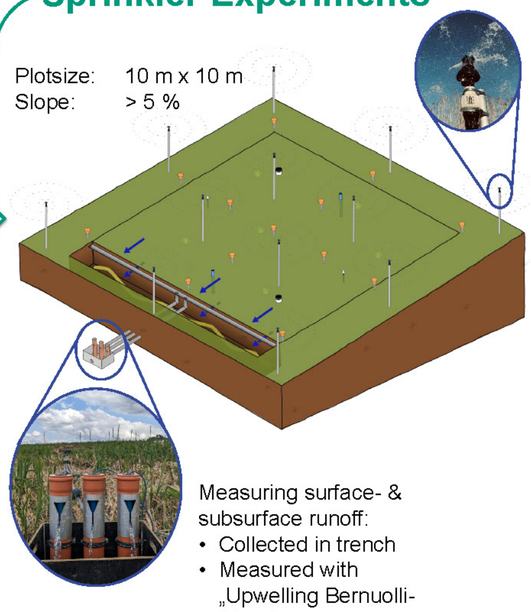


Fig. 1: Schematic representation of the simulation of heavy rainfall experiments using RoGeR

Sprinkler Experiments

Plotsize: 10 m x 10 m
Slope: > 5 %



Measuring surface- & subsurface runoff:
- Collected in trench
- Measured with „Upwelling Bernuolli-tubes“

Sequence of Simulated Events

	Day 1			Day 2	
Duration (min)	60	15	30	60	180
Intensity (mm/h)	46	114	74	46	21

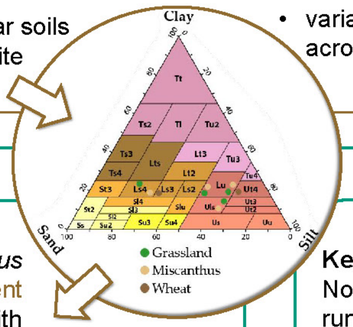
Min. 60 minutes in between

Cultivated Crops per Field Site

Miscanthus & Grassland & Winter Wheat*

* Only on selected Sites

Soil Textures on Field Sites
- similar soils per site
- variability across sites



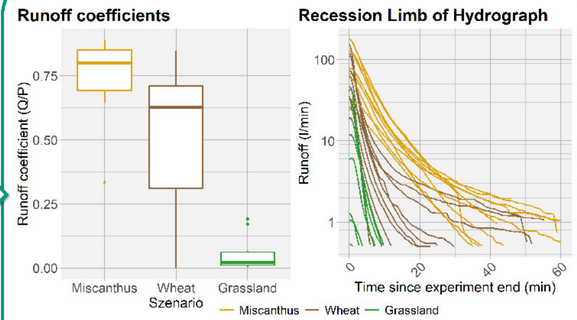
Modelling

To disentangle the effects of *Miscanthus* from confounding factors, the recent sprinkler experiments are modelled with the RoGeR-model and compared to the previously modeled experiments of the existing Dataset. Model setups are site- and field-specific, based on measured data.

Estimate Influence on Infiltration Properties of Soil
- Setup site specific model with reference site (Baseline)
- Field specific adjustments with pre-moisture condition and slope (DEM)
- Evaluate field specific soil properties based on the model and validate with measurements and observations

Estimate Surface Roughness Coefficient:
- Fitting recession limb of modelled hydrograph to measured hydrograph
- If possible: Distinguish between effect of root clumps and mulch layer

Sprinkler Experiment Results



Limitations for Comparibility:
- Differences in biomass
- Differences in interception Capacity
- Differences in soil moisture preconditions
- Residual soil differences (*Miscanthus* vs. reference)
- Slightly different slopes

→ **Therefore, Modelling is essential.**

Conclusion & Outlook

Key Finding:
No clear reduction in surface runoff under *Miscanthus* observed in the experimental data during heavy rainfall events

H1 rejected for extreme events
H2 remains unresolved.

Ongoing Work:
- Collect data in further experiments
- Partially remove mulch layer for selected experiments (Fig. 4)
- Model the experiments and compare with the existing data set

Next Step:
Isolate the specific effect of the mulch layer:
- Vertical hydraulic conductivity
- Horizontal water retention

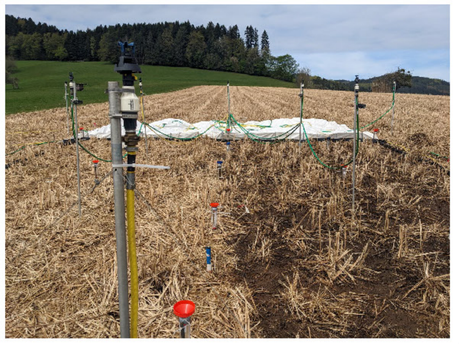


Fig. 4: Experimental site with partly removed mulch layer on *Miscanthus*.

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(1) Professur für Hydrologie, Albert-Ludwigs-Universität Freiburg
florian.bucher@hydrology.uni-freiburg.de
(2) Geographisches Institut, Universität Bonn
tuschen@uni-bonn.de

Abstract:

Sharing is encouraged

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KARODUR
UNIVERSITÄT BONN GEOGRAPHIE
universität freiburg