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Deriving tillage-controlled runoff patterns (TCRP) for agricultural fields

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Key points

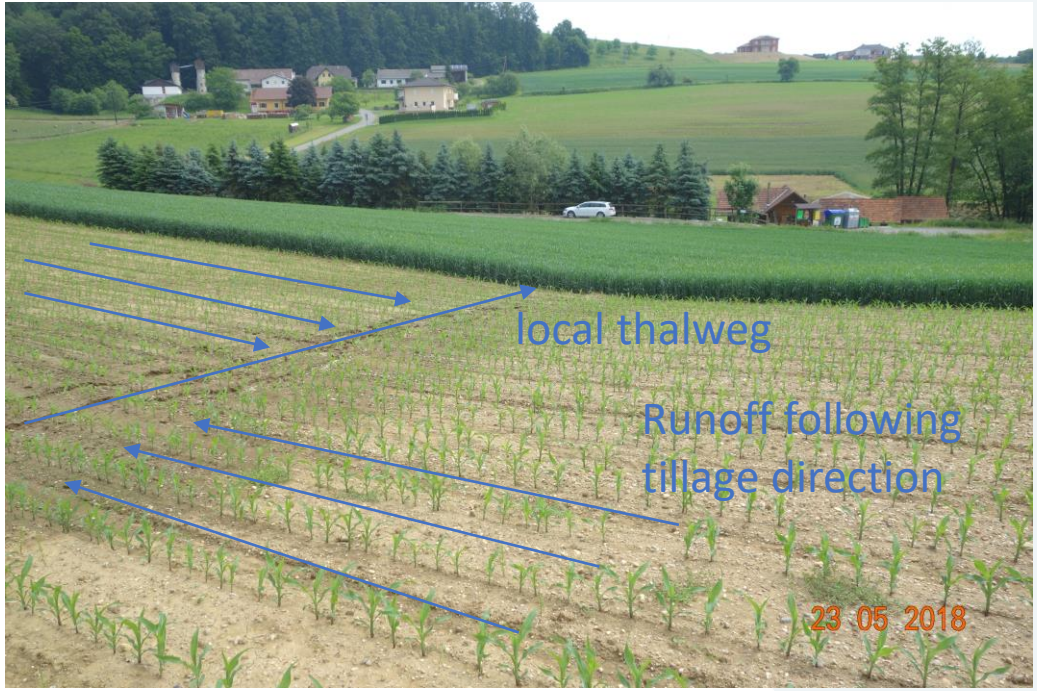
- Does the explicit inclusion of the tillage direction in agricultural fields lead to significant changes of modelled surface runoff flowpaths and associated soil erosion by water?
- Does the algorithm used for determining the actual tillage controlled runoff pattern yield results that stand ground truthing?
- Is the inclusion of additional parameters possible or necessary (e.g. design storm or some representation of runoff concentration?)

Motivation

- Tillage direction is known to influence patterns of surface runoff and subsequent soil erosion by water on cultivated fields
- On catchment scale, this process is usually ignored, for example when using a digital elevation model (DEM) with 1m resolution
- The applied procedure includes some sub-gridsize information (tillage direction and roughness) and is supposed to lead to more realistic surface runoff and erosion modelling results
- Procedure is based very closely on „TCRP" concept *(Takken et al., 2001)*

Motivation

- Erosion field mapping will often show the pattern of parallel surface runoff in tillage direction until concentration in some thalweg situation
- 1x1m DEM will not capture this pattern, but instead „blur" the surface flow paths diagonally



Motivation

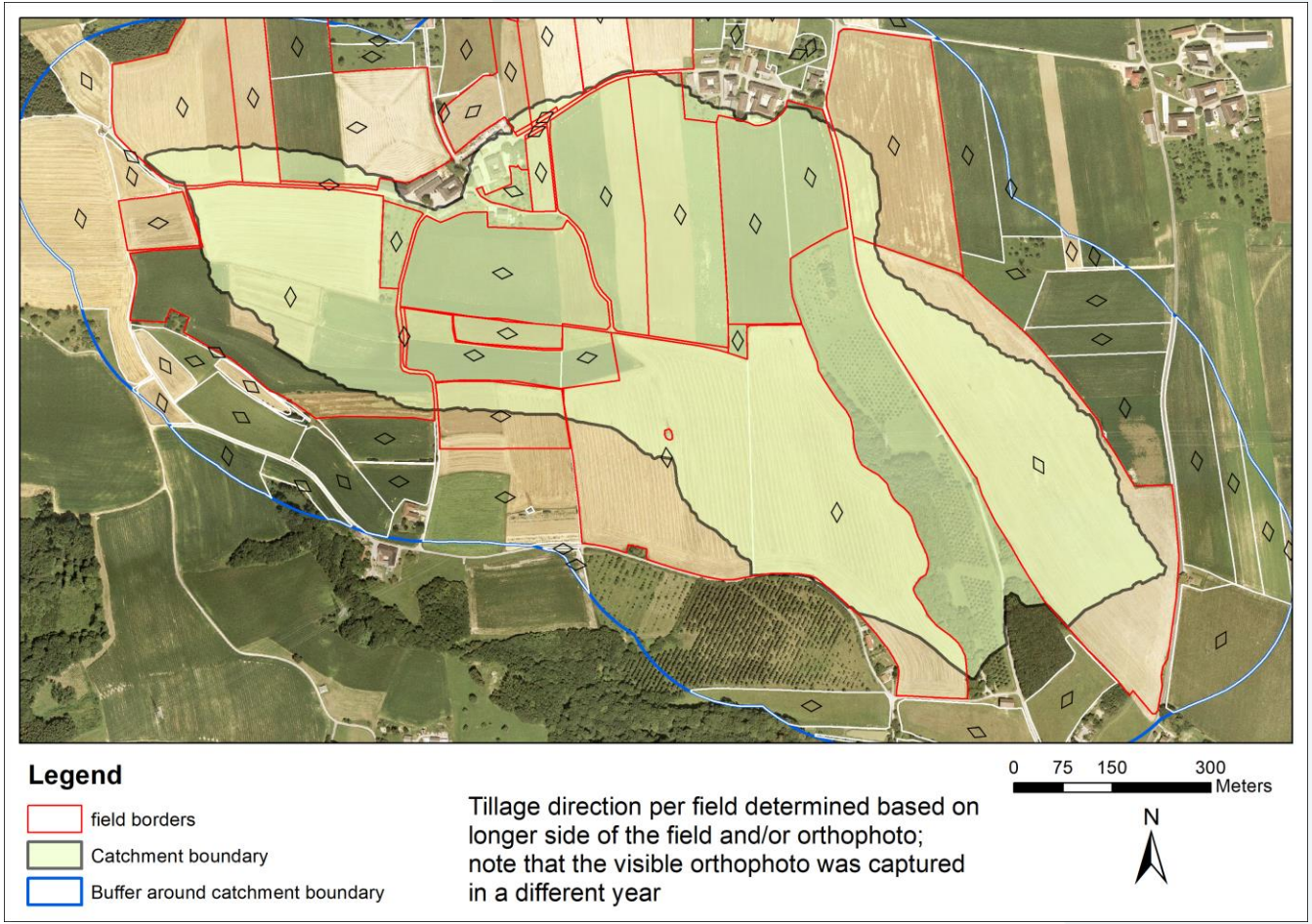
- In other configurations, runoff will break through the tillage direction and follow the topography alone
- This is increasingly likely with high slope, high rainfall intensity and low roughness

Methods

- Application of decision algorithm created by *(Takken et al., 2001)*
  - $Logit = -5.9 + 13.3 * S + 0.1 * A - 0.4 * R$
  - Function of slope (S), angle between tillage direction and topographic aspect (A), oriented roughness (R)
  - Based on Belgian field data
- Decides, which cell follows tillage direction (tilldir) and which follows topography (topo)
- Corrections are necessary to create valid flow directions

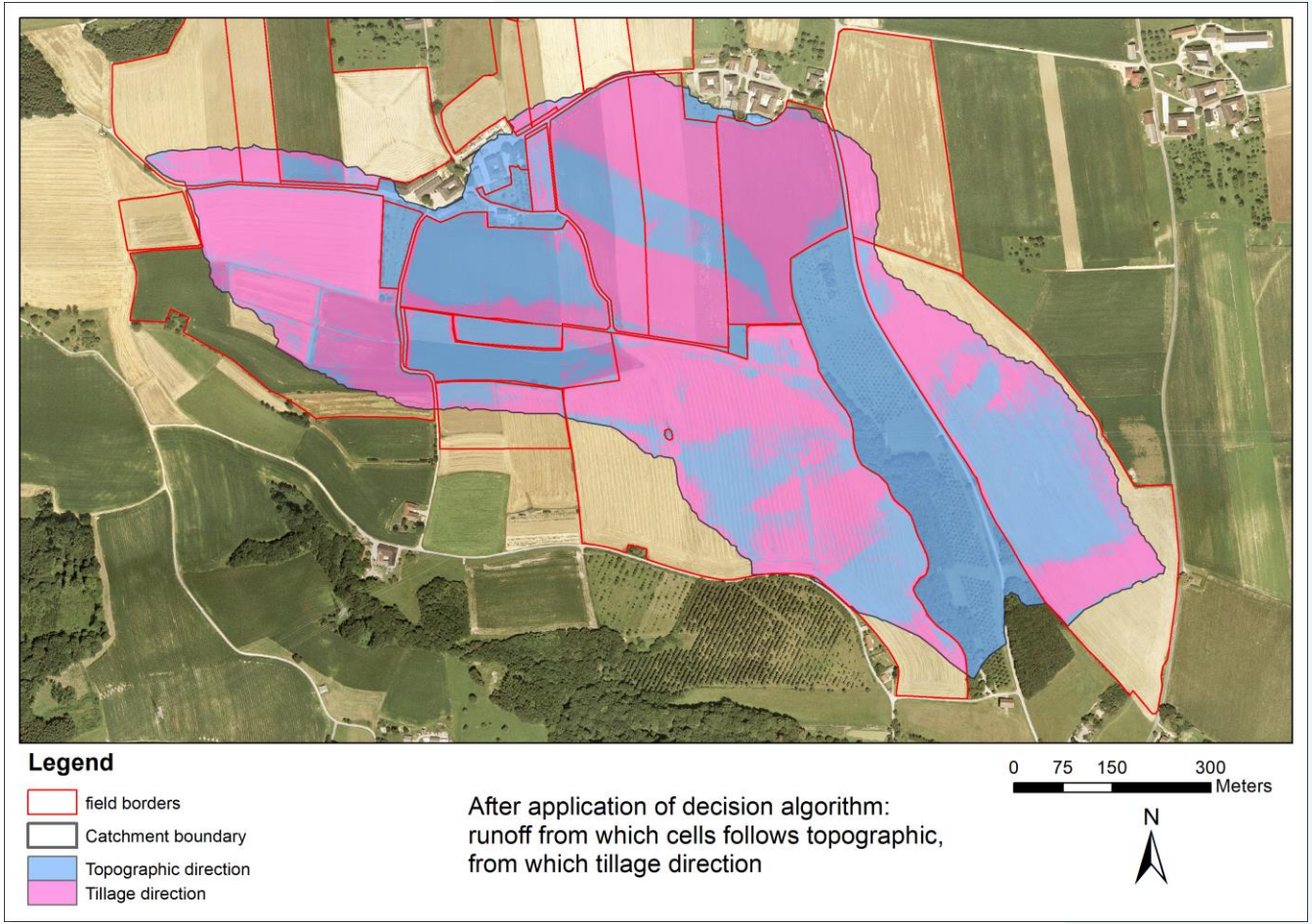
Methods

- Preparatory work: DEM derivatives: slope, aspect
- Tillage direction
- Oriented roughness



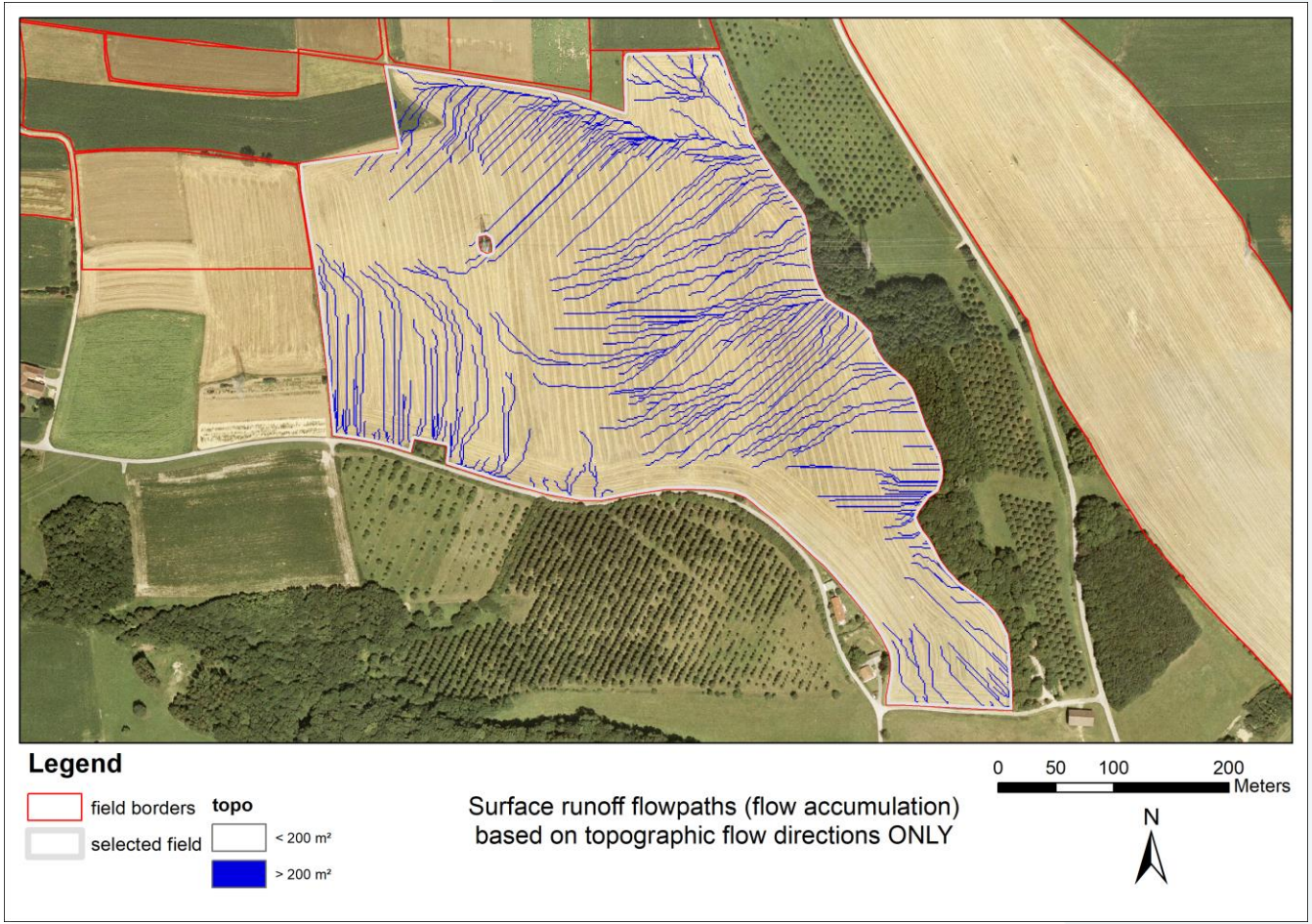
Methods

- After application of the algorithm: Which cells follow topo, which follow tilldir?



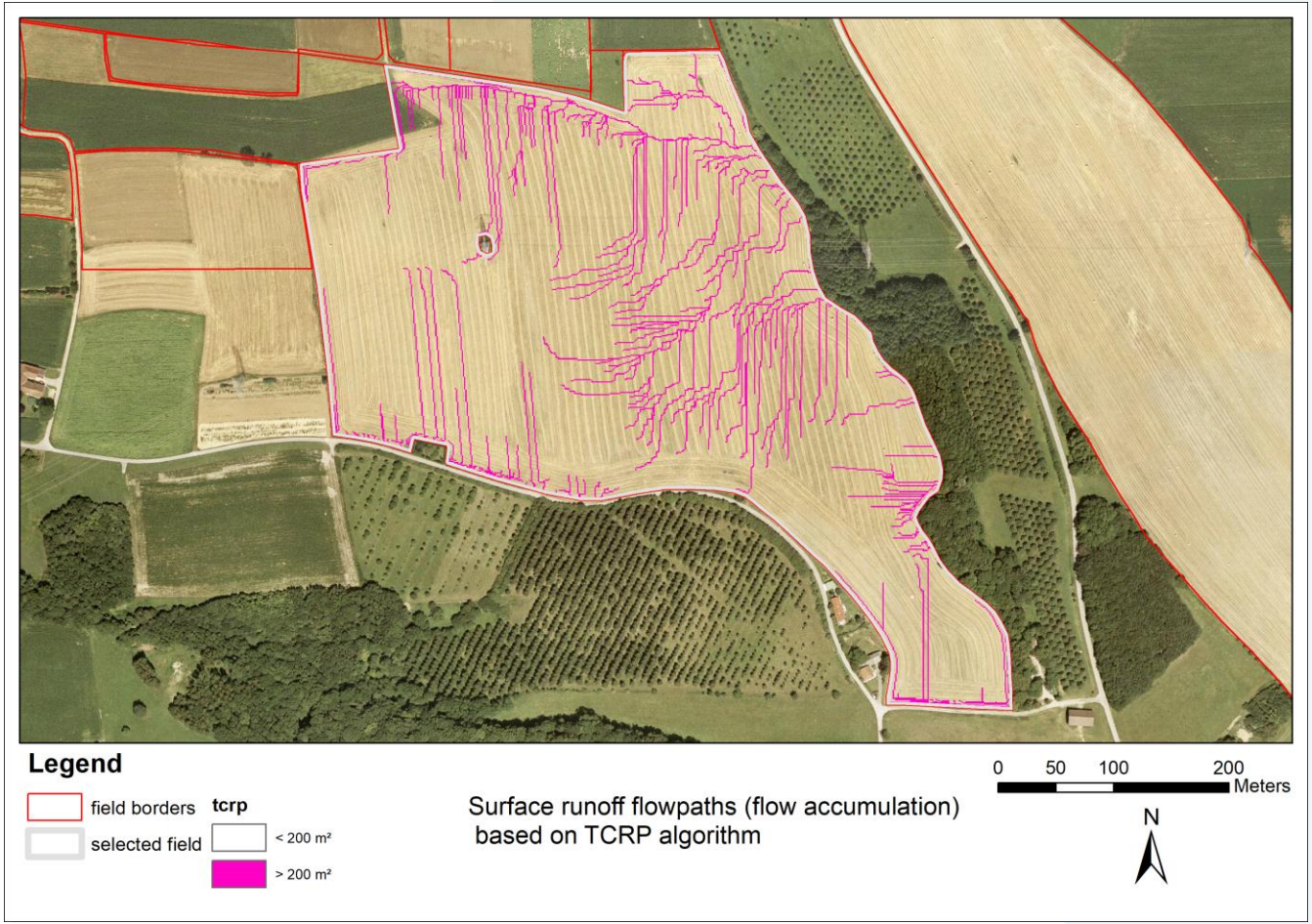
Methods

- Closeup of an individual field in the catchment
- Regular D8 surface runoff flowpaths (flow accumulation)



Results

- Calculated „TCRP“ runoff flowpaths
- In some places identical with topographic (usually steep slopes and thalweg situations)



Conclusions and outlook

- Main work in 2019: script and concept preparation
- Main work starting 05/2020
  - generation of field observations for validation and improvement of the algorithm for Austrian conditions
  - perform surface runoff and erosion modelling with the output of the TCRP method as input
    - ➢ decide whether the implementation is worth the effort

References

Takken, I., Jetten, V., Govers, G., Nachtergaele, J., Steegen, A., 2001. The effect of tillage-induced roughness on runoff and erosion patterns. Geomorphology 37, 1–14. https://doi.org/10.1016/S0169-555X(00)00059-3

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Takken, I., 2001. The prediction of runoff flow directions on tilled fields. J. Hydrol. 248, 1–13. https://doi.org/10.1016/S0022-1694(01)00360-2