Surface runoff in flat landscapes

Measuring and modelling surface runoff at the field scale

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Introduction

Although **surface runoff** plays an important role in contaminant transport, it remains poorly quantified. Because it is difficult to **measure** directly and computationally demanding to **model** at scales larger than the field-scale, there is a need for efficient **upscaling** methods. This research will explore the applicability of both high- and low-end models to calculate surface runoff at the field scale and from there develop an effective upscaling procedure, enabling more accurate estimates of surface runoff at the regional scale. Because it is one of the most important controlling factors, the focus of upscaling efforts will lie on parameterizing **microtopographic variability**.

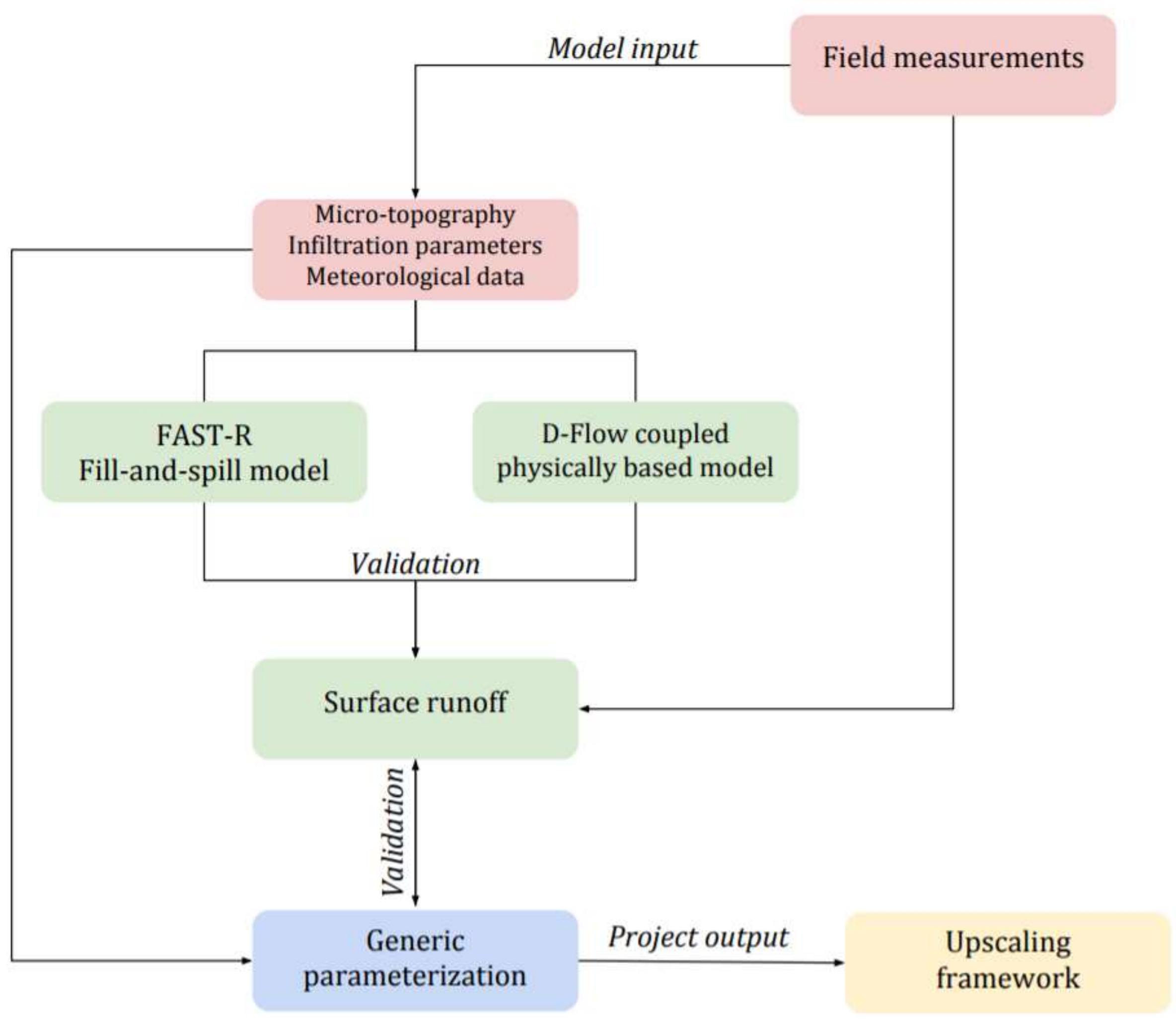

Figure 1: *flow chart of the research project.*

Figure 2: *Surface runoff collecting gulley.*

Measurements

Primary:

- Surface runoff (validation) [See Figure 2]

Model input:

- Microtopography (TLS) [See Figure 3]
- Precipitation
- Infiltration characteristics

Secondary (model calibration):

- Groundwater table height
- Soil moisture content
- Phosphate load
- Discharge

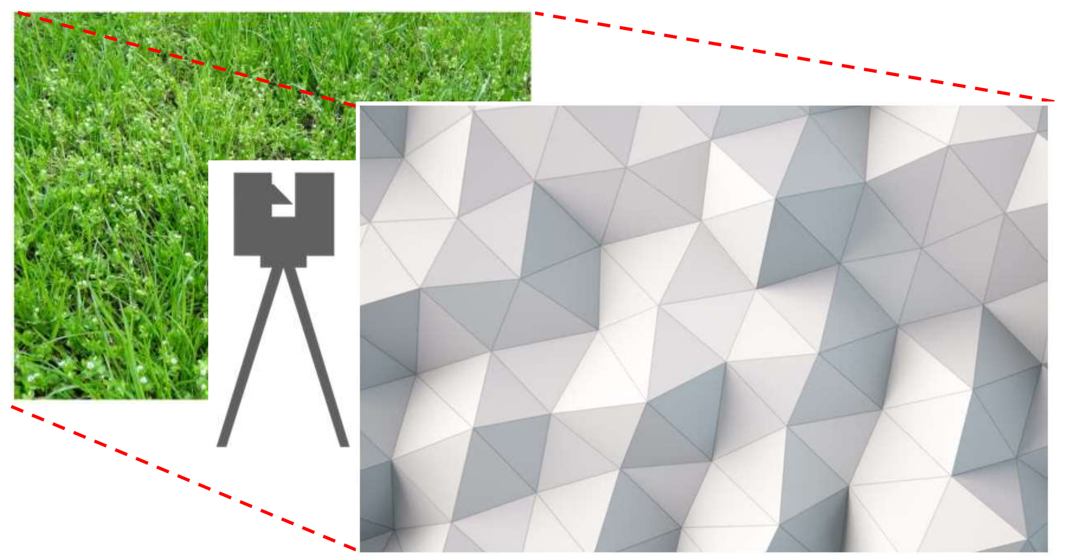

Figure 3: *A terrestrial laser scanner provides high resolution elevation data, allowing the analysis of processes at microtopographic scale.*

Modelling

Fill-and-spill model FAST-R

- Computationally less demanding than the physically based models
- No conservation of momentum → instantaneous water transfer (spilling) after a reservoir has filled.
- Includes infiltration and a simplified representation of the subsurface.

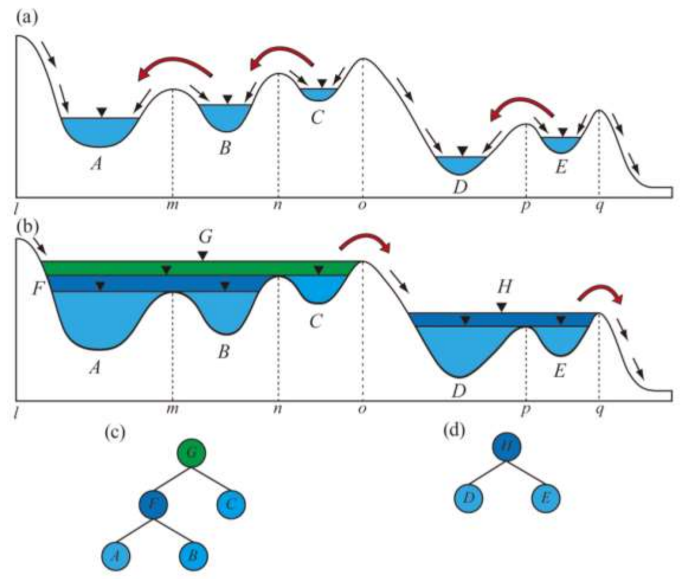

Figure 4: *The fill-and-spill concept.*

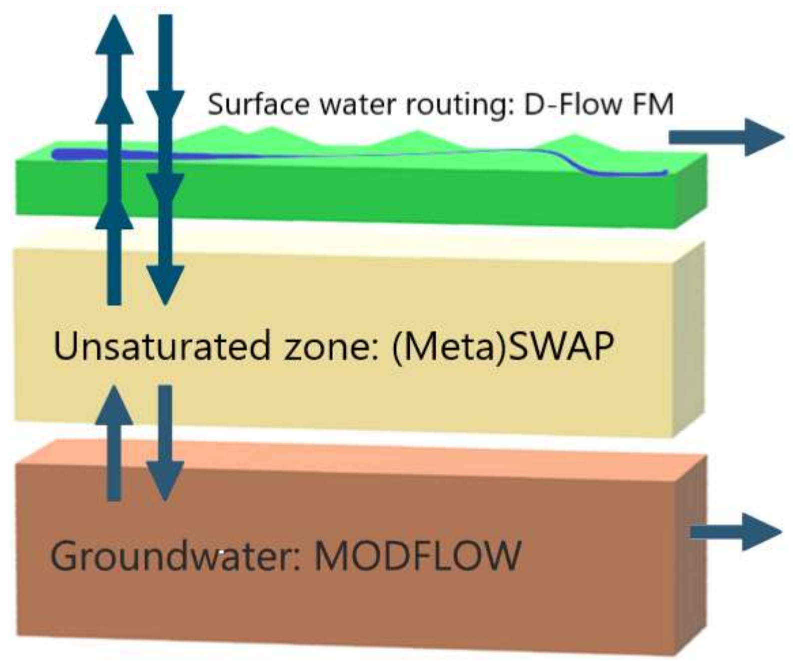

Figure 5: *Coupled hydrological model with fluxes*

Physically based model D-Hydro suite

- Computationally demanding
- State-of-the-art representation of physical processes

Upscaling

Following the work of Antoine et al. (2009) and Appels et al. (2011), this project will try to establish a link between statistical parameters describing **microtopographic variability** and the shape of the surface runoff hydrograph. Such parameters may include autocorrelation, covariance and integral length scale.

Surface runoff tool

If microtopography can be correlated to surface runoff, this will form the basis of a surface runoff tool, to be developed in cooperation with national stakeholders. The input of this tool will consist of rain events (Dutch return period standard), land use/cover and time of season. It will then generate a surface runoff hydrograph for each specific scenario [See figure 6]. The tested models will, together with more field measurements, provide the necessary theoretical and empirical foundation.

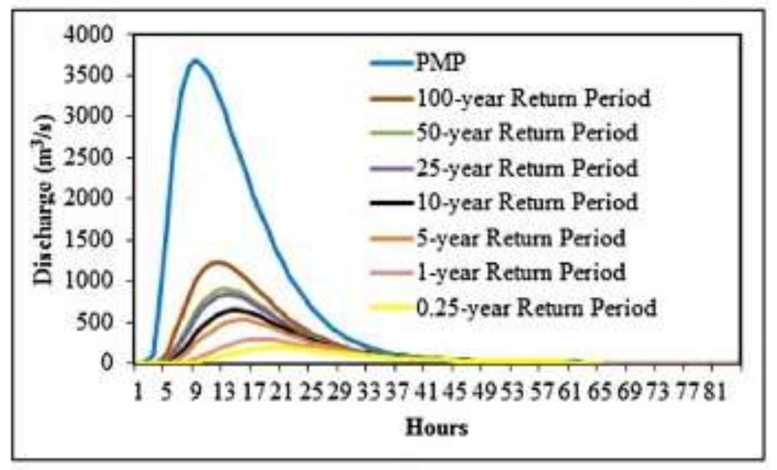

Figure 6: *Possible output of the surface runoff tool: a location-, time- and event specific surface runoff hydrograph.*

References

Antoine, M., Javaux, M., & Bielders, C. (2009). What indicators can capture runoff-relevant connectivity properties of the micro-topography at the plot scale ? *Advances in Water Resources*, *32*(8), 1297–1310. https://doi.org/10.1016/j.advwatres.2009.05.006

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Wu, Q., & Lane, C. R. (2017). Delineating wetland catchments and modeling hydrologic connectivity using lidar data and aerial imagery. *Hydrology and Earth System Sciences*, *1990*, 3579–3595.