

Runoff Generation, Residence Times & Dynamics of Surface/Sub-Surface Exchange in a Wetland with Micro-topography – a Modeling Study.

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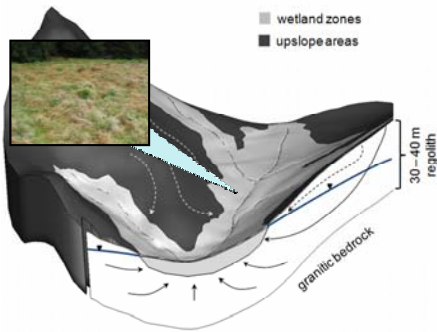
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1 Background

In mountainous catchments wetlands often make up large fractions of the total catchment area with potential implications for runoff generation and nutrient export. Wetland surfaces are often characterized by a distinct micro-topography (hollows and hummocks). The effects of such micro-topography on surface-subsurface exchange, runoff generation and sub-surface residence times for a 10 by 20 m synthetic section of a riparian wetland are investigated in this modeling study. The structure of the micro-topography replicates that of a riparian wetland in a small mountainous catchment in South-East Germany (Lehstenbach) and is created using geostatistical simulation. Flow is modeled with the fully integrated surface-subsurface code HydroGeoSphere. Simulation results show that the specific structure of the wetland surface results in distinct shifts between surface and subsurface flow dominance. The micro-topography efficiently buffers rainfall inputs and produces a hydrograph that is characterized by subsurface drainage during most of the year and only temporally shifts to surface flow dominance during intense rainstorms. Micro-topography induces a very heterogeneous sub-surface hydrology where a shallow and a deep flow system coexist resulting in a very complex sub-surface residence time distribution. Preliminary results show that the complex sub-surface flow field, with its broad range of different sub-surface flow paths, leads to biogeochemical patchiness.

Lehstenbach watershed



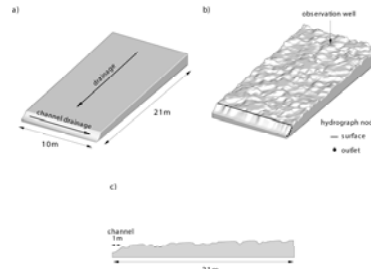
2 Objectives

- what effect does micro-topography in riparian wetlands have on stream discharge generation
- effects of micro-topography on residence time distribution & biogeochemistry

3 Methods

Numerical surface/subsurface flow simulation

HydroGeoSphere (Therrien et al. 2008)



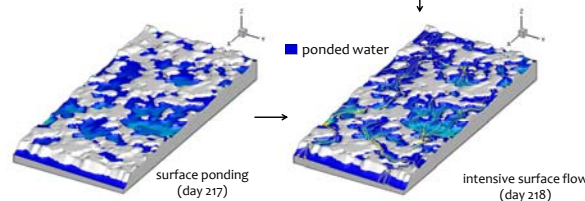
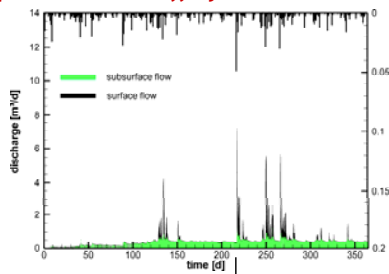
- Richard's equation for subsurface flow
- fully integrated and coupled
- diffusion-wave approximation for surface flow
- homogeneous, isotropic peat body

4 Results

Flow component separation & runoff dynamics

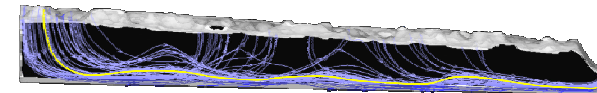
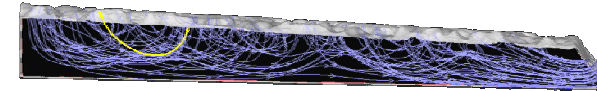
development of interconnected surface-flow networks during intensive rainfall events

responsible for peak discharges



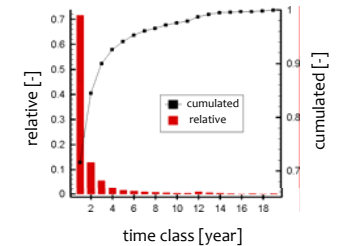
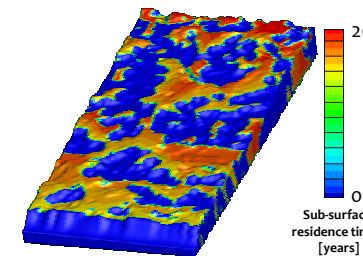
Complex sub-surface flow patterns & residence times (RT)

shallow, surface near flow system → shorter sub-surface RT



deep flow system → longer sub-surface RT

Spatial RT – distribution & RT histogram



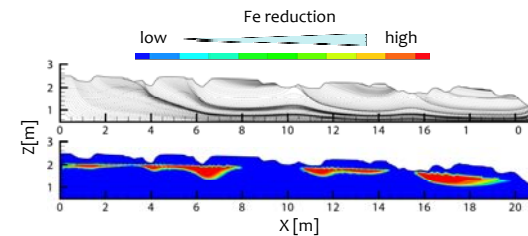
MICRO-TOPOGRAPHY



complex sub-surface flow patterns & residence time distribution

Outlook

Coupling hydrology to bio-geochemical model (PHREEQC)



micro-topography induced sub-surface flow field

bio-geochemical patchiness & hot spot generation