CZECH TECHNICAL UNIVERSITY IN PRAGUE
FACULTY OF CIVIL ENGINEERING
Dept. of Irrigation, Drainage and Landscape Engineering

Investigating runoff generation on compacted subsoil using a field rainfall simulator

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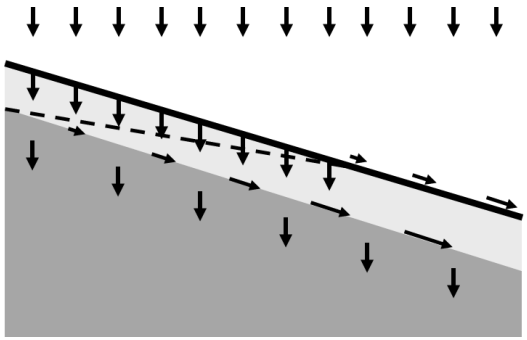
WHAT DO WE DO AND WHY?

- Soil conservation and flood mitigation
- Soil erosion, small rural catchment hydrology
- Understanding → preventing
- Runoff formation processes
- Observations and simulations



- Compacted subsoil phenomenon and large macroporosity of the topsoil
- Saturated area runoff concept
- Lateral subsurface stormflow as dominant runoff process

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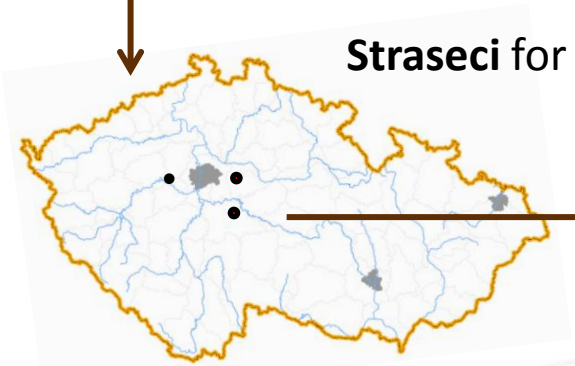
WHERE DO WE DO IT?



Experimental **Bykovicky stream catchment**, Central Bohemia

- 6,3 km^2, 60 % arrable land, 67 % sandy loam, since 2005
- Erosion plots for both continuous and event-based monitoring
- Basic hydrologic characteristics monitoring

Additional observed catchment **Nucice** and plots near **Nove Straseci** for specific and comparative studies

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Experimental tools and setup

HOW DO WE DO IT?

- Rainfall simulator consisting of folding boom on telescopic legs and trailer with 1 m^3 tank, pump and control unit
- 9x 40WSQ nozzles 1,2 m apart, 2,6 m height, el-magnetic valves
- Control unit maintaining constant pressure working in schemes enabling arbitrary rainfall intensity from 20 to 150 mm/h with 5 mm/h step

- Setup with two exp. plots, 8x2 m and 1x1 m
- 45 % oversprays, CU index cca 80 %, 15 % var.
- Vegetation / cultivated fallow

For more details look up our poster X1.125

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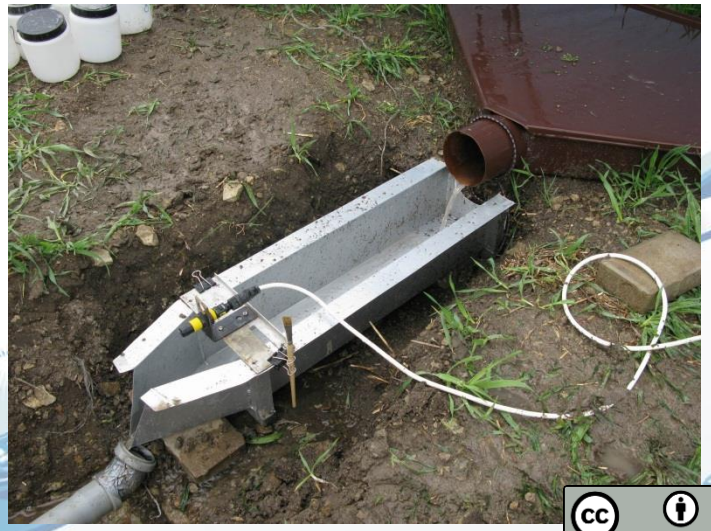
Experimental tools and setup

HOW DO WE DO IT?

- Subsurface runoff collected with a 0.5 m deep drain and a tipping bucket
- Soil moisture monitoring in three depths using Theta ML2x and TMS-3 „Lolly“ probes
- Surface runoff manual samples and automatic continuous measurement with HS-flume and ultrasonic sensor

Other measurements:

- Sediment particle size distribution
- Overland flow velocity
- LAI / Canopy cover



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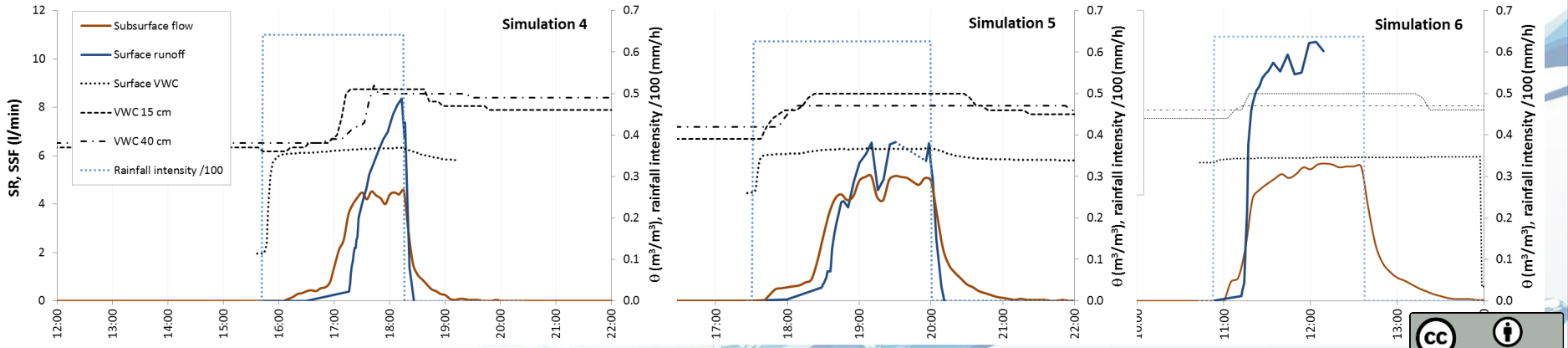
WHAT DID WE FIND OUT?

Sim. #	Canopy cover	Rainfall intensity (mm/h)	Duration (min)	Subsurface flow		Surface runoff	
				Start (min)	Q_{max} (l/min)	Start (min)	Q_{max} (l/min)
1	seedbed cond.	23	78	19	1,16	--	--
2	barley 30 cm	40	71	20	0,96	--	--
3	barley 80 cm	63	58	20	6,2	38	6,0
4	barley ripening	64	154	30	**4,4**	90	8,4
5	barley ripe	63	150	15	**5,1**	57	**6,5**
6	stubble	64	105	10	**5,6**	19	10,7
7A/B	rapeseed ripe	77/162	62/18	27/0	2,2/11,6	--/1	--/8,2
8A/B/C	rapeseed stubble	88	39/24/51	9/1/0	2/5,6/**5,0**	--/14/5	--/8,0/13,5



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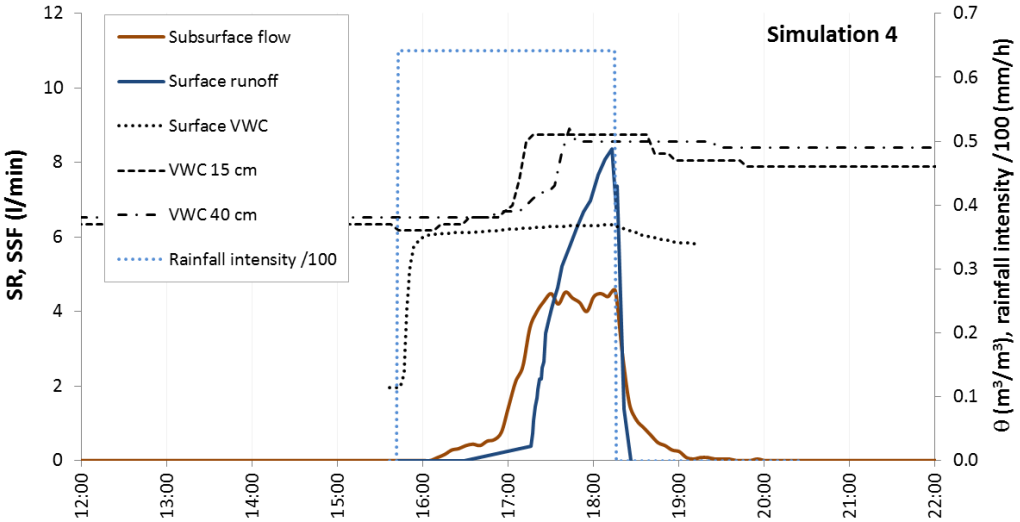
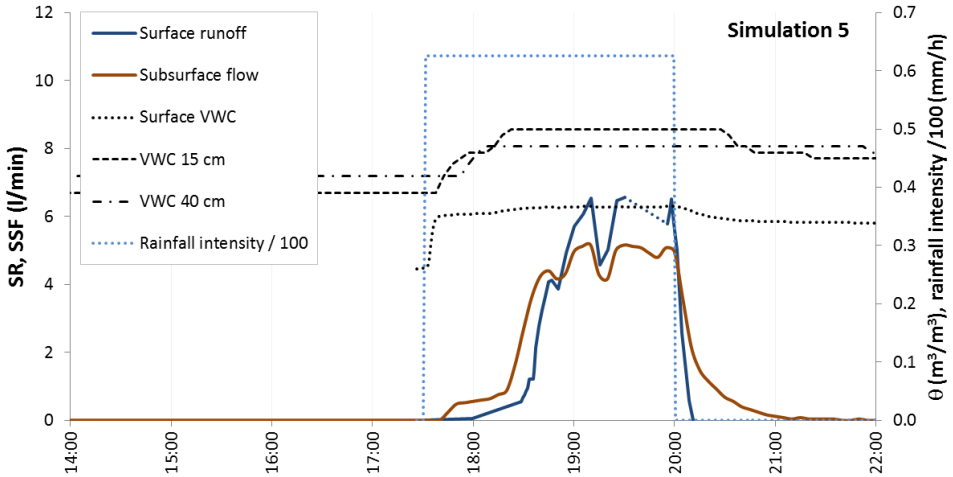
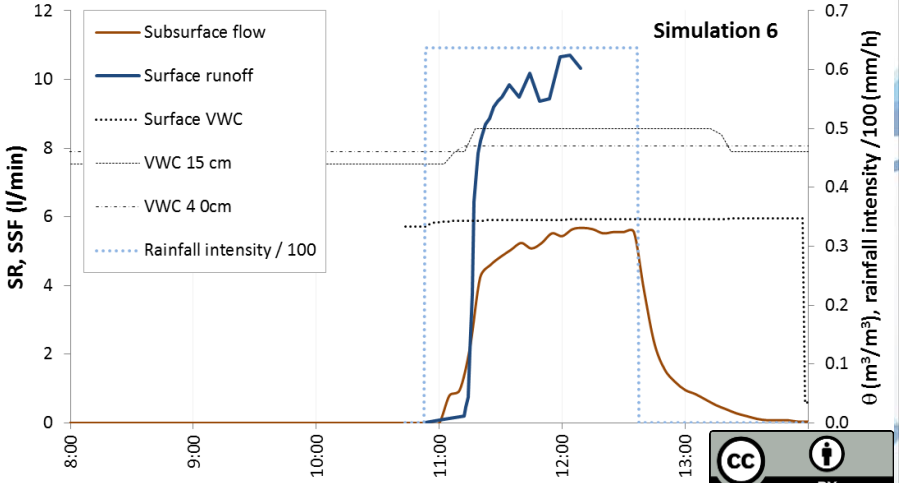
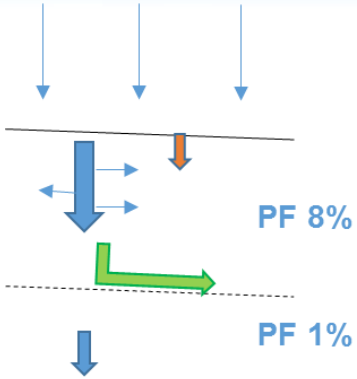




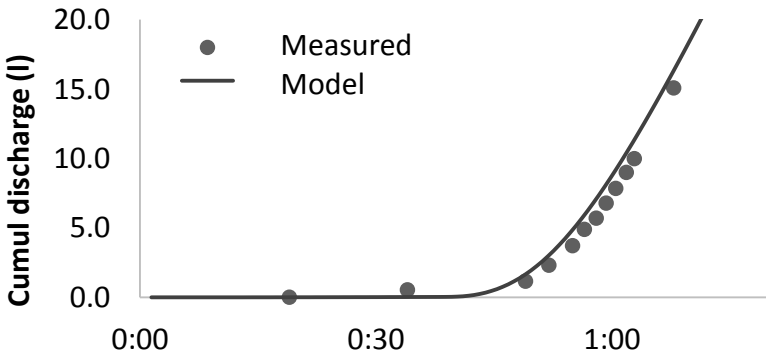


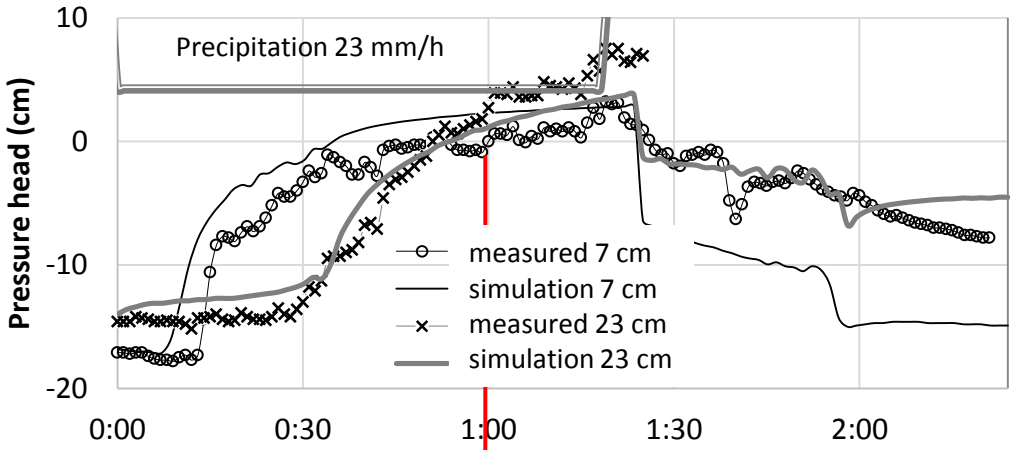


DO THE OBSERVATIONS FIT THE THEORY?

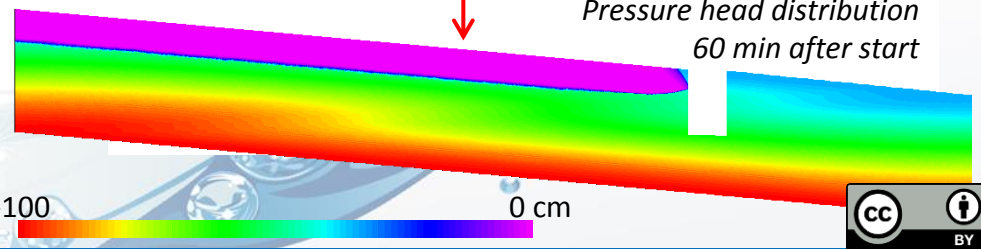
- Dual permeability model (matrix and preferential flow domains)
- Two Richards eq. coupled with transfer term
- Approaches to simulate subsurface runoff:
  - 1D infiltration S1D + 1D subsurface lateral outflow HYPO kinematic wave (Vogel et al., 2010, Dusek et al, 2012)
  - **2D model S2D (Vogel et al.,1993)**

Measured and modeled discharge





Pressure head distribution 60 min after start



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Conclusions and outlook

WHAT DID WE LEARN ABOUT OUR STUDY SITE?

- Shallow subsurface runoff precedes the surface runoff independently on initial soil saturation or crop cover
- **Conceptual model is in an agreement with the measured data** from the experiments
- Preferential pathways are dominant when the soil profile is near to saturation
- More numeric simulations need to be done in order to identify key hydrologic parameters and their variability throughout the season
- Links between plot and catchment scale behaviour need to be analysed and ways of implementig the concept into the catchment models will be sought

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Thanks for your attention!

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