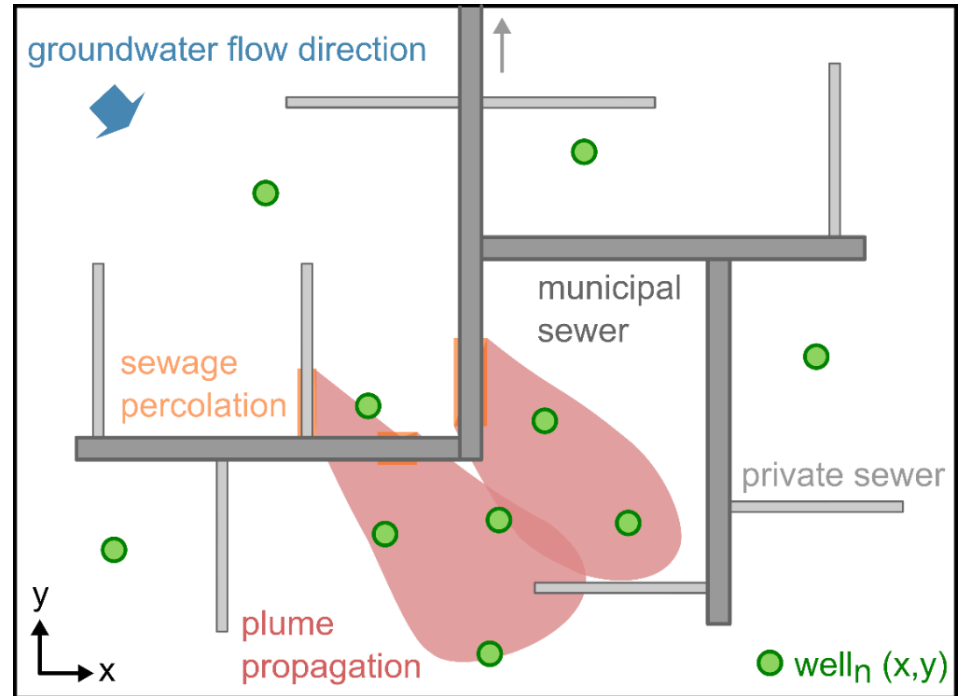


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Leaky sewer systems: Influence of soil properties and sewer failure characteristics on the shape of contaminant plumes

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Background / Objective

- aging waste water infrastructure ► urban soils / aquifers are subject to contaminations by sewer leakages
- protection of groundwater (GW) resources requires tool chains for risk assessment ► GW monitoring supported by model-based data analysis
- main challenge : large scale 3-D simulation including all sewer defects is neither realistic nor expedient
- possible solution: using parallelization combined with selective simplifications (e.g. line sources) on smaller scale
 - evaluation of introduced information loss
 - creation of sim data for evaluation (on multi-scale)
= this study's objective

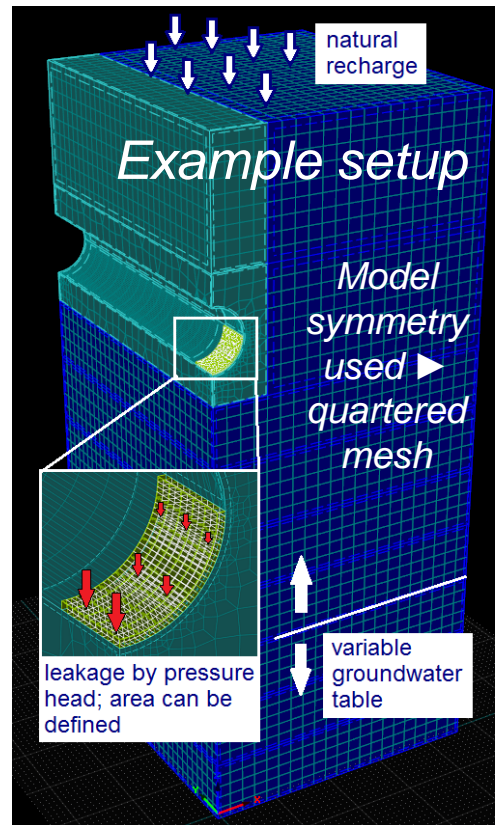
Small scale / Single leakage (setup)

- HYDRUS [1]
code used for Richards flow

- colmation of defect area :
separate thin layer with low permeability

- selective
matrix variation

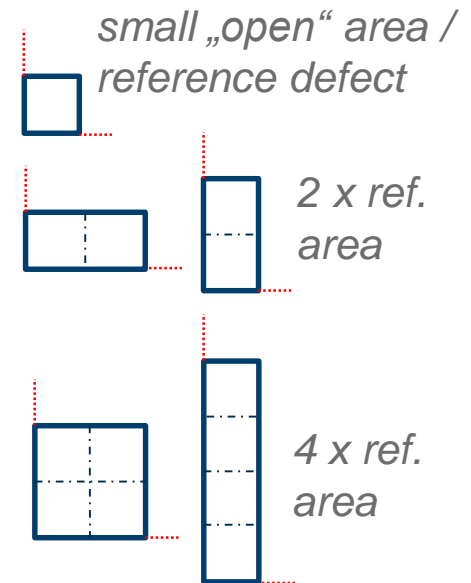
- defect shape
- pipe water level
- natural recharge
- soil type etc.
- with / without trench
- ...



- natural material (loamy sand)
- backfill trench (sand)
- colmation layer (sandy clay loam)

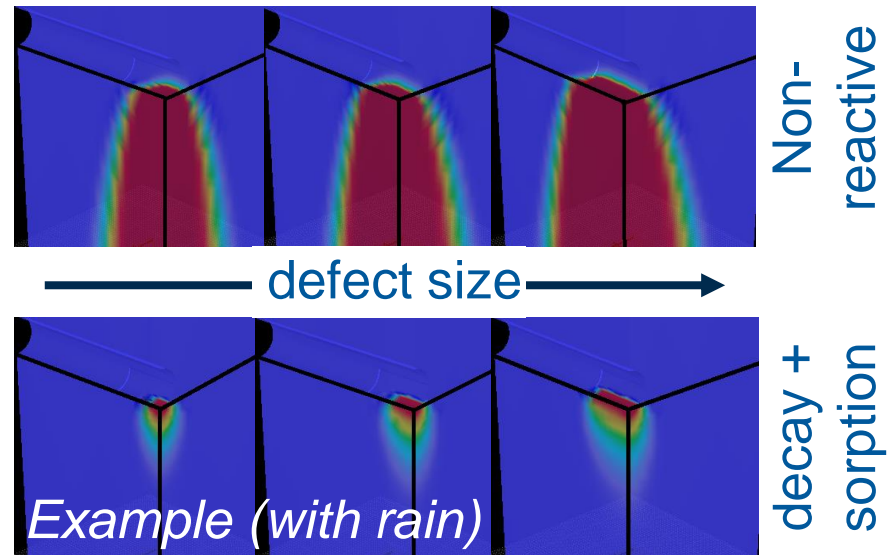
note: the given materials are examples and refer to the HYDRUS soil catalogue

- 5 defect shapes
(red lines = symmetry)



Small scale / Single leakage (some results)

- 3-D raw results from ~1000 model runs available
- work in progress: data analysis (quantitative) + 1D model comparison



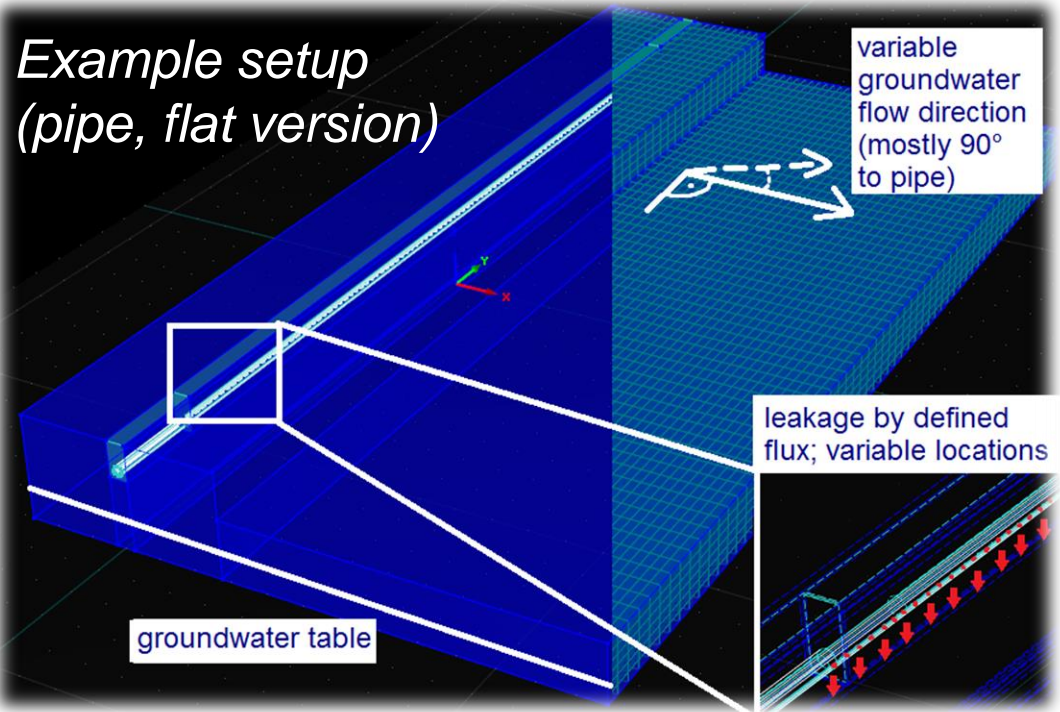
- main observations
 - pipe water level fluctuations barely affects the plume (long term)
 - significant change of plume diameter by natural recharge
 - significant reduction in overall plume size by decay / sorption
 - shape of defect is projected, but less significant than its hydraulically active area
 - ...

Intermed. scale / Multiple leakages (setup)

- selective matrix variation

- leakage position
- leakage rate
- hydraulic gradient
- GW level / direction
- aquifer thickness
- soil type
- ...

*Example setup
(pipe, flat version)*

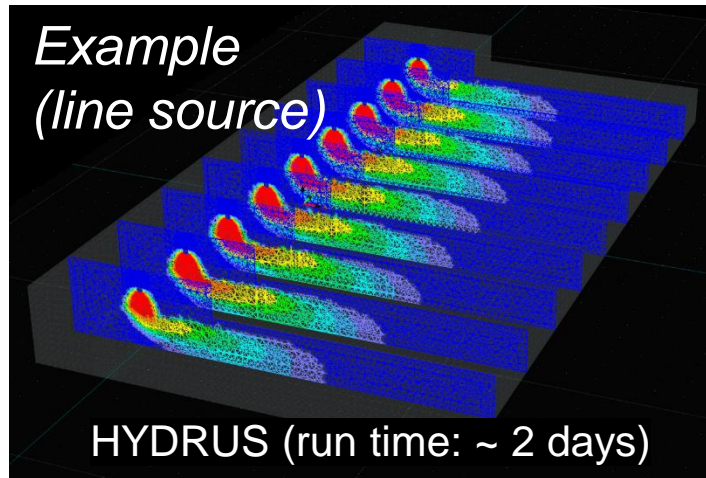


- mainly usage of HPC*-capable code ParSWMS [2]
(*partial verification with HYDRUS*)

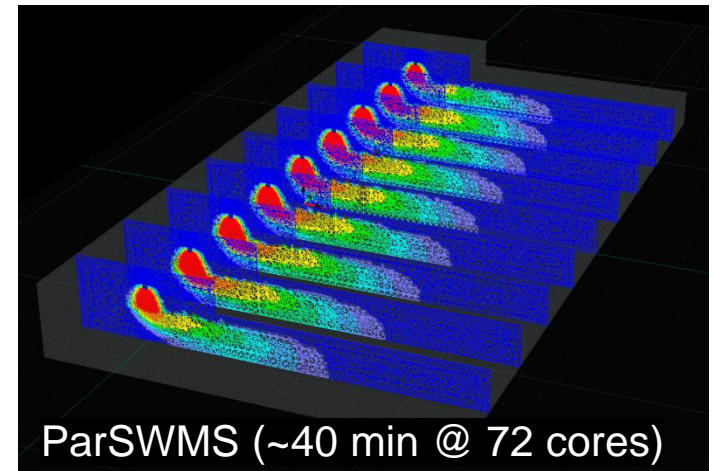
* High Performance Computing, here:
TU Dresden HRSK-II / TAURUS Cluster

Intermed. scale / Multiple leakages (results)

- 3-D raw results from >4000 model runs available (mainly realized via HPC code ParSWMS ► good to very good scaling)



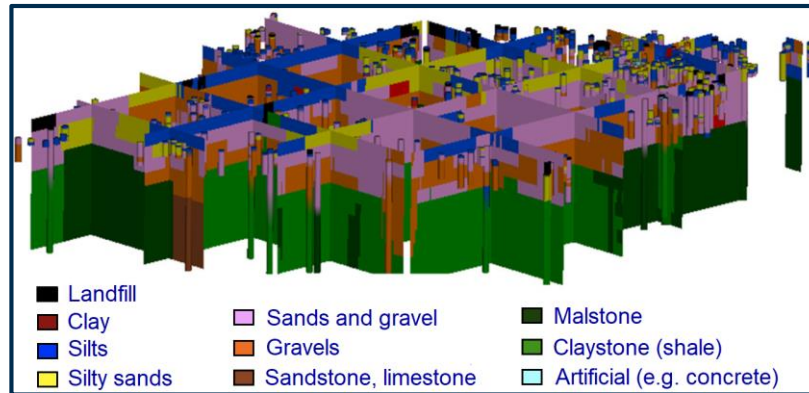
massive
reduction
of run-time



- plume shapes: **clear similarities detected** between different leakage setups ► large potential for simplifications
- quantitative similarity matrix will be created soon

Conclusions and outlook

- simulation datasets available for throughout testing of simplifications ► possible on small- and intermed. scale
- HPC code tested and workflow adapted to the requirements of our research
- further steps include the simulation of a case study on kilometer scale in Dresden-Leuben



*Sewer network and subsurface model
in case study region*

References

- [1] Šimůnek, J., M. Th. van Genuchten, and M. Šejna, Recent developments and applications of the HYDRUS computer software packages, Vadose Zone Journal, 15(7), pp. 25, doi: 10.2136/vzj2016.04.0033, 2016.
- [2] Hardelauf, H., M. Javaux, M. Herbst, S. Gottschalk, R. Kasteel, J. Vanderborght, and H. Vereecken, PARSWMS: a parallelized model for simulating 3-D water flow and solute transport in variably saturated soils, Vadose Zone Journal, 6(2), 255-259, 2007.

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