# Quantification of Uncertainty for transport-based Well Vulnerability Criteria

International Research Training Group nupus

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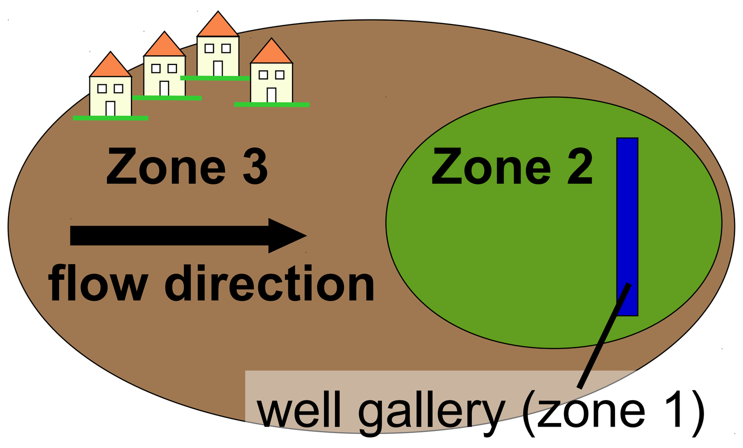
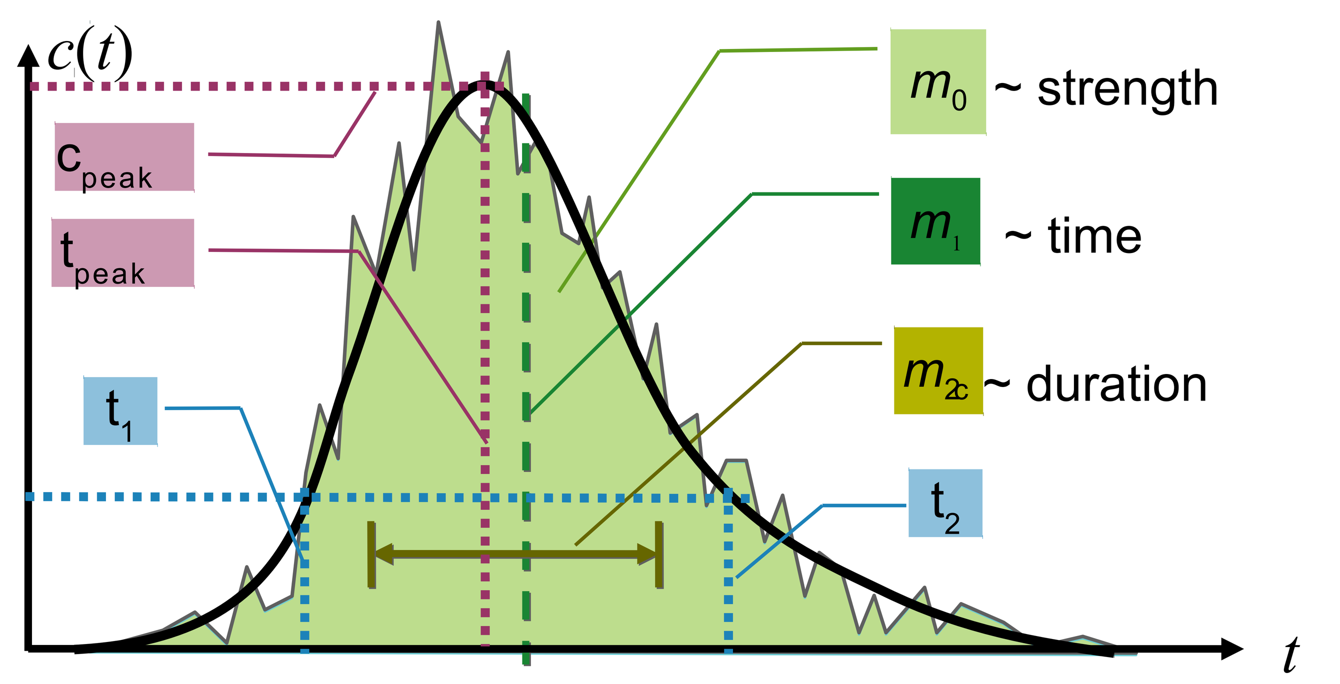
## Motivation




According to current Water Safety Plans, water suppliers and all other water actors should ensure safe drinking water supply by controlling the risk from catchment to tap through a preventive risk management concept. The most common concept to control the risk of drinking water contamination is the delineation of advection-based well-head protection zones. In 2006 Frind et. al extended this concept by introducing four intrinsic transport-based well vulnerability criteria. Our approach quantifies the uncertainty of well catchments and protection zones based on these advective-dispersive vulnerability criteria within a probabilistic framework, allowing water actors to take informed risk-based decisions in order to better control and manage the risk within their well catchment.

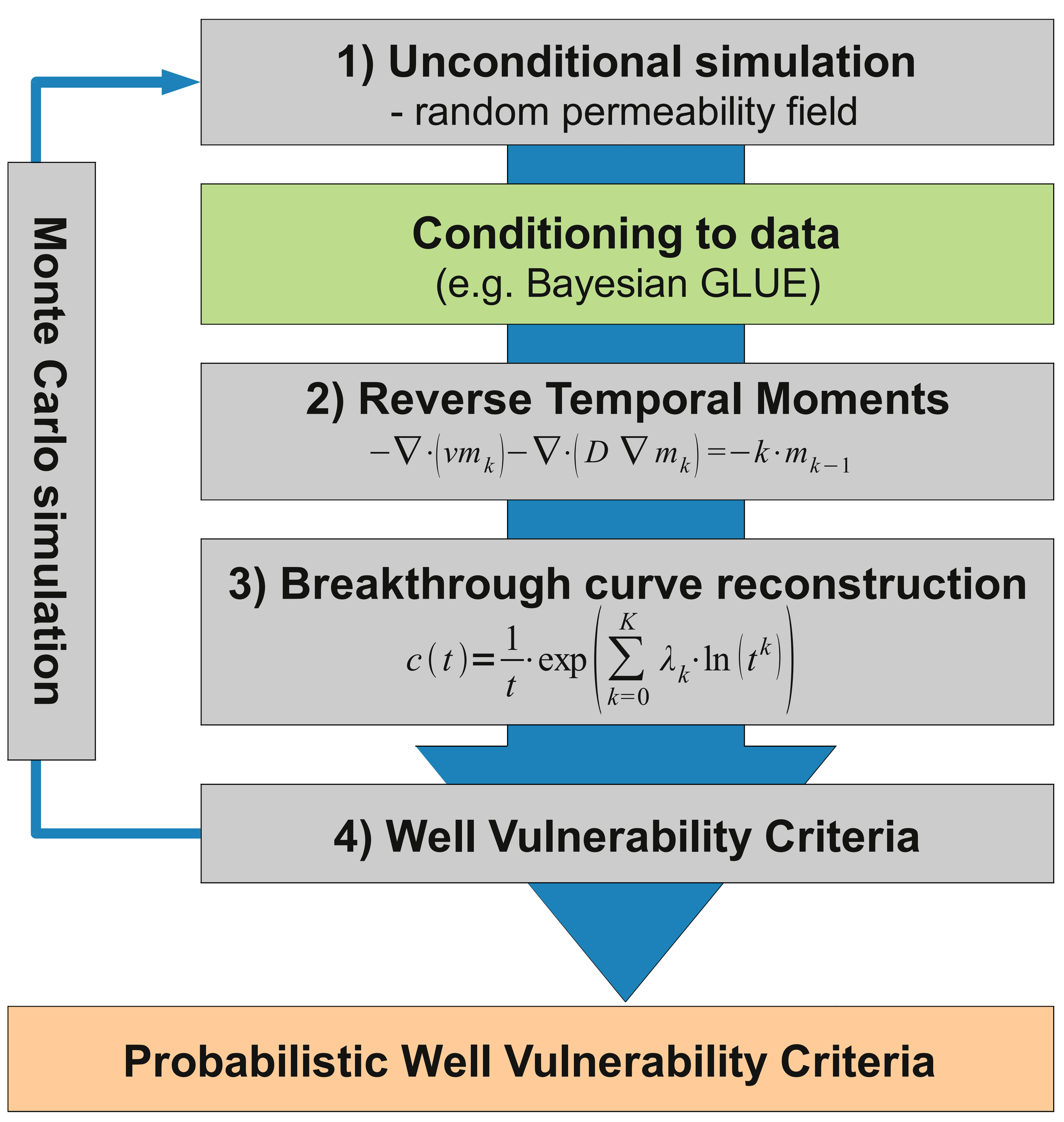
## Approach

Four instrinsic transport-based well vulnerability criteria (Frind et. al, 2006):
(a) Time $t_{peak}$ between a spill and arrival of peak concentration at the well,
(b) Level of peak concentration $c_{peak}$ relative to the spill concentration,
(c) Time $c_{crit}$ to breach a given drinking-water standard and
(d) Time of exposure $t_{exp}$ (exceeding the water standard).

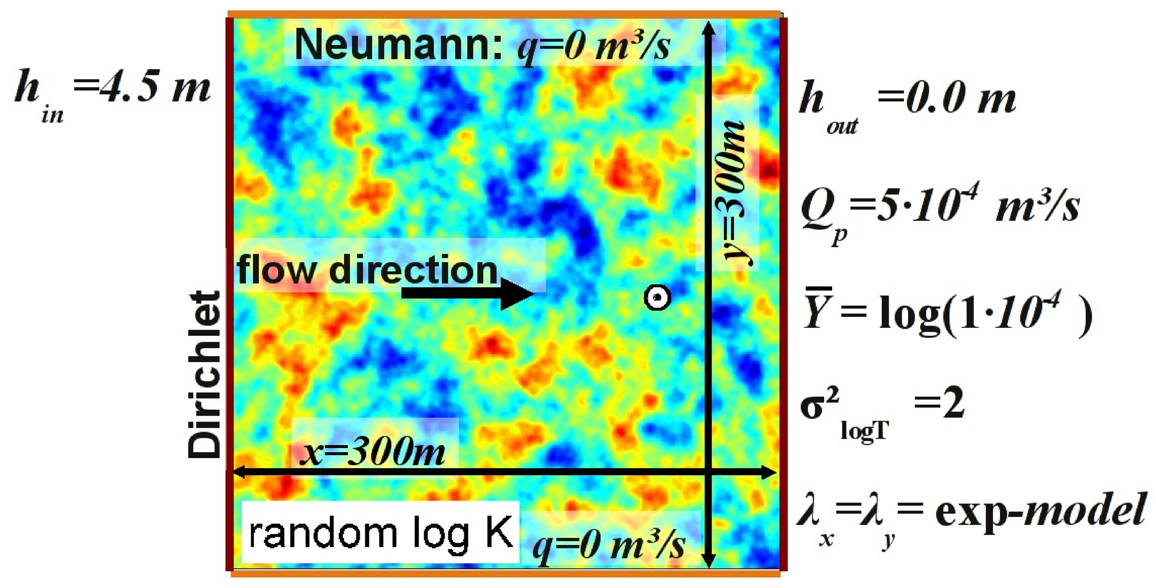



Further: asymmetry ($m_3$), compactness ($m_4$),…

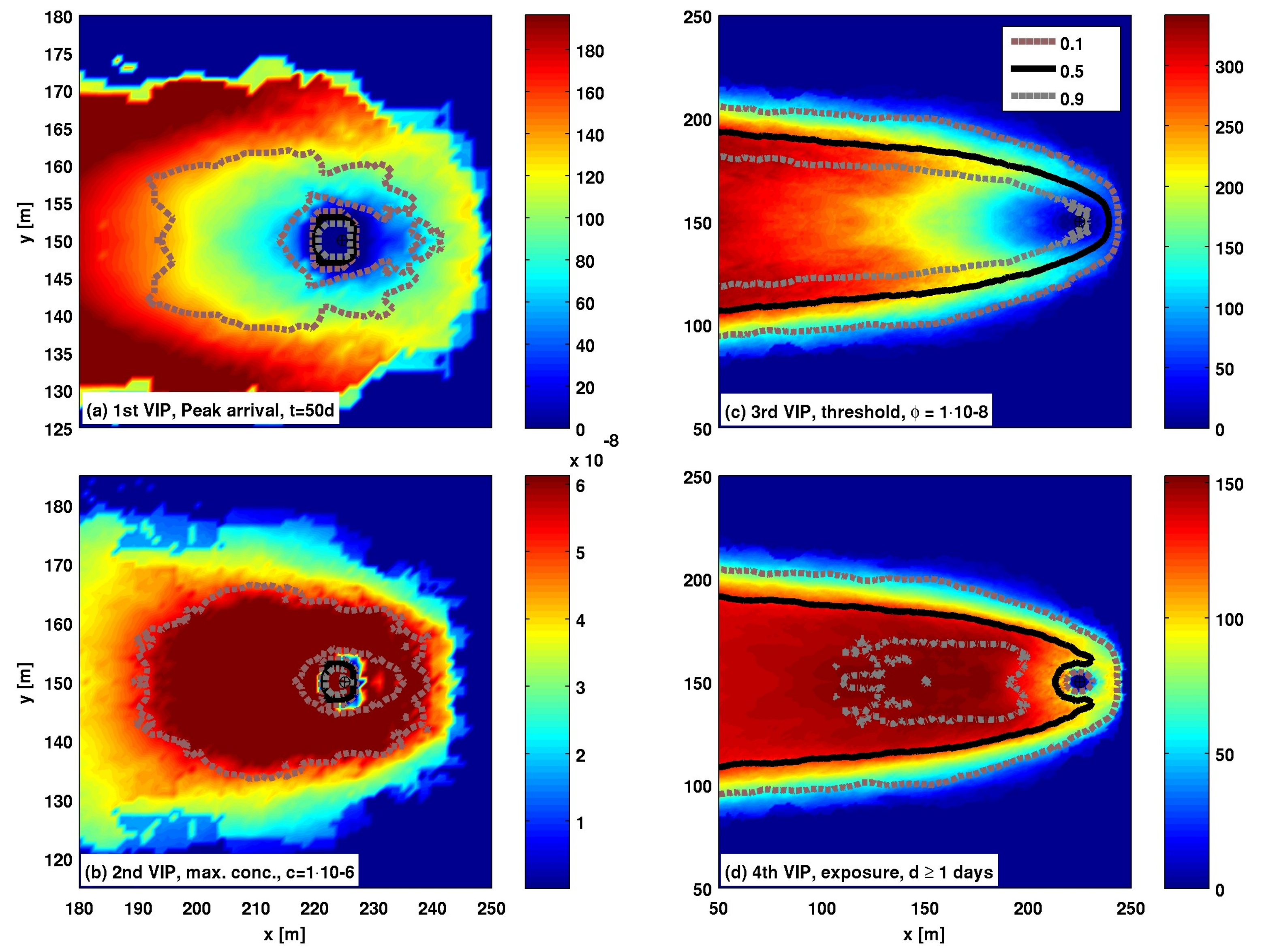
**Illustrative sketch showing the four intrinsic well vulnerability criteria and temporal moments characterizing the concentration breakthrogh curve *c(t)***




## Illustrative Example




## Results




**Probabilistic isopercentiles [0.1, 0.5, 0.9] for the four instrinsic well vulnerability criteria from n=100 simulations**

## Discussion & Future Work

- Vulnerability isopercentile (VIP) maps are easy to understand
- VIPs support catchment managers with indispensible information
- Zones of higher and lower well vulnerability are displayed
- Allows prioritization of contamination sites
- Approach is independent of dimensionality and boundary conditions
- Conditioning method can be arbitrarily chosen (e.g. GLUE, EnKF)
- Computational savings and information gain justify model reduction

**Future Work will be:**

- Data assimilation by Bayesian GLUE
- Application to Copenhagen aquifer in cooperation with DTU
- Transfer to DuMu$^x$, a flow and transport simulation platform
- Adopting the approach to a fracture-matrix system
- Application to a fractured system in cooperation with LW

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- Conditional Transport simulation: A. Schöniger, J. Koch

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