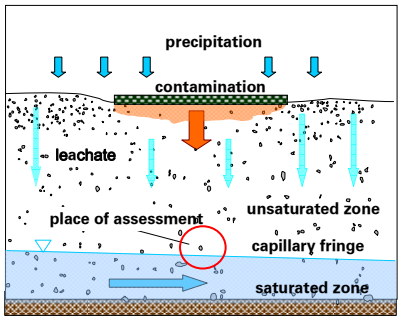
TECHNISCHE UNIVERSITÄT DRESDEN

Faculty of Environmental Sciences, Department of Hydro Sciences

PCSiWaPro® – a Computer Aided Leachate Forecast Tool

Problem



Definition of leachate forecast

(§2, Abs. 5 BBodschV - German law):
Risk assessment of groundwater contamination due to leachate water that is passing potentially contaminated areas or environmental harmful changes of the soil structure.
Therefore the concentration, load and transition zone between the saturated and unsaturated zone have to be taken into account.

Advantages of the computer-based leachate forecast with PCSiWaPro®

- 2D-simulation of water balance and transport processes
- easy to handle Windows Software
- GUI that is adapted to several languages (German, English, Spanish, French, Polish, Japanese, Vietnamese, Arabic)
- easy presentation of the results due to several interfaces to graphical software
- flexible choice of boundary conditions
- consideration of atmospheric boundary conditions, root water uptake and soil evaporation
- interface for GeODin-databases
- consideration of hysteretic processes within the unsaturated zone
- implemented algorithm for parameter identification
- integrated weather generator for arbitrary time series in high resolution
- automatic discretization with finite element – mesh generator
- soil databases DIN 4022, DIN 4220, pedotransfer function

Mathematical background

- RICHARDS- Equation → flux and water balance

$$\frac{\partial \theta}{\partial t} = \frac{\partial}{\partial x_i}\left[K\left(K_{ij}^{A}\frac{\partial h}{\partial x_j} + K_{iz}^{A} \right)\right] - S$$

θ - volumetric water content
t - time
X_i - coordinates
K - hydraulic conductivity
h - pressure head
S - sources/sinks

- Transport: Convection-Dispersion-Equation

$$\frac{\partial \theta c}{\partial t} + \frac{\partial \rho s}{\partial t} = \frac{\partial}{\partial x_i}\left(\theta D_{ij}\frac{\partial c}{\partial x_j}\right) - \frac{\partial q_i c}{\partial x_i} + \mu_w \theta c + \mu_s \rho s + \gamma_w \theta + \gamma_s \rho - S c_s$$

c - concentration
s - sorbed concentration
ρ - bulk density
t - time
q - flux
D_{ij} - tensor of dispersion coefficients
S - sink/source term
C_s - concentration of sink/source term
γ_w, γ_s - parameters for 1st order processes
μ_w, μ_s - parameters for 0th order processes

Composition and properties of the program

- computation of two dimensional vertical plane as well as rotationally symmetric flow and transport processes (including degradation and sorption processes) in the unsaturated and saturated zone
- discretization via built-in mesh generator
- user interface that can be easily changed to other languages
- implementation of existing information systems:
  - soil layer information systems (e.g. GeODin)
  - soil and pollutant data bases

Water balance problems

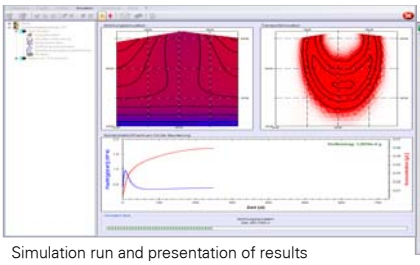
The assessment of the contaminant input requires a detailed knowledge on the input values of the soil water budget, which is strongly connected with the water balance and the atmospheric boundary conditions at the particular test site. Due to the lack of detailed data, in practise often average values are used for the input values of the local water budget.
This may result in large mistakes within the particular assessment!

Actual investigations on that show a strong dependency between the transport of substances within the unsaturated zone and the variation of precipitation.

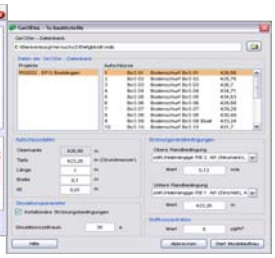
Connection of a weather simulation tool and PCSiWaPro®

- parameterisation of the weather simulation tool on the base of available weather data from local weather stations of the German Weather Service (DWD)
- creation of synthetic data time series of precipitation, temperature, evapotranspiration up to a time resolution of 30 minutes
- integration of further models like water removal caused to plant roots and interception

It is possible to calculate and simulate transient flow conditions by combining the weather simulation tool with PCSiWaPro®

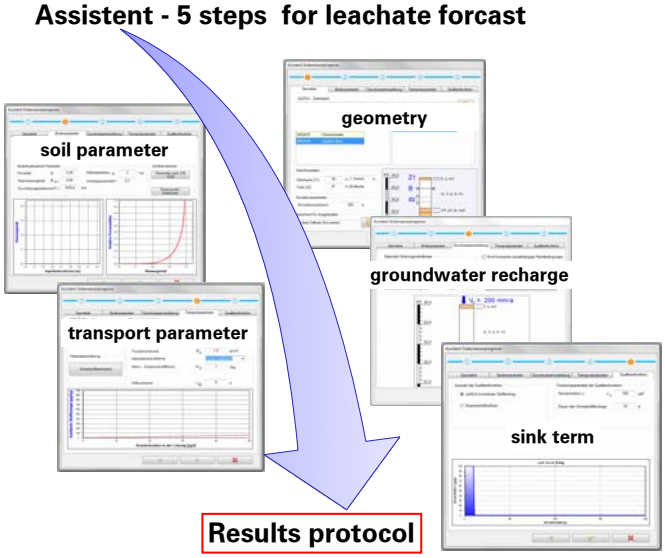


Simulation run and presentation of results



GeODin-interface

Assistent - 5 steps for leachate forcast



Application for PCSiWaPro®

Application for

- risk assessment
- design of plants and experiments
- analysis of efficiency for facility optimization

Areas of application

- remediation of contaminated sites and landfills(seepage flow prediction)
- sealing of landfills/capillary barriers/ recultivation layers
- mining
- agriculture
- dam seepage flow

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