DRUtES

TUTORIAL: STANDARD RICHARDS EQUATION MODULE: INFILTRATION – F

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CONTENTS

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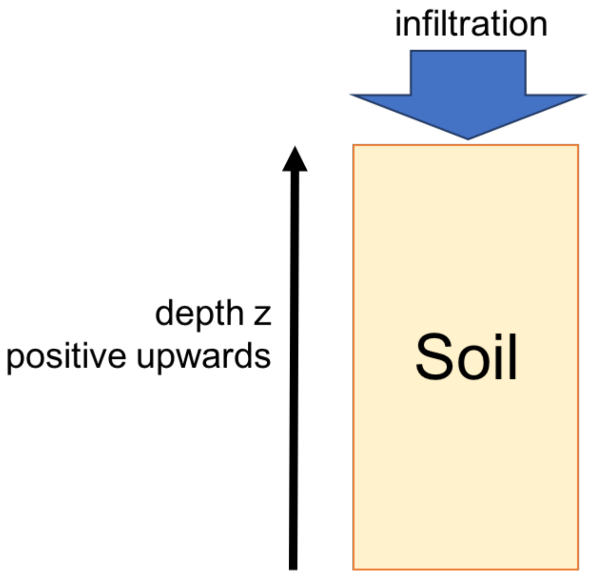
GOAL AND COMPLEXITY

Complexity: Beginner

Prerequisites: None

The goal of this tutorial is to get familiar with the *DRUtES* standard Richards equation module and *DRUtES* configuration in 1D by simulating infiltration into different soil



The process of infiltration is fundamental and yet very important in soil science. Infiltration into the soil determines water, heat and contaminant transport. Infiltration experiments can be used to determine some parameters describing soil hydraulic properties.

In this tutorial three configuration files will be modified step by step. All configuration files are located in the folder *drutes.conf* and respective subfolders.

1. For selection of the module, dimension and time information we require *global.conf*. *global.conf* is located in *drutes.conf / global.conf*.
2. To define the mesh or spatial discretization in 1D, we require *drumesh1D.conf*. *drumesh1D.conf* is located in *drutes.conf / mesh / drumesh1D.conf*.
3. To define the infiltration, we require *matrix.conf*. *matrix.conf* is located in *drutes.conf /water.conf/ matrix.conf*.

DRUtES works with configuration input file with the file extension .conf. Blank lines and lines starting with # are ignored. The input mentioned in this tutorial therefore needs to be placed one line below the mentioned keyword, unless stated otherwise.

SOFTWARE

1. Install *DRUtES*. You can get *DRUtES* from the github repository drutes-dev or download it from the drutes.org website.

2. Follow website instructions on drutes.org for the installation.
3. Working R installation (optional, to generate plots you can execute freely distributed R script)

SCENARIOS

We are using the well-known van Genuchten-Mualem parameterization to describe the soil hydraulic properties of our soils.

Table 1: Material properties needed for scenarios.

	α	n	m	θ_s	θ_r	Ss	K_s
	cm^{-1}	-	-	-	-	cm d^{-1}	
Material							
Sand	0.15	2.5	0.60	0.4	0	1e-9	400
Silt	0.08	2.0	0.50	0.45	0.05	1e-9	40
Clay	0.01	1.5	0.33	0.5	0.1	1e-10	4

SCENARIO 1

Infiltration into sandy soil.

global.conf: Choose correct model, dimension, time discretization and observation times.

1. Open ***global.conf*** in a text editor of your choice.
2. Model type: Your first input is the module. Input is **RE**.
3. Initial mesh configuration
   a) The dimension of our problem is 1. Input: 1.
   b) We use the internal mesh generator. Input: 1.
4. Error criterion
   a) Maximum number of iteration of the Picard method: 20
   b) h tolerance: 1e-2.
5. Time information
   a) Time units are in hours: input d
   b) Initial time: 1e-3.
   c) End time: 1.
   d) Minimum time step: 1e-6.
   e) Maximum time step: 0.01.
6. Observation time settings
   a) Observation time method: 2
   b) Set file format of observation: pure. Output in 1D is always in raw data. Different options will not impact output in 1D.
   c) Make sequence of observation time: n
   d) Number of observation times: 10
   e) Observation time values: 0.05, 0.1, 0.2, 0.3, 0.4, 0.5, 0.6, 0.7, 0.8, 0.9. Use a new line for each input. *DRUtES* automatically generates output for the initial time and final time. DRUtES will generate 13 output files, e.g. *MISSINS.dat*, where x is the number of the file and not the output time. The initial time is assigned an x value of 0.

7. Observation point settings
   a) Observation point coordinates: 0, 1000. Use a new line for each input. *DRUtES* will generate 2 output files, e.g. *MISSING*, where x is the ID of the observation point.
8. Ignore other settings for now.
9. Save *global.conf*

drumesh1D.conf: Mesh definition, i.e. number of materials and spatial discretization

1. Open ***drumesh1D.conf*** in a text editor of your choice.
2. Geometry information: 1000 cm - domain length
3. Amount of intervals: 1
4.

density	bottom	top
5	0	1000

5. number of materials: 1
6.

id	bottom	top
1	0	1000

matrix.conf: Configuration file for water flow

1. Open *matrix.conf* in a text editor of your choice.
2. How-to use constitutive relations? [integer]: 1
3. Length of interval for precalculating the constitutive functions: 500
4. Discretization step for constituitive function precalculation: 0.1
5. number of soil layers [integer]: 1
6.

alpha	n	m	theta_r	theta_s	specific storage
0.15	2.5	0.60	0.00	0.40	1e-9

7. anisothprophy description and hydraulic conductivity

angle [degrees]	K_11
0	400

8. sink(-) /source (+) term per layer: 0
9.

init. cond [real]	type of init. cond	RCZA method [y/n]	RCZA method val.
0.0	H_tot	n	0

10. number of boundaries: 2
11.

boundary ID	boundary type	use rain.dat [y/n]	value
101	1	n	0.0
102	2	n	4

12. Save matrix.conf.

RUN SCENARIO 1

Run the simulation in the terminal console.

1. Make sure you are in the right directory.
2. To execute *DRUtES*:
   $ bin/drutes
3. After the simulation finishes, to generate png plots execute provided R script:
   $ Rscript drutes.conf/water.conf/drutesplots.R sand
4. The output of the simulation can be found in the folder out

TASKS FOR SCENARIO 1

1. Q1
2. Q2
3. Q3

OUTCOME

1. You got familiar with the *DRUtES* standard Richards Equation modules in 1D.
2. You understand basic parameterization of a typical sand, silt and clay with the van Genuchten-Mualem model.
3. You simulated infiltration in different soils.
4. You understand the term *Neumann boundary condition* and *initial condition*.