FACULTY OF
BIOSCIENCE ENGINEERING

DEPARTMENT OF ENVIRONMENT
RESEARCH GROUP SENSE

MODELLING WATER FLOW: EFFECT OF LAND USE

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AIM OF THE PRACTICUM

- Simulate the water flow in Hydrus 1D for the case study in Bottelare
- Compare your output to the measurements

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DATA SENSORS

Soil moisture measurements at:

- 10 cm depth (sensor 1 [m^3/m^3])
- 36 cm depth (sensor 2 [m^3/m^3])
- 80 cm depth (sensor 3 [m^3/m^3])

Tube containing the Diver (measurement depth groundwater table)

Matric potential measurements at:

- 16 cm depth (sensor 1 [kPa])
- 36 cm depth (sensor 2 [kPa]) – only for part of the dataset

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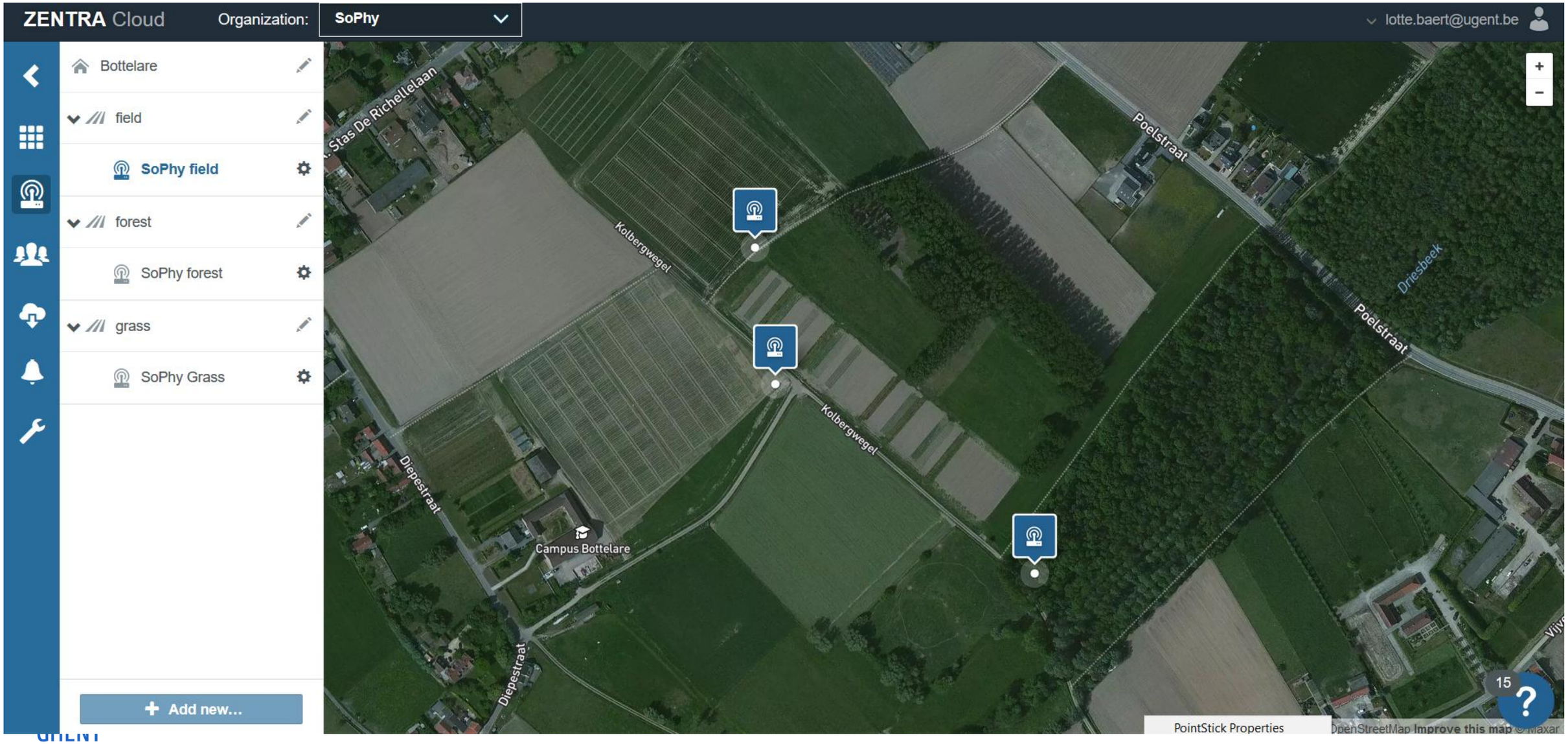
DATA SENSORS



HYDRUS 1D

Used to model …

- Water transport
- Heat transport
- Solute transport

… in 1D

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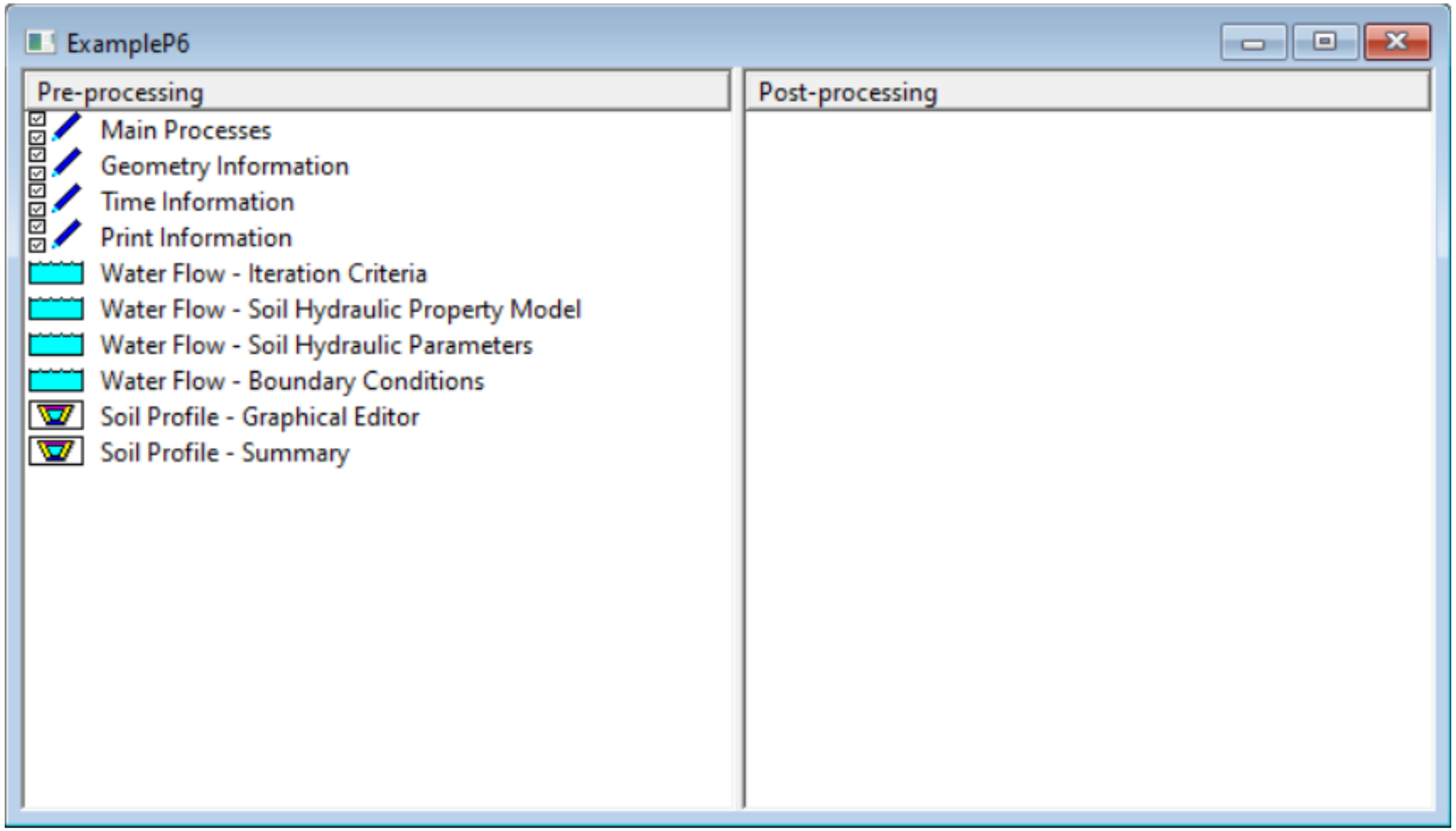
SIMULATION IN HYDRUS

Make a new project

→Choose where you will save the output



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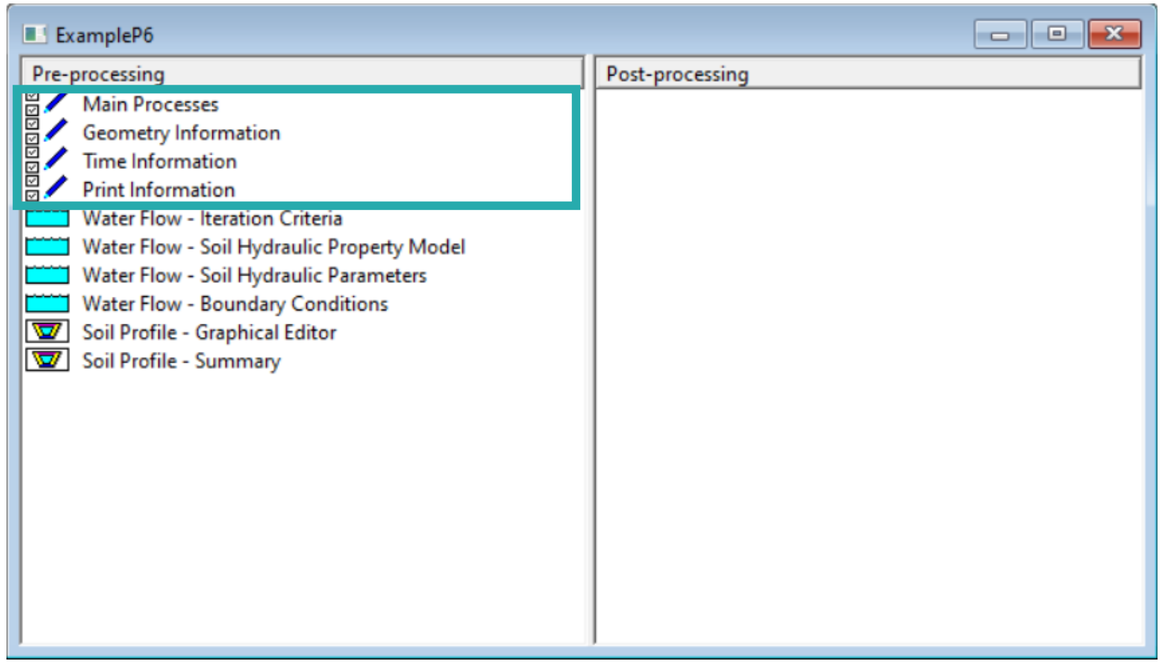
SIMULATION IN HYDRUS

Part A: general information about the simulation

- Length soil profile = 2 m
- How many soil materials do you have? (~available data on Ufora)
- For how long will you simulate?
- When does Hydrus have to make a printout of the simulation?



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SIMULATION IN HYDRUS

Part B: water flow

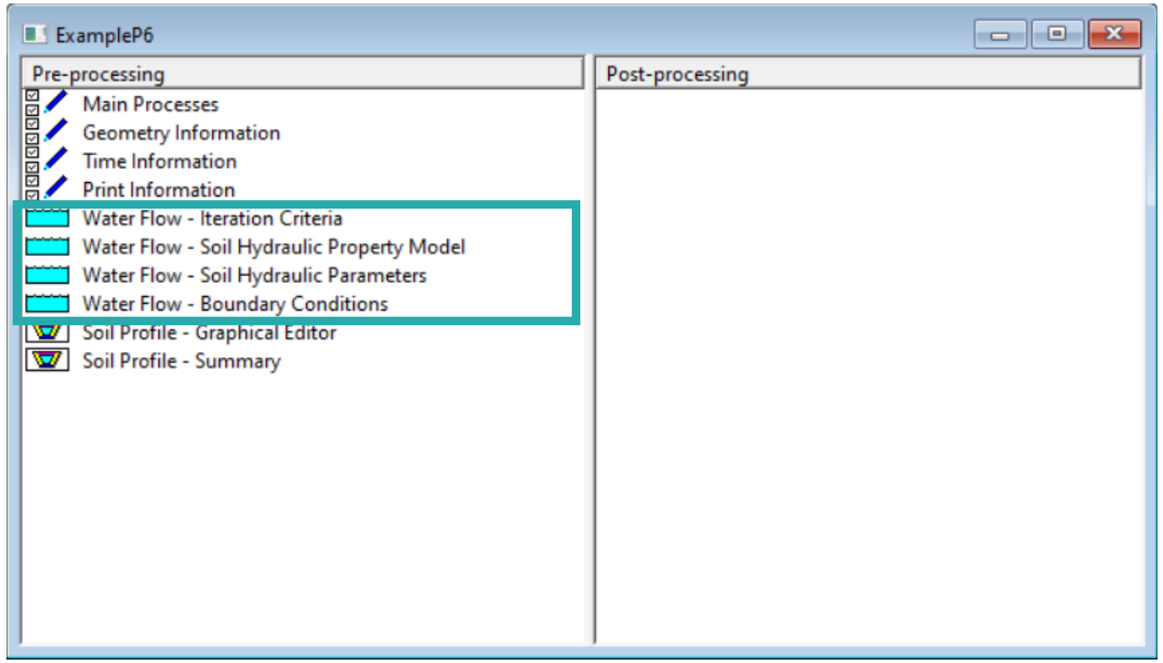
- Which hydraulic model should be used?

  Unimodal: Van Genuchten-Mualem

  Bimodal: Dual-porosity (Durner, dual Van Genuchten-Mualem)
- Enter the Van Genuchten parameters for each soil layer (~values = PRA3 Soilview analysis, available on Ufora)
- Select the boundary conditions

  Upper boundary: rainfall data

  Lower boundary: GWT data



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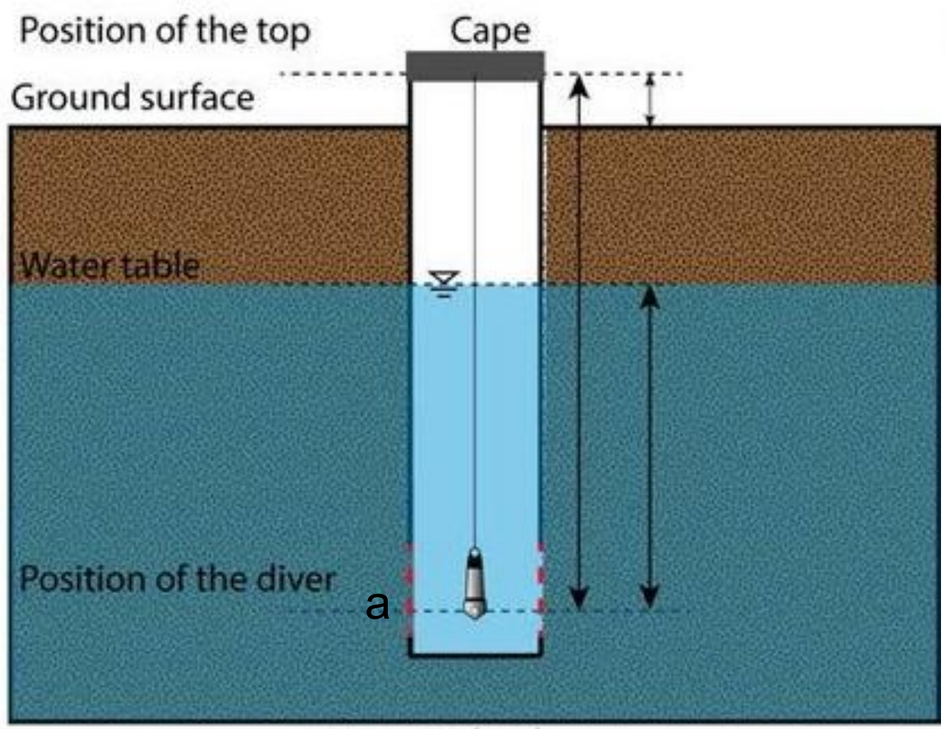
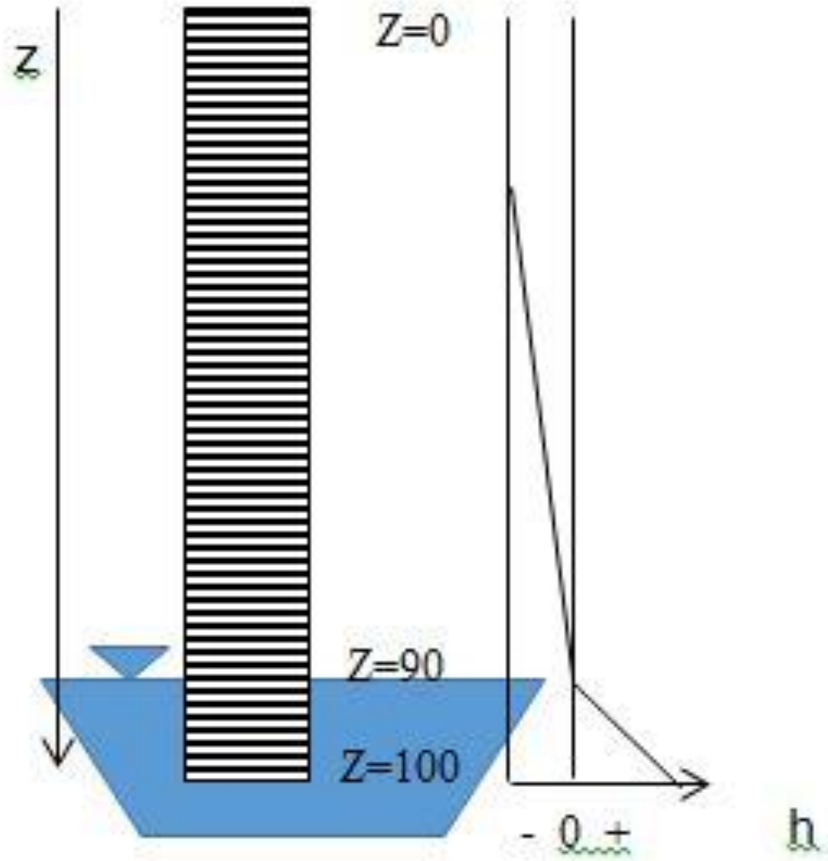
SIMULATION IN HYDRUS

Lower boundary: Diver data

1 cm = 1 hPa





a [hPa] = pressure water column + atmospheric pressure

FYI: location of the sensor = 2m below soil surface

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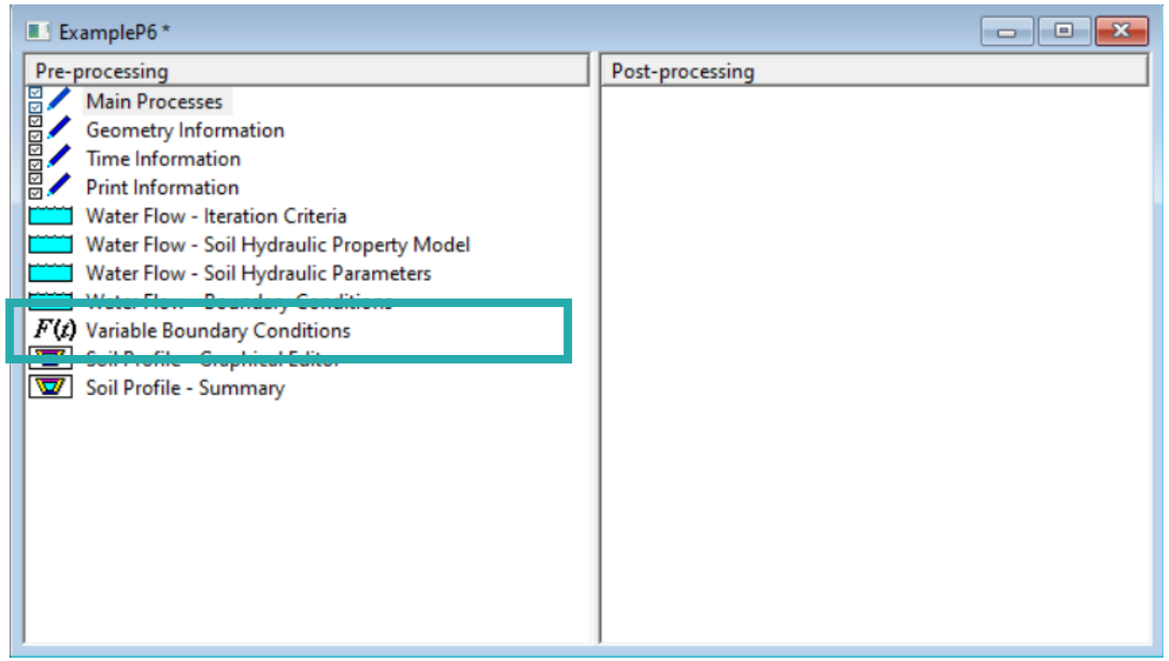
SIMULATION IN HYDRUS

Part C: variable boundary conditions

- Go to Time information → specify the amount of records you will enter
- Enter the hourly weather and GWT data



The highlighted box only appears if we selected the correct boundary condition

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SIMULATION IN HYDRUS

Part D: soil profile

- Enter the distribution of the different soil materials
- Define the initial pressure head profile (use measurements and GWT at start simulation)
- Add observation points (nodes) at interesting depths

We take samples from the middle of the layer it represents

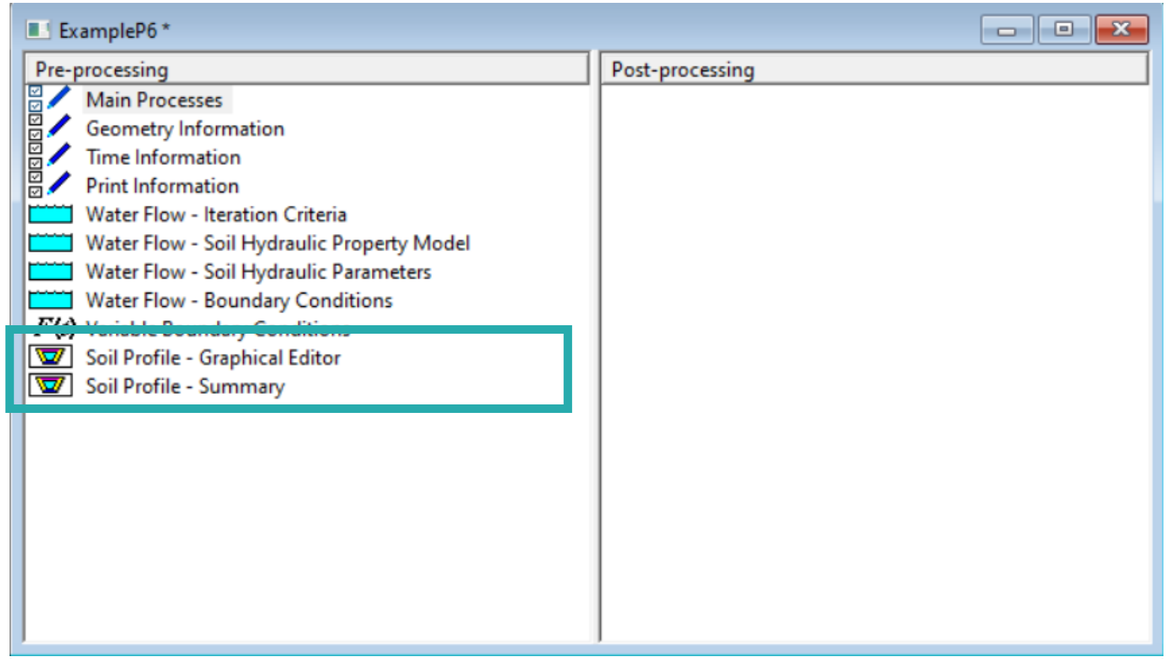
use 3 nodes to compare to R script

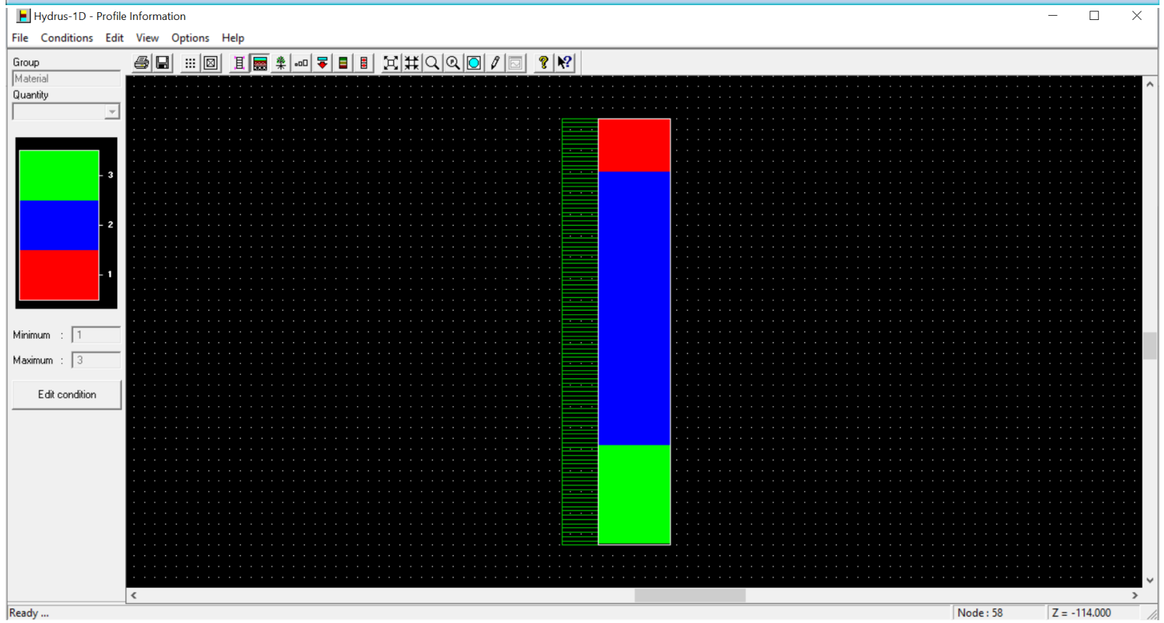
what are the interesting depths, (based on measured depths?)

Define initial pressure head

groundwater level and matric protential can eb used to find it

Distribution of soil materials is different for one of the soil materials - it must be adapted





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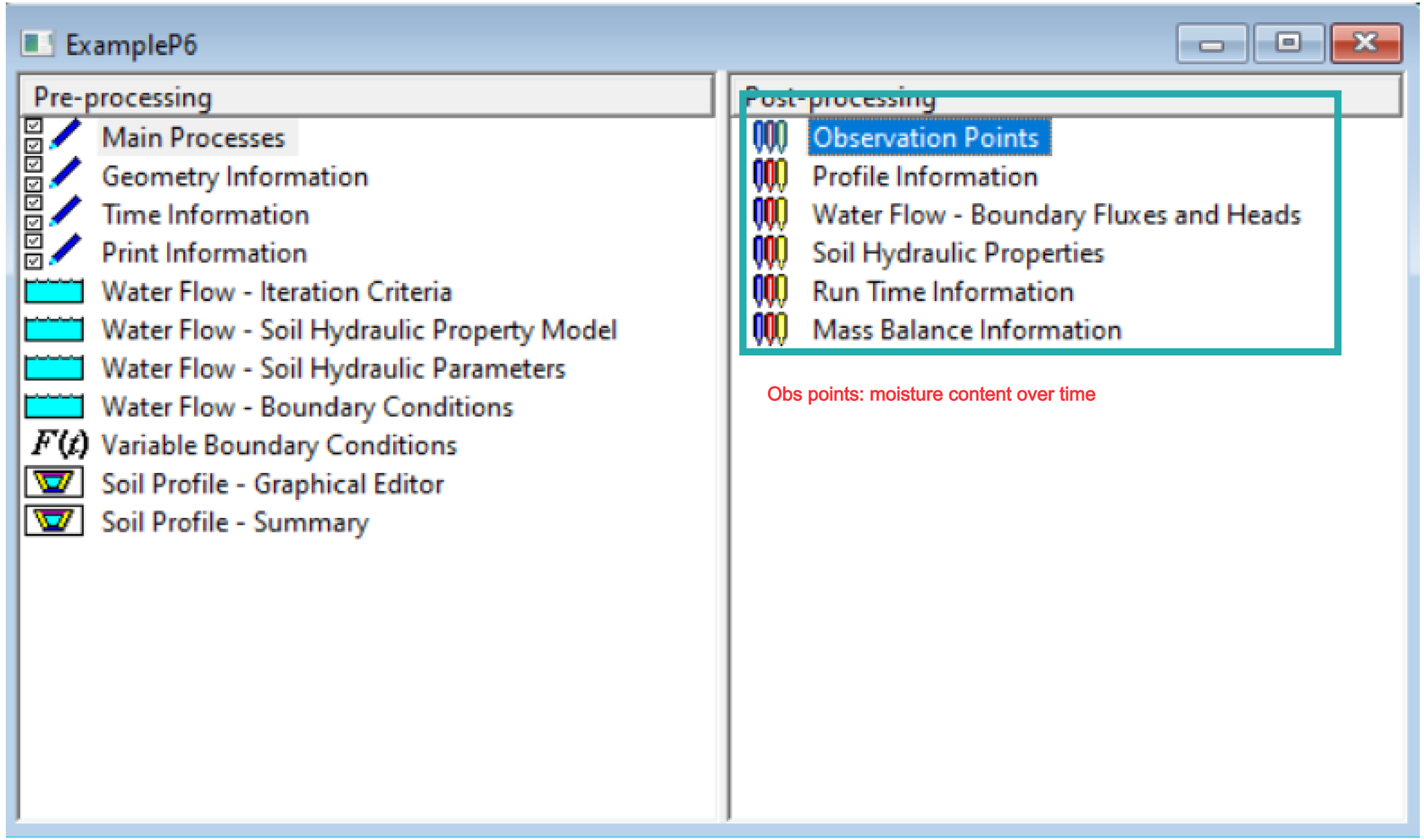
SIMULATION IN HYDRUS

Part E: Output and interpretation

Run Hydrus 1D



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SIMULATION IN HYDRUS

Press F1 for help

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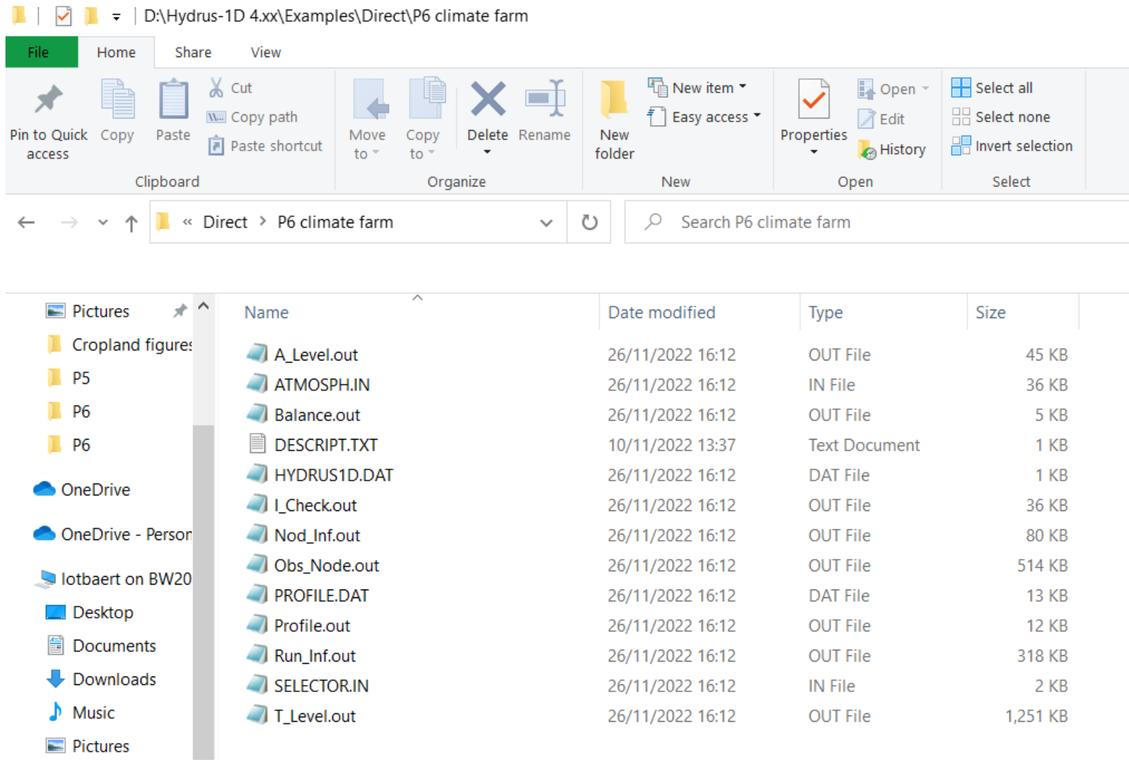
OUTPUT FILES

- Output per node: Obs_Node.out
- Output profiles at different times: Nod_Inf.out

Hydrus overwrites these files after each run!

Athena users: watch out where the output is saved!



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PLOT THE OUTPUT AND MEASURED DATA

- Use the R script on Ufora

PRA5 Plot simulated and measured data

```r
#This script is part of the practical exercise of the course Soil Physics. This script is only to be used for the exercise in this course.
rm(list=ls())

#Mention here for which land use you are doing the simulation. 1 = cropland, 2 = forest, 3 = grass
LU = 2

##Load all data
#Output file Hydrus simulation.
input_sim = read.csv("D:/Hydrus-1D 4.xx/Examples/Direct/P6 climate forest/Obs_Node.out",skip=10,sep=" ")
#Measured data by the sensors. Load as csv file.
measured =read.csv("E:/Users/lotbaert/vakken/2022-2023/Soil Physics/P5/forest.csv")

##In order to compare to the correct measured data you need to insert the starting day of your simulation.
#Update the field between "". Change to the start moment of your simulation. Only change the date, do not adapt the hours:minutes:seconds. Keep an iden
s = "2021-01-01 00:00:00"

##Variables related to the plotting
#Limits of the y axis
SMC_min = 0.1 #Soil moisture content (m³/m³)
SMC_max = 0.55
w_min = 0 #soil water storage (mm)
w_max = 300

##Place where the output will be stored
#Change the path to the location where the output csv file can be stored. The last letters make the name of the csv file. In order to distinguish betwe
path = "E:/Users/lotbaert/vakken/2022-2023/Soil Physics/P5/PRA5.csv"

### Don't change anything in this script underneath this line ###

#Obtain the dataset of
input_sim=input_sim[,2
m = 3 #only adapt this
data = matrix(ncol=(m*3+1))
```

This R script only works when you have inserted **3 nodes** in Hydrus 1D

PLOT THE THREE LAND USES

- Use the R script on Ufora

  PRA5 Plot comparison land uses

```
#This script is part of the practical exercise of the course Soil Physics. This script is only to be used for the exercise in this course.
rm(list=ls())

##Read the input data, adapt the path to the location where the Hydrus file is saved

#Input cropland
Cropland = read.csv("E:/Users/lotbaert/Vakken/2022-2023/Soil physics/P5/PRA5C.csv")
#Input forest
Forest = read.csv("E:/Users/lotbaert/Vakken/2022-2023/Soil physics/P5/PRA5F.csv")
#Input grassland
Grass = read.csv("E:/Users/lotbaert/Vakken/2022-2023/Soil physics/P5/PRA5G.csv")

#Plotting of the output. You can adapt here limits of the X and Y axes
SMC_min = 0.1
SMC_max = 0.4
MP_min = -1500
MP_max = 0
w_min = 0
w_max = 300

### Don't change anything in this script underneath this line ###

#Retain the correct columns in the dataset and give appropriate column names
Cropland=Cropland[,2:ncol(Cropland)]
colnames(Cropland)=c("time (hours)","N1 matric potential (hPa)","N1 theta (m³/m³)","N1 flux (cm/h)","N2 matric potential (hPa)","N2 theta (m³/m³)","N2
Forest=Forest[,2:ncol(Forest)]
colnames(Forest)=c("time (hours)","N1 matric potential (hPa)","N1 theta (m³/m³)","N1 flux (cm/h)","N2 matric potential (hPa)","N2 theta (m³/m³)","N2 fl
Grass=Grass[,2:ncol(Grass)]
colnames(Grass)=c("time (hours)","N1 matric potential (hPa)","N1 theta (m³/m³)","N1 flux (cm/h)","N2 matric potential (hPa)","N2 theta (m³/m³)","N2 flu

#Calculate the soil water storage for each land use
dl1 = 250 #Depth of the first layer (inserted in Hydrus) in mm
dl2 = 200 #Depth second layer
```

SIMULATION IN HYDRUS

Make a realistic simulation…

… take into account:

- Weather data
- Groundwater table data (Diver)
- Soil parameters for your land use + appropriate depths for each layer
- Initial pressure head in the soil profile based on measurements and groundwater table at the start of the simulation

TASK

- **Each group member**
  - Makes a Hydrus simulation for your time period for 1 land use
  - Compare the output to the measured soil moisture content at the different depths for which you have the measurements
    PRA4 Plot simulated and measured data
- **Group exercise**
  - Compare the simulations for the three land uses (same month)
    - You need to exchange the output of the individual task
    - R script *PRA4 Plot simulated and measured data* generates a .csv file
      → exchange this.
      = input for R script *PRA4 Plot comparison land uses*
  - Answer the questions in the notes (groupwork)

QUESTIONS DURING THE SESSION

https://ugentbe-my.sharepoint.com/:x:/g/personal/lotte_baert_ugent_be/ETAuW_boeEBLnCnqmj8xoTQBjoC2xJbMb4qLpdP6T7MYSA?e=jCDw8a

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