OPTAIN

OPtimal strategies to retAIN and re-use water and nutrients in small agricultural catchments across different soil-climatic regions in Europe

Soil parameters and soil input data

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This project has received funding from the European Union's Horizon 2020 research and innovation program under grant agreement No. 862756.

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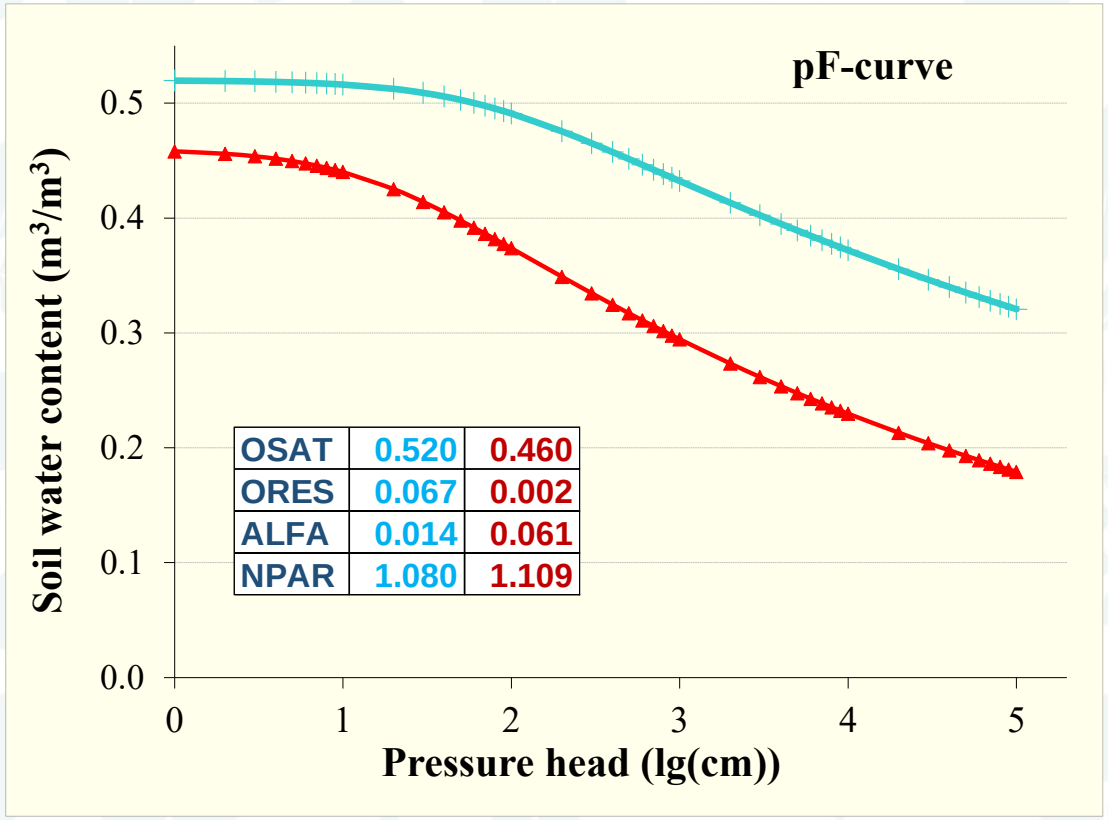
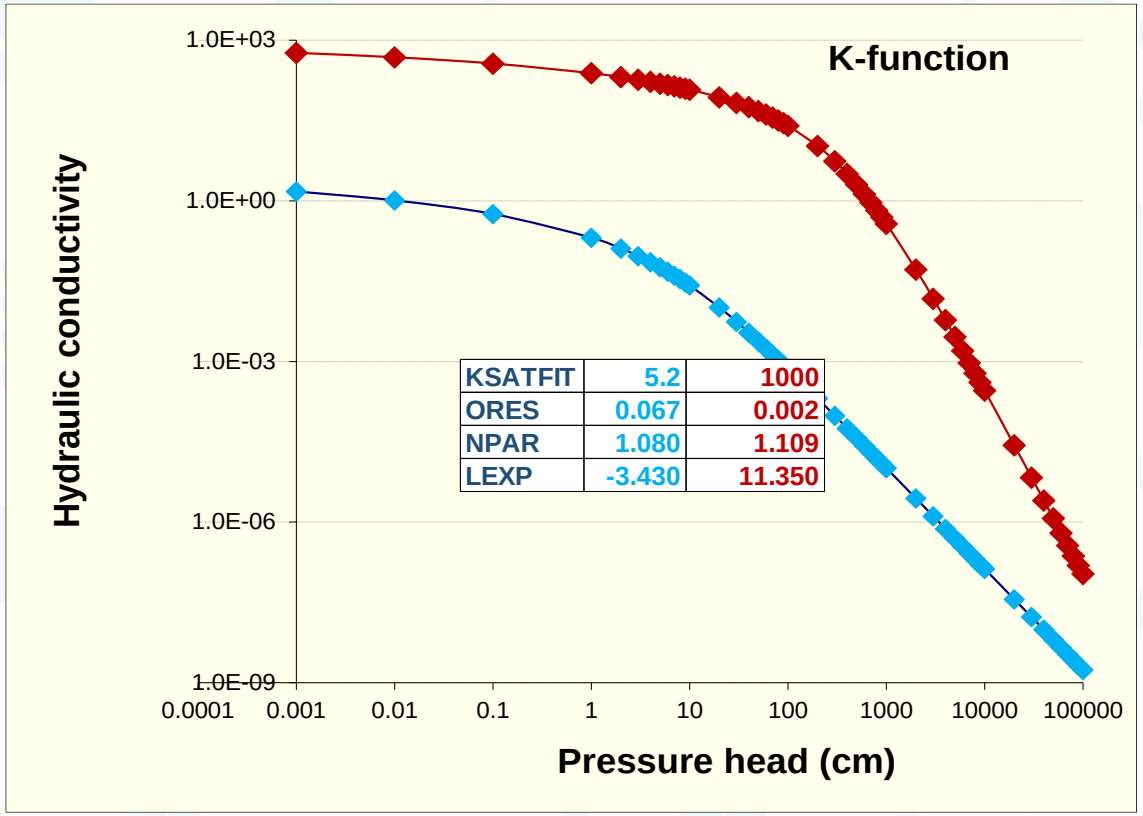
Soil hydraulic functions – main soil input data

Soil water retention curve; Θ = f(h)



Hydraulic conductivity function; K=f(h)



Identifying the soil hydraulic functions

Measurements (lab, in situ)

Estimate from other soil properties

= we use pedotransfer functions (PTFs)

Due to the numerical scheme we need continuous functions

- Measurements are usually done at few – up to 8-10 – data points – NOT enough
- We need to fit analytical functions to measured data

- We can estimate discrete points and fit an analytical function
- We can estimate the parameters of the analytical function directly

The most commonly used analytical description of the two functions is the van Genuchten – Mualem method

The van-Genuchten model for soil water retention curves

SWAP manual: The analytical $\theta(h)$ function proposed by Van Genuchten (1980) reads:

$$\theta = \theta_{res} + (\theta_{sat} - \theta_{res})\left(1 + |\alpha h|^{n}\right)^{-m} \qquad m = 1 - \frac{1}{n} \qquad (2.4)$$

```
  ISOILLAY1  ORES     OSAT       ALFA     NPAR  KSATFIT       LEXP     ALFAW H_ENPR  KSATEXM  BDENS
       1     0.01     0.42     0.0276    1.491    12.52     -1.060    0.0542  0.0    12.52   1315.0
       2     0.02     0.48     0.0213    1.951     2.68      0.168    0.0426  0.0    12.68   1315.0
       3     0.02     0.38     0.0213    1.951    12.68      0.168    0.0426  0.0    12.68   1315.0
* --- end of table

* If SWSOPHY = 1, specify names of input files [A80] with soil hydraulic tables for each soil laye
  FILENAMESOPHY = 'topsoil_sand_B2.csv', 'subsoil_sand_O2.csv'
```

OSAT or Θ_{sat} - saturated water content ($cm^3\ cm^{-3}$)

ORES or Θ_{res} - residual water content ($cm^3\ cm^{-3}$)

ALFA or α (cm^{-1})

NPAR or n (-)

m (-)

empirical shape factors

The van Genuchten – Mualem model for the K(h) curve

SWAP manual:

$$K = K_{sat} S_e^{\lambda} \left[1 - \left(1 - S_e^{\frac{1}{m}} \right)^m \right]^2 \qquad S_e = \frac{\theta - \theta_{res}}{\theta_{sat} - \theta_{res}}$$

```
  ISOILLAY1  ORES     OSAT      ALFA     NPAR   KSATFIT      LEXP     ALFAW H_ENPR  KSATEXM   BDENS
       1     0.01     0.42    0.0276    1.491    12.52    -1.060    0.0542  0.0    12.52    1315.0
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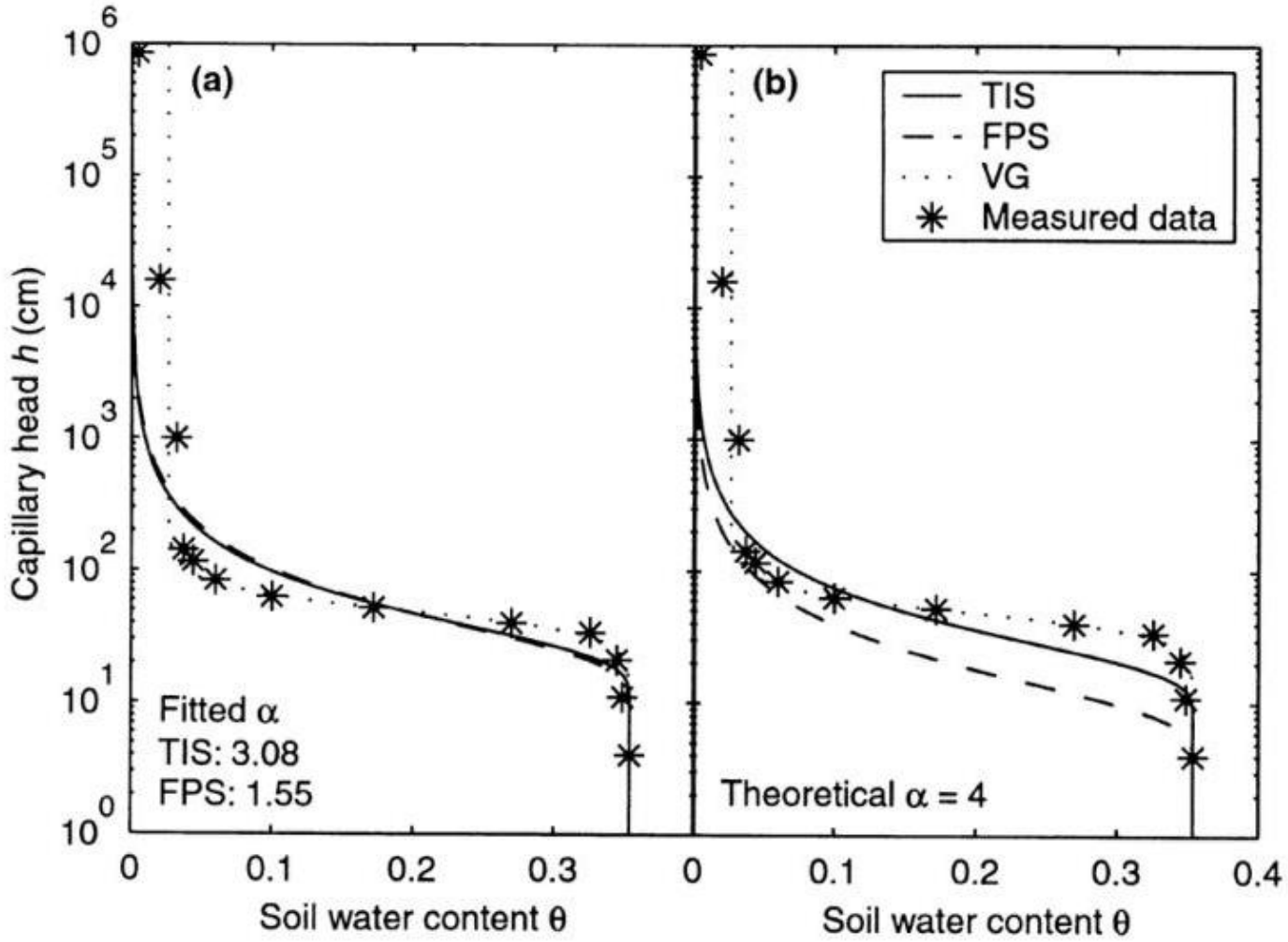
KSATFIT or K_{sat}- saturated hydraulic conductivity; fitted (cm day^{-1})

LEXP or λ – shape parameter (-)

KSATEXM – measured hydraulic conductivity; fitted (cm day^{-1})

BDENS – soil bulk density (mg cm^{-3})

Measured and fitted soil water retention curves



Van-Genuchten model (VG)

Other models

In SWAP you can not define parameters for other models than van-Genuchten – Mualem

Chan et al. 2004

Soil input data

Parameters of analytical functions

Table format: user-defined data

0 ⟵ **SWSOPHY** ⟶ **1**

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* Part 5: Soil hydraulic functions

* Switch for analytical functions or tabular input:
  SWSOPHY = 0    ! 0 = Analytical functions with input of Mualem - van Genuchten parameters
                 ! 1 = Soil physical tables

* If SWSOPHY = 0, specify MvG parameters for each soil physical layer (maximum MAHO):
* ISOILLAY1 = number of soil physical layer, as defined in part 4 [1..MAHO, I]
* ORES     = Residual water content [0..1 cm3/cm3, R]
* OSAT     = Saturated water content [0..1 cm3/cm3, R]
* ALFA     = Parameter alfa of main drying curve [0.0001..100 /cm, R]
* NPAR     = Parameter n [1.001..9 -, R]
* KSATFIT  = Fitting parameter Ksat of hydraulic conductivity function [1.d-5..1d5 cm/d, R]
* LEXP     = Exponent in hydraulic conductivity function [-25..25 -, R]
* ALFAW    = Alfa parameter of main wetting curve in case of hysteresis [0.0001..100 /cm, R]
* H_ENPR   = Air entry pressure head [-40.0..0.0 cm, R]
* KSATEXM  = Measured hydraulic conductivity at saturated conditions [1.d-5..1d5 cm/d, R]
* BDENS    = Dry soil bulk density [100..1d4 mg/cm3, R]

  ISOILLAY1  ORES    OSAT      ALFA    NPAR  KSATFIT      LEXP    ALFAW H_ENPR  KSATEXM  BDENS
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```

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Table format for user-defined data

- h – water potential (cm)
- Q – soil water content ($cm^3\ cm^{-3}$)
- K – hydraulic conductivity ($cm\ day^{-1}$)

- Use small increments
- Separate file for each layer

	h	Θ	K
1	headtab	thetatab	conductab
2	-1E+07	0.103427	3.90E-13
3	-5000000	0.109281	1.64E-12
4	-2000000	0.118016	1.10E-11
5	-1500000	0.121015	2.00E-11
6	-1200000	0.123432	3.18E-11
7	-1000000	0.125468	4.64E-11
8	-500000	0.133737	1.95E-10
9	-200000	0.146074	1.31E-09
10	-150000	0.150311	2.38E-09
11	-120000	0.153725	3.78E-09
12	-100000	0.156601	5.51E-09
13	-50000	0.168281	2.32E-08
14	-20000	0.185707	1.56E-07

Table format for user-defined data

layer5n.csv

layer1n.CSV

layer2n.csv

Swap.swp - Notepad

File Edit Format View Help

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```

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K

ab	conductab
427	3.90E-13
281	1.64E-12
016	1.10E-11
015	2.00E-11
432	3.18E-11
468	4.64E-11
737	1.95E-10
074	1.31E-09
311	2.38E-09
725	3.78E-09
601	5.51E-09
281	2.32E-08
707	1.56E-07

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Identifying the soil hydraulic functions

Measurements (lab, in situ) **Estimate from other soil properties**

…ns (PTFs)

- Fitting analyti… …tions from measured dat… …measure

OPTAIN: Contact Brigi for the WP3 R script

Outside OPTAIN: contact Brigi and Attila

BUT…

+ you could check https://www.sciencedirect.com/science/article/pii/S0098300421001898

Identifying the soil hydraulic functions

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irect.com/science/a

Identifying the soil hydraulic functions

Measurements (lab, in situ)

- Fitting analytical functions to measured data

RETC tool

Estimate from other soil properties

= we use pedotransfer functions (PTFs)

- Estimate soil hydraulic functions from properties that are easier to measure

ROSETTA neural network

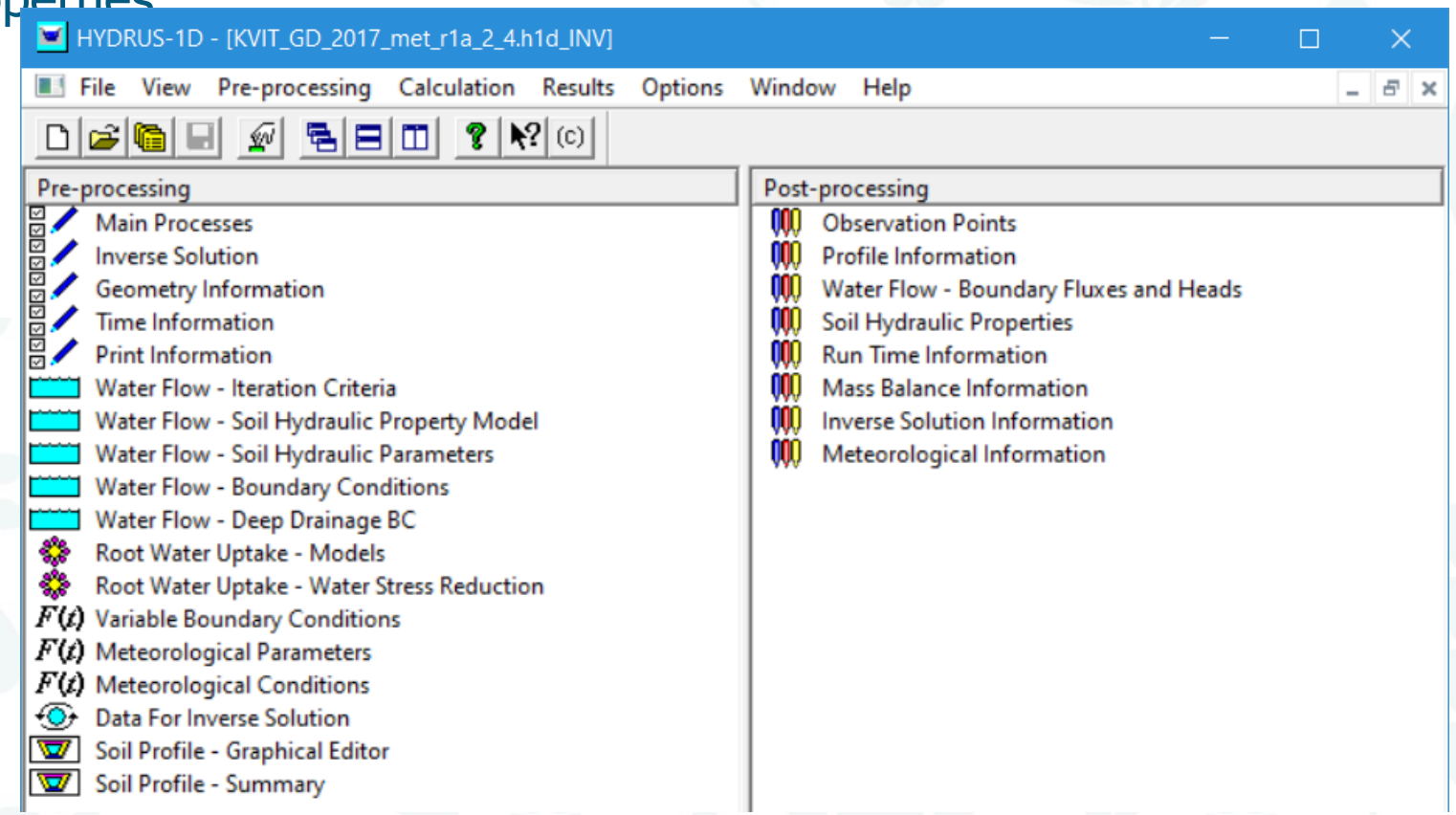
+ you could check https://www.sciencedirect.com/science/article/pii/S0098300421001898

Using the ROSETTA neural network

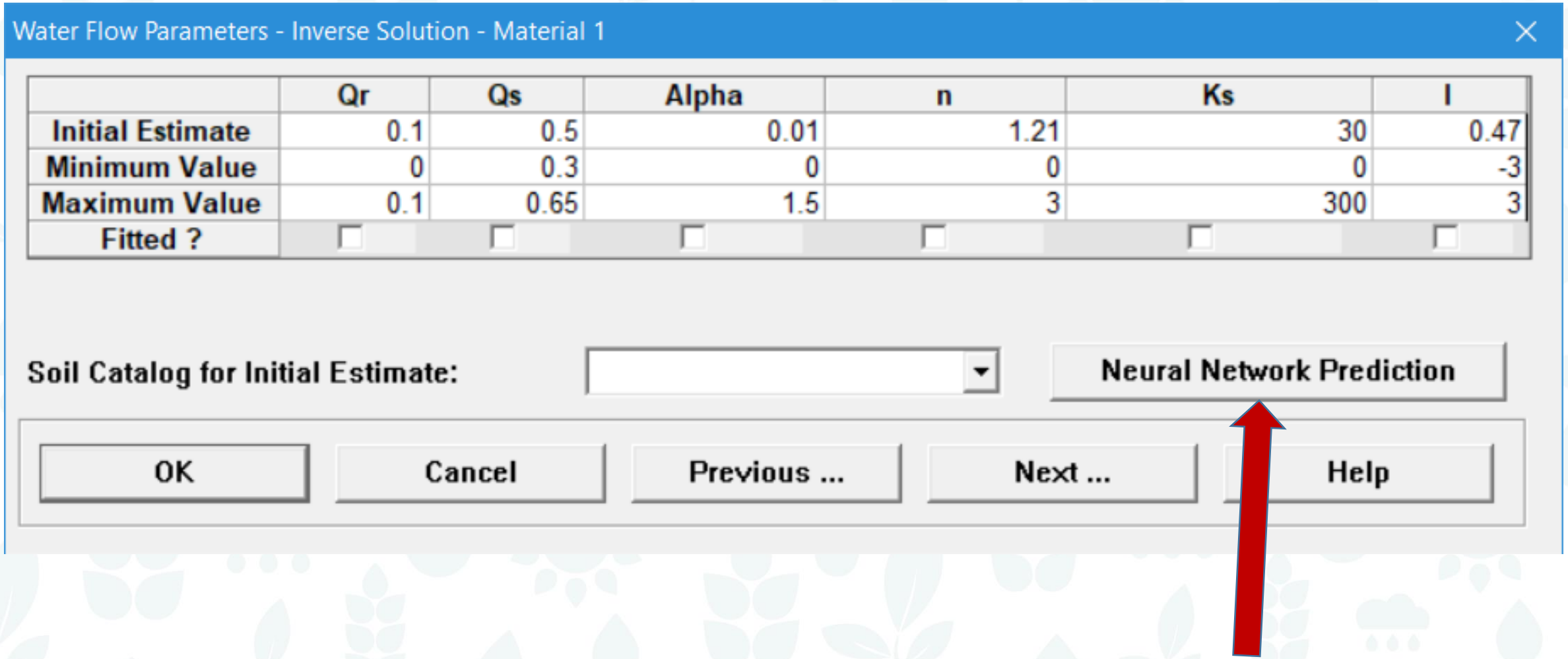
- Install the HYDRUS-1D model from here:

  https://www.pc-progress.com/en/Default.aspx?Downloads

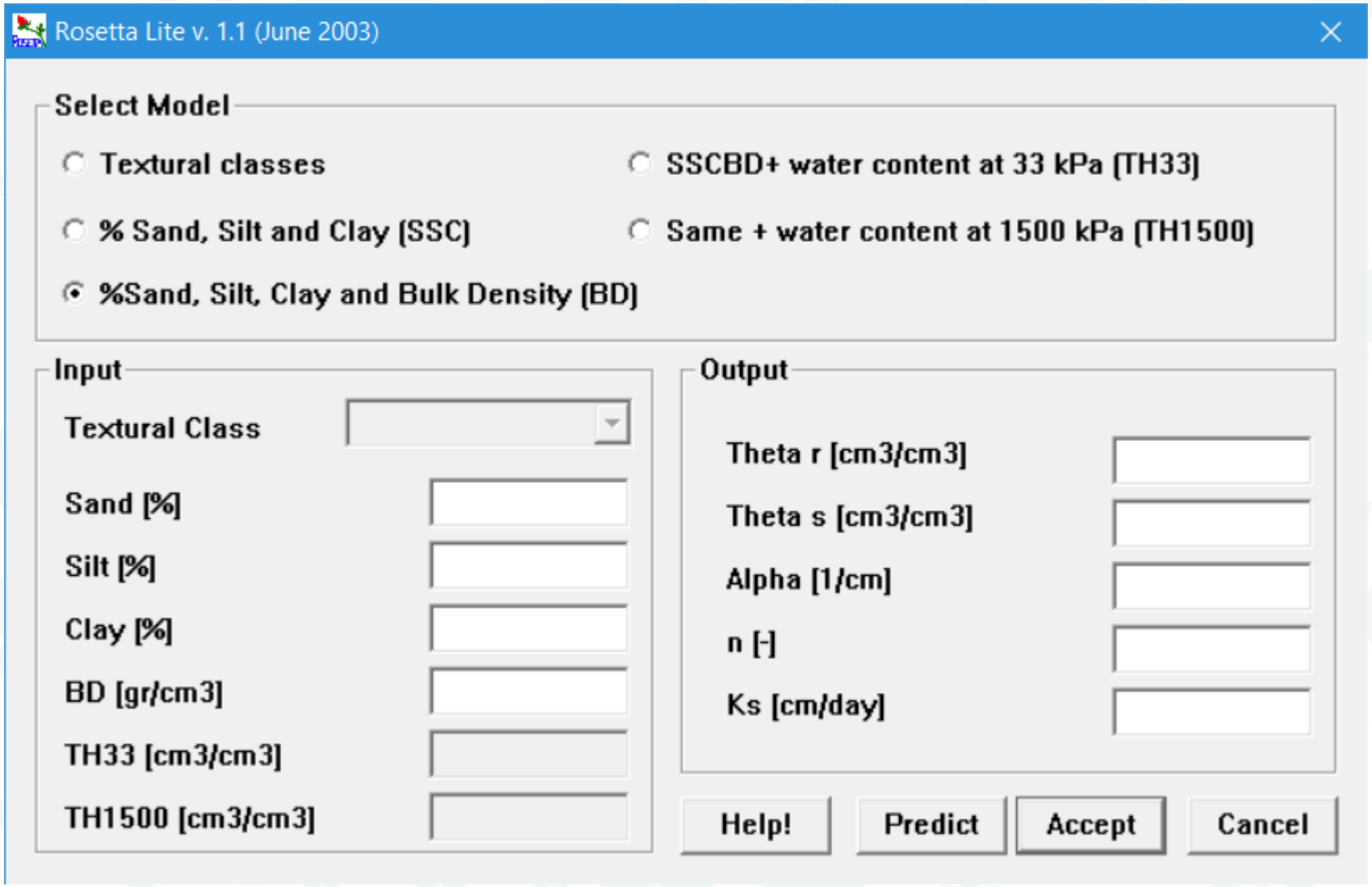
- Start any of the example projects
- Open the table with soil hydraulic properties
- Click on Neural Network Prediction
- Make your estimation depending on data availability



Using the ROSETTA neural network

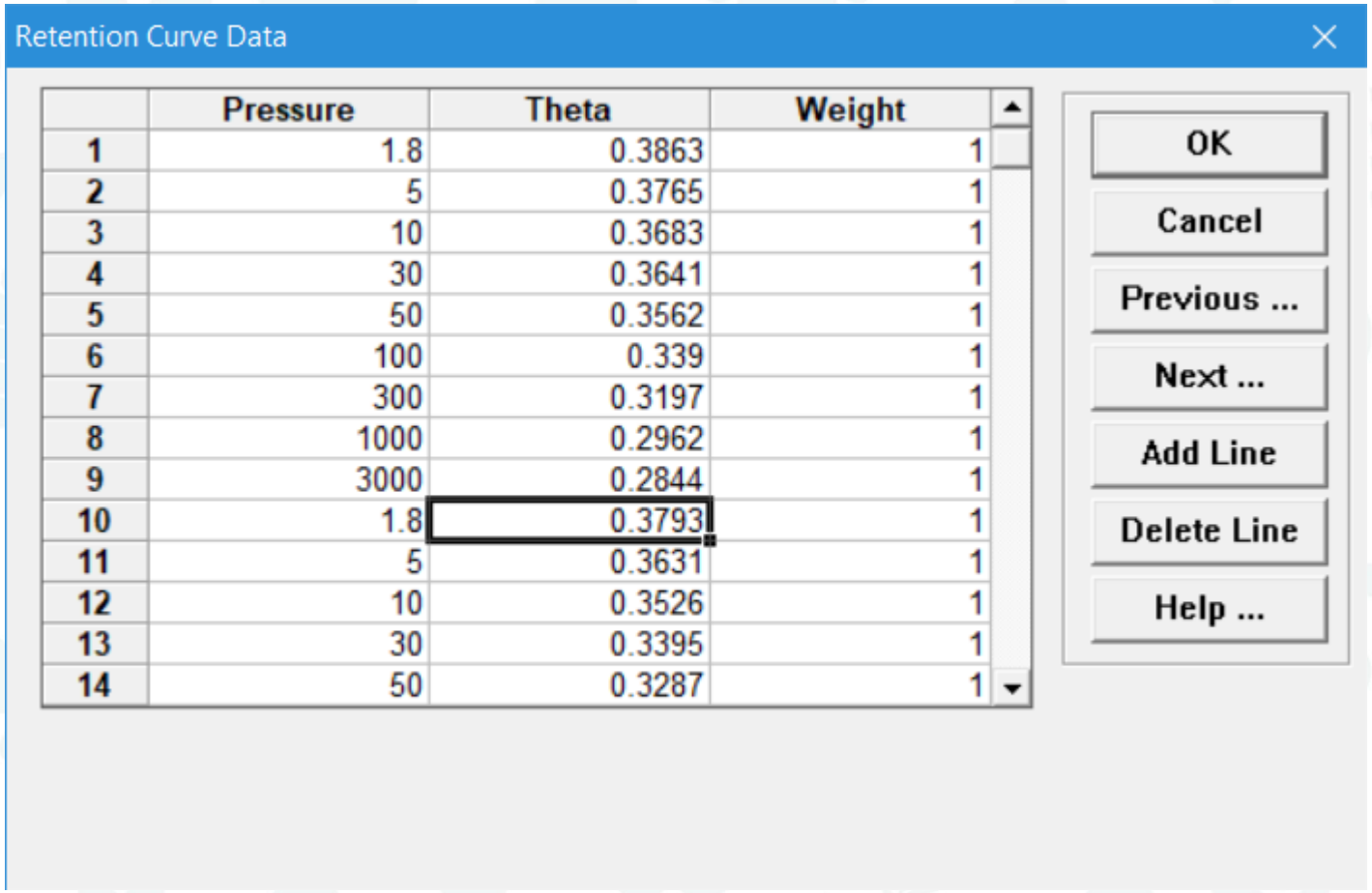


Using the ROSETTA neural network



Using the RETC software

- Prepare your data in the following format:

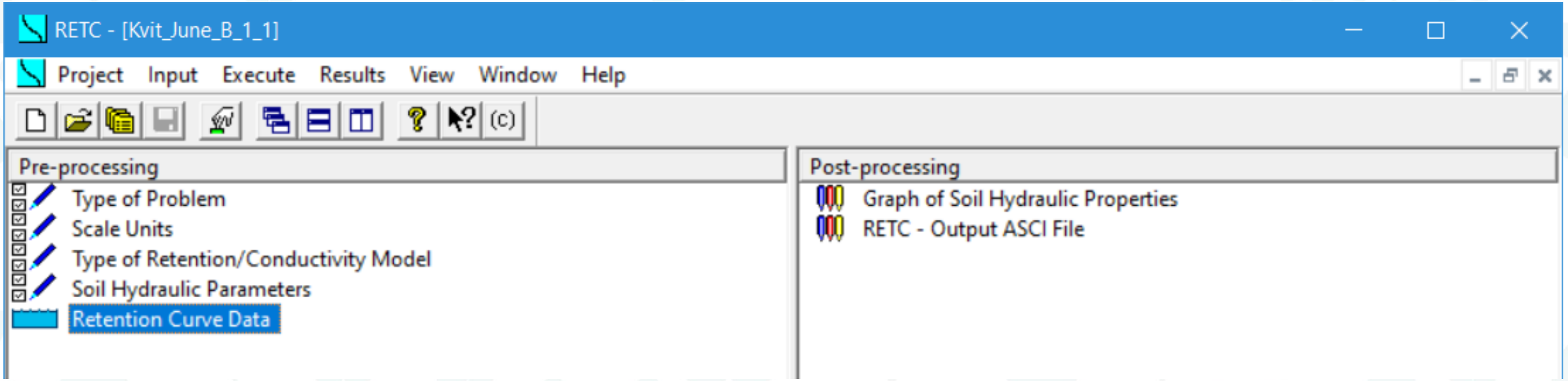


Using the RETC software

- Install the RETC from here:

  https://www.pc-progress.com/en/Default.aspx?retc

- Paste your data in the „retention curve data”
- Run the program and get your estimates



Thank you for your attention!

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