OPTAIN

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

SWAP input and reference data requirement

Csilla Farkas

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NIBIO
NORSK INSTITUTT FOR BIOØKONOMI

The modelling procedure

INPUT DATA

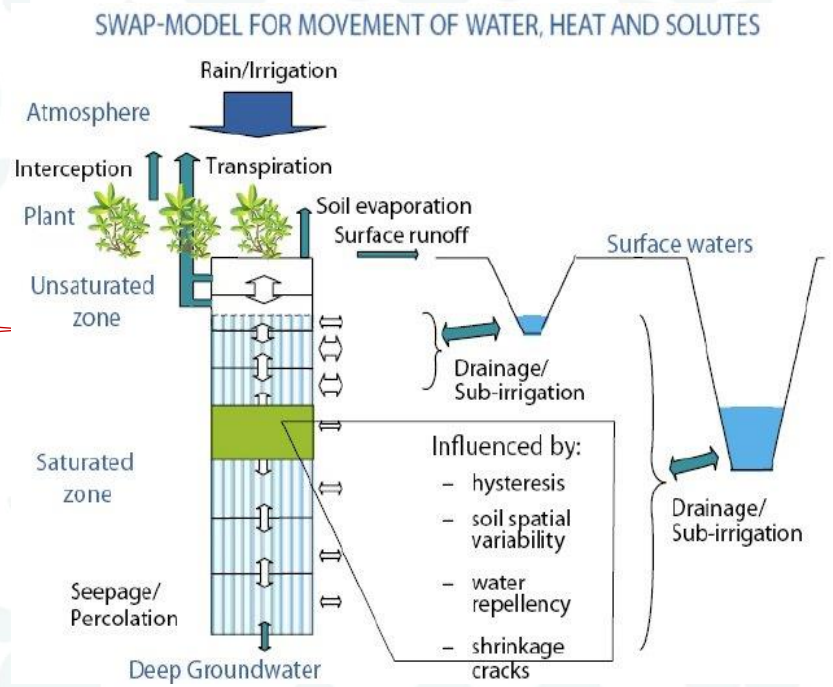
Meteorological data
- Air temperature
- Precipitation
- Solar radiation
- Wind speed
- Humidity

Soil data (field and lab measurements)
- Bulk density
- Total porosity
- Soil texture (sand, silt, clay content)
- Soil water retention characteristics
- Hydraulic conductivity

Crop data (measurements & literature)
- Crop type
- Leaf area index
- Crop height
- Rooting depth

Drainage data (records & literature)
- Depth of tile drains
- Distance between drainpipes

SWAP model



- Switches
- Model parameters

REFERENCE DATA

Soil data (monitored)
- Soil water content

Drainage data (monitored)
- Drainage outflow

calibration

MODEL OUTPUT

- **Soil water content**
- **Drainage outflow**
- Plant water uptake
- Evaporation
- Transpiration

OPTAIN WP3 and WP4 actions on setting up the SWAP model

- Data Inventory for Field Scale Models (UFZ OPTAIN Cloud)
- Data source for field-scale models (UFZ OPTAIN Cloud)
- Setting up your SWAP project (GitHub)
  - Reference data availability table
  - Guidelines on reference data quality check (see presentation by Levente on Tuesday)
  - Crop rotation table
  - Other information
- Swap test run guideline (GitHub)
- Example project for each case study site (GitHub)
- Crop database (UFZ OPTAIN Cloud)
- Soil hydraulic properties (R-scripts in WP3, see presentation on Tuesday)

SWAP meteorological input files

Daily data **Short, constant time intervals**

=0 **SWMETDETAIL** **=1**

time interval < 1 day

Box 3.4 Detailed rainfall data.

SWMETDAIL = 1
SWRAIN = 3

```
************************************************************
* Filename: Raindetail.003
* Contents: Detailed rainfall data of Wageningen weather station
************************************************************
* Comment area:
*
* Amount refers to the rainfall amount in the previous period
* (like  a tipping bucket rainfall measurement device)
************************************************************
  Station        Day    Month  Year     Time     Amount
*                 nr       nr    nr        d         mm
************************************************************
  'Wageningen'     1        1  2003     0.00        0.0
  'Wageningen'     1        1  2003     0.43        2.0
  'Wageningen'     1        1  2003     0.50        4.2
  'Wageningen'     3        1  2003     0.35        0.0
  'Wageningen'     3        1  2003     0.37        0.2
  'Wageningen'     4        1  2003     0.10        1.2
  'Wageningen'     4        1  2003     0.15        2.0
```

OPTAIN

SWAP meteorological input files

Daily data

=0

time interval = 1 day

SWMETDETAIL

Short, constant time intervals

=1

time interval < 1 day

NMETDETAIL

the number of weather records each day

SWAP meteorological input files

Daily data

Short, constant time intervals

- SWAP 4.x did not run with the example file given in the Manual

Box 3.3 Weather records for short, constant time intervals.

```
*****************************************************************************
* Filename: Raindetail.003
* Contents: Detailed meteorological data of Wageningen weather station
*****************************************************************************
* Comment area:
*
* Each day 10 weather records, as specified in general input file
*****************************************************************************
    Date         Record       Rad       Temp       Hum       Wind       Rain
*                   nr      kJ/m2        'C       kPa        m/s         mm
*****************************************************************************
  01-may-2003         1       0.0       10.0      0.75        0.5        0.0
  01-may-2003         2       3.0       10.0      0.76        0.4        0.1
  01-may-2003         3    1347.0        9.0      0.76        0.6        1.2
  01-may-2003         4    3622.0        8.5      0.74        1.2        4.7
```

SWAP meteorological input files

Daily data

Short, constant time intervals

- SWAP 4.x did not run with the example file given in the Manual
- SWAP 4.x accepted the file from an earlier

```
* Source of data    : Royal Netherlands Meterological Institute (www.knmi.nl)
* File content      : Meteo from www.knmi.nl; input file for Swap 3.2 (www.swap.alterra.nl)
* File generated by : Alterra - Wageningen-UR (www.alterra.wur.nl)
* File generated at : 2021-02-24 08:14:12
Date,Record,Rad,Temp,Hum,Wind,Rain
2021-01-01,1,0.0,5.9,0.687,5.0,0.0
2021-01-01,2,0.0,5.6,0.682,5.0,0.0
2021-01-01,3,0.0,5.8,0.682,5.0,0.0
2021-01-01,4,0.0,5.0,0.672,5.0,0.0
2021-01-01,5,0.0,4.8,0.662,5.0,0.0
2021-01-01,6,0.0,4.7,0.658,5.0,0.0
2021-01-01,7,0.0,4.0,0.651,4.0,0.0
2021-01-01,8,0.0,3.6,0.648,4.0,0.0
```

SWAP meteorological input files

Daily data

Short, constant time intervals

- SWAP 4.x did not run with the example file given in the Manual
- SWAP 4.x accepted the file from an earlier version
- The LT team prepared a script for creating this type of met input

SWAP meteorological input files

Daily data

- SWAP 4.x runs with two types of input data sets in daily time step

Short, constant time intervals

SWAP meteorological input files

Daily data

- SWAP 4.x run
  sets in daily t

*Borucin.018 - Notepad

File Edit Format View Help

```
*****************************************************************
*           Filename:     EXAMPLE STATION  2018
*           Contents:     SWAP- 4- Daily meteorological data
*****************************************************************************************************
*           Comment       area: BORUCIN
*
*
*****************************************************************************************************
 Station          DD          MM      YYYY      RAD       Tmin      Tmax      HUM       WIND      RAIN     ETref      WET
*                 nr          nr        nr     kJ/m2        oC        oC       kPa       m/s        mm        mm        d
*****************************************************************************************************
 'Borucin'        1           1       2018    6290.0       2.2       5.6      0.77       3.8       0.2     -99.0     -99.0
 'Borucin'        2           1       2018    6350.0       0.6       3.3      0.68       3.3       0.8     -99.0     -99.0
 'Borucin'        3           1       2018    6410.0       0.7       2.3      0.66       8.3       7.2     -99.0     -99.0
 'Borucin'        4           1       2018    6480.0       2.0       5.6      0.86       4.0       3.5     -99.0     -99.0
 'Borucin'        5           1       2018    6550.0       2.0       7.3      0.79       3.7       1.2     -99.0     -99.0
 'Borucin'        6           1       2018    6620.0       3.0       6.1      0.74       3.9       0.3     -99.0     -99.0
 'Borucin'        7           1       2018    6710.0      -4.4       3.4      0.57       3.9       0.3     -99.0     -99.0
 'Borucin'        8           1       2018    6790.0      -4.8       0.1      0.45       2.4       0.0     -99.0     -99.0
 'Borucin'        9           1       2018    6880.0      -3.3       1.2      0.49       5.8       0.1     -99.0     -99.0
 'Borucin'        10          1       2018    6980.0      -1.7       0.7      0.55       2.3       1.6     -99.0     -99.0
 'Borucin'        11          1       2018    7080.0      -3.0       0.3      0.52       1.5       0.8     -99.0     -99.0
 'Borucin'        12          1       2018    7190.0      -4.3      -1.3      0.44       2.0       0.2     -99.0     -99.0
 'Borucin'        13          1       2018    7290.0      -6.8      -0.6      0.40       3.0       0.1     -99.0     -99.0
 'Borucin'        14          1       2018    7410.0      -8.6      -4.3      0.32       2.1       0.1     -99.0     -99.0
```

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This was provided originally on GitHub as an example, with an Excel table in accordance with the SWAP Manual

SWAP meteorological input files

Daily data

- SWAP 4.x ru
  sets in daily

kvithamar.020 - Notepad

File Edit Format View Help

```
Station,DD,MM,YYYY,RAD,Tmin,Tmax,HUM,WIND,RAIN,ETref,WET
'kvithamar',1,1,2020,34.6,3.7,10.4,0.70,2.6,0.5,-99.0,0.4646
'kvithamar',2,1,2020,17.3,3.2,11.5,0.72,1.1,1.2,-99.0,0.1201
'kvithamar',3,1,2020,25.9,-2.1,8.0,0.56,3.7,21.4,-99.0,0.1042
'kvithamar',4,1,2020,25.9,-0.5,4.0,0.54,3.7,5.3,-99.0,0.3646
'kvithamar',5,1,2020,17.3,-0.2,6.1,0.61,1.8,10.3,-99.0,0.0910
'kvithamar',6,1,2020,25.9,2.1,7.9,0.70,1.9,0.7,-99.0,0.0576
'kvithamar',7,1,2020,34.6,0.9,8.6,0.60,2.3,1.2,-99.0,0.0743
'kvithamar',8,1,2020,60.5,1.2,9.2,0.61,3.0,10.7,-99.0,0.0965
'kvithamar',9,1,2020,34.6,-3.1,4.9,0.47,2.4,0.6,-99.0,0.0000
'kvithamar',10,1,2020,25.9,-2.5,3.2,0.50,0.8,0.2,-99.0,0.0000
'kvithamar',11,1,2020,25.9,1.7,8.2,0.51,2.9,0.9,-99.0,0.0028
'kvithamar',12,1,2020,60.5,0.5,4.8,0.59,1.5,3.6,-99.0,0.0715
'kvithamar',13,1,2020,17.3,-0.1,4.9,0.48,1.4,0.0,-99.0,0.0215
'kvithamar',14,1,2020,34.6,1.2,7.0,0.49,3.0,0.0,-99.0,0.0451
'kvithamar',15,1,2020,51.8,-0.6,5.4,0.52,2.0,0.0,-99.0,0.4215
'kvithamar',16,1,2020,34.6,0.6,7.4,0.59,1.7,1.5,-99.0,0.6354
'kvithamar',17,1,2020,34.6,0.9,6.4,0.61,2.0,0.1,-99.0,0.6646
'kvithamar',18,1,2020,51.8,-1.9,4.7,0.57,0.9,1.2,-99.0,0.4340
'kvithamar',19,1,2020,43.2,2.6,5.1,0.63,3.1,6.1,-99.0,0.4632
'kvithamar',20,1,2020,25.9,3.4,12.3,0.89,2.9,13.9,-99.0,0.5792
'kvithamar',21,1,2020,25.9,1.3,6.5,0.62,4.7,33.3,-99.0,0.3451
'kvithamar',22,1,2020,43.2,1.2,3.7,0.57,3.8,10.0,-99.0,0.2368
'kvithamar',23,1,2020,43.2,0.4,8.0,0.69,2.1,11.9,-99.0,0.0000
'kvithamar',24,1,2020,34.6,0.2,3.3,0.59,3.1,16.3,-99.0,0.0000
```

Ln 1, Col 1 | 100% | Windows (CRLF) | UTF-8

This format works as well and easier to handle; it is generated by the R-script written by Mo

SWAP meteorological input files

Daily data

- SWAP 4.x runs with two types of input data sets in daily time step
- Separate file is needed for each year; the year is the file extension
- In the R-script package, you can find a formula to calculate vapour pressure (kPa) from relative humidity (%)
- The last too columns are not obligatory
  - ETref - potential evapotranspiration
  - WET – the part of the day with precipitation (runoff, extreme events)

```
*****************
 ETref     WET
   mm       d
*****************
 -99.0    -99.0
 -99.0    -99.0
 -99.0    -99.0
```

Short, constant time intervals

The modelling procedure

INPUT DATA

Meteorological data

- Air temperature
- Precipitation
- Solar radiation
- Wind speed
- Humidity

Soil data (field and lab measurements)

- Bulk density
- Total porosity
- Soil texture (sand, silt, clay content)
- Soil water retention characteristics
- Hydraulic conductivity

Crop data (measurements & literature)

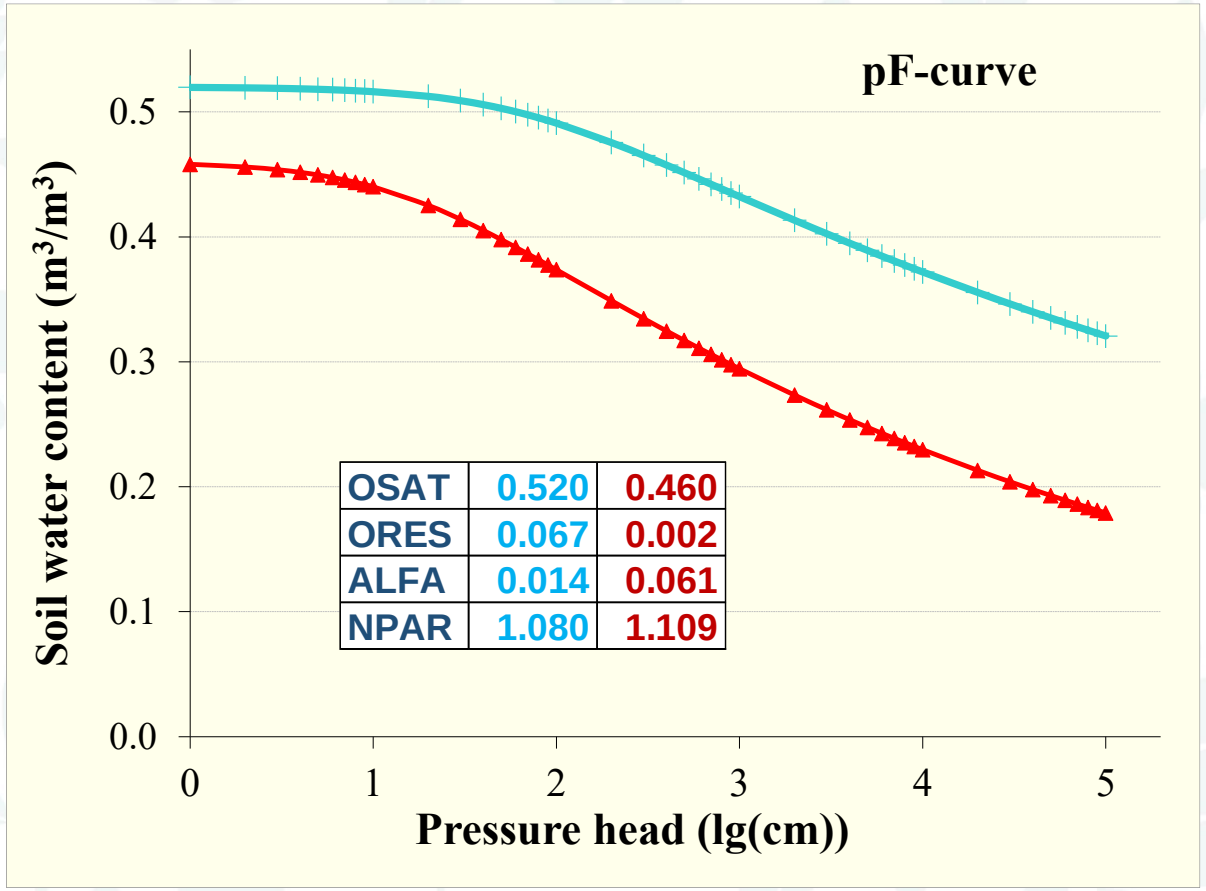
- Crop type
- Leaf area index
- Crop height
- Rooting depth

Drainage data (records & literature)

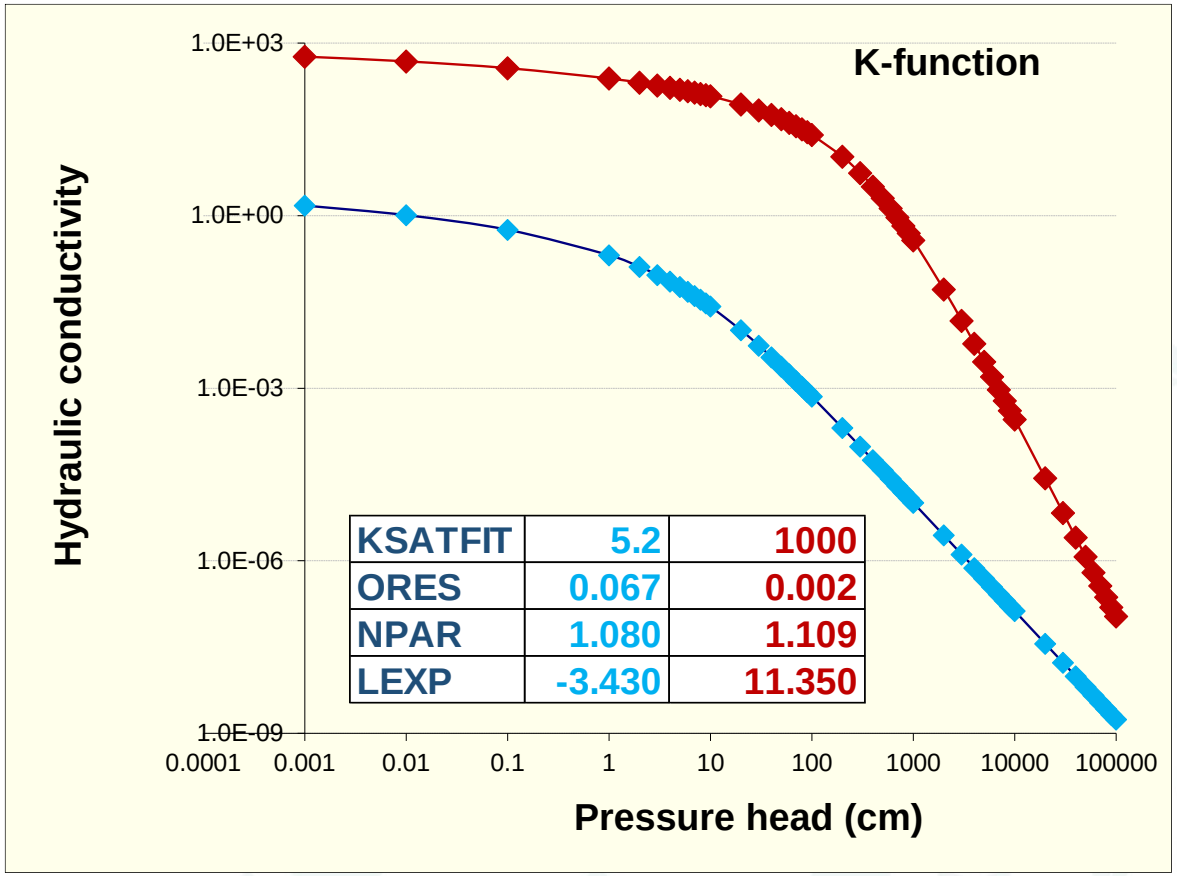
- Depth of tile drains
- Distance between drainpipes

Soil input data

Soil water retention curve; Θ = f(h)



Hydraulic conductivity function; K=f(h)



Soil input data

Soil water retention curve; Θ = f(h) Hydraulic conductivity function; K=f(h)

Swap.swp - Notepad

File Edit Format View Help

```
* 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
        1     0.01    0.42    0.0278   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 layer:
  FILENAMESOPHY = 'topsoil_sand_B2.csv', 'subsoil_sand_O2.csv'
```

Ln 558, Col 1 100% Windows (CRLF) ANSI

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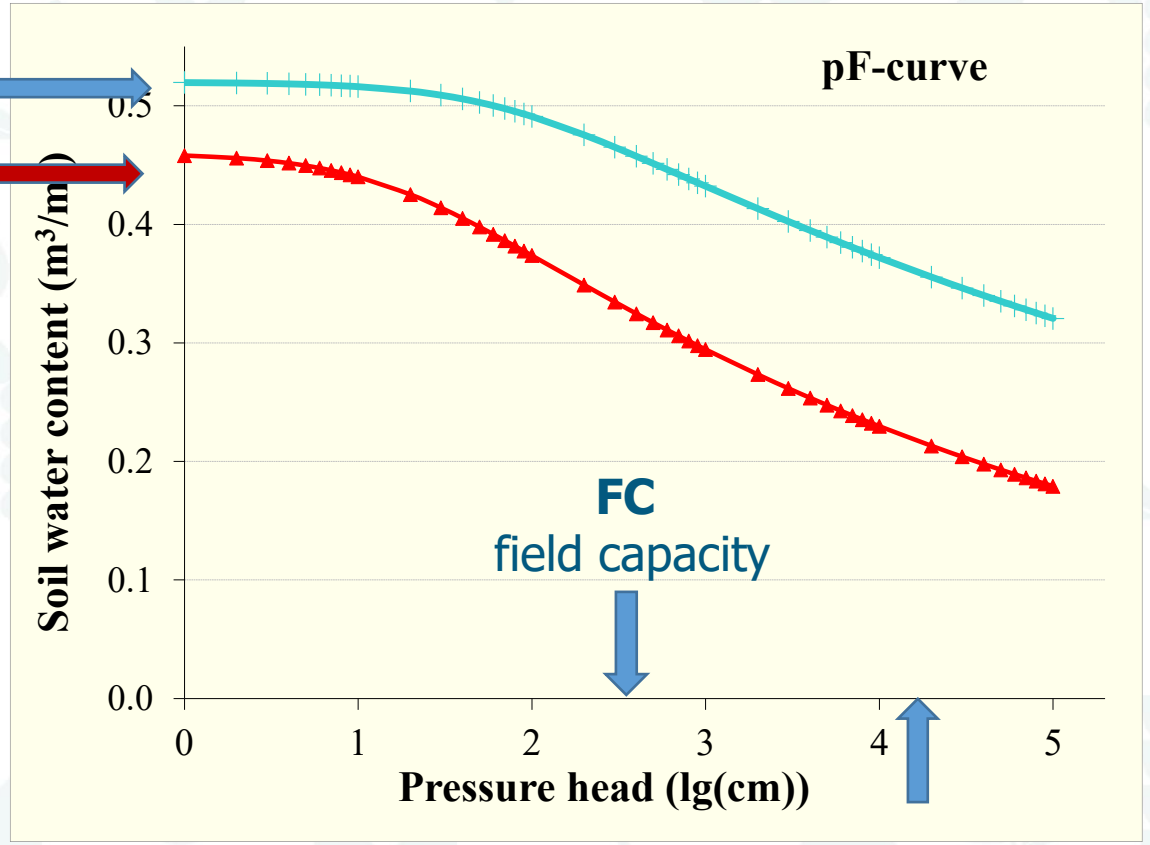
Soil input data

Soil water retention curve; Θ = f(h)

OSAT = f (structure, texture, bd, porosity)
saturated water content

n, alfa – influence the shape of the curve

OSAT	0.520	0.460
ORES	0.067	0.002
ALFA	0.014	0.061
NPAR	1.080	1.109



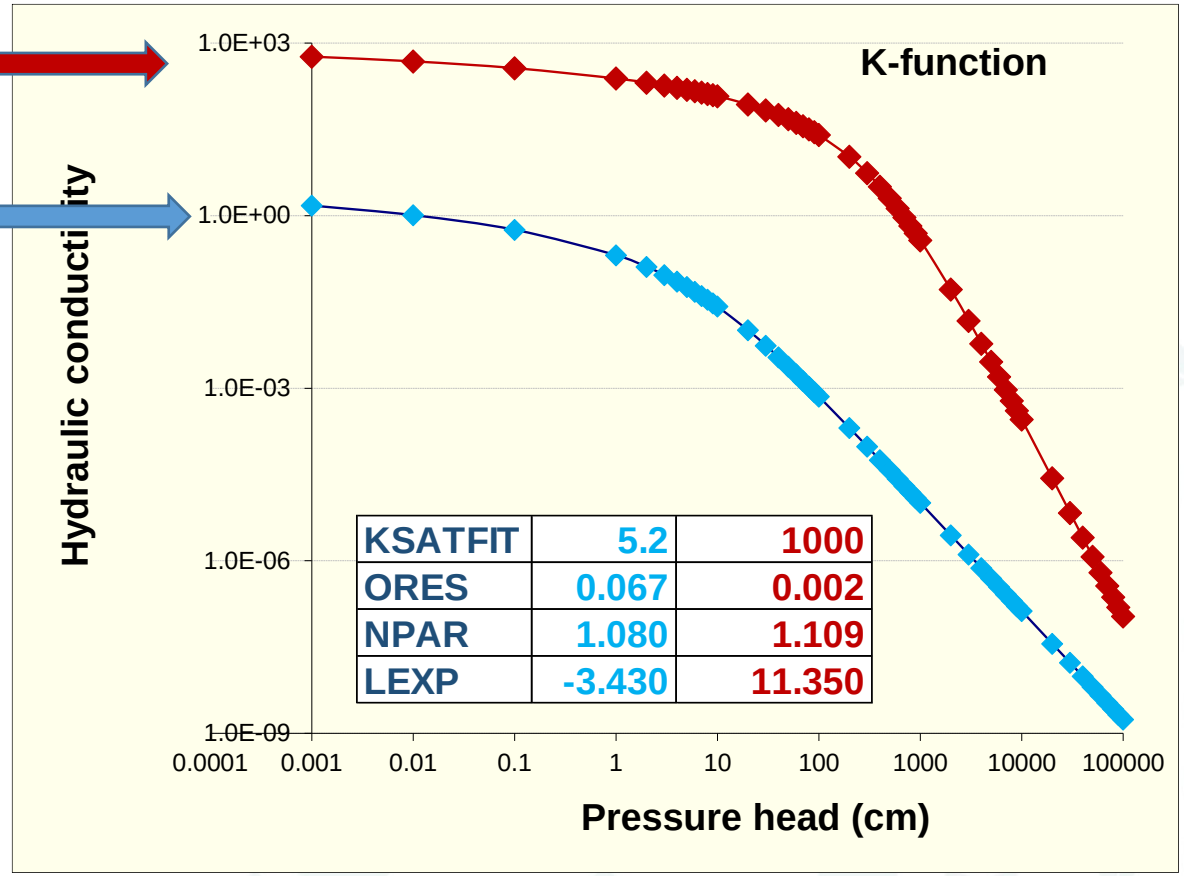
ORES = f (texture, OM)
residual water content

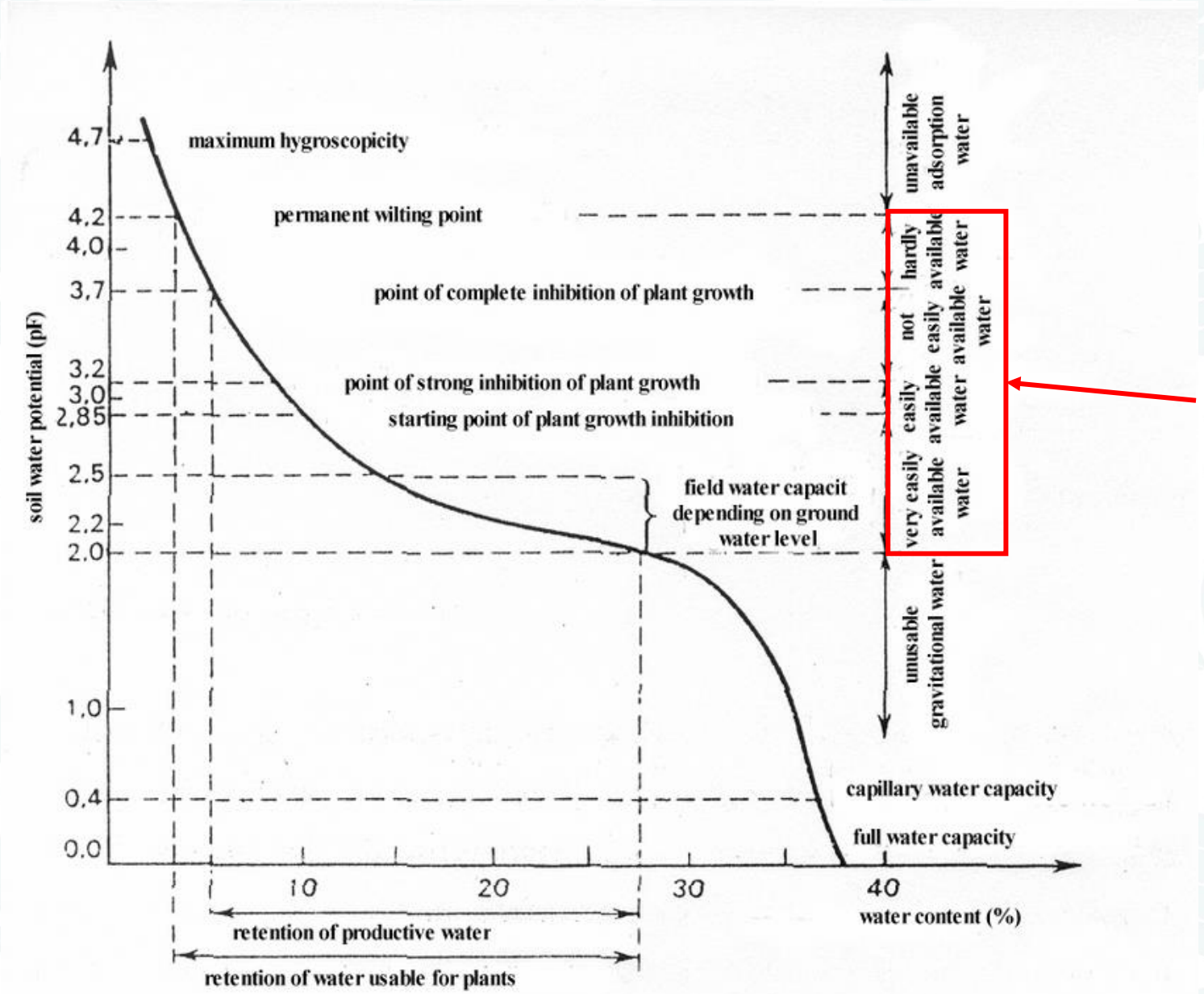
Soil input data

Hydraulic conductivity function; K=f(h)

KSAT = saturated hydraulic conductivity

NPAR, LEXP – define the shape





Available water content

Soil moisture retention curve after Turski R., Dom Śał H., Borowiec J., Flis-Bujak M., Misztal M., 1997. Gleboznawstwo – ćwiczenia dla studentów wydziałów rolniczych. AR, Lublin.

Representation of soils in the hydrological models

MODEL	CODE	MODEL PARAMETER
HBV	SM	soil moisture content
	FC	maximum amount of water stored in the layer
	INFMAX	maximum infiltration rate
	DRAW	capillary rise parameter
SWAT	SM	soil moisture content
	SOL_CRK	crack volume
	TEXTURE	texture (gravel; sand; silt; clay)
	SOL_BD	bulk density
	SOL_AWC	available water capacity
	SOL_K	hydraulic conductivity
PERSIST	SM	soil moisture content
	K	maximum infiltration rate
	POR	porosity
	WAT_MAX	maximum amount of water stored in the layer
INCA	TEXTURE	texture (gravel; sand; silt; clay)
	K	maximum infiltration rate
	TOT/AV	Ratio of total to available water
	DEF	Maximum soil moisture deficit

ALL THE BLUE PARAMETERS ARE STATIC

Soil input data

Soil water retention curve; Θ = f(h) **Hydraulic conductivity function; K=f(h)**

More about soil hydraulic properties and their variability:

Nemes & Farkas: What kind of tree does soil data grow on?

More about how to use soil hydraulic properties during model calibration:

Sinja: SWAP key functions

More about the estimation of soil hydrauilc properties:

Day 2, July 12, 2022			
	Time	**Responsible**	**Moderator**
Soil input data, soil parameters and their representativeness; soil input data files	9:30 - 10:30	Brigitta, Csilla	Ali
Reference data quality check –			

The modelling procedure

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Soil data (field and lab measurements)

- Bulk density
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- Soil water retention characteristics
- Hydraulic conductivity

Crop data (measurements & literature)

- Crop type
- Leaf area index
- Crop height
- Rooting depth

Drainage data (records & literature)

- Depth of tile drains
- Distance between drainpipes

Crop input data

- Crop database (UFZ OPTAIN Cloud)
- We try to provide initial parameter files for all the crops
- APEX, SWAP crop databases are being looked up (Sinja)
- The crop files are region-specific and might not match your region
- Some crop parameters are subject to calibration

The modelling procedure

INPUT DATA

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- Soil texture (sand, silt, clay content)
- Soil water retention characteristics
- Hydraulic conductivity

Crop data (measurements & literature)

- Crop type
- Leaf area index
- Crop height
- Rooting depth

Drainage data (records & literature)

- Depth of tile drains
- Distance between drainpipes

Drainage design and data

- Some basic characteristics of the tile drains (depth, spacing, diamter) should be known
- Parameterisation of drainage routine - (Sinja)

Experience gained when setting up and calibrating the SWAP version 4.x model

- Not all the example projects provided belong to version 4
- There might be files from SWAP3.x and your model will not run with them
- Check the data in the example file, visualise
- User-defined soil files – contact us, if you want to use such, the example file is NOT functioning
- The parameter names in the *.swp file and code might not match (OSAT or THETASAT)
- In some example *.swp files the macropore paramteres are missing or coming from SWAP3.x. use the Kvithamar example if you want to parameterise macropore flow.

Experience gained when setting up and calibrating the SWAP version 4.x model

- Met input file: missing value is -99; but you can't indicate a missing value for precipitation as that does not accept negative values

Thank you for your attention!

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