

9.5 Upgrading the soil table

The scheme of soil parametrization has been restructured and significantly extended. The new [soil_table] allows a horizon-dependent parametrization of the vertical soil profile including the consideration of macropore runoff. Similar to the scheme of the new [landuse_table] (described in the section before), the parametrization of soil profiles can be done in (i) multi-line or/and (ii) single-line formats. Each parameter block (containing all parameter entries of one soil profile) is framed by curly brackets, whereas parameter groups within one block are separated by semicolons. The method identifier “MultipleHorizons“ signalized WaSiM-ETH that an extended table entry has to be read in.

The new soil parametrization scheme is characterized by a high level of structural flexibility. The restructured [soil_table] can generally handle different formats, i.e. individual soil profiles can be defined in both single-line and multi-line formats within the same table. In addition, the compatibility to the format of the older soil table (cf. Chapter 5) is guaranteed.

The extended [soil_table] is structured as follows:

```
[soil_table]
1           # number of following soil codes
#co- name of the
#de  soil profile
#-- -----
1   profile_1 {method = MultipleHorizons;
  PMacroThresh  = 5.0;
  MacroCapacity = 4.0;
  CapacityRedu = 1.0;
  MacroDepth   = 1.5;
  horizon      = 1      2      3;
  Name          = SL    SC    Li;
  ksat          = 1.2e-5 3.3e-7 3.0e-6;
  k_recession   = 0.4    0.4    0.8;
  theta_sat     = 0.41   0.38   0.43;
  theta_res     = 0.065  0.10   0.078;
  alpha          = 7.50   2.70   3.60;
  Par_n          = 1.89   1.23   1.56;
  Par_tau        = 0.5    0.3    0.5;
  thickness      = 0.10   0.20   0.40;
  layers         = 3      2      25; }
```

The parameters denote:

PMacroThresh	:	precipitation capacity needed to activate macropore runoff [mm/h]
MacroCapacity	:	capacity of the macropores [mm/h]
CapacityRedu	:	relative reduction of the macropore capacity per meter depth [0..1]
MacroDepth	:	maximum depth of the macropores [m]
Horizon	:	soil horizon; coding corresponds with the actual horizon sequence from top to down
Name	:	name of the horizon
ksat	:	saturated hydraulic conductivity [m/s]
k_recession	:	ksat recession with depth [-]
theta_sat	:	saturated water content [0.01 Vol. %]
theta_res	:	residual water content [0.01 Vol. %]
alpha	:	van Genuchten parameter [1/m]
Par_n	:	van Genuchten parameter [-]
Par_tau	:	Mualem parameter in the van Genuchten Equ.[-] (default: 0.5)
thickness	:	layer thickness [m]
layer	:	numerical number of soil layers in the actual horizon

9.5.1 Macropore runoff

The macropore approach implemented into WaSiM-ETH follows the „bypass-flow-concept“ after Jansson und Karlberg (2001). This approach allows the simulation of macropore runoff in layered soil profiles. The approach describes macropores by three parameters: depth of the macropores, capacity of the macropores and reduction of the macropore capacity per meter soil depth. By means of these parameters a maximum possible macropore flow can be calculated for each soil layer (potential macropore runoff). An additional parameter is given by the precipitation threshold value. Only if this predefined precipitation intensity is reached or exceeded, water can infiltrate into the macropores and macropore runoff can be generated. The real amount of macropore infiltration depends on the actual water content of the adjacent

soil layers. Water which exceeds the free capacity of these soil layers, can not infiltrate into the macropores.

The infiltrated macropore water is used to fill up the adjacent soil layers from down to top. When an actual soil layer is saturated then the remaining macropore water is trying to infiltrate into the next upper soil layer. Macropore water is not stored from one simulation time step to another but it has to completely infiltrate into the adjacent soil layers within the actual time step. As the macropore infiltration is strongly dependent on the free water capacity of the soil, the actual macropore runoff can be reduced with respect to the potential runoff.

The parametrization of the macropores is optional. Missing entries are automatically replaced by the following values (i.e. deactivation of the macropore system):

- $MacroThresh = 1000$
- $MacroCapacity = 0$
- $CapacityRedu = 1.0$
- $MacroDepth = 1.0$

9.5.2 Horizon-dependent soil parametrization

The user can define individual horizon sequences with specific parametrization. For each soil horizon, it can be specified the following parameter entries: saturated hydraulic conductivity ($ksat$), recession of $ksat$ with depth ($k_{recession}$), van Genuchten parameters for defining the soil-water-retention curve ($theta_{sat}$, $theta_{res}$, $alpha$, Par_n , Par_tau), horizon *thickness*, and number of soil layers per horizon. For technical reasons all soil profiles must be divided into the same number of layers but the depth of the soil profiles (column) may vary from one grid cell to another due to different thicknesses of soil layers (horizons). In this context, it is important to note that the depth of the soil profile has to be larger than the thickness of the uppermost (first) groundwater aquifer. Otherwise problems can arise during the use of the WaSiM-ETH groundwater model (groundwater table is falling below the deepest soil layer). For $k_{recession} = 1.0$ the parameter $ksat$ remains constant within the actual soil horizon. In the letter case interflow is only generated at the horizon boundaries (if the actual soil profile uses different horizon-dependent $ksat$ values).