

### Subirrigation

The modelling option for flexible drainage and subirrigation (Fig. 1) has been further developed and tested within the [TKI project conceptuele modelverbetering NHI](#). The drainage level is flexible through connections of the drains to a stilling well or surface water channel with a level control mechanism, and from there a connection to an external source of supply (optional). The supply can be from a (fictitious) surface water source or from groundwater (new option). The groundwater can be extracted from any location in the model.

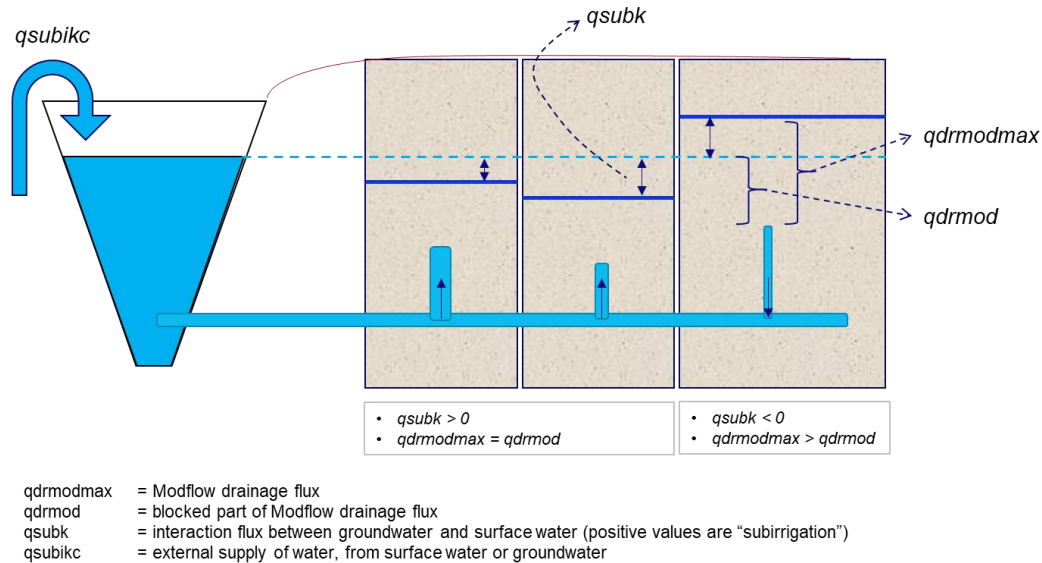


Fig. 1 Schematic of modelled flexible drainage.

The stilling well and the collector drainage tube (or surface water channel, whatever the configuration is) does not only serve the purpose of controlling the flexible drainage level but also acts as a medium for water transfers between the MetaSWAP columns ("SVATs"). Such transfers make it possible that also outside the actual supply season there can be positive  $q_{subk}$ 's for the infiltration through subirrigation. Negative  $q_{subk}$ 's occur in SVATs where the groundwater level is above the target level of the surface water, with drainage of water contributing to the water balance of the surface water reservoir.

The sketch given in Fig. 1 shows the two main hydrologic situations:

- a. Surface water head is higher than the groundwater head, and both are above the drainage level. There is subirrigation with  $q_{subk} > 0$ . The full Modflow drainage flux is blocked, meaning that  $q_{drmod} = q_{drmodmax}$ , where  $q_{drmod}$  is the part of the flux that gets blocked, and  $q_{drmodmax}$  is the Modflow drainage flux.
- b. Surface water head is lower than the groundwater head. There is no subirrigation in the form of water being put into the column. Instead, a negative  $q_{subk}$ , caused by the draining of the groundwater with the surface water head as the drainage base. This water gets collected in the reservoir, and is available for subirrigation in the other columns, thus reducing the required total supply to the control unit. Not all of the Modflow drainage is blocked in this case, so  $q_{drmod} < q_{drmodmax}$

The blocked Modflow flux  $qdrmod$  is zero for situations where the groundwater head is below the level of the drain or where the surface water head is below the level of the drain. The sum of  $qdrmod$  and  $qsubk$  (only the positive values of  $qsubk$ ) is added to the interaction flux with Modflow, separately for each column.

The number of target level periods has been expanded by increasing the number of transition moments from three to four. If all four transition moments are actually used then the target level periods are High (from January 1), Low, High, Low, High. This means that both in spring and autumn there can be a period with a low level for respectively land preparation and harvest. The scheme can be simplified by letting transition moments coincide.

One of the SVATs in the management unit is used for providing feedback. The high target level can be intermittently lowered based on feedback from the simulation of oxygen stress and shallow groundwater levels. In the period preceding the planting of the crop the level can be lowered based on the pressure head at 15 cm b.s.s., to improve the conditions for land preparation and sowing.

The code has been expanded to make checks with respect to the consistency of input data. An extra output variable  $qsubikc$  has been included for the actual supply in the model to the surface water unit.

The flexible drainage module can now be used without having to use WOFOST.

In the iMOD programme tools area available for adding a scheme with flexible drainage using the above MetaSWAP module. However, this does not yet fully exploit its potential. The module can potentially also be used for surface water controlled drainage/subirrigation of existing drains and surface water channels.

### **Simple WOFOST crop in LHM4.2plus**

The option for a simple WOFOST crop in the SWAP format has been made available in MetaSWAP. It is used in LHM for the winter period of arable land crops, which is then planted with a so-called *vanggewas*. The function of the *vanggewas* is to remove nutrients in order to avoid excessive leaching. This type of rotation is also used in *Waterwijzer Landbouw*. The used crop file is *vanngewas.crp*. It is coded with  $croptype=1$  and  $initcrp=1$  in *vg2crp\_svat.inp*, and also involves the rotation file *lurota\_svat.inp*. The parameters are available at `sftp .\metaswap\par\V8_1_1_2\LHM4.2_plus`

### **Simulation of moisture stresses.**

As mentioned in the previous release notes there was still a bug in the method to simulate oxygen stress using the pressure head as a proxy, the method of Feddes (1978). This has now been fixed.

The code for simulating plant stresses has been extensively revised. The downscaling of the root zone pressure to compartment level has been made completely independent of the downscaling done by PostMetaSWAP. The compartments used for the stress simulation can be supplied by the user via *comp\_post\_o2s.csv*, which should be an aggregation of *comp\_post.csv*. But it is recommended to use the defaults supplied in the code, respectively in cm: 2,3, and

then 5 for the rest. The main advantage of this aggregation of *comp\_post.csv* is that now 3 compartments are used for the first 15 cm instead of 15 compartments of 1 cm, which greatly reduces the simulation time of oxygen stress without much affecting the result. The aggregation could not be done via *comp\_post.idf* due to the fact that TRANSOL has extremely strict checks that cause fatal errors if a 5 cm compartment contains a transition of soil physical building blocks like in a few of the soil units.

The simulation of oxygen stress with Bartholomeus is based on a combination of 'macro' and 'micro' oxygen transportation model. A well-known limitation of the macro model is that it is steady state. The consequence can be that a relatively moderate rainfall storm can cause an instant reduction to zero of the simulated oxygen content in the whole profile. That is because water saturation at the soil surface causes an oxygen supply cut-off that due to the steady state concept is instantly translated to the rest of the profile.

In order to mitigate the frequency of the oxygen cut-offs an option has been created to average the soil moisture profile over several time steps. This is controlled by the new parameter *postmswo2\_opt* in *para\_sim.inp*. A value of 2 is recommended; it should be supplied by the user in the file because the default has been kept at 1. The simulation method is to average the profile over the 2 days and then use it for the subsequent period of 2 days. So – in order to save computation time – it has not been implemented as a moving average.

The simulation of oxygen stress can now be combined with hourly data of the precipitation, without having to repeat the oxygen stress simulation for each hour, which would just repeat the same calculation 24 times. The simulation is now limited to once per day.

The simulation of salt stresses has now been enabled. The option requires the salt simulation with TRANSOL, and is activated by *saltstress\_mdl=1* in *para\_sim.inp*.

Separate values of the Jarvis compensation parameter can be specified in *luse-svat.inp* for drought stress and oxygen stress, but not (yet) for the combination with salt stress.

### **Separation of crop damage percentages, including indirect damage**

The mechanisms for simulating the consequences of suboptimal conditions in spring have been in place in earlier releases. But the simulation of this so-called indirect damage with respect to a reference level was not yet available.

For the reference level a spring situation with a groundwater level of 1 m b.s.s. has been chosen. That is the situation of a so-called Gt4, which in many respects is considered ideal for agriculture. With that groundwater level the start of the crop growing season can still be delayed. But remedying that by lowering the spring level through artificial means (drainage) is not a practical option. So choosing a deeper level for the reference situation would overestimate the indirect damage.

The simulation of the situation with the spring groundwater level at 1 m b.s.s. has been included in a single run of MetaSWAP combined with three options for WOFOST:

- IND: without indirect damage with respect to the chosen reference situation, and without moisture stresses (in the next release this run will be renamed to ULT, for ultimate);
- OPT: without moisture stresses;
- ACT: with moisture stresses.

The IND run is made possible without a rerun of MetaSWAP by making use of the MetaSWAP database with meta-functions. That is done by using the percolation flux from the root zone and doing a lookup-operation to see what the effect is on the rootzone pressure head if the groundwater level would be equal to the 'ideal' level of 1 m b.s.s.

The simulation of the IND (ULT) run is enabled by setting *indirectdamage\_mdl=1* in *para\_sim.inp*.

The damage percentages of drought, oxygen and salt stress are simulated using the reductions of crop assimilations caused by the stresses. The accumulated totals of the forfeited assimilation are used for distributing the damages. The indirect damage follows from the difference between the IND run and the OPT run.

The output of the crop damages is in % of the reference level, which is the IND-run if it is used, or else the OPT run.

The parameters for using the above mentioned functionality have been posted at the sftp site of MetaSWAP, at *.\metaswap\par\V8\_1\_1\_2\LHM4.2\_plus*

### ***Drip irrigation***

It has been made possible to implement drip irrigation. That is done via the extra parameter *apptype* in *scap\_svat.inp*.

### ***Initial temperature profile***

It has been made possible to specify the initial temperature profile, via file *init\_svattemp.inp*.

### ***Extra output option pressure heads of PostMetSWAP compartments***

Previously it was only possible to write the moisture contents of PostMetSWAP to *idf*. This has now also been enabled for the pressure heads, via parameter *idf\_phead\_per* in *para\_post.inp*.

See also further changes in earlier versions of MetaSWAP on the NHI website:

<http://nhi.nu/nl/index.php/software-tools/modelcode/>