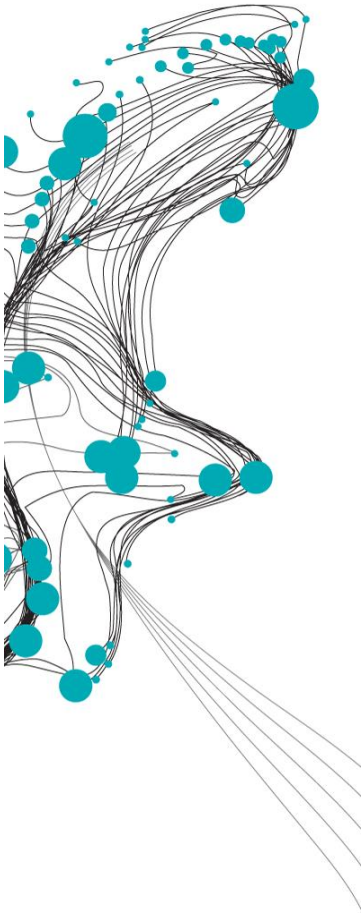
Application and evaluation of the 3Di groundwater model in the Waalenburg polder, Texel, the Netherlands



The 3Di hydrodynamic model was recently expanded with the addition of a groundwater domain, the 3Di groundwater model. This research focuses on the evaluation of the 3Di groundwater model for a polder area on its accuracy and its sensitivity to changes in time-independent model parameters and model design choices. This is done by the creation of a model for the Waalenburg polder on the island of Texel, the Netherlands.

A sensitivity analysis was done for the time-independent model parameters, hydraulic conductivity and storativity. This analysis showed that the mean of the simulated groundwater levels is most sensitive to changes in the hydraulic conductivity, increasing values of hydraulic conductivity cause lower mean groundwater levels. The standard deviation in simulated groundwater levels was shown to be sensitive to the storativity of the ground. The same volume of water can create a bigger change in groundwater levels for grounds with lower storativity.

This sensitivity analysis was used to calibrate the model parameters hydraulic conductivity and storativity. The calibrated model is further evaluated on its accuracy. The simulated model results as shown in Figure 1 compared well to the measured groundwater levels, little deviation is shown in the mean results of the model and measurements, and also the variability of the model results is in accordance with the measurements. The model performance for computing groundwater levels provides confidence in the ability of the model to simulate the groundwater flows, especially so for the winter period. The current state of the 3Di groundwater model, however, may lack the ability to simulate the groundwater recharge of high precipitation events after a dry period as illustrated by the overestimation of groundwater levels in the period July through November 2017.

It was shown that a well-performing model could be created using a grid of 20 m by 20 m for the majority of the area of interest. The grid size is mostly dictated by the surface water system as a calculation cell cannot include multiple surface water levels. It was shown that grid size does affect the groundwater levels. A finer grid may lead to an increase in groundwater levels of up to tens of centimetres, as is shown in Figure 2. Due to this fact, changes in grid size may lead to the need for re-calibration of the model.

It can be concluded that with the 3Di groundwater model it is possible to simulate groundwater levels within a polder with good accuracy, especially for winter periods. The modelled mean groundwater level is sensitive for the hydraulic conductivity and the modelled variability in groundwater levels is sensitive to the storativity. These sensitivities can be used to calibrate a model of a particular area. The model design is adequate for the simulation of groundwater levels during wet periods.

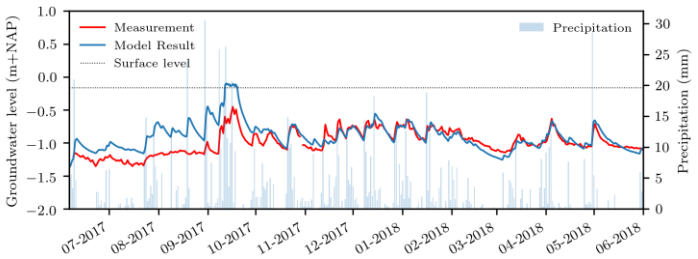


Figure 1: Measured and simulated groundwater levels, the surface level at a measuring well in the Waalenburg polder and daily precipitation at Den Burg.

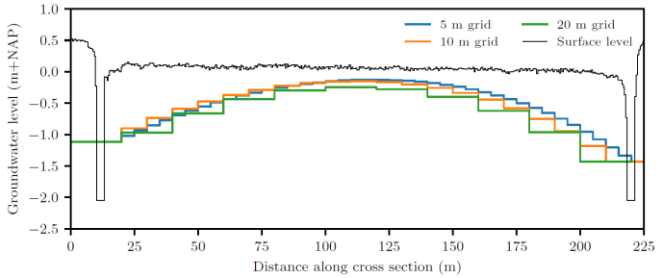


Figure 2: Cross-section of simulated groundwater levels of a farming lot bounded by two ditches in the Waalenburg polder using different sizes for the calculation grid.

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