# SUPPORTING INFORMATION 2. Modelling of water flow into an idealised burrow

# Article title: The effect of crab burrows on soil-water dynamics in mangroves

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A groundwater model was used to estimate the potential impact of crab burrows on the drainage of mangrove sediments. The model was constructed using the United States Geological Survey (USGS) groundwater modelling software, Modflow (or MODFLOW) 6 and is based on a generic model developed for pumping test analysis.

The model setup and results are accessed through an Excel spreadsheet to facilitate ease of model use. The original version of the spreadsheet model was developed for pumping test analysis and has been benchmarked against Theis (1935), which is an analytical solution for pumping test analysis of a confined aquifer under idealised conditions. Modifications were made to the model setup to allow it to represent unconfined conditions, and to allow a pressure head to be specified for the well instead of a pumping rate.

The model setup makes use of the Newton-Raphson formulation and upstream weighting capabilities of Modflow 6 which allow much better simulation of the partially-saturated conditions which can occur as water tables are lowered. The model also makes use of the unstructured mesh capabilities of Modflow 6 which allows a polar coordinate system to be defined, based on appropriate definition of the node dimensions and connections. Note that the best agreement to the Theis analytical solution was obtained when the node areas were calculated using a simplified approximate formula (centroid circumference multiplied by annular width) rather than more rigorous area calculations. The approximate formula was therefore used for the crab burrow simulations.

The model calculates groundwater heads for multiple distances from the well (burrow) and for multiple depths below the ground surface for each time step. Therefore, a 3-D model setup was used. For the purposes of this study, a total of 167 model columns were used to represent different distances from the burrow (with higher resolution close to the burrow), 20 layers were used to represent different depths below the ground surface, and 22 time steps were used, with higher resolution during the early parts of the simulation. The overall dimensions and parameterisation of the model are as described in the main paper.

The groundwater flow equations have been solved using a modified version of the ‘complex’ solver parameters. The modifications were made to ensure that the solver produced well-converged results for the small-scales and specific ranges of parameter values of interest in this study. In all cases the cumulative water balance error for the model simulations was less than 1 %.