

Q&A: Applications of groundwater modelling in TUFLOW

Question #	Question	Answer(s)
1	If we have known aquifer properties, should we be using specific yield or porosity? Or are we just broadly accounting for storage as best fits the data?	<p>If you have known hydraulic properties we would recommend that you adopt these properties to start with. As there can be considerable uncertainty in the hydraulic properties' parameters, any reduction in uncertainty by calibrating a model to measured data is still strongly recommended.</p> <p>Generally, soil porosity is provided as part of the soil type data, and we would recommend to use that porosity as given. You can then calibrate for GW storage with adjustments to soil depth and horizontal hydraulic conductivity.</p>
2	Do you think that groundwater flow would be likely to have a significant effect on the observed peak of the hydrograph, or would effects on the hydrograph be mostly limited to shape due to the relative speeds of overland / groundwater flow?	<p>It really depends on the catchment runoff characteristics, rainfall intensity, rate of infiltration (especially relative to the rainfall intensity), and baseflow (relative to the surface flow). In some scenarios, the groundwater flow has negligible influence on the peak (high rainfall, low infiltration, no baseflow). Conversely, in some extreme cases the overland flooding is driven by groundwater surcharging! I've come across chalk soil types in the UK and alluvial sandy environments in Texas where groundwater is the dominant surface water flooding source.</p> <p>Note that for the horizontal hydraulic conductivity may not influence the first peak if the model is started dry, but in a continuous simulation it controls how quickly the catchment drains, which then determines the soil capacity at the start of the next rain event, and that does control the peak response.</p>
3	When the simulation starts, will we have 2 groundwater table levels till the soil layer beneath the interflow layer becomes saturated and then afterwards, we will have just one groundwater table level?	If you start the model with no GW initialisation, then both layers will be dry and you will get two water table levels as it fills up. After some time, the lower layer(s) may become saturated and then they will use the top layer water table slope for the advection calculation. Also you may use any number of GW layers from 1 up to a maximum of 10.
4	Can TUFLOW model randomised Kh or heterogenous and anisotropic models with multiple layers?	TUFLOW (as of 2024) only implements isotropic flow properties for the horizontal direction. Please email support@tufLOW.com with any suggestions for implementing alternative approaches.
5	Regarding the equation used to calculate the velocity as a function of Kh and S in unsaturated zone, is Kh assumed as a constant or a function of water suction curve?	Currently it is constant. Moisture dependent Kh is shown in the second part of the presentation.
6	<p>What TUFLOW can do, that MODFLOW cannot do? Apart from surface water modelling.</p> <p>Also, how TUFLOW is different from Hydrogeosphere?</p>	<p>MODFLOW is a much more specialized groundwater modelling software. Whereas, TUFLOW is very specialised for surface water flow. The groundwater implementation in TUFLOW is to allow it to better model catchment runoff (flow) response especially for longer term continuous simulations, and for simulation of catchment pollutants for water quality purposes.</p> <p>We have no experience or knowledge of Hydrogeosphere to provide an informed comparison.</p>
7	<p>What methods were used to collect ground water levels and the geology?</p> <p>Was LIDAR (ground penetrating radar) used?</p>	Boreholes were used for data collection and also to guide the geology.

8	<p>Would you say the key application here is for shallow aquifers where there is significant surface/groundwater interaction? This example is quite a small application where there is a lot of data, can you see this being applied at a larger catchment scale to pickup seasonal baseflow - for example?</p>	<p>We envisage that this style of modelling is going to become common for continuous simulations extending over months and years for catchment quantity (flow) and water quality assessments at a fine scale (e.g. Tony's assessment). Accounting for the sub-surface / surface interaction produces a more realistic low flow behaviour after and between events, and the fine scale allows a much more realistic representation of a catchment's features. Importantly, the groundwater functionality allows for much better modelling of low flows, which is critical for water quality assessments. This is one type of model behaviour that this solution captures really well is something that lumped hydrology approaches struggle with.</p>
9	<p>How long it took to develop the surface water -groundwater model you just showed? What did you use to calibrate? What calibration method did you use? Any automated method inbuilt TUFLOW?</p>	<p>It took around 4-6 weeks, and the calibration was primarily visual/qualitative. If automating some of the calibration process, modellers tend to script up the process to suit their needs with running TUFLOW built into the script.</p>
10	<p>Great presentation dear. It's done first time or taking second of any model.</p>	<p>Thank you for the comment.</p>
11	<p>Is TUFLOW being used by the Murray Darling Basin Authority to better manage waterflow?</p>	<p>TUFLOW is used by the Murray Darling Basin. We however only have detailed knowledge of modelling that either we have done or our clients have shared with us. Mitchell's presentation from this previous webinar focused on modelling at the MD entrance. https://www.youtube.com/watch?reload=9&v=3a4L5ydHOvY</p>
12	<p>FlowMer has done work on the water native trees need in wetlands.</p>	<p>Thank you for the comment.</p>
13	<p>Has there been any discussion or consideration around whether this feature and the associated math is application to dewatered aquifers? Are BMT aware of any studies/projects completed which utilise this feature in a mining context - where systems are highly altered and availability of calibration data is low?</p>	<p>We're not familiar the details, or the modelling is confidential, with applications of TUFLOW for mining applications. However, we're aware that TUFLOW is used for mining operations, and the mainstream mining companies have TUFLOW licences for their in-house teams. Note that the purpose of the groundwater model implementation in TUFLOW is to help improve the catchment runoff response. It is not really intended for when the primary interest is on groundwater flows through aquifers and anisotropic materials.</p>
14	<p>Would you feel confident to use TUFLOW for the estimation of groundwater levels at different times given a surface water system with tidal effects, rainfall system to have increases in surface water levels and a simple coastal sand based aquifer? Would the groundwater elevations be suitable to be used for the design of a surface water system for a development? Or would an integrated surface water/groundwater model such as Hydrogeosphere or a coupled modelling approach be used?</p>	<p>Yes, provided that the quality of the input data is sufficiently accurate to meet the modelling objectives, and especially if the model has been calibrated to a range of events.</p> <p>We have no experience or knowledge of Hydrogeosphere to provide an informed comment.</p>
15	<p>Easy question - I assume we can now add an evapotranspiration timeseries as a boundary condition for the shallow aquifer / upper computational layer, such that storage can be removed over time?</p>	<p>Yes, evapotranspiration is one of the forcing processes of the model. However, it is only applied to remove storage from the topmost groundwater layer when the surface is dry.</p>
16	<p>If I had to provide the groundwater recharge for a more specialized modeling software, like FEFLOW, is it something that I can obtain from TUFLOW?</p>	<p>Potentially, yes, noting that TUFLOW does not currently have recharge as a map output type which would be needed to input into FEFLOW.</p>
17	<p>Is hydraulic conductivity chosen randomly within given range for both horizontal and vertical?</p>	<p>Not random, but it is up to the user to decide on the best values and compare with any available calibration data for the catchment response. Sensitivity testing, across the range of appropriate hydraulic conductivities, to understand its importance and influence, is strongly recommended as part of understanding the overall uncertainty of the modelling.</p>

18	Can TUFLOW do 3D model and does it have different mesh to choose from?	We have a 3D modelling product TUFLOW FV which can take the groundwater flow outputs from TUFLOW HPC and import them into the 3D model of the estuary/river. For example, TUFLOW HPC can track the movement of passive tracers (representing water quality constituents such as dissolved nitrogen etc) through the groundwater layers and these are then passed into TUFLOW FV for water quality simulations. TUFLOW FV uses arbitrary mesh (quads and triangles) - the mesh interface between TUFLOW HPC and TUFLOW FV is computed automatically.
19	Follow up from the previous question - Can it do saltwater intrusion from flooding (vertical inundation) using the TUFLOW FV?	No - the salt water in the 3D model cannot go into the 2D HPC model at the moment.
20	Just to clarify r.e. moisture dependent hydraulic conductivity. If we set K values in the .tsoilf, does TUFLOW adjust them depending on the saturation of the soil layer/s? or is it something we calculate and bring into the model?	Moisture dependent hydraulic conductivity is still in testing and development. It is not available in the current (2023) TUFLOW release, but is slated to part of the next major release (early 2025). Once this becomes available, users can specify the saturated hydraulic conductivity plus the parameters in the van Genuchten (1980)'s function, and TUFLOW will automatically adjust the conductivity during the simulation.
21	Is there a way to calculate a high level water balance for the system? E.g. change in storage in the aquifers, inflows, outflows etc. So that mass balance checks can be made including the groundwater system? Also, are outflow boundaries all constant head based or are time varying heads possible?	Time varying heads are possible. See groundwater boundary type GT in the manual. Some mass balance reporting is available, and you may find groundwater PO lines and regions will provide what you are looking for. If not sure, please email support@tufLOW.com and we'll help you out.
22	Nice presentation. Does it work in irrigation system area where there is no surface water?	Yes. Rain can infiltrate straight to groundwater without having to form surface water first.
23	What are the units for K, S and the calculated flow? Is there a cross-sectional area involved in the formulation?	K is in mm/hr (or in/hr for US units), S (slope) is dimensionless and groundwater flow is in mm/hr (or in/hr for US units). The cross-section area uses the depth of water in the groundwater layer times soil porosity times the cell width.
24	Thanks for the insightful presentations!	Thank you for the comment.
25	Is the K value uniform, i.e. no spatial variability?	Horizontal is different to vertical, but the horizontal is isotropic for horizontal directions. TUFLOW does not support reading K with a Read GRID or Read GIS command. However you can define a large number of different soil types, each with different K values, and specify their spatial distribution via soil ID layer(s).