

Application of Quadtree Mesh to a Fixed Grid Finite Volume 2D SWE Scheme



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Why?

- Fixed grid 2D models are fast and very easy to setup (no mesh design) required), but have large memory footprints and the same cell size across the entire model. The analogy is a DEM (grid) versus a TIN (triangular network) for defining topography.
- Utilising a quadtree approach for fixed grid 2D solvers offers the opportunity for utilising the benefits of a flexible mesh (variable cell resolution, small memory footprint) but retain the ease of setup and superior speed of fixed grids.

How?

- Single square cells are divided into four cells.
- These smaller cells can further be divided into four cells and so on.
- Instead of a single, large rectangular grid, a mesh of varying size square cells is created utilising a much smaller memory footprint.
- Polygons are used to change the level of quadtree nesting, with



Example of a Quadtree Mesh Applied to an Urban Area





automatic buffering used to fill in any transitions between cells of more than one nesting level.

Quadtree Mesh Applied to a Catchment



Real-World Application – Bed Shear Stress (BSS) Analysis

• Cell size convergence refers to the tendency for model results to trend towards a common answer as cell size decreases. This behaviour occurs due to features that influence the hydraulic flow, thereby better approximating reality as resolution increases.



- Quadtree allows for the refinement of target areas within a model.
- Cell size convergence can be achieved with Quadtree using less computational cells. This translates to faster model simulations with comparable result accuracy.
- Sediment mobility for a given particle size occurs when the bed shear stress (BSS) exceeds the critical sheer stress. Bed shear stress can be used to estimate if a sediment is mobile.

Bed Shear Stress = $\frac{\rho g V^2 n^2}{y^{\frac{1}{3}}}$

• Quadtree can be used to obtain more accurate bed shear stress estimates using models that require less time to simulate.





	1000/	Bed Shear Stress Estimate Convergence Accuracy	
ult)	100%		
esolution Res	140%	——Single Grid Without Sub-Grid Sampling 50m Resolution	
	1200/	Single Grid Without Sub-Grid Sampling 25m Resolution	
	12070	——Single Grid Without Sub-Grid Sampling 12.5m Resolution	
	100%		



