Model resolution: Lower = faster but at what cost

Haddon Smith, Beca

ABSTRACT

When considering the spatial and temporal resolution required in a hydraulic model, model runtimes are often the first factor that springs to mind. However, the resolution required for a fit-for-purpose model depends on a large range for factors. With regard to cell sizes, this includes the following:

- Flow regime: even within the same model, the required 2D cell size depends on the behaviour of the flow. For example, areas used predominately for storage require a far lower resolution than those used for conveyance.
- Model purpose: if the purpose of a model is to determine average river channel water levels a coarse 2D or 1D model may be sufficient, however if velocity distribution or water level difference around specific features are required, a fine resolution 2D or 3D model may be required.
- Underlying terrain: spatial resolutions should be increased in areas with steep surface profiles where flow velocities will be higher.
- Numerical scheme: recent advances in 2D numerical schemes, such as sub-grid sampling (SGS), mean that the cell size required in one software package will be different to another.
- Turbulence model: some formulations are such that head losses due to turbulence are dependent on the cell size. Thus, when reducing cell size to gain additional accuracy, modellers should consider whether the eddy viscosity or other turbulence parameters need to be adjusted.

Similarly, the required temporal resolution (time step) for accurate modelling should be evaluated with respect to the characteristics of the flow being simulated and the formulation of hydraulic model implemented in the software. Relevant factors include the numerical scheme used to solve the equations (i.e. implicit or explicit).

To gain the best balance between temporal / spatial resolutions and model run times, result convergence testing is a useful tool. This simple procedure, that can be efficiently incorporated into model development, will be demonstrated using a simple example.