USACE Guidance: EM 1110

- USACE “Official” Guidance concerning the selection of 1D vs 2D models is sparse and old (1993)
- However, the basic criteria delineated in this EM for the choice of 1D vs 2D models is still valid (mainly because Newtonian Physics hasn’t changed since then)
- Guidance is found in Chapter 4: Multi-Dimensional Modeling
1D vs 2D: USACE Guidance

- 1D models are useful when flow is dominantly in the streamwise direction, with little lateral momentum.
- 2D models may be necessary when
  - lateral momentum effects are important
  - Flow distribution is unknown and must be simulated
  - Energy losses due to horizontal turbulence and flow separation (such as flow expansions) must be simulated
- Each of these effects can sometimes be calibrated with 1D models, but not directly modeled.
- As a result, good engineering judgement is the most important criterion for model selection.
1D vs 2D: Some Additional Notes

- **1D models**
  - Are sufficiently computationally efficient to permit Monte-Carlo type analyses, for robust evaluation of risk and uncertainty
  - Local losses due to 2D and 3D effects must be parametrized with observations and/or experimental data.

- **2D models**
  - Increased computational burden usually means Monte-Carlo analysis is impractical: sensitivity testing and bracketing of uncertainty is usually the best one can do
  - 2D losses and cross-channel momentum exchange can be directly simulated (IF the model has sufficient resolution to properly simulate the losses)

- **Redundancy is your friend**: multiple models are very useful to gain confidence in results
- **Paranoia is your friend**: the model is a tool, not a prophet. If you can’t explain the results, you don’t understand them.
Some USACE 2D options

Adaptive Hydraulics (AdH)
- 2D finite element model
- Mesh can dynamically adapt (add and take away resolution) to resolve important flow features while minimizing computational burden
- Also has constituent transport and sediment transport capability.

HEC-RAS 5.0 2D module
- 2D finite volume model
- Individual cell faces have volume and momentum relationships that are functions of sub-grid scale properties. This eases the computational burden while still capturing much of the sub-grid scale influence on the solution
- Constituent and sediment transport not yet available, but development of these capabilities continues apace.
Thank you

gary.l.brown@erdc.dren.mil