Empowering Floodplain Administrators on 2D Hydraulic Modeling using HEC-RAS 5.0

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Agenda

• Introduction

• 1D vs 2D

• 2D Basics with HEC-RAS 5.0

• Conclusions
Introduction

1D

2D

3D
1D vs 2D

• Not well defined channel / flow direction
• Flat topography
• Flow directions changes significantly with different stages
• Parallel stream reaches with shared floodplains
• Urbanized areas

• Other Reasons:
  – Need local flow velocities
  – Circulation patterns
  – Variations in lateral velocity
The modeler can use angle points or “doglegs” in cross sections if necessary to satisfy this requirement. The cross section data can be obtained from direct survey of the cross sections, or can be derived from topographic mapping or digital terrain.

### Table CH12-601. Differences between One-Dimensional and Two-Dimensional Modeling

<table>
<thead>
<tr>
<th>Property or Factor</th>
<th>One-Dimensional Modeling</th>
<th>Two-Dimensional Modeling</th>
</tr>
</thead>
<tbody>
<tr>
<td>flow direction</td>
<td>prescribed (streamwise)</td>
<td>computed</td>
</tr>
<tr>
<td>transverse velocity and momentum</td>
<td>neglected</td>
<td>computed</td>
</tr>
<tr>
<td>vertical velocity and momentum</td>
<td>neglected</td>
<td>neglected</td>
</tr>
<tr>
<td>velocity averaged over...</td>
<td>cross sectional area</td>
<td>depth at a point</td>
</tr>
<tr>
<td>transverse velocity distribution</td>
<td>assumed proportional to conveyance</td>
<td>computed</td>
</tr>
<tr>
<td>transverse variations in water surface</td>
<td>neglected</td>
<td>computed</td>
</tr>
<tr>
<td>vertical variations</td>
<td>neglected</td>
<td>neglected</td>
</tr>
<tr>
<td>unsteady flow routing</td>
<td>can be included</td>
<td>can be included</td>
</tr>
</tbody>
</table>
1D vs 2D....
HEC-RAS 5.0
2D Theory

- Full Momentum Equation (Dynamic Wave / Shallow Wave)
  - Change in Momentum (Velocity) = Change in Hydrostatic Pressure Gradient.

- Diffusion Wave Equation
  - Bottom friction = Pressure Gradient

\[
\frac{\partial v}{\partial t} + u \frac{\partial v}{\partial x} + v \frac{\partial v}{\partial y} = -g \frac{\partial H}{\partial y} + v_t \left( \frac{\partial^2 v}{\partial x^2} + \frac{\partial^2 v}{\partial y^2} \right) - c_f v + fu
\]
2D MODEL with HEC-RAS Inputs

• Establish a Horizontal Coordinate Projection from within HEC-RAS Mapper
• Develop a terrain model in HEC-RAS Mapper
  • Used to establish the geometric and hydraulic properties of the 2D cells and cell faces
  • Useful to perform any inundation mapping
• Build a Land classification data set in order to establish Manning’s n values within the 2D analysis area
2D - Mesh
2D Mesh

• Mesh automatically generated within 2D area boundary
  – Add breaklines to re-align cell faces
  – Manually adjust points

• Underlying terrain provides geometric and hydraulic property tables representing cells and cell faces
  – “Subgrid” allows cells to be partially wet
  – Improves computation time
Geometric Data Window with 2D Area

Figure 3-3. HEC-RAS 2D modeling computational mesh terminology.
Define Mannings n values with LandCover
2D Model Inputs...

[Image of a software interface showing 2D Flow Areas with various input fields and settings, including Default Manning's n Value, Cell Volume Filter Tol(ft), Face Profile Filter Tol(ft), Face Area-Elev Filter Tol(ft), Face Conveyance Tol Ratio, and options for Mesh, Generate Computation Points on Regular Interval, Enforce Selected Breaklines, and View/Edit Computation Points.]
RAS Mapper
2D Model Inputs...
Running 2D analysis
Viewing 2D Output

- RAS Mapper
  - Real-Time Query
  - Dynamic Mapping
  - Managing Map Layers
  - Velocity Mapping
  - Adding profile lines*
  - Results by Cell
Viewing 2D Output cont...
Rasmapper
Conclusions

**Technical obstacles:**
1. Unsteady modeling experience (stability, flows)
2. 2D modeler expertise/experience
3. Linking 1D to 2D areas
4. Hydraulic structures

**Regulatory obstacles:**
1. Unsteady models
2. Awareness and acceptance
3. Expertise (reviewers)
Next time!....
THANK YOU