A New Era in Inundation Mapping

Using GIS to Develop Dam Breach Modeling and Mapping

Scott Arends, P.E., Dam Safety / Water Resources Engineer
Hanson Professional Services Inc.
Inundation Mapping

Emergency Planning
Inundation Mapping

Resource Allocation
Inundation Mapping

Evacuation

AP Photo/Dave Martin
Inundation Mapping

How to convert

Data ➔ Illustration

Dam Breach Model ➔ Dam Breach Map

Floodplain Model ➔ Flood Plain Map
Start with Hydrologic and Hydraulic Analysis
Tools of the Trade
Total Watershed > 5,000 sq miles
Reach to be modeled extracted from Hydrography
Longest Flow Path (ArcHydro)
Reach Lengths for routing hydrographs from distant basins
Land Cover
### Attributes of Watershed LC_Soilhydro_EastFINAL

<table>
<thead>
<tr>
<th>ID</th>
<th>Shape</th>
<th>FID</th>
<th>Waters</th>
<th>ID</th>
<th>GRIDCODE</th>
<th>M804</th>
<th>m805</th>
<th>m806</th>
<th>m807</th>
<th>Hydrogeom</th>
<th>Hydrogeom_code</th>
<th>Shape</th>
<th>Length</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Polygons</td>
<td>201700000</td>
<td>12</td>
<td>201700000</td>
<td>1075A</td>
<td>DC</td>
<td>U</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Polygons</td>
<td>201700000</td>
<td>12</td>
<td>201700000</td>
<td>1075B</td>
<td>DC</td>
<td>U</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Polygons</td>
<td>201700000</td>
<td>12</td>
<td>201700000</td>
<td>1075C</td>
<td>DC</td>
<td>U</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Polygons</td>
<td>201700000</td>
<td>12</td>
<td>201700000</td>
<td>1075D</td>
<td>DC</td>
<td>U</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Polygons</td>
<td>201700000</td>
<td>12</td>
<td>201700000</td>
<td>1075E</td>
<td>DC</td>
<td>U</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>Polygons</td>
<td>201700000</td>
<td>12</td>
<td>201700000</td>
<td>1075F</td>
<td>DC</td>
<td>U</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>Polygons</td>
<td>201700000</td>
<td>12</td>
<td>201700000</td>
<td>1075G</td>
<td>DC</td>
<td>U</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>Polygons</td>
<td>201700000</td>
<td>12</td>
<td>201700000</td>
<td>1075H</td>
<td>DC</td>
<td>U</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>Polygons</td>
<td>201700000</td>
<td>12</td>
<td>201700000</td>
<td>1075I</td>
<td>DC</td>
<td>U</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>Polygons</td>
<td>201700000</td>
<td>12</td>
<td>201700000</td>
<td>1075J</td>
<td>DC</td>
<td>U</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>11</td>
<td>Polygons</td>
<td>201700000</td>
<td>12</td>
<td>201700000</td>
<td>1075K</td>
<td>DC</td>
<td>U</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>12</td>
<td>Polygons</td>
<td>201700000</td>
<td>12</td>
<td>201700000</td>
<td>1075L</td>
<td>DC</td>
<td>U</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>13</td>
<td>Polygons</td>
<td>201700000</td>
<td>12</td>
<td>201700000</td>
<td>1075M</td>
<td>DC</td>
<td>U</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>14</td>
<td>Polygons</td>
<td>201700000</td>
<td>12</td>
<td>201700000</td>
<td>1075N</td>
<td>DC</td>
<td>U</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>15</td>
<td>Polygons</td>
<td>201700000</td>
<td>12</td>
<td>201700000</td>
<td>1075O</td>
<td>DC</td>
<td>U</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>16</td>
<td>Polygons</td>
<td>201700000</td>
<td>12</td>
<td>201700000</td>
<td>1075P</td>
<td>DC</td>
<td>U</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>17</td>
<td>Polygons</td>
<td>201700000</td>
<td>12</td>
<td>201700000</td>
<td>1075Q</td>
<td>DC</td>
<td>U</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>18</td>
<td>Polygons</td>
<td>201700000</td>
<td>12</td>
<td>201700000</td>
<td>1075R</td>
<td>DC</td>
<td>U</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>19</td>
<td>Polygons</td>
<td>201700000</td>
<td>12</td>
<td>201700000</td>
<td>1075S</td>
<td>DC</td>
<td>U</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>20</td>
<td>Polygons</td>
<td>201700000</td>
<td>12</td>
<td>201700000</td>
<td>1075T</td>
<td>DC</td>
<td>U</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>21</td>
<td>Polygons</td>
<td>201700000</td>
<td>12</td>
<td>201700000</td>
<td>1075U</td>
<td>DC</td>
<td>U</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>22</td>
<td>Polygons</td>
<td>201700000</td>
<td>12</td>
<td>201700000</td>
<td>1075V</td>
<td>DC</td>
<td>U</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>23</td>
<td>Polygons</td>
<td>201700000</td>
<td>12</td>
<td>201700000</td>
<td>1075W</td>
<td>DC</td>
<td>U</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>24</td>
<td>Polygons</td>
<td>201700000</td>
<td>12</td>
<td>201700000</td>
<td>1075X</td>
<td>DC</td>
<td>U</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>25</td>
<td>Polygons</td>
<td>201700000</td>
<td>12</td>
<td>201700000</td>
<td>1075Y</td>
<td>DC</td>
<td>U</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>26</td>
<td>Polygons</td>
<td>201700000</td>
<td>12</td>
<td>201700000</td>
<td>1075Z</td>
<td>DC</td>
<td>U</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Legend:**
- **ID**: Unique identifier
- **Shape**: Geometric shape
- **FID**: Feature identification number
- **Waters**: Watershed code
- **ID**: Unique identifier
- **GRIDCODE**: Grid code
- **m804**: Measurement 1
- **m805**: Measurement 2
- **m806**: Measurement 3
- **m807**: Measurement 4
- **Hydrogeom**: Hydrogeom code
- **Hydrogeom_code**: Hydrogeom code
- **Shape**: Geometric shape
- **Length**: Length measurement
Convert Soils/Land Data to Curve Numbers
Curve numbers - closeup
Build HEC-HMS hydrology model
Steps to Building HEC-RAS model
Reaches (Rivers to be modeled)
Cross-Sections
More Cross-Sections
Even more Cross-Sections
Stop! Enough Cross-Sections!!
Now to add bank stations
Channel Bank Lines — can you see them
How about now?
Flow Paths
Stream Crossings
All layers are complete – ready to export to HEC-RAS
Example of Additional Layers
HEC-RAS Model - schematic
LiDAR – Light Detection and Ranging
DEM - 30 meter resolution
Dam Breach

Plan: Merged Unsteady Sunny Day Breach Saddle

3/29/2010

Main Channel Distance (ft)

Elevation (ft)
WE NOW HAVE A MODEL AND DATA, BUT NO MAP

WHAT’S NEXT?

EXPORT TO GIS
Mapping with Storage Areas
Mapping Cross-sections – good for small backwater areas
Mapping Cross-sections
TIN – Triangulated Irregular Network
Flood Depth
Inundation Area
Stage/Flow hydrograph near Dam
Blue = Water Elevation
Green = Discharge
Downstream
Farther Downstream
Inundation Area on USGS Quad Map
Inundation Area on Orthophoto
Identify Structures at Risk
Communities at Risk
Add User Valued Information
Same concept – on a smaller scale
Benefits of GIS Modeling & Mapping
Benefits of GIS Modeling & Mapping

- Minimal Survey
Benefits of GIS Modeling & Mapping

- Minimal Survey
- Data Organization
Benefits of GIS Modeling & Mapping

- Minimal Survey
- Data Organization
- Updating
Benefits of GIS Modeling & Mapping

- Minimal Survey
- Data Organization
- Updating
- Exhibits
  - Data is the exhibit
Benefits of GIS Modeling & Mapping

- Minimal Survey
- Data Organization
- Updating
- Exhibits
  - Data is the exhibit
- Graphical review
Benefits of GIS Modeling & Mapping

- Minimal Survey
- Data Organization
- Updating
- Exhibits
  - Data is the exhibit
- Graphical review
- Collaboration
Thank You

Special Thanks to

Tony Comerio, P.E., CFM
Lead Technical Advisor

Amanda Macklin
Lead Modeler

For more information, please contact
Scott Arends, P.E.,
at Hanson Professional Services Inc.
at (217) 788-2450 or at sarends@hanson-inc.com.