Integrating HEC HMS generated flow hydrographs with FLO-2D

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Focus of this Presentation

• Introduction
• Methodology
• Challenges & Solutions
• Cost Effectiveness
• Conclusion
• Q & A
Introduction

• Study Area – New Jersey
  • 420 Sq. Mi., 320 miles of study scope
  • Northern portion of study area - Moderate to Steep slope
  • Southern portion – Flat terrain
  • 2D model proposed to accommodate wide floodplains
  • 3 HMS models and 20 FLO-2D models

• Selection of Hydrology Method
  • Regression Analysis
    • Constant Hydrograph
  • FLO-2D
    • Rain on Grid approach - Not approved for Hydrology by FEMA yet.
Introduction

• Selection of Hydrology Method
  • Rainfall –Runoff Model
    • Adequately produces stream flow hydrographs that represent the physical characteristics of the watershed
    • Applicable in the areas of significant floodplain storage
    • Used HEC-HMS version 4.0
    • Subbasin flow hydrographs
Methodology

- **Hydrology**
  - Watershed Delineation
    - Streams with moderate to steep slopes – USGS 10m DEM
    - Flat Streams – 2 m LiDAR
  - Precipitation
    - Frequency Storm method – NOAA Atlas 14
  - Infiltration/Loss Method
    - Curve Number from SSURGO and 2011 NLCD dataset
  - Lag Time
    - Watershed Lag method
Methodology

• Hydrology
  • Channel Routing
    • Attained through FLO-2D
  • Comparison
    • Regression Equation Discharges – Headwater Basins
  • Discharges
    • Hydrographs for each sub basin generated
Methodology

- Hydraulics
  - FLO-2D
    - Volume conservation flood routing model
    - Routes rainfall-runoff and flood hydrographs over unconfined flow surfaces or in channels
    - Governing equations are the continuity equation and the equation of motion
    - Moves blocks of volume around on the grid system in eight directions

*Integrating HEC HMS generated flow hydrographs with FLO-2D*  October 15, 2015
Methodology

• Hydraulics
  • FLO-2D
    • Grid Developer System (GDS)
      • Pre-processor program –
        Overlays the grid system on the
        DTM points, interpolates and
        assign elevations to the grid
        elements
      • Roughness, Inflow & Outflow
        nodes, Area and width reduction
        factors.
      • Prepares the basic input files for
        the FLO-2D model
    • Grid Element Size of 50 feet –
      100 feet
Methodology

• Hydraulics
  • FLO2D
    • MAPPER
      • Primary program for displaying results
      • Creates Ground Elevation, & Water Surface Elevation and Flood Depth maps
      • Creates an approximate Area of Inundation layer
      • Floodplain Delineation based on detailed topo data – ArcGIS methods work best
1) Challenge

**Grid Developer System – Long**

*Loading times due to detailed topo data and roughness data*

**Solution**

- Used the 100 feet grid from GDS in ArcGIS
  - Extracted elevation and manning’s n values using Zonal Statistics
- Used ‘R’ (a programming language) scripts to write the elevation & manning’s n values into FPLAIN.DAT file, an input file for FLO-2D
2) **Challenge**

*Inflow nodes – Laborious process to get the outflow hydrograph from HEC-HMS and input into the GDS – more than 600 flow change locations*

**Solution**

- Used HEC-DSSVue to export all the hydrographs into a spreadsheet.
- Linked the flow change points spatial file and grid spatial file.
- Used ‘R’ scripts to extract specific hydrographs for each point and write them into INFLOW.DAT file.
3) Challenge

Handoff Points – To reduce computation times, study area was divided into multiple models – Outflow hydrograph of U/S becomes inflow hydrograph of D/S model

Solution

- FPXSEC.DAT identifies grid cells where the user wants flow computations
- Read the CROSSQ.OUT (output files) from the U/S model run – Identify grid cells that are intersecting from D/S model
- Used ‘R’ scripts to extract specific hydrographs for each grid cell and write them into INFLOW.DAT file for the D/S model
4) Challenge

Floodplain Mapping – Extremely time consuming in FLO-2D to delineate floodplain based on high resolution LiDAR data. Example: 5 feet LiDAR based raster

Solution

• Used ArcGIS to develop the work flow to delineate floodplains.
• Flood Depth at each grid cell is used
• Model builder is to used to reduce any redundancies
Cost Effectiveness

• Cost/Time matched the 1-D HECRAS approach.

• Cost includes learning time, overcoming challenges (script development)

• Next application of this method (HEC-HMS/FLO-D) – 75% of the 1-D HECRAS approach.
Conclusion

• Integrating HEC-HMS results into FLO-2D is a challenging process, if FLO-2D’s GUI (2009 version) is solely used

• Process Improvements such as R scripts to reduce computation times do help.

• Rain-on-Grid approach i.e., generating the flood hydrograph at a specific location by modeling the rainfall-runoff in FLO-2D might be an approach that needs consideration

• With HEC-RAS 2D on the horizon, it needs to be seen how cost effective FLO-2D can still be.
Questions?