What is Rain-On-Grid

- Micro-hydrology
  - It is traditionally hydrology performed at a small scale in which infiltration and shallow water equations generate runoff for small sub units.
  - Compared to large generalized sub-basins
What is Rain-On-Grid

Step 1: Hydraulic properties

Step 2: Hydrologic cycle calculations (Per cell)

Rain on cell

Soil infiltration, evaporation, etc.

Excess precipitation

A presentation by Wood.
What is Rain-On-Grid

Step 3: Hydraulic routing

What is HEC-RAS (5.0.7) Rain-On-Grid

• Currently, only a single hyetograph can be applied to a 2D area and there are no infiltration features.
• Hydrologic cycle must be taken out prior to application.
  – HEC-HMS
  – Spreadsheet
What is HEC-RAS (5.0.7) Rain-On-Grid

Step 1: Hydraulic properties

Step 2: Hydrologic cycle calculations (per cell)

Rain on cell

Soil infiltration, evaporation, etc.

Excess precipitation
What is HEC-RAS (5.0.7) Rain-On-Grid

Hydraulic properties

Excess precipitation (by others)

Hydraulic runoff

Step 3: Hydraulic routing

Hydraulics – At cells

As precipitation falls the elevation rises filling storage volume.

At same time water is conveyed through face to the adjacent cells.
HEC-RAS vs HEC-HMS rainfall and losses

**HEC-RAS**
- Can only input a single hyetograph per basin
- No hyetograph development
- No loss calculations
- Easiest way to develop excess rainfall hyetographs is to use HEC-HMS and link it to HEC-RAS using the .dss output file

**HEC-HMS**
- Can develop hyetographs from rainfall depth input
- Can perform loss calculations
- Still only one calculation per basin

HEC-RAS vs HEC-HMS routing and transform

**HEC-RAS**
- Water is routed from cell to cell through detailed faces
- Detail level depends on quality of topography and cell layout

**HEC-HMS**
- A unit hydrograph transform is performed per basin
- Basins are routed together using generalized calculations for each basin
- Additional input development is required (time of concentration, flow lengths, storage coefficients)
HEC-RAS vs HEC-HMS results

HEC-RAS

- Resulting depths, flows, and velocities can be viewed at each cell face, or group of cell faces
- Hydrologic and Hydraulic outputs are combined

HEC-HMS

- A single hydrograph output per element
HEC-RAS vs HEC-HMS

Red = HEC-RAS    Blue = HEC-HMS

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HEC-RAS vs HEC-HMS

Red = HEC-RAS     Blue = HEC-HMS
HEC-RAS vs HEC-HMS

Red = HEC-RAS     Blue = HEC-HMS
Considerations – Manning’s N

• Manning’s N (not just CN) can vary based on assumptions:
  – Condition of cover type (good, fair, poor)
  – Density of cover type (row crop spacing, residential lot sizes, density of trees, etc)
  – Specifics of land cover (type of crop planted, residue left on field, frequency of mowing, etc)

• HEC-RAS uses the Manning’s n value from the input land cover data that falls at the center of each cell face.
Considerations - Manning’s N

- Manning’s N:
  - Depth of water VS roughness???

Variable N values not available in HECRAS 2D yet.

**Considerations - Manning’s N**
Considerations - Manning’s N

Red = Shallow Manning’s n   Blue = Floodplain Manning’s n

A presentation by Wood.
Considerations – Cell Layout

• Cell “leaking”
  – Precipitation equally distributed on cell but incorrectly distributed through face
  – Breaklines resolve this issue to re-orient cells

Considerations – Rainfall and Losses

• RAS can currently only use 1 hyetograph per 2D area
• May consider creating separate 2D model areas for the following:
  – Additional detail is needed in the modeling
  – CN varies greatly across the basin
    • Especially typical for towns
  – Rainfall varies greatly across the basin
  – Soil types vary greatly across the basin
Considerations – Curve Number

• CN can vary from source to source, and are often dependent on assumptions such as:
  – Condition of cover type (good, fair, poor)
  – Density of cover type (row crop spacing, residential lot sizes, density of trees, etc.)
  – Specifics of land cover (type of crop planted, residue left on field, frequency of mowing, etc.)

Considerations - Calibration

• Hydrograph accuracy is very dependent on:
  – Quality of data
  – Years of record
  – Historical information available
• Calibration requires preplanning & careful consideration
Advantages Using 2D Modeling

- Detailed data inputs
  - Land cover
  - Terrain
- Accuracy in complex areas
  - Flat terrain
  - Urban areas
  - Parallel streams
  - Multiple structures
  - Storage areas
- Detailed results
  - Obtain results on a per cell basis
  - Useful gridded information
    - Arrival times, durations
    - Depths, velocities
    - Maximum water surface
  - Mapping and animations

Limitations

- Requires DEM manipulation based on policy needs and modeling situation.
  - Storage considerations, bathymetric, etc.
- Cannot use HEC-RAS bridge modeling capabilities inside of a 2D flow area. They can be added using the connection tool.
- Cannot perform sediment transport erosion/deposition.
- Cannot perform water quality modeling in 2D flow areas.
- Cannot combine storm and open channel hydraulics together.
- Processing time & large datasets
  - Recent variable time step capabilities is huge!
  - Limiting Rain-On-Grid models to approximately 200-300 sq. mile.
Limitations

- Bridges
  - Emphasis on terrain
  - No piers, deck, abutments, etc.
  - No pressure/weir flow calculation
  - Full momentum – contraction/expansion, multiple openings

Example: Velocities around piers. Okay as long as deck/low chord not a factor.

Upcoming 2D Capabilities

- Infiltration - initial and constant, SCS curve number, green and ampt
- Rainfall – ability to apply varying rainfall over a single 2D area
- 2D bridge modeling
- Non-Newtonian and sediment flows
Questions/discussion

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