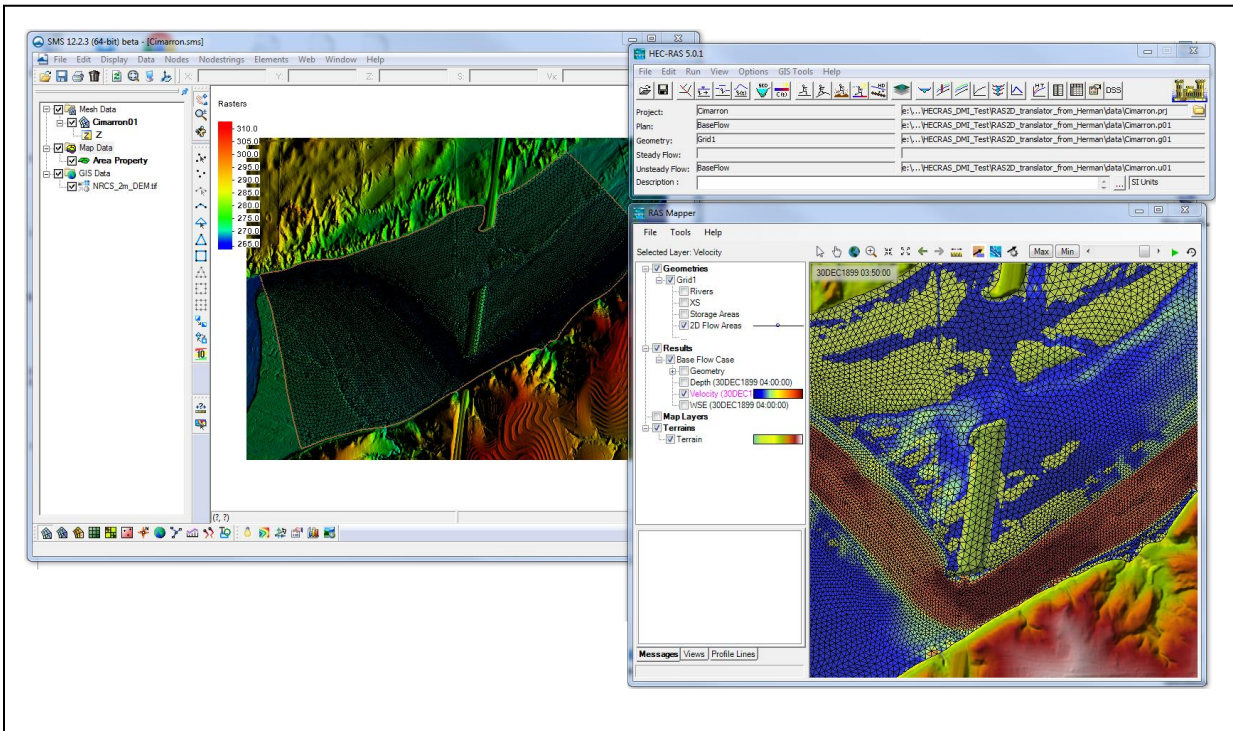


SMS 12.3 Tutorial HEC-RAS



Objectives

This tutorial introduces the HEC-RAS model and how it can be used to generate files for use with the HEC-RAS software.

Prerequisites

- Overview Tutorial

Requirements

- HEC-RAS 5.0
- Mesh Module
- Map Module

Time

- 30–45 minutes



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1 Introduction

The Hydrologic Engineering Center's (CEIWR-HEC) River Analysis System (HEC-RAS) is a one- and two-dimensional model for computing water surface profiles for steady state or gradually varied flow. Two-dimensional capabilities were added to the program in version 5.0. HEC-RAS supports networks of channels and is capable of modeling subcritical, supercritical, and mixed flow regime profiles. HEC-RAS is able to model obstructions in the flow path. The HEC-RAS software can be downloaded for free.¹

Starting with SMS version 12.2, SMS can be used to create geometric data (grids or meshes) for the HEC-RAS 2D software. This tutorial does not provide thorough coverage of the capabilities of the HEC-RAS software. Instead it focuses on the initial functions to couple the SMS with HEC-RAS 2D.

This tutorial uses a mesh generated from data gathered in a portion of the Cimarron River in Oklahoma.

2 Importing a Mesh

To save time, the mesh has been already been generated. The process used to generate this mesh is shown in the “Overview” and “SRH-2D” tutorials. Refer to these tutorials for more information about mesh generation.



Import the mesh by doing the following:

1. Select *File* | **Open...** to bring up the *Open* dialog.
2. Select “Project Files (*.sms)” from the *Files of type* drop-down.
3. Browse to the *HEC-RAS\datafiles* folder and select “input.sms”.
4. Click **Open** to import the project and exit the *Open* dialog.

¹ Download the HEC-RAS software at <http://www.hec.usace.army.mil/software/hec-ras/>

5. If there is geometry open from a previous tutorial, a message will ask to delete existing data. If this happens, click **Yes**.

A mesh will appear in the Graphics Window similar to Figure 1.

6. Use the **Rotate**  tool to review the elevation data applied to the mesh.
7. When done reviewing the mesh, switch to **Plan View** .

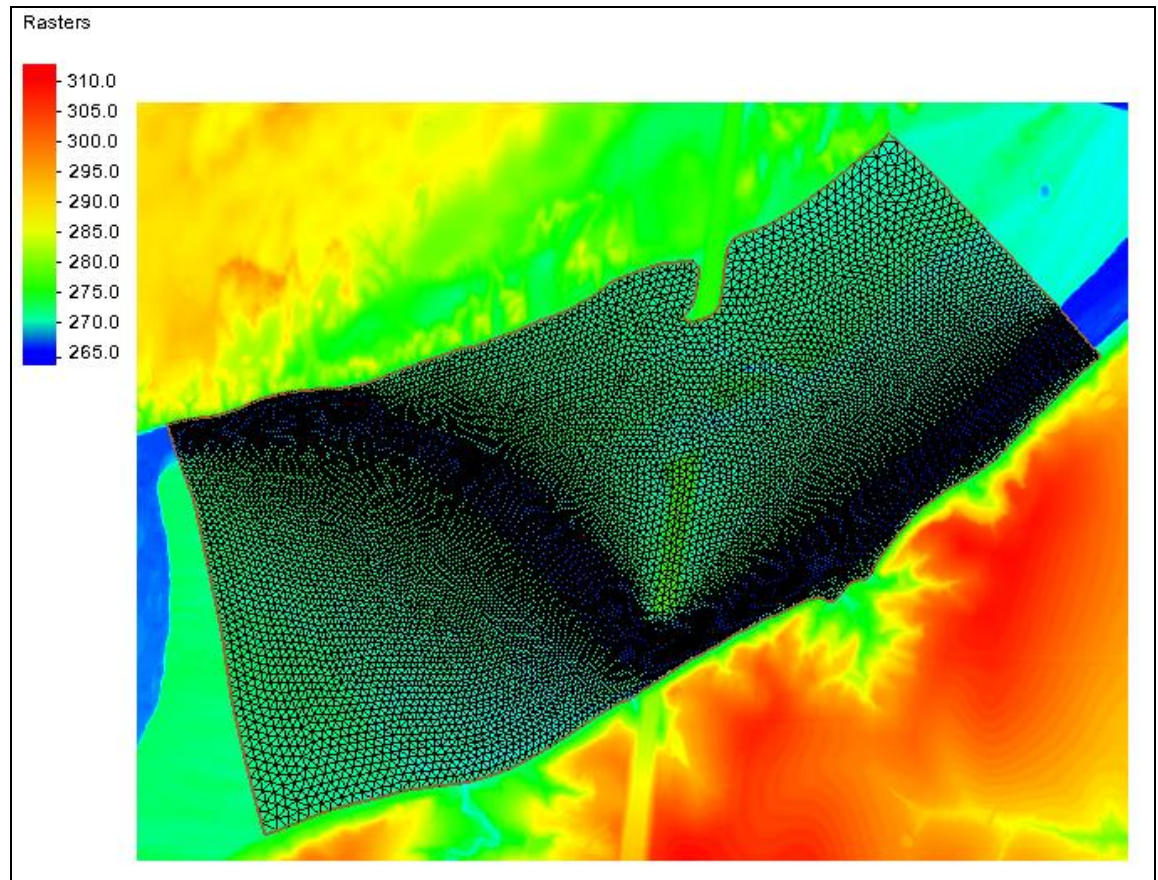


Figure 1 The imported mesh

3 Setting Up a HEC-RAS Simulation in SMS

The HEC-RAS interface in the SMS makes use of simulation based modeling. This allows creation of multiple scenarios in one SMS project. This project only uses one mesh, but multiple meshes could be used create multiple simulations/scenarios.

With the mesh available, the HEC-RAS simulation needs to be created.

1. Right-click on an empty space in the Project Explorer and select *New Simulation* | **HEC-RAS** (Figure 2).

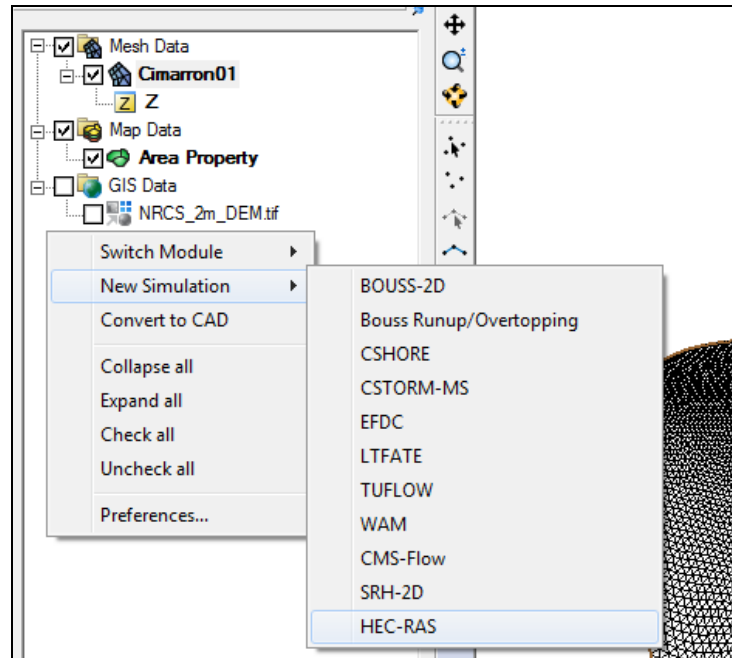




Figure 2 Creating a new HEC-RAS simulation

Notice a new simulation item called “Sim” is now in the Project Explorer.

2. Right-click on “ Sim” and select **Rename**.
3. Enter “Q100” and press *Enter* to set the new name.

The Q100 simulation currently contains no properties or data. Components need to be added to the simulation before the simulation can be launched. Add components by either clicking and dragging the components under the simulation item or using the right-click menu.

To link the mesh to the simulation, do the following:

4. Right-click on “ Cimarron01” and select **Link To | HEC-RAS Simulations → Q100**.

The simulation should appear similar to Figure 3.

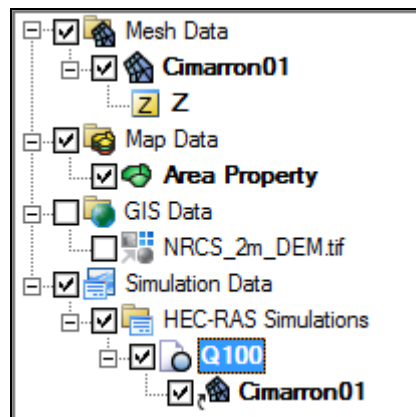


Figure 3 The HEC-RAS simulation in the Project Explorer

4 Saving the project

This tutorial started with an SMS project. However, most projects start from background data. Before scenarios or simulations can be saved and evaluated, the SMS project must be saved. For this reason, this tutorial illustrates the step of saving a project. To do this:

1. Select *File* | **Save As...** to bring up the *Save As* dialog.
2. Select “Project Files (*.sms)” from the *Save as type* drop-down.
3. Enter “Cimarron.sms” as the *File name* and click **Save** to close the *Save As* dialog and save the project under the new name.


Note: When SMS saves the project, it also creates a projection file for digital elevation maps (DEMs) such as the one included in this project which have internal projection specification. This projection file will be used later in the HEC-RAS modeling processes.

HEC-RAS requires a projection file for the terrain in a standard ESRI “*.prj” file. This should not be confused with a HEC-RAS project file (which also has a “*.prj” extension).

5 Exporting the “rasgeo” file

For the initial coupling of SMS with HEC-RAS, SMS is only used to generate the geometric grid or mesh. In future versions, the interface will include specification of boundary conditions, material zones with roughness values or land use rasters, background DEMs and model parameters.

The HEC-RAS interface in SMS creates an intermediate file referred to as a RASGEO file which is converted for use in the HEC-RAS program. To create this file:


1. Right-click on “ Q100” simulation and select **Export HEC-RAS**.

This creates the geometry file the HEC-RAS translator uses to generate the input files for HEC-RAS. The export time varies based on the speed of the computer and the size of the mesh.

Note: if desired, view the RASGEO file in a windows explorer in simulation folder as: “*project_directory*”\Cimarron\HEC-RAS\Q100\Cimarron.rasgeo

6 Running HEC-RAS Translator

The HEC-RAS interface in SMS does not run HEC-RAS. Rather, it prepares the geometry input files for a HEC-RAS run. To create these files, launch the HEC-RAS model translator by doing the following:

1. Right-click on “ HEC-RAS” and select **Launch HEC-RAS** to bring up the *HEC-RAS: Q100* model wrapper dialog.

2. When the process finishes, click **Exit** to close the *HEC-RAS: Q100* model wrapper dialog.

The HEC-RAS translation run should have created the following files use with the HEC-RAS software.

- “Cimarron.g01” – HEC-RAS geometry file
- “Cimarron.g01.hdf” – HEC-RAS 2D geometry file
- “Cimarron.prj” – HEC-RAS project file

These files in the same directory as the RASGEO file.

7 Opening the HEC-RAS project

The geometry data is now ready for use in the HEC-RAS program. The remainder of this tutorial will illustrate how to set up and run a simple 2D HEC-RAS simulation. HEC-RAS 5.0.3 will be used. This software can be downloaded for free. If unable to obtain a working copy of HEC-RAS 5.0.3, skip to the end fo this tutorial.

To use these files with HEC-RAS, do the following:

1. Launch the HEC-RAS software outside of SMS.
2. In HEC-RAS, select the *File* | **Open Project...** to bring up the *Open Project* dialog.
3. Browse to the *HEC-RAS\datafiles\Cimarron \HECRAS\Q100* directory.
4. Select “Cimarron.prj” and click **OK** to import the file into HEC-RAS.





With the geometry from SMS loaded, the HEC-RAS simulation requires the following steps in order to run:

- Load/create a terrain model.
- Set up the boundary conditions.
- Set up the plan.

This tutorial is not intended to describe all the functions and options of HEC-RAS. The following sections give instructions to define a set of parameters to run the model. If more information is required, refer to the HEC-RAS documentation. Aquaveo does not provide technical support for the HEC-RAS software.

8 Loading the Terrain

The HEC-RAS engine requires a terrain definition based on a digital elevation map. To create the terrain, do the following:

1. Click on the  icon to open the *RAS Mapper* window.
2. Check on the “2D Flow Areas” to see the extents of the domain.
3. Right-click on the “Terrains” object and select **Create a new terrain**
4. HEC-RAS will bring up a notification that a projection is desired. Click **Yes**. The *Spatial Reference Projection File* dialog will appear.
5. Click on the  browser icon to open a browser window.
6. Browse to the directory the Cimarron project is saved from SMS. This will probably just be a few directories above where the HEC-RAS project is.
7. Select “NRCS_2m_DEM.prj” and click **Open** to import the file into HEC-RAS. (Remember that there are two type of “*.prj” files used here. This is a projection file, not a HEC-RAS project file.
8. HEC-RAS may give an error message that the projection does not appear valid. Ignore this message and click **OK** to close the *Spatial reference Projection File* dialog.
9. In the **New Terrain Layer** dialog that appears, click the  plus button to select a new digital elevation map in another browser window.
10. Browse to the same project directory again and select the “NRCS_2m_DEM.tif” file and click **Open**.
11. Click **Create** to create the terrain layer.
12. At this point HEC-RAS brings up a dialog to track the progress of its processing of the DEM . When it is done, click **Close**.
13. Check on the “Terrains” box in the RAS Mapper window to display the terrains and the image will appear.
14. Close  the *RAS Mapper* window for now.



HEC-RAS has now created a “Terrain” folder in the project directory and copied the DEM into that folder. It has also created the files “Terrain.hdf” and “Terrain.vrt” for use with this project. In addition, the file “Cimarron.rasmap” has been created.

9 Setting up Boundary Conditions


The boundary conditions for the 2D hydraulic regions are specified in two steps. First, the location of the lines are defined, then the values.


To define the location, do the following:

1. Click the  **View/Edit Geographic Data** button to open the *Geometric Data* window.

2. Click on the  **SA/2D Area BC Lines** button to digitize the boundary condition location. This will change the cursor to a pencil
3. Create a line near the left edge of the domain. It does not need to be precise, in fact it is recommended to just click two points near the two left corners. Double-click on the last point in the line to end the line and bring up a dialog
4. HEC-RAS will ask for a name for this boundary condition line. Specify the name as “Inflow” and click **OK**. HEC-RAS will snap the line to the edge of the domain.
5. Repeat steps 3–4 to create a line on the right side of the domain named “Outflow”.
6. Select the **Save Geometry Data** command from the *File* menu. HEC-RAS will update the “g01” and “g01.hdf” files.
7. Close  the *Geometric Data* editor.


To define the boundary condition values do the following:

1. Click the  **View/Edit Unsteady Flow Data** button to open the *Unsteady Flow Data* window.
2. Click on the empty field next to the “Outflow” line in the lower portion of the dialog.
3. For this case a stage hydrograph will define the outflow boundary, so click on the **Stage Hydrograph** button to open the *Stage Hydrograph* dialog.
4. Set the *Data time interval* to “4 Hour”.
5. Set the *Time* edit field to “4” hours as well.
6. Enter the value of “271” meters in the first two rows in the *Stage* column in the *Hydrograph Data* table.
7. Click **OK** to close the *Stage Hydrograph* dialog.
8. Click on the empty field next to the “Inflow” line in the lower portion of the *Unsteady Flow Data* dialog.
9. For this case a flow hydrograph will define the inflow boundary, so click on the **Flow Hydrograph** button to open the *Flow Hydrograph* dialog.
10. Set the *Data time interval* to “4 Hour”.
11. Set the *Time* edit field to “4” hours as well.
12. Enter the value of “1000” cubic meters per second in the first two rows in the *Flow* column in the *Hydrograph Data* table.
13. Enter “0.001” for *EG Slope for distributing flow along BC Line*.
14. Click **OK** to close the *Flow Hydrograph* dialog.

15. Select the **Save Unsteady Flow Data** command from the *File* menu.
16. When HEC-RAS prompts, enter “Q100” for the *Title* and click **OK**. HEC-RAS will save a file named Cimarron.u01 to save this unsteady flow data.
17. Close  the *Unsteady Flow Data* dialog.

10 Setting up the Plan

The final step this tutorial will follow to set up the simulation is to define a plan. To do this:


1. Click the  **Perform an unsteady flow simulation** button to open the *Unsteady Flow Analysis* dialog.
2. Turn on the *Geometry Preprocessor*, *Unsteady Flow Simulation*, *Post Processor*, and *Floodplain Mapping* options.
3. Enter “0” hours for the *Starting Time* and enter “4” hours for the *Ending Time*.
4. Set the *Computation Interval* to “30 Second”.
5. Set the *Mapping Output Interval*, the *Hydrograph Output Interval* and the *Detailed Output Interval* options all to “10 Minute”.
6. Select the **Save Plan** command from the *File* menu.
7. When HEC-RAS prompts, enter “Q100” for the *Title* and click **OK**.
8. HEC-RAS will prompt for a short plan Identifier. Enter the name “Q100 Flow Case” and click **OK**.

11 Running the HEC-RAS analysis

The simulation is now ready to run. To do this:


1. Click the **Compute** button to launch the analysis.

At this point HEC-RAS will process the geometry and run the simulation. The *HEC-RAS Computations* dialog will appear to report progress and other notifications. It should take only a few minutes to run the 4 hours simulation


2. Click **Close** when the computations are complete.
3. Close  the *Unsteady Flow Analysis* dialog.

12 Viewing the results

To view the solution:

1. Click the  icon to open the *RAS Mapper* window.
2. Note the items under the “Results” section.
3. Turn on the “Velocity (Max)” dataset.

The inundated area at the active time will be filled with a blue color in the graphic display.

4. In the upper right portion of the window, drag the scroll bar to the right to select 4 hours. Notice the change in the inundated areas.
5. Double-click on the “Velocity” dataset to set the display options the *Layer Properties* dialog.
6. Click in the color ramp to bring up the *Select Surface Fill* dialog.
7. Change the *Max* edit field to “1.5” and click **Create** to redistribute the colors.
8. Click the **Apply** button to close the *Select Surface Fill* dialog.
9. Close  the *Layer Properties* dialog.

The velocity magnitudes will now be clearly visible in the graphic display.

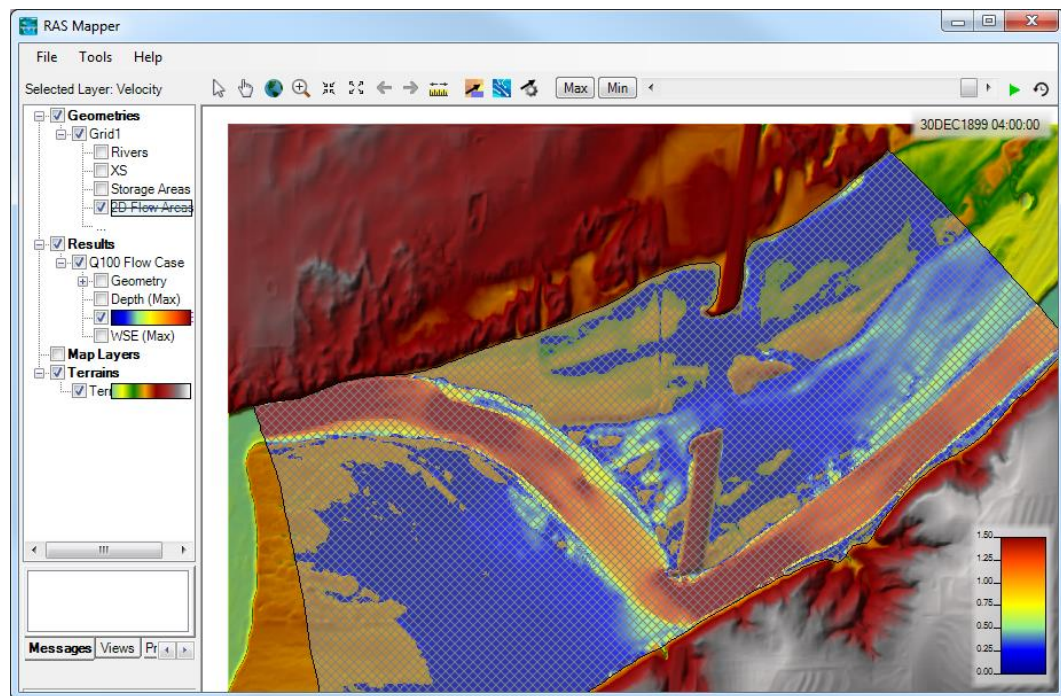


Figure 4 Velocity magnitude dataset

Explore the solution by changing which dataset is displayed and which time step is selected. The buttons at the top also allow for display of vectors.

13 Conclusion

This concludes the “HEC-RAS” tutorial. The tutorial covered:

- Exporting a mesh file from SMS for use in HEC-RAS 2D.
- Running the HEC-RAS translator in SMS to create files for a HEC-RAS 2D project.
- Using HEC-RAS 5.0 with the files prepared in SMS.

If desired, experiment further with the HEC-RAS simulation in SMS. When done, exit the program.