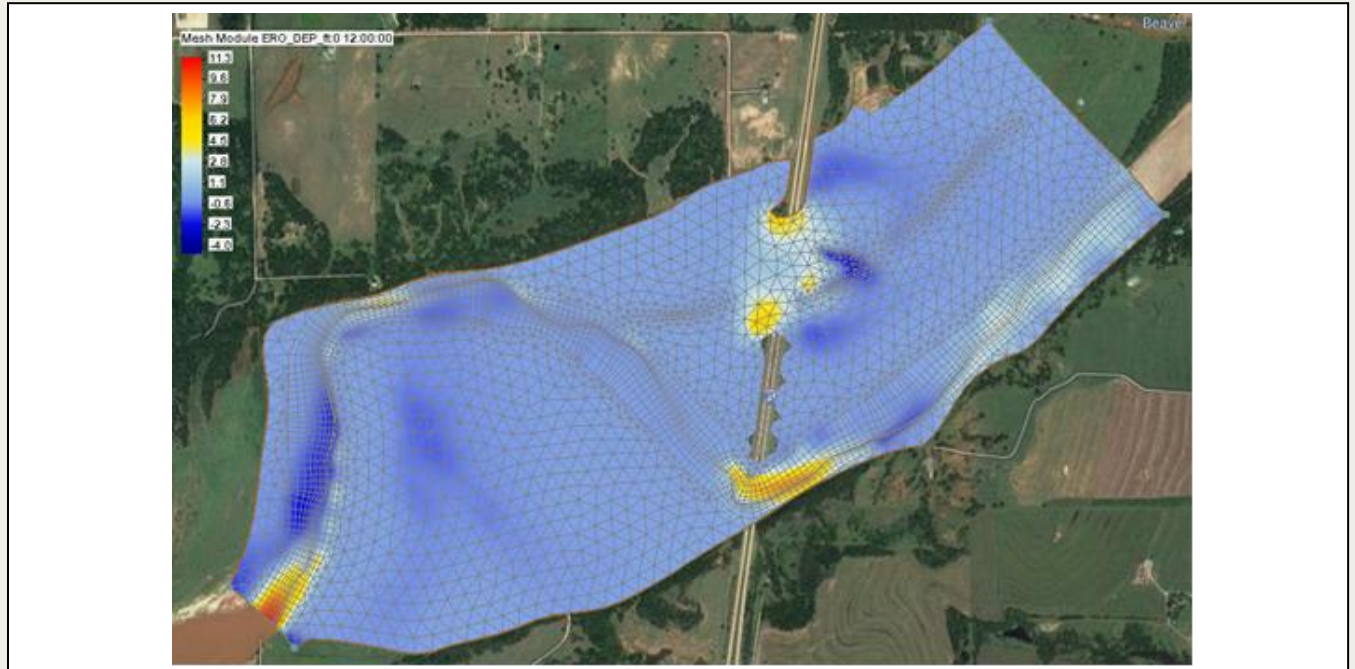


SRH-2D Tutorial

Variable Flow Sediment Transport Modeling

Variable flow sediment transport for SRH-2D simulations



Objectives

This tutorial demonstrates how to perform sediment transport simulations in SRH-2D that use a variable flow boundary condition.

Prerequisite Tutorials

- SRH-2D
- SRH-2D – Sediment Transport

Required Components

- SMS Core
- SRH-2D Model & Interface

Time

- 15–30 minutes
- 4–7 hours model run

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1 Introduction

The Sedimentation and River Hydraulics – Two-Dimensional (SRH-2D) model is a hydraulic, sediment, temperature, and vegetation model for river systems developed by the United States Bureau of Reclamation (USBR) and sponsored by the United States Federal Highway Administration (FHWA).

For this tutorial, a previously developed SRH-2D sediment transport simulation with steady state flow will be modified to include a variable flow in the form of a hydrograph. The primary interest for FHWA is in relation to bridge scour, and SRH-2D sediment transport simulations can be very informative for estimating contraction scour, which is essentially an erosion and sediment transport problem. SRH-2D also provides detailed hydraulic output that can be used to estimate pier and abutment scour potential.

1.1 Background

The Cimarron River example used in the SMS “SRH-2D Sediment Transport” tutorial will be used in this tutorial. If needed, review the “SRH-2D Sediment Transport” tutorial before proceeding with this tutorial.

This tutorial will cover defining parameters and properties for an unsteady flow in a sediment transport model including boundary conditions and other input parameters. This tutorial is for instruction purposes and is not intended as an analysis of actual conditions at this bridge crossing.

2 Getting Started

To start this tutorial:

1. Launch the SMS application.
2. Select *File* | **Open...** to bring up the *Open* dialog.
3. Browse to the file “Sed_Variable_Flow.sms” located in the *data files* folder for this tutorial.
4. Click **Open** to import the project file and close the *Open* dialog.

This file opens the existing steady state sediment transport model as shown in Figure 1. This project will be modified to perform sediment transport with a variable flow hydrograph.

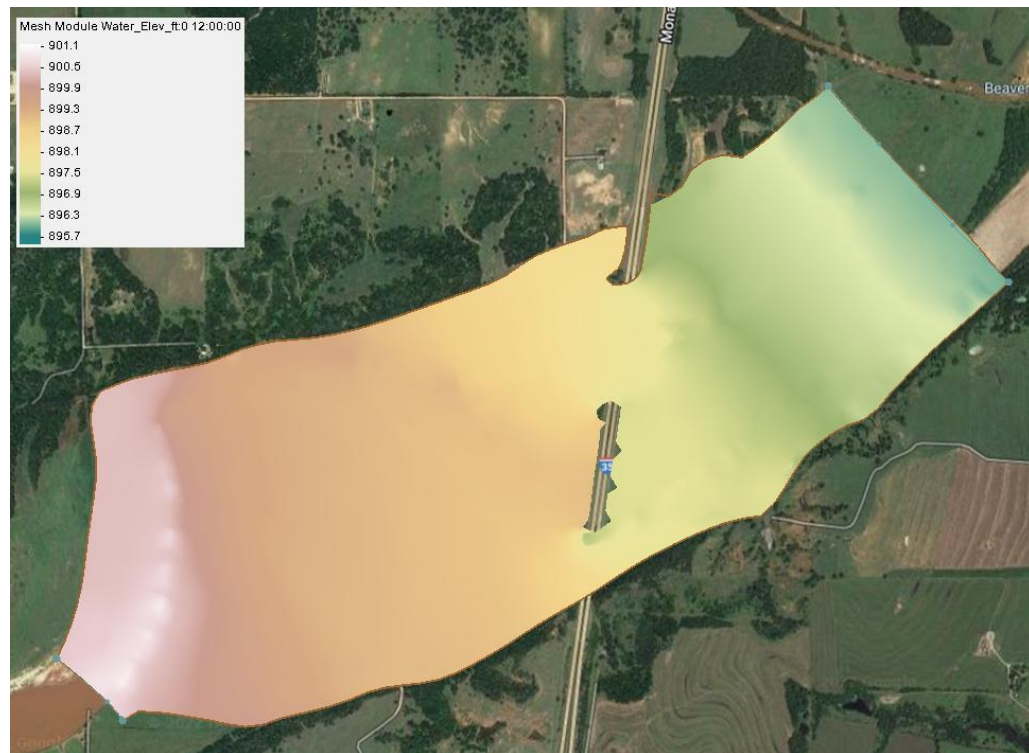


Figure 1 The steady state sediment transport model of the Cimarron River

3 Boundary Conditions

This section outlines the process of setting up an unsteady simulation from the existing steady state simulation. This involves copying the simulation and boundary condition coverages and modifying the parameters of each.

3.1 Creating the Boundary Condition Coverage

The existing boundary condition coverage used in the steady state sediment transport model has most of the parameters defined that will be used in the unsteady state simulation. Therefore, copying the coverage provides a good starting point. To do this:

1. Under the “BC” folder, right-click on the “Base Flow” coverage and select **Duplicate**.

This will create a new coverage named “Base Flow (2)” that can be used to define the boundary conditions.

2. Right-click on the “Base Flow (2)” coverage and select **Rename**.
3. Enter the name “Hydrograph SedRC” for this coverage.

The coverage properties set on the “Base Flow” coverage have now been transferred to the “Hydrograph SedRC” coverage along with all feature objects. The attributes of the feature arcs representing the model boundary conditions do need to change to allow for variable flow.

3.2 Assigning Boundary Conditions

Currently, the boundary conditions arcs have been defined for steady flow. Adding a time series to the upstream boundary and a rating curve to the downstream boundary will create a variable flow.

To assign boundary conditions at the upstream boundary:

1. Under the “BC” folder, ensure that the “Hydrograph SedRC” coverage is on and select it to make it active.
2. Using the **Select Feature Arc** tool, double-click on the arc on the left (upstream) side (Inlet-Q). This will open *SRH2D Assign BC* dialog.
3. Change *Discharge option* to “Time series” and set the units to “hrs -vs- cfs”.
4. Click on the **XY Series...** button to open the *XY Series Editor* dialog.
5. Click **Import...** to bring up an *Open* browser.
6. Navigate to the *data files* folder for this tutorial and select the file named “Inflow_Hydrograph.xls” then click **Open** to import the file data into the editor.
(**Note:** This is an ASCII file containing the definition of the hydrograph. For information on the file format refer to the XMSWiki at: https://www.xmswiki.com/wiki/SMS:XY_Series_Files)

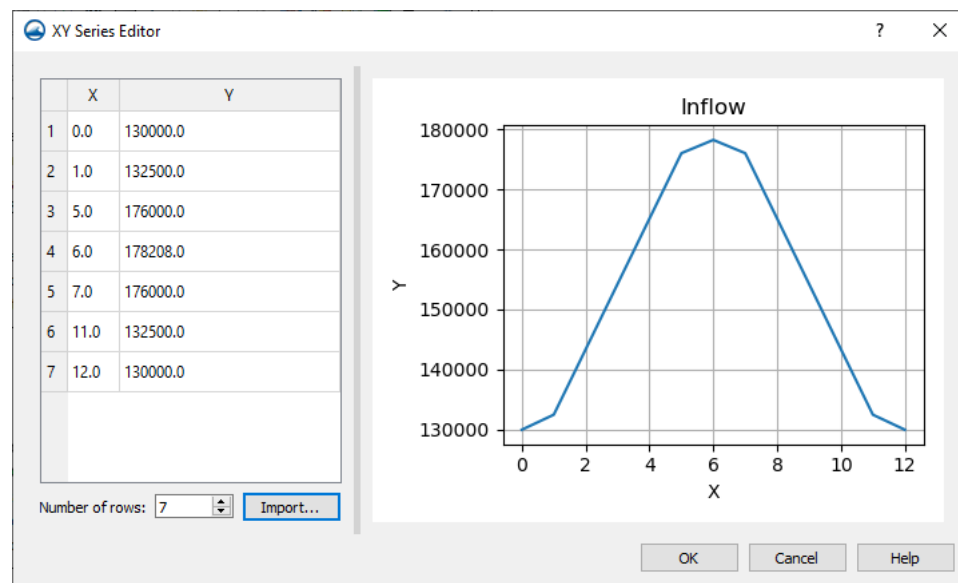


Figure 2 The imported time series in the XY Series Editor

7. Click **OK** to close the *XY Series Editor* dialog.
8. Under *Sediment Discharge Type*, select the “File” option.
9. Click the **Select File...** button to bring up a *Select File* browser.
10. Navigate to the *data files* folder and select the file named “Sed_RC.xls” then click **Open** to import the file.

Note: This is an ASCII file containing the relationship between sediment flow rate (Q_s) for nine different size bins of sediment for varied hydraulic flow rates. For more information on this file, refer to the XMSWiki at https://www.xmswiki.com/wiki/SMS:SRH-2D_Files as well as the SRH-2D documentation.

11. Click **OK** to exit the *SRH2D Assign BC* dialog.

To assign boundary conditions at the downstream boundary:

1. Double-click on the arc on the right (downstream) side (Exit-H) to open *SRH2D Assign BC* dialog.
2. Change the *Water surface (WSE) option* to “Rating curve” and set the units to “cfs -vs- feet”.
3. Click the **XY Series...** button to bring up the *XY Series Editor* dialog.
4. Click on the **Import...** button to bring up an *Open* browser.
5. Navigate to the *data files* folder and select the file named “WSE_RC.xls” then click **Open** to import the file data.

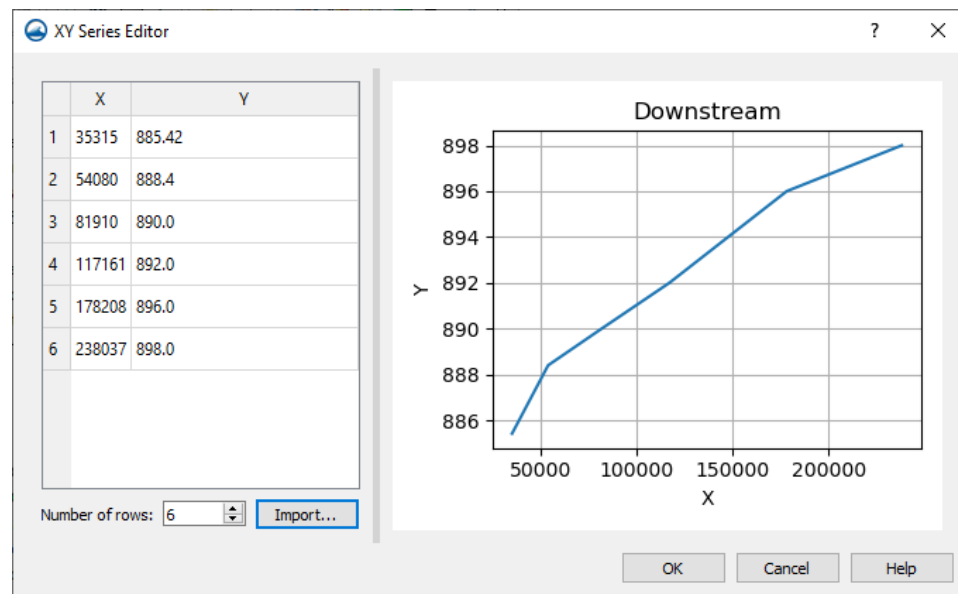


Figure 3 The imported rating curve in the XY Series Editor

6. Click **OK** to close the *XY Series Editor* dialog.
7. Click **OK** to exit the *SRH2D Assign BC* dialog.

4 Defining the SRH-2D Simulation

Many of the properties and components that were used in the “Sed_Steady_State” simulation can be used for the variable flow simulation. To save time, the steady state simulation can be copied and modified for variable flow.

To copy a simulation:

1. Right-click on the “Sed_Steady” simulation and select the **Duplicate** command.

This creates a copy of the simulation with its model parameters and components.

2. Right-click in the “Sed_Steady (2)” simulation and select the **Rename** command.
3. Enter “Hydrograph SedRC” as the new name.

4.1 Linking Components

Most of the components needed for the simulation are already linked since they were copied from the steady state simulation. However, the boundary condition coverage component needs to be changed.

Change the boundary condition component by:

1. Under the  “Hydrograph SedRC” simulation, right-click on the  “Base Flow” and select **Remove**.
2. Under the  “BC” folder, right-click on the  “Hydrograph SedRC” coverage and select the *Apply to | SRH-2D Simulations* → **Hydrograph SedRC** command.

All the necessary components are now linked to the simulation.

4.2 Assigning SRH-2D Parameters

The steady state model parameters were also copied. Most of these parameters will work for the model run, but a few of the parameters must be changed.

To do this:

1. Right-click on the  “Hydrograph SedRC” simulation and select **Model Control...** to bring up the *SRH2D Model Control* dialog.
2. In the *General* tab, change the following:
 - a. Change the *Simulation description* to “Hydrograph sediment transport with sediment rating curve”.
3. Set *Case name* to “Sed_hydrograph”. Click **OK** to close the *SRH2D Model Control* dialog.
4. Save (**Ctrl + S**) the project.

4.3 Running SRH-2D

Running a sediment transport models can be a long process. In this case, it takes around 10 minutes. If desired, this section can be skipped to save time. The solution files have been provided for the next section.

Note: Sediment transport simulations require significant computation power. Any computer system with hardware less than the recommended system for running SMS will not be able to complete an SRH-2D sediment transport simulation.

To run the model:

1. Right-click on the  “Hydrograph SedRC” simulation and select **Save Project, Simulation and Run**.

This command will save the SMS project, export all necessary files for PreSRH-2D, run the preprocessor and then run SRH-2D.

Once the run is complete, SRH-2D will display a completion message.

2. Click **Load Solution** to load the solution into the project.
3. Click **Close** to close the model wrapper.

4.4 Viewing SRH-2D Output

Use the visualization tools within SMS to evaluate the results.

If the model run was skipped to save time, import the solution file by doing the following:

1. Select **File** | **Open...** to bring up the *Open* dialog.
2. Browse to *Solution\Cimarron_Sed_Variable_Flow_models\SRH-2D\Base Hydro* folder for this tutorial and select the “135_XMDF.h5” file.
3. Click **Open** to close the *Open* dialog and import the solutions file.

After the solution has been loaded, select the sediment dataset:

4. Select the “ ERO_DEP_ft” dataset to see the predicted scour/deposition pattern for this simulation. (Note: the contour options are set in a template.) The warmer colors indicate scour. The cooler colors indicate deposition.

See the visualization tools in SMS, as described in the “Data Visualization” tutorial, to evaluate the solution created by the SRH-2D model. You can also refer to the tutorials for display templates.



Figure 4 Erosion at the end of the unsteady flow sediment transport simulation

5 Conclusion

This concludes the “SRH-2D Variable Flow Sediment Transport Modeling”¹ tutorial. This tutorial demonstrated:

¹ This tutorial was developed by Aquaveo, LLC under contract with the Federal Highway Administration.

- Setting an SRH-2D boundary conditions coverage to use variable flow in a sediment transport simulation.
- Defining an SRH-2D simulation for variable flow in a sediment transport simulation.

Continue to experiment with the sediment transport options for SRH-2D in SMS or exit the program.