SMS 14.0 Tutorial

Adaptive Hydraulics (AdH) - Advanced

2D AdH model of the Red River using SMS

Objectives

This tutorial shows how to use the interface for AdH and run the model for a sample application. This example steps through the process of setting up and running a simulation using data from the area of the Red River.

Prerequisite Tutorials

- Overview
- AdH

Required Components

- SMS Core
- AdH Model & Interface

Time

- 15–30 minutes

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1 Introduction

Adaptive Hydraulics (AdH) is a multi-dimensional modeling system for saturated and unsaturated groundwater, overland flow, three-dimensional Navier-Stokes flow, and two-dimensional or three-dimensional shallow water problems. The 2-dimensional (2D) shallow water module of AdH was developed by the Coastal and Hydraulics Laboratory at the Engineer Research and Development Center in Vicksburg, MS. To learn more about the AdH model, visit their website: https://www.erdc.usace.army.mil/Locations/CHL/AdH/

This tutorial will demonstrate how to modify an existing AdH model for more advanced options. The “AdH” tutorial should have been completed before starting this tutorial.

To create an AdH model in SMS, SMS requires a 2D mesh with an elevation dataset, a material coverage and a boundary conditions coverage. The 2D mesh and the arcs for the coverages are provided to minimize time required to run this tutorial. The data used for boundary conditions are included as XYS files.

2 Getting Started

The mesh, coverages, and AdH simulation was created previously and are provided here to save time.

1. If necessary, launch SMS.
2. If SMS is already running, select *File* | **New** to ensure that the program settings are restored to their default state.
3. Select *File* | **Open…** to bring up the *Open* dialog.
4. Browse to the *data files* folder for this tutorial and select “RedRiver-Advanced.sms”.
5. Click **Open** to import the project and exit the *Open* dialog.

The project should appear similar to Figure 1. Before continuing, it is best to save the project under a new name in order to preserve the starting project for future use.

6. Select *File* | **Save As…** to bring up a *Save As* dialog.
7. Enter the *File name* “RedRiver-Adaption.sms” and click **Save** to close the *Save As* dialog.

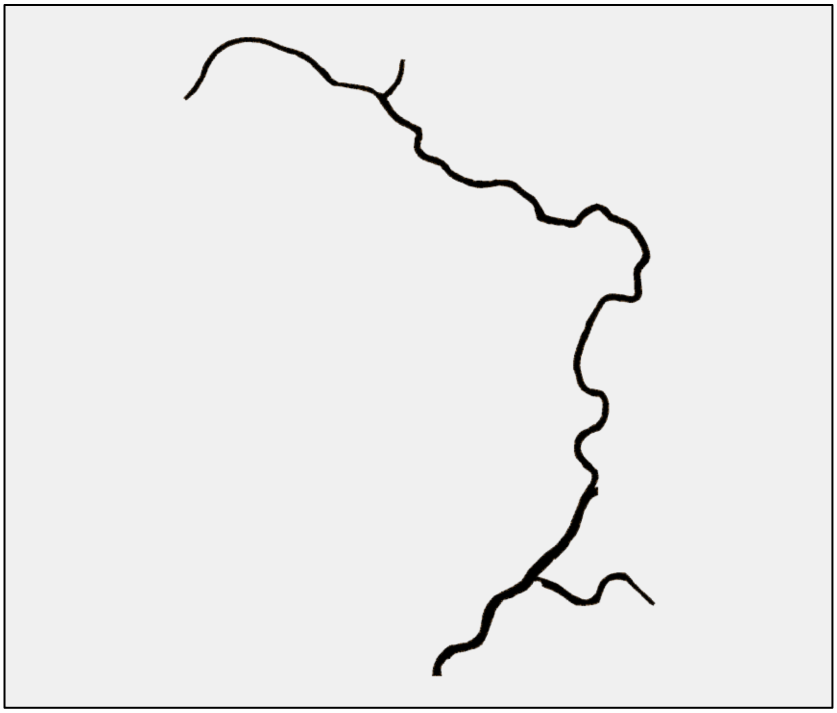

Figure 1 Initial project

3 Transport

AdH contains the ability to model transport of contaminate.

1. Right-click on an empty space in the Project Explorer, select *New AdH component* | **Transport Constituents**.
2. Right-click on the " Transport Constituents" component and select **Constituents** to open the *Transport Constituents* dialog.
3. Under the *User defined constituents* section, click the **Add row** button.
4. Change the *Concentration* of the constituent to "1.0".
5. Click **OK** to close the *Transport Constituents* dialog.
6. Select the " Red River Boundary Conditions" coverage to make it active.

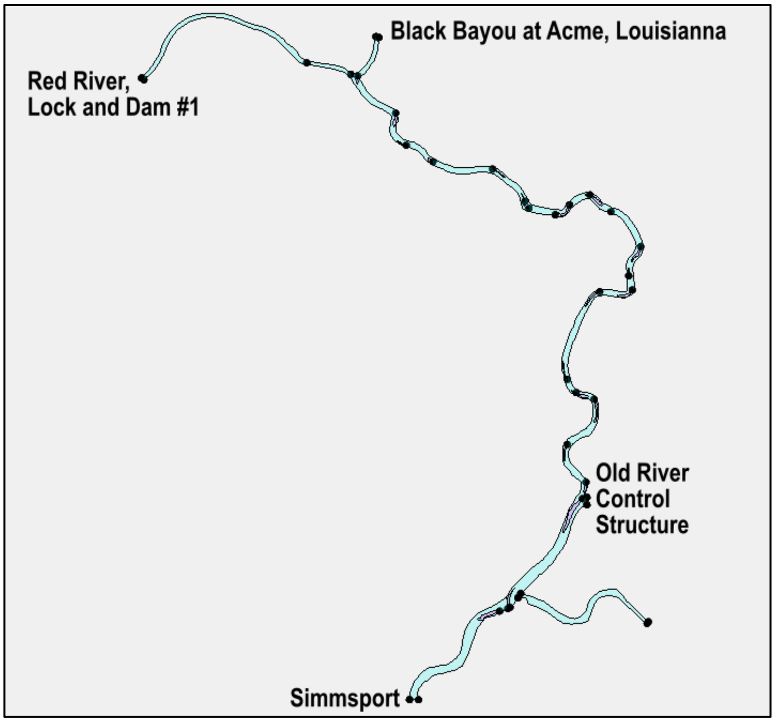

Figure 2: Boundary Condition arcs with locations labeled

7. Navigate to the label Old River Control Structure shown in Figure 2, then using the **Select Feature Arc** tool, select the closest arc.
8. Right-click and select **Assign Arc Transport** to open the *Arc Transport Constituents* dialog.
9. Turn on the *Transport constituents* option.
10. Click the **Select…** next to *Transport constituents* to open the *Select Transport Constituents* dialog.
11. Select the " Transport Constituents" component and click **OK** to close the *Select Transport Constituents* dialog.
12. Change the *Type* to "Natural".
13. Click **Edit Curves**… to open the *XY Series Editor*.
14. Change the *Number of rows* to "2".
15. Enter the following table:

0.0	50.0
8647000.0	50.0

16. Click **OK** to close the *XY Series Editor*.
17. Click **OK** to close the *Arc Transport Constituents* dialog.

3.1 Adding Adaption

Adaptive Hydraulics (AdH) can adapt the mesh for the model. Start with adjusting the material 1, which is set to the shallower areas of the channel, to adapt the mesh.

1. Turn on and right-click on the " Red River Materials" coverage and select **Material List and Properties** to bring the *Material List and Properties* dialog.
2. Turn on the *Transport constituents* option.
3. Under *Transport constituents*, click the **Select** button to open the *Select Transport Constituent* dialog.
4. Select the " Transport Constituents" component and click **OK** to close the *Select Transport Constituents* dialog.
5. Select "Material 1".
6. In the *Transport* tab, change the *Refinement Tolerance* for the *Constituent* to "1000.0".
7. In the *General* tab, change the *Refinement tolerance* to "10000.0".
8. Change the *Max refinement level* to "4".
9. Click **OK** to close the *Material List and Properties* dialog.

Next update the model control to output the adapted mesh.

10. Right-click on the " Red River" simulation and select **Model Control** to bring up the *Model Control* dialog.
11. Select the *Output* tab.
12. Turn on the *Print adaptive mesh* option.
13. Click **OK** to close the *Model Control* dialog.

3.2 Run Model and Review Results

1. Right-click on the " RedRiver" simulation and select **Save Project, Simulation, and Run** to open the *Simulation Run Queue* dialog
2. If a *Model Checker* dialog appears, there was a mistake in setting up the model. Fix the errors shown in the *Model Checker* dialog, save and run the model again.

If using a standard installation of SMS, the model should launch immediately. If SMS cannot find the executables, a message will be displayed asking to locate the Pre-AdH executable and then the AdH executable.

This simulation may take several minutes to run, depending on the speed of the computer being used. If it takes more than an hour, then it is likely that there was a mistake in the model and it is not converging. Please review the tutorial and model to ensure that each step was followed.

3. After the model run is complete, click the **Load solution** button and close the *Simulation Run Queue*.
4. Select the " Concentration 1" dataset to view the resulting calculated concentration levels.

Move around the model and through the time steps to see how the concentration levels change across location and time.

4 Vorticity

Vorticity calculations will model helical flow around bends which has important consequences for velocity distribution and sediment transport. Continue using the transport model and include vorticity by doing the following:

1. Right-click on the " Transport Constituents" component and select **Constituents** to open the *Transport Constituents* dialog.
2. Turn on the *Vorticity* option.
3. Click **OK** to close the *Transport Constituents* dialog.
4. Right-click on the " Red River Materials" coverage and select **Material List and Properties** to bring the *Material List and Properties* dialog.
5. Select "Material 1".
6. In the *Transport* tab, change the *Refinement Tolerance* for the *Vorticity* to "10000.0".
7. Click **OK** to close the *Material List and Properties* dialog.
8. Right-click on the " Red River" simulation and select **Model Control** to bring up the *Model Control* dialog.
9. Select the *Output* tab.
10. Turn off the *Print adaptive mesh* option.
11. Click **OK** to close the *Model Control* dialog.

4.1 Run Model and Review results

1. Right-click on the " RedRiver" simulation and select **Save Project, Simulation, and Run** to open the *Simulation Run Queue* dialog.
2. Click **OK** if a message appears stating the solution files will be unloaded.
3. If a *Model Checker* dialog appears, there was a mistake in setting up the model. Fix the errors shown in the *Model Checker* dialog, save and run the model again.

This simulation may take several minutes to run, depending on the speed of the computer being used. If it takes more than an hour, then it is likely that there was a mistake in the model and it is not converging. Please review the tutorial and model to ensure that each step was followed.

4. After the model run is complete, click the **Load solution** button and close the *Simulation Run Queue*.
5. Select the " Concentration 1" dataset to view the resulting calculated concentration levels.

Move around the model and through the time steps to see how the concentration levels change across location and time.

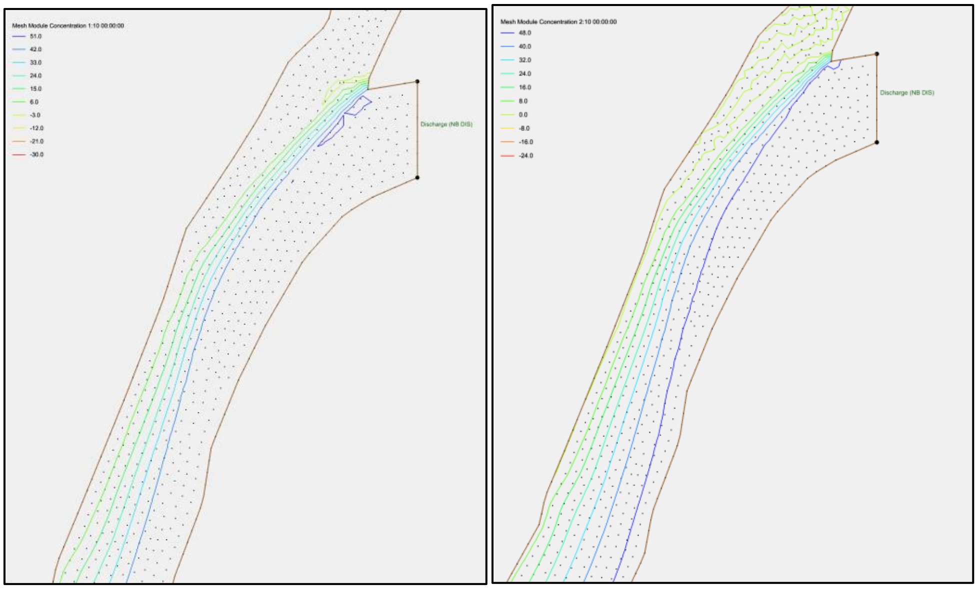

Figure 3: constituent dataset comparison. Image on the right shows constituent calculations with vorticity enabled.

5 Wind

AdH can model wind stresses on the water column based on wind speed and stress.

Multiple wind stations can be included in the boundary conditions file inside or outside of the model domain. Each node will use distance between wind stations to determine the local influence of each wind station.

1. Select *File* | **Save As…** to bring up a *Save As* dialog.
2. Enter the *File name* “RedRiver-Wind.sms” and click **Save** to close the *Save As* dialog

5.1 Define Wind Station Data

Now to define the wind station in the Boundary condition:

1. Select the “ Red River Boundary Conditions” coverage to make it active.
2. **Zoom** in on the location shown in Figure 4.
3. Using the **Create Feature Point** tool, create a new node at the location shown in Figure 4.

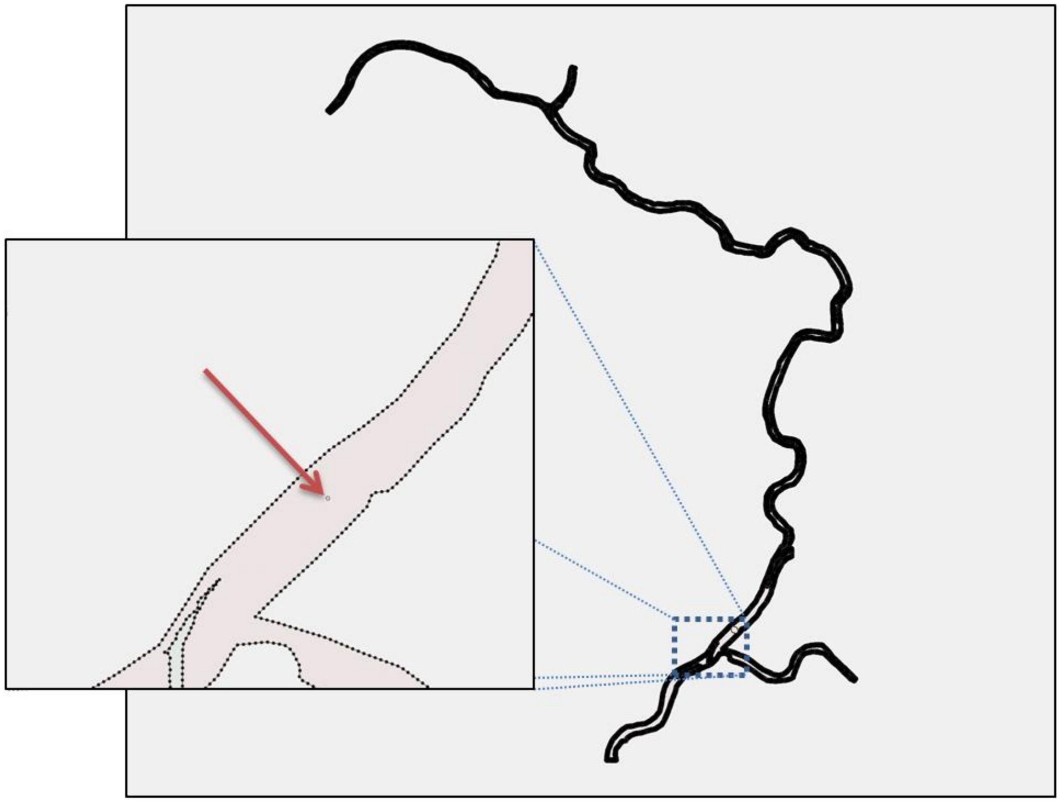

Figure 4: Wind Station location

4. Using the **Select Feature Point** tool, select the newly created point then right-click and select **Assign Point Attributes** to open the *Point Attributes* dialog.
5. Change the *Point type* to "Wind Definition (OP WND)".
6. Click **Edit…** next to *Wind* to open the *XY Series Editor*.

The wind station data is defined in a three column table. The first column is the time step, the second column is the x-component of the wind speed, and the third column is the y-component of the wind speed.

The wind station used in this demonstration is artificial and uniform to demonstrate the activity of wind in the calculations and is not meant to represent a model of the natural environment.

7. Outside of SMS, use a spreadsheet application to open the "wind.csv" file included in *data files* for this tutorial.
8. Copy the contents of the three columns in the "wind.csv" file.
9. Paste the wind data into the *XY Series Editor.*
10. Click **OK** to close the *XY Series Editor*.
11. Click **OK** to close the *Point Attributes* dialog.
12. Right-click on the " RedRiver" simulation and select **Model Control…** to open the *Model Control* dialog.
13. Select the *Operation* tab and turn on *Wind.*
14. Click **OK** to close the *Model Control* dialog.

15. Right-click on the "Red River Materials" coverage and select **Material List and Properties** to open the *Material List and Properties* dialog.
16. Select *Material 1* and turn on the *Wind properties* option.
17. Change the *Stress formulation* to "1 – Wu".
18. Select *Material 2* and turn on the *Wind properties* option.
19. Change the *Stress formulation* to "1 – Wu".
20. Click **OK** to close the *Material List and Properties* dialog.

5.2 Run Model and Review Results

1. Right-click on the " RedRiver" simulation and select **Save Project, Simulation, and Run** to open the *Simulation Run Queue* dialog.
2. Click **Yes** if asked to renumber the boundary conditions.
3. Click **OK** if a message appears stating the solution files will be unloaded.

If a *Model Checker* dialog appears, there was a mistake in setting up the model. Fix the errors shown in the *Model Checker* dialog, save and run the model again.

This simulation may take several minutes to run, depending on the speed of the computer being used. If it takes more than an hour, then it is likely that there was a mistake in the model and it is not converging. Please review the tutorial and model to ensure that each step was followed.

4. After the model run is complete, click the **Load solution** button and close the run simulation queue.

Reviewing the results is the same as the last examples; choose a dataset and time step.

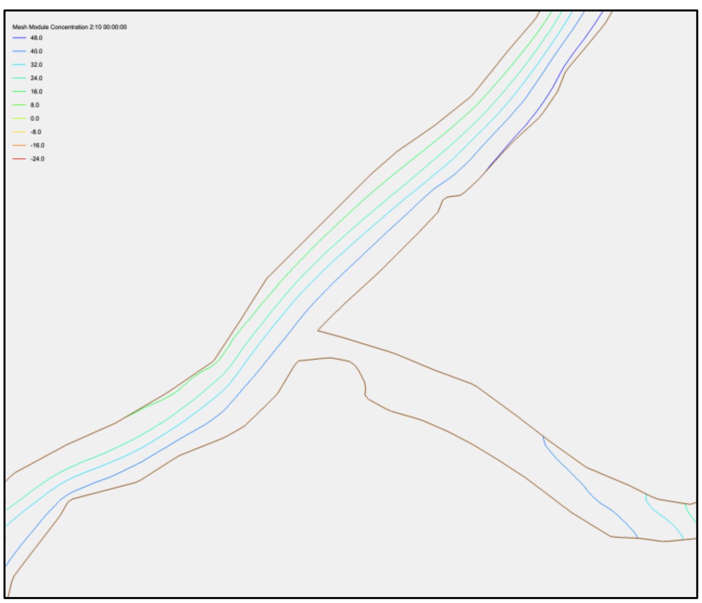

Figure 5: Computed concentration levels without wind effects.

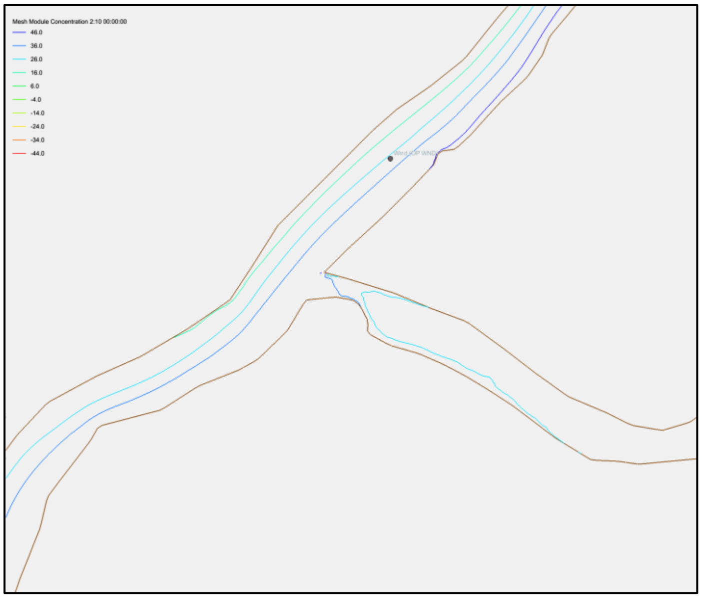

Figure 6: Computed concentration levels with wind effects.

6 Conclusion

This concludes the AdH tutorial. Feel free to continue experimenting with the SMS interface or exit the program.

