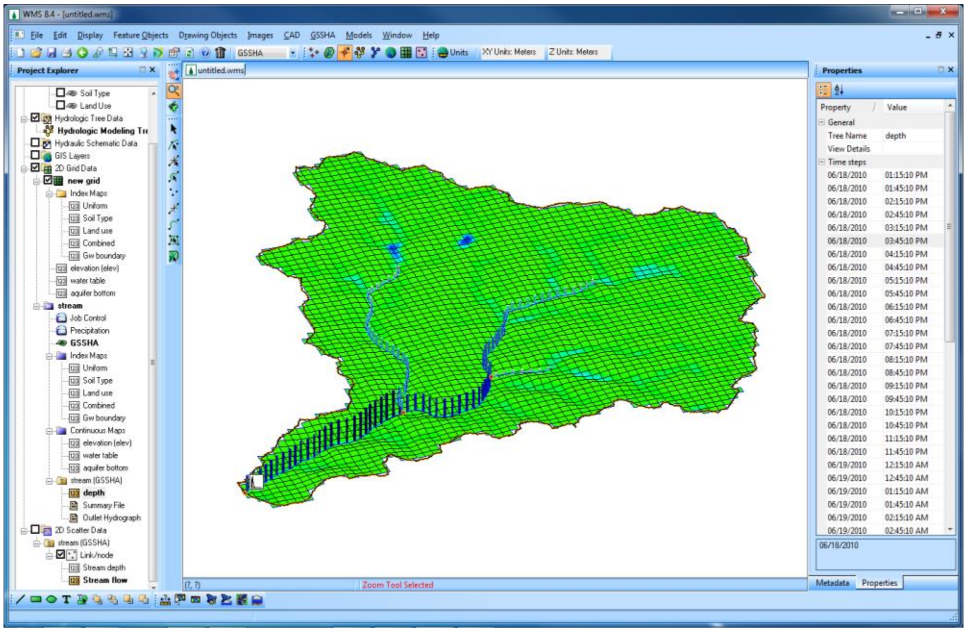
WMS

v. 10.0

WMS 10.0 Tutorial

GSSHA – Applications – Simulating Sediment Transport

Model sediment transport in GSSHA



Objectives

Develop input parameters for and run a long-term model that simulates sediment transport impacts based on proposed land use changes.

Prerequisite Tutorials

- GSSHA – Applications – Long Term Simulations in GSSHA

Required Components

- Data
- Drainage
- Map
- Hydrology
- 2D Grid
- GSSHA

Time

- 30-45 minutes

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1 Contents

2 Introduction

In this workshop, you will learn how to develop inputs for a sediment transport simulation using GSSHA. You will begin with an existing GSSHA model. Some ski resorts are located in the Park City, Utah watershed. You will simulate a scenario where some of the forested hill slope is cleared to develop ski runs. This clearing results in increased erosion and deposition. The GSSHA model you will start with is setup to run a long term simulation.

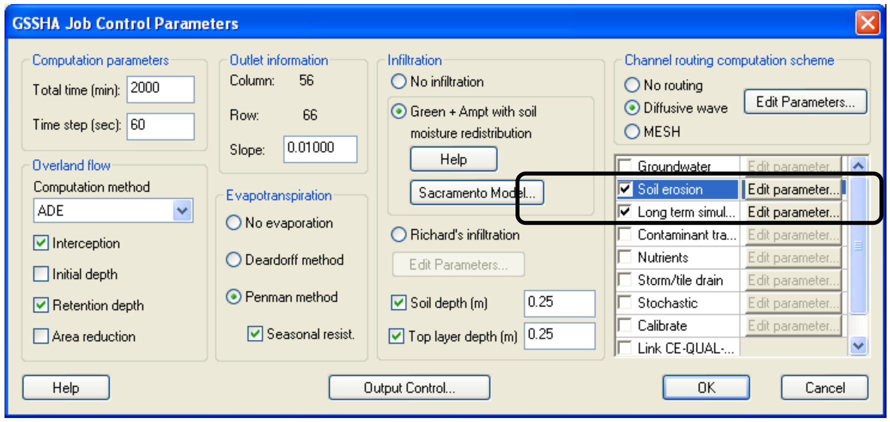
3 Open an Existing GSSHA Project

Open the GSSHA model for Park City watershed:

1. Start a new instance of WMS.
2. In the 2D Grid Module, select **GSSHA | Open Project File.**
3. Locate the ***GSSHA Distributed Hydrologic modeling*** folder in the files for this tutorial. If needed, download the tutorial files from www.aquaveo.com.
4. Browse and open ***\GSSHA Distributed Hydrologic modeling\Sediment\Base.prj***
5. Save the project as ***\GSSHA Distributed Hydrologic modeling\Personal\Sediment\sed.prj***

3.1 Turning Soil Erosion on and adding sediment

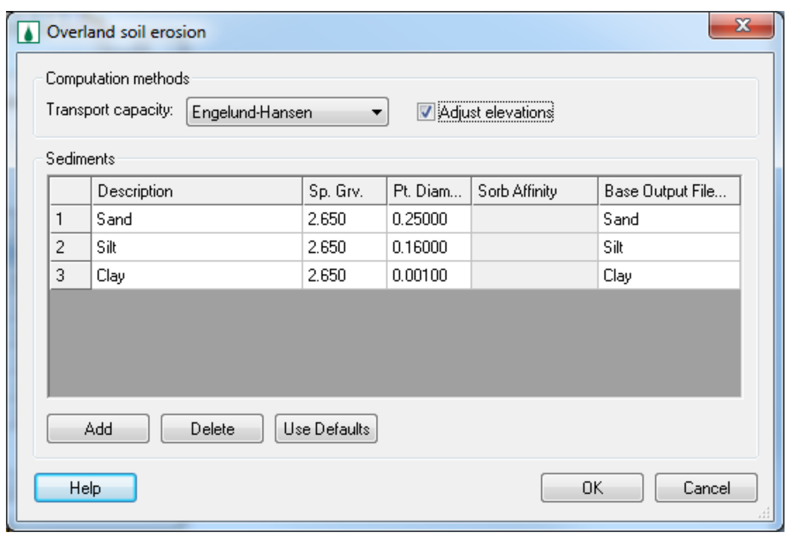
1. In the 2D Grid Module select ***GSSHA| Job Control...***
2. Click on the ***Soil erosion*** option to turn it on
3. Click the *Edit parameter...* button next to the soil erosion spreadsheet option



4. In the *Overland Soil Erosion* dialog, select *Kilinc-Richardson* for Transport capacity.
5. Although you can specify as many sediment particle sizes as you desire, typically three sediment sizes are used to describe the soils – sand, silt, and clay. Click the *Add* button three times to add three sediments
6. Fill in the Sediments spreadsheet with values from the following table:

ID	Description	Sp. Gr.	Particle Diameter (mm)	Base output file name
1	Sand	2.65	0.25	Sand
2	Silt	2.65	0.16	Silt
3	Clay	2.65	0.001	Clay

7. Select the option to *adjust the elevation* by checking the toggle. If this option is turned on, GSSHA will create an adjusted elevation map based on erosion and deposition which can be compared with the original elevation map to find out the areas of erosion and deposition.



8. Click OK to close the *Overland Soil Erosion* dialog
9. In the *Job Control* dialog, click on *Edit Parameters...* button in the *Channel routing computation scheme* portion (top right corner).

10. Make sure the *Sediment porosity* is set to 0.4, the *Water temperature* at 20.0 deg C, and the *Sand size* at 0.25 mm.
11. Click OK to close the *GSSHA Channel Routing Parameters* dialog
12. Click OK to close the GSSHA *Job Control* dialog

3.2 Specifying Soil Erosion Parameters

Now you will specify the properties of the soils in the watershed related to soil erosion. We will use an index map that has new ski tracks to define these parameters.

3.3 Assigning an Index Map

There is an index map already prepared for you which shows the location of new ski tracks being developed. We will need to assign this index map to the current GSSHA model

1. In the project explorer, find *Sed* GSSHA model.
2. Right click *Index Maps* folder under *Sed* GSSHA model and assign *SkiTracks.*

3.4 Defining Erosion Parameters

1. In the 2D Grid Module select ***GSSHA | Map Tables...***
2. Click on the *Soil Erosion* tab.
3. In the *Using index map* combo box, select *SkiTracks* as the index map
4. Click *Generate IDs.* You should see four different Ids among which the last column with Id 100 represents the new ski tracks which we are assuming is highly susceptible to erosion.

ID	13	14	15	100
Description 1				
Description 2				
Coefficient for detachment by rainfall (1/J)	10.8	20.5	18.5	20.5
Rill erodibility coefficient (s/m)	0.0004	0.0004	0.0004	0.0004
Rill erodibility exponent (dimensionless)	0.65	0.65	0.65	0.65
Critical rill detachment (Pa)	0.1	0.1	0.1	0.1
Erodibility coefficient (dimensionless)	0.12	0.11	0.13	0.11
Sand	0.65	0.45	0.2	0.34
Silt	0.2	0.35	0.65	0.33
Clay	0.15	0.2	0.15	0.33

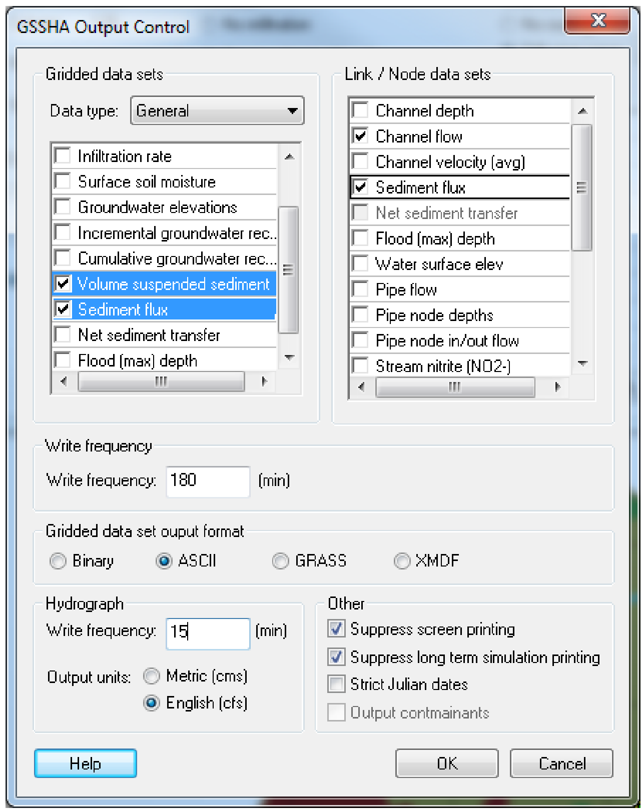
5. Fill in the spreadsheet with values from the following table (Since it is a lot of information to enter manually, there is an Excel spreadsheet that already has these numbers. Outside of WMS browse and open file ***\GSSHA Distributed Hydrologic modeling\Sediment\ErosionParams.xls***. Copy the data from this spreadsheet and paste into the Erosion tab in the Map table dialog).

Normally you will not change most of these basic parameters. For the Kilinc-Richardson the key parameters are the fractions of each sediment size and the erodibility coefficient.

6. Click *Done* to close the GSSHA Map Table Editor

3.5 Specify the output parameters

1. In ***GSSHA| Job Control***, click on *Output Control* button.
2. Under *Gridded Data sets*, turn on *Volume suspended sediment* and *Sediment Flux*.
3. Similarly, under *Link\Node data sets*, select *Sediment Flux.*
4. Set the *Gridded data set output format* to *ASCII* if it is not selected by default.



5. Click OK and OK again.

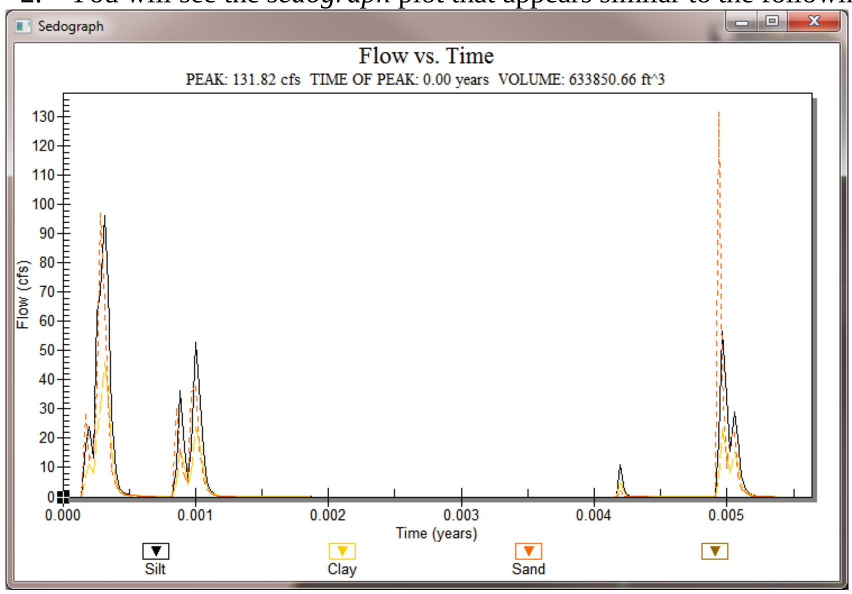
3.6 Save and Run the Model

1. In the 2D Grid Module select ***GSSHA | Save Project File...***
2. Save it as ***\GSSHA Distributed Hydrologic modeling\Personal\Sediment\sed.prj***
3. In the 2D Grid Module select ***GSSHA | Run GSSHA...***
4. Once the model is done running, click Close to read in the solution.
5. You may visualize different solution outputs.

3.7 Visualizing the results

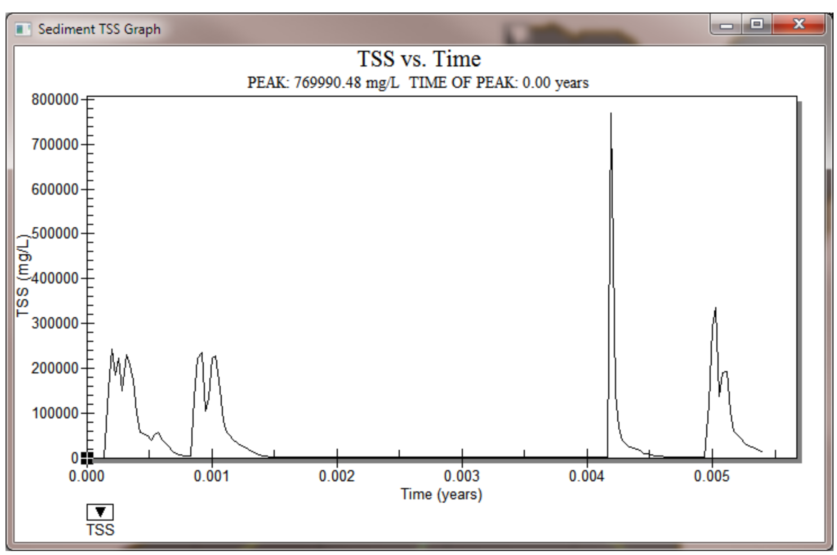
Visualizing Outlet Sediment Graph

1. In the project explorer, find the solution folder for *sed* GSSHA project and right click *Outlet Sediment Graph.* Select *View Graph.*
2. You will see the *sedograph* plot that appears similar to the following plot.



Visualizing the TSS plot

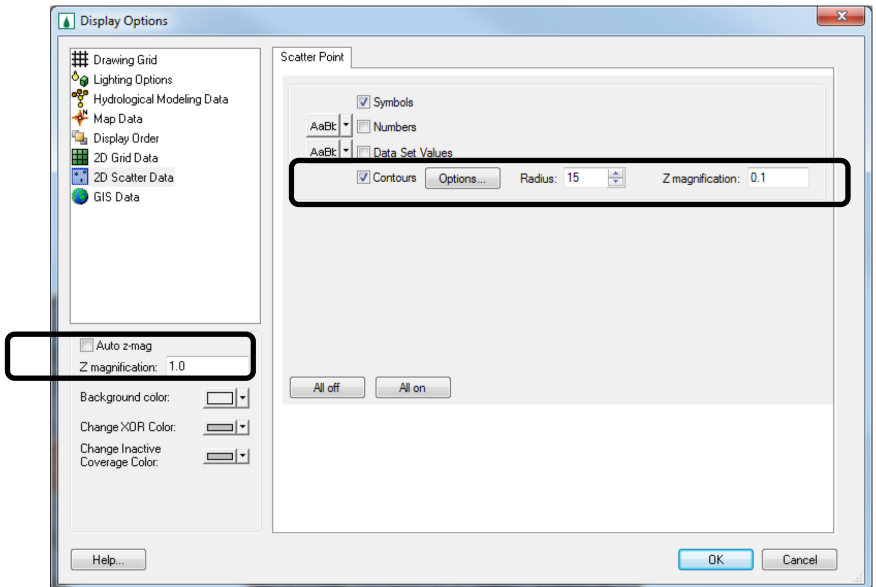
1. GSSHA generates the TSS plot as well. To see the TSS plot at the watershed outlet, right click *Outlet Sediment TSS Graph.* Select *View Graph.*
2. You will see the TSS plot that appears similar to the following plot.



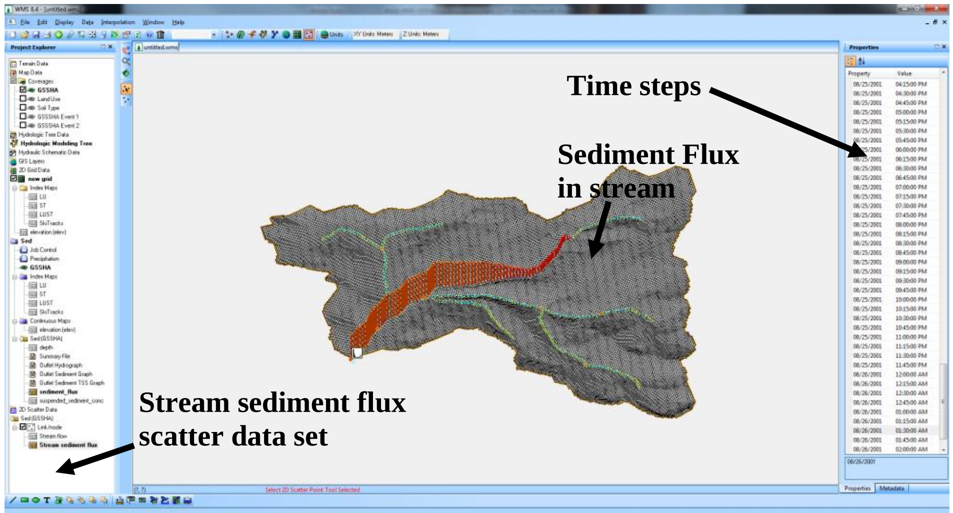
Visualizing Sediment flux in the channel

To visualize the sediment motion in the channel network follow these steps:

1. Select ***Display|Display Options.***
2. Select *2D Scatter Data* and click on the check box for the Contours.
3. Click the *Options* button select *Color Fill* for *Contour Method*. Click OK
4. Enter Radius of 15 and Z-magnification of 0.1.
5. Similarly on the left side of the dialog, there is another place to enter Z-magnification. Uncheck the *Auto z-mag* box and change the value to be 1.0.
6. Click OK.

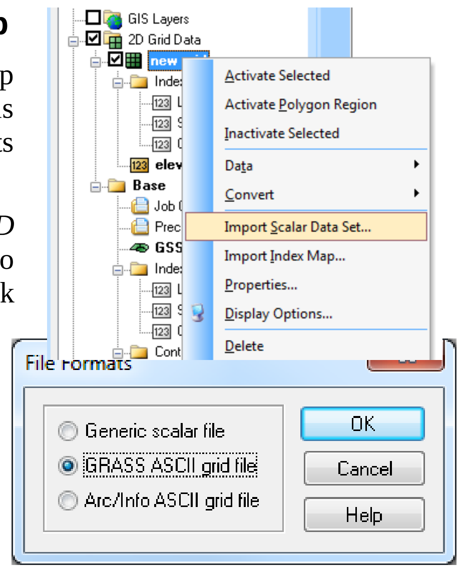


1. In *2D Grid Module,* select Rotate button  and rotate the watershed as shown in the following figure.
2. In the project explorer, under the *2D Scatter Data* folder, click on *Stream sediment flux* and toggle through the time steps as seen in the properties window. Most of the sediment fluxes are associated with the runoff events, so you should expect to see something whenever there a storm or whenever you see a considerable peak in the outflow hydrograph.



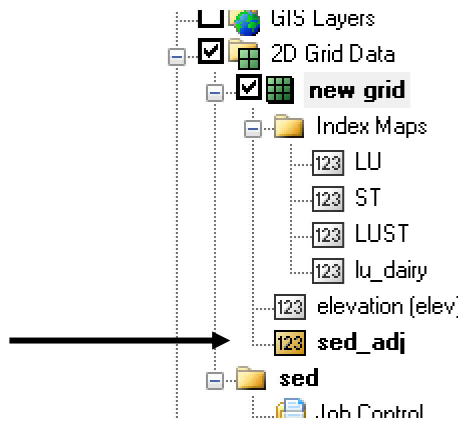
3. These animations can be exported as Google Earth animation. This is optional step and you may export .kmz animation if you want.

Visualizing Erosion and Deposition Map

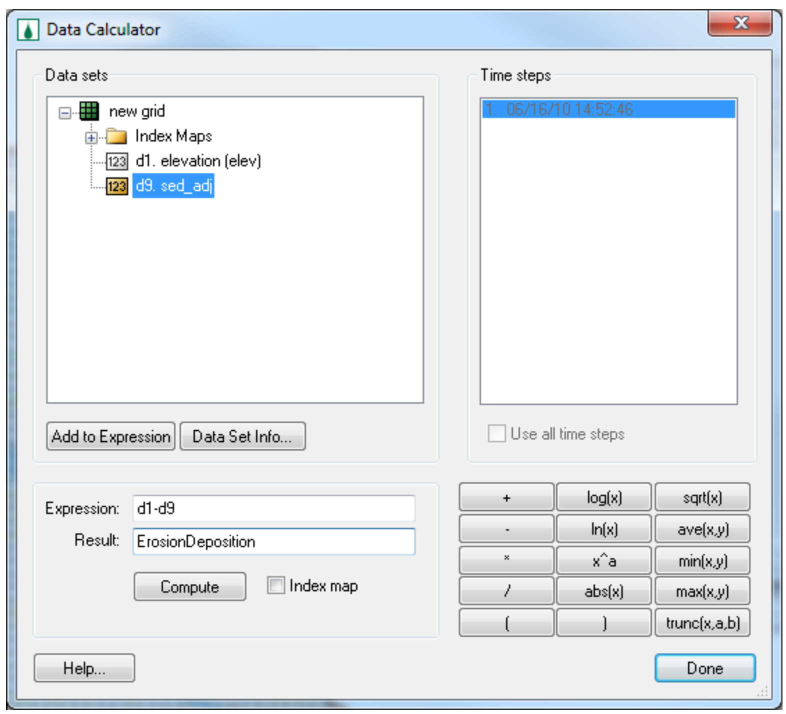


GSSHA has produced an adjusted elevation map based on erosion and deposition while this map is not loaded into WMS by default when the results are read it can be loaded manually.

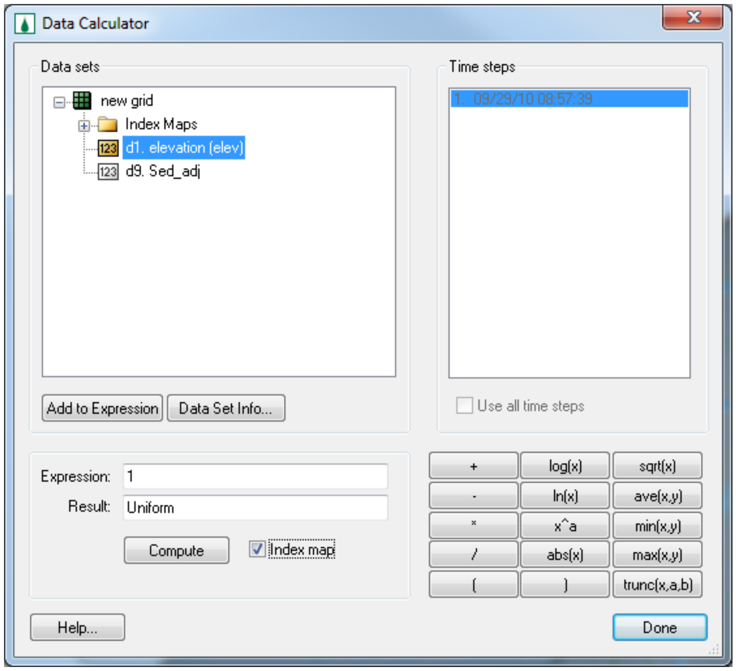
1. In the project explorer, under *2D Grid Data* you should be able to find *new grid* 2D grid. Right click on this *new grid* and select *Import Scalar Data Set.* See the following figure.
2. In the pop up window, select *GRASS ASCII grid file* and click OK.
3. Browse and open ***\GSSHA Distributed Hydrologic modeling\Personal\Sediment\sed_adj.ele.*** You might need to change the file type filer to *All files (*.*)*
4. You can now see the Adjusted Elevation data added in the data tree.



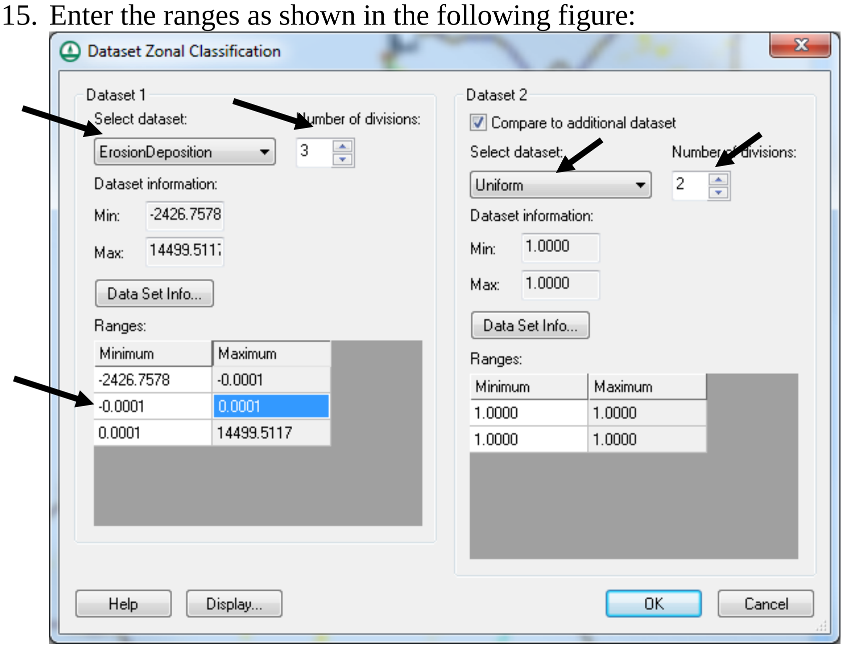
5. Select ***Data|Data Calculator...***
6. Double click *sed_adj* which will put a symbol in the *Expression* field. Type or click '-' (minus) and double click on *elevation (elev).* Then multiply the difference by 10000. We just want to exaggerate the values for better visualization.
   The formula is *(sed_adj - elevation)*10000*
7. Enter *ErosionDeposition* in the *Result* field.



8. Click *Compute* (DO NOT select Index map toggle)
9. We will use a *Uniform* index map to compare the *ErosionDeposition* map. To create a uniform index map, enter 1 in the expression field and type *Uniform* in the *Result* field. Toggle *Index map* option ON. Then click *Compute*. See the following figure.

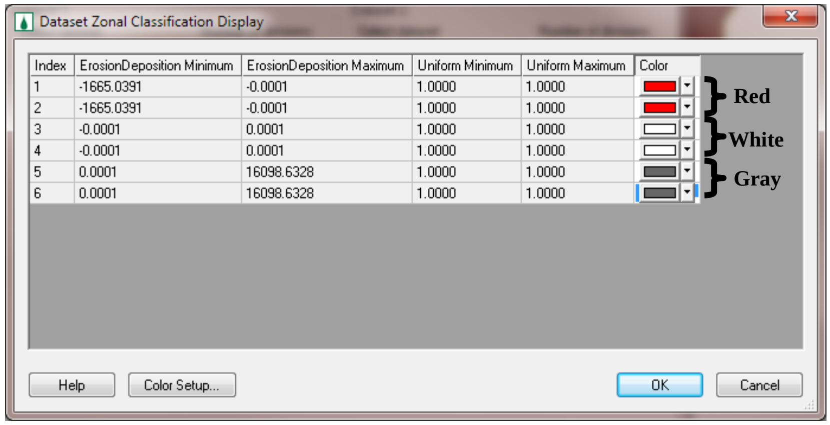


10. Click *Done* to close the data calculator.
11. You should have seen a new continuous map and an index map under *2D grid data*.
12. You will now use zonal classification tool. In 2D grid module, select ***Data|Dataset zonal classification…***
13. Select *ErosionDeposition* as Dataset 1, toggle *Compare to additional dataset* ON, and select *Uniform* as Dataset 2.
14. Change the *number of divisions* for dataset 1 to be 3 and for dataset 2 to be 2.
15. Enter the ranges as shown in the following figure:



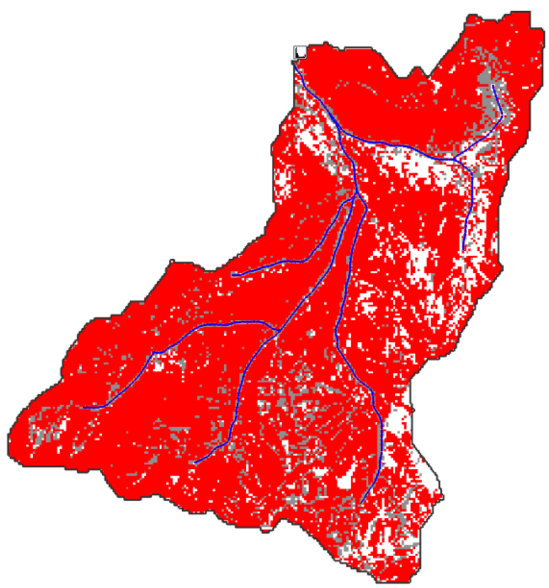
16. Once done defining these values, click *Display* button.
17. Change the color as follows:

    First two rows - Red
    Middle two rows - White
    Last two rows - Gray



Index	ErosionDeposition Minimum	ErosionDeposition Maximum	Uniform Minimum	Uniform Maximum	Color
1	-1665.0391	-0.0001	1.0000	1.0000	
2	-1665.0391	-0.0001	1.0000	1.0000	
3	-0.0001	0.0001	1.0000	1.0000	
4	-0.0001	0.0001	1.0000	1.0000	
5	0.0001	16098.6328	1.0000	1.0000	
6	0.0001	16098.6328	1.0000	1.0000	

18. Click OK and OK again. You will then see an index map that shows the areas of erosion and deposition.
19. The cells filled red are the cells where erosion has occurred, the white cells are the ones where there was no change and the gray cells are where the deposition occurred.



Summary File

Double click on the summary file in the data tree to open it up. If you scroll down the file,

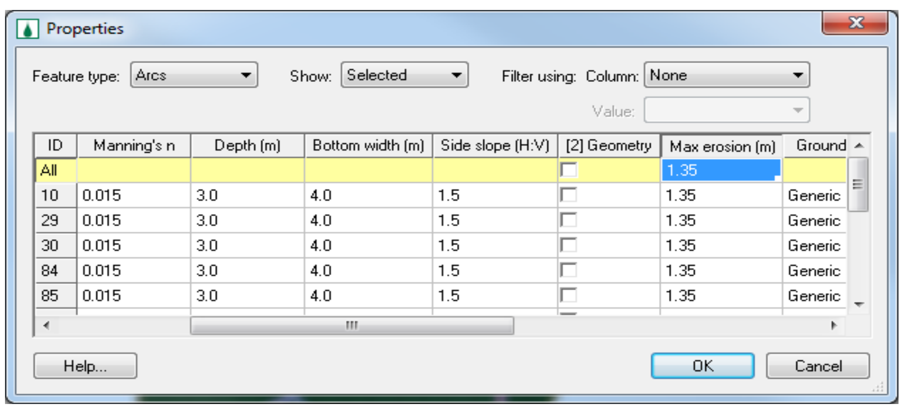
- You can see the volume of each sediment 1, sediment 2 or sediment 3 (Sand, silt and clay) that eroded from the surface.

- Similarly, you can see how much of the eroded sediment actually reached the stream.
- You should have seen how of the eroded sediment actually made to the stream.
- Notice that the initial volume of sand in the channel is zero. It is because, in this exercise we did not allow the channel to erode. In reality the channel beds also erode and the following section shows how you include channel erosion.

3.8 Updating Channel Erodibility Parameters

In the previous exercise, we did not allow the channels to erode. Now you will turn the channel erosion option on and rerun the model.

1. Click on *Plan View* macro to zoom to the full extent of the watershed in a plan view.
2. In the *Map Module*, click on *Select feature line branch* tool and double click on the stream arc just upstream of the watershed outlet.
3. In the *Channel Properties* dialog that opens, scroll to the right to find *Max Erosion (m)* column.
4. Enter a value of 1.35 for all the channels which is the maximum erosion depth for the channels.
5. Click OK.



6. In the *2d Grid Module* save the project as ***\GSSHA Distributed Hydrologic modeling\Sediment\SedStrErosion.prj***
7. Run the project.
8. Repeat the visualization you did in section 3.7 of this tutorial and see the differences in stream sediment flux.

Summary File

You can open the Summary file and see how much sediment is eroding, how much of it is getting into the channel and ultimately got out of the watershed. You can also see the mass balance errors if any.

