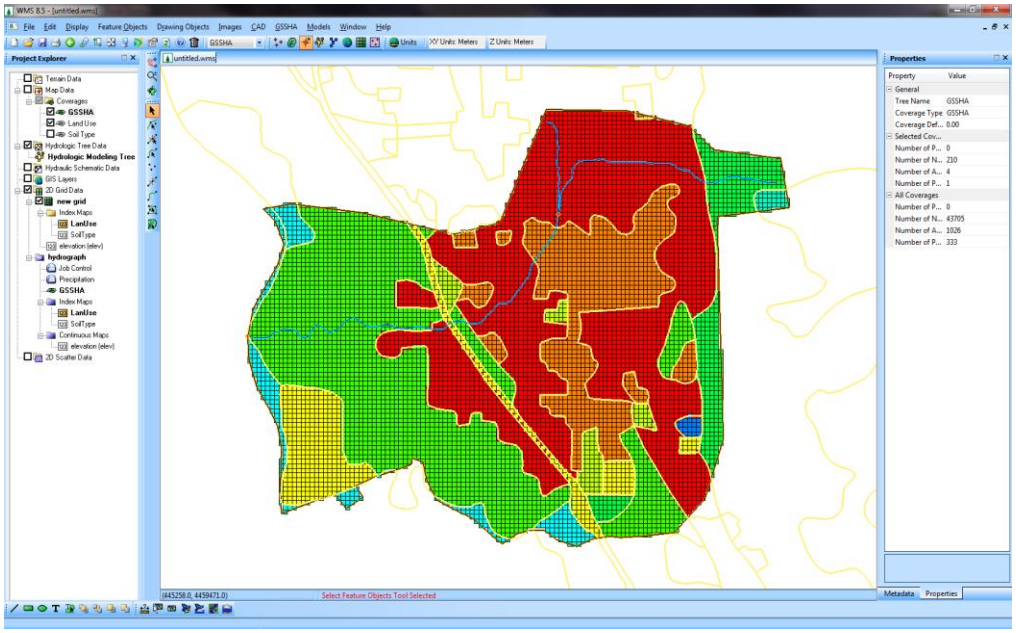
WMS

v. 10.1

WMS 10.1 Tutorial

GSSHA – WMS Basics – Creating Feature Objects and Mapping Attributes to the 2D Grid

Populate hydrologic parameters in a GSSHA model using land use and soil data



Objectives

This tutorial demonstrates how to use land use and soil data to create land use, soil, and combined (both land use *and* soil) index maps for a 2D grid. It then instructs how to assign hydrologic and hydraulic parameters to index map IDs for use in the GSSHA model.

Prerequisite Tutorials

- GSSHA – WMS Basics – Watershed Delineation using DEMs and 2D Grid Generation

Required Components

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

Time

- 30-60 minutes

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1 Contents

1 Contents 2
2 Introduction 2
3 Opening an Existing GSSHA Project 2
4 Mapping GIS shape files to WMS Coverage 3
4.1 Adding Land Use Coverage 3
4.2 Adding Soil Type Coverage 4
5 Creating Index Maps 5
5.1 Creating Uniform Index Map 5
5.2 Creating a Land Use Index Map 6
5.3 Creating a Soil Type Index Map 7
6 Exploring Mapping Tables 7
6.1 Understanding the Mapping (.cmt) File 9
6.2 Combined Index Map Concept 10
7 Saving a GSSHA Project 10
8 Task 11
8.1 Copying an index map 11
8.2 Editing an Index Map 12

2 Introduction

In order to develop a grid into a GSSHA model, several attributes such as surface roughness, infiltration, porosity, moisture content, and others need to be defined for each cell. This tutorial focuses on the development of these hydrologic parameters for GSSHA grids using commonly available land use and soil GIS data.

Since GSSHA uses spatially varying parameters, it would be extremely time consuming to enter such parameters for each grid cell one by one. Define the parameters for each cell by aggregating cells of similar soil and/or land use properties using Index Maps. If there are only 5-6 different soils in a watershed then define infiltration properties for each of these soils in a table. This is much less time consuming than having to define the values separately for each cell. This tutorial will show how these Index Maps are created in WMS.

3 Opening an Existing GSSHA Project

1. Switch to the *2D Grid Module*  and select ***GSSHA | Open Project File...***. It's also possible to select ***File | Open*** to open a GSSHA project file.
2. Locate the ***GSSHA Distributed Hydrologic modeling*** folder in the files for this tutorial. If needed, download the tutorial files from www.aquaveo.com.
3. If having saved the project in the previous workshop, open the project from ***\GSSHA Distributed Hydrologic modeling\Personal\WatershedDel\ JudysBase.prj***.

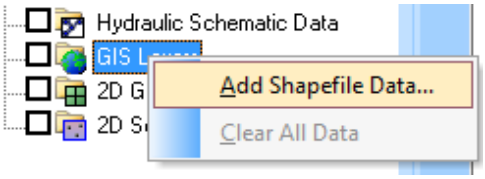
4. If unable to save the project, open ***\GSSHA Distributed Hydrologic modeling\WatershedDel\ JudysBase.prj***.
5. Select ***GSSHA | Save Project File***... and save the project with new a name as ***\GSSHA Distributed Hydrologic modeling /Personal/FeatureObjects/ JudysParam.prj*** so the original project is not overwritten.

4 Mapping GIS shape files to WMS Coverage

A previous workshop described how to work with land use and soil GIS data. In this workshop, use land use and soil data to set up GSSHA modeling parameters.

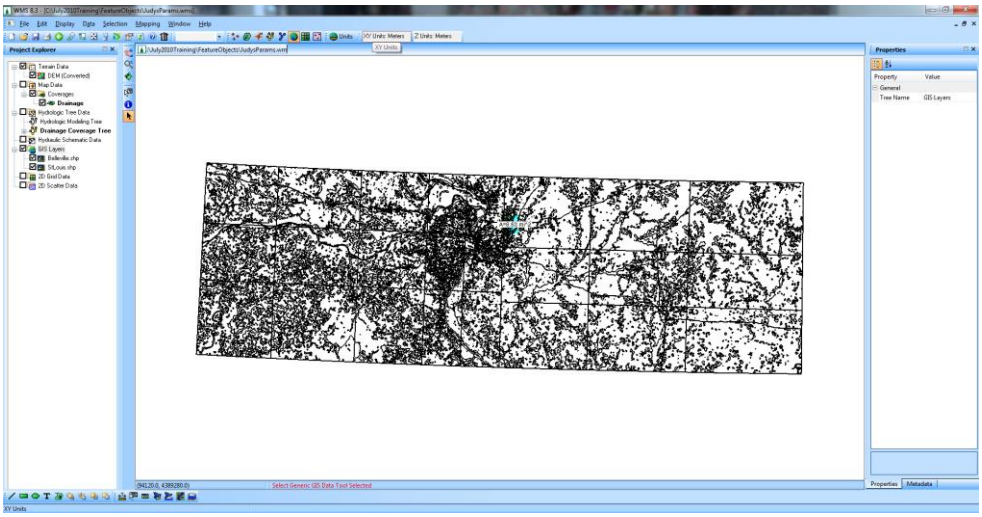
4.1 Adding Land Use Coverage

1. In the project explorer, right-click on the *GIS Layers* folder and select *Add Shapefile Data.*



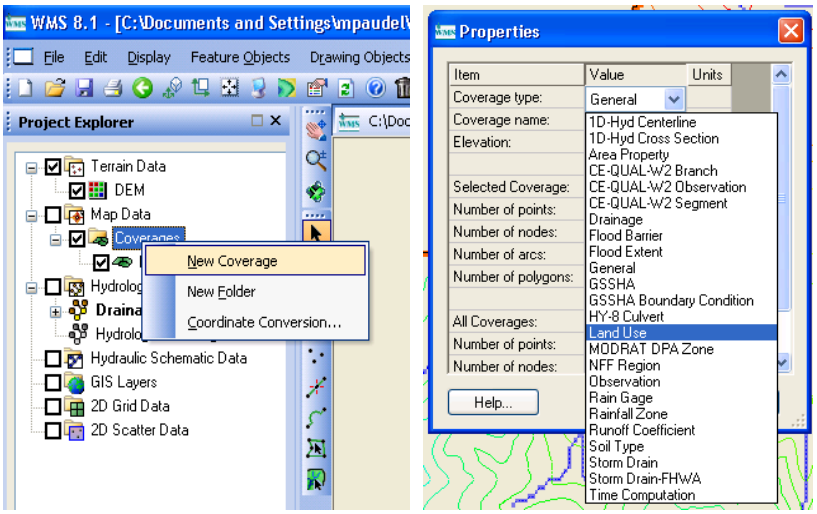
2. Browse to ***\GSSHA Distributed Hydrologic modeling/RawData/ JudysBranch/Landuse*** and open ***Belleville.shp and StLouis.shp.*** These are the two land use shapefiles that provide coverage for our watershed.

Two shapefile layers are imported and added to the project explorer under **GIS layers**. The land use extent should overlay the watershed. The project should now look like the following figure.



3. Right-click the shapefiles and view the attribute tables. Notice the USGS land use code (LUCODE).
4. In order to use the land use data, the polygons overlapping our watershed need to be copied to a WMS land use coverage. This is done from the GIS module.

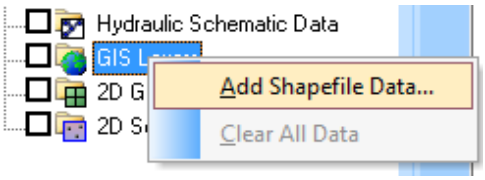
5. In the project explorer, right-click on *Coverages* and select *New Coverage.*



6. Set the coverage type to be *Land use* and click *OK*. This will create a new land use coverage in the project explorer.
7. Click on the new Land use coverage in the Explorer window to make it active.
8. Select either *Belleville.shp* or *StLouis.shp* (under GIS layers) to activate the GIS module.
9. Click on the "*Select shapes tool*"  (should be selected by default) and drag a rectangle around the watershed area to select all land use polygons that overlap this basin.
10. Select ***Mapping | Shapes –> Feature objects***, click *Nex*t and make sure that LUCODE is mapped to Land use. Click *Next* and click *Finish*.
11. WMS no longer needs the GIS data once it is mapped to a coverage in the map module. Now delete the shape files under GIS layers (Right-click on the shapefiles *Belleville.shp* and *Stlouis.shp* and select delete).

4.2 Adding Soil Type Coverage

1. In the project explorer, right-click on *GIS Layers* folder and select *Add Shapefile Data.*



2. Browse to the following SSURGO soil shapefile and open it: ***\GSSHA Distributed Hydrologic modeling \RawData\JudysBranch/SSURGOSoil\ Raw\Spatial\soilmu_a_il119.shp.***
3. This data is as it was downloaded and needs to be processed to join the soil attributes.

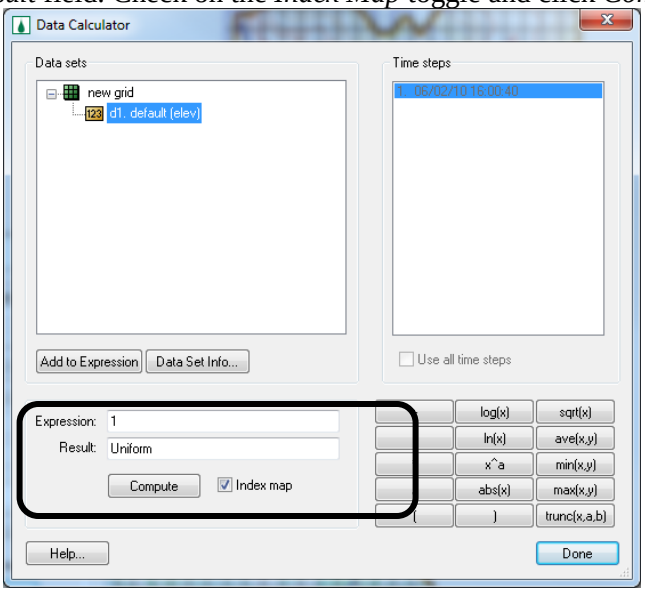
4. Join the attributes for the added shapefile. To do this, right-click the shapefile (**soilmu_a_il119.shp**) and select *Join NRCS Data*. Turn on the options to *Fill blank values* and *Compute hydraulic conductivity…*. Refer to the tutorial "*40 Gssha-WMSBasics-DEMImageCoords*" for details about joining a SSURGO soil shapefile's soil types with other SSURGO attributes.
5. Create a new coverage and change the type to *Soil Type.*
6. Map the polygons from the soil shapefile that overlap the watershed to the newly created soil type coverage. (Similar to how the land use data was mapped, see section 4.1)
7. Once having mapped the soil polygons delete the SSURGO shapefile (**soilmu_a_il119.shp**) from the project explorer.
8. Now turn off the display of the **Land Use** and **Soil Type** coverages by turning off the toggle boxes next to these coverages in the project explorer. Make sure that the display of the **GSSHA** coverage and **2D Grid Data** are turned on.
9. Click the **"Frame"** button  .

5 Creating Index Maps

WMS has an interface to automatically generate an index map. In this section, create uniform, land use, and soil index maps.

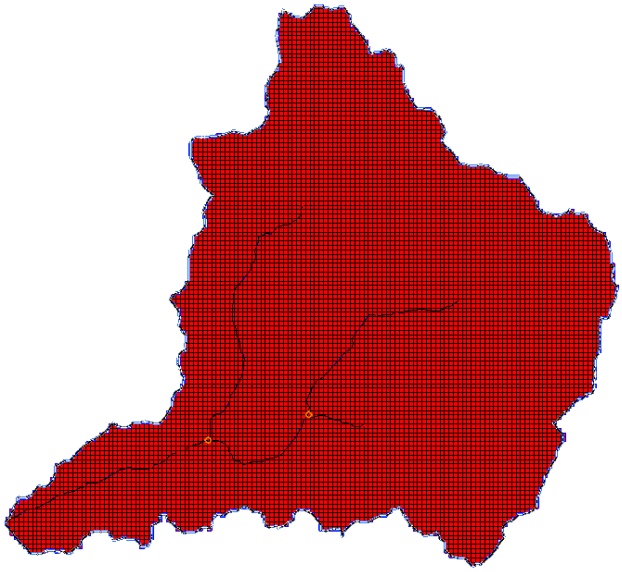
5.1 Creating Uniform Index Map

1. Switch to the ***2-D Grid module*** by clicking the grid module  button.
2. Select ***GSSHA | Maps…***
3. Click the *Data Calculator* button.
4. In the *Data Calculator* dialog enter 1 for the *Expression* and enter *Uniform* for the *Result* field. Check on the *Index Map* toggle and click *Compute.*



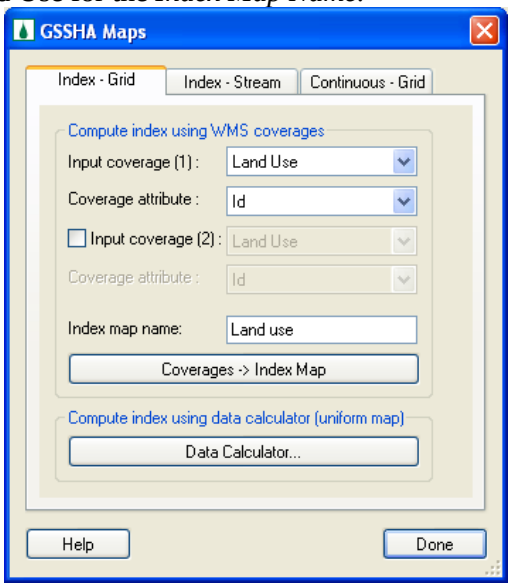
5. Click *Done*.

This will create an index map that has the same ID value (1 in this case) for each grid cell. A uniform index map is used to define parameters which are uniform over the watershed domain. For example, if assuming uniform overland roughness in the watershed, then a uniform index map can be used to define the roughness for the whole watershed.

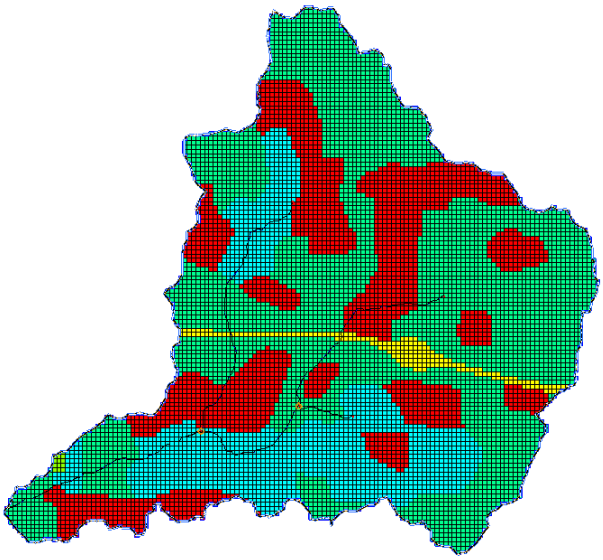


5.2 Creating a Land Use Index Map

1. In the *GSSHA Maps* dialog, select *Land Use* for *Input Coverage (1)*. Enter the name Land Use for the *Index Map Name*.

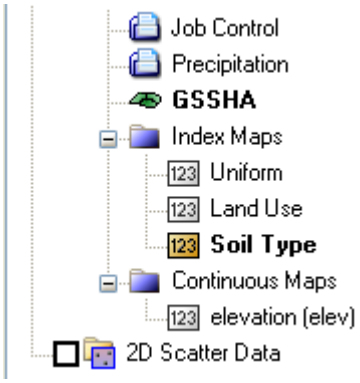


2. Click on the *Coverages → Index Map* button.
3. Colored grid cells should appear. Each color represents a different land use code.



5.3 Creating a Soil Type Index Map

1. In the *GSSHA Maps* dialog, select *Soil Type coverage* for *Input Coverage (1)*. Enter the name Soil Type for *Index Map Name*.
2. Click on the *Coverages* → *Index Map* button.
3. Click *Done* to close *GSSHA Maps* dialog.
4. At this point the project should have three index maps and the project explorer will look something like the following figure:

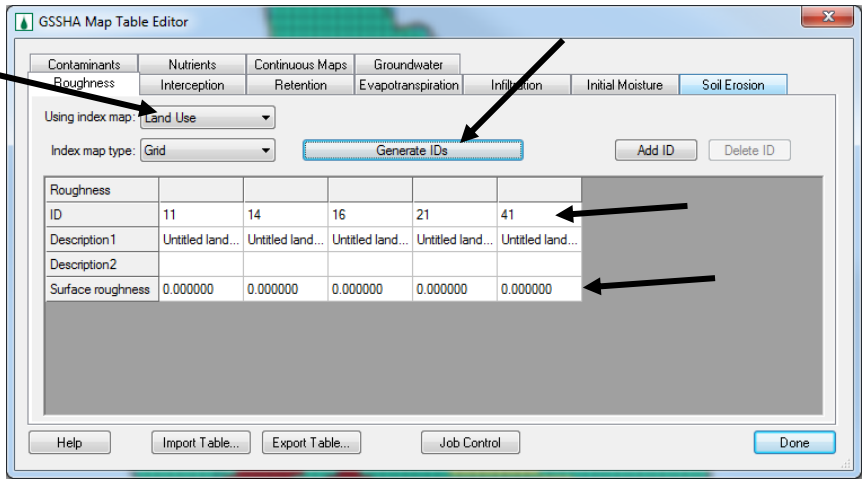


6 Exploring Mapping Tables

After index maps are created, land use or soil characteristics can be entered into **GSSHA Map Tables**. Map tables are tables of hydrologic and hydraulic parameters for all possible values in a certain index map.

1. Select ***GSSHA | Map Tables.*** This will bring up the *GSSHA Map Table Editor* dialog.
2. The R*oughness tab* is selected by default. Currently, this tab does not have any information but it is possible to use one the index maps to generate mapping table IDs.

3. Select *Uniform* from the dropdown box for *Using Index Map* field and click *Generate IDs*. This will create one Land Use ID field. Recall the step when the *Uniform* index map was created. A value of 1 was entered for all the grid cells. Since each cell in the index map has a value of 1, it's only necessary to enter the roughness parameters for this single value in the mapping table. Using this index map for the *Roughness* IDs assumes a uniform surface roughness for the entire watershed. In the real world, however, the surface roughness varies over the watershed domain. If wanting to create a GSSHA model that uses distributed surface roughness based on land use IDs, use another map such as the *Land use* index map to create the Roughness mapping table IDs.
4. Select *Land Use* from the dropdown box for the *Using Index Map* field and click *Generate IDs*. Select *Yes* if prompted to delete existing IDs. This will create mapping table IDs for each unique land use ID that existed in the land use shape file (or now exists in the land use index map).



5. Now enter the descriptions and roughness values for each of these IDs. Notice in the following section how to read a file containing the descriptions and default roughness values, so there is no need to enter the descriptions and roughness values at this time. The IDs seen in the spreadsheet are USGS Standard Land use codes. The USGS classification table helps identify each land use type based on its ID. A portion of this table is shown below:

Classification Code	*Land Use Description*
11	Residential
12	Commercial Services
13	Industrial
14	Transportation, Communications
15	Industrial and Commercial
16	Mixed Urban or Built-Up Land
17	Other Urban or Built-Up Land

6. Map tables are created for other hydrologic and hydraulic characteristics of a watershed using different index maps. Switch through each of the different tabs in the *GSSHA Map Table Editor* dialog. When selecting

some tabs, a prompt will appear to change job control settings. For example, if selecting the *Infiltration* tab in the mapping table editor but not having turned infiltration on, WMS prompts to turn the infiltration on. Select *No* when these messages appear.

7. Select Done in the **GSSHA Map Table Editor** to close the window.

6.1 Understanding the Mapping (.cmt) File

The entered parameter values in the *GSSHA Map Table Editor* dialog are saved in a mapping table file in the GSSHA project directory that has a *.cmt extension. GSSHA uses the .cmt file as a lookup table to find defined values for GSSHA parameters for corresponding index map IDs.

1. Select ***File | Edit File*** in WMS. Browse and open ***\GSSHA Distributed Hydrologic modeling\gssha.cmt***
2. This will open the sample .cmt file in a text editor. Go through different sections of this file and see how the parameters for each index map value are stored in a .cmt file. The roughness values for each USGS land use in this file are obtained from standard text books.
   Similarly, the infiltration parameters in this file were obtained from Rawls and Brakenseik's table (Rawls, W. J., Brakensiek, D. L., and Miller, N. (1983). "Green-Ampt infiltration parameters from soils data," ASCE J. Hyd. Engr. 109(1), 62-70.). This table provides Green and Ampt infiltration parameters based on soil textures. Soil texture was imported while processing the SSURGO soil data in a previous section so use this texture to derive infiltration parameters.
   The USGS land use files and SSURGO soils files use consistent IDs and texture classifications. To avoid defining the roughness and infiltration values each time creating a new GSSHA model, created a "master" mapping file from the literature that has roughness values defined for each USGS land use code and infiltration parameters for each SSURGO soil texture. This table can be found in ***\GSSHA Distributed Hydrologic modeling\tables\gssha.cmt***. These values are not intended to be absolute for every project, but the values define a reasonable starting point.
3. It is important to note that WMS creates a .cmt file each time a GSSHA model is created. This .cmt file is saved in the same folder where the GSSHA project is saved. However, this .cmt file does not have all the parameters listed as seen in the master .cmt file found in ***\GSSHA Distributed Hydrologic modeling\table\gssha.cmt***. WMS will save out only those parameters for the IDs that are present in the index maps.
4. Close the .cmt file.
5. Instead of typing the parameters for roughness, infiltration, or other mapping table parameters, import a .cmt file that already has these values listed like the one just viewed. To import the gssha.cmt file, select ***GSSHA | Map Tables***. Click on the *Import Table* button in the *GSSHA Map Table Editor* dialog and browse for the ***\GSSHA Distributed Hydrologic modeling\table\gssha.cmt*** file. Open this file and notice the values in the mapping table editor are populated with the values from the .cmt file. Click *Done* to close the **GSSHA Map Table Editor** dialog.

6.2 Combined Index Map Concept

The values of infiltration parameters obtained from Rawls and Brakenseik's table are for bare earth conditions where the soils are assumed to be exposed. But in a natural watershed, the land cover will change the infiltration characteristics of the soil. For example, sand with grassland as land use will have significantly different infiltration characteristics from sand covered with crops or asphalt.

Because of this, it is advisable to create a combined index map which generates unique IDs for each different land use-soil type combination within the watershed. Once the soil and land use data are mapped to respective WMS coverages, a combined index map can be generated.

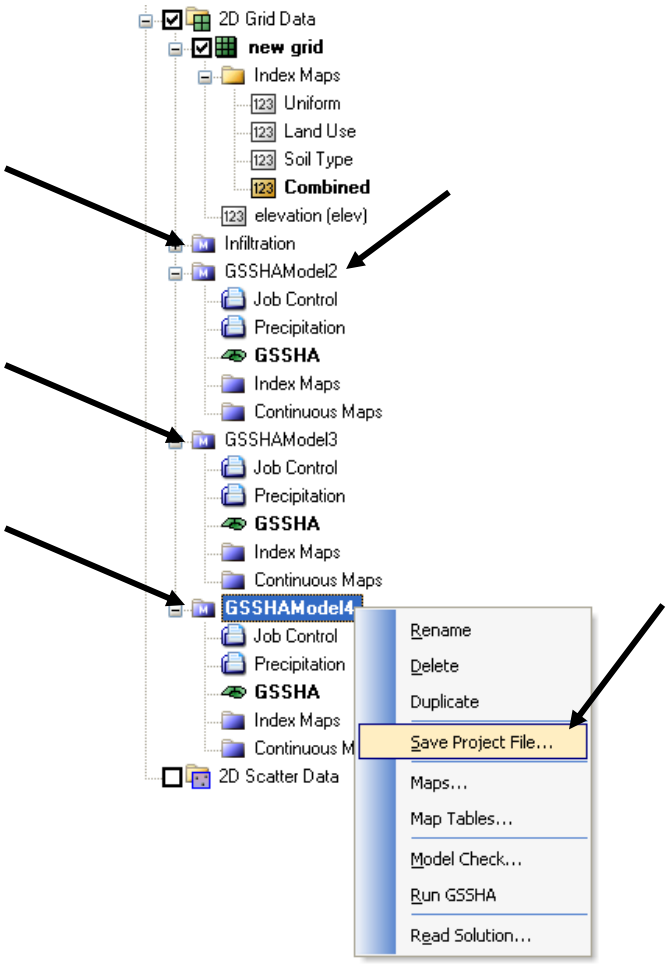
1. In the *2D Grid Module*, select ***GSSHA | Maps*** to open the *GSSHA Maps* dialog. Then check the toggle to use the second input coverage (turn on *Input coverage (2)*).
2. Select *Soil Type* for the first input with *Texture* as the attribute and *Land use* for the second input with *ID* as the attribute.
3. Change the name to *Combined* and create an index map by selecting the *Coverages→Index Map* button.
4. This combined index map can now be used in the *GSSHA Map Table Editor* to generate infiltration parameter IDs.

One thing to note here that when importing a standard .cmt file to fill in the infiltration parameters, the parameter values are obtained from Rawls and Brakenseik's table and, as already discussed, these values are for the bare earth condition. Manually adjust the parameters during calibration if using a combined index map to generate infiltration parameters.

7 Saving a GSSHA Project

There are two different commands to save files when creating a GSSHA model in WMS. If selecting ***File | Save*** or using the save button  , a WMS project will be saved. This does not save the index map or the GSSHA project. After creating a 2D grid, save the GSSHA project using the ***Save Project File*** command in the ***GSSHA*** menu. This command saves a GSSHA project and all the data important for running a GSSHA model. It is usually a good idea to save the project using ***File | Save*** before creating a 2D grid so as to save the pre-GSSHA model. Then save theproject using ***GSSHA | Save Project File*** after creating the 2D grid so all the necessary data for running a GSSHA model are saved with the project.

1. To save a GSSHA project, switch to *2D Grid module*  and select ***GSSHA | Save Project File.***
2. It is possible that there might be more than one GSSHA model based on the same grid. This is demonstrated in later scenario modeling workshops. In the situation when there is more than one model, when choosing ***GSSHA | Save Project File,*** the GSSHA project which is currently selected in the project explorer will be the project that is saved.
3. As an alternative, save a GSSHA project by right-clicking on the GSSHA model in the project explorer and select *Save Project File.* See the following figure.



In the above figure, there are four GSSHA projects namely *Infiltration*, *GSSHAModel2*, *GSSHAModel3* and *GSSHAModel4*. The screenshot shows the saving of *GSSHAModel4*.

8 Task

In this workshop taught how an index map is created using WMS. It showed that an index map can be created using the data calculator (as in the uniform index map example), using land use and soil type data, and using a combination of land use and soil data.

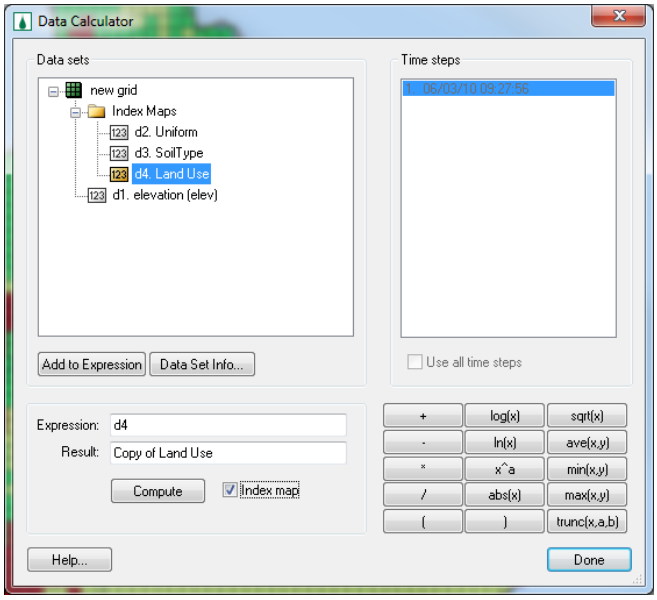
This section gives a few more tips about editing index maps.

8.1 Copying an index map

There might be some situations when a copy of an index map is needed, such as when wanting to preserve an index map generated from land use but also wanting to change individual cells in the index map.

1. In the *2D Grid Module*, open the *GSSHA Maps* dialog (***GSSHA* | *Maps*** menu item).
2. Open the *Data Calculator* by clicking the *Data Calculator* button.

3. In the data calculator, double-click the index map to copy. Doing this will put text representing the index map in the *Expression* field.
4. Check the *Index Map* toggle on and enter an appropriate name.
5. Click the **Compute** button. This will create a copy of the selected index map.
6. See the index map added to the project explorer.

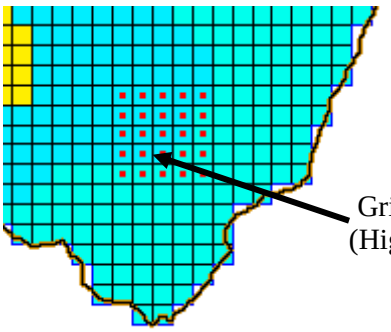


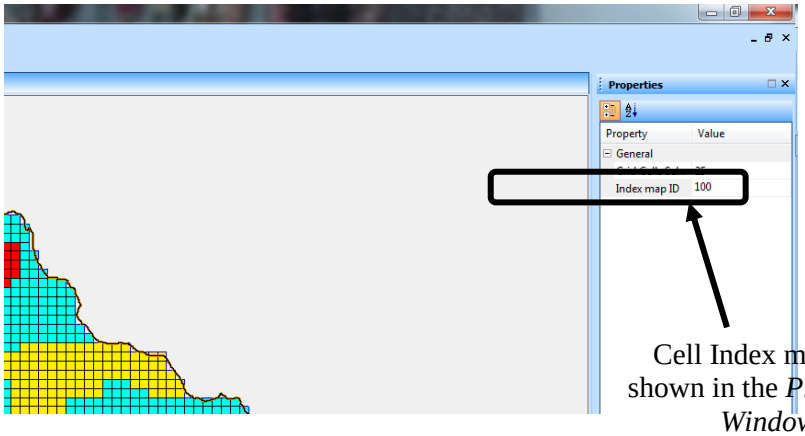
7. In the figure above, the data calculator is set to create a copy of the *Land Use* index map. Close both the **data calculator** and the **GSSHA Maps** windows by clicking on the *Done* buttons in each dialog.

8.2 Editing an Index Map

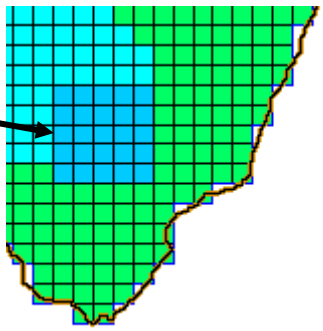
Sometimes it's necessary to modify an existing index map. Editing an index map cell means assigning it a different ID (overriding what was mapped from a coverage). For example, if there is a land use index map but where a certain portion of the land has been converted to a built up area. This land use change is not reflected in the land use index map. Modify the index map for a few cells to incorporate the change.

1. In the project explorer, select the land use index map copied in the previous step.
2. Select the *Select Grid Cell Tool* and drag a box to select some grid cells to be changed.
3. In the WMS properties window edit the IDs of the selected cells. Go ahead and assign the *Index Map ID* to be 100.
4. Changing the Index Map IDs for the selected cells will update the index map. Because these cells have new index map IDs, they will now display as a different color.





When the cell IDs are changed, the index map is updated and the cells are given a new color



5. If the area to change IDs is not rectangular, then with the *Select Grid Cell Tool* selected, press and hold Shift Key in the Keyboard and click on the cells to change.
6. Alternatively, select grid cells with a polygon. Select ***Edit | Select with Polygon***. Then draw the polygon to include the cells to select.