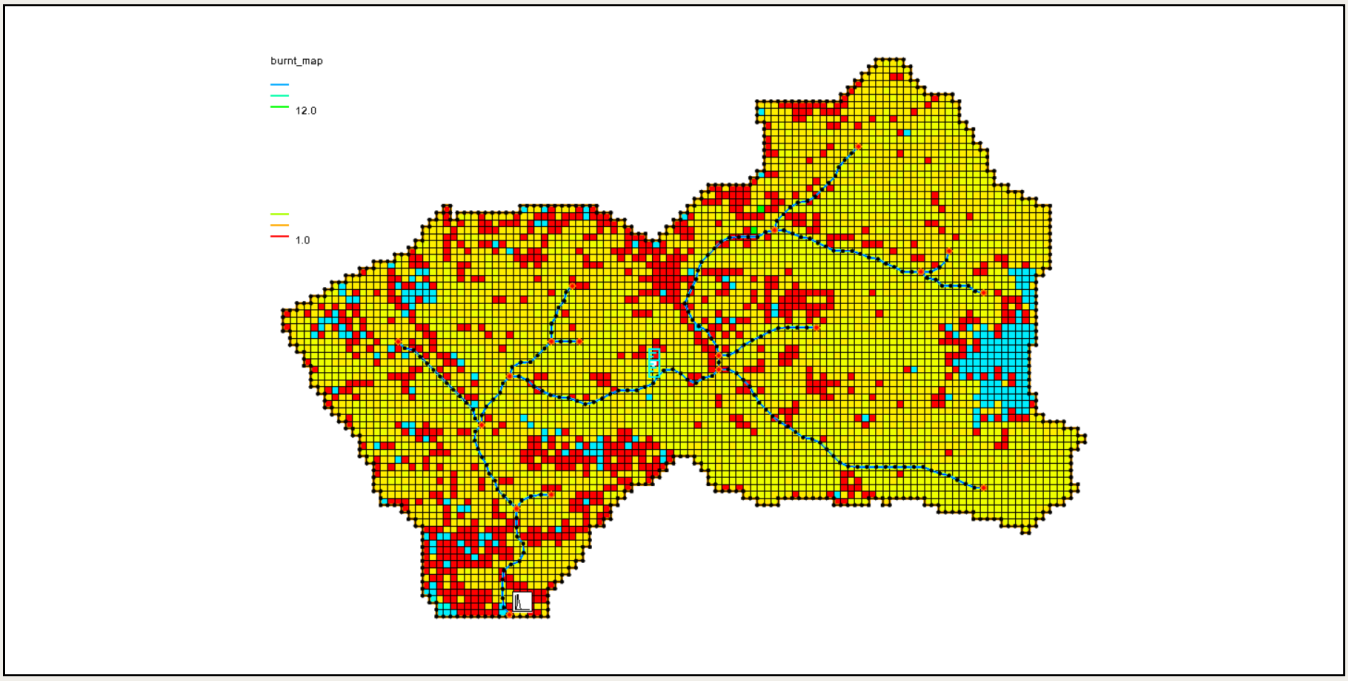
WMS 11.4 Tutorial

Post Wildfire Simulations in GSSHA

Modeling post-wildfire simulations in GSSHA



Objectives

Starting with a GSSHA model defined for a pre-wildfire scenario, modify the GSSHA model to simulate a post-wildfire scenario.

Prerequisite Tutorials

- Developing a GSSHA Model Using the Hydrologic Wizard

Required Components

- WMS Core
- GSSHA Model

Time

- 20–30 minutes

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1 Introduction

The tutorial illustrates modeling post-wildfire hydrological modeling with GSSHA. This example demonstrates a post-wildfire scenario after the Station Fire in the Upper Arroyo Seco watershed. The GSSHA project used in this tutorial includes surface runoff where infiltration and runoff-routing components are turned on. The soil moisture and soil physical states are defined using the Green and Ampt Equation with soil moisture redistribution.

1.1 Getting Started

To begin the tutorial, do the following:

1. Start WMS, or click **New** if WMS is already open.
2. Switch to the **2D Grid Module** .
3. Select *GSSHA* **| Open Project File...** to bring up the *Open* dialog.
4. Browse to the *GsshaWildfire* folder for this tutorial.
5. Select “gssha_pre_fire.prj” and click **Open** to exit the *Open* dialog.
6. Select *File* | **Save As…** to bring up the *Save As* dialog.
7. For the *File Name*, enter “gssha_post_fire.wms”.
8. Click **Save** to save the project under the new name and close the *Save As* dialog.

The project should appear similar to Figure 1.

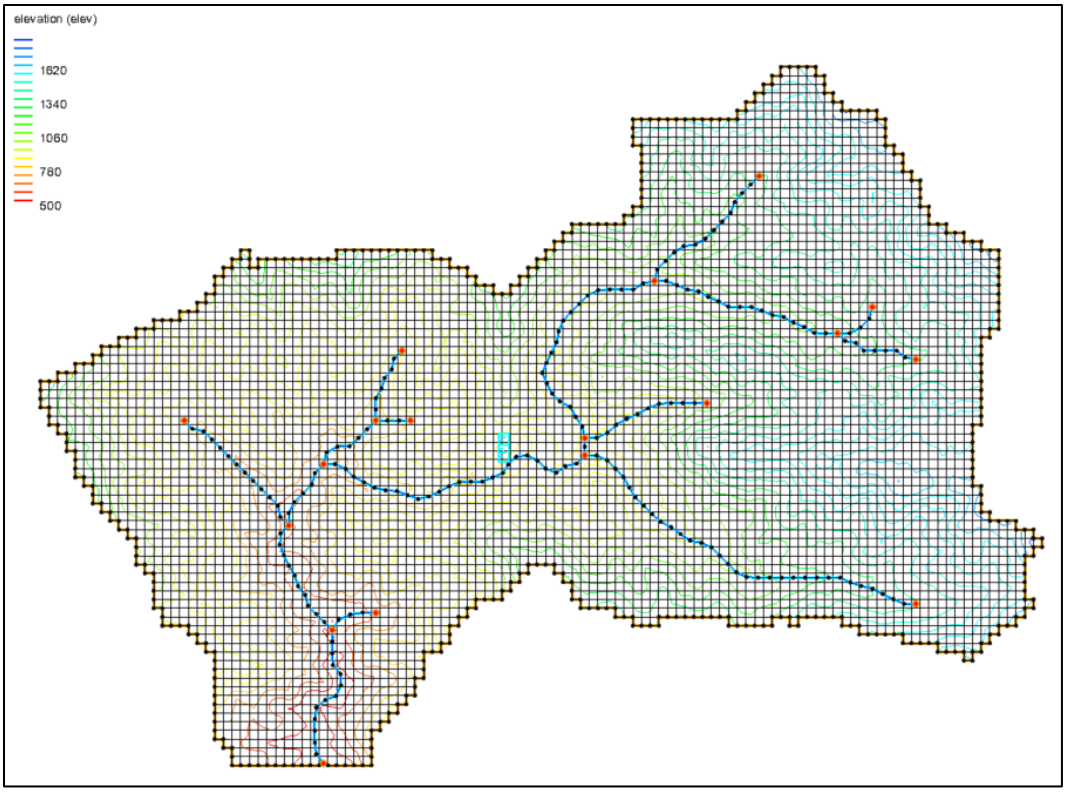

Figure 1 Initial GSSHA project

1.2 Duplicate Model

Before building and running the post-wildfire scenario, duplicate the GSSHA model to create a post-wildfire scenario for comparison.

1. In the Project Explorer, under "2D Grid Data", right-click on the "gssha_pre_fire" model and select **Duplicate**.
2. Right-click on the new "gssha_pre_fire (2)" model and select Rename.
3. Enter "gssha_post_fire" as the new name.

2 Adding Post Wildfire Parameters

This section will demonstrate defining a burn severity index map and updating the initial moisture map to match post-wildfire conditions. Then, it will demonstrate turning on the Post Wildfire option in the *GSSHA Job Control Parameters* dialog and defining the required input parameters for modeling the wildfire options.

2.1 Defining a Burn Severity Index Map using Web Services

If WMS does not have internet access, please process to section 2.2. If WMS does have internet access, define the burn severity index map as follows:

1. In the Get Data Toolbar. select the **Get Data** tool.

2. Using the **Get Data** tool, drag a box around the watershed but outside of the watershed boundaries as shown in Figure 2. The *Data Service Options* dialog will appear automatically.

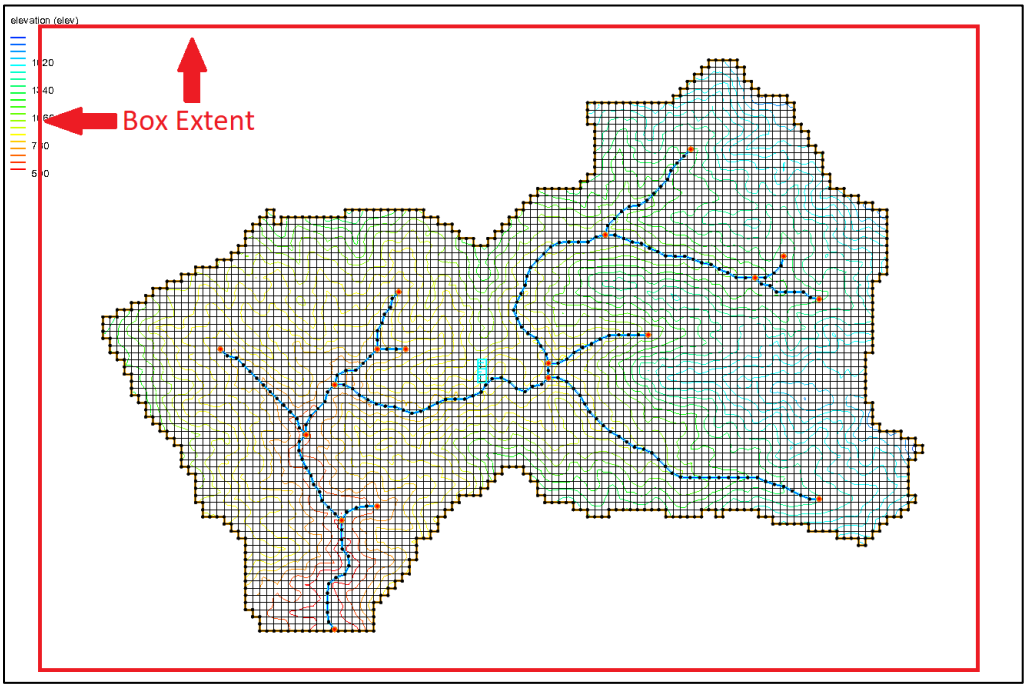

Figure 2: Get Data tool data extents.

3. In the *Data Service Options* dialog, select the **Advanced…** button to open the *Select Online Source* dialog.
4. Click the **Add Sources From File…** button to open the *Select Online Source File (s)* dialog.
5. Browse to the *material_and_results* folder.
6. Select the "Wildfire MTBS Dataset 2009.csv" file and click **Open** to close the *Select Online Source File (s)* dialog.

Note about additional MTBS dataset years: The "Wildfire MTBS Dataset 2009.csv" file adds a new web service that allows downloading a burn severity map anywhere in the continental United States for the year 2009. MTBS burn severity maps are currently available and can be downloaded through web services from 1984 through 2024, but it is anticipated that future maps will be added as they become available. To add options to download maps from additional years, duplicate the Wildfire MTBS Dataset 2009 data source that was added when loading the CSV file and select the **Edit Source** button. Modify the *Service name* field as desired and then select the **Query Layers** button to specify a new layer representing the MTBS data for a different year. Also modify the *File abbreviation* field to specify the different year. See Figure 3.

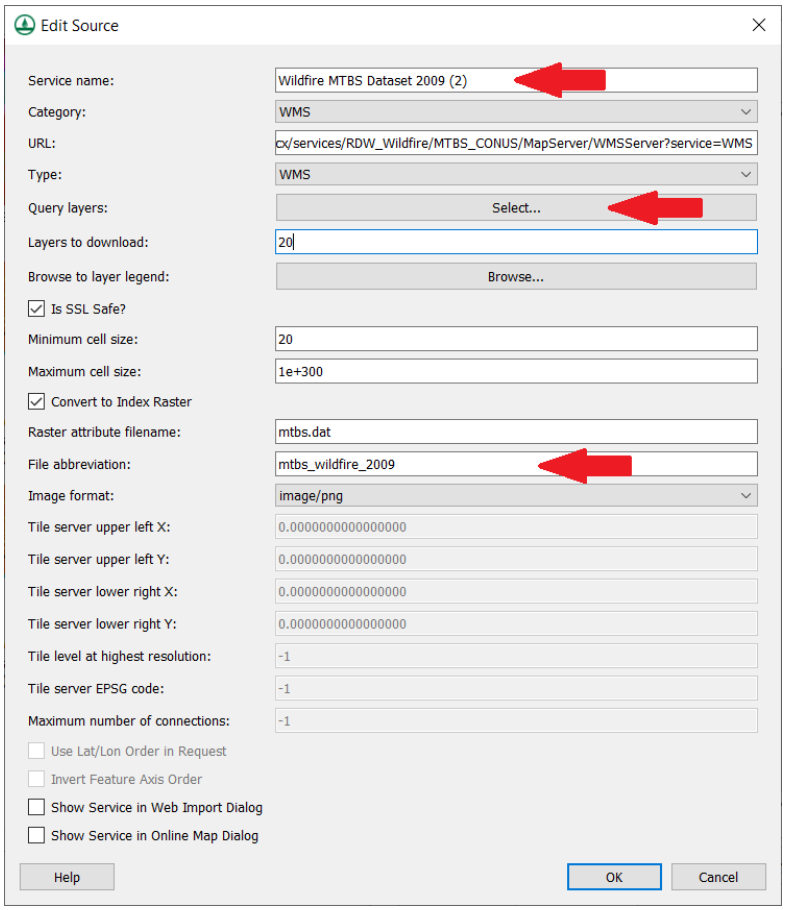

Figure 3: The Edit Source dialog for modifying the MTBS dataset year.

7. Back in the *Select Online Source* dialog, in the *Select data source* list, select the **Wildfire MTBS Dataset 2009** data source towards the bottom of the list
8. Click **OK** to close the *Select Online Source* dialog and open the *Save Web Services Data Files(s)* dialog.
9. For the *File name*, enter "arroyo_seco" as the base name for the downloaded file.
10. Click **Save** to close open the *Save Web Services Data Files(s)* dialog.
11. At the message asking to create the file, click **Yes** to accept the given file name for the downloaded file and bring up the *Raster Cell Size* dialog.
12. Accept the default raster cell size of 20 meters and select **OK** to close *Raster Cell Size* dialog.

In the Project Explorer, under "GIS Data", notice that "arroyo_seco_mtbs_wildfire_ 2009.tif" has been added to the project.

13. Right-click on "arroyo_seco_mtbs_wildfire_ 2009.tif" and select *Convert To* | **Land Use Grid** to use this file with the GSSHA model.

Note that the burn severity map is not actually a land use grid, but it can be converted to a land use grid to use it with the GSSHA model.

14. Switch to the **2D Grid Module**. From the menus, select *GSSHA* | **Maps** to bring up the *GSSHA Maps* dialog.

This dialog is used to convert the downloaded burn severity map to an index map that can be used with the GSSHA model.

15. Change the *Index map nam*e to “2009_wildfire_severity”.
16. Select **Coverages→Index Map** to create the index map.
17. Click **Done** after the index map has been computed to close the *GSSHA Maps* dialog.
18. In the Project Explorer, under “ GIS Data”, turn off the “ arroyo_seco_ mtbs_wildfire_ 2009.tif” index raster.

The display should show the burn severity index map and should look similar to Figure 4.

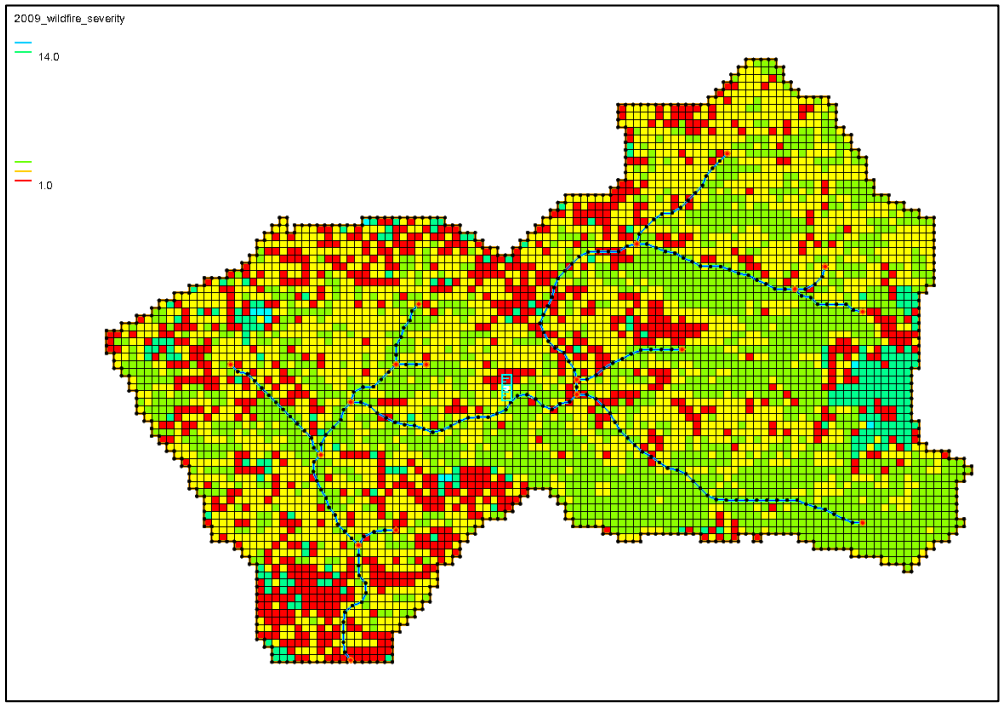

Figure 4: Burn severity index map (downloaded).

2.2 Defining a Burn Severity Index Map from a File

If internet access is not available, read the pre-defined burn severity map as follows:

1. In the Project Explorer, under “ 2D Grid Data”, right-click on “ new grid” and select **Import Index Map…** to open the *Import Index Map* dialog.
2. Browse to the *material_and_results* folder and select the “burnt_map.idx” file.
3. Click **Open** to close the *Import Index Map* dialog.

The display should show the burn severity index map and should look similar to Figure 5.

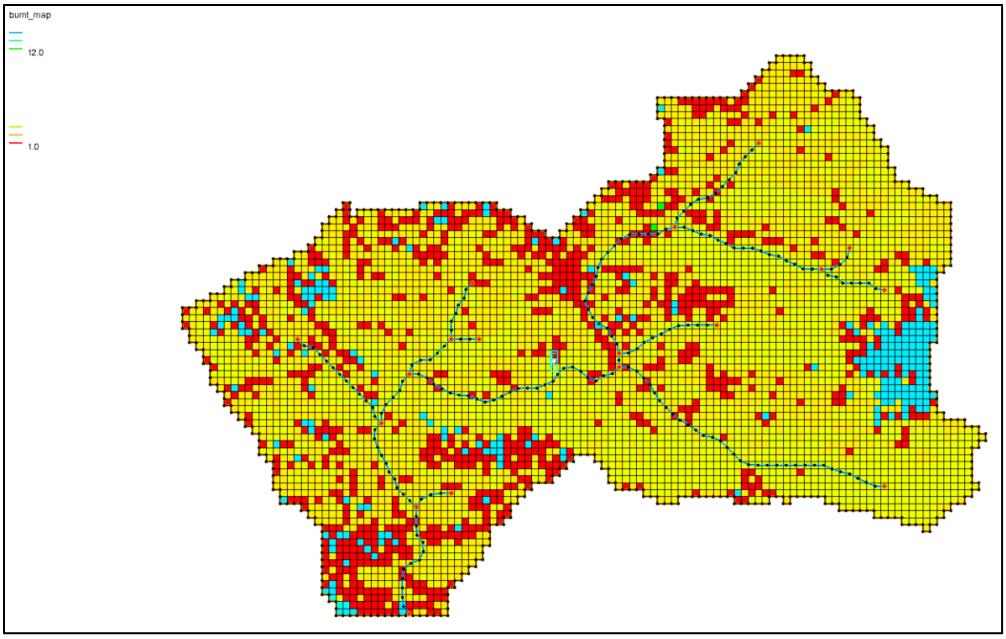

Figure 5: Burn severity index map (provided).

2.3 Updating the Initial Moisture Continuous Map

In the original model, a continuous moisture map was used to define the initial soil moisture content in each cell in the watershed model. The initial soil moisture content is significantly reduced in the post-wildfire model, so compute post wildfire soil moisture values using a downloaded MODIS Normalized difference vegetation index (NDVI) file representing the post-wildfire condition. NDVI files can be downloaded from several sources on the web, including the USGS Earth Explorer (https://earthexplorer.usgs.gov/) and NASA's AppEEARS application (https://appeears.earthdatacloud.nasa.gov/). MODIS NDVI files at a 250 M resolution are available beginning around the year 2000 at 16-day intervals. Sentinel-2 NDVI data at a 30 M resolution is also available beginning around 2015 from NASA's Earth data web site (https://search.earthdata.nasa.gov/). Since the station fire took place in 2009, this example will use the MODIS 250 M NDVI data.

1. From the WMS menu, select *File* | **Open** to bring up the *Open* dialog.
2. Browse to the *material_and_results* folder and select the "ArroyoSecoPostFireNDVI.tif" file.
3. Click **Open** to import the file and close the *Open* dialog.
4. Select *GSSHA* | **Generate Soil Moisture Dataset** to open the *GSSHA Generate Soil Moisture Dataset* dialog.
5. For the *Normalized Difference Vegetation Index (NDVI) Raster*, make sure "ArroyoSecoPostFireNDVI.tif" is selected.
6. Change the *Initial Moisture Dataset Name* to "Post Fire Moisture".
7. Leave the NDVI multiplication factor at its default value and select **OK** to compute the Post Fire Moisture dataset and close the *GSSHA Generate Soil Moisture Dataset* dialog.
8. Under "GIS Data", turn off the "ArroyoSecoPostFireNDVI.tif" raster.
9. Select the *Display* | **Frame Image** menu item.

The display should show contours of the continuous soil moisture map and should look similar to Figure 6.

10. Select *GSSHA* | **Map Tables** to open the *GSSHA Map Table Editor* dialog.
11. Select the *Continuous Maps* tab and turn on the *Initial soil moisture* parameter.
12. For the *Initial soil moisture*, set the selected *Data set* to "Post Fire Moisture".
13. Select **Done** to close the *GSSHA Map Table Editor* dialog.

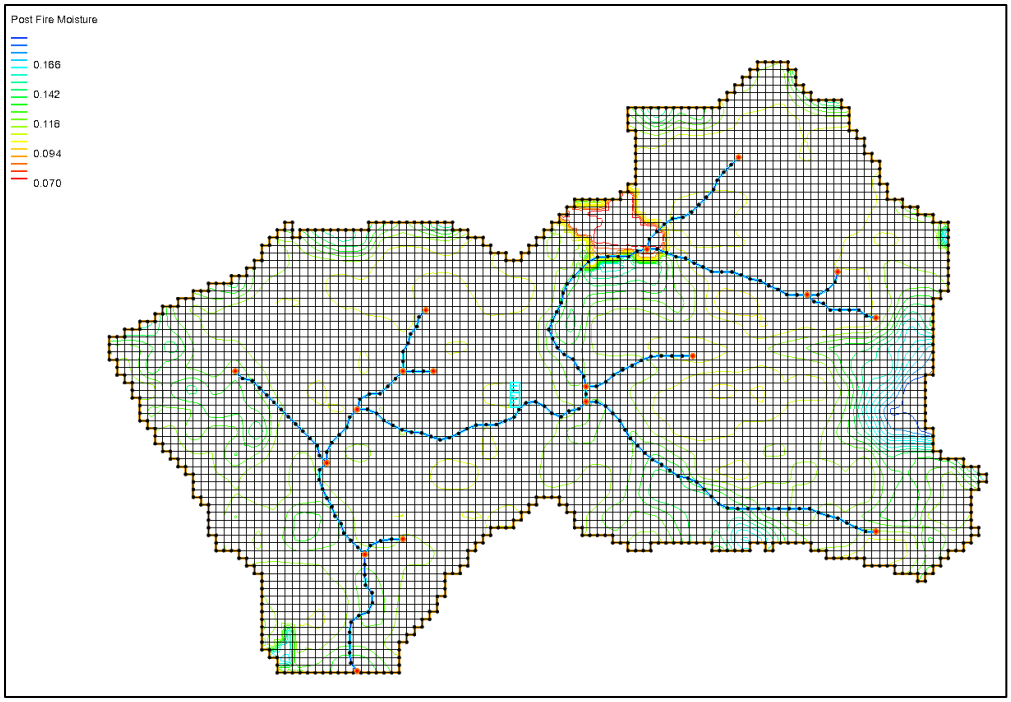

Figure 6: Post-wildfire continuous soil moisture map.

2.4 Updating the Land Use Map

The overland flow Manning's roughess values were defined in the original model using a land use index map based on the pre-fire conditions. In the post-fire scenario, the overland Manning's roughess values have changed. This example will now show reading a new land use index map and define fire-modified roughness values to apply these changes to your model.

1. In the Project Explorer, under "2D Grid Data", right-click on on "new grid" and select **Import Index Map…** to open the *Import Index Map* dialog.
2. Browse to the *material_and_results* folder and select the "Landuse_burnt.idx" file.
3. Click **Open** to close the *Import Index Map* dialog.
4. Select *GSSHA* | **Map Tables** to open the *GSSHA Map Table Editor* dialog.
5. Select the *Roughness* tab and change the *Using index map* selection to "Landuse_burnt".
6. Select the **Generate IDs** button and then select **No** to the prompt so new IDs are added but old IDs and their properties are not deleted.

Three new IDs should be added to the roughness mapping table.

7. Define the properties listed in Table 1 for this mapping table:

Table 1: Parameters for additional burned land use IDs.

ID	97	98	99
Description 1	Roughness ID #97	Roughness ID #98	Roughness ID #99
Description 2	L_burnt	M_burnt	H_burnt
Surface roughness	0.200000	0.180000	0.150000

8. Select **Done** to save changes and close the *GSSHA Map Table Editor*.

2.5 Turning on the Post Wildfire Options in Job Control

1. Select *GSSHA* | **Job Control…** to bring up the *GSSHA Job Control Parameters* dialog (Figure 7).
2. In the list on the right, turn on the *Post Wildfire* option.

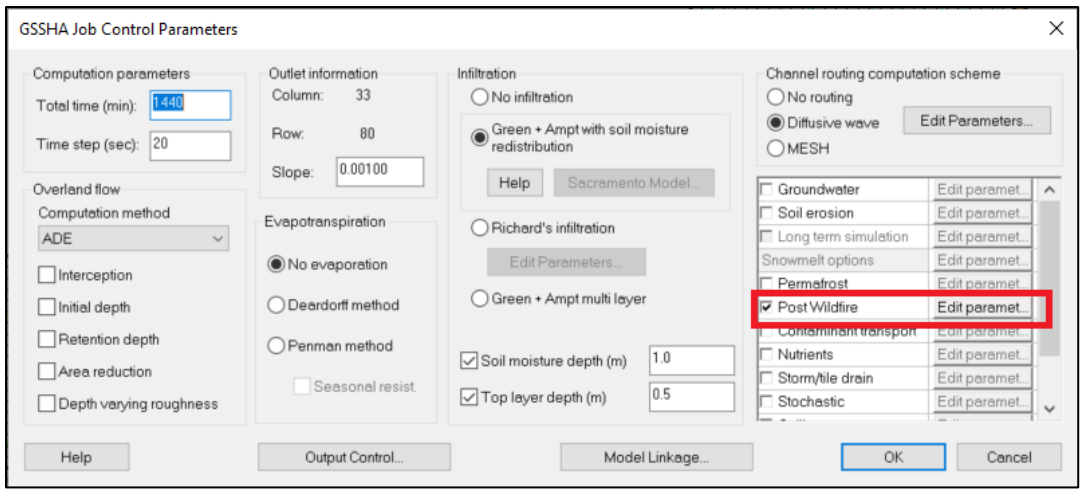

Figure 7 GSSHA Job Control Parameters dialog

3. Next to the *Post Wildfire* option, select the **Edit parameters…** button to open the *GSSHA Post Wildfire Options* dialog.
4. Select a value for the *Burn index map* option depending on whether the burn severity index map was downloaded from the internet or loaded from disk. Select “2009_wildfire_severity” if downloaded or “burnt_map” if loaded from disk.
5. Leave the other values at their default values and select **OK** to close the *GSSHA Post Wildfire Options* dialog.
6. Click **OK** to close the *GSSHA Job Control Parameters* dialog.

2.6 Saving and Running the Pre- and Post-Wildfire Scenarios

Before running the models, the project should be saved.

1. Select *File* | **Save**.

2. Select *GSSHA* | **Run GSSHA Group…** to bring up the *Save and Run GSSHA Group* dialog.
3. In the Run column, turn on both the “gssha_pre_fire” and the “gssha_post_fire” projects.
4. Make sure the *Suppress screen printing* and *Read solutions on finish* options are turned on.
5. Click **OK** to close the *GSSHA Run Options dialog* and run each of the scenarios.

GSSHA may take some time to complete its run.

3 Visualizing the Results

This section will discuss how to visualize differences between the pre- and post-wildfire scenarios.

3.1 Summary File

To view the hydrographs for each of the simulations, do the following:

1. In the toolbar, select the **Select Hydrographs** tool.
2. Double-click on the hydrograph icon located at the outlet of the watershed shown in Figure 8 to open a *Hydrograph* window.

Notice that the peak for the post-wildfire hydrograph is much higher than the peak for the pre-wildfire hydrograph (over 100 CMS vs about 1.7 CMS) and that the peak flow occurs sooner than the pre-wildfire hydrograph.

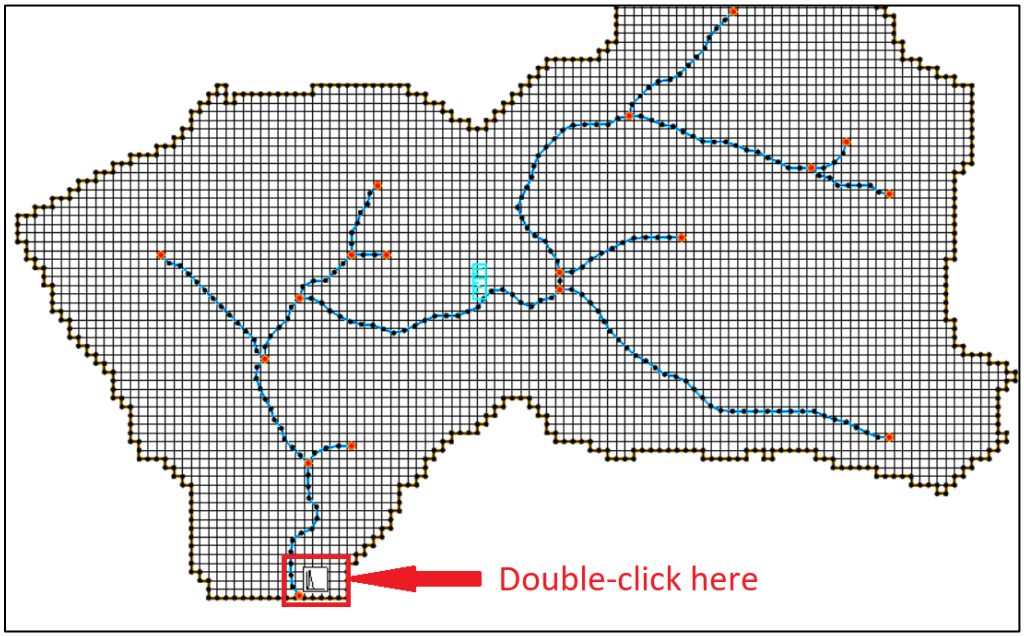

Figure 8: Solution hydrograph icon.

4 Conclusion

This concludes the “Post Wildfire Simulations in GSSHA” tutorial. Feel free to continue to experiment or exit the program.