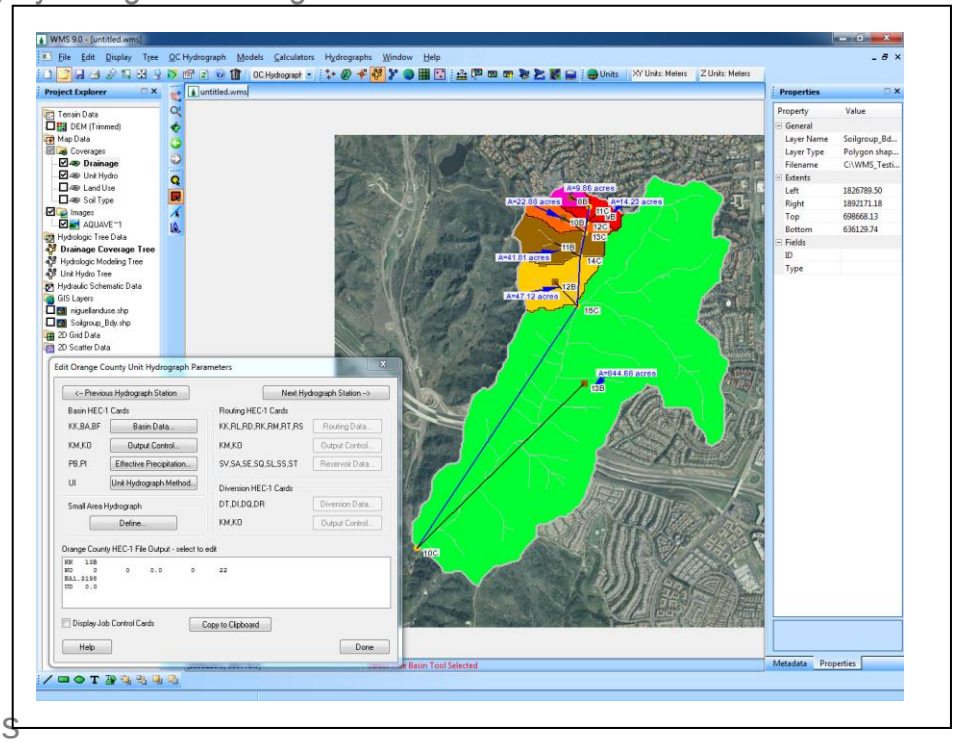
WMS

v. 10.1

WMS 10.1 Tutorial

Watershed Modeling – Orange County Hydrology – Using GIS Data

Learn how to delineate sub-basins and compute soil losses for Orange County (California) hydrologic modeling



Objectives

This tutorial shows how to use digital terrain and GIS data to delineate watershed sub-basins and to compute Orange County soil loss rates using soil type and land use data.

Prerequisite Tutorials

- Introduction – Images
- Introduction – Basic Feature Objects
- Editing Elevations – DEM Basics

Required Components

- Data
- Drainage
- Map
- Hydrology
- Hydrologic Models

Time

- 30-45 minutes

AQUAVEO™

1 Introduction

WMS has many features and tools that will help get the most use out of digital terrain and GIS data for delineating sub-areas and computing loss rates. This exercise demonstrates how to use WMS to automate sub-area delineation with a Digital Elevation Model (DEM) for rational and unit hydrograph analyses and shows how to compute Orange County loss rates (Fm and Ybar) with soil type and land use GIS data. Refer to the following chapters in the standard WMS tutorials for an in depth treatment of GIS data:

- Images (2 Introduction-Images)
- Basic Feature Objects (3 Introduction-BasicFeatureObjects)
- DEM Basics (4 EditingElevations-DEMBasics)
- Advanced Feature Objects (6 Introduction-AdvancedFeatureObjects)
- DEM Delineation (7 WatershedModeling-DEMDelineation)
- Time of Concentration Calculations and Computing a Composite CN (9 WatershedModeling-TimeConcAndCN)

2 Automated Sub-area Delineation

2.1 DEM Data

1. Open WMS. If WMS is already open, click *File* | **New** then click **No** if asked to save changes.
1. Select *File* | **Open…** 
2. In the *Open* dialog, locate the "OrangeCounty\UnitHydro" folder in the files for this tutorial. If needed, download the tutorial files from www.aquaveo.com.
3. Open "LagunaBeach.asc" and "SanJuanCapistrano.asc".
4. The *Importing ArcInfo Grid* dialog will appear. Select **OK**.
5. Right-click on the file name under "Terrain Data" in the Project Explorer. It will be called "SanJuanCapistrano, LagunaBeach".
6. After right-clicking, select *Projection* | **Projection**.
7. The *Projection* dialog will appear. Toggle on the *Global projection* then click **Set Projection**.
8. In the *Select Projection* dialog, set the *Projection* to "State Plane Coordinate System".
9. Set the *Zone* to "California 6 (FIPS 406)".
10. Set the *Datum* to "NAD 83 (US)".
11. Click **OK** to close the *Select Projection* dialog.
12. Set *Horizontal Units* to "Meters".
13. Set *Vertical Units* to "Meters".
14. Select **OK**.

2.2 Trimming the DEM

The DEM often covers a much larger area than the user is really interested in. To decrease the amount of computations required, it is often beneficial to "trim" the DEM.

1. Switch to the **Terrain Data**  module.
2. Select *DEM* | *Trim* | **Polygon…**
3. The *Polygon Selection Options* dialog will appear. Select "Enter a polygon interactively".
4. Select **OK**.
5. Use the left mouse button to outline an area that approximates the rectangle shown in Figure 1 below. Double-click on the last corner to end the polygon and trim the DEM.

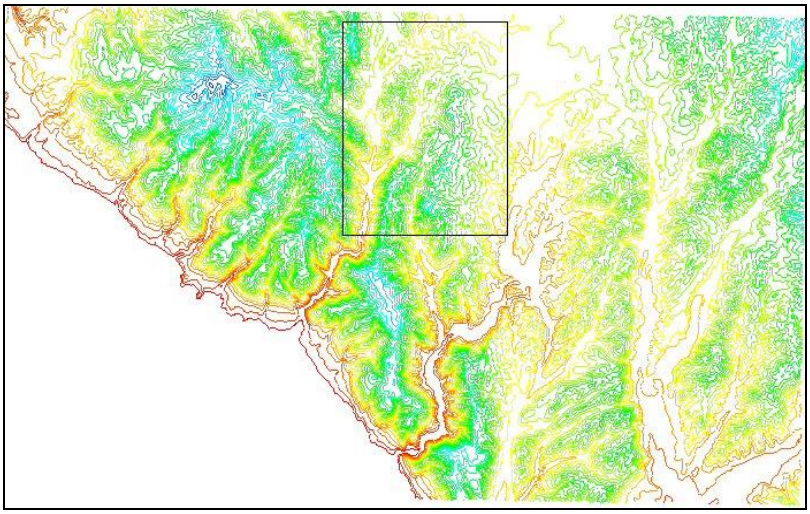


Figure 1 DEM trim area

2.3 Compute Flow Directions and Accumulations

1. Select the **Frame** macro.
2. Switch to the **Drainage** module.
3. Select *DEM* | **Compute Flow Direction/Accumulation**.
4. In the *Flow Direction/Accumulation Run Options* dialog, select **OK**.
5. The *Units* dialog will appear. Under the *Parameter units* section, det the *Basin Areas* units to "Acres" (in order to specify the units to view upstream area of any DEM cell).
6. Set the *Distances* units to "Feet".
7. Select **OK**.
8. A new window will automatically open and TOPAZ will run. Choose **Close** once TOPAZ finishes running (wait a few seconds to a minute or so).
9. Select *Display* | **Display Options…** to open the *Display Options* dialog.
10. Select *DEM Data* from the menu on the right, and change *Min Accumulation For Display* to "5.0" acres.
11. Select **OK**.

2.4 Add Concentration Point (Outlet)

1. Use the **Zoom** tool to zoom in to the rectangle shown in Figure 2.

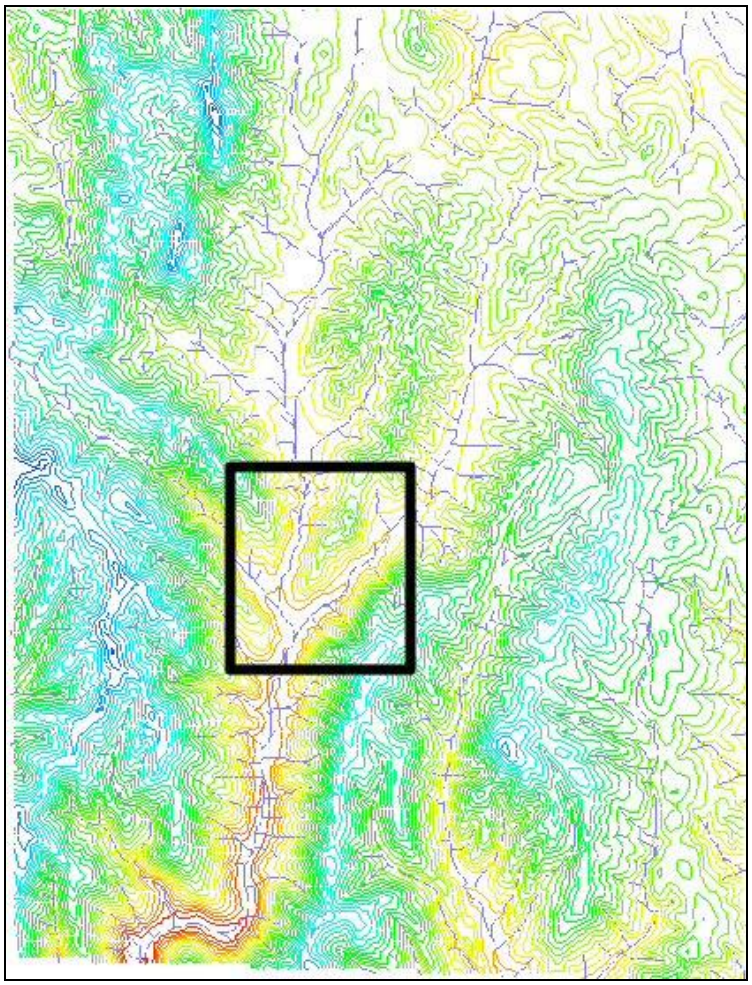
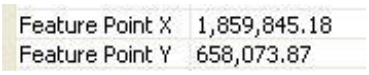


Figure 2 Zoom area

2. Select the **Create Outlet Point** tool.

As the cursor is moved over any DEM cell that has flow accumulation data, the total upstream area is displayed in the bottom part of the screen. This feature helps place concentration points at appropriate locations.

3. Add a concentration point by clicking in or near a cell with the coordinates (1859845.18, 658073.87)
4. Move the concentration point to the correct point by typing in the coordinates in the Feature Point X and Y cells in the Properties window on the right of the screen.



2.5 Delineate Sub-area (Basin)

1. Select *DEM* | **Delineate Basins Wizard**.
2. Select **OK**.
3. After the *Units* dialog appears, set ***Basin Areas*** to *Acres* and select *OK*.

NOTE: Set Basin Areas units to square miles so that areas are computed in the correct units for a unit hydrograph (HEC-1) model or to Acres for a Rational analysis.

4. Toggle off the display of the DEM in the Project Explorer
5. Select the *Frame* macro

The sub-area (basin) will automatically be delineated and its area is displayed as shown in Figure 2-3.

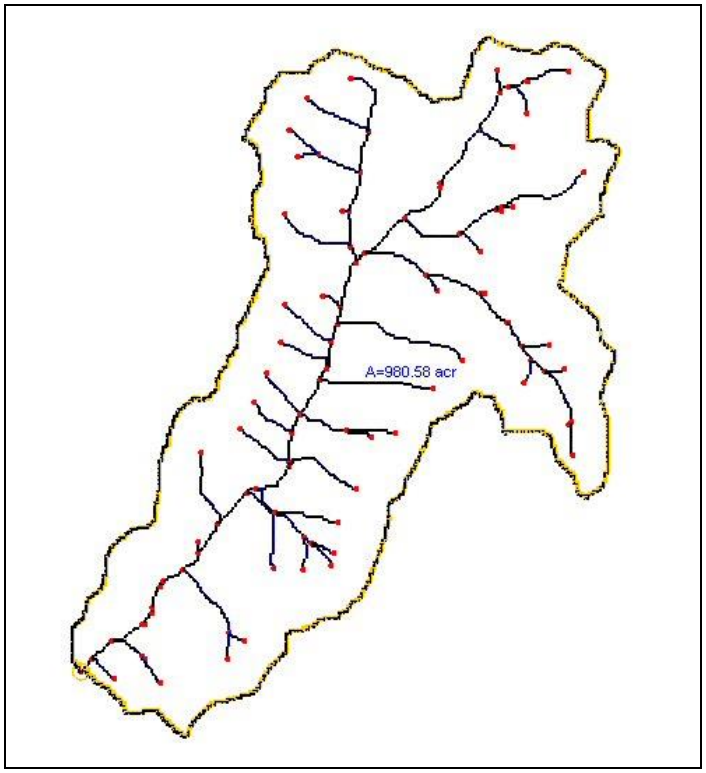
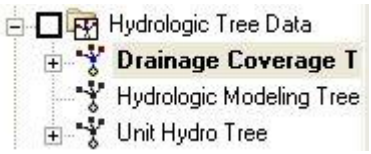


Figure 2-3: Delineated sub-area

3 Creating Multiple Models (Rational and Unit Hydrograph)

If performing both Rational and Unit Hydrograph analyses on the same watershed, it may be beneficial to create a second drainage coverage so that the Rational method can be performed using one while the Unit Hydrograph method is performed using the other. The two hydrologic models require different parameters for analysis.

1. Right-click on the Drainage coverage and select ***Duplicate***
2. Right-click on the Copy of Drainage coverage and select ***Rename***
3. Enter "Unit Hydro" for the coverage name
4. In the Hydrologic Tree Data folder of the Project Explorer right-click on the Copy of Drainage Coverage Tree and select ***Rename***
5. Enter "Unit Hydro Tree"
6. Switch to the *Hydrologic Modeling* module

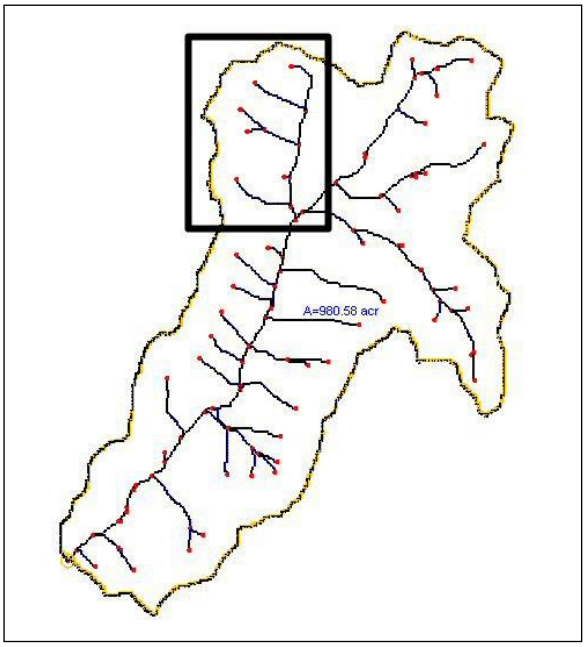


7. Select OC Hydrograph in the Model pull down menu at the top of the screen
8. In the Hydrologic Tree Data folder of the Project Explorer select the Drainage Coverage Tree to make it the active hydrologic tree
9. Select OC Rational in the Model pull down menu at the top of the screen

4 Creating Additional Sub-areas

When working with the rational method, the initial sub-area should be no more than 10 acres and have a flow path less than 330 feet. Succeeding sub-areas will gradually increase in size until reaching the final concentration point. In order to create additional sub-areas, the user merely needs to create the concentration points for each of the sub-areas and run the Delineate Basins Wizard.

4.1 Create Additional Concentration Points (Outlets)



1. Toggle off the Unit Hydro coverage in the Project Explorer
2. Select the Drainage coverage in the Project Explorer to make it active
3. Zoom in to the rectangle shown in the figure to the right.
4. Switch to the *Drainage* module 
5. Use the *Create Outlet Point* tool  to add concentration points at or near the locations shown in Table 4-1 (remember that it's always possible to add the concentration point and enter the exact coordinates in the Properties window on the right side of the screen):

Table 4-1: Concentration points

X	Y
1861174.92	660701.38
1861154.71	660581.42
1861144.65	660501.35
1861104.98	660319.40
1861084.98	659937.40

4.2 Delineate Sub-areas (Basins)

1. Select *DEM* | **Delineate Basins Wizard**

2. Select the **OK** button
3. Select **OK** *i*n the message to delete all existing feature data
4. Select **OK** on the *Units* dialog.

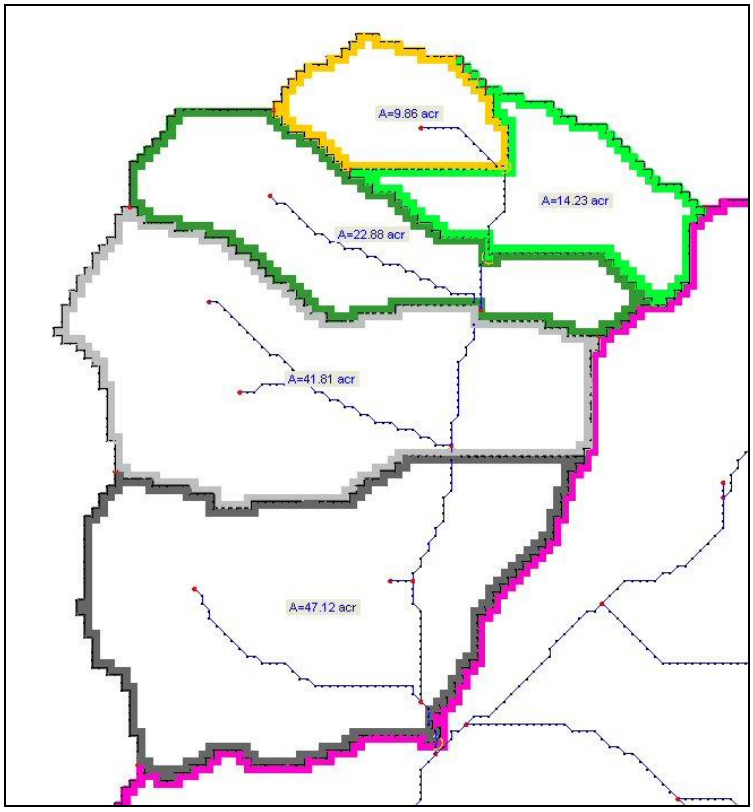


Figure 4-1: Multiple sub-areas

5 Computing Loss Rates

5.1 Add Land Use and Soil Type Coverages

1. Select the *Frame* macro 
2. Right-click on the Coverages folder in the Project Explorer and select **New Coverage**
3. Change the Coverage type to Land Use
4. Select **OK**
5. Right-click on the Coverages folder in the Project Explorer again and select **New Coverage**
6. Change the Coverage type to Soil Type
7. Select **OK**

5.2 Add Land Use Data

Land use data can come from many different sources. It is possible to digitize polygons representing different land use types using a background image/map or an aerial photograph. WMS also has tools for generating land use data from existing GIS data.

1. Ensure that the Land Use coverage is the active coverage by selecting it in the Project Explorer
2. Switch to the *GIS* module
3. Select *Data* | **Add Shapefile Data…**
4. Open *"niguellanduse.shp"*
5. Select *Mapping* | **Shapes → Feature Objects**
6. Select **Yes** to use all shapes in all visible shapefiles for mapping
7. Select **Next >**

Notice that the Level2 column is automatically mapped to the Level2 Mapping type and that the LU_CODE column is automatically mapped to the Land use Mapping type in WMS. This maps attributes in the shapefile database table to become attributes of the polygons that will be generated as feature objects.

8. Select **Next >**
9. Select **Finish**
10. Toggle off *niguellanduse.shp* in the Project Explorer

11. Switch to the *Map* module
12. Use the **Select Feature Polygon** tool to select any one of the land use polygons
13. Select *Feature Objects* | **Attributes…**
14. Toggle on *Percent impervious* in the Display parameters section

The Land use mapping dialog appears. This dialog shows the land use ID that was mapped from the shapefile to the polygon, but there is no curve number or percent impervious data for the land use IDs. Add this data by importing a land use table.

15. For Import file type choose Orange County Land use file
16. Click on the **Import** file button
17. Select **OK** on the overwrite message
18. Open *"ocland.txt"*

Notice that curve numbers and percent impervious values now exist for each land use ID.

19. Select **Close**

5.3 Add Soil Type Data

1. Make the Soil Type coverage the active coverage by selecting it in the Project Explorer

2. Switch to the *GIS* module
3. Select ***Data | Add Shapefile Data…***
4. Open *"Soilgroup_Bdy.shp"*

The Soilgroup_Bdy shapefile is a file that encompasses all of Orange County. Since this project is only concerned with a small portion of the county, only a small section needs to be converted to feature objects.

5. Select the *Select Shapes* tool
6. Use the mouse to drag a box that encompasses the area in question, which appears grey within the box shown in Figure 5-1.

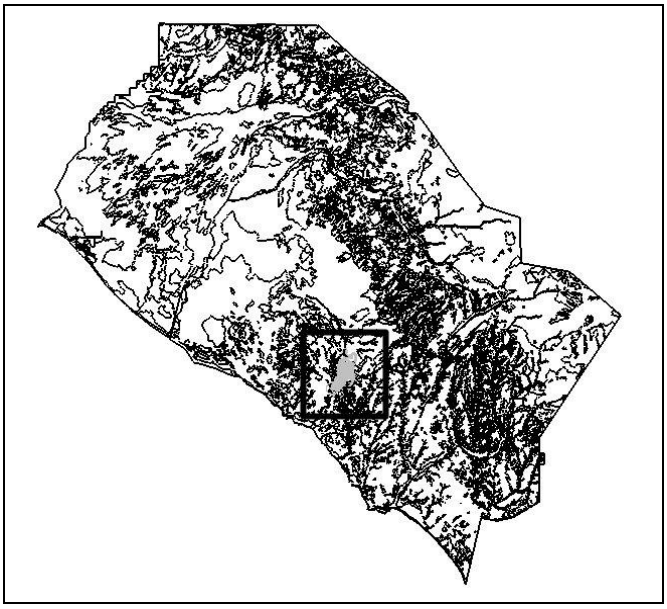
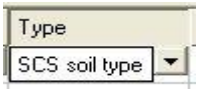


Figure 5-1: Selection for mapping soil type polygons

7. Select ***Mapping | Shapes -> Feature Objects***
8. Select Next >
9. the Type column choose SCS soil type for Mapping



10. In Select Next >
11. Select Finish
12. Toggle off *Soilgroup_Bdy.shp* in the Project Explorer

5.4 Compute GIS Attributes

1. Select the Drainage coverage to make it active
2. Switch to the *Hydrologic Modeling* module
3. Select ***Calculators | Compute GIS Attributes…***
4. Set Computation to Orange County Losses

5. Verify that the Soil Type coverage will be used for determining soil type and the Land Use coverage will be used for determining land use
6. Select OK
7. Accept the default filename for saving the GIS loss calculation details and select Save

5.5 View Results

1. Select ***File* | *Edit File…***
2. Open the newly saved file (*ocgiscalcs.txt*)
3. Select OK to open the file with Notepad, if prompted

This file contains a listing of the area attributed to each combination of land use and soil type within each sub-area.

4. Close the file
5. Toggle off the display of the Land Use and Soil Type coverages in the Project Explorer
6. Select the *Frame* macro 
7. Use to *Select Basin* tool  to select any one of the sub-basins
8. Select ***OC Rational* | *Edit Parameters…***

The ap, Fp, and Fm values computed using GIS data are displayed in the Losses section of the dialog. Select any of the other sub-areas to view its Losses values.

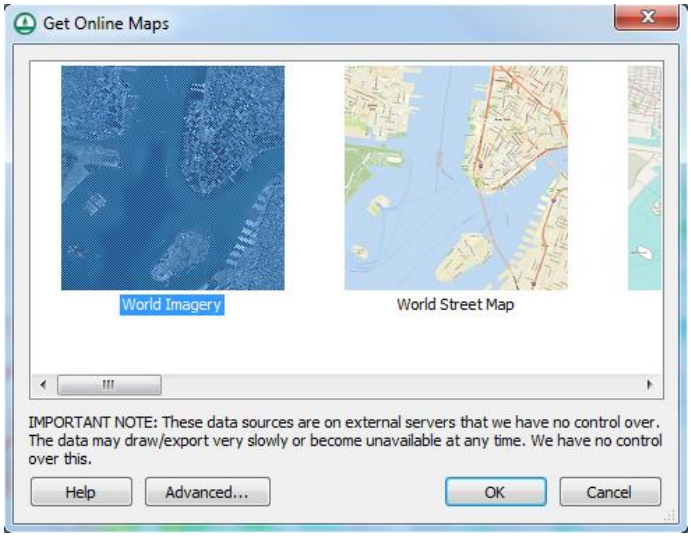
9. Select Done

6 Getting a Background Image Using Online Services

If unable to connect to the Internet, skip this section.

Using an Internet connection load a background image (Aerial photo or a topo map) for the project site. WMS uses built in web services tool to load such images.

1. Select the *Get Online Maps* tool  located in the *Add GIS Data* drop-down menu  in the Get Data menu bar. The *Get Online Maps* dialog will appear.
2. Select *World Imagery* and click *OK*.

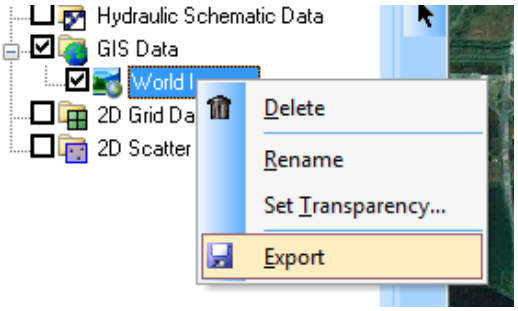


3. WMS will load the background image file. It will take few moments depending upon the internet connection. Once done, notice the aerial photo added to the background.

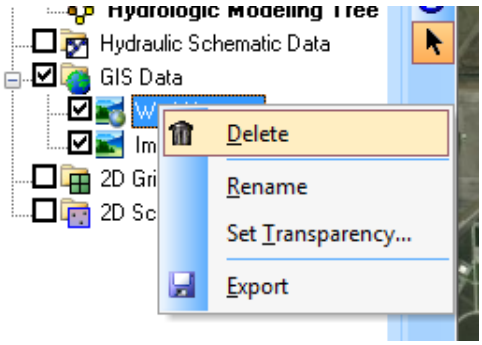
6.1 Create a local copy of the images

The loaded image is read in from the server and sometimes take longer time to zoom and pan around. Create a local copy of the image to expedite such navigations.

1. In the project explorer, under the *GIS Data* folder, right-click on the image and select **Export**.



2. Select **OK** to accept suggested value of *resample ratio.* A resample ratio of 1 means the image will have exactly as many pixels as it is being displayed on the screen. Increase the factor if needing a higher resolution image. But, note that it will take longer time to download.
3. WMS will download the image to the local drive. The download progress is shown.
4. Once the image is downloaded, remove the bigger online image (the one that has little *globe* on its icon). To do this, right-click on the online image under the *GIS Data* folder and select **Delete.**



7 Data Catalog

The remaining sections are to be completed only if the Orange County data files are accessible.

7.1 Open Background Image

1. Select *File* | **New**
2. Select **No** if prompted to save changes to the project
3. Select *File* | **Open…**
4. Open "OCMap.tif"

7.2 Get Data

1. Select the **Get Data** tool
2. Drag a box over a location on the map in Orange County
3. Choose the *Catalog* option
4. Click on the **Browse…** button
5. Open "OCCatalog.txt"
6. Toggle on *DEM Data*
7. Change *Resolution* to 10 Meter
8. Toggle on *Image – Topo*
9. Toggle on *Shapefile – Soil Type*
10. Select **OK**
11. Select **OK** to read in DEMs

8 Conclusion

In this exercise, WMS was used to automate sub-area delineation with a Digital Elevation Model (DEM) for rational and unit hydrograph analyses and shows how to compute Orange County loss rates (Fm and Ybar) with soil type and land use GIS data.

If desired, continue to experiment with WMS or exit the program.