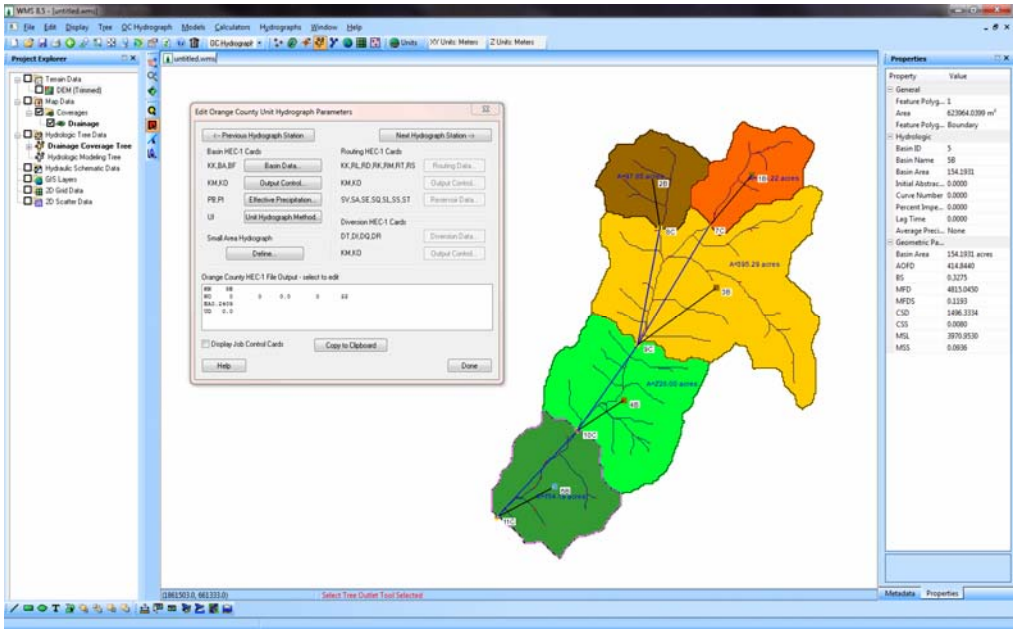
WMS

v. 8.4

WMS 8.4 Tutorial

Modeling – Orange County Rational Method –GIS

Learn how to define a rational method hydrologic model for Orange County (California) from GIS data



Objectives

This tutorial shows you how to define a map-based Orange County unit hydrograph model in WMS using pre-delineated watershed boundaries in CAD format. You learn how to correlate the imported boundaries with a DEM and to extract information you need to run the Orange County unit hydrograph model.

Prerequisite Tutorials

- Watershed Modeling – Advanced DEM Delineation Techniques

Required Components

- Data
- Drainage
- Map
- Hydrology
- Hydrologic Models

Time

- 45-60 minutes

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2 Introduction

An Orange County unit hydrograph analysis is performed by entering job control parameters, defining a storm event, and then entering parameters associated with each drainage sub-area in order to run a HEC-1 simulation. Effective precipitation is computed by selecting the event type and applying losses, which can be calculated by overlaying data on soil type and land use coverages with the drainage basin boundary. Routing data is entered at drainage outlets (concentration points). It is possible to use GIS data in WMS to expedite the development of spatial data, which plays an integral part in the modeling process.

3 GIS Data

3.1 CAD Data

1. Close all instances of WMS

2. Open WMS
3. Switch to the *Map* module
4. Select ***File* | *Open…***
5. Locate the folder ***C:\WMS80\tutorial\OrangeCounty\UnitHydro***
6. Open "*NiguelCreek.dxf*"
7. Select ***CAD* | *CAD -> Feature Objects***
8. Select OK
9. Change Name to "Drainage"
10. Select OK
11. Toggle off the display of the CAD Data folder in the Project Explorer
12. Use the *Select Feature Arc* tool to select the top stream arc indicated in Figure 3-1

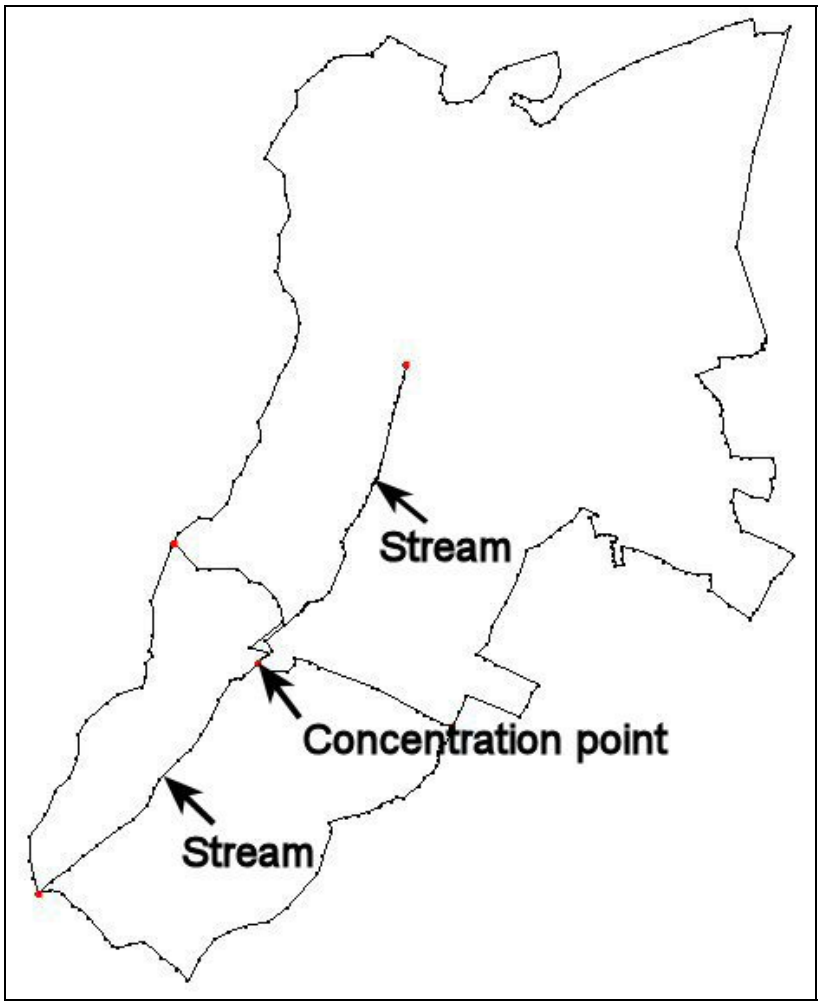


Figure 3-1: GIS data representing sub-areas, streams, and concentration points

13. Select ***Feature Objects* | *Attributes…***

14. Change the Type to Stream
15. Select OK
16. Use the *Select Feature Point/Node* tool to select the concentration point labeled in Figure 3-1
17. Select ***Feature Objects* | *Attributes…***
18. Change the type to Drainage outlet
19. *Select* OK
20. Use the *Select Feature Arc* tool to select the bottom stream arc indicated in Figure 3-1
21. Select ***Feature Objects* | *Attributes…***
22. Change the Type to Stream
23. Select OK
24. Select ***Feature Objects* | *Build Polygon***
25. Select OK to use all arcs

3.2 DEM Data

1. Select ***File* | *Open…***
2. Open *"LagunaBeach.asc"* and *"SanJuanCapistrano.asc"*
3. Select OK
4. Zoom in around the background image and sub-area boundaries
5. Switch to the *Terrain Data* module
6. Select ***DEM* | *Trim* | *Polygon…***
7. Choose Enter a polygon interactively
8. Select OK
9. Use the left mouse button to click points and create a polygon that encompasses the background image and sub-area boundaries. Double-click on the last point to end the polygon and trim the DEM.
10. Switch to the *Drainage* module
11. Select ***DEM* | *Polygon Basin IDs -> DEM***
12. Select ***DEM* | *Compute Basin Data***
13. Click on the Current Coordinates button
14. Change Horizontal System to State Plane NAD 83 (US)
15. Change St. Plane Zone to California 6 – 0406
16. Verify that the Horizontal and Vertical Units are Meters
17. Select OK

18. In the Parameters units section of the dialog verify that Basin Areas are Square miles and Distances are Feet
19. Select OK
20. Toggle off the display of the DEM in the Project Explorer

Skip section 3.3 if you are not able to connect to the Internet using your computer.

3.3 Getting a Background Image Using the TerraServer

Using an Internet connection we will now download the aerial map image directly from the TerraServer and open it in WMS.

1. Select the Get Data tool 
2. Drag a box around the extents of the area to define the region of the image
3. Toggle on the TerraServer aerial photo option
4. Select OK to start the downloading process
5. Enter *"Niguelaerial.jpg"* and click Save
6. Accept the suggested resolution by selecting *OK*. It may take 30 seconds to one minute to complete the downloading process.

WMS will automatically open the image after downloading it.

3.4 Background Image

We will open a nice looking color image. You can choose to use either this image or the image downloaded in the previous section.

1. Select ***File | Open…*** 
2. Open "*NiguelCreek.jpg*"

3.5 Land Use Data

1. Right-click on the Coverages folder in the Project Explorer and select ***New Coverage***
2. Change the Coverage type to Land Use
3. Select OK
4. Switch to the *GIS* module 
5. Select ***Data | Add Shapefile Data…***
6. Open *"niguellanduse.shp"*
7. Select ***Mapping | Shapes -> Feature Objects***
8. Select Yes to use all visible shapefiles for mapping
9. Select Next >

10. Select Next >
11. Select Finish
12. Toggle off the display *of niguellanduse.shp* in the Project Explorer

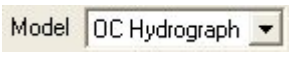
3.6 Soil Type Data

1. Right-click on the Coverages folder in the Project Explorer and select ***New Coverage***
2. Change the Coverage type to Soil Type
3. Select OK
4. Select ***Data | Add Shapefile Data…***
5. Open *"Soilgroup_bdy.shp"*
6. Zoom in around background image and the sub-area boundaries
7. Use the *Select Shapes* tool  to drag a box that encompasses the background image and sub-area boundaries
8. Select ***Mapping | Shapes -> Feature Objects***
9. Select Next >
10. In the Type column choose SCS soil type for Mapping
11. Select Next >
12. Select Finish
13. Toggle off the display of *Soilgroup_Bdy.shp* in the Project Explorer
14. Select ***File | Save*** 
15. For File name enter "NiguelExample.wpr" and select Save to save a WMS project file
16. Select No to saving image files in the project directory

4 Global Unit Hydrograph Parameters

4.1 Enter Job Control Parameters

1. Select the Drainage coverage to make it active in the Project Explorer
2. Switch to the *Hydrologic Modeling* module 



3. Make sure that the Model combo box at the top of the screen is set to OC Hydrograph
4. Select ***OC Hydrograph | Job Control…***
5. For Computational time interval (min) enter 5

This value defines the computational time interval that will be used for computing the storm distribution and unit hydrograph.

6. Change the Number of hydrograph ordinates to 300
7. Toggle on Expected value (50% confidence interval)
8. Select OK

4.2 Compute Losses

The Compute GIS Attributes dialog will automatically appear because there is GIS data in WMS and you toggled on Expected value in the Job Control dialog. The expected value toggle changes the precipitation input, which affects loss calculations.

1. 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
2. Click on the Import button
3. Select OK to overwrite the current land use table, which is displayed in the Mapping section of the Compute GIS Attributes dialog
4. Open *"ocland.tbl"*
5. Select OK
6. Choose a filename for saving the GIS loss calculation details and select Save

The GIS calculator computes losses by overlaying the soil type and land use coverages with the drainage coverage and using the percent impervious and curve number values in the land use mapping table to compute composite Fm and Ybar loss values. A land use mapping table of curve numbers representing the proper antecedent moisture condition (AMI I, AMC II, or AMC III) should be used.

4.3 Define Storm

1. Select ***OC Hydrograph | Define Storm…***
2. Change the Frequency to ***100*** *year*

This is the storm event that will be used to compute the effective precipitation.

3. Select OK

The Compute GIS Data dialog will automatically appear again because changing the storm frequency also changes the precipitation input, which alters loss calculations.

4. Select OK
5. Choose a filename for saving the GIS loss calculation details and select Save

5 Sub-area Parameters

5.1 Basin Data – Upper

1. Toggle off the display of the Land Use and Soil Type coverages and the *Images* folder in the Project Explorer

2. Select the *Frame* macro 
3. Use the *Select Basin* tool  to select the upper sub-area
4. Select ***OC Hydrograph | Edit Parameters…***
5. Click the Basin Data… button to edit sub-area parameters including name, area, and base flow
6. For Basin name enter "Upper"
7. Select OK

5.2 Effective Precipitation – Upper

1. Click the Effective Precipitation… button

The computational time interval (min) from the Job Control is displayed.

2. Click the Compute Mountainous button to compute the fraction of terrain that is above 2000 ft in order to use weighted precipitation values. The Compute button will compute this value only if a digital terrain model (DTM) exists.

The point precipitation and area-reduction factors to be used in computing the effective precipitation are displayed in a spreadsheet.

If precipitation values change (from computing the Mountainous fraction) or losses are not yet computed, click the Compute Losses button to use the GIS calculator to compute losses. This command only needs to be done once because composite loss values for each drainage sub-area are computed.

3. Click the Next -> button

A plot of the effective precipitation is displayed. Right-click on the plot in order to view values or maximize the display of the plot.

4. Select Done

5.3 Unit Hydrograph – Upper

1. Click the Unit Hydrograph Method… button
2. Enter a Lag time of 0.209 hours

The time of concentration (hours) will automatically be computed as lag time divided by 0.8.

The time of concentration that is entered here will generally come from the Rational method analysis of the same drainage sub-area.

3. Toggle on Valley developed and enter 0.78
4. Toggle on Valley undeveloped and enter 0.22

A unit hydrograph can be calculated by using any combination of weighted S-graphs.

5. Click the Plot Unit Hydrograph button to compute and display the unit hydrograph

Right-click on the plot in order to view values or maximize the display of the plot.

6. Select OK to recompute the unit hydrograph using the currently displayed values in the dialog

You can scroll through and view the HEC-1 cards that are written in the bottom of the Edit Orange County HEC-1 Parameters dialog.

5.4 Basin Data – Lower

1. Use the *Select Basin* tool to select the lower sub-area. You may need to move the Edit Orange County HEC-1 Parameters dialog around on the screen in order to view and select the sub-area.
2. Click the Basin Data… button to edit sub-area parameters including name, area, and base flow
3. For Basin name enter "Lower"
4. Select OK

5.5 Effective Precipitation – Lower

1. Click the Effective Precipitation… button
2. Select Next ->
3. Select Done

5.6 Unit Hydrograph – Lower

1. Click the Unit Hydrograph Method… button
2. Enter a Lag time of 0.261 hours
3. Toggle on Valley developed and enter 0.11
4. Toggle on Valley undeveloped and enter 0.89
5. Select OK

6 Concentration Point Data (Routing)

6.1 Edit Parameters

1. Select the concentration point for the lower sub-area
2. Click on the Routing Data button
3. Change the Routing name to "1.16R"
4. Change the Combining name to "1.16C"
5. Select OK

6.2 Convex Routing

1. Select the concentration point for the upper sub-area

2. Click on the Routing Data button to define routing
3. Change the Routing name to "1.14R"
4. Change the Combining name to "1.14C"
5. For Routing type select Convex (RV)

Notice that geometric parameters such as channel length and slope are automatically computed when you compute basin data and a digital terrain model exists.

6. Enter a N value of 0.035
7. Enter a WD value of 1.0
8. Enter a Z value of 5.0
9. Select OK
10. Select Done in the Edit Orange County Unit Hydrograph Parameters dialog

6.3 Storage Routing (Modified Puls)

1. Select ***Tree | Add | Reservoir***
2. Double-click on the concentration point labeled 1.14C
3. Click on the Reservoir Data… button
4. Choose Reservoir and click on the Define button
5. In the Outflow section of the dialog choose Known outflow
6. Toggle on SE and click on the Define button
7. Enter the values in the Elevation column of Table 6-1 (Notice there is no data for an elevation of 10)

Table 6-1: Elevation, storage, discharge values

Elevation (SE)	Outflow (SQ)	Volume (SV)
0.0	0.0	0.0
1.0	5.0	2.0
2.0	10.0	4.0
3.0	16.0	6.0
4.0	19.0	8.0
5.0	22.0	10.0
6.0	24.0	12.0
7.0	26.0	14.0
8.0	28.0	17.0
9.0	30.0	20.0
11.0	33.0	24.0
12.0	35.0	28.0
13.0	35.02	30.0
14.0	139.0	32.0
15.0	319.0	36.0
16.0	440.0	38.0
17.0	477.0	40.0

Elevation (SE)	Outflow (SQ)	Volume (SV)
18.0	545.0	44.0
19.0	632.0	48.0
20.0	736.0	52.0

8. Select OK
9. Toggle on SQ and click the Define button
10. Enter the values in the Outflow column of Table 6-1
11. Select OK
12. In the Volume section of the dialog choose Known volume
13. Toggle on SE and click the Define button
14. Change the Selected curve to 1.14C Outflow elev
15. Select OK
16. Toggle on SV and click the Define button
17. Enter the values in the Volume column of Table 6-1
18. Select OK
19. Select OK in the HEC-1 Reservoir Routing Options dialog
20. Select OK in the Reservoir Routing Data dialog
21. Select Done in the Edit Orange County Unit Hydrograph Parameters dialog

7 Running the Simulation

1. Select ***OC Hydrograph | Run Simulation…***
2. Click the browse button  next to the Input File
3. Enter a filename and click Save (this specifies the file name but does not actually save it)
4. Verify that the Save file before run is toggled on
5. Select OK
6. Select Close once HEC-1 finishes running (you may have to wait a few seconds to a minute or so)
7. Double-click on a hydrograph window to view the hydrograph in the plot window. Use the SHIFT key to select multiple hydrographs to view at once. Draw a smooth curve using these hydrograph ordinates in order to determine the peak discharge at outlined on page E-40 of the Orange County Hydrology Manual.

8 Multi-day Storm Event

8.1 Define Storm

1. Select ***OC Hydrograph | Define Storm…***
2. Change Event type to Multi-day event with flow-through detention
3. Select OK
4. Select OK to recompute Orange County losses
5. Choose a filename for saving the GIS loss calculation details and select Save
6. Select Yes to recompute effective precipitation for sub-areas

8.2 Job Control

1. Select ***OC Hydrograph | Job Control…***
2. Change Number of hydrograph ordinates to 600
3. Select OK

8.3 Run Simulation

1. Select ***Hydrographs | Delete All***
2. Select ***OC Hydrograph | Run Simulation…***
3. Click the browse button  next to the Input File
4. Enter a filename and click Save (this specifies the file name but does not actually save it)
5. Verify that the Save file before run is toggled on
6. Select OK
7. Select Close once HEC-1 finishes running (you may have to wait a few seconds to a minute or so)
8. Double-click on a hydrograph window to view the hydrograph in the plot window. Use the SHIFT key to select multiple hydrographs to view at once.