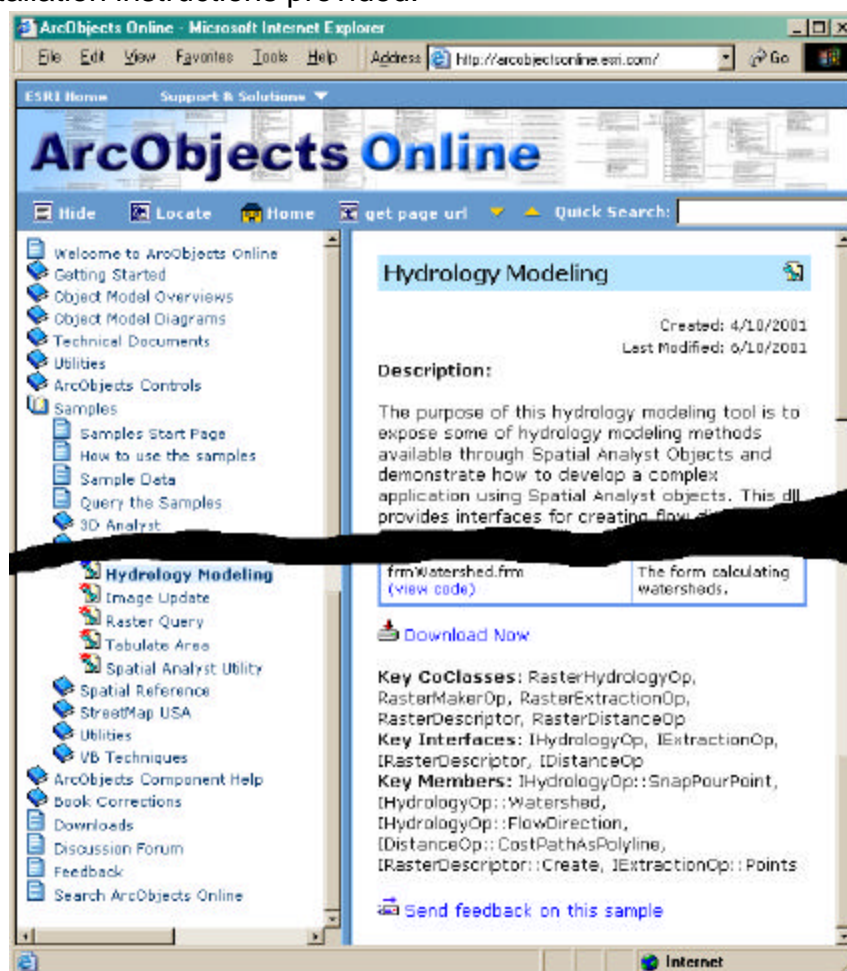


Creating Watersheds from a DEM

These instructions enable you to create watersheds of specified area using a good quality Digital Elevation Model (DEM) in ArcGIS 8.1. The modeling is performed in ArcMap with the aid of the Spatial Analyst and Hydrology Modeling extensions.

You may need to download the Hydrology Modeling extension from <http://arcobjectsonline.esri.com/>. Locate SAMPLES → SPATIAL ANALYST → HYDROLOGY MODELING in the Table of Contents (left side of the web page). Scroll down on the right side of the web page to access the DOWNLOAD NOW link. Read and follow the installation instructions provided.



This procedure is useful if you wish to delineate topographic boundaries based on drainage basins in your study area. In the example provided, watersheds that have a minimum area of 200 square kilometers (or 20,000 X100 m cells) are used.

The following lists the data layers used for this instruction set (simply substitute your file names):

ORIGINAL DATA THEME**DEM**

- a raster grid coverage of elevation information for the study area – 100 m cells

Boundary.shp

- a polygon shapefile of administrative area

CREATED DATA THEMES**Fill**

- a raster grid coverage of a “depressionless” DEM that has had all the sinks filled

Direction

- a raster grid coverage indicating the direction of flow for each cell based on the elevation of neighboring cells

Accumulation

- a raster grid coverage indicating where water is likely to accumulate into a drainage network

Watersheds

- a raster grid coverage of drainage basins or watersheds of specified minimum cell count (area)

Watersheds.shp

- a polygon shapefile resulting from the conversion of the watershed grid

Start the ArcMap document

1. Open ARCMAP
2. ADD DATA: **DEM** and **Boundary.shp**
3. Modify the SYMBOLOGY as appropriate
4. Choose VIEW → DATA FRAME PROPERTIES... and set the Map and Display units under the GENERAL tab as appropriate (e.g. **meters**)
5. Click OK

Enable the required extensions:

First, enable the Spatial Analyst extension.

6. Choose TOOLS → EXTENSIONS
7. Click a check beside Spatial Analyst
8. Click CLOSE

Next, make the toolbar visible.

9. Choose VIEW → TOOLBARS → SPATIAL ANALYST



10. If not already installed, follow the instructions provided at the download page for the Hydrology Modeling extension at <http://arcobjectsonline.esri.com/>

Make the Hydrology Modeling toolbar visible.

11. Choose VIEW → TOOLBARS → HYDROLOGY MODELING



12. Position the toolbars where you want within the document

Set up the Analysis Options:

13. Choose SPATIAL ANALYST → OPTIONS
14. Under the GENERAL tab set the Working directory to where you want to save your files (e.g. **C:\WorkSpace\hydro**)

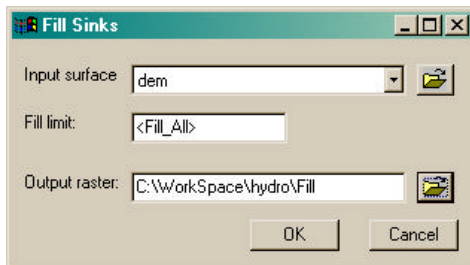
In the event that you want to restrict the watershed modeling to within the exact extent of the Boundary.shp layer, then set the ANALYSIS MASK to Boundary.shp; otherwise leave this as “None” as used in this example.

15. Save the ArcMap document (e.g. **C:\WorkSpace\hydro\Watersheds.mxd**)

Perform the Hydrology Modeling tasks

The following four steps are performed in sequence to model watersheds from the DEM using the Hydrology Modeling toolbar:

- Fill the sinks in the DEM to create a depressionless surface
- Calculate the direction of flow for each cell
- Calculate the flow accumulation
- Calculate the watersheds based on minimum cell count

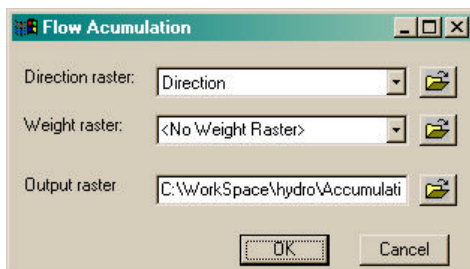
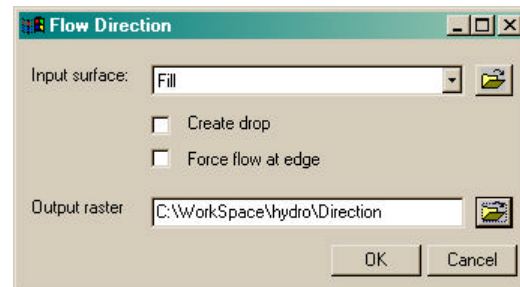


Fill the sinks:

1. Choose HYDROLOGY → FILL SINKS...
2. Select **DEM** as the input surface
3. Specify an output file (e.g. **C:\WorkSpace\hydro\Fill**)
4. Keep Fill Limit at the default to fill all
5. Click OK

Calculate flow direction:

6. Choose HYDROLOGY → FLOW DIRECTION...
7. Select **Fill** as the input surface
8. Specify an output file (e.g. **C:\WorkSpace\hydro\Direction**)
9. Optionally, set the other parameters
10. Click OK

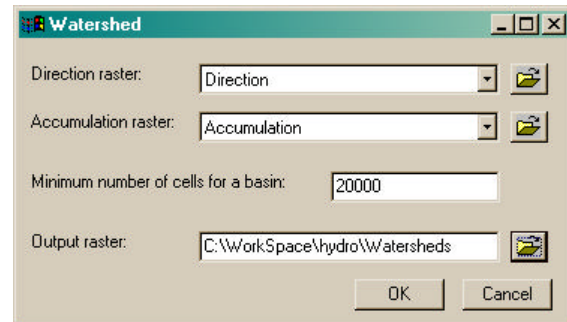


Calculate flow accumulation:

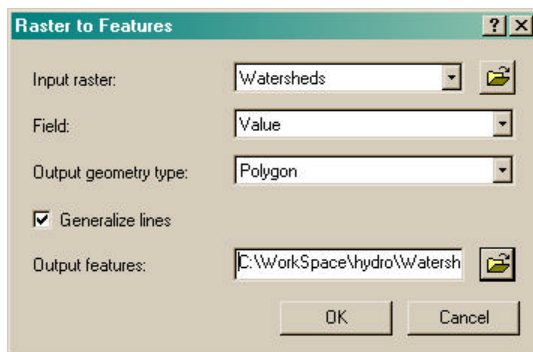
11. Choose HYDROLOGY → FLOW ACCUMULATION...
12. Select **Direction** as the direction raster
13. Specify an output file (e.g. **C:\WorkSpace\hydro\Accumulation**)
14. Optionally, specify a Weight Raster
15. Click OK

Calculate watersheds:

16. Choose HYDROLOGY → WATERSHEDS...
17. Select **Direction** and **Accumulation** as the input layers
18. Specify the Minimum Number of Cells for a Basin (e.g. **20000**)
19. Specify an output file (e.g. **C:\Workspace\hydro\Watersheds**)
20. Click OK



This example yields 26 watershed basins that have at least 20,000 cells (200 square kilometers). You may wish to experiment with different cell minimums on your data by repeating the above steps 16 through 20 to create your watersheds.

Convert to polygon shapefile and “clip” to the boundary

1. Choose SPATIAL → CONVERT → RASTER TO FEATURES
2. Select the **Watersheds** grid layer as the input raster
3. Use **Value** as the Field and **Polygon** as the Output Geometry Type
4. Optionally, choose to Generalize Lines
5. Specify a new output shapefile (e.g. **C:\Workspace\hydro\Watersheds.shp**)
6. Click OK

“Clip” the shapefile by Boundary.shp:

The following suggests two methods for selecting watersheds within your study area boundary; choose one that makes the most sense for your objective.

This step is only necessary if you did NOT set the Analysis Mask when you set up the map document. This example assumes not.

FIRST METHOD: Geoprocessing Wizard – Clip

7. Choose TOOLS → GEOPROCESSING WIZARD...
8. Select CLIP as the overlay procedure to use
9. Select **Watersheds** as the input layer
10. Select **Boundary** as the overlay clip layer
11. Specify a new output file (e.g. **C:\Workspace\hydro\WatershedClip.shp**)
12. Click OK


SECOND METHOD: Select by Location and Export Data

13. Choose SELECTION → SELECT BY LOCATION

14. Enter the following to complete the selection expression:

- select features from
- Watersheds
- that are contained by
- Boundary

15. Click APPLY

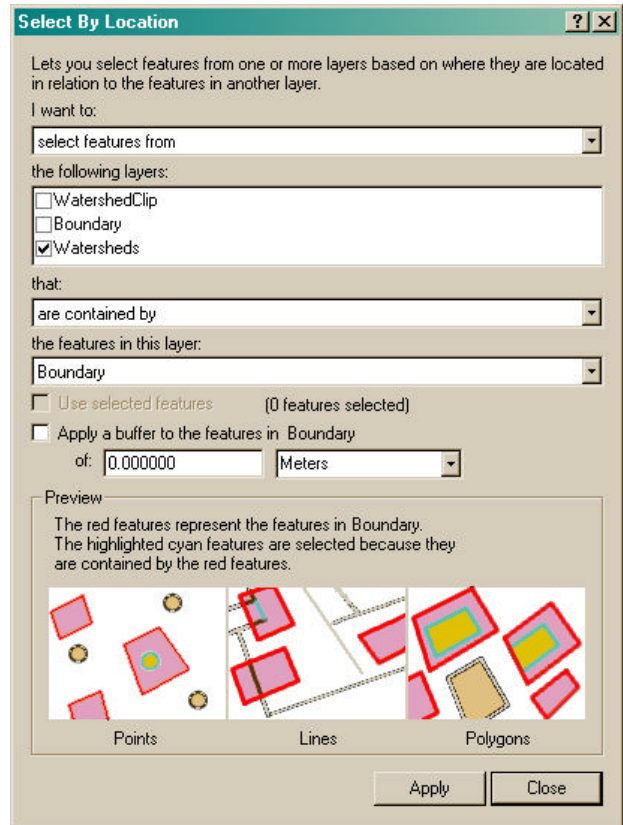
16. Optionally, hold the  SHIFT key and use the SELECT FEATURES tool to interactively select additional watersheds that may mostly inside the boundary

17. In the table of contents, right-click on **Watersheds.shp**

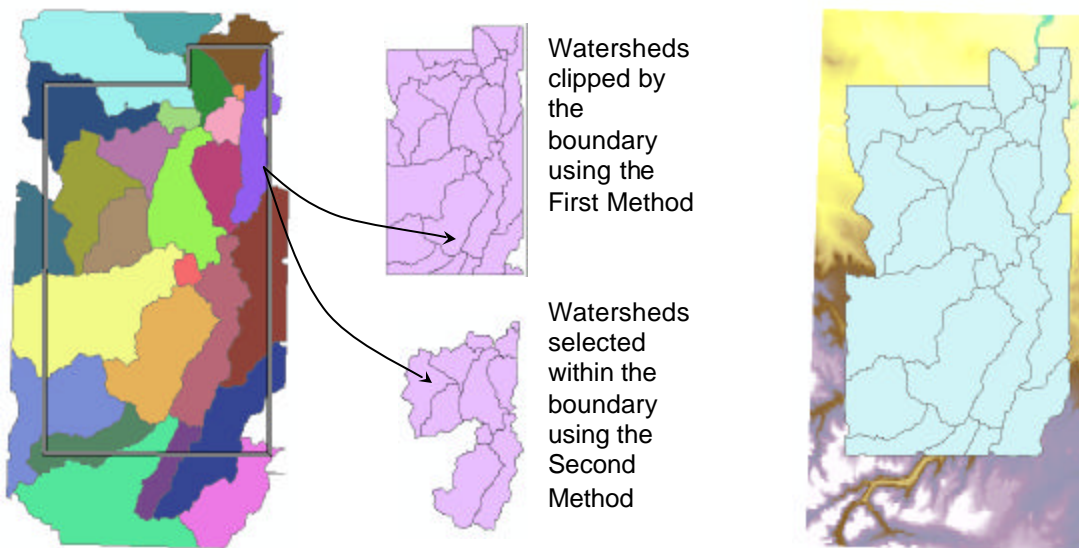
18. Select DATA → EXPORT...

19. Export Selected Features and specify a new output file (e.g. **WatershedSelect.shp**)

20. Click OK



The result of the first clipping method, gives you watersheds that are physically intersected by the extent of the study area boundary. The second method yields watersheds that are contained by the study area boundary. Why you may wish to “clip” the watersheds to a study area boundary is apparent if you have limited data within an arbitrary or administrative area (e.g. FMA or municipality). Otherwise, you may opt to use the entire DEM (i.e. do NOT set the Analysis Mask) if data limitations are not an issue. Your watersheds are now ready for your analyses...



Watersheds for the entire DEM plus the boundary

Watersheds forced within the boundary mask