

Building a Stream Network in ArcGIS Pro

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Methodology adapted from Venkatesh Merwade, Purdue University

Adapted for an ArcGIS Pro workflow by Jenna Epstein, University of Pennsylvania

Overview

This exercise is designed to demonstrate how the hydrology tools in ArcGIS Pro allow you to turn a digital elevation model (DEM) into an ordered network of streams and watersheds. The Spatial Analyst toolbox in ArcGIS Pro has a suite of [specific tools](#) built for watershed delineation – and this task remains one of its most effective uses.

Many tools will be used throughout this exercise. Use the “Geoprocessing” pane to search for each tool as it is needed.

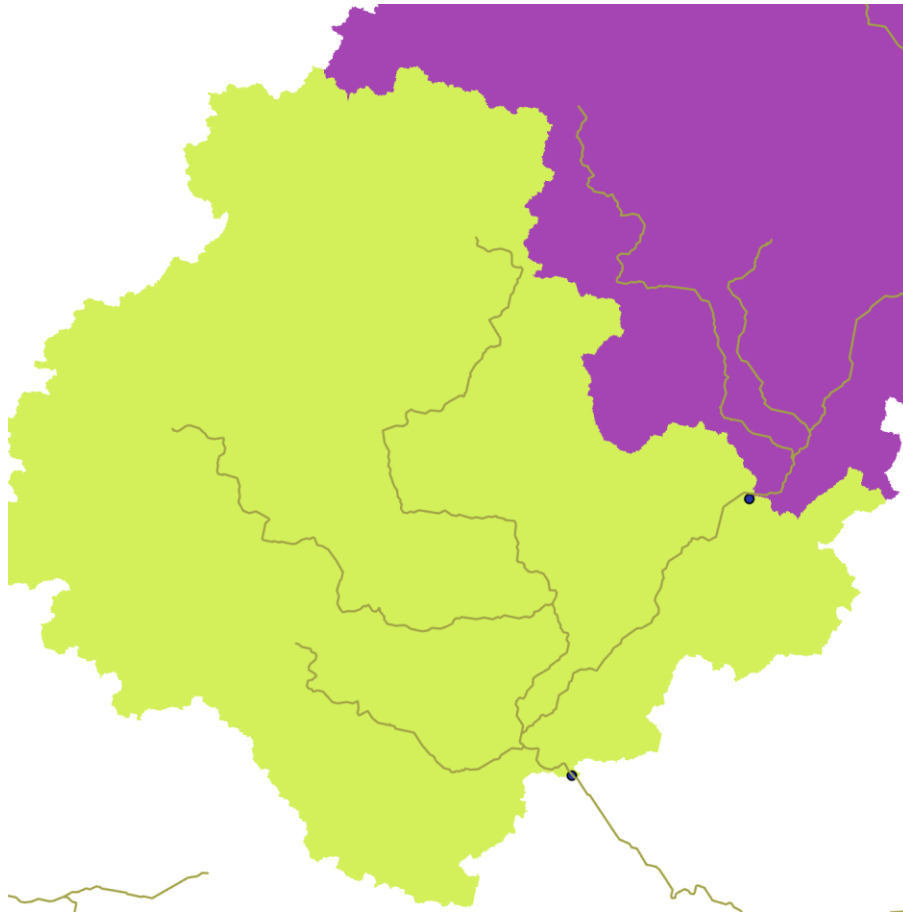
Steps

Before you begin, download the week 4 data. Then, create a new project in ArcGIS Pro and add a connection to your week 4 folder.

1. Start with **cedar_dem** – the same elevation raster we used last week.
 - a. Examine the data set to determine the max and min elevation.
2. Fill sinks using the “**fill**” function. Let’s call our output **cedar_fill**
 - a. If there are natural sinks (e.g, 10m deep lake), you can set the “Z limit” to a certain depth retain these features.
3. Next, we calculate **Flow Direction**. Call this raster **cedar_fdr**.
4. Calculate **Flow Accumulation**. Call this raster **cedar_fac**. Change the output data type to **integer**.
5. Create a raster attribute table using the **Build Raster Attribute Table** tool. Leave the options boxes for “overwrite” and “convert colormap” unchecked.
6. Now we build the stream network.
 - a. Let’s assume a drainage threshold of 25km².
 - b. We figure out which grid cells represent a drainage of this area or more using some arithmetic - $(25000000/(30*30)) = 27,777$ cells
 - c. How would we get all the cells that are 27,777 or more? In this case we’re going to use the **Set Null** tool using the input raster **cedar_fac**.
 - i. For the “Expression,” input the following: `VALUE < 27778`. This sets any value less than 27777 to NoData and anything greater to ‘1’.
 - ii. Set the “false raster or constant value” equal to 1.
 - iii. Let’s name our output **stream**

- d. What are some factors that affect how you would choose a threshold? For info on criteria for stream “thresholds,” consult [Tarboton et al., 1991](#).
7. Next, we need to assign a unique number of each stream segment or “link”. Use the **stream link** tool. Set the input to **stream** and the flow direction raster to **cedar_fdr**. Let’s call our output **str_lnk**.
 - a. To see what’s happening, set NoData to black and use red as the stretched color.
8. Next we create stream basins – our watersheds. The **Basin** tool uses the flow direction grid to find all sets of connected cells that belong to the same drainage basin
 - a. This tool takes **cedar_fdr**. Call the output **cedar_basin**.
 - b. Look at the edges – has something gone wrong?
9. Next we convert these basins to polygons using **Raster to Polygon**. Call the output **cedar_boundary.shp** and check the “simplify polygons” box.
10. Now we start to build a hierarchy of streams using the **Stream Order** tool.
 - a. Use **stream** as our input stream raster and **cedar_fdr** as our direction raster. We call our output **str_order**. Let’s set the method to “STRAHLER”
 - b. Examine the output - what is this telling us?
11. Now let’s convert our stream network to polyline with the **Stream to Feature** tool. This tool can be used to turn any of our stream-related grids into polylines.
 - a. The input raster is **stream**, the flow direction raster is **cedar_fdr**. Call the output **stream.shp** and check the option to “simplify polylines.”
 - b. Check out the attribute table. What information do you see?
 - c. What is the total length of streams in the study area?
12. We use the **Flow Length** tool to calculate the distance from each cell to the most downstream cell.
 - a. Our flow direction raster is **cedar_fdr**. We will call our output raster **cedar_len**. Set the direction of measurement to DOWNSTREAM.
 - b. Visualize as quantiles to see what our data look like.
 - c. What is the roughly the farthest distance in miles that a water drop will travel?
13. Let’s say we have a point of interest where we want to assess water quality or volume from upstream. This is called a pour point.
 - a. Grab **point.shp** from the data folder. Notice that these points are not quite on the stream line. Why might this be?

- b. Fix these irregularities with the **Snap Pour Point** tool. Before you run this, make sure the processing extent in the environments is set to **cedar_dem**.
 - c. Now, run the tool. Use **point.shp** as your input, use **cedar_fac** as the accumulation raster, and set the Pour point field to "Id". We will call our output **snap_pt**. Set the snap distance to 200m.
 - d. If you zoom in on the point, you will see the grid cell.
14. We can subsequently assess the watershed upstream of our snapped point using the **Watershed** tool.
- a. Use **cedar_fdr** as your input flow direction raster and **snap_pt** as your pour point data. Set the pour point field to "VALUE" and call your output **watershed**.
 - b. What do you make of the map? If your watersheds seem small, check your processing extent.



15. If you plan to use a process like this on a regular basis, consider using the "model builder" in ArcGIS to automate the whole process.