

# How to use SA for Hydrology

M. Boucher, 2023-08-14

## Delineating watersheds

These are instructions on how to delineate watersheds in GIS using a DEM (Digital Elevation Model raster dataset). The tools used below are in the Spatial Analyst Toolbox and in the Conversion Toolbox.

Create a polygon mask around the watershed being generous to have a buffer around where you think the watershed boundary is. Name it “**mask**”. Make the mask bigger than what you think the watershed boundary is and the mask.

Using “Extract by Mask” (1) and extract from the DEM the area covered by the mask. Name the output “**rawdem**”

Use the “Fill” tool (2) to fill the sinks in the DEM. Name the output “**fil**”

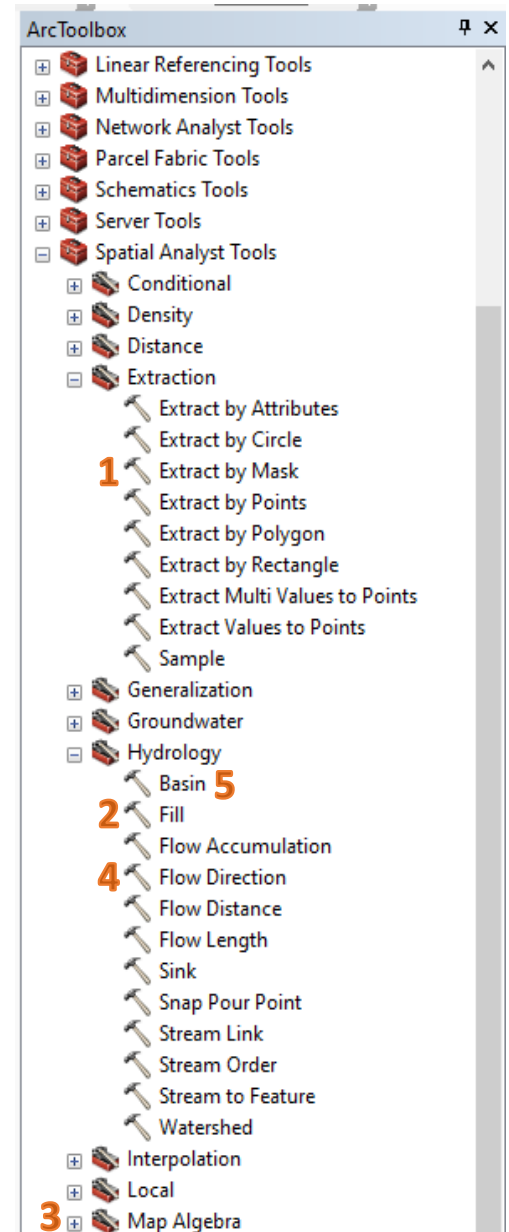
You can use the “Minus” (3) tool in the Map Algebra Toolbox bar to subtract DEM from fil. Name it “**minus**”.

Change the symbology of minus to make the zero values “null” in color.

Examine the areas that are filled in and make sure you agree and understand what was filled. If there are areas that are filled and shouldn't be, you may need to add an “agrestreams” layer (a default layer name in Arc Hydro) and burn streams into your DEM. This is a procedure that is part of the Arc Hydro workflow, but it can be accomplished “manually”. The burning streams process is explained in the next section.

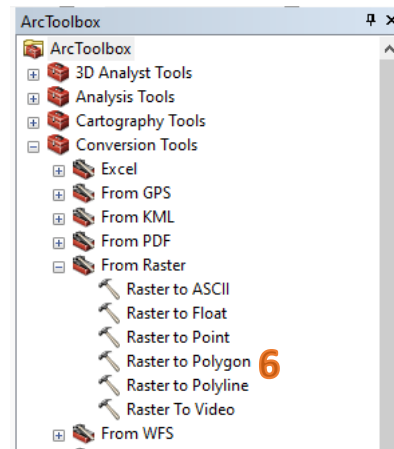
Use Flow Direction tool (4). Name it “**fdr**”.

Use “Basin” tool (5). Name it “**basin**”.



Use the Raster to Polygon Conversion tool (6). to convert the basin raster to polygons. Name it “watershed”

At this point, you should have watersheds delineated. You should examine these watersheds to make sure they make sense. If there are a lot of storm drain lines in the watershed, the boundaries of the watershed may not match what happens in reality.



## Burning Streams

Burning streams is a process of modifying the DEM to lower DEM raster cells that block the flow. These raster cells or grids can appear at road crossings, underground storm drains, and dams. Arc Hydro uses the term “rawdem” for the original DEM used in the process.

In the Arc Hydro process, the step of lowering these grid points where needed in the rawdem is called “**burning streams**”. Basically, you place polylines representing lines where you want to force the DEM to be lowered so that the flow direction grid will be hydrologically correct. My understanding is that a “hydrologically correct DEM” is one that has been “reconditioned” to produce flow paths that match reality. Other steps in reconditioning include building walls and breaching walls. Those steps are not covered here.

After the agreestream polylines are created, you convert them to a raster with the same grid size and origin as the DEM. The resulting grid should have a 1 value where the agreestream features are and 0 elsewhere (call it: agreedem). Then you use raster math to multiply the this created raster by a large number (say 500) and subtract it from the DEM. This creates a deep “slot” in the DEM and the resulting DEM is called the “agreedem” in Arc Hydro.

When you perform the fill sinks function on the agreedem, the elevations of the slot are raised to match the lowest grid elevation next them (assuming the flow path has no other blockages). Then the resulting filled DEM can be used for flow direction.

Occasionally there will be areas next to the agreestream polylines that have parallel flow paths. Arc Hydro resolves this by performing additional processes to lower the cells around the agreestream polylines to force the areas adjacent to the agreestream features to “drain” into the agreestream slot.