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Snapping a Pour Point for Watershed Delineation in ArcGIS Hydrologic Analysis

Yanli Zhang
Arthur Temple College of Forestry and Agriculture, Stephen F. Austin State University, zhangy2@sfasu.edu

Matthew W. McBroom
Stephen F Austin State University, Arthur Temple College of Forestry and Agriculture, mcbroommatth@sfasu.edu

Jason Grogan
Arthur Temple College of Forestry and Agriculture, Stephen F. Austin State University, jgrogan@sfasu.edu

I-Kuai Hung
Arthur Temple College of Forestry and Agriculture, Stephen F. Austin State University, hungi@sfasu.edu

GIS for Foresters

Snapping a Pour Point for Watershed Delineation in ArcGIS Hydrologic Analysis

By Yanli Zhang, Matthew McBroom, Jason Grogan, and I-Kuai Hung

A watershed, catchment, or drainage basin is the natural hydrologic unit enclosed by a drainage divide lying upslope from a specified outlet, or "pour point." This defined area is the basic watershed management unit, analogous to a stand in silviculture. Establishing accurate watershed boundaries is important for many facets of natural resources management, including hydrologic analysis, watershed modeling, watershed protection planning, endangered species conservation, and total maximum daily load (TMDL) development. Historically, watershed boundaries were established, or delineated, from contour maps. However, this method relies on the accuracy of the contour map and the delineator's experience, and can be time consuming for multiple delineations and subsequent analysis of drainage-basin or stream-channel characteristics.

GIS has greatly expedited the process of watershed delineation and analysis. By using a digital elevation model (DEM) and establishing the watershed outlet, or pour point, GIS users can quickly and accurately conduct watershed delineations. DEMs are available from the US Geological Survey (http://seamless.usgs.gov/) with 30- or 10-meter resolutions. The general watershed delineation procedure in ArcGIS is illustrated in Figure 1.

The overall procedure is rather straightforward, but there are additional steps that require special attention. One of these is snapping the pour point, as illustrated in Figure 2. This is how Esri explains the process: "Search within a snap distance around the specified pour points for the cell of highest accumulated flow and move the pour point to that location." This explanation may not adequately describe the process for non-GIS professionals, so the following practical example of a stream-crossing study will help to illustrate this issue.

To manage stream crossings, it is necessary to determine the appropriate design flow, both for the structure to perform properly and to prevent failures. The peak flow of a particular recurrence interval (such as 10, 20, or 50 years, which means a 10 percent, 5 percent, or 2 percent probability in any given year) needs to be estimated before designing or evaluating a stream crossing. Most peak-flow determination methods require that the watershed or contributing area be defined and quantified. Figure 3 shows the contribution area delineation of a stream crossing. Roads and streams are vector data and the intersection shown with a solid triangle is used as the pour point. Topographic data are from a 26-meter resolution DEM. After the procedure in Figure 1 is processed, the contribution area is only one cell (26 meters by 26 meters, the pink cell in the enlarged inset in Figure 3). Then, three more pour points 26 meters apart are selected along the road. After the same procedure, the points symbolized with star and square have six- and two-cell watersheds, respectively. The circle point represents the correct contributing area for the stream crossing. In other words, the circle point is the outlet of the watershed for the stream crossing. In this case study, a snap distance of 60 meters is needed to correctly determine the contribution area.

Figure 4 gives the flow accumulation raster; the circle point is located on one cell having the highest accumulation. It is clear that vector stream coverage and the flow accumulation do not overlay each other. The possible reasons for this could be the difference between the original georeference and the raster resolution. In this case, one DEM cell has 26-by-26-meter (676 square meter) coverage and its height is the average value within that area. Raster data at this resolution may not precisely match with vector data. Other potential reasons for the slight location difference between the pour point and the true outlet of the watershed include, but are not limited to, the accuracy differences in GIS data, accuracy of GPS unit, and terrain changes.

In summary, snapping a pour point is needed for watershed delineation, and a snap distance is the search radius for finding the point that has the highest accumulated flow. For different data sets, a suitable snap distance should be set based on trial tests. However, a global snap distance may not be appropriate in some cases. For example, a stream crossing may be located on a tributary and near the point where the tributary joins the main stream. If the snap distance is too long, the calculated pour point could be the confluence of the tributary and the main stream. In this case, the contributing area of the main stream above the confluence will be delineated instead of the contributing area of the stream crossing. In future articles we will further discuss the watershed delineation process and practical applications using ArcGIS.

Yanli Zhang and Matthew McBroom are assistant professors in the Arthur Temple College of Forestry and Agriculture at Stephen F. Austin State University. I-Kuai Hung is an associate professor and Jason Grogan, CF, is a research specialist at the same institution.

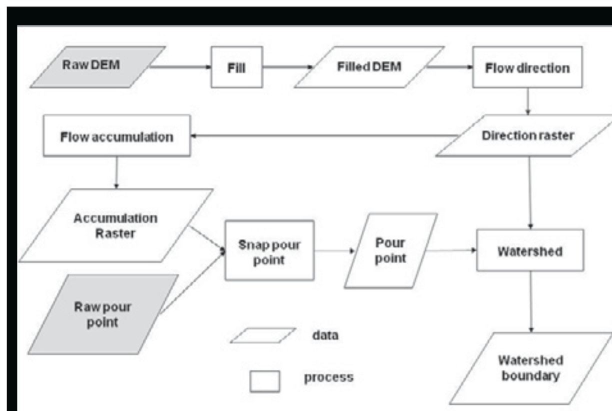

Figure 1. The general watershed delineation process using ArcGIS.

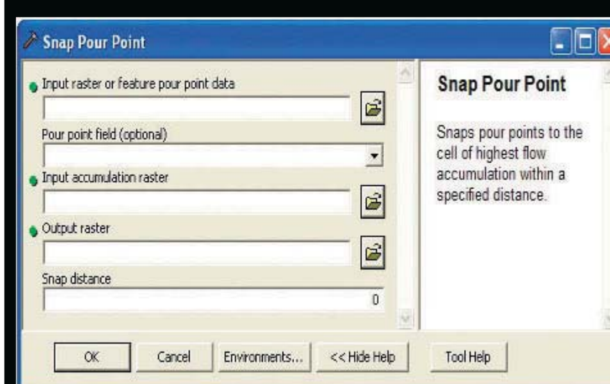

Figure 2. User interface of Snap Pour Point function in ArcGIS.

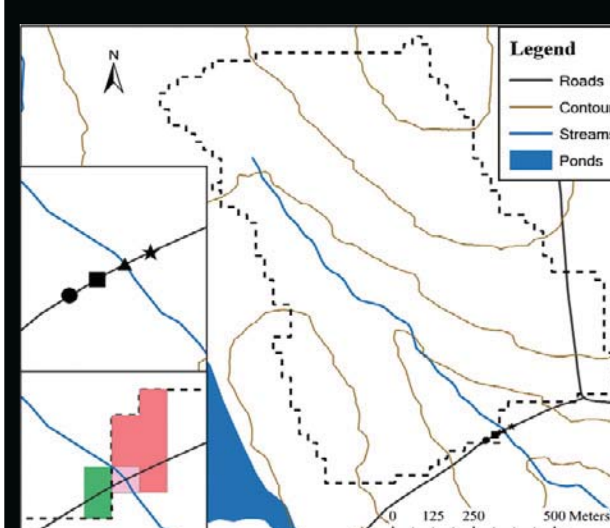

Figure 3. Snap distance illustration (to delineate the contribution area of the stream crossing, a snap distance is required in finding the point having the highest accumulated flow).

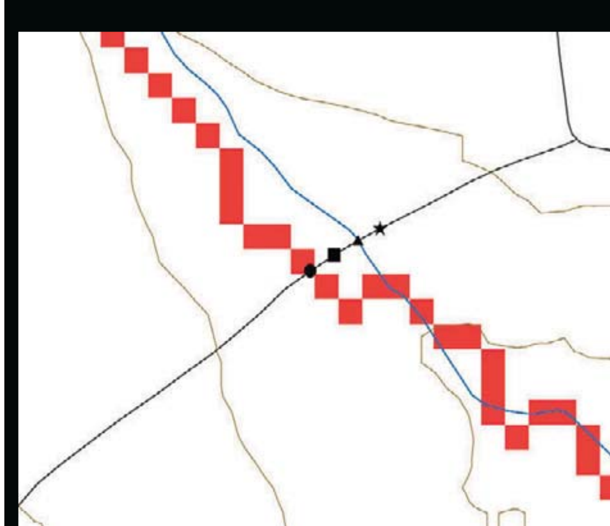
Figure 4. Flow accumulation raster and vector stream comparison.