University of Massachusetts Boston – Department of Environmental, Earth, and Ocean Sciences

EEOS 383 - GISCIENCE FOR WATER RESOURCES RESEARCH – Spring 2010

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Exercise 02: Watershed Delineation from Elevation Contours

Introduction

The study of hydrology requires measurement of the quantity and distribution of hydrological variables in the landscape. The basic unit for landscape-scale hydrologic studies is the watershed (also called drainage basin or catchment). This is defined as the area of land that captures precipitation inputs that contribute to surface runoff, river flow, and groundwater recharge. As you will see in this lab, watershed properties such as size, topography, relief, drainage density and climate all control the hydrological response of a drainage basin. The purpose of this exercise is to introduce you to the use of topographic maps of a drainage basin (Coldstream Creek) to calculate various hydrological properties of the basin. You will delineate Upper Coldstream Creek, the catchment above sampling site BCCOL06.

Data

The exercises in the first half of the course will use spatial data from the vicinity of the Coldstream Creek catchment, a small watershed in Okanagan Valley of British Columbia, Canada. This exercise will use the following 2 datasets:

- contours.shp – This line shapefile has isopleths of elevation at 100-meter intervals
- sampling.shp – This point shapefile marks 8 sampling sites and channel characteristics at those locations

Procedure and Questions

<u>Finding Critical Points</u>

- Add the two datasets to your map document
- This exercise will inquire you to interpret the elevation contours. It will be necessary for you to able to distinguish the elevations of various contour lines. To help you do so, you may wish to label the contour lines with their elevations by setting up the properties in the *Labels* tab of the *Layer Properties* of contours.shp (reach this by double-clicking on the contours layer in the *Table of Contents* of you map document) **AND/OR** setting the *Symbology* (again, within the *Layer Properties*) of the contours layer based on their elevation attributes (use a *Graduated colors* symbology [locaed within *Quantities*] based on the *CONTOUR* field with 12 classes of *Equal Intervals*)
- To make the amount of work here manageable, this assignment will be confined to working with the portion of the contour map that drains to sampling site BCCOL06. Use the *Identify* tool to figure out which of the sampling layer points this is. Then, zoom in so just the northeast quadrant of the contour layer is visible in your map view.

- Now, we are ready to find critical points in the landscape. If necessary, refresh your memory about what peaks, pits, and passes are by referring back to this week's materials (Maxwell, 1870; Mark, 1978; slides). **Hint: Peaks will be found in closed contours surrounded by a contour of lower elevation, pits will be found in closed contours surrounded by a contour of higher elevation, and passes will occur between two contours of equal elevation.**
- Mark your critical points on-screen by creating a new point shapefile in your H:\ space (you'll need to use ArcCatalog to create your new shapefile, and set its *Spatial Reference* by importing the required information from one of the provided datasets). Be sure to add a text attribute to this shapefile so you can identify each point you create as a peak, pit, or pass, and thus so you can symbolize them differently. Of course, you'll need the *Editor* toolbar to *Create New Features* in your point shapefile.

Question 1 – How many pits, peaks, and passes did you find in the northeast corner of the provided contour data? Describe your results and whether or not this is what you have expected and why. Print out and hand in with your exercise a map of your critical points on top the contours. Be sure to include a title, North arrow, scale bar, and legend describing the symbology used.

Question 2 – What elevation is the highest point that you found? Given the available data, how precisely can we know what the elevation at that location is?

Delineating the Watershed

- Now that you have the found critical points, you are ready to connect them and delineate the Upper Coldstream Creek watershed. To do this, follow these guidelines and general rules:
  - Start at the outlet of the basin (at the BCCOL06 site) and progress upslope on one side, crossing contour lines at right angles.
  - Continue the line until its trend is opposite to the direction in which it began.
  - Return to the starting point and progress upslope in the other direction, then continue toward the headwaters to meet up with the first line.
  - Once finished check your divide at several locations to assure that if an imaginary drop of water were to fall within the divide, it would eventually flow downslope into the river.
- You will create your watershed boundary again via on-screen digitization, by creating a new polygon shapefile for this purpose. You may find it useful to first 'sketch' the boundary using the *Drawing* toolbar to create some graphical guides to help you, or by printing off the contours and your critical points and sketching the boundary by hand first.
- Once you have a watershed polygon you are satisfied with, you can calculate its area. Use the *Calculate Areas* too inside the *Utilities* section of the *Spatial Statistics* toolbox. Use your polygon shapefile as the *Input Feature Class* and specify a new shapefile filename in your H:\ space for the *Output Feature Class*. This will produce a new shapefile that is identical to the original one, with one additional attribute that contains the calculated area of your watershed polygon.

Question 3 – What elevation is the lowest point in your delineated watershed, and where is it located? Given the available data, how precisely can we know what the elevation at that location is?

Question 4 – What is the area of the watershed as you have delineated it? Print out and hand in with your exercise a map of your watershed polygon on top the contours. Please use a hollow symbology for your polygon so the contours below it can be seen. Be sure to include a title, North arrow, scale bar, and legend describing the symbology used.

Delineating the Stream Network

- Now that you have the delineated the watershed, you are ready to locate streams within it. To do this, follow these guidelines and general rules:
    - Look for contour lines that point abruptly upslope. These indicate the location of stream channels (often ephemeral) that can be traced across several contours. If these contour deviations indicate flow within your basin, they should be included in the stream network.
    - Begin at BCCOL06 and work your way upstream.
    - Remember that a stream line can never cross the watershed boundary, except at the outlet.
    - Keep in mind that how extensive a stream network you develop is somewhat subjective; confine yourself to locations where there is obviously a stream channel.
- You will create your stream network again via on-screen digitization, by creating a new polyline shapefile for this purpose. You may find it useful to first 'sketch' the boundary using the *Drawing* toolbar to create some graphical guides to help you, or by printing off the contours and your watershed delineation and sketching the stream network by hand first.

Question 5 – How long is the main channel of Upper Coldstream Creek (use the Measure tool to trace along the stream network) as you have digitized it? Print out and hand in with your exercise a map of your stream network on top of your watershed boundary, and the contours. Be sure to include a title, North arrow, scale bar, and legend describing the symbology used.

Question 6 – Comment on the effect that the resolution of contour data has on the processes you have used in this exercise. That is, supposing you had contours for this same area that described the topography such that there were isopleths for every 50 meters of elevation change instead of every 100 meters; what effect do you think this would have these analyses? How might that change the resulting set of critical points, the shape of the delineated watershed, and the stream network?