CEE 166A/266A
WATERSHEDS AND WETLANDS

Autumn 2014-15

Exercise No. 3: Watershed Characterization Using GIS Tools

Due at the beginning of class, 13 October 2014

Goals: The goals of this exercise are to: 1) become familiar with basic Geographic Information Systems (GIS) concepts and tools; 2) practice using GIS tools to delineate watershed boundaries and to quantify different physiographic characteristics of watersheds relevant to hydrologic understanding; 3) develop some appreciation for the pros and cons of using GIS for watershed delineation and characterization.

Collaboration: You are welcome to discuss this exercise *ad nauseum* with other classmates, with friends, with your parents, or with anyone from whom you think you might learn. There are many students in the class with considerable GIS experience so please use each other as a resource. However, we would like you to work specifically with your map partner from Exercise No. 1 to prepare a single comparative report as described below. Because GIS is of growing importance in both academic and professional settings we strongly recommend that each student work through all of the steps of the exercise individually, collaborating with your partner to prepare a single report document. If your partner from Exercise No. 1 has disappeared, we will be happy to set you up with a new partner. Just let us know promptly.

Submission: Please prepare a written hard-copy document responding to the questions below. It does not need to be word-processed (although that is preferred), as long as the presentation is clear and legible. Note that some graphs and maps are requested. Please include your names and a page number on each sheet. If you prepare an electronic document, with supporting material for example, you may submit it as back-up via CourseWork, either using the Drop Box of one partner or using the Assignment page. Please include your family names in the file name of any file you upload via CourseWork. Hand in any non-electronic supporting documentation at the end of our discussion of the exercise in class.

Discussion: On your submission please provide enough discussion so that the TAs and I may understand how you have approached each question. This will allow us to provide you with cogent feedback focused on your understanding and learning. Simply providing a quantitative result is inadequate. Assumptions should be clearly identified. Discuss places where you had trouble. If you choose to use supplemental tools, such as spreadsheets or MATLAB, be sure to show clearly all formulae and other relationships mathematically, i.e., don't make us decipher your spreadsheet or code.

Background

You have been provided with two types of data for this assignment:

1. National Hydrology Dataset (NHD) Files.
   National Hydrography Dataset (NHD) is the surface water component of *The National Map*. The NHD is a digital vector dataset and contains features such as lakes, ponds, streams, rivers, canals, dams and stream gages. We are interested in the Flowlines component of this dataset. (http://nhd.usgs.gov/nhd_faq.html)

2. Digital Elevation Model
   You have been provided with a 10m raster DEM from *The National Map*. Recall that a 10 m DEM means that each pixel is 10m x 10m

Watersheds can be delineated in Geographical Information Systems (GIS) from gridded elevation data. Geoprocessing analysis is performed to fill sinks and generate data on flow direction, flow accumulation, streams, stream segments, and watersheds. These data are then used to develop a vector representation of catchments and drainage lines.

The Task:

Working with your partner from Exercise No. 1, follow the tutorial available at https://web.stanford.edu/~jdeane to delineate and characterize the two watersheds from Exercise No. 1. As you perform the following steps you should keep in mind potential sources of uncertainty in the digital delineation.

For consistency, we are going to specify the latitude and longitude coordinates of the outlets for the two watersheds as follows:

McKinley Mountain: 41º 50’ 08.116’’ N, 122 º 50’ 33.860’’ W
Hatchet Mountain Pass: 40° 49' 36.490" N, 121° 51' 59.885" W

You will need to make reference to your delineated USGS quad sheets.

Your written report should emphasize comparisons of the different characterization parameters for the two watersheds. In addition, your report should discuss the pros and cons of manual, paper-map-based characterization, i.e., what you did for Exercise No. 1, and GIS-based characterization.

Questions:

1) Compare the Drainage Line streams created from the DEM with those of the NHD streams and those seen on the USGS quad maps. Can you explain any differences you observe?

2) What are the calculated catchment areas (km^2 and mi^2)? How do these values compare to the values you acquired from planimetering the areas on the USGS quad sheets? Which estimate do you think is more accurate? Why? If the comparison between planimetered and GIS-tool areas are different for the two catchments, can you explain why?

3) Determine the elevation of the watershed outlets for the catchments (second column of the table on p. 2 of Exercise No. 1) in two different ways (m and ft):

   a) Interpolate using the contour crossings on the USGS quad sheets.
   b) Identify the elevation from the pixel cell in the GIS representation.

4) What are the main channel lengths and slopes? How do these values compare to the values you estimated from the USGS quad sheets?

5) Create the hypsometric curves of the watersheds and compare. Note the relief for the catchments and compare with relief determined from the USGS quad sheets.

6) Construct maps showing the maximum rate of change in elevation for each cell (slope) using the Spatial Analyst Slope Tool. Format the map as thoroughly as you can, i.e., choose appropriate color scales and include titles, legends, scales, etc. Export them as JPEGs and include them in your report.
   From these slope maps, create cumulative distribution plots and include them in your report. Based upon these plots, what is the percentage of each watershed with a slope (or maximum rate of change in elevation for each cell) above 30°?

7) Create a contour map for each catchment from the original DEM. Use elevation units consistent with the specific USGS quad sheet. How do the contours on your digital map compare to the contours on the USGS quad sheet? Include a well formatted contour map of the catchment in your report.