Pollution Control and Hydrologic Modeling – Part II

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Objectives: the purpose of this lab is to introduce you to surface hydrologic modeling in GIS and derived products such as wetness and stream power indices. You will apply your skills in the context of chemical pollution control but the same techniques, with a few modifications, could also be applied in the context of water quality management, non-point source pollution and nutrient loadings, etc.

Report: Create your report in a Word processor, insert figures when necessary or when asked, and submit through Blackboard on or before XXX.
Answer all questions marked with a "**Q**."

Background:

You are working for Essex County (NY) Environmental Agency and you have to provide information to support decision making and to coordinate response to environmental disasters. A chemical company wants to build a new plant in the county. The chemical to be produced reacts when in contact with water creating a very hazardous compound. Thus, your job is to identify 'wet' areas in the county where the plant should not be allowed to be installed nearby. You are also asked to assess the appropriateness of the area chosen by the company.

Instructions:

1. Create a `HydroLab2` folder in your working directory; open ArcCatalog and connect to your folder.
2. Download the datasets from Blackboard and extract to your folder.
3. Open ArcMap and add your DEM `blueridge`. **Q.** Describe it (rows, columns, basic statistics, etc).
4. Run flow direction and flow accumulation. Create a stream raster using the `Con` (conditional) operator in raster calculator. Use a "cut-off" value of at least 13,000; document your choice.
5. According to your class notes, wetness index can be calculated as:

$$WI = \ln\left(\frac{A}{\tan(B)}\right)$$

$$where\ A = upstream\ contributing\ area\ and\ B\ is\ the\ slope.$$

Should you use slope (calculated with the Horn algorithm) or gradient? What should be the unit (percentage or degrees)? Which ArcGIS function should you use to calculate slope/gradient?

6. You can derive A directly from flow accumulation. Then, use the formula to calculate wetness index using raster calculator. Name your output `wibluer`. **Q.** Write down the raster calculator operation(s) used to calculate WI.
7. Examine your `wibluer` raster. **Q.** What are the basic statistics? What terrain features are associated with areas with high wetness index? What about low values? Does it make sense?
8. Comment: wetness index is a good method to identify ponds and wetlands, where standing water are ‘probable.’ Can you see any group of connected cells with large wetness index?
9. Use information generated in (7) and (4) to delineate areas where the company should not be allowed to construct its new facility. (You may have to make some assumptions…document every decision). **Q.** Write down your GIS operations used here. Make a map (make sure the map displays well the different wetness values).
10. Calculate stream power index according to the formula:

$$SP = A * \tan(B)$$

Name output `spbluer`. **Q.** Write down the raster calculator operation(s) used.

11. **Q.** Analyze your `spbluer` raster (see item 7).
12. Use the stream power index to identify areas where it would be easier or more difficult to stop the dispersal of the chemical once in the water. **Q.** Show your raster operations and make a map.
13. Load the point vector file `chem._plant.shp`. Suppose this is the place chosen by the company to install its new plant. Suppose you are responsible to make a plan to avoid that the chemical reaches any stream segment calculated in (4) if there is an accident. Show the path the chemical is likely to descent until it reaches a stream and the path it will take until it leaves the study area. Click on Spatial Analyst → Distance → Shortest Path and enter the following arguments
    a. Path to: chem._plant.shp
    b. Cost distance raster: your flow accumulation
    c. Cost direction raster: your flow direction
    d. Path type: For each cell
    e. Output feature: toxicpath
14. Obs: I will explain least cost path analysis this week. You’ll see how functions from hydrology can be used in least cost path analysis and vice-versa.
15. **Q.** Make a figure showing where the chemical is likely to reach a stream and the entire path to the boundary of the study area. Make sure your team is prepared for a chemical leak accident (I have a three year old boy and am always prepared for leak accidents!)