Watershed Terrain Analysis on GIS

Ethan Choate and Tony Cabrales

Summary: In this assignment we are going to be using raster datasets to get a better overall understanding of terrain within the Cache la Poudre Watershed and make inferences about the conditions. For each dataset needed, we will use the website's interface to get the specific data and then transform it with geospatial analysis tools in ArcGIS Pro. The previously delineated HUC 10 watersheds will be compared to one another with respect to slope, precipitation, soil types, and land cover to make inferences about their relative hydrologic conditions across the Poudre Watershed.

Learning Objectives: After completing this assignment, students should be able to use the spatial analyst toolkit, symbology, and map creation within ArcGIS Pro to determine hydrologic conditions across watersheds.

Background:

- USGS DEMs - This DEM or digital elevation model data is 1 arc-second resolution mapping for terrain mapping and analysis. This data is distributed in NAD 83 and works well for hydrologic modeling.
    - Data Source: https://apps.nationalmap.gov/downloader/#/
- MRLC National Landcover Dataset - These nationwide land cover datasets are created in a joint partnership between federal agencies known as the Multi-Resolution Land Characteristic Consortium. This dataset presents land cover at 30m resolution based around a 16 category classification system.
    - Data Source: https://www.mrlc.gov/data?f%5B0%5D=category%3Aland%20cover&f%5B1%5D=region%3Aconus
- USDA historic precipitation raster - Precipitation data for both historical and future are mean values across 20 global climate models from the CMIP5 experiment put into a grid with 4km cell sizes.
    - Data Source: https://www.fs.fed.us/rm/boise/AWAE/projects/NFS-regional-climate-change-maps/categories/us-raster-layers.html
- SSURGO/ESRI soil data - The soil database has been formed with data input from soil samples collected by the National Cooperative Soil Survey with data from over a century ago. The samples are analyzed just by observation or through laboratory analysis and then matched in tables with the characteristics they have such as their infiltration and hydraulic conductivity which is then used to group them. This Esri tool uses this data to create a web tool to select watersheds and get their specific soil attributes.
    - Data Source: https://www.arcgis.com/home/item.html?id=cdc49bd63ea54dd2977f3f2853e07fff

Assessment:

Maps (60 points, 15pt ea)

1.) Create a map displaying the Flow Accumulations from the slope DEM
2.) Create a map displaying the dominant land covers
3.) Create a map of the soil hydrologic groups
4.) Create a map to the display historic precipitation

- All maps should :
    - Be easy to read/interpret with a legend
    - Be masked to the Poudre watershed and the HUC 10 boundaries overlaid within
    - Have a figure caption

Interpretation (40 points) - Using the 4 maps you just created, what are some assumptions/inferences that can be made on the hydrologic conditions seen across the Cache La Poudre Watershed (i.e. risk of erosion, flooding, contamination, etc.). Refer to each of the figures at least once.

Answer Key

Maps:

1.) Flow Accumulation

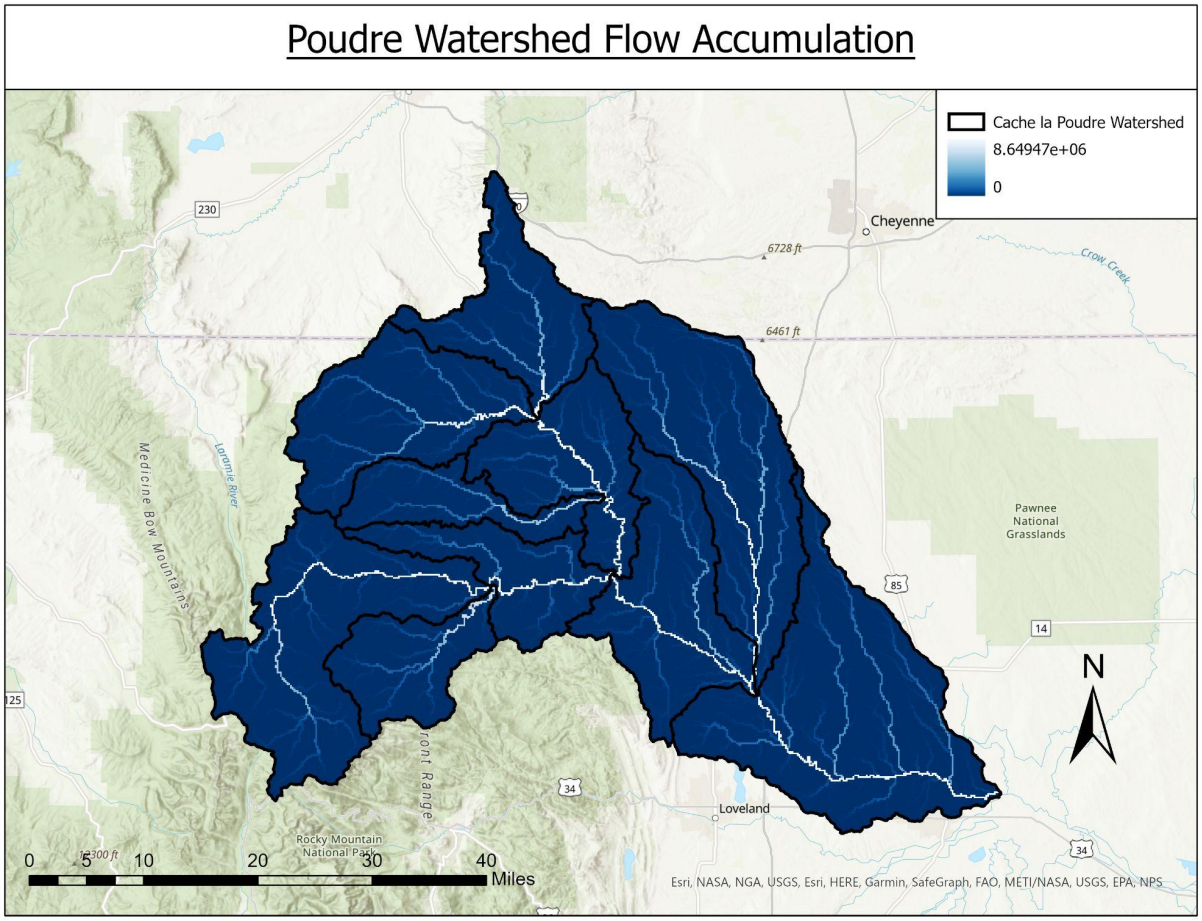

Figure 1. Flow Accumulation for the Cache La Poudre Watershed. Higher values and lighter color indicates greater flow accumulation, while lower values and darker colors represent lower flow accumulation.

2.) Land Cover

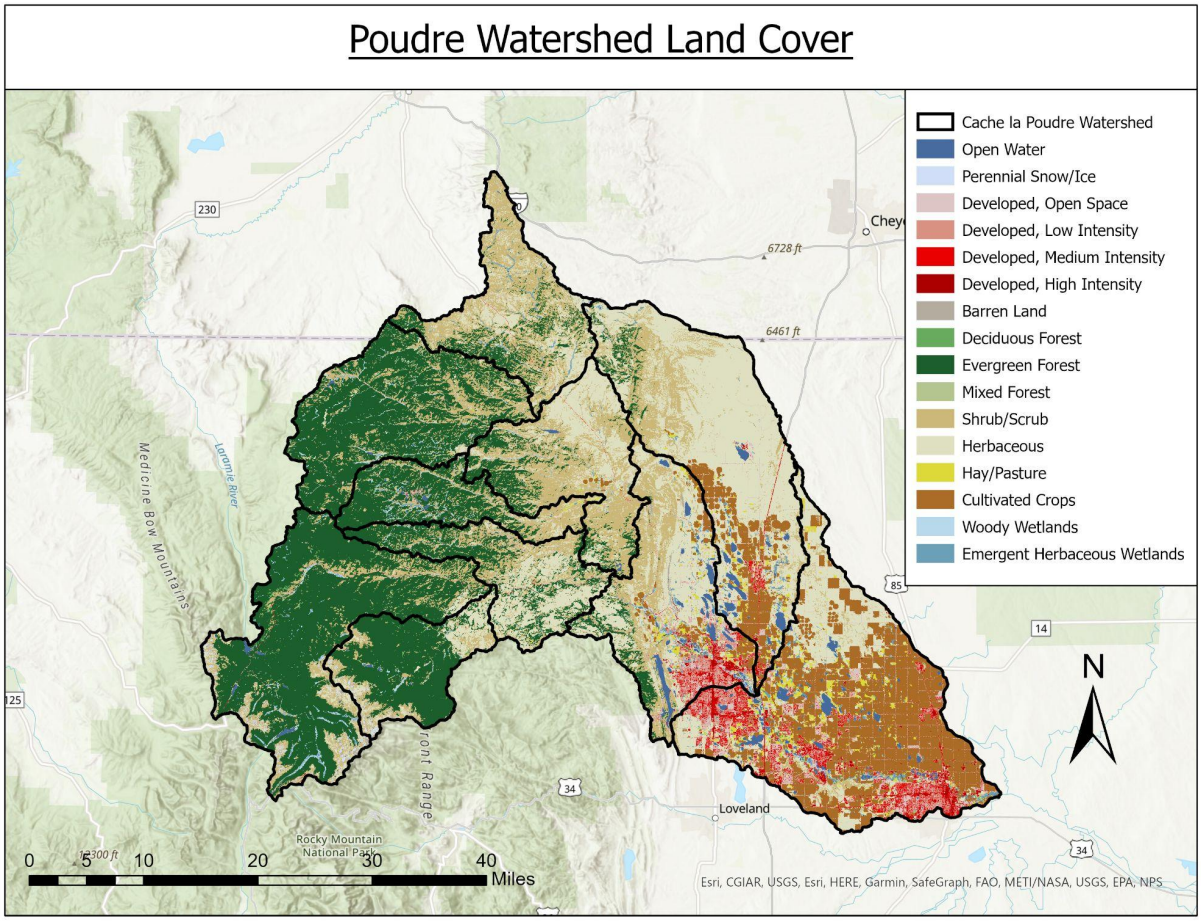

Figure 2. Land cover types in the Cache La Poudre watershed.

3.) Soil Types

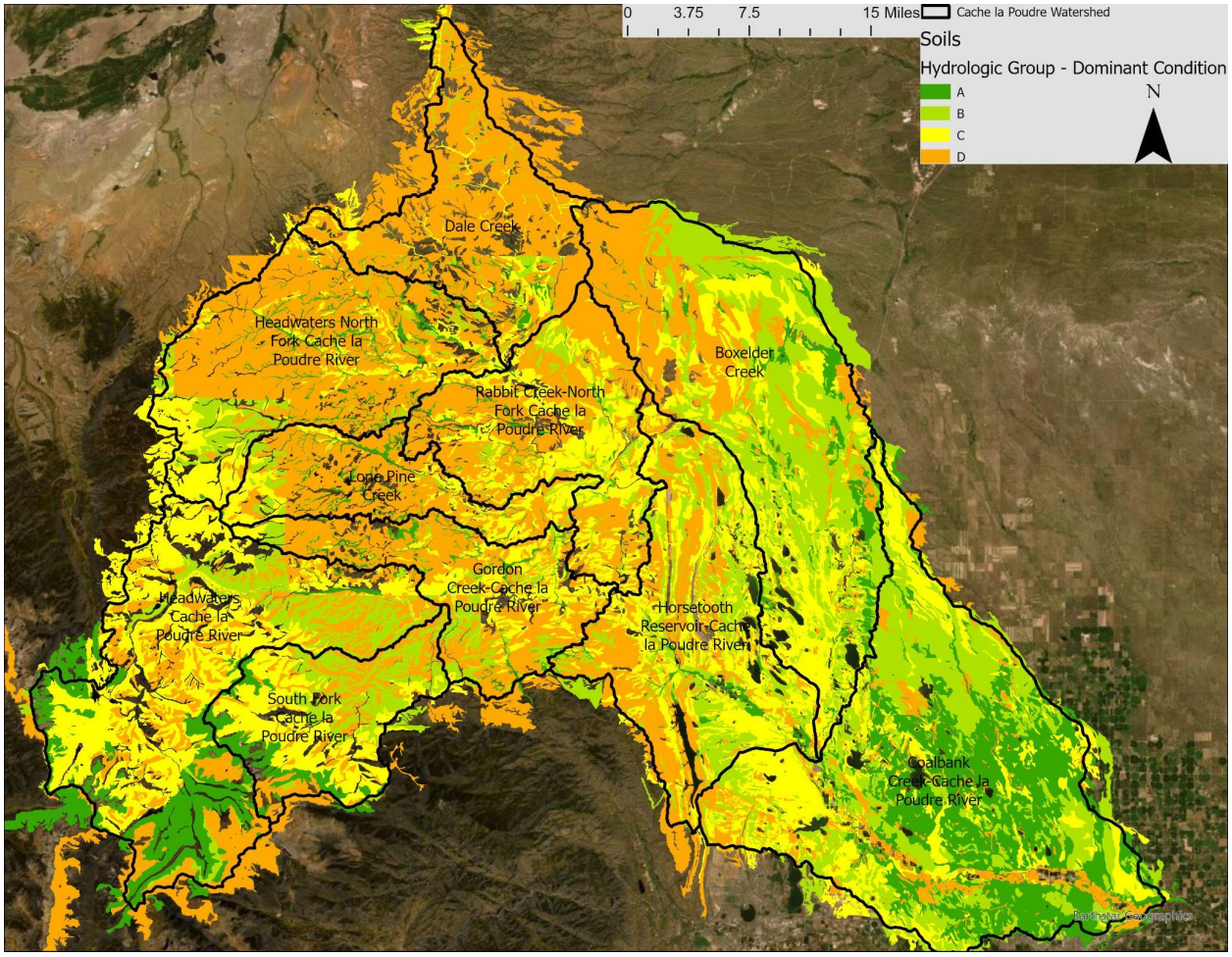

Figure 3. Soils in the Cache La Poudre watershed, sorted by hydrologic group where A indicates lowest runoff potential and D indicates the highest.

4.) Historic Precipitation

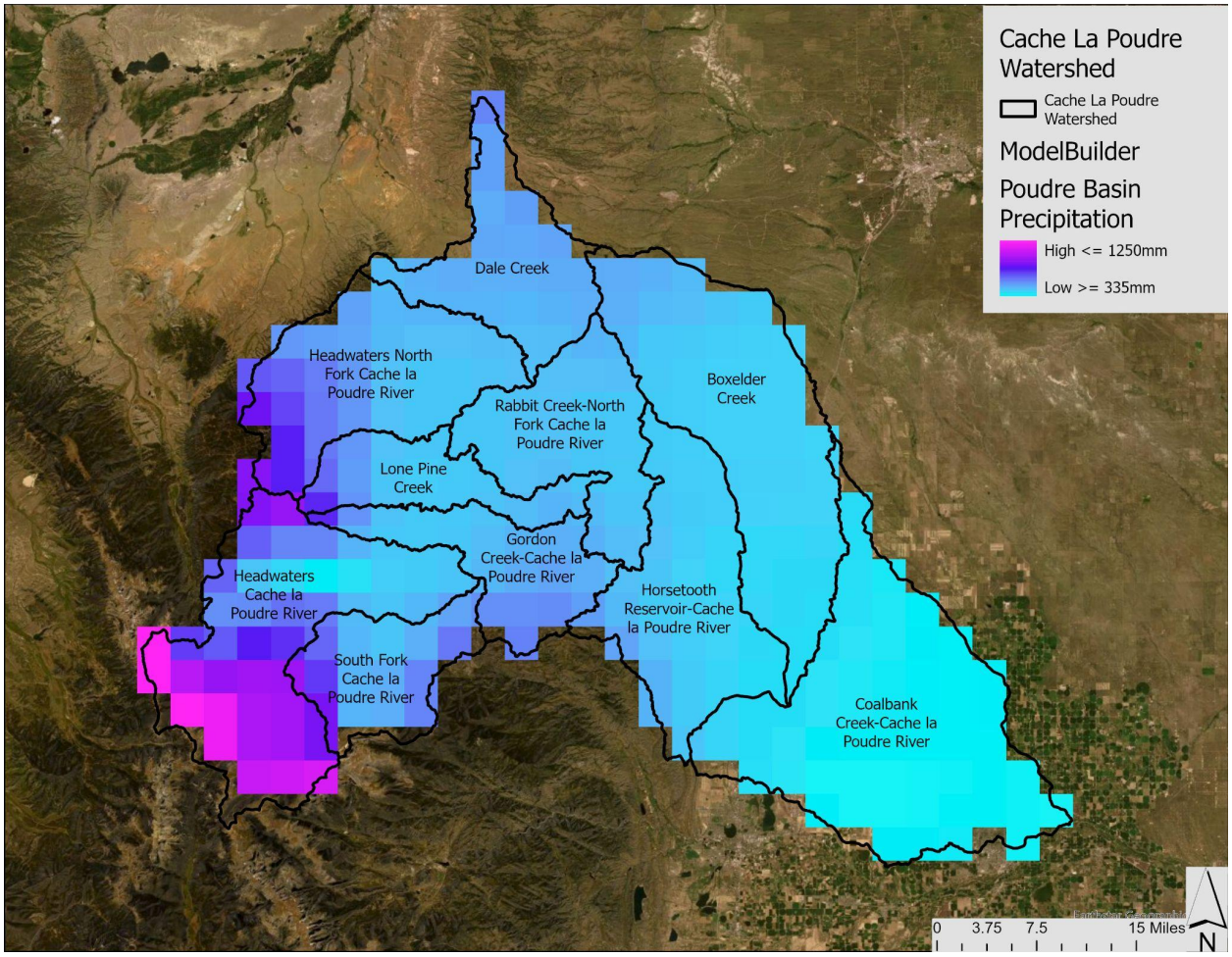

Figure 4. Averaged historic precipitation grid map for the Cache La Poudre Watershed in millimeters.

Interpretation:

- Can have a variety of answers that explain either or both the good and bad conditions that can be inferred upon from the maps.
- Must refer to each figure at least once
- Important areas of focus: upper basins near headwaters, lower basin near confluence

Example:

When looking at the maps that were made, the first thing that sticks out with respect to hydrology is that land use in **figure 2** where there seems to be a gradient of land use. In the western basins where the headwaters lie, there is mostly natural forest and shrub cover and as it moves east towards the confluence, there is a significant change to developed land ending with mostly agricultural land. Considering this along with the flow accumulation map in **figure 1**, as the water moves from the headwaters to the confluence, I would expect the water quality to decrease due to more pollutants entering via runoff and the smaller tributaries from the more intensely developed land, especially agricultural. This would have an effect on the biota that are present as well as there being higher channelization from human sources.

In the soil analysis map for **figure 3**, there is a large concentration of D - class soils in the northern most basins around the headwaters and Wyoming which are indicative of higher runoff potentials. That combined with the precipitation map in **figure 4** showing higher levels in the same area could be a recipe for higher volume erosion events when there is intense rain. Something that I don't think the soils map takes into account well is the fact that the land use in the eastern most Coal Bank basin is predominantly agricultural which generally sees higher runoff and erosion due to the open and disturbed soils depending on time of year. This is a benefit of having multiple factors to look at. It can also be seen when cross referencing the flow accumulation and soils maps, that around the main poudre channel, the soils have higher runoff potential which make sense.