IMNAHA RIVER BASIN

Watershed and Stream Network Delineation

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Introduction

This report will focus on using ArcGIS to build watersheds and delineate flow networks within the Imnaha River Basin. The project will utilize tools that were learned in CE 413 Ex4. The purpose of the project is to become more familiar with many of the tools offered within ArcGIS and gain more knowledge regarding the acquisition of geospatial data and how to manipulate it for the desired use.

Site Description

The Imnaha River Basin is located in the far northeast corner of Oregon. The basin drains an area of 850 mi^2 and the watersheds outlet drains into the Snake River in Hells Canyon. The terrain within the watershed is very rugged, composed of mostly basalt and granite bedrock and little vegetation aside from fescue. The basin also contains a large variety of elevation with a high point of nearly 9,700 ft and a lot point of 941 ft at the outlet point. The longest drainage path within the basin is 86 mi and the total length of streams is 953 mi.
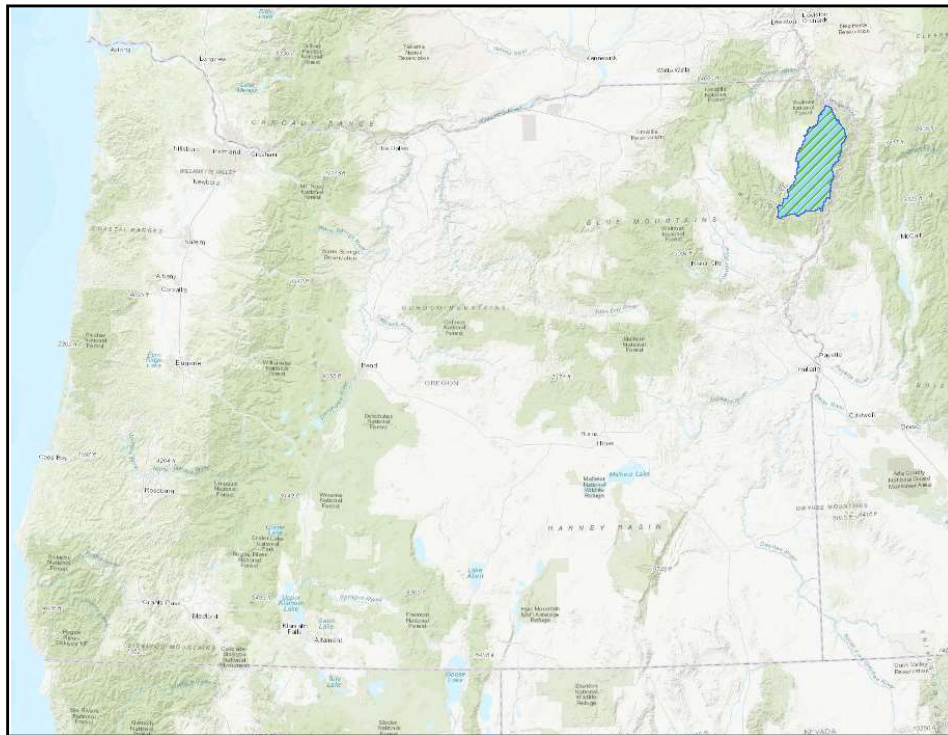

Figure 1: The green hatching marks the location of the Imnaha River Basin in NE Oregon
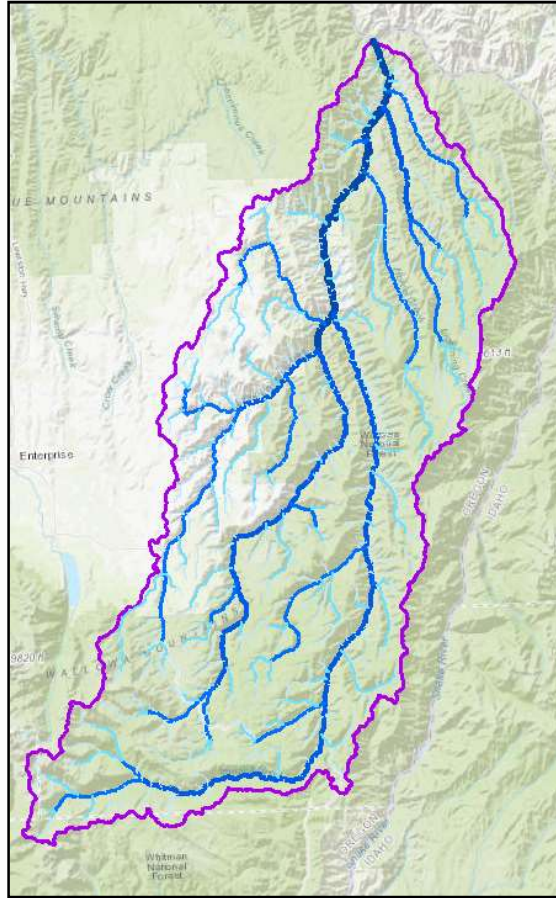
Figure 2: Imnaha River Basin

Data

Data	Source	Data Type	Use for Data
10-meter DEM	USDA Geospatial Data Gateway	Raster	Provides elevation data for project site
NHD Flowlines	USGS NHDplus	Vector	Provides established travel path for streams within project site
HUC 8, 10, 12	USDA Geospatial Data Gateway	Vector	Provides delineation of project watersheds and catchments
USGS Stream Gage	USGS Water Resources	Vector	Provides location of stream gage within project site

Table 1: Data layers used

All data was converted into a Lambert Conformal Conic projection on the NAD 1983 Oregon Statewide Lambert coordinate system for this project.

GIS Methods

The first step in this project was going online to gather all of the data sources that would be needed to recreate Ex4. With the help of the instructor, data sets for HUC 8-12, USGS streamgages, NHDPlus flowlines, the Oregon 10-meter DEM were located. Next, the Imnaha River HUC-8 was isolated into its own layer and all other data layers were trimmed to only include data within this HUC region using the "Clip" or "Extract by Mask" tools.
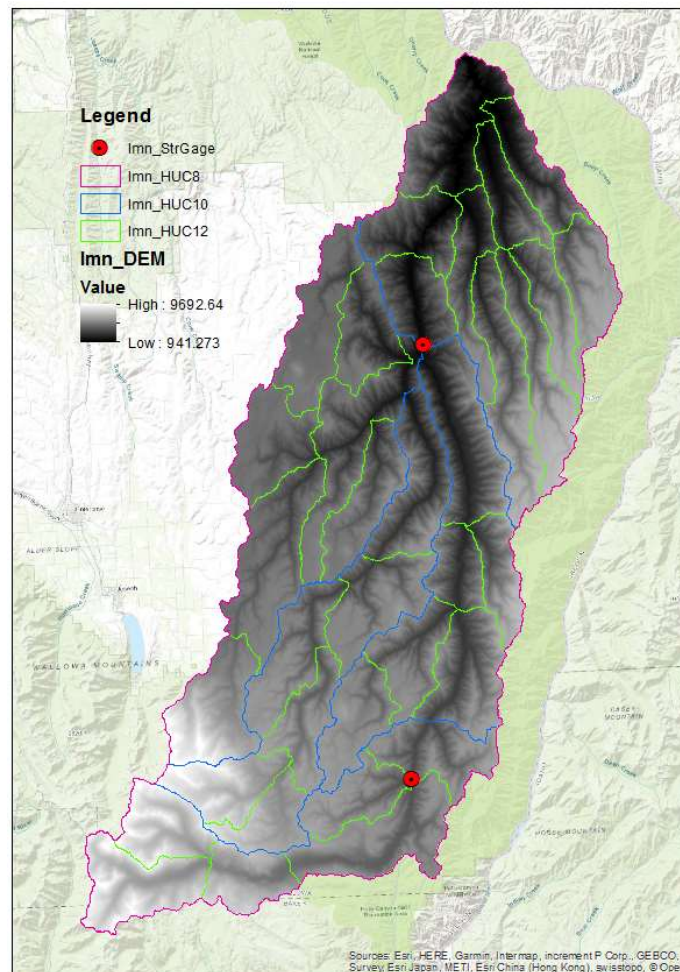

Figure 3: All data sets clipped to only include data sets within Imnaha Basin

Next, Arc Hydro Tools were used to fill in sinks in the DEM, create flow direction based on elevation changes, and determine flow accumulation to create drainage lines throughout the basin. In order to get drainage lines that were similar to those provided by NHD flowlines, flow accumulation (FAC) counts of 10,000 were used to delineate the

streams. This FAC was far less than the recommended 1% of the total watershed cells for creating drainage lines, but any higher value resulted in far more stream lines than the NHD flowlines.
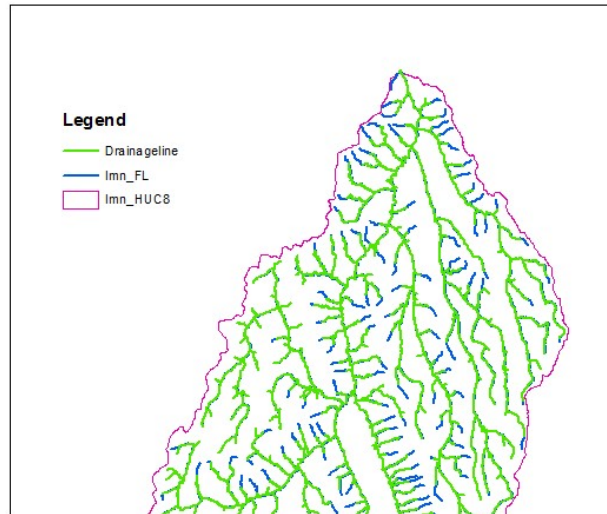

Figure 4: Drainage lines after filling sinks and calculating FAC.
Drainage lines are green and NHD flowlines are

With drainage lines created, the next step was to create an Outlet feature class to mark the end of the Imnaha River. This was done using editor to place a marker on the last river cell within the watershed boundary. This was located using the elevation gradient on the DEM layer.
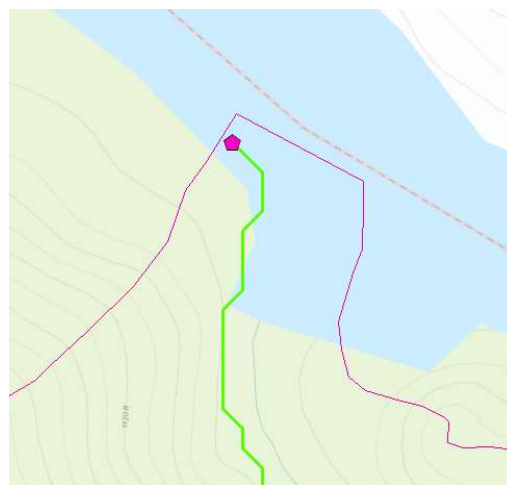

Figure 5: The pink hexagon is used to mark the end of the
Imnaha River as it enters the Snake River

Then, various tools were used to create a network of individual streams and catchments which were later converted to a gradient network with assigned Strahler Order numbers to define the stream size in each portion of the watershed.
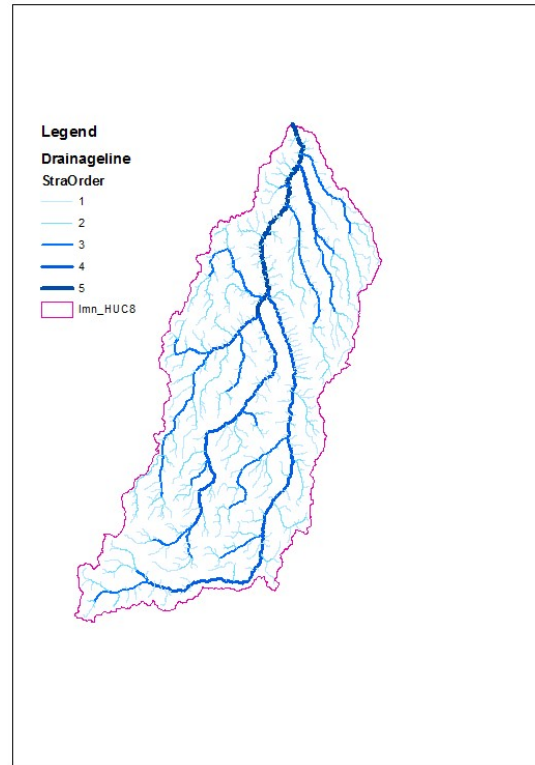

Figure 6: Strahler Order representation of the Imnaha
River Watershed

Once the Strahler Order drainage lines were created, the "watershed" tool was used to connect the Flow Direction layer with the Streamgage layer. This allows ArcGIS to divide the entire watershed into smaller watersheds that produce flow for each particular USGS stream gage. The drainage lines can then be traced upstream and downstream to calculate things like the longest flow path and drainage density in different areas of the overall watershed. In this particular watershed there are only two stream gages at this time.
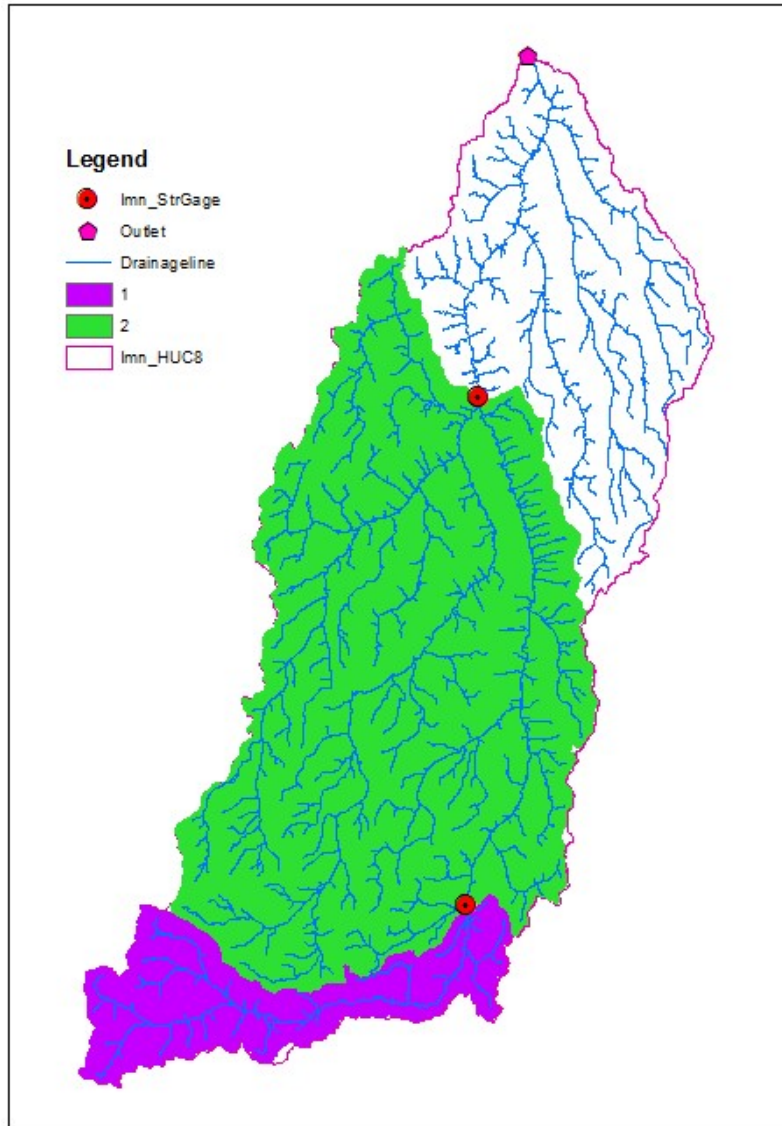
Figure 7: Drainage areas for each of the stream gages
within the watershed

Finally, the Utility Network Analysis tools were used to digitally set the flow direction for each stream, assign flow direction arrows and set flags to determine the upstream and downstream flow paths at each of the stream gages.
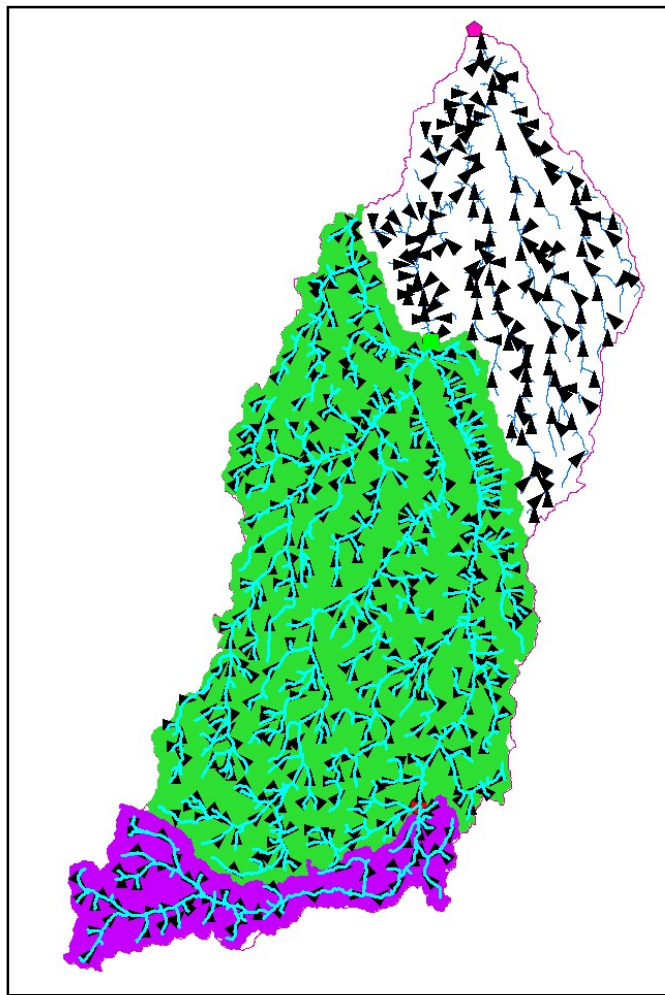
Figure 8: Upstream trace from one of the stream gages on the
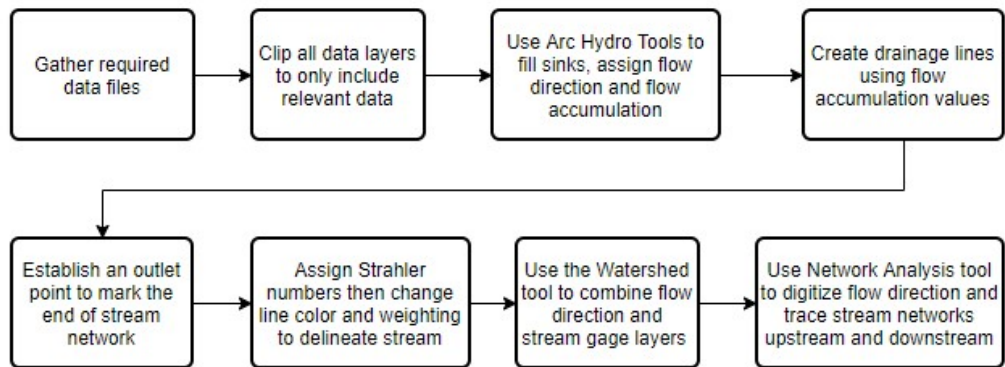Imnaha River w/ flow direction arrows

GIS Methods Flow Chart

Figure 9: Steps involved in completing project

Outcomes and Results

1. *Data procurement*

   One of the main outcomes that was sought going into this project was learning how and where to obtain the different data layer and information used while working on water resources projects within ArcGIS. This was achieved through using the NHDPlus website, NCRS Geospatial Data Gateway, and USGS Waterdata website. I had the opportunity to download and explore numerous data layers, some of which were useful on this project and others that were not.

2. *Report the area of the Imnaha River Basin drainage area.*

   $$A = 21,980,562 \ cells * 100 \frac{m^2}{cell} = 2,198,056,200 \ m^2 = 849 \ mi^2$$

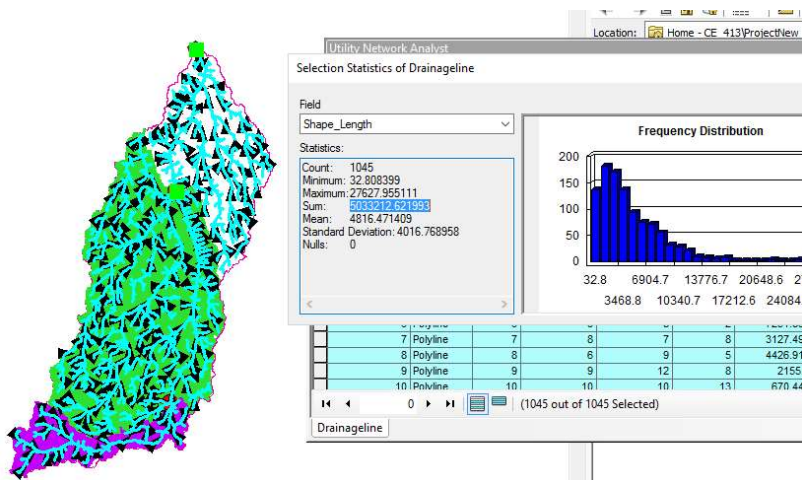3. *Determine the number and average area of HUC 8, HUC 10 and HUC 12 areas within the basin.*

   HUC 8: 1   Ave. Area=850 mi^2

   HUC 10: 5   Ave. Area= 170 mi^2

   HUC 12: 35   Ave. Area= 24.3 mi^2

4. *Calculate the drainage density of the Imnaha River Basin?*

   $$Area = 850 \ mi$$

   $$Drainage \ length = \ 5033213 \ ft/ \ 5280 = 953.26 \ mi$$

   $$Drainage \ Density = \frac{953.26}{850} = 1.12$$
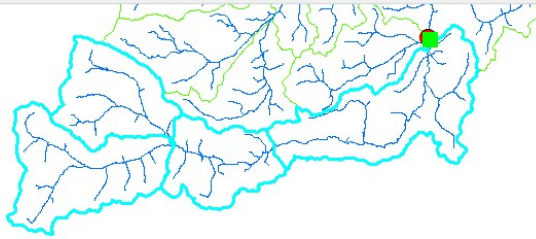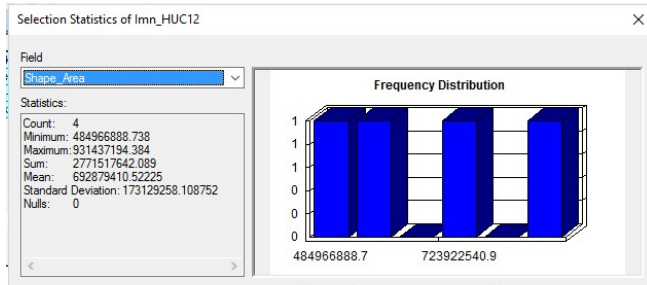
5. Calculate the drainage density of the area draining to the most upstream USGS gage.

$Area = 2771517642\ ft^2 = 99.4\ mi^2$

$Drainage\ length = 502,803\ ft = 95.2\ mi$

$Drainage\ density = 95.2/99.4 = 0.958$

6. Find the longest drainage path in the watershed.

Longest path=456155 ft=86.4 mi

7. Challenges Encountered:

The main challenge that was faced during the project was that for some reason the NHD flowline file that I downloaded initially ended up being corrupted somehow. When the layer was saved in a data feature class, for some reason the geometric networking tool within ArcGIS would not recognize that it existed. After several hours of trying to troubleshoot the problem, I ended up having to download all of my data again and start the entire exercise over. The second time through the project everything worked seamlessly. This was frustrating but gave me a good opportunity to troubleshoot within the program as well as a lot of extra practice using the different tools!

I do not know for sure what was causing the issues with the data layer but it may have had to do with using too many characters to name some of the layers. When I saved the original flowline layer, I used a 15 character name. After restarting the project I made sure to keep everything 10 characters or less and everything worked much better.

References

Arras, T. (n.d.). Exercise 4. Watershed and Stream Network Delineation [PDF]. Corvallis, OR: Oregon State University.

"HUC Data." (2017) <https://datagateway.nrcs.usda.gov> (Feb. 14, 2019)

"10-meter DEM." (2016) <https://datagateway.nrcs.usda.gov> (Feb. 14, 2019)

"NHDPlus Flowlines." (2012) <http://www.horizon-systems.com/NHDPlus/NHDPlusV2_17.php> (Feb. 14, 2019)