CE 413

Willamette Basin

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http://web.engr.oregonstate.edu/

Introduction

In this project, the Willamette Watershed, located in this Pacific Northwest, will be looked at. It is very valuable to be aware of the characteristics of a watershed in order to analyze existing or potential problems. Information from a base data set that includes the watershed boundaries and stream information will be taken, and that will them be correlated to water storage information, which will come from a soil database. Being able to reconfigure this information is important because it is what can help understand availability of water in a region, impact of water on the environment, and understand the limitations of the watershed.

The main objective of this project will be to identify the Willamette Basin and display its features such as subwatersheds, subbasins, flowlines, and soil classes. Identifying and correlating these features will help understand how the different streams interact with its surrounding environment.

Site Description

More specifically, the Lower Willamette watershed will be analyzed, which covers the Portland metro area in Oregon. Its Hydrologic Unit Code is 17090012 and is approximately 412,000 acres. When looking at the topography in Figure 1, it can be seen that the edges of the watershed are more mountainous, while the majority of it is relatively flat. In this figure you can also see the Columbia River goes right through the location and connects to other streams. Figure 2 shows that the mountainous areas have a lot of vegetation, and the other, urban, areas have lot less. It’s important to take note of this because it will help us interpret the watershed’s data. Another characteristic of the location that should be kept in mind is its climate. This watershed, like mentioned, is in the Pacific Northwest, so it gets a fair amount of rain, as well as snow, and may be reflected in our data throughout the project.

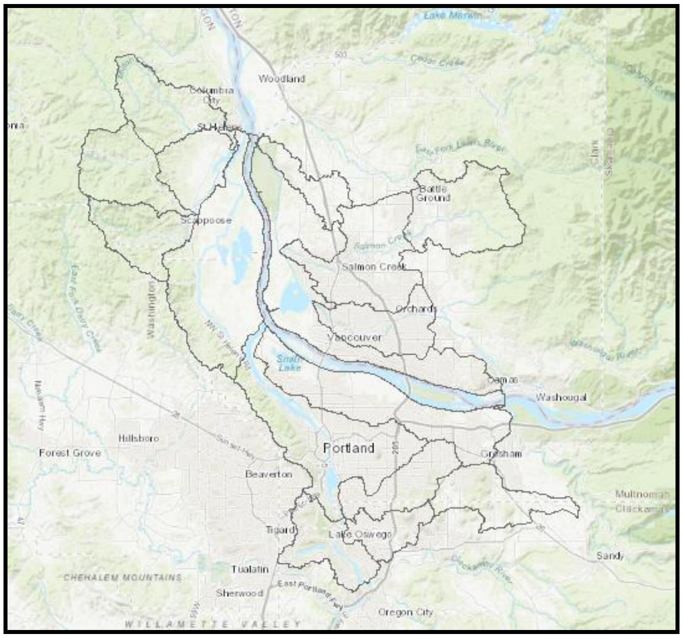

Figure 1: Topography of Lower Willamette Watershed

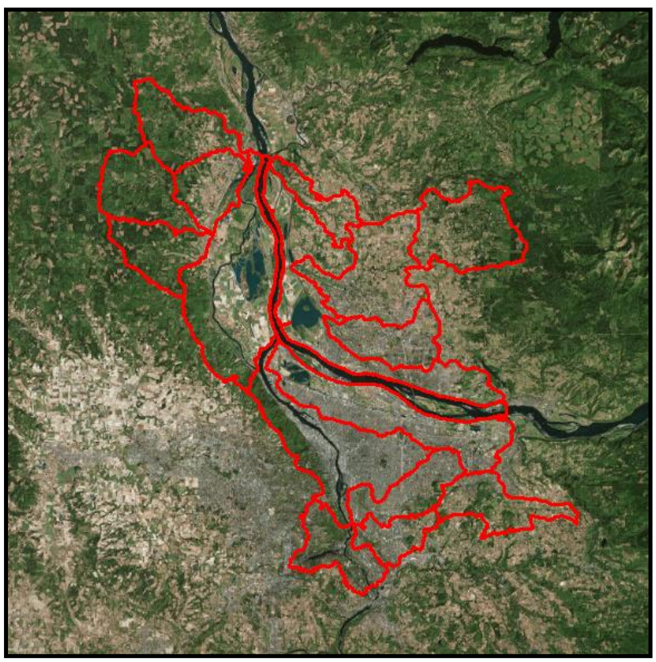

Figure 2: Imagery of Lower Willamette Watershed

Data

The data that will be used in this project has been obtained through the National Hydrography Dataset Plus (NHD) and the SSURGO soils database. The NHD data, which was taken from Water Resource Region 17, includes watershed attributes, flowlines, basins, as well as a Watershed Boundary Dataset (WBD) which gives us information of the subwatersheds. The soil data includes information about the Hydrologic Soil Groups and available water storage. All of our data will have the NAD83 coordinate system.

GIS Methods

The main steps that will be taken in this project begin with creating a new geodatabase and assigning an appropriate a coordinate system. Starting with the Watershed Boundary Dataset, we have to narrow down to the basin, since the data includes subwatersheds for all of Region 17. Using the Select by Attribute tool, all of the HUC 8 subwatersheds (17090012) were highlighted, then exported as a new feature class, Watershed, within the BaseData feature dataset. This layer was then organized to highlight the HUC 10 watersheds. Using the dissolve tool, a single polygon for the Basin was created by inputting the Watershed. The final representation of these steps can be seen in Figure 3.

The NHD Flowlines data was then brought in. Using the Select by Location tool, the flowlines within the Basin layer were highlighted and exported as a new feature class. The EROM data downloaded includes information about the estimated mean annual flow of streams and rivers for this area, so joining this information to the flowlines feature will be beneficial in order to display this characteristic on the map for this specific basin. Within the Flowlines attribute table, a new field for Mean Annual Flow was created, and the table was then joined with the EROM table. Using the field calculator on the new field, this column is set equal to the Q0001E column from the EROM table in order to obtain the flow values. The joins can now be removed and the Flowline layer can be manipulated to display the Mean Annual Flow. This can be seen in Figure 4, along with the basin's main rivers labeled.

Other useful information for analyzing a basin comes from the soil. In this project specifically, the available water storage was looked at in our data. Using the clip tool, the soil information only within the Willamette basin can be shown on the map and be added as a new feature class. Within this layer, the areas of each hydrological soil group can be found, as well as the Available Water Storage within 100 cm can be shown on the map, see Figure 5. This information will help determine the volume of water that can be stored in the basin.

Lastly, the gage data and aquifer data can be brought into the map. Similarly to before, the Select by Location tool was used in order to create a new feature class of only the stream gages within the Willamette basin. The aquifers that intersect this basin were also selected and created into their own layer. A map with aquifers, stream gages, and flowlines can now be created, and analysis of these features can be made.

A summary of these step may be found in Figure 3

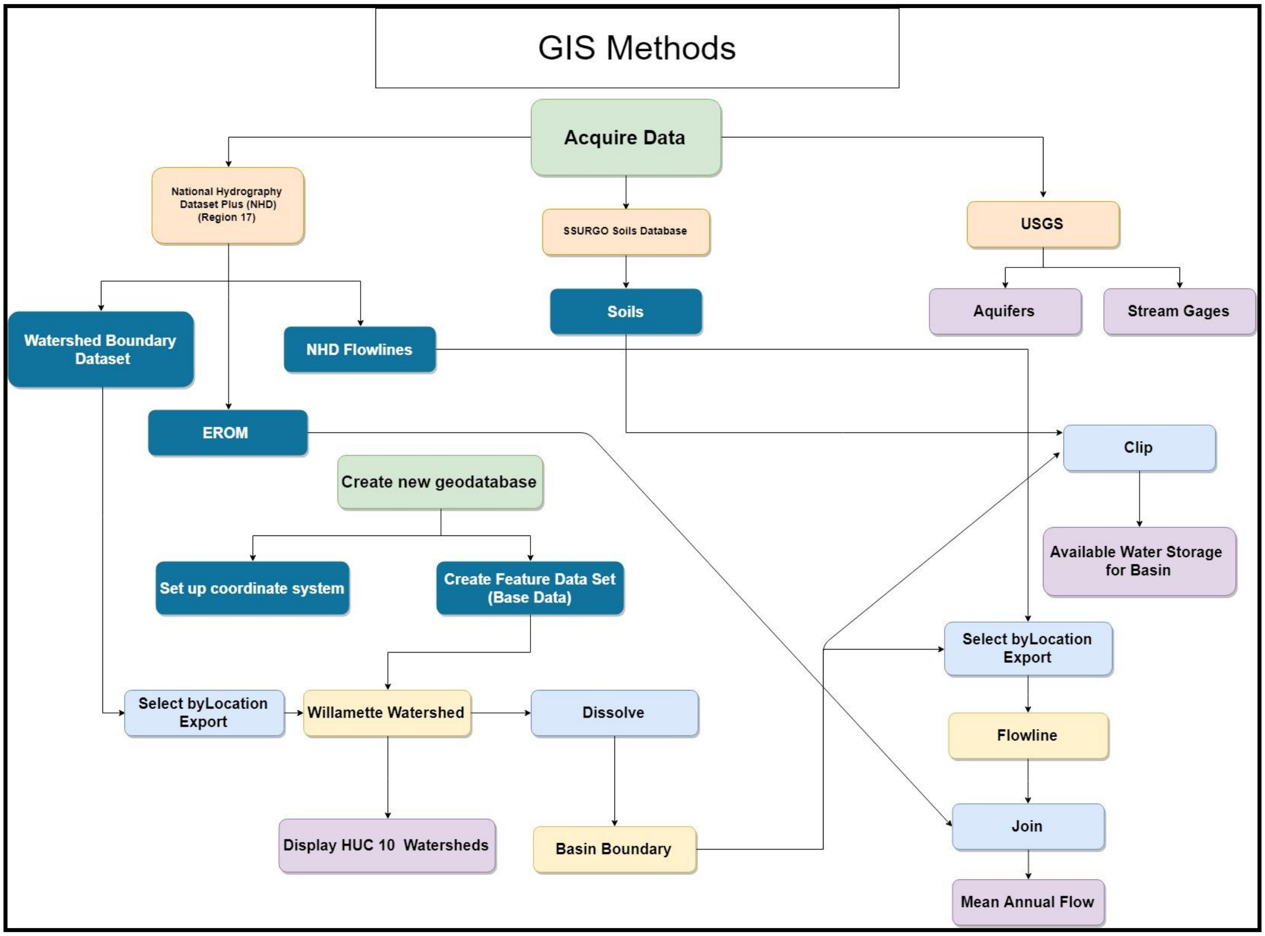

Figure 3: Flowchart of Methods

Outcomes/Conclusions

Looking at Figure 4, the HUC 8 basin can be seen, along with its eighteen HUC 12 subwatersheds, organized into five watersheds. The entire HUC 8 area is ***644 mi^2***, the Average HUC 10 area is ***128.8 mi^2***, and the average HUC 12 area is ***35.78 mi^2***.

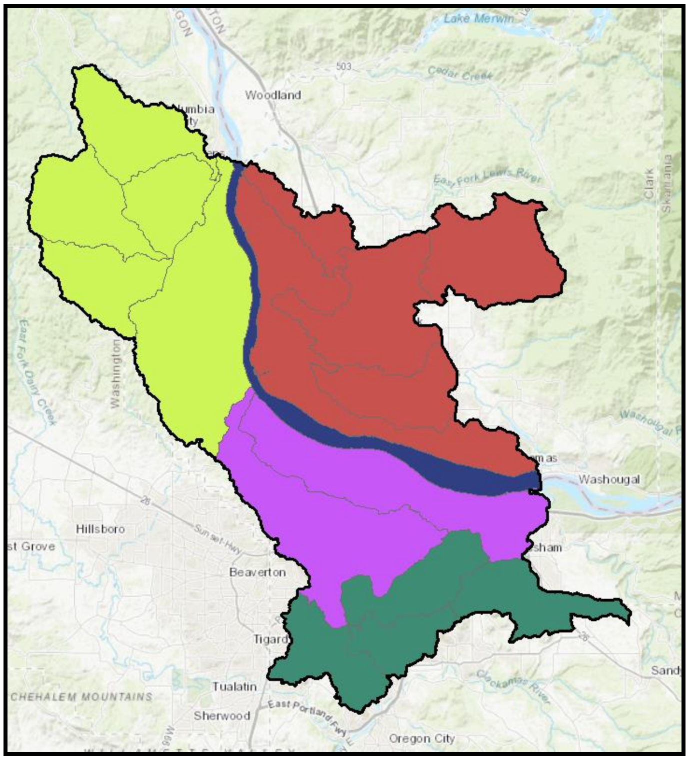

Figure 4: Willamette Basin HUC-10 & HUC-12

Flowline information was the next step in analyzing this basin. Figure 5 shows the main rivers in the basin labeled and is displayed on a topographic basemap. It can be seen that there are more rivers and streams where there is more variation in terrain, and there is a lack of streams in the southern region, which is where there are urban cities. Looking at the annual flow data, there is a high of ***236,988.25 cfs*** and a low of ***0 cfs***. Excluding the Columbia River, the mean annual flow in the basin is ***830.6 cfs***. These flows can be considered high, and is a result of the geographic location. The Pacific Northwest has many streams, rivers, and lakes that interconnect. A map with more details of annual flow and stream gauges may be found in the Appendix.

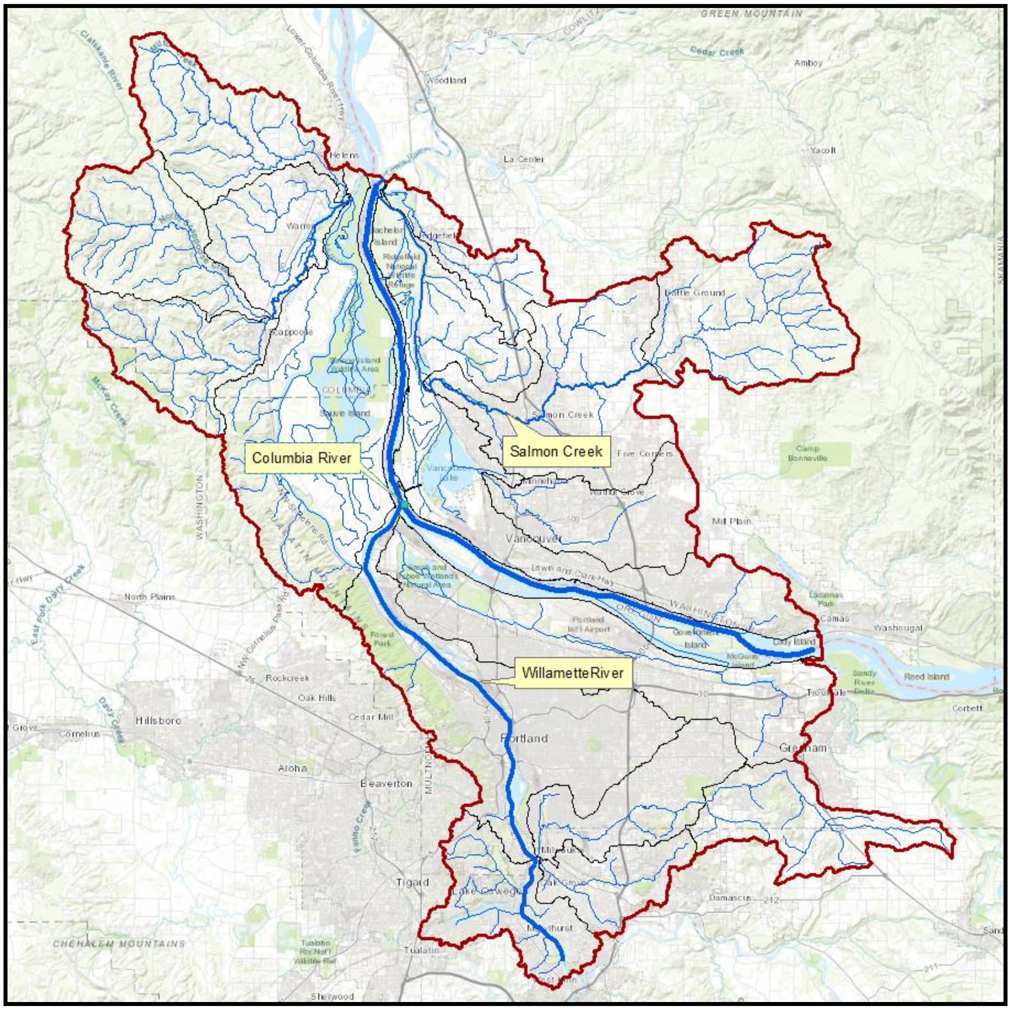

Figure 5: Willamette Basin and Streams

With information about flowlines now organized, the total length of flowines can be determined to be ***1,169.396 km***, and the area of the Willamette Basin is ***1,667.96 km²***.

The drainage density can now be calculated:

$$\text{Drainage Density} = \frac{1169.369\ km}{1667.96\ km^2} = 0.701\ {}^{1}/_{km}$$

The next phase of analysis will take information about soil data. A map that gives a visual representation of the available water storage in the basin may be found in the Appendix. Using the attribute table for the soil data, the average available water storage is ***17.36 cm***. If this basin area is rounded to be 1,668 km^2, the volume of water that can potentially be stored in the soil in the top meter of soil if the soil were fully saturated ca be calculated.

$$Volume\ Stored = \left(\frac{17.36\ cm}{10^4}\right) * 1668\ km^2 = 2.89\ km^3$$

If compared to the San Marcos Basin in Texas, which was ***0.459 km^3***, the Willamette Basin can store a lot more water. This makes sense when the site location is considered. The PNW receives a lot of rain, so the soil would need to be able to retain more water than a basin in a much drier climate. It is beneficial to know the area of each hydrologic soil group when calculating runoff, so these areas have been determined.

Soil Group	Area(mi^2)
A	25.795
B	157.91
B/D	18.29
C	255.89
C/D	42.04
D	25.5

The final analysis of this basin includes stream gage data and aquifer information. In figure 6, the Willamette Lowland basin-fill aquifer (pink) and the Pacific Northwest basaltic-rock aquifer (green) are the two aquifers that impact the Willamette basin.

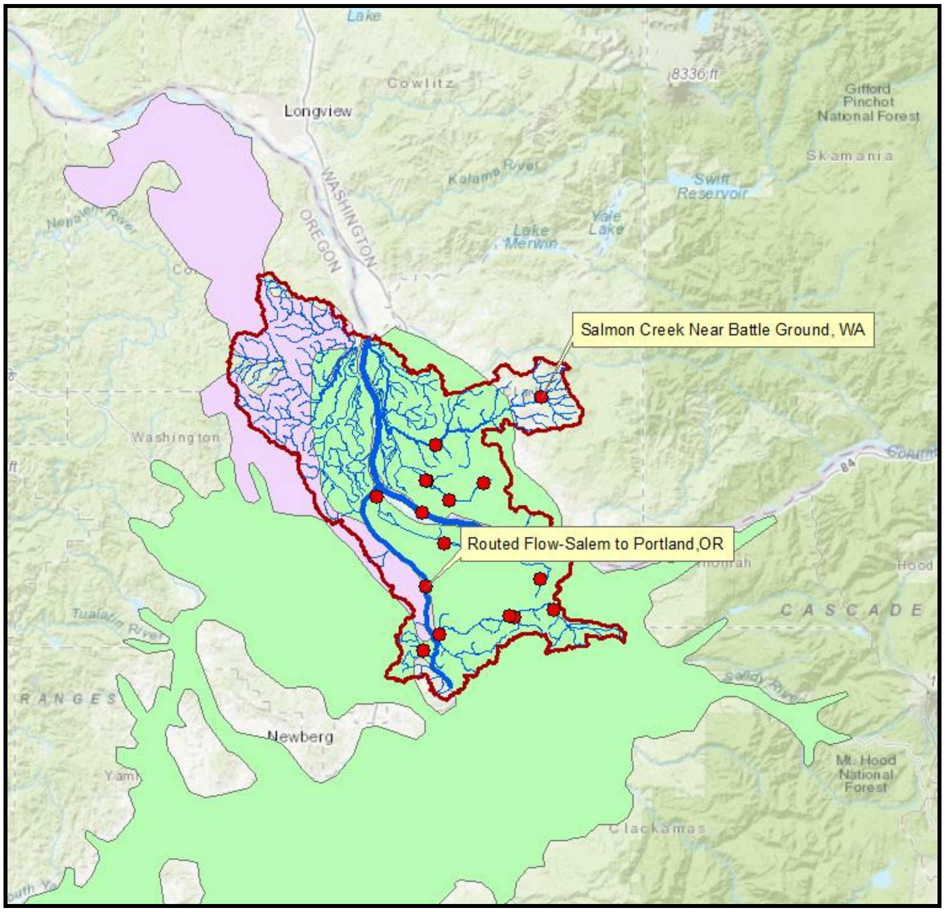

Figure 6: Aquifers and Willamette Basin

Looking at the gage station Salmon Creek near Battle Ground, WA, the flow is ***62.538 cfs***. At Routed Flow-Salem to Portland, OR the average flow is ***33,000.72 cfs***. This is much larger due to the fact that it is located at the Columbia river, which itself has a large flow due to the rivers size, but may also be a result of its location in reference to the aquifers. It is right on the outcrop regions of one of the aquifers, so some of flow is coming from the groundwater from the aquifers, in addition to the rivers flow.

All of the above analyses offer various information to solve or predict problem within a basin. A limitation of the different HUC area calculations is that one of the five watersheds varied in shape and size and mainly consists of a single river. If one was to do more a more advanced analysis for the average HUC 10, it would need to be noted that the Hayden Island-Columbia River watershed may have different characteristics than the other watersheds because the majority of its area is made up by the Columbia River. Another issue that could arise with a more advanced analysis would sprout from the hydrological soil class data. In this project, there instances where a soil area fit within two soil groups, or had no soil group. This could impact runoff calculations that depend on the soil group specifications, and it may be beneficial to do further research.

Appendix

Bibliography

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Map of Willamette Basin: Stream Gages

Project.pdf

Map of Available Water Storage for Willamette Basin

SoilData.pdf