GS407/507 River Environments – Stream Ordering Exercise

Introduction

Watersheds represent a collection of stream tributary networks with interconnected branches that flow from drainage divides (interfluves) to the exit point, downstream. Smaller-area watersheds are in turn connected to larger-area watersheds until they reach a scale that empties into the ocean. The primary physical function of the stream network is to deliver water and sediments over time, under the influence of gravity. The sediment or water discharge of a river system is calculated by:

$Q = vol. / t$ where Q = discharge, volume = vol. of sediment or water, and t = time.

Gravitational force is the driving mechanism moving sediment and water downstream, climate-derived rainfall/precipitation is necessary for water flux, the sediment and water transported by the river represents its "load", and the discharge represents the "output" of the watershed over time. The number and types of tributary connections in watersheds are important factors that control the output. The critical controlling morphometric parameters include:

Drainage basin area (i.e. precipitation "catchment" area)
stream gradient (slope of channel = gravitational force)
Number of stream segments in the network
Lengths of stream segments in the nework

An example of these controlling factors is:

The greater the drainage basin area and the steeper the stream gradient, the greater the volume of water and faster the stream velocity, the greater the energy to transport sediment = higher discharges of water and sediment over time.

The following exercise illustrates the analytical techniques used to characterize the physical drainage morphometry of a watershed.

Exercises

Examine the map of the watershed and drainage network shown on the following page.

1. Label the drainage boundary on this map. Label the tributary outlet for the watershed.
2. Compare the map to the drainage patterns shown on "Figure 5.2A" on p. 32 of your field guide. What drainage type is associated with this map?
3. Using the drainage pattern as a guide, draw drainage divides around the stream network systems labeled "sub-basin 1", "sub-basin 2", "sub-basin 3", "sub-basin 4", "sub-basin 5", and "sub-basin 6".
4. Using the "Strahler stream ordering method" illustrated on "Figure 5.17", p. 34 of your field guide, determine and label the stream order numbers for each tributary in the watershed. Label the stream order numbers next to the stream segments on your map.
5. Answer the following questions:

What is the highest stream order of the basin?
How many total first order stream segments are there? = ________
How many total second order stream segments are there? = ________
How many total third order stream segments are there? = ________
How many total fourth order stream segments are there? = ________

What is the general relationship between stream order and the no. of stream segments in the order? Plot the general relationship on an x-y graph, with stream order on the x-axis, and number of segments on the y-axis.

Hypothesize the relationship you would expect between stream order and stream channel width. Plot the general relationship on an x-y graph, with stream order on the x-axis, and channel width on the y-axis.

Hypothesize the relationship you would expect between stream order and channel gradient. Plot the general relationship on an x-y graph, with stream order on the x-axis, and channel gradient on the y-axis.

If the bedrock underlying a given watershed was very porous and permeable (i.e. sponge-like), would you expect the number of stream channel segments to increase, decrease, or stay the same? Why, explain your answer.

Figure 1. Stream Order Exercise