Lab # 6: Steady Flow Modeling: Modeling Water Surface Profiles for Natural Rivers with a Junction

Introduction:

In previous five labs, five hypothetical test cases (i.e., constant slope, three-slope, sinusoidal bed, broad crested weir and venture flume) have been modeled. By modeling hypothetical test cases, basics of steady flow modeling using Gradually Varied Flow equation have been described. Moreover, Different components of HEC-RAS also have been covered. We will use these understandings now for Natural Rivers.

Natural rivers have variations in bed elevation as well as in cross-sections. These variations produce variations in water surface elevation and depending on the magnitudes of variation a jump or vertical fall may form. In addition, natural rivers have tributaries, branches, confluences and bifurcations which produce a network of rivers with one or more junctions. A typical river network has been shown in figure 1.

A confluence is a junction where two or more rivers are met at one point, and a bifurcation point is a junction where one river is divided into two or more rivers. To simulate a junction, one needs two extra boundary conditions. The first condition comes from the continuity equation. For a confluence, the continuity equation becomes: $Q_1+Q_2=Q_3$ where Q_1 and Q_2 are the discharges of two upstream rivers meeting at a junction and Q_3 is the total downstream discharge. For a bifurcation junction, the continuity equation becomes: $Q_1=Q_2+Q_3$ where Q_1 is the upstream discharge and Q_2 and Q_3 are the discharges of two bifurcated rivers. Distribution of Q_2 and Q_3 depends on the conveyance of those bifurcated rivers. The second condition at a junction comes from the momentum or energy condition. This states that energy levels or water surface elevations for all rivers meeting at a junction should be equal. Therefore, mathematically, $WSE_1= WSE_2 =WSE_3$.

In previous labs, model results are verified and compared with the analytical uniform or critical depths. Verification of a model result is an important part of mathematical modeling. Without verification, any model result is ineffectual. Similar to the modeling of hypothetical test cases, simulation with natural rivers must need to be verified. In natural rivers, this verification is done with the observed or measured data at one/more locations those are located within the model boundaries.

Verification of model results is done in two parts: *Calibration* and *Validation*. *Calibration* means tuning of model parameters with one set of data and *Validation* means further verification of calibrated model results using another set of data. In both processes, comparisons are done using visual inspection normally. Beside visual inspection, different statistical parameters, such as correlation parameter, NSE () etc. can be calculated.

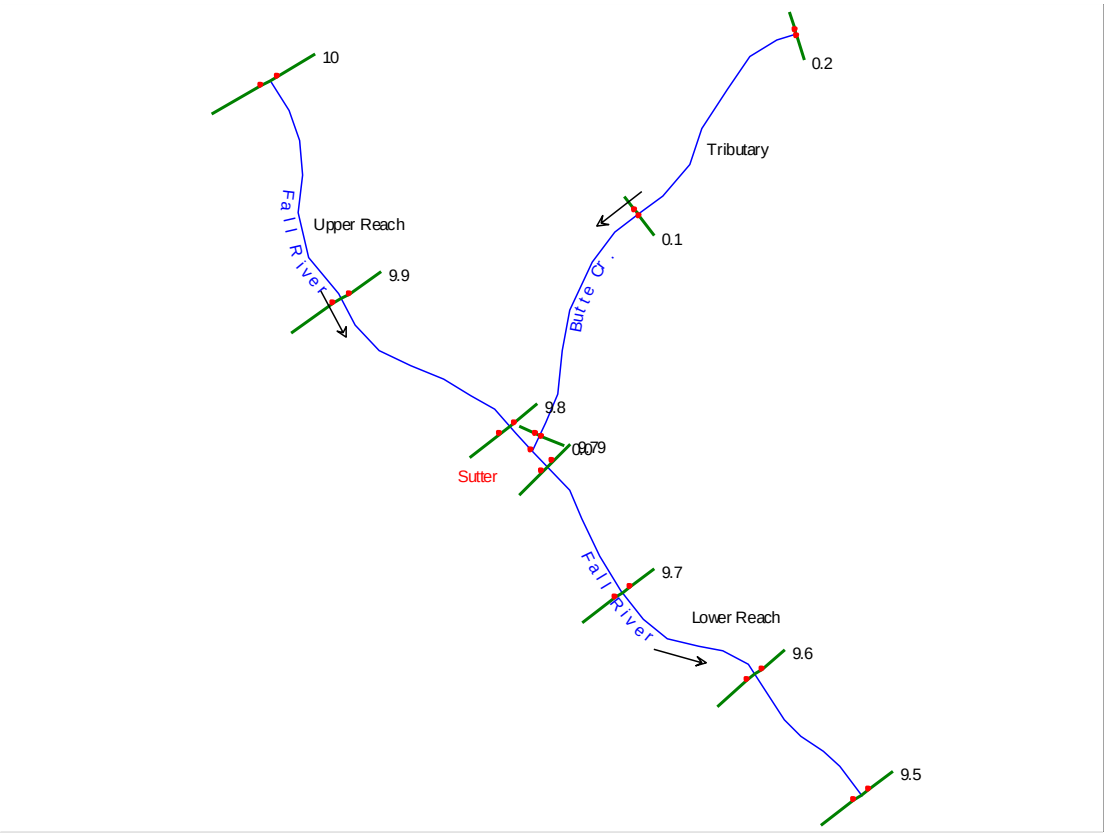


Figure 1: A plan view of a river network

Objective of this lab:

In this lab, our main objectives are to understand the hydraulics of natural river and to understand the calibration and validation processes in mathematical modeling. Therefore, in this lab we will simulate water surface profiles with a natural river network.

Specific Objectives:

8. Create a new project.
1. Draw a schematic of a river network using the given data.
2. Assign cross section data.
3. Assign boundary condition data.
4. Perform the analysis
5. View and present the results.
6. Calibrate and Validate the model.

Following information are needed for this lab:

- The channel is irregular. Cross section data will be given in an excel file
- The channel length data will be given in an excel file.
- Manning's *n* needs to be adjusted.
- The discharge data will be given in the class.
- Boundary condition will be given in the class.

Submissions:

1. Adjust Manning's *n* to calibrate the model results with the observed data.
2. Printing of longitudinal profile of water surface elevation.
3. What is calibration and validation? Why these two processes are important in mathematical modeling?
4. What is a junction? How a junction is handled in HEC-RAS?
5. Discussions.