Practical 4: Hydrological Analysis

Creating hydrologically correct topographic surfaces, processing flow, identifying and filling sinks, flow direction, stream networks, drainage basins, flow length, delineate area wide watersheds

1. Introduction

The current exercise involves about detailed introduction into creation of watershed maps for various drainage outlet access points using DEM datasets.

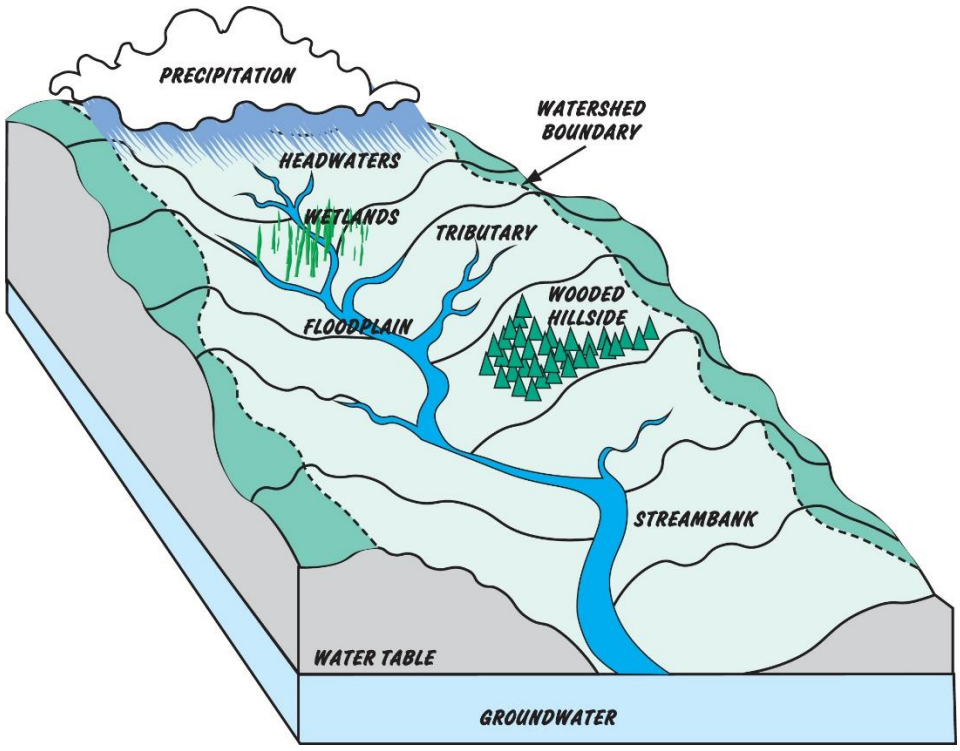
2. Objectives

1. To download the DEM and Shapefile of their ROI (Region of Interest)
2. Perform watershed modelling
3. Interpretation of the analysis.

3. Watershed

A watershed is the area of land where all the water that drains off it, goes into the same place—a river, stream or lake. The smallest watersheds are the drainage areas for small streams and lakes. Think about your local creek or river. Where does it start? What type of landscape does it flow through? Where does it end up? All the area covered is a watershed.

Each small watershed is part of the more extensive watershed for a larger stream or lake in the vicinity. These larger watersheds are, in turn, part of even larger drainage networks, and so on.



3.1 Watershed mapping in ArcGIS

The hydrologic modelling tools in the ArcGIS Spatial Analyst extension toolbox provide methods for describing the physical components of a surface. The hydrologic tools allow you to identify sinks, determine flow direction, calculate flow accumulation, delineate watersheds, and create stream networks.

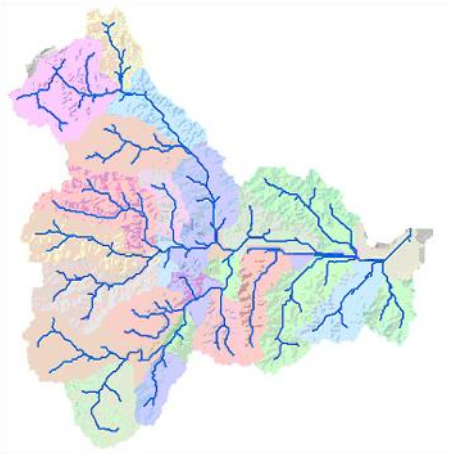
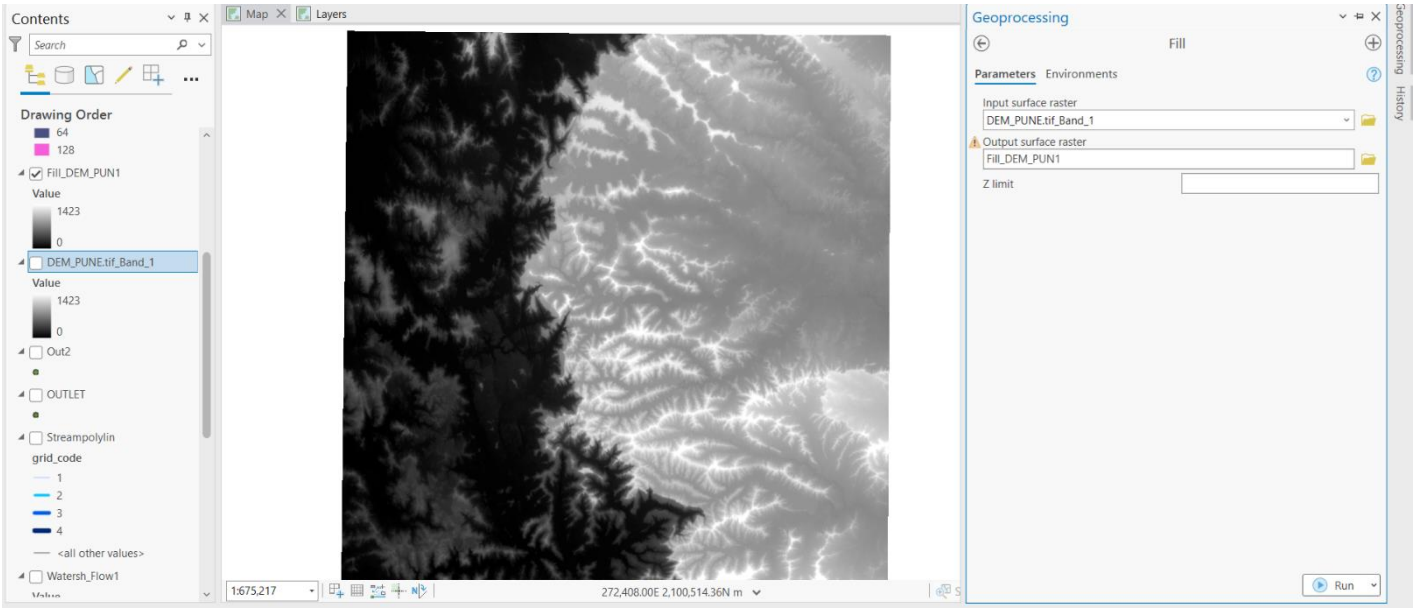


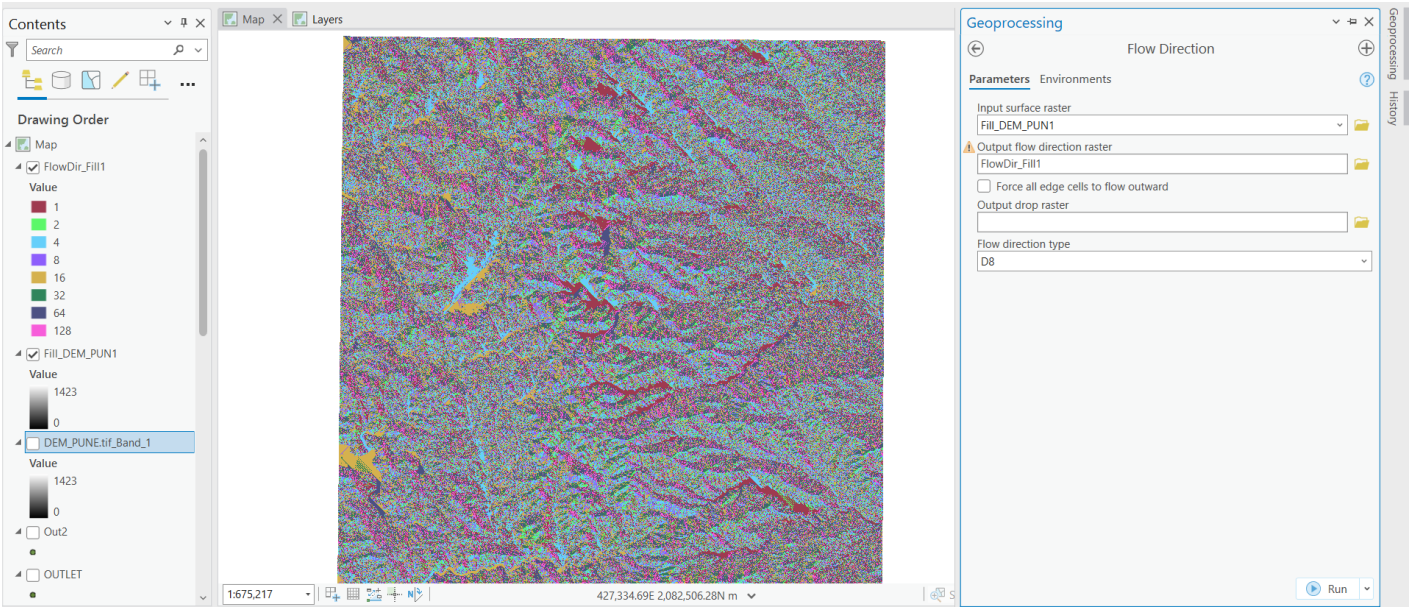
Figure: Sample Watershed map involving Hydrological modelling

Steps Involved:

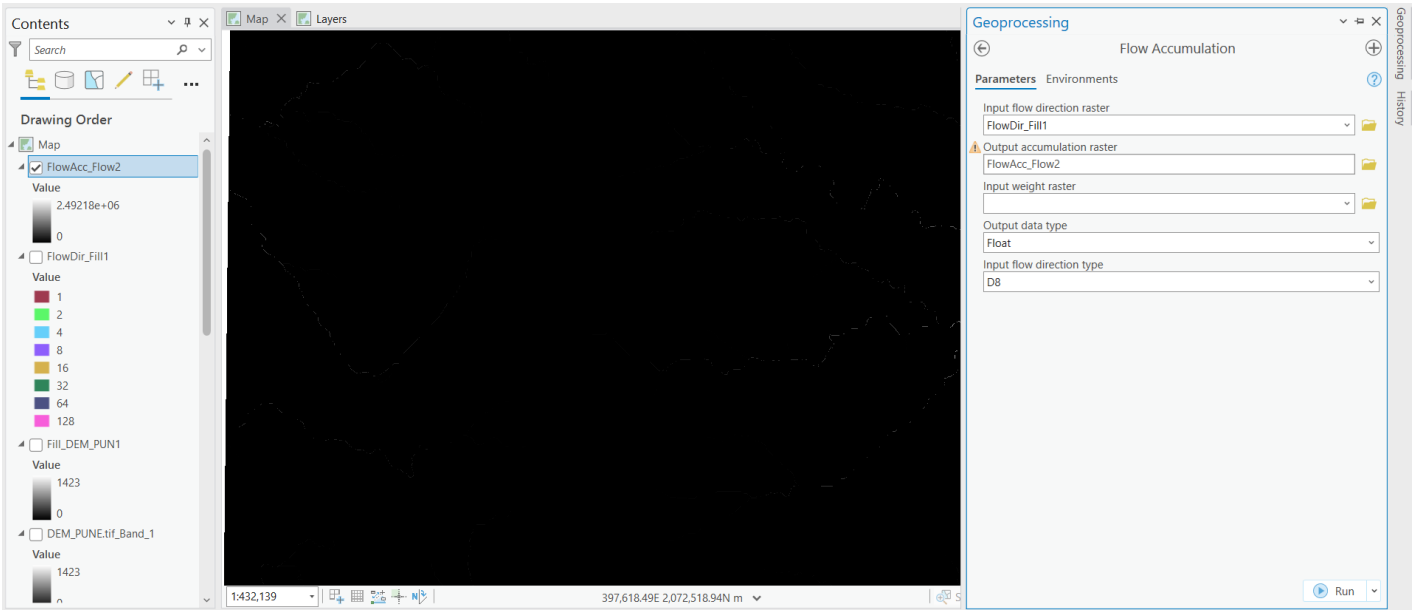
1. **Fill**: Correction of sinks and peaks that occur due to errors in the elevation raster.



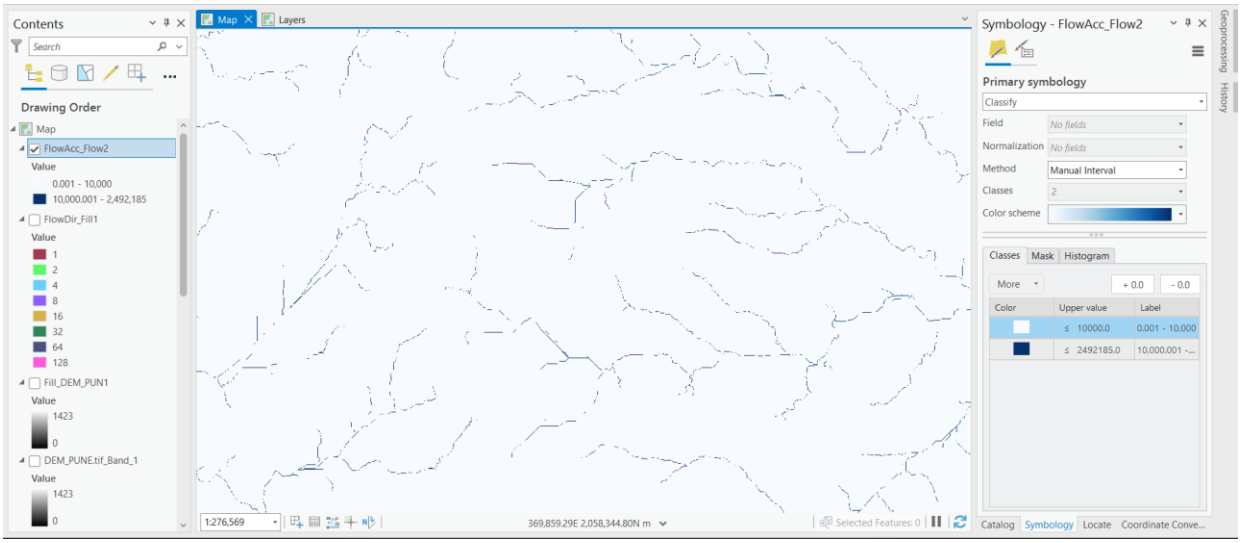
2. **Flow Direction**: Determining the direction of the downward stream flow.



3. **Flow Accumulation**: The accumulation of cells based on the flow direction is calculated.



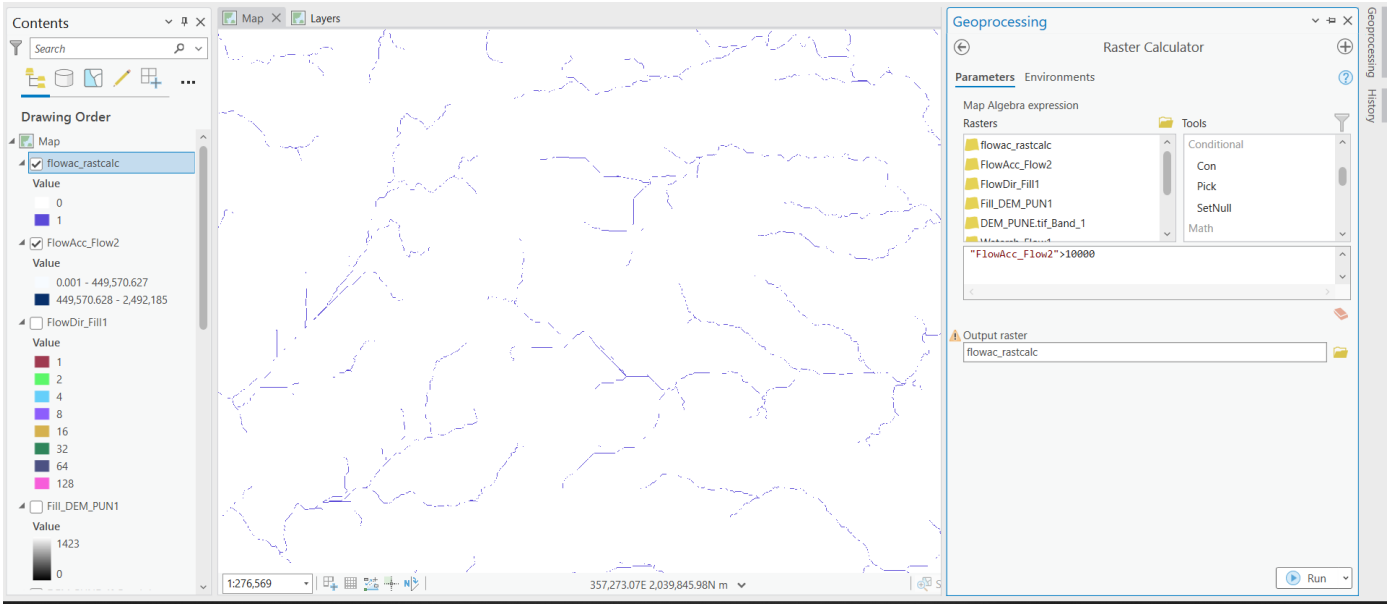
Since the output is not visible, change symbology using Classify. Classifying using 2 classes (binary output) is visually better in this case. The cell value depends on the topography of the study area.



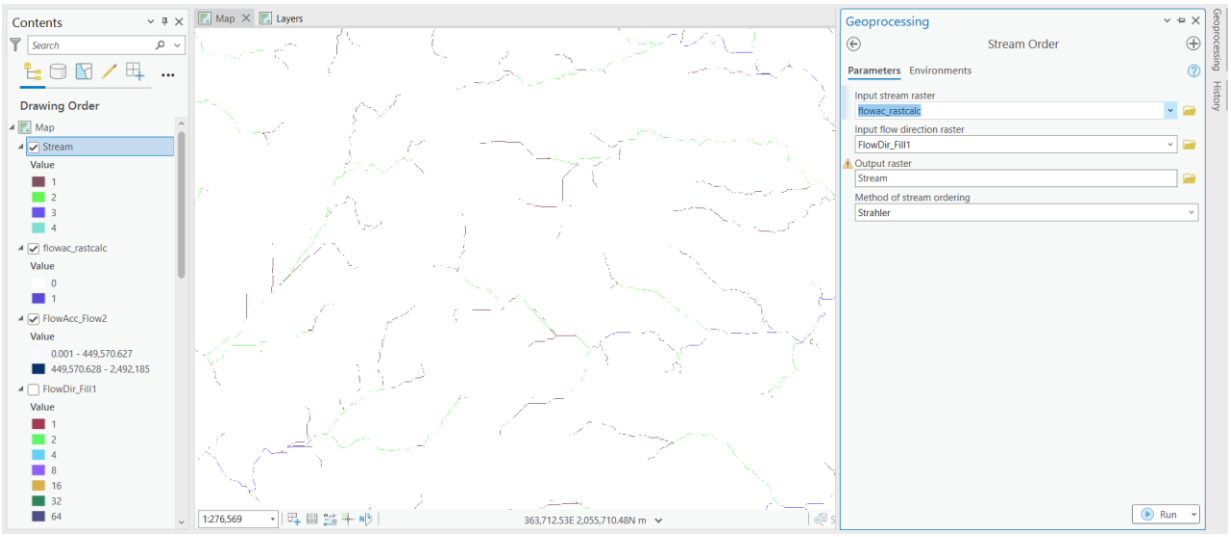
4. **Delineating Stream**:

   In this case, the cells with values greater than 10000 start delineating the stream network of this study area.

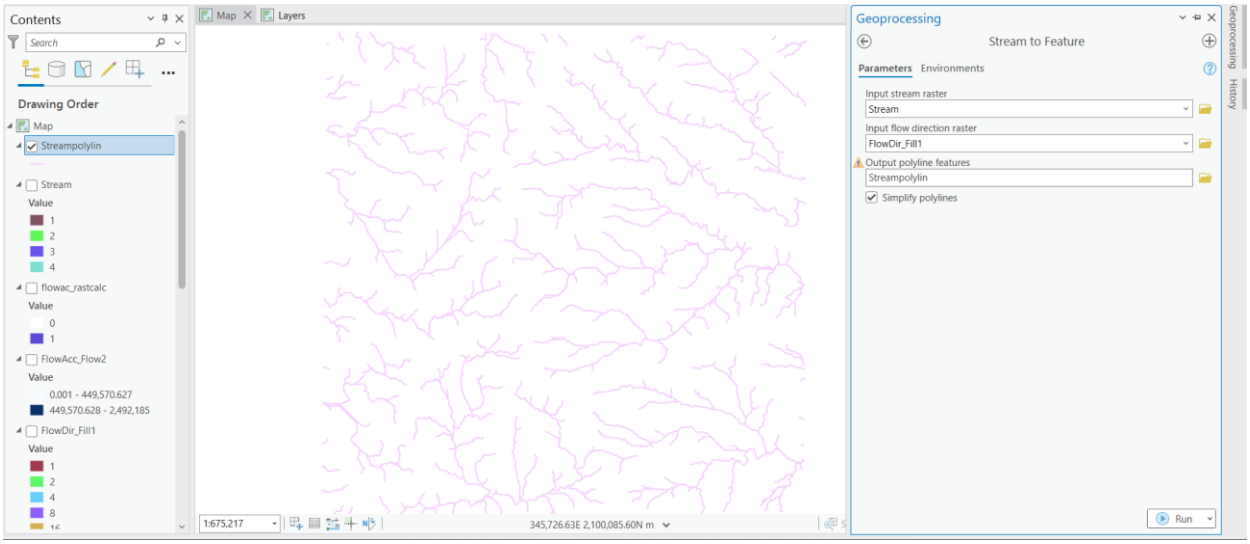
   To extract these streams as a binary raster we can use Con or Raster Calculator where Flow Accumulation > 10000 (site suitable accumulation value)



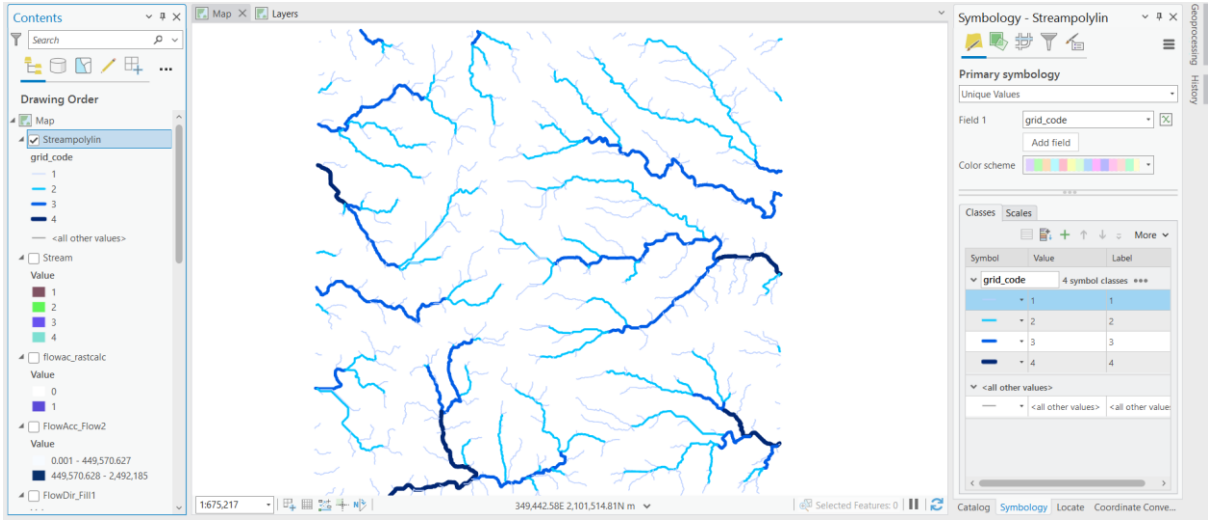
5. **Stream Order**:
   a. Assign order to the branches of the stream network.



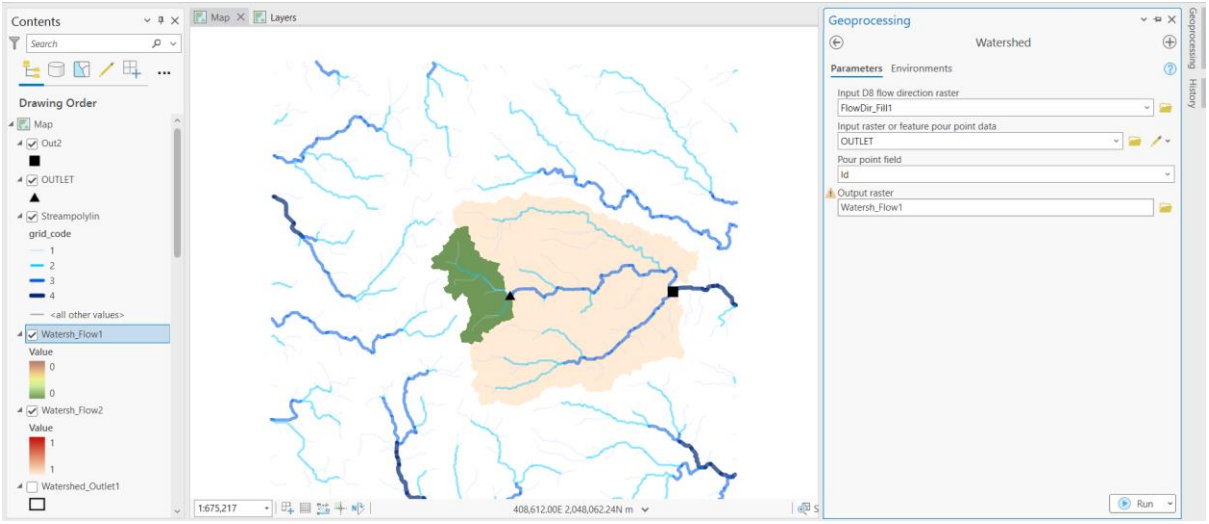
   b. **Stream to Feature**: Convert the raster output into polylines.



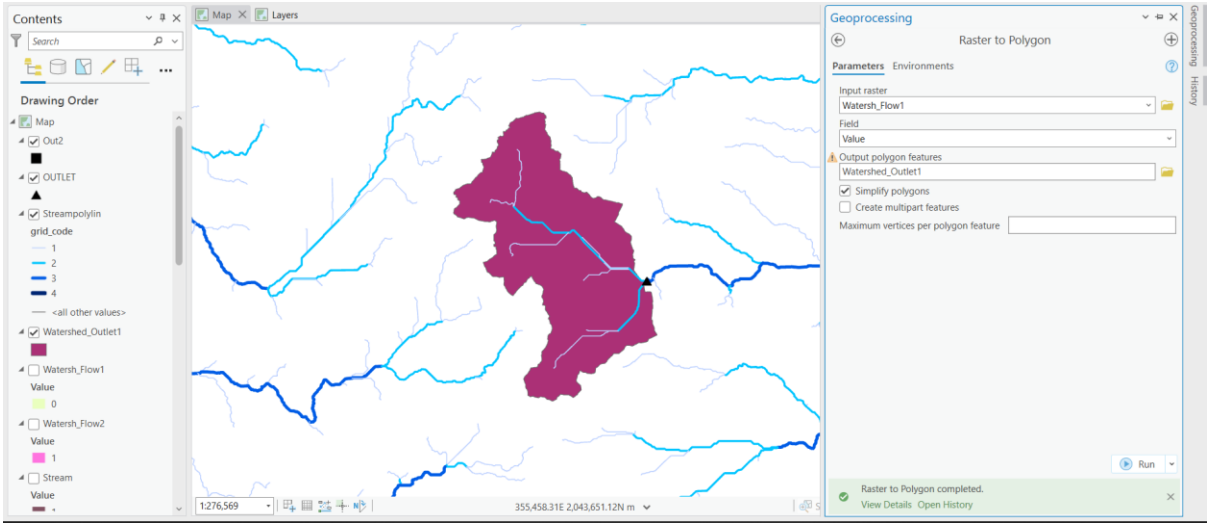
Classify using the order (grid codes) as unique values.



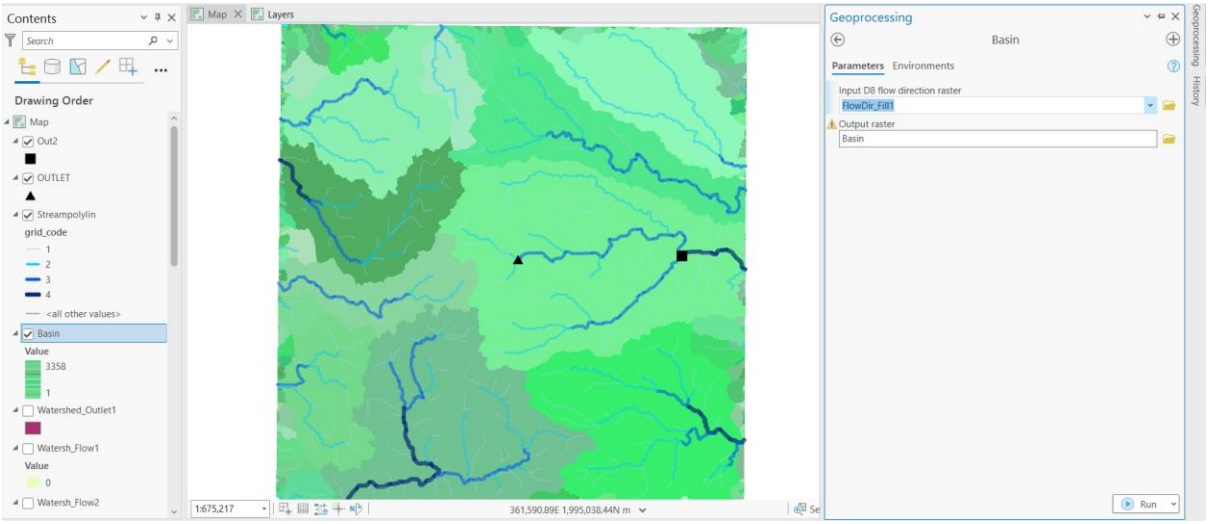
6. **Watershed Delineation**: Based on the input outlet point(s) or pour points, the flow contributing (upslope) area is calculated using ‘Watershed’ tool.
   The outlet point should be snapped to the raster input.



We can convert the raster output into polygon using ‘Raster To Polygon’



7. Basin: This tool is used to delineate all possible river basins based on the flow direction.



Many smaller watersheds can be part of river basins.