Purpose

The purpose of this exercise is to illustrate, step-by-step, how to use the major functionality available in the Arc Hydro tools for Raster Analysis. In this exercise, you will perform drainage analysis on a terrain model for Oak Ridges Moraine (ORM). The Arc Hydro tools are used to derive several data sets that collectively describe the drainage patterns of the catchment. Raster analysis is performed to generate data on flow direction, flow accumulation, stream definition, stream segmentation, and watershed delineation. These data are then used to develop a vector representation of catchments and drainage lines from selected points. The utility of the Arc Hydro tools is demonstrated by applying them to develop attributes that can be useful in hydrologic modeling. To accomplish these objectives, you are exposed to important features and functionality of the Arc Hydro tools, both in the raster and the vector environments.

You need to have saved the ArcMap document before using any ArcHydro functions because it needs to create an output folder in the folder where the map document is saved.

Follow this instruction step by step and answer all questions (question1 to question6).
**Terrain Preprocessing**

Terrain Preprocessing uses DEM to identify the surface drainage pattern. Once preprocessed, the DEM and its derivatives can be used for efficient watershed delineation and stream network generation.

All the steps in the Terrain Preprocessing menu should be performed in sequential order. All of the preprocessing must be completed before Watershed Processing functions can be used.

Be aware, some of the terrain processes may take some time to finish. Process like Filling Sinks and Flow accumulation took about 10 minutes to process on one of our computers, so please be patient!

Copy the data from H:\Courses\geog4340\lab6\data to your C drive or desktop. Open ArcMap and add the DEM data.

1. **Fill Sinks**

This function fills the sinks in a grid. If cells with higher elevation surround a cell, the water is trapped in that cell and cannot flow. The Fill Sinks function modifies the elevation value to eliminate these problems.

Select **Terrain Preprocessing | Fill Sinks**.
Confirm that the input for DEM is “DEM”. The output is the Hydro DEM layer, named by default “Fil”. This default name can be overwritten.

![Fill Sinks dialog box]

Press OK. Upon successful completion of the process, the “Fil” layer is added to the map.

This process takes up to 10 minutes!

3. **Flow Direction**

This function computes the flow direction for a given grid. The values in the cells of the flow direction grid indicate the direction of the steepest descent from that cell.

Select **Terrain Preprocessing | Flow Direction**.
Confirm that the input for Hydro DEM is “Fil”. The output is the Flow Direction Grid, named by default “Fdr”. This default name can be overwritten.

Press OK. Upon successful completion of the process, the flow direction grid “Fdr” is added to the map.

**Question1:** Make a screen capture of the attribute table of Fdr and give an interpretation for the values in the Value field.

**4. Flow Accumulation**
This function computes the flow accumulation grid that contains the accumulated number of cells upstream of a cell, for each cell in the input grid.

Select **Terrain Preprocessing | Flow Accumulation**.

```plaintext
Confirm that the input of the Flow Direction Grid is “Fdr”. The output is the Flow Accumulation Grid having a default name of “Fac” that can be overwritten.

Press OK. Upon successful completion of the process, the flow accumulation grid “Fac” is added to the map.

**5. Stream Definition**

This function computes a stream grid which contains a value of "1" for all the cells in the input flow accumulation grid that have a value greater than the given threshold. All other cells in the Stream Grid contain no data.
Select **Terrain Preprocessing | Stream Definition.**

Confirm that the input for the Flow Accumulation Grid is “Fac”. The output is the Stream Grid. “Str” is its default name that can be overwritten.

![Stream Definition dialog box](image)

Press OK. Upon successful completion of the process, the stream grid “Str” is added to the map.

### 6. Stream Segmentation

This function creates a grid of stream segments that have a unique identification. Either a segment may be a head segment, or it may be defined as a segment between two segment junctions. All the cells in a particular segment have the same grid code that is specific to that segment.

Select **Terrain Preprocessing | Stream Segmentation.**
Confirm that “Fdr” and “Str” are the inputs for the Flow Direction Grid and the Stream Grid respectively. The output is the Link Grid, with the default name “Lnk” that can be overwritten.

Press OK. Upon successful completion of the process, the link grid “Lnk” is added to the map.

7. Catchment Grid Delineation

This function creates a grid in which each cell carries a value (grid code) indicating to which catchment the cell belongs. The value corresponds to the value carried by the stream segment that drains that area, defined in the stream segment link grid.

Select Terrain Preprocessing | Catchment Grid Delineation.
Confirm that the input to the Flow Direction Grid and Link Grid are “Fdr” and “Lnk” respectively. The output is the Catchment Grid layer. “Cat” is its default name that can be overwritten by the user.

Press OK. Upon successful completion of the process, the Catchment grid “Cat” is added to the map.

8. Catchment Polygon Processing

This function converts a catchment grid into a catchment polygon feature.

Select Terrain Preprocessing | Catchment Polygon Processing.
Confirm that the input to the CatchmentGrid is “Cat”. The output is the Catchment polygon feature class, having the default name “Catchment” that can be overwritten.

Press OK. Upon successful completion of the process, the polygon feature class “Catchment” is added to the map.

9. Drainage Line Processing

This function converts the input Stream Link grid into a Drainage Line feature class. Each line in the feature class carries the identifier of the catchment in which it resides.

Select Terrain Preprocessing | Drainage Line Processing.
Confirm that the input to Link Grid is “Lnk” and to Flow Direction Grid “Fdr”. The output Drainage Line has the default name “DrainageLine”, that can be overwritten.

Press OK. Upon successful completion of the process, the linear feature class “DrainageLine” is added to the map.
**Question2: A layout showing the delineated Catchments and DrainageLines**

**10. Adjoint Catchment Processing**

This function generates the aggregated upstream catchments from the "Catchment" feature class. For each catchment that is not a head catchment, a polygon representing the whole upstream area draining to its inlet point is constructed and stored in a feature class that has an "Adjoint Catchment" tag. This feature class is used to speed up the point delineation process.

- Select **Terrain Preprocessing | Adjoint Catchment Processing**.
Confirm that the inputs to Drainage Line and Catchment are respectively “DrainageLine” and “Catchment”. The output is Adjoint Catchment, with a default name “AdjointCatchment” that can be overwritten.

Press OK. Upon successful completion of the process, the polygon feature class “AdjointCatchment” is added to the map.

11. Drainage Point Processing

This function allows generating the drainage points associated to the catchments.

- Select Terrain Preprocessing | Drainage Point Processing.
Confirm that the input to Drainage Line is “DrainageLine”, and the input to Catchment is “Catchment”. The output is Drainage Point, having the default name “DrainagePoint” that can be overwritten.

Press OK. Upon successful completion of the process, the point feature class “DrainagePoint” is added to the map.


Question 3: How many DrainagePoints, DrainageLines and Catchments are there? What is the ID field in each feature class that associates the appropriate DrainagePoint with its DrainageLine and Catchment?

Watershed Processing

Now, let’s explore the data that we’ve created. Turn off all the themes in the display, except for the original Digital Elevation Model. From the Arc Hydro tools, select the Flow Path Tracing button and click on a few places on the elevation model. You’ll see flow paths traced to the watershed outlet. This path is traced using the Flow Direction grid created earlier in the exercise.
The flow paths just created are graphics. They can be deleted from the map by using the Select Elements tool in the ArcMap Draw toolbar, drawing a box around the graphics and then using the Delete key.

**Question 4:** A screenshot showing drainage paths traced over the digital elevation model.

Now let's take a look at the Flow Accumulation. Turn on the Fac Grid, and the DrainageLine theme. Make a Drainage Path trace, and notice how the path follows the drainage lines.
Zoom in on a part of the trace, and notice how the DrainageLines (blue) are exactly coincident with the Flow Accumulation cells with high flow accumulation values. The Flow Accumulation grid has here been colored to light to dark blue to make this contrast easier to see:
Use the Identify tool in the Tools toolbar to get the flow accumulation values along a DrainageLine. Notice how the flow accumulation increases as you go downstream, and how it jumps as you go over a confluence in the streams.

**Question5:** A screenshot showing an Identify enquiry on the Flow Accumulation Grid
Zoom in right close to the outlet and with the **Flow Accumulation** Grid visible, use the tool to examine the values of the various grids near where the stream exits the watershed.

**Tracing**

As part of the Catchment processing, the NextDownID attribute has been populated for each Catchment and Stream Segment so that it knows which Catchment or Stream segment is next downstream. Click on the Trace by NextDownID tool and Select Catchment as the theme to be traced, and Trace Upstream as the action. Click in a Catchment that has others upstream, and you’ll see the upstream Catchments traced out. Pretty cool!

You can similarly trace downstream, and both upstream and downstream to define the “Region of Hydrologic Influence” of any Catchment/Stream Segment. In order to invoke the NextDownID tracing tool a second time, it is necessary first to click another tool first, such as the Select Element tool in the Tools toolbar. This shows the Trace Both applied to Drainage Lines.
Question 6: A screenshot showing the Region of Hydrologic Influence of your chosen catchment.