Part A – Least-cost Path Analysis for a Pipeline

In this part you will carry out various least-cost path analyses, each using slightly different settings. The purpose of the analysis is to determine the optimal path for a new pipeline based on specific criteria.

Start a new map document and add the following data to a data frame:

- elevation – a DEM of the study area
- rivers.shp – a vector version of rivers in the study area
- source.shp – the origin of the pipeline
- destination.shp – the destination of the pipeline
- study_area.shp – polygon of the study area

Start by setting the proper environments, including workspaces and processing extent (same as study_area.shp).

Scenario 1: Slope

In the first scenario, you will only consider slope as a cost factor. Lower slopes are preferred.

- Create a slope grid in degrees from the DEM
  - Note that the horizontal units of the coordinate system are in feet, while the vertical units of the DEM are in meters, so you will need to use a Z factor of 3.28084 to adjust for this.
- Reclassify the slope based on the following cost factors:

Slope (degrees)	Cost factor
< 2	100
2 to 5	110
5 to 10	120
10 to 15	130
15 to 20	140
20 to 25	150
25 to 30	175
> 30	200

Here is what the results looks like, after applying a stretched symbology:
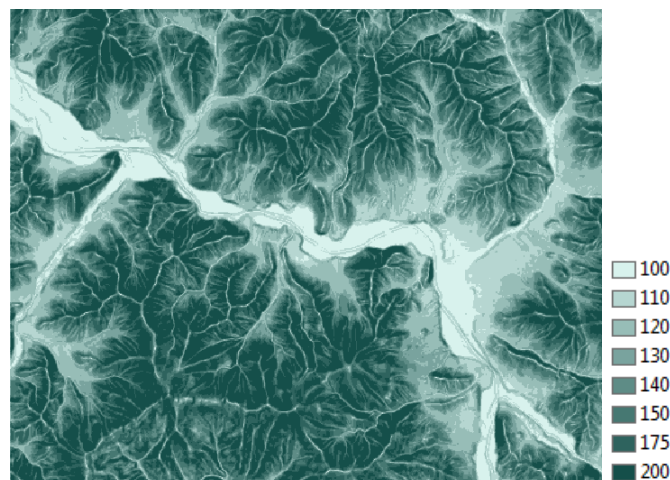
- Create a cost distance raster and associated backlink raster using the Cost Distance tool:
    - Feature source data: source.shp
    - Input cost raster: reclassified slope
    - Specify cost distance and backlink raster outputs
    - Leave the maximum distance parameter blank
    - Run the tool
- Examine the nature of your results

Deliverable 1: Examine the cost distance raster. What do the cell values represent? What are the units, if any? (5 pts)

Deliverable 2: Examine the cost backlink raster. What do the cell values represent? What are the units, if any? Why is this raster needed for further analysis? (5 pts)

- Now perform the least-cost path analysis using the Cost Path tool:
    - Feature destination data: destination.shp
    - Use the previously created cost distance and backlink rasters as inputs
    - Specify an output raster
    - Leave the other parameters to their defaults
    - Run the tool

- Convert the result from the cost path analysis to vector using Raster to Polyline
    - Specify appropriate inputs and outputs
    - Leave the other parameters to their defaults

When you examine the result, you will notice that the least-cost path follows the main valley bottom to a large degree and crosses the river multiple times.

- Determine how many times and where exactly the least-cost path solution crosses the river.
    - You can use vector or raster analysis tools for this, or a combination.
    - If your final result is raster, you will still need to convert the result to vector using Raster to Point
    - *Note: detailed steps are not provided here and you will need to determine the appropriate tools*

Deliverable 3: Brief description of your analysis steps (only for the step to determine the locations of the crossings). (5 pts)

Deliverable 4: How many river crossings are there for the least-cost path solution for scenario 1? (5 pts)

- Modify the symbology:
    - Clearly recognizable symbols for source and destination
    - Hillshaded elevation
    - Rivers in light blue
    - Least-cost path solution in a contrasting color, e.g. dark red
    - Clearly recognizable symbols for the crossings

Below is an example of what your results should look like: