Lab Report

Title: Lab 2 Part 2
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Project Repository: *https://github.com/casones/GIS5571.git*
Time Spent: 10 hours

Abstract
Using various input raster and vector layers, the goal of this lab was to create an ideal path between two points based on specific parameters. Elevation, land cover, roads, and stream data were used to execute a weighted overlay to generate a cost surface, which was then used to generate a least cost path displaying the ideal path based on weights for each input data.

Problem Statement
A fictional character named Dory needs to travel between two points, but has preferences for where she walks. She doesn't like to walk in farm fields, crossing over large bodies of water if there isn't a bridge, and doesn't want the path to be too steep. Using elevation, landcover, and stream data, I performed an analysis involving executing a weighted overlay, generating a cost surface, and finding a least cost path to provide an ideal route for Dory to take.

Table 1. Part 2 requirements for analysis

#	Requirement	Defined As	(Spatial) Data	Attribute Data	Dataset	Preparation
1	MN Counties	Feature layer containing MN county boundaries.	Vector polygon layer	Counties	MN Geospatial Commons	Create feature from selection of counties for study extent
2	MN DEM	Raster layer containing MN elevation data.	Raster layer	Elevation	MN Geospatial Commons	Extract with county study area as mask, slope, and reclassify
3	MN NLCD	Raster layer containing MN land cover data.	Raster layer	Land cover	MN Geospatial Commons	Extract with county study area as mask, reclassify
4	MN Streams	Feature layer containing MN streams.	Vector line layer	Stream size	MN Geospatial Commons	Clip with study extent, convert to raster, reclassify
5	MN Roads (NLCD Impervious Descriptor)	Raster layer containing MN land cover data pertaining to impervious road features.	Raster layer	Roads land cover	MN Geospatial Commons	Extract with county study area as mask, reclassify

Input Data
Minnesota counties were needed to create a study extent that was used as a mask for extracting input raster data and clipping input vector data. Minnesota DEM data was used to generate slope. Minnesota stream data was converted to raster data. Minnesota DEM, NLCD, streams, and roads were all reclassified after prior preparation and used to perform a weighted overlay.

Table 2. Part 2 input data

#	Title	Purpose in Analysis	Link to Source
1	MN Counties	To create a study extent that will be used as a mask for extracting input raster data and clipping input vector data	MN Geospatial Commons
2	MN DEM	To generate slope data and reclassify for weighted overlay	MN Geospatial Commons
3	MN NLCD	To reclassify desired land types to be used in weighted overlay	MN Geospatial Commons
4	MN Streams	To convert to raster and reclassify for desired stream sized to be used in weighted overlay	MN Geospatial Commons
5	MN Roads (NLCD Impervious Descriptor)	To reclassify for desired roads and use in weighted overlay	MN Geospatial Commons

Methods
To begin the analysis, I downloaded all of the necessary input data to be used. All of my data was obtained from the Minnesota Geospatial Commons. In an ArcGIS Pro Jupyter Notebook, I created variables for each of the input data layers for the ease of inputting features in the following analysis.

The next step was creating a study extent. To do this, I used the Minnesota Counties layer as an input for the Feature Class to Feature Class tool and set the parameters to give an output of Wabasha, Winona, and Olmsted counties. I then used the output as the input layer for the Dissolve tool to give me one boundary encompassing all three counties without the internal boundaries (Figure 1).

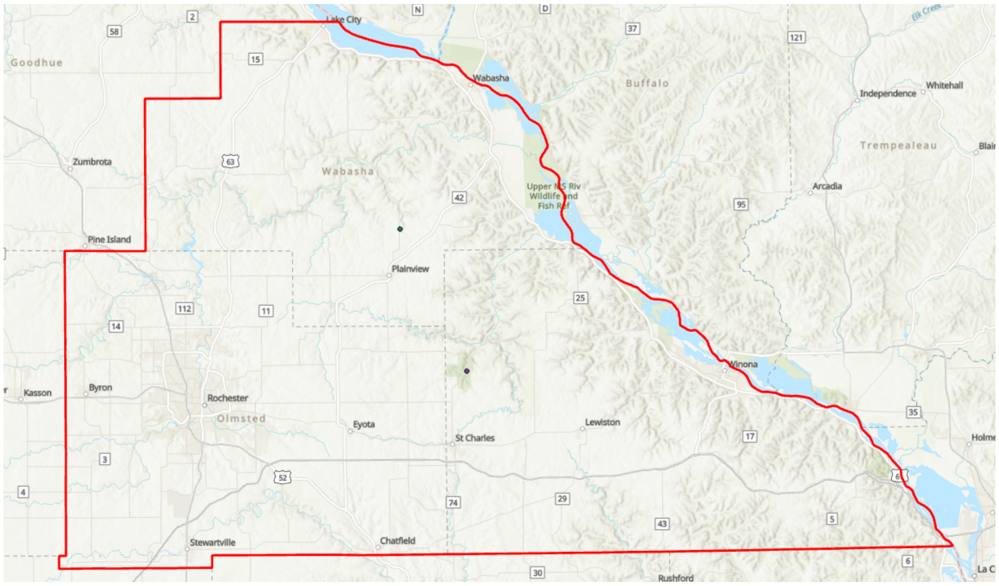

Figure 1: Study extent created from county boundary data

After creating a study extent boundary, I began the part of analysis involving extracting raster data (Extract by Mask in arcpy) and clipping vector data (Clip tool in arcpy) within the study extent and reclassifying (Reclassify in arcpy). For the streams data I had to convert it to a raster layer using the Feature to Raster tool. The reclassification parameters are shown on the following tables for each raster layer used in the analysis. 1 is most desirable and 10 is least desirable.

Table 3: Roads Reclassification

Roads Class	**Reclassification**
Primary Road	1
Secondary Road	1
Tertiary Road	2
Non-road/non-energy impervious	2
LCMAP impervious	3
Wind turbines	7
Unclassified	10

**Roads significant to analysis because they are most walkable and more likely to show where bridges may cross streams.*

Table 4: Slope Reclassification

Slope Class	**Reclassification**
0-3%	1
3-6%	2

6-12%	3
12-15%	4
15-18%	8
18-21%	9
>21%	10

**Slope significant to analysis because Dory doesn't want to walk on steep surfaces.*

Table 5: Land Cover Reclassification

Land Cover Class	**Reclassification**
Developed Open Space	2
Developed Low Intensity	2
Developed Medium Intensity	2
Developed High Intensity	2
Barren Land	5
Deciduous Forest	7
Evergreen Forest	7
Mixed Forest	7
Shrub	7
Herbaceous	7
Hay/Pasture	9
Cultivated Crops	9
Woody Wetlands	9
Emergent Herbaceous Wetlands	9
Open Water	10

**Land Cover significant in analysis because it provides information on areas that may be wet or muddy.*

Table 6: Streams reclassification

Streams Class (lower number is smaller streams)	**Reclassification**
1	1

2	2
3	8
4	8
5	10
6	10
8	10

**Streams significant in analysis because Dory doesn't want to cross streams that are too wide.*

After reclassifying all of the raster data needed, I began the process of generating a cost surface using the Weighted Overlay tool. At this point I was able to adjust the weights for each raster layer in the analysis to generate various cost surface results. Going forward in the analysis I decided to give all four rasters a 25% weight. The output cost surface raster layer can be seen in Figure 2.

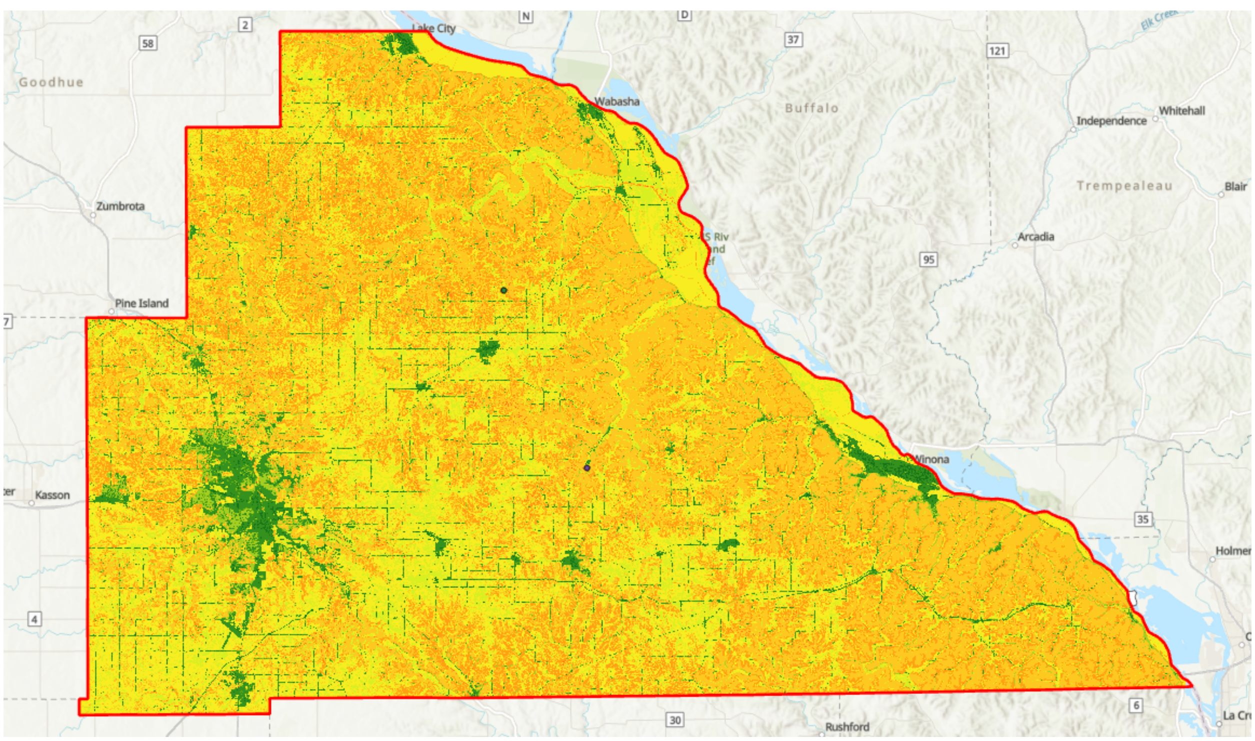

Figure 2: Cost surface raster generated from Weighted Overlay. Green areas are more suitable and more red areas are less suitable.

The next step was adding the start and end points for the route. I created a CSV file in Excel for each point with their respective coordinates. I then used the CSV files as inputs for the XY Table to Point tool in arcpy to create points to be used in the Cost Distance and Cost Path analysis and generate a least cost path between the two points.

After adding the start and end points as variables in the script, I used the Cost Distance tool and used the start point and cost surface raster as input data. This produced a cost distance and direction surface that I then used as input data, along with the end point, in the Cost Path tool. The resulting least cost path can be seen in Figure 4 in the results section of the lab report.

The data flow diagram that I used throughout this analysis can be seen below in Figure 3.

Figure 3: Data flow diagram used in analysis

Results

Overall, the analysis seemed to be successful in creating a least cost path that satisfies all of the parameters described in the problem. The path seems to follow roads for the most part, which makes sense, because roads generally have easier terrain, aren't muddy, and cross rivers that would be too wide to cross. Without the roads raster layer in the analysis, this may have produced significantly different results.

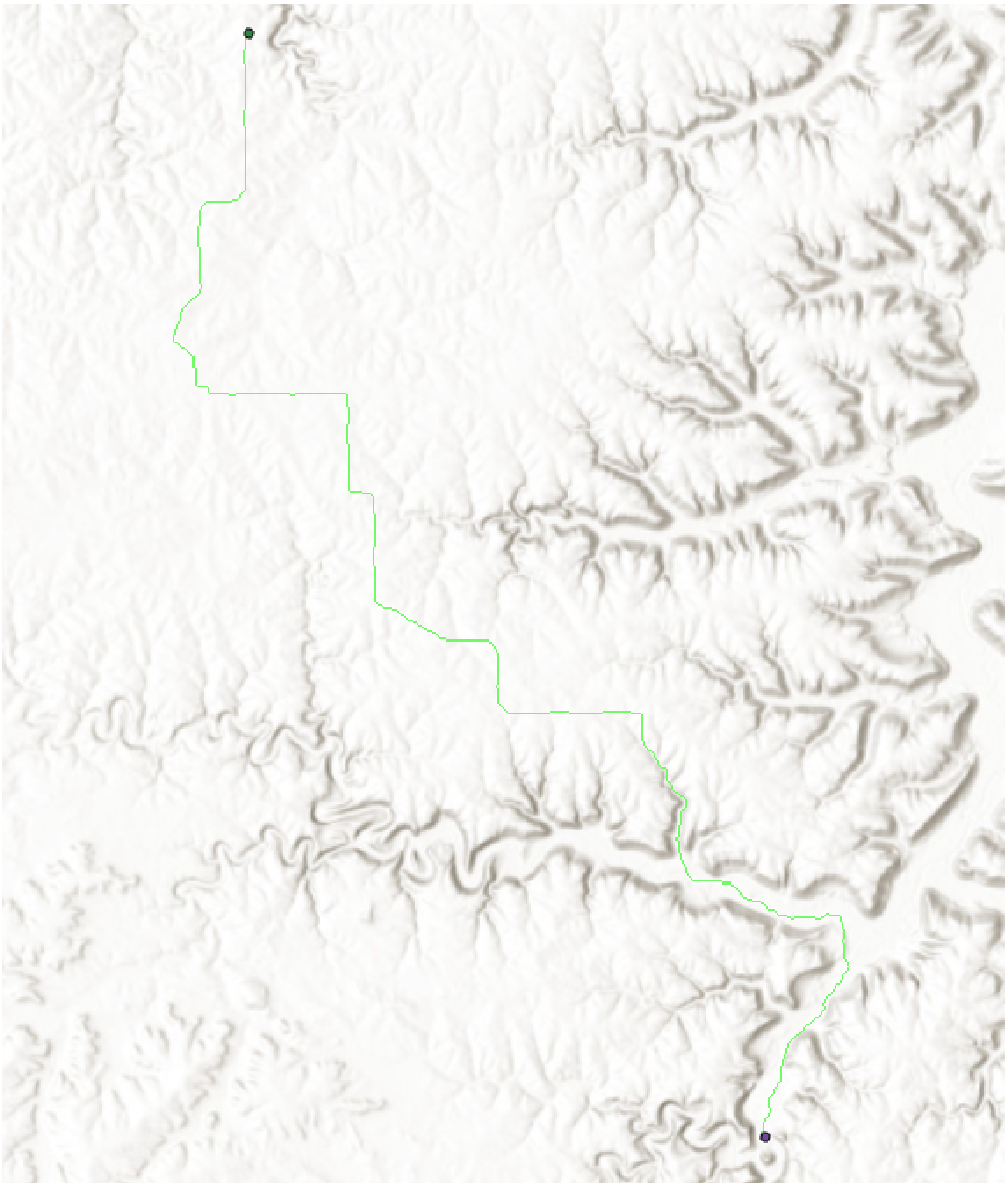

Figure 4: Least cost distance generated from analysis

Results Verification

To ensure that the results were accurate, I inspected each result throughout the analysis to check for quality and consistency. Based on the verification of the data produced throughout the analysis, the results can be considered reliable. I also compared my results with my peers to see if I was getting similar results as others doing their own analysis of the same problem.

Discussion and Conclusion

I hadn't had much experience with performing weighted overlays to produce cost surfaces, let alone using cost surfaces to produce least cost distances. Throughout this lab I feel like I learned many useful skills that I can use in the future when performing suitability analysis on projects. I also haven't worked with raster data in a while before this project, so it was good to spend time learning about more ways to use it. I'm interested in building more on the knowledge I've gained from this lab.

References

N/A

Self-score

Category	Description	Points Possible	Score
Structural Elements	All elements of a lab report are included **(2 points each)**: Title, Notice: Dr. Bryan Runck, Author, Project Repository, Date, Abstract, Problem Statement, Input Data w/ tables, Methods w/ Data, Flow Diagrams, Results, Results Verification, Discussion and Conclusion, References in common format, Self-score	28	**28**
Clarity of Content	Each element above is executed at a professional level so that someone can understand the goal, data, methods, results, and their validity and implications in a 5 minute reading at a cursory-level, and in a 30 minute meeting at a deep level **(12 points)**. There is a clear connection from data to results to discussion and conclusion **(12 points)**.	24	**24**
Reproducibility	Results are completely reproducible by someone with basic GIS training. There is no ambiguity in data flow or rationale for data operations. Every step is documented and justified.	28	**28**
Verification	Results are correct in that they have been verified in comparison to some standard. The standard is clearly stated **(10 points)**, the method of comparison is clearly stated **(5 points)**, and the result of verification is clearly stated **(5 points)**.	20	**20**
		100	**100**