Lab Report

Title: Lab 2 Part 2 Deliverable
Notice: Dr. Bryan Runck
Author: Taylor Andersen-Beaver
Date: 11/2/22

Project Repository: https://github.com/and03449/GIS5571.git
Google Drive Link: N/A
Time Spent: 20.5 hrs

Abstract
Using a robust group of datasets, analyze the best route for Dory to take when talking from her farm to her fly fishing spot in Whitewater State Park. To properly analyze the best route, this group of datasets must include road networks, water networks, elevation, and land cover classification. Once obtained, using mapd algebra and a raster calculator, all of the rasters are combined and different weights can be applied to evaluate a cost surface analysis.

Problem Statement
What is the optimal route for Dory to take to get to her fly fishing spot near Whitewater State Park in SE Minnesota?

Table 1. Requirements Needed for Cost Surface Analysis

#	Requirement	Defined As	(Spatial) Data	Attribute Data	Dataset	Preparation
1	XY Table to Point	Converting XY coordinates to a point	XY coordinates	N/A	Imported from GitHub	Import from GitHub
2	Select Layer By Attribute	Select the counties around the XY coordinates	County boundaries	County names	MN County Boundaries	None
3	Pairwise Clip	Clip the data to the study area	Boundaries	N/A	County Boundaries, Streams, Roads	Select Layer By Attribute
4	Raster Clip	Clip the raster data to the study area	Boundaries	N/A	Digital Elevation Model, Land Cover	Select Layer by Attribute
5	Buffer	Buffer the roads and streams to make more visible	Road network and streams	N/A	Roads, Streams	Clip
6	Feature to Raster	Converting vector data to rasters	N/A	N/A	Roads, Streams	Buffer

7	Reclassify	Reclassify raster classification to a set number of classifications	N/A	N/A	All but county boundaries	Feature to Raster
8	Pairwise Intersect	Find intersections in Roads & Rivers	N/A	N/A	Roads and Streams	Buffer
9	Pairwise Erase	Erase rivers where roads intersect to make bridges visible	N/A	N/A	Roads and Streams	Intersect
10	Raster Calculator	Use formula to remove null values	N/A	N/A	Streams	Reclassify
11	Slope	Slope the digital elevation model	N/A	N/A	DEM	None
12	Raster Calculator	Combine all rasters together	N/A	N/A	All but county boundaries	Reclassify
13	Weighted Overlay	Create weights for all of the rasters to analyze cost surface	N/A	N/A	All but county boundaries	Raster Calculator

Input Data

The data I have chosen to use for this lab is MN Road Networks, MN County Boundaries, MN Digital Elevation Model, Stream Routes with Stream Order, and Land Cover Classification. I have chosen these datasets because of the problem statement listed above: what is the optimal route for Dory to take to her favorite fly fishing spot? To determine the optimal route, all conditions need to be considered including roads, rivers, and elevation.

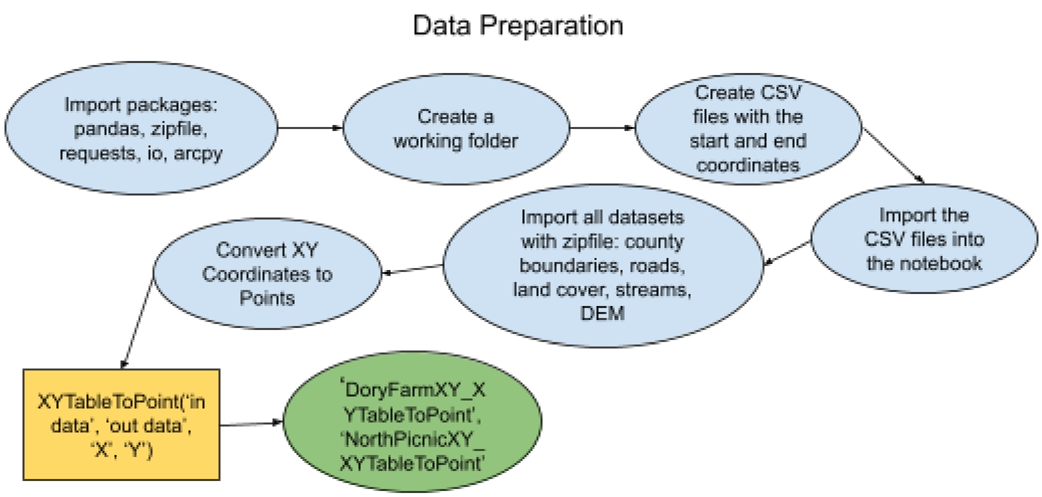
Table 2. All Datasets Needed for Cost Surface Analysis

#	**Title**	**Purpose in Analysis**	**Link to Source**
1	Minnesota Roads	Raw input dataset for routing analysis from MNDOT	https://gisdata.mn.gov/dataset/trans-roads-mndot-tis
2	MN County Boundaries	Having a foundation to clip the data to the study area	https://gisdata.mn.gov/dataset/bdry-counties-in-minnesota
3	MN Digital Elevation Model	Using to analyze elevation on the path from point A to point B	https://gisdata.mn.gov/dataset/elev-30m-digital-elevation-model
4	Stream Routes with Stream Order	Locate streams and rivers including stream order to determine bigger rivers from small streams	https://gisdata.mn.gov/dataset/water-strahler-stream-order

4	NLCD 2019 Land Cover	Land cover classification to classify different land types to help analyze the best path	https://gisdata.mn.gov/dataset/biota-landcover-nlcd-mn-2019

Methods

To begin the analysis, first I need to locate the data needed and prepare it for analysis. Starting with importing packages into an ArcGIS Pro Notebook, create a working folder to store all of the data and import the data into the notebook. Lastly, creating a CSV file with the start point (Dory's Farm) and another CSV with the end point (North Picnic), importing the CSVs into the ArcGIS Pro Notebook and converting the XY Coordinates to Points.

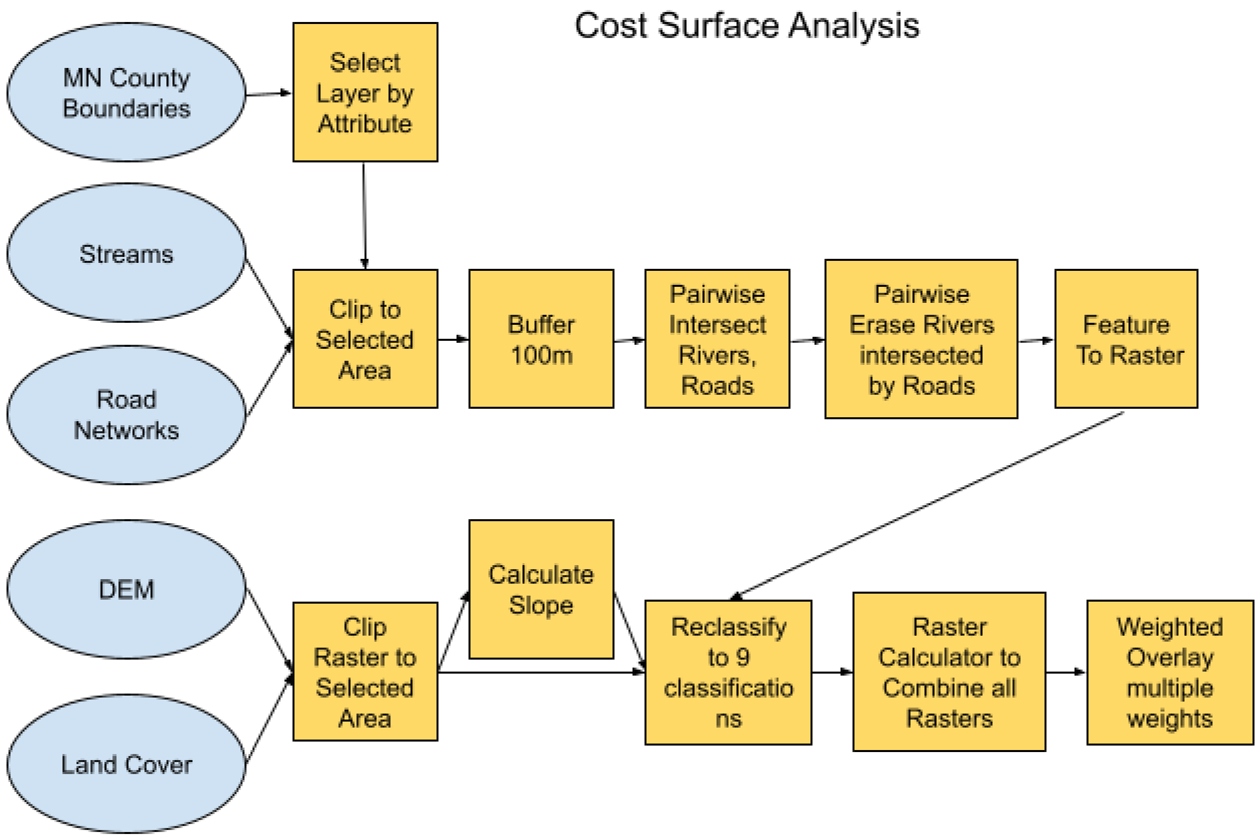


With the data imported and prepared for analysis, the next step is to clip the data to the same extent. The points are in two different counties and 'as-the-crow-flies' crossing over a third county, so I have decided to clip the data to all 3 of those counties: Olmstead, Wabasha, Winona. By selecting the 3 counties and clipping the county boundaries, I can then use the clip as a template to clip all of the other datasets whether with a pairwise clip or a raster clip.

Once clipped, the datasets follow two different paths: vector and raster. The vector data, roads and streams, are first buffered to 100 meters to make them 'thicker' to eventually be converted into a raster. Next with the vectors, is finding intersecting points and erasing any places where rivers intersect with roads which will essentially erase any rivers that are overlapping the bridges that cross them making the bridges available to Dory's path. Once intersected and erased, the datasets can be converted into rasters and then reclassified.

For the raster data, once clipped, the land cover data can go directly to reclassification. The digital elevation model needs to be sloped before reclassified. The reclassification, for both vectors to rasters or just rasters in general need to be as similar as possible in order to best create a cost surface raster (*Creating a Cost Surface Raster—ArcGIS Pro | Documentation*, n.d.). For this analysis I have chosen to use 9 classifications since that seemed to be the average amount of classifications per raster.

Once reclassified, each of the rasters can be combined into one using the raster calculator which can then be used to find the cost surface analysis (*Raster Calculator (Spatial Analyst)—ArcGIS Pro | Documentation*, n.d.). The last step in the process is to set weights to each of the rasters using the weighted overlay by adding each raster and giving them each a weight calculating to 100% (*Weighted Overlay (Spatial Analyst)—ArcGIS Pro | Documentation*, n.d.).

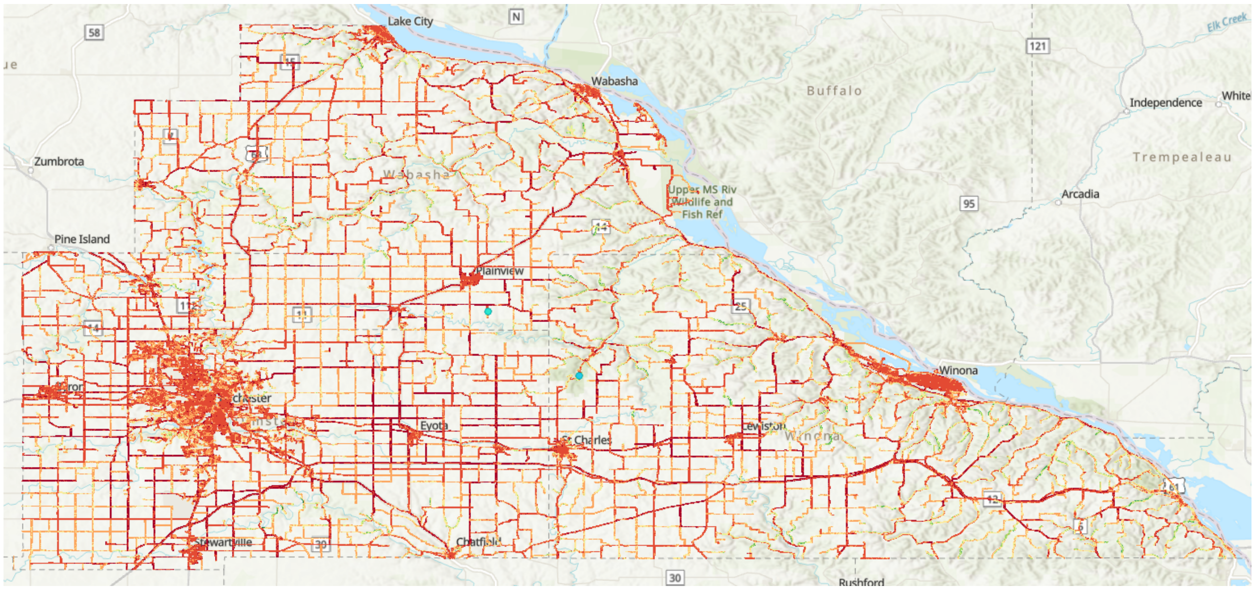


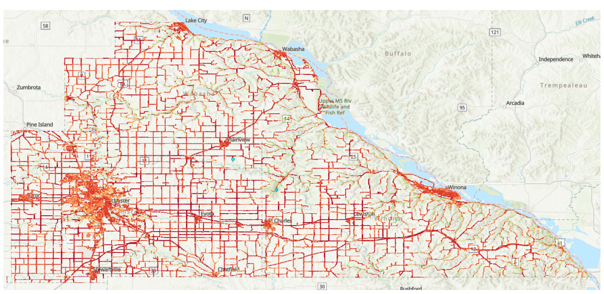
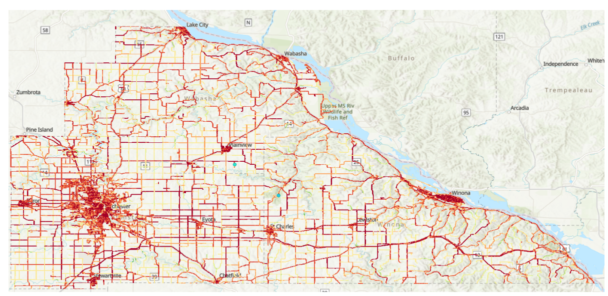
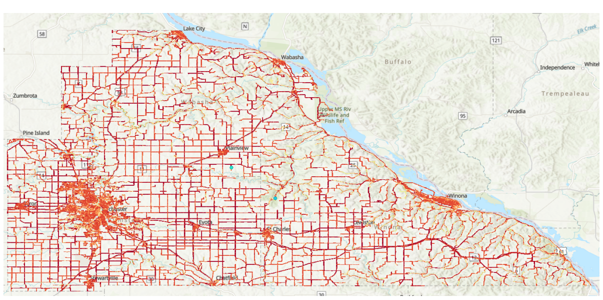
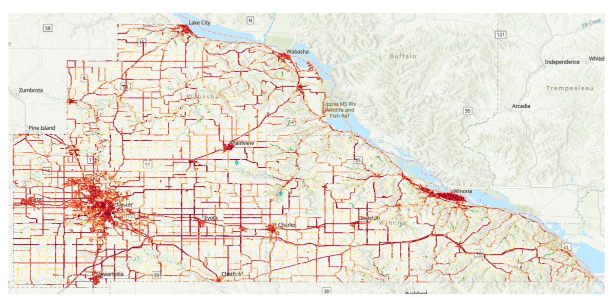
The deliverable was a little unclear about what the final results should be whether it is a few different cost surfaces with different weights or a true optimized route from point A to point B. I did a little research on how to do a cost distance analysis but ultimately was unable to successfully get a cost distance analysis so I decided to keep the multiple cost surfaces instead *(Cost Distance—Help | ArcGIS for Desktop, n.d.)*.

Results

To visualize the difference between the overlays I chose a variety of weights and compared them all below. To start, I started with equal weights of 25% to see what a controlled cost surface looked like to be able to see the differences in the other cost surfaces. Each of the rasters are pretty neutral - equal amounts of streams, roads, elevation, and land cover.

The differences are more clear in the four other weighted overlays in the table below. One of the clearest rasters is the road raster which is seen in the images on the right where the road weight is 40%. The same can be said for the streams in the lower left image where streams are 40% weighted and are most clearly outlined than in the other cost surface rasters.



Roads 10%, Streams 10%, Elevation 40%, Land Cover 40%	*Roads 40%, Streams 40%, Elevation 10%, Land Cover 10%*
	
Roads 10%, Streams 40%, Elevation 10%, Land Cover 40%	*Roads 40%, Streams, 10%, Elevation 40%, Land Cover 10%*
	

Results Verification

I can verify the results are correct by completing the steps above in the methods section and comparing the results. Another way to verify the results are correct is by logically considering the results that are given and if they make sense with how the rasters are being weighted. Lastly, another way to verify results is by comparing my results with another student in the class to see if we get similar results. Luckily I was able to do this and found that my results were similar to other students!

Discussion and Conclusion

I have actually found this lab one of the easier labs as well as one of the most useful. I could absolutely see using this distance optimization analysis in the future over a plethora of different datasets. The methods, though relatively simple, were a good reminder to geoprocessing tools that we have all used before but now we are using them in a more complicated way. The visualizations of the different weights in the cost surface rasters is a good way to compare the different rasters and their influence on the cost surface.

References

Cost Distance—Help | ArcGIS for Desktop. (n.d.). Retrieved November 2, 2022, from https://desktop.arcgis.com/en/arcmap/10.3/tools/spatial-analyst-toolbox/cost-distance.htm

Creating a cost surface raster—ArcGIS Pro | Documentation. (n.d.). Retrieved November 2, 2022, from https://pro.arcgis.com/en/pro-app/latest/tool-reference/spatial-analyst/creating-a-cost-surface-raster.htm

Raster Calculator (Spatial Analyst)—ArcGIS Pro | Documentation. (n.d.). Retrieved November 2, 2022, from https://pro.arcgis.com/en/pro-app/latest/tool-reference/spatial-analyst/raster-calculator.htm

Weighted Overlay (Spatial Analyst)—ArcGIS Pro | Documentation. (n.d.). Retrieved November 2, 2022, from https://pro.arcgis.com/en/pro-app/latest/tool-reference/spatial-analyst/weighted-overlay.htm

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	**20**
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	**26**

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	**18**
		100	**92**