Lab Report

Title: **Lab 3 – Part 1 – Dory's Other Paths**
Notice: Dr. Bryan Runck
Author: Kyle Smith
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Project Repository: kylejsmith4/GIS5571/Lab3
Time Spent: 76 hours (Lab 3)

Abstract

Dory is back and she is still trying to get to Whitewater State Park from her farm in Southeast Minnesota. She seeks a path that avoids potentially muddy farm fields, water bodies without bridges, and steep slopes. This lab will build upon Lab 2 where ArcPy & ArcGIS Pro were used to develop a cost surface model for Dory by using advanced spatial modeling techniques. Three additional paths, using differing weighting scenarios, are developed and analyzed here. Different weights applied to the potentially muddy farm fields, water bodies without bridges, and steep slopes will alter the cost surface and potentially change Dory's path. This will show how different modeling weights can impact a result.

Problem Statement

Dory wants to get from her farm to the North Picnic area in Whitewater State Park's North Picnic area via a route avoiding mud, water, and slopes. She is unsure which she prefers to avoid the most. Therefore, we are providing three new paths for Dory based on applying different weights to each of her desired avoidable elements. The following table summarizes the datasets and operations required to produce this model:

#	Requirement	Defined As	(Spatial) Data	Attribute Data	Dataset	Preparation
1	Minnesota County Boundary Data	.shp	County boundaries within MN	County name, geometry	MN DNR County Boundary Dataset	- Download from MN Geo Commons - Clip Winona, Wabasha, and Olmsted counties - Save & export
2	Land Use/Land Cover Data	Raster	NLCD land cover classification	Land use codes, geometry	MN DNR Landcover NLCD	- Download land cover data from NLCD data (via MN DNR) - Clip raster to target counties - Reclassify farm fields - Save & export
3	Hydrology Data	Shapefile, Raster	Water bodies and bridge locations	Water body class, geometry	MN DNR Hydrography and MN DOT Bridges	- Download hydrology and bridge datasets from MN DNR and MN DOT - Clip to target counties - Convert hydrology and bridge data to raster format and reclassify - Save & export
4	Digital Elevation Model (DEM)	Raster	Elevation and slope for study area	Elevation, slope degrees	MN DNR Digital Elevation Model	- Download DEM - Clip to target counties - Reclassify slope - Save & export
5	Cost Surface Model	Raster	Combined slope, land use, and hydrology data	Cost values based on walking preference	Cost Surface Model	- Combine slope, land cover, and water bodies - Adjust weights - Export varied cost surfaces based on preference

6	Cost Distance & Least-Cost Path	Raster	Distance from Dory's Farm to North Picnic Area	Cost distance, backlink values	Cost Surface Model	- Calculate cost distance - Least-cost path analysis - Save & export

Input Data

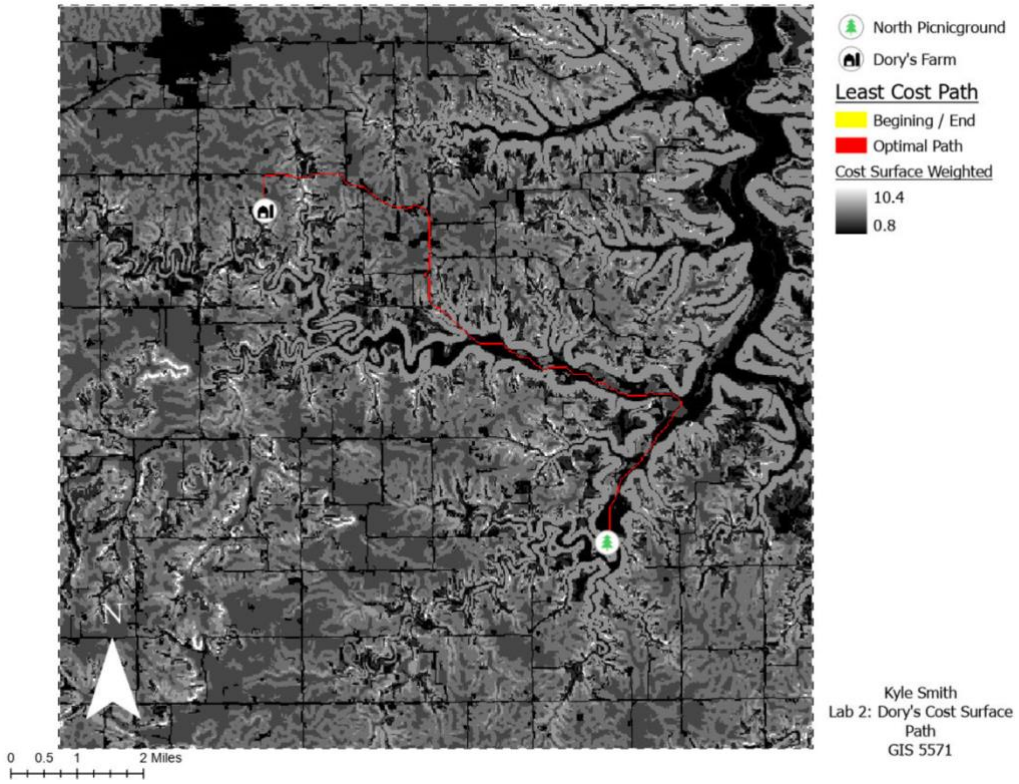
#	Title	Purpose in Analysis	Link to Source
1	Minnesota County Boundaries	Define the boundaries for target counties (Winona, Wabasha, Olmsted)	County Boundaries
2	NLCD Land Cover Data	Classify land use types, specifically farm fields	Landcover NLCD
3	MN DNR Hydrology and MN DOT Bridges	Identify water bodies and bridge locations for route planning	Hydrology Bridges
4	Digital Elevation Model (DEM)	Provide slope and elevation data for determining walking preference	MN DNR

Methods

Dory's optimal path calculated in Lab 2 used a Boolean suitability analysis and the following weights:

Slope 0.5
Farm 0.3
Water 0.2

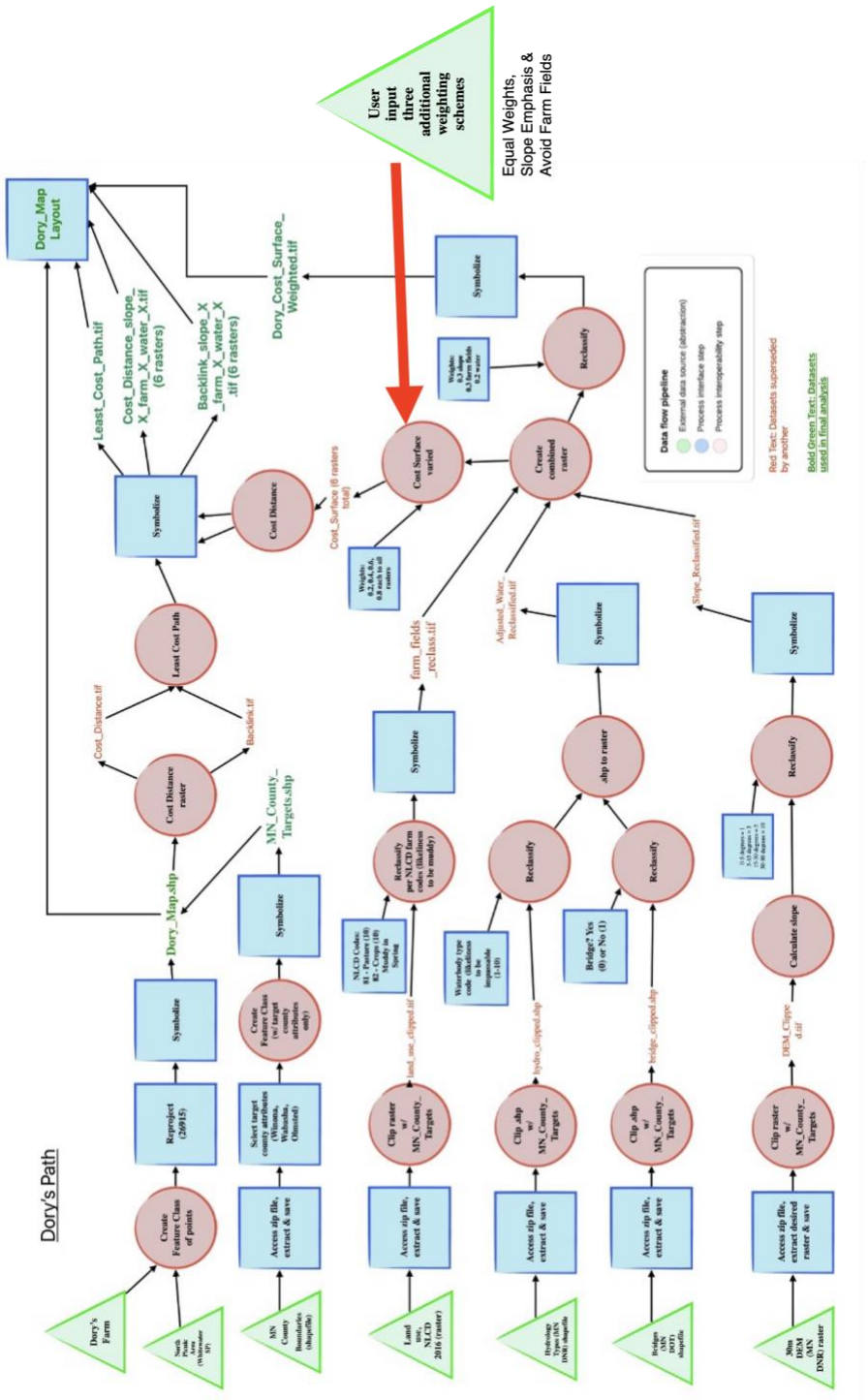
What resulted was this path:



Now, we will produce three additional paths by altering the weights to emphasize certain desires. We will look at the following:

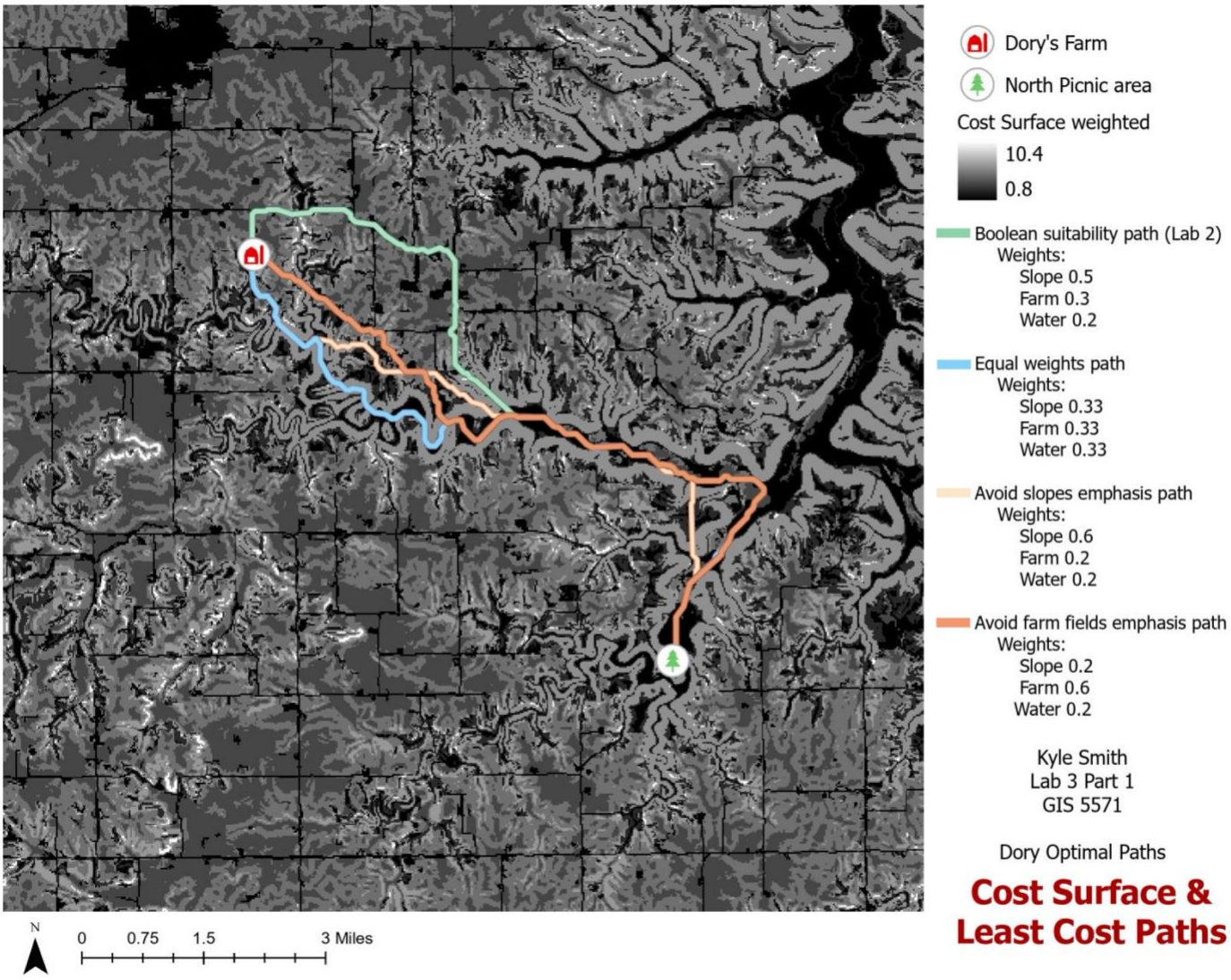
weights	Path emphasis on avoiding slopes	Path emphasis on avoiding Farm Fields	Equal weights path
Slope	**0.6**	**0.2**	**0.33**
Farm fields	**0.2**	**0.6**	**0.33**
Water	**0.2**	**0.2**	**0.34**

This lab only slightly modifies the data flow diagram used in Lab 2 by adding the additional weighting schemes to the chart.



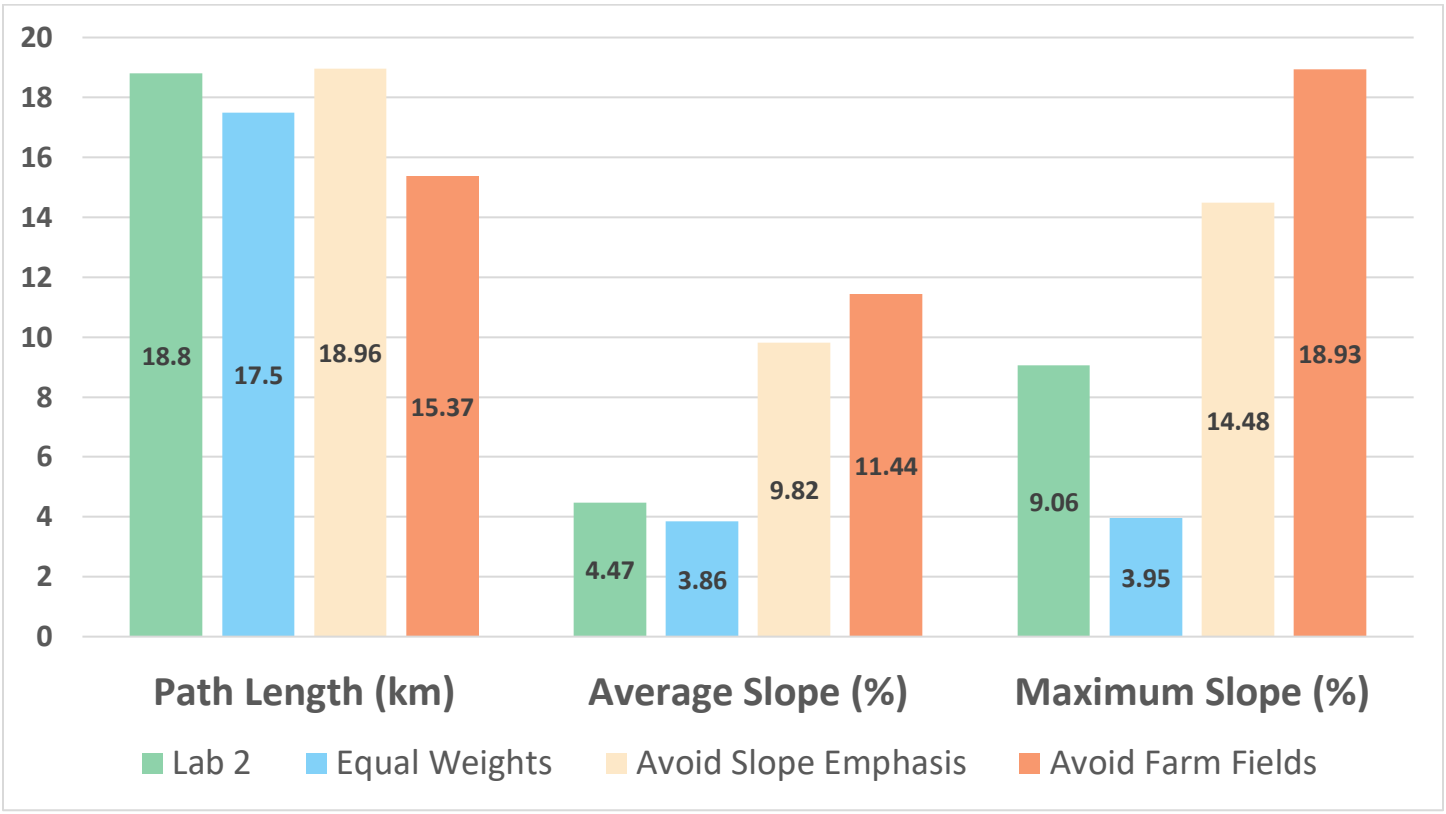
Results

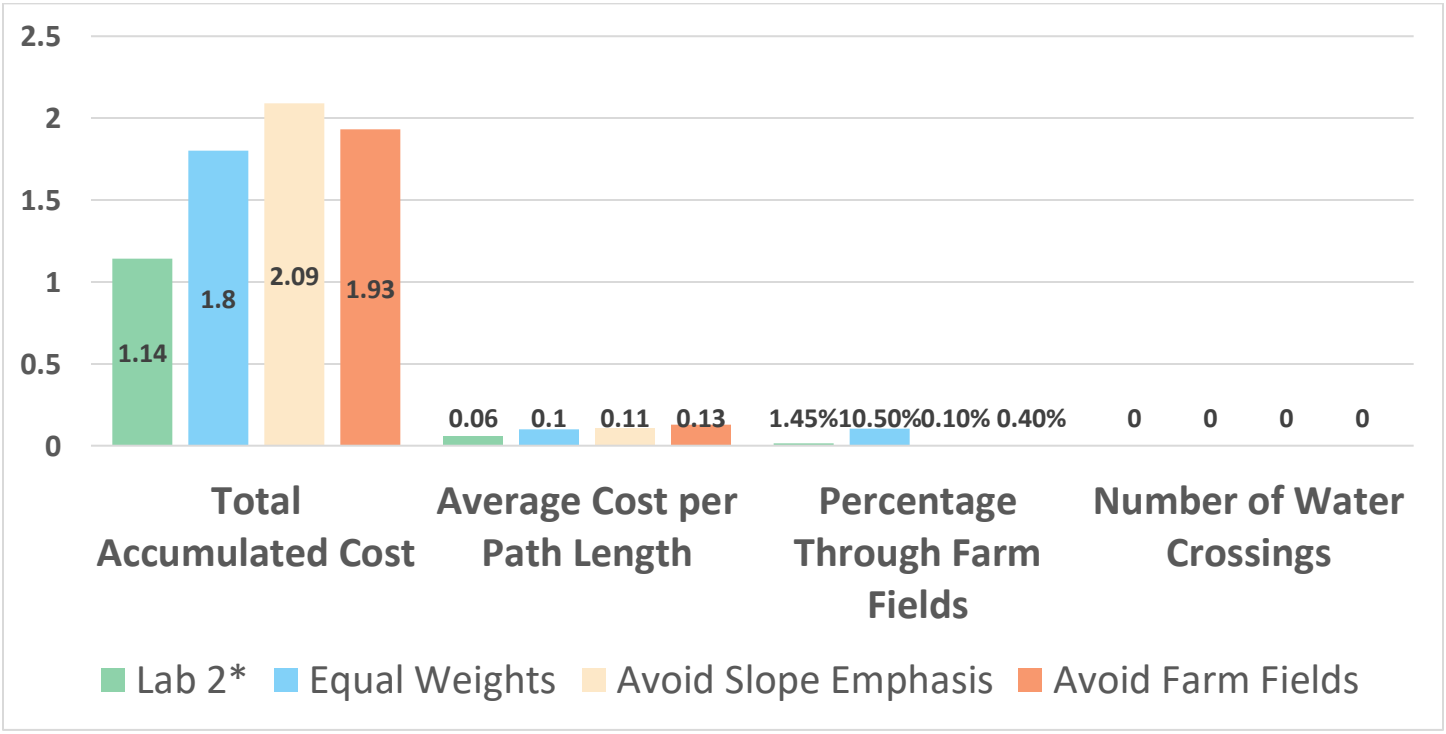
The three new weighting methods produced three entirely new paths, which only shared a small portion of common ground.



Using the summary statistics geoprocessing tool in ArcPro, the following info regarding each path can be shown:

	Lab 2*	Equal Weights	Avoid Slope Emphasis	Avoid Farm Fields
Path Length (km)	18.8	17.5	18.96	15.37
Total Accumulated Cost	1.14	1.8	2.09	1.93
Average Cost per Path Length	0.06	0.1	0.11	0.13
Average Slope (%)	4.47	3.86	9.82	11.44
Maximum Slope (%)	9.06	3.95	14.48	18.93
Percentage Through Farm Fields	1.45%	10.5%	0.1%	0.4%
Number of Water Crossings	0	0	0	0
Weights:				
slope	0.5	0.33	0.6	0.2
farm	0.3	0.33	0.2	0.6
water	0.2	0.34	0.2	0.2





Results Verification

Verification was conducted by recalculating statistics and double checking output to aerial photos and other maps to ensure accuracy.

Discussion and Conclusion

As shown in the map and charts above, manipulating weights did indeed produce different paths for Dory. Each new path meets certain ranked preferences as how to get from the farm to the state park. The shortest path also avoids all farm fields but is the steepest route. The longest path only has slightly less steep areas. Dory must decide which criteria matters to her the most, however the total accumulated cost metric does provide some help in her decision. The path from Lab 2 (Boolean suitability analysis) with the weights 0.5 for slope, 0.3 for farm fields, and 0.2 for water accumulates the least weight (1.14) and therefore is the closest to meeting all of Dory's criteria. Of the new paths introduced in this lab, the equal weights path (all 0.33) has the lowest accumulated cost at 1.8. The paths which emphasize avoiding farm fields and steep areas do achieve this goal, but at the cost of greater accumulated weight (2.09 and 1.93). Therefore, I think Dory should take the path from Lab 2 – the green line on the map above!

References

Esri. (n.d.-a). Reclassify (Spatial Analyst). ArcGIS Pro Tool Reference. https://pro.arcgis.com/en/pro-app/latest/tool-reference/spatial-analyst/reclassify.htm

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Self-score

Fill out this rubric for yourself and include it in your lab report. The same rubric will be used to generate a grade in proportion to the points assigned in the syllabus to the assignment.

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	**25**
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	**23**
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	**25**
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	**91**