Lab 2 Report – Part 2

Title: Least Cost Considerations for Movement
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Project Repository: https://github.com/Tuletara/GIS5572.git

Abstract
Good planning can save time, energy, and costs. Cost modelling is a means to good planning and applies to many different situations such as transit routing, natural resource management, or construction siting. In this study, data for landcover, streams, and roads was gathered from the MN Geospatial Commons site and used in a Least Cost Path assessment to find the best route across the landscape for a fisherwoman in southern Minnesota. This assessment used several esri tools including Weighted Overlay and Cost Distance to obtain the most efficient route. The calculated path appears feasible for a person on foot with one minor issue near the destination point. Despite this issue the overall analysis provides valuable information.

Problem Statement
The path least taken or the path of least resistance? If adventure is the goal than the clear choice is to take the path that isn't a path at all; but if the goal is to maximize efficiency and effectiveness while garnering the most benefits, then the path of least resistance is essential. Unfortunately, the easiest and best path isn't always the most obvious, especially when considering factors other than mere distance. This scenario is critical for wildlife searching for food and safety as well as construction projects in need of the most cost effective or least invasive routes.

Running a Least Cost Model to determine what costs should be considered and to what extent is a good place to begin. The Least Cost Path analysis in ArcGIS Pro will weigh the costs against all possibilities and calculate the most efficient path that meets the unique needs of the situation. In this study, that scenario is finding an actual path for Dory that gets her from her house to her favorite fishing spot in Whitewater State Park, Figure 1. The costs she will incur are stream crossings, steep slopes, muddy farm fields, and distance, Table 1. Using both Arc Pro and ArcPy, this study finds the path that incurs these costs to least amount possible.

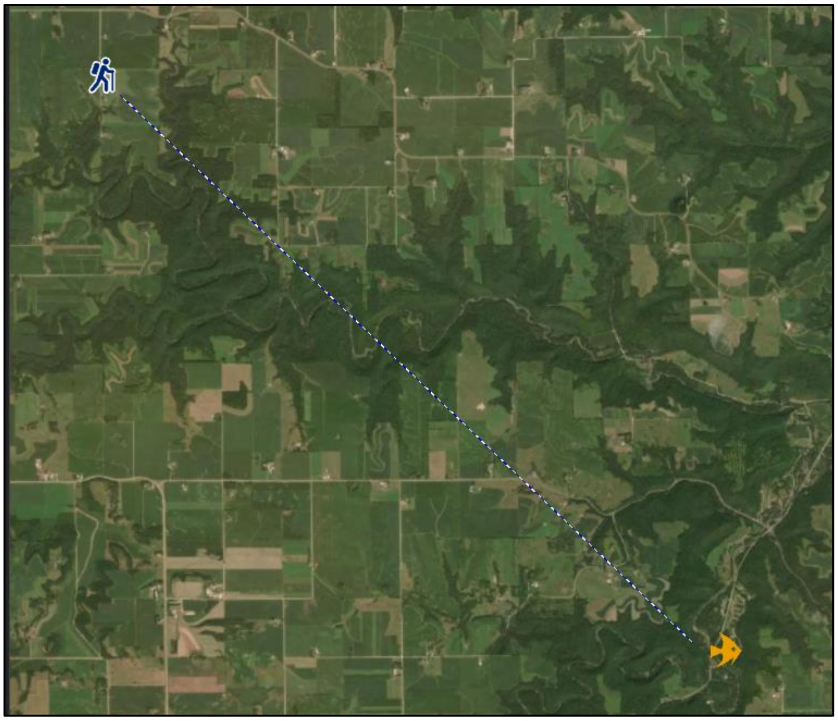

Figure 1. Dory's Origin and Destination points among the landscape of farm country. Running a Least Cost Path Study will find the best route.

Table 1. Necessary cost data inputs for this Least Cost Path assessment.

#	**Requirement**	**Defined As**	**Spatial Data**	**Attribute Data**	**Dataset**	**Preparation**
1	Elevation Data	All elevation in meters	SE Wabasha & NW Winona Counties	Elevation	MN GOV Elevation	Unzip files
2	Agriculture Fields	Land use type	Study area as defined above	Landcover classification	MN Geo Ag	Clip to map extent
3	Waterways	Polylines	Study area as defined above		MN Geo Streams	Clip to map extent
4	Roads & Bridges	Polylines	Study area as defined above		Mn Geo Roads	Clip to map extent

Input Data

All data, listed in Table 2, was gathered from the MN Geospatial Commons website and includes LiDAR elevation for the area surrounding Dory's home and her favorite fishing spot. This includes approximately 15 tiles for both southeast Wabasha and northwest Winona counties. The cropland layer specifies the type of fields in the area including forest cover types. The stream layer accounts for the presence of water bodies and was used in conjunction with the roads layer to discover bridges that allow for convenient stream crossings.

Table 2. Data acquired that covers costs.

#	Title	Purpose in Analysis	Link to Source
1	Lidar Elevation, Southeast Minnesota, 2008	Raw input for slope – what is walkable	MN Geo LiDAR
2	agri_cropland_data_layer_2018	Raw input for agriculture land use barriers	MN Geo Ag
3	shp_water_strahler_stream_order	Raw input data for stream barriers	MN Geo Streams
4	shp_trans_road_centerlines	Raw input data for bridges	Mn Geo Roads

Methods

Once the data was gathered and prepared, a new mosaiced raster was created to hold both county DEMs. Slope for the area of interest (AOI) was generated from the elevation raster and reclassified to assign moderate and steep slopes higher costs. Cropland fields were also reclassified with a low cost for pastures and non-dense forest types such as deciduous or Christmas tree plantations and medium to high costs for all other types. A barrier layer was created with the stream data to eliminate open water crossings. This was achieved by using the roads layer to locate accessible bridges. To avoid any bridge being overlooked due to mixed pixels in the barrier raster a large buffer was applied to roads before erasing intersections. This new stream layer was reclassified to assign all water values as high cost and no water as no data. A value of no data is equivalent to no costs and thus considers all bridge crossings as a possible path.

After all cost inputs were prepared and classified the Cost Surface was created with the Weighted Overlay tool. All three costs were weighted equally here since each layer had already been assessed for their unique costs. The Cost Surface and Origin were inputs for Cost Distance which creates a Cost Backlink Raster. This layer, along with the Destination point, is used to find the return costs. These cost layers were then used to calculate the final Least Cost Path for Dory.

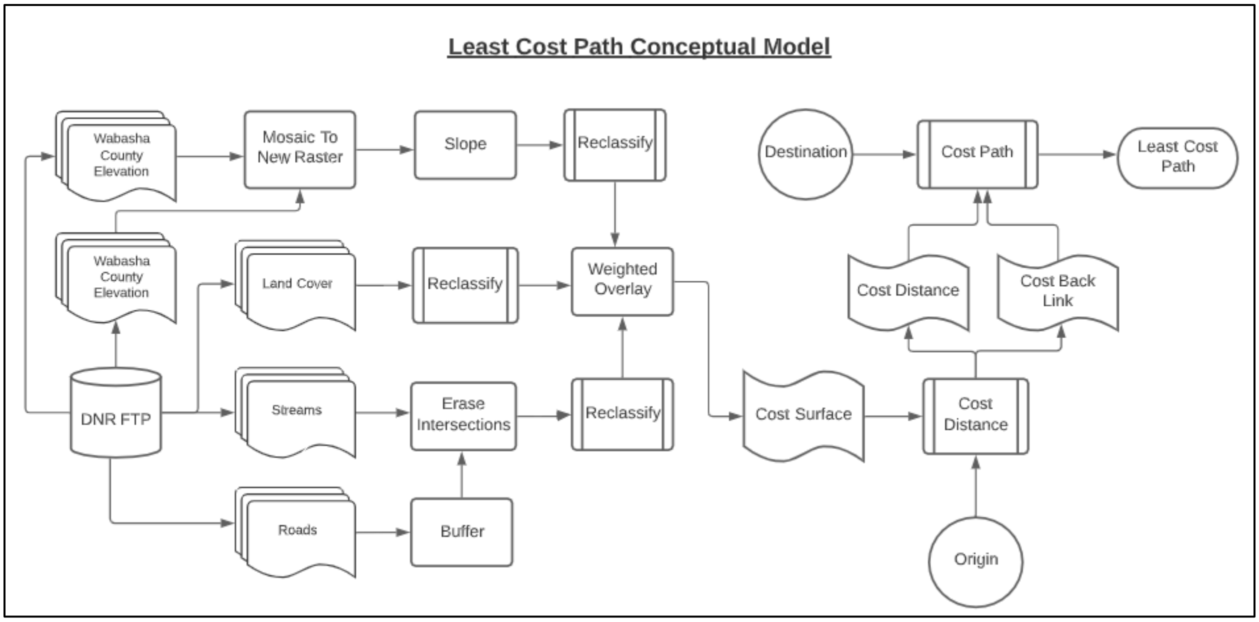

Figure 2. Workflow for data preparation and Least Cost Path analysis.

Results

All data processing and analysis were successfully completed. The Cost Surface seen in Figure 3 and Least Cost Path in Figure 4 were generated along with the associated costs listed in the Contents pane.

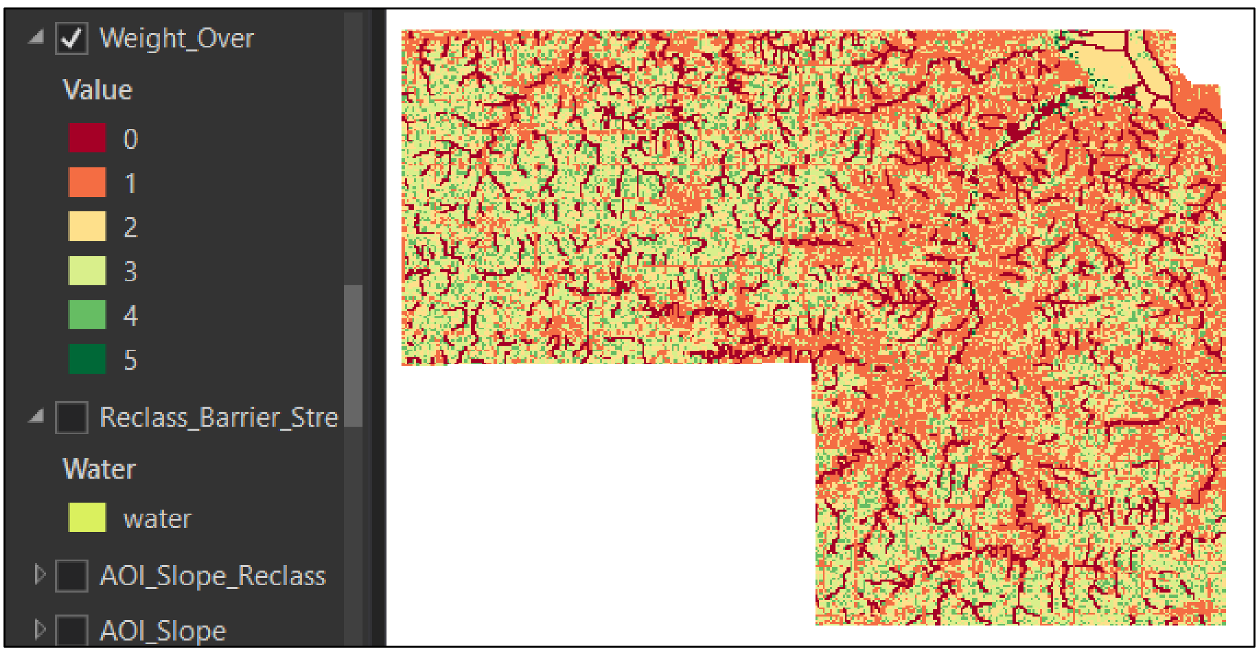

Figure 3. Cost Surface and associated costs in the Contents pane.

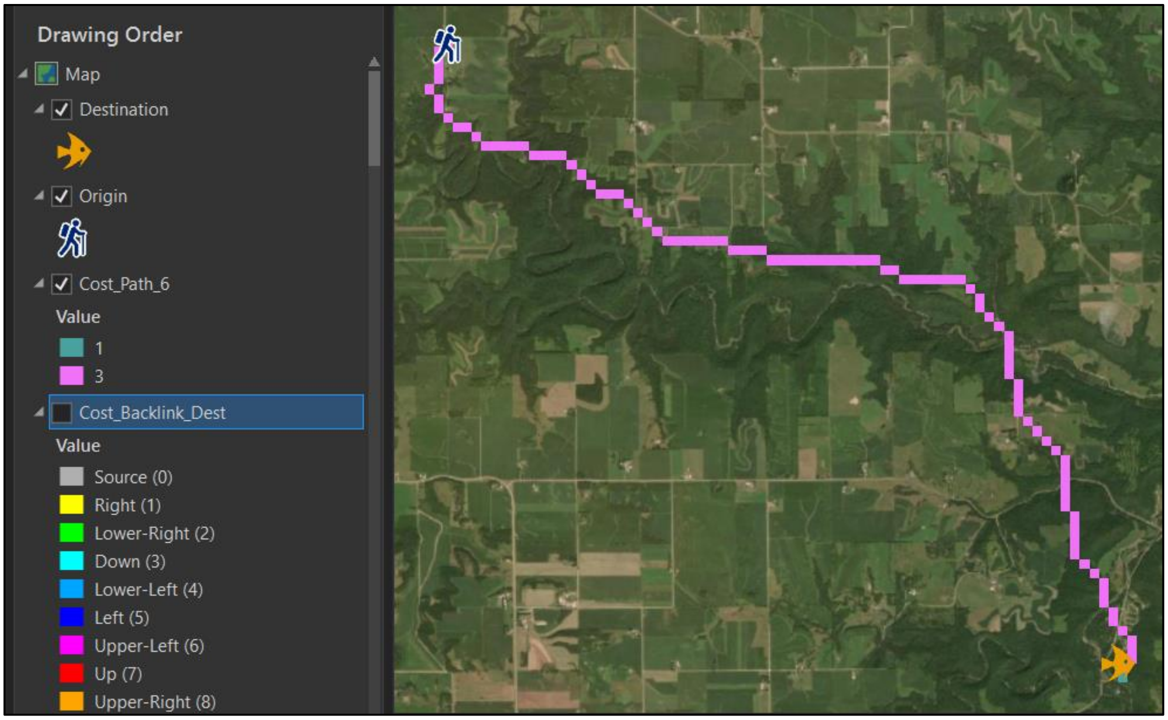

Figure 4. Least Cost Path. The majority of the path has a cost of 3 as labelled in the Contents pane.

Results Verification

Cost Surface and Path were compared to satellite imagery to assess how well the output met the criteria. As seen in Figure 4 above, a relatively direct path was generated that closely follows the river. This not only implies a gentle slope but also appears to exclude many farm fields due to proximity of the water way. However there are some sections that go through denser forest cover and one questionable stream crossing. The crossing may be due to the presence of a minor forest or park road near the stream that incorrectly buffered over the stream for the barrier layer. This would be a complication from the large buffer size and should be reassessed.

Discussion and Conclusion

There are many factors that go into Cost Models. It's easy to see how complex this type of analysis can become and how useful a tool it is. Even with a relatively simple task such as finding the best path for Dory, I am aware of how the inputs can affect the results. It's interesting that such a technical analysis is based on reclassification schemes where costs are determined somewhat arbitrarily. This allows for a wide range possibilities that may be difficult to accurately assess. It also allows for a highly specialized analysis of every situation. The key to maximizing this flexibility while maintaining consistent analyses is a solid understanding of the costs and standardization across all relevant variables. This standardization can also benefit modelling for different sites as some of the costs are pre-calibrated and well understood.

References

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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	**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	**22**
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	**24**
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	**19**
		100	**93**