Lab Report

Title: Cost surface
Notice: Dr. Bryan Runck
Author: Aleksei Rozanov
Date: 10/27/2024

Project Repository: GIS5571/Lab2 at main · alexxxroz/GIS5571
Google Drive Link: -
Time Spent: 4 h

Abstract
This report presents the development of a geospatial cost surface model to identify the optimal walking route for Dory, a fly fishing enthusiast, from her farm near Whitewater State Park in southeast Minnesota to the North Picnic area within the park. The cost surface was generated using map algebra to account for Dory's walking preferences, including avoiding muddy farm fields, minimizing slope steepness, and limiting water crossings where no bridge is present. The impact of uncertainty in the model weights was assessed by varying the weights assigned to different cost factors and analyzing the resulting cost surfaces. The model's results provide a range of potential walking routes based on different preference scenarios.

Problem Statement
The current lab posed the following goals:

1. Create an ETL for data to go into a cost surface model
2. Create a cost surface model and justify how you created your cost surface
3. Map the range of cost surfaces given uncertain preferences and model weights

Table 1. Data requirements

#	Requirement	Defined As	(Spatial) Data	Attribute Data	Dataset	Preparation
1	Minnesota Geospatial Commons Dataset	.lyr	NLCD land cover data		NLCD 2019 Land Cover, Minnesota - Resources - Minnesota Geospatial Commons	
2	Minnesota Geospatial Commons Dataset	.lyr	Elevation data		Minnesota Digital Elevation Model - 30 Meter Resolution - Resources - Minnesota Geospatial Commons	

3						
4						

Input Data

Table 2. Data sources

#	Title	Purpose in Analysis	Link to Source
1	Minnesota Geospatial Commons Dataset		Index of /pub/data/elevation/lidar
2	PRISM data		PRISM Climate Group at Oregon State University

Methods

To determine the optimal walking route for Dory from her farm to the North Picnic area in Whitewater State Park, a geospatial cost surface model was developed using map algebra techniques. The analysis began with acquiring and preparing the necessary data, including elevation (Digital Elevation Model, DEM) and land cover information from the Minnesota GIS Data Clearinghouse. These datasets were clipped to an 8 km buffer around Dory's starting and ending points (Fig. 1), which ensured the analysis encompassed relevant areas. From the DEM, the slope was calculated to represent the steepness of the terrain, with higher slope values indicating more difficult areas for walking. The slope data was then reclassified into discrete cost classes, assigning higher costs to steeper slopes.

For land cover data, the National Land Cover Database (NLCD) was used to identify different surface types within the buffer zone. The land cover categories were reclassified to reflect Dory's walking preferences: higher costs were assigned to farm fields due to the potential for muddy conditions and to water bodies, while forested areas and open spaces, which are more suitable for walking, received lower costs. These cost factors were integrated into a combined cost surface using weighted linear combinations, where the weights represented the relative importance of slope versus land cover.

To assess the impact of uncertainty in model weights, multiple cost surfaces were created by varying the weights assigned to slope and land cover in different scenarios. This process involved generating cost surfaces with different weight ratios, such as 0.25 (Fig. 3), 0.5 (Fig. 4), and 0.75 (Fig. 5), to understand how changes in Dory's preferences could influence the resulting paths. The scheme (Fig. 6) shows the data flow diagram: from data acquisition, DEM and NLCD processing, to buffer creation and cost surface modeling, followed by iterative uncertainty analysis. This approach provided a comprehensive view of the factors influencing Dory's preferred walking routes and demonstrated how preference uncertainty could alter the optimal path configuration.

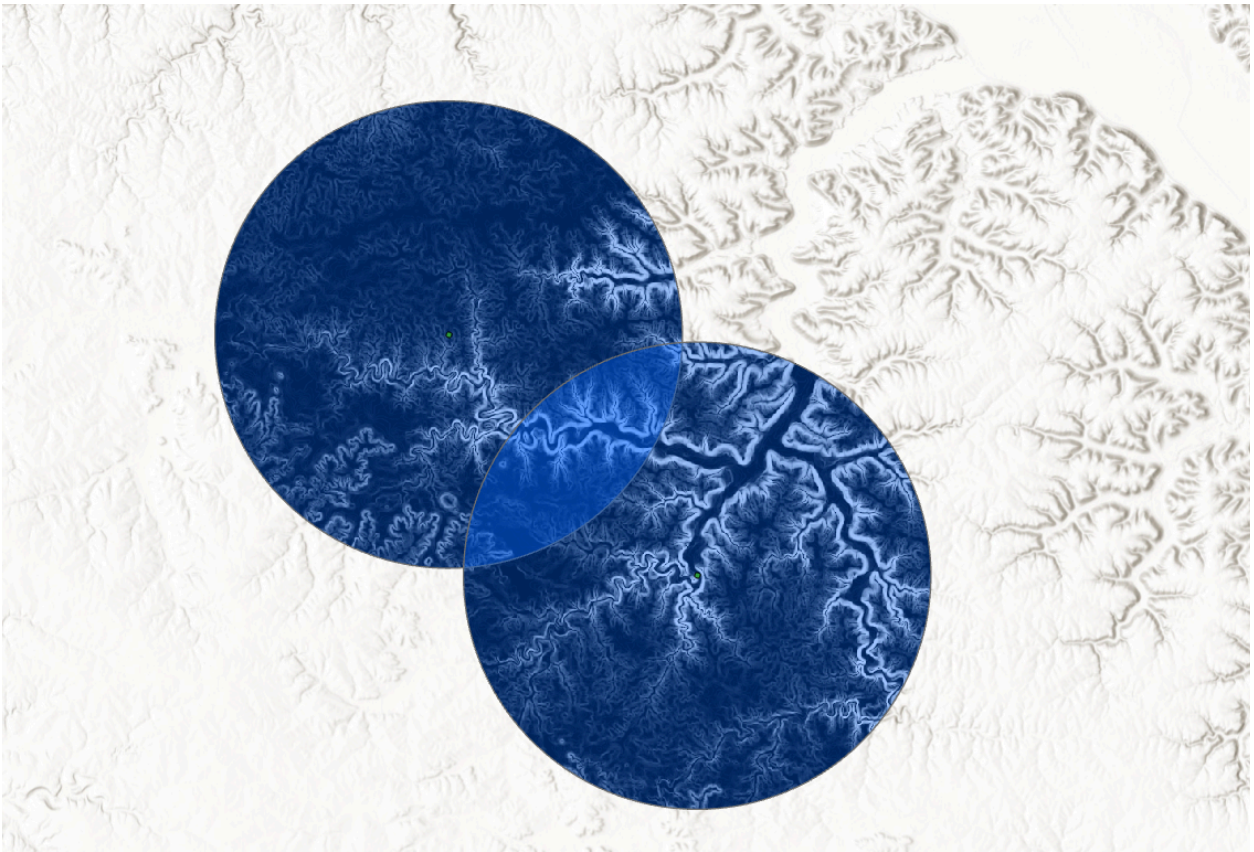

Fig. 1. Starting and ending points with 8 km buffers and clipped elevation data.

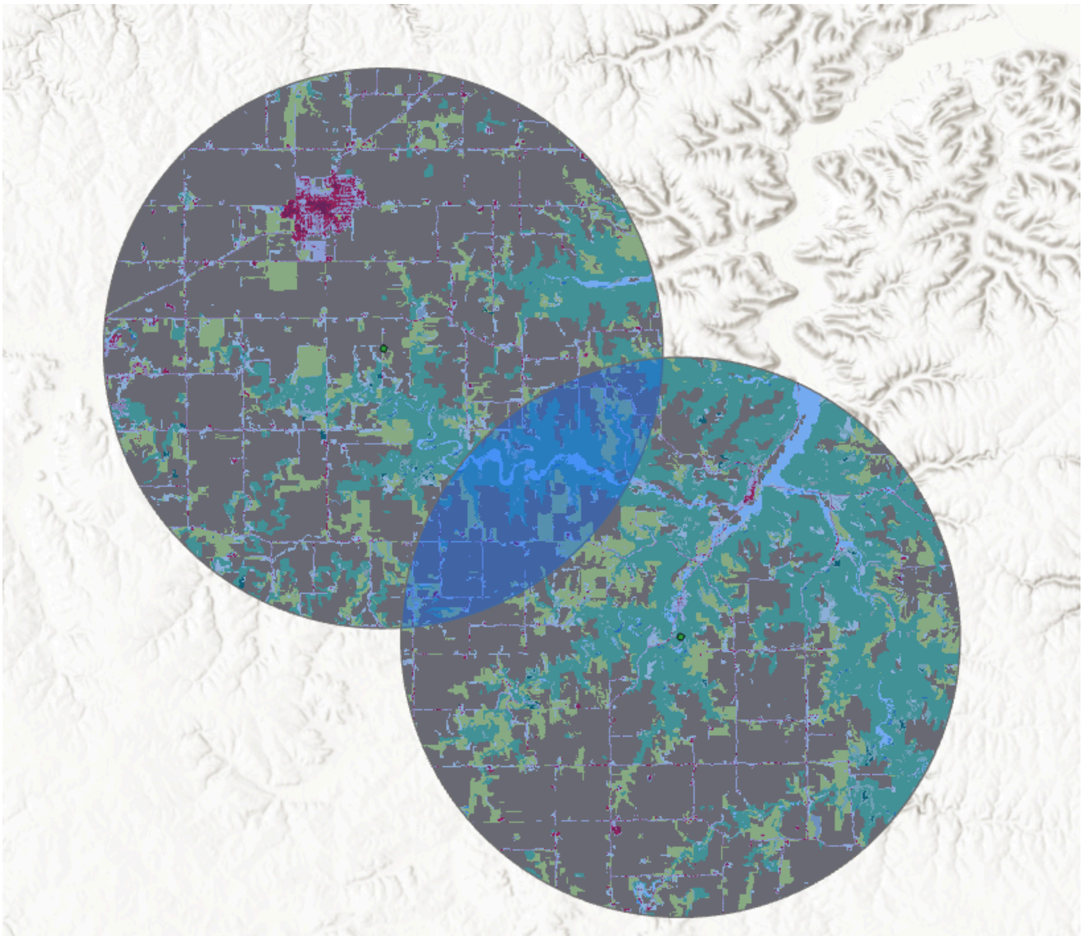

Fig. 2. Starting and ending points with 8 km buffers and clipped land cover data.

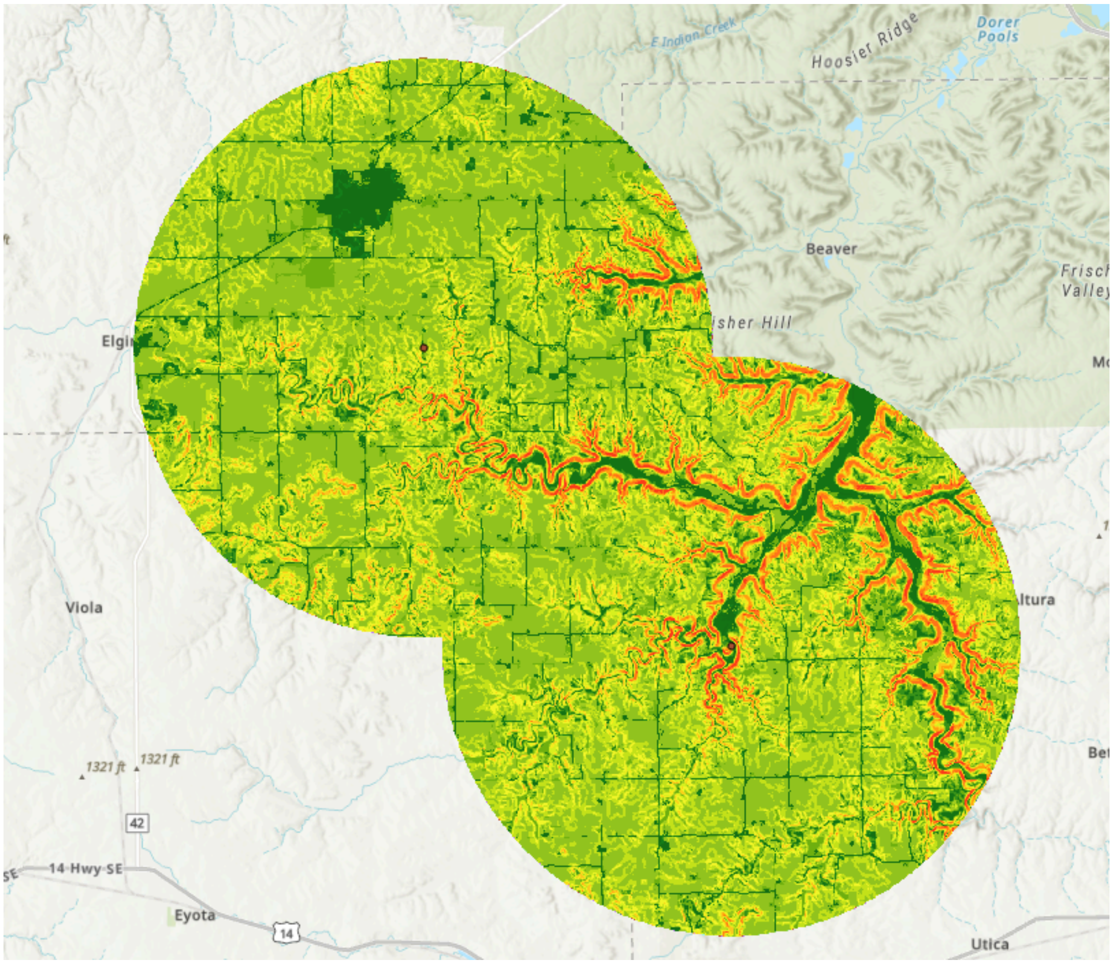

Fig. 3. The first cost surface scenario: 0.25/0.75 weight ratio.

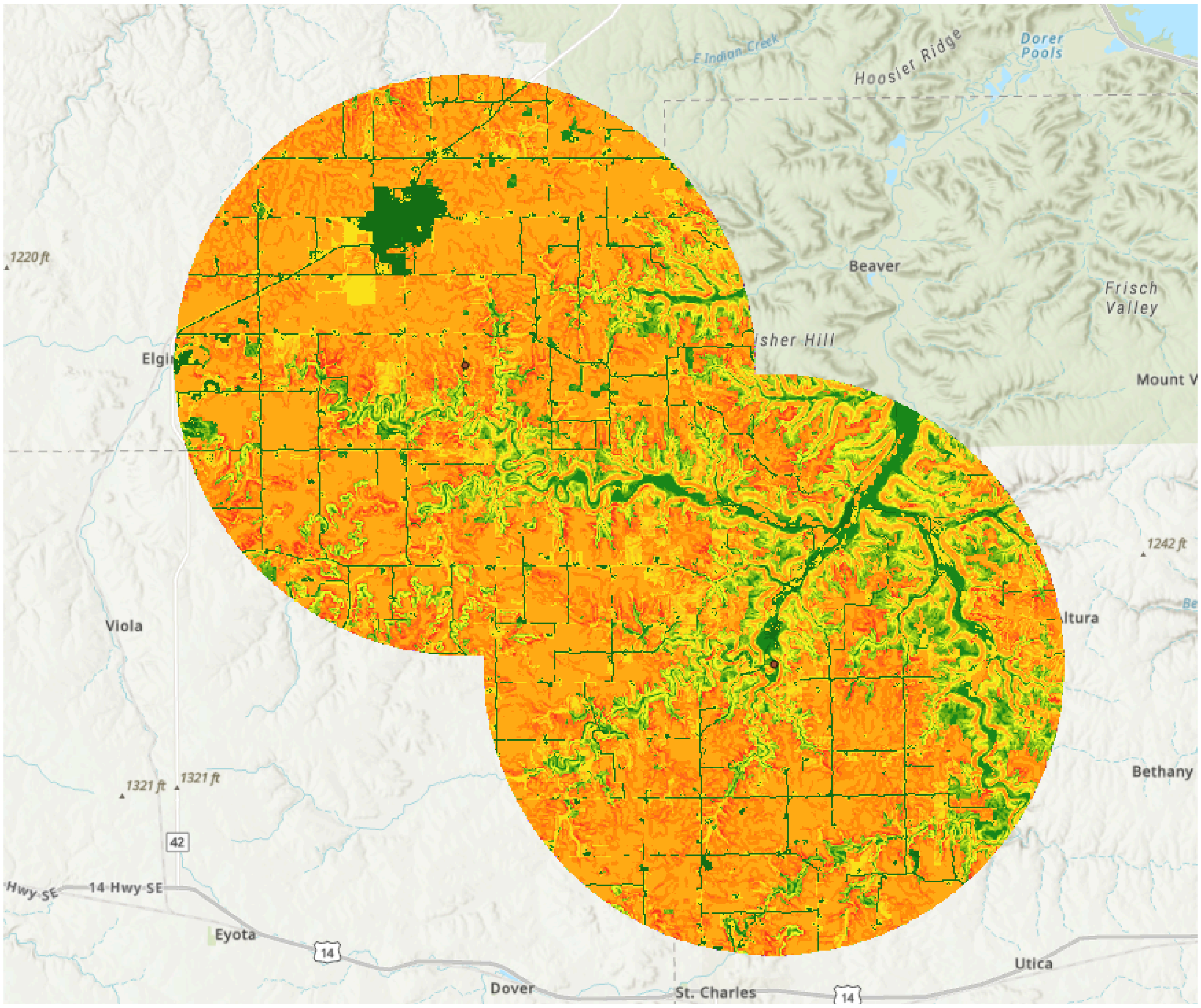

Fig. 4. The second cost surface scenario: 0.5/0.5 weight ratio.

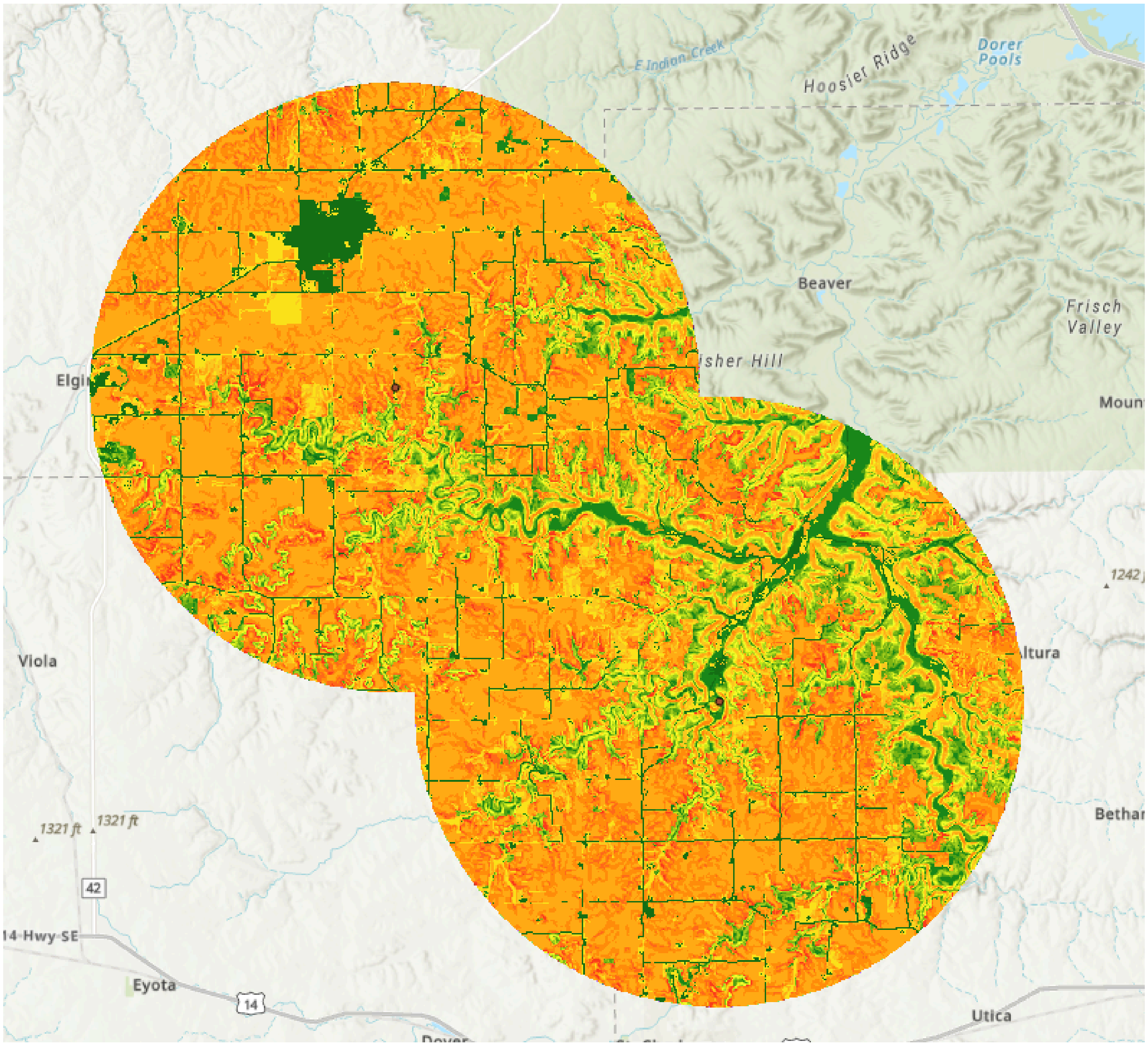

Fig. 5. The third cost surface scenario: 0.75/0.25 weight ratio.

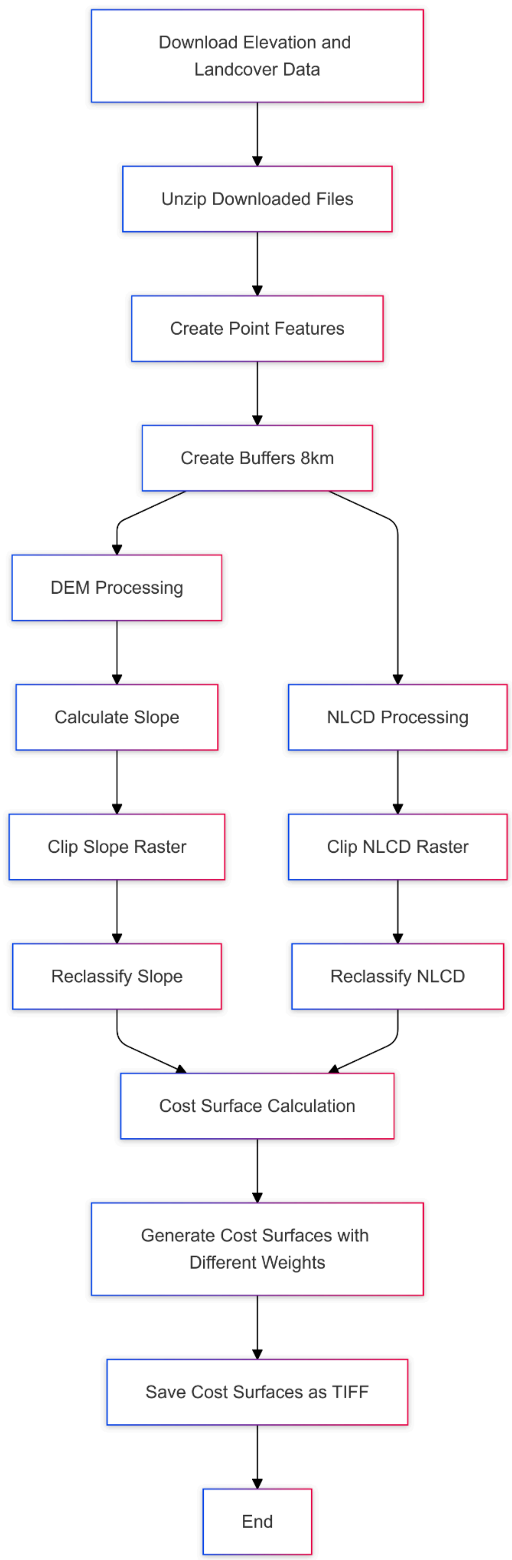

Fig. 5. The data flow diagram.

Results

The cost surface analysis revealed that the preferred walking routes were significantly influenced by the weights assigned to slope and land cover preferences. When slope was given higher importance, the paths tended to avoid steeper terrain, resulting in longer but more gradual routes. Conversely, when land cover was prioritized, the paths avoided farm fields and water bodies, potentially leading to more direct but steeper paths.

The uncertainty analysis showed that small changes in the weights could result in noticeable shifts in the optimal route, indicating sensitivity in the model. The range of possible cost surfaces generated provides insights into how varying Dory's preferences for slope and land cover could affect her hiking experience.

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**