A METHOD FOR PREDICTING NETWORK DISTANCE USING NETWORK SHORTEST DISTANCE AND SPATIAL INTERPOLATION

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Objective

This research will develop a methodology that will be used in the Robert Wood Johnson Foundation school siting research.

- The State of Florida provides bus transportation to school if the distance from their place of residence is more than two miles from the school or hazardous walking conditions exist.

  “A distance of less than 2 miles is considered to be walkable”

- However, two-mile network distance is different than the two-mile Euclidean distance.

This research provides tools to calculate the network distance, rather than the Euclidean distance, and adjust the school attendance zone (SAZ) boundaries accordingly.
School Network Analyst Interface within ArcMap:
Shows all possible shortest routes to the school from different Parcels.

GIS Network Analysis

How to Get the Network Distance?
GIS network Analysis
Calculates the shortest route from each parcel to the assigned school
Aims of the Research:

• To understand the difference between Euclidian and predicted network distance.

• To develop tools to automate the measurement of network distance.

• To construct, present and compare statistical surfaces for predicting the network distance from residential parcels to the assigned schools in the County.
Study Design:

Automation Procedures:

Constructing automation models using GIS Model Builder and Network Analyst.

Looping Scripts by Python programming language to loop the models for all the schools.

Methodology:

- Calculating Network distance for each Parcel.
- Constructing statistical surfaces for network distance.
- Calculating errors, comparisons and classifications.
Access and Egress distances

Nearest Euclidian distance between school and network line or node

Network Point

School Point
Distance Components

Distance D1 is the distance between the parcel center point to the nearest network node or line.

Distance D2 is the shortest network distance.

Distance D3 is the distance between the nearest network point to the school center point.
Study Assumptions

• All the roads in the network are walkable while ignoring physical barriers.

• Center point of the school and the parcels are the start and the end point for analysis.
Automation: Shortest Distance Model

This model is constructed using Model Builder to find the shortest distance from the nearest parcel network point to the nearest school network point.

(Network Distance D2)
Automation 2: Looping for all SAZ

- The previous Model is looped for all schools using a python script

Input:
School points, Parcels, SAZ boundaries and road network

Python Program

Output
shortest network routes from each parcel to the corresponding school in terms of a line feature shape file

Python Script Interface
Results: Shortest Routes

The output from the python program is the shortest routes for all residential parcels.
Distances D1 and D3 which are the egress and access distances to the network are found using the nearest Euclidean distance and added to the network distance by field calculator.
Euclidean vs. Network Table Comparison
Statistical Analysis

• Each route was assigned to a parcel point as an attribute.

• Statistics are used to plot network distance versus Euclidean distance

• Results using different methods are compared.
### Different Statistical Surfaces

#### Table 4-1: Comparison between methods.

<table>
<thead>
<tr>
<th></th>
<th>Points</th>
<th>Kriging</th>
<th>IDW Power 1</th>
<th>IDW optimized</th>
</tr>
</thead>
<tbody>
<tr>
<td>Avarage (miles)</td>
<td>3.266</td>
<td>3.488</td>
<td>3.473</td>
<td>3.329</td>
</tr>
<tr>
<td>Std. Dev. (miles)</td>
<td>1.918</td>
<td>2.477</td>
<td>2.579</td>
<td>2.157</td>
</tr>
</tbody>
</table>
SAZ Network vs. Euclidean

a) IDW (Anisotropic)
b) Euclidean distance- Conical surface
Slope or Surface Division

Three Methods to find the relationship:
1- Slope using 3D analyst
2- Map Algebra by dividing surfaces
3- Field division and constructing Circuity surface (Best Result)
Automating Statistical surfaces

A Model to generate a statistical surface for one attendance zone

Looping for all School Attendance Zones was done by a Python script
This raster can be reclassified according to the distance value to give a color index of the walking suitability.
Sample Reclassification

Legend
Reclass_netw1 Value
High : 9
Low : 1

New Reclass Tool
Euclidian to Network Distance

<VALUE>

- 0.023916557 - 0.5
- 0.5 - 0.75
- 0.75 - 1
On Going Research
Adjusting Attendance Zones based on Nearest Neighborhood

• Every residential parcel will be connected to the nearest school using the shortest path.

• Generating new attendance zones based on that distance.

• Taking into consideration barriers and sidewalks in the analysis.