Introduction

The goal of this project is to create a user-friendly tool that will provide emergency management coordinators a means to quickly and accurately generate evacuation plans for cities or other municipalities.

The application has been built as a plug-in for ArcGIS, a full-featured software package for geographic information systems. Besides being a powerful program, ArcGIS is in widespread use among the target communities of emergency management planners. We used Eau Claire County data for the initial test run we executed with the application.

The specific objectives for this application are:

1. Build a network dataset
2. Calculate travel time from each individual pick up zone to each individual shelter
3. Automate this process using model builder
4. Use a mathematical algorithm to determine optimal routes for each zone to the shelter with the shortest driving time
5. Send the route to the feature dataset named projectOut.

Why?

The interactive tool allows managers to easily designate the locations of shelter facilities and pick-up zones. Given these locations, the application will calculate driving times between all points using roadway network analysis. Network analysis generates a map where drive time can be calculated to two or more points using a distance calculation.

The information from this analysis will be processed by a simplex-based algorithm to determine optimal routes based on travel time. At the end of the analysis, the optimal routes can be added to ArcMap for better visual presentation.

Data Preparation and Methods

First, geospatial data layers must be gathered from various sources and prepared for analysis. Addresses of shelters where geocoded using ESRI Street Map data. Geocoding is process where address are mapped based on their street address. Then emergency management zones were imported into the software and zone centers were generated; the zone centers will serve as the pickup spots. The road data was obtained from the ESRI Street Map data clipped to the county of Eau Claire and used to build the network dataset; a collection of geospatial layers that organized such that route calculations can be made.

Once the data is entered into the map (Figure 1), a network data set was created to perform route analysis. The possible routes are found (Figure 2) and then the algorithm can be used with the data to find the optimal routes.

ArcGIS Model for Application

Part 1 of the application sets up the zone pickup locations to be added as a route. It selects one zone location and sends that to part 2 of the model. For the Eau Claire County data, this part will repeat 122 times (once for each Zone Center).

Part 2 of the application does 5 separate things which will repeat 46 times (once for each shelter location) for the Eau Claire County data. They are:

1. Sets up the a shelter location to be added to a route
2. Adds the currently selected shelter as a location
3. Add the zone location from part 1 to the route
4. Finds the route
5. Send the route to the feature dataset named projectOut.

Results

The simplex algorithm successfully takes all the pickup-to-shelter routes generated by ArcGIS and selected the most optimal set to evacuate a specified area. The accuracy of travel times is now much more accurate than previous incarnations of the algorithm because of the tool. Also, total data entry time for large data sets is drastically reduced versus past implementations of the algorithm, for which all of the travel times and shelter/zone capacities had to be entered by hand. An example of the calculated data is shown below. It has the total drive time in seconds for a zone to each shelter. This data is repeated for ever zone to each shelter.

Figure 1

Shows the city of Eau Claire with the added zones and shelters. Routes will be calculated from the data.

Figure 2

Shows a sample route between a shelter and a pick-up location. The route shown is from zone center 160 to the shelter location at DeLong Middle School.

Conclusion

The tool that we have created is very powerful and can do precise calculations with only a little bit of user overhead. This tool shows the power of the model builder in ArcGIS. We hope that the application will help in planning evacuation routes out of an area and help prevent the loss of lives during natural disasters or emergencies.

Future additions:

- Threading to reduce run time
- Limit steps that only need to be ran once
- Limit generated feature data sets
- Additional functionality to fit different needs

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