ArcCASPER User Manual

A Network Analyst Evacuation Routing Extension

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Introduction

This how-to document covers what the end user needs to know about "Evacuation Routing Analysis" and its functionality. It's recommended that the user gets familiar with other built-in analysis of Network Analyst beforehand. Repetitive instructions that are common among other analysis like 'Route' and 'Closest Facility' will not be highlighted here. Following is a good online tutorial in this regard.

http://help.arcgis.com/en/arcgisdesktop/10.0/help/index.html#//00470000005r000000.htm

Section 1: Build a Network Dataset

In order to create and build a network dataset from your street data files please follow the link below:

http://help.arcgis.com/en/arcgisdesktop/10.0/help/index.html#/Exercise_1_Creating_a_network_dataset/00470000005t000000/

Once your network dataset is ready, you need to create one additional network attribute called "Edge Capacity".

Steps:

1. Start ArcMap by clicking Start > All Programs > ArcGIS > ArcMap 10.
2. Enable the Network Analyst extension if you haven't done so already.
    a. Click Customize > Extensions.
    b. The Extensions dialog box opens.
    c. Check Network Analyst.
    d. Click Close.
3. Open the Catalog window. Click Window > Catalog.
4. Locate your network dataset, then right click on it and select "Properties" (Figure 1)
5. Navigate to the "Attributes" tab. Here you'll see previously identified attributes.
6. Adding "Capacity" attribute:
    a. Click "Add"
    b. Choose the name "Capacity"
    c. Usage type "Descriptor"
    d. Data Type "Double" or "Integer". It depends on the related street shapefile field type.
    e. Click OK when you're done.
7. Click "Apply"
8. Now select "Capacity" from the list and click "Evaluators".

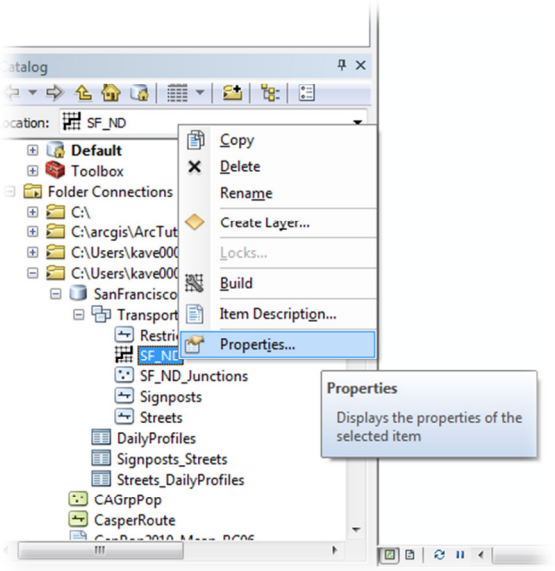

Figure 1: Network Dataset Properties

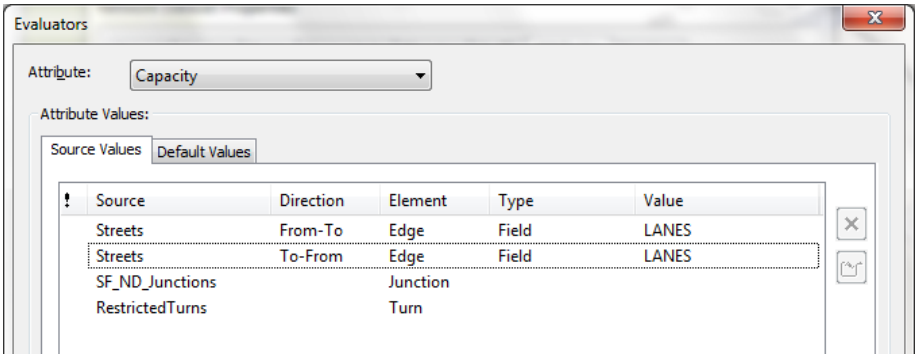

Figure 2: Capacity Network Attribute Evaluator

9. Here you have to specify which field of your street shapefile indicates road width or capacity. For example number of lanes could be one possibility. The program is going to use this number to determine if the road is saturated with evacuees or not. Set this only for the edges and leave the junction empty (Figure 2). When you're then click "Apply".
10. No from the top attribute drop menu select "Heuristic". Select junction, set the type to "Constant" and the value to "0" (Figure 3). When you're then click "OK".
11. Click OK to exit network properties.
12. Build the network dataset.

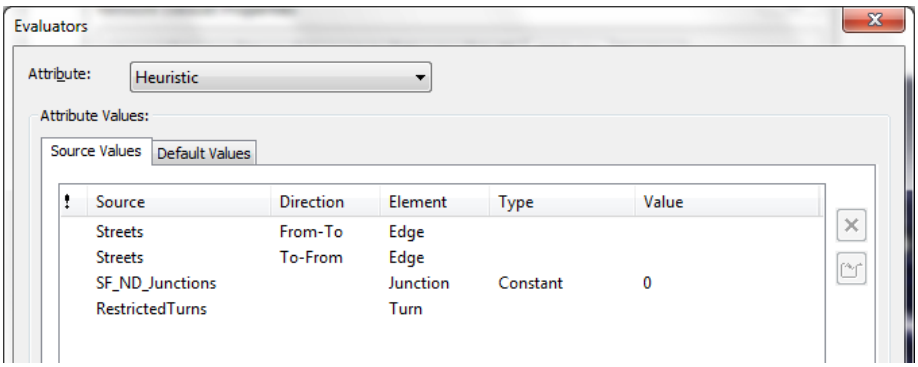

Figure 3: Heuristic Network Attribute Evaluator

Section 2: Identify Zones

In order to perform an evacuation routing, you need two sets of points: Safe Zone Points, and Evacuee Points. Safe zones are simply locations on the map where evacuees need to be routed to. Evacuee points are locations of people who are in danger. Each evacuee point needs to have a name field and a population field. The population indicates the number of people at that location whom need to be evacuated. The program assumes that each group of people at one location are not separable so one evacuation route will be generated for each evacuee location independent of its population.

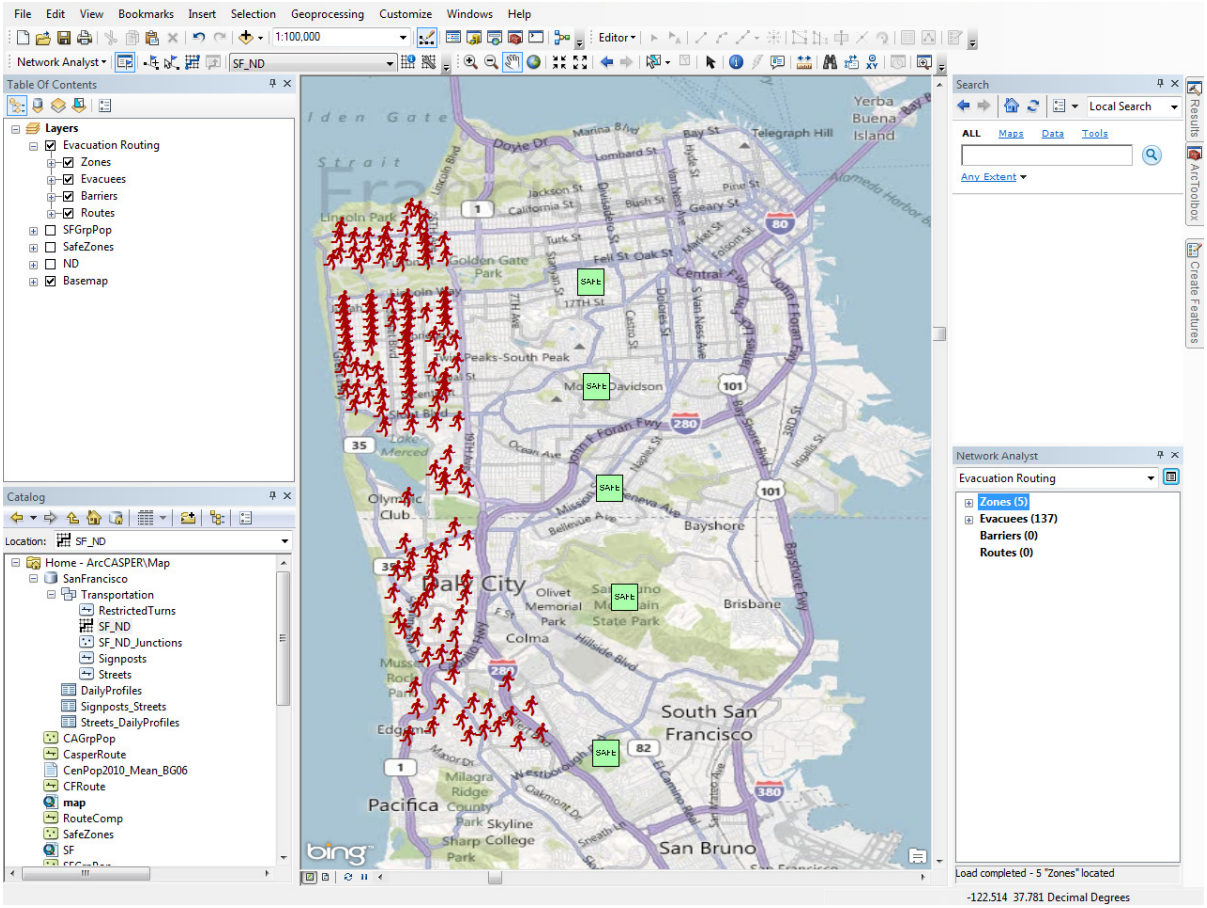

Figure 4: San Francisco Evacuation Routing Example

Let us have an example. Imagine a tsunami is coming toward San Francisco and we need to evacuate people who live close to the west side toward inland. We can use the Census block group population data for evacuees. A safe zone is simply a location with a good distance from the beach.

Steps:

1. Locate the Network Analyst toolbar in ArcMap. Click on “Network Analyst Window” so that you can see new added layers.
2. From the toolbar, open the Network Analyst drop menu and select “New Evacuation Routing”. This will create a new empty layer and five sub-layers which you can see in the Network Analyst Window.
3. Right click on “Zones” layer from Network Analyst Window and select “load locations”. Select the point shapefile with safe zone points.
4. Right click on “Evacuees” layer from Network Analyst Window and select “load locations”. Select the point shapefile with population data. Select the appropriate fields for population and name.

Once you loaded these data, it’s ready to perform the evacuation routing.

Section 3: Evacuation Setting

If you right click on the "Evacuation Routing" layer from the table of contents, you'll see the evacuation options (Figure 5).

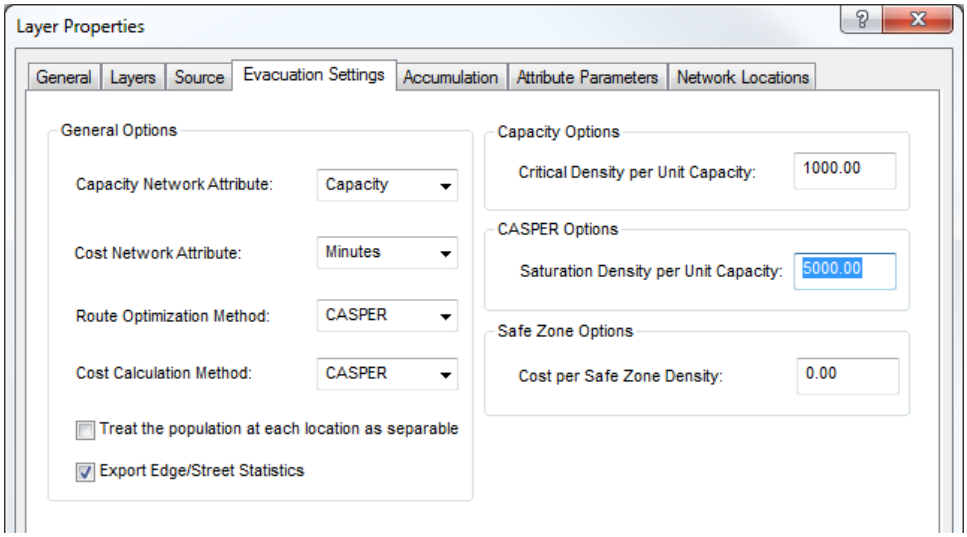

Figure 5: Evacuation Options Window

- Impedance Network Attribute: Select your impedance or cost attribute.
- Capacity Network Attribute: Indicates the "Capacity" network attribute which we added in Section 1. Make sure it's set correctly. The program will read roads widths/lanes/capacities through this attribute.
- Critical Density per Unit Capacity: This constant indicates the critical density of a road with one unit of capacity. It means the road can route up to this many evacuees without affecting the traversal speed.
- Saturation Density per Unit Capacity: This constant indicates the saturation density of a road with one unit of capacity. It means if the road is routing this many evacuees, its traversal speed will reduce to 0.368 (e^{-1}) of the original traversal speed.
- Route Optimization Method: Indicates the routing algorithm.
    - SP: ShortestPath search for each evacuee. All the capacities will be ignored here.
    - CCRP: A known capacity constrained technique which will fill up each path with evacuees from source to sink.
    - CASPER: Capacity-Aware ShortestPath Evacuation Routing which will use a logarithmic function to determine realistic traversal speeds for each road segment based on road capacity and number of evacuees (population).
- Cost Calculation Method: Indicates the cost calculation method on each route. It's only good to compare results of different routing method.
- Separable Population: This checkbox indicates if the program is allowed to separate the population at each location in order to optimize the routes. This will possibly take more time to compute but might lower the total evacuation time.

- Export Edge/Street Statistics: If you select this, the tool will also output the edge reservations which will be helpful in understanding the network better.

In order to get the evacuation routes, from the toolbar, click on “Solve”.

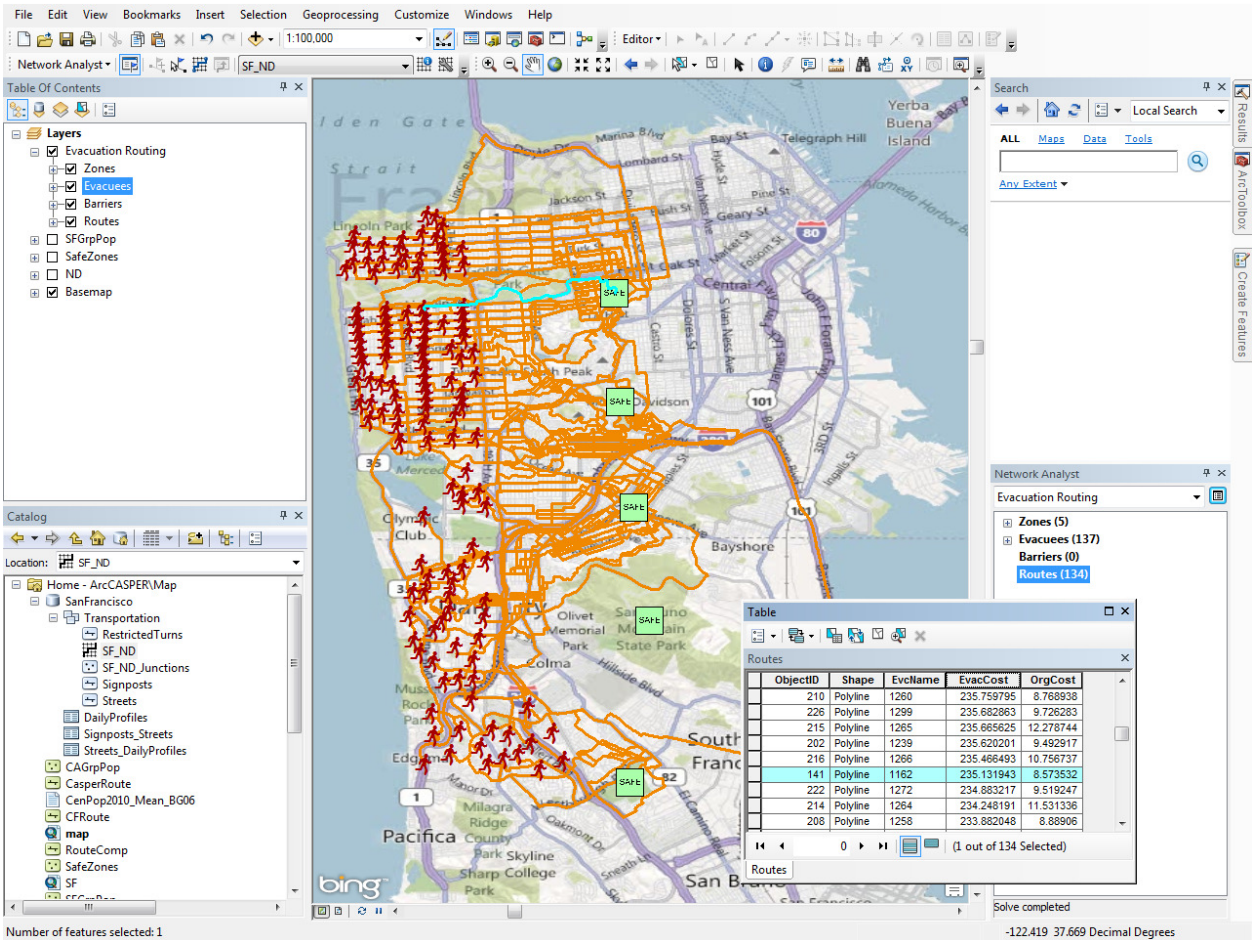

Figure 6: Calculated Evacuation Routes