Florida Statewide Hurricane Evacuation Model / TIME

presented by
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December 9, 2015

Acknowledgements


- Northeast Florida Regional Council
- Florida Division of Emergency Management
- The Regional Planning Councils of the State of Florida
- Florida Department of Transportation
- Florida Department of Economic Opportunity
- Florida’s County Emergency Managers
- Florida’s County Planning Departments
- And many others…

Outline


- Basic Concepts in Evacuation Modeling
- SRESP Evacuation Method
- Initialization
- Calculating Demand
- Trip Distribution
- Segment Trips
- Assign Trips
- Clearance Times

Basic Concepts


- Evacuation models are a specialized type of travel demand model
- Though many of the mechanics are similar to standard travel demand models, there are considerations unique to evacuation modeling that makes it different
- Someone familiar with travel demand modeling should be able to work with an evacuation model with only a minimal learning curve

Response

- Response is the determination of how a population reacts to an immanent threat with regard to evacuating toward safety

- There are two principal components to response:
  - The number of individuals that evacuate, known as “participation” or “demand”; and,
  - When those individuals choose to begin their evacuation journey, known as the “response curve”

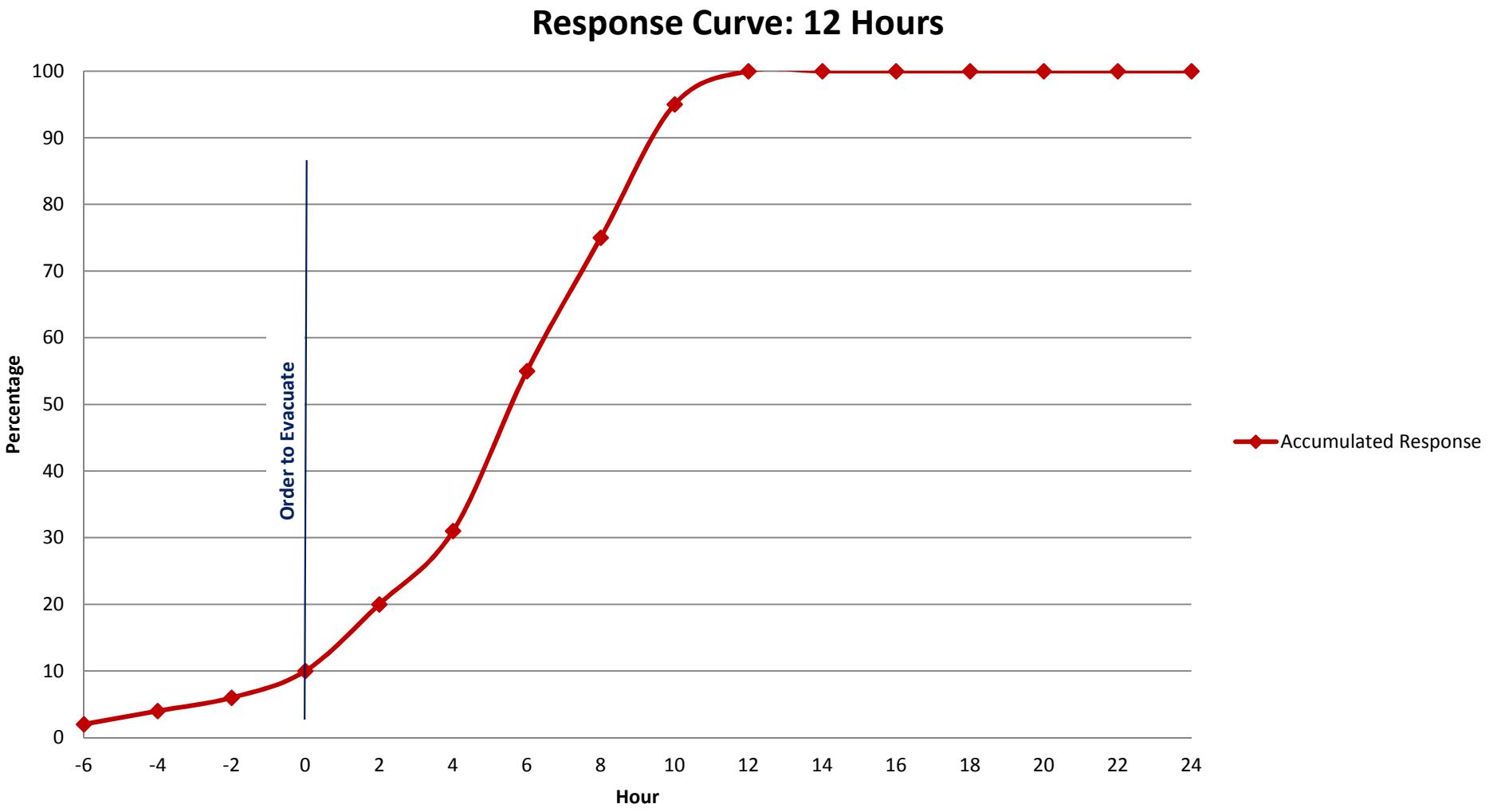
Demand

- Demand is the amount of involvement from the population during an evacuation scenario
- Demand includes not only the population, but ultimately, the number of vehicles that will be making their journey
- There are various methods to calculated demand, but the use of participation rates is the most common
- Participation rates are typically derived from behavioral surveys

Response Curve

- Response Curves describe at what time each individual in the region begins their evacuation
- These curves are expressed as a percentage of the population at a given interval of time
- The curves are based off of when an order to evacuate is given and accounts for population evacuating before an order is given and after

Response Curve



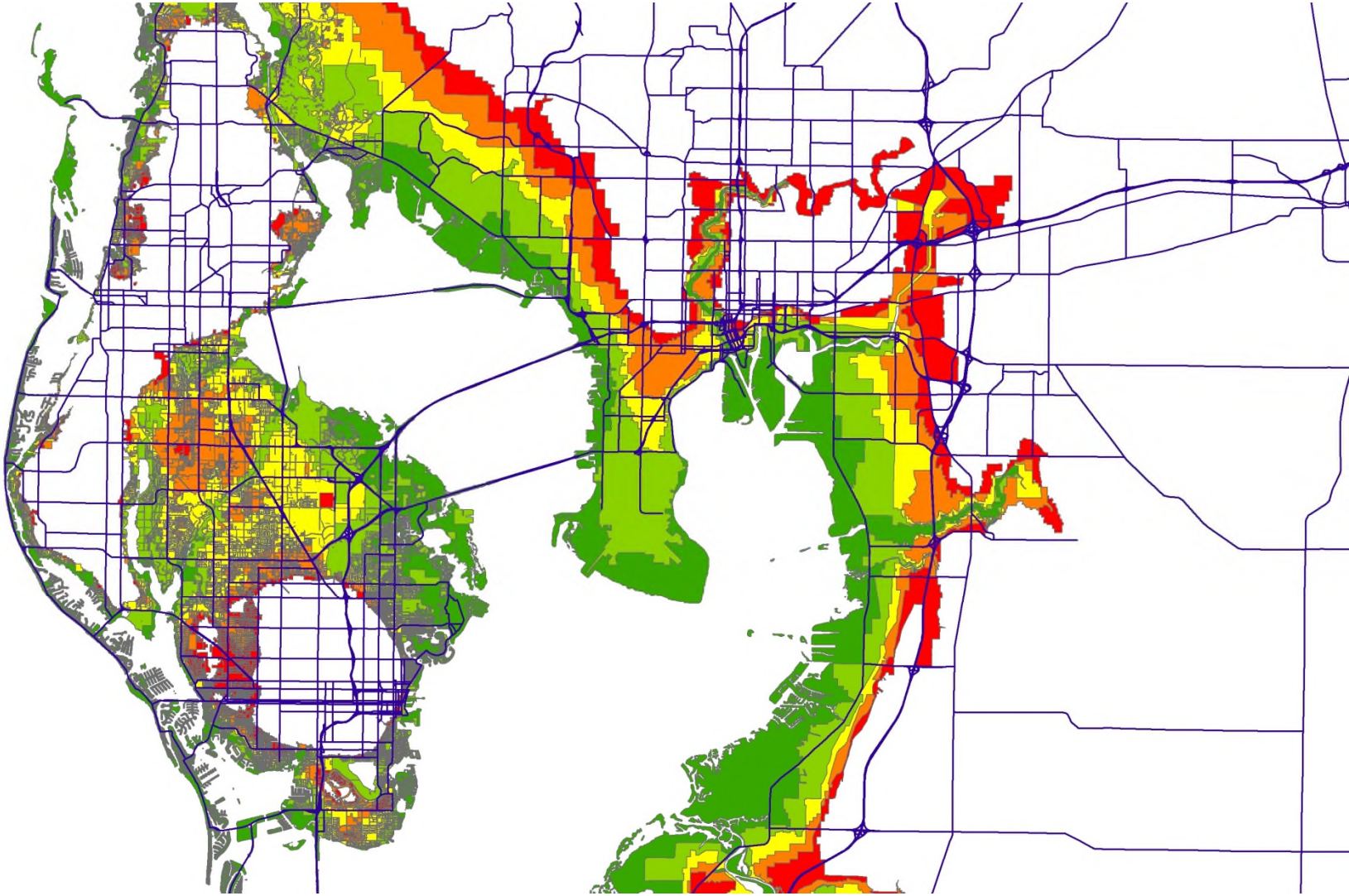
Evacuation Zones

- An evacuation zone is an area of a county that will be ordered to evacuate when a storm threat becomes immanent

- Different evacuation zones are designated depending on the severity of the event anticipated

- Evacuation zones are designated based on the likelihood of an area experience surge flooding during a storm and the ability of emergency management staff to effectively communicate an evacuation order

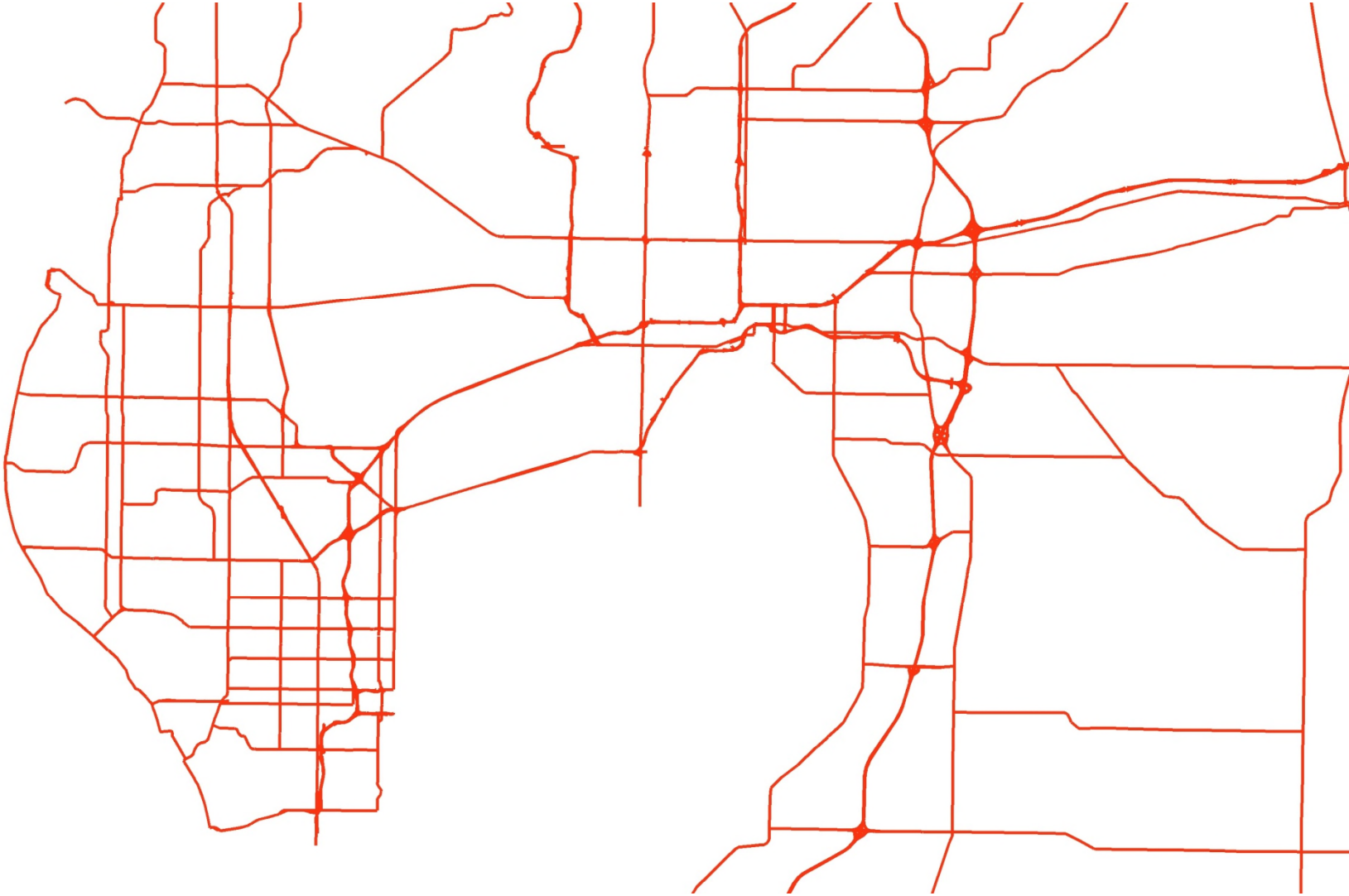
Evacuation Zones



Evacuation Network

- An evacuation network is a series of roads that have been identified as evacuation routes
- Evacuation models must at a minimum contain all of the roads identified in the evacuation network
- These roads represent what is believed to be the most efficient way of getting evacuees to safety throughout the state

Evacuation Network



SRESP Evacuation Method

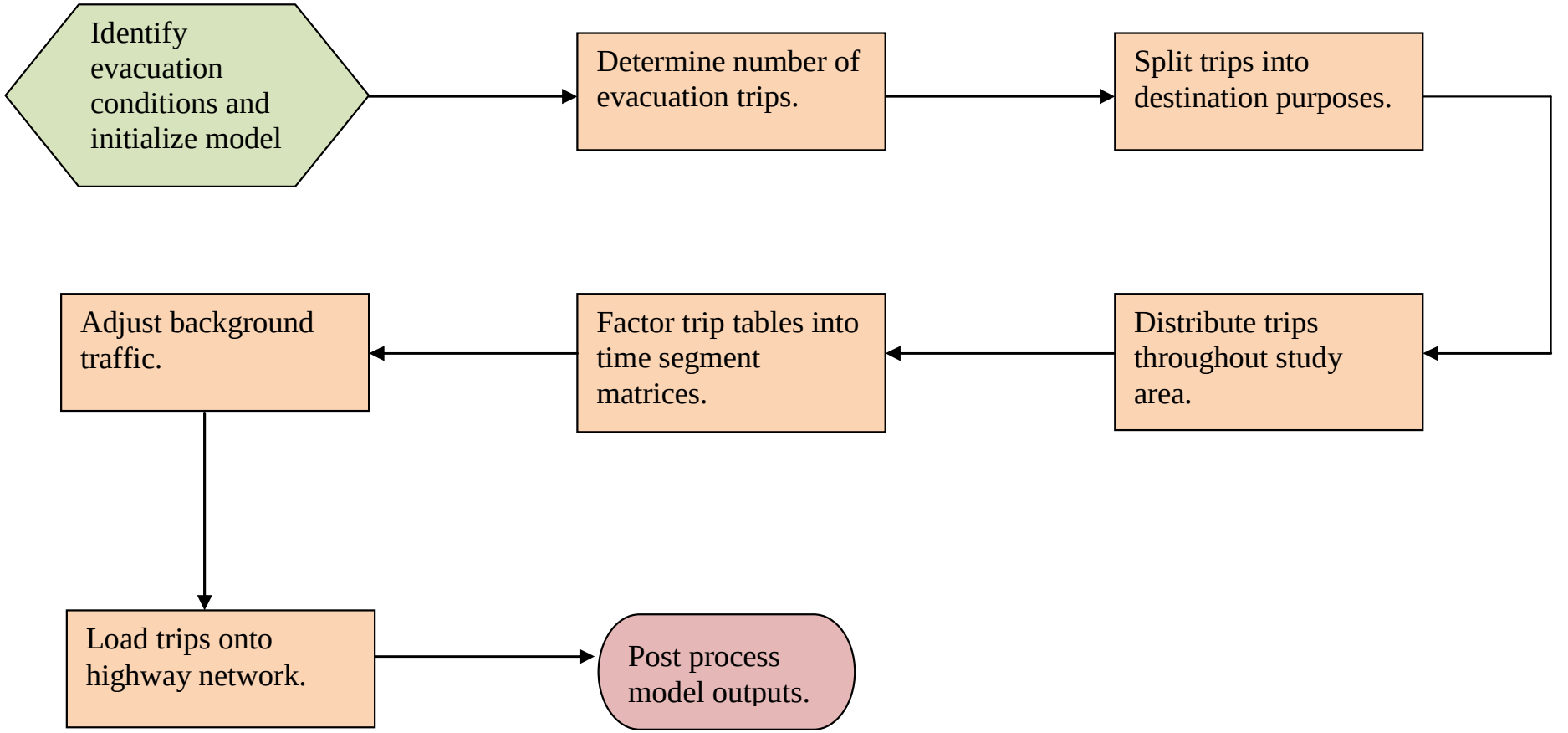
- Statewide Regional Evacuation Study Program (SRESP)
- Satisfy State Requirements
  - Standardized definitions for clearance times
- Statewide Consistency
  - All RPC regions use same transportation methodology
- Single or Multi-Region Analysis
  - Each RPC has ability to conduct own analysis
- Transportation Interface for Modeling Evacuations (TIME)
  - Allows users ability to easily create and run evacuation scenarios
  - GIS-based interface running on top of Cube Voyager and Cube Avenue

SRESP Evacuation Method

- Only trip generation, trip distribution, and trip assignment are used

- These steps are further subdivided into a total of eight modeling steps:
  - Identify evacuation conditions and initialize model;
  - Determine number of evacuation trips;
  - Split trips into destination purposes;
  - Distribute trips throughout study area;
  - Factor trip tables into time segment matrices;
  - Adjust background traffic;
  - Load trips onto highway network; and,
  - Post process model outputs.

SRESP Evacuation Method



Initialization


- Model needs to determine the hazard conditions representing the particular scenario that will be analyzed
- This allows the model to accurately identify the areas that are be subject to evacuation and to determine the intensity of the evacuation event
- This process establishes the appropriate rates that will be used to determine the number of evacuation trips that will be generated

Initialization


- The modeler begins any scenario run by establishing a set of parameters specific to the evacuation scenario that the modeler wishes to analyze
- These parameters let the evacuation model know which sets of data to use and which evacuation rates are appropriate for a given scenario
- The parameters that can be selected by the user on the following slide

Initialization

Transportation Interface for Modeling Evacuations (TIME)

Scenario

IntFaceTest

Description

Comments

Behavioral Assumption: Planning Assumptions

Population Period: 2015

Network Period: 2015

Model Run Mode: Run Full Model

Save Animation

Active Reverse Lane Evacuation Plans

University Population: Fall/Spring Session (100% in residence)

Evacuating Counties (Plan): Franklin (C) — Edit

Import Zones — Reset

Directional Evacuation Selection: Original — Edit

Counties with Roadway Network Modified — Edit

Shelters : Open Capacity: Customized — Edit

Counties with Small Area Data modified — Edit

"No-Go" Counties: — Edit

Counties including Tourist Population — Edit

C:\Scenarios\IntFaceTest

Counties

- The SRESP model contains all 67 counties in the State of Florida and also includes two coastal counties in Alabama (Baldwin and Mobile) and two coastal counties in Georgia (Camden and Glynn)

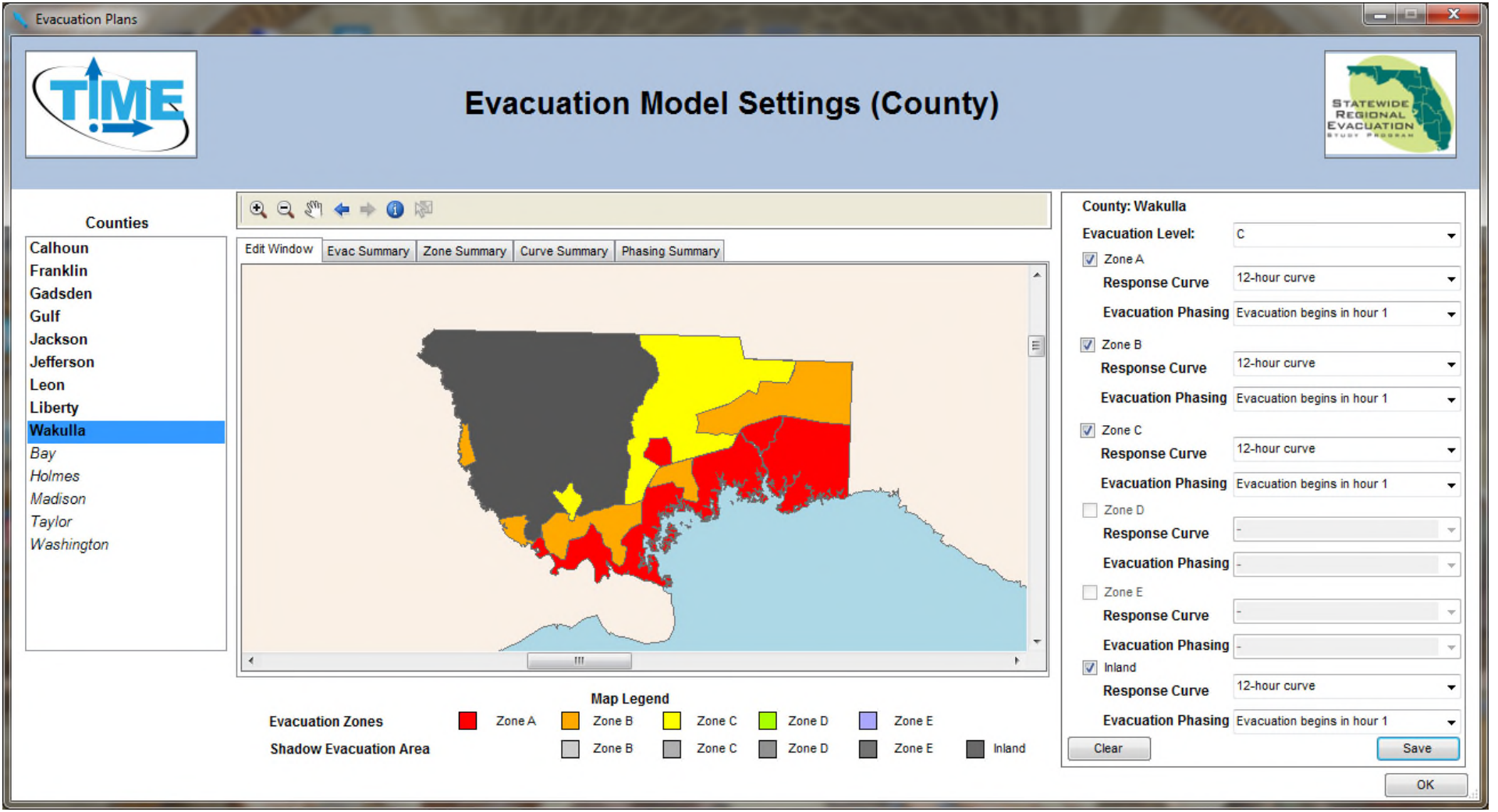
- Monroe county separated into 5 distinct parts: mainland, upper keys, middle keys, lower keys, and Key West

- Each county (or part of Monroe County) can be assigned its own set of parameters separate from other counties

Evacuation Level

- Evacuations are modeled in the SRESP model by designating an intensity of evacuation for each county
- Individual evacuation zones can be ordered to evacuate at different times within a county and between counties
- No evacuation level = No evacuation
- The evacuation level has a direct impact on the amount of evacuation traffic that is ultimately loaded onto the model's highway network
  - This depends heavily on where households are located in relation to the evacuation zones

Evacuation Level



Behavioral Rates


- Behavioral data collected and analyzed as part of the SRESP effort

- County specific planning rates developed from behavioral data:
  - Participation rates
  - Vehicle use rates
  - Out-of-County evacuation rates
  - Public shelter use rates
  - Friends and Family rates
  - Hotel/Motel use rates
  - Other destinations rates

Behavioral Rates


- Rates are distinguished between site-built and mobile home dwelling units
- Model user can select between to basic rate types for each scenario:
  - Planning rates response: Evacuation response is consistent with the planning rates developed from the SRESP behavioral survey for each county
  - 100% response rates: 100% of site-built homes in the evacuation zone plus 100% of mobile homes plus shadow evacuations outside of the evacuation zone

Response Curves

- Response curves developed for the SRESP were based on observed evacuation data from prior storms
- Temporal data not available from recent round of behavioral studies
- Standard curves are described as fast (12 hours), medium (18 hours), and slow (24 hours)
- No clearance time can be shorter than the response curve

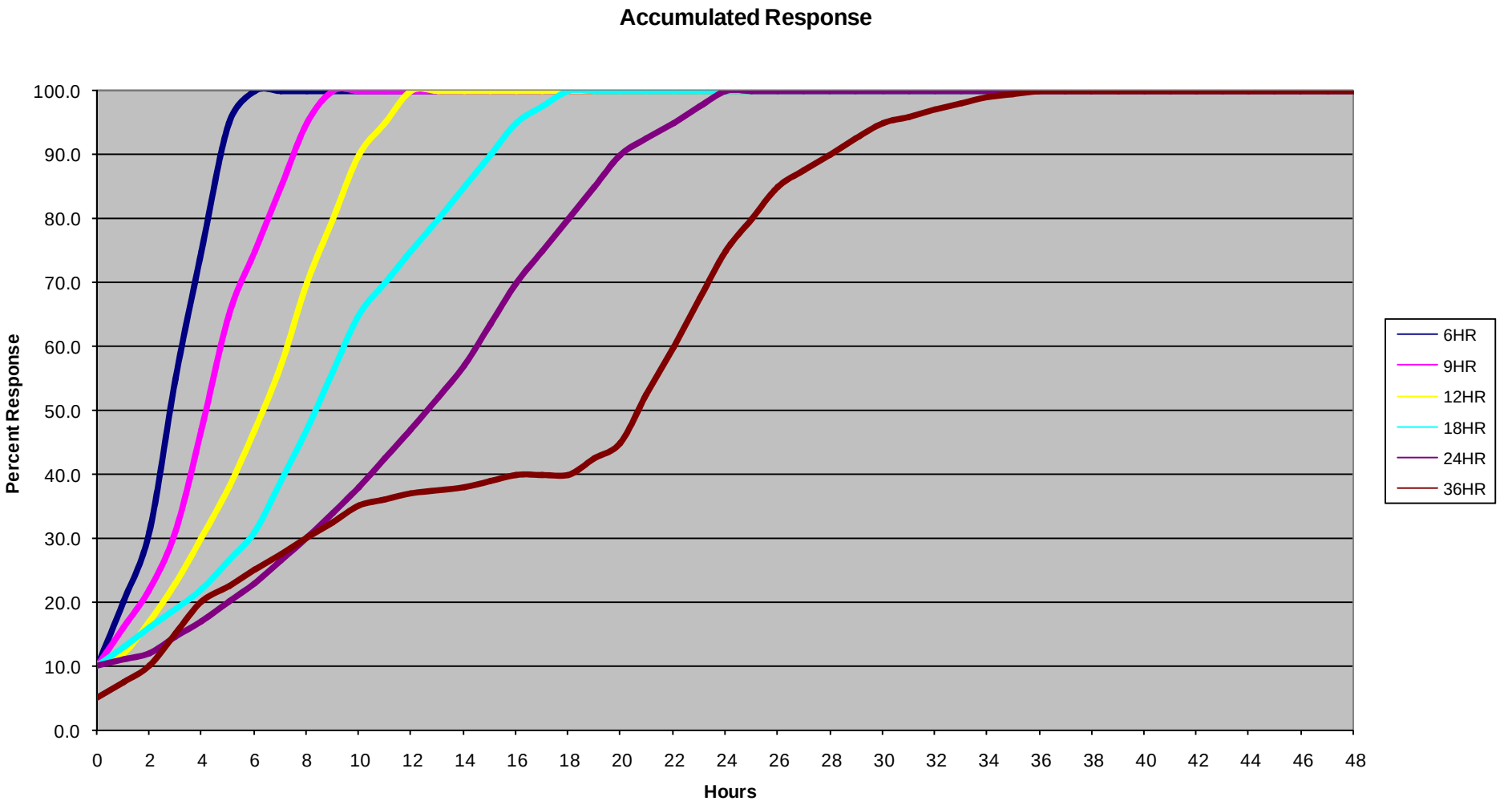
Response Curves

- The modeler can select between six different curves:
  - 6 hours
  - 9 hours
  - 12 hours
  - 18 hours
  - 24 hours
  - 36 hours

Standard SRESP curves

- The first five curves assume that 10% of all evacuees leave and are clear before the order to evacuate is given; the last curve assumes 5%

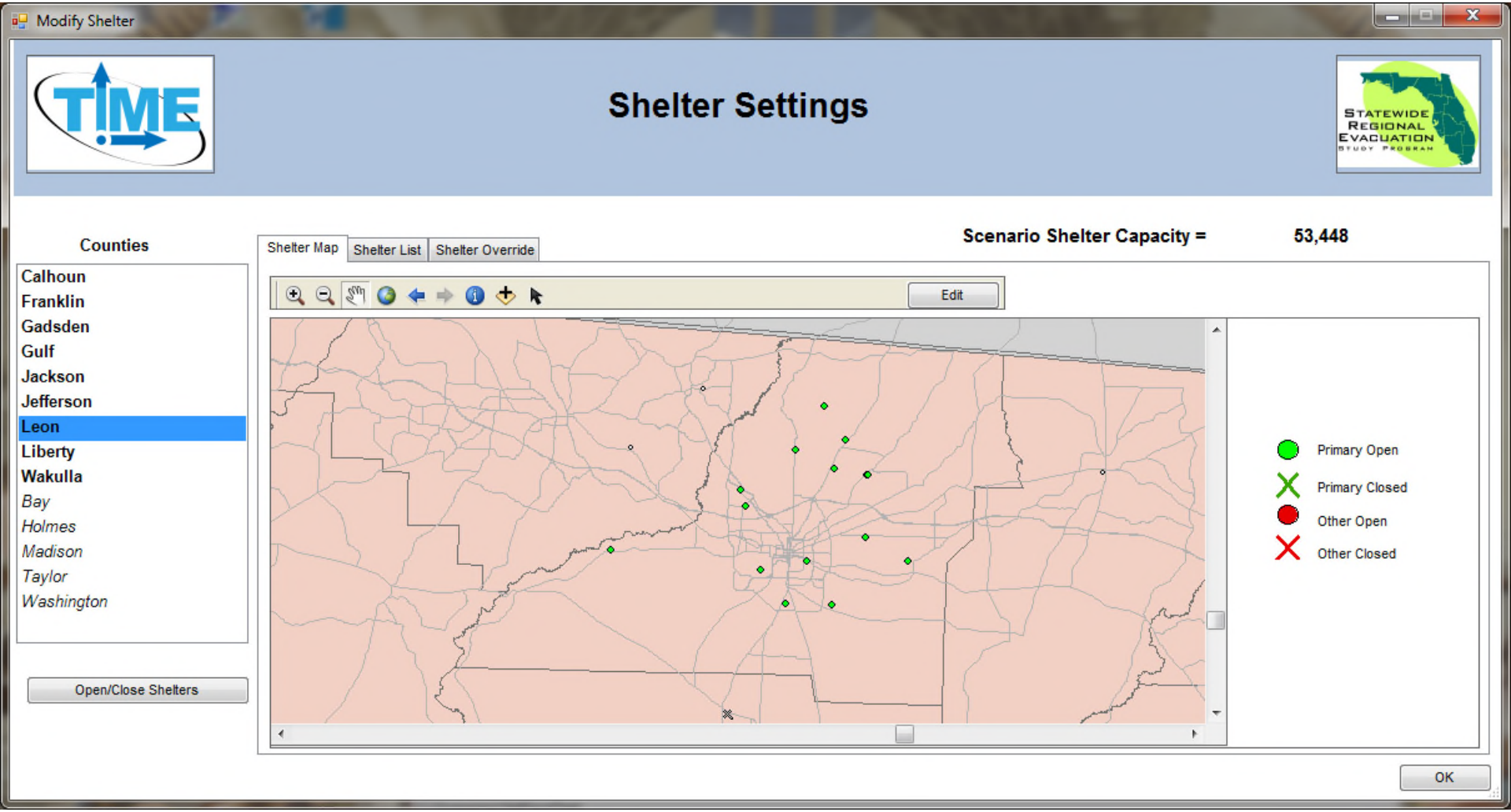
Response Curves



Shelters

- The model contains data on shelters throughout Florida
- Each shelter has a designated capacity in terms of available beds
  - The model assumes 1.85 persons per automobile for trips heading to shelters
- Each shelter is designated as **primary** or **other**
- The model user can identify which shelters are open or closed and can modify the shelter capacities if needed

Shelters


Modify Shelter
TIME
Shelter Settings
STATEWIDE REGIONAL EVACUATION STUDY PROGRAM
Counties
Calhoun
Franklin
Gadsden
Gulf
Jackson
Jefferson
Leon
Liberty
Wakulla
Bay
Holmes
Madison
Taylor
Washington
Open/Close Shelters
Shelter Map
Shelter List
Shelter Override
Scenario Shelter Capacity = 53,448
Edit
Primary Open
Primary Closed
Other Open
Other Closed
OK

Analysis Years


- The model has data for the following years:
  - 2015
  - 2020
- The model user selects a year for the population data and the roadway network
- Population data and roadway characteristics are automatically updated based on the year selected
- This allows testing of 2020 population with existing 2015 network conditions

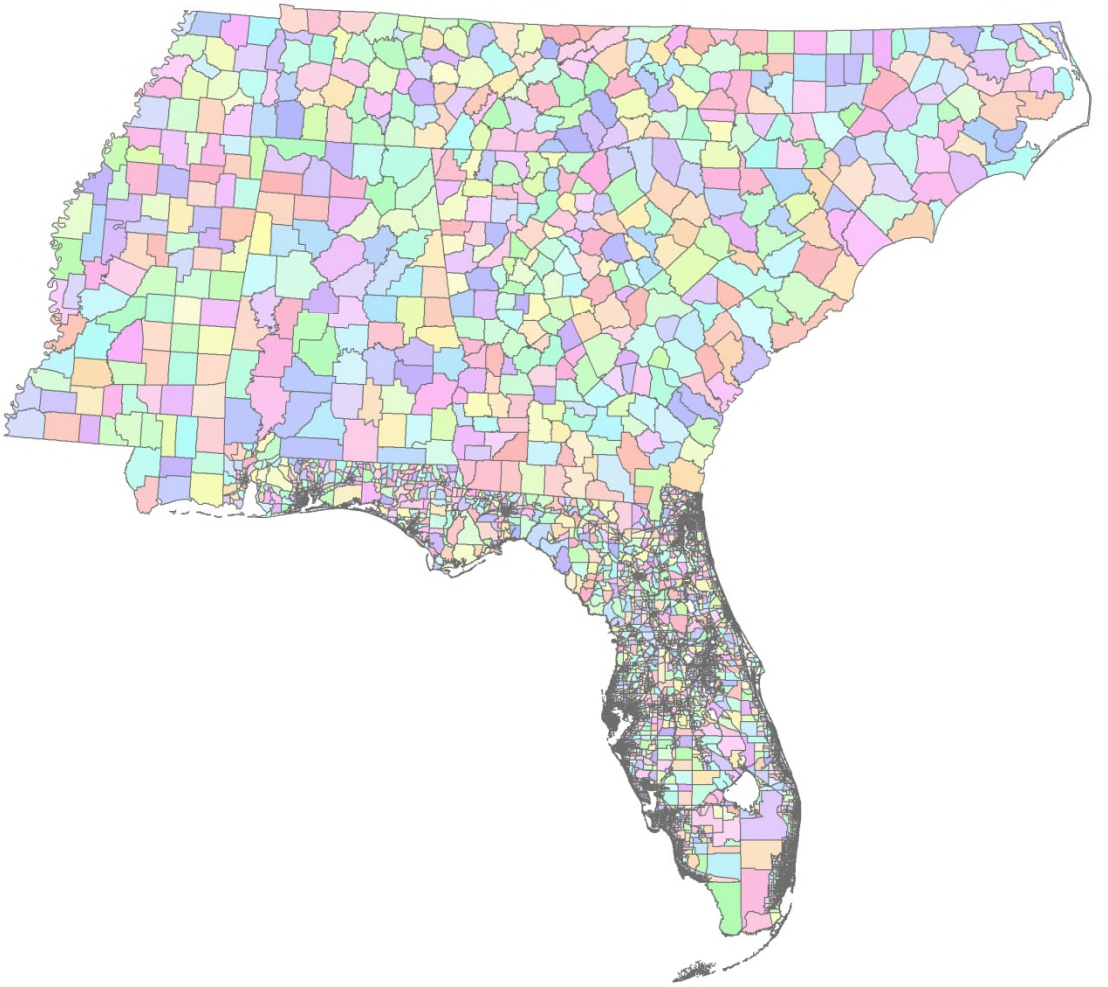
Traffic Evacuation Zones

- Demographic data were developed by the RPCs at the small area level:
  - Census block groups
  - Metropolitan Planning Organization (MPO) TAZs

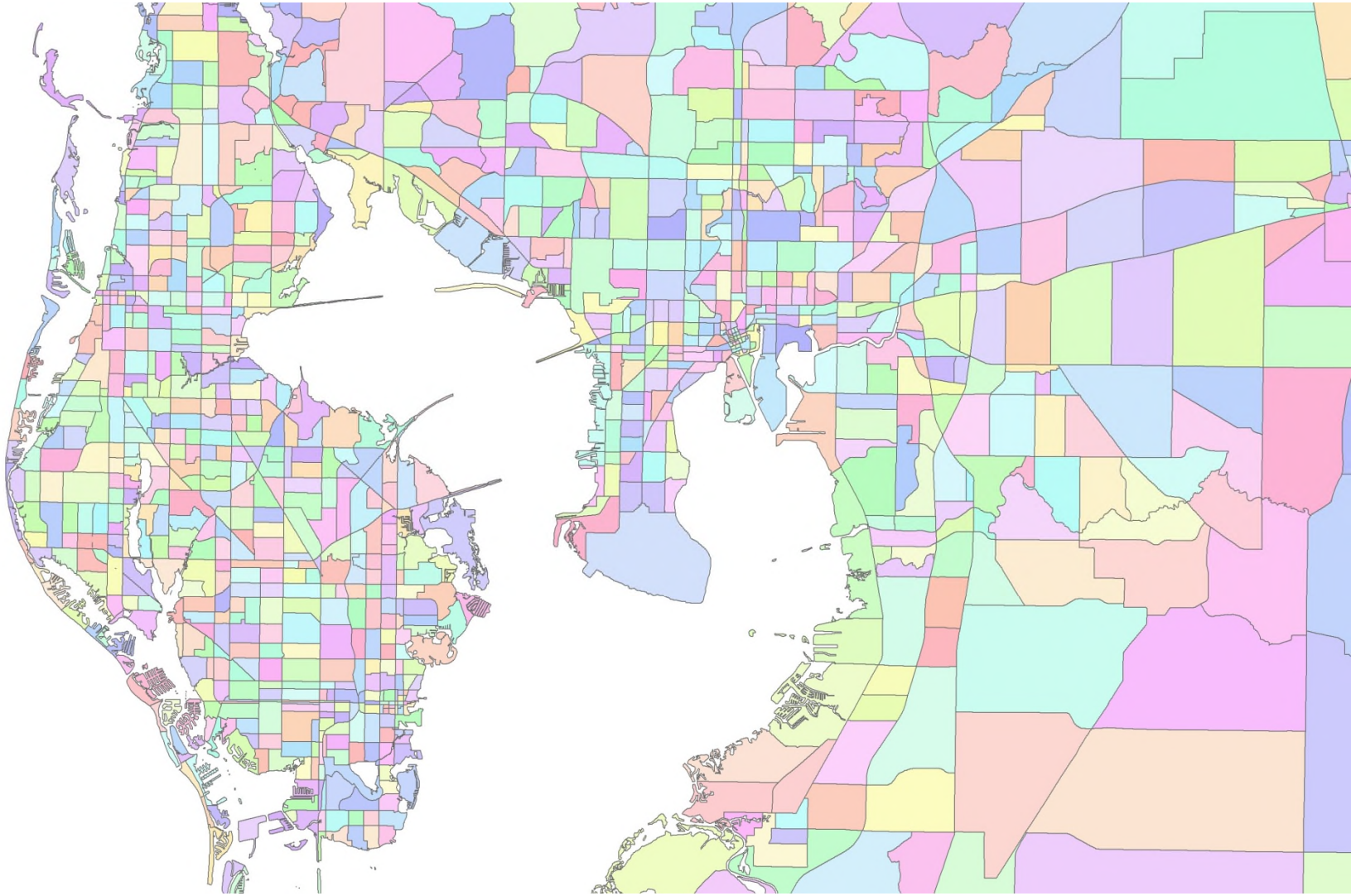
- Small area data geographies were aggregated into larger units called Traffic Evacuation Zones (TEZ)

- TEZs form the basic unit of analysis in the evacuation model similar to how traffic analysis zones form the basic unit of analysis in a standard travel demand model

Traffic Evacuation Zones



Traffic Evacuation Zones



Demographic Data


- Each TEZ has associated demographic data:
  - Dwelling units
  - Population
  - Vacancy rates
  - Auto ownership
  - Tourists
  - University population
  - PCAT
- Data exist for each analysis year and are distinguished between site-built and mobile homes
- The evacuation model has no economic component

Calculating Demand

- There are three key factors considered by the model when deciding which rates to apply to which households:
  - Dwelling unit type
  - Evacuation level
  - Evacuation zone in which the household is located

- Evacuation zones and TEZ boundaries do not line up

- The PCAT fields are used to determine which evacuation zone each household is in

Calculating Demand


- There are six PCAT fields in the TEZ database:
  - PCAT1: percentage of households in evacuation zone A
  - PCAT2: percentage of households in evacuation zone B
  - PCAT3: percentage of households in evacuation zone C
  - PCAT4: percentage of households in evacuation zone D
  - PCAT5: percentage of households in evacuation zone E
  - PCAT6: percentage of households not in an evacuation zone

- PCAT assumes an even distribution of population in a TEZ
  - Since most TEZs near evacuation zones are small, this is safe assumption
  - Some rural coastal TEZs needed to be adjusted manually

Destination Purposes

- Trip purposes for the SRESP model are not based on the reason for the trip, all trips have the same reason: to flee from danger; rather,

- Trip purposes for the SRESP model are based on the type of destination where the evacuee wants to go and where that destination is located

Destination Purposes


- The types of destination in the SRESP model are:
  - Friends and Family
  - Public Shelter
  - Hotel / Motel
  - Other
- These destinations can either be:
  - In-county; or,
  - Out-of-county
- Trips are split into the different destination purposes using rates developed from the behavioral surveys

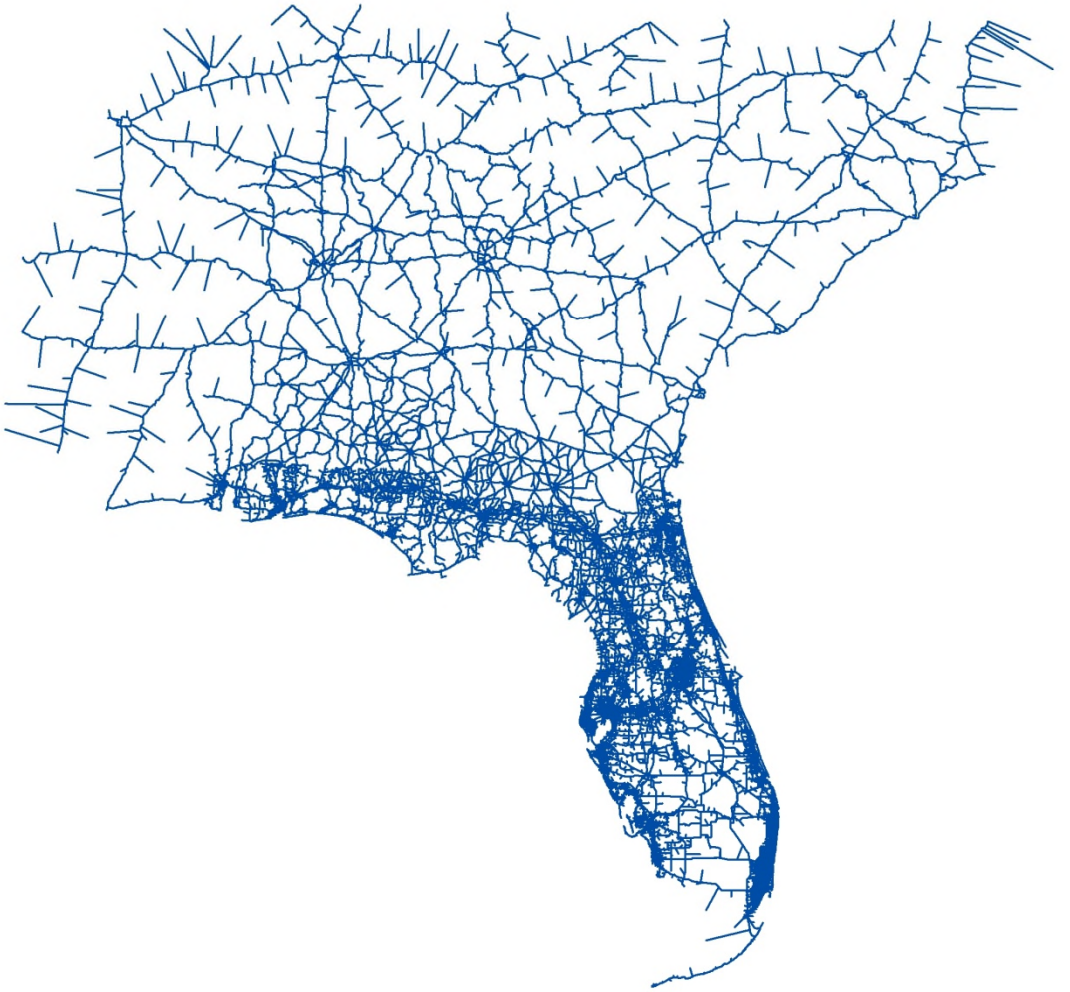
Highway Network

- SRESP model highway network is originally based off of the Florida Statewide Model

- The highway network is stored as a geodatabase:
  - It can be opened in ESRI ArcGIS (if Cube is installed on that machine); but,
  - Can only be edited in Cube

- The network is a master network: it contains data for 2006, 2010, and 2015

Highway Network



Trip Distribution

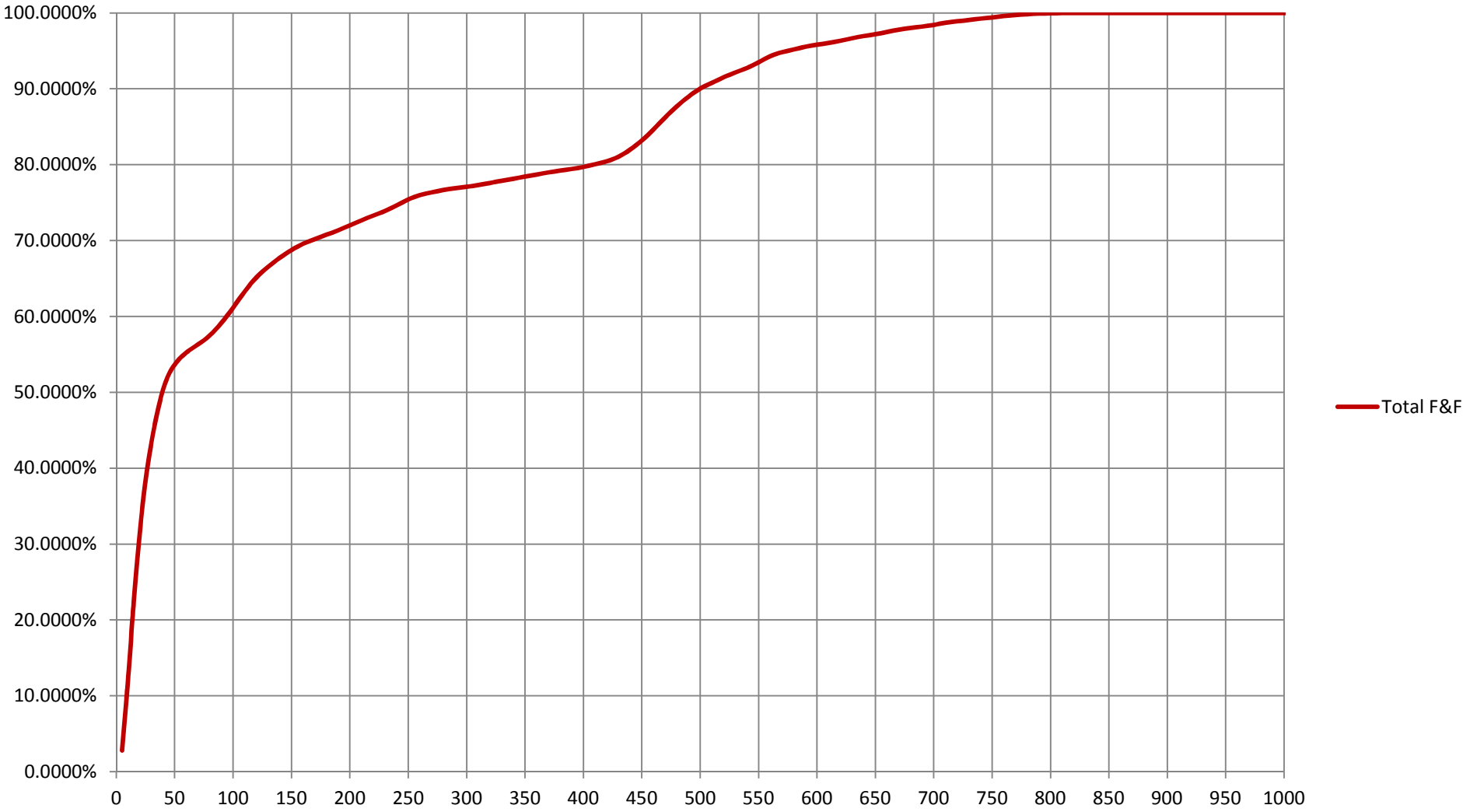

- Trip attractions are balanced regionally
- This prevents skewing of where trips want to go
- Regional distribution data was extracted from the behavioral survey
- Using a regional balancing of attractions helps to ensure that trips are properly distributed throughout the model
- The regional balancing applies only to out-of-county trips

Trip Distribution

Out-of-County Trips: Regional Distributions

Region	Apalachee	Central	East Central	North Central	Northeast	South	Southwest	Tampa Bay	Treasure Coast	West	Withlacoochee	Out-of-State
Apalachee	31.19%	0.13%	1.10%	2.28%	2.11%	0.00%	0.13%	0.72%	0.30%	3.50%	0.76%	57.80%
Central	5.91%	9.82%	13.00%	4.41%	4.69%	0.00%	4.19%	5.91%	5.41%	0.73%	1.73%	44.20%
East Central	2.53%	1.71%	27.11%	5.41%	5.88%	1.53%	2.65%	6.70%	0.76%	1.41%	3.12%	41.20%
North Central	5.23%	0.73%	3.63%	15.17%	6.26%	0.31%	0.33%	3.09%	0.23%	1.26%	1.99%	61.80%
Northeast	3.72%	0.75%	4.21%	6.59%	10.33%	0.59%	0.59%	1.79%	0.16%	1.89%	1.99%	67.40%
South	1.99%	3.37%	20.91%	2.07%	3.37%	24.51%	5.75%	2.07%	8.96%	0.54%	3.06%	23.40%
Southwest	1.39%	5.23%	15.94%	3.91%	3.28%	4.60%	11.03%	8.38%	3.15%	0.76%	5.36%	37.00%
Tampa Bay	3.21%	3.73%	14.12%	2.81%	4.48%	2.18%	1.32%	15.67%	2.01%	0.52%	7.35%	42.60%
Treasure Coast	2.77%	1.52%	22.84%	3.04%	4.36%	4.49%	3.96%	9.37%	11.48%	0.20%	1.98%	34.00%
West	6.25%	0.24%	2.10%	0.90%	3.49%	0.42%	0.07%	0.31%	0.31%	8.68%	0.80%	76.40%
Withlacoochee	2.39%	1.66%	12.35%	7.37%	3.27%	0.99%	0.67%	6.54%	0.47%	1.25%	15.00%	48.00%

Trip Distribution: F&F



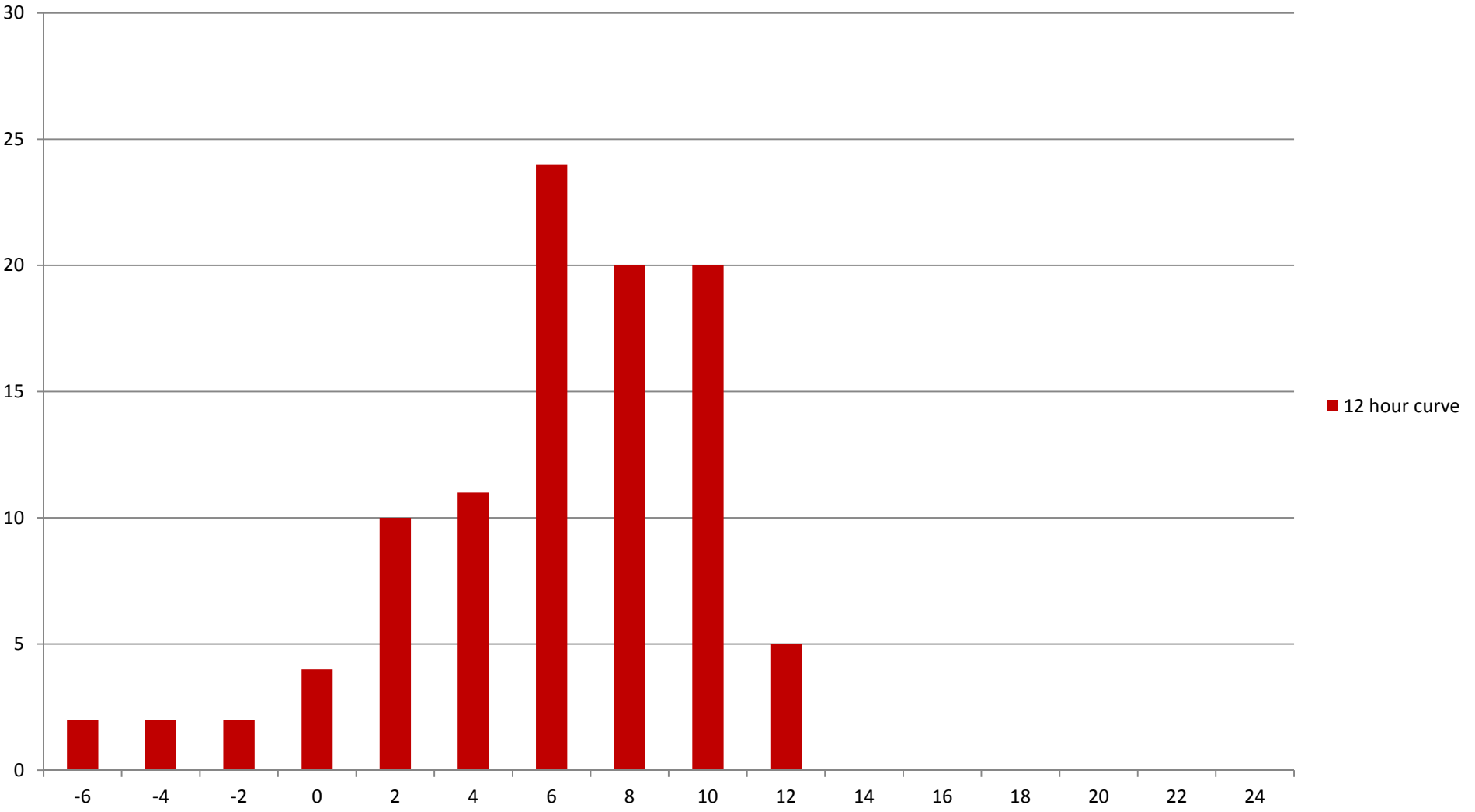
Segment Trips

- During an evacuation, trips load onto the network over time – *not all at once*
- To do this the trip table will need to be parceled out into separate tables for each time interval
- This process is known as time segmentation
- The response curves used by the model are factors that are applied to the trip table in order to get the necessary time segments

Segment Trips


- Time segments are half-hour long
- There are 192 time segments in the model, representing:
  - A period of 96 hours; or,
  - Four days
- Each of the two trip tables coming out of trip distribution are divided into 192 segments
- The time segmentation assumes that there is lead time to initiating an evacuation (securing property, collecting family members, leaving work, etc.)

Segment Trips



Assign Trips


- Once the demand has been calculated by the model and the trip tables generated and segmented, the model begins to put trips on the model network. This is called trip assignment.

- The traffic that consumes the roadway capacity of a transportation system during an evacuation can be divided into two groups:
  - Background Traffic
  - Evacuation Traffic

Background Traffic

- The *Florida Traffic Information* DVD was used to develop average peaking characteristics for various functional classes of roadways throughout the state

- These characteristics were analyzed to determine how much capacity is available throughout a given day during an evacuation and a set of factors representing the available capacity is then applied by the model during trip assignment

- The model assumes less background traffic in evacuating coastal counties

Evacuation Traffic


- The trips that represent evacuees leaving the area are the evacuation traffic
- These trips must be modeled directly in order to develop the necessary clearance time statistics
- Traditional travel demand assignment techniques are static
- Static assignments produce only a snapshot of traffic for the whole day and can not develop clearance times

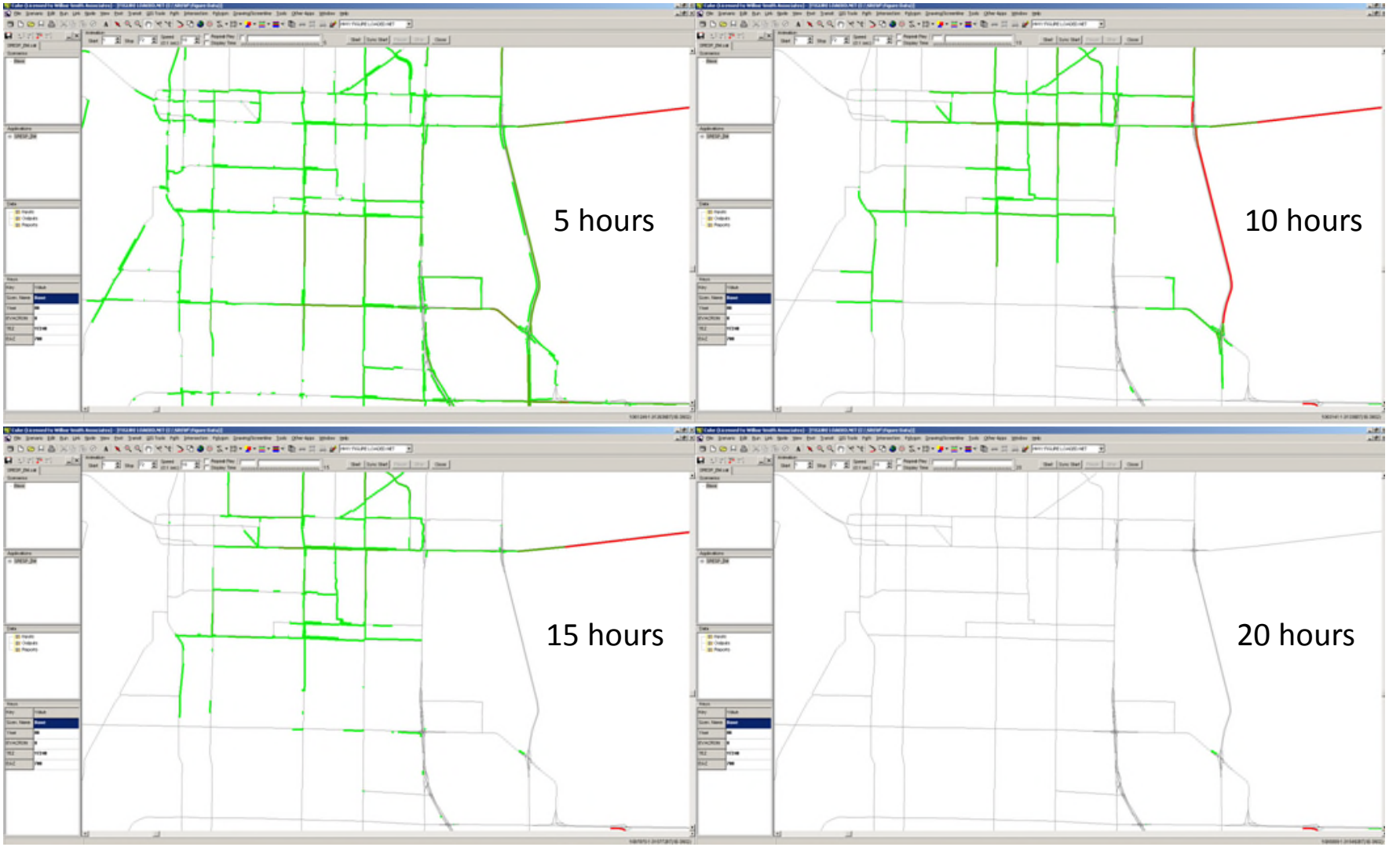
Evacuation Traffic

- Instead, the SRESP model uses **Cube Avenue** for DTA
- DTA works by assigning a certain number of vehicles to the highway network in a given interval of time and tracking the progress of these trips through the network over the interval
- Another set of vehicles is assigned during the following time interval and the progress of these trips are tracked along with the progress of the trips loaded in the previous time interval.

Evacuation Traffic

- By dynamically adjusting the travel times and speeds of the vehicles moving through the network as they respond to congestion the model is able to do the following:
  - Estimate the critical clearance time statistics needed for this study;
  - Take into account the impact of compounded congestion from multiple congestion points;
  - Adjust the routing of traffic throughout the network as a function of congestion as it occurs throughout the evacuation; and,
  - Adjust the capacities from time segment to time segment, making it possible to represent such phenomena as reverse lane operations and background traffic.

Evacuation Traffic



Clearance Times


- A clearance time is the time it takes for trips to vacate the network after beginning their journey

- Clearance times are used by emergency management staff to:
  - Determine the window of opportunity available to initiate an evacuation order;
  - To ensure that evacuees have enough time to reach safety before the storm arrives

Clearance Time


- Clearance times are used as a measure for how long an evacuation can be expected to take place once it has begun

- The legislation driving the SRESP identifies the follow four clearance times:
  - Clearance Time, In-County
  - Clearance Time, Out-of-County
  - Clearance Time, To Shelter
  - Regional Clearance Times

Calculating Clearance Times

- Volumes are stored on the network by time segment
- Model reads the loaded network data and determines the time segments in which trips first enter and last leave a given area:
  - Evacuation Zone
  - County
  - Region
- The difference between the two is the duration of time segments for which there were trips present; when multiplied by 0.5, this gives the clearance times

Questions?

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Variability of Clearance Times due to Random Seeds