Evacuation Plan for San Francisco County

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Problem Statement

- Less than half transportation agencies believe their emergency management plans and resources were adequate (TRB, 2009)
- Sacramento's Multi-Hazard Mitigation Plan identifies the need, a multihazard emergency plan:

" [a city] shall maintain and implement the multihazard emergency plan to address disasters such as earthquakes, flooding, dam or levee failure, hazardous material spills, epidemics, fires, extreme weather, major transportation accidents and terrorism" (Connie, 2013)

What is a Evacuation Plan?

- A plan that specifies procedures for handling sudden or unexpected situations
- A planned immediate and urgent movement of people away from the threat or actual occurrence of a hazard



Introduction

- Natural or Man-made Disasters are a risk
- ► To mitigate risk robust methodologies for planning are required



Problem Statement

For the San Francisco County develop a evacuation plan that will:

- That will use the best route for peak hours
- On vacant parcel of land
- Within the City Limits
- As close as possible to shore line
- In the most densely populated neighborhood with lots of children
- In a low in come neighborhood

Goal:

Use traffic models to develop a tool which can assess:

- Hazard analysis
- Vulnerability analysis
- Behavioral analysis
- Transportation analysis
- Design evacuation routing
 - Service a set of orders with a fleet of vehicles
 - Finding Routes to service a set of Paired vehicles
 - Choosing optimal safety zones

Objective:

- Conduct a pilot study that will assess the methodology and modeling tools for planning a vehicular traffic evacuation preceding and during a event
- This is achieved through a traffic model

Scope: San Francisco County

The urban land is shown as red polygons on a shaded relief background



Methodology: Technical and Policy Components for Evacuation

- Transportation Research Board generalized seven (7) item:
- 1. Hazard Analysis
- 2. Vulnerability Analysis
- 3. Behavioral Analysis
- 4. Transportation Analysis
- 5. Shelter Analysis
- 6. Decision Making
- 7. Development Management (Plan Creation)

Methodology:

- Research Variables:
 - Population Characteristics or Census Data (Independent)
 - Entry and Exit Time Lengths (Dependent)
 - Transportation Infrastructure V/C ratio (Independent)
- Metrics:
 - Critical Density
 - Saturation Density
 - ▶ Time & Distance
 - V/C ratio
- Method of Investigation:
 - Simulation software
- Identify your procedure:
 - Discuss how you intend to analyze your data.
- A methodology flow chart showing the overall design of the research is required.

Evacuation Planning Model



Evacuation Modeling

- Route Congestion Estimation: Ability to measure the rate and capacity of traffic flow through a street network
- Closest Facility Solution: Determining which safety areas are nearest, and a measure of the time it takes for people to travel

Review of Models

Models exist:

- Macro-scale (broad regional)
 - Large scale entire county or large city
 - Movement of vehicles in aggregate group averages
- Meso-scale (confined region)
 - Moderate scale small city
 - Vehicles aggregated representing average flow rates and speeds
- Micro-scale (fine scale)
 - Small network of streets 18-30 nodes
 - ► Fine scale
 - Detailed performance

Meso-Scale Models

- ► Fitting balance
 - Model extent
 - Computational efficiency
 - Accuracy

- SACOG MODEL
 OUBE Voyager
- Network Analyst
- ArcCASPER

Meso Scale - Methodology

| Evacuation Model Overview | | |
|---------------------------|---------------|------------------|
| Evacuation Solution | Traffic Model | Closest Facility |
| CUBE VOYAGER | Х | |
| NETWORK ANALYST | | X |
| ArcCASPER | Х | Х |





ArcCASPER

Data: The Evacuation Network

- Road network data
 - Lane count information
 - Road Capacity
 - Road alignments
 - Road speed limit information
 - ► Turn information
- Evacuation Candidates
 - ▶ SF County Population date (TIGER U.S. Census data)
 - Total population
 - Total house count
 - Total unit count
 - Assume each property owns one vehicle (unless otherwise noted)

Management Plan



Designated Deliverables

Develop Evacuation Plan for San Francisco that will :

- Work under natural and man-made disaster constraints
 - Service a set of orders with a fleet of vehicles
 - Finding Routes to service a set of Paired vehicles
 - Choosing optimal safety zones
- Direct traffic
- Temporary modification of transportation network
- Changing the direction of travel
- Changing the traffic control
- Identifying safe & unsafe areas
- Moving large volumes safely and efficiently

References

- Bolton, P. P. (2007). Managing Pedestrians During Evacuation of Metropolitan Areas. Federal Highway Administration, Department of Transportation. Columbus: FHWA.
- Colombo, F. M. (2009). "On the continum Modeling of Crowds", In Proceedings of Hyp2008. 517-526.
- Colombo, R. (2009). "Existence of nonclassical solutions in a pedestrian flow model", Nonlinear Analysis: Real World Applications. 2716-2728.
- Colombo, R. G. (2010, Oct). Macroscopic Models for Pedestrian Flows. HAL archives-ouvertes , 2.
- Connie, P. (2013). Annual Progress Report for Local Mitigation Plan. Sacramenot, CA, USA: City of Sacramento.
- Emiliano Cristiani, B. P. (2009). Modeling Self-Organization In Pedestrians and Animal Groups form Macroscopic and Microscopic Viewpoints. 1.
- FRUIN, J. J. (n.d.). Designing for Pedestrians. Retrieved 2015, from National Transportation Library : http://ntl.bts.gov/DOCS/11877/Chapter_8.html
- Jon Kerridge, A. A. (2004). Using Low-Cost Infrared Detectors to Monitor Movement of Pedestrians. Transportation Research Record , 1878, 17.
- Norm, S. D. (2004). Methodology to Asses Design Features for Pedestrian and Bicyclist Crossings at Signalized Intersections. Transportation Research Record , 43-50.
- Piccoli, B. T. (2009). Pedestrian Flows in Bounded Domains with obstacles. (85-107), 106.
- Sacramento, C. o. (NA). Flood Map for Hypothetical Levee Break Scenario at CSU Sacramento. Retrieved from http://www.stormready.saccounty.net/Pages/Flood-Depth-and-Evacuation.aspx
- Vamos, I. (2011). Evacuation Planning. Perils for Ped. 114. (J. Z. Wetmore, Interviewer) youtube. Albany.
- Wintana Debessay, N. F. (2014). University of California, Berkeley Emergency Evacuation Plan. University of California, Berkeley. Berkeley: City of Regional Planning 255.

What is Transportation Engineering in the context of emergency planning?

The application of technology and scientific principles to the planning, functional design, operation, and management of facilities for any mode of transportation in the event of a natural or human-made disaster.