Smart Cities:
Better Evacuation

Gerhard-Wilhelm Weber
IAM, Middle East Technical University
Ankara, Turkey

Hediye Tuydes Yaman
Civil Engineering Department
Middle East Technical University
Ankara, Turkey
Civil Protection

- Cooperation
- Prevention, preparedness and response
- Information
- Intervention
- Post-disaster analysis and recovery
Disaster Management

- A Disaster definition:

“situations when the local resources of a community are not enough to overcome the event faced”

(Quarantelli, 1998)

Cooperation
Disasters and Transportation

Transportation systems are crucial for a successful disaster management, but they are vulnerable, too.
Disaster Response and Transportation

- Disaster Types
- Disaster Phases
- Transportation Problems
- Technology
Disaster Types

Most Common Disasters

Natural
- Earthquakes
- Hurricanes
- Floods
- Volcanic eruptions
- Fires
- Tsunamis
- etc.

Non-natural (Man-made)

Intentional
- Terrorist attacks

Accidental
- Meltdowns or malfunctions
  - Nuclear power plant
  - Chemical factories
- Hazardous material spills
  - During transportation
  - On-site accidents
Disaster Types & Transportation Issues

• Warning Time
  Is there any warning time?

• Damage to the Transportation Infrastructure
  Can we forecast the damage pattern in the system?

• Available Traffic Network Capacity
  What is the maximum available capacity w/ contraflow, parking/travel restrictions, etc.

• Forecasted Demand
  How many people to relocate? Where to send them?
  How many evacuation, emergency vehicle trips?

• Level of Preparedness for the Disaster
  Can we prepare in advance?
  – hurricanes, floods vs earthquakes, terrorist attacks

• Emergency Operations
  Precautionary evacuation of medical units?
  Transportation of HAZMAT teams?
  Search and Rescue operations?
Disasters & Transportation Issues

Pre-disaster
- Administrative actions
- Data collection
- Infrastructure assessment
- Disaster scenario analysis
- Emergency actions preparedness
- Mitigation/prevention actions

During-disaster
- Disaster assessment
- Traffic network assessment
- Emergency response
- Evacuation preparation
- Evacuation deployment
- Immediate recovery actions

Post-disaster
- Post-disaster traffic management
- Short-term recovery actions
- Long-term recovery actions

Major transportation problems

Preparation Mitigation Prevention
Disaster Response
Traffic Network Management
Logistics of Disaster Relief Aid
Infrastructure Maintenance & Recovery
Disaster Management & Transportation

Pre-disaster | During-disaster | Post-disaster
---|---|---
Preparation | Disaster Response | Logistics of Disaster Relief Aid
Mitigation | | 
Prevention | | 
Infrastructure Maintenance | Traffic Network Management | Infrastructure Recovery
Disaster Management & Transportation

Disaster Traffic Network Management

Emergency Operations
Evacuation
Immediate recovery operations
Post-disaster Commuter Traffic Management
Disaster Traffic Network Management

Evacuation
• Massive operation
• Before or after disaster

• Determination of
  • “network clearance time”
  • evacuation routes

• If can not clear disaster zone on time,

Contraflow  Zone scheduling
Disaster Traffic Network Management

Contraflow

- A Network Re-design Problem:
  - No capacity increase
  - Better utilization of available capacity
Disaster Traffic Network Management

Zone Scheduling
A Demand Management Problem:

- Tell people where to go
- when to go
- on what route to go
Disaster Traffic Network Management

• Evolving Nature of Conditions
  
  Disaster and its nature
  Collected information
  Human response
  Disaster response
  … changes over time.

  1) Traffic management goals and objectives
  2) Traffic conditions
     change over time

  Real-time Traffic Management
Disaster Traffic Network Management

Real-time Traffic Management

Real-time
  a) Traffic Network Information
  b) Shelter Capacity Information
  c) Hazard Information
  d) Disaster Response Information

Technology

Intelligent Transportation Systems (ITS)
Intelligent Transportation Systems

Vehicle Routing/Tracking
- Car Navigation Systems
- Variable Message Signs
- Emergency Vehicle Tracking

Traffic Counts
- Loop detectors
- Video cameras
- after the disaster ??? – GPS-based

Incident/Congestion Detection
- Loop detectors
- Video cameras
- Closed Circuit TVs
Disaster Traffic Management in the USA

Major Disasters:

• Hurricanes
  Hurricane Evacuation Studies for the coastal states
  -- with contraflow option

• Nuclear Power Plants
  Evacuation Plans

• 9/11
  Developing Evacuation Plans for metropolitan cities

• New Orleans Flood
  Evacuation via car – OK
  But post-disaster management failed

• HAZMAT Spills
  Help center
  – simulations for dispersion of the toxic chemicals
  – workshops for coordination

• San Francisco Earthquakes
  ????
Disaster Traffic Management in the USA

Evacuation Models

• Mostly planning models
  – specific to hurricanes or nuclear power plants
    – static traffic assignment → not realistic delay calculations
    – simple demand mobilization curves

• Models currently in use
  – OREMS (Oak Ridge National Laboratory)
    → macroscopic model
    → contraflow optimization via scenario analysis
  – TrEPs by FEMA
    → real-time traffic management
  – ETIS by PBS&J
    → historical data tabulation
  – I-DYNEV by KLD Associates
    → nuclear power plant evacuations
    → microscopic – small regions
Disaster Traffic Management in the USA

Evacuation Models
• Model under development

  – **VISTA** by Prof. Ziliaskopoulos
    → mesoscopic

  for evacuations
    → system optimal evacuation module
    → optimal contraflow optimization
    → optimal zone scheduling
Disaster Traffic Management in Turkey

Major Disasters:
- Earthquakes
  - Majority of Turkey is at high EQ risk
  - Earthquake Engineering Center at METU

Worst-case: Istanbul Earthquake
- Population ≈ 13 millions
- With the help of JICA (Japan), earthquake damage patterns are developed
  - Major evacuation routes
  - Emergency operations and logistics
  - Search and rescue exercises
  - Crisis Management Center tests
Disaster Traffic Management in Turkey

Major Disasters:

• Floods

-- Uncontrolled settlements in river basins around major cities
-- Trans-border rivers such as Avros/Meric
-- No modeling for transportation issues, yet

→ International cooperation over trans-border waters!
Disaster Traffic Management -- Future

• Developing Evacuation and Emergency Operations Plans
  → Specific for metropolitan cities
  → Specific for disasters

• Real-time Traffic Management
  → Models
  → ITS technologies
  → Crisis Center Support

• Publicizing developed plans and technologies → public support
Thanks you very much!

Questions?

gweber@metu.edu.tr

htuydes@metu.edu.tr