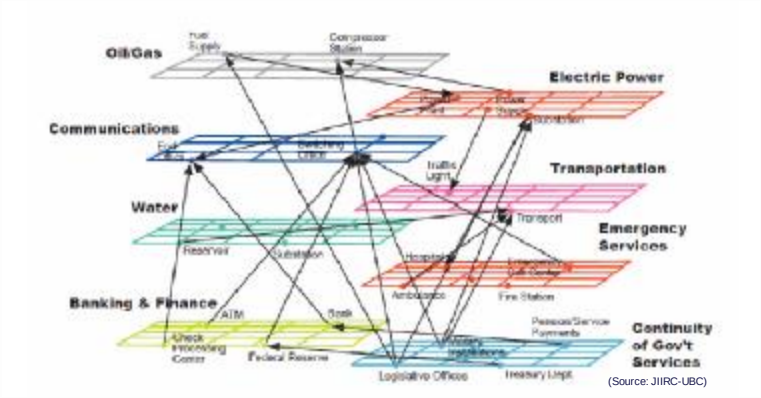
Launching the Lifelines Council's Interdependency Study



Lifelines Council Meeting #6
August 11, 2011

Lifelines Council's Objectives

- Develop and improve collaboration in the City and across the region by regularly convening a group of Executive Officers and Senior-level operational deputies of local and regional lifelines providers
- Understand inter-system dependencies to enhance planning, restoration and reconstruction.
- Share information about recovery plans, projects and priorities.
- Establish coordination processes for lifeline restoration and recovery following a major disaster event.

Interactions among Lifeline Systems in Earthquakes

(Source: Kameda, Nojima, 1992)

	Electric power supply	Gas supply	Water supply	Transportation	Communication
Electric power supply	*	○ Malfunction of plant, gas holders, pressure devices; ○ Malfunction of centralized control system; □ No illumination	○ Malfunction of filtration plants & pumping engines; ○ Malfunction of centralized control system; □ No illumination	○ Traffic signal disorder; ○ Malfunction of electric car & urban railways; ○ Malfunction of centralized control system; □ No illumination	○ Malfunction of tel. offices; ○ Malfunction of centralized control system; ○ No illumination; ○ Malfunction of online service; □ Loss of data
Gas supply	□ Excessive use as alternatives, e.g. Hot supply	*	△ Recovery work complications; △ Scramble for machinery	○ No passing owing to repair work	
Water Supply	○ Lack of coolant for independent power plants; ● Inundation of underground pipes and cables	△ Recovery work complications; △ Scramble for machinery; ○ Lack of coolant; ○ Lack of coolant for independent power plants	*	○ No passing owing to repair work; □ Lack of coolant for independent power plants; ● Flooding	○ Lack of coolant for switchboard; ● Inundation of underground cables; ● No insulation; ○ Lack of coolant for independent power plants
Transportation	△ Battery cars unavailable; △ Delay in recovery work; ○No commuting; ○ No transportation of materials and fuel	△ Delay in recovery work; ○ No commuting; ○ No transportation of materials and fuel	△ Water wagons unavailable; △ Delay in recovery work; ○ No commuting; ○ No transportation of materials and fuel	*	□ Telephone excessive use
Communication	○ Malfunction of centralized control system; △ No communication for recovery work	○ Malfunction of centralized control system; △ No communication for recovery work	○ Malfunction of centralized control system; △ No communication for recovery work	○ No passing owing to repair work; ○ Malfunction of centralized control system; △ No communication for recovery work	*

m Functional disaster propagation due to interdependence
△ Interaction hinders recovery
I Physical disaster propagation
Influences on alternative systems
* Influence on same systems

Interactions among Lifeline Systems in Earthquakes

(Yao et al 2005, based on Kameda, Nojima, 1992; Scawthorn 1993; and others)

- Type A – Functional disaster propagation, due to failure of interdependence among lifelines
  - Example: Malfunction of electric power reduces serviceability of water supply system in the same area
- Type B – Collocation interaction, physical disaster propagation among lifeline systems
  - Example: Bridge collapse also disrupts telecommunication cables fixed on the bridge
  - Example: Water from a broken water pipe degrades the transmission performance of telecommunications fiber-optics in proximity to the water pipe
- Type C – Substitute interaction, influences on alternative systems
  - Example: Gas system failure results in excessive requirements for power systems
- Type D – Restoration interaction, various hindrances in the restoration stage
  - Example: system interference in recovery/reconstruction of buried lifelines (e.g. water-gas, power-water, sewer-water)
- Type E – Cascade interaction, increasing impacts on a lifeline due to initial inadequacies
  - Example: Increasing degradation of water service in a conflagration as structures collapse and break service connections, reducing system pressure and water supply for fire-fighting
- Type F – General interaction, between internal components of a lifeline system
  - Example: Connected electrical substation equipment

Interdependencies - Previously Identified by Lifelines Council members

	Power	Water	Transportation	Telecom	Other
Power		Low	High	High	
Water	High		High	High	Fuel
Transportation	Medium	Low		High	Fuel
Telecom	High	High	High		Fuel Access Security

Proposed Next Steps
(April 11th Lifeline Council Discussion on Interdependency Study)

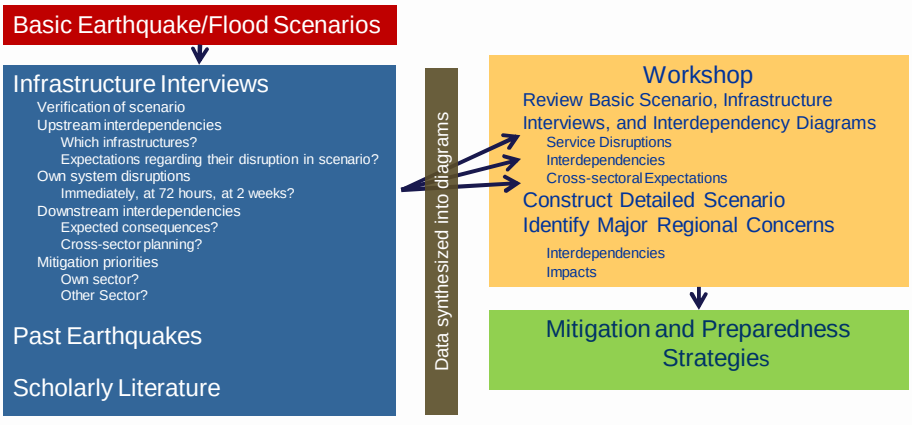
- √ Establishing a small working group of Council members and other partners/advisors to design and advise on the study (met on July 21)
- √ Collect and analyze interdependency modeling studies and develop system performance and upstream and downstream interdependency analytics
- Scenario development, modification, and data packaging
- Operators identify internal working team to participate in the study
- Develop study work program and launch analyses with all operators

Designing Our Study

	Vancouver (McDaniels, Chang)	Shakeout Southern California (Porter)	Proposal for Our Study
Data	Empirical observation, Experts	Empirical observation, Experts	Empirical observation, Experts
Focus	Systems	Systems	Systems
Context	Two events (scenarios)	Single event (scenario)	Scenario(s)
Emphasis	System/Societal impacts	System/Societal impacts	System impacts
Outcome	Scenario ranked strategies	Scenario	Lifeline-specific additions to scenario; Understanding interdependencies
Purpose	Mitigation and preparedness	Lifeline-specific additions to Shakeout scenario	Mitigation and preparedness, response and restoration improvements

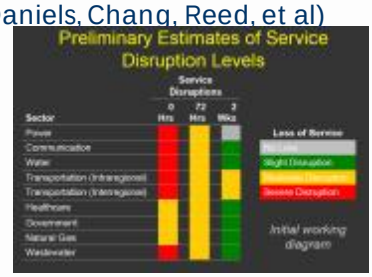
Vancouver Study - Analyzing Infrastructure for Disaster Resilient Communities (AIDRC)

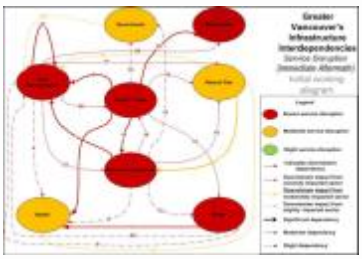
(University of British Columbia – McDaniels, Chang, Reed, et al)



Vancouver Study - Analyzing Infrastructure for Disaster Resilient Communities (AIDRC)

(University of British Columbia – McDaniels, Chang, Reed, et al)





M7.8 Shakeout Scenario – Lifeline Panels

(Porter et al)

Shakeout Earthquake Scenario

Infrastructure Panel(s) by Sector
- Present scenario and lifeline damage inputs
- Summarize findings of priori panels or relevant studies
- Describe system construction
- Describe past seismic performance
- Describe expected performance for scenario
- Complete damage and restoration grid (by county)
- Discuss situational awareness
- Make mitigation recommendations

Data synthesized into scenario

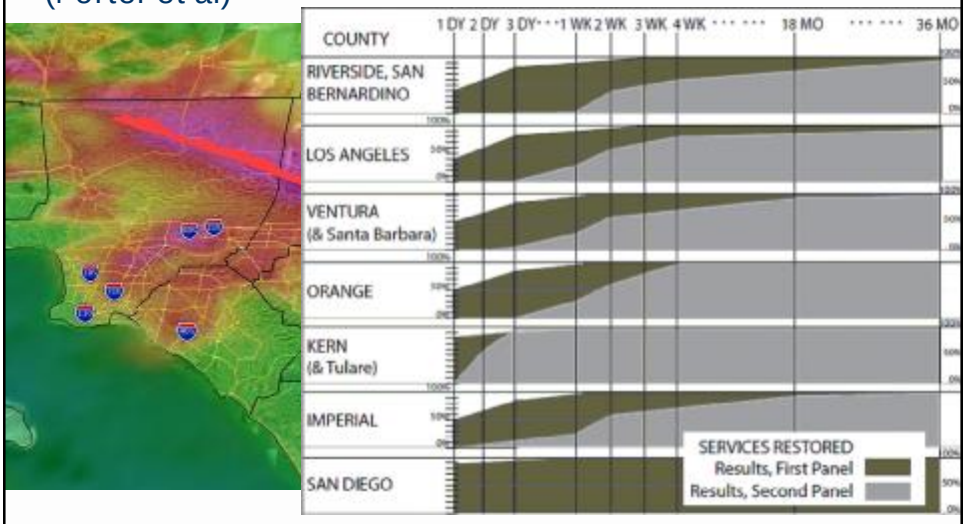
2nd Multi-sector Panel
(Led by Southern California Edison)
Review scenario and infrastructure panel results
Revise damage and restoration grid

Inputs to Economic Analysis for Shakeout Scenario Study

Information for state's Golden Guardian Exercise

Develop Set of Mitigation Recommendations

M7.8 Shakeout Scenario – Lifeline Panels
(Porter et al)



"Strawman" Approach for Our Study

1. Scenario development and verification for the interdependency study
2. Operators answer series of questions about
   - System performance and disruptions (immediately and over time)
   - Upstream infrastructure dependencies (assumptions about disruptions and restorations)
   - Downstream infrastructure dependencies (assumptions about disruptions and restorations)
3. Data synthesis and integrative analysis
4. Potential interviews or group workshop to evaluate responses and prioritize interdependencies
5. Develop action agenda and work program for next phase of analyses and Council work

Key Questions to be Answered in Undertaking Study

- Scenario Selection
  - Size of earthquake
  - Regional vs. city
  - Details on impacts, consequences
- Interdependency Analysis Approach
  - Conduct analysis by sectors, operators, systems and/or assets
  - Questions and Information to be provided (and at what resolution)
- Establishing Goals and Outcomes of the Analysis
  - Help define next phase in the analysis
  - Work program for next year(s)
- Understanding Community Expectations for Lifeline Performance