Towards Disaster-Resilient Cities: Characterizing Vulnerability of Infrastructure Systems

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Overview

1. Introduction
2. Our Approach (hazard scenario and background info, expert interviews, workshop)
3. Data Synthesis: Service Disruption and Interdependencies
4. Workshop
5. Key Findings
6. Results and Conclusions
Introduction

- Goal: To develop an approach for communities to characterize their vulnerability to infrastructure failures in disasters
  - Demonstrated through case study of earthquake planning in Vancouver, B.C., Canada
Specific Approach

- Examine the potential for disruption to infrastructure services caused by vulnerabilities and interdependencies
  - Creation of a regionally specific scenario for a hypothetical hazard
  - Expert interviews
  - Data synthesized into diagrams
  - Diagrams facilitate discussion at workshop
Upstream/Downstream Dependencies

- **Upstream**
  - Electric Power
  - Land Transportation
    - Operate traffic lights, trolleys and SkyTrain
    - Replenish medical supplies and staff

- **Downstream**
  - Health
Infrastructures Interviewed

Utilities
- BC Hydro
- MetroVancouver (water & wastewater)
- Terasen Gas

Transportation
- Ministry of Transport
- Translink
- Airports (YVR and Abbotsford)
- Port of Vancouver

Telecom
- Telus

Health
- Fraser Valley Health Authority
- BC Children's & Women's Hospital

Government
- BC PEP
- Coquitlam (municipality)
- JELC
Interview Content

- Verification of scenario
- Upstream interdependencies
  - Which infrastructures?
  - Expectations regarding their disruption in scenario?
- Own system disruptions
  - Immediately, at 72 hours, at 2 weeks?
- Downstream interdependencies
  - Expected consequences?
  - Cross-sector planning?
- Mitigation priorities
  - Own sector?
  - Other sectors?
Service Disruption Scale

Service Disruption Level

- No Loss
- Slight Disruption
- Moderate Disruption
- Severe Disruption
## Preliminary Estimates of Service Disruption Levels

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<th>Sector</th>
<th>0 Hrs</th>
<th>72 Hrs</th>
<th>2 Wks</th>
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### Loss of Service

- No Loss
- Slight Disruption
- Moderate Disruption
- Severe Disruption
Greater Vancouver’s Infrastructure Interdependencies
Service Disruption (Immediate Aftermath)

Initial working diagram

Legend
- Severe service disruption
- Moderate service disruption
- Slight service disruption
- Indicates downstream dependency
- Downstream impact from severely impacted sector
- Downstream impact from moderately impacted sector
- Downstream impact from slightly impacted sector
- Significant dependency
- Moderate dependency
- Slight dependency
Workshop

• Review of data and key findings
  ▪ Using the scenario and diagrams

• Discussion
  ▪ Allowed participants to consider, revise, and augment the findings

• Workbooks
  ▪ Provided opportunity for diagram revisions
### Revised Estimates of Service Disruption Levels

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Key Findings

• Variation amongst sectors for types of information sources, and for the amount of cross-sectoral discussions
  ▪ 31% drew information from both experience-based sources and regional cross-sectoral discussion

• Service level diagrams were changed, with sectors typically increasing the level of disruption
  ▪ Greater disruption, over longer time period

• Trend towards increase in service over time, with no sectors completely recovered (no service loss) after two weeks

• Interdependency diagrams reveal core/peripheral sector distinction
  ▪ Electric power is most connected, followed by land transportation and telecommunication
  ▪ Water?
Results

• Upstream service loss expected to increase in the days and weeks after disaster
  ▪ Backup resources depleted
• Each sector is highly interconnected with all of the others
  ▪ Directly upstream sectors dependent on other sectors
  ▪ High complexity
• Resolved discrepancies in expectations between sectors
  ▪ E.g., Transportation/Healthcare’s expectation on roads
• Developed or strengthened cross-sectoral contacts
• Increased practitioners’ understanding of infrastructure interdependencies and their potential outcomes in disasters