Have We Mitigated Known Cross-Sector Interdependencies?

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Outline

• About East Bay Municipal Utility District (EBMUD)
• Overview of Cross-sector Interdependencies
• Discussion of Selected Interdependencies
  – Assessment of “Common Knowledge”
  – Survey of Actual Practice
  – Gap Between Knowledge and Practice
• Possible Reasons for Gaps
• Conclusions
About EBMUD

- EBMUD provides water to 1.3M people
- Service area is over 86K hectares (212K ac)
- Significant seismic hazard
- Also exposed to other hazards including:
  - Flood
  - Power outage
  - Acts of malice
  - Pandemic
EBMUD – Background

Gravity vs. Pumped Zones

<table>
<thead>
<tr>
<th></th>
<th>Average. Winter Demand</th>
<th>Number of Services</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gravity</td>
<td>65 MGD</td>
<td>204,000</td>
</tr>
<tr>
<td>Pumped</td>
<td>52 MGD</td>
<td>176,000</td>
</tr>
</tbody>
</table>
Possible Approach to Addressing Cross-sector Interdependencies

1. Gather data & experience
2. Identify limits of models, identify improvements
3. Develop better models
4. Perform modeling
5. Test model based on experience (i.e., a disaster)
6. Adjust model as required
7. Perform needed mitigations for modeled outcomes
A Simpler Approach

Gather data, experience & assumptions
Identify common knowledge and assumptions
Perform needed mitigations to reconcile assumptions
Situation: we want to drive solo across the desert

**Modeling Approach**
- We need data on
  - Anticipated road conditions
  - Fuel station locations
  - Tire performance statistics
  - Desired level of reliability
- Then we build a model
- And hope it’s right

**Common Knowledge Approach**
**Carry a spare tire**
Example “Common Knowledge”

• Every water customer should plan for at least 3 days without water; 7-14 days is more appropriate for some customers.

• Every power customer, including water companies, should plan for power outages of at least 3 days.
Advantages of Using Common Knowledge

• Available right now
• Free
• Reasonable, even if not provably correct
• Robust
  – Insensitive to details of scenario
  – Insensitive to model error
  – Anchored to reality
Common Knowledge Gathered by Examining:

- Regulations
- Codes and standards
- Expert belief
- Stated goals, e.g. “We strive to maintain a 30-day supply of chemicals”
- Actions, e.g. “We always keep at least two days worth of fuel on hand”
Knowledge Assessed for These Dependencies

• Water sector dependency on:
  – Energy (fuel, power)
  – Transportation
  – Telecommunications
  – Food (including drinking water)
  – Chemicals
  – Medical

• Medical sector dependency on:
  – Water
  – Energy
Example Findings: Power Dependency

Regulations, Codes and Standards

Federal requirements not quantitative

AWWA says at least 72 hours

10 States Standards say 8 hours ?!
Example Findings: Power Dependency

**Expert Beliefs and Goals**

- “Backup power for ... 48 hours” per *Security and Emergency Planning by States*
- Some surveyed water utilities have no specific goal
- Of those utilities with a goal, the range is 24-72 hours
Example Findings: Power Dependency

Assumptions Revealed by Actions of dependent parties

• Hospitals in the US must plan for 96 hours without power; the plan can include evacuation or diversion

• In California, hospitals required to be operable for 72 hours without power or water (by the year 2030)
Summary of “Common Knowledge” Findings for Power

“Common knowledge” is that one should plan for:

• 3-day outage of regional line power; longer outages in smaller areas

• 3-day interruption in fuel availability, longer periods of limited supply
## Summary of Common Knowledge, Various Sectors

<table>
<thead>
<tr>
<th>Dependency</th>
<th>Common Knowledge says plan for:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Electrical power</td>
<td>3-day outage</td>
</tr>
<tr>
<td>Fuel</td>
<td>3-day outage</td>
</tr>
<tr>
<td>Telecommunications</td>
<td>3-day disruption</td>
</tr>
<tr>
<td>Chemicals</td>
<td>30-day disruption</td>
</tr>
<tr>
<td>Food supply</td>
<td>3-14 day interruption</td>
</tr>
<tr>
<td>Transportation</td>
<td>Potentially major disruption lasting for months, highly variable in space and time</td>
</tr>
<tr>
<td>Drinking water</td>
<td>3-14 day system-wide outage, months of impacted service</td>
</tr>
</tbody>
</table>
Are Infrastructure Providers Mitigating Those Known Dependencies?

Utilities and hospitals were asked about desired and actual readiness to operate without power, drinking water, food, etc.

• Often wanted to answer different questions than asked, e.g., the percent full a tank is kept, or number of gallons kept rather than number of days

• Utilities often had no specific readiness goals in various areas

• Utilities often indicated that goals and practices are fractured within a single utility

• Hospitals often did not know their baseline water usage
Utility/Hospital Survey

**Power and Fuel Readiness**

- Typical goals for fuel are between 24-72 hours for utilities; 96 hours for hospitals
- Hospitals generally feel confident they can meet goals
- Readiness among utilities is typically less
  - Standby generators for a only a fraction of facilities
  - “Oversized” treated-water storage a source of resilience but will tend to shrink over time based on water quality goals
  - Fuel stockpiles based on normal levels of usage; post-disaster use could be higher
  - No fuel stockpiled for employees, or other viable plan for them to get to/from work
Utility/Hospital Survey

Food and Water Readiness

• Less formal goals than for fuel, often *ad hoc* and inconsistent within an agency

• 3-day is most commonly cited goal level, on the extreme low end of “common knowledge” of 3-14 days

• Some utilities stockpile food for only a small fraction of total employees, contrary to industry finding that 41% of workforce is critical
Utility/Hospital Survey

Communications Readiness

• Utilities typically have multiple communication methods, e.g. internet, phone, radio, satellite phone
• Typically reliant on commercial or regional providers for some or all communications
• Often, a utility’s many redundant communication systems are vulnerable to common-cause failure due to power outage or act of malice
Findings: Lack of Internal Coherence

Many responses reveal no coherent “Concept of Operations”

For example:

– If employees are to commute, fuel would need to be stockpiled for that purpose – but it’s not

– If employees are instead to “camp out” at work, one would need food for more people, on a 24-hour basis, with rudimentary lodging provisions – but no utility reported lodging provisions for large #'s of employees
Findings:

**Lack of Cross-Sector Alignment**

Example:
- Hospital plans for 96-hour water outage often involve patient diversion
- But society will expect hospitals to be open after a major disaster

Another example:
- Common knowledge that transportation may be heavily impacted for many days
- But utilities’ fuel inventories are often based on business-as-usual fuel deliveries, e.g., daily

Still another example:
- Common knowledge that we’re vulnerable to a regional power outage
- But many utilities rely on primary and backup commercial communication systems that are vulnerable to loss of power
Possible Reasons for the Gaps

• Information not 100% consistent
• Information too compartmentalized
• Information not universally believed (the unfamiliar seems unlikely)
• Lack of incentive or wrong incentive
• Cognitive bias
• Inability to perceive slow increases in one’s own vulnerability
Example of Wrong Incentives

Federal government shows increasing tendency to pay for rebuilding *after* a disaster

At that same time, government subsidizes building in floodplains
Cognitive Bias Hinders Awareness of Risk

Most data could fit Gaussian or Weibull curve. That would mean risk of big problems is low. But complex systems tightly connected systems can have power-law distributions; risk of big problems is not so low.
Slow Change in Risk Difficult to Perceive
Summary

• Cascading failures of infrastructure are very difficult to model or predict

• However there exists generally agreed upon “common knowledge” about prudent planning assumptions

• This common knowledge is not consistently and uniformly accounted for in response planning or in actual practice

• Enhancing consistent application of “common knowledge” would likely enhance post-disaster infrastructure performance
Thank You

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Teddy the Yorkshire terrier applies common knowledge to his stockpile of water