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Scientific Letter

National Critical Infrastructure Interdependency Model

Stakeholders' Workshop 26 October 2016

Background

In 2009 the Federal Government, the Provinces and Territories agreed on a National Strategy and Action Plan for Critical Infrastructure (CI) [1, 2]. The objective was to promote adoption of an all hazards risk management approach, strengthen partnerships and promote information sharing. The Strategy noted risks—whether from natural, accidental or intentional causes—could be exacerbated by the complex system of interdependencies and lead to cascading effects. The Action Plan outlined a number of initiatives intended to support implementation of the Strategy; one of which, sponsored by the National Cross Sector Forum (NCSF), was the development of a National CI Interdependency (NCI) model.

In partnership with Public Safety (PS), DRDC’s Centre for Security Science (CSS) established a project to develop a NCI model in 2013\(^1\). A literature review was conducted to identify approaches, trends and best practices [3]. A functionally focused approach was adopted and the North American Industry Classification System (NAICS) [4] used to provide an integrating framework and define functions. Concepts of Operations (CONOPs) were generated describing Sector models and relationships, and a Microsoft ACCESS database was created. Lead Departments, Subject Matter Experts (SMEs) and focus groups assisted in refining and validating the model. A case study based on a flood scenario in an Ontario county was used to “field test” the model.

Initial efforts focused on model development and proof of concept. An 18 month follow-on project was initiated in September 2016 to consider transfer of ownership from CSS and investigate institutionalization options. As a first step, a one day workshop was held to consult stakeholders and solicit feedback not least to affirm the requirement for the model, discuss how it might be used and could be improved, identify institutionalization options and to provide the genesis for generating an agreed action plan for moving forward.

Purpose of the Document

This document describes the conduct of the workshop, summarizes the advice provided and outlines thoughts on the Way Ahead.

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\(^1\) DRDC CSS Project: CSSP-2012-TI-1142 Development of a National Critical Infrastructure Interdependency Model.
The Workshop

The workshop was held 26 October at 111 Sussex Drive in Ottawa and attended by sector representatives from both government and industry. Opening presentations introduced the model and described its application in two case studies. The model consists of characterization / Concepts of Operations (CONOPS) of the 10 CI sectors, and Microsoft ACCESS database and application using a software application (RiskOutlook™)² developed for Y2K and previously used in Ontario and New Brunswick. In addition to the afore-mentioned flood case study, the results of an illustrative case study based on an earthquake in B.C.’s Lower Mainland and used to assist in characterizing the Safety Sector was presented. Vulnerability identification, risk assessment, business continuity planning, options analysis, portfolio management and exercise design were identified as potential opportunities for exploiting the model. For example, impact analyses can be used to inform contingency and investment plans (e.g., the effect of the closure of Port of Vancouver on the Automotive Manufacturing sector). The supporting software application, RiskOutlook™, has been used to track dependencies between projects. Conceptually the NCI model could be used to assist portfolio managers in recognizing links between initiatives and proposed capability enhancements.

Participants were divided into three groups and, following the formal presentation, two separate, facilitated breakout sessions were held, during which the participants were asked a series of questions followed by a discussion. The first session focused on the model and the second on the Way Ahead.

The Model

Participants were asked “What did you like about the model?” The comprehensive and consistent treatment of sectors was singled out as a strength as was SME review of the sector CONOPs and the model’s flexibility (e.g., the ease with which additional functions and/or relationships could be added). It was felt that the NCI model would be useful in raising awareness levels, highlighting dependency chains (providing both upstream and downstream perspectives) and facilitating discussion. It was noted that the use of the NAICS and creation of a relational database would enable impact assessments to be based on economic data and support export to and exploitation by other software applications. It was concluded that the NCI model addressed a gap and, potentially, the NCI model could be used to provide evidence based advice and used to inform investment decision and contingency plans.

Next participants were asked “What didn’t you like about the model?” It was observed the model reflects the scale and complexity of the environment. Some participants were intimidated by the scope and were uncertain how it could be used / were unconvinced of its relevance to their sector. Concerns were raised with respect to data collection, validation and maintenance requirements and reliance on subjective expert judgement. Attention was also drawn to some of the weaknesses identified in the introductory presentation. For example, the challenges involved in defining minimal acceptable service levels and treating “failure” as a binary function and the need to develop a series of models to appreciate how vulnerability and risk changes over time. (RiskOutlook™ provides a static snapshot, scores must be reassessed and these data sets used to generate a series of snapshots in order to study risk dynamics.)

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Next participants were asked “What would you like to see changed?” A requirement for continued/further validation was noted and it was suggested that linkage to impact indicators (e.g., lives lost / injuries and costs) should be strengthened. All three groups stressed the requirement for a champion and “marketing” i.e., endorsement and situating the NCI model—clarifying and accentuating its “value proposition” and positioning the NCI model as one of an integrated set of emergency management risk assessment, decision support tools. One group raised concerns over access and RiskOutlook™ licensing and support costs and indicated that they would like to see a geospatial dimension added to facilitate cataloguing assets and visualizing results.

The fourth and final question posed to the groups was “How—if at all—do you feel your sector could make use of the model?” For the most part the responses reflected usage suggested in the presentations describing the model (e.g., event planning). The list of dependent relationships can serve as a checklist to ensure all factors are considered: risk assessment, options analysis and investment planning and exercise design. Education and awareness were singled out by one group. There was a significant divergence of opinions of potential take up by sectors. Stakeholders observed that some sectors have mature risk management processes and tools (e.g., the Finance/Banking Sector) and felt the NCI model had little to offer as a complement to existing intrasectoral models although it was acknowledged that it might prove more useful in drawing attention to intersectoral dependencies.

The focus of much of the ensuing discussion was on the RiskOutlook™ output. Note was taken of the complexity of the environment and affirmation of the need to use scenario to provide context for analysis and facilitate the capture of assumptions. There was little, if any, discussion on the merits of a functional approach per se—suggesting this is noncontentious—and/or discussion on sector characterization. Time may have been a factor. It could also reflect the fact that the draft CONOPs have not been widely distributed. It does suggest that there is no immediate disagreement with the sector/subsector breakdown and functional decomposition.

The facilitators presented their group’s advice in plenary; then, the break out groups reconvened to discuss the Way Ahead.

**The Way Ahead**

The first question posed to the group was whether model refinement and validation should continue and, if so, what should be the priorities. Although the general feeling among all three groups was that model refinement and validation should continue, stakeholders wanted more information and recommended additional case studies be carried out. Specific concerns related to socialization—better understanding underlying assumptions and scoring and further review by sector SMEs to establish model credibility. One group suggested developing a case study based on a past or regularly occurring event, another suggested that a Table Top Exercise(s), to assist in validating and legitimizing the model. The need for continued and directed communications was emphasized. This should include descriptions of inputs and outputs.

Next the Working Groups were asked whether additional case studies and/or an options analysis and development of a concept of use were warranted. The consensus was that additional case studies—tailored to specific national, regional or sector concerns—were needed to market and validate the model. It was observed that additional case studies would assist in refining the data collection methodology and in determining the level of effort expected from stakeholders. A cyber related case study was proposed by some stakeholders.
The third question focused on institutionalization options. All three Working Groups agreed that there was a requirement for cross-sector engagement and it was suggested that Public Safety was best positioned to provide the necessary leadership. It was noted that analytical capability could be leveraged and capacity augmented through expanding partnerships within government and with academia and industry. It was felt that the NCI model might serve to as a supplement to current Public Safety initiatives i.e. the Regional Resiliency Assessment Program (RRAP) and Virtual Risk Analysis Cell (VRAC). Governance options were discussed; in particular, potential means to support the broader emergency management community. A process of soliciting and selecting case studies and/or developing a “reach back” capability was proposed. There was some divergence of opinion on whether commitment by all sectors—which may be difficult to realize given that value propositions, priorities, available resources and maturity of networks/associations differ across sectors—was a prerequisite or whether sufficient information could be garnered through open source research and SMEs to populate the model and validate the results.

Finally the Working Groups were asked “What thoughts/observations they would like relayed to the NCSF?” The Working Groups noted that modelling interdependencies was a priority several years ago when the project was conceived and suggested the NCSF affirm that it remains a priority. Secondly, the Working Groups wished to report that the NCI Model has potential value—not least to collate information and promote dialogue—but that continued development was required to demonstrate “concrete” benefits and mature the model. Lastly, it was noted that thought needed to go into presenting and documenting the model to ensure acceptance and appropriate use.

**Exit Surveys**

Workshop participants were asked to fill out an exit survey. This provided an opportunity to capture individual’s feedback on the NCI Model and the workshop itself. Thirty four stakeholders participated in the workshop in addition to the workshop organizers. Unfortunately some stakeholders had to leave before the workshop was concluded and exit surveys were distributed. Nineteen surveys were completed; this reflects a return rate of 56%. Nonetheless, as shown (Figure 1), most sectors were represented. A representative from the Water Sector phoned in and participated in portions of the workshop but did not complete a survey. Government representations from New Brunswick and Manitoba (emergency management offices) participated. Energy and Manufacturing sectors were not represented at the workshop.

Familiarity with interdependency modelling, and the NCI model, varied as shown (Figure 2). Most participants were somewhat or very familiar with interdependency modelling. Several had contributed to sector characterization or attended previous presentations describing the NCI model.

Participants were asked to assess (using a 5 point scale) how successful the presentations and breakout sessions were in presenting the NCI model. It was thought that the feedback may prove useful in subsequent presentations and demonstrations of the NCI model to sector associations. A majority indicated that the introductory presentation provide a clear explanation of the model. A number of participants indicated that they wished for a more detailed review of the illustrative scenario and case study and “live” demonstration of the model. This reflected a conscious decision by the workshop organizers to ensure adequate time was provided for discussion in work groups and to mitigate risk by reducing reliance on IT connectivity and the application. The licensed laptop was set up and participants invited to visit and view the software in operation. Presenters also participated in breakout sessions and were available to
answer questions and discuss the model during breaks. The results to the final question posed indicated that the workshop provided a (better than) adequate introduction to the model. One participant scored both presentations and the workshop as a 1 and indicated he/she could see no value and no utility for the model. This suggests a predisposition and may bias the survey results; nonetheless, the scores have been included (Figure 3).

**Figure 1: Survey Participation by Sector.**

**Figure 2: Participants Familiarity with Interdependency Modelling.**
As shown below (Figure 4), twelve of the 19 survey participants indicated that they saw benefits in adapting and applying the NCI model to a case study relating to their sector. Three indicated that they saw no (or little) value in adapting and applying the NCI model to a case study relating to their sector. (They may have established risk assessment processes and tools in place.) Three of the 4 “No Opinions” indicated that they needed more information first before offering an opinion and/or saw potential once the model was more mature.

Next the workshop participants were asked to identify impediments to model exploitation/institutionalization. The results are depicted below (Figure 5). The dominant concern relates to competing priorities—presumably contention for time and/or resources. Concerns relating to model complexity and to data protection are also notable albeit two respondents observed that “complexity can be managed under the right conditions” and complexity would not be a concern “if outcomes are clear [and] based on realistic scenarios”. Although not fully
explored, informal discussion suggested that some representatives found the number of functions and relationships and the underlying concepts (e.g., probability and directed graph theory) daunting. Three respondents indicated that relevance was an issue i.e. sectoral interdependencies were well understood. Another took an opposite stance and indicated that the model was “very much needed”. “Other” concerns raised related to governance, sector engagement and model maturity.

![Figure 5: Concerns Inhibiting Exploitation/Institutionalization of the NCI Model.](image)

Lastly workshop participants were asked directly if they thought their sector would be interested in a demonstration of the model and/or reviewing the CONOPS/characterization of their sector. “Votes” were split evenly between those who thought their sector would be interested in a demonstration and/or willing to review the CONOPS and those who were unwilling to accept fully or kill the model—that felt more time was needed to “grow” and the model or were reluctant to speak for / commit on behalf of their sector. The (anonymous) nay sayer mentioned earlier felt that the model was overly subjective and of limited value in coordinating incident response (Figure 6).
A number of stakeholders took advantage of the invitation to include comments. Illustrative extracts include (with authors’ comments in italics):

- This is interesting and overwhelming at the same time.
- For me this is a tool that can help create understanding of the interdependencies and build awareness of what sectors can do to improve things they can control and to work with others on things they can’t control.
- This model has value from our aspect as a Paramedic Service… the ability to assess risk and plan accordingly is important.
- I rather doubt that it will be a standalone tool but more likely one of the tools or part of an integrated system that brings tools together. *(Comment – agree.)*
- [The work] will now need to be massaged so that it becomes more than an “academic looking” approach… it needs to be packaged—a lot of detail removed for the user.
- Needs to be packaged correctly/appropriately.
- DRDC needs to approach the communications regarding the model from the perspective of demonstrating concrete impact. *(Comment – this is likely as much if not more a PS remit.)*
- More case studies are needed. Keep Going! It will be important to keep this very important work going in order to realize this initial investment.
- Champions—both sectors and individuals in sectors—will need to be identified.
- I would [think my sector would be interested in a demonstration and/or reviewing the applicable CONOPS] but not sure about my government department.
- Hard to tell if further investment should be considered until it can be determined if all sectors are on board. *(Comment – a potential show stopper proposing alignment to the “slowest” and giving all sectors a veto. Plus it assumes that entries from non-participating sectors/subsectors cannot be estimated with a reasonable degree of accuracy based on research and insights from SME partners from other sectors.)*
- Not relevant to assessments that occur during events. Should not be used for assessments because it is too subjective and time consuming. *(Comment – it was never intended to*
Summary of Responses to Key Questions

1. Should refinement and validation of the model continue?
   - There was general agreement that refinement and validation of the model should continue, but stakeholders wanted more information on assumptions.

2. Are further case studies warranted?
   - There was a consensus that more case studies were needed.

3. What are the options for institutionalization?
   - There was agreement that there was a requirement for cross-sector engagement and that Public Safety was best positioned to provide the necessary leadership.
   - It was noted that analytical capability could be leveraged and capacity augmented through expanding partnerships within government and with academia and industry.

4. Are there observations to pass to the NCSF?
   - Modelling interdependencies was a priority several years ago when the project was conceived and suggested the NCSF affirm that it remains a priority.
   - The NCI Model has potential value—not least to collate information and promote dialogue—but that continued development was required to demonstrate "concrete" benefits and mature the model.
   - Thought needed to go into presenting and documenting the model to ensure acceptance and appropriate use.

Conclusion

The aim of the stakeholders’ workshop was to increase exposure to the NCI model and to solicit feedback on the methodology, determine if continued development was warranted and, if so, inform what the priorities should be and how the model might be used. The workshop achieved these objectives. The exit surveys indicate that most stakeholders felt that the workshop provided an adequate introduction and exposure to the NCI model. The input provided was appreciated and timely. Constructive criticism was offered suggesting how the model could be improved and employed, and practical advice received on presentational prerequisites and governance preferences. Stakeholder comments underscored the requirement for an ability to adapt modelling and relate analysis to the need of the audience. The need for a risk assessment tool which could be used to support disaster resiliency planning—one capable of identifying vulnerabilities, considering risk tolerance thresholds and investigating trade-offs, protective and preparatory actions which can be taken in advance to mitigate societal and property losses—was recognized. Notably, participating stakeholders affirmed that the NCI model had potential and further case studies should be conducted.
References:


Prepared by: Paul Chouinard, Mark Espenant, Anthony Masys and Greg Walker (DRDC – Centre for Security Science) and Doug Hales (D. Hales Consulting Inc.).

Attachment
Annex A: National CI Interdependency Model—Workshop Presentations Slide Decks
Why we are here

- To review the interdependency model
- Provide an overview of two case studies
- Solicit your feedback regarding the model
  - Applicability
  - Concepts of use
    - For what purpose
    - By whom
  - Improvements to the model
  - Next steps

The National Critical Infrastructure Interdependency Model - Introduction
Presentation Overview

- Background
- Modelling Approach
- Model Components
- Characterizing Sectors
- Application
- Observations

Project Background

- Scope:
  - Develop an integrated national critical infrastructure (NCI) interdependency model to inform decision-making and increase critical infrastructure resiliency.
  - Focus on prevention and preparedness with respect to incidents of national interest typically spanning post immediate (72 hours) to normalization (3 months).
  - Stakeholder engagement (to validate the model and establish credibility and acceptance): sessions with OGDs, review by SMEs, workshops, network association meetings.
Approach – Model Development

Appreciation Analysis Assessment Action

Orientation → Open Source Research/Literature Review

Lead Dep’t/SME Review & Input

Logic Models CONOPS Development Scenarios

ACCESS Database Risk/Outlook Model

Focus Group(s)

Model Verification & Validation

NCSF Public Safety

Documentation

Approach – The Challenge

- **Constraint:**
  - Interdependency is a *mess (wicked problem)* not a *puzzle*
  - Introduces *reliance on judgment*
  - CI owners concerned about proprietary asset data

- **Approach:**
  - Structuring the problem is important
  - Keep the model relatively small by structuring **top-down versus bottom-up**
  - Distinguish the direction if not the address
    - Intent to identify more tangible problems for follow-on analysis
Approach - Stakeholder Engagement

Ten sectors established by the National CI Strategy (with lead departments)

- Energy (Natural Resources Canada)
- Finance (Finance Canada)
- Food (Agriculture & Agri-Foods Canada)
- Government (Public Safety Canada)
- Health (Health Canada & Public Health Agency of Canada)
- Information & Communications Technology (Industry Canada)
- Manufacturing (Industry Canada)
- Safety (Public Safety Canada)
- Transport (Transport Canada)
- Water (Public Safety Canada)

Approach - Current Practice

Intent is to decompose, quantify and order dependencies

Reference: Chemical Sector-Specific Plan 2016, page 3
Critical Infrastructure

Critical infrastructure refers to processes, systems, facilities, technologies, networks, assets and services essential to the health, safety, security or economic well-being of Canadians and the effective functioning of government. Critical infrastructure can be stand-alone or interconnected and interdependent within and across provinces, territories and national borders. Disruptions of critical infrastructure could result in catastrophic loss of life, adverse economic effects and significant harm to public confidence.
Components – Defining Functions

- Leverage (and extend) the North American Industry Classification System

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Common, established taxonomy
Helps to ensure a consistent level of resolution for entities
Links model entities to a reliable data source – Statistics Canada

Characterizing Sectors – Sub Models

- Ambulatory Health Care
- Hospital (Secondary/Tertiary) Services
- Nursing & Residential Care
- Medical Support Services
Characterizing Sectors - Core Facilities

- Energy
  - Petroleum/RPP Terminals
  - Natural Gas/LPG Terminals/Oilers
  - Electric Power Distribution

- Electrical Supply

- ICT
  - Wired Telecommunications

- Safety
  - Protective Services
  - Waste Management & Remediation

- Transportation
  - Highways, Bridges & Bridges

- Water
  - Water Distribution
  - Waste Water Collection

- Management
- Operations
- Maintenance & Repair

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Characterizing Sectors - Documentation

- Introduction
- Sub Sectors
- Issues & Trends
- Logic Models
  - Relationships
- Stakeholders
- Description of Functions
Characterizing Sectors – Summary

**What sub-models are included**

- Energy – Electricity, Petroleum, Natural Gas
- Finance – Banking/Credit Intermediation, Securities & Commodity Exchanges
- Food – Agri-Suppliers, Crop Production, Animal Production, Processing & Distribution
- Government – Federal, Aboriginal, Provincial, Municipal/Regional
- Health – Primary/Ambulatory Care, Secondary (Hospitals, Nursing & Residential Care), Medical Support Services
- Information & Communications Technologies – Telecommunications, Information Services
- Manufacturing – Basic Materials, Chemicals, Machinery, Technology, Transportation, Health
- Safety – Environmental Protection, Preparedness, Incident Response, Protective Services, Professional Services
- Transport – Air, Marine, Rail, Roads, Trucking, Urban Transit
- Water – Watershed Management, Water Distribution, Wastewater & Storm water
- **Plus Other** – Population, General Economy

**Result:** 800 Functions & 5000 Relationships

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The National CI Model - Database

![Diagram of the National CI Model Database]

- Sectors & Sub-Sectors
- NCIM Functions
- NAICS

**Analysis - ACCESS Database**
Application - RiskOutLook

RiskOutLook models dependency relationships between entities and calculates cumulative risk (impact and likelihood).

An entity is an independent object with attributes and is represented by nodes in a network model of risk. Each has a
  - Name
  - Degree of impact (of nodal “failure event”)
  - Likelihood (of nodal “failure event”)

A relationship is a dependency between entities i.e. the output from a reference/ upstream entity is taken directly as input by a dependent/ downstream entity. Relationships are represented by links
  - Directed from the reference entity to the dependent entity
  - Defined by the strength of the relationship/ degree of dependence

One of the inherent challenges lies in establishing what constitutes failure. RiskOutLook treats failure as a binomial.

Application – Quantification

- Leveraging Previous Work:
  - All hazards Risk Assessment Tool (jointly developed by PS Canada and DRDC CSS)

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DALY = Disability-Adjusted Life Years

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Adjustment for Regional Data

- Adjusted Population (A): Description
- Natural disaster (e.g., volcanic eruption)
- Regional, e.g., city (e.g., major cities or cities)
- Local, e.g., smaller communities
(Project Team) Observations

- A functional approach has credibility with CI stakeholders
- The NAICS provides a sound departure point as an integrative framework
- PowerPoint Logic Models resonate with stakeholders
- The NCI Model and CONOPs will require periodic review and refreshment
- Scenarios are needed to provide context
- Automation and optimization within sectors and industries has increased dependence on ICT, Mutual Aid, and Coordination
- Shared accountability and disparate incentive structures create governance challenges

Summary - The National CI Model

Appreciation - CONOPs Sector Characterizations

Analysis
ACCESS Database

Assessment

NCSF - Action
Questions & Discussion

The National Critical Infrastructure Interdependency Model – Using the Model (Case Studies)
Case Study 1 – Sector Validation

- Safety Sector development - responder subject matter experts
- Validation of Incident Response
  - Project plan = validation through sector focus groups
- Safety Sector Incident Response
  - Local focus since response starts locally
- Local County volunteered
  - Project benefit = validation
  - County benefit = identified areas for risk reduction

Case Study 1 – Level of Effort

- Process:
  - Orientation: Presentation of CI model to Emergency Management staff
  - Scenario Selection & Refinement of the CI Model
  - Key stakeholder workshop – focus on critical safety sector functions / key issues
  - Open source data collection & quantification
- Analysis:
  - Overall risk assessment – heat map / priorities
  - Investigation of sources of risk – tracing / opportunities for risk reduction
  - Options analysis – cost-effectiveness / return on investment
- Total effort (based on one actual case):
  - 1 person-month for regional staff including workshop
  - 2 person-months for analysts including documentation
Case Study 1 - Setting

Scenario Selection – Flooding in an Ontario County

Scenario chosen by localEM staff based on prior risk assessments
- Potential flooding in four different watersheds
- Secondary hazard of source water contamination

Model Refinement
- Only 40% of functions needed
- Only 35% of relationships

Wastewater
**Workshop - Discussion Template**

- **Function upon which the function of interest depends**
- **Dependency**
- **Function of Interest**
- **Subject entity**

**Upstream entity**

Used to capture information and subjective assessments by workshop participants.

Questions for each slide - for the Green (upstream) functions:
- Categorize the functions in terms of the impact on the blue function (5-point scale):
  - Significantly Higher
  - Higher
  - Average
  - Lower
  - Significantly Lower

**Questions for each slide - for the Blue function:**
- What does failure mean?
- What is the reasonable worst case consequence of that failure (i.e., consequence associated with the highest risk where risk = likelihood x consequence)?
- What is the likelihood (frequency of occurrence) associated with the reasonable worst case?
- How well can the blue function perform if a high dependency, upstream function fails?

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**Workshop - Data Capture**

- **Flood risk assessment by watershed management, contamination assessed by health laboratories**
- **Medium**

**Incident Hazard Risk Assessment**

- High
- Significant High

- Incident Operations
- Public Protection (Hazards)
- Evacuation Operations
- Search & Rescue

- Logistical Operations

**Information Services**

- Surveying & Mapping
- GPS
- Weather
- All Other Services

- Medium

**Information Source**

- Medium
- Internet Publishing & Broadcasting
- Radio Wave Broadcasting

- Low

**Incident Situation Awareness**

- Failure = Inappropriate / unauthorized information source, inaccurate information, unverified information, lack of timeliness

**Likelihood = Medium**

**Direct (intrinsic) Impact = Low**

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*Canadian Safety and Security Program*
Open Source Data Collection & Assessment

1) Open Source Data Collection
   • Identify relevant assets
     • Asset inventory for each sub-model

2) Assessment
   • Assess vulnerability of assets to hazards
     • Assess potential effect on functions
     • Identify potentially affected ‘service areas’ (i.e., geographic dependencies)
     • Quantify assessments according to scales tailored for the County
       • Input assessments into analytical tool

Inventoried Assets

Cell tower mapping - available open source, on-line

- Wireless Access is vulnerable to disruption in areas where coverage is sparse
  - Damage by hazards
  - Inaccessible to maintenance
  - Energy supply disrupted
Statistical Data Collection  
(Population & Local Economy)

<table>
<thead>
<tr>
<th>Town</th>
<th>Population</th>
<th>Jobs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Town 1</td>
<td>5,000</td>
<td>5,000</td>
</tr>
<tr>
<td>Town 2</td>
<td>1,000</td>
<td>100</td>
</tr>
<tr>
<td>Town 3</td>
<td>5,000</td>
<td>1,000</td>
</tr>
<tr>
<td>Town 4</td>
<td>1,000</td>
<td>100</td>
</tr>
<tr>
<td>Town 5</td>
<td>1,000</td>
<td>100</td>
</tr>
<tr>
<td>Town 6</td>
<td>6,000</td>
<td>1,000</td>
</tr>
<tr>
<td>Town 7</td>
<td>500</td>
<td>100</td>
</tr>
<tr>
<td>Town 8</td>
<td>2,000</td>
<td>100</td>
</tr>
<tr>
<td>Town 9</td>
<td>4,000</td>
<td>200</td>
</tr>
<tr>
<td>Town 10</td>
<td>6,000</td>
<td>1,000</td>
</tr>
<tr>
<td>Town 11</td>
<td>500</td>
<td>100</td>
</tr>
<tr>
<td>Town 12</td>
<td>5,000</td>
<td>1,000</td>
</tr>
</tbody>
</table>

Total: 6,000 | 200 | $8,000,000 |

Allows assessment of impact of flood on the population and the economy, but geography also allows assessment of CI disruption through mapping of CI service delivery areas.

The concept is applicable to virtual services such as service delivered by ICT.

Assessment - Quantification

<table>
<thead>
<tr>
<th>Watershed</th>
<th>Town</th>
<th>Vulnerable Population</th>
<th>Houses</th>
<th>Damage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Watershed 1</td>
<td>Town 1</td>
<td>5,000</td>
<td>175</td>
<td>$2,000,000</td>
</tr>
<tr>
<td>Watershed 2</td>
<td>Town 5</td>
<td>5,000</td>
<td>273</td>
<td>$2,000,000</td>
</tr>
<tr>
<td>Watershed 3</td>
<td>Town 7</td>
<td>500</td>
<td>10</td>
<td>$200,000</td>
</tr>
<tr>
<td>Watershed Total</td>
<td></td>
<td>6,000</td>
<td>300</td>
<td>$8,000,000</td>
</tr>
</tbody>
</table>

Damage estimates based on insurance industry estimates of typical flood damage per residence between $20,000 and $60,000. Estimate in the table uses $30,000 per residence.

Potential economic losses easily translated into “scores” for the analytical tool.

Statistical data informs and bounds scores.
Results – Risk Heat Map

Users can estimate the total loss in the scenario.

Results - Ranked Risk Issues

High Risk Entities
(Illustrative Data)
Tracing Risk – What to do about high risk

Sources of vulnerability for 'Public Protection (Hazards) [Ranked]

- Incident Logistics
- Unified Command
- Road Network
- Responder Services
- Preparedness
- Intrinsic (execution)
- Health Sector
- Waste Remediation

Logistics is the highest source of risk for public protection (versus floods, contaminated water) operations

Sources of Vulnerability for Logistics

- Unified Command
- Incident Communications
- Municipal Public Administration
- Intrinsic (Execution)
- Preparedness
- Road Network
- Provincial Public Administration
- Volunteers
- Incident Mutual Aid
- CEMC
- Incident Finance
- Supplies & Donations
- Emergency Transportation
- Site Security

Identifying Opportunities for Improvement

Collective Decision Making & Coordination

Potential Improvement (Risk Reduction)

- Improvement (Risk Reduction)

Legend
- Intrinsic Risk
- Important Risk

Upstream Functions (Sources of Vulnerability)

Investment options can be explored - example UAV contributions

Components of risk for Collective Decision Making & Coordination
Final Recommendations for the County

Opportunities for Improvement:
1. Provision of timely, accurate & credible public information
   - Both commercial sector & private citizens
   - Major consequences associated with recovery if communities are evacuated
2. Reliable responder communications
   - Large area with sparse infrastructure in spots
3. Cross CI Sector Coordination & Communication
   - Different levels of government EM involved
4. Situation Awareness
5. Volunteer Management
   - Not just for immediate response but also recovery

Case Study 2 – Sector Development/Model Exploitation

- Safety Sector development - responder subject matter experts
- Development of Incident Response Functions & Relationships
  - Discussion required the focus of a large, complex scenario
  - EMBC recently developed an earthquake response plan
  - Opportunity to leverage Pacific Quake ’16 Exercise
  - Open source data collected for V2010
  - EMBC-DRDC collaborative work with local stakeholders
  - Earthquake scenario selected
- Opportunity for Exploitation of the Model
  - EMBC – NRCan Collaboration
  - EMBC - enhanced understanding of earthquake risks
  - NRCan – development of risk assessment tools
  - Initial discussion for use of the National CI Model
Case Study 2 – Level of Effort

- **Process:**
  - Orientation: Presentation of CI model NRCAN staff
  - Scenario Selection & Refinement of the CI Model – to be done
  - Key stakeholder workshop – to be determined
  - Open source data collection & quantification – some already done for V2010
- **Analysis:**
  - EMBC and stakeholder guidance
  - Automotive Parts Manufacturers interested in supply chain vulnerability
- **Total effort:**
  - Greater scope than Ontario County Flood Case Study
    - Larger area
    - Several scenarios

Case Study 2 – Setting

**Lower Mainland & Strait of Georgia Earthquakes**

- May require 3 or 4 scenarios
- 1. Vancouver Island
- 2. Moderate Lower Mainland
- 3. Severe Lower Mainland
- 4. ???

- Model Refinement
  - To be determined
  - Perhaps 20-25% reduction in functions
Preliminary Results – Risk Rank

High Risk Entities
(Illustrative Data)

Legend
- Community Risk
- Functional Risk

Opportunities for Improvement

Public Protection Operations
(Illustrative Data)

Legend
- AMMP Risk
- Imported Risk

Vulnerabilities
Opportunities for Improvement

**Wireless Telecommunications**
(Illustrative Data)

Legend
- Imported Risk
- Vulnerabilities

Opportunities for Improvement

**Water Distribution**
(Illustrative Data)

Legend
- Intrinsic Risk
- Imported Risk
- Threat/Blade Risk
- Vulnerabilities
Current Risk Assessment Practice

- Emergency Management (EM)
  - Community / region wide
  - All hazards / threats
  - Focus on hazards / threats and direct consequences
  - Indirect consequences aggregated – extrapolated from historical cases (e.g. cascading CI consequences)
  - Aggregated results (e.g. heat maps)

- Enterprise Risk Management
  - Focus on a single enterprise – clear common values
  - Standardized best practices – e.g. ISO 31000
  - Includes options for managing risks
  - Business continuity in isolation of other enterprises
    - May be conflicts in event of a large scale incident

National CI Model

- Collective Risk Assessment
  - Informs EM risk assessment with CI consequences specific to the community or region
  - Considers risk across industries and enterprises
    - A level playing field for de-conflicting business continuity plans
  - Can de-compose the sources of vulnerability for high risk elements – helps to identify actionable areas for risk reduction
    - Solutions can be low-cost (e.g., improved coordination)
  - Can be scaled and tailored to specific needs, interests or regions
  - Does not replace other tools – e.g., validated industry tools
(Project Team) Observations

- A wealth of open-source data exists to inform assessments
- Horizontal silos pose as much of a challenge as vertical silos
- Method requires pre-processing (linking asset status to functional performance)
- Method would benefit from post-assessment analysis tools
- Level of effort is moderate
- Experienced analyst required for both pre-processing and post analysis

Exploitation

- **Potential Uses:**
  - Vulnerability identification/risk assessment
  - Supply chain analysis
  - Business-continuity planning
  - Return on Investment (ROI) analysis
  - Capability-based planning/portfolio management
  - Exercise Design & Support
Risk Assessment – Vulnerability Identification

Flood Scenario – Heat Map
- Excursion – non-catastrophic dam failure

Supply Chain Analysis

Effect of closure of Port of Vancouver on Automotive Manufacturing:
- Automotive Imports: % imported via Port of Vancouver
- Functions affecting imports
- Industry functions depending on imports

Users: Emergency Managers – all levels and all sectors, Safety & Security Program Managers, Insurance Companies
Use: informs priorities, EM operational plans
Business Continuity Planning

Earthquake – Water Distribution

Opportunities for Improvement

Water Distribution (Historic Data)

Opportunities for Improvement

Water Maintenance & Repair (Historic Data)

Users: Business Continuity Planners
Use: informs plans via exploring vulnerabilities, identify options for investment

Return on Investment

Options Analysis:
(Flood Scenario)

- UAV potential benefits:
  - Surveillance
  - Aid Search & Rescue
  - Communications relay
  - Emergency supplies

- Potential risk reduction about 4% of overall expected loss

Users: Safety & Security Program Managers, Decision-Makers at all levels and across all sectors
Use: informs investment plans and options
Capability Based Planning

Dept of Homeland Security – Core Capabilities Portfolio:

- Planning
- Public Information
- Operational Coordination
- Community Resilience
- Critical Transportation
- Mass Care
- Search & Rescue
- Operational Comms
- Situational Assessment
- ...

Users: Safety & security program managers
Use: Identify “gaps,” inform program wide priorities and investments

Exercise Design & Support

Earthquake Scenario:
- Use the National CI Model to identify issues to include in the exercise

Results - Ranked Risk Issues

Issue: Coordination amongst utilities, EOC and responders

Users: EM operational planners
Use: informs exercise plans
Questions & Discussion

The National Critical Infrastructure Interdependency Model – First Break Out Session
Challenges

- CI community Challenges
- Governance Challenges
- Model-specific Challenges

Feedback & Questions - Utility

- What did you like about the model?
- What didn't you like about the model?
- What would you like to see changed?
- How (if at all) do you feel your sector could make use of the model?
The National Critical Infrastructure Interdependency Model – Second Break Out Session

Feedback & Questions – Way Ahead

❖ Should model refinement and validation continue? If so, what priorities would you suggest?

❖ Are additional case studies and/or options analysis and development of a concept warranted?

❖ What could be feasible options for institutionalizing the model – governance, resources, analytical capability?

❖ What thoughts/observations would you like relayed to the NCSF?
Questions & Discussion