

Risk and resilience assessment

A summary of methodologies and tools in support of the development of an application for the 2017 United Nations (UN) Fifth Regional Platform for Disaster Risk Reduction (DRR) in the Americas

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Reference Document
DRDC-RDDC-2017-D014
February 2017

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Abstract

This Reference Document provides a brief summary of risk and resilience assessment tools and methodologies developed by Defence Research and Development Canada's Centre for Security Science (DRDC CSS), funded by the Canadian Safety and Security Program (CSSP), as well as developed by other experts nationally and internationally. The content is organized around two broad categories, CSS-developed and CSSP-supported methodologies and tools; and other Canadian and international methodologies and tools. CSS tools are organized into six thematic areas: i) risk assessment; ii) resilience assessment; iii) critical infrastructure vulnerability; iv) capability assessment; and v) scenario development. Non-CSS tools featured herein fall into two categories: i) risk and hazard assessment; and ii) resilience assessment.

This document is not meant to be exhaustive, rather, it is meant to be illustrative and provides a general overview of the diversity of risk and resilience assessment tools, methods and approaches available for public safety and security application. The document serves as supporting material for the development of an application for the 2017 United Nations (UN) Fifth Regional Platform for Disaster Risk Reduction (DRR) in the Americas. It is anticipated that the document will also prove useful for operational, intelligence, science and technology (S&T), risk practitioners and policy specialists across a broad range of jurisdictions and stakeholder communities in accessing risk assessment information and products.

Résumé

Le présent document de référence contient un sommaire des outils et méthodes d'évaluation des risques et de la résilience élaborés par Recherche et développement pour la défense Canada – Centre des sciences pour la sécurité (RDDC CSS), grâce au financement du Programme canadien pour la sûreté et la sécurité (PCSS), ainsi que par d'autres experts canadiens et étrangers. Le contenu est réparti en deux grandes catégories : d'un côté les méthodes et outils mis au point par le CSS et soutenus par le PCSS; de l'autre les méthodes et outils élaborés par d'autres organisations au Canada et à l'étranger. Les outils du CSS peuvent être regroupés en six thèmes : i) évaluation des risques; ii) évaluation de la résilience; iii) évaluation de la vulnérabilité des infrastructures essentielles; iv) évaluation des capacités; v) élaboration de scénarios. Les outils qui ne proviennent pas du CSS, pour leur part, sont classés en deux catégories : i) évaluation des risques et des dangers; ii) évaluation de la résilience.

Ce document n'a pas la prétention d'être exhaustif; il se veut plutôt explicatif et est conçu pour donner un aperçu général de la diversité des outils, des méthodes et des approches d'évaluation des risques et de la résilience en matière de sécurité publique et de sa mise en pratique. Il servira de document à l'appui en vue de l'élaboration d'une communication pour la cinquième Plate-forme régionale pour la réduction des risques de catastrophes (RRC) dans les Amériques, une réunion des Nations Unies qui aura lieu en 2017. Ce document devrait également s'avérer utile aux spécialistes des opérations, du renseignement, des sciences et technologies (S et T), des risques et des politiques dans un large éventail de champs d'application et de collectivités intéressées à avoir accès à des produits et des renseignements sur l'évaluation des risques.

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1 Introduction

1.1 Background

Defence Research and Development Canada's Centre for Security Science (DRDC CSS) was founded in 2006 to manage a suite of Public Security Science and Technology (S&T) program activities. Since its founding, DRDC CSS has been continuously evolving, updating, and adding to a palette of risk and capability assessment methodologies as well as tools for applying them, contributing S&T innovation to the ability of Canada's safety and security community to methodically identify, prioritize, and respond to risks faced from all hazards [1]. In addition, the Canadian Safety and Security Program (CSSP), a federally-funded program led by Defence Research and Development Canada's Centre for Security Science (DRDC CSS), in partnership with Public Safety Canada, has funded numerous risk assessment methodologies and tools through its collaborative mechanisms, for fostering innovative science and technology advancements contributing to the safety and security of Canadians. Meanwhile, other Canadian and international experts have developed noteworthy risk and resilience assessment tools adding to available resources for organizations seeking to gather risk and resilience-based information, either in their communities or on a larger scale. Taken together, this inventory of tools provides a starting point for initiating risk and resilience assessment in furtherance of "Understanding Disaster Risk," the first priority outlined in the Sendai Framework for Disaster Risk Reduction [2].

2 Aim

In support of the United Nations Fifth Regional Platform for Disaster Risk Reduction (DRR), to be hosted by Public Safety Canada in Montreal in March 2016, DRDC CSS is creating an online application to direct participants from across the Americas to a range of methodologies and tools for undertaking risk and resilience assessments that can help to reduce disaster risk losses.

The aim of this Reference Document was to gather together an inventory of such methodologies and tools that were either created at DRDC CSS, were supported by the Canadian Safety and Security Program (CSS), or have come to be familiar to DRDC CSS through its work in the portfolios of risk assessment and community resilience.

3 Discussion

3.1 DRDC CSS and CSSP-supported tools

Developing risk assessment methods and tools was an activity that DRDC CSS undertook from its inception. On the one hand, risk-based evidence was needed to support its investments in S&T solutions to public safety and security problems. On the other hand, requests were consistently received from its partners for risk related expertise and tools to support policy, program, and operational requirements. As such, DRDC CSS, as well as the Canadian Safety and Security Program led by DRDC CSS in partnership with Public Safety Canada, have been extensively involved in developing as well as supporting the development of risk assessment methods and tools.

Table 1 consolidates risk-related assessment tools and methodologies developed by DRDC CSS and supported by the Canadian Safety and Security Program:

- Under “theme”, the various risk assessment tools and methods were grouped into the following categories: i) risk assessment; ii) resilience assessment; iv) critical infrastructure vulnerability; v) capability assessment; and iii) scenario development.
- The name of the tools/methods is a brief description of the project and how the method was implemented. In some cases, the tool was developed by a third party with support from CSSP. If not otherwise indicated, the tool was developed in-house at DRDC CSS.
- The date describes when the work was originally developed and carried out.
- The technical approaches range considerably, from capturing expert opinion in Microsoft (MS) Excel based on consensus ratings to the development of customized software that aids in data collection and visualization of results.
- A total of 8 risk assessment methodologies and tools were reviewed. Since the purpose of this Reference Document is to support the UN DRR Public Forum web application, only methodologies and tools linked to online published documents or web applications were included, with an emphasis on useable, web-based tools.
- Annex A provides additional information on these tools and methodologies, including descriptions of objectives/aims, technical approach, and links to the website where the tool and/or more detailed documentation can be accessed.
- A more elaborate inventory of CSS tools and methodologies that includes unpublished and in-development products and additional iterations and tests, as well as a thematic reflection on the direction underlying these developments, is being developed by the authors in support of Public Safety Canada’s implementation of the National Risk Profile.

Table 1: Summary description of DRDC CSS risk and resilience assessment methodologies and tools.

Theme	Tool/method	Date	Technical approach
Risk assessment	1. All Hazards Risk Assessment (AHRA) [3] [4]	2009	Guideline tool for scenario-based risk assessment.
	2. Enterprise Risk Management (ERM) User's Guide ¹ [5]	2013	Guide describing how to use ERM to identify and analyse risk events.
Resilience assessment	3. Rural Disaster Resilience Planning Guide (Justice Institute of British Columbia [JIBC]) ¹ [6]	2014	Automated questionnaire tool enabling community self-assessment of disaster resilience.
	4. Aboriginal Disaster Resilience Planning (JIBC) ¹ [7]	2014	Automated questionnaire tool enabling community self-assessment of disaster resilience, including a Traditional Knowledge toolkit (TK).
Critical infrastructure (CI) vulnerability assessment	5. Community Resilience Architectural Framework / Combined Effect Methodology [8]	2013	Methodology for modelling disruption to capabilities supporting a CI system.
Capability assessment	6. Capability Assessment User's Guide [9]	2013	Matrix-based methodology for modelling SME's scenario-based identification and rating of capabilities.
	7. Capability Assessment Management System [4]	2013	Practical how-to guide for conducting scenario-based capability assessments.
Scenario development	8. Public Security Technical Program (PSTP) Scenario Planning Framework [10]	2010	Methodology for selecting scenarios for scenario-based risk assessment and/or capability assessment.

3.2 Canadian and international risk and resilience assessment methodologies and tools

Since the early 2000s, corresponding with the 1999 creation of the United Nations Office of Disaster Risk Reduction and the issuing of the *The Hyogo Framework for Action 2005–2015: Building the Resilience of Nations and Communities to Disasters*, there has been an international focus on developing improved methodologies and tools for risk and hazard assessment. A new emphasis has also emerged on the creation of resilience assessment tools to capture and measure features of communities that allow them to rebound in case disaster strikes.

Table 2 consolidates noteworthy risk-related and resilience-related assessment tools and methodologies developed by Canadian and international experts:

- Under “theme”, the various risk assessment tools and methods were grouped into the following categories: i) risk assessment methodologies and tools; ii) resilience assessment tools.

¹ Supported by the Canadian Safety and Security Program.

- The name is a brief description of the project and how the method was implemented.
- The date describes when the work was originally developed and carried out.
- The technical approaches range from guidelines and checklists to automated rating tools.
- A total of 8 assessment methodologies and tools were reviewed; this list is not meant to be exhaustive.
- Annex B provides additional information on these tools and methodologies, including a summary description of objectives/aims, technical approach, and a link to the website where the tool and/or more detailed documentation can be accessed.

Table 2: Summary description of Canadian and international risk and resilience methodologies and tools.

Perspective	Tool/method	Date	Technical approach
	1. Hazus (Federal Emergency Management Agency [FEMA]) [11]	1997–2004	Automated geographic information system (GIS)-tool for estimating risks and losses due to natural hazards.
	2. Hazard Risk Vulnerability Analysis (Government of British Columbia) [12]	2004	Guided tool for stakeholder focus-group hazard and risk assessment.
	3. Hazus Canada (Natural Resources Canada) [13]	2011	Automated geographic information system (GIS)-tool for estimating risks and losses due to natural hazards, adapted by Natural Resources Canada for Canadian use.
	4. Risk-Based Land Use Planning Guide (Government of British Columbia) [14]	2015	Checklist guided tool for hazard, vulnerability and impact assessment.
Resilience Assessment	5. Getting My City Ready (UNISDR) [15]	2010	Checklist tool for resilience planning.
	6. Ten Essentials for Making Cities Resilient (UNISDR) [16]	2015	Checklist tool for reducing urban disaster risk and building resilience.
	7. Local Government Self-Assessment (UNISDR) [17]	2015	Automated resilience rating tool.
	8. Resilient City Scorecard (UNISDR) [18]	2015	Automated resilience progress scoring tool.

4 Conclusion

Risk and resilience assessment serve as analytical constructs meant to address uncertainty in the evolving public safety and security environment, and provides decision makers with an improved understanding of relevant risks (e.g., likelihood, impact) as well as resilience measures that could affect organizational objectives, the effectiveness of risk treatment measures already in place, the potential effectiveness of additional risk treatment and resilience-building options, and a shared appreciation of the inherent uncertainties in all key aspects of the risk and resilience assessment process. This Reference Document is intended to quickly inform and guide operational, intelligence, science and technology (S&T), risk practitioners and policy specialists towards existing tools that might be helpful in addressing their specific risk and resilience assessments needs.

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Annex A List of DRDC CSS and CSSP supported risk assessment methodologies and tools

A.1 Risk assessment methodologies and tools

A.1.1 All Hazards Risk Assessment (AHRA) (2009–2013) [3] [4]

Objective: To perform and aggregate federal risk assessments into a whole-of-government risk picture that can serve as a baseline for Federal Emergency Management planning, recording and managing interdependencies, and decision-making about future capacity and investment.

Technical approach: Scenario-based risk assessment by subject matter experts based on probability as well as impact over six domains: People, Economy, Environment, Territorial Security, Canada's Reputation & Influence, Society & Psycho-Social and Critical Infrastructure. The AHRA application tool is a user-friendly Excel program with step-by-step prompts that is a fully automated and online capable solution using Microsoft SharePoint as the enabling platform.

Links:

<https://www.publicsafety.gc.ca/cnt/rsrscs/pblctns/ll-hzrds-sssmnt/index-eng.aspx>

http://publications.gc.ca/collections/collection_2016/rddc-drdc/D68-5-031-2013-eng.pdf

A.1.2 Enterprise Risk Management (ERM) User's Guide (Make-it Solutions, 2013) [5]²

Objective: To describe how to use ERM to identify and analyse risk events. The ERM system assists organizations in managing its risks by identifying, assessing and monitoring them in accordance with ISO 31000 standards. The user guide describes how to use ERM to identify and analyse risk events, prioritize risks and develop treatment strategies.

Technical Approach: Guidebook.

Link: http://cradpdf.drdc-rddc.gc.ca/PDFS/unc189/p801928_A1b.pdf

A.2 Resilience assessment tools

A.2.1 JIBC Rural Disaster Resilience Planning (RDRP) Guide (2014) [6]²

Objective: To guide rural communities through hazard risk assessment and hazard resilience rating and planning.

² Supported by the Canadian Safety and Security Program.

Technical Approach: Automated web-based questionnaire for focus group self-rating and planning with four steps. Step One helps communities identify and describe their local resources, capacities, and hazards; Step Two supports a qualitative analysis of a community's resilience across dimensions associated with social, contextual, and disaster and emergency management factors as well as specific hazard-risks; Step Three draws on a locally-defined vision, goals and the outputs of the integrated resilience assessment process to produce a place-based, locally defined resilience plan; and Step Four focuses on implementation and ongoing evaluation.

Link: <https://rdrp.jibc.ca/>

A.2.2 JIBC Aboriginal Disaster Resilience Planning (ADRP) (2014) [7]²

Objective: To guide aboriginal communities through hazards risk assessment and resilience rating and planning.

Technical Approach: Automated web-based questionnaire and guide for focus group self-rating and planning with additional toolkit facilitating the sharing of traditional knowledge (TK) on resilience. The ADRP process guides working through steps to increase resiliency in a community including: Step 1: Getting Started; Step 2: Resilience Assessment; Step 3: Building a Resilience Plan; and Step 4: Plan Implementation. The TK Toolkit outlines how to use storytelling and talking circles to facilitate the sharing of Traditional Knowledge about Aboriginal resilience among TK holders, their communities and local emergency management practitioners by accessing information about community strengths, past emergencies, existing risks and wise practices.

Link: <https://adrp.jibc.ca/>

A.3 Critical infrastructure (CI) vulnerability assessment methodologies

A.3.1 Community Resilience Architectural Framework / Combined Effect Methodology (2013) [8]

Objective: To model disruptions to a 'resiliency system,' the set of plans, capabilities and resources that strengthen a community's resilience to disruptive influences and crisis events and to elicit steps for improving its protection against key threats and hazards.

Technical Approach: Uses an architectural framework / combined effects methodology to identify CI systems upon which a study location depends; 2) identify key capabilities supporting these systems as well as interdependencies; 3) model disruption to one or more key capabilities through the simulation of an incident that isolates the location; 4) test the community's ability to ride out the disruption.

Link: http://cradpdf.drdc-rddc.gc.ca/PDFS/unc140/p538067_A1b.pdf

A.4 Capability assessment methodologies, lists, and tools

A.4.1 Capability Assessment User's Guide (CAUG) (2013) [9]

Objective: To develop a flexible scenario-based approach for assessing and performing a gap analysis of the capabilities of diverse stakeholders in a complex and cascading hazard situation.

Technical Approach: The CAUG provides a matrix for exercise hosts and participants to generate capabilities across a categorical schema based on the EM pillars of Prevent, Prepare, Respond, Recover as well as Governance and Common/Enabling capabilities.

Link: http://cradpdf.drdc-rddc.gc.ca/PDFS/unc140/p538062_A1b.pdf

A.4.2 Capability Assessment Management System (CAMS) [4]

Objectives/Aims: A practical guide for conducting a structured capability assessment based on one or more illustrative scenarios, complementing the AHRA and CAUG approaches. A version 2 of CAMS is currently under development that will be a web-based application hosted on a virtual machine government server.

Link: http://publications.gc.ca/collections/collection_2016/rddc-drdc/D68-5-031-2013-eng.pdf

A.5 Scenario development and management frameworks

A.5.1 Public Security Technical Program (PSTP) Scenario Planning Framework (2008) [10]

Objectives/Aims: To assist in selecting, sharing and exploiting planning scenarios for emergency management stakeholders from the national to the community level.

Technical Approach: Combines 1) a taxonomy for defining scenarios; 2) dimensions for categorizing scenarios including risk criteria, triggers and time horizons; and 3) a selection of representative scenarios covering generic threats or hazards anticipated in the near future.

Link: http://cradpdf.drdc-rddc.gc.ca/PDFS/unc103/p534210_A1b.pdf

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Annex B List of Canadian and international risk and resilience assessment tools

B.1 Risk assessment tools

B.1.1 Hazus (1997–2004) [11]

Objective: To use geographic information system-based information and risk information to estimate the risks of natural hazards.

Technical Approach: Automated tool calculating the risk exposure in a given geographical area by characterizing the hazard level and calculating potential losses in terms of economic losses and structural damage. The version developed for the continental United States (US) is freely distributed by the US Federal Emergency Management Agency (FEMA). The Hazus program is also adaptable for use by other countries.

B.1.2 Hazard Risk Vulnerability Analysis (Govt of B.C., 2004) [12]

Objective: To guide communities through risk-based choices to address vulnerabilities, mitigate hazards and prepare for response to and recovery from hazard events.

Technical Approach: Structured tool for stakeholder focus-group hazard and risk assessment and analysis as well as community engagement and action planning.

Link: http://www2.gov.bc.ca/assets/gov/public-safety-and-emergency-services/emergency-preparedness-response-recovery/local-government/hrva_toolkit.pdf

B.1.3 Hazus Canada (2010) [13]

Objective: To use geographic information system-based information and risk information to estimate the risks of natural hazards.

Technical Approach: Automated tool calculating the risk exposure in a given geographical area by characterizing the hazard level and calculating potential losses in terms of economic losses and structural damage, adapted by the Government of Canada's Department of Natural Resources for Canadian use. Software available by request.

Link: <http://hazuscanada.ca/>

B.1.4 Risk-Based Land Use Planning Guide: Safe Use of Land, Based on Hazard Risk Assessment (British Columbia, 2015) [14]

To Objective: To assist municipal staff in evaluating risk features of hazard, vulnerability and impact in areas affected by land-use plans and in offering advice on how to mitigate risks to acceptable levels and monitor them.

Technical approach: Extensive checklist-based guideline.

Link:

http://www.pacificdisaster.net/pdnadmin/data/original/GSC_2015_RiskBased_LandUseGuide_Vol1.pdf

B.2 Resilience assessment tools

B.2.1 United Nations Office of Disaster Risk Reduction (UNISDR) “Getting My City Ready” (2010) [15]

Objective: To inform local actors of the characteristics of a disaster resilient city, elements of urban risk, and steps they can take to make their cities safer from disasters.

Technical Approach: Action checklist.

Link: http://www.unisdr.org/files/14043_campaignkit1.pdf

B.2.2 UNISDR Ten Essentials for Making Cities Resilient (2015) [16]

Objective: To indicate strategic areas of intervention and identify key actions for reducing urban disaster risk and building resilience.

Technical approach: Checklist.

Link: <http://www.unisdr.org/campaign/resilientcities/home/toolkitblkitem/?id=1>

B.2.3 UNISDR Local government self-assessment tool (2015) [17]

Objective: To facilitate urban stakeholders in setting resilience baselines, identifying gaps and generating comparable data for measuring advancement.

Technical approach: Online resilience rating tool (requires registration).

Link: <http://www.unisdr.org/campaign/resilientcities/home/toolkitblkitem/?id=3>

B.2.4 UNISDR Resilient City Scorecard (2015) [18]

Objective: To provide for a numerical and visual assessment of a city's disaster resiliency progress along a prioritized list of actions relating to its resiliency posture and planning gaps.

Technical approach: Scorecard based on the UNISDR's Ten Essentials for Making Cities Resilient.

Link: <http://www.unisdr.org/campaign/resilientcities/home/toolkitblkitem/?id=4>

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DOCUMENT CONTROL DATA		
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	<p>2b. CONTROLLED GOODS</p> <p style="text-align: center;">(NON-CONTROLLED GOODS) DMC A</p>	
<p>3. TITLE (The complete document title as indicated on the title page. Its classification should be indicated by the appropriate abbreviation (S, C or U) in parentheses after the title.)</p> <p style="text-align: center;">Risk and resilience assessment : A summary of methodologies and tools in support of the development of an application for the 2017 United Nations (U.N.) Fifth Regional Platform for Disaster Risk Reduction (DRR) in the Americas</p>		
<p>4. AUTHORS (last name, followed by initials – ranks, titles, etc., not to be used)</p> <p style="text-align: center;">Waldman, S.; Friesen, S. K.; Verga, S.</p>		
<p>5. DATE OF PUBLICATION (Month and year of publication of document.)</p> <p style="text-align: center;">February 2017</p>	<p>6a. NO. OF PAGES (Total containing information, including Annexes, Appendices, etc.)</p> <p style="text-align: center;">22</p>	<p>6b. NO. OF REFS (Total cited in document.)</p> <p style="text-align: center;">18</p>
<p>7. DESCRIPTIVE NOTES (The category of the document, e.g., technical report, technical note or memorandum. If appropriate, enter the type of report, e.g., interim, progress, summary, annual or final. Give the inclusive dates when a specific reporting period is covered.)</p> <p style="text-align: center;">Reference Document</p>		
<p>8. SPONSORING ACTIVITY (The name of the department project office or laboratory sponsoring the research and development – include address.)</p> <p>DRDC – Centre for Security Science Defence Research and Development Canada 222 Nepean St., 11th Floor Ottawa, Ontario K1A 0K2 Canada</p>		
<p>9a. PROJECT OR GRANT NO. (If appropriate, the applicable research and development project or grant number under which the document was written. Please specify whether project or grant.)</p>	<p>9b. CONTRACT NO. (If appropriate, the applicable number under which the document was written.)</p>	
<p>10a. ORIGINATOR'S DOCUMENT NUMBER (The official document number by which the document is identified by the originating activity. This number must be unique to this document.)</p> <p style="text-align: center;">DRDC-RDDC-2017-D014</p>	<p>10b. OTHER DOCUMENT NO(s). (Any other numbers which may be assigned this document either by the originator or by the sponsor.)</p>	
<p>11. DOCUMENT AVAILABILITY (Any limitations on further dissemination of the document, other than those imposed by security classification.)</p> <p style="text-align: center;">Unlimited</p>		
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13. **ABSTRACT** (A brief and factual summary of the document. It may also appear elsewhere in the body of the document itself. It is highly desirable that the abstract of classified documents be unclassified. Each paragraph of the abstract shall begin with an indication of the security classification of the information in the paragraph (unless the document itself is unclassified) represented as (S), (C), (R), or (U). It is not necessary to include here abstracts in both official languages unless the text is bilingual.)

This Reference Document provides a brief summary of risk and resilience assessment tools and methodologies developed by Defence Research and Development Canada's Centre for Security Science (DRDC CSS), funded by the Canadian Safety and Security Program (CSSP), as well as developed by other experts nationally and internationally. The content is organized around two broad categories, CSS-developed and CSSP-supported methodologies and tools; and other Canadian and international methodologies and tools. CSS tools are organized into six thematic areas: i) risk assessment; ii) resilience assessment; iii) critical infrastructure vulnerability; iv) capability assessment; and v); scenario development. Non-CSS tools featured herein fall into two categories: i) risk and hazard assessment; and ii) resilience assessment.

This document is not meant to be exhaustive, rather, it is meant to be illustrative and provides a general overview of the diversity of risk and resilience assessment tools, methods and approaches available for public safety and security application. The document serves as supporting material for the development of an application for the 2017 United Nations (UN) Fifth Regional Platform for Disaster Risk Reduction (DRR) in the Americas. It is anticipated that the document will also prove useful for operational, intelligence, science and technology (S&T), risk practitioners and policy specialists across a broad range of jurisdictions and stakeholder communities in accessing risk assessment information and products.

Le présent document de référence contient un sommaire des outils et méthodes d'évaluation des risques et de la résilience élaborés par Recherche et développement pour la défense Canada – Centre des sciences pour la sécurité (RDDC CSS), grâce au financement du Programme canadien pour la sûreté et la sécurité (PCSS), ainsi que par d'autres experts canadiens et étrangers. Le contenu est réparti en deux grandes catégories : d'un côté les méthodes et outils mis au point par le CSS et soutenus par le PCSS; de l'autre les méthodes et outils élaborés par d'autres organisations au Canada et à l'étranger. Les outils du CSS peuvent être regroupés en six thèmes : i) évaluation des risques; ii) évaluation de la résilience; iii) évaluation de la vulnérabilité des infrastructures essentielles; iv) évaluation des capacités; v) élaboration de scénarios. Les outils qui ne proviennent pas du CSS, pour leur part, sont classés en deux catégories : i) évaluation des risques et des dangers; ii) évaluation de la résilience.

Ce document n'a pas la prétention d'être exhaustif; il se veut plutôt explicatif et est conçu pour donner un aperçu général de la diversité des outils, des méthodes et des approches d'évaluation des risques et de la résilience en matière de sécurité publique et de sa mise en pratique. Il servira de document à l'appui en vue de l'élaboration d'une communication pour la cinquième Plate-forme régionale pour la réduction des risques de catastrophes (RRC) dans les Amériques, une réunion des Nations Unies qui aura lieu en 2017. Ce document devrait également s'avérer utile aux spécialistes des opérations, du renseignement, des sciences et technologies (S et T), des risques et des politiques dans un large éventail de champs d'application et de collectivités intéressées à avoir accès à des produits et des renseignements sur l'évaluation des risques.

14. **KEYWORDS, DESCRIPTORS or IDENTIFIERS** (Technically meaningful terms or short phrases that characterize a document and could be helpful in cataloguing the document. They should be selected so that no security classification is required. Identifiers, such as equipment model designation, trade name, military project code name, geographic location may also be included. If possible keywords should be selected from a published thesaurus, e.g., Thesaurus of Engineering and Scientific Terms (TEST) and that thesaurus identified. If it is not possible to select indexing terms which are Unclassified, the classification of each should be indicated as with the title.)

Risk Assessment; Resilience Assessment; Disaster Risk Reduction; Disaster Management