Using Risk Analysis to Manage Terrorism Risk

Henry H. Willis
RAND, hwillis@rand.org

Follow this and additional works at: http://research.create.usc.edu/project_summaries

Recommended Citation
http://research.create.usc.edu/project_summaries/97

This Article is brought to you for free and open access by CREATE Research Archive. It has been accepted for inclusion in Research Project Summaries by an authorized administrator of CREATE Research Archive. For more information, please contact gribben@usc.edu.
National Center for Risk and Economic Analysis of Terrorism Events
University of Southern California
Los Angeles, California

Using Risk Analysis to Manage Terrorism Risk
October 2010 to September 2011

Henry H. Willis
RAND Corporation
hwillis@rand.org

"This research was supported by the United States Department of Homeland Security through the National Center for Risk and Economic Analysis of Terrorism Events (CREATE) under Cooperative Agreement 2007-ST-061-RE0001. However, any opinions, findings, and conclusions or recommendations in this document are those of the authors and do not necessarily reflect views of the United States Department of Homeland Security or the University of Southern California."

Cooperative Agreement No. 2010-ST-061-RE0001
Department of Homeland Security

December 31, 2011
ABOUT CREATE
The National Center for Risk and Economic Analysis of Terrorism Events (CREATE) was the first university-based Center of Excellence (COE) funded by University Programs of the Science and Technology (S&T) Directorate of the Department of Homeland Security (DHS). CREATE started operations in March of 2004. This annual report covers the seventh year of CREATE funding from October 2010 to September 2011, the first year under Cooperative Agreement 2010-ST-061-RE0001 from DHS. While the text of this report focuses on the seventh year, all data tables, publications, lists of participants, students, and presentations and events are cumulative from the inception of CREATE.

CREATE’s research mission is to develop advanced models and tools for risk assessment, economic assessment, and risk management to counter terrorism. CREATE accomplishes this mission through an integrated program of research, education, and outreach, spanning the disciplines of economics, psychology, political science, industrial and systems engineering and information science. CREATE develops models, analytical tools, methodologies and software, and tests these tools in case analyses, representing critical homeland security investment and policy decisions.

Due to the cross-cutting nature of research in risk, economics, and risk management, CREATE serves the need of many client agencies at the DHS, including the Transportation Security Agency, Customs and Border Protection, Immigration and Customs Enforcement, FEMA and the US Coast Guard. In addition, CREATE has developed relationships with clients in the Offices of National Protection and Programs, Intelligence and Analysis, General Council, Health Affairs, and Domestic Nuclear Detection. Using a mix of fundamental and applied research, CREATE faculty and students take both the long-term view of how to reduce terrorism risk through fundamental research and the medium-term view of how to improve the cost-effectiveness of counter-terrorism policies and investments through applied research.

Please visit www.create.usc.edu for more information.
1. Executive Summary

The primary focus of research at RAND Corporation has been to apply tools from disciplines of risk and decision analysis to support risk management challenges salient to the national homeland security enterprise. Over the past year, this work has been directed towards two related efforts:

- Comparing Risks in the Homeland Security Mission Space
- Risk Management (Theme 6) Coordination

The results of this work have been disseminated through consultations with DHS policy and analytic professionals and to the scholarly community through journal papers, poster and oral presentations at conferences, and service to DHS advisory meetings.


The Department of Homeland Security (DHS) is responsible for protecting communities from the consequences of countless types of accidents, disasters and malicious attacks motivated by terrorism and crime. Managing risks from these hazards involves making choices among alternatives to protect facilities, strengthen infrastructure resilience, and enhance communities’ emergency preparedness. However, doing this requires comparing risks that are different in kind and consequence, and these differences influence risk management priorities.

Reliably capturing these priorities for addressing different accidents, disasters, and terrorism events is a challenging example of comparative risk assessment. The recent National Academy of Sciences review of DHS risk analysis identifies developing methods of comparative risk assessment as an analytic priority for homeland security planning and analysis\(^1\). This study builds on methods of comparative risk assessment in the field of environmental policy to demonstrate and evaluate approaches to help DHS set strategic risk management priorities.

This research will: (a) demonstrate and evaluate an approach for understanding public and policymaker risk management priorities, (b) use that approach, along with broader surveys, to describe the priorities of these different stakeholder groups, (c) communicate the results of the studies to policymakers developing DHS strategic policies and plans, and (d) describe the process of conducting comparative risk assessments to homeland security practitioners who could leverage these methods for their own planning. Over the past year, researchers built on prior work to identify a comprehensive and concise means of summarizing homeland security risks and used this approach to write risk summary sheets that describe a representative set of hazards that span the DHS mission space. These risk summary sheets were subjected to independent peer review and will form the basis of ongoing work directed towards understanding public preferences for prioritizing homeland security risk management.

The results of this work have been disseminated at academic meetings and through consultations with DHS officials at the Office of Risk Management and Analysis. Through these interactions, DHS has incorporated insights from the risk summary sheets into completing the US National Homeland Security Risk Assessment and incorporated results of the study into recommendations to FEMA of how to conduct regional Homeland Security Risk Assessments.

1.2. Risk Management (Theme 6) Coordination

To complement the research project on using comparative risk management to inform DHS strategic priorities, Henry Willis served as the Theme 6 Coordinator at CREATE. In this role he facilitated collaborations across CREATE. This effort culminated in a workshop entitled, Improving the Use of Analysis in Homeland Security and Defense Strategic Planning. This workshop assembled leadership from DHS S&T, DHS Policy, DHS RMA, DHS PA&E, DNDO, CBP, TSA, USCG, DOD-OSD Policy and CAPE, and leading analysts from academia, think tanks, and national labs. A summary of the meeting has been briefed to DHS leadership and is being turned into a formal report. In addition, Theme 6 coordination effort has led to publication of collaborative papers in Decision Analysis (published in collaboration with Vicki Bier), the Journal of Homeland Security and Emergency Management, and the Journal of Contingencies and Crisis Management (published in collaboration with Brian Jackson).

Keyword 1: homeland security national risk assessment
Keyword 2: risk management
Keyword 3: comparative risk

2. Research Accomplishments

2.1. Comparing risks in the homeland security mission space

The terrorism, natural disaster, and accident hazards that DHS is responsible for addressing affect communities in a variety of ways. A first step in managing this broad set of risks is to better understand how to compare them and, having done so, to understand what drives the public’s concerns about the risks the hazards pose. Last year’s CREATE study on comparative risk assessment developed a set of 14 attributes that describe the consequences of risks from natural disaster, accidents, and terrorism and factors that affect individual perceptions of these risks. The set of characteristics included six 4 measures describing health and safety consequences, two 2 describing economic consequences, and three 3 describing other environmental and social concerns. Additionally, the set includes 5 characteristics of hazards that risk perception research has shown to influence how individuals perceive risks (see Table 1).
Table 1  Characteristics for describing risks from terrorism, natural disasters, and accidents

<table>
<thead>
<tr>
<th>Public Health and Safety</th>
<th>Other Economic, Environmental and Social Consequences</th>
<th>Aspects of Dread and Uncertainty</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Average number of deaths per year</td>
<td>• Average economic damages per year</td>
<td>• Cause of event (Natural or human-induced)</td>
</tr>
<tr>
<td>• Greatest number of casualties in a single episode</td>
<td>• Greatest economic damages in a single episode</td>
<td>• Ability of individual to control their exposure</td>
</tr>
<tr>
<td>• More severe injuries/illnesses</td>
<td>• Average environmental damage per year</td>
<td>• Time between exposure and health effect</td>
</tr>
<tr>
<td>• Less severe injuries/illnesses</td>
<td>• Average households displaced per year</td>
<td>• Quality of scientific understanding</td>
</tr>
<tr>
<td></td>
<td>• Expected disruption of government operations</td>
<td>• Combined uncertainty in health and economic consequences</td>
</tr>
</tbody>
</table>

This year’s CREATE study used the attributes listed in Table 1 in risk summary sheets for ten hazards (See Table 2). These hazards were selected to be representative of the types of events that DHS is responsible for managing. They stem from both natural and human-induced causes. They produce different combinations of economic, health and safety, and environmental outcomes. They also span the range of well understood and newly recognized hazards. By describing current knowledge about these hazards, this study demonstrated the feasibility of producing concise summaries available information about risks that can be used as a foundation for informed discussions about risk management priorities.

Table 2  Hazards described by risk summary sheets

<table>
<thead>
<tr>
<th>Natural Disasters</th>
<th>Terrorism</th>
<th>Accidents</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Earthquakes</td>
<td>• Nuclear detonation</td>
<td>• Oil spills</td>
</tr>
<tr>
<td>• Hurricanes</td>
<td>• Anthrax attacks</td>
<td>• Industrial gas release</td>
</tr>
<tr>
<td>• Pandemic influenza</td>
<td>• IED attacks</td>
<td></td>
</tr>
<tr>
<td>• Tornados</td>
<td>• Cyber attacks</td>
<td></td>
</tr>
</tbody>
</table>

The format for these risk summary sheets followed experience from prior comparative risk assessment studies. Consistent with the approaches used in these studies, the risk summary sheets answer four questions, in order:
1. What is included within the scope of the hazard being described?
2. What is known about the causes and consequences of the hazard in the U.S.?
3. What is known about exposures to the hazard in the U.S.?
4. What has already been done to reduce or control risks from the hazard in the U.S.?

Looking across the descriptions reveals qualitative differences in the risks posed by hazards DHS manages (see Figure 1 and Table 3).

---

Figure 1  Low, best, and high estimates of the average number of deaths per year expected in
the United States attributed to hazards within the DHS mission space. (Note: the
values on the log-scale y-axis are suppressed in this report to avoid reporting potentially
sensitive information.)

Table 3  Qualitative assessment of the quality of scientific understanding and combined
uncertainty surrounding estimates of risks from hazards within the DHS mission
space.

<table>
<thead>
<tr>
<th>Combined Uncertainty</th>
<th>Quality of Scientific Understanding</th>
</tr>
</thead>
<tbody>
<tr>
<td>high</td>
<td>low</td>
</tr>
<tr>
<td></td>
<td>oil spills</td>
</tr>
<tr>
<td></td>
<td>cyber attacks</td>
</tr>
<tr>
<td></td>
<td>nuclear, anthrax, explosives</td>
</tr>
<tr>
<td>moderate</td>
<td>low</td>
</tr>
<tr>
<td></td>
<td>chemical accidents</td>
</tr>
<tr>
<td></td>
<td>hurricanes</td>
</tr>
<tr>
<td></td>
<td>tornadoes</td>
</tr>
<tr>
<td>low</td>
<td>moderate</td>
</tr>
<tr>
<td></td>
<td>pandemic flu, earthquakes</td>
</tr>
</tbody>
</table>

Some risks have higher expected consequences than others. The expected consequences of some risks are
better understood for some risks than others. The overall level of uncertainty surrounding some risks is
greater for some and low for others. Each of these factors, and others, can influence how concerned
policymakers and the public are about the risks DHS manages. Continued research at CREATE will use
these risk summary sheets to better understand how different groups perceive risks from these types of
hazards, what factors most influence their concerns, and what implications such information would have for national homeland security risk management.

2.2. Risk Management (Theme 6) Coordination

The applied risk management activities conducted during the past year led to three research accomplishments. The first accomplishment was a workshop on improving the use of analysis in homeland security and defense strategic planning. Motivated by requests from the DHS Office of Policy and DHS Office of Risk Management and Analysis, Henry Willis organized a workshop that provided an opportunity for leading analysts and policymakers to identify challenges to effective strategic planning and discuss promising approaches to address them. The workshop was attended by 40 thought leaders from DHS, DOD, academia, think tanks, and national labs. Discussions focused on questions such as:

- How can national policy be translated into program goals and objectives for terrorism security and emergency response?
- What constitutes adequate capabilities to prevent terrorism attacks and appropriate standards for community preparedness and emergency response?
- How many people, how much technology, or which types of operations best provide desired capabilities?

The primary product of the workshop will be a public report that documents key observations made throughout the workshop sessions. A summary of those findings has been briefed to leadership at the DHS Office of Policy and DHS Office of Risk Management and Analysis and results are being used to develop efforts to improve strategic planning in the homeland security and defense mission areas.

The second accomplishment led to publication of a peer-reviewed journal article by Vicki Bier, Nara Paoprasert at the University of Wisconsin and Henry Willis at RAND Corporation. This study focused on understanding the role of nuclear detection technologies in deterring nuclear terrorism. By applying a model developed by Paoprasert and Bier, we were able to provide analytic insights into the value of increased investment in nuclear detection programs like the Secure Freight Initiative. The results suggest that unless the defender imposes high retaliation costs on the attacker, 100% inspection is likely to be needed, and deterrence with partial inspection may not be achievable in practice even though it is possible in theory. On the other hand, when the defender can credibly threaten the attacker with costly retaliation, partial inspection may be sufficient to deter nuclear smuggling attempts. Thus, for policy debates about how to prevent nuclear terrorism, consideration of the diplomatic stance on retaliation is as important as, or maybe even more important than, debate about the optimal percentage of containers to inspect. The study was published in the journal Decision Analysis.

Likewise, the third accomplishment was the publication of two peer-reviewed journal articles by Brian Jackson, Kay Sullivan Faith, and Henry Willis at RAND Corporation. This study was an extension of a CREATE study for FEMA that applied methods of probabilistic risk analysis to evaluate the reliability of emergency preparedness systems. Published in the Journal of Homeland Security and Emergency Management and the Journal of Contingencies and Crisis Management the papers report on how reliability assessment can be used to evaluate preparedness, assessment information can be extracted from incident and exercise After-Action Reports and how these reports can be written in the future to enhance the use of reporting for performance measurement and evaluation.

3. Applied Relevance

By its nature, the work conducted in these studies was conceived of and carried out in a manner to enhance the applied relevance of study results. In each case, research was conducted in collaboration with homeland security professionals and results of interim or final analysis were shared through both
formal and informal collaborations with those collaborators. Specific examples that emphasize the applied relevance can be drawn from each component of this effort.

### 3.1. Comparing risks in the homeland security mission space

Presidential Preparedness Directive 8 emphasized the importance of a national risk assessment to the process of setting DHS priorities. As such, the results of this CREATE study have directly supported efforts in DHS to implement this Presidential directive. Through consultation with the DHS Office of Risk Management and Analysis, Henry Willis provided recommendations on how to adapt the research methods being demonstrated at CREATE for use in developing regional homeland security assessments given schedule and resource constraints confronted by FEMA. These recommendations were incorporated into recommendations to FEMA by the DHS Office of Risk Management and Analysis. In addition, the risk summary sheets developed in this study were used by the DHS Office of Risk Management and Analysis as reference materials when conducting the National Homeland Security Risk Assessment in response to the Presidential Directive.

### 3.2. Risk Management (Theme 6) Coordination

The applied risk management tasks conducted as part of this effort were largely generated in response to specific policy questions that resulted from discussions with homeland security professionals at the federal, state, and local levels. Both of the research accomplishments described in Section 2.2 are examples of this. The workshop on improving the use of analysis in homeland security and defense strategic planning was motivated by recognition at DHS of an increased capability for strategic planning but a continued need to better integrate analysis into planning. This workshop has catalyzed development of analytic plans to continue the process of maturing analytic capabilities at DHS and coordination of homeland security and defense strategic planning at DHS.

Similarly, collaboration between Henry Willis, Vicki Bier and, Nara Paoprasert was motivated by and contributed to consultations with analysts and leadership at Customs and Border Protection, DHS Headquarters, the Domestic Nuclear Detection Office, and the DHS Office of Policy about how to assess the benefits of nuclear detection programs and technologies. Early consultations were conducted as part of service on the National Academies of Sciences Committee on Advanced Spectroscopic Portals, which contributed to decisions to modify DNDO acquisition programs. Others were conducted as part of informal briefings to DHS Policy and National Security Council staff coordinating the National Cargo Security Strategy.

### 4. Collaborative Projects

This project involved collaboration both across CREATE and with homeland security professionals at federal, state and local levels. Collaborations within CREATE included:

- **Improving the use of analysis in homeland security and defense strategic planning:** The workshop drew together several CREATE researchers and affiliates who have worked on studies related to risk management including, Steve Hora, Isaac Maya, Detlof von Winterfeldt, Ralph Keeney, and Henry Willis. By drawing upon the experiences and contacts of these researchers, CREATE was able to provide DHS with access to thought leaders in the fields of risk analysis, decision analysis, and homeland security strategic planning.

- **Applying risk analysis to preventing nuclear terrorism:** Through collaboration with Vicki Bier and her graduate student Nara Paoprasert, the applied studies aspect of this research developed insights on the value of nuclear detection technologies for preventing nuclear terrorism in the U.S. As described in Sections 2.2 and 3.2, this research concluded that the value of nuclear
detection technologies was strongly dependent on policy decisions made with respect to threats of retaliation against would-be or successful nuclear terrorist. These findings were briefed to analysts at the DHS Office of Policy and Domestic Nuclear Detection Office during discussions of the National Strategy for Cargo Security.

Collaborations with federal, state and local homeland security professionals have included:

- **Support to Presidential Preparedness Directive 8**: Current year CREATE research developed methods for conducting a National Homeland Security Risk Assessment. Working with Mr. Bob Kolasky and Dr. Steve Bennett, Henry Willis provided guidance on how to adapt CREATE research to meet requirements for DHS laid out in this Presidential directive. Results were incorporated into both the risk assessment performed by the DHS Office or Risk Management and Analysis and to the recommendations this office provided to FEMA on how to conduct regional homeland security risk assessments. This support was provided through comment on interim study reports.

- **Support to development of the National Strategy for Cargo Security**: As described already in this section, collaboration with Dr. Vicki Bier directly supported parallel efforts at DHS to develop the strategy for securing the global containerized supply chain. This effort was led for the DHS Office of Policy by Ms. Christa Brzozowski. Collaboration occurred through participation in stakeholder meetings, briefings of CREATE study results to the intra-agency study team led by Ms. Brzozowski, and formal comment on interim reports produced by this study team.

5. Research Products

<table>
<thead>
<tr>
<th>Research Products (Please detail below)</th>
<th>#</th>
</tr>
</thead>
<tbody>
<tr>
<td>5a # of peer-reviewed journal reports published</td>
<td>3</td>
</tr>
<tr>
<td>5a # of peer-reviewed journal reports accepted for publication</td>
<td>0</td>
</tr>
<tr>
<td>5a # of non-peer reviewed publications and reports</td>
<td>0</td>
</tr>
<tr>
<td>5a # of scholarly journal citations of published reports</td>
<td>?</td>
</tr>
<tr>
<td>5b # of scholarly presentations (conferences, workshops, seminars)</td>
<td>5</td>
</tr>
<tr>
<td>5b # of outreach presentations (non-technical groups, general public)</td>
<td>0</td>
</tr>
<tr>
<td>5c # of products delivered to DHS, other Federal agencies, or State/Local</td>
<td>0</td>
</tr>
<tr>
<td>5c # of patents filed</td>
<td>0</td>
</tr>
<tr>
<td>5c # of patents issued</td>
<td>0</td>
</tr>
<tr>
<td>5c # of products in commercialization pipeline (products not yet to market)</td>
<td>0</td>
</tr>
<tr>
<td>5c # of products introduced to market</td>
<td>0</td>
</tr>
</tbody>
</table>

5.1. Publications and Reports


5.2. Presentations


5.3. Models, Databases, and Software Tools and Products

This research has not resulted in prototype models, databases, or software tools.

6. Education and Outreach Products

<table>
<thead>
<tr>
<th>Education and Outreach Initiatives (Please detail below)</th>
<th>#</th>
</tr>
</thead>
<tbody>
<tr>
<td># of students supported (funded by CREATE)</td>
<td>1</td>
</tr>
<tr>
<td># of students involved (funded by CREATE + any other programs)</td>
<td>1</td>
</tr>
<tr>
<td># of students graduated</td>
<td>0</td>
</tr>
<tr>
<td># of contacts with DHS, other Federal agencies, or State/Local (committees)</td>
<td>14</td>
</tr>
<tr>
<td># of existing courses modified with new material</td>
<td>1</td>
</tr>
<tr>
<td># of new courses developed</td>
<td>0</td>
</tr>
<tr>
<td># of new certificate programs developed</td>
<td>0</td>
</tr>
<tr>
<td># of new degree programs developed</td>
<td>0</td>
</tr>
</tbody>
</table>

**Education**

Several lectures on terrorism and emergency preparedness included in a course on risk analysis instructed by Henry Willis at the Pardee RAND Graduate School.

Student supported by CREATE funding: Russell Lundberg, Pardee RAND Graduate School

Student supported by other CREATE-related funding: Kay Sullivan, Pardee RAND Graduate School

**Outreach**

Support to development of the National Cargo Security Strategy
DHS Policy
National Security Council Staff

Support to Homeland Security National Risk Assessment
DHS Office of Risk Management and Analysis

Support to response to Presidential Preparedness Directive 8
DHS Office of Risk Management and Analysis
FEMA

Support on efforts to integrate analysis into strategic planning for homeland security and defense
DHS Policy
DHS Program Analysis and Evaluation
DHS Office of Risk Management and Analysis
USCG
TSA
DNDO
US Customs and Border Protection
DHS S&T
DoD OSD Policy