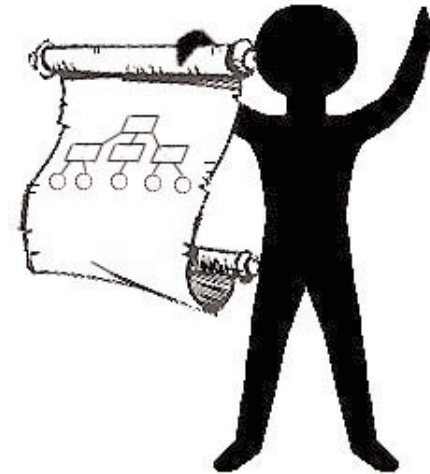




Society for Risk Analysis

## Risk Analysis: The Science and the Art



## 2008 Annual Meeting

December 7-10, 2008

Westin Boston Waterfront Hotel  
Boston, Massachusetts

**Disclaimer:** All presentations represent the views of the authors, and not the organizations that support their research. Please apply the standard disclaimer that any opinions, findings, and conclusions or recommendations in abstracts, posters, and presentations at the meeting are those of the authors and do not necessarily reflect the views of any other organization or agency. Meeting attendees and authors should be aware that this disclaimer is intended to apply to all abstracts contained in this document. Authors who wish to emphasize this disclaimer should do so in their presentation or poster. In an effort to make the abstracts as concise as possible and easy for meeting participants to read, the abstracts have been formatted such that they exclude references to papers, affiliations, and/or funding sources. Authors who wish to provide attendees with this information should do so in their presentation or poster.

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## Meeting Highlights

### Poster Reception!

This year's meeting will feature a poster reception on Monday evening from 6:00 to 8:00 pm with food and drinks. Posters will be on display starting at noon and poster presenters will be at their posters for questions and discussion during the reception. Vote for the best poster awards. Don't miss it!

### Meeting Events!

Start with the opening reception on Sunday (December 7, 6:00-7:30 PM), and continue to the closing (wine and cheese and free t-shirts!) reception on Wednesday (December 10, 5:30-6:30 PM). The meeting includes three Plenary Sessions and lunch on all three days.

### Location this Year!

This year's meeting is being hosted at the Westin Boston Waterfront Hotel, in Boston, Massachusetts. Check the location of each event, and use the maps on both sides of the back cover.

**Westin Boston Waterfront Hotel  
425 Summer Street  
Boston, MA 02210  
617-532-4600**

**GRAND BALLRM C    GRAND BALLRM D    GRAND BALLRM E    COMMONWEALTHA    COMMONWEALTHB**

<b>Monday</b>	<b>Monday</b>	<b>Monday</b>	<b>Monday</b>	<b>Monday</b>
<b>10:30 AM-Noon</b>	<b>10:30 AM-Noon</b>	<b>10:30 AM-Noon</b>	<b>10:30 AM-Noon</b>	<b>10:30 AM-Noon</b>
M2-A Symposium: Responding to Terrorism	M2-B Symp: Improving Decision Making for Environ Risk Mgmt in Developing Countries	M2-C Modeling, Statistics, and Uncertainty	M2-D Information and Regulation	M2-E Corporate and Financial Management
<b>2:00-3:30 PM</b>	<b>2:00-3:30 PM</b>	<b>2:00-3:30 PM</b>	<b>2:00-3:30 PM</b>	<b>2:00-3:30 PM</b>
M3-A Poster Platform: Managing Multi-Criteria Environmental Contamination	M3-B Poster Platform: Technical Hazards	M3-C Poster Platform: Analysis of Genomic Dose-Response Data for Risk Assessment	M3-D Symposium: Legal & Scientific Treatment of Evidence & Inference	M3-E Symposium: Produce Food Safety: Challenges & Achievements
<b>4:00-5:30 PM</b>	<b>4:00-5:30 PM</b>	<b>4:00-5:30 PM</b>	<b>4:00-5:30 PM</b>	<b>4:00-5:30 PM</b>
M4-A Symposium: Solution-Focused Risk Assessment: Is Now the Time for a New Paradigm?	M4-B Natural Hazards	M4-C Symposium: ToxCast: Steps Toward the 'New Technology'	M4-D Symposium: Reform of Risk Regulation in the European Union	M4-E Food Safety Risks

<b>Tuesday</b>	<b>Tuesday</b>	<b>Tuesday</b>	<b>Tuesday</b>	<b>Tuesday</b>
<b>10:30 AM-Noon</b>	<b>10:30 AM-Noon</b>	<b>10:30 AM-Noon</b>	<b>10:30 AM-Noon</b>	<b>10:30 AM-Noon</b>
T2-A BSE: Health Risks	T2-B Visual Tools	T2-C Kinetics & Mixtures in Risk Assessment	T2-D Symposium: Emotion, Values & Cognition of Risk	T2-E Air Pollution
<b>2:00-3:30 PM</b>	<b>2:00-3:30 PM</b>	<b>2:00-3:30 PM</b>	<b>2:00-3:30 PM</b>	<b>2:00-3:30 PM</b>
T3-A Poster Plat: Practicing the Science & the Art: Real World Case Studies in Sample Collection for Chem and Microbial Assessment	T3-B Poster Platform: Culture and Risk Perceptions	T3-C Symposium: Cumulative Risk Assessment Methods, Resources and Applications, Part I...	T3-D Symposium: The Acceptability and the Tolerability of Life-Safety Risks	T3-E Symposium: Valuing Health Risks I: Types of Death
<b>4:00-5:30 PM</b>	<b>4:00-5:30 PM</b>	<b>4:00-5:30 PM</b>	<b>4:00-5:30 PM</b>	<b>4:00-5:30 PM</b>
T4-A Poster Platform: Nanotechnology - International Perspectives	T4-B Mechanisms of Communication	T4-C Symposium: Cumulative Risk Assessment Methods, Resources and Applications, Part II...	T4-D Symposium: Chemicals Policy: REACH and CHAMP	T4-E Symposium: Valuing Health Risks II: Children

<b>Wednesday</b>	<b>Wednesday</b>	<b>Wednesday</b>	<b>Wednesday</b>	<b>Wednesday</b>
<b>10:30 AM-Noon</b>	<b>10:30 AM-Noon</b>	<b>10:30 AM-Noon</b>	<b>10:30 AM-Noon</b>	<b>10:30 AM-Noon</b>
W2-A Poster Platform: Biomonitoring & Risk Assessment	W2-B Public Participation	W2-C Symposium: Low Dose Dose-Response and Thresholds in Health Risk Assessment...	W2-D Symp: Integrating Criminology, Perception, & Comm to Better Understand Environ Risks	W2-E Anthrax Attacks
<b>2:00-3:30 PM</b>	<b>2:00-3:30 PM</b>	<b>2:00-3:30 PM</b>	<b>2:00 - 3:30 PM</b>	<b>2:00-3:30 PM</b>
W3-A Symp: Making Sense of Sustainable Energy Sources, Part I	W3-B Trust	W3-C Assessing Dose-Response and Risk for Controversial Chemicals	W3-D Use of Risk Assessment in Risk Management	W3-E Public Health Risk Assessment
<b>4:00-5:30 PM</b>	<b>4:00-5:30 PM</b>	<b>4:00-5:30 PM</b>	<b>4:00-5:30 PM</b>	<b>4:00-5:30 PM</b>
W4-A Symposium: Making Sense of Sustainable Energy Sources, Part II	W4-B Risk Amplification	W4-C Poster Platform: A Palette of Scientific Data: Online Risk Assessment Tools	W4-D Assessing Tools for Informing Decisions	W4-E Terrorist Attack on the Food Supply

COMMONWEALTHC	OTIS	STONE	WEBSTER	HANCOCK
<p><b>Monday</b> <b>10:30 AM-Noon</b> M2-F Air Quality Exposure Assessment</p> <p><b>2:00-3:30 PM</b> M3-F Exposure Assessment Methods</p> <p><b>4:00-5:30 PM</b> M4-F Drinking Water &amp; Fish Consumption</p>	<p><b>Monday</b> <b>10:30 AM-Noon</b> M2-G Symposium: Emerging Methods and Tools for Environmental Risk Assessment...</p> <p><b>2:00-3:30 PM</b> M3-G Symposium: Nano Risk Analysis: Advancing the Science of Nanomaterial Risk Management...</p> <p><b>4:00-5:30 PM</b> M4-G Symposium: Emerging Contaminants: Challenges in Federal Detection, ...</p>	<p><b>Monday</b> <b>10:30 AM-Noon</b> M2-H Issues in Ecological Risk</p> <p><b>2:00-3:30 PM</b> M3-H Inhalation Risk Assessment</p> <p><b>4:00-5:30 PM</b> M4-H Chemical Care and Prevention</p>	<p><b>Monday</b> <b>10:30 AM-Noon</b> M2-I Innovative Risk-Based Approaches in Federal Regulatory Agencies</p> <p><b>2:00-3:30 PM</b> M3-I Symposium: Game Theoretic Risk Analysis of Security Threats</p> <p><b>4:00-5:30 PM</b> M4-I Symposium: Mental Modeling: Needs and Implementation Challenges</p>	<p><b>Monday</b> <b>10:30 AM-Noon</b> M2-J Engineering Risk Analysis Methods</p> <p><b>2:00-3:30 PM</b> M3-J Symposium: Progress in Thinking About Security Risk Analysis Issues</p> <p><b>4:00-5:30 PM</b> M4-J Decision &amp; Risks for Aerospace Systems</p>
<p><b>Tuesday</b> <b>10:30 AM-Noon</b> T2-F Symposium: Model Evaluation: Getting the Predictions Right, Part I</p> <p><b>2:00-3:30 PM</b> T3-F Symposium: Model Evaluation: Getting the Predictions Right, Part II</p> <p><b>4:00-5:30 PM</b> T4-F Variability and Uncertainty in Exposure Assessment</p>	<p><b>Tuesday</b> <b>10:30 AM-Noon</b> T2-G Symposium: Life Cycle Impacts Assessment in Application of High Uncertainty: Decision-Making for Nanomaterials</p> <p><b>2:00-3:30 PM</b> T3-G Symposium: Nanotechnology Risk and Regulation: From Public Perception to Oversight Policy</p> <p><b>4:00-5:30 PM</b> T4-G Food</p>	<p><b>Tuesday</b> <b>10:30 AM-Noon</b> T2-H Epidemiology &amp; Environmental Risk Assessment</p> <p><b>2:00-3:30 PM</b> T3-H Sym: Comprehensive Environ Assessment of Ethanol: Applying Lessons Learned from the MTBE Experience to Biofuels</p> <p><b>4:00-5:30 PM</b> T4-H Models, Myths, and Risk-Based Decision Making</p>	<p><b>Tuesday</b> <b>10:30 AM-Noon</b> T2-I Symposium: Homeland Security Risk Management: A Look Under the Hood</p> <p><b>2:00-3:30 PM</b> T3-I Climate Change: Multidisciplinary Approaches</p> <p><b>4:00-5:30 PM</b> T4-I Symposium: Risk Analysis to Support Counter-Terrorism, Security, and Disaster Response</p>	<p><b>Tuesday</b> <b>10:30 AM-Noon</b> T2-J Symposium: Building Resilience to Extreme Events Within Regional Infrastructure Systems</p> <p><b>2:00-3:30 PM</b> T3-J Infrastructure Interdependence and Modeling</p> <p><b>4:00-5:30 PM</b> T4-J Symposium: CRS Perspectives on Broadening Risk Considerations for Infrastructure Design</p>
<p><b>Wednesday</b> <b>10:30 AM-Noon</b> W2-F Symposium: Risk Regulation: Ideas for the Obama Administration</p> <p><b>2:00-3:30 PM</b> W3-F Symposium: New Perspectives on Cost-Benefit Analysis: Meet the Authors</p> <p><b>4:00-5:30 PM</b> W4-F International Study of the Effects of Information about Precautionary Measures on Risk Perceptions of Mobile Telephony</p>	<p><b>Wednesday</b> <b>10:30 AM-Noon</b> W2-G Nano: Uncertainty, Disclosure &amp; Business Needs</p> <p><b>2:00-3:30 PM</b> W3-G Nano Risk Assessment &amp; Risk Communication</p> <p><b>4:00-5:30 PM</b> W4-G Symposium: Acceptable Risk for Biothreat Agents</p>	<p><b>Wednesday</b> <b>10:30 AM-Noon</b> W2-H Ecosystem Risk Management</p> <p><b>2:00-3:30 PM</b> W3-H Symposium: Decision Tools for Contaminated Sediment Management</p> <p><b>4:00-5:30 PM</b> W4-H Symposium: Vapor Intrusion: Challenges, Risks, and Uncertainties</p>	<p><b>Wednesday</b> <b>10:30 AM-Noon</b> W2-I Risk Analysis Theory and Decision Analysis Applications</p> <p><b>2:00-3:30 PM</b> W3-I Symposium: Global Catastrophic Risks</p> <p><b>4:00-5:30 PM</b> W4-I Symp: Integrated CBRN Risk Assessment at DHS: Consequence and Medical Countermeasure Analysis for Radiological and Nuclear Terrorism</p>	<p><b>Wednesday</b> <b>10:30 AM-Noon</b> W2-J Symposium: Risk Modeling, Assessment and Management of Interdependent Systems</p> <p><b>2:00-3:30 PM</b> W3-J Symposium: Risk Assessment in Energy</p> <p><b>4:00-5:30 PM</b> W4-J Symposium: Risk Education</p>

### **2008 Council**

**President:** Jonathan Wiener

**President-Elect:** Alison Cullen

**Secretary:** Mitchell Small

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**Past President:** Kimberly Thompson

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Elaine Faustman	Kara Morgan
Sharon Friedman	Richard Reiss
David Hassenzahl	Oliver Salvi
James Lambert	

Many thanks to the members of the SRA 2008 Annual Meeting Program Committee who sorted and selected the abstracts and scheduled this year's meeting:

### **2008 Program Committee**

Alison Cullen, President-elect and Chair

Laina Bush	Igor Linkov
Michael Dellarco	Margaret MacDonell
Adam Finkel	Kara Morgan
Susan Flack	Rick Reiss
Seth Guikema	Martin Schultz
Tee Guidotti	Joanne Shatkin
Emma Hartnett	Bob Tardiff
Sara Henry	Kim Thompson
Jim Lambert	Katherine von Stackelberg
Stanley Levinson	Jonathan Wiener
Steve Lewis	

### **Student Travel Award Winners**

#### US Student Winners

Baum, Seth, *W3-I.2*  
Chakraborty, Sweta, *W3-B.1*  
Cheon, Kyeongmi, *P.38*  
Eosco, Gina, *T2-B.2*  
Hong, Tao, *W2-E.2*  
Kazemi Tabriz, Reza, *M2-E.4*  
Kellon, Delanie, *M2-B.1*  
Khanna, Vikas, *T2-G.3*  
Li, Min, *P.23*  
Loney, Drew, *W3-H.3*  
Rickard, Laur, *T4-B.3*  
Uban, Nicolle, *P.55*  
Weir, Mark, *T2-H.5*  
Yang, Janet, *M2-D.3*

#### International Student Winners

Allio, Lorenzo, *M4-D.1*  
Amorim, Tade-Ane, *T4-A.5*  
Elmieh, Negar, *M3-F.5*  
Ho, Chi-Chang, *P.36*  
Rheinberger, Christoph, *T3-E.4*  
Rosas, Camilo, *P.91*  
Vittini, Clara, *P.56*  
Zhang, Ying, *P.7*  
Zhang, Wei, *P.65*

### **International Travel Award Winners**

Bayramov, Azad, <i>T4-A.1</i>	Mikhailenko, Victor, <i>P.81</i>
Farag, Amina, <i>W4-J.2</i>	Mysiak, Jaroslav, <i>M3-D.1</i>
Hannigan, John, <i>W3-A.3</i>	Serbanescu, Dan, <i>T4-H.2</i>
Hsieh, Dennis, <i>T2-F.1</i>	Simic, Zdenko, <i>M2-J.4</i>
Kher, Swaroop, <i>T4-G.4</i>	Srdjevic, Zorica, <i>W2-I.2</i>
Lin, Meng-Hung, <i>P.35</i>	Swarnakar, Pradip, <i>M4-B.3</i>
Lundy, Shaun, <i>W7-J.3</i>	Tkachuk, Alexander, <i>P.74</i>
Lynch, Iseult, <i>M2-G.2</i>	Watt, John, <i>W4-J.1</i>
Ozbas, Birnur, <i>W2-I.4</i>	

### **Specialty Group Student Merit Award Winners**

#### *Biological Stressors*

Jade Mitchell Blackwood, *W2-E.3*

#### *Decision Analysis & Risk*

Negar Elmieh, *M3-F.5*

#### *Economics & Benefits Analysis*

Christoph Rheinberger, *T3-E.4*

#### *Emerging Nanoscale Materials*

Tade-Ane de Amorim, *T4-A.5*

#### *Engineering & Infrastructure*

Oris, B.D. Dickey, *W2-J.2*

#### *Risk Policy & Law Award Winner*

Frederic Boudier, *M4-D.3*

## Registration Hours

Sunday, December 7, Westin Boston Waterfront ..... 4:00-7:00 PM  
Monday, December 8, Westin ..... 7:30 AM-5:30 PM  
Tuesday, December 9, Westin ..... 8:00 AM-5:30 PM  
Wednesday, December 10, Westin ..... 8:00 AM-5:30 PM

## Conference Events/Council Meetings

### Sunday, December 7

SRA Council Meeting

Noon-5:00 pm - Westin, Hancock Room

SRA Welcome Reception – (Cash Bar)

6:00-7:30 pm - Westin, Commonwealth Ballroom

### Monday, December 8

Poster Reception

6:00-8:00 pm - Westin, Exhibit Hall

### Tuesday, December 9

SRA Council Meeting

6:30-10:00 pm - Westin, Hancock Room

### Wednesday, December 10

Wine and Cheese Reception, Sponsored by Sapphire Group

5:30-6:30 pm - Westin, SRA Registration Desk

## Specialty Group Business Meetings

Monday, 12/8 - Noon-2:00 PM - Westin

All Specialty Group Business Meetings will take place during lunch time on Monday, December 8, 2008. Pick up your box lunch and attend the meeting(s) of your choice in rooms indicated. Each Specialty Group has a dedicated room for networking during the entire lunch break.

**12:05-12:40 pm** - Business meeting Specialty Groups:

Dose-Response - *Grand Ballroom C*

Economics & Benefits - *Grand Ballroom D*

Risk Communication - *Grand Ballroom E*

**12:40-1:15 pm** - Business meeting Specialty Groups:

Ecological Risk Assessment - *Commonwealth B*

Exposure Assessment - *Commonwealth C*

Risk Policy & Law Specialty Groups - *Otis*

**1:15-1:50 pm** - Business meeting Specialty Groups:

Decision Analysis and Risk - *Stone*

Emerging Nanoscale Materials - *Webster*

Engineering & Infrastructure - *Commonwealth A*

Biological Stressors - *Hancock*

## Specialty Group Mixers/Regional Meetings

### Tuesday, December 9

European Regional Meeting

5:30-6:00 pm - *Otis Room*

New England Regional Meeting

5:30-6:00 pm - *Grand Ballroom E*

Biological Stressors/Economics & Benefits Analysis Mixer

5:30 - 7:00 pm - *Harbor Ballroom 1*

Dose Response Mixer

6:00-7:00 pm - *Paine Room*

## Committee/Other Meetings

### Monday, December 8

New Member and Fellows Breakfast

7:00-8:00 am - *Grand Ballroom C*

All SRA Fellows and 2008 and 2009 New Members (badges with a New Member ribbon) are welcome to attend.

Publications Committee

7:00-8:00 am - *Executive Board Room*

### Tuesday, December 9

Communications Committee

7:00-8:00 am - *Executive Board Room*

Regions Committee Chairs/Presidents Meeting

7:00-8:00 am - *Adams Room*

Specialty Group Chairs Meeting

7:00-8:00 am - *Bulfinch Room*

Student (Grad and Undergrad) Breakfast

7:00-8:00 am - *Grand Ballroom C*

Annual Awards Luncheon and Business Meeting

Noon-2:00 pm - *Grand Ballroom A/B*

Don't miss the annual Awards Luncheon and SRA Business Meeting, which will include the announcement of all SRA Awards and the 5 Best Poster Award winners!

### Wednesday, December 10

Conferences and Workshops Committee

7:00-8:00 am - *Adams Room*

Education Committee

7:00-8:00 am - *Executive Board Room*



**Wednesday, December 10 (Continued)**

Membership Committee

7:00-8:00 am - Bulfinch Room

US Regions Committee Chairs

7:00-8:00 am - Hale Room

Roundtables

Noon-2:00 pm - See page 30 for details and locations.

Pick up your box lunch and attend the Roundtable of your choice.

**Exhibition – Ballroom Foyer**

Monday, December 8 ..... Noon-4:00 pm

Tuesday, December 9 ..... 9:45 am-4:00 pm

Wednesday, December 10 ..... 9:45 am-Noon

**ICF International**

9300 Lee Highway

Fairfax VA 22031

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ICF International partners with government and commercial clients to deliver consulting services and technology solutions in the environment, energy, climate change, transportation, social programs, health, defense, and emergency management markets.

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Books and journals for the risk community.

**Stylus Publishing**

22883 Quicksilver Drive

Sterling VA 20166

703-996-1012; Fax: 703-661-1547

**Toxicology Excellence for Risk Assessment**

2300 Montana Avenue, #409

Cincinnati, OH 45211

513-542-7475; Fax: 513-542-7487

We will provide information on TERA projects and activities including ITER (International Toxicology for Risk), VERA (Verifiable Estimates for Risk Assessment), and Peer Consultation and Review Program.

**US Nuclear Regulatory Commission**

11555 Rockville Pike

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Begin a career with the U.S. Nuclear Regulatory Commission where you can be part of a select group of professionals who protect people and the environment with the peaceful use of nuclear materials in medicine, industry and research.

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ICF International – Coffee Break Co-Sponsor

Sapphire Group - T-Shirt giveaway, wine and cheese reception

**Books On Display**

**The MIT Press**

55 Hayward Street

Cambridge MA 02142

617-258-5764; Fax: 617-253-1709

Environmental Law, Policy and Economics. 2008. *Nicholas A. Ashford and Charles C. Caldart*. ISBN/ISSN: 978-0262-01238-6. List \$90.00/SRA Discount Price \$63.00

The Resilient Enterprise: Overcoming Vulnerability for Competitive Advantage. 2007. *Yossi Sheffi*. ISBN/ISSN: 978-0262-69349-3. List \$18.95/SRA Discount Price \$13.27

**Taylor & Francis/CRC Press**

6008 Broken Sound Parkway, NW, Suite 300

Boca Raton FL 33487

561-998-2524; Fax: 561-998-2559

Analytical Methods for Risk Management: A Systems Engineering Perspective. 2008. *Paul R. Garvey*. ISBN/ISSN: 978-J58-48863-72. List \$99.95/SRA Discount Price \$79.60



# PLENARY SESSIONS

Monday, December 8, 8:30-10:00 am

*Grand Ballroom A/B*

## Risk Management in a Complex World

“Three Models of Games and Risks: Some Challenges in Formulation”

*Speaker:* Elisabeth Pate-Cornell

“Managing High Impact Low Probability Disruptions”

*Speaker:* Yossi Sheffi

Tuesday, December 9, 8:30-10:00 am

*Grand Ballroom A/B*

## Challenges in Climate and Ocean Risk Science

“Assessing Hurricane Wind Risk in a Changing Climate”

*Speaker:* Kerry Emanuel

“The Three Things You Need to Know about Tsunamis”

*Speaker:* Eddie Bernard

Wednesday, December 10, 8:30-10:00 am

*Grand Ballroom A/B*

## Risk Regulation: Ideas for the Obama Administration

*Speakers:* Richard Revesz, Sally Katzen, John Graham

## Workshops - Sunday, December 7

### **Full Day Workshops – 8 AM-5 PM**

**(Lunch is on your own for all workshops)**

#### **WK1: Probabilistic Risk Analysis with Hardly Any Data**

*Organizer: Scott Ferson*

**\$245 preregistration; \$295 onsite registration**

This full-day tutorial introduces and compares methods for developing a probabilistic risk analysis when little or no empirical data are available to inform the risk model. The talks are organized around the basic problems that risk analysts face: not knowing the input distributions, not knowing their correlations, not being sure about the model itself, or even which variables should be considered. Possible strategies include traditional approximative methods and recent robust and bounding methods. Numerical examples are given that illustrate the use of various methods including traditional moment propagation, PERT, maximum entropy, uniformity principle, probability bounds analysis, Bayesian model averaging and the old work horse, sensitivity analysis. All of the approaches can be used to develop a fully probabilistic estimate useful for screening decisions and other planning. The advantages and drawbacks of the various approaches are examined. Essentially, the drawbacks are that bounding approaches may say too little about risks, and the rough and ready approximate methods may say too much. The discussion addresses how defensible decisions can be made even when little information is available, and when one should break down and collect some data and, in that case, what data to look for. The presentation style will be casual and interactive. Participants will receive a CD of the illustrations and numerical examples used during the tutorial.

#### **WK3: Risk Analysis and MS Excel: No Need for Addins**

*Organizer: William McGill*

**\$225 preregistration; \$275 onsite registration**

MS Excel is a very popular computational platform in the risk world for one simple reason – everyone has it. This workshop will equip novice Excel users with the skills needed to develop custom risk analysis tools for their clients leveraging both the power of Excel's built in mathematical and indexing functions and the added power of Visual Basic for Applications.

The concept of “sheets” as “subroutines” will be explained and demonstrated, as well as suggestions on building a friendly user interface using Excel's form tools. All topics will be complemented by a wealth of case studies and practical exercises. Note that all participants should bring with them a PC laptop with MS Excel 2003 or later installed and working..

#### **WK4: Linking Probabilistic Analyses to Decision Making Using Sensitivity Analysis**

*Organizer: Amir Mokhtari*

**\$245 preregistration; \$295 onsite registration**

This workshop will answer key questions faced by those who conduct, manage, or review probabilistic and sensitivity analysis of risk models. When should you perform sensitivity analysis? What are the typical simulation techniques and software packages? What are the roles of uncertainty and sensitivity analyses as value added techniques in risk assessment? How do you prepare a model to facilitate sensitivity analysis? What are key considerations in the development of scenarios that are the basis for sensitivity analysis? What are some typical sensitivity analysis methods and how can you select among them? How should particular sensitivity analysis methods be applied? How should the results of sensitivity analysis be presented and interpreted? This workshop will answer these questions.

The methods and case studies presented are based upon several years of research at NC State University (Dr. Frey) and RTI International regarding developing quantitative risk assessment models for environmental and microbial systems and research regarding transferring, applying, and adapting sensitivity analysis methods developed in other disciplines (e.g. complex engineering systems) to quantitative exposure and risk assessment models. Results included a guidance document regarding selection, application, and interpretation of sensitivity analysis methods applied to quantitative risk assessment models. This workshop helps practitioners select specific sensitivity analysis methods relevant to the particular case study and model characteristics. The workshop will also aid in interpreting results from a sensitivity analysis in response to a particular modeling objective. Participants will be provided with course notes, a copy of the guidance document, and a tutorial with examples for how to perform sensitivity analysis using common methods. The basic concepts of probabilistic risk assessment

will be illustrated using software packages such as @Risk and Crystal Ball. The uncertainty and sensitivity analysis methods will also be illustrated with practical case studies. This workshop is aimed at practitioners, managers, or reviewers who wish to refine their knowledge regarding approaches in risk assessment and sensitivity analysis methods.

### **WK6: Improving Risk Governance: Defining a Better Process for Risk Communication and Stakeholder Participation**

*Organizer: Ortwin Renn*

**\$300 preregistration; \$350 onsite registration**

Why should politicians, stakeholders or researchers communicate risks to other audiences and the public? How can we make sure that the intended message on risk is well understood by the targeted audiences? What is so special about risk communication? How and to what degree can scientific researchers contribute to successful risk communication?" Responses to these questions are addressed in this SRA Special Workshop.

Communicating risk to the public is often an end-of-pipe-product informing the public of what a researcher has assessed and what actions a risk manager has taken. Methods such as risk scenarios, risk classification, dose response modeling, exposure assessments, and probabilistic risk assessment provide scientific insights. These assist industrial risk managers and public regulators to handle and administrate hazardous substances. Our emphasis in this course is on food and pharmaceutical risks. These risks are particularly of concern to the public and can become hot topics in public debates. The basic core of this workshop is formed by a broad conceptual framework for risk governance developed by the International Risk Governance Council (IRGC), a private, non-profit foundation in Geneva, Switzerland.

The workshop will be a combination of lecture and interactive case studies, including development of mock press conferences and other role-playing exercises, and feedback discussions. It is designed to help workshop participants think through the issues involved in dealing with risk communication both in the design of programs for the governance of new risks and when faced with a crisis.

### **WK7: From Discounting to QALYs to VSLYs and Other Cost Benefit Analysis Approaches to Help Inform Decision Making**

*Organizer: Cristina McLaughlin*

**\$270 preregistration; \$320 onsite registration**

Cost Benefit (CB) Analysis has become increasingly useful in helping policy makers evaluate health and safety policies. However, CB analysis carries considerable controversy, especially because it provides ways to measure health, safety and the environment in monetized terms. This workshop will address how some of the components of CB analysis are used for measuring health and safety. For example, valuation approaches can include direct cost of illness approaches to estimates that includes society's willingness to pay (WTP) or Value of a Statistical Life Year (VSLY). One focus of this workshop is to address limitations in VSL estimates from compensating wage studies. Different valuation approaches will also be discussed such as cost effectiveness analysis and the use of QALYs and DALYs. Another focus of this workshop is to explore how discounting can help evaluate costs and benefits of policies whose effects will happen in the very distant future or span over a long period of time.

This workshop will present a case study about short and long term occupational risks from Silica dust exposure and will discuss different health valuation approaches in measuring health effects of this problem. Workshop participants will have an opportunity to formulate their own cost benefit analysis approach of potential policy options regarding the case study or other subjects of interest. The workshop will be concluded with presenters forming a panel to discuss issues raised by participants – including Anna Alberini (University of Maryland), Laina Bush (DHHS-ASPE), Frank J. Hearl (CDC-NIOSH), Amber Jessup, DHHS-ASPE), Cristina McLaughlin (FDA-CFSAN), Rene Pana-Cryan (CDC-NIOSH), and David Zorn (FDACFSAN).

### **Morning Half-Day Workshops – 8:30 AM-12:30 PM**

#### **WK9: New Features and Models of the Benchmark Dose Software – BMDS Version 2.0**

*Organizer: Jeffrey Gift*

**\$200 preregistration; \$250 onsite registration**

This training course will provide instruction in the changes that have been implemented in version 2.0 of the U.S. EPA's benchmark dose software (BMDS). Some of the additions to this latest version include a new

user interface that allows multiple run processing, the ability to save model option choices separately from the data sets, and summary sheets that compare different modeling results side by side. In addition, the following new models in BMDS 2.0 will be discussed: dichotomous models dealing with additivity to background, a dichotomous hill model and continuous exponential models. This course will provide hands-on training in using the new program and exercises to demonstrate the use of the new models. Models currently under development for addition to BMDS in the future will also be briefly introduced, including a new multistage model (MS\_Combo) for estimating BMDLs associated with risk from multiple independent tumor sites. This course is an advanced training in the features of BMDS 2.0 and it is therefore recommended that prior to this training students who are not familiar with BMD modeling take the online BMD training course, which introduces the use of benchmark dose modeling in risk assessment (<http://www.epa.gov/ncea/bmds/training/index.html>). Note that all participants should bring with them a PC laptop. To facilitate the installation of BMDS, the laptops should be running Windows XP and the user should have administrative rights for software installation.

### **WK10: Risk Analysis: Fundamental Concepts, Applications and Controversies**

*Organizer: David Hassenzahl*

**\$200 preregistration; \$250 onsite registration**

Meetings and publications of the Society for Risk Analysis can be daunting to newcomers. More generally, risk analysis incorporates and spans many disciplines. It is often difficult for people, even those who work on some topic within risk analysis — be it toxicology, terrorist threat assessment or human behavior — to understand how their work fits into the risk analysis “big picture.” Likewise, disciplinary training does not prepare people to understand, much less converse with, fellow practitioners. This workshop, taught by three experts with extensive histories in practice, government and academia, is designed to fill that gap. We introduce fundamental risk analysis concepts, terminology, applications and calculations. The workshop is suitable for first time Society for Risk Analysis Annual Meeting attendees, as well as all individuals new to risk analysis and those who have been involved in only a limited aspect of risk analysis. Participants should have an undergraduate degree in an area relevant to risk analysis, and / or relevant work experience. Upon completion of this course,

students will understand the origins, applications and controversies surrounding risk analysis. They will be prepared to evaluate risk analysis reports and presentations. Most importantly, they will be prepared to engage comfortably in the range of conversations that distinguish Society for Risk Analysis Annual Conferences.

### **WK11: Intermediate Topics in Chemical Mixtures Health Risk Assessment**

*Organizer: Linda Teuschler*

**\$259 preregistration; \$309 onsite registration**

This half-day workshop presents intermediate topics and hands-on exercises on methodologies for assessing cumulative health risk from environmental exposure to chemical mixtures. Topics include additivity methods, common mode of action decision schemes for mixtures, physiologically-based pharmacokinetic (PBPK) modeling, toxicological interactions, and multiple route exposures, along with comparisons with traditional approaches such as time-weighted average exposures and the dose-additive Hazard Index. A brief overview will be given on basic concepts and terminology, with the bulk of the course focused on advanced chemical mixture health risk assessment methods with exercises for several important classes of chemical mixtures (e.g., PCBs, VOCs, pesticides, metals, drinking water disinfection by-products). Workshop topics include: Relative Potency Factors for common mode of action chemical groups; mechanistic information and interpretation of toxicological interactions; PBPK modeling of changes in kinetics for simple mixtures and their practical applications and significance; and mixtures assessment using multiple route exposures. Discussions include real world examples, exercise results, and general questions and comments.

### **Afternoon Half-Day Workshops – 1:30-5:30 PM**

#### **WK12: Introduction to Environmental and Health Aspects of Nanotechnology**

*Organizer: Jo Anne Shatkin*

**\$330 preregistration; \$380 onsite registration**

This course will provide participants with an overview of the emerging concerns regarding nanotechnology and nanomaterials and impacts for occupational and public health and the environment. The course introduces the topics of nanotechnology, nanotoxicology, environmental aspects of



nanotechnology, and addresses ethical, legal, societal and regulatory perspectives. Through lectures and interactive sessions, participants will obtain a knowledge base for understanding the exposure, human health, and safety issues for nanomaterials and nanotechnologies and the potential impacts for workers, consumers, stakeholders, and the environment.

Nanotechnology is the understanding and control of matter at dimensions of roughly 1 to 100 nanometers, where unique phenomena enable novel applications. Nanotechnology is emerging in all economic sectors, including: energy, medicine, food technology, imaging, manufacturing, electronics and air and water purification. Some of the current and potential future materials and technologies have the potential for significant impacts on health and the environment. This course introduces participants to the technological basis of nanoscale phenomena, the current and potential future uses of nanotechnology, explores the breadth of issues raised for health and the environment, and implications of current research and gaps on regulatory policy and societal impacts.

At the conclusion of this course, the participants will have gained insights into (1) Key concerns regarding nanotechnology risks for employees, the public, and the environment; (2) Characteristics and properties of nanomaterials and nanotechnologies; (3) Nanotoxicology: state-of-the-science regarding the toxicity of nanomaterials and nanotechnologies; (4) Environmental aspects of nanotechnology; and (5) Risk assessment and risk management issues for nanomaterials and nanotechnologies.

### **WK13: Current Topics in Risk Analysis**

*Organizer: David Hassenzahl*

**\$200 preregistration; \$250 onsite registration**

The Society for Risk Analysis now comprises a range of specialty groups. These include Biological Stressors, Decision Analysis and Risk, Dose-Response, Ecological Risk Assessment, Economics and Benefits Analysis, Emerging Nanoscale Materials, Engineering and Infrastructure, Exposure Assessment, Risk Communication, and Risk Policy and Law. In this workshop, expert representatives from these specialty groups will give presentations summarizing major topics in their fields.

### **WK14: Chemical Specific Adjustment Factors: Evaluating and Using Data to Quantify Inter- and Intraspecies Extrapolation for Risk Assessment**

*Organizer: John Lipscomb*

**\$250 preregistration; \$300 onsite registration**

The World Health Organization's International Programme on Chemical Safety (IPCS) has established guidance for replacing default uncertainty factor values for interspecies extrapolation and intraspecies extrapolation in risk values such as Reference Doses (RfDs) and Tolerable Concentrations (TCs). It guides the evaluation and quantitation of data that can be used to replace defaults with chemical specific adjustment factors (CSAFs). The approach subdivides the uncertainty factors for interspecies differences (UFA) and human variability (UFH) into toxicokinetic (TK) and toxicodynamic (TD) components. Default values for any or all of these four subfactors can be replaced by CSAF values. In the absence of chemical-specific data, default values of 2.5 and 4.0 have been established for the TD and TK component of UFA, while the default values for the TD and TK components of UFH were each established at one-half order of magnitude (3.2). This framework enables the incorporation of quantitative data, reducing the uncertainties in dose extrapolation. This emerging approach has been used to support the U.S. EPA in deriving an RfD for boron and by Health Canada in deriving a TC for 2-butoxyethanol. This half-day workshop will review the use of uncertainty factors and present a historical perspective on the reliance on quantitative data to develop values for inter- and intraspecies extrapolation. The course will focus on the IPCS methodology for CSAF development, including the thinking process and steps used for evaluating data. Examples and classroom activities will be used as instructional aids.

**Monday, December 8**

**10:30 AM-Noon  
Grand Ballroom C  
M2-A Symposium:  
Responding to Terrorism**  
*Chairs: Brooke Rogers, Ben Sheppard*

**10:30 am** **M2-A.1**  
Do as I say, not as they do: addressing variations in risk assessment, operating procedures and PPE between emergency response organisations  
*Rogers MB  
King's College London*

**10:50 am** **M2-A.2**  
Motivating disaster preparedness: effects of anger, guilt, and fear on risk perception and behavioral intentions  
*Turner MM, Underhill JC  
University of Maryland*

**11:10 am** **M2-A.3**  
Psychological effects of Weapons of Mass Disruption (WMD)  
*Pastel R  
Uniformed Services University of the Health Sciences (USUHS)*

**11:30 am** **M2-A.4**  
The psychology of strategic terrorism: government and public responses  
*Sheppard B  
Simfore Ltd*

**10:30 AM-Noon  
Grand Ballroom D  
M2-B Symposium:  
Improving Decision Making for Environmental Risk Management in Developing Countries**  
*Chair: Joseph Arvai*

**10:30 am** **M2-B.1**  
Five propositions for improving decision making about the environment in developing countries: lessons from Costa Rica  
*Kellon DS, Arvai JL  
Michigan State University*

**10:50 am** **M2-B.2**  
Variation in cultural orientations and their impact on environmental risk perception, attitudes, and information acquisition: Lessons from China  
*Lapinski MK  
Michigan State University*

**11:10 am** **M2-B.3**  
Invisible losses: using decision-focused methods to identify environmental risks and impacts  
*Gregory R  
Decision Research*

**11:30 am** **M2-B.4**  
Toward understanding perceptions of risk associated with co-conservation of livelihoods and lemurs in northeastern Madagascar  
*Gore ML  
Michigan State University*

**10:30 AM-Noon  
Grand Ballroom E  
M2-C Modeling, Statistics, and Uncertainty**  
*Chair: Scott Ferson*

**10:30 am** **M2-C.1**  
Parameters of a dose-response model are on the boundary. What happens with BMDL?  
*Kopylev L, Fox J  
Environmental Protection Agency*

**10:50 am** **M2-C.2**  
Quantification and correction of the bias in the estimated geometric standard deviation: Impact on Regulatory Standards  
*Lynch MK, Heiger-Bernays WJ, Hattis D, Ozonoff A  
Abt Associates Inc.*

**11:10 am** **M2-C.3**  
Analysis of the cholinesterase variability in animals and implications for dose-response assessment  
*Reiss R, Edwards M  
Exponent*

**11:30 am** **M2-C.4**  
Adaptive optimal designs for dose-finding based on the Sigmoid Emax model  
*Padmanabhan KP, Dragalin VD, Hsuan FH  
Temple University*

**10:30 AM-Noon  
Commonwealth A  
M2-D Information and Regulation**  
*Chair: Rick Belzer*

**10:30 am** **M2-D.1**  
Regulation by rules of thumb  
*MacGillivray BH, Alcock RE, Busby JS  
Lancaster University*

**10:50 am** **M2-D.2**  
A call for changes in the precautionary principle  
*Blodgett J  
Risk Evaluation Forum*

**11:10 am** **M2-D.3**  
The role of positive affect in motivating risk information seeking and processing - a study on communication about clinical trial enrollment  
*Yang Z, McComas KA, Gay G, Leonard JP, Dannenberg AJ, Dillon H, Kornhaber R  
Cornell University*

**11:30 am** **M2-D.4**  
Risk assessment and information quality: an empirical study of federal agency performance  
*Belzer RB  
Regulatory Checkbook*

**10:30 AM-Noon  
Commonwealth B  
M2-E Corporate and Financial Management**  
*Chair: Clark Nardinelli*

**10:30 am** **M2-E.1**  
Corporate sustainability initiatives and their food safety risks: the role of certification, traceability, and authentication  
*Spink J, Phillips A  
Michigan State University, National Food Safety & Toxicology Center (NFSTC)*

**10:50 am** **M2-E.2**  
Art or Science - Can these two paradigms co-exist within the field of Risk Management?  
*Hall I  
Lloyds TSB Asset Finance*

**11:10 am** **M2-E.3**  
Risk ranking procedures for fraud signals detected in trade data  
*Kopustinskas V, Arsenis S, Perrotta D  
Institute for Protection and Security of Citizens, Joint Research Center, European Commission*

**11:30 am** **M2-E.4**  
A bayesian methodology for uncertainty analysis of default  
*Kazemi R, Mosleh A  
University of Maryland, College Park*

**Speaker Preparation**

Speakers should go to the session room at least 10 minutes before the session starts to ensure their presentations are loaded correctly.

**Speaker Ready Room - Executive Board Room**

You may use the Ready Room to preview and practice your talk. It is open from 8:00 am-4:00 pm.

**Monday, December 8**

**10:30 AM-Noon**  
**Commonwealth C**  
**M2-F Air Quality**  
**Exposure Assessment**  
*Chair: Jonathan Levy*

**10:30 am** **M2-F.1**  
Predictors of heterogeneity in aircraft emissions of air toxics associated with individual and population cancer risks  
*Zhou Y, Levy JI*  
*Harvard School of Public Health*

**10:50 am** **M2-F.2**  
Airborne Cr(VI) monitoring during building demolition  
*Brenner D, Olliges S, Anderson T, Jimenez A*  
*Neptune and Company, Inc., NASA, ISSi, ISSi*

**11:10 am** **M2-F.3**  
Modeling variability in environmental tobacco smoke exposure and health risk at fine spatial resolution  
*Chahine T, Levy JI*  
*Harvard School of Public Health*

**11:30 am** **M2-F.4**  
Air pollution Exposure Model for Individuals (EMI) in health studies: model evaluation of residential air exchange rates  
*Breen MS, Breen M, Williams RW*  
*National Exposure Research Laboratory, US Environmental Protection Agency, National Center for Computational Toxicology, US Environmental Protection Agency, North Carolina State University*

**10:30 AM-Noon**  
**Otis**  
**M2-G Symposium:**  
**Emerging Methods and**  
**Tools for Environmental**  
**Risk Assessment, Decision-**  
**Making, and Policy for**  
**Nanomaterials: Summary**  
**of NATO Advanced**  
**Research Workshop**  
*Chairs: Idrult Lynch, Gitanjali Adlakha-Hutcheon*

**10:30 am** **M2-G.1**  
Nanotechnology, its applications, consumer products, and benefits  
*Adlakha-Hutcheon G, Korenstein R*  
*Defense Research and Development, Canada and Tel Aviv University, Israel*

**10:50 am** **M2-G.2**  
Outcome of the human health working group at the NATO Advanced Research Workshop (ARW) on emerging methods and tools for environmental risk assessment, decision-making, and policy for nanomaterials  
*Lynch I, Elder A*  
*University College Dublin, Ireland, Rochester University*

**11:10 am** **M2-G.3**  
Ecological risk assessment for nanomaterials: NATO working group discussion summary  
*Metcalfe C, Chappell M, Steevens J, Bennett E*  
*Trent University, US Army Engineer Research and Development Center and Intertox Inc.*

**11:30 am** **M2-G.4**  
Implementation of manufactured nanomaterial policy and governance – reflections from a NATO advanced research workshop  
*Hakkinen PJ, Hansen SF, Satterstrom KF, Davis T*  
*Toxicology Excellence for Risk Assessment (TERA)*

**10:30 AM-Noon**  
**Stone**  
**M2-H Issues in Ecological**  
**Risk**  
*Chairs: Wayne Landis, Katherine von Stackelberg*

**10:30 am** **M2-H.1**  
Wildlife toxicity reference values for Ecological Soil Screening Levels (Eco-SSLs)  
*Burris JA*  
*Syracuse Research Corporation*

**10:50 am** **M2-H.2**  
Waterborne zoonoses and changes in hydrologic response due to watershed development informs risk assessment  
*Walker M*  
*University of Nevada, Reno*

**11:10 am** **M2-H.3**  
Monitoring the long-term performance of engineered containment systems: mitigating ecological risks  
*Traynham B, Clarke J, Burger J, Waugh J*  
*Vanderbilt University*

**11:30 am** **M2-H.4**  
Beyond contaminated sites, ecological risk assessment as the default environmental evaluation and management tool  
*Landis WG*  
*Inst. Env. Tox.*

**10:30 AM-Noon**  
**Webster**  
**M2-I Innovative Risk-**  
**Based Approaches in**  
**Federal Regulatory**  
**Agencies**  
*Chair: Mark Walderhaug*

**10:30 am** **M2-I.1**  
Marginal economic analysis and risk assessment to inform risk management options  
*Bauer N, Disney T, Ebel E, Schlosser W, Withee J*  
*United States Department of Agriculture*

**10:50 am** **M2-I.2**  
Use of multi criteria decision analyses to prioritize risks and allocate resources  
*Oryang D, Dennis S*  
*FDA-CFSAN*

**11:10 am** **M2-I.3**  
Targeting containers at US Ports-of-Entry based on risk of pathogens and pests  
*Auclair A, Chioino C*  
*United States Department of Agriculture*

**11:30 am** **M2-I.4**  
A stock and flow model of the U.S. blood supply and potential impact of pandemic influenza  
*Walderhaug MO, Menis M*  
*Center for Biologics Evaluation & Research, U.S. Food and Drug Administration*

**10:30 AM-Noon**  
**Hancock**  
**M2-J Engineering Risk**  
**Analysis Methods**  
*Chair: Seth Guikema*

**10:30 am** **M2-J.1**  
Development, implementation, and monitoring of risk and safety programs for engineering and technology-based systems  
*Teng KY, Lambert JH*  
*University of Virginia*

**10:50 am** **M2-J.3**  
Constructing risk indices  
*MacKenzie CA*  
*Stanford University*

**11:10 am** **M2-J.4**  
Comparison of PSA results obtained with BDD and conventional approach  
*Simic Z, Banov R, Mikulicic V*  
*University of Zagreb, Faculty of EE and CE*

**11:30 am** **M2-J.5**  
Measures of critical infrastructure density around vulnerable facilities  
*Zimmerman R, Simonoff J, Naphtali Z, Restrepo C, Willis H*  
*New York University*

<p align="center"><b>M1 = 8:30-10:00 am</b> <b>(Plenary Session see page 7)</b></p> <p align="center"><b>M2 = 10:30 am-Noon</b></p> <p align="center"><b>M3 = 2:00-3:30 pm</b></p> <p align="center"><b>M4 = 4:00-5:30 pm</b></p>
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2:00-3:30 PM

**Grand Ballroom C**

**M3-A Poster Platform:  
Managing Multi-Criteria  
Environmental  
Contamination**

Chair: Terry Sullivan

**M3-A.1** Theoretical approaches and limitations for multi-criteria decision analysis techniques applied to environmental problems

*Sullivan T, Yatsalo B, Grebenkov A, Linkov I*

*Brookhaven National Laboratory*

**M3-A.2** Agent based simulation for spatially explicit exposure assessment in DECERNS

*Grebenkov AJ, Yakushau AP, Pluta SV, Linkov I*

*Joint Institute for Power and Nuclear Research D Sosny*

**M3-A.3** Multicriteria decision analysis, spatial analysis and land management: DECERNS approach

*Yatsalo B, Didenko V, Tkachuk A, Mirzeabasov O, Grebenkov A, Sullivan T, Linkov I*

*Obninsk State Technical University of Nuclear Power Engineering (IATE), Russia*

**M3-A.4** Integration of multi-criteria decision analysis with neural networks and bayesian methods: methodology and application case studies

*Tkachuk A, Linkov I, Yatsalo B, Gritsuk S, Shipilov D, Mirzeabasov O, Didenko V, Sullivan T*

*Obninsk State Technical University*

**M3-A.5** Multi-criteria decision analyses and re-emerging infectious diseases: a case study of West Nile virus

*Elmieh N, Dowlatabadi H*

*University of British Columbia*

2:00-3:30 PM

**Grand Ballroom D**

**M3-B Poster Platform:  
Technical Hazards**

Chairs: Joseph Arvai, Robyn Wilson

**M3-B.3** Communicating the benefits of an integrated risk management approach: a mental model study of farmer decision making

*Wilson RS, Tucker M, Hooker N, LeJeune J, Doohan D*  
*The Ohio State University*

**M3-B.4** The influence of a nuclear power plant's location on the image of the region, and the effect of information emphasizing the benefits of the nuclear power plant

*Oiso S, Tanaka Y*  
*Institute of Nuclear Safety System, Incorporated, Osaka Gakuin University*

**M3-B.5** The rural communities of Nevada and national defense externalities: an examination of public attitudes toward environmental activities at the Nevada Test Site

*Neill H.R., Ward J.*  
*University of Nevada, Las Vegas*

**M3-B.6** The media coverage of a disaster over time: framing and tone-of-voice

*Kuttschreuter M, Gutteling JM*  
*Center for Risk & Safety Perception, University of Twente, Netherlands*

**M3-B.7** The Chernobyl accident and public health

*Borodyanskiy NI*  
*Europa Institute for Management*

**M3-B.8** Assessing technical and other hazards in new technologies: Developing common metrics in the EU

*Jovanovic AS, Salvi O*  
*European Institute for Integrated Risk Management*

2:00-3:30 PM

**Grand Ballroom E**

**M3-C Poster Platform:  
Analysis of Genomic  
Dose-Response Data for  
Risk Assessment**

Chairs: Jeff Gift, Thomas Russell

**M3-C.1** Automated quantitative dose response modeling

*Burgoon LD, Zacharewski TR*  
*Michigan State University*

**M3-C.2** Analysis of genomic dose-response data in the EPA ToxCast Program

*Dix D*  
*Environmental Protection Agency*

**M3-C.3** Useful lessons for toxicogenomics using systems based approaches for dose and temporal response modeling

*Faustman EM, Xiao Y, Griffith WC, Robinson JF*  
*University of Washington*

**M3-C.4** Integration of toxicogenomics data in mode of action analyses and cancer risk assessment

*Keshava C, Keshava N, Davis A, Gift J*  
*US Environmental Protection Agency*

**M3-C.5** Potential impacts of genomics on EPA regulatory and risk assessment applications

*Benson WH, Birchfield N, Gallagher K\**  
*US Environmental Protection Agency*

**M3-C.6** Comparative benchmark dose estimates for genomic data from TCDD-, TCDF-, or PeCDF-treated human and rat normal hepatocytes

*Rowlands JC, Budinsky R, Gollapudi B, Dombkowski A, Thomas R*  
*The Dow Chemical Company*

**M3-C.7** The potential of genomic dose-response data to define mode-of-action and low-dose behavior of chemical toxicants

*Thomas RS, Allen BC, Longlong Y, Clewell HJ, Andersen ME*  
*The Hamner Institutes for Health Sciences*

2:00-3:30 PM

**Commonwealth A**

**M3-D Symposium: Legal  
& Scientific Treatment of  
Evidence & Inference**

Chair: Pasky Pascual

2:00 pm

**M3-D.1** Evolving European law regarding scientific evidence

*Pascual P, Mysiak J*  
*Fondazione Eni Enrico Mattei*

2:20 pm

**M3-D.2** Using models to support decision-making: is your model good enough?

*Bridges TS, von Stackelberg K*  
*US Army Engineer Research and Development Center; Harvard Center for Risk Analysis*

2:40 pm

**M3-D.3** Mathematical modeling of climate: Massachusetts et al. v. EPA and The Precautionary Principle

*Driesen DM, Siegel D*  
*Syracuse University*

2:00-3:30 PM

**Commonwealth B**

**M3-E Symposium:  
Produce Food Safety:  
Challenges &  
Achievements**

Chair: Sherri Dennis

2:00 pm

**M3-E.1** Produce safety initiatives and regulatory update

*Green AL*  
*Federal Government*

2:20 pm

**M3-E.2** Research needs for leafy greens assessment

*Fanaselle WL*  
*Food and Drug Administration, CFSAN*

2:40 pm

**M3-E.3** Food safety risks along the farm-to-fork continuum: data development and prioritization of pathogen-commodity pairs of concern

*Jaykus L, Anderson M, Beaulieu S, Dennis S*  
*RTI International*

3:00 pm

**M3-E.4** Food safety risks along the farm-to-fork continuum: quantitative modeling of high priority pathogen-commodity pairs

*Mokhtari A, Beaulieu S, Jaykus L, Dennis S*  
*RTI International*

**Monday, December 8**

<p align="center"><b>2:00-3:30 PM</b> <b>Commonwealth C</b> <b>M3-F Exposure Assessment Methods</b> <i>Chair: Donna Vorhees</i></p> <p><b>2:00 pm</b>                    <b>M3-F.1</b> Categorization framework to aid exposure assessment of nanomaterials in consumer products <i>Hansen SF, Michelson ES, Kamper A, Borling P, Stuer-Lauridsen F, Baum A</i> <i>Department of Environmental Engineering, NanoDTU, Technical University of Denmark</i></p> <p><b>2:20 pm</b>                    <b>M3-F.2</b> Comprehensive human health and ecological risk assessment of a carbon reactivation facility <i>Foster SA, Chrostowski PC</i> <i>CPF Associates, Inc.</i></p> <p><b>2:40 pm</b>                    <b>M3-F.3</b> Exposure to contaminated sediments during recreational activities at a public bathing place <i>Filipsson M, Lindstrom M, Peltola P, Oberg T</i> <i>University of Kalmar</i></p> <p><b>3:00 pm</b>                    <b>M3-F.4</b> Further examination of the Persistent Low-level Contact Exposure (PLACE) hypothesis using Pentachlorophenol and 2,4-Dichlorophenoxyacetic acid data from CTEPP <i>Kissel JC, Shirai JH, Smith JA, Nevhage BA, Parker AN</i> <i>University of Washington</i></p>	<p align="center"><b>2:00-3:30 PM</b> <b>Otis</b> <b>M3-G Symposium: Nano Risk Analysis: Advancing the Science of Nanomaterial Risk Management Workshop</b> <i>Chair: Jo Anne Shatkin</i></p> <p><b>2:00 pm</b>                    <b>M3-G.1</b> Nanomaterials in the environment: facing the challenges involved in exposure assessment <i>Abbott L, Maynard A</i> <i>US Department of Agriculture; Woodrow Wilson International Center for Scholars</i></p> <p><b>2:20 pm</b>                    <b>M3-G.2</b> Big risk communication challenges from small things <i>Bostrom A, Lofstedt R</i> <i>University of Washington, Kings College London</i></p> <p><b>2:40 pm</b>                    <b>M3-G.3</b> Characterizing nanomaterials for risk assessment: coping with uncertainty to support decision-making <i>Paoli GM, Shatkin JA</i> <i>Risk Sciences International, CLF Ventures</i></p> <p><b>3:00 pm</b>                    <b>M3-G.4</b> Symmetrical characterization of risk - the case of nanotechnology <i>Williams R, Kulinowski K, Louis G</i> <i>Mercatus Center at George Mason University</i></p>	<p align="center"><b>2:00-3:30 PM</b> <b>Stone</b> <b>M3-H Inhalation Risk Assessment</b> <i>Chairs: Bernard Goldstein, Doug Johns</i></p> <p><b>2:00 pm</b>                    <b>M3-H.1</b> Effectiveness of the US Clean Air Act (CAA) in comparison with the decline in cigarette smoking in producing a decrease in the risk of benzene-induced acute myelogenous leukemia (AML). <i>Goldstein BD, Wu F, Liu Y</i> <i>University of Pittsburgh</i></p> <p><b>2:20 pm</b>                    <b>M3-H.2</b> An analysis of sulfur dioxide-induced respiratory health effects observed in controlled human exposure studies <i>Johns DO, Brown JS</i> <i>U.S. Environmental Protection Agency, National Center for Environmental Assessment, Research Triangle Park, NC</i></p> <p><b>2:40 pm</b>                    <b>M3-H.3</b> Assessment of female lung cancer risk in Taiwan as related to levels of ambient fine particulate matter (PM2.5) <i>Chan TC, Chiang PH, Chen HL, Hsieh DPH, Wen CP</i> <i>National Health Research Institutes</i></p> <p><b>3:00 pm</b>                    <b>M3-H.4</b> Risk assessment and fine particles: methods and uncertainties <i>Tainio M, Pekkanen J, Ruuskanen J, Tuomisto JT</i> <i>National Public Health Institute, University of Kuopio</i></p>	<p align="center"><b>2:00-3:30 PM</b> <b>Webster</b> <b>M3-I Symposium: Game Theoretic Risk Analysis of Security Threats</b> <i>Chair: Vicki Bier</i></p> <p><b>2:00 pm</b>                    <b>M3-I.1</b> Designing networks to withstand terrorist attacks <i>Cox T</i> <i>Cox Associates, University of Colorado</i></p> <p><b>2:20 pm</b>                    <b>M3-I.2</b> Defending against terrorism, natural disaster, and all hazards <i>Hausken K, Bier V, Zhuang J</i> <i>University of Stavanger, University of Wisconsin-Madison, SUNY-Buffalo</i></p> <p><b>2:40 pm</b>                    <b>M3-I.3</b> A bayesian model for a game of information in optimal attack/defense strategies <i>Azaiez MN</i> <i>King Saud University</i></p> <p><b>3:00 pm</b>                    <b>M3-I.4</b> Protecting complex infrastructures against strategic attackers <i>Hausken K</i> <i>University of Stavanger</i></p>	<p align="center"><b>2:00-3:30 PM</b> <b>Hancock</b> <b>M3-J Symposium: Progress in Thinking About Security Risk Analysis Issues</b> <i>Chair: William McGill</i></p> <p><b>2:00 pm</b>                    <b>M3-J.1</b> An interagency analysis of terrorism risk assessment disclosure <i>Bagby JW</i> <i>Pennsylvania State University</i></p> <p><b>2:20 pm</b>                    <b>M3-J.2</b> Risk assessment and the terrorist: current and future directions for research <i>Horgan J</i> <i>Penn State University</i></p> <p><b>2:40 pm</b>                    <b>M3-J.3</b> Just how confident are you in your analysis? The role of analytic confidence in evidence-based terrorism risk assessments <i>McGill WL</i> <i>The Pennsylvania State University</i></p> <p><b>3:00 pm</b>                    <b>M3-J.4</b> Observations on the importance of risk communication in managing homeland security risk <i>Ross RG</i> <i>Department of Homeland Security</i></p>
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**Monday, December 8**

**4:00-5:30 PM**  
**Grand Ballroom C**  
**M4-A Symposium:**  
**Solution-Focused Risk**  
**Assessment: Is Now the**  
**Time for a New**  
**Paradigm?**  
*Chair: Dale Hattis*

**4:00 pm** **M4-A.1**  
 "Solution-focused risk assessment":  
 Quickening the pace, accomplishing  
 missions, expanding horizons  
*Finkel AM*  
*UMDNJ School of Public Health, Penn*  
*Law School*

**4:20 pm** **M4-A.2**  
 Challenges to risk assessment for "solution-  
 focused" approach  
*Gray G*  
*Office of Research and Development,*  
*US Environmental Protection Agency*

**4:40 pm** **M4-A.3**  
 Environmentalist perspectives on  
 "solution-focused risk assessment"  
*Balbus JM*  
*Environmental Defense Fund*

**5:00 pm** **M4-A.5**  
 Defining the range of potentially feasi-  
 ble control options: a natural topic for  
 productive interaction of risk assess-  
 ment and risk management expertise  
*Hattis D, Goble R*  
*Clark University*

**4:00-5:30 PM**  
**Grand Ballroom D**  
**M4-B Natural Hazards**  
*Chairs: Kjetil Rod, Ian*  
*McCammon*

**4:00 pm** **M4-B.1**  
 Communicating avalanche risk to out-  
 of-bounds skiers and snowboarders  
*McCammon I, Haegeli P, Gunn M*  
*SP Technologies*

**4:20 pm** **M4-B.2**  
 Science, society, politics, and the media  
 - joining efforts to manage the risk of  
 termite infestation in the Azores  
*Arroz AM, Palos AC, Rego IE, Borges*  
*P*  
*University of the Azores*

**4:40 pm** **M4-B.3**  
 Are we drinking poison?  
 Understanding the notion of risk per-  
 ception with reference to groundwater  
 arsenic contamination in West Bengal  
 state of India  
*Swarnakar PS*  
*Research institute: Centre for*  
*Interdisciplinary Studies in*  
*Environment and Development*  
*(CISED)*

**5:00 pm** **M4-B.4**  
 Assessing people's knowledge, percep-  
 tions, and decision-making during the  
 2008 Super Tuesday tornado outbreak  
*Demuth JL, Barjenbruch K, Nietfeld D*  
*National Center for Atmospheric*  
*Research, National Weather Service*

**5:20 pm** **M4-B.5**  
 Living with rockslide risk  
*Rod K*  
*Norwegian University of Science and*  
*Technology*

**4:00-5:30 PM**  
**Grand Ballroom E**  
**M4-C Symposium:**  
**ToxCast: Steps Toward**  
**the 'New Technology'**  
*Chairs: Richard Judson, Harvey*  
*Clewell*

**4:00 pm** **M4-C.1**  
 An Introduction to ToxCast™  
*Setzer RW*  
*US Environmental Protection Agency*

**4:20 pm** **M4-C.2**  
 Classification and dose-response char-  
 acterization of environmental chemi-  
 cals based on structured toxicity infor-  
 mation from ToxRefDB  
*Martin MT*  
*US Environmental Protection Agency*

**4:40 pm** **M4-C.3**  
 Predictive modeling of apical toxicity  
 endpoints using data from the EPA  
 ToxCast Program  
*Judson R, Dix D, Houck K, Martin M,*  
*Kavlock R, Shah I, Knudsen T*  
*US Environmental Protection*  
*Agency/ORD/NCCT*

**5:00 pm** **M4-C.4**  
 Assessing the exposure-dose-toxicity  
 relationship within the EPA's ToxCast  
 Program  
*Clewell HJ, Tsai LC, Dix DJ, Tan YM,*  
*Andersen ME, Thomas RS*  
*The Hamner Institutes for Health*  
*Sciences*

**4:00-5:30 PM**  
**Commonwealth A**  
**M4-D Symposium:**  
**Reform of Risk**  
**Regulation in the**  
**European Union**  
*Chair: Jonathan Wiener*

**4:00 pm** **M4-D.1**  
 How to manage the Regulatory State?  
 Current developments in the EU's risk  
 management processes  
*Allio L*  
*King's College London*

**4:20 pm** **M4-D.2**  
 The better regulation initiative at the  
 judicial gate  
*Alemanno AA*  
*European Court of Justice*

**4:40 pm** **M4-D.3**  
 What is the prospect of risk-based regu-  
 lation in Sarkozy's France?  
*Bouder FE*  
*King's Centre for Risk Management,*  
*King's College London*

**5:00 pm** **M4-D.4**  
 Better regulation in Italy: making a  
 virtue out of necessity  
*Torriti J*  
*European University Institute*

**4:00-5:30 PM**  
**Commonwealth B**  
**M4-E Food Safety Risks**  
*Chair: Emma Hartnett*

**4:00 pm** **M4-E.1**  
 The economic burden of foodborne ill-  
 ness in the United States  
*Scharff RL, Klontz K, Lasher A,*  
*Medeiros L, Nardinelli C, Zorn D\**  
*The Ohio State University, US Food*  
*and Drug Administration*

**4:20 pm** **M4-E.2**  
 Use of a model to rank risk of E. Coli  
 O157:H7 contamination in leafy greens  
*Estrin A, Robert AG, Nadeau L,*  
*Sertkaya A*  
*US Food and Drug Administration,*  
*Eastern Research Group, Inc.*

**4:40 pm** **M4-E.3**  
 Use of a risk-ranking model of  
 Salmonella contamination in fresh and  
 fresh-cut tomatoes and to evaluate cost  
 effectiveness of interventions  
*McLaughlin CR, Fenton C, Robert AG,*  
*Sertkaya A*  
*US Food and Drug Administration,*  
*Eastern Research Group, Inc.*

**5:00 pm** **M4-E.4**  
 Risk assessment for evaluating the pub-  
 lic health benefits of generic E. coli,  
 Salmonella, and Campylobacter  
*Golden NJ, Ebel E, Williams M*  
*Food Safety and Inspection Service*

**Monday, December 8**

<p align="center"><b>4:00-5:40 PM</b> <b>Commonwealth C</b></p> <p align="center"><b>M4-F Drinking Water &amp; Fish Consumption</b> <i>Chair: Jacqueline Patterson</i></p> <p><b>4:00 pm</b>                    <b>M4-F.1</b> National reconnaissance of the chemical quality of water from public-supply wells <i>Toccalino PL, Norman JE</i> <i>Federal Government</i></p> <p><b>4:20 pm</b>                    <b>M4-F.2</b> Evaluation of human exposure to organotin in drinking water transported by polyvinyl chloride pipe using probabilistic modeling <i>Fristachi A, Xu Y, Rice G, Impellitteri CA, Carlson-Lynch H, Little JC</i> <i>Battelle Memorial Institute, Virginia Tech, U.S. Environmental Protection Agency, Syracuse Research Corporation</i></p> <p><b>4:40 pm</b>                    <b>M4-F.3</b> Development of a screening-level fate and transport and fish bioaccumulation model for Minnesota ecosystems <i>Shapiro A, Burch D, McVey M, Humphrey N, Turley A, Dymond M</i> <i>ICF International</i></p> <p><b>5:00 pm</b>                    <b>M4-F.4</b> Fish consumption and mercury exposure in a US recreational fishing population <i>Lincoln RA, Vorhees D, Shine J, Chesney E, Grandjean P, Senn DB</i> <i>Harvard School of Public Health</i></p> <p><b>5:20 pm</b>                    <b>M4-F.5</b> An assessment of exposure to prescribed estrogens in drinking water <i>Nowak E, Caldwell D, Mastrocco F, Johnston J, Anderson P, Hoyt M, Pfeffier D</i> <i>Johnson &amp; Johnson Pharmaceutical Research and Development, LLC, Pfizer Inc, Wyeth, Giralda Farms, AMEC Earth &amp; Environmental</i></p>	<p align="center"><b>4:00-5:30 PM</b> <b>Otis</b></p> <p align="center"><b>M4-G Symposium: Emerging Contaminants: Challenges in Federal Detection, Analysis and Response</b> <i>Chair: Andrew Rak</i></p> <p><b>4:00 pm</b>                    <b>M4-G.1</b> The Federal and State response to identification, management, and response to emerging contaminants <i>Rak A, Gibb S</i> <i>Noblis</i></p> <p><b>4:20 pm</b>                    <b>M4-G.2</b> Overview of an emerging contaminants program and the role of chemical ranking <i>Gibb SK</i> <i>Noblis</i></p> <p><b>4:40 pm</b>                    <b>M4-G.3</b> DODs emerging contaminants response to perchlorate, hexavalent chromium and naphthalene <i>Hulla JE</i> <i>US Army Corps of Engineers</i></p> <p><b>5:00 pm</b>                    <b>M4-G.4</b> Evaluating emerging conaminant issues within DoD <i>Pitrat CA, Hutchens SL, Markiewicz ME, Rak A</i> <i>US Army Center for Health Promotion and Preventive Medicine</i></p>	<p align="center"><b>4:00-5:30 PM</b> <b>Stone</b></p> <p align="center"><b>M4-H Chemical Care and Prevention</b> <i>Chair: David Hassenzahl</i></p> <p><b>4:00 pm</b>                    <b>M4-H.1</b> Influence of the perceived severity of disease on probability perception <i>Savadori L, Barilli E, Pighin S*</i> <i>University of Trento, Italy</i></p> <p><b>4:20 pm</b>                    <b>M4-H.2</b> Effectiveness of food safety education for low-income pregnant women <i>Scharff RL, Medeiros L, LeJeune J, Kendall P, Sofos J</i> <i>The Ohio State University, Colorado State University</i></p> <p><b>4:40 pm</b>                    <b>M4-H.3</b> Risk assessment to evaluate lead exposure from a consumer product <i>Chaudhuri IS</i> <i>ENSR Corporation</i></p> <p><b>5:00 pm</b>                    <b>M4-H.4</b> A risk management approach to unused pharmaceuticals <i>Ruhoy IS, Hassenzahl DM</i> <i>University of Nevada, Las Vegas</i></p>	<p align="center"><b>4:00-5:30 PM</b> <b>Webster</b></p> <p align="center"><b>M4-I Symposium: Mental Modeling: Needs and Implementation Challenges</b> <i>Chair: Igor Linkov</i></p> <p><b>4:00 pm</b>                    <b>M4-I.1</b> Cognitive barriers in flood risk perception and management: mental modeling <i>Wood M, Bridges T, Linkov I</i> <i>Carnegie Mellon University, US Army Engineer Research and Development Center</i></p> <p><b>4:20 pm</b>                    <b>M4-I.2</b> Are we safe? can we trust you: expert model/mental models approach applied <i>Butte G, Thorne S, Bostrom A</i> <i>Decision Partners LLC</i></p> <p><b>4:40 pm</b>                    <b>M4-I.3</b> Using situational simulations/gaming environments to develop mental models of risk and decision-making <i>Watkins MT</i> <i>Michigan Tech</i></p> <p><b>5:00 pm</b>                    <b>M4-I.4</b> Using automated tools to analyze externalized mental models of risk and decision-making <i>Ifenthaler D, Pirnay-Dummer P</i> <i>Albert-Ludwigs-University Freiburg, Germany</i></p>	<p align="center"><b>4:00-5:30 PM</b> <b>Hancock</b></p> <p align="center"><b>M4-J Decision &amp; Risks for Aerospace Systems</b> <i>Chair: Roger Cooke</i></p> <p><b>4:00 pm</b>                    <b>M4-J.1</b> Addressing risks to earth from potentially hazardous Near Earth Objects (NEOs) <i>Race MS, Morrison D, Davies R, Harrison AA</i> <i>SETI Institute, NASA-Ames Research Center, Western Disaster Center, University of California Davis</i></p> <p><b>4:20 pm</b>                    <b>M4-J.2</b> Leadership of risk decision making in a complex aerospace organization: a deliberative decision making case study <i>Flaming SC</i> <i>Capella University</i></p> <p><b>4:40 pm</b>                    <b>M4-J.3</b> To boldly go... testing a structured decision approach for participatory mission planning at NASA <i>Arvai J, Gregory R</i> <i>Decision Research</i></p> <p><b>5:00 pm</b>                    <b>M4-J.4</b> Civil aviation transport safety modeled with non-parametric continuous Bayesian belief net <i>Cooke RM, Kurowicka D, Morales O, Ale B, Van Der Boom R, Roelen ALC, Spouge J</i> <i>Resources for the Future, Delft University of Technology</i></p>
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6:00-8:00 PM

Exhibit Hall

P Poster Session

**P.1** Partitioning health impact measures into likelihood and consequence components

Brand KP

University of Ottawa

**P.2** Ecological cost/benefit approaches in DECERNS

Grebenkov AJ, Yakushau AP, Lukashovich AG, Pluta SV

Joint Institute for Power and Nuclear Research D Sosny

**P.3** Uncertainty and variability in environmental externalities from coal-fired power plants in the United States

Levy JI, Baxter LK, Schwartz J  
Harvard School of Public Health

**P.4** Evaluating efficiency-equality tradeoffs for mobile source control strategies in an urban area

Levy JI, Greco SL, Melly SJ, Mukhi N  
Harvard School of Public Health

**P.5** Aggregate human health risk from exposure to toluene and xylenes using "Quality Adjusted Life-Years (QALYs)"

Makino R

National Institute of Advanced Industrial Science and Technology

**P.6** Development of a screening level tool to evaluate health impacts of electricity technology options

von Stackelberg KE, Nishioka Y, Levy JI  
Harvard Center for Risk Analysis

**P.7** Use of QALY for risk-benefit analysis for fish consumption in Japan

ZHANG Y, MASUNAGA SK

Yokohama National University

**P.9** Inhalation cancer risk from airborne polycyclic aromatic hydrocarbons measured in the Erie, PA region

Homan MM, Tallmadge W  
Gannon University

**P.11** Special considerations for industrial facilities in assessment of and response to vapor intrusion risks

Brown MJ, Beaulieu GM  
WSP Environment & Energy

**P.12** Evaluating risks associated with recreational use of streams in an urban setting

Praga R, Bartrand TA, Haas CN  
Drexel University

**P.13** "mc2d", an R package for two-dimensional Monte-Carlo simulations

Pouillot R, Delignette-Muller M-L, Denis J-B

Center for Food Safety and Applied Nutrition, Universite de Lyon, France, Institut National de la Recherche Agronomique, France

**P.14** A preliminary exposure assessment of microcystins from consumption of drinking water in the United States

Fristachi A, Rice G, Steevens J, Linkov I  
Battelle Memorial Institute, US Environmental Protection Agency, US Army Corps of Engineers

**P.15** The role of genetic polymorphism on Susceptibility to 2-Amino-1-methyl-6-phenylimidazo[4,5-b]pyridine

Kim D, Lee Y, Ryu H, Kim H, Lee J, Chang D, Kim Y, Park R, Moon J, Yoon H

National Institute of Toxicological Research

**P.16** The identification of risk factor in intake of the children favorite foods

Hwang JH, Ryeom TK, Oh WY, Shim JY, Seong SK, Jang DD, Lee HM  
Korea NITR

**P.17** The risk of developing obesity in African American women in Alabama

Abebe M, Tameru B, Nganwa D, Habtemariam T, Ayanwale L, Robnett V, Wilson W  
Tuskegee University

**P.18** Risk and risk-benefit assessment of contaminants in water: a combined epidemiology and traditional risk assessment model

Bucchini L, Prandi M  
Hylobates

**P.19** Development and demonstration of the risk and technology review multimedia human exposure and risk calculator for the U.S. Environmental Protection Agency

Cleland J, Burch D, Dederick E, Schoeneck L, Turley A, Shapiro A, Smith R  
ICF International, U.S. Environmental Protection Agency

**P.20** Case studies of non-paint sources of lead exposures in the United States

Coluccio V, Vetrano K  
TRC

**P.21** Inverse analysis of emission source around high-concentration monitoring points by using METI-LIS model

Kajihara H, Takai A, Yoshikado H  
National Institute of Advanced Industrial Science and Technology (AIST), Saitama University

**P.22** Risk assessment of cadmium intake from food in Japan

Hara T, Kayama F, Koizumi N\*  
Commissioner, Food Safety Commission, Japanese Government

**P.23** Quantitative risk assessment for *Listeria monocytogenes* reduction on poultry products during post-package thermal processing

Li M, Li YB  
University of Arkansas

**P.24** Microbial risk assessment: overview

Marcum T, Julius C, Luke N  
Camp Dresser & McKee Inc.

**P.25** Measurement error in disinfection by-product exposure assessment due to spatial and temporal variability

Meyer AM, Wright JM  
Oak Ridge Institution for Science and Education

**P.26** A Risk assessment of acrylamide intake from drinking coffee

Nieh C  
University of Illinois at Chicago

**P.27** A flexible computational approach for estimating cancer risks from exposure to mutagenic carcinogens during early life stages

Stineman CH  
Ecology and Environment, Inc.

**P.28** Programs to facilitate exchange of risk assessment information among states: the State Hazard Evaluation Lending Program (StateHELP)

Kroner O, Dourson M, Patterson J, Maier A, Wullenweber A  
Toxicology Excellence For Risk Assessment (TERA)

**P.29** Derivation of Immediately Dangerous to Life or Health (IDLH) values for high priority chemicals to emergency response personnel using refined methodology

Maier A, Parker A, Dotson GS, Geraci CL

Toxicology Excellence for Risk Assessment (TERA), The National Institute for Occupational Safety and Health (NIOSH)

**P.31** Using human therapeutic data to assess potential risks from pentaerythritol tetranitrate at contaminated sites

Weinrich AJ, Choudhury H  
US EPA National Center for Environmental Assessment

**P.32** Characterizing the quantitative features of hormetic dose-responses in a single high-throughput assay evaluating anticancer agents

Nascarella MA, Calabrese EJ  
University of Massachusetts Amherst

**P.33** Dose metric issues pertaining to microbial risk assessment

Swartout JC  
U.S. Environmental Protection Agency

**P.35** Effect of exercise in dusty air on respiratory health: a twin study

Lin MH, Ho WC, Ho CC, Lin YS, Chen PC, Wu TN, Lin RS  
China Medical University, Taichung, Taiwan

**P.36** Body mass index may modify the short-term effect of ozone on the pulmonary function in young children

Ho CC, Ho WC, Lin MH, Hsu HT, Lien CH, Shiao GM, Chen PC, Lin RS  
China Medical University, Taichung, Taiwan

## Monday, December 8

- P.37** Prediction uncertainty in risk assessment  
*Farrar D, Wang NCY*  
*EPA/ORD/NCEA*
- P.38** Test of treatment related trend for clustered exchangeable discrete data using stochastic ordering  
*Cheon K, Szabo A, George E, ,*  
*The University of Memphis; Medical College of Wisconsin*
- P.39** Process of communicating risk in concerned workers  
*Geckle LS*  
*West Chester University*
- P.41** Synergy between public and academic sectors focused in the administration of major industrial risks: Bogota/Colombia  
*Batista J, Quintero F, Puerto G, Munoz F*  
*Private University*
- P.42** Public Perceptions of Public Meetings  
*Besley JC, McComas KA, Trumbo CW*  
*University of South Carolina*
- P.43** Science and art - an interaction tool or a great risk?  
*Borodyanska IN, Shamo TI*  
*Nuernberg Conservatoire, Rodnik eV*
- P.44** Why can't they get it right? Mobilizing journalism, government accountability, and the autism-vaccine controversy  
*Clarke C*  
*Cornell University*
- P.45** The effects of presenting imprecise probabilities in intelligence forecasting  
*Dieckmann NF, Mauro R, Slovic P*  
*Decision Research & University of Oregon*
- P.46** Visual literacy and complex science: implications for risk communication  
*Eosco G, Halpern M, Scherer C*  
*Cornell University*
- P.47** Money matters: how economic status influences perceptions of potential terrorism-related outcomes in the community  
*Gibson S, Lemyre L, Lee JEC*  
*University of Ottawa*
- P.48** Ritualistic risk taking: the case of US college females upon turning twenty-one  
*Gordon JC, Crouse A*  
*Kansas State University*
- P.49** The influence of statistics in climate change frames  
*Hart PS*  
*Cornell University*
- P.50** HIV risk communication in a culturally diverse environment in Mexico  
*Holtz CS, Friedman MA*  
*Kennesaw State University, Univ. Louisville School of Medicine*
- P.51** Trust and terrorism: citizen responses to anti-terrorism history  
*Johnson BB*  
*Rutgers University*
- P.52** Disclosing uncertainty in government risk communication: citizens' perspective  
*Markon M-P L, Crowe J, Lemyre L*  
*University of Ottawa*
- P.53** The economics of doom: media responsibility in covering predicted catastrophes  
*Swain KA*  
*University of Mississippi*
- P.54** Institutional trust moderates the effect of source credibility and value similarity on perception of risk for in-situ uranium mining  
*Trumbo CW, McComas KA, Besley JC*  
*Colorado State University, Cornell University, University of South Carolina*
- P.55** The external fetal monitor: an obstetric risk communication system  
*Uban NM, Liaschenko J*  
*State University (University of Minnesota)*
- P.56** Differences by gender using confirmatory factor analysis  
*Vittini CA, Gutierrez VV, Bronfman NC*  
*Universidad Diego Portales*
- P.57** Exploring occupational risk communication and workplace culture among Green Industry pesticide applicators in New York State  
*Rickard LN, Dantzer HC*  
*Cornell University*
- P.59** Use of Years of Potential Life Lost (YPLL) as a risk management tool at hazardous waste sites  
*Greenberg GI, Beck BD*  
*Gradient Corporation*
- P.60** "Greener" peer review meetings - as close as your PC  
*Patterson J, Nance PM, Dourson ML*  
*Toxicology Excellence for Risk Assessment (TERA)*
- P.61** Development of a post graduate curriculum in risk management  
*Watt J*  
*Middlesex University Centre for Decision Analysis and Risk Management*
- P.64** An ecological risk assessment of the impact of whirling disease on populations of Rio Grande cutthroat trout in the southwestern United States  
*Landis WG, Kaminski LA, Bryant PT, Caldweell CA*  
*Institute of Environmental Toxicology WWU, US Geological Survey*
- P.65** Probabilistic risk assessment for polycyclic aromatic hydrocarbons (PAHs) in road runoff in Beijing, China  
*Zhang W, Ye YB, Wang XJ*  
*Peking University*
- P.66** Microbial risk assessment: activities and applications within the food safety and inspection service  
*Eblen DR, Schroeder C\**  
*United States Department of Agriculture Food Safety and Inspection Service*
- P.67** EPA's microbiological risk assessment efforts to support regulatory programs  
*Schaub SA*  
*US Environmental Protection Agency*
- P.68** FDA/CFSSAN food safety risk assessment activities, applications, and advancements  
*Dennis SB*  
*Food and Drug Administration*
- P.69** Quantitative risk assessment for Salmonella in raw frozen chicken nuggets  
*Dominguez SA, Schaffner DW*  
*Rutgers University*
- P.70** Information resources for food safety risk assessment  
*Gendel SM, McKillop K*  
*FDA/CFSSAN, JIFSSAN*
- P.71** Modeling norovirus transmission in the foodservice systems  
*Li D, Schaffner DW*  
*Rutgers University*
- P.72** Experience with the Listeria monocytogenes risk ranking algorithm for sampling allocation of Listeria rule establishments and significant correlation of establishment rank with sampling results  
*LaBarre DD, Gallagher DL, Hicks-Quesenberry H, Schroeder C, Kause J*  
*Food Safety and Inspection Service United States Department of Agriculture*
- P.73** Multicriteria spatial decision support system DECERNS WebSDSS for risk based land management  
*Yatsalo B, Didenko V, Tkachuk A, Mirzeabasov O, Gritsuk S, Shipilov D, Slipenkaya V, Grebenkov A, Sullivan T, Linkov I*  
*Obninsk State Technical University of Nuclear Power Engineering (IATE), Russia*
- P.74** Multicriteria decision analysis within DECERNS WebSDSS  
*Tkachuk A, Yatsalo B, Gritsuk S, Shipilov D, Mirzeabasov O, Didenko V, Sullivan T, Linkov I*  
*Obninsk State Technical University*
- P.75** Analyzing benefits & costs of security when facing adaptive adversaries  
*Ross RG*  
*Department of Homeland Security Science and Technology*
- P.76** Modeling secrecy and deception in a multiple-period attacker-defender signaling game  
*Zhuang J, Bier V, Alagoz O*  
*University at Buffalo, SUNY, University of Wisconsin-Madison*

- P.77** Effects of the display of evacuation condition in a local area on decisions to evacuate  
*Inaba M, Tanaka K*  
*University of Electro-Communications*
- P.78** Measuring the human health risk reduction from medical countermeasure strategies  
*McMillan NJ, Carnell RC, Hale TL, Dingus CA*  
*Battelle Memorial Institute*
- P.79** Importance of event identification and countermeasure delivery in medical mitigation strategies for bioterrorism  
*Middleton JK, Hale TL, McMillan NJ, Dingus CA, Burns JM, Wheeler ED*  
*Battelle Memorial Institute*
- P.80** Novel domoic acid risk assessment framework: new considerations for two susceptible populations  
*Scherer AC, Younglove LR, Griffith WC, Krogstad FTO, Tsuchiya A, Faustman EM*  
*University of Washington*
- P.81** Risk assessment of nanoparticles impact on organism based on biological markers system  
*Mikhailenko VM, Ieleiko LO, Glavin OA, Sorochinska JB*  
*R.E.Kavetsky Institute of Experimental Pathology, Oncology and Radiobiology of National Academy of Sciences*
- P.82** Integrative tools for improving our evaluation of accountability: lessons for pesticide biomarker studies  
*Vigoren EM, Griffith WC, Krogstad F, Faustman EM*  
*University of Washington*
- P.83** Development of a hazard assessment framework for quantitative risk trade-off analysis of chemical substances  
*Gamo M, Kishimoto A, Kanefuji K, Tsubaki H*  
*National Institute of Advanced Industrial Science and Technology (AIST), The Institute of Statistical Mathematics*
- P.84** Assessment of health protectiveness of the risk-based groundwater remediation standards of the midwestern states  
*Erdal S, Carollo AN*  
*University of Illinois-Chicago*
- P.85** A multi-factorial risk prioritization framework for food-borne pathogens  
*Ruzante JM, Fazil A, Davidson VJ, Cranfield JAL, Henson SJ, Caswell JA, Anders SM, Schmidt C, Farber J*  
*University of Guelph*
- P.87** Risk path finder for FoodRisk.org  
*Maeda Y, Gendel S, Long W, Parish M, Lei D*  
*Shizuoka University, Food and Drug Administration, University of Maryland*
- P.88** Development of Rapid Risk Assessment Framework (r-raf) by FDA/CFSAN for use during emergency/crisis situations  
*Flari V, Dennis S*  
*CFSAN, FDA*
- P.89** The Port of Poti: a case study in risk assessment of a commercial port for military usage  
*Proper K, Taylor T, Magerijl R*  
*University of Phoenix*
- P.90** Risk and sustainable development: an overview of the issues  
*Louis GE*  
*University of Virginia*
- P.91** Development of public policies for the major industrial risk administration based in the analysis of critical events in a storage zone of hydrocarbons: Bogota/Colombia  
*Rosas C, Fajardo H, Puerto G, Munoz F*  
*Private University*
- P.92** Under-screening for colorectal cancers. Persons and Physicians' explanations  
*Eisinger F, Cals L, Calazel-Benque A, Blay JY, Pivot X, Rixe O, Serin D, Namer M, Roussel C, Morere JF*  
*Institut Paoli-Calmettes; INSERM UMR 912*
- P.93** Risk factor analysis - body lesions of cart-pulling equines in Sherbin, Egypt  
*Madany MM, Rostom A, Childs AC, Eager RA*  
*Brooke Hospital for Animals*
- P.94** Risk Assessment (RA) in working equine welfare  
*Eager RA, Rostom A, Madany MM, Childs AC*  
*Brooke Hospital for Animals*
- P.95** Plagiarism in the undergraduate community: decision making and risk analysis  
*Boersma HJ*  
*University of Massachusetts- Boston*
- P.96** Selection and application of important determinants of aviation insurance  
*Lin Yi Hsin*  
*Asia University, Taiwan*
- P.97** An assessment of exposure to nanoscale materials in drinking water  
*Ferland H, Anderson P*  
*AMEC Earth and Environmental*
- P.102** The effects of acute exposure to Methyl Isothiocyanate (MITC)  
*Dourson ML, Kohrman MJ, Cain WS*  
*Toxicology Excellence for Risk Assessment (TERA) (1,2); University of California (3)*
- P.103** Risk factors and theory building as an alternative to the causal chain framework: a study to improve maritime safety  
*Szwed PS*  
*US Coast Guard Academy*
- P.104** Systematic review of the literature on communicating uncertainty associated with environmental health risks  
*Jardine CG, Given LM, Driedger SM, Routledge M, Ritcey C, McMillan A*  
*University of Alberta*
- P.105** Public health risks associated with cadmium accumulation in Puget Sound shellfish  
*Lindquist SK, Bastaki M*  
*The Evergreen State College (MB, SKL)*
- P.106** Modelling the cost-effectiveness of risk reducing measures  
*van der Vlies AV*  
*Radboud University Nijmegen*
- P.107** F344/N Rats show biphasic nonmonotonic responses to subchronic levels of antimony potassium tartrate  
*Walker JT, Walker OA, Diwan S*  
*US Environmental Protection Agency*
- P.109** Building trust in counterweight to risks in inter-organisational relations of business networks in Russia  
*Weck M\**  
*Häme University of Applied Sciences*
- P.110** Effect of fulvic acid fractions on the removal efficiency of permanent organic pollutants by algae  
*Aimin Li AL, Xujun Wang XW*  
*Peking University*
- P.111** Polycyclic aromatic hydrocarbons (PAHs) in road dust in Beijing, China: the potential risk for environment  
*Ye YB, Zhang W, Wang XJ*  
*Beijing University*
- P.112** Quantifying the level of knowledge of health risks for new tobacco products: development of a Measurement Certainty Index  
*Kallischnigg G, Weitkunat R, Browne H, Smith M, Sanders E, Dempsey R, Urban HJ*  
*Philip Morris International*
- P.113** Derivation of an Oral Cancer Slope Factor for 4-(Methylnitrosamino)-1-(3-pyridyl)-1-butanone using three approaches  
*Naufal ZS, Kathman SJ, Wilson CL*  
*Duke University, RJ Reynolds Tobacco Co.*
- P.114** A Probabilistic Cancer Risk Assessment Model of 4-(Methylnitrosamino)-1-(3-pyridyl)-1-butanone in Smokeless Tobacco  
*Naufal ZS, Kathman SJ\*, Wilson CL*  
*Duke University, RJ Reynolds Tobacco Co.*
- P.115** From smoke to disease risk modelling. An integrated approach for risk assessment of potential reduced-risk tobacco products  
*Martin Leroy C, Hoeng J, Browne H, Birthistle K, Dempsey R\*, Kallischnigg G, Smith M, Sanders E*  
*Philip Morris Products S.A., Research & Development, Neuchatel, Switzerland*



**P.116** Benefit-cost analysis to develop targets for ambient air sampling

*Huang Y, Hong T, Gurian PL, Haas CN, Bartrand T, Tamarakar S, Weir M Drexel University*

**P.117** Industrialized food risks and green consumerism: towards a multidimensional approach

*Vandermoere FV, Blanchemanche S Agroparistech Metarisk*

**P.118** Can QMRA be used to discount pathogen risk to swimmers from animal fecal contamination? Doheny Beach, CA case study

*Schoen M, Ashbolt N Environmental Protection Agency*

**P.119** Expert elicitations to value technology R&D for mitigating climate change

*Baker ED, Chon HW, Keisler JM\* University of Massachusetts Amherst, University of Maryland, University of Massachusetts Boston*

**P.120** Open assessment on impacts of emission trading on city-level

*Pohjola MV, Kollanus V, Jantunen M, Ahtoniemi P, Tuomisto JT National Public Health Institute (KTL)*

**P.121** Quantitative risk assessment for *Listeria monocytogenes* in selected categories of deli meats: impact of lactate-diacetate on listeriosis cases

*Pradhan AK, Ivanek R, Grohn YT, Geornaras I, Sofos J, Wiedmann M Cornell University, Colorado State University*

**P.122** The MIASMA model for exposure to indoor emission sources

*Henning CC, Shapiro AJ, Rosenbaum AS, Turley AT\*, Palma T, Langstaff JE ICF International, EPA/OAQPS*

**P.123** Public health planning and surveillance: the importance of maps and geographic information systems for analyzing and communicating risk

*Driedger SM, Kothari A, Rush-Sirski A\*, Zahab M, Morrison JB, Sawada M, Crighton E, Graham ID University of Manitoba, Univeristy of Ottawa, University of Western Ontario*

**P.124** Risk assessment method based on strict scientific criticism

*Tuomisto JT, Pohjola MV National Public Health Institute (KTL)*

**P.125** Integrating analysis and deliberation to evaluate biodiesel occupational and environmental exposures

*Traviss N Keene State College*

**P.126** Calibration of subjective judgments for long-term energy demand through bounding analysis

*Schweizer VJ, Morgan MG Carnegie Mellon University*

**P.127** Risk Perception and Behavior among the Poor: Design of Policy and Poverty Alleviation Programs

*Anderson CL, Cullen AC, Fletschner D, Gordon AC, Nguyen M University of Washington, Seattle, Institute FGS Hanoi, Vietnam*

**P.128** Sustaining Disaster Policy: A Commitment Based Mitigation Model

*Koc E Middle East Technical University, Turkey*

**P.129** Agroterrorism and Farm Management

*Moses M, Goldsmith D The George Washington University*

**P.130** Pandemic Flu Planning for the City of Alexandria, Virginia

*Moses MS., Clizbe J, Konigsberg C The George Washington School of Public Health and Health Services, The Alexandria Health Department*

**P.131** Community Ready! Assessing and Meeting the Needs of Parents in Arlington County, Virginia

*Moses MS, Caruso DS, Otten TG, Guidotti TL The George Washington School of Public Health and Health Services, Public Health Division, Department of Human Services, Arlington, VA*

**Join SRA for the  
December 6-9, 2009  
Annual Meeting  
in  
Baltimore, Maryland**

**Tuesday, December 9**

<p><b>10:30 AM-Noon</b> <b>Grand Ballroom C</b> <b>T2-A BSE: Health Risks</b> <i>Chair: Steve Anderson</i></p> <p><b>10:30 am</b>      <b>T2-A.1</b> Assessment of health risk to Taiwanese consumers from Canadian beef <i>Hsieh DPH, Wu CH, Chiang PH, Chen HL, Wen CP, Chang HY</i> <i>National Health Research Institutes; Center for Health Risk Management, China Medical University, Taiwan</i></p> <p><b>10:50 am</b>      <b>T2-A.2</b> Quantitative risk assessment for cattle contagious bovine spongiform encephalopathy in Taiwan <i>Liu WS, Liao HJ, Chou CC</i> <i>National Taiwan University</i></p> <p><b>11:10 am</b>      <b>T2-A.3</b> Incorporation of the mechanism of abnormal prion accumulation in the assessment of variant Creutzfeldt-Jakob Disease risk from daily beef consumption <i>Wu KY, Chen CC, Chang HY</i> <i>National Health Research Institutes, Taiwan</i></p> <p><b>11:30 am</b>      <b>T2-A.4</b> Toward improved risk communication about BSE: perceived risks of domestic beef in Japan based on the findings from a large-scale face-to-face interview survey <i>Yoshizawa N, Hikawa T, Hirakawa S, Nakajima S, Kohori N, Sata T</i> <i>Mitsubishi Research Institute, Inc.</i></p>	<p><b>10:30 AM-Noon</b> <b>Grand Ballroom D</b> <b>T2-B Visual Tools</b> <i>Chair: Hiromi Hosono</i></p> <p><b>10:30 am</b>      <b>T2-B.1</b> Evidence maps - a tool for summarizing and communicating evidence in assessment of uncertain noxes and its practical appliance: Two case studies <i>Spangenberg A, Fleischer T, Hocke-Bergler P, Kastenholtz H, Krug HF, Quendt C, Schuetz H, Wiedemann PM</i> <i>Research Center Juelich, Research Center Karlsruhe, EMPA</i></p> <p><b>10:50 am</b>      <b>T2-B.2</b> Visual validity: how scientific intent translates through visuals to evoke public understanding of science and risk assessment <i>Eosco GM</i> <i>Cornell University</i></p> <p><b>11:10 am</b>      <b>T2-B.3</b> Influence of the use of risk ladders on risk perception depending on numeracy <i>Keller C</i> <i>ETH Zurich, Institute for Environmental Decisions (IED)</i></p> <p><b>11:30 am</b>      <b>T2-B.4</b> Re-investigating the factors affecting consumers - food-related risk perception; a cross-national case study applying laddering method <i>Niiyama Y, Hosono H, Kawamura R, Kiyohara A, Kudo H, Kito Y</i> <i>Kyoto University, Ritsumeikan University, Chugokugakuen University</i></p>	<p><b>10:30 AM-Noon</b> <b>Grand Ballroom E</b> <b>T2-C Kinetics &amp; Mixtures in Risk Assessment</b> <i>Chairs: Jerry Campbell, Margaret MacDonell</i></p> <p><b>10:30 am</b>      <b>T2-C.1</b> Statistical tools for studying component effect and interactions in chemical mixtures toxicity <i>Parvez S, Venkataraman C, Mukherji S</i> <i>NCEA, US Environmental Protection Agency</i></p> <p><b>10:50 am</b>      <b>T2-C.2</b> A novel interaction-based algorithm for predicting biological doses during chronic exposures to chemical mixtures <i>Isukapalli SS, Sasso AF, Georgopoulos PG, Krishnan K</i> <i>Environmental and Occupational Health Sciences Institute, University of Montreal, Canada</i></p> <p><b>11:10 am</b>      <b>T2-C.3</b> Using simple kinetic models to integrate experimental datasets: lessons learned with chlorpyrifos <i>Griffith WC, Schumacher KM, Ramaprasad J, Faustman EM</i> <i>University of Washington</i></p> <p><b>11:30 am</b>      <b>T2-C.4</b> Nasal tissue dosimetry of naphthalene using a hybrid CFD-PBPK model for interspecies extrapolation: assessing variability in model derived human equivalent concentrations <i>Campbell, Jr. JL, Morris JB, Clewell, III HJ</i> <i>The Hamner Institutes for Health Sciences, University of Connecticut</i></p>	<p><b>10:30 AM-Noon</b> <b>Commonwealth A</b> <b>T2-D Symposium: Emotion, Values &amp; Cognition of Risk</b> <i>Chairs: Adam Finkel, Dan Kahan</i></p> <p><b>10:30 am</b>      <b>T2-D.1</b> The cultural cognition of risk: Mechanisms <i>Kahan DM</i> <i>Yale Law School</i></p> <p><b>10:50 am</b>      <b>T2-D.2</b> Values, emotion, and bounded rationality <i>Sunstein CR</i> <i>Harvard Law School</i></p> <p><b>11:10 am</b>      <b>T2-D.3</b> The affect heuristic &amp; the cultural theory of risk <i>Slovic P</i> <i>Decision Research</i></p> <p><b>11:30 am</b>      <b>T2-D.4</b> Numeracy and the perception and communication of risk <i>Peters EM</i> <i>Decision Research</i></p>	<p><b>10:30 AM-Noon</b> <b>Commonwealth B</b> <b>T2-E Air Pollution</b> <i>Chair: Chris Dockins</i></p> <p><b>10:30 am</b>      <b>T2-E.1</b> Development of de minimis emission rates for screening ingestion exposures to persistent and bioaccumulative hazardous air pollutants <i>Burch DF, Turley AT, Shapiro A, McVey MM, Schoeneck E, Cleland J, Smith RL</i> <i>ICF International, US Environmental Protection Agency</i></p> <p><b>10:50 am</b>      <b>T2-E.2</b> Evaluation of health benefit of acute mortality due to PM10 and PM2.5 <i>Shin DC, Lee YJ, Lim YW, Yang JY, Kim CS</i> <i>Institute for Environmental Research, College of Medicine, Yonsei University, Korea</i></p> <p><b>11:10 am</b>      <b>T2-E.3</b> Characterization of the economic and public health impacts of traffic congestion <i>von Stackelburg K, Buonocore JJ, Smith TJ, Levy JI</i> <i>Harvard School of Public Health</i></p> <p><b>11:30 am</b>      <b>T2-E.4</b> Comparative study on countermeasures for health risk by exposure to asbestos in Japan <i>Fujinaga A, Ishikawa H</i> <i>Osaka Prefectural College of Technology</i></p>
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**10:30 AM-Noon**  
**Commonwealth C**  
**T2-F Symposium: Model Evaluation: Getting the Predictions Right, Part I**  
*Chair: Pamela Williams*  
**10:30 am** **T2-F.1**  
Evaluation practices used across EPA for determining when an environmental model is suitable for informing decisions  
*Gaber N, Foley G, Nachman K, Sunderland E*  
*Council for Regulatory Environmental Modeling, Office of the Science Advisor, US Environmental Protection Agency*

**10:50 am** **T2-F.2**  
On the evaluation of chemical fate and transport models  
*Israelsson PH, Connolly JP*  
*Quantitative Environmental Analysis, LLC*

**11:10 am** **T2-F.3**  
How well are we predicting fish tissue concentrations?  
*von Stackelberg K*  
*Consulting*

**11:30 am** **T2-F.4**  
Improving risk predictions through the integration of spatial heterogeneity and habitat suitability: an application of the Spatially-Explicit Exposure Model (SEEM)  
*Johnson MS, Quinn MJ, Wickwire WT*  
*US Army Center for Health Promotion and Preventive Medicine*

**10:30 AM-Noon**  
**Otis**  
**T2-G Symposium: Life Cycle Impacts Assessment in Application of High Uncertainty: Decision-Making for Nanomaterials**  
*Chair: Thomas Seager*  
**10:30 am** **T2-G.1**  
A critique of LCA with respect to nanomaterial applications  
*Seager TP, Landi BR, Raffaella RP*  
*Golisano Institute for Sustainability, Rochester Institute of Technology*

**10:50 am** **T2-G.2**  
Probabilistic and Monte Carlo risk models for carbon nanomaterial production processes  
*Ok ZD, Benneyan JC, Isaacs JA*  
*Northeastern University*

**11:10 am** **T2-G.3**  
Life cycle energetic evaluation of carbon nanofiber polymer composites  
*Khanna V, Bakshi B.R.*  
*The Ohio State University*

**10:30 AM-Noon**  
**Stone**  
**T2-H Epidemiology & Environmental Risk Assessment**  
*Chairs: Clark Carrington, Mark Weir*  
**10:30 am** **T2-H.1**  
Interaction of birth weight and air pollution related to asthma, a discordant twin study  
*Ho WC, Lin MH, Ho CC, Lu L, Hsieh CJ, Chen PC, Lin RS*  
*China Medical University, Taichung, Taiwan*

**10:50 am** **T2-H.2**  
Strategies to protect children from environmental hazards: the example of lead  
*Guidotti TL*  
*George Washington University*

**11:10 am** **T2-H.3**  
Health profile and vulnerability assessment for a low-income, multi-ethnic population exposed to multiple built-environment stressors in Worcester, Massachusetts  
*Downs TJ, Ross L*  
*Clark University*

**11:30 am** **T2-H.4**  
Using epidemiological data for dose-response modeling: fish consumption and cardiovascular disease  
*Carrington CD, Bolger PM*  
*US Food and Drug Administration*

**11:50 am** **T2-H.5**  
Microbial dose response modeling in the 21st century: the development of mechanistic dose response models  
*Weir MH, Haas CN*  
*Drexel University*

**10:30 AM-Noon**  
**Webster**  
**T2-I Symposium: Homeland Security Risk Management: A Look Under the Hood**  
*Chair: Robert Ross*  
**10:30 am** **T2-I.1**  
Comparison of Homeland Security risk assessment methodologies  
*Smith CM, Parnell G*  
*United States Military Academy*

**10:50 am** **T2-I.2**  
Improving risk and intelligence analyst collaboration  
*Baker JC*  
*HSI*

**11:10 am** **T2-I.3**  
Supporting medical countermeasure decision-making in the Federal Government  
*Bennett SP*  
*US Department of Homeland Security*

**11:30 am** **T2-I.4**  
Homeland Security risk management - A status report  
*Ross RG, Gabbrielli T, Kolasky R*  
*Department of Homeland Security*

**10:30 AM-Noon**  
**Hancock**  
**T2-J Symposium: Building Resilience to Extreme Events Within Regional Infrastructure Systems**  
*Chair: Tim McDaniels*  
**10:30 am** **T2-J.1**  
Worst case electricity scenarios: the benefits & costs of prevention  
*Apt J, Lave LB, Morgan MG*  
*Carnegie Mellon University*

**10:50 am** **T2-J.2**  
Characterizing failures and building resilience in infrastructure systems  
*Chang SE, McDaniels TL, Reed D, Longstaff H*  
*University of British Columbia, University of Washington*

**11:10 am** **T2-J.3**  
Fostering regional resilience in disasters: setting priorities for mitigation efforts  
*Longstaff H, McDaniels T, Hawkins D, Chew G, Chang S*  
*The University of British Columbia*

**11:30 am** **T2-J.4**  
Building regional resilience: characterizing vulnerability of infrastructure systems to an earthquake scenario  
*McDaniels TL, Chang SE, Fox JA, Dhariwal R, Reed D, Longstaff H, Chew G*  
*University of British Columbia, University of Washington*

**T1 = 8:30-10:00 am**  
**(Plenary Session see page 7)**  
**T2 = 10:30 am-Noon**  
**T3 = 2:00-3:30 pm**  
**T4 = 4:00-5:30 pm**

2:00-3:30 PM

**Grand Ballroom C**

**T3-A Poster Platform:  
Practicing the Science and  
the Art: Real World Case  
Studies in Sample  
Collection for Chemical  
and Microbial Assessment**

*Chairs: Marianne Miliotis,  
Tonya Nichols*

**T3-A.1** Sample to sample analysis: improvement in detection and recovery  
*van Gieson EJ, Quizon R, Quizon J, Proescher A  
Johns Hopkins Applied Physics Laboratory*

**T3-A.2** Innovative thinking: how to validate a sampling plan and lessons learned from a validation exercise  
*Brooks LR  
Department of Homeland Security*

**T3-A.3** Determining recovery rates of microbes for different poultry carcass rinse volumes to estimate total carcass-level pathogen counts  
*Ebel, ED, Williams, MS, Golden, NJ  
Risk Assessment and Residue Division, Food Safety Inspection Service, USDA*

**T3-A.4** Listeria sampling plans - considerations and selection  
*Hwang C  
ERRC-ARS-USDA*

**T3-A.5** Tackling the true prevalence of Listeria monocytogenes in 16 tons of frankfurters  
*Luchansky JB  
USDA/ARS/ERRC*

**T3-A.6** Application of data quality objectives to operational range groundwater investigations  
*Borry B, Leach J, Thran B\*  
US Army Center for Health Promotion and Preventive Medicine*

2:00-3:30 PM

**Grand Ballroom D**

**T3-B Poster Platform:  
Culture and Risk  
Perceptions**

*Chair: Shoji Tsuchida*

**T3-B.1** Risk communication support platform: recent issues and lessons  
*Maeda Y  
Shizuoka University*

**T3-B.2** Public understanding of climate change: their logic and motivation for supporting climate change prevention actions  
*Aoyagi-Usui M, Sampei Y, Kuribayashi A, Shinada T  
National Institute for Environmental Studies*

**T3-B.3** Disaster risk governance: lights and shadows of disaster risk communication  
*Ikeda S, Nagasaka T, Usuda Y  
National Research Institute for Earth Science and Disaster Prevention, Tsukuba, Japan*

**T3-B.4** Risk perception of the Japanese: which has more effects on risk perception, affect or reason?  
*Tsuchida S  
Kansai University*

**T3-B.5** Understanding public risk perception of personalized nutrition: A comparison of Australia and The Netherlands  
*Pin RR, Critchley CR, Hardie EA  
University of Twente*

**T3-B.6** Cognitive misers or rational processors? The role of trust, awareness and benefit beliefs in predicting public support for health biotechnologies  
*Critchley CR  
Swinburne University of Technology*

**T3-B.7** Community acceptance of genetic technology for health promotion purposes: exploring the influence of perceived risks and benefits for Australians' intentions to have their genes tested.  
*Hardie EA, Critchley CR  
Swinburne University of Technology*

**T3-B.8** Risk and culture: the variations of perceptions of dioxin risk among seven social groups in Jeonju City, Korea  
*Park S  
State University of New York*

**T3-B.9** Media presentation of risks and benefits associated with nanotechnology and its cultural implication  
*Shih TJ, Tsai JY  
University of Wisconsin-Madison*

2:00-3:30 PM

**Grand Ballroom E**

**T3-C Symposium:  
Cumulative Risk  
Assessment Methods,  
Resources and  
Applications, Part I:  
Concepts, Incorporation  
of Human Data, and  
Exposure - Toxicity  
Groupings**

*Chairs: Linda Teuschler,  
Margaret MacDonell*

**2:00 pm** **T3-C.1**  
Cumulative risk assessment: integrating established approaches with new concepts to improve population health protection  
*Preuss PW, Teuschler LK, MacDonell MM  
US Environmental Protection Agency*

**2:20 pm** **T3-C.2**  
Cumulative risk assessment: considerations for quantifying the risk of exposure to multiple chemicals and stressors.  
*Wright JM, Hertzberg R, Rice G, Teuschler LK, Lipscomb J, Lambert J, MacDonell M  
US Environmental Protection Agency*

**2:40 pm** **T3-C.3**  
Exposure-based groupings to guide cumulative risk analyses  
*MacDonell MM, Rice GE, Picel KC, Hildebrand RD, Butler JP, Chang YS, Hertzberg RC, Haroun LA, Wright JM  
Argonne National Laboratory, US Environmental Protection AgencyPA, US Department of Education, Emory University, Environ*

2:20 pm

**T3-C.2**  
Cumulative risk assessment: considerations for quantifying the risk of exposure to multiple chemicals and stressors.  
*Wright JM, Hertzberg R, Rice G, Teuschler LK, Lipscomb J, Lambert J, MacDonell M  
US Environmental Protection Agency*

2:40 pm

**T3-C.3**  
Exposure-based groupings to guide cumulative risk analyses  
*MacDonell MM, Rice GE, Picel KC, Hildebrand RD, Butler JP, Chang YS, Hertzberg RC, Haroun LA, Wright JM  
Argonne National Laboratory, US Environmental Protection AgencyPA, US Department of Education, Emory University, Environ*

3:00 pm

**T3-C.4**  
Resource toolbox for cumulative risk assessment  
*Butler JP, MacDonell MM, Collie SL, Haroun LA, Hildebrand RD, Hertzberg RC, Finster ME  
Argonne National Laboratory, Synergy Toxicology, Environ, US Department of Education, Emory University*

2:00-3:30 PM

**Commonwealth A**

**T3-D Symposium: The  
Acceptability and the  
Tolerability of Life-Safety  
Risks**

*Chair: Martin Schultz*

**2:00 pm** **T3-D.1**  
Tolerable risk: state of the practice review  
*Linkov I, Schultz M, Bridges T, Moser D, Yoe C, Loney D  
US Army Corps of Engineers, College of Notre Dame of Maryland and Massachusetts Institute of Technology*

**2:20 pm** **T3-D.2**  
ALARP evaluation: justifying life-safety risk reduction using cost effectiveness and disproportionality  
*Bowles DS, McDonald LA  
Utah State University*

**2:40 pm** **T3-D.3**  
Use of tolerable risk guidelines for infrastructure management  
*Halpin EC, Snorteland ND, Regan PF  
US Army Corps of Engineers*

**3:00 pm** **T3-D.4**  
A demonstration of the application of a two-dimensional risk assessment for estimating risk management metrics for food safety  
*Crouch EA, LaBarre D, Dearfield K, Kause J, Golden NJ  
Cambridge Environmental Inc., Food Safety and Inspection Service*

2:20 pm

**T3-D.2**  
ALARP evaluation: justifying life-safety risk reduction using cost effectiveness and disproportionality  
*Bowles DS, McDonald LA  
Utah State University*

2:40 pm

**T3-D.3**  
Use of tolerable risk guidelines for infrastructure management  
*Halpin EC, Snorteland ND, Regan PF  
US Army Corps of Engineers*

3:00 pm

**T3-D.4**  
A demonstration of the application of a two-dimensional risk assessment for estimating risk management metrics for food safety  
*Crouch EA, LaBarre D, Dearfield K, Kause J, Golden NJ  
Cambridge Environmental Inc., Food Safety and Inspection Service*

2:00-3:30 PM

**Commonwealth B**

**T3-E Symposium: Valuing  
Health Risks I: Types of  
Death**

*Chairs: Lisa Robinson, Jim Hammitt*

**2:00 pm** **T3-E.1**  
Benefits transfer of VSL in an air pollution context: can expert elicitation help?  
*Roman HA, Stieb D, Walsh TL, Hammitt JK  
Industrial Economics, Inc., Health Canada, Harvard School of Public Health*

**2:20 pm** **T3-E.2**  
Valuing mortality risk reductions for environmental policy  
*Dockins C, Maguire K, Simon N  
US Environmental Protection Agency*



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**2:40 pm** **T3-E.3**  
Valuing mortality risk reductions for homeland security rules

*Robinson LA  
Consultant*

**3:00 pm** **T3-E.4**  
Discrete choice experiments: false friends for valuing mortality risk?

*Rheinberger CM  
WSL Swiss Federal Institute for Snow and Avalanche Research*

**2:00-3:30 PM**

**Commonwealth C**

**T3-F Symposium: Model Evaluation: Getting the Predictions Right, Part II**

*Chair: Katherine von Stackelberg*

**2:00 pm** **T3-F.1**  
Variability in model evaluation - A review of EPA exposure models

*Williams PRD, Hubbell BJ, Weber E, Fehrenbacher C, Hrdy D, Zartarian V  
US Environmental Protection Agency*

**2:20 pm** **T3-F.2**  
Evaluation of predictive multi-source, -route and -pathway exposure

*Driver JH, Ross JH, Pandian M, Assaf N  
infoscientific.com, Inc., risksciences.net, LLC*

**2:40 pm** **T3-F.3**  
Evaluation of a mathematical model used for estimating solvent exposures in the workplace

*Plisko MJ, Spencer JW  
Environmental Profiles, Inc.*

**3:00 pm** **T3-F.4**  
Model evaluation for regulatory air quality human exposure models: Real world challenges and perspective

*Richmond HM, Langstaff JE, Palma T, Graham SE  
US Environmental Protection Agency*

**2:00-3:30 PM**

**Otis**

**T3-G Symposium: Nanotechnology Risk and Regulation: From Public Perception to Oversight Policy**

*Chair: Jennifer Kuzma*

**2:00 pm** **T3-G.1**  
Nanotechnologies: perception of technological risk & constraints on benefit among comparative US/UK publics

*Harthorn BH, Pidgeon N  
University of California at Santa Barbara, Cardiff University-Wales*

**2:20 pm** **T3-G.2**  
Voices in the media on nanotechnology risks and regulation

*Friedman SM, Egolf BP  
Lehigh University*

**2:40 pm** **T3-G.3**  
Impact of information about risk and regulation on public perception of nanotechnology

*Priest SH, Yaros R, Greenhalgh T  
University of Nevada, Las Vegas*

**3:00 pm** **T3-G.4**  
Ethical and policy analysis of linkages between public perception and oversight of emerging technologies

*Kuzma J, Thompson P  
University of Minnesota, Michigan State University*

**2:00-3:30 PM**

**Stone**

**T3-H Symposium: Comprehensive Environmental Assessment of Ethanol: Applying Lessons Learned from the MTBE Experience to Biofuels**

*Chairs: Angela Howard, Andrew A. Rooney and J. Michael Davis*

**2:00 pm** **T3-H.1**  
Comprehensive environmental assessment of ethanol: applying lessons learned from the MTBE experience to biofuels

*Davis JM  
National Center for Environmental Assessment, US Environmental Protection Agency, Research Triangle Park*

**2:20 pm** **T3-H.2**  
Comparative analysis of human exposure profile of ethanol-based biofuels and oxygenated gasolines

*Erdal S, Freeman JL, Lin J  
University of Illinois-Chicago*

**2:40 pm** **T3-H.3**  
Ground and surface water quality issues related to ethanol production and use

*Bauman B, Rooney AA, Davis JM  
API*

**3:00 pm** **T3-H.4**  
Advantages of the comprehensive environmental assessment approach to evaluating trade-offs associated with ethanol and biofuels

*Rooney AR, Davis JM  
US Environmental Protection Agency*

**2:00-3:30 PM**

**Webster**

**T3-I Climate Change: Multidisciplinary Approaches**

*Chair: Donald Hornstein*

**2:00 pm** **T3-I.1**  
Human risk perceptions of climate change

*Dutt V, Gonzalez C  
Carnegie Mellon University*

**2:20 pm** **T3-I.2**  
Statistical examination of the possible link between climate change and hurricane hazard in the United States

*Nateghi R, Guikema SD  
Johns Hopkins University*

**2:40 pm** **T3-I.3**  
Prospect theory under uncertainty with application to assessing global environmental-economic policies

*Tamura H., Teraoka R.  
Kansai University*

**3:00 pm** **T3-I.4**  
Climate change and insurance: (In)coherence in financing adaptation under conditions of ambiguity

*Hornstein DT  
University of North Carolina School of Law*

**2:00-3:30 PM**

**Hancock**

**T3-J Infrastructure Interdependence and Modeling**

*Chair: Stanley Levinson*

**2:00 pm** **T3-J.1**  
Estimating risk and system performance of interdependent infrastructures during disasters

*Torres JM, Booker G, Bagchi A, Horbaczewski I, Brumbelow K, Sprintson A, Guikema SD  
Johns Hopkins University*

**2:20 pm** **T3-J.3**  
Risk-based strategic homeland preparedness: balancing protection and resilience in regional interdependent systems

*Crowther KG  
University of Virginia*

**2:40 pm** **T3-J.4**  
Clarification of interdependency associated with a system failure of critical infrastructure networks in views of a seismic risk

*Shoji G, Tabata M  
University of Tsukuba*

**4:00-5:30 PM**  
**Grand Ballroom C**  
**T4-A Poster Platform:**  
**Nanotechnology -**  
**International Perspectives**

*Chairs: S Foss-Hansen, Bert Hakkinen*

**T4-A.1** Environmental risks of polymeric nanomaterials  
*Bayramov AA*  
*Institute of Physics National Academy of Sciences of Azerbaijan*

**T4-A.2** Uncertainty and sensitivity analysis of environmental and health risks of nanomaterials  
*Grieger K, Hansen SF, Baun A*  
*Technical University of Denmark*

**T4-A.5** How much safe is safe enough? Nanomedicine and perceptions of risk.  
*Amorim T-A*  
*Santa Catarina Federal University*

**T4-A.6** Nano: Amplification and the new media  
*Martin KN*  
*North Carolina State University*

**T4-A.7** Nanotechnology and nanotoxicology: Challenges  
*Luke N*  
*Camp Dresser & McKee Inc.*

**T4-A.8** Engaging public into nanotechnology R&D: Challenges and progress  
*Sekiya M, Ishizu S, An S, Tanabe T, Ata M*  
*National Institute of Advanced Industrial Science and Technology*

**T4-A.9** Risk analysis for the nanomaterial fullerene C60  
*Shinohara N, Gamo M, Nakanishi J*  
*National Institute of Advanced Industrial Science and Technology (AIST)*

**4:00-5:30 PM**  
**Grand Ballroom D**  
**T4-B Mechanisms of**  
**Communication**

*Chair: Dorian Watts*

**4:00 pm T4-B.1**  
 Risk perception and communication in the blogosphere: data and observations  
*Emani S, Desroches C*  
*MGH Institute of Health Professions*

**4:20 pm T4-B.2**  
 Improving communication of weather forecast uncertainty information by understanding its use in decision making  
*Morss RE, Lazo JK, Demuth J*  
*National Center for Atmospheric Research*

**4:40 pm T4-B.3**  
 Service with a smile: Accidental Risk Communicators (ARCs) and the role of emotional labor  
*Rickard LN*  
*Cornell University*

**5:00 pm T4-B.4**  
 Media risk communication methods and the West Nile virus  
*Watts DE, Driedger SM*  
*University of Manitoba*

**4:00-5:30 PM**  
**Grand Ballroom E**  
**T4-C Symposium:**  
**Cumulative Risk**  
**Assessment Methods,**  
**Resources and**  
**Applications, Part II:**  
**Concepts, Incorporation**  
**of Human Data, and**  
**Exposure - Toxicity**  
**Groupings**

*Chairs: Margaret MacDonell, Linda Tueschler*

**4:00 pm T4-C.1**  
 Grouping chemicals by toxicity for cumulative risk assessment  
*Rice GE, Teuschler LK, Hertzberg R, Lipscomb JC, Lambert JC, Wright JM, MacDonell M*  
*US Environmental Protection Agency*

**4:20 pm T4-C.2**  
 Application of pharmacokinetic data in cumulative risk assessments  
*Lipscomb JC, Rice G, Lambert JC*  
*US Environmental Protection Agency ORD NCEA*

**4:40 pm T4-C.3**  
 Categorical regression modeling of multiple effects from chemical mixture exposures in cumulative risk assessment  
*Teuschler LK, Hertzberg RC*  
*UE Environmental Protection Agency*

**5:00 pm T4-C.4**  
 Handling uncertainties in cumulative risk characterization  
*Hertzberg RC, Rice G, Teuschler L, MacDonell MM*  
*Biomathematics Consultant*

**4:00-5:30 PM**  
**Commonwealth A**  
**T4-D Symposium:**  
**Chemicals Policy:**  
**REACH and CHAMP**

*Chairs: Jay West, Ron White*

**4:00 pm T4-D.1**  
 EPA's new Chemical Assessment and Management Program (ChAMP) and EPA's efforts under ChAMP  
*Sheridan D*  
*US Environmental Protection Agency*

**4:20 pm T4-D.2**  
 The animal welfare perspective on the benefits of tiered testing: application of the 3R's: refinement, reduction, replacement  
*Beck N*  
*Physicians Committee for Responsible Medicine*

**4:40 pm T4-D.3**  
 Methods and approaches for evaluating chemicals in commerce: using science to meet policy challenges  
*West J, Becker R*  
*American Chemistry Council*

**5:00 pm T4-D.5**  
 Application of REACH with respect to US companies: an opportunity to improve chemicals management activities in the United States  
*Tickner JA*  
*University of Massachusetts Lowell*

**4:00-5:30 PM**  
**Commonwealth B**  
**T4-E Symposium: Valuing**  
**Health Risks II: Children**

*Chairs: Sandra Hoffman, Lisa Robinson*

**4:00 pm T4-E.1**  
 VSL for children and adults: evidence from a survey in Italy  
*Alberini A, Chiabai A*  
*University of Maryland*

**4:20 pm T4-E.2**  
 The value of reducing children's mortality risk: effects of disease type and latency  
*Hammitt JK, Haninger K*  
*Harvard University, University of Pennsylvania*

**4:40 pm T4-E.3**  
 School buses, diesel emissions, and respiratory health  
*Beatty TKM, Shimshack JP*  
*York University, Tufts University*

**5:00 pm T4-E.4**  
 Integrating household perceptions into revealed preference models  
*Vasquez F, Hanemann MW, Brandt SJ*  
*University of Massachusetts, University of California*

**5:20 pm T4-E.5**  
 Estimating parental willingness to pay to reduce risk of neurological damage to children from lead paint: a test of the role of intra-household bargaining  
*Hoffmann S, Krupnick A, Adamowicz V, Bostrom A*  
*Resources for the Future, University of Alberta, University of Washington*

**Tuesday, December 9**

**4:00-5:30 PM**  
**Commonwealth C**  
**T4-F Variability and**  
**Uncertainty in Exposure**  
**Assessment**  
*Chair: Scott Ferson*

**4:00 pm** **T4-F.1**  
Conceptual framework for analysis of uncertainty in coupled models for the source-to-dose continuum  
*Özkaynak H, Frey HC, Burke J, Pinder R*  
*US Environmental Protection Agency*

**4:20 pm** **T4-F.2**  
Expert uncertainty in recycled water health risk assessment  
*Flander LB, McBride MF, Burgman MB*  
*University of Melbourne*

**4:40 pm** **T4-F.3**  
Contributors to variability in organophosphate and pyrethroid pesticide doses in a low-income urban environment  
*Wason SC, Smith TJ, Evans JS, Perry MJ, Levy JI*  
*Harvard School of Public Health*

**5:00 pm** **T4-F.4**  
Uncertainties in the estimate of cumulative exposure to organophosphate insecticides  
*Cochran RC, Ross JH, Li Y, Krieger RI*  
*California Department of Pesticide Regulation*

**5:20 pm** **T4-F.5**  
Probabilistic risk-cost-benefit analysis of additional benzene emissions controls  
*Eidson AF*  
*Shaw Environmental, Infrastructure, Inc.*

**4:00-5:30 PM**  
**Otis**  
**T4-G Food**  
*Chair: Swaroop Kher*

**4:00 pm** **T4-G.1**  
Motivating consumers to act during food recalls  
*Hallman WK, Cuite CL, Nucci ML, Hooker NH*  
*Rutgers, The State University of New Jersey*

**4:20 pm** **T4-G.2**  
To label or not to label of papaya fruits  
*Shehata S*  
*University of Hawaii at Hilo*

**4:40 pm** **T4-G.3**  
Is your diet as natural as you think it is? The relationship between diet patterns, consumer acceptance of chemicals in food and phthalate exposure through food  
*Dickson-Spillmann M, Keller C, Wormuth M, Lorenz C, Siegrist M*  
*Swiss Federal Institute of Technology Zurich*

**5:00 pm** **T4-G.4**  
Understanding consumer perceptions of food contaminants and vulnerabilities associated with food chains: results from a cross-national study  
*Kher SV, De Jonge J, Wentholt MTA, Frewer LJ*  
*Wageningen University*

**4:00-5:30 PM**  
**Stone**  
**T4-H Models, Myths, and**  
**Risk-Based Decision**  
**Making**  
*Chair: William Huber*

**4:00 pm** **T4-H.1**  
Don't confuse me with the facts!  
*Cain LG, Hanna C, Linkov I*  
*United States Army Corps of Engineers*

**4:20 pm** **T4-H.2**  
Scientific knowledge and mythology  
*Serbanescu D*  
*Private Participation*

**4:40 pm** **T4-H.3**  
Role of participatory approaches in developing risk assessments in equine welfare  
*Rostom A, Madany MM, Childs AC, Eager RA*  
*Brooke Hospital for Animals*

**5:00 pm** **T4-H.4**  
Optimal design of qualitative risk matrices to classify quantitative risks  
*Huber WA, Cox LA*  
*Quantitative Decisions, Cox Associates*

**5:20 pm** **T4-H.5**  
Self-fulfilling prophecy in health and disease management. A Meta risk  
*Eisinger F*  
*Institut Paoli-Calmettes; INSERM UMR 912*

**4:00-5:30 PM**  
**Webster**  
**T4-I Symposium: Risk**  
**Analysis to Support**  
**Counter-Terrorism,**  
**Security, and Disaster**  
**Response**  
*Chair: Henry Willis*

**4:00 pm** **T4-I.1**  
Estimating the effects of counter-terrorism on terrorist threat  
*John RS, Rosoff H*  
*University of Southern California*

**4:20 pm** **T4-I.2**  
Public response to terrorism: connecting links between perceived risk and economic impacts  
*Burns W*  
*Decision Research*

**4:40 pm** **T4-I.3**  
Using risk analysis and constructive simulation to evaluate border security technologies  
*MacKenzie C, Willis HH*  
*Stanford University, RAND Corporation*

**5:00 pm** **T4-I.4**  
Defender-attacker decision trees for terrorism risk analysis  
*von Winterfeldt D*  
*University of Southern California*

**4:00-5:30 PM**  
**Hancock**  
**T4-J Symposium: CRS**  
**Perspectives on**  
**Broadening Risk consid-**  
**erations for**  
**Infrastructure Design**  
*Chair: Brian Meacham*

**4:00 pm** **T4-J.1**  
General resource allocation for security and protection (GRASP): a framework for public administrators and private managers  
*Sarkis J, Azaria C, Ratick S, Meacham B, Thompson G, Goble R*  
*Clark University*

**4:20 pm** **T4-J.2**  
CRS criteria for testing the applicability of adaptive management concepts to emergency planning and response: a study case for fire  
*Meacham BJ, Sarkis J, Araiza C*  
*Worcester Polytechnic Institute, Clark University, Claremont Graduate University*

**4:40 pm** **T4-J.3**  
Application of set cover location modeling and hazard zone sets to site emergency and backup facilities  
*Ratick S, Meacham BJ*  
*Clark University, Worcester Polytechnic Institute*

**5:00 pm** **T4-J.4**  
Multi-criteria frameworks for considering diverse risks in infrastructure design  
*Thompson G*  
*Institute for Resource and Security Studies, Clark University*



<p><b>10:30 AM-Noon</b> <b>Grand Ballroom C</b> <b>W2-A Poster Platform:</b> <b>Biomonitoring &amp; Risk</b> <b>Assessment</b> <i>Chair: Scott Arnold</i></p> <p><b>W2-A.1</b> Biomonitoring - Introduction <i>Robison SH</i> <i>Procter and Gamble Company</i></p> <p><b>W2-A.2</b> Interpretation of benzene urinary biomarker data in populations with low-level exposures <i>Arnold SM, Price PS</i> <i>The Dow Chemical Company</i></p> <p><b>W2-A.3</b> The use of Biomonitoring Equivalents (BEs) in risk assessment <i>Hays SM, Aylward LL</i> <i>Summit Toxicology</i></p> <p><b>W2-A.4</b> Assessment of human biomonitoring data in a public health risk context: utility of biomonitoring equivalents <i>Aylward LL, Hays SM</i> <i>Summit Toxicology, LLP</i></p> <p><b>W2-A.5</b> Opportunities when human biomonitoring results are expressed in a health risk context <i>Becker RA</i> <i>American Chemistry Council</i></p> <p><b>W2-A.6</b> Probabilistic reverse dosimetry: using pharmacokinetic modeling to estimate population-scale distributions of exposure from biomonitoring data <i>Tan Y, Clewell H</i> <i>The Hamner Institutes for Health Sciences</i></p>	<p><b>10:30 AM-Noon</b> <b>Grand Ballroom D</b> <b>W2-B Public Participation</b> <i>Chair: Caron Chess</i></p> <p><b>10:30 am</b> <b>W2-B.1</b> Living with nuclear risk: a narrative approach <i>Pidgeon NF, Henwood KL, Parkhill K, Venables D, Simmons P</i> <i>Cardiff University</i></p> <p><b>10:50 am</b> <b>W2-B.2</b> Do fair procedures matter? An empirical investigation of a former disposal project for nuclear waste in Switzerland <i>Stauffacher M, Kruetli P, Scholz RW</i> <i>ETH Zurich</i></p> <p><b>11:10 am</b> <b>W2-B.3</b> The multiple meanings of dialoguing with the public in the evolving practice of public health communication <i>Hamilton JD, Wills Toker C</i> <i>Center for Health and Environmental Communication Research, Gainesville State College</i></p> <p><b>11:30 am</b> <b>W2-B.4</b> Public participation in environmental assessment and decision making: a National Research Council report <i>Dietz T, Stern PC, Bingham G, Chess C, Dekay ML, Fox JM, Lewis SC, Markus GB, North DW, Renn O</i> <i>Rutgers University</i></p>	<p><b>10:30 AM-Noon</b> <b>Grand Ballroom E</b> <b>W2-C Symposium: Low Dose Dose-Response and Thresholds in Health Risk Assessment: A Cross-Disciplinary Analysis of Key Events from Exposure to Adverse Effect</b> <i>Chair: Elizabeth Julien</i></p> <p><b>10:30 am</b> <b>W2-C.1</b> An introduction to the key events analytical framework and application to environmental chemicals <i>Daston G, Boobis A, Preston J, Julien E, Olin S</i> <i>Procter &amp; Gamble Company, Imperial College London, US Environmental Protection Agency, ILSI/RF</i></p> <p><b>10:50 am</b> <b>W2-C.2</b> The key events analytical framework: application to food allergens <i>Gendel SM, Houben GF, Taylor SL</i> <i>US Food and Drug Administration</i></p> <p><b>11:10 am</b> <b>W2-C.3</b> The key events analytical framework: a case study with <i>Listeria monocytogenes</i> <i>Havelaar AH, Smith MA, Whiting RC, Buchanan RL</i> <i>National Institute of Public Health and the Environment</i></p> <p><b>11:30 am</b> <b>W2-C.4</b> The key events analytical framework: a case study with retinol (Vitamin A) <i>Russell RM, Ross AC, Miller SA, Munro I, Yetley EA, Rodricks JV</i> <i>Tufts University</i></p>	<p><b>10:30 AM-Noon</b> <b>Commonwealth A</b> <b>W2-D Symposium:</b> <b>Integrating Criminology, Perception, and Communication to Better Understand Environmental Risks</b> <i>Chair: Meridith Gore</i></p> <p><b>10:30 am</b> <b>W2-D.1</b> Addressing international trade in electronic waste: integrating criminal justice strategies into risk management <i>Gibbs C, McGarrell E</i> <i>Michigan State University</i></p> <p><b>10:50 am</b> <b>W2-D.2</b> Persuasion, political ideology, and social identity theory: an investigation into factors that affect efforts to communicate climate change <i>Hart PS, Nisbet EC</i> <i>Cornell University</i></p> <p><b>11:10 am</b> <b>W2-D.3</b> Environmental and security risk perception <i>McGarrell EF, Gibbs C, Zimmermann CR</i> <i>Michigan State University</i></p> <p><b>11:30 am</b> <b>W2-D.4</b> Who's afraid of the big bad wolf? Some thoughts about values, environmental concern and perceived risk associated with wildlife management <i>Clarke C</i> <i>Cornell University</i></p>	<p><b>10:30 AM-Noon</b> <b>Commonwealth B</b> <b>W2-E Anthrax Attacks</b> <i>Chair: Greg Paoli</i></p> <p><b>10:30 am</b> <b>W2-E.1</b> Economic impacts of the amerithrax attacks <i>Schmitt K</i> <i>Concordia University</i></p> <p><b>10:50 am</b> <b>W2-E.2</b> Surface sampling areas required to inform risk-based responses to b. anthracis contamination <i>Hong T, Gurian PL</i> <i>Drexel University</i></p> <p><b>11:10 am</b> <b>W2-E.3</b> An evaluation of the risk threshold for prophylaxis and treatment after an anthrax release <i>Mitchell-Blackwood J, O'Donnell C, Gurian P</i> <i>Drexel University</i></p> <p><b>11:30 am</b> <b>W2-E.4</b> Consequence mitigation of hypothetical medical countermeasures for anthrax exposure in a bioterrorism attack <i>Hale TL, McMillan NJ, Dingus CA, Burns JM, Wheeler ED</i> <i>Battelle Memorial Institute</i></p>
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<b>10:30 AM-Noon</b> <b>Commonwealth C</b>	<b>10:30 AM-Noon</b> <b>Otis</b>	<b>10:30 AM-Noon</b> <b>Stone</b>	<b>10:30 AM-Noon</b> <b>Webster</b>	<b>10:30 AM-Noon</b> <b>Hancock</b>
<p><b>W2-F Symposium: Risk Regulation: Ideas for the Obama Administration</b> <i>Chair: Adam Finkel</i></p> <p><b>10:30 am</b>      <b>W2-F.1</b> The future of the Bush Administration Regulatory Reforms <i>Shapiro S</i> <i>Rutgers University</i></p> <p><b>10:50 m</b>      <b>W2-F.2</b> Improving the regulatory process in the new administration <i>Bass GD</i> <i>OMB Watch</i></p> <p><b>11:10 am</b>      <b>W2-F.3</b> Ten ideas to improve regulatory oversight <i>Wiener JB</i> <i>Duke University</i></p> <p><b>11:30 am</b>      <b>W2-F.4</b> Eliminating anti-regulatory biases <i>Revesz R</i> <i>New York University</i></p> <p><b>11:50 am</b>      <b>W2-F.5</b> Regulation and the new administration <i>Katzen S</i> <i>University of Michigan Law School</i></p> <p><b>12:10 pm</b>      <b>W2-F.6</b> Enhancing regulatory oversight <i>Graham JD</i> <i>Indiana University School of Public and Environmental Affairs</i></p>	<p><b>W2-G Nano: Uncertainty, Disclosure &amp; Business Needs</b> <i>Chair: Halina Brown</i></p> <p><b>10:30 am</b>      <b>W2-G.1</b> GRI as a model for company reporting on nanotechnologies <i>Brown HS, Vergragt PJ</i> <i>IDCE, Clark University</i></p> <p><b>10:50 am</b>      <b>W2-G.2</b> Local disclosure ordinance as regulatory catalyst: insights from the Berkeley, CA Manufactured Nanoscale Materials Health and Safety Disclosure Ordinance <i>Rabinovici S, Barandiaran J, Taylor M</i> <i>University of California</i></p> <p><b>11:10 am</b>      <b>W2-G.3</b> Business and venture capital perceptions of the benefits, risks, and potential regulations of nanotechnologies <i>Philbrick M</i> <i>University of California, Berkeley</i></p> <p><b>11:30 am</b>      <b>W2-G.4</b> Nano: quantifying uncertainty <i>Gardner GE</i> <i>North Carolina State University</i></p>	<p><b>W2-H Ecosystem Risk Management</b> <i>Chair: John Watt</i></p> <p><b>10:30 am</b>      <b>W2-H.1</b> Risk communication in global climate change: policy issues and challenges for Nigeria <i>Olorunfemi FB, Raheem UA</i> <i>Federal Research Institute, Federal University</i></p> <p><b>10:50 am</b>      <b>W2-H.2</b> Designing environmental risk indicators to motivate sustainable behavior <i>Turaga RMR, Borsuk M</i> <i>Dartmouth College</i></p> <p><b>11:10 am</b>      <b>W2-H.3</b> The role of public safety in the sustainable risk management of urban trees <i>Watt JM, Ball DJ, Fay N</i> <i>Centre for Decision Analysis and Risk Management, Middlesex University, Treeworks Environmental Practice</i></p> <p><b>11:30 am</b>      <b>W2-H.4</b> Seismic and volcanic risk in the Azores: reasons to stay in endangered places <i>Rego IE, Arroz AM, Palos AC</i> <i>University of the Azores</i></p>	<p><b>W2-I Risk Analysis Theory and Decision Analysis Applications</b> <i>Chair: Tayfur Altiok</i></p> <p><b>10:30 am</b>      <b>W2-I.1</b> Two structurally different approaches to interval data <i>Ferson S</i> <i>Applied Biomathematics</i></p> <p><b>10:50 am</b>      <b>W2-I.2</b> The AHP based assessment of human-related work risk factors by forklift drivers <i>Srdjevic Z, Srdjevic B</i> <i>University Serbia</i></p> <p><b>11:10 am</b>      <b>W2-I.3</b> Development of a comprehensive vessel traffic risk management tool <i>van Dorp JR, Merrick JRW, Harrald JR, Grabowski M</i> <i>George Washington University</i></p> <p><b>11:30 am</b>      <b>W2-I.4</b> Risk analysis of the maritime traffic in the Strait of Istanbul <i>Altiok T, Uluscu O, Ozbas B, Or I</i> <i>Rutgers, the State University of New Jersey - Bogazici University</i></p>	<p><b>W2-J Symposium: Risk Modeling, Assessment and Management of Interdependent Systems</b> <i>Chair: Joost Santos</i></p> <p><b>10:30 am</b>      <b>W2-J.1</b> Pandemic analysis: incorporating time varying perturbations into the dynamic inoperability input-output model <i>Orsi MJ, Santos JR</i> <i>University of Virginia</i></p> <p><b>10:50 am</b>      <b>W2-J.2</b> Multi-Objective Network Optimization (MONO) method for improving incident response of safety service patrol via route configuration modifications: an extreme event analysis <i>Dickey BD, Santos JR</i> <i>University of Virginia</i></p> <p><b>11:10 am</b>      <b>W2-J.3</b> An index to measure risk co-relationships in engineering enterprise systems <i>Garvey PR, Pinto CP</i> <i>Mitre, Old Dominion University</i></p> <p><b>11:30 am</b>      <b>W2-J.4</b> Delayed bang approach: Risk tradeoff between prevention &amp; preparedness <i>Pinto CA, Pathak A</i> <i>Old Dominion University</i></p>

W1 = 8:30-10:00 am  
W2 = 10:30 am-Noon  
Roundtables = 12:00-2:00 pm (See page 30)  
W3 = 2:00-3:30 pm  
W4 = 4:00-5:30 pm

12:00 PM

**Grand Ballroom C**

**RT1 Roundtable: Risk education symposium of the SRA Education Committee. Part I. Contents, experiences and insights.**

*Chair: Martin Clauberg*

**RT1.1** Collection and development of an SRA online risk tutorial resource  
*Clauberg M, Louis G, Hassenzahl DM University of Tennessee, Knoxville & Dr. Clauberg—Consulting; Univ. Virginia; UNLV*

**RT1.2** Experience in teaching the concepts of variability and uncertainty in environmental risk analysis  
*Oberg T University of Kalmar*

**RT1.3** Challenges for institutional education of risk communication for organizations in Germany  
*Wiedemann P, Clauberg M, Schuetz H Research Centre Juelich*

**RT1.4** Synopsis of informal collection of risk analysis academic syllabi and curricula  
*Hassenzahl DM University of Nevada Las Vegas*

**RT1.5** Group / panel discussion of the SRA Education Committee  
*Louis G, Hassenzahl DM, Clauberg M, Oberg T, Watt J, Corr L, Thran B University of Virginia, University of Nevada Las Vegas, University of Tennessee Knoxville, University of Kalmar, Middlesex University, University of Nevada Reno*

12:00 PM

**Grand Ballroom D**

**RT2 High uncertainty is a challenge to risk management not just an unfortunate aspect of risk assessment: A roundtable discussion of research and policy implications**

*Chair: Rob Goble*

**RT2.1** Risk research and policy implications of a management perspective on uncertainty  
*Goble R, Bier V, Hassenzahl D, Hattis D, Kasperson RE, Larson H, Tuler S Clark University, University of Wisconsin, UNLV, SERI*

**RT2.2** Competing revolutions for the management of uncertainty in risks from environmental chemicals  
*Hattis D Clark University*

**RT2.4** Three modes of management response to highly uncertain risks  
*Goble R, Bier V, Hassenzahl D, Hattis D, Kasperson RE, Larson H, Tuler S Clark University, University of Wisconsin, UNLV, SERI*

**RT2.5** Implications of Uncertainty for Stakeholders  
*Hassenzahl DM University of Nevada, Las Vegas*

**RT2.6** Institutional challenges and adaptability in pandemic planning  
*Bier VM, Zach LS, King SB, O'Sullivan T, Burgos I University of Wisconsin-Madison, University of Southern California, University of Puerto Rico-Mayaguez*

**RT2.7** Institutional capabilities for coping with uncertainty  
*Kasperson RE Clark University*

**RT2.8** Risk and uncertainty in long term planning for the AIDS epidemic  
*Larson H, Goble R aids2031, Clark University*

12:00 PM

**Grand Ballroom E**

**RT3 Report from the NRC Committee on Improving Risk Analysis Approaches Used by the US EPA**

*Chair: Jonathan Levy*

Panelists - Members of the NRC Committee

A National Research Council (NRC) committee is developing scientific and technical recommendations for improving the risk analysis approaches used by the U.S. Environmental Protection Agency (EPA). Taking into consideration past evaluations and ongoing studies by the NRC and others, the committee was tasked to review EPA's current risk analysis concepts and practices, and to recommend improvements that could be made in the near term (2-5 years) and over the longer term (10-20 years). Specific topics that the committee was asked to address included the scientific bases for and alternatives to default assumption choices made in areas of uncertainty, approaches for assessing cumulative risk resulting from multiple exposures to contaminant mixtures, the quantitative implications of different biologically relevant modes of action on dose-response relationships, ways in which the concepts and practices of ecological risk assessment can inform and improve human health risk assessment, and the use of value of information analyses to identify priorities and obtain relevant data to increase the utility of risk analyses. Within this symposium, we will provide a summary of the key conclusions and recommendations in the committee's final report, highlighting both the framework in which risk analysis is utilized and the technical details of such analyses. At the 25th anniversary of the "Red Book", this symposium provides the opportunity to look at the past trajectory of risk analysis and its potential future path.

12:00 PM

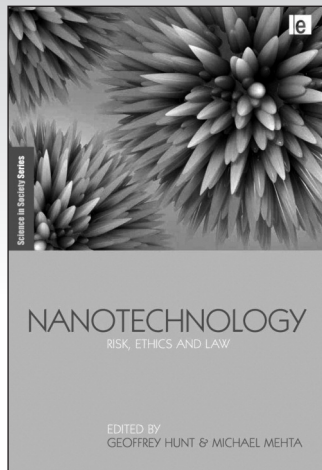
**Commonwealth A**

**RT4 SRA and the Future of Risk Analysis**

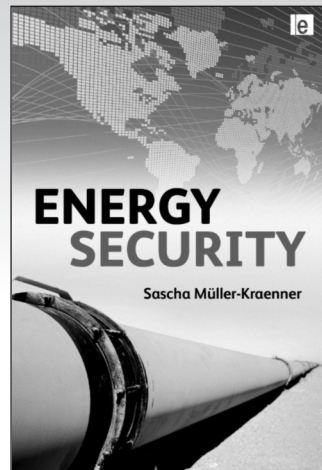
*Chairs: Alison Cullen, Rick Reiss, Jonathan Wiener*

The Society for Risk Analysis has opportunities to attract new members and develop new partnerships around the world, to promote the use of sound analysis in research and decisions, and to support the growth of the field into new areas. We face decisions about how to engage in effective discussions of risk choices and science, as well as about the best venues for discourse and debate, and about how best to target our resources for future growth. What shape would you like the future of SRA to take? How and where should it grow, geographically and topically? What do you think is the most appropriate role for the SRA with respect to risk issues of our time - - supporting analytical methodology, publishing new research, convening events, advocating the use of sound risk analysis, making recommendations, or something else? What risk areas should be covered and highlighted by our Specialty Groups structures? How can we best continue to develop and strengthen our international relationships? Join the outgoing president, incoming president, and new president-elect of SRA to share your views in a roundtable discussion of the role and future of the Society for Risk Analysis.





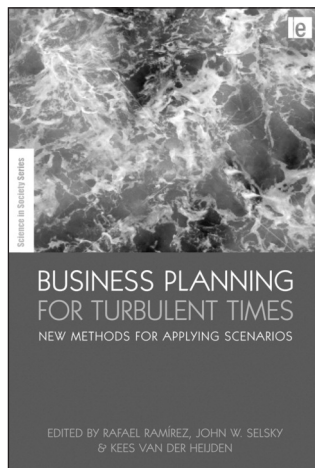
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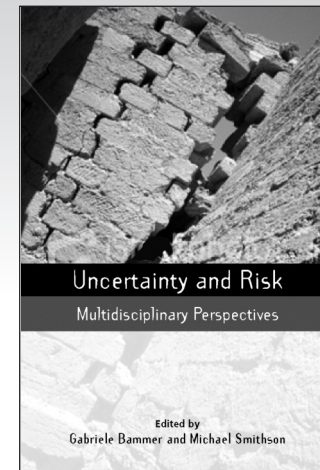
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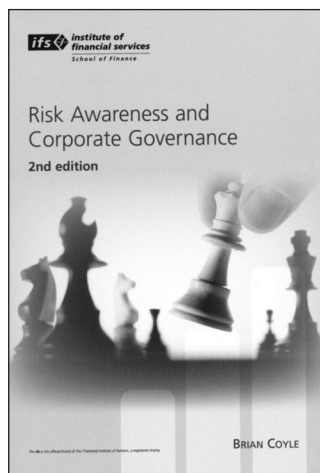


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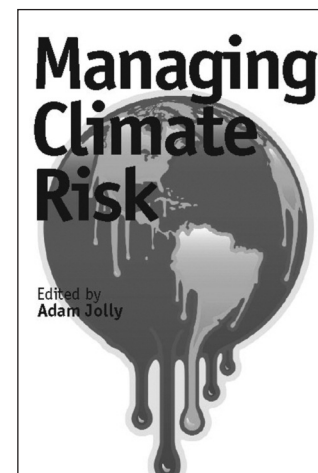


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<p><b>2:00-3:30 PM</b> <b>Grand Ballroom C</b> <b>W3-A Symposium:</b> <b>Making Sense of Sustainable Energy Sources, Part I</b> <i>Chair: Tom Horlick-Jones</i></p> <p><b>2:00 pm</b>                      <b>W3-A.1</b> Learning about, and making sense of, nuclear fusion as an energy technology: the roles of materiality, sociality, different kinds of knowledge, and practical reasoning. <i>Horlick-Jones T, Prades A, Oltra C, Espluga J</i> <i>Cardiff School of Social Sciences, Cardiff University</i></p> <p><b>2:20 pm</b>                      <b>W3-A.2</b> Rhetorics of risk and a proposed nuclear renaissance <i>Kinsella WJ</i> <i>North Carolina State University</i></p> <p><b>2:40 pm</b>                      <b>W3-A.3</b> Applying an ‘emergence’ model of nature, society and environment to studying public reactions to new sustainable energy technologies <i>Hannigan JA</i> <i>University of Toronto</i></p> <p><b>3:00 pm</b>                      <b>W3-A.4</b> Lay perceptions of hydrogen energy: The limits of upstream engagement in an emergent technology <i>Flynn R, Bellaby P, Ricci M</i> <i>Salford University</i></p>	<p><b>2:00-3:30 PM</b> <b>Grand Ballroom D</b> <b>W3-B Trust</b> <i>Chair: Ragnar Lofstedt</i></p> <p><b>2:00 pm</b>                      <b>W3-B.1</b> A critical analysis on the role of trust in patient adherence to treatment regimens <i>Chakraborty S</i> <i>KCRM</i></p> <p><b>2:20 pm</b>                      <b>W3-B.2</b> When voice matters: exploring the relative influence of procedural fairness and salient values similarity on trust judgments in the context of risk <i>McComas KA, Trumbo CW, Besley JC</i> <i>Cornell University, Colorado State University, University of South Carolina</i></p> <p><b>2:40 pm</b>                      <b>W3-B.3</b> Trust and confidence: the effects of emotional reactions, value similarity and perceived performance on the perception of border security <i>Cvetkovich GT, Faucett JF</i> <i>Western Washington State University</i></p> <p><b>3:00 pm</b>                      <b>W3-B.4</b> Post trust risk communication and the rise of the whistle blower <i>Lofstedt RE</i> <i>King’s College London</i></p>	<p><b>2:00-3:30 PM</b> <b>Grand Ballroom E</b> <b>W3-C Assessing Dose-Response and Risk for Controversial Chemicals</b> <i>Chairs: Janet Hess-Wilson, Bob Tardiff</i></p> <p><b>2:00 pm</b>                      <b>W3-C.1</b> EPA’s strategy for responding to the NAS expert panel comments on the assessment of the health effects of dioxin <i>Hawkins B, Hess-Wilson J, Swartout J, Teuschler L, Zwayner B, Rice G, Gillespie A, Preuss P</i> <i>US Environmental Protection Agency</i></p> <p><b>2:20 pm</b>                      <b>W3-C.2</b> Application of nonlinear dose-response methods based on mode of action for PCBs <i>Keenan RE, Gwinn PO, Schell JD, Carlson EA, Silkworth JB</i> <i>AMEC Earth &amp; Environmental, Inc.,</i></p> <p><b>2:40 pm</b>                      <b>W3-C.3</b> Weight of evidence evaluation of the mode of action for PCB-promoted rat liver tumors using the human relevance framework <i>Golden R, Carlson E, Silkworth J</i> <i>ToxLogic LLC, GE Global Research Center</i></p> <p><b>3:00 pm</b>                      <b>W3-C.4</b> Interference of disease management by environmental chemicals: the application of disease-specific parameters to a PBPK model to assess subpopulation sensitivity <i>Hess-Wilson JK, Lipscomb JC, Teeguarden JG</i> <i>US Environmental Protection Agency, National Center for Environmental Assessment, Pacific Northwest National Laboratory</i></p>	<p><b>2:00-3:30 PM</b> <b>Commonwealth A</b> <b>W3-D Use of Risk Assessment in Risk Management</b> <i>Chair: Smita Siddhanti</i></p> <p><b>2:00 pm</b>                      <b>W3-D.1</b> Case studies: use of risk assessment in risk management at five contaminated sites (Washington DC, WA, CA, NJ &amp; WI) <i>Camera F</i> <i>State Government</i></p> <p><b>2:20 pm</b>                      <b>W3-D.2</b> Insights on use and implementation of risk-based criteria at sites by various state regulators <i>Mora-Applegate L, Siddhanti S*</i> <i>State Government, EnDyna Inc.</i></p> <p><b>2:40 pm</b>                      <b>W3-D.3</b> Regulator, stakeholder, and end-user perspectives on use of risk assessment in risk management <i>Frantzen KA</i> <i>Consultant</i></p> <p><b>3:00 pm</b>                      <b>W3-D.4</b> Recommendations for improving risk assessment to be useful in risk management <i>Meyer AK, Siddhanti S*, Frantzen KA</i> <i>Department of Defense, EnDyna Inc., Consultant</i></p>	<p><b>2:00-3:30 PM</b> <b>Commonwealth B</b> <b>W3-E Public Health Risk Assessment</b> <i>Chair: Eric Erel</i></p> <p><b>2:00 pm</b>                      <b>W3-E.1</b> Simplified framework for microbial risk assessments: a multiplier approach <i>Williams, MS, Ebel, ED</i> <i>Risk Analysis and Residue Division, Food Safety and Inspection Service, US Department of Agriculture</i></p> <p><b>2:20 pm</b>                      <b>W3-E.2</b> The risk of Trypanosoma cruzi infections from blood transfusions in the U.S. <i>Forshee RA, Anderson SA, Walderhaug MO, Yang H</i> <i>US Food and Drug Administration</i></p> <p><b>2:40 pm</b>                      <b>W3-E.3</b> Trade-offs between blood availability and safety associated with malaria antibody screening and donor deferral policies <i>Yang, Walderhaug O, Forshee A, Anderson A</i> <i>Center for Biologics Evaluation and Research, US Food and Drug Administration</i></p> <p><b>3:00 pm</b>                      <b>W3-E.4</b> Cost-benefit analysis of repeated cytotoxin tests for clostridium difficile <i>Curry SR, Schmitt KA, Shutt KA, Pasculle AW, Harrison LH</i> <i>University of Pittsburgh, Concordia University</i></p>
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<p><b>2:00-3:30 PM</b> <b>Commonwealth C</b> <b>W3-F Symposium: New perspectives on cost-benefit analysis: meet the authors</b> <i>Chair: Adam Finkel</i></p> <p><b>2:00 pm</b>                      <b>W3-F.1</b> Retaking rationality <i>Livermore MA, Revesz RA</i> <i>New York University School of Law</i></p> <p><b>2:20 pm</b>                      <b>W3-F.2</b> New foundations of cost-benefit analysis <i>Adler MD</i> <i>University of Pennsylvania Law School</i></p> <p><b>2:40 pm</b>                      <b>W3-F.3</b> Environmental law, policy, and economics: reclaiming the environmental agenda <i>Ashford NA</i> <i>Massachusetts Institute of Technology</i></p> <p><b>3:00 pm</b>                      <b>W3-F.4</b> Comments on Revesz/Livermore and Adler/Posner <i>Kysar DA</i> <i>Yale University</i></p> <p><b>3:20 pm</b>                      <b>W3-F.5</b> Incorporating equity issues into benefit-cost analysis <i>Levy JI</i> <i>Harvard School of Public Health</i></p>	<p><b>2:00-3:30 PM</b> <b>Otis</b> <b>W3-G Nano Risk Assessment &amp; Risk Communication</b> <i>Chair: David Berube</i></p> <p><b>2:00 pm</b>                      <b>W3-G.1</b> Nano: risk assessment challenge <i>Berube DM</i> <i>North Carolina State University</i></p> <p><b>2:20 pm</b>                      <b>W3-G.2</b> How close are we to reliably predicting the toxic potential of engineered nanomaterials based on physical-chemical properties? <i>Long CM, Valberg PA</i> <i>Gradient Corporation</i></p> <p><b>2:40 pm</b>                      <b>W3-G.3</b> Change in public acceptance and commercialization of nanotechnology products in Japan <i>Kishimoto A</i> <i>National Institute of Advanced Industrial Science and Technology</i></p> <p><b>3:00 pm</b>                      <b>W3-G.4</b> Nano: risk and engagement models <i>Cummings CL</i> <i>North Carolina State University</i></p>	<p><b>2:00-3:30 PM</b> <b>Stone</b> <b>W3-H Symposium: Decision Tools for Contaminated Sediment Management</b> <i>Chair: Richard Wenning</i></p> <p><b>2:00 pm</b>                      <b>W3-H.1</b> A risk-informed decision framework for contaminated dredged material management in S. Korea <i>Suedel BC, Hong G, Kim S, Clarke J, Kim J</i> <i>US Army Corps of Engineers, Korea Ocean Research and Development Institute, Republic of KOREA</i></p> <p><b>2:20 pm</b>                      <b>W3-H.2</b> Multi-criteria decision analysis to assess options for managing contaminated sediments: application to southern Busan Harbor, S. Korea <i>Kim SH, Kim JB, Hong GH, Suedel B, Clarke J</i> <i>Korea Ocean Research and Development Institute, US Army Corps of Engineers</i></p> <p><b>2:40 pm</b>                      <b>W3-H.3</b> Use of multi-criteria decision analysis tools to facilitate weight-of-evidence evaluation in environmental management <i>Loney D, Kim J, Kim SH, Suedel B, Bridges T, Hong G, Linkov I, Loney Drew, Loney Drew, Loney Drew</i> <i>MIT</i></p> <p><b>3:00 pm</b>                      <b>W3-H.4</b> Framework for evaluating beneficial use impairments posed by contaminated sediments <i>Wenning RJ, Magar VS, Conder JM</i> <i>ENVIRON</i></p>	<p><b>2:00-3:30 PM</b> <b>Webster</b> <b>W3-I Symposium: Global Catastrophic Risks</b> <i>Chair: Jason Matheny</i></p> <p><b>2:00 pm</b>                      <b>W3-I.1</b> Climatic consequences of nuclear conflicts <i>Oman LD</i> <i>Johns Hopkins University</i></p> <p><b>2:20 pm</b>                      <b>W3-I.2</b> Catastrophic climate change scenarios <i>Baum SB</i> <i>Pennsylvania State University</i></p> <p><b>2:40 pm</b>                      <b>W3-I.3</b> Global risks: a quantitative analysis <i>McCabe TS</i> <i>Rensselaer Polytechnic Institute</i></p> <p><b>3:00 pm</b>                      <b>W3-I.4</b> Public engagement with global warming: a social representations approach <i>Smith N, Joffe H</i> <i>University College London</i></p>	<p><b>2:00-3:30 PM</b> <b>Hancock</b> <b>W3-J Symposium: Risk Assessment in Energy</b> <i>Chair: Cameron MacKenzie</i></p> <p><b>2:00 pm</b>                      <b>W3-J.1</b> Scenario analysis and the development of an international system to manage nuclear fuel cycle risks <i>Farber D</i> <i>Penn State University</i></p> <p><b>2:20 pm</b>                      <b>W3-J.2</b> Case study: letter math vs number games <i>Plum MM, Turk BJ</i> <i>Systems Engineers and Economist, Idaho National Laboratory</i></p> <p><b>2:40 pm</b>                      <b>W3-J.3</b> Risk analysis in oil &amp; gas field development plans - an oilfield approach to the energy related risks <i>Thoma A, Quintero L</i> <i>ODS LLC, oilfield consulting services</i></p> <p><b>3:00 pm</b>                      <b>W3-J.4</b> Risk assessment for operator performance in complex systems <i>Yemelyanov A</i> <i>Georgia Southwestern State University</i></p>
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4:00-5:30 PM

**Grand Ballroom C**  
**W4-A Symposium:**  
**Making Sense of**  
**Sustainable Energy**  
**Sources, Part II**

*Chair: Tom Horlick-Jones*

**4:00 pm W4-A.1**

Household energy behavior change and consumers' considerations

*Johnson BB, Vercellotti T, Bunzl M Rutgers University, Western New England College*

**4:20 pm W4-A.2**

Engaging with the public around renewable energy technologies in the UK

*Barnett J, Burningham K, Walker G, Devine-Wright P University of Surrey*

**4:40 pm W4-A.3**

Designing sustainable energy policies in the light of climate change: the tri-energy public consultation program in Switzerland

*Renn O University of Stuttgart, Germany*

**5:00 pm W4-A.4**

Understanding the institutional logic and practice in risk communication: a communicative turn on social perception of technology

*Farré J, Gonzalo J, Espluga J, Prades A, Oltra C Communication Department University Rovira i Virgili, Spain*

4:00-5:30 PM

**Grand Ballroom D**  
**W4-B Risk Amplification**

*Chair: Andrew Binder*

**4:00 pm W4-B.1**

Subjective interpretations of risk amplification

*Duckett DG, Busby JS Lancaster University*

**4:20 pm W4-B.2**

Implicit measures in risk perception: Linking affect and feelings of dread

*Dohle S, Keller C, Siegrist M ETH Zurich*

**4:40 pm W4-B.3**

How much fear is necessary; how much fear is justifiable? Six decades of fear appeal research

*Gutscher H, Nuebold N University of Zurich UZH*

**5:00 pm W4-B.4**

Risk amplification and attenuation through news media: Incorporating theories of mass communication into the social amplification of risk framework

*Binder AR University of Wisconsin-Madison*

4:00-5:30 PM

**Grand Ballroom E**  
**W4-C Poster Platform: A**  
**Palette of Scientific Data:**  
**Online Risk Assessment**  
**Tools**

*Chairs: Patricia Nance, Asish Mohapatra*

**W4-C.1** US FDA CDER's toxicological and adverse human clinical effect databases

*Benz RD US Food and Drug Administration*

**W4-C.2** eChemPortal-The global portal to information on chemical substances

*Leczyński B OPPT, US Environmental Protection Agency*

**W4-C.3** Risk related databases and other resources from the US National Library of Medicine (NLM)

*Wexler P National Library of Medicine*

**W4-C.4** Collaboration and communication of global risk assessment information

*Wullemweber A, Kroner O, Patterson J, Wexler P, Rak A, Tomljanovic C Toxicology Excellence for Risk Assessment, National Library of Medicine, Noblis, Inc., Concurrent Technologies Corporation*

**W4-C.6** Toxipedia - toxicology information for participatory risk assessment

*Gilbert S Institute of Neurotoxicology & Neurological Disorders*

**W4-C.7** Developing shared risk assessment resources: a repository of toxicological dose-response data and arrays of available health effect reference values

*Woodall GM US Environmental Protection Agency*

4:00-5:30 PM

**Commonwealth A**  
**W4-D Assessing Tools for**  
**Informing Decisions**

*Chair: Ellen ter Huurne*

**4:00 pm W4-D.1**

Difficulties in risk communication: frequency formats do not automatically elicit Bayesian reasoning

*Siegrist M ETH Zurich*

**4:20 pm W4-D.2**

Understanding perceptions about cancer and other health risks held by pesticide applicators in New York State's Green Industry

*Dantzker HC, Snedeker SM Cornell University*

**4:40 pm W4-D.3**

Increasing stakeholder uncertainty while increasing trust in science: an exploratory study

*Scherer CW, Sengco M, Bauer M Cornell University, Smithsonian Environmental Research Center, NOAA National Ocean Service*

**5:00 pm W4-D.4**

To know or not to know? A framework of risk information seeking in the sphere of industrial risks

*ter Huurne EFJ University of Twente*

4:00-5:30 PM

**Commonwealth B**  
**W4-E Terrorist Attack on**  
**the Food Supply**

*Chair: Laina Bush*

**4:00 pm W4-E.1**

Modeling the effects of an intentional attack on the United States food supply

*Franz CJ, Ackerley NA, Sertkaya A, Brown B US Food and Drug Administration, Eastern Research Group, Inc.*

**4:20 pm W4-E.2**

Decision-support tool exploring the public health system response to a terrorist event in the food supply

*Hartnett E, Schaffner D Risk Sciences International, Canada, Rutgers University*

**4:40 pm W4-E.3**

Food terrorism mental models: factors that impact consumer decision-making and experts? Knowledge of those factors

*Verrill L, Choiniere CJ, Thorne S, Butte G, Eggers S US Food and Drug Administration*

**5:00 pm W4-E.4**

How do we know when a food is safe to eat (again)?

*Cuite CL, Dellava JE, Nucci ML, Hallman WK Rutgers, The State University of New Jersey*



<p><b>4:00-5:30 PM</b> <b>Commonwealth C</b> <b>W4-F International study of the effects of information about precautionary measures on risk perceptions of mobile telephony</b> <i>Chair: Peter Wiedemann</i> <b>4:00 pm</b> <b>W4-F.1</b> Project overview, coordinated sampling, and international comparisons <i>Barnett J, Clauberg M, Croft R, de Villiers B, Gutteling JM, Kemp R, Kikkawa T, Schuetz H, Shukla R, Wiedemann PM</i> <i>Research Centre Juelich</i> <b>4:20 pm</b> <b>W4-F.2</b> Data and observations from USA <i>Clauberg M., Dolislager FG</i> <i>University of Tennessee Knoxville</i> <b>4:40 pm</b> <b>W4-F.3</b> Data and observations from the Netherlands <i>Gutteling JM</i> <i>University of Twente, the Netherlands</i> <b>5:00 pm</b> <b>W4-F.4</b> Data and observations from Germany <i>Wiedemann PM, Schuetz H</i> <i>Research Centre Juelich</i></p>	<p><b>4:00-5:30 PM</b> <b>Otis</b> <b>W4-G Symposium: Acceptable Risk for Biothreat Agents</b> <i>Chairs: Peg Coleman, Lynne Haber</i> <b>4:00 pm</b> <b>W4-G.1</b> Modeling inhalation anthrax in primates to inform discussions on ‘acceptable risk’ <i>Diamond G, Lumpkin M, Rhoades J, Massulik S, Coleman M</i> <i>Syracuse Research Corporation</i> <b>4:20 pm</b> <b>W4-G.3</b> Concerns about release from Biosafety Level 3/4 laboratories <i>Gronvall GK</i> <i>Center for Biosecurity of UPMC</i> <b>4:40 pm</b> <b>W4-G.4</b> Primate dose-response datasets: understanding resistance and susceptibility to inhalation anthrax set the stage for discussing ‘acceptable risk’ levels <i>Pitt MLM</i> <i>United States Army Medical Research Institute of Infectious Diseases</i> <b>5:00 pm</b> <b>W4-G.5</b> Framework to evaluate child: adult differences in inhalation dosimetry of gases: application to selected systemically-acting volatile organic chemicals <i>Haber LT, Krishnan K, Gentry PR, Patterson J, Parker A, Adamou T</i> <i>TERA</i></p>	<p><b>4:00-5:30 PM</b> <b>Stone</b> <b>W4-H Symposium: Vapor Intrusion: Challenges, Risks, and Uncertainties</b> <i>Chairs: Laura Green, Stephen Zemba</i> <b>4:00 pm</b> <b>W4-H.1</b> Health risk assessment perspectives on chlorinated ethylenes: focus on perchloroethylene toxicity values <i>Green LC, Crouch EAC*</i> <i>Cambridge Environmental Inc.</i> <b>4:20 pm</b> <b>W4-H.2</b> Investigation of multiple lines of evidence for vapor intrusion at Air Force facilities <i>Bell DC, Strausbach SV, Mills WB, Elliot J, Rigby MC, Sayenko KI, Johnson KM</i> <i>US Air Force School of Aerospace Medicine</i> <b>4:40 pm</b> <b>W4-H.3</b> State-to-state variations in approaches to vapor intrusion risk assessment <i>Folkes DJ</i> <i>EnviroGroup Limited</i> <b>5:00 pm</b> <b>W4-H.4</b> Data and decision analysis in the context of vapor intrusion <i>Zemba SG</i> <i>Cambridge Environmental Inc</i></p>	<p><b>4:00-5:30 PM</b> <b>Webster</b> <b>W4-I Symposium: Integrated CBRN Risk Assessment at DHS: Consequence and Medical Countermeasure Analysis for Radiological and Nuclear Terrorism</b> <i>Chair: Brooke Buddemeier</i> <b>4:00 pm</b> <b>W4-I.1</b> A public health response model for radiological terrorism events <i>Dingus CA, Carnell RC, Buddemeier BR, Daxon E, Maheras SJ</i> <i>Battelle Memorial Institute, Lawrence Livermore National Laboratory</i> <b>4:20 pm</b> <b>W4-I.2</b> A dose-response model for characterizing radiological exposure in terrorist events <i>Carnell RC, Buddemeier BR, Maheras SJ</i> <i>Battelle Memorial Institute, Lawrence Livermore National Laboratory</i> <b>4:40 pm</b> <b>W4-I.3</b> Public health recognition and response to a radiologic event <i>Harlander S, Sholl J, Jaine A</i> <i>BTsafety, LLC</i> <b>5:00 pm</b> <b>W4-I.4</b> Updated modeling for nuclear terrorism consequence assessments <i>Buddemeier BR, Dombroski MJ, Wheeler RM, Maheras SJ, Carnell RC</i> <i>Lawrence Livermore National Laboratory, Battelle Memorial Institute</i></p>	<p><b>4:00-5:30 PM</b> <b>Hancock</b> <b>W4-J Symposium: Risk Education</b> <i>Chair: John Watt</i> <b>4:00 pm</b> <b>W4-J.1</b> Insights into the future of risk education from a survey of SRA members <i>Watt J, Corr L</i> <i>Middlesex University</i> <b>4:20 pm</b> <b>W4-J.2</b> Reproductive health and environment in Alexandria Egypt: development of a model training course <i>Farag A, Marzouk H, Walker K, Abdou S</i> <i>University of Alexandria, Egypt, WHO (consultant)</i> <b>4:40 pm</b> <b>W4-J.3</b> Development of post graduate education and continuing professional development in occupational safety and health risk management <i>Lundy SJ, Watt J</i> <i>Middlesex University</i> <b>5:00 pm</b> <b>W4-J.4</b> Program development for the first SRA Risk Analysis Education Conference to be held July 14-15 2009 at the University of Nevada, Reno <i>Thran BH, Ross CS, Clauberg M, Louis G, Hassenzahl DM</i> <i>Branded Professional Services</i></p>
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Don't miss the closing wine, cheese and t-shirt reception!  
Join us from 5:30-6:30 pm, Registration Area  
Generously Sponsored by Sapphire Group

## ABSTRACTS (ALPHABETICAL BY AUTHOR)

**M3-G1** Abbott L, Maynard A; lcabbott@starpower.net

US Department of Agriculture, Woodrow Wilson International Center for Scholars

### **NANOMATERIALS IN THE ENVIRONMENT: FACING THE CHALLENGES INVOLVED IN EXPOSURE ASSESSMENT**

Nanotechnology-based consumer products are appearing in the marketplace at an increasing rate. Environmental or occupational exposure to the nanomaterials in these products during manufacture, use and disposal is not well characterized. Nanomaterials from these products may be dispersed into a variety of environmental media – water, air, soil, vegetation, or human food crops or animals. Familiar routes of human exposure – inhalation, dermal and ingestion – may need to be reconsidered and new exposure scenarios developed to account for the novel fate and transport of nanomaterials. Monitoring the fate and transport of these nanomaterials is complicated by the lack of detection techniques. Modeling the behavior of nanoparticles may require new types of exposure models that take into account transformations of the particles as well as their agglomeration in different solutions. Unique properties of nanomaterials present challenges to the traditional methods used to assess exposure to chemical substances in the environment. Estimating the concentration of nanomaterials in various types of environmental media may be inadequate to characterize exposure without also estimating the number of particles, particle size, volume and amount of surface area available for reactions. This paper summarizes the discussion of a white paper on exposure assessment of nanomaterials presented at September's SRA Workshop on Nano Risk Analysis: Advancing the Science for Nanomaterial Risk Management.

**P.17** Abebe M, Tameru B, Nganwa D, Habtemariam T, Ayanwale L, Robnett V, Wilson W; meemya2000@yahoo.com

Tuskegee University

### **THE RISK OF DEVELOPING OBESITY IN AFRICAN AMERICAN WOMEN IN ALABAMA**

Obesity is characterized by excessive accumulation and storage of fat in the body. It is typically indicated by a body mass index (BMI) of 30 or greater in adults. Obesity has become an epidemic in the United States and African-American women (AAW) have the highest rate of obesity. Alabama is among the top seven most obese states in the nation. A science-based risk assessment can serve as a tool in the identification, interplay and assessment of risk factors that lead to the development of obesity in AAW in Alabama. The source of data for this study was a health disparities questionnaire which was designed in order to collect health and disease burden from black belt counties of Alabama. Different categories were included in the questionnaire. However, for the purpose of this study, we used the appropriate specific questions. The study included 413 AAW with age ranging from 18 to 83 years old. Based on the information they provided, their BMI was calculated and 51% and 34.4% were found in obese and overweight body range respectively. A model was developed with the @Risk kit software and assumptions specified in this study, 71% AAW with obese BMI showed that they had excess energy intake compared with those in the overweight body range (50%). It also indicated that AAW with low socioeconomic status and with a family history of obesity are more prone to being obese. In all the risk pathways, the model showed that excess energy, which is not balanced with energy expenditure, had the highest regression coefficient (0.942). This can be used as a mitigation measure in order to prevent obesity. As new data and information become available, these can be incorporated and used to improve upon the model to arrive at better parameter estimates and decisions. In the future, given the risk

factors and based on the data available it will potentially be possible to develop a model that can determine if a person is susceptible to becoming obese.

**M2-G1** Adlakha-Hutcheon G, Korenstein R; Gitanjali.Adlakha-Hutcheon@drdc-rddc.gc.ca

Defense Research and Development, Canada, Tel Aviv University, Israel

### **NANOTECHNOLOGY, ITS APPLICATIONS, CONSUMER PRODUCTS, AND BENEFITS**

Nanotechnology represents a platform technology that utilizes the properties of matter that arise at the nanometer scale thereby providing exciting new applications in materials science, communications, electronics, medicine, energy, and the environment, to name just a few areas. Today over 600 consumer products are available globally that utilize nanomaterials. Given the large number of applications being designed that utilize nanomaterials and nanotechnologies, and the perception that nanotechnology can (or will) provide the ultimate solution for the world's problems; questions arise regarding who benefits from these technological advances. In addition, in general within the popular press all nanotechnology products are portrayed as being beneficial to society without necessarily distinguishing between real and potential benefits of the technology. An attempt will be made to address fundamental questions such as: What information do we have that identifies the real benefits of nanomaterials and nanotechnologies? How can these benefits be meaningful across society writ large? How can the environmental and health benefits of nanotechnology be realized without tipping the scales in terms of risks to human and environmental health?

**W3-F2** Adler MD; madler@law.upenn.edu

University of Pennsylvania Law School

### **NEW FOUNDATIONS OF COST-BENEFIT ANALYSIS**

New Foundations of Cost-Benefit Analysis (Adler and Posner, 2006) challenges traditional economic wisdom about the justification for cost-benefit analysis, but also defends the technique against those who would abandon it entirely. Cost-benefit analysis is traditionally tied to Kaldor-Hicks efficiency and to a preference-satisfaction account of well-being. But Kaldor-Hicks efficiency is a misguided criterion, and satisfying an individual's preferences need not enhance her well-being (for example, when the preferences are poorly informed or disinterested). New Foundations of Cost-Benefit Analysis argues that well-being is a matter of well-informed, self-interested preferences; that interpersonal welfare comparisons are indeed possible; that overall well-being is one of a plurality of normative criteria that are relevant to policy choice; and that cost-benefit analysis is a rough, administrable proxy for overall well-being. This new account has numerous implications for the actual practice of cost-benefit analysis. For example, it calls into question the widespread use of existence values; suggests that agencies might use distributive weights to compensate for the diminishing marginal utility of money; and argues for separate procedures to sensitize governmental decisions to considerations other than overall well-being, such as equity and rights. New Foundations of Cost-Benefit Analysis also provides a strong basis for defending cost-benefit analysis against standard criticisms, such as those grounded in incommensurability or the pricelessness of certain goods.

**T4-E.1** Alberini A, Chiabai A; aalberini@arec.umd.edu

University of Maryland

### **VSL FOR CHILDREN AND ADULTS: EVIDENCE FROM A SURVEY IN ITALY**

We present the results of a stated-preference survey that includes choice contingent valuation questions as well as conjoint choice experiments to estimate the VSL for children and adults. We use the conjoint choice experiments to explore whether the VSL depends on the specific cause

of death, and whether the risk reduction is privately undertaken or is delivered by a public program. Regarding the specific cause of death, we focus on cancer, respiratory illnesses, and road-traffic accidents. In the conjoint choice experiments, we also manipulate the time when the risk reduction would be incurred by the beneficiary, so that we can estimate the rate at which people discount future risks when they have to pay for the risk reductions now. The survey is conducted in an identical fashion in Italy and in the Czech Republic, and the results should be useful for environmental policy and benefit transfer purposes.

**M4-D.2** Alemanno AA; alemanno@post.harvard.edu  
European Court of Justice

#### **THE BETTER REGULATION INITIATIVE AT THE JUDICIAL GATE**

While most academic attention is currently being paid to the goals and to the merits of the Better Regulation initiative (BR), this article examines the most immediate legal implications stemming from reliance on the main tools of BR (such as systematic impact analysis and consultation procedures on proposed legislation) within the European legal order. Since the BR package boils down into a set of regulatory requirements, enforcement issues are likely to arise. For instance, what if the Commission omits to undertake (or badly performs) an impact assessment (IA) of a legislative proposal? Who is currently in charge of ensuring the Commission's compliance with these requirements? After illustrating the existing administrative oversight mechanisms designed to ensure effective compliance with BR requirements, by focusing notably on the recently-established Impact Assessment Board, the article examines to what extent the European courts may be called upon to review the respect paid to the requirements of BR by the Commission services. To prevent the BR initiative from turning into a Trojan Horse within its own walls, the Commission is likely to comply with these regulatory requirements, thereby paving the way for the initiative's success.

**M4-D.1** Allio L; lorenzo.allio@kcl.ac.uk  
King's College London

#### **HOW TO MANAGE THE REGULATORY STATE? CURRENT DEVELOPMENTS IN THE EU'S RISK MANAGEMENT PROCESSES**

Throughout OECD countries, policy-makers are increasingly facing problems related to complex and extensive risks, frequently involving threats of harm to human health, public safety, and the environment. In many cases, legislators are urged to manage emerging risks posed by technological progress and life-styles. Modern risk management models have tended to take the form of what can be defined as "Technical Regulatory Decision-making" (TRDM). At the level of the European Union, TRDM includes the establishment of agencies; the creation of independent scientific committees; the use of comitology procedures; the development of guidelines; and the diffusion of standardisation. The presentation will outline these various strands and address a number of related critical issues. Options for improving the accountability and effectiveness of the process will be presented and discussed.

**W2-I.4** Altiock T, Uluscu O, Ozbas B, Or I; altiok@rci.rutgers.edu  
Rutgers, the state university of new jersey - Bogazici University

#### **RISK ANALYSIS OF THE MARITIME TRAFFIC IN THE STRAIT OF ISTANBUL**

This study is going to concentrate on the risks involved in vessel traffic in Strait of Istanbul. It will discuss a detailed mathematical risk model to be used in the risk mitigation process to improve safety in the Strait. The talk will discuss a detailed simulation modeling effort mimicking maritime traffic, operations and surrounding environmental conditions. It will also discuss the

current vessel scheduling practices by the VTS at the Strait. Finally, a scenario analysis will be discussed in order to study the behavior of accident risks and arrive at some critical policy suggestions. This analysis allowed us to investigate the impact of various factors on the risk profile of the Strait. These factors included vessel arrivals, scheduling policies, pilotage, overtaking, and local traffic density. Policy suggestions will be made based on findings of the study.

**T4-A.5** Amorim, T-A; tade-ane@hotmail.com  
Santa Catarina Federal University

#### **HOW MUCH SAFE IS SAFE ENOUGH? NANOMEDICINE AND PERCEPTIONS OF RISK.**

Nanomedicine has been pointed as one of the greatest scientific innovations of the last years, but if the promises are many, these live with uncertainties about risks of medium, short, and long terms. Yet, how is the safeness and risk question has been analyzed by researchers for those who study nanomedicine? In this presentation, we will discuss the Nanomedicine controversies, especially the risk perception. Our research compares the risks and danger perceptions that Brazilian, North American, and European, whom develop nanomedicine, have about nanomedicines. We analyzed the way in which both North American and European scientists divulgate, or not, in scientific journals - "Nanomedicine", published in the UK, and "Nanomedicine: NBA", published in the USA, the concern about nanomedicines risks. As there an extremely restricted number of academic publications about this subject in Brazil, we interviewed scientists whom develop academic researches in the country. Great differences among the three analyzed universes were noticeable. In general lines, the European researchers showed themselves more opened in the discussion about scientific uncertainties, the North American demonstrated a wish of reaching the "truth" about the nanomedicines risks or its security, and, finally, the Brazilian scientists tend to not consider the possible risks of nanomedicine. We believe that these so distinct approaches explanations are not only explained by the regulation differences or individual scientists perceptions, but also by how the science, in a wide way, is developed in these countries. Starting with a critic to the objectivist and technical approach of risk analysis, we showed that the risk perceptions are a lack of cultural, political, social values, and economical interests.

**P.127** Anderson CL, Cullen AC, Fletschner D, Gordon AC, Nguyen M; cla@u.washington.edu  
University of Washington

#### **RISK PERCEPTION AND BEHAVIOR AMONG THE POOR: DESIGN OF POLICY AND POVERTY ALLEVIATION PROGRAMS**

An individual's preferences in decision making are defined by both personal characteristics and the dimensions of the risk or opportunity in question. Risk is perceived and behaviour is shaped by inherent risk aversion, gender, wealth, residential location, experience, worldview and position. Our goal is to improve understanding of these perceptions and behaviors in order to inform the design and effectiveness of poverty alleviation programs. Specifically we explore risk perception among the poor in Vietnam, China and Thailand in contrast with the populations commonly studied, which are largely American/European and relatively wealthy. Three individual characteristics lie at the heart of risk perception research – affect, risk aversion, and worldview. In a series of field surveys and exercises we find that risk perception among impoverished population differs from risk perception in other populations according to the characteristics of the individuals. Specifically, we find that the poor, males, rural dwellers and farmers are more optimistic than their counterparts. And we find that poor farmers express the most caution – somewhat in contrast with their stated optimism. Finally, we find risk aversion to be strong in all groups surveyed, with the interesting exception that a majority of policy makers in Vietnam express a risk



taking stance. Policy and program designs that both recognize and appeal to the inherent optimism, while acknowledging the preference for caution, certainty and loss aversion, could encourage the target population to engage in new activities and opportunities designed to be beneficial to their lives and livelihoods.

**T3-B.2** Aoyagi-Utsui M, Sampei Y, Kuribayashi A, Shinada T; aoyagi@nies.go.jp

National Institute for Environmental Studies

### **PUBLIC UNDERSTANDING OF CLIMATE CHANGE: THEIR LOGIC AND MOTIVATION FOR SUPPORTING CLIMATE CHANGE PREVENTION ACTIONS**

How people understand the climate change issues, and what is the motivation for taking actions against it? We used combination of qualitative and quantitative survey: one is public opinion survey in Japan and another is the focus group interview in Tokyo metropolitan area, and investigated about people's understanding of climate change and their motivation for supporting and implementation of climate change prevention actions. Our result is as follows. 1) Many people misunderstood main cause and effects of climate change, and mixed up with the depletion of Ozone layer. 2) Mass media is effective information source for taking actions, but "internet" is the two-edged blade. People who often checked internet tended to see climate change issues as "still on the way to reach a settlement among scientists", as they could find many "skepticisms" on internet. 3) So, almost all people felt "world climate is changing", but they cannot believe governmental proposal for climate change reduction plan, and that distract people to take actions.

**T2-J.1** Apt J, Lave LB, Morgan MG; apt@cmu.edu

Carnegie Mellon University

### **WORST CASE ELECTRICITY SCENARIOS: THE BENEFITS & COSTS OF PREVENTION**

The American economy and our lifestyles are dependent on reliable, low cost electricity. Unfortunately, natural hazards and human error frequently leave us in the dark. Blackouts cost the economy billions of dollars and threaten health and safety. Parts of the electricity system are highly vulnerable to attack. The combination of high cost of disruptions and high vulnerability have lead disgruntled workers, environmental extremists, and land owners to target the electricity system. Fortunately, natural hazards and human error have posed major challenges to the electricity system; the efforts to lessen the disruption and to speed recovery from these challenges has made it easier to cope with a terrorist threat. In fact, it is unlikely that terrorists or other human attackers could cause the amount of damage or the frequency of damage caused by natural hazards and human error. With thought and redesign, steps could be taken to accomplish simultaneously: Improving reliability, protecting the system against natural hazards and human error, and protecting the system against human attack. We stress the importance of interactions among the four types of threats since the benefits of improving any one might be too small to justify taking action, while the benefits of defending against all four threats might generate several times the benefit of any one and justify taking action. In particular, recognizing the interactions among the four would justify steps to improve the reliability of electricity delivery beyond the level currently prevailing. The general goal is improving the resiliency of the US electricity system. We explore eight ways of enhancing resilience. In general, each one of these would improve reliability while providing greater protection against natural hazards, human error, and terror attack. We recommend that DHS do a careful analysis of the costs and benefits of each of these eight ways of improving resilience.

**W2-A.2** Arnold SM, Price PS; pprice@dow.com

The Dow Chemical Company

### **INTERPRETATION OF BENZENE URINARY BIOMARKER DATA IN POPULATIONS WITH LOW-LEVEL EXPOSURES**

Published measurements of benzene and its metabolites in urine were evaluated and used to propose limits of airborne concentrations that can be reliably characterized using urinary measurements of t,t-muconic acid (MA), phenol, catechol, and hydroquinone (HQ). This project analyzed data from 52 reported "reference" populations who were not exposed to benzene containing products or industrial sources, but who had exposures to benzene from background sources. The overall range of central tendency measures (mean, geometric mean, or median) for the metabolites in urine were 0.5 - 18 ug/L (S-phenylmercapturic acid, SPMA), 33 - 414 ug/L (MA), 2.8 - 16 mg/L (phenol), 1.3 - 18 mg/L (catechol), and 0.3 to 7.5 mg/L for (HQ). Urinary or airborne benzene levels were available for thirteen of the reference populations. These data allow the determination of the urinary concentrations of benzene metabolites that resulted from benzene exposure, and the levels of each metabolite that occurred from non-benzene "background" sources. Measured metabolite concentrations in the central tendency measures of the 13 studies were 4.5 (SPMA), 11 (MA), 57 (phenol), 405 (catechol), and 310 (HQ) times greater than the amounts predicted to occur from the benzene exposures. This calculation assumes an average conversion of inhaled benzene of 0.11%, 4.5%, 45%, 6%, and 3% for each urinary metabolite, respectively. The reported conversion of inhaled benzene to the urinary metabolites varies across studies and individuals. For SPMA, assuming a percent conversion of 0.3% (a reported upper range for the formation of this metabolite) decreased the above ratio from 4.5 to 1.6. A ratio of 1 would be consistent with the current understanding that there are no other known sources of SPMA. Assuming that the contribution of benzene will need to be twice the background levels of a metabolite in order to be properly detected, the detection limits of benzene for each metabolite will be 0.08 ppm for MA, 0.5 ppm for phenol, 2.3 ppm for catechol, and 2.7 ppm for HQ.

**M4-B.2** Arroz AM, Palos AC, Rego IE, Borges P; imcer@uac.pt

University of the Azores

### **SCIENCE, SOCIETY, POLITICS, AND THE MEDIA – JOINING EFFORTS TO MANAGE THE RISK OF TERMITE INFESTATION IN THE AZORES**

Termites are well-established and serious pests of structural wood in the Azores archipelago (Portugal). The drywood termite *Cryptotermes brevis* has been referred to four of the nine islands, and the damages to the buildings and other artefacts are severe and constitute a serious threat, especially in its main towns. There has been a considerable scientific and political investment to survey and classify the infestation, and to develop mitigation strategies, over the last five years. Nevertheless, the infestation is far from being controlled and, also, most of the Azorean citizens are still unaware of the dangers and risks associated to this urban pest. If, however, effective educational and management practices are initiated soon, the losses can be greatly reduced. Therefore, the major aims of this research project are: (i) to understand people's perspectives about the consequences of the termite infestation and their appraisal about the effectiveness of the proposed and existing management strategies; (ii) to understand the functions of the media in the making of public opinion; (iii) to develop simple ways of communicating complex technical information according to people's perception of who is accountable and trustworthy, in order to avoid misunderstandings between science, politics, managers and society; (iv) to develop and implement devices focused on the communication between the population and the main stakeholders, to promote the involvement of citizens and their commitment as essential partners of the termite



control. This paper aims to integrate data from the abovementioned stakeholders in order to identify communication problems, to create adequate strategies to solve conflicts, to facilitate dialogue and partnerships among stakeholders and to promote termite risk literacy. Data gathered from interviews, analysis of media, scientific discourses and existing operational programs shows that the lack of integration among stakeholders is the most obvious barrier to be overcome by the communication devices to implement.

**M4-J.3** Arvai J, Gregory R; arvai@msu.edu  
Decision Research

### **TO BOLDLY GO...TESTING A STRUCTURED DECISION APPROACH FOR PARTICIPATORY MISSION PLANNING AT NASA**

This presentation reports the results of a two year project (2005 through 2007) aimed at helping NASA to develop a better understanding, through the use of a structured decision aiding approach, of public values, concerns, and objectives as they relate to alternative agency plans for space exploration. Structured elicitations with members of the public were carried out in the states of Maryland, Ohio, Michigan, Oregon, and Washington. These workshops examined public perceptions of risk and benefit in the context of multidimensional space exploration options (e.g., missions to the moon and Mars), specific technologies to facilitate such options (e.g., space nuclear power), and potential mission objectives (e.g., sample return, technology development, health science, the discovery of life or life-sustaining properties). Findings from these workshops were tested for validity in a follow-up survey that was administered over the internet to a nationally representative survey of tax paying adults (n=870). A third phase of this research involved a field experiment that focused on the relationship between affective responses to space exploration options and (1) public support for NASA as well as (2) perceptions of risk and benefit.

**W3-F.3** Ashford NA; nashford@mit.edu  
Massachusetts Institute of Technology

### **ENVIRONMENTAL LAW, POLICY, AND ECONOMICS: RECLAIMING THE ENVIRONMENTAL AGENDA**

This presentation will introduce a new book of the same title and a new paradigm for reclaiming the environmental agenda. Rather than relying on even sophisticated improvements of the so-called rationalist school of public policy centered on cost-benefit analysis, the needed environmental and public health progress depends on design, and use of the law to stimulate significant technological change and dynamic industrial transformation, rather than to merely control pollution or stimulate incremental changes. The law can be used to implement an “industrial policy for the environment,” and beyond changes in industrial inputs, products, and processes, there is a need to address the broader issues of sustainable development, which will involve a shift from products to product services, and further to larger system changes. The focus departs from those environmental law, environmental policy, and environmental economics perspectives that argue for a reduced role for government, or at least a more rational approach. The environmental record of the past 35 years suggests there is much to be gained when government provides clear, stringent legal requirements for environmental improvements and for technological transformations, although these requirements must be coupled both with flexible means to achieve environmental targets and with meaningful stakeholder participation. Rather than using cost-benefit analysis as a decision-tool, it is argued that trade-off analysis that promotes accountability, technological innovation, and precaution, rather than simplistic static accounting is what is needed and more closely represents democratic political processes focused on dynamic change.

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United States Department of Agriculture

### **TARGETING CONTAINERS AT US PORTS-OF-ENTRY BASED ON RISK OF PATHOGENS AND PESTS**

“We cannot inspect our way out of the problem” is a current perception based on the recognition that over the past 8 years total imports (minus crude oil) increased 6.5 times faster than addition of inspectors at the 326 US Ports-of-Entry. Analysis of patterns in USDA’s Pest Inspection Database (PestID) now provides APHIS and CBP managers with enhanced container surveillance and inspection algorithms. Innovations include real-time email alerts, access to GIS maps and historical time-series of pest origin, points of interception, and final destination, automatic pest targeting, feedback on regulatory effectiveness, and improved detection surveys of escaped pests. APHIS is developing ways to predict the risk of outbreak for selected, especially high-threat species such as Medfly (worldwide), vineyard snail (Australia), and glassy-winged sharpshooter (California), among others. A global monitoring system is visualized that will track climate signals at four to five “epicenters” of frequent pests arriving on commodities from offshore.

**W2-A.4** Aylward LL, Hays SM; laylward@summittoxicology.com  
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### **ASSESSMENT OF HUMAN BIOMONITORING DATA IN A PUBLIC HEALTH RISK CONTEXT: UTILITY OF BIOMONITORING EQUIVALENTS**

Measurements of environmental chemicals in air, water, or other media can be compared to health-based screening values to identify chemical exposures that may be of concern, or to identify chemicals for which a wide margin of safety appears to be present. Interpretation of biomonitoring data for environmental compounds is hampered by a lack of similar screening criteria applicable to measurements of chemicals in biological media such as blood or urine. Such screening criteria would ideally be based upon data from robust epidemiological studies that evaluate a comprehensive set of health endpoints in relationship to measured levels of chemicals in biological media. However, development of such epidemiologically-based screening values is a resource- and time-intensive effort. As an interim effort, the development of Biomonitoring Equivalents (BEs) has been proposed (Hays et al. 2007) and developed and detailed during an expert workshop. A Biomonitoring Equivalent (BE) is defined as the concentration of chemical in a biological medium (blood, urine, or other medium) that would be predicted to result from exposure at an existing health-based screening criterion under the conditions of exposure consistent with that criterion. This presentation will highlight chemical-specific BEs that have been developed, how they can be used in helping to put human biomonitoring data into a public health risk context, and how the interpretations using the BE approach should be communicated to the interested parties.

**M3-I.3** Azaiez MN; mnazaiez@ksu.edu.sa  
King Saud University University

### **A BAYESIAN MODEL FOR A GAME OF INFORMATION IN OPTIMAL ATTACK/DEFENSE STRATEGIES**

In defense/attack strategies, the attacker estimates the chance of a successful attack prior to launching his/her attack. If such a chance is not sufficiently high, then the attacker can be deterred. Ideally, the estimation is made under perfect knowledge of the targeted system so that it is error-free. For the defender, the ideal case in which the attacker could be deterred is one of nearly complete absence of knowledge, in which case the estimation error would be unreliable. In practice, the available information constitutes an intermediate situation between the two extreme cases

above. We consider the case where the attacker can have information at the system level but has no access to information at the component level. The proposed game is so that the defender could make improvement on the targeted system to make the information to be collected by the attacker as ambiguous as possible in a way to deter the attack. At the same time, the improvement may increase the survivability of the system components, as a second alternative to deter the attack. The attacker strategy is to attack only if the chance of a successful attack is perceived to be sufficiently high, and the estimation made using only information at the system level is sufficiently accurate. We assume that the attacker is also aware of the system configuration, the survivability of the system components prior to any improvement and of the defender optimal defense strategy. A Bayesian approach is suggested to analyze the problem. A variety of systems are investigated and optimization/decision models are suggested to solve the problem of each player. The problem is also extended to the situation where the attacker can access more information without reaching the perfect case, in which precise information at every component is available to the attacker.

**M3-J.1** Bagby JW; jbagby@ist.psu.edu  
Pennsylvania State University

#### **AN INTERAGENCY ANALYSIS OF TERRORISM RISK ASSESSMENT DISCLOSURE**

Provisions of at least three laws (Export Administration, Arms Export Control, Foreign Assistance ) require the Secretary of State to designate State Sponsors of Terrorism (SST) currently the five SSTs are: Syria, Cuba, Iran, North Korea and Sudan. Various SST restrictions on U.S. government assistance and U.S. firms constrain export controls and finance. Other nations also impose terrorism risks for U.S. interests but are not yet designated SSTs including risks to U.S. companies direct & indirect business activities. The SEC's Reg. SK generally requires publicly-traded companies to disclose "risk factors" for investor decisions (investment, financial & operational risks). The SEC's Office of Global Security Risk monitors such disclosures for "material" information regarding global security risks, generally assessed under the probability-magnitude calculus. A three week pilot web tool project in the summer of 2007 experienced a deluge of 150,000 queries, most focused on Iran. The SEC is now considering a requirement of XBRL data tagging of terrorism risk disclosures to facilitate immediate access by investors and securities/financial analysts. The SEC project is another example of interagency risk assessment: it focuses through the financial disclosure system, it reveals a continuing struggle between investor demands for transparency and publicly-traded companies' reluctance to reveal confidences, and it raises issues of optimal risk assessment methodologies depending on the assessment's audience. This presentation reviews these public policy issues from several perspectives: optimal political and terrorism risk analysis methods, financial market efficiency and investor rights, private-sector secrecy in national security contexts, IT diffusion in eGovernment applications.

**T2-I.2** Baker JC; john.baker@hsi.dhs.gov  
HSI

#### **IMPROVING RISK AND INTELLIGENCE ANALYST COLLABORATION**

Risk models are used for a variety of purposes at the Department of Homeland Security (DHS), including resource allocation, gap identification, and strategic planning. A major focus of the risk assessment work is to evaluate the risk presented by terrorist threats to the U.S. homeland. DHS risk models therefore require cross-discipline collaboration between risk analysts, who rely on tailored threat information for their models, and intelligence analysts, who play an important role in providing needed information and judgments. Various types of expert elicitation processes

are being used to elicit conditional probabilities from intelligence analysis concerning scenario attack paths, frequency of attack, as well as other key judgments needed for risk modeling purposes. This presentation examines the different types of impediments that exist to cross-discipline collaboration between risk and intelligence analysts in meeting the diverse information requirements of DHS risk models. It also identifies ways to improve how the risk and intelligence analytic communities communicate and work together in undertaking homeland security risk assessments.

**P.119** Baker ED, Chon HW, Keisler JM\*; jeff.keisler@umb.edu  
University of Massachusetts Amherst, University of Maryland, University of Massachusetts Boston

#### **EXPERT ELICITATIONS TO VALUE TECHNOLOGY R&D FOR MITIGATING CLIMATE CHANGE**

The economic damages due to climate change are uncertain and potentially quite large, as much recent work has shown. Approaches to mitigating this risk include both spending to deploy currently existing technologies and spending now on R&D for technologies that may be available in the future. Although detailed goals have been defined for these technologies, it is uncertain whether these goals will be achieved and there is little agreement about which directions are most compelling. The loss averted depends on the economic scenario (damage cost curves) and technological scenarios (marginal abatement cost – or MAC – curves). We have modeled the latter in an integrated assessment model (representing the overall economy). We surveyed experts about the probability of achieving different levels of technical performance as a function of the R&D funding available for: carbon capture and sequestration, solar photovoltaic cells, bio-electricity, nuclear and wind energy in the electricity sector, as well as bio-fuels and battery technology in the transportation sector. For each area, we identified candidate technologies and technical hurdles as well as performance metrics from which we derived economic model parameters. Each technology's performance is translated to an effect on the economy-wide marginal abatement cost curve. By combining the economic models, the probability assessments and the funding trajectories, we then consider technologies' impacts on the MAC (which relates to possible cost savings) as a function of funding level. In some cases we find high levels of agreement about both the technical risk and the potential impact for funding research, in other cases there is agreement about the viability of technology but not about how much work it will take to demonstrate results. It is rare for experts to disagree about the theoretic potential of the technologies. We present the preliminary results of these elicitations and the associated economic analysis.

**M4-A.3** Balbus JM; jbalbus@edf.org  
Environmental Defense Fund

#### **ENVIRONMENTALIST PERSPECTIVES ON "SOLUTION-FOCUSED RISK ASSESSMENT"**

This presentation will provide a critique of the theoretical and practical concerns associated with the "solution-focused risk assessment" paradigm, from my perspective as a physician and scientist at a national environmental group.\* \*The opinions expressed in this presentation are those of the presenter and not necessarily of the Environmental Defense Fund.

**W4-F.1** Barnett J, Clauberg M, Croft R, de Villiers B, Gutteling JM, Kemp R, Kikkawa T, Schuetz H, Shukla R, Wiedemann PM; p.wiedemann@fz-juelich.de  
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#### **PROJECT OVERVIEW, COORDINATED SAMPLING, AND INTERNATIONAL COMPARISONS**

The survey experimental studies described here provide crucial scientific data related to understanding trust and risk perception of mobile communication technology by the general public in regards to the issue of precautionary measures towards both mobile phones and base stations. Contrary to the prevailing assumption that implementation of precautionary measures, or more precisely communicating or informing about taking such precautionary measures, will increase trust, alleviate fears, and reduce risk perceptions in the general public, we previously found that the opposite effect is observed. Various theoretical hypotheses may be posited to explain this countervailing effect which perhaps stems from an incongruity in the social amplification of the perceived risk as a result of trust issues towards those implementing the precautionary measure and the perceived need for them to implement it. To verify whether this effect holds true across larger sample sizes and across different cultures and countries, an international comparative study was performed in nine countries using a standardized survey instrument that, however, was culturally adapted. Stimulus texts in 20 different survey variants were randomly addressed by 400 respondents in each country. Survey variables included the information about the level of precautionary measure, the basic intention behind implementing it, and the order of addressing base stations and mobile phones. Respondents rated their perceived risks and organizational trust. The implications of the results are not only important for improving the understanding of risk perception and risk communication, but may have significant ramifications for risk management. This presentation will provide an overview of the project and discuss the coordinated sampling and data collection procedure. Survey results from countries not represented by individual presentations will be summarized and comparatively presented here.

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University of Surrey

#### **ENGAGING WITH THE PUBLIC AROUND RENEWABLE ENERGY TECHNOLOGIES IN THE UK**

Current and future trajectories of different energy technologies may reflect the ways in which key actors have engaged with the public. Certainly this notion has become embodied in a range of requirements for public engagement that are enshrined in planning and development processes. Drawing on interviews with actors within the institutional framework of energy socio-technical systems, who are involved with the development and marketing of different renewable energy technologies in the UK, this paper explores the ways in which engagement with the public is constructed. We identify the perceived functions of engagement and how these relate to the preferred mechanisms for engaging with the public. More specifically we examine the relationships that are revealed between the characteristics of the public and the potential of engagement processes. We suggest both that the ways in which “the public” and their views about RET are conceived may have implications for the nature and range of public engagement strategies that are advocated; and also that the mode of engagement chosen may reinforce certain constructions of the public.

**W2-F.2** Bass GD; gbass@ombwatch.org  
OMB Watch

#### **IMPROVING THE REGULATORY PROCESS IN THE NEW ADMINISTRATION**

The impacts of regulatory issues on our daily lives have suddenly drawn major national attention. Virtually every day there is a new story in the media about unsafe food and drugs, tainted toys, contaminated pet food, inadequate regulation in the financial sector, a cozy relationship between airline companies and the regulatory agency dealing with safety issues, inadequate regulation of greenhouse gases, worker safety disasters such as mine collapses, and much more. Our regulatory framework has been so devastated, it seriously undermines the ability of government to protect the public. In response, OMB Watch launched a regulatory reform project to restore integrity in the decision-making process and promote a better balance between public and economic interests, thereby ensuring public protections that the public has every right to expect. This presentation will present findings from this project with recommendations for the next U.S. president on improving the regulatory machinery of government, including ways to engage the public in the rulemaking process, as well as principles for longer-term advocacy. The topics include scientific integrity, transparency and participation, policies that guide regulatory review, and tools for assessing the need for regulation. The emphasis will be on changes the next president can make unilaterally as well as staking out longer-range ideas that may take ongoing initiative to get implemented.

**P.41** Batista J, Quintero F, Puerto G, Munoz F; j-batist@uniandes.edu.co  
Private University

#### **SYNERGY BETWEEN PUBLIC AND ACADEMIC SECTORS FOCUSED IN THE ADMINISTRATION OF MAJOR INDUSTRIAL RISKS: BOGOTA/COLOMBIA**

According to the National Administrative Department of Statistics, between April of 2007 and March 2008, the Colombian manufacturing industry registered a growth of 7,40%. It highlights the results achieved in the production of non metallic minerals (18,91%), basic industries of iron and steel, metal melting (20,20%) and milling products and starches (11,57%). This growth and intensification of technology demands from different national actors, a set of actions directed towards the administration of emerging dangers from the industrial activity. Colombia, in its condition as an emerging country, starts to articulate public and private institutions, aimed to the construction of a national culture of prevention of major industrial accidents. As a result of this, in its capital Bogota, The Prevention and Attention of Emergencies Department has united forces with the Universidad de los Andes, to generate a space of reflection about the administration of major industrial risks locally. This initiative articulates case studies, methods and methodologies, for the development of public policies, based on skills development of phenomenological competences for the study of undesired critical events, such as: explosions, fires and dispersions. One of the strategies to guarantee the sustainability of this kind of initiatives is the appropriation of knowledge and interpretation inside a local context. As a response to this need, the Universidad de los Andes has been encouraging the development of postgraduate and undergraduate courses, and the formation of a group of inter-institutional studies for the analysis of major industrial accidents. This work presents the management process done with the different local actors, directed to the construction of instruments for the analysis of major industrial risks, in an emerging country without a tradition for this kind of studies. And at the same time, it does highlight the role that the Universidad de los Andes plays as a managing body of this process and the interaction with the rest of the public and private actors.

**M2-I.1** Bauer N, Disney T, Ebel E, Schlosser W, Withee J; james.withee@fsis.usda.gov  
United States Department of Agriculture

### **MARGINAL ECONOMIC ANALYSIS AND RISK ASSESSMENT TO INFORM RISK MANAGEMENT OPTIONS**

The Food Safety and Inspection Service's (FSIS) Risk Assessment Branch has developed an approach that provides FSIS management with a quantitative tool for assessing the public health impact of a policy/regulatory decision. As a specific example, we will discuss the E. coli O157:H7 Pre-harvest Risk Assessment (OPRA) which models the relationship between prevention of E. coli O157:H7 infection of live cattle and human illnesses attributed to consuming beef. The Centers for Disease Control and Prevention estimate that every year approximately 73,000 consumers become ill from Escherichia coli O157:H7, with approximately 2,000 resulting in hospitalizations and 60 progressing to death. The majority of human illnesses are caused by consumption of contaminated foods- with undercooked beef being one of the primary sources of infection. The path from infected animals to human illness involves the slaughter, processing, handling and preparation of meat before consumption. Because in most cases we lack empirical data on the relationship between infected animals and the above steps, OPRA models a direct relationship between infected cattle and human illness that accounts for all steps in the pathway from farm to illness. The model also incorporates economic marginal analysis as a means of allowing risk managers and regulatory decision makers to directly compare the benefits of an intervention to implementation costs. For instance, OPRA evaluates the utility of preharvest interventions for E. coli O157:H7 by estimating the cost for a given pre-harvest intervention to prevent a single human illness and then comparing that cost to the social value of each human illness prevented. Overall, this approach allows relatively rapid assessment of risk management options in a regulatory environment with the option to further refine a model specifically in the areas marginal analysis indicates are worth pursuing further.

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Pennsylvania State University

### **CATASTROPHIC CLIMATE CHANGE SCENARIOS**

Climate change is widely recognized as a major global risk. However, the magnitude of expected damages is subject to great uncertainty. One key source of uncertainty concerns whether climate change could be "catastrophic" on a global scale, i.e. if it could end civilization as we know it or even cause humanity's extinction. In the absence of rigorous probabilistic estimates of catastrophic climate change, it is helpful to consider catastrophic climate change scenarios. This session will discuss three scenarios in which climate change could be so catastrophic. The first scenario involves massive change to the physical climate, leaving Earth marginally inhabitable or completely uninhabitable. The second scenario involves a more moderate physical climate change triggering global violence in the form of war or terrorism. The third scenario involves the backfiring of a climate change response effort such as geoengineering or draconian climate policy. The session will review the state of the art knowledge on these scenarios, consider what policies may be effective at reducing the chance of climate catastrophe, and discuss important directions for future research.

**T3-H.3** Bauman B, Rooney AJ, Davis JM; bauman@api.org  
API

### **GROUND AND SURFACE WATER QUALITY ISSUES RELATED TO ETHANOL PRODUCTION AND USE**

New federal ethanol use mandates will lead to a rapid doubling of US corn ethanol production and use to almost 12 billion gallons in 2010 from the current (2007) use of 6.5 billion gallons. Nonpoint water quality impacts from >25 million acres of corn needed as feedstock have not yet been included in full life cycle evaluations of ethanol use, and potential point source impacts from ethanol releases during distribution and storage will also require assessment. About 60% of US gasoline was blended with ethanol in 2007, usually at 10% by volume. However initiatives and testing programs are ongoing which are assessing the emissions and material compatibility issues of the potential use of ethanol blends of 11-20% or higher, and there is very limited use of E85 (~81% ethanol). It is important to identify all known release scenarios (e.g., small chronic releases, sudden large releases, etc.) and receptors (e.g., surface and ground water, utilities) for these different fuel formulations, and assess the adequacy of current release investigation and management procedures. Existing conceptual models for spill response and corrective action require review to fully account for all important direct and indirect effects. While ethanol is readily biodegradable in water, transformation rates and overall water quality impacts will be site specific. Additionally, nonpoint source water quality impacts and sustainability issues related to this biofuels transition require EPA evaluation. The ecological impacts (pesticides, fertilizer, soil erosion, etc.) from this scale of feedstock production for corn or other ethanol feedstocks are yet to be assessed or compared to the environmental impacts of equivalent petroleum energy production. Metrics will need to be developed that will allow comparisons of relative environmental impacts.

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### **ENVIRONMENTAL RISKS OF POLYMERIC NANOMATERIALS**

In the paper various aspects of modern nanotechnologies and, as a result, risks of nano-materials impact on an environment are considered. The analysis of nano-materials manufacture shows, what even at normal functioning, the influence of such objects on an environment is connected both to social - psychological influence on people, and with the potential danger of pollution of an atmosphere and territory dangerous substances. Therefore, the model of risk should reflect all essential factors on which functioning system to the greatest degree depends should be taken into account. The mathematical methods of simulation of the group, individual and social risks are considered for the purpose of nano-materials risk reduction and remediation. At last, we have carried out researches at a plant of polymeric materials (and nano-materials), located near to Baku (Azerbaijan). We have made assessment the individual risk of person affection and constructed the map of equal isolines and zones of individual risk for a plant of polymeric materials (and nano-materials).

**T4-E.3** Beatty TKM, Shimshack JP; jay.shimshack@tufts.edu  
York University, Tufts University

### **SCHOOL BUSES, DIESEL EMISSIONS, AND RESPIRATORY HEALTH**

Diesel emissions from school buses are a particularly prominent public health risk. On average, school buses are old, ubiquitous, and travel primarily in residential areas. Further, recent research indicates that diesel air pollutants often collect inside of school buses themselves. Yet, the health risk associated with school buses is one that society can readily limit. Many states, in coop-



eration with the Environmental Protection Agency, have begun instituting aggressive school bus clean-up programs. Despite the importance and growing prominence of Clean School Bus Initiatives, we know very little about the effects of these policies. Most notably, no systematic revealed evidence exists on the consequences of bus retrofits for public health. This paper uses novel data and a difference-in-differences research design to examine the impact of Clean School Bus programs on health outcomes. We combine state of Washington bus-level data on vehicle characteristics, retrofit type, retrofit date, and exact retrofit cost with health outcome data from the state's Comprehensive Hospital Abstract Reporting System (CHARS). The difference-in-differences research design isolates causality and controls for confounding factors. The treatment group is school districts with substantial bus retrofits, and the quasi-control group is school districts with no bus retrofits. The standard intuition applies. School districts without retrofits provide information on the expected change in health outcomes for those districts with substantial retrofits, had these areas not implemented the clean school bus program. We find that retrofits induced statistically and practically significant reductions in bronchitis, asthma, pleurisy, and pneumonia incidence for sensitive populations. We also interpret our empirical results using novel developments in valuing children's health. Here, we find that total costs are substantially less than annual benefits for children alone. Benefit-cost calculations suggest that clean school bus programs appear both effective and efficient.

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Physicians Committee for Responsible Medicine

#### **THE ANIMAL WELFARE PERSPECTIVE ON THE BENEFITS OF TIERED TESTING: APPLICATION OF THE 3R'S: REFINEMENT, REDUCTION, REPLACEMENT**

For many years, tiered testing strategies have been recognized as useful tools in setting testing priorities. Benefits of this approach have been increased efficiency in utilization of resources by industry and government, e.g., cost and time. From the animal welfare perspective, these varied approaches to tiered testing are particularly significant in the application of the 3R's: refinement, reduction and replacement of animals in testing. Several tenets have been used to establish tiered testing. For example, one approach is based on levels of potential or known exposure to humans or the environment. This approach is evident as practiced in programs administered by EPA, e.g., industrial chemicals as well as pesticides. Exposure may be assessed by surrogate measures (production volumes, e.g., high production volume versus moderate production volume) or use profiles (pesticides, e.g., minor use versus food use). Another tenet is the use of screening level hazard data. Several regulatory programs have successfully used these types of data (which generally use fewer animals) to set priorities, e.g., the Screening Initial Data Set (SIDS) used in EPA's HPV program and OECD's Existing Chemicals program. Such testing provides preliminary hazard data which may or may not trigger further testing. The application of the 3R's, where possible, is an internationally recognized goal, and tiered testing has been successfully utilized in this effort, not only in the US but also the OECD. Initiatives to develop/validate alternatives to the use of animals to assess hazard to chemicals are also underway in the US (ICCVAM) and Europe (ECCVAM). The application of these principles and their ability to reduce the numbers of animals used in chemical testing will be presented, along with quantitative examples.

**W2-A.5** Becker RA; rick\_becker@americanchemistry.com  
American Chemistry Council

#### **OPPORTUNITIES WHEN HUMAN BIOMONITORING RESULTS ARE EXPRESSED IN A HEALTH RISK CONTEXT**

Human biomonitoring data has tremendous potential for use in risk assessment, product stewardship and risk management programs. To date, however, most biomonitoring studies have only provided a hazard-based context for interpreting and communicating results, typically by presenting hazards identified in studies using lab animals treated with dose levels that are often several orders of magnitude higher than environmentally relevant exposures in humans. Such a hazard context, which is clearly insufficient for risk-based decision making, can foster the erroneous speculation that mere detection of a substance in a human biomonitoring study affords appreciable risk to an individual or a population for the same adverse effects as were identified in the high-dose lab animal studies. With the recent development of efficient and scientifically robust methods for interpreting human biomonitoring data in a health risk context, many opportunities have now opened up for applying such methods to better inform all stakeholders about the significance of the specific levels measured in human biomonitoring studies. This discussion will help to highlight how interpreting biomonitoring data in a health risk context will assist with risk-based prioritization, product stewardship, and regulatory and risk management activities.

**W4-H.2** Bell DC, Strausbach SV, Mills WB, Elliot J, Rigby MC, Sayenko KI, Johnson KM;  
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#### **US Air Force School of Aerospace Medicine INVESTIGATION OF MULTIPLE LINES OF EVIDENCE FOR VAPOR INTRUSION AT AIR FORCE FACILITIES**

The USAFSAM Occupational & Environmental Health Division is investigating the application of Multiple Lines of Evidence to buildings on Air Force facilities to evaluate which lines of evidence best predict indoor vapor intrusion, and estimate indoor air concentrations in support of risk assessment in the most cost effective manner. The investigation is specific to industrial and commercial buildings and the corresponding exposure pathways. Currently, several different media including multiple paired samples of sub-slab soil gas and indoor air, near-slab soil gas are being collected at commercial/industrial buildings at several Air Force bases. Other lines of evidence, such as groundwater, ambient air, building air exchange rates, and pressure differentials are also being collected to assess the potential for indoor vapor intrusion from groundwater contaminated with chlorinated solvents. The buildings are all single story slab-on-grade structures located over groundwater plumes contaminated with trichloroethene and other chlorinated solvents. After the data are collected, the mean, minimum, maximum, UCL95, and spatially weighted average for all three source media sampled will be used with the Johnson and Ettinger (JE) model, the Vapor intrusion Model (ViM; Mills et al., 2007, Environmental Science and Technology 41: 4993-5001), and USEPA's (2008) recently published attenuation factors to estimate indoor vapor concentrations. The estimated indoor vapor concentrations will then be compared to the concentrations measured in indoor air. The results of these comparisons will be used to evaluate 1) the usefulness of sampling each of the potential source media for vapor intrusion, 2) which model's (i.e., JE, ViM, or attenuation factors) estimates are closest to the observed indoor air concentrations, and 3) which method for calculating a source term (i.e., mean, minimum, maximum, UCL95, and spatially weighted average) produces the best results in each model.

**M2-D.4** Belzer RB; belzer@RegulatoryCheckbook.org  
Regulatory Checkbook

#### **RISK ASSESSMENT AND INFORMATION QUALITY: AN EMPIRICAL STUDY OF FEDERAL AGENCY PERFORMANCE**

Legislation enacted in 2000 requires federal agencies to achieve specified quality standards for publicly disseminated information, most notably objectivity in substance and presentation. By 2002 agencies must have established effective systems for pre-dissemination review (minimizing the number of errors committed) and post-dissemination error correction. This paper analyzes five years' data on error correction petitions and agency responses thereto. Risk assessment, in its various forms, is shown to be the dominant type of information covered by error correction petitions. The number of error correction petitions submitted has been modest, with many agencies receiving no petitions at all. A plurality of petitions has been submitted by environmental groups, other nongovernmental organizations, and allied individuals rather than industry. The paper uses several procedural tests (e.g., efficient and effective public access, reasonableness of internal procedures, timeliness of response, transparency in decision-making) to show that agencies' performance has varied widely, with some agencies performing superbly while others have failed to implement the law at all. To date, the courts have denied petitioners standing to obtain judicial review of agency compliance. However, plaintiffs in the cases that have been litigated have either failed to seek administrative remedies first, failed to prove standing, attempted to establish jurisdiction outside the scope of the Administrative Procedure Act, or sought relief well beyond the scope of the law. Despite the high prevalence of risk assessments among the petitions filed, none of the cases litigated has involved risk assessment. It is predicted that the courts will take a more active interest in agency adherence to information quality principles and procedures as they are folded into routine agency practices within the Administrative Procedure Act and incorporated into amendments to authorizing legislation.

**T2-I.3** Bennett SP; steve.bennett@dhs.gov  
US Department of Homeland Security

#### **SUPPORTING MEDICAL COUNTERMEASURE DECISION-MAKING IN THE FEDERAL GOVERNMENT**

A terrorist attack using Weapons of Mass Destruction (defined here as Chemical, Biological, Radiological, or Nuclear releases) could have enormous public health consequences on affected populations. Consequently, WMD terrorism risk management strategies must include planning considerations regarding medical countermeasures (MCMs) in sufficient quantity for use following an attack, as well as a concept of operations for delivering countermeasures in sufficient time to save lives. A number of Executive and Legislative requirements related to medical countermeasures have been established since September 11th 2001 including the BioShield Act of 2004, the Pandemic and All-Hazards Preparedness Act, and Homeland Security Presidential Directives (HSPDs) 10, 18, and 21. These requirements provide guidance about determining which threat agents/materials warrant stockpiled MCMs, the quantities of those countermeasures that should be maintained in the Strategic National Stockpile (SNS), and the target delivery times for medical countermeasures following a request for SNS release. Most of these responsibilities are managed by the U.S. Department of Health and Human Services (HHS). However, HPSD 18 requires the U.S. Department of Homeland Security (DHS) to conduct an integrated all-CBRN risk assessment to support MCM research, development, and procurement across the Government. While some previous assessments have considered risk impacts of MCM strategies within a particular threat area, there are no known previously attempts to conduct a cross-threat CBRN terrorism assess-

ment that provides decision makers with an understanding of the relative risk reductions and trade-offs between countermeasures for one threat area versus another. This presentation will provide a brief history of MCM activities relevant to WMD counterterrorism, as well as an overview of the integrated CBRN risk assessment approaches DHS is executing to support medical countermeasure decision makers.

**M3-C.5** Benson WH, Birchfield N, Gallagher K\*; benson.william@epa.gov  
US Environmental Protection Agency

#### **POTENTIAL IMPACTS OF GENOMICS ON EPA REGULATORY AND RISK ASSESSMENT APPLICATIONS**

Advances in molecular technology have led to the elucidation of full genomic sequences of several multicellular organisms. The related molecular fields of proteomics and metabolomics are now beginning to advance rapidly as well. In addition, advances in bioinformatics and mathematical modeling provide powerful approaches for analyzing patterns of biological response imbedded in the massive data sets produced through genomics research. Many defensive responses to external stimuli are common among many organisms, including wildlife species (fish, birds, invertebrates) and humans. In view of this, genomic technologies may provide great insight into how diverse organisms respond to environmental stressors and provide information for regulatory and risk assessment applications at the U.S. Environmental Protection Agency (EPA). In this regard, a cross-Agency Genomics Task Force developed a White Paper which outlined implications for the use of genomics technologies in EPA. Four areas were identified as those likely to be influenced by the generation of genomics information within EPA and the submission of such information to EPA: (1) prioritization of contaminants and contaminated sites, (2) monitoring, (3) reporting provisions; and (4) risk assessment. It is important to note that significant research by EPA and other agencies and researchers will be necessary to fully understand and apply genomics technologies to human health and ecological risk assessment. A critical need in the area of technical development was identified as the need to establish a framework for the analysis and acceptance of genomics information for scientific and regulatory purposes. This presentation will discuss the various activities of the EPA's Genomics Task Force in the context of implications for regulatory and risk assessment applications with particular emphasis on environmental risk assessment.

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#### **US FDA CDER'S TOXICOLOGICAL AND ADVERSE HUMAN CLINICAL EFFECT DATABASES**

ICSAS creates toxicological and clinical databases, transforms these data into a format suitable for quantitative structure-activity relationship (QSAR) modeling, evaluates the performance of data mining and QSAR software, and develops and makes publicly available toxicological and adverse clinical effect QSAR prediction models. The goal of ICSAS is to use computer software to predict accurately all toxicological endpoints and adverse clinical effects of chemicals of interest to the FDA, and thereby substantially reduce the need for animal toxicological testing and provide proactive decision support information on potential adverse effects of pharmaceuticals in humans. To date, ICSAS has developed animal toxicological QSAR models to predict: 1) carcinogenicity (24,708 reports on 1,510 chemicals); 2) genetic toxicity (53,104 reports on 8,207 chemicals); 3) reproductive and developmental toxicity (51,724 reports on 2,115 chemicals); 4) phospholipidosis (227 reports on 583 chemicals); 5) maximum tolerated dose (3,925 reports on 1,266

chemicals) and 6) acute toxicity (1,668 reports on 1,273 chemicals). Human data-based QSAR models are now being used by ICSAS to predict: 1) hepatobiliary (120,419 reports on 1,660 chemicals); 2) urinary tract (214,563 reports on 1,660 chemicals); 3) cardiological (396,985 reports on 1,632 chemicals) drug-induced adverse events; and 4) maximum recommended daily dose of pharmaceutical-like molecules (1,246 reports on 1,246 chemicals). Many of the data in ICSAS datasets are available publicly in the open literature, through freedom of information inquiries to FDA and EPA, by subscription to Elsevier's PharmaPendium(tm) database, by purchase of FDA ToxML datasets from Leadscope, Inc., and to Lhasa, Ltd. members through their VITIC database. Proprietary data on unapproved drugs, EPA confidential business information, and data assembled as part of FDA cooperative research and development agreements are not available to the public, however.

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#### **NANO: RISK ASSESSMENT CHALLENGE**

Assessing risk in nanoscience is especially troublesome given the extremely high levels of uncertainty associated with hazard, dose, and exposure. A project at NCSU involves the design of a White Paper for the NNCO (National Nanotechnology Coordinating Office) of the National Nanotechnology Initiative. In the process of designing this project, we were funded to locate the "hot button" issues regarding newly emerging technologies and communicating risk of this genre of technologies to multiple audiences, especially the media and the public. This paper will review the status of this research as well as highlight some of the anomalies.

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#### **PUBLIC PERCEPTIONS OF PUBLIC MEETINGS**

The proposed research will use survey data collected as part of a seven-community study on cancer cluster risk perceptions (n=866) to explore how individuals perceive public meetings, both in terms of overall PUBLIC MEETING SATISFACTION, as well as in terms of WILLINGNESS TO ATTEND future meetings. Despite the centrality of public meetings in risk communication, minimal research has explored how citizens feel about such forums. The study will first replicate a 2003 study that explicated factors underlying public meeting perceptions. Building on this replication, the study will develop a model that seeks to explain overall PUBLIC MEETING SATISFACTION and WILLINGNESS TO ATTEND using variables central to previous risk communication research, including risk perceptions, the trustworthiness and credibility of key community actors, and media use. The findings suggest that those with previous meeting experience express more PUBLIC MEETING SATISFACTION. Also, viewing public officials as trustworthy was also associated with greater PUBLIC MEETING SATISFACTION. Those who said they received risk-related information from the media were less satisfied with public meetings. Half of the variance in PUBLIC MEETING SATISFACTION is explained by the proposed model. In a second model, WILLINGNESS TO ATTEND future public meetings was largely explained by PUBLIC MEETING SATISFACTION. However, greater perceived media credibility was associated with less WILLINGNESS TO ATTEND public meetings. This second model explained a quarter of WILLINGNESS TO ATTEND. Overall, the proposed research advances understanding of public meetings, a key method of citizen engagement and highlights the role that views about key community actors plays in how individual perceive such events. The available data enables the use of previously validated multiple-measure scales for key variables. Also, given the multi-level nature of the data, a GLM mixed model is used.

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#### **INSTITUTIONAL CHALLENGES AND ADAPTABILITY IN PANDEMIC PLANNING**

The potential for an influenza pandemic creates significant challenges for safety management. First, responding effectively to a pandemic requires not just the involvement of public health and emergency management, but also significant inter-agency and public-private collaboration, which may not be the primary responsibility of any one entity. For example, a project performed for the Wisconsin Department of Health and Family Services had implications for the Department of Workforce Development, the Department of Public Instruction, the Department of Commerce, and the Department of Administration. Even just achieving effective communication between such different agencies can be challenging; people whose primary expertise is in epidemiology may not be able to quantify the impacts of a pandemic in terms that are easily comprehensible to an unemployment administrator. Coordinating such disparate functions obviously requires significant advanced planning. However, some decisions regarding response to a pandemic may be better made in an adaptive manner after the pandemic has already begun. For example, deciding ahead of time whether to close schools may lead to unnecessary cost and hardship (if schools are closed but the pandemic is not especially severe), or to significant morbidity and mortality (if schools are not closed, but the pandemic is extremely infectious or lethal). Therefore, such decisions might be better postponed until after information is available on the infectiousness, lethality, and age profile of the pandemic. If waiting for the availability of such information does not create too much of a penalty (e.g., because the actions required for school closure have been pre-planned), then value of information suggests that an adaptive approach would be beneficial; with contingency plans already in place, the decision of when and whether to act may be safely and even beneficially postponed.

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#### **RISK AMPLIFICATION AND ATTENUATION THROUGH NEWS MEDIA: INCORPORATING THEORIES OF MASS COMMUNICATION INTO THE SOCIAL AMPLIFICATION OF RISK FRAMEWORK**

There has been a wide variety of studies examining the production and dissemination of information about risk events using the social amplification of risk framework (SARF) as an explanatory mechanism. Many of these studies, however, treat the mass media as fickle transmitters of inaccurate or sensationalized information. Theories of mass communication offer several concepts that can add valuable explanatory power to the SARF, especially with regard to how audiences receive and interpret information from the mass media. This paper is a three-part examination of the links between media studies and the concept of amplification station in the SARF. First is the question of salience. The media has a limited capacity as an amplification station because only a finite number of issues or events can appear in the news. Here, research from agenda-setting and agenda-building perspectives is especially pertinent. Second, once an issue or event arrives on the media agenda, its portrayal in news stories shapes how the public perceive it and whether or not the risk is amplified or attenuated. I argue that this process is best understood in terms of media priming and framing, which have been underutilized in past SARF research. Finally, this paper outlines a theoretical rationale for news media as an amplification and attenuation station. Incorporating concepts from communication theory, this final section focuses on a



synthesis of the theoretical and methodological concerns addressed in the first two sections. This synthesis provides a more detailed and theoretically sound conceptualization of mass media outlets, the role they play in the SARF, and how they can influence the secondary outcomes outlined by the framework.

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#### **A CALL FOR CHANGES IN THE PRECAUTIONARY PRINCIPLE**

The precautionary principle has problems. The precautionary principle is supposed to reverse the burden of proof in cases of scientific risk. Rather than requiring the level of evidence necessary for publication to prove the risk, the precautionary principle requires that those who advocate a risky activity prove that it is safe. However, the precautionary principle fails at the extreme, when advocates of an activity can plausibly claim that there is no risk whatever. Advocates can then dismiss opponents as crackpots, forcing them to prove their claims, which is contrary to the precautionary principle. The issue cannot be solved by giving full standing to all concerns since some concerns are truly crackpot and do not merit termination of valuable activities. On the other hand, the error of ignoring serious concerns is all too possible given the conflict of interest inherent in advocacy. Solutions require a method of assuring that attention is paid to plausible concerns, and a method of adjudication as to whether concerns can be considered plausible, preferably built into the precautionary principle itself and part of standard protocols for its implementation. We invite development and acceptance of these protocols.

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#### **PLAGIARISM IN THE UNDERGRADUATE COMMUNITY: DECISION MAKING AND RISK ANALYSIS**

Plagiarism is of increasing concern in academia, within both educational institutions and the professional community, and its continuing importance as a factor in academic integrity has led to the creation of detection software packages and enhanced penalties for those whose inauthentic work is discovered. While plagiarism's importance in matters of academic integrity is recognized, information on the reasoning of those who engage in it is incomplete. A traditional utility model regarding decision-making and risk analysis in this context is less than adequate, as it assumes perfect rationality on the part of the subjects in question. Cumulative prospect theory, as conceived of by Kahneman and Tversky, appears to be the appropriate vehicle for analyzing this subject, as it is based on a more realistic interpretation of how subjects assess their relative risk, the associated probabilities of potential outcomes, and the subsequent decisions that are made. This poster summarizes my research on two related questions; the first attempts to determine how undergraduate students assess their individual risk when considering plagiarism and how that assessment affects their eventual decision, and the second seeks to determine if there is a difference between the assessment and decision making of students at lower grade levels and of those who are closer to graduation. While it may seem logical to assume that juniors and seniors would not experience diminished marginal sensitivity, which is a decrease in sensitivity with regard to larger gains and losses, it is generally accepted that humans operate in an environment defined by bounded rationality, with imperfect information and unclear objectives. This examination is based on a study of the past research on plagiarism and on empirical evidence gathered through a survey of randomly selected students and professors at the University of Massachusetts-Boston, and the poster represents both aspects of the research.

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#### **SCIENCE AND ART - AN INTERACTION TOOL OR A GREAT RISK?**

Science and art - an interaction tool or a great risk? Art evokes emotions in a human being, expands his spiritual sphere, influences his image thinking, and finally, brings him joy, which is very important in our technogenic century. At the same time science is based on the empirical experience, it is regulated by exact calculations; the science teaches, and specifies the direction. With the development of the scientific thought and as a result of the technological progress, their influence on personality becomes stronger; an individual assumes more average characteristics losing his personality. Due to the science, changes in business and methods of doing business as well as methods of marketing and management take place. The level of personal communications has also changed. Almost every day new ideas and trends concerning both technological development, transfer of information and services and their using come into being. These opportunities have come into science and technology. They allow capturing the particular mood of the moment, understanding how phenomena and facts disconnected at the first sight are connected with each other and influence our lives. Exchange of ideas and data is a powerful tool! And what is art experiencing in the meantime? It is set up on a production line. Paintings are replicated. "Mona Liza" by Leonardo da Vinci is looking mysteriously from posters and wrappers at us. The inimitable, sweated by the author Beethoven's "Moonlight Sonata" sounds from hundred thousands of advertisement recordings. Art is not the exclusive "piece goods" any more. On the one hand, availability of art causes risk of loss of its originality. On the other hand, art is growing and synthesizing alongside with the development of the scientific thought. This is the paradox of the present-day stage of development. The more scientific and technological progress interferes in the sphere of art, the more we risk to lose its originality.

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#### **THE CHERNOBYL ACCIDENT AND PUBLIC HEALTH**

The Chernobyl disaster is described as the greatest technological catastrophe in human history. In the report presented different problems of risk perception of the Chernobyl accident are considered. The accident caused the cancellation of nuclear power programmes in Ukraine and became a turning point for the world nuclear history. There is still ongoing discussion about the quantity of radioactive material released in 1986. The economical damage to CIS and EU countries is described. The health problems in the countries of Russia, Ukraine and Belarus are analyzed. Other health effects on the population are discussed. The situation with dangerous reactors and Sarcophagus shutting down is given. Due to the serious risk of the next coming accident at Chernobyl it is clear that Chernobyl problems in the Ukraine require wider governmental actions in the area of emergency prevention, response, mitigation and rehabilitation. Among our priorities for international co-operation are: creation of a legal basis for joint efforts in the field of emergency prevention and response on bilateral and multilateral basis; joint plans and procedures outlining implementation of mutual aid agreements; improvement of interoperability with foreign and international organisations dealing with emergency prevention and response; exchange of information and experiences. Among the key elements of international co-operation are joint research programmes involving support from the side of international foundations. Only in this way we can find the solutions for Chernobyl problem.



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### **APPLICATION OF DATA QUALITY OBJECTIVES TO OPERATIONAL RANGE GROUND-WATER INVESTIGATIONS**

There are many challenges that must be overcome when investigating ground water to assess potential off-range human health risk due to range training activities. Operational range areas can be very large (thousands of acres). The amount of ground-water samples that can be collected is often severely limited. Decisions regarding the ground water at these ranges must often be made using very little data. In the past, ground-water data from a limited number of sample events was directly compared to regulatory standards or health risk-based thresholds. Data that exceeded a threshold or standard were assumed to indicate a risk or a violation. Data that did not exceed a threshold or standard were assumed not to indicate a risk or violation. These comparisons did not account for either measurement or sample error. A strategy to assess ranges using the DQO systematic planning process will be presented. Key components of this strategy include development of a concise study question, the construction of a viable pathway conceptual site model (CSM), estimates of data uncertainty, and a rationale for evaluating data points that fall within that range of estimated uncertainty. Estimating data uncertainty as part of the planning process allows a more defensible rationale to support conclusions regarding potential health effects or the need for additional data.

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### **BIG RISK COMMUNICATION CHALLENGES FROM SMALL THINGS**

Nanotechnologies operate at atomic, molecular and macromolecular scales, at scales where matter behaves differently than at larger scales and quantum effects can dominate. Nanotechnologies have captured the imagination of science fiction writers, as science, engineering and industry have leapt to the challenge of harnessing them. Applications are proliferating. In contrast, the regulatory landscape remains incoherent, and public awareness of nanotechnology low. These factors and other research findings to date have led risk researchers and critics of current nanotechnology risk communication efforts to call for proactive strategies that do more than address the facts. This paper takes stock and suggests new strategies for nanotechnology risk communication.

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### **WHAT IS THE PROSPECT OF RISK-BASED REGULATION IN SARKOZY'S FRANCE?**

French agencies follow a fiduciary model of decision-making (O'Riordan and Wynne 1987), which relies on top-down decisions from elected "patrons" assisted by a strong bureaucratic apparatus. When confronted to risk this system tends to avoid probabilistic quantification (Poumadre and Mays, 1997). A tangible consequence is that, from vaccine management (Boudier, 2006) to environmental regulation (Boudier 2008) the French model has often favoured risk avoidance over risk management. The constitutional value given to the precautionary principle is a tangible result of the imbedded risk aversion of this regulatory model. In practice, however, the degree of precaution of French regulators varies greatly. Like other countries, French agencies can be more or less precautionary depending on the specific issues at stake (Wiener and Rogers 2002). Since 2007, the new political leadership of France has generated intense econom-

ic and political activities at home, and many expectations abroad. What is the consequence of the Sarkozy leadership for the regulation of environmental and health risks? What is the likely effects of current measures to liberalise the economy and introduce regulatory reform? Will France, for example, introduce specific risk-based mechanisms to check its regulations, such as risk benefit analysis and cost-benefit analysis? This presentation will explore the prospect and likelihood of the introduction of traditional risk-based instruments. It will reach its conclusions from the analysis of the results of a systematic review of France's regulatory performance developed in 2007 and 2008 by the King's Centre for Risk Management for the Bertelsmann foundation (Frick and Ernst 2008).

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### **ALARP EVALUATION: JUSTIFYING LIFE-SAFETY RISK REDUCTION USING COST EFFECTIVENESS AND DISPROPORTIONALITY**

"One accepts options, not risks." (Fischhoff et al. 1981) Public safety policy seeks to advance the principles of equity and efficiency, while a third principle of protection against liability is important to hazard owners. Equity is recognized by requiring that risks be reduced to minimum safety levels regardless of cost. Efficiency is recognized through evaluating the costs and benefits of risk reduction below minimum safety levels. Protection against liability can be addressed by the ALARP (as low as reasonably practicable) principle: the need to demonstrate gross disproportion between costs and benefits in favor of safety by a number of considerations, including the cost to save a statistical life (CSSL). In common law countries, meeting ALARP is a legal obligation, as demonstrated by the Ford Pinto case. The cost-effectiveness and disproportionality approaches to ALARP evaluation are presented as ways to justify the extent of risk reduction. The former considers the magnitude of CSSL and the latter considers the ratio of CSSL to the value of saving a life (VSL) (UK HSE 2001). The following questions will be discussed: If CSSL is used to prioritize risk reduction actions for a portfolio of hazards, should the portfolio be limited to one hazard type, or should it include multiple types of hazards to optimally address the wider societal need for safety? Does investment in low cost-effectiveness risk reduction measures draw resources away from more cost-effective safety improvements, to the overall detriment of society? Should a traditional safety standard be pursued if reducing risks below minimum safety levels to meet the standard has a low cost effectiveness? What level of confidence or uncertainty is appropriate for life-safety decisions? These issues pose a challenge to technical professionals to engage with government, regulators and key stakeholders to decide the basis for safety decisions and choices about the priority of safety improvements.

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### **PARTITIONING HEALTH IMPACT MEASURES INTO LIKELIHOOD AND CONSEQUENCE COMPONENTS**

A wide variety of yardsticks are available for summarizing health impacts. For example, if one were to use broad categories, these would include, probabilities (AKA risk), health expectancies (e.g., life expectancy), and health gaps (e.g., DALYs). Regardless of which yardstick is adopted, impacts are generally quantified as a change (either relative or absolute) applied to the yardstick of interest. So for example, we might forecast that a smoking cessation intervention would yield an absolute increase in life expectancy of, say, 1.5 years. In this presentation the author proposes Kaplan and Garrick's (1981) definition of risk (risk = likelihood x consequence) as an

organizing scheme for classifying the various alternative measures of health impact. According to this scheme, impact measures can capture likelihood alone (class-1), consequence alone (class-2) or a hybrid of the two (class-3). A wide variety of health impact measures are shown to fit neatly into this scheme. The scheme is shown to reveal quantitative (albeit approximate) relationships between the hybrid measures and their class-1 and class-2 counterparts, thus revealing rules of thumb for translating between summary measures of impact. The performance of these rules of thumb are tested using mortality data drawn from 191 countries (select results results will be presented). The scheme and ensuing insights are offered as a step towards consolidating the spectrum of methods that have been applied to compute what are a dizzying array of alternative health impact assessment summaries.

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#### **AIR POLLUTION EXPOSURE MODEL FOR INDIVIDUALS (EMI) IN HEALTH STUDIES: MODEL EVALUATION OF RESIDENTIAL AIR EXCHANGE RATES**

Air pollution epidemiology studies have observed statistically significant associations between particulate matter (PM) concentrations and increased rates of morbidity and mortality. These studies often use air pollution measurements from central ambient monitoring sites as exposure surrogates. To better understand the linkages between ambient concentrations and exposures, we are developing an air pollution exposure model for individuals (EMI) in health studies to predict personal exposures from ambient concentrations and questionnaire information such as building operation, indoor sources, and time-activity patterns. A critical aspect of the EMI is the estimation of the air exchange rate (AER) within individual homes where people spend most of their time. The balanced flow of air into and out of a residence is the primary mechanism for the entry of outdoor pollutants, and the removal of indoor source emissions. We developed an AER model to predict daily residential AER from infiltration airflows created by indoor outdoor temperature differences and wind speed, natural ventilation from opening of windows, and mechanical ventilation from operation of whole house or attic fans. Model parameters were estimated using questionnaires and AER measurements from the Research Triangle Park (RTP) PM Panel Study. The RTP study collected daily questionnaires and residential AER for seven consecutive days during each of four seasons in 36 homes within the RTP area of North Carolina. The individual model predicted AER closely correspond to the measured AER with an absolute difference of  $0.34 \pm 0.44$  h<sup>-1</sup> (mean  $\pm$  SD). Our study demonstrates the feasibility of using the AER model to help reduce the uncertainty of AER estimates in air pollution exposure models, such as the EMI, in support of human health risk assessments. This work was reviewed by the U.S. EPA and approved for publication but does not necessarily reflect Agency policy.

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#### **AIRBORNE CR(VI) MONITORING DURING BUILDING DEMOLITION**

Building N218 at NASA Ames Research Center (ARC) and its associated wind tunnel structure underwent demolition between mid-July and the end of December 2007. Because the wind tunnel and its associated structural elements were coated with chromium containing paints and coatings there was concern that Cr (VI) dust and particulates would be released during the demolition process. Because the chromium was released during demolition as solid particulates,

sampling for Cr (VI) involved collecting airborne particulates over a 24-hr period and sending the collected sample to an outside laboratory for analysis of TSP weight and Cr (VI) content. Samples were collected during three different phases of the demolition process. Prior to demolition samples were collected to establish a baseline Cr (VI) concentration in the Moffett Field area. Knowing the normal baseline concentration allowed comparisons to be made to the measured Cr (VI) concentrations during the demolition process. The second phase of sampling was during the demolition itself and the third phase was after demolition was complete but site cleanup and grading and filling activities were taking place. Due to limitations in available equipment PM10 samples could not be collected during Phase 2, consequently one of the other goals of the Phase 1 sampling was to collect both PM10 and TSP samples, so that the TSP samples collected during Phase 2 could be calibrated relative to the PM10 concentration for risk assessment purposes. Data from all three phases of the sampling will be presented. The comparison of the PM10 and TSP results from Phase 1 to establish the utility of TSP Phase 2 sample results for risk assessment purposes will be presented. Additional data showing the relationship of the results to meteorological conditions, type and level of demolition activities and proximity of sample locations to the demolition site will also be presented.

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**USING MODELS TO SUPPORT DECISION-MAKING: IS YOUR MODEL GOOD ENOUGH?**

Mathematical models are increasingly used to support decision-making to address a broad range of environmental problems. Controversy associated with the use of models is closely related to the need to establish confidence in models and their application. In reality, models provide a means of organizing information to describe, implicitly/explicitly or qualitatively/quantitatively, the processes relevant to environmental problems and alternative solutions. The broad range of purposes motivating model development and application include establishing national policy, rule-making or decision-making for a specific site or project. In view of this range of uses, a key question relates to how to support judgments about whether a model, a set of models, and modeling results are adequate for the decision at hand. A related question concerns how efforts to develop confidence in modeling activities can be scaled to complement the scope and implications of the resulting decision. These and other questions were central to the National Research Council report entitled "Models in Environmental Regulatory Decision Making." The report describes 12 individual elements for successful model evaluation with respect to decision making. In this paper, we will discuss the application of those elements to model development and application at the level of an individual, site-specific project, with the purpose of identifying both the benefits and challenges of evaluating models. Case applications that will be discussed include regulatory decisions concerned with contaminated sediment, environmental/ecosystem restoration, and flood risk management. These case applications will be used to demonstrate the utility of models in evaluating alternative policies or management actions and the value of applying a robust approach to evaluating models.

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#### **INNOVATIVE THINKING: HOW TO VALIDATE A SAMPLING PLAN AND LESSONS LEARNED FROM A VALIDATION EXERCISE**

An interagency technical working group (known as Validation Sampling Plan Working Group) was established to develop a strategic plan for validating environmental sampling steps

(strategy, collection, recovery, transportation, extraction and analysis) that occur across all phases of response to an accidental or intentional incident involving biological contamination. In order to validate the overall process of constructing and executing sampling plans in a field environment, a sampling plan exercise was established at the Idaho National Laboratory (INL) building test bed. Sampling and analysis methods were first analyzed in closed test chambers prior to the tests conducted in the building environment. The INL Test Bed enabled pre- and post- decontamination sampling over a multi-level, multi-room facility. This larger environment permitted with the release of *Bacillus atrophaeus* (BG) spores the testing of sampling plans that involve targeted and statistical approaches. The target of the release of the BG aerosol was to provide a gradation of contamination across the building floors to include a space of no contamination, testing the ability of sampling plans and methods to properly plot contamination. Useful lessons were learned regarding the development of judgmental and probabilistic sampling. However, general observations about their relative efficacy could not be made. Even with the small amount of biological simulant released, the building was heavily contaminated and both strategies provided effective characterization. Swab, wipe, and vacuum methods were effectively evaluated in the operational test bed. Using the lessons learned from the initial test at the INL test bed, the facility and aerosol release parameters were adjusted to achieve of low contamination to an area of no contamination to more effectively evaluate the various environmental sampling steps for biological contamination.

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#### **GRI AS A MODEL FOR COMPANY REPORTING ON NANOTECHNOLOGIES**

The uncertainty about definitions and the lack of information about hazardous properties and exposures are central obstacles to assessing the risks of nanotechnologies and to formulating coherent regulatory policies. This is especially relevant for consumer products, such as food, food packaging, and cosmetics, where public concerns may be very strong. In this presentation we describe the efforts of the Dutch Food and Consumer Products Regulatory Authority (VWA) to overcome these obstacles through voluntary information disclosure by industry. Information disclosure on sustainability performance has become a standard procedure by many companies worldwide. Global Reporting Initiative (GRI) has become the best known and respected guide for such voluntary reporting. GRI Guidelines, which specify what and how should be reported, are developed through a multi-stakeholder processes, which includes industry, civil society organizations, the financial sector, and other non-governmental actors. The process of developing the Guidelines for nanotechnology industry could provide a platform for a dialogue among the stakeholders about reporting on products, production and R&D activities. Inclusion of this kind of information in companies' sustainability reports could subsequently become a form of civil regulation. We conceptualize it as a new form of constructive technology assessment, in which information disclosure plays a dominant role. The access to this information by risk assessors in governments and academia could help improve not only risk assessments, but also the quality of public dialogue and, possibly, public acceptance of nanotechnologies. Our research on the willingness of Western European multinational companies participate in such a process shows that about one third of the companies (especially those that are active GRI participants) have an interest in such a process. They see it as a useful mechanism for protecting themselves against possible reputation damage. In this presentation we report on the VWA's current and planned activities in that area.

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#### **SPECIAL CONSIDERATIONS FOR INDUSTRIAL FACILITIES IN ASSESSMENT OF AND RESPONSE TO VAPOR INTRUSION RISKS**

Guidance, regulations, and potential strategies for investigation and mitigation of vapor intrusion (VI) frequently focus on large groundwater plumes that affect multiple residential properties. Because the contamination sources are typically industrial facilities, however, potential VI at industrial sources must be considered in investigation, risk assessment, and remediation. Evaluating VI at industrial sites poses a number of unique challenges that contrast with the residential plume situation. Source proximity means that even in the absence of a significant groundwater plume, VI may be significant. Achievement of soil standards, often based on other pathways such as direct contact or leaching to groundwater, does not rule out VI risks. Soil gas sampling, indoor air sampling, or site-specific risk assessment may be warranted for such sites. The area of affected soil or groundwater is generally small compared to the building area, so that use of maximum concentrations may overestimate risk. Industrial facilities may continue to use the same compounds that have been released to the subsurface, or residues from historical usage may be present inside the building structure. Regulations may mandate mitigation of a subsurface source, even where existing sources within the building contribute much higher fluxes of the same chemicals. We will explore issues unique to assessing industrial VI risks with case studies of recent projects in Connecticut and Massachusetts. For example, at one site, a sub-slab depressurization system was required under state regulations to address a TCE plume, even though large quantities of TCE continue to be used in the plant. At a second site, standards are not exceeded in soil or groundwater, but levels in soil gas exceed VI-based standards. The hypothesis is that the soil concentrations, though below applicable standards, are consistent with the measured concentrations in soil gas.

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Hylobates

#### **RISK AND RISK-BENEFIT ASSESSMENT OF CONTAMINANTS IN WATER: A COMBINED EPIDEMIOLOGY AND TRADITIONAL RISK ASSESSMENT MODEL**

Water scarcity is an emergent problem. Water with contaminants needs to be directed to human use. Contamination may consist of chemicals, but also of microbes. Waterborne disease is a leading cause of mortality and morbidity in developing countries; waterborne epidemics are also reported in North America and in Europe. Contaminants are also generated by the water treatment process (in case of chlorination, disinfectant by-products, or DBPs). Risk assessors are requested to assess the human health risks associated with contaminated water, very often in a risk-benefit, or risk-risk context. Use of epidemiological evidence in risk assessment has long been advocated. In 2006, the European Commission funded an epidemiology and risk-benefit assessment project, named Hi-wate, to investigate risks from DBP versus those from pathogens. The risk-benefit assessment was to combine data and methods from epidemiology with those of risk assessment. The resulting health burden and net benefit estimates are to inform regulation, at the European, but also management decisions at the local level. The modular Hi-wate risk-benefit model has been developed through a Media-wiki collaborative approach. Chemical exposure modeling required the simultaneous modeling of different exposure proxies (from less specific metrics from epidemiological studies to the more detailed ones used in traditional risk assessment). It also encompassed the combination of several pathways (e.g., swimming, bathing, showering, cooking, soft drinks)

with original data when available and dynamic modeling to allow for the time dimension for acute versus chronic health outcomes. Dose-response was modeled ad hoc from published epidemiological meta-analyses. For risk evaluation, net benefits have been calculated comparing health burdens (DALYs) and also in terms of health care costs; risk-perception studies were also used to derive risk-risk comparisons.

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#### **UPDATED MODELING FOR NUCLEAR TERRORISM CONSEQUENCE ASSESSMENTS**

Homeland Security Presidential Directive (HSPD) 18 calls for an integrated Chemical, Biological, Radiological, and Nuclear terrorism risk assessment (iCBRNra) to inform public policy on medical countermeasure development. In support of this activity, the Department of Homeland Security's Science and Technology Directorate has undertaken detailed consequence modeling of a nuclear detonation in several modern U.S. cities that obtain insight into the nature and distribution of injuries and the potential effects of medical countermeasures. Atmospheric dispersion and prompt effects models are important tools for planning an initial response to a nuclear detonation; however some current operational predictions make overly simplified assumptions, which may impact the ability to make effective planning decisions. The analysis used for this study provided more realistic methods of estimating exposure by accounting for the presence of different building types, which can provide shielding and sheltering of the population, and also provide more realistic estimations of the number and type of casualties from nuclear-detonation prompt effects (prompt radiation, thermal and blast overpressure) that account for how these structures both protect people and cause injury due to building collapse and glass breakage. Results indicate that although high levels of casualties and extensive destruction may be unavoidable, both casualties and secondary effects can be significantly reduced with proper planning, equipment, training, and medical countermeasure development.

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#### **DEVELOPMENT OF DE MINIMIS EMISSION RATES FOR SCREENING INGESTION EXPOSURES TO PERSISTENT AND BIOACCUMULATIVE HAZARDOUS AIR POLLUTANTS**

ICF is assisting U.S. EPA in evaluating human health risks associated with exposures to air toxics, including risks associated with ingestion exposures to persistent and bioaccumulative hazardous air pollutants (PB-HAPs) that have the potential to accumulate in aquatic and agricultural food chains. Specifically, ICF has assisted in the development and implementation of a screening-level approach that EPA is using in its Risk and Technology Review (RTR) to determine the potential for emissions of mercury, dioxins, and other PB-HAPs from a point source to pose an unacceptable risk to human health. The approach employs EPA's chemical mass-balanced compartment model TRIM.FaTE to estimate chemical concentrations in environmental media. The outputs of the TRIM.FaTE screening scenario, configured to represent a hypothetical farm homestead and fishable lake near the source, are coupled with an ingestion exposure and risk calculator. The modeling scenario is designed to ensure that potential incremental exposures to PB-HAPs are not underestimated, given the range of possible settings and conditions that might be encountered near point sources of PB-HAPs. Using this combined agricultural/fishing scenario, we calculated de

minimis emission rates that correspond to risk levels interest based on chemical-specific toxicity endpoints. In this presentation, we provide a technical overview of the configuration of the agricultural and fish ingestion components of the screening scenario, describe the results of sensitivity analyses and other model-related evaluations, and compare the estimated exposures and risks to those from more refined, site-specific assessments. The results of this work suggest that the de minimis air emission rates calculated with the TRIM.FaTE screening scenario can be compared with facility emission rates as an effective screen by which to identify emissions of negligible risk and determine if more site-specific analyses are needed.

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#### **AUTOMATED QUANTITATIVE DOSE RESPONSE MODELING**

In 2007 the National Research Council released a report on toxicity testing in the 21st century that promoted the development of computational modeling and in vitro high throughput screening (HTS) capabilities, including toxicogenomics, in order to support mechanistically-based quantitative safety and risk assessments. This includes the creation of high performance computing methods for dose-response modeling of large toxicogenomic and HTS data sets. We have developed the ToxResponse Modeler which uses the particle swarm optimization algorithm and a weighted voting method to identify the best-fit model for each response. This approach has been used to calculate probabilistic points of departure and ED50 values to rank and prioritize putative biomarkers of 2,3,7,8-tetrachlorodibenzo-p-dioxin (TCDD) that can be associated with specific functions and toxic responses. The ToxResponse Modeler has also been used to evaluate the relative effect potencies (REPs) of 2,3,7,8-tetrachlorodibenzofuran (TCDF)- and PCB126 ?elicited responses compared to TCDD. In principle the automated ToxResponse Modeler can be used to analyze any large dose response dataset including outputs from high throughput screening assays to assist with the ranking and prioritization of compounds that warrant further investigation or development, and to support homeland security compound identification and screening.

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#### **PUBLIC RESPONSE TO TERRORISM: CONNECTING LINKS BETWEEN PERCEIVED RISK AND ECONOMIC IMPACTS**

To capture the community response and economic impacts following a terrorist attack a system dynamics model was constructed that is capable of addressing the complex and nonlinear properties of this kind of community crisis. Casualties and property damage was represented using estimates from a leading provider of risk information to insurers and specialist in terrorist modeling. Interviews with community leaders and first responders provided input for modeling emergency response systems. Public response was based on data gathered from a longitudinal survey using different disaster scenarios that unfold over time consistent with crisis news reporting. Interviews with news professionals were used to determine patterns of journalistic behavior in the communication of threat, focusing on the three types of structural information that people commonly search for following a crisis: damages, causes, and future threats. An economic analysis of the immediate and long-term consequences using computable general equilibrium (CGE) modeling provided estimates of the direct and indirect impacts of risk amplifying effects likely to follow such an event. The CGE model was based on consumer and producer decisions informed by the longitudinal risk perception surveys and analyses.



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### **WILDLIFE TOXICITY REFERENCE VALUES FOR ECOLOGICAL SOIL SCREENING LEVELS (ECO-SSLs)**

Wildlife Toxicity Reference Values were developed by the USEPA Superfund for the calculation of Ecological Soil Screening Levels (Eco-SSLs) protective of terrestrial wildlife. The wildlife Eco-SSL is the soil contaminant concentration where the Effect Dose (TRV) and Exposure Dose are equal (amount of contaminant in the diet that is taken up from soil). The TRV is defined as the dose above which ecologically relevant effects might occur to wildlife species following chronic dietary exposure and below which it is reasonably expected that effects will not occur. A four-step process was used to derive TRVs: 1) Literature search, 2) Literature review and data extraction, 3) Data evaluation, and 4) TRV derivation. This presentation provides the results of the final TRV derivation processes and subsequent Eco-SSLs for polynuclear aromatic hydrocarbons (PAHs) and DDT and metabolites. The extracted toxicological data is classified by effect type for six classes of endpoints including mortality, reproduction, growth, biochemical, behavioral, and physiological. Each extracted result is assigned a data evaluation score ranging from 30 to 100 indicating the quality of the study. Studies with scores above 65 are then plotted by effect type and used to derive the wildlife TRV (Step 4) according to a pre-established selection and calculation hierarchy. The derivation process and results (both TRV and associated Eco-SSL) are discussed for each new contaminant specific document issued in 2006 and 2007 including DDT, copper, manganese, PAHs, nickel, silver, selenium, and zinc.

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### **RESOURCE TOOLBOX FOR CUMULATIVE RISK ASSESSMENT**

Federal, State, and other organizations have developed a variety of approaches and tools for assessing health risks, each with its own purpose, strengths and limitations. Although many tools consider multiple contaminants, exposures, and effects, relatively few explicitly describe a cumulative risk context, such as by addressing specific groupings or joint toxicity, or being population-focused. Nevertheless, collectively these materials represent a valuable resource for cumulative risk analyses. Until recently, no systematic effort had been conducted to assemble a practical toolbox for risk assessors and others interested in evaluating cumulative risks. Instead, people have had to search across program offices and other organizational websites to identify resources that could be relevant. To address this integration need and facilitate community-based involvement, the U.S. Environmental Protection Agency (EPA) and U.S. Department of Energy (DOE) have jointly developed such a toolbox. This new cumulative risk toolbox contains 70 resources organized into four areas: (1) planning, scoping, and problem formulation, including stakeholder involvement; (2) contaminant fate/transport and exposure; (3) toxicity assessment; and (4) risk and uncertainty characterization, and presentation of results. In text and summary tables the toolbox identifies each resource and where it can be found, its purpose and scope, and context for cumulative risk applications. The materials range from conceptual model builders and approaches for involving local schools and communities, to geographic information system (GIS)-based transport models, indicator-based screening tools, toxicity databases, and risk calculation software. The presentation will illustrate how selected tools can be integrated to address different types of cumulative risk questions. The toolbox will be available on the EPA Web site, to enhance access to these combined resources and strengthen cumulative risk applications.

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### **ARE WE SAFE? CAN WE TRUST YOU: EXPERT MODEL/MENTAL MODELS APPROACH APPLIED**

Many public and private organizations have mandates or incentives to inform people about risks. The best among these have used focus groups and attitude surveys together with conventional wisdom about risks, risk management and risk communication to guide their efforts, but choice of content has remained surprisingly ad hoc. Some efforts have worked well others haven't as might be expected from approaches employing relatively casual methods. The expert decision model/mental models approach developed at Carnegie Mellon University was created to meet the challenge of effective and strategic risk communication to inform risk decisions. It is an approach that combines the natural science of how risks occur and can be controlled with the social science of how people comprehend and respond to such risks. Its heart is commitment to scientific facts of risk, an empirical understanding of human behavior, openness in communication, and informed decision making. Fundamentals of the approach and how applications of the CMU decision-analytic approach have varied methodologically will be discussed with a focus on implementation of, and challenges in, applying the method.

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### **DON'T CONFUSE ME WITH THE FACTS!**

Consider the theme of this conference; the science and the art. Science is defined as skillful application of facts or principles. Interestingly, art is defined as skillful application of methods or principles. Either can be applied to essentially any human endeavor. Where science is concerned with facts, principles, and methods, art is concerned with principles and methods. Taken together, one may conclude that the arts may not be so concerned with the facts. In practice, risk assessors apply scientific skill to multiple facts, principles, and sources of information. Successful risk assessment requires an instinctive temperament and "artsy" skill. The challenge to bring contrast to the familiar "gray" is only heightened by quips that risk assessors are not encumbered by the facts! This presentation will explore examples of DoD site investigations at military sites with munitions and explosives of concern (MEC) and munition constituents (MC). Quantitative methods to gauge MEC and MC are inherently incompatible with potentially overwhelming human perception regarding physical hazards of explosions or uncompensated loss due to chemical contamination. Multi criteria decision analysis will be discussed as an effective consensus-building decision support tool to successfully join the fray of environmental decision-making. Examples of consensus-based critical information will be provided including the development of transport model partition coefficients for emerging and emergent contaminants, discrepancies in observations versus transport model predictions (calibration), uncertainties in bench scale tests supporting predictive transport models versus actual environmental conditions, and logical use of up-to-the-minute sampling methods like Method 8330B. The opportunities are plentiful for risk assessors to further develop their unique qualities as the decision making "pot" is stirred.

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### **CASE STUDIES: USE OF RISK ASSESSMENT IN RISK MANAGEMENT AT FIVE CONTAMINATED SITES (WASHINGTON DC, WA, CA, NJ & WI)**

A discussion in regards to the information collected for each case study will be presented first. The Risk Team developed a data collection form to ensure that a consistent framework was

used for the case studies. The information collected dealt with background information, sampling strategies employed, pertinent risk questions, etc. Summaries of all five cases examined will be the next discussion topic. And finally, the presentation will conclude with lessons, individual as well as collective, learned from all the case studies.

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#### **NASAL TISSUE DOSIMETRY OF NAPHTHALENE USING A HYBRID CFD-PBPK MODEL FOR INTERSPECIES EXTRAPOLATION: ASSESSING VARIABILITY IN MODEL DERIVED HUMAN EQUIVALENT CONCENTRATIONS**

Naphthalene is a widely used intermediate in chemical synthesis of phthalic anhydrides, carbamate insecticides, resins and tanning agents; is a component of petroleum fuels and is used as a moth repellent. Chronic inhalation of naphthalene leads to nasal inflammation, hyperplasia of the respiratory epithelium and metaplasia of the olfactory epithelium in rats at concentrations >10 ppm, the lowest concentration tested. Increased incidences of adenoma in respiratory epithelium (male rat) and neuroblastoma in the olfactory epithelium (female rat) were also noted. Differences in anatomy and biochemistry between the rodent and human nose are important considerations in conducting interspecies extrapolations for a naphthalene risk assessment. A hybrid CFD-PBPK model of the upper respiratory tract in the rat and human was developed to support cross-species dosimetry comparisons of naphthalene concentrations in the nasal respiratory and olfactory epithelium. This model was applied to estimate human equivalent inhalation concentrations (HECs) corresponding to several NOAELs or LOAELs for the non-cancer effects of naphthalene in rats. Two approaches for cross-species extrapolation were compared: (1) equivalence based on tissue concentrations at the NOAEL or LOAEL, and (2) equivalence based on tissue concentrations at the NOAEL or LOAEL divided by any uncertainty factors. The two methods produced similar results. Relative gas dosimetry ratios (RGDRs) obtained with the model are slightly greater than one, roughly a factor of 5 higher (less conservative) than RGDRs obtained using the default approach for a category 1 gas, which are on the order of 0.2. These results are similar to those reported for several other category 1 gases, including acrylic acid and acetaldehyde. Sensitivity and Monte Carlo analyses were conducted to assess the uncertainty and variability in model predictions.

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#### **A DOSE-RESPONSE MODEL FOR CHARACTERIZING RADIOLOGICAL EXPOSURE IN TERRORIST EVENTS**

A key component of any radiological terrorism consequence analysis is a careful consideration of the various modalities of exposure that can cause early fatalities (to include blood, lung and gastrointestinal syndromes). As part of the Department of Homeland Security's efforts to conduct an integrated CBRN risk assessment to support medical countermeasure decision making, a novel dose-response model appropriate for radiological terrorism scenarios has been produced as a component of the consequence calculations for acute radiation sickness, early fatality, and latent cancer fatality. The radiological dose-response model described in this presentation builds on the relevant literature to provide a framework for calculating the consequences of radiological events in a variety of terrorist attack scenarios. Early fatalities due to hematopoietic syndrome, gastrointestinal syndrome, and pulmonary syndrome are considered. These consequence calculations are essential in accomplishing the goal of assessing the benefit of medical countermeasures at reducing mortality should a radiological terrorism event occur.

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#### **USING EPIDEMIOLOGICAL DATA FOR DOSE-RESPONSE MODELING: FISH CONSUMPTION AND CARDIOVASCULAR DISEASE**

Since it was hypothesized over 25 years ago that the low incidence of cardiovascular disease in Greenland Eskimos might be attributable to high levels of fish consumption, many prospective epidemiologic studies have been conducted that have examined the relationships between fish consumption and the incidence of coronary heart disease and stroke. These individual studies have invariably employed the Cox proportional hazards model that is designed to relative risks without making any assumptions about the underlying dose-response relationship. Since raw data from epidemiology studies is generally not available, generating a dose-response relationship between fish and cardiovascular disease involves integrating analytical results from multiple studies that were not intended for that use. Three technical presumptions associated with meta-analyses are examined: 1) The use of relative risk, as opposed to disease rates, as the basis for dose-response modeling. It is concluded that the use of a relative risk results in analyses that underestimate the uncertainty associated with the disease rates in the referent groups. 2) The use of linear models, as opposed to alternative nonlinear models, and the equations used to generalize a dose-response relationship. It is concluded that the use of linear models tend to overestimate dose-dependent effects at high doses. 3) The relation presumptions that a) the treatment of study differences as arising from sampling error, and b) an underlying mean value is "true" value that needs to be estimated. These assumptions tend to understate the range of plausible interpretation associated with the dose-response function. In spite of many differences from other analyses, a similar overall conclusion results: Although the confidence intervals include an interpretation of no casual relationship, there appears to a reduction in the rates of both coronary heart disease and stroke associated with fish consumption. Most of the benefit appears to be associated with consumption of 25 g/day.

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#### **MODELING VARIABILITY IN ENVIRONMENTAL TOBACCO SMOKE EXPOSURE AND HEALTH RISK AT FINE SPATIAL RESOLUTION**

Communities are increasingly involved in identifying and addressing environmental hazards and exposures, but data are inadequate to allow communities to quickly but reasonably prioritize across disparate exposures and endpoints. National-scale risk assessments are available for some stressors but may not be readily scaled to a community given variability in exposure patterns and vulnerability attributes. One of the stressors of concern in many communities involves indoor air pollution, for which community-specific factors may be particularly significant. The objective of our analysis is to characterize at a community level across the United States the magnitude and distribution of adverse health outcomes associated with residential exposure to environmental tobacco smoke (ETS). Based on mass balance principles, residential ETS exposure can be approximated as a function of time spent at home, frequency of smoking at home, air exchange rate, and home volume. We use previously derived models and publicly available data to estimate each of these parameters as a function of demographic characteristics, housing characteristics, and behavioral characteristics, taking account of correlations among parameters given common socioeconomic and geographic drivers. Combining these parameters, we determine residential ETS exposure by community, stratified by a proxy for socioeconomic status which is a common predictor across these parameters. We link ETS exposure with dose-response functions for key health out-

comes, taking account of effect modifiers previously determined in the epidemiological literature and spatial patterns of age and disease state. We characterize total population risk and average per capita risk and determine parameters that drive variability in these and other risk measures. The result is a risk characterization for each geographic location, which will inform community awareness, risk prioritization efforts, and action toward mitigating indoor air pollution from ETS.

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### **A CRITICAL ANALYSIS ON THE ROLE OF TRUST IN PATIENT ADHERENCE TO TREATMENT REGIMENS**

Public trust in the pharmaceutical industry and patient compliance to their drug therapy treatments is at an all time low. It is estimated that 50-70% of patients do not fill and/or refill their drug prescriptions, which has been deemed by the World Health Organization as a “crisis of striking magnitude.” This results in an annual loss for the pharmaceutical industry ranging from \$25-70 billion with the broader impacts on public health, adding up to an annual loss of \$100 billion, a crippling and unsustainable burden that is shouldered by the average taxpayer. This paper will address this dilemma by determining the answer to the following question: To what extent does trust play a role in patient adherence to their drug treatment regimens in relation to all other potential factors? Existing research suggests that failures in managing a risk, such as patient non-compliance, stem from failure to recognize the need for public trust. High perceived risks are linked to high distrust, and in this context may play a significant role behind patient non-compliance. The role of trust will be determined by systematically uncovering implicit chronic prescription drug users’ (for the treatment of high-cholesterol) attitudes and beliefs through mental models methodology developed from the discipline of risk perception. This presentation will draw on the preliminary results from thirty unstructured interviews with patients in the tri-state area, as well as on the results from a follow-up structured survey administered to an additional 200 patients in order to ensure external validity. The results of this research have the potential to reveal a correlation between public distrust towards the pharmaceutical industry and its relative implications for chronic prescription drug taking, and allow for the engineering of risk communications that can systematically look to resolve the hypothesized discrepancies with the purpose of improving patient compliance.

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### **ASSESSMENT OF FEMALE LUNG CANCER RISK IN TAIWAN AS RELATED TO LEVELS OF AMBIENT FINE PARTICULATE MATTER (PM2.5)**

The adverse health effects of ambient airborne PM2.5 have been well documented in the recent scientific literature. The annual average daily level of this air pollutant in Taiwan is more than double of those found in many other countries including USA, due to a very high density of automobile in Taiwan especially motorcycles. In an effort to urge our government to regulate PM2.5 in air, this study was conducted to show a significantly positive correlation between the female lung cancer mortality rate and the PM2.5 level in air in Taiwan. Data on daily ambient air PM2.5 levels were collected by 73 air monitoring stations of Taiwan Environmental Protection Administration. The annual average 24 hour level of a township of 0.669 km by 0.669 km was calculated using Spatial Analyst extension of ArcGIS (ArcMap, version 9.2, ESRI). There were 259 townships selected for this study throughout the country. These townships were classified into six groups each with a 5 µg/m<sup>3</sup> increment of PM2.5, taking 20-24.99µg/m<sup>3</sup> as the reference

group. Within these townships lived 9,766,595 females representing 89.12% of the whole female population in Taiwan. Demographic and female lung cancer mortality data available for 1998 to 2002 were analyzed against the PM2.5 levels in 2006. During these five years, there were 8,215 female lung cancer deaths, giving an annual average age adjusted cancer mortality rate (per 100,000) of 17.10 (SD 4.86). The annual average daily level of PM2.5 in these townships was 36.13µg/m<sup>3</sup> (SD 6.43). Kendall’s tau-b and c were used to test the trend between pollution level and cancer mortality rate. The trend was significantly positive. Overall population attributable risk of female lung cancer due to PM2.5 was 16.6%. The calculated relative risk associated with a 10 µg/m<sup>3</sup> increment in PM2.5 was 1.09 (95 % CI: 1.02 ~ 1.16).

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### **CHARACTERIZING FAILURES AND BUILDING RESILIENCE IN INFRASTRUCTURE SYSTEMS**

This paper provides an overview of recent research on infrastructure system resilience, with a focus on the problem of infrastructure failure interdependencies (IFIs) as a critical dimension. Analyzing and reducing risks associated with the failure of infrastructures such as electric power, water delivery, and transportation networks in disasters is complex. Not only could failures in any one of these systems lead to substantial urban and regional disruption, but they could cause failures in dependent infrastructures. Yet each system is managed independently, with little accountability and information sharing across systems for reducing interdependent risks. The problem of IFIs is thus an interdisciplinary one that involves engineering, planning, risk management, and risk communication dimensions. This paper provides a typology of recent approaches on IFIs. These range from theoretical engineering frameworks to practical emergency management approaches. In the case of Greater Vancouver (Canada), at least four independent efforts have been initiated to address IFIs using contrasting yet complementary approaches. One of these, being conducted by our research groups at the University of Washington and the University of British Columbia, is then summarized. Our approach includes two major efforts: the first develops, analyzes, and disseminates empirical data on IFIs and their societal consequences from multiple disaster events occurring across North America. The second focuses locally on Greater Vancouver. In the context of an earthquake scenario, it gathers and synthesizes expert information into tools for a structured workshop with local infrastructure sector representatives. The paper concludes with a discussion of the interdisciplinary nature of characterizing, analyzing, and reducing IFIs. In particular, the issue of risk communication between professionals (in this case, managers at different but interdependent infrastructures) emerges as a key research need.

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### **RISK ASSESSMENT TO EVALUATE LEAD EXPOSURE FROM A CONSUMER PRODUCT**

A risk assessment approach was used to quantify whether lead present in a landscaping light fixture could present potential risks through contact with the light fixture. The evaluation was conducted to determine whether the light fixture complied with the limits set by the State of California under Prop 65 (also known as the Safe Drinking Water and Toxic Enforcement Act of 1986). A likely receptor is a homeowner who would install these light fixtures in their yard or along a walkway. Potential exposure routes included dermal contact and incidental ingestion of lead present in the lead solder of the light fixture. The first step was to determine how much of the lead could



potentially come off on somebody's hands while they are handling the light fixture. In order to estimate the amount of lead to which a homeowner could be exposed through contacting the fixtures, it was necessary to determine how much lead could be wiped off the light fixture. A wipe test laboratory analysis was conducted using standard U.S. EPA methods. This analytical information was used in an exposure equation along with information on incidental ingestion and dermal absorption to determine an intake rate of lead in units of micrograms per day ( $\mu\text{g}/\text{day}$ ). The estimated intake rate was compared against the Prop 65 safe harbor levels for lead. If the estimated intake rate is less than the safe harbor levels, then these results demonstrate that a consumer does not face significant health risks from exposure to the product, and that a warning label is not necessary. The estimated intake rate for lead based on contact with the lampshades was found to be less than the safe harbor levels for lead.

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**TEST OF TREATMENT RELATED TREND FOR CLUSTERED EXCHANGEABLE DISCRETE DATA USING STOCHASTIC ORDERING**

Characterizing dose-response relationship is of central importance in understanding and controlling toxic substances. The definition of dose related trend has been ambiguous in studies with clustered data. Usually, a choice needs to be made between defining treatment effects in terms of per cluster member response rate or in terms of per whole cluster response rate. Other issues in describing the effect of toxic materials include the assumption of certain parametric models or the assumption of linearity in the trend of effects with increasing dose levels, which might limit the applicability and generality of the methods. Most of the currently available procedures can be used for only binary data, therefore they combine multiple responses to turn them into binary data, which warrants the need of joint modeling of multinomial data. In this paper, we propose a new test for treatment related trend using stochastic ordering for clustered exchangeable multinomial data. To construct a likelihood ratio test for trend we devise an EM algorithm and the vertex-direction method of Lindsay, by adapting the procedure of Hoff. We address the problem of sparseness and augment data using the marginal compatibility assumption of Pang and Kuk. Our method is based on per whole cluster response, and does not require specifying a certain parametric models. Our test is flexible due to the use of stochastic ordering and allows for various forms of monotone increases, capturing linear increase in marginal mean response as a special case. We illustrate our method with binomial and trinomial data and it can be easily extended to multinomial data. We obtained 0.00 for p-values when there exists a generally increasing trend in the marginal response rates in the datasets. When there is no trend and decreasing trend in dose groups, p-values of 0.64 and 1.00 were obtained respectively. We also compare our work to the existing procedures, including the exact method of Corcoran et al. (Biometrics, 2001).

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**WHO'S AFRAID OF THE BIG BAD WOLF? SOME THOUGHTS ABOUT VALUES, ENVIRONMENTAL CONCERN AND PERCEIVED RISK ASSOCIATED WITH WILDLIFE MANAGEMENT**

Understanding how individuals perceive risk associated with wildlife management can help managers better interact and communicate with stakeholders. Building on research that emphasizes the role of personal values and environmental concern in shaping environmental risk perceptions, this presentation explores (from a theoretical angle) how these concepts influence risk judgments about wolf management. As a potential source of both attitude and value-based conflict

among stakeholders, wolf management remains controversial in areas where wolves are re-colonizing former range. In particular, the presentation argues three points. First, scholars need to incorporate value conceptualizations that transcend risk contexts. Second, scholars should view "environmental concern" as a manifestation of underlying values, not as end-point determinants of risk perceptions themselves. Finally, research should consider how these two concepts interact with issue attributes to influence risk judgments. Implications for future research, wildlife-related risk communication, and management will be discussed.

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**WHY CAN'T THEY GET IT RIGHT? MOBILIZING JOURNALISM, GOVERNMENT ACCOUNTABILITY, AND THE AUTISM-VACCINE CONTROVERSY**

The mass media are often criticized for inadequately presenting health risk information to the public. This presentation argues, however, that including risk information represents a tension between norms of objectivity and "government accountability" on one end and "mobilizing journalism" on the other. In other words, journalists may be more adept to adopt a "watchdog" mindset – and its emphasis on the accountability of government officials – than provide guidance to news consumers, which may be seen as a breach of objectivity. This premise is explored in the context of the autism-vaccine controversy (AVC). A content analysis of 279 British and U.S. newspaper articles shows that mobilizing information – messages that, in theory, would have helped provide guidance in assessing vaccine safety – was largely absent from the combined sample (16% of articles). U.S. newspapers, however, were significantly more likely to provide it than their British counterparts (38% versus 8.3% respectively). By contrast, messages related to government accountability – i.e., actions that health officials were taking (or should take) – were far more ubiquitous (38% of all articles). Finally, mobilizing and accountability information were mentioned together in only 11% of the combined sample. Implications for journalism ethics and risk communication are discussed.

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UT TIEM University of Tennessee Knoxville

**DATA AND OBSERVATIONS FROM USA**

Is the risk perception of US university students more or less susceptible to stimuli addressing precautionary measures about mobile phones / base stations than their international counterparts? Will the mention of precautionary measures for mobile phones and/or base stations decrease or increase the US students' perceived risks? These are the basic questions addressed in an international survey experimental study on risk perception of mobile communication technology by the general public in regards to the issue of precautionary measures towards both mobile phones and base stations. In the US, the debate over the risks of mobile communications technology has so far been relatively low-key as compared to the debate in other countries. That is, until recently (July '08) when the director of a leading cancer research institute issued a memo to 3000 of his employees warning of a possible higher risk from mobile phone use. This memo specifically focused on precautionary measures and was quickly picked up by the newswires and stirred the debate in the US anew. In this light, the results of this survey experimental study will provide crucial scientific data from a US student population whether the prevailing assumption that implementation of precautionary measures, or more precisely communicating or informing about taking such precautionary measures, will increase trust, alleviate fears, and reduce risk perceptions in



the general public hold true, or whether results of our previous studies indicating that the opposite effect may be observed are supported. The results are not only important for improving the understanding of risk perception and risk communication, but may have significant ramifications for risk management. This project is supported by the GSM Association ([www.gsmworld.com](http://www.gsmworld.com)) a global trade association of mobile phone operators, manufacturers, and suppliers, in coordination with other country surveys supported by the Mobile Manufacturers Forum ([www.mmfa.org](http://www.mmfa.org)).

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University of Tennessee, Knoxville, Consulting, University of Virginia, University of Nevada, Las Vegas

#### **COLLECTION AND DEVELOPMENT OF AN SRA ONLINE RISK TUTORIAL RESOURCE**

Among the goals of the SRA Education Committee (EduComm) is the provision of resources to individuals who teach risk analysis and promoting opportunities for individuals who want to learn risk analysis. Both of these goals are reflected in the EduComm initiative to collect, categorize, and synoptically describe freely accessible online tutorials dealing with relevant issues of risk analysis / risk management. A broad collection and structuring of the available online tutorials on risk, which has previously not been available, will serve both user groups of educators seeking teaching resources and students or newcomers to risk wishing to be introduced to basic risk analysis concepts and to perhaps learn more. However, these two user group have very different needs profiles and require a differentiated solution for selecting the appropriate tutorials. Furthermore, online risk analysis tutorials have been developed for a diverse range of fields, from environmental health risk to business organizational risk to financial risk and for different expertise levels. Overlaps in the scope of a given tutorial make categorization into specific topic fields challenging. Although no overall judgment is sought to be made, a set of criteria is applied to evaluate the usefulness of the characteristics of the tutorial. The identification of specific and general deficits will be used to assess whether development of an SRA-branded set of risk tutorials is warranted. Plans for expansion of the collection and for dissemination will be discussed.

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ICF International, US Environmental Protection Agency

#### **DEVELOPMENT AND DEMONSTRATION OF THE RISK AND TECHNOLOGY REVIEW MULTIMEDIA HUMAN EXPOSURE AND RISK CALCULATOR FOR THE U.S. ENVIRONMENTAL PROTECTION AGENCY**

Section 112(d) of the Clean Air Act requires the U.S. EPA to assess the “residual risk” from sources of hazardous air pollutants (HAPs) after implementing technology-based Maximum Achievable Control Technology (MACT) standards. ICF assisted EPA in developing a comprehensive Risk and Technology Review (RTR) exposure and risk modeling framework to evaluate inhalation and ingestion exposures and risks. One product of this RTR framework is a versatile, multimedia ingestion exposure and risk calculation tool that can easily be applied to a wide variety of regulatory and site-specific projects. The Microsoft Access-based tool combines established EPA data and methods, including built-in dose-response data, age-specific exposure factors from EPA’s Exposure Factors Handbook, and farm foodchain algorithms from EPA’s Methodology for Assessing Health Risks Associated with Multiple Pathways of Exposure to Combustor Emissions. Exposures can be estimated for 14 ingestion sources, including drinking water, soil, fish, breast-milk, and 10 produce and livestock food products. Chemical-specific and combined lifetime can-

cer risk or chronic non-cancer hazard quotients may be calculated for any combination of exposure source and four age groups. Analyses may be performed with mean, median, 90th, or 95th percentile exposure parameter values or with user-defined values, and exposure scenarios may be saved to facilitate sensitivity analyses. The calculator is designed to use environmental concentrations imported from EPA’s TRIM.FaTE chemical-mass balance, multimedia fate and transport model. ICF and EPA applied TRIM.FaTE and the exposure and risk calculator in a detailed demonstration of the RTR framework. The approach, models, and findings of this demonstration were submitted for review by EPA’s Science Advisory Board (SAB) in July 2008. This poster presentation will document the application of the exposure and risk calculator for the case study, and the findings of the SAB review.

**M4-C.4** Clewell HJ, Tsai LC, Dix DJ, Tan YM, Andersen ME, Thomas RS; [hclewell@thehammer.org](mailto:hclewell@thehammer.org)

The Hamner Institutes for Health Sciences

#### **ASSESSING THE EXPOSURE-DOSE-TOXICITY RELATIONSHIP WITHIN THE EPA’S TOXCAST PROGRAM**

The EPA’s National Center for Computational Toxicology has initiated a research program called ToxCast with the intent of improving EPA’s chemical toxicity evaluations by developing methods to evaluate a large number of chemicals for potential toxicity and using the information to help prioritize testing of those chemicals that pose the greatest risk. As an adjunct to the ToxCast program, a project was initiated to provide refined exposure-dose-toxicity evaluations that will aid in interpretation of the high-throughput in vitro testing results. Such context will be essential for identifying appropriate priorities for follow-up testing and risk evaluation exercises. In the first part of the project, organ slice cultures have been established for rat liver, lung, and kidney. The cultures were exposed to a subset of the ToxCast Phase I chemicals in a 5-point dose response, with cytotoxicity measured as the endpoint. The data from these studies were used to calculate EC50 values and provide an estimate of organ-specific toxicity in the rat. The second part of the project used computational and in vitro methods to predict the pharmacokinetic properties of the ToxCast chemicals. The pharmacokinetic properties were used to predict what exposure conditions (i.e., route and dose) would be needed to produce target tissue doses equivalent to the EC50 values measured in the cytotoxicity experiments.

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California Department of Pesticide Regulation

#### **UNCERTAINTIES IN THE ESTIMATE OF CUMULATIVE EXPOSURE TO ORGANOPHOSPHATE INSECTICIDES**

Under the Food Quality Protection Act of 1996 (FQPA), the USEPA estimates the cumulative dietary exposure to organophosphate insecticides (OPs) using measured residue levels surveys by the United States Department of Agriculture’s Pesticide Data Program supplemented with information from the Food and Drug Administration Center for Food Safety and Applied Nutrition. Some of the residues USEPA used in determining cumulative dietary exposure came from surveys conducted in different years. However, the lack of measurable residues of a given OP on commodities in one year probably reflects a different use pattern. Consequently, it is necessary to substantiate USEPA’s method for estimating cumulative exposure. One validation technique has been to compare data derived from biological monitoring surveys with the USEPA estimate. These comparative studies have approximated USEPA’s estimate of cumulative exposure to OPs from all sources. Since 2002, virtually all general public exposure to OPs has been through

the dietary route due to voluntary cancellations of virtually all residential use products. Thus, USEPA's cumulative OP exposure estimate from dietary sources can be validated directly from more current biomonitoring surveys. Metabolites of OPs in urine, such as dialkyl phosphates, are often used as biomarkers for human exposure to the parent compounds. It is generally assumed that all of the metabolites in the urine were derived from parent compounds. However, recent and older data indicate that OPs are readily converted to metabolites by both environmental conditions and plant metabolism, prior to human consumption. Thus, a substantial amount of the metabolites measured in human urine entered monitored individuals in the hydrolyzed (biomarker) form. These data strongly suggest that the USEPA cumulative OP dietary exposure estimate can exaggerate actual dietary exposure to organophosphate insecticides by up to 2-fold.

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TRC

### **CASE STUDIES OF NON-PAINT SOURCES OF LEAD EXPOSURES IN THE UNITED STATES**

Lead-based paint is often cited as the primary source of children's lead exposures, but exposures to "non-paint" lead sources may now be the cause of the most severe cases of adult and childhood lead poisonings, and a major cause of lead poisonings, in certain communities. The predominant "non-paint" sources originate in developing countries and include products such as traditional remedies, foods and spices. In addition, many immigrants with high body burdens of lead from exposures in their native countries settle in the US, and US-born children of immigrant mothers with high lead burdens are exposed to maternal lead stores in utero and via post-natal breast milk feeding. The nature and scope of this "non-paint" lead poisoning problem will be described along with documented case studies of lead poisonings attributed to these sources. A brief historical review of the medical literature on "non-paint" lead sources as well as examples of traditional customs that predispose certain immigrant groups to "non-paint" lead exposures will be presented. Guidance will be provided for field recognition of ethnic-specific lead hazards. The importance of effective caregiver interview techniques and cultural sensitivity will also be addressed.

**M4-J.4** Cooke RM, Kurowicka D, Morales O, Ale B, Van Der Boom R, Roelen ALC, Spouge J; cooke@rff.org

Resources for the Future, Delft University of Technology

### **CIVIL AVIATION TRANSPORT SAFETY MODELED WITH NON-PARAMETRIC CONTINUOUS BAYESIAN BELIEF NET**

Bayesian belief nets (BBNs) are attractive tools for decision support. However, (a) discrete BBNs and (b) "discrete-normal" BBNS are highly constrained with regard to (a) complexity and (b) distributional form. A large project for the Dutch Ministry of Transport provided resources to overcome these problems. Non-parametric continuous BBNs allow arbitrary 1-dimensional distributions, for all probabilistic nodes. Influence is represented as conditional rank correlation between parent and child node, according to a protocol that uniquely characterizes the joint distribution. The choice of copula is unconstrained in principle, but for large problems, such as modeling risk in civil air transport from take-off to landing, the joint normal copula is the only feasible option. The current application involves upwards of 700 probabilistic nodes and 600 functional nodes. Some nodes have more than 60 parents. The marginal distributions are recovered from data, in all but a few cases. The probabilistic dependences were quantified with structured expert judgment. The model runs in real time. Using analytical conditioning, conditional accident probabilities can be calculated given values of input nodes. This enables quantitative risk trade-offs

between diverse subsystems. For example, we can compare the risk benefit of new Merging and Spacing protocols against the benefit achieved by requiring that pilot and first mate share the same mother tongue. The paper presents methods and results.

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### **DESIGNING NETWORKS TO WITHSTAND TERRORIST ATTACKS**

How can we design telecommunications networks to withstand deliberate attacks by intelligent agents? This talk presents methods and models for designing highly resilient communications networks that quickly and automatically reroute traffic around affected areas to maintain communications with little or no interruption in service. Current network architectures, routing and restoration protocols, and design methods already protect networks against loss of any single link or node, so we focus on designing networks that can reroute traffic even when multiple simultaneous failures occur. Deterministic optimization approaches that can reroute all traffic after loss of any  $k$  links or nodes, where  $k$  is an integer reflecting the attacker's capacity for simultaneous attacks, are relatively well developed for  $k = 1$  or  $2$ , but remain largely an open problem for larger  $k$ . Simple probability models for failures in packet-switched data networks caused by attacks on the  $k$  most-loaded nodes suggest that such networks are inherently resilient to attacks if each node has enough spare capacity (typically about 10k% more than would be required in the absence of attacks). Networks with less than this critical amount of extra node capacity are vulnerable to cascading failures following a successful attack. Finally, we present simple game theory models showing that network owners and users may have incentives to under-invest in network resilience: everyone would benefit from institutional frameworks that enable trustworthy mutual commitments to invest more in network resiliency.

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### **COGNITIVE MISERS OR RATIONAL PROCESSORS? THE ROLE OF TRUST, AWARENESS AND BENEFIT BELIEFS IN PREDICTING PUBLIC SUPPORT FOR HEALTH BIOTECHNOLOGIES**

The idea that public attitudes are informed by a cognitive appraisal of the benefits and risks associated with an attitude object is widely accepted within the public understanding of science literature. Moreover, the public deficit model argues that an awareness of a particular technology leads to increased support because awareness allows one to conclude that the benefits outweigh the risks. More recently, trust theorists have suggested that the public are cognitive misers who are more inclined to base their attitudes on their level of trust in those who are conducting or controlling the science. This research compares both views across a range of different biotechnologies, including human embryonic stem cell research, therapeutic cloning, genetic testing, and genetically modified foods. The results from five national Australian telephone surveys ( $n = 1013$ ;  $n = 1013$ ;  $n = 1000$ ;  $n = 1000$ ;  $n = 1000$ ) suggest that generally the public are both cognitive misers and information processors. However, the use of finite mixture modeling and structural equation modeling reveals that attitudes are more likely to be based upon trust than information as the complexity of the technology increases, and for some sections of the public more than others.

**T3-D.4** Crouch EA, LaBarre D, Dearfield K, Kause J, Golden NJ; neal.golden@fsis.usda.gov  
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#### **A DEMONSTRATION OF THE APPLICATION OF A TWO-DIMENSIONAL RISK ASSESSMENT FOR ESTIMATING RISK MANAGEMENT METRICS FOR FOOD SAFETY**

The Codex Committee on Food Hygiene recently developed Guidelines on Microbiological Risk Management Metrics that involve definitions of ALOP (Appropriate Level Of Protection), FSO (Food Safety Objective), PO (Performance Objective), and MC (Microbiological Criterion). This development took place in the abstract, with little demonstration of a method for their implementation. We demonstrate here a general methodology that allows estimation of an ALOP and evaluation of corresponding FSO, PO, and MC at appropriate points in the food chain. It requires a two-dimensional (2-D) probabilistic risk assessment (RA), the example used being the Monte Carlo RA for *Clostridium perfringens* in ready-to eat and partially cooked meat and poultry products ([http://www.fsis.usda.gov/Science/Risk\\_Assessments/index.asp](http://www.fsis.usda.gov/Science/Risk_Assessments/index.asp)) with minor modifications to evaluate and abstract required intermediate measures. For demonstration purposes, the RA model was applied specifically to hot dogs in the U.S. Evaluation of the cumulative uncertainty distribution for illness rate allows specification of an ALOP that, with defined confidence, corresponds to current industry practices. An FSO is to be defined at the point of consumption in terms of frequency and/or concentration of a hazard that provides or contributes to the ALOP; we define a more general specification using arbitrary surrogate measures and demonstrate how a 2-D RA allows evaluation of an FSO that provides the ALOP with required confidence. A PO may be defined at any point in the food chain, and the same approach to evaluation as for the FSO may be followed, provided the RA is suitably specified. The RA allows exploration of various specifications for a PO, selection of the most practical or efficient, and an evaluation that again provides the ALOP with required confidence. Finally, given the PO, an MC may be defined using standard approaches to sampling and experimental design. We summarize the lessons learned in this demonstration.

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University of Virginia

#### **RISK-BASED STRATEGIC HOMELAND PREPAREDNESS: BALANCING PROTECTION AND RESILIENCE IN REGIONAL INTERDEPENDENT SYSTEMS**

The recently released National Infrastructure Protection Plan (NIPP) integrates federal risk analysis concepts from the last decade concerning the protection of critical infrastructure and key resources (CI/KR). Two major types of risk management strategy emerge from the NIPP: protecting system assets and adding resilience to systems. Much of the NIPP focuses on analyzing component systems and assets for protecting systems. Systems engineers are particularly interested in characteristics that emerge from the system design, which are affected by both changes to component systems and by changes in system construction and integration. Adding resilience to a system expands the focus beyond component systems to include a study of emergent, system-level attributes. Balancing protective and resilience actions through system-level analysis provides a means to improve the efficiency of regional and national preparedness. This presentation explores concepts of emergence, resilience, and preparedness as a foundation for establishing a framework to assess the balance between the two areas of infrastructure risk mitigation. A framework to assess protection and resilience tradeoffs is demonstrated through three examples, which focus on potable water distribution systems in hurricane-threaten coastal regions, regional workforce con-

tinuity under threats of influenza, and identity management policies and technologies that impact the tradeoffs of security and flexibility in disaster response. These example case studies provide an illustrative study that demonstrates the application of the framework and provides a means for further discussion about the complex interactions that are faced when evaluating the resilience of a system.

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#### **HOW DO WE KNOW WHEN A FOOD IS SAFE TO EAT (AGAIN)?**

Food safety and food recalls have received significant media attention. The current paper uses hypothetical scenarios and the real-world example of the 2006 spinach recall to explore how consumers know when a previously contaminated food product is considered “safe” to eat again. Multiple data sources, including a television content analysis and two national telephone surveys, are used to facilitate an understanding of whether and how this information reaches consumers. A content analysis of network television coverage regarding the spinach recall was conducted. A total of 86 stories appeared on national broadcast news in the month following FDA’s initial advisory against eating spinach. Of these, 31 stories appeared after the advisory was lifted, which occurred one week after it had been announced. However, only 9 of these stories (36% of all stories after the advisory was lifted) mentioned that spinach was considered safe to eat again. To examine consumer reactions, we conducted two national telephone surveys, in 2006 and 2008, which examine Americans’ perceptions of the safety of fresh spinach over time. Seventy percent of the public first heard about the spinach recall on television. However, two months after the recall, at least 45% of Americans were confused about the status of spinach. We illustrate how those beliefs have changed in the intervening two years. In addition, the 2008 national survey uses a hypothetical scenario to identify the beliefs that people have when they encounter a previously recalled food in the absence of subsequent messages about its safety, and measures their likely actions and ratings of the safety of the food. Barriers to understanding the status of foods that return to the marketplace after a recall, and significant predictors of returning to prior consumption levels of recently recalled foods will be presented. Finally, we explore how these issues relate to food terrorism, where an all-clear message may never be possible.

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#### **NANO: RISK AND ENGAGEMENT MODELS**

Assessing risk in nanoscience is especially troublesome given the extremely high levels of uncertainty associated with hazard, dose, and exposure. A project at NCSU involving the design of a White Paper for the NNCO (National Nanotechnology Coordinating Office) of the National Nanotechnology Initiative. Consensus conferencing and deliberative polling as experiments in public engagement concerning the risks associated with science and technology require further assessment and scrutiny. In considering the emergent fields of nanoscience, the use of such engagement tools must be carefully planned and effects from such devices must be gauged given the expenses associated with these projects. This paper assesses the current models of public engagement and argues that further emphasis be placed on proper quantitative and qualitative data collection and analysis.



**W3-E.4** Curry SR, Schmitt KA, Shutt KA, Pasculle AW, Harrison LH; ketrasmitt@gmail.com  
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#### **COST-BENEFIT ANALYSIS OF REPEATED CYTOTOXIN TESTS FOR CLOSTRIDIUM DIFFICILE**

*Clostridium difficile* is a common hospital-acquired bacterial disease that frequently results in excess morbidity, mortality, and healthcare costs. The clinical gold standard, highly specific diagnostic test for detection of *C. difficile* toxins in human stools is plagued by expense, long turn-around times, and poor sensitivity compared to a research gold standard (culture for toxigenic *C. difficile*). As a consequence, patients are routinely tested for *C. difficile* toxins serially in an effort to enhance the sensitivity of the test. As testing for *C. difficile* is significantly more costly for patients and hospitals than is empirical treatment, repeated cytotoxicity testing has been found to be of questionable clinical value in previous studies. These studies focused on the microbiology laboratory perspective, a setting in which many patients with a low prior probability of *C. difficile* disease were tested multiple times. Unsurprisingly, multiple *C. difficile* toxin tests performed in patients without *C. difficile* disease have been found to be of limited value. In contrast, this study focuses on a large retrospective dataset from 2001-2005 representing all *C. difficile* toxin tests from a large teaching hospital in Pittsburgh that experienced a *C. difficile* epidemic in 2000-2002. This data set allows the value of repeated cytotoxicity testing in epidemic and endemic settings with varying pre-test probabilities of *C. difficile* disease to be tested. The practice of sending three stool toxin tests for each patient with suspected *C. difficile* became routine practice at this hospital in the wake of its epidemic, so this practice can be evaluated in terms of value to the patient in terms of disease detection and cost.

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#### **TRUST AND CONFIDENCE: THE EFFECTS OF EMOTIONAL REACTIONS, VALUE SIMILARITY AND PERCEIVED PERFORMANCE ON THE PERCEPTION OF BORDER SECURITY**

Perceptions of border security influence support for management and compliance to security measures. This study investigated perceptions of the adequacy of US security at the Canadian and Mexican borders & along the West Coast. Sample 1 consisted of 204 university students who completed paper and pencil questionnaires and 91 older individuals solicited through public meetings and flyers for completion of an on-line questionnaire. Results have implications for research and theory on: a) the experiential, affective aspects of risk perception (Slovic, Peters, Finucane, & MacGregor, 2005) and b) the Trust, Confidence and Co-operation (TCC) model (Earle, Siegrist, & Gutscher, 2007). Regarding the affective aspects of risk perception, it was found that perception of high adequacy of security at each of the 3 borders was related to higher reported fear, but not to anger. Assessments of poor overall security performance since 9/11/01, however, were related to high reported anger, but not fear. The perception that security managers did not share salient values was related to increased levels of reported fear and anger. Results indicate support of the TCC model in that participants implicitly made a distinction between trust and confidence. Judgments of confidence directly affected assessments of border security. The effects of trust judgments were mediated by confidence judgments. Both confidence and trust were affected by judgments of shared similar values and past security performance. Implications for theory development and border security management will be discussed. References Earle, T. C., Siegrist, M., & Gutscher, H. (2007). Trust, risk perception and the TCC model of cooperation. In M. Siegrist, T. C. Earle & H. Gutscher (Eds.), *Trust in Cooperative Risk Management: Uncertainty and*

*Skepticism in the Public Mind*. London: Earthscan. Slovic, P., Peters, E., Finucane, M. L., & MacGregor, D. G. (2005). Affect, Risk, and Decision Making. *Health Psychology. Special Issue: Basic and Applied Decision Making in Cancer Control*, 24(4,Suppl), S35-S40.

**W4-D.2** Dantzker HC, Snedeker SM; hac4@cornell.edu  
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#### **UNDERSTANDING PERCEPTIONS ABOUT CANCER AND OTHER HEALTH RISKS HELD BY PESTICIDE APPLICATORS IN NEW YORK STATE'S GREEN INDUSTRY**

In New York State (NYS), a growing number of local laws governing the application of lawn and garden pesticides reflects rising public concern about the health risks associated with these chemicals. Health risks such as cancer are often cited as reason for such legislation. Indeed, over 150 pesticide products registered for turf and ornamental use in NYS contain ingredients rated as probable or likely human carcinogens by the US Environmental Protection Agency. Yet in NYS, applicator certification curricula include little or no training for applicators on understanding, or communicating to co-workers and clients about the long-term health risks posed by these chemicals. The purpose of this study is to improve communication among Green Industry professionals-such as golf course managers, landscapers, arborists, and others-about the cancer risks associated with common turf, lawn, and garden pesticide chemicals. A mail survey was administered to 1,200 NYS-certified turf and ornamental pesticide applicators (n=412) to better understand their attitudes about the potential health risks associated with pesticide exposure. Results integrate applicator risk perceptions related to pesticide exposure with those related to illness and diseases, including cancer. Discussion will include how risk perceptions may be influenced by such factors as high exposure experiences, personal experience with cancer, and workplace safety culture. The health risk information needs and preferences reported by applicators will also be discussed.

**W2-C.1** Daston G, Boobis A, Preston J, Julien E, Olin S; daston.gp@pg.com  
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#### **AN INTRODUCTION TO THE KEY EVENTS ANALYTICAL FRAMEWORK AND APPLICATION TO ENVIRONMENTAL CHEMICALS**

Risk assessment for chemicals, nutrients, allergens or microbes makes assumptions about the existence of biological thresholds, assumptions based on theoretical considerations about the underlying processes leading to toxicity or disease. These assumptions were developed several decades ago and need to be revisited given the huge volume of information that has been generated about the molecular pathogenesis that leads to disease. A reductionist approach that evaluates the potential for the existence of a threshold for each key event from exposure to frank toxicity or disease is now technically feasible, given advances in molecular biology and biotechnology. For chemical agents, there is empirical evidence available to challenge assumptions about thresholds; e.g., we now know that cancer can only occur after several mutations in key cellular control genes, contradicting the assumption that a single mutation is sufficient for tumor formation. We also know that chemically-induced mutational spectra frequently differ from spontaneous spectra and are therefore not additive, contradicting the assumption that chemically-induced cancers are adding to a pre-existing background of molecular lesions. There is evidence for non-genotoxic mechanisms of carcinogenicity for which persistent inflammation, cell proliferation or other events involving large numbers of cells are necessary to drive the response. It has been assumed



that non-cancer responses exhibit a threshold because of the requirement that numerous cells must be affected in order to produce an adverse effect. However, particularly for receptor-mediated effects (e.g., endocrine or neurotoxicity), consideration needs to be given to the possibility that the exogenous substance adds to the endogenous background. Case studies for genotoxic and non-genotoxic carcinogens and for receptor-mediated toxicity will be discussed.

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National Center for Environmental Assessment, US Environmental Protection Agency

#### **COMPREHENSIVE ENVIRONMENTAL ASSESSMENT OF ETHANOL: APPLYING LESSONS LEARNED FROM THE MTBE EXPERIENCE TO BIOFUELS**

This introduction to the symposium highlights some of the key lessons learned from experience with the fuel additive methyl tertiary butyl ether (MTBE), particularly the need for a holistic approach such as Comprehensive Environmental Assessment (CEA) in weighing the trade-offs associated with different fuels and fuel additives. CEA combines a product life-cycle framework with the risk assessment paradigm, encompassing multimedia environmental pathways of exposure to both primary and secondary contaminants and considering ecological as well as human health effects. An outline of the CEA approach is presented as an organizing structure for the remaining presentations in the session. Disclaimer: Views expressed here are those of the author and do not necessarily reflect the views or policies of the U.S. Environmental Protection Agency.

**M4-B.4** Demuth JL, Barjenbruch K, Nietfeld D; jdemuth@ucar.edu

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#### **ASSESSING PEOPLE'S KNOWLEDGE, PERCEPTIONS, AND DECISION-MAKING DURING THE 2008 SUPER TUESDAY TORNADO OUTBREAK**

On February 5-6, 2008, a major tornado outbreak occurred over the south-central portion of the United States. February 5 was "Super Tuesday" for the presidential election, thus the event was dubbed the "Super Tuesday" tornado outbreak. Over 80 tornadoes were confirmed and 56 people were killed in Arkansas, Tennessee, Kentucky, and Alabama, making it the deadliest outbreak in over 20 years. A week later, a team of National Weather Service forecasters, an emergency manager, and a research scientist deployed to the damage area and spent eight days assessing the event. Two key components of the event assessment were to better understand why the large loss of life occurred and, more generally, to gather information about people's actual warning response behaviors. Specifically, there was an emphasis on ascertaining (1) what information people had about the severe weather situation and how they interpreted that information; (2) how people perceived their risk in this situation; and (3) what decisions people made. These aspects were assessed through semi-structured interviews with 41 members of the public. This type of empirical data is critical to helping the meteorological community improve its understanding of how people assess risk and, potentially, to improve its communication of risk to the public. This presentation will discuss findings from this study as well implications for future research.

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Food and Drug Administration

#### **FDA/CFSAN FOOD SAFETY RISK ASSESSMENT ACTIVITIES, APPLICATIONS, AND ADVANCEMENTS**

The Food and Drug Administration, Center for Food Safety and Applied Nutrition is developing new ways to address complex food safety issues by advancing the application of risk analysis principles and practices in our decision-making process. CFSAN developed and implemented frameworks for identifying, prioritizing and executing risk-based projects. A wide range of quali-

tative and quantitative tools are being used to address critical food safety and food defense issues. Risk profiles are an example of a new tool under development to evaluate our scientific knowledge of a food safety problem and potential control measures. Further advances in the development and use of food safety risk assessment methodology will increasingly require an emphasis on sustained collaborations with other federal agencies, international organizations, and our stakeholders. This presentation will provide an update of CFSAN's food safety risk assessment program activities, including the risk-based approaches outlined in the 2007 FDA Food Protection Plan.

**W4-G.1** Diamond G, Lumpkin M, Rhoades J, Massulik S, Coleman M; diamond@syrrs.com

Syracuse Reserach Corporation

#### **MODELING INHALATION ANTHRAX IN PRIMATES TO INFORM DISCUSSIONS ON "ACCEPTABLE RISK"**

The practice of microbial risk assessment for biothreat agents is made difficult by limited methodologies available to extrapolate dose-response relationships across species. However, there is great need to quantify internal dosimetry in animals and humans of agents that may be released in bioterrorist attacks. Data to develop predictive internal dosimetry models exist for multiple species of animals, but not humans. We have developed a physiologically based biokinetic/biodynamic (PBBK/BD) model for inhalation anthrax in nonhuman primates (NHPs) and humans that provides estimates of kinetic (spore dose in the deep lung) and dynamic (bacteria levels in lymph and blood) internal dosimeters useful for dose-response analysis. The ICRP human respiratory tract model for radionuclides was allometrically scaled to NHPs and found to predict metal oxide particle lung deposition and clearance in close agreement with observations in monkeys and baboons. Assuming that *Bacillus anthracis* spores and metal oxide particles of the same size are deposited and taken up by alveolar macrophages similarly, the NHP model was extended to describe *B. anthracis* spore germination and bacterial growth and clearance in the thoracic lymph and blood. The resulting model is able to predict bacteria levels in monkey lymph and blood quite similar to observations. The PBBK/BD model for NHPs was used to predict internal dosimetry for describing the dose-response of inhaled anthrax spores resulting in mortality or survival in Rhesus and African Green monkeys. From these analyses, the human model was used to extrapolate NHP survival to humans. These exercises are useful for identifying data needs for reducing uncertainty in the model predictions, particularly for humans. They also represent a significant advance in developing a biologically based tool to inform selection of "acceptable risk".

**W2-J.2** Dickey BD, Santos JR; bdd8c@virginia.edu

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#### **MULTI-OBJECTIVE NETWORK OPTIMIZATION (MONO) METHOD FOR IMPROVING INCIDENT RESPONSE OF SAFETY SERVICE PATROL VIA ROUTE CONFIGURATION MODIFICATIONS: AN EXTREME EVENT ANALYSIS**

This research develops a methodology for analyzing the trade-offs among multi-objective solutions using network modeling. This application of the Multi-Objective Network Optimization (MONO) method compares the expected (mean) and conditional expected (extreme) values derived from probability distributions of risk measures. By considering not only the mean value of a distribution but also the expected value in the case of an extreme event, decision-makers will have a more comprehensive understanding of possible consequences. In network modeling, consecutive arc values, which can be represented by distributions, must be combined to determine the total "cost" of a path. In order to calculate the conditional expected values, such multiple distribu-

tions can be convolved using Monte Carlo simulation. Furthermore, sensitivity analysis, such as a modification of the Hurwitz rule, is performed on mean and extreme values to determine scenario-specific optimal solutions. The MONO method can be applied whenever multiple options exist with uncertain parameters. One such application is the Safety Service Patrol (SSP) deployment problem, which involves minimizing the response of incident assistance vehicles from various patrolling locations. The “golden hour” in incident response is critical for managing traffic conditions and ensuring the safety of those involved in roadway accidents. Since the travel time from the SSP location to the incident varies, decision-makers must consider the response time during average and irregular traffic conditions. By evaluating the trade-offs between expected and conditional expected values, the overall efficiency of assistance vehicles can be improved.

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#### **IS YOUR DIET AS NATURAL AS YOU THINK IT IS? THE RELATIONSHIP BETWEEN DIET PATTERNS, CONSUMER ACCEPTANCE OF CHEMICALS IN FOOD AND PHTHALATE EXPOSURE THROUGH FOOD**

Phthalates are organic chemicals that are primarily used to soften polyvinylchloride. These chemicals have been detected in various types of retail food. Consumer exposure to phthalates is common and thus of concern to health authorities. This study aimed at investigating the relationships between diet patterns, consumer exposure to phthalates through food, and consumer acceptance of chemicals, particularly chemicals in food. Data were collected through a mail survey in the adult Swiss-German population (N=1063). A food frequency questionnaire led to the identification of diet patterns through the use of principal component analysis. Two diet patterns were discerned, one with an emphasis on natural and fresh foods, the other with frequent consumption of processed foods and meats. The natural and fresh diet pattern was more frequent in females and in older people. A number of rating scales assessed consumer perception of chemicals. Compared with followers of the processed and meat diet pattern, adherents of the natural and fresh approach showed higher perceptions of risk for food additives and contaminants, higher motivation to reduce chemical risks, and an enhanced interest in a natural and healthy diet. Exposure to five phthalates was modeled using food frequencies, phthalate concentrations reported from food surveys, and portion sizes typically consumed. Exposure to particular phthalates differed between the two diet patterns, whereas overall phthalate exposure did not. The extent to which modeled exposure to phthalates approached the respective tolerable daily intake values depended on the diet pattern. In summary, this study shows that distinct diet patterns are related to differing phthalate exposure. Even those consumers who express strong interest in natural food and low acceptance of food chemicals cannot avoid food-related exposure to phthalates.

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#### **THE EFFECTS OF PRESENTING IMPRECISE PROBABILITIES IN INTELLIGENCE FORECASTING**

Policy makers often rely on intelligence forecasts to guide risk management and decision making. Due to the complexity of intelligence forecasting these reports are often rife with analytic uncertainty. How analytic uncertainty should be presented to policy makers has emerged as an important topic in risk and policy analysis. In three studies, we explored the effects of presenting probability with analytic uncertainty as a confidence range (second-order uncertainty).

Participants were presented with mock terrorism intelligence forecasts that include story-based evidence as well as numerical estimates of probability and second-order uncertainty. Participants were sensitive to second-order uncertainty communicated through the confidence range, although they thought that a forecast with a probability confidence range was only useful at higher probability (e.g. 20% compared to 5%). In addition, the story-based evidence appeared to have a smaller effect on judgments when accompanied by a probability confidence range as opposed to a point estimate. Finally, when evaluating a forecast in hindsight (knowing that the forecasted event occurred), decision makers tended to report lower levels of blame and higher levels of usefulness and source credibility for forecasts that reported ranges of probability as compared to point estimates. These results highlight interesting effects of presenting probability assessments and analytic confidence to decision makers. This has important implications for risk communication and forecasting.

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#### **PUBLIC PARTICIPATION IN ENVIRONMENTAL ASSESSMENT AND DECISION MAKING: A NATIONAL RESEARCH COUNCIL REPORT**

Public participation has been advocated as means of improving environmental assessment and decision making and has also been criticized as ineffective and inefficient. A new study from the National Research Council assesses whether, and under what conditions, various forms of public participation achieve desired results. The study draws on multiple sources of evidence, including the peer reviewed literature, insights from practitioners, papers commissioned for the study, and discussions at three workshops, to draw conclusions about public participation, defined as including any of a variety of mechanisms and processes used to involve members of the public or their representatives in informing or making environmental assessments or decisions. The report establishes three general evaluative criteria. It considers and draws conclusions about whether overall, public participation improves results on these criteria and whether there are inevitable tradeoffs among them. It identifies a set of principles for effective public participation and enumerates conditions under which it may be difficult to implement these principles. It offers recommendations regarding the use of public participation and an approach for addressing difficulties that sometimes arise. Further detail, including conclusions, cannot be released in time for abstract submission, but will be provided at the SRA meeting, which will be held after release. Thomas Dietz and P.C. Stern, eds. Public Participation in Environmental Assessment and Decision Making NRC panel members: Gail Bingham, Caron Chess, Michael L. Dekay, Jeanne M. Fox, Steven C. Lewis, Gregory B. Markus, D. Warner North, Ortwin Renn, Margaret A. Shannon, Elaine Vaughan, Thomas J. Wilbanks

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#### **A PUBLIC HEALTH RESPONSE MODEL FOR RADIOLOGICAL TERRORISM EVENTS**

Homeland Security Presidential Directive (HSPD) 18 (Medical Countermeasures against Weapons of Mass Destruction) requires a risk assessment of Chemical, Biological, Radiological, and Nuclear terrorism for the purpose of risk based decision support in the area of medical countermeasure acquisition and development. The Department of Homeland Security's Science and Technology Directorate has developed a public health response model for radiological terrorism

events as a framework for evaluating proposed medical countermeasures. This presentation focuses on the development of the public health response model, its important parameters and inputs, and on various medical countermeasure strategies that it can assess. The model uses a time, countermeasure efficacy, and countermeasure quantity approach to determine the potential reduction in fatalities caused by a number of treatments. The methodology employs a discrete events model to simulate groups of people moving through the stages of illness and the public health system.

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### **ANALYSIS OF GENOMIC DOSE-RESPONSE DATA IN THE EPA TOXCAST PROGRAM**

The U.S. EPA must assess the potential adverse effects of thousands of chemicals, often with limited toxicity information. Accurate toxicity predictions will help prioritize chemicals for further testing, focusing resources on the greater potential hazards or risks. In vitro genomics is part of EPA's ToxCast research program, which is developing the ability to forecast toxicity based on bioactivity profiles derived from high-throughput screening (HTS) assays. From several of the HTS assays, ToxCast is generating gene expression data from in vitro cell systems designed to model the rodent or human liver. Following exposure to each of the 320 ToxCast phase I chemicals, analysis of these data will be used to generate in vitro concentration-response curves for individual gene or protein targets, and for the biological pathways populated by these targets. The suitability of specific in vitro targets and pathways for predictive modeling of in vivo toxicity will be assessed based on several factors. First, whether the in vitro concentration-response for gene expression changes suggests plausible in vivo tissue concentrations could have similar effects on the same targets and pathways in vivo. A second suitability factor will be the plausibility of the mode of action inferred by affected genes, targets and pathways, relative to the demonstrated toxicity for specific ToxCast chemicals. An initial focus in study design and data analysis is examining the concentration-response of gene expression regulated by the nuclear receptors CAR, PXR and PPARalpha. These nuclear receptors were selected because they regulate key metabolic pathways modulated by xenobiotics such as the ToxCast chemicals, and critical to non-genotoxic carcinogenic modes of action. This work has been reviewed by EPA and approved for presentation but does not necessarily reflect official Agency policy.

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### **VALUING MORTALITY RISK REDUCTIONS FOR ENVIRONMENTAL POLICY**

Reductions in mortality risk constitute the largest quantifiable benefits category of many of EPA's regulations. As such, mortality risk valuation estimates are an important input to most of the Agency's benefit-cost analyses. EPA has used the same central default value of \$4.8 million (1990\$), adjusted for inflation, per death averted in most of its primary analyses since the Agency last updated its Guidelines for Preparing Economic Analyses. EPA is now revising its guidance on such estimates as the literature has grown considerably since its default estimate was derived and several EPA-funded reports have raised issues about the robustness of published estimates. EPA recently sought advice from its Science Advisory Board Environmental Economics Advisory Committee (SAB-EEAC) on the use of meta-analysis to derive VSL estimates as well as the underlying construct of such estimates. This paper presents one response to the SAB-EEAC recommendations. Here, we derive a central VSL focused on stated preference (SP) studies. Following an in-depth literature search of all recent SP studies on mortality risk, we apply selec-

tion criteria to narrow the list of estimates for our VSL derivation. In developing the database for analysis we include all estimates presented in each underlying study. Using our set of selected estimates, we apply various techniques to summarize the results and derive a central estimate and range of estimates. These include fitting a distribution to the set of estimates and using econometric analysis to account for underlying differences in study characteristics. The results of this research will help inform future analysis of the VSL literature with the goal of updating EPA's mortality risk valuation practices.

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### **IMPLICIT MEASURES IN RISK PERCEPTION: LINKING AFFECT AND FEELINGS OF DREAD**

This study examines the influence of affect (measured implicitly) on risk perception. Recent discussions in this field have suggested that the dread dimension of the psychometric paradigm might be closely related to affect. The relationship between feelings of dread and affect has scarcely been investigated, however. Our research is aimed at examining this link in more detail. We address the question of whether hazards that vary along the dread dimension of the psychometric paradigm also differ in the affect they evoke. A Single-Category Implicit Association Test (SC-IAT) was used to measure affect. This test measures the strengths of the associations between a concept and evaluative attributes. The advantage of this technique is that it can measure affective evaluations that are not always captured by other, more conventional explicit measures. Eighty-three undergraduates from the University of Zurich participated in the study (44 males, 39 females, mean age: 25 years). They conducted three SC-IATs, which were presented on a portable computer. The SC-IATs assessed affective evaluations toward a non-, a medium, and a highly dreadful hazard. Afterwards, participants completed a questionnaire, which assessed their explicit attitudes, including perceived risks and benefits. The results of the SC-IATs demonstrate that a highly dreadful hazard (nuclear energy) led to negative affect. In contrast, a non-dreadful hazard (home appliances) aroused positive affect. A medium dreadful hazard (hydroelectric power) led to positive affect as well. We also demonstrate that implicitly measured affect toward nuclear energy is connected to the perceived risks and benefits of nuclear energy. In addition, we find significant gender differences in the general assessment of nuclear power. Females judge nuclear power more negatively than males do, and they associate more risks and fewer benefits with this technology. This difference was not found in the implicit measure, however.

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### **QUANTITATIVE RISK ASSESSMENT FOR SALMONELLA IN RAW FROZEN CHICKEN NUGGETS**

Frozen chicken products have been identified recently as cause of salmonellosis. Outbreaks in Canada, Australia and the United States have been associated with consumption of undercooked frozen chicken products (nuggets, strips and entrées) containing raw poultry. The presence of Salmonella in such raw products is not unusual, and may pose an infection risk if improperly cooked. Epidemiological investigations report that consumers often perceive such processed chicken products as being precooked, and may use microwave ovens to heat them. Microwave heating produces an uneven temperature distribution in the cooked food, and its use for cooking frozen chicken products containing raw poultry is currently a matter of concern. The objective of this study was to provide a quantitative estimation of the risk of salmonellosis associated with the

consumption of raw frozen chicken products, utilizing relevant published data and data generated in our laboratory. A quantitative risk assessment using @Risk (Palisade Corporation, Ithaca, NY) was developed. Data on Salmonella prevalence and concentration were taken from USDA reports and the published literature. Data on consumer cooking practices and microwave use was also obtained from the published literature. Thermal inactivation data for microwaves of different wattages was collected in our laboratory. The Salmonella dose response model developed by FAO/WHO was used to predict probability of illness. Risk model calculations indicate that microwave wattage and cooking time are critical in assuring the safety of these foods. The smallest size consumer microwave oven (500 watts) appears to present the greatest risk of producing an undercooked product. The results of this risk assessment may provide useful quantitative data relevant for risk management initiatives, ultimately aiming at controlling the risk of salmonellosis from raw frozen chicken products.

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#### **THE EFFECTS OF ACUTE EXPOSURE TO METHYL ISOTHIOCYANATE (MITC)**

Methyl isothiocyanate (MITC) is the degradate that provides the pesticidal properties of a number of fumigants (e.g. metam sodium). As a vapor, MITC can move off-site and potentially affect bystanders near treated areas in addition to field workers and pesticide handlers. Based on a review and synthesis of literature, eye irritation, mediated through stimulation of the trigeminal nerve, appears to be the most sensitive endpoint after acute exposure. Thus, risk assessment for exposure to MITC can rely on studies of eye irritation to determine the point of departure for acute inhalation studies. We used the human study by Russell and Rush (1996) to assess the risk of MITC for acute exposure. We identified subjects in this study as responders if they showed an adverse response in two or more of the three study endpoints (lacrimation, perceived irritation, and blink rate). This higher bar for defining adverse responses was necessitated by the large inter- and intra-individual variability found in this study. Using this information, we then analyzed the hazards through concentration-time (CxT) analyses and benchmark concentrations (BMCs) and determined a BMCL of 0.20 ppm. Because the derived BMC is based on human data, no uncertainty factor (UF) for extrapolation from experimental animals is necessary. Similarly, since the lower limits to the BMCs are NOAEL surrogates, no UF is needed for extrapolation from LOAEL to NOAEL, nor is a database uncertainty factor needed. An UF for human variability is necessary, however. Based on the available information, we conclude that an UF of 1 is appropriate because there is reduced intraspecies variability for direct contact effects (i.e. eye irritation) since only dynamic, not kinetic, variability is relevant, and the Russell and Rush (1996) study included a sensitive population. The best estimate of a health protective concentration for MITC, based on this assessment, is 0.8 ppm for 14 minutes and 0.2 ppm for 4 hours and longer.

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#### **HEALTH PROFILE AND VULNERABILITY ASSESSMENT FOR A LOW-INCOME, MULTI-ETHNIC POPULATION EXPOSED TO MULTIPLE BUILT-ENVIRONMENT STRESSORS IN WORCESTER, MASSACHUSETTS**

Little is known about health vulnerability among low-income, multi-ethnic populations exposed to multiple stressors in built environments, the fastest-growing human habitat. Four environmental stressors conspire in Main South/Piedmont, Worcester: pollution stressors; physical stressors; social stressors; and economic stressors. We developed a vulnerability assessment tool

to capture demographic data, local knowledge, time-activity patterns, health information; risk and stress perception; existing capacities and resources. Respondent-reported health problems of highest prevalence were: allergies 28%; back pain 23%; smoking 19%; asthma 16%; depression 13%; high BP 13%; sleep disorder 12% and chronic pain 10%. Gender and ethnicity disparities emerged: on average, females have twice the disease burden ( $M = 2.545$ ,  $SE = 0.2713$ ,  $Var = 9.715$ ,  $n = 132$ ), of males ( $M = 1.351$ ,  $SE = 0.2713$ ,  $Var = 3.628$ ,  $n = 114$ ,  $t(221) = -3.67$ ,  $p < 0.01$ ). On average whites bear 1.6 times the burden ( $M = 2.885$ ,  $SE = 0.413$ ,  $Var = 8.849$ ,  $n = 52$ ), of people of color ( $M = 1.769$ ,  $SE = 0.193$ ,  $Var = 6.764$ ,  $n = 182$ ,  $t(75) = 2.450$ ,  $p < 0.01$ ). Significantly higher neighborhood-group membership by people of color may be an important adaptation that mitigates stress. We found no significant differences by ethnicity in education, income or residence time. Health and risk/stress perception data strongly suggest psychosocial (social, economic) stressors dominate, but physical stressors including pollution are significant. We argue for a transformation in assessment and regulation, one that recognizes exposures to multiple agents/stressors and social adaptive capacities, but focuses on dominant ones and their drivers to be cost-effective and keep data needs reasonable.

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#### **PUBLIC HEALTH PLANNING AND SURVEILLANCE: THE IMPORTANCE OF MAPS AND GEOGRAPHIC INFORMATION SYSTEMS FOR ANALYZING AND COMMUNICATING RISK**

The use of maps to display information is becoming more common in the field of Public Health. A method to relay information to both professionals and laymen, it is imperative to maximize the capabilities and promote the various advantages of maps as a method of knowledge translation and as a decision-support system. Combined with the use of Geographic Information Systems (GIS), maps are a valuable component in analyzing and communicating risk, program planning and knowledge translation. For example, GIS capabilities and GIS concepts are critical for manipulating surveillance data and providing effective and efficient methods to determine and display risk; tracking symptoms and pharmaceutical purchases spatially for the purpose of detecting illness and preventing outbreaks; and, more generally, enhancing the efficiency of public health programs. Our research has been based on a project that developed a custom web-based GIS that encourages the sharing of local data across various regions, each with differing degree of functionality in GIS software capabilities. Important lessons learned about using GIS in a public health context will be shared and GIS applications to contexts beyond program planning will be presented, using mock data. These lessons will focus on challenges which are modifiable with enhanced training. Modifiable challenges for users include learning to be spatially literate and operating GIS software packages efficiently. Non-modifiable challenges deal with data quality and availability. Knowing how to adjust for non-modifiable challenges is equally, if not more important than knowing how to respond to and identify those that can be changed. These skills, combined with public health knowledge and an appreciation of the magnitude of possibilities for the use of maps and GIS present an innovative opportunity to enhance risk analysis and communication.



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### **MATHEMATICAL MODELING OF CLIMATE: MASSACHUSETTS ET AL. V. EPA AND THE PRECAUTIONARY PRINCIPLE**

This paper uses the scientific modeling at issue in *Massachusetts v. EPA* to examine the the precautionary principle's operation in the face of the limitations of scientific modeling. EPA and Congress will face this issue in assessing climate change risks and choosing actions to address climate change. The Supreme Court opinion relied on General Circulation Model (GCM) predictions of coastal land loss in Massachusetts to justify a finding that greenhouse gases from automobiles would likely injure Massachusetts. Justice Roberts, in a dissenting opinion, argued that uncertainties in the GCM model rendered Massachusetts' claim of injury "conjectural or hypothetical." GCM forecasts at the global scale have sometimes proven inaccurate: global sea level change and ice loss has been much faster in the last few decades than forecasted. Model error probably reflects mathematical and computing limitations coupled with a lack of understanding of the many feedback mechanisms between landscape, ocean and biota. Moreover, model error is even more likely on a regional scale. Yet, tidal and temperature measurements do in New England show a trend towards the probable loss of coastal land—although the magnitude and rate of the loss cannot be determined with certainty. The precautionary principle justifies the Supreme Court's finding that regional GCM models show an injury to plaintiffs in spite of modeling uncertainties. We explore how the precautionary principle should operate in the face of modeling error and uncertainties in addressing the issue facing EPA on remand, whether greenhouse gases endanger the environmental, and in subsequent Congressional or administrative action to address global warming. .

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### **EVALUATION OF PREDICTIVE MULTI-SOURCE, -ROUTE AND -PATHWAY EXPOSURE**

This presentation provides a case study involving a synthetic pyrethroid, i.e., permethrin, that illustrates probabilistic, aggregate exposure modeling associated with food, water and residential sources, and a comparison of model estimates to relevant population-based biological monitoring data. Stochastic modeling represents a rational means to estimate potential multi-route/pathway, population-based exposures from environmental measurements. Population-based and/or subpopulation-specific (e.g., residential) biomonitoring data presents an opportunity to evaluate the results from such modeling constructs, provided relevant biomarkers and toxicokinetics are characterized for the chemical of interest. In this presentation, we summarize existing residential biomonitoring data in an effort to better characterize both a central tendency and upper bound exposure estimate in the general population. Results are then compared to stochastic model-based estimates derived from environmental measures as a reality check.

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### **SUBJECTIVE INTERPRETATIONS OF RISK AMPLIFICATION**

SARF (Kasperson et al, 1988) uses a communications theory metaphor of amplification and attenuation to explain the phenomenon of an over-worried or under-worried public. SARF is strongly criticized for naively implying a "true" or "real" signal strength (Rayner, 1988). Yet SARF still seems to capture an idea that appeals to individual actors at a subjective level. Our study investigated how actors think about risk amplification in the context of zoonoses, for exam-

ple "bird flu". We held focus groups and group interviews with several lay groups, regulatory agencies and academics to find out how people reasoned about zoonoses and about other actors involved in managing, creating, or communicating about zoonotic outbreaks. These showed that as individual and institutional actors we subscribe to the idea that there is a "true" signal strength, to which we sometimes have privileged access. And it is other actors, not ourselves, who typically exaggerate risks or underplay them. Moreover, it is our interests and roles that shape our image of amplification. For example, the agricultural regulator needs to promote zoonotic risk to farmers in order to maximise biosecurity, and sees farmers as attenuating their perceptions of risk. The same agency needs to play down risk to the consumer, in order to minimise product boycotts. This means they see consumers as amplifying their perceptions of risk. Equally, when different lay groups share a similar knowledge they can still have quite different risk perceptions. For example, mothers of young children perceive higher risk during a food scare than pensioners. These images of amplification are strongly influenced by narrative resources, such as plausible conspiracy theories and stigma. Actors seem to deploy these in order to enrol others in a more general worldview and ways of acting: for example, avian influenza was strongly linked to intensive farming.

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### **HUMAN RISK PERCEPTIONS OF CLIMATE CHANGE**

In this paper we discuss the human risk perceptions of climate change through the use an interactive simulation based on the "bath tub" metaphor of the effects of emissions and absorptions of anthropogenic carbon dioxide (CO<sub>2</sub>) in the atmosphere. The interactive simulation allows participants to make decisions on the anthropogenic CO<sub>2</sub> emissions, observe the consequences of the decisions and try new decisions again. In a laboratory experiment, we tested the participants' ability to control the CO<sub>2</sub> concentration to a realistic amount (i.e. a goal) in the atmosphere over a period of 100 to 200 years in 4 different scenarios which differed in frequency of emission decisions (every 2 or 4 years) and removal rates of CO<sub>2</sub> (1.2% or 1.6% of CO<sub>2</sub> concentration). Participants were told that controlling the CO<sub>2</sub> concentration at a value above the goal might present humanity with catastrophic consequences in future like melting of polar ice caps, violent storms and submerging of landmass under oceans. Participants were also told that controlling the carbon dioxide at a value below the goal would mean cutting down on technological progress for humanity like shutting down of thermal power plants and other CO<sub>2</sub> emission intensive industries. On account of human perceptions of risk in different situations, we expected people maintaining CO<sub>2</sub> concentration below the goal as opposed to maintaining it above the goal as by doing so people show preferences for certain, familiar, voluntary and control risks that are uninteresting and less dramatic than uncertain, involuntary, uncontrolled and dramatic risks. Results from experiment are consistent with our expectations and show that participants, controlled by their risk perceptions, maintain the CO<sub>2</sub> concentration below the goal under all 4 scenarios for median concentration and in 3 out of the 4 scenarios for mean concentration of CO<sub>2</sub>. Implications of these research findings are discussed.

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### **RISK ASSESSMENT (RA) IN WORKING EQUINE WELFARE**

The Brooke is an animal welfare charity focussing on working equines in developing countries. These animals often belong to the poorest members of society and work long hours in harsh conditions to support their owners. Brooke works with local communities to improve equine wel-

fare through evidence-based interventions. The welfare status of animals is established through welfare assessment. The causes of prioritised problems are then investigated. Often, choices made in animal welfare interventions can be based on assumptions that do not hold true. Developing causal analysis tools to identify risk factors associated with priority welfare issues is therefore important. Currently, RA examines environmental, resource, animal and human-based measures which may be directly or indirectly associated with the welfare issue. Survey design is based on available literature, local veterinary knowledge and scrutiny of the equines working life. Crucially, input is gained from local communities through focus group discussions and participatory work with key stakeholders. Designing an appropriate intervention strategy requires understanding of owner/user motivations and owner-animal interactions. RA includes measures of human behaviour to gain information on work and husbandry practices and attitudes. Stratified sampling plans ensure sufficient statistical power for comparisons between groups and accurate representation of the population. Quality assurance techniques are being developed to ensure reliability, completeness and accuracy. Statistical screening of variables identifies key risk factors, in addition to focused analysis based on field experience and scientific literature. The Brooke is presently using RA data for intervention planning and the development of further research hypotheses in many countries. Brooke is also investigating transferability of RA findings between populations and optimising current RA methodology to increase efficiency and application of results.

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#### **DETERMINING RECOVERY RATES OF MICROBES FOR DIFFERENT POULTRY CARCASS RINSE VOLUMES TO ESTIMATE TOTAL CARCASS-LEVEL PATHOGEN COUNTS**

The Food Safety and Inspection Service is evaluating the change in human illnesses associated with proposed performance standards for generic *Escherichia coli*, *Salmonella* and *Campylobacter*. These performance standards – applied during the production and processing of broiler chickens – establish bounds on either the proportion of contaminated carcasses or the level of contamination found on chicken carcasses at the end of production (carcasses tested by rinsing post-chill). A risk assessment model is used to estimate changes in human illnesses; this model incorporates the results of three different data sets. Each data set used different sampling methods. One substantive difference between these data sets was the rinse volume used (100 and 400 ml). This difference affects the detection threshold for a one milliliter sub-sample, as well as inferences about the total number of microorganisms on sampled carcasses. The methodologies used to scale rinse sample data up to a carcass level are described. We focus on the estimation of the different recovery rates for the 100 and 400 ml samples using a Markov Chain Monte Carlo model. The study found that the estimated recovery rate for the 100 ml rinse sample was about 10%, while the 400 ml rinse sample was greater than 60%. The uncertainty for 100 ml rinse volume was much smaller than that of the 400 ml.

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**MICROBIAL RISK ASSESSMENT: ACTIVITIES AND APPLICATIONS WITHIN THE FOOD SAFETY AND INSPECTION SERVICE**

The United States Department of Agriculture, Food Safety and Inspection Service is the federal Agency charged with safeguarding the US supply of meat, poultry and egg products. As such,

the Agency exercises its regulatory authority to require the industry to meet certain requirements mandated by the relevant inspection Acts. The impact of these regulations, both in terms of public health protection, and the economic burden on the industry, is measured by risk assessments. Recent work performed by FSIS' risk analysts includes development of risk-based sampling programs for *Listeria monocytogenes* and *Escherichia coli* O157:H7, evaluation of the public health benefits of generic *E. coli*, *Salmonella* and *Campylobacter* performance standards, use of marginal economic analyses to assess the effects of pre-harvest interventions in beef on the public health impact of *E. coli* O157, evaluation of the benefits of "team inspection" as a way to prioritize Agency resources in the field, and assessment of the likelihood of illness from highly-pathogenic avian influenza reaching the food supply. Such risk assessments are used by the Agency to evaluate various strategies to manage risk, and to provide the scientific basis for regulatory decision-making.

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#### **PROBABILISTIC RISK-COST-BENEFIT ANALYSIS OF ADDITIONAL BENZENE EMISSIONS CONTROLS**

The risk-based cost benefit analysis of a decision to install additional airborne vapor emission control equipment involves multiple factors related to potential health risks, including: (1) the airborne transport of vapors to a nearby city, (2) the anticipated exposures of people at key locations, (3) the toxicity of inhaled benzene, and (4) the population of the city. Cost information related to equipment purchase and operation is required also. This information can be combined to estimate the costs of new emission control equipment and the resulting benefit described as the number of cancer cases avoided in the city population by its use. The analysis is based on an assessment of benzene vapor emissions for a baseline scenario (no additional controls) and for a controls scenario (with proposed controls). The AERMOD vapor dispersion model was used to estimate vapor transport from the facility and to predict benzene concentrations at locations of interest across the city. Standard EPA unit risk exposure assessment methods and the EPA benzene unit risk factor range were used to estimate inhalation cancer risk to residents, students and workers at schools, a college, and a hospital in the city. Risk estimates calculated for the controls scenario were less than for the baseline scenario, as expected. The risk benefit was expressed as the number of cancer cases avoided in the city population. The cost of additional control equipment was expressed as the net present value (NPV) of the purchase, installation, and operation costs discounted at a rate of 10% over its anticipated operational life (30 years). The cost benefit ratio is expressed as the NPV cost per cancer case avoided. This presentation describes how probabilistic analysis can evaluate the uncertainties to determine which uncertain factors contribute to the overall risk-based cost benefit ratio, and to its related decisions.

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**SELF-FULFILLING PROPHECY IN HEALTH AND DISEASE MANAGEMENT. A META RISK**

To be afraid of low risk leads to at least three deleterious side effects. Firstly being afraid is uncomfortable, secondly being afraid of low risks prevents you from mitigating higher risks and lastly precaution could be more hazardous and "costly" than the actual focused risk reduction. One of the counter productive impacts of prevention, a peculiar and ironical one is to increase the risk expected to be avoided by action. Cancer is still defined by a pathologist identifying cancerous

cells under microscopic examination. However, moving upstream towards smaller tumors has increased a kind of pathological-clinical dissociation. Indeed, if some of the small tumors identified using early screening should have had evolve towards clinically life-threatening tumors, some of them, if not removed, wouldn't have progressed. Currently, there is not yet a molecular analysis that could distinct aggressive tumors, which will become life threatening, from the indolent, non-progressing tumors. Therefore, in some cases, early screening is life saving, but in others it is worthless. This has been described as "overdiagnosis" (with its deleterious implication "overtreatment"). Recently it had been observed a paradoxical still higher risk of breast cancer in women who tested negative for a known familial BRCA mutation (an extremely important risk factor for breast cancer). Besides possible epidemiological bias, the authors made the hypothesis of other shared risk factors: genetic or environmental. However, an alternative hypothesis could be made: relatives of women with breast cancer undergo mammography screening more often and at an earlier age than women without such family history. Their mammogram are usually subjected to more cautious interpretation resulting in a higher rate of biopsies; which in turn might increase the rate of diagnosed cancers (only a part of them should have had evolve to a clinical threat). Perceived risk could in this way create a self-fulfilling prophecy.

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#### **UNDER-SCREENING FOR COLORECTAL CANCERS. PERSONS AND PHYSICIANS' EXPLANATIONS**

Evidence of the efficacy of screening for colorectal cancer led the U.S. Preventive Services Task Force to recommend mass screening. The French National Cancer plan focused on screening interventions (including colo rectal cancer) and, from 2002 onwards, regional organised screening programs were set up. In these programs, biennial faecal occult blood test is proposed by mail and free of charge to all subjects aged 50 to 74 years. Despite mass communication and physicians' training and education, the declared rate of compliance with screening behaviour, in the targeted population, is still low (less than 30% as a mean in 2005). Two nationwide observational surveys (opinion polls; "EDIFICE" program) were carried out by telephone from January 18t to February 2, 2005. One, among a representative sample of subjects living in France and aged 40-74 years, and the other among a representative sample of French general practitioners (GPs). Persons who didn't undergo a screening test were asked why so, and physicians were asked the reasons why they think persons did not undergo such screening test. Overall, the main reasons given were: - "Not concerned" for 36% of the persons but only 11% for physicians. - "The fear of the result" for 3% of the person but 16% of physicians. - "The absence of recommendation from GP" for 16% of the persons and 9% of physicians. It appears clearly that physicians differ from persons in their interpretation of the reasons behind the under utilization of screening test. Without clear representation of the breaks that limit screening, increasing participation rate will be hard to achieved.

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#### **MULTI-CRITERIA DECISION ANALYSES AND RE-EMERGING INFECTIOUS DISEASES: A CASE STUDY OF WEST NILE VIRUS**

A Multi-Criteria Decision Analysis Survey (N=458) in three Canadian provinces (BC, AB, MB) with varying severity of West Nile virus (WNV) activity revealed a difference in trade-offs

for prevention and control of the disease, regardless of disease frequency. Participants were asked to make programmatic decisions based on 5 performance criteria (cost, effectiveness, public acceptance, ease and speed of implementation and environmental consequences) to assess environmental, economic and health decision trade-offs. Results indicate that the public values interventions differently based on gender, age, performance criteria, and actual WNV risk. Women, on average, preferred public education in contrast to men who preferred larvaciding. Those between 19 and 34 years of age were also more concerned about the implications surrounding adulticiding. When asked about performance criteria in a high-risk scenario, respondents preferred larvaciding followed by source reduction, education and finally adulticiding. WNV is one example of a number of vector borne diseases that, in the past decade, have posed new human and environmental health risks in North America. This study underscores the importance of systematic assessments of risk perceptions and decision trade-offs for effective management and risk communication across areas with varying risk levels.

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#### **RISK PERCEPTION AND COMMUNICATION IN THE BLOGOSPHERE: DATA AND OBSERVATIONS**

The availability and use of weblogs, or blogs in short, have yielded a new medium for the communication of risks. Blogs allow individuals to present news stories and personalized articles but more importantly allow visitors to post comments in response to the stories. Thus, blogs facilitate two-way communication of information among the public. Blogs can also facilitate two-way communication among the public and government. For this reason, blogs and the act of blogging can serve as an important medium for risk communication. In this paper, we explore the role of blogs in the perception and communication of risk via the conceptual framework of social amplification of risk. On the one hand, the personalized nature of blogs and associated comments yield signals about the seriousness and manageability of risk that can drive the amplification of risk. On the other, the information sharing and public discourse aspects of blogging may shape risk perceptions toward the attenuation of risk. In reviewing these linkages between blogging and risk perception and communication, we present data from a case study of a terrorism scare in Boston, Massachusetts. On the morning of January 31, 2007, the City of Boston initiated a massive response to public reports of suspicious devices at a number of locations across the city. Bomb squads were called in, roads were closed, and public life in Boston was disrupted. In contrast to this heightened public perception of risk and public response, the blogosphere portrayed and communicated the risk to be minimal. At the onset of the terrorism scare, bloggers recognized the devices as a promotional advertising campaign for a late night television show and the information was rapidly disseminated among bloggers. We review the implications of these contrasting responses for risk communication. We conclude with a discussion of the role of Web 2.0 technologies and features such as blogging for the perception and communication of risk.

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#### **VISUAL VALIDITY: HOW SCIENTIFIC INTENT TRANSLATES THROUGH VISUALS TO EVOKE PUBLIC UNDERSTANDING OF SCIENCE AND RISK ASSESSMENT**

Visuals are at the forefront of providing information in today's society. They are on the front page of every newspaper, highlighted on the evening news, all around the Internet, and in every textbook used. They are particularly important in explaining risk and scientific processes such as

the intricacies of climate change or the risks of cancer treatments. These visuals do not simply appear in the newspaper or on television without thought, but often have a distinct objective or purpose given to them by their creator. The original objective of the graphic may not be achieved because viewers may misunderstand or misinterpret the graphic. Misinterpretations of risk visuals, such as hurricane track graphics, may have harmful consequences. Therefore, it is critically important to understand how scientific intent translates through visuals to evoke public understanding of science and risk assessment, a process that the author calls visual validity. Researchers often consider the validity of their studies asking themselves if their methodologies accurately measured what they intended to measure. Why not apply a similar process to visuals? Scientists should also consider whether their visual is presenting what they intended to present. This paper explores the concept of visual validity through an experimental study in which participants are asked to provide their understanding and interpretation of the cone of uncertainty, a highly visible hurricane track graphic. A comparison of this data is made with the scientific intent of the graphic as determined by in-depth interviews with hurricane forecasters. The case study provides the first glimpse at showing how accurately intent translates through visuals to create visual validity.

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#### **VISUAL LITERACY AND COMPLEX SCIENCE: IMPLICATIONS FOR RISK COMMUNICATION**

Risk communicators are increasingly relying on visuals to disseminate messages. This paper examines what kind of visual literacy is required to understand visual risk messages by first examining the concept of visual literacy itself. In the first section of this paper, the authors discuss widely used definitions of visual literacy in the context of complex science, particularly those that consider visual literacy as a metaphor that aligns the “reading” of visuals with the reading of literature. The authors review literature from a variety of disciplines that both accept and reject the success of this metaphor. While many believe reading a visual is an acquired or even inherent skill, some find that interpretation of visuals requires sophisticated thinking that must be learned. In order to understand what visual literacy means in risk contexts, both the viewer and the representation must be considered. Therefore, in the second section of this paper, the authors discuss the difference between “reading” visual representations such as a photograph or line drawing of an easily recognizable object, and “reading” an MRI or satellite image. The authors suggest that reading visual representations of science must be considered in a different way than reading simple visuals. Through various literatures in the history and philosophy of science as well as art history and criticism, the authors develop the concept of levels of visual representations. Finally, by looking at an in-depth case study of meteorological risk visuals, the authors develop the concept of a visual literacy for complex science, which will be of use in the field of risk communication.

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#### **COMPARATIVE ANALYSIS OF HUMAN EXPOSURE PROFILE OF ETHANOL-BASED BIOFUELS AND OXYGENATED GASOLINES**

Ethanol-blended biofuels has recently been replacing oxygenated gasoline in many geographic regions of the U.S. in order to meet the oxygenate requirement specified under the 1990 Clean Air Act. Given the fact that ethanol has increasingly gained oxygenate market share in the absence of a comprehensive life-cycle evaluation should remind the regulatory agencies, especially the EPA and the scientific community the importance of critical findings gleaned through the

MTBE experience. This study aims to fill this data gap from a consumer exposure assessment perspective. When blended in gasoline, ethanol increases volatility of other compounds in fuel, resulting in an increase in evaporative emissions of Volatile Organic Compounds (VOCs), including benzene. Many of these VOCs are known or suspected carcinogens and also have adverse health effects associated with noncancer health endpoints. The North East States for Coordinated Air Use Management estimated that the use of ethanol instead of MTBE would increase emission rates of acetaldehyde, a combustion by-product, into the atmosphere in the Northeast by 50-70%. Acetaldehyde is also a probable human carcinogen. In addition, NESCAUM estimated that ethanol at 10% by volume in conventional gasoline would increase the VOC emissions significantly. In regards to water contamination which was the culprit for the discontinuation or ban of MTBE in many districts, the replacement of MTBE by ethanol is hypothesized to have some benefits due to ethanol’s relative toxicity and rapid biodegradation although these benefits have not yet been quantified. Our study focusing on comparative state-of-art synthesis and analysis of multi-media exposure profile of both fuel types for consumers is designed to aid in comparative health risk analysis and policy-making for the two major fuel types used in the U.S. marketplace.

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#### **ASSESSMENT OF HEALTH PROTECTIVENESS OF THE RISK-BASED GROUNDWATER REMEDIATION STANDARDS OF THE MIDWESTERN STATES**

In the last decade, risk-based remediation following a framework similar to RBCA has gained acceptance across the country and generic/Tier 1 Risk-Based Action Limits (RBALs) for hundreds of chemicals have been tabulated. However, there have been only a few studies which focused on understanding the causes of discrepancy among cleanup standards and policies of the hazardous waste programs among the States for groundwater. This study aims to fill this critical need by examining the basis of generic (i.e., Tier 1) groundwater RBALs developed by the States, which are within the regulatory domain of EPA Region 5. Specifically, we seek to investigate the approaches/methodologies and the policy/technical rationale used in establishing RBALs, along with degree of inconsistency, and the causes and implications of inconsistencies. In addition, we developed RBALs for a case study site using both deterministic and probabilistic risk assessment approaches and compared these against RBALs developed by the States to infer about public health-protectiveness of the State-specific RBALs. We found significant differences among State RBALs for different chemicals. The degree of clean up deemed appropriate under Tier 1 evaluation by the Midwestern States significantly differ from one another, which has both public health and economic implications.

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#### **USE OF A MODEL TO RANK RISK OF E. COLI O157:H7 CONTAMINATION IN LEAFY GREENS**

Recent foodborne outbreaks involving fresh produce have motivated FDA to better understand the pathogen contamination mechanisms in fresh produce, particularly lettuce, spinach and other leafy green vegetables. In 2006, an E. Coli O157:H7 outbreak associated with contaminated spinach resulted in 205 confirmed illnesses and three deaths. This outbreak was one of 22 outbreaks of E. Coli O157:H7 associated with leafy greens since 1995. FDA contracted with Eastern Research Group, Inc. (ERG) to develop a quantitative assessment model to permit estimates of the



reductions in E. Coli O157:H7 associated with a range of harvest and post-harvest interventions in the production of leafy green vegetables. Each stage of leafy green production involves activities (such as manure application), characteristics (such as animal intrusion), and interventions (such as washing with sanitizer before fresh-cut processing) that increase or decrease the risk of E. Coli O157:H7 contamination. The model is based on a comprehensive assessment of the activities, characteristics, and interventions associated with leafy green growing, packing, and distribution. To determine overall contamination risk, key activity, characteristic, and intervention combinations are scored according to their contribution to the likelihood that a leafy green will arrive at retail contaminated with enough E. Coli O157:H7 to cause foodborne illness *ceteris paribus*. The relative importance of these activity-characteristic-intervention combinations are then ranked to scale their relative contribution to contamination risk. The operational model uses these risk scores and rankings obtained through an expert elicitation and data from secondary sources, such as peer-reviewed studies, government reports, and USDA farm statistics to evaluate the cost effectiveness of various interventions, such as fencing, buffer zones, employee training programs, etc. The baseline scenario of the model is calibrated using an estimate of annual incidence of foodborne illness caused by E. Coli O157:H7 in leafy greens.

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#### **RESEARCH NEEDS FOR LEAFY GREENS ASSESSMENT**

The enormous impact of leafy green vegetable (LGV)-related outbreaks in the last 10 years, suggests the need to identify new ways to ensure the safety of produce throughout the food supply system, from the farm to the consumer. A quantitative risk assessment would assist in our understanding the complex interrelationships and factors leading to human illnesses associated with LGVs and E. coli O157, and in evaluating the potential efficacy of intervention strategies. To assist in the accomplishment of this task, subject matter experts from governmental agencies, industry, and academia were invited to attend an Interagency Risk Assessment Consortium (IRAC) sponsored workshop focused on the identification and prioritization of research necessary for a quantitative risk assessment. A decision tree model was used to assist in the identification and prioritization of data gaps. The sources of contamination and interventions for each step in the food supply system, from farm to table, were used. This novel approach enhances transparency and stakeholder involvement towards the development of a scientifically valid, properly focused quantitative risk assessment. This presentation will provide a summary of the workshop findings.

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#### **REPRODUCTIVE HEALTH AND ENVIRONMENT IN ALEXANDRIA EGYPT: DEVELOPMENT OF A MODEL TRAINING COURSE**

In 2007, the World Health Organization, Special Programme of Research, Development and Research Training in Human Reproduction, funded an unusual collaboration between professors from diverse faculties at the University of Alexandria ? the Faculties of Agriculture, Arts, Medicine, and Nursing, the High Institute of Social Service, senior managers at the Health Directorate in Alexandria, Maternal and Child Health Clinics and Occupational Health Centers, and Health and Safety Managers from key industries in Alexandria. They were charged with developing a training course focused on the potential impacts of environmental exposures on reproductive health. It was offered to fourth year undergraduates or graduate students recruited from each of the Faculties listed above, nurses, occupational health educators and community

health educators The course provided students with an increased awareness of potential reproductive health and environmental contamination, basic understanding of the methodologies necessary to study them, and practical experience working with a multi-disciplinary team of students and practitioners to evaluate and seek solutions to health problems. The project is unique in Egypt and has been an important first step toward building capacities for future training and research efforts in reproductive health and the environment in Alexandria, Egypt's second largest city home to about 40% of Egypt's industry and a major agricultural area. It may serve ultimately as a model for similar efforts in other Egyptian universities. This paper provides insights into the challenges of conducting environmental health research in Egypt as well as an overview of the course, its achievements, and plans for the future.

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#### **SCENARIO ANALYSIS AND THE DEVELOPMENT OF AN INTERNATIONAL SYSTEM TO MANAGE NUCLEAR FUEL CYCLE RISKS**

Nuclear power has the potential to provide a significant portion of the world's carbon dioxide-free electricity in both developed and developing nations. With an expected increase in nuclear power, how nations manage the portfolio of fuel cycle risks will impact the effectiveness of the global non-proliferation regime. This paper explores the interconnections among the technical, economic, social, political, and environmental risks specifically addressing the goals of the United States' Global Nuclear Energy Partnership in relation to an expanded U.S. nuclear industry and the Partnerships' potential effect on an international nuclear industry expansion. Scenarios are developed that particularly account for uncertainties in the U.S. Department of Energy's Loan Guarantee Program and other programs crucial to the growth of the U.S. nuclear industry, policy decisions on nuclear fuel recycling, and the state of international agreements on nuclear energy, such as the Fissile Material Cutoff Treaty. Recently, International Atomic Energy Agency Director General Dr. Mohamed El Baradei has called for a new multi-national framework for the governance of nuclear energy. "The three big challenges . . . are to strengthen nuclear non-proliferation, accelerate the nuclear disarmament process and ensure that the benefits of nuclear energy - for power generation and other applications including in health, water and food - are made available to developing countries to help them lift their people out of poverty." Understanding the risk insights gained from the scenarios may be used to inform the design and governance of an international nuclear energy system. Ethical concerns are also addressed in the scenarios such that these concerns may greatly influence international cooperation

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#### **UNDERSTANDING THE INSTITUTIONAL LOGIC AND PRACTICE IN RISK COMMUNICATION: A COMMUNICATIVE TURN ON SOCIAL PERCEPTION OF TECHNOLOGY**

When investigating "lay perceptions" the concept of communication has been often used in an instrumental or secondary way, or focusing specifically on media and their potential effects. Furthermore, the building of middle-range communicative theoretical models becomes very useful to understand lay perceptions, public engagement processes as well as to propose ways to link different contexts and technological scenarios in a comparative logic. In this sense, we propose a theoretical framework which emphasise trust, governance or risk perception as a communicative whole, bringing out the complex interdependencies among social agents and the way they man-

age it from a communicative approach. The exploration of a wide communicative model allows to understand the complexity of technological and industrial risk management process, a process where the inside social agents are impelled to take partial decisions knowing little of the whole interactions. The proposed model implies a sort of map allowing to analyse the social agents and their mutual relationships and interdependencies, in a kind of communicative twist that shows how the isolating parts become incomprehensible out of the general process. In order to do this, empirical evidences has been obtained thanks to the deployment of two funding projects by the Spanish Science and Education Ministry (SEJ2004-00892 and SEJ2007-63095) about Risk Communication Process at Tarragona's Petrochemical Cluster, one of the largest chemical clusters in Southern Europe. The implementation of this communicative model to the analysis of the social responses to petrochemical technology can provide useful lessons for the study of lay perceptions and citizen engagement in new energy technologies.

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#### **PREDICTION UNCERTAINTY IN RISK ASSESSMENT**

In a regulatory context, it is important to recognize the uncertainties associated with quantitative results and the range of situations where a procedure can be used with acceptable uncertainty. Regression and related statistical prediction procedures may be used in a variety of ways in environmental analyses. This study focuses on situations involving unit predictive uncertainties (e.g. prediction error). For example, quantitative structure-property relationships (QSPR) methods use the measured physicochemical properties (e.g., octanol-water partition coefficient or boiling point) and other molecular descriptors of a series of similar chemicals as a means to predict the same physicochemical properties for an unknown compound within the same chemical class. Additional examples include the use of allometric scaling to predict species-specific metabolic parameters and the use of ecological stressor information to predict ecological quality at individual monitoring stations. In general, assessors would try to obtain a reasonable estimate for a quantity that has not been measured for some unit. This analysis aims to quantify uncertainty in predictions (for single units) and to identify the combinations of predictor variables for which a model is reasonably accurate. The latter issue has been of considerable interest in QSPR literature, where it is termed the applicability domain problem. Both parametric and nonparametric procedures were utilized for placing bounds on predictions, accounting for uncertainty. In addition, methods for expressing uncertainty using distributions, particularly those based on Monte Carlo and Bayesian procedures, in order to address the simultaneous effects of uncertainty from multiple sources are presented.

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#### **USEFUL LESSONS FOR TOXICOGENOMICS USING SYSTEMS BASED APPROACHES FOR DOSE AND TEMPORAL RESPONSE MODELING**

The explosion of "Omic" information available for risk assessment requires a reassessment of quantitative risk assessment tools. Although microarray technology has emerged as a powerful tool to explore expression levels of thousands of genes or even complete genomes after exposure to toxicants, the functional and quantitative interpretation of microarray datasets still is a time-consuming and challenging task. Gene ontology (GO) and cell signaling pathway mapping have both been shown to be powerful approaches to generate an overall global view of biological processes and cellular responses impacted by toxicants rather than focusing on single genes. However, cur-

rent methods do not allow for adequate comparisons across dose and time points and have limited capabilities for translation across levels of biological complexity. Frequently results are presented in extensive gene lists with minimal or limited quantitative information, data that is crucial in risk assessment. To facilitate quantitative interpretation of dose or time dependent genomic data, we propose several systems based approaches. First, we have developed a program (GO-Quant) to extract quantitative gene expression values and to calculate average intensities or ratios based on functional gene categories using MAPPFinder results. An application of this approach will be given. Secondly, computational approaches will be discussed that integrate GO-Quant across cellular, organ, and organism level responses. To evaluate these responses across biological systems necessitates the use of toxicokinetic and dynamic models that can incorporate biological information. A discussion of benchmark doses (BMDs) and minimal effective levels (MELs) will be included and challenges for using such responses within the context of the risk assessment framework will be presented. Supported by NIEHS 5-P01-ES009601, NIEHS P30-ES007033, NIEHS P50-ES012762, NIEHS U10-ES011387, NSF OCE-0434087, EPA RD-83170901, and EPA RD-83273301.

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#### **AN ASSESSMENT OF EXPOSURE TO NANOSCALE MATERIALS IN DRINKING WATER**

The potential effects to the aquatic ecosystem of trace levels of microconstituents present in wastewater treatment plant effluents has been receiving ever greater attention in recent months and years. Interestingly, nanomaterials are not generally included in the suite of "emerging trace constituents" that are the focus of this attention and potential concern, despite the ever increasing use of nanoscale materials in consumer products. This study uses the PhATE model to develop predicted environmental concentrations (PECs) in surface water for two nanoscale materials (Multi and Single Walled Carbon Nanotubes, as well as nanoscale silver). The nature of some nanomaterials, such as carbon nanotubes, makes it difficult to measure concentrations in surface water using existing analytical methods. Using PhATE allows us to develop PECs for over 27,000 kilometers of rivers in the US. The potential for these two nanomaterials to pose a potential risk to the aquatic ecosystem is determined by comparing PECs to available aquatic toxicity data to determine whether they exceed concentrations that have been shown to have potential effects.

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#### **TWO STRUCTURALLY DIFFERENT APPROACHES TO INTERVAL DATA**

Data sets whose values contain interval uncertainty arise from various kinds of censoring, intermittent measurements, missing data, plus-or-minus digital readouts, data binning, and intentional data blurring for privacy and security reasons. Two broadly different approaches to such data have been proposed for situations in which the uncertainty about the values cannot reasonably be neglected. The first approach, which can trace its roots to Laplace's principle of insufficient reason, models the interval uncertainty of each datum with a uniform distribution over its range. It allows relatively straightforward calculation of sample statistics. However, it does not necessarily have good statistical properties. In particular, it cannot guarantee that estimates computed from such models will approach the parameters of the actual distribution from which the data were drawn even when there are asymptotically many random samples. The second approach is completely different from the first and models the interval uncertainty of each datum solely in

terms of the bounds on the possible value, which corresponds not to any single distribution but rather to a class of distributions all having support over the interval's range. This approach is motivated under the theory of imprecise probabilities so it has a much more recent heritage. Although calculation of even basic descriptive sample statistics such as the variance is generally computationally difficult under this approach, it nevertheless has several interpretational advantages. The differences and advantages of each approach are illustrated with problems such as estimating descriptive statistics, the empirical distribution function, and best-fit normal distributions.

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### **EXPOSURE TO CONTAMINATED SEDIMENTS DURING RECREATIONAL ACTIVITIES AT A PUBLIC BATHING PLACE**

Only a few risk assessments have been reported in the literature that specifically deals with recreational activities at polluted shores and beaches. Here, we give results for a public bathing place in a small lake close to the main highway into Stockholm, Sweden. Previously high concentrations of metals and polycyclic aromatic hydrocarbons (PAH) have been found in the deeper anoxic sediments, originating from various historical pollution and traffic. In our study, however, we focused on the beach sand and water directly encountered by bathers. Three exposure pathways were considered; intake of water, intake of sand and sediment, and dermal uptake. Exposure factors were taken from the literature, a US EPA study of accidental intake of water by swimmers, and our own observations of behavior at the bathing place. In contrast to the deeper sediments, the chemical analyses showed very low concentrations of most elements in both beach sand and lake water samples and arsenic was the only element of concern in any of the intake estimates. Here, we therefore limit our evaluation to this element and PAH, reported as benzo[a]pyrene-equivalents. The exposure estimates were calculated as reasonable maximum exposures (RME). Arsenic and some PAH are both carcinogenic and genotoxic, and hence the exposure estimates were evaluated on a lifetime basis. The RME daily intakes for the most exposed group were 1.4E-5 respectively 2.8E-7 mg/kg-day. The RME for arsenic was then twice the daily intake associated with 1/1000000 increased risk to develop cancer. However, this RME was estimated assuming water concentrations at the detection limit, which is likely to exaggerate the maximum exposure. The RMEs for PAH (BaP-equivalents) were below the risk-based daily intake and this seems to be confirmed by a probability bounds analysis. It was only when dependencies were assumed between some of the exposure factors that the risk-based daily intake was slightly exceeded.

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### **“SOLUTION-FOCUSED RISK ASSESSMENT:” QUICKENING THE PACE, ACCOMPLISHING MISSIONS, EXPANDING HORIZONS**

Re-conceptualizing risk assessment as a method for helping to solve environmental problems, rather than (merely) understanding environmental hazards, may provide three major classes of benefits over the status quo. First, it can help break the endless cycle of analysis: when the goal is to know enough to decide, rather than to know everything, natural stopping points emerge. Secondly, it can lead to more true decisions about risk reduction, rather than pronouncements about them. As much as agencies rightly value performance-oriented interventions, it is unfortunately the case that setting a permissible exposure limit or a national ambient air quality standard is often more a conclusion about what level of risk would be acceptable than any kind of guarantee that such a level will be achieved, let alone a decision about which actual behaviors will change and how. Third, it can promote expansive thought about optimal decisions, ones that resolve mul-

multiple risks simultaneously, avoid needless risk-risk tradeoffs, and involve affected stakeholders in debating what should be done. Arguably, the longer the disembodied analysis of risk information is allowed to proceed before solutions are proposed and evaluated, the more likely it is that the “problem” will be defined in a way that constrains the free-wheeling discussion of solutions (in other words, a new mirror-image adage that “if everything around you looks like a nail, the only question is what kind of hammer to pick out”). This presentation will explain these benefits with reference to several case studies of “what might have been,” and then proceed to anticipate some of the significant concerns with the notion of eliminating the organizational part of the “firewall” between risk assessors and risk managers.

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### **LEADERSHIP OF RISK DECISION MAKING IN A COMPLEX AEROSPACE ORGANIZATION: A DELIBERATIVE DECISION MAKING CASE STUDY**

Aerospace program risks, if unsuccessfully analyzed and managed, can result in significant technical failures and multi-million dollar losses. How do senior technical, program leaders assess major risks? What leadership practices help them manage the tradeoffs between the need for thorough risk analysis versus the constraints of program budgets and schedules? What organizational systems and engineering cultural values-behavioral norms support their success? This presentation describes the findings of a descriptive study of the complex organizational decision ecology that supports successful risk analysis and management in a major aerospace firm. Interviews and observational data were collected from twenty-two satellite program risk and technical experts on seven communications satellite programs. Frequency analysis of the qualitative data demonstrated consistent leadership decision activities across different risk types, program activities and product functions. Six major leadership decision activities were identified that were applied in adaptive sequences to manage the most difficult risks. Leaders worked first to understand a risk's severity, and then choose a data structuring strategy, apply tactics for data analysis, manage stakeholder bias, resolve debates, then manage decision closure with key stakeholders. Consultative as well as consensus-based decision making practices were observed. Three of these leadership activities appeared unique to this decision model compared with other prominent models: management of stakeholder bias, debates and commitment to the decision. These unique roles appeared to address purposes and values specific to this high tech, engineering product culture. The six leadership decision activities are incorporated into a deliberative decision making model along with supporting organizational systems and engineering cultural values. Findings from this study have been applied to support program leaders' risk management success and the company's risk management skill training.

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### **EXPERT UNCERTAINTY IN RECYCLED WATER HEALTH RISK ASSESSMENT**

Recycled water treated for different uses contains a range of micropollutants including endocrine-disrupting chemicals below detectable limits. There is considerable scientific uncertainty about which chemicals to monitor, how to monitor them and whether clinically significant health effects may emerge over long-term low-dose exposures. At present there are few data for human health risk assessment from these exposures. Probability bounds analysis (“P-bounds”) provides an alternative to Monte Carlo and other methods for examining these risks and improving risk communication, and can be useful where data are unknown (or unknowable) and there

can be no assumption of independence among parameters. We demonstrate results of our evaluation of expert elicitation software for generating P-bounds and visualising expert uncertainty, using experimental models simulating trace chemical exposures from recycled water used for domestic and horticultural purposes.

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#### **DEVELOPMENT OF RAPID RISK ASSESSMENT FRAMEWORK (R-RAF) BY FDA/CFSAN FOR USE DURING EMERGENCY/CRISIS SITUATIONS**

The Food and Drug Administration (FDA) is responsible for protecting and promoting public health, in part by assuring the safety, efficacy and security of the nation's food supply. When an emergency occurs (from unintentional or deliberate contamination of food), FDA investigators trace the problem to the source and work to remove the affected products from market shelves to contain outbreaks and prevent further illnesses. FDA's Center for Food Safety and Applied Nutrition (CFSAN) has been developing a framework for conducting risk assessments during an emergency or crisis situation. A workgroup, representing a wide variety of expertise, e.g. risk analysts, risk assessors, toxicologists, microbiologists, chemists, risk managers, risk communicators reviewed a number of selected past emergency cases. The workgroup followed a stepwise course of action, i.e. definition of product, collection of information, identification of gaps and alternative approaches, verification of alternative approaches, report. This presentation concerns the major outcomes of this process regarding specific emergency cases, e.g. the presence of melamine in pet food.

**W3-A.4** Flynn R, Bellaby P, Ricci M; r.flynn@salford.ac.uk  
Salford University

#### **LAY PERCEPTIONS OF HYDROGEN ENERGY: THE LIMITS OF UPSTREAM ENGAGEMENT IN AN EMERGENT TECHNOLOGY**

In the search for sustainable energy carriers, there is an increasing amount of research and development (and government interest) in hydrogen energy and hydrogen technologies. Some proponents envisage a radical shift towards a 'hydrogen economy', requiring fundamental transformations in energy production, distribution and infrastructure, and major changes in consumer behaviour. Hydrogen energy is an emergent technology in which stakeholders and developers are seeking assurance the 'the public' understands the benefits and finds the costs and risks acceptable. This paper discusses current approaches to consultation about hydrogen futures. It critiques the technocratic model of public acceptability and its assumption of a homogeneous and passive 'public' which has a deficit of relevant knowledge. It also considers the challenges of 'upstream' engagement. Evidence is drawn from recent and ongoing case studies in the UK using qualitative methodology (focus groups and citizens' panels). Among the themes identified from this research are the importance of ambivalence and uncertainty; diffuse distrust of business and industry; lay recognition of a 'whole systems' approach to risk assessment; and expectations that personal and wider environmental benefits must be demonstrated before conditional public approval is likely.

**W4-H.3** Folkes DJ; dfolkes@envirogroup.com  
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#### **STATE-TO-STATE VARIATIONS IN APPROACHES TO VAPOR INTRUSION RISK ASSESSMENT**

In the absence of federal standards, State regulatory agencies interested in the evaluation of vapor intrusion from contaminated sites have developed widely varying approaches. In particular,

States' approaches differ with regard to: (i) methods of evaluating vapor intrusion (reliance on modeling from measurements in soil vapor vs. insistence on indoor air quality measurements); (ii) toxicity reference values; and (iii) requirements for initial and ongoing monitoring. Screening levels for the same compound can vary surprisingly widely: for trichloroethylene (TCE), for example, screening levels in indoor air range from the essentially below background value of 0.4 ug/m<sup>3</sup> (in California) to 42 ug/m<sup>3</sup> (in Michigan). Even more strikingly, screening levels for TCE in groundwater range from (in New Jersey) 1 ug/L (which is below EPA's acceptable concentration for drinking water) to 42,000 ug/L (in Pennsylvania). Some of the key factors for this variation will be discussed. These variations, and other factors, presented challenges to the author, and others, as we created the ASTM "Standard Practice for Assessment of Vapor Intrusion into Structures on Property Involved in Real Estate Transactions" (Designation E 2600 - 08) (VI Standard). Some unique aspects of specific State's approaches, such as New York's, will also be detailed.

**W3-E.2** Forshee RA, Anderson SA, Walderhaug MO, Yang H; Richard.Forshee@fda.hhs.gov  
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#### **THE RISK OF TRYPANOSOMA CRUZI INFECTIONS FROM BLOOD TRANSFUSIONS IN THE U.S.**

*Trypanosoma cruzi* is a flagellated protozoan parasite and the causative agent of Chagas' disease. Infected individuals usually experience an acute phase lasting 1-3 months followed by a long asymptomatic phase of the disease. Eventually, 10% to 30% of persons chronically infected may develop more serious symptoms arising from irreversible damage to the heart and nervous system. The *T. cruzi* parasite can be transmitted by blood transfusion. As the number of immigrants entering the U.S. from endemic areas has increased, the risk of transmission via transfusion in the U.S. is thought to be increasing. *T. cruzi* is not currently classified as a Relevant Communicable Disease Agent or Disease (RCDAD), so blood donations are not required to be tested for the agent. However, the risks associated with the presence of *T. cruzi* in blood cell products have been discussed at recent meetings of FDA's Blood Products Advisory Committee. The FDA is considering whether to make *T. cruzi* a RCDAD and to recommend testing all blood donors for *T. cruzi*. This presentation describes a quantitative probabilistic model for predicting the risks of *T. cruzi* transmission via transfusion of blood products in the U.S. and the loss of uninfected donors as a result of the screening questionnaire. The model is comprised of two main modules: Immigration and Donation. The Immigration Module contains a model of the estimated number of foreign born persons in the U.S. who may be infected with the *T. cruzi* parasite. The Donation Module contains a model of the number of units of whole blood and blood cell products that may contain the *T. cruzi* parasite and associated parameters. The model predicts that blood transfusions are likely to be responsible for some new *T. cruzi* infections in the U.S. The magnitude of the new infections is related to several factors including the effectiveness of screening questionnaires and number of donors born in areas where Chagas' Disease is endemic.

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#### **COMPREHENSIVE HUMAN HEALTH AND ECOLOGICAL RISK ASSESSMENT OF A CARBON REACTIVATION FACILITY**

This paper will describe a comprehensive human health and ecological risk assessment performed for a carbon reactivation facility. While numerous risk assessments have been performed for different types of waste combustion facilities, similar analyses for carbon reactivation facilities have not previously been conducted. A carbon reactivation facility regenerates spent carbon, which has been previously used to remove pollutants from water and air, by heating it to very high



temperatures in a furnace. The reactivated carbon product can then be reused. Some of the spent carbon accepted at this facility is classified as RCRA-designated hazardous waste. The risk assessment incorporated site-specific information (e.g., detailed stack test results, local land use and meteorological data) and was consistent with USEPA's combustion risk assessment guidance. Over 170 compounds were selected for detailed evaluation based on stack test data, including over 80 compounds analyzed for but not detected in the stack tests. The human health risk assessment calculated exposures for several hypothetical receptors (adults, children and nursing infants) through a variety of pathways. The human health risk assessment addressed chronic excess lifetime cancer risks, the potential for chronic non-cancer effects, the potential for acute inhalation effects, and a comparison to USEPA Region IX preliminary remediation goals. The ecological risk assessment focused on selected receptors considered to be representative of the facility area (aquatic life, plants, the badger, Gambel's quail, the great horned owl, the burrowing owl, the southwestern willow flycatcher, the double-crested cormorant, the Yuma clapper rail and mule deer). Potential ecological risks were evaluated by comparing calculated concentrations or exposures to toxicity reference values. This paper will describe the analyses that were performed and present the human health and ecological risk assessment results.

**W3-D.3** Frantzen KA; kfrantzen@kleinfelder.com  
Consultant

#### **REGULATOR, STAKEHOLDER, AND END-USER PERSPECTIVES ON USE OF RISK ASSESSMENT IN RISK MANAGEMENT**

The ITRC overview document presented the results of case studies to elucidate the influence of risk practices and assessment approaches of state regulatory agencies on risk management outcomes. Additionally, team members (regulators, stakeholders and end-users [the regulated]) contributed suggestions for improving the use of risk assessment from their particular perspectives. The issues and perspectives brought out elaborated on the findings arising from the case studies and supported the conclusions reached. The talk will highlight the perspectives raised in light of the case study findings and their contribution to the proposed recommendations by this ITRC team. Additionally, the case study approach allowed this ITRC Team to diagnose the sources of variation in risk assessment leading to differences in risk management outcomes. This resulted in guidance recommendations concerning identification of likely sources of variation and concerning the site assessment/remediation process to assure transparency and predictability via systematic project planning principles.

**W4-E.1** Franz CJ, Ackerley NA, Sertkaya A, Brown B; nyssa.ackerley@erg.com  
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#### **MODELING THE EFFECTS OF AN INTENTIONAL ATTACK ON THE UNITED STATES FOOD SUPPLY**

A model framework was developed to estimate the potential effects of deliberate contamination of the US food supply using biochemical agents. The model can be used to analyze "what-if" scenarios for intentional food contamination events. Publicly-available data are utilized to assess three categories of impacts: human health impacts, product recall costs, and long term impacts on product manufacturers and their suppliers. Consideration is given to the likelihood of an attack on any particular food-agent combination, the extent of contamination possible, and the point in the supply chain at which the contamination occurs. Input-output (IO) data are used to track food product and ingredient flows from raw material, intermediate product, and final product industries to consumers. Economic impacts are determined using IO final demand multipliers

to transmit changes in consumption to affected industries characterized by Census data. ACNielsen data are used to decompose Economic Census value of shipment data into price and quantity components and determine the quantity of contaminated product that potentially reaches consumers. Human health impacts are modeled using National Health and Nutrition Examination Survey data to estimate consumption rates, and thus exposure to the contaminant. Morbidity and mortality rates are estimated from literature on the health impacts of the contaminant and converted to project losses in quality-adjusted life years using health-state preference rankings. Publicly-available data sources are supplemented by gathering information on industry-specific operations and food defense practices through expert elicitation. In particular, an expert panel identified the most effective food protection practices for food processors and the relative costs of implementation across food product sectors and facility sizes.

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#### **VOICES IN THE MEDIA ON NANOTECHNOLOGY RISKS AND REGULATION**

When people accept new technologies and products, they do so because they trust the new field and those developing it. How to build and maintain public trust for nanotechnology has been a question for many government officials, scientists and industry representatives. One major factor that affects trust is how much people know about an issue. Recent studies have shown that there is little public knowledge of or understanding about nanotechnology. In a 2007 survey, people who had heard anything about nanotechnology said their most frequent information sources were newspapers and television news programs (Peter D. Hart Research Associates, Inc.). Newspapers and wire services in the United States and the United Kingdom have not reported much nanotechnology risk information during the past eight years, emphasizing instead the potential benefits of the field. However, from 2005 to 2007, these media outlets increasingly discussed nanotechnology oversight and regulatory issues related to risk. In such discussions, reporters turned to different groups of sources to provide information including scientists and engineers, government officials, and representatives from nanotechnology organizations, environmental groups and industry. This paper will explore the variety of individuals and groups that served as information sources for U.S. and U.K. newspapers and wire services from 2000 to 2007, particularly related to their possible influence on public knowledge about nanotechnology risks and oversight. It also will discuss how the media covered three areas of nanotechnology regulation, and timelines of other measures of media coverage of nanotechnology's health and environmental risks from 2000 to 2007.

**M4-F.2** Fristachi A, Xu Y, Rice G, Impellitteri CA, Carlson-Lynch H, Little JC; fristachia@batelle.org

Battelle Memorial Institute, Virginia Tech, US Environmental Protection Agency, Syracuse Research Corporation and Virginia Tech

#### **EVALUATION OF HUMAN EXPOSURE TO ORGANOTIN IN DRINKING WATER TRANSPORTED BY POLYVINYL CHLORIDE PIPE USING PROBABILISTIC MODELING**

The leaching of organotin (OT) heat stabilizers from polyvinyl chloride (PVC) and chlorinated polyvinyl chloride (CPVC) pipes used in residential water piping systems, may affect the quality of drinking water. These organotins, principally mono- and di-substituted species of butyltins and methyltins, are of concern because they belong to a broad class of compounds that may be immune, nervous and reproductive system toxicants. This paper reports estimated probability distributions of U.S. population exposures to mixtures of OT encountered in drinking water

transported by PVC and CPVC. We employed a series of mathematical models to estimate OT leaching rates from PVC/CPVC pipe as a function of surface area and time. The estimated distribution of leaching rates were integrated into an exposure model to estimate the probability distribution of OT concentrations in tap waters and resulting potential human OT exposures via tap water consumption. While the estimated 90th percentile “real world” OT concentration of 0.044 µg/L is consistent with the highest level of dibutyltin (DBT), the most toxic of the OT considered here, reported in occurrence studies of 0.052 µg/L, the estimated 90th percentile adult average daily dose (ADD) of  $4.6 \times 10^{-3}$  µg/kg-day is approximately 913 times lower than the World Health Organization ADD for DBT (4.2 µg/kg-day).

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Battelle Memorial Institute, US Environmental Protection Agency, US Army Corps of Engineers  
**A PRELIMINARY EXPOSURE ASSESSMENT OF MICROCYSTINS FROM CONSUMPTION OF DRINKING WATER IN THE UNITED STATES**

This presentation offers a human exposure assessment for concentrations of Microcystin-LR equivalents (MC-LR) from consumption of treated drinking water in the United States. MC-LR, a hepatotoxin produced by *Microcystis aeruginosa* is the most frequent and most toxic microcystin congeners found in surface water and therefore may affect drinking water supplies. The assessment is based on data reported in an occurrence study of North American drinking waters conducted by the American Water Works Association from June 1996 to January 1998. An exposure model was developed that employed probability distributions of log MC concentrations, tap water intake rates and body weight, and exposure duration under the assumption of independence of the parameters. Because drinking water consumption varies with age and gender, we binned our estimates into four main age group categories and 11 age subcategories (years): Infants (<0.5 and 0.5–0.9); Children (1–3, 4–6 and 7–10); Teens (11–14 and 15–19); and Adults (20–44, 45–64, 65–74 and 75+). Over a 75-year lifetime, the estimated lifetime average daily dose of MC-LR from the consumption of drinking water was estimated to be  $1.5 \times 10^{-3}$  µg/kg-day with a standard deviation of 0.02. The 90th and 95th percentile exposure estimates were  $1.7 \times 10^{-3}$  and  $3.9 \times 10^{-3}$ , respectively. Our results suggest that most individuals are exposed to MC-LR levels in finished U.S. drinking waters at levels approximately an order of magnitude lower than the World Health Organization’s provisional guideline level of 1 µg/L, which corresponds to a dose of approximately 0.04 µg/kg-day. Our analysis indicates that there is a large seasonal influence on MC-LR concentrations in finished drinking water, with greatest exposures in summer months. A lack of historical data prevents the development of baseline MC-LR levels needed to analyze geographical or temporal trends. These limitations highlight the need for longer-term studies at refined temporal scales.

**T2-E.4** Fujinaga A, Ishikawa H; fujinaga@ipc.osaka-pct.ac.jp  
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**COMPARATIVE STUDY ON COUNTERMEASURES FOR HEALTH RISK BY EXPOSURE TO ASBESTOS IN JAPAN**

This study examines countermeasures against asbestos by predicting air concentrations of asbestos in order to reduce health risk of asbestos from demolishing buildings and other processes. A comparative study was conducted on three cases as follows; Case 1 was “No action”, Case 2 was “Demolishing by hand”, and Case 3 was “Vitrification treatment”. The result showed that health risk of Case 2 is 30% less risky than Case 1, if Case 2 is accomplished perfectly. More desirably, the health risk of Case 3 is 40% less risky than Case 1. In addition, “No action” takes the

longest time to achieve a goal of risk reduction. Therefore, this study indicates that “Demolishing by hand” should be conducted first. If it is not possible to conduct perfectly, “Vitrification” can be applied even though the cost is high.

**T2-F.1** Gaber N, Foley G, Nachman K, Sunderland E; gaber.noha@epa.gov  
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**EVALUATION PRACTICES USED ACROSS EPA FOR DETERMINING WHEN AN ENVIRONMENTAL MODEL IS SUITABLE FOR INFORMING DECISIONS**

EPA’s Council for Regulatory Environmental Modeling (CREM) is charged with promoting consistency and consensus among environmental model developers and users. In its report on Models in the Regulatory Decision Process, an NRC Committee found that EPA has played a major role in advancing the science of environmental modeling but that models will always be constrained by computational limitations, assumptions and knowledge gaps. These characteristics mean that model evaluation (the process of deciding whether a model is suitable for its intended purpose) should be an integral and ongoing part of the life cycle of a model. In addition, the NRC panel recommended that EPA attempt to learn from the history of model applications supporting regulatory decision making by studying the processes (approaches to model development and evaluation) that led to successful models and model applications through retrospective model evaluation. In response to the NRC Committee’s report, the CREM is working with modelers and decision makers across EPA’s Program Offices and Regions to help generalize prior experiences with models and classes of models into systematic improvements for the future. This presentation will report on progress made in compiling an Agency-wide synthesis of model evaluation practices and the potential scope and several candidate examples for retrospective model evaluation that will be pursued by an EPA working group. In addition, we will discuss how various model evaluation practices can reduce EPA’s vulnerability to regulatory and judicial challenges on the basis of model quality.

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**DEVELOPMENT OF A HAZARD ASSESSMENT FRAMEWORK FOR QUANTITATIVE RISK TRADE-OFF ANALYSIS OF CHEMICAL SUBSTANCES**

Risk trade-off problem is important in risk management of chemical substances because risk reduction of a chemical substance is sometimes achieved by the use of substitute substances. However, since most of the conventional risk assessment frameworks for chemical substances have been developed for the purpose of evaluating and characterizing the risk of individual chemical substances in conservative manners, risk trade-off analysis remains somewhat qualitative. We are now developing a hazard assessment framework for quantitative risk trade-off analysis of chemical substances. Although use of risk measures such as loss of QALY (quality adjusted life years) ensures comparability of risk values of various chemical substances, calculation of loss of QALY requires human epidemiological data. A key of the framework is an algorithm for inferring the dose-response (in term of loss of QALY) relationships based on only the data from animal experiments. The algorithm is being designed so that it can evaluate not only the dose-response relationship but also the uncertainty (as distributions of possible values) in the estimation. We believe that uncertainty analysis is one of the essential components of risk trade-off analysis. Although a substitute is generally expected to have less hazard and/or less exposure, it is anti-

pated that availability of information on hazard and exposure for the substitute is more limited, and that the risk estimation is more uncertain. Thus, comparison of point estimates of risk values of substitute and original substances, no matter whether they are best estimates or conservative ones, are considered misleading. We hope that the framework will be a scientific basis for rational decision making in risk trade-off problems.

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#### **NANO: QUANTIFYING UNCERTAINTY**

Assessing risk in nanoscience is especially troublesome given the extremely high levels of uncertainty associated with hazard, dose, and exposure. A project at NCSU involves the design of a White Paper for the NNCO (National Nanotechnology Coordinating Office) of the National Nanotechnology Initiative. High levels of uncertainty may cause the power of rhetoric to supplant the power of empirical data due to experts having differential interpretations of the limited data available. Perceived conflict on the part of experts then leads to precaution on the part of the general public. The precautionary reaction often closes down avenues for revolutionary applications in medicine, water treatment, environmental remediation, etc.

**W2-J3** Garvey PR, Pinto CP; pgarvey@mitre.org  
Mitre, Old Dominion University

#### **AN INDEX TO MEASURE RISK CO-RELATIONSHIPS IN ENGINEERING ENTERPRISE SYSTEMS**

This paper presents an index that measures the impacts of dependency risks between parts of an enterprise which can negatively affect the ability of the whole enterprise to deliver capabilities and services. This measure will be termed the risk co-relationship index. The purpose of this index is to enable engineers and managers to identify and evaluate the ripple effects of risks from one part of an enterprise to another. Presenting a way to model and measure these effects advances engineering management practice by allowing engineers and managers to consider dependency risks and use the index in decisions on resource allocation and enterprise design and implementation.

**P.39** Geckle LS; Lori.Geckle@us.army.mil  
West Chester University

#### **PROCESS OF COMMUNICATING RISK IN CONCERNED WORKERS**

Addressing concerns of workers effectively, particularly when concerns are high, can be challenging. In this case study, workers had signed a petition requesting “an independent survey of health problems,” in part due to an undiagnosed illness in at least one employee. This session will cover the response team’s preparation, proposed plan to respond to concerns, and ultimate decision regarding the call for a health survey.

**P.70** Gendel SM, McKillop K; steven.gendel@fda.hhs.gov  
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#### **INFORMATION RESOURCES FOR FOOD SAFETY RISK ASSESSMENT**

Food safety risk assessment is a powerful tool for enhancing the scientific basis of decisions related to food safety. It is also information intensive, integrative, and multidisciplinary. The FDA Center for Food Safety and Applied Nutrition (CFSAN) and the University of Maryland Joint Institute for Food Safety and Applied Nutrition (JIFSAN) have collaborated to meet this information need by creating FoodRisk.org, a continually updated web site that contains modeling tools, training resources, published risk assessments, data (including data sets that are not available else-

where), and a fully searchable database of food safety-related links. All of the content on the site is reviewed before posting, providing a critical quality control function. Each entry in the database is annotated with keywords focused on food safety and risk assessment. The FoodRisk.Org database currently contains over 7500 entries. Analysis of the complex data needed for food safety risk assessment and of user interaction with the FoodRisk.Org database demonstrates the critical importance of data descriptors and accurate terminology in providing access to data and other resources. To facilitate improved data access, the existing keyword list is being used as the basis for developing a food safety ontology that includes descriptors of both concepts and relationships. This ontology will be applied to information analysis through the use of metadata tags and an xml schema. Because these technologies support a decentralized approach to data access, they will make it possible to integrate data across disciplines and will improve our ability to find and use the data needed to support the risk analysis decision process.

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#### **THE KEY EVENTS ANALYTICAL FRAMEWORK: APPLICATION TO FOOD ALLERGENS**

Food allergies are caused by immunological reactions to normal protein components of foods. True food allergies may affect 2-3% of adults and 6-8% of children. Food allergies can manifest in a wide variety of signs and symptoms, ranging from mild itching or nausea to extensive urticaria or anaphylactic shock. For any given allergic individual, the severity of a reaction is generally assumed to be proportional to the level of exposure to the allergenic protein. Current regulatory approaches for food allergens are largely qualitative - i.e., a product either does, or does not, contain allergens. In order for manufacturers to provide more accurate and informative labels, it would be valuable to understand whether thresholds for eliciting allergic reactions exist - and if they do exist, to understand how such thresholds are distributed within the food-allergic population. Government agencies could also benefit from this understanding when establishing regulatory thresholds or providing GMP guidance. Unlike other biological stressors, information on individual sensitivities can be obtained through direct clinical testing using double blind placebo controlled studies. However, use of the “key events” approach will help generate a coherent picture of the various “drivers” of the allergic response and identify which events in the overall elicitation process appear to control the nature or severity of response. This approach might also make it possible to identify the sources of interindividual and intraindividual variability.

**M4-G2** Gibb SK; steve.gibb@noblis.org  
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#### **OVERVIEW OF AN EMERGING CONTAMINANTS PROGRAM AND THE ROLE OF CHEMICAL RANKING**

The Emerging Contaminants Directorate within the DoD’s Office of the Secretary of Defense has innovated rigorous methods for assessing the environmental and operational impact of materials or chemicals for which new risk information is emerging or where changes are imminent in their regulatory status. Using a three-stage process entitled “Scan, Watch, Action,” the Directorate gathers environmental, safety and regulatory information about emerging contaminants and assesses their uses by the Department. Chemicals or materials that have DoD applications and that may strongly impact cleanup, research, safety/health, disposal and handling, and readiness are subjected to increased levels of scrutiny. If new action is warranted, chemical ranking and substitution systems are often used to ensure DoD missions can be sustained and to reduce reliance on high-toxicity materials.

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### **ADDRESSING INTERNATIONAL TRADE IN ELECTRONIC WASTE: INTEGRATING CRIMINAL JUSTICE STRATEGIES INTO RISK MANAGEMENT**

Electronic waste (E-Waste) such as computers, LCDs, cell phones, and circuit boards, has received increasing attention from environmental advocacy groups, the United Nations Environment Program, and governments. Of particular concern is the international trade in E-Waste whereby developed nations ship E-Waste to developing nations that are ill-equipped to properly recycle or dispose of it, resulting in toxic dumps that present significant hazards to human health and the environment. Although national and international laws vary significantly on whether such export is criminal or even subject to regulation, there seems to be growing consensus that the export of E-Waste represents an environmental and human health risk. This presentation provides an overview of risks associated with exporting E-Waste to developing nations and an assessment of gaps in the U.S. regulatory framework designed to address it. Data gathered from multiple methods on the scope and structure of the E-Waste market are presented along with a discussion of criminal, regulatory and broader risk management tools that may be used to intervene.

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### **MONEY MATTERS: HOW ECONOMIC STATUS INFLUENCES PERCEPTIONS OF POTENTIAL TERRORISM-RELATED OUTCOMES IN THE COMMUNITY**

As part of a larger study on public perceptions of terrorism in Canada, this study aims to determine how one's economic status relates to their perceptions regarding the potential physical, social, and economic outcomes of terrorism within the community. Participants (N=1502) rated the extent to which they had thought about the occurrence of each of the following outcomes related to terrorism in their community: Discrimination; poorer mental health; casualties; economic losses; lowered sense of security and safety; increased political involvement; loss of a loved one; limited resources for social and health services; lowered quality of life; loss of employment; loss of civil liberties; and increased community solidarity. Results suggest that differences between the highest and lowest income groups exist in their perceptions regarding a number of possible outcomes: Specifically, the lowest income group had given significantly more thought to outcomes such as loss of employment and loss of civil liberties. In addition, the lowest income group reported giving more thought to the occurrence of increased political involvement, as well as increased community solidarity, when compared to the highest income group. These results indicate that individuals with the lowest incomes may be more sensitive to the potential for indirect, negative socio-economic and socio-political consequences of terrorism threats; however, the results also suggest that these individuals are also more likely to consider positive community outcomes which may increase their future resiliency in response to these negative consequences. With funding from the Social Sciences and Humanities Research Council (SSHRC) and the CBRN Research and Technology Initiative (CRTI)

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Institute of Neurotoxicology & Neurological Disorders

### **TOXIPEDIA - TOXICOLOGY INFORMATION FOR PARTICIPATORY RISK ASSESSMENT**

A participatory risk assessment risk requires not just exposure and hazard information but also a historical and societal perspective that is readily available to professionals and community members. One of the challenges facing the toxicological and risk assessment sciences is communicating scientific information in a manner that creates an informed public and provides sufficient information to facilitate a risk assessment. Toxicological research provides a seemingly overwhelming, and expanding, amount of information. To keep abreast of the growing amount of information on any one agent or issue, scientists and public health professionals must specialize. Currently there is no easy way for specialist to easily share their knowledge with the public or even other scientists. Toxipedia ([www.toxipedia.org](http://www.toxipedia.org)) is a new wiki-site concept that is designed to encourage toxicology specialists, risk assessors, and public health professionals to share their knowledge of agents that affect human and environmental health. The goal of Toxipedia is to be a definitive, yet accessible, resource on the hazards and history of chemical and physical agents, regulatory requirements, risk management, and ethical, legal, and social issues related to public health. Toxipedia is a web-based tool for scientific information exchange and communication for the public, the media, students, NGOs, legislators, and professionals that grows as the toxicological and risk sciences advance. The accuracy and credibility of Toxipedia will be supported by subject-specific associate editors using a four-tiered review system. The highest level of review will require peer review, not unlike peer-reviewed professional publications, that can be periodically updated through a rigorous review process. The ultimate goal of Toxipedia is to provide researchers, public health professionals and the public to engage in a participatory assessment of a compounds health effects.

**RT.2.4** Goble R, Bier V, Hassenzahl D, Hattis D, Kaspersen RE, Larson H, Tuler S;  
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Clark University, University of Wisconsin, University of Nevada, Las Vegas, SERI

### **THREE MODES OF MANAGEMENT RESPONSE TO HIGHLY UNCERTAIN RISKS**

Different sorts of situations involving high uncertainty pose different sorts of challenges to risk management depending on the nature of the information available. Sometimes there is little or no information, "unknown" hazards; sometimes there is a sudden discovery, a "surprise". Or much information may be available, but the information base may be in flux with new aspects acquiring prominence. Or instead key issues may have been extensively studied, but seem consistently to defy resolution. We have identified three modes of management response that can be appropriate in such settings: 1) adaptive management, 2) reframing (or redefining) the presenting problem (often this means embedding it in a broader problem), and 3) maintaining vigilance to seek out new findings and things that can go wrong. We introduce illustrative examples of such uncertain situations and possibilities for management response. The three modes make demands on institutional capabilities that may or may not be met. Other papers in this symposium explore such demands in more depth and with further examples.



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#### **RISK RESEARCH AND POLICY IMPLICATIONS OF A MANAGEMENT PERSPECTIVE ON UNCERTAINTY**

Adaptive management, problem reframing, and maintaining vigilance make substantial demands on the capabilities of the institutions responsible for managing uncertain risks. Those demands are not easy to meet under the daily pressures of business as usual. Furthermore, these modes of response require considerable attention to acquiring and interpreting new information: adaptive management requires feedback on system change and on response to management actions; reframing generally involves using new knowledge (often from taking a broader perspective) and identifying missing knowledge; maintaining vigilance has as its cornerstone the paying attention to the appearance of and discovering new information. We offer for discussion an agenda of research and policy proposals that could respond to new demands for knowledge about uncertain risks and to strengthen capabilities for applying such knowledge.

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Food Safety and Inspection Service

#### **RISK ASSESSMENT FOR EVALUATING THE PUBLIC HEALTH BENEFITS OF GENERIC E. COLI, SALMONELLA, AND CAMPYLOBACTER**

The Food Safety and Inspection Service (FSIS) is developing a risk assessment to estimate the public health impact of reducing generic *Escherichia coli* (GEC), *Salmonella*, and *Campylobacter* on young chickens at slaughter plants. To estimate the public health effect of levels of GEC, a 2004-5 joint Agricultural Research Service and FSIS study was used where 10 chicken carcasses were collected at post-pick (rehang) and post-chill over the 4 seasons of the year. The estimated probability of having low or high levels GEC was determined by drawing 1,000 bootstrap samples and plants were stratified into these two subpopulations. The effectiveness of reductions in GEC was notably different between these strata. These different effects, when applied to the random variables for *Salmonella*, and *Campylobacter* levels at rehang, produce different distributions for *Salmonella* and *Campylobacter* at post-chill. The effect of mitigations to reduce GEC is assessed by estimating a scenario where plants with high GEC levels become like those plants with low GEC levels; the difference in predicted human illnesses is assessed indirectly by reductions in *Salmonella* and *Campylobacter*. To assess the human health impact of directly reducing *Salmonella* and *Campylobacter* at young chicken slaughter plants, preliminary data from an FSIS baseline study are used. Again, slaughter plants are stratified into high and low plants based on their probability of having high or low pathogen levels. A similar approach is used to estimate this effect of reducing those levels through mitigations. Preliminary results suggest that there are modest benefits to public health from reducing GEC at post-chill. Furthermore, reduction of *Salmonella* and *Campylobacter* are predicted to result in a moderate decrease of human cases from consumption of *Salmonella* or *Campylobacter* contaminated chicken.

**W3-C.3** Golden R, Carlson E, Silkworth J; rgolden124@aol.com

ToxLogic LLC, GE Global Research Center

#### **WEIGHT OF EVIDENCE EVALUATION OF THE MODE OF ACTION FOR PCB-PROMOTED RAT LIVER TUMORS USING THE HUMAN RELEVANCE FRAMEWORK**

It is well established that sufficient exposure of rodents to mixtures of PCBs (i.e., Aroclors) can promote liver tumors, although the mode of action (MOA) remained elusive. A recent publi-

cation described the likely MOA by which PCBs promote hepatic tumorigenesis in Aroclor-dosed Sprague-Dawley rats. This study involved numerous biochemical measurements taken over the course of a chronic bioassay with Aroclors 1016, 1242, 1254 and 1260 and showed that liver tumors were closely, consistently, and predictably correlated with the net hepatic cytosolic activity of redox-cycling quinones (RCQ) acting as catalysts for the production of reactive oxygen species (ROS). This indicated a tumorigenic MOA whereby (1) tissue PCB/TEQ accumulations induce expression of mixed function oxidases (MFOs) and (2) MFOs convert endogenous substrates to RCQs, eventually resulting in ROS-mediated promotion of spontaneously initiated liver cells. Findings from this study are corroborated by the results of other bioassays with TCDD, individual PCB congeners and binary mixtures of PCB congeners based on the results of bioassays conducted by the National Toxicology Program (NTP). Because a well-defined MOA can now be described for PCB promoted rat liver tumors, the totality of the data can be used in a systematic weight of evidence (WOE) evaluation of the relevance of these tumors to human health and for risk assessment. This evaluation follows EPA's Guidelines in conjunction with the methods of ILSI-RSI and IPCS. This methodology provides a decision-logic based approach for determining the relevance of the PCB-induced cancer in animal studies to humans. The WOE supporting the postulated MOA fulfills the Hill Criteria and the comprehensive requirements of strength, consistency, specificity, temporality, dose-response and the key criterion of biological plausibility. Since the MOA fulfills the rigorous ILSI/IPCS HR Framework and none of the elements show linearity at low doses a non-linear approach is justified for cancer risk assessment.

**M3-H.1** Goldstein BD, Wu F, Liu Y; bdgold@pitt.edu

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#### **EFFECTIVENESS OF THE US CLEAN AIR ACT (CAA) IN COMPARISON WITH THE DECLINE IN CIGARETTE SMOKING IN PRODUCING A DECREASE IN THE RISK OF BENZENE-INDUCED ACUTE MYELOGENOUS LEUKEMIA (AML)**

We have estimated the relative impact on AML mortality of the CAA and of the decrease in cigarette smoking. Benzene, a known cause of AML, has been regulated under the CAA since 1984 resulting in a decline of benzene emissions and of outdoor benzene concentrations. During the same period there has been a significant decrease in smoking due to a concerted effort by the public health community. Both mainstream and sidestream tobacco smoke are known to contain benzene and other presumed leukemogens. An EPA cost-benefit study estimates that two fewer deaths from leukemia will occur in the Houston area due to CAA activities during the 20 year period beginning 1990. Extrapolating to the entire US suggests that the CAA is currently responsible for saving approximately 5 lives a year due to leukemia. The US Surgeon General recently added AML to the list of cancers caused by cigarette smoking; and CDC has estimated that there were 1,090 deaths due to AML attributable to cigarette smoking during the period 1997-2001. The percent decline in cigarette smoking is estimated to lead to a midpoint of 80 fewer deaths from AML per year, primarily in smokers, approximately half of which are due to benzene. A similar comparison based on benzene exposure assumptions suggests less of a differential. Overall, there has been approximately a 50% decline in outdoor benzene levels throughout the United States from 3.0 to 1.5ppb from 1997-2007. This leads to estimates of a decline in total population benzene exposure nationwide with midpoints in the range of 10-15 kg/day. During this same time period estimates of the decline in cigarette smoking have midpoints in the range of 20-25 kg/day to smokers. Both CAA activities and smoking prevention have a favorable impact on AML mortality, with smoking prevention apparently more effective.

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Kansas State University

#### **RITUALISTIC RISK TAKING: THE CASE OF U. S. COLLEGE FEMALES UPON TURNING TWENTY-ONE**

There is not one event, but several that mark the social transition from adolescence to adulthood. But one rite of passage stands out in the third major sequence of rites of passage-the incorporation. Twenty-first birthday celebrations often mark the event when a youth is allowed to take his or her place in the broader social scheme. This research effort examines the twenty-first birthday celebrations of young women at a Midwestern university who are members of social sororities to explore the psychological motivations for engaging in ritualistic risk taking. A common practice is to drink 21 shots (1.5 ounces or 45 ml) of hard liqueur on one's 21st birthday...and event typically attended by friends and documented with text and photographs in one's "shot book." The correlation with alcohol consumption and harm among college-aged youths is well documented including serious health consequences, injuries, and unplanned sexual and drug activity. Binge drinking (which is defined by the CDC as more than three drinks during one occasion for women) is an addressed concern on most college campuses. However, the event-specific ritual of 21 shots seems to be very prevalent among sorority females. Such consumption is an overtly dangerous behavior that will result in a blood alcohol level well in excess of legally intoxicated and could result in possible death. Through interviews and examination of shot books, the researchers examine participants' understandings of risk involved, their perceptions of under what conditions excessive alcohol consumption is acceptable, and their own motivations for participating in 21-shot birthday celebrations. Results are discussed in relation to past drinking prevention campaigns based on education and social norming strategies.

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#### **TOWARD UNDERSTANDING PERCEPTIONS OF RISK ASSOCIATED WITH CONSERVATION OF LIVELIHOODS AND LEMURS IN NORTHEASTERN MADAGASCAR.**

Poaching is predominantly viewed in ecological literature as detrimental to the conservation of biodiversity, thus protected areas are often created and involve deterring people from using wildlife, and wildlife habitat, for livelihood resources. Local people may perceive exclusion from wildlife as a loss and risk to their livelihood, even if they are engaged in some part of the planning process. The risks from ecological and social tension arising from poaching are perhaps nowhere more acute than on the Greater Makira/Masoala landscape in northeastern Madagascar. This small region of the world is home to an estimated 5% of global biodiversity and approximately 120,000 people living on less than US\$1 day; 15 species of lemur found in Makira are listed in the IUCN Red Book. Incentive programs, education, and outreach programs designed to reduce risks from lemur poaching appear promising, however compliance with existing interventions is low. This presentation previews ongoing research designed to integrate individualistic and sociocultural dimensions of risk perception to better understand the environmental tradeoffs of degrading or preserving the lemur diversity of Makira. Challenges to collecting useful data about an illegal activity, among peoples who have varying literacy rates and are experiencing changes to and erosion of fady (taboos) due in part to outmigration, will be highlighted. Ecological and social repercussions of inadequate inquiry will be summarized. Participatory action research-informed risk ranking, scoring, and mental model methods that will be used to elicit perceptions of risk to lemurs and livelihoods will be discussed. Insight gleaned from this research will provide vital entry points

for social learning and enhanced adaptive capacity to reduce risks to lemurs and livelihoods from not poaching. This research will also inform discourse about improving decision-making for environmental risk management in developing countries.

**W2-F.6** Graham JD; grahamjd@indiana.edu  
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#### **ENHANCING REGULATORY OVERSIGHT**

White House oversight of the federal regulatory process can be improved as follows: (1) ensure the poor are treated fairly by regulators, (2) seek weights on non-quantified benefit and costs, (3) seek ex post validation of risk, benefit and cost estimates; (4) commission the Institute of Medicine to prepare periodic blueprints of lifesaving opportunities; (5) ask Congress to codify authority for OMB and citizens to issue "prompt" letters; (6) ask Congress to codify "default" principles risk analysis and benefit-cost-analysis; (7) ask Congress to authorize "risk trading"; (8) implement sustained program of U.S.-E.U. regulatory cooperation. With these reforms, future administrations can produce more protective and cost-effective federal regulations than are now being issued.

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#### **CHALLENGES TO RISK ASSESSMENT FOR "SOLUTION-FOCUSED" APPROACH**

The use of risk assessment to guide choices among potential solutions would bring environmental risk management closer to the decision-analytic approaches used in many other fields. There would be some significant methodologic challenges to current approaches to environmental risk assessment to in this reorientation. One need will be enhanced quantitative assessment of uncertainty, which will be differential across solutions. Another is the challenge of identifying and setting priorities across risk areas needing solutions. In addition, challenges posed by current regulatory and statutory directions that seem to enforce a "Red Book" approach must be considered as well.

**M3-A.2** Grebenkov AJ, Yakushau AP, Pluta SV, Linkov I; sasha\_grebenkov@mail.ru  
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#### **AGENT BASED SIMULATION FOR SPATIALLY EXPLICIT EXPOSURE ASSESSMENT IN DECERNS**

In order to identify ecologically viable and economically sustainable remediation scenarios for contaminated sites, it is often necessary to assess existing and future risks to biota associated with heterogeneous contamination in the environment. The exposure to contaminated environment is stipulated by receptor's movement in directions determined and weighted by location, forage volume, and attractiveness of forage resources. In our previous studies, the receptor's migration rate within its habitat was supposed to be inversely proportional to the available forage volume and habitat quality. The present study involves the Learning Agent Based Simulation (LABS) approach that allows more sophisticated description of behavior of animals. The LABS is incorporated in our RiskTrace model, which provides with more correct evaluation of spatially explicit exposure and environmental risk assessments.

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### **ECOLOGICAL COST/BENEFIT APPROACHES IN DECERNS**

The presented modeling approach to be accommodated in the Decision Evaluation for Complex Environmental Risk Networked Systems (DECERNS) introduces economic valuation to the cost of remediation of affected environmental objects and the benefits of services provided by restored ecosystems. Not only the environmental objects, which can be directly attributed with economic value, are objectives in such analysis. The cost/benefit analysis can also be applicable to the land use alternatives in case of, e.g., protection of habitat of endangered species, when values of other dimensions (non economic origin) dominate. The model allows economic valuation of several scenarios when the biological resources are protected to achieve a certain sustainability of biodiversity in unique ecosystems. For example, the developed model and software were used in selection of land use alternatives for wildlife sanctuaries Dikoye and Zvanets in Belarus, which are the biggest eutrophic bogs in Europe of the mesotrophic type in its natural condition.

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Federal Government

### **PRODUCE SAFETY INITIATIVES AND REGULATORY UPDATE**

Despite many efforts by the U.S. Food and Drug Administration (FDA) and our food safety partners, foodborne illnesses linked to fresh consumption continue to occur. Given the significant role of fresh produce in a healthy diet, preventing the contamination of fresh produce is critical. FDA believes that the most effective strategy for reducing foodborne illness is one that approaches the problem from several different angles and that periodically examines what we have learned and what we still do not know. Recent activities that FDA has engaged in to address the problem of fresh produce contamination include the multi-year Leafy Greens and Tomato Safety Initiatives. These produce safety initiatives are components of the 2004 Produce Safety Action Plan (PSAP) which is intended to minimize the incidence of foodborne illness associated with fresh produce consumption. In 2006, the Leafy Greens Safety Initiative began in response to continuing outbreaks of E.coli O157:H7 in leafy greens. Similarly, in 2007, the Tomato Safety Initiative started in response to continuing outbreaks of Salmonella, spp. in tomatoes. This presentation will discuss the planning, operations and preliminary data from these initiatives and other recent produce safety efforts by FDA.

**W4-H.1** Green LC, Crouch EAC\*; Green@cambridgeenvironmental.com  
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### **HEALTH RISK ASSESSMENT PERSPECTIVES ON CHLORINATED ETHYLENES: FOCUS ON PERCHLOROETHYLENE TOXICITY VALUES**

Vapor intrusion often involves chlorinated ethylenes, the most hazardous of which, according to most toxicologists (and epidemiologists), is vinyl chloride. However, many remedial actions intended to minimize vapor intrusion involve the higher chlorinated ethylenes, trichloro- and tetrachloroethylene. For several reasons, both qualitative and quantitative, estimates of risk from these compounds, especially at low part-per-billion concentrations in air, are highly uncertain (and highly contentious). Focusing on tetrachloroethylene (perchloroethylene; perc), this talk presents and explains the quantitative reasons that part-per-billion concentrations of perc may be characterized as an “imminent hazards” in residential settings, even as airborne concentrations at least 1,000 times greater are routinely (and legally) tolerated in the workplace. Among other factors, methods for, and results of, estimating fractions of perc metabolized at low-level exposures result in sub-

stantial differences in unit risk values. Even greater differences follow from decisions as to whether the rodent bioassay dose-response data should be extrapolated, for purposes of human health risk assessment, by low-dose linear extrapolation, or instead by a “margin of safety” approach. Estimates of low-dose carcinogenic potencies for perc made by U.S. EPA, the Massachusetts DEP, the European Commission, and the authors are compared and contrasted.

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Gradient Corporation

### **USE OF YEARS OF POTENTIAL LIFE LOST (YPLL) AS A RISK MANAGEMENT TOOL AT HAZARDOUS WASTE SITES**

The goal of the Superfund and similar hazardous waste site programs is to reduce chemical or radionuclide risks to populations potentially exposed to site media. Risk management decisions are often based on limiting risks to exposed populations, but may not account for the health and safety risks to workers involved in implementing these decisions. Years of potential life loss (YPLL) is an epidemiological measure that has been used to measure premature mortality associated with disease, such as cardiovascular disease, and more recently worker fatalities associated with site remediation. We have conducted a YPLL analysis for a hazardous waste site, using some of the same assumptions in Cohen et al. (1997); however, we updated the assessment with 2008 fatality (injury and cancer) statistics and conducted a number of sensitivity analyses. As in previous studies, we found that the combination of safety and chemical hazards encountered by remediation workers engaged in excavation and transport activities can result in greater YPLL to workers than YPLL reduced to the community due to the remediation. The ratio of YPLL workers/YPLL residents in 2008 dropped slightly from 1997 due to higher life expectancies and 5-year cancer survival rates. The sensitivity analyses indicated that YPLL is heavily dependent on the age distribution of measured fatalities and population size, although most assumptions still resulted in greater YPLL created to workers than reduced to the exposed community. Fatalities at younger ages have a large impact on the outcome because they result in more years of potential life lost. Consequently, YPLL is usually greater for remediation workers because fatalities occur at younger ages than in the general population. We conclude that YPLL can be a useful risk management tool when comparing the cost/benefit of various remedial actions at hazardous waste sites to help select among remedial options.

**M2-B.3** Gregory R; rgregory@interchange.ubc.ca  
Decision Research

### **INVISIBLE LOSSES: USING DECISION-FOCUSED METHODS TO IDENTIFY ENVIRONMENTAL RISKS AND IMPACTS**

Risk analyses are required as part of many environmental initiatives. A common criticism advanced by local and traditional (e.g., Native American) communities is that important types of losses are often omitted from conventional analyses. These include concerns about lifestyle changes, effects on the transmission of knowledge between generations, loss of social structure, and the fear or worry that accompanies uncertainty regarding health effects related to contamination or the loss of traditional resource use practices. We discuss the use of structured decision making approaches in identifying and articulating these sources of loss in ways that enhance their visibility as part of formal risk analyses.



**T4-A.2** Grieger K, Hansen SF, Baun A; kdg@env.dtu.dk  
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### **UNCERTAINTY AND SENSITIVITY ANALYSIS OF ENVIRONMENTAL AND HEALTH RISKS OF NANOMATERIALS**

Uncertainty about the environmental, health and safety issues (EHS) of nanomaterials has been recognized as a possible barrier towards nanotechnology reaching its full potential. Historically, research efforts tend to be directed towards specific, narrow scientific research questions with very limited perspective of reducing the overall uncertainty in the short-term, and hence they have had a limited prospect of facilitating informed risk-reducing decision-making processes. This study investigates the main areas of uncertainty related to EHS of nanomaterials, as well as investigates the level, nature and sensitivity of the scientific uncertainty. In this study the scientific uncertainty was systematically mapped by locating the areas of uncertainty through an in-depth analysis of government reports, scientific reviews and primary articles dealing with and/or investigating the potential risks of nanomaterials. Once the locations of uncertainty were identified, we assigned and discussed the level and the sensitivity of the uncertainty. We found that significant knowledge gaps exist not only in terms of documenting potential (eco)toxicological effects, but also in terms of characterizing exposure and nanoparticles behaviour even in simple test systems. For example, uncertainty related to testing strategies and environmentally-realistic exposure scenarios, impedes a successful risk characterisation of engineered nanoparticles. This includes establishing, developing and standardising reference materials, monitoring and detection equipment and estimating human and environmental exposure concentrations. These issues ultimately lead to significant challenges in performing human and environmental risk assessments and present a daunting task for regulators.

**T2-C.3** Griffith WC, Schumacher KM, Ramaprasad J, Faustman EM; griffith@u.washington.edu  
University of Washington

### **USING SIMPLE KINETIC MODELS TO INTEGRATE EXPERIMENTAL DATASETS: LESSONS LEARNED WITH CHLORPYRIFOS**

The purpose of this research has been to determine the utility of using kinetic models for improving comparisons and integrating results from diverse experimental datasets. We use the example of chlorpyrifos (CP), as it has a very robust but complex dataset with multiple endpoints and varied experimental designs. We have focused on the neuro developmental toxicity studies in order to better understand how kinetic information may help in relating exposures to toxicodynamic changes seen during critical periods of neuro development. We modified a 2 compartment model by including different absorption half lives to distinguish between routes of exposure. In this model we use doses of CP administered to the rodent, frequency of exposure, number of doses, ending time (time of measurement) and rate of exposure to calculate area under the curve (AUC) using a SAAMII program. For in utero experiments we used maternal AUCs as a surrogate in these simple kinetic assessments to approximate fetal conditions. We calculated AUCs for 34 developmental toxicity animal studies for CP using the models for multiple exposure routes across studies, multiple doses within and across rodent strains and for experiments with discontinuous timing of doses. This simple kinetic model allowed us to make better comparisons across rodent experiments especially among experiments with different designs. These assessments now provide examples for application of this approach to other compounds. It has shown that a fairly simple pharmacokinetic model can help us compare endpoints across these varied designs. In addition, we have also shown an improved way to graphically present data from these analyses to further enhance our experimental comparisons. Supported by NIEHS P01-ES009601, NIEHS P30-ES007033, EPA RD-83170901, and EPA RD-83273301.

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### **CONCERNS ABOUT RELEASE FROM BIOSAFETY LEVEL 3/4 LABORATORIES**

This talk will describe the public concerns about high-containment (BSL 3/4) laboratories, what may be done to reduce concerns, and what can be done to reduce the risks these laboratories pose. High-containment laboratories have become increasingly controversial because of highly publicized laboratory errors, especially the missteps of Boston University in handling tularemia infections, and the failure of Texas A&M to report infections to the CDC. These errors have fueled resistance to high-containment laboratory siting proposals. Public resistance was experienced during efforts to build high-containment facilities in Boston, in Davis, California, in Hamilton, Montana, and in Seattle, whereas generally positive support was achieved for the Galveston laboratory administered by the University of Texas Medical Branch. In the end, both the Davis and Seattle facilities were not built, in part due to public opposition. Public protests against the siting of the Boston University National Biocontainment Laboratory eventually led to citywide regulations on research activities and practice, and litigation that is ongoing. Going forward, high-containment laboratories need to actively address these community concerns. Lessons should be learned from laboratories that have been accepted by their communities, which have by and large have procedures that not only encourage active reporting of problems but also keep the community informed about operations.

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George Washington University

### **STRATEGIES TO PROTECT CHILDREN FROM ENVIRONMENTAL HAZARDS: THE EXAMPLE OF LEAD**

There are three basic strategies to protect children: individual intervention (major hazard control), the preventive medicine strategy (screening and prevention for subjects at risk), and the public health strategy (prevention through elimination). The individual child must be protected by the parent or guardian, family, and immediate community; the basic strategy is through education. In the case of lead, individual protection means raising parental awareness and providing instructions for control of lead exposure at home and under supervision. Children are individually protected in or removed from homes where a hazard exists, on a case-by-case basis in order to prevent lead poisoning, but placing such responsibility on the parent is not reliable and lapses are frequent. Current applications of the “preventive medicine” approach (defined as by G Rose) to lead poisoning prevention are limited to secondary prevention, in which children at high risk are screened in order to identify a source, with intervention specific to the child. (Medical intervention is tertiary prevention, designed to reduce disability.) This strategy is deeply flawed, because it cannot prevent exposure in the first instance. The risk associated with housing quality should be identified before the adverse event occurs, in order to achieve primary prevention. At this time, nearly insurmountable obstacles exist that involve rights involving private property. This is wrong and should change. The basic strategy of “public health” (Rose), which for lead means to reduce exposure from all sources, applies to children exposed to lead at all levels of exposure and achieves reduction of group risk. The public health model requires that all significant sources of environmental lead be controlled to reduce lead exposure and therefore mean blood lead level in the entire population. This can only be undertaken by a systematic and organized program and because resources are limited such programs compete with other possible investments to achieve health gains.



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### **HOW MUCH FEAR IS NECESSARY; HOW MUCH FEAR IS JUSTIFIABLE? SIX DECADES OF FEAR APPEAL RESEARCH**

Today we know that central, phylogenetically old structures in the brain serve primarily protection against threats. However, the threats that during the course of evolution helped to build these rapid and intuition-based mechanisms are not the same threats today. It is therefore not by chance that in the population today we frequently find missing, unnecessary, ineffective, or counterproductive defensive strategies against danger. Communication professionals are often unable to predict with sufficient certainty what effect the fear appeals used in a public campaign will have on behavior. Experts complain about irrational behavior patterns of overreaction but also underreaction to objective threats. Fear appeals are thus not monotonic in their effect, meaning that their persuasiveness does not increase in proportion to the amount of fear that is evoked. Even after 60 years of empirical research on the mechanisms and effectiveness of fear appeals, the scientific community has not been able to develop a comprehensive understanding of the processes involved. But in recent years - in the context of two-process theories, for example - there have been increased efforts to more strongly focus interest on the cognition of threats, the connected experiencing of emotions, and the subsequent effects on assessment of the situation, decisions, and finally behavior. The aim of this presentation is to look back on the theory development and to point out the key findings of the empirical research. The primary focus is on practical implications for implementation, in particular the question: How, in scientific risk communication, can we utilize fear appeals successfully, without overstepping the line between information and manipulation?

**W4-F.3** Gutteling JM; j.m.gutteling@utwente.nl  
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### **DATA AND OBSERVATIONS FROM THE NETHERLANDS**

The survey experimental study from the Netherlands described here provides crucial scientific data related to understanding trust and risk perception of mobile communication technology by the general public in regards to the issue of precautionary measures towards both mobile phones and base stations. Contrary to the prevailing assumption that implementation of precautionary measures, or more precisely communicating or informing about taking such precautionary measures, will increase trust, alleviate fears, and reduce risk perceptions in the general public, previous studies indicated that the opposite effect may be observed. Various theoretical hypotheses can be posited to explain this countervailing effect which perhaps stems from an incongruity in the social amplification of the perceived risk as a result of trust issues towards those implementing the precautionary measure and the perceived need for them to implement it. To verify whether this effect holds true across larger sample sizes and across different cultures and countries, an international comparative study was performed in nine countries using a standardized survey instrument that, however, was culturally adapted. Stimulus texts in 20 different survey variants were randomly addressed by 400 respondents in the Netherlands. Survey variables included the information about the level of precautionary measure, the basic intention behind implementing it, and the order of addressing base stations and mobile phones. Respondents rated their perceived risks and organizational trust. The implications of the [insert county name] results and combined international results are not only important for improving the understanding of risk perception and risk communication, but may have significant ramifications for risk management.

**W4-G.5** Haber LT, Krishnan K, Gentry PR, Patterson J, Parker A, Adamou T; haber@tera.org  
Toxicology Excellence for Risk Assessment (TERA)

### **FRAMEWORK TO EVALUATE CHILD:ADULT DIFFERENCES IN INHALATION DOSIMETRY OF GASES: APPLICATION TO SELECTED SYSTEMICALLY-ACTING VOLATILE ORGANIC CHEMICALS**

A key issue in considering children's risk is the relative tissue dosimetry in adults vs. children. To address this question, we developed a framework and analytical approach for evaluating the mean relative tissue dose in adults and children for systemic effects of inhaled gases. Such information can help to focus efforts for obtaining additional data and for more refined analyses on the chemicals where there is the greatest potential of children being at greater risk. The results can be combined with information on variability, to evaluate the adequacy of default UFs for protecting children, or to determine the need for chemical-specific modifications to UFs. We conducted case studies at steady state for systemic effects of VOCs for various combinations of physico-chemical and metabolic characteristics. These case studies aim to provide perspective on the potential range of internal dose in children at different ages (3 months, 1 year, 5 years, and 10 years) vs. adults. Calculations were conducted for the parent, reactive metabolite, and stable metabolite for blood:air partition coefficients of 1-50, hepatic extraction ratio of 0-1, and for high or low intrinsic clearance (1000 or 0.1 L/hr). Illustrative analyses were also developed on relative dosimetry for chemicals with flow-limited and enzyme-limited clearance, and those that show significant age-related variability in enzyme capacity. These analyses indicate that in most cases, the ratio of internal dose for children:adults for these chemicals is likely to be within a factor of 2.3 when the toxic moiety is the parent, and within a factor of 1.5 when it is a reactive metabolite. Ratios were generally 1 or less for stable metabolites, but higher ratios were obtained when the toxic moiety is a stable metabolite that is cleared efficiently in adults, but poorly in children. The framework provides a structure for evaluating age-related kinetic differences and to focus future research in this area.

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Toxicology Excellence for Risk Assessment (TERA)

### **IMPLEMENTATION OF MANUFACTURED NANOMATERIAL POLICY AND GOVERNANCE – REFLECTIONS FROM A NATO ADVANCED RESEARCH WORKSHOP**

Nanomaterial (NM) policy and governance holds great challenges due to the lack of environmental, health and safety information and the diversity of NMs. We report on the discussions from a recent NATO Advanced Research Workshop. The WG agreed that while many different policy frameworks for manufactured NMs have been developed globally, a significant lag period remains between the development of nanotechnologies and the development and implementation of new policies. Hence the focus of discussions in the policy workgroup (WG) was on guidance deemed helpful for developing policies. A challenge for developing NM policies is the need to consider the risks and benefits of these materials and their uses. The WG recommend that efforts be directed towards understanding tradeoffs and finding superior risk management alternatives rather than focusing on estimating the exact risks and benefits. There is also a need to include an understanding of risk perceptions, which can depend on the applications in which the technologies are being used, and then developing appropriate risk communication efforts. A third challenge is the lack of a common, standardized taxonomy and terminology for NMs which captures key aspects of their physical and chemical characteristics, together with the establishment of standardized "use categories". Overall, the WG recommends that a tiered adaptive management approach

should be utilized to respond to new developments and gain additional information through policy. A future policy framework should employ multiple tools at different levels of the regulatory spectra ranging from self-regulation to mandatory legislation, with specific tools chosen on a case-by-case basis. The ideal policy should take a holistic viewpoint, considering the entire lifecycle of a NM including disposal/recycling. Interactions and collaborations among regulators, scientists, and other stakeholders should continue and be further encouraged to develop coherent, adequate policies to address such a dynamic field.

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Battelle Memorial Institute

#### **CONSEQUENCE MITIGATION OF HYPOTHETICAL MEDICAL COUNTERMEASURES FOR ANTHRAX EXPOSURE IN A BIOTERRORISM ATTACK**

Recent Homeland Security Presidential Directives (HSPDs) 10 (Biodefense for the 21st Century) and 18 (Medical Countermeasures against Weapons of Mass Destruction) have provided specific requirements from the President for executing risk assessments specific to Weapons of Mass Destruction (WMD) for the purpose of guiding strategic planning in such areas as biodefense and medical countermeasure acquisition to defend against chemical, biological, radiological, and nuclear (CBRN) terrorism. In support of this activity, the Department of Homeland Security's Science and Technology Directorate has undertaken detailed modeling of how the public health system would be able to mitigate fatality and illness consequences of such an attack, should it occur. In this talk, a simple discrete event simulation model describing the progression of events following a covert terrorist attack with a biological agent is briefly described. The progression of events after exposure of a group of people to a biological agent is highly dependent on the biological agent. Based on the 2001 Amerithax attacks, disease etiology is modeled to resemble anthrax. Critical parameters impacting the ability to treat disease include time between exposure and treatment, as well as countermeasure efficacy and quantity parameters. The model is then exercised under a variety of assumptions on the timeline between exposure and treatment and the prophylactic and treatment capabilities of several medical countermeasure strategies.

**M2-E.2** Hall I; ian\_s\_hall@hotmail.com  
Lloyds TSB Asset Finance

#### **ART OR SCIENCE - CAN THESE TWO PARADIGMS CO-EXIST WITHIN THE FIELD OF RISK MANAGEMENT?**

Over the past 5 years, Corporate Lenders have seen the benefits of developing automated scoring solutions allowing for operational efficiencies and a reduction in the costs of processing applications for new credit applications. Additionally, the segmentation of portfolios into low, medium and high risk customers, has allowed institutions to price risk more effectively and become more astute at using rationed capital. Changes in legislation and the instability of the global economy threaten these efficiencies through a change in the environment in which these businesses compete. The question for Corporate Lenders therefore, is should they trust statistically based credit models, or allow themselves to become more reliant on subjective assessments of the risk of non payment by customers based upon the mental models of "expert" actors within the business. This paper seeks to consider how the art of Risk Management can be used to supplement statistical models and allow an organisation to navigate through the rapidly changing landscape of the business environment.

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#### **MOTIVATING CONSUMERS TO ACT DURING FOOD RECALLS**

Motivating people to appropriately respond to a food recall can be extremely difficult. Some consumers are unaware of particular recalls because the right information never reaches them. Others hear about the recall but pay no attention to it, wrongly assuming that the information does not apply to them. Some consumers who are aware of the recall choose to disregard it, and eat the recalled product anyway. At the other extreme, some consumers may avoid the recalled product for months (or years) after the recall has ended. They may also generalize the recall warning to other similar products, or to products produced by the same manufacturer, and may change their purchasing and food preparation practices in ways that are not necessarily warranted by the recall. To identify messages that may facilitate the desired responses to recalls involving food contamination, we conducted a national, random-digit dial telephone survey of 1,200 Americans in all 50 states. Respondents were asked about their behaviors with regard to past recalls as well as how they would behave in hypothetical scenarios. Using a set of message-testing experiments, the survey provides empirical data that addresses how risk communicators (via the media) can increase consumer attention to food recalls. We present the types of food recall communications that command the most attention from consumers, and whether this varies by food product or category. We use both demographic and psycho-social variables to predict which consumers are most receptive to particular messages, and how we can tailor specific messages to get the attention of those least receptive. In addition, we explore the possible channels of communication for messages about food recalls, including consumers receptivity to personalized, tailored messages about food recalls based on past purchases, which is a recent development employed by a number of retailers.

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#### **USE OF TOLERABLE RISK GUIDELINES FOR INFRASTRUCTURE MANAGEMENT**

Risk assessment methodologies have been used in various industries around the world to provide decision makers information on the probability of an adverse outcome and the resulting consequences. Of particular interest to the management of risks for dams and levees is risk assessment's ability to assess potential failure modes that are not amenable to deterministic analytical solutions and to capture the affects of uncertainty in the analysis parameters on the results of the analysis. The US Army Corps of Engineers, US Bureau of Reclamation, and the Federal Energy Regulatory Commission are working to develop guidance for incorporating risk-based decision making into their dam and levee safety programs. In order for the three agencies to move forward in a consistent manner, a common understanding of tolerable risk as it applies to dams and levees is necessary. The agencies' interest in tolerable risk was driven by a common desire to: make better decisions; better determine, prioritize and justify risk reduction actions; better communicate risks to decision makers and the public; and better understand and evaluate public safety risks in an environment of shared flood risk management responsibilities. Tolerable risk guidelines will be discussed. Emphasis will be given to describing how cross-cutting principles and analytical approaches to tolerable risk inform these guidelines including risk assessment, governance, communication, and risk-informed decision making methods.

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### **THE MULTIPLE MEANINGS OF DIALOGUING WITH THE PUBLIC IN THE EVOLVING PRACTICE OF PUBLIC HEALTH COMMUNICATION**

It is common knowledge among environmental and public health officials that they need to engage affected publics when controversial issues or major decisions are at stake. Although the trend in public participation studies for the last several decades has been to encourage “dialogue” in these situations, the term holds multiple meanings within various discourse communities such as public participant groups, agency officials, and practitioners in the field. These multiple meanings can complicate efforts to create understanding among groups and inform decision-making. Here, we analyze the discourse of officials and practitioners working to develop community response plans for the impending pandemic influenza in order to increase understanding of these multiple meanings. Using a methodology known within critical and rhetorical circles as “public vocabulary” (Condit & Lucaites, 1993) we examine official documents and interviews with public health officials and consultants for the characterizations, narratives, and key terms that reflect the meanings of “dialogue” circulating within this community. A few studies have looked at participant perspectives on public participation and its goals (Webler & Tuler, 2006). The significance of our analysis here is that it narrows that focus to a key term of dialogue within this community and discusses how the move toward dialogue and its accompanying vocabulary are impacting the evolving practice of public health communication. Our argument is that to usefully contribute to the recent trend in public participation of exploring diversity, creating understanding, and building long-term relationships, we need research that elucidates the various meanings circulating and competing within the sphere of public participation.

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### **THE VALUE OF REDUCING CHILDREN’S MORTALITY RISK: EFFECTS OF DISEASE TYPE AND LATENCY**

Despite research showing that children may be differentially susceptible to environmental health hazards and that risks to children may be of greater social concern than risks to adults, there have been relatively few studies that estimate the economic value of reducing risk to children’s health. We estimate household willingness to pay (WTP) to reduce risk of developing a fatal chronic disease and examine how WTP depends on the age and other characteristics of the individual at risk, on characteristics of the disease, and on characteristics of the survey respondent’s household. Values are elicited using a contingent valuation (CV) survey administered over the internet to a nationally representative sample of 2,200 US households. Respondents are asked to value reductions in risk of fatal degenerative illness caused by pesticides on food. By asking respondents to consider a food that only a designated household member will eat, we estimate WTP to reduce risk to specific household members, including the adult respondent, a child, and another adult in the household. Values are elicited for diseases affecting each of four organ systems (brain, bladder, liver, lymphocytes). For each organ system, the disease is described as a terminal cancer or non-cancer illness that presents identical symptoms and prognosis. Latency (the duration of the period between exposure to the pesticide and development of symptoms) is varied between 1 and 20 years. For comparison, values are also elicited for reducing risk of fatal trauma in a motor-vehicle crash, an endpoint that has been studied in numerous other valuation studies. Results of this work provide insight about the private value to households of reducing environmental health risks to children and adults in the household, and how these values depend on the

disease, latency between exposure and realization, and household characteristics.

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### **APPLYING AN “EMERGENCE” MODEL OF NATURE, SOCIETY AND ENVIRONMENT TO STUDYING PUBLIC REACTIONS TO NEW SUSTAINABLE ENERGY TECHNOLOGIES**

Nuclear fusion and hydrogen energy are “emergent technologies” that seek to provide a sustainable substitute for hydrocarbon fuels. Several leading teams of researchers in the U.K. and Spain have studied patterns and processes of lay perception, engagement and social learning in these cases, concluding that there is a need for public consultation that is more intensive, deliberative and upstream. In this paper, I advocate an approach to analyzing public reaction to and understanding of new, poorly understood energy technologies that synchronizes with other elements of a general emergence model of nature, society and the environment as introduced by Hannigan (2006). More specifically, I argue that lay interpretations of nuclear fusion and other incipient sustainable energy technologies be explored in the context of two related phenomena: recent models of science-policy interface in environmental decision-making that feature “emergent boundary organizations”; and emergent patterns of belief, communication and response that arise in technological emergencies, natural disasters and other occasions characterized by considerable urgency together with a high degree of normative, structural and ideological ambiguity.

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### **CATEGORIZATION FRAMEWORK TO AID EXPOSURE ASSESSMENT OF NANOMATERIALS IN CONSUMER PRODUCTS**

Exposure assessment is crucial for risk assessment for nanomaterials. We propose a framework to aid exposure assessment in consumer products. We determined the location of the nanomaterials and the chemical identify of the 580 products listed in the inventory maintained by the Woodrow Wilson International Center for Scholars. 37% used nanoparticles suspended in liquids, whereas < 1% contained “free airborne nanoparticles”. C60 are currently only used as suspended in liquids and nano-silver is used more as surface bound nanoparticles than as particles suspended in liquids. Based on the location of the nanostructure we were able to further group the products into categories of: 1) expected; 2) possible; and 3) no expected exposure. Most products fall into the category of expected exposure, but we were not able to complete the quantitative exposure assessment mainly due to the lack of information on the concentration of the nanomaterial in the products - a problem that regulators and industry will have to address if we are to have realistic exposure assessment in the future. To illustrate the workability of our procedure, we applied it to four product scenarios using best estimates available and/or worst case assumptions. Using best estimates available and/or worst case assumptions we estimated the consumer exposure to be 26, 15 and 44 µg/kg bw/year for a facial lotion, a fluid product and a spray product containing nanoparticles respectively. The application of sun lotion containing 2% nanoparticles result in an exposure of 56.7 mg/kg bw/day for a 2 years old child, if the amounts applied correspond to the European Commissions recommendations on use of sunscreen.



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#### **RISK ASSESSMENT OF CADMIUM INTAKE FROM FOOD IN JAPAN**

In the past Japan had several regional areas that were polluted with cadmium originated from adjacent mining districts. The so-called Itai-itai disease broke out in the severely polluted locations. Ever since, the government has taken measures for soil improvement/replacement; thus few highly contaminated regions is still remained. However, cadmium concentration in rice produced is generally higher in Japan than other countries, because many ore deposits and abandoned mines exist throughout the territory. Rice, Japan's main staple, accounts for approximately half the total national cadmium intake from food. Therefore the Food Safety Commission implemented a risk assessment of cadmium intake from food in response to the request for opinion received from the Ministry of Health, Labour and Welfare. The assessment, conducted with a key focus placed on a long-term and low level exposure in the general environment, led to setting a TWI (tolerable weekly intake) based upon the following epidemiological studies: - The total cadmium intake that yields an equivalent prevalence of "2-microglobulin-uria to that in the control group was estimated to be approximately 2.0g, which in turn provides a basis to calculate the intake value of 14.4µg/kg bw/week or lower that produced an adverse effect on health. - The prevalence of proximal tubule dysfunction was not significantly increased in the population exposed to similar cadmium levels to the PTWI (7µg/kg bw/week) set by JECFA, compared with the control group in the non-polluted area. Scrutinizing these results in a comprehensive manner, we set TWI of cadmium at 7 µg/kg bw/week. Meanwhile, rice consumption per capita has been declining since 1962, thus the current cadmium intake has also considerably dropped. These facts provide evidences that in general population cadmium intake from food would be less than the TWI set.

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#### **COMMUNITY ACCEPTANCE OF GENETIC TECHNOLOGY FOR HEALTH PROMOTION PURPOSES: EXPLORING THE INFLUENCE OF PERCEIVED RISKS AND BENEFITS FOR AUSTRALIANS' INTENTIONS TO HAVE THEIR GENES TESTED.**

While beliefs about the perceived risks and benefits of medical advances are likely to influence public acceptance of the use of genetic technologies for health promotion purposes, general trust in medical experts may also play a key role. To assess this possibility we conducted a national telephone survey of 800 Australian adults. Vignette methodology was used to assess community responses to a hypothetical doctor. After describing the expertise of "Dr Benson" in the use of genetic profiling for health promotion purposes, respondents were asked to rate how much they would trust this doctor, how likely they would be to have their genes profiled by this doctor, and to provide subjective reasons for this intention. A qualitative analysis of these open-ended responses explored the subjective reasons behind the intentions of those who said they were likely and those who said they were not likely to have their genes tested. Respondents also rated a series of questions about their general levels of trust in doctors and the health care system, and their beliefs about the perceived risks and benefits of medical advances. Structural equation modeling was used to examine the relative influence of trust, risk and benefit factors on intention to have genetic tests for health promotion purposes. Implications of the qualitative and quantitative findings will be discussed.

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#### **PUBLIC HEALTH RECOGNITION AND RESPONSE TO A RADIOLOGIC EVENT**

Physician and public health department (PHD) recognition and response to a radiological terrorism attack will be critical in order to intervene, mitigate and minimize the impact of an event. The purpose of this study was to gain an understanding of how medical personnel and PHDs would recognize and respond to the covert introduction of radiologic agents into the food supply. The approach involved personal interviews with 24 medical personnel from a variety of disciplines (i.e., emergency, epidemiology, family medicine, gastroenterology, hematology, infectious disease, microbiology, pathology, pediatrics, pharmacy, toxicology, etc.) and a variety of institutions (i.e., emergency rooms/trauma centers, hospitals, clinics, urgent care facilities, tribal care center) in urban and rural areas. Ten PHDs with variable experience in foodborne illness outbreak investigations were also interviewed. All interviewees were presented with a symptom description for a patient who exhibited acute radiation syndrome as defined by HHS' Radiation Event Medical Management consistent with a whole body exposure to 5.3 - 8.3 Grays. A questionnaire was used to explore initial and differential diagnoses, laboratory tests they would request, and initial treatment options. Additional information including metabolic panels and blood chemistry test results was provided to inform their decision-making process. The number of patients to trigger action, what actions would be taken and the factors that influence recognition and response were also explored. The results of the study indicate that all medical personnel recognized that they were dealing with symptoms consistent with advancing sepsis, but none of the medical personnel or PHDs recognized they were dealing with a radiologic exposure. Although the sample size was small, this study provides some basis for an estimate of recognition and response parameters for events for which we have no prior experience.

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#### **PERSUASION, POLITICAL IDEOLOGY, AND SOCIAL IDENTITY THEORY: AN INVESTIGATION INTO FACTORS THAT AFFECT EFFORTS TO COMMUNICATE CLIMATE CHANGE**

In recent years global warming has become a highly salient and polarizing scientific and political issue. One of the challenges facing science communicators today is how best to communicate the impacts of climate change and other environmental issues to lay audiences who have varying political identities. Drawing from social identity theory, this study uses a mall-intercept experiment to examine how individuals with different political orientations responded to potential in-group and out-group victims of global climate change. Specifically, a 2 (in-group victim vs. out-group victim) X 2 (one victim vs. many victims) experimental design was used to examine how respondents would respond to an altered news story discussing the link between climate change and a likely increase in infectious diseases carried by insects. The study finds that individuals who identify as Democrats or Republicans appear to rely more on ideological markers than the framing of climate change when responding to messages about the issue. However, individuals who identified as independents did respond to the different frames in a manner consistent with social identity theory: independent respondents had the strongest emotional reactions and were most willing to take action when given a story depicting a group of in-group victims, less so with stories depicting individual in-group or out-group victims, and had the weakest emotional reactions and were least willing to take action when given a story depicting a group of out-group victims. These results are discussed in terms of how social identity theory can inform related work on the



identified victim effect, how practitioners can best communicate climate change to lay audiences, and future directions for research.

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#### **THE INFLUENCE OF STATISTICS IN CLIMATE CHANGE FRAMES**

In recent studies examining episodic and thematic framing of risk issues, multiple researchers have only used highly numeric descriptions of issues for stimuli in thematic conditions. However, thematic frames can be framed either with or without statistics. This study uses the context of climate change to examine the impact of two different ways of portraying thematic information: either numeric descriptions (e.g. 2/3) or non-numeric descriptions (e.g. most) of likely climate change impacts on polar bears and arctic ice. Based on previous research concerning numeracy, levels of numeracy were expected to be a significant predictor in the numeric condition but not in the non-numeric condition, which was confirmed in the study. This study finds a main effect of thematic frames with numeric descriptions generated more concern and willingness to take action in respondents. This effect was driven primarily by individuals who were low in the ability to process numerical information; individuals with low numeracy were much more concerned in the numeric than non-numeric condition, while individuals with high numeracy had similar responses to the numeric and non-numeric stimuli. Implications for future research on episodic and thematic representations of risk are discussed.

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#### **NANOTECHNOLOGIES: PERCEPTION OF TECHNOLOGICAL RISK & CONSTRAINTS ON BENEFIT AMONG COMPARATIVE US/UK PUBLICS**

This paper presents qualitative findings on public risk perception from a comparative cross-national US-UK study of public deliberation on benefits and risks of nanotechnology energy and health applications. The paper begins from an analytic-deliberative perspective on nanotech public participation, noting that on-going low awareness of new nanotechnologies among US and UK publics poses unique problems for framing, contextualizing, and deliberating about technoscientific futures and modes of public participation. Yet, deliberative venues in the emergent risk perception context provide an important context for qualitative research on perceived risks and benefits and theorizing connections to governance raised by this panel. The paper situates comparative nanotech risk perception that emerges in deliberative workshops within broader science and technology risk perception patterns in the US and UK, and then moves to explore the technological, social, and regulatory constraints US and UK publics perceive in relation to the likelihood of their realizing full benefits from new nanotechnologies. More particularly, the paper explores US and UK themes concerning governance of potentially socially disruptive technologies, including impediments to safe governance such as organizational “miscreancy” (Freudenburg) on the part of government and industry in safe management of risks to the public. The comparative analysis of US-UK publics and their responses to nanotechnologies for both Health and Energy allows a more nuanced analysis of commonalities of public concerns and queries the extent to which these override national differences in systems of governance, health care systems, and energy delivery systems. The paper concludes with an analysis of what is needed for the analytic-deliberative approach to effectively bridge public perception and policy in the nanotechnology case and how research indicates this may need to differ across applications.

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#### **DECISION-SUPPORT TOOL EXPLORING THE PUBLIC HEALTH SYSTEM RESPONSE TO A TERRORIST EVENT IN THE FOOD SUPPLY**

Bioterrorism vulnerability assessments have determined that intentional food poisoning is a plausible and devastating means to widely disseminate pathogens and other hazards. We have developed a simulation model that explores the response of the public health system to intentional contamination of the food supply. There are three components to the model: 1) the definition of individual exposure over time and the outcomes of exposure 2) the definition of the geographical dispersal of the food-hazard pair, and 3) the response of the public health authority when symptomatic individuals are identified. The model explicitly considers the variation in the multiple inter-related facets of the response system, including: differences in individual responses to exposure (e.g. probability individuals develop symptoms, probability individuals seek care), variation between health care providers in the likelihood they will take samples and make the appropriate reports, the subsequent processing of samples and confirmation of cases. The model is intended to be used by public health agencies to explore and understand how the components of the health care system and individual behaviour interact following an incident. Health system response components that can be explored include: the likelihood an investigation will be initiated when symptomatic patients present to a health care provider, the time it takes to elucidate the causative agent, and the impact upon public health of the speed of removal of contaminated product from the food supply. Use of the model can provide health authorities a scientific basis upon which to make decisions related to policies for response to food contamination events (for example the criteria for advisory issue), and further inform the current understanding of how the components of the public health system combine to protect public health.

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#### **IMPLICATIONS OF UNCERTAINTY FOR STAKEHOLDERS**

Incorporating uncertainty an integral part of decision and management processes is a central theme of this session. It is critical, then, to understand whether, how and to what extent different participants in a decision or management arena react to uncertainty, and similarly, to understand how discussion of uncertainty affects the relationships among stakeholders. This set of dynamics is poorly understood; I explore possibilities through two cases. The first qualifies as a “surprise”: recent attention to household accumulation and disposal of unused pharmaceuticals. The second is an ongoing controversy: nuclear power, and in particular, nuclear waste management. I compare and contrast the types and sources of information, the uncertainties, and the perspectives of various stakeholders on the importance and implications of that uncertainty. From this, I propose some norms / expectations for the implications of uncertainty for adaptive management, reframing problem definitions, and maintaining vigilance.

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#### **SYNOPSIS OF INFORMAL COLLECTION OF RISK ANALYSIS ACADEMIC SYLLABI AND CURRICULA**

Risk analysis courses are taught in an increasing number of institutions of higher learning, and an increasingly diverse set of programs within those institutions. In this presentation, I update

information reported at SRA in 2005, using a content analysis of risk course syllabi to assess topical coverage, objectives and institutional home of risk courses.

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#### **DEFINING THE RANGE OF POTENTIALLY FEASIBLE CONTROL OPTIONS-A NATURAL TOPIC FOR PRODUCTIVE INTERACTION OF RISK ASSESSMENT AND RISK MANAGEMENT EXPERTISE**

The conceptual separation of risk assessment and risk management analyses was designed to counteract two kinds of perversions: The experts have a tendency to want to make the decisions; and the decision-makers have a tendency to want to change the facts (or, at least, avoid responsibility for their value choices by saying that the facts as conveyed to them left them no reasonable options other than the one they selected). This paper argues, however, that there is a natural basis for assessors and managers to work together early in the process of regulatory impact analysis. This is the framing of competing regulatory options to address particular hazards, and the simultaneous identification of types of impacts that will be comparatively assessed for each policy option. Good framing of regulatory options benefits from insights into the comparative effectiveness of different ways to intervene in the causal chain leading to harm, and a sensitivity to the issues of how to capture the full range of feasible control options available to the decision-maker. Good design of comparative regulatory impact analyses involves identification of the ways different types of beneficial and adverse effects may be changed by different regulatory options, and how positive and negative consequences should be aggregated or disaggregated to illuminate the likely winners and losers from different policy options.

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#### **COMPETING REVOLUTIONS FOR THE MANAGEMENT OF UNCERTAINTY IN RISKS FROM ENVIRONMENTAL CHEMICALS**

An NRC report "Toxicity Testing in the 21st Century" calls for a long term project to replace much in vivo animal testing for apical endpoints of concern with a large ensemble of high-throughput in vitro test systems involving short term changes in gene expression intended to identify concentrations of environmental chemicals that "sufficiently perturb" particular toxicity pathways (in tissue culture cells derived from humans) to be of concern. This would essentially direct a large portion of future toxicity testing resources to inform choices on the use of large numbers of poorly studied chemicals within the traditional no-effect-level toxicological paradigm, and without explicit quantitative assessment of likely benefits in the form of reductions in health risks and associated uncertainties. By contrast, a competing revolutionary proposal would expand the reach of quantitative assessment of health risks. This would involve replacing the current set of safety/uncertainty factors for noncancer risk assessment with distributions based on empirical data, and extensive quantitative assessment of likely interactions chemical exposures with background processes involved in existing human pathological conditions. Rather than a vision of static homeostatic systems, it emphasizes analysis of dynamic changes in protective feedback systems, including errors in initial set up and eventual degradation of homeostasis with ageing. Explicit quantitative treatment of uncertainties in this alternative paradigm would facilitate "value of information" analysis for the addition of specific types of test results in clarifying the consequences of alternative regulatory options for human health protection.

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#### **DEFENDING AGAINST TERRORISM, NATURAL DISASTER, AND ALL HAZARDS**

This work considers both natural disasters and terrorism as threats. The defender chooses tradeoffs between investments in protection against natural disaster only, protection against terrorism only, and all-hazards protection. The terrorist chooses strategically how fiercely to attack. Three kinds of games are considered: when the agents move simultaneously; when the defender moves first; and when the terrorist moves first. Conditions are shown for when each type of agent prefers each kind of game. Sometimes their preferences for games coincide, but often their preferences are opposite. An agent advantaged with a sufficiently low normalized unit cost of investment relative to that of its opponent prefers to move first, which deters the opponent entirely, causing maximum utility for the first mover and zero utility to the deterred second mover, who prefers to avoid this game. When all-hazards protection is sufficiently cheap, it jointly protects against both the natural disaster and terrorism. As the cost increases, either pure natural disaster protection or pure terrorism protection joins in, dependent on which is more cost effective. As the unit cost of all-hazards protection increases above the sum of the individual unit costs, the extent of such protection drops to zero, and the pure forms of natural disaster protection and terrorism protection take over.

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#### **PROTECTING COMPLEX INFRASTRUCTURES AGAINST STRATEGIC ATTACKERS**

A framework is provided for how to analyze the strategic defense of an infrastructure attacked by multiple strategic attackers. Merging operations research, reliability theory, and game theory for optimal analytical impact, the optimization program for each agent is specified. Each agent determines how much to invest in defending versus attacking each of multiple targets. A target can have economic, human, and symbolic values, which generally vary across agents. Investment expenditure functions for each agent can be linear in the investment effort, concave, convex, logistic, can increase incrementally, or can be subject to budget constraints. Contest success functions (e.g. ratio and difference forms) determine the probability of a successful attack on each target, dependent on the relative investments of the defender and attackers on each target, and on characteristics of the contest. Targets can be in parallel, in series, interlinked, interdependent, or independent. The number of first order conditions for the optimization program equals the number of agents times the number of targets. These are conveniently solved applying conventional software on a computer, and give the optimal investments for each agent for each target. Alternative optimization programs are discussed, together with repeated games, dynamic games, and incomplete information. An example is provided for illustration.

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#### **THE KEY EVENTS ANALYTICAL FRAMEWORK: A CASE STUDY WITH LISTERIA MONOCYTOGENES**

There are three main categories of foodborne microbial pathogens, based on their general biological mechanisms. One group, toxigenic (e.g., *C. botulinum*, *S. aureus*), releases toxin into food products prior to food ingestion. A second group, toxicoinfectious (e.g., *V. cholerae*, entero-

hemorrhagic *E. coli*), colonizes the GI tract and then releases toxin that is absorbed into the body. A third group, infectious (e.g., *Listeria monocytogenes* *Salmonella enterica*), is capable of invading the intestinal epithelium and often internal tissue. For each of these mechanistic categories, current approaches to characterizing the dose-response relationship at low dose rely heavily on assumptions regarding thresholds. This presentation describes our working group's application of the Key Events Analytical Framework to a case study of *L. monocytogenes*, for which (based on single hit and independent action assumptions), it is widely assumed that intake of a single bacterium has a non-zero probability of causing infection and illness. Our Key Events analysis systematically considers each major biological step in the pathway from ingestion to the endpoint of concern with regard to: i) the interplay between the pathogen and host response mechanisms (e.g., innate and adaptive immune response); and ii) modifying factors (e.g., life stage, disease state, prior exposure) that may modify the effectiveness of host response and thereby affect the ultimate dose-response relationship. The dynamic and probabilistic nature of individual key events and their integration into a multiple step pathway will be discussed, along with the potential influence of inter- and intraindividual variability at specific key events. Finally, the potential value of this Key Events approach for advancing the scientific basis of dose-response evaluation of foodborne pathogens will be noted.

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#### **EPA'S STRATEGY FOR RESPONDING TO THE NAS EXPERT PANEL COMMENTS ON THE ASSESSMENT OF THE HEALTH EFFECTS OF DIOXIN**

In 2003, the U.S. Environmental Protection Agency (EPA) released a comprehensive reassessment of dioxin exposure and human health effects. A National Academy of Sciences (NAS) expert panel reviewed this reassessment and identified three key areas for improvement: 1) justification of approaches to dose-response modeling for cancer and noncancer endpoints; 2) transparency and clarity in selection of key data sets for analysis; and 3) transparency, thoroughness, and clarity in quantitative uncertainty analysis. EPA will respond to the NAS comments through a Technical Report that considers dose-response analyses for both cancer and noncancer endpoints and provides a quantitative analysis of the uncertainty associated with the dose-response relationships, where feasible. The overall strategy will employ the use of the best available science, continual engagement of both internal and external stakeholders and maximal public transparency. A key step in the development of the Technical Report will be a public Kickoff Meeting to be held in late fall 2008, which will bring together dioxin experts in dose-response and human health effects. The meeting goals include identifying the key studies for dioxin dose-response and confirming the most important science issues to be addressed in the Technical Report. Based on this input, EPA will draft a Technical Workplan which will guide the development of the Technical Report. EPA will solicit external input and peer-review by both an Interagency Work Group (IWG) and an independent external review panel throughout the process of developing the Technical Report.

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#### **THE USE OF BIOMONITORING EQUIVALENTS (BES) IN RISK ASSESSMENT**

A Biomonitoring Equivalent (BEs) is the concentration or range of concentrations of a biomarker of exposure for an environmental chemical consistent with existing exposure guidance values. Guidelines for the derivation and communication of BEs have been developed and employed

to interpret biomonitoring data from a range of specific compounds. Included in these guidelines are specific recommendations and strategies for how to develop BEs for short-lived compounds, such as benzene. In addition, the communication guidelines provide advice for how biomonitoring data for such short-lived compounds should be interpreted in a public health risk assessment context using the BEs and how this interpretation should be communicated to the various interested audiences. These concepts will be discussed and advice provided on how such approaches should be used to interpret human biomonitoring data for benzene.

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#### **THE MIASMA MODEL FOR EXPOSURE TO INDOOR EMISSION SOURCES**

The Mass-Balance Indoor Air Source Modeling Application (MIASMA) has been developed to model exposure to common indoor air emission sources. The model is an Excel-based tool with simple spreadsheet inputs and batch mode run capabilities. The model currently includes the emissions of both criteria pollutants and hazardous air pollutants for 35 different types of emission sources. Six different indoor microenvironments are modeled: residences, offices, schools, hospitals, restaurants/bars, and public access buildings. The emission parameters, building characteristics, and loss parameters are entered as distributions and the model creates probabilistic iterations based on these distributions. In general, these distributions can vary by time of day, time of year, microenvironment, and EPA region. A mass balance module then executes using input from each iteration and estimates the annual average exposure concentration in the building, assuming the air is well mixed. These iterations are finally used to determine percentiles of the concentration predictions. An extensive literature search was carried out to develop input distributions for all the pollutants. In particular, emission sources include building materials, various combustion sources including smoking, cooking, and heating, and electronic equipment including office equipment and air purifiers. The model was then run using 1,000 iterations for each pollutant/microenvironment/region combination. The resulting concentration distributions are evaluated and placed within context by comparison with EPA thresholds and actual measured concentrations where available. These distributions were specifically designed for use in the Hazardous Air Pollution Exposure Model (HAPEM) model, which models personal exposure to ambient concentrations and allows the capability to add an additional concentration for the indoor emissions sources. The MIASMA concentrations can be used in HAPEM or in other modeling applications.

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#### **HANDLING UNCERTAINTIES IN CUMULATIVE RISK CHARACTERIZATION**

Cumulative risk assessment (CRA) adds several multiples (factor combinations) to what would usually be covered by a single chemical or mixture risk assessment. The risk characterization phase must not only clearly present the risk estimates but also address the importance of the multiple uncertainties, and do so in a manner accessible to the regulatory decision makers as well as the stakeholders. Because CRA is defined to include multiple stressors, exposures, effects, and population groups, the characterization has several more levels than single chemical or mixture risk assessments. Uncertainties then include, for example, choice of tissue dose metric, interaction magnitudes, impact of how and how well chemicals were grouped (via exposure and/or toxicity), as well as all the statistical parameter estimates in the models and how each of the multiple factors might vary across population subgroups. The presentation will identify ways to evaluate such uncertainties and describe several cumulative risk characterization tools, such as checklists,



weight-of-evidence categorizations, summary drivers of risk and uncertainty, and statistical graphics. An illustrative uncertainty evaluation will be demonstrated for the cumulative hazard index (CHI) approach applied to chemical mixtures. The CHI, an adaptation of dose addition, is a double sum of hazard quotients (e.g., oral dose divided by the reference dose) across pathways and across chemicals. The quality of the CHI then depends on the validity of the underlying assumption of similarity, both of uptake and of toxicity, and the lack of significant interaction across chemicals or exposure routes. The final CHI description includes the recommended value(s) along with a discussion of quality. This presentation will include several ways to capture uncertainty in presenting CRA results.

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#### **INTERFERENCE OF DISEASE MANAGEMENT BY ENVIRONMENTAL CHEMICALS: THE APPLICATION OF DISEASE-SPECIFIC PARAMETERS TO A PBPK MODEL TO ASSESS SUBPOPULATION SENSITIVITY**

Individuals with specific diseases may demonstrate heightened sensitivity to environmental compounds, due to the disease-mediated molecular milieu and/or the interference of environmental compounds with pharmaceutical drug targets. Prostate cancer (PCa) is a significant clinical challenge in the U.S. For advanced disease, standard therapies are ineffective, leading to high patient morbidity and mortality. Understanding the complex reasons for therapy resistance is critical for improving the life-expectancy for patients. Common somatically derived mutations that arise following the selective pressure of standard PCa treatments facilitate sensitivity to environmental contaminants. Somatic mutation of the androgen receptor allows exogenous agents, for example bisphenol A (BPA), to bind and activate the receptor, thus increasing proliferation and tumor growth despite the presence of the traditional therapy regimen. In an in vivo xenograft model of PCa, low level exposure of BPA was sufficient to reduce the efficacy of treatment. The effect of BPA on PCa therapy for humans is explored as an example of environmental endocrine disruptor exposure reducing the efficacy of disease management. Using current estimates of BPA exposure in the U.S. adult population, physiologically based pharmacokinetic modeling is utilized to determine internal prostate tissue dose. Molecular alterations of the androgen receptor and physiological conditions mimicking PCa therapy are included in the model to establish the exposure necessary to illicit inappropriate BPA-mediated proliferation of prostatic adenocarcinoma cells. These data demonstrate that using disease-specific parameters in a PBPK model may help determine the sensitivity of that select subpopulation to an environmental exposure. This analysis underscores the importance of addressing human variability in receptor-mediated pathways and identifies a potentially susceptible subgroup of the population for human health risk assessment.

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#### **INTERACTION OF BIRTH WEIGHT AND AIR POLLUTION RELATED TO ASTHMA, A DISCORDANT TWIN STUDY**

The objective of this study is to examine the possible interaction effect of birth weight and air pollution on asthma morbidity, and to determine whether big twin having higher birth weight has higher risk of developing asthma in early adulthood. A cohort of 309 pairs of discordant twins born in Taiwan during 1979-1984 is analyzed. Conditional logistic regression is used for the twin-pair analysis, the interaction of birth weight and ozone exposure significantly related to asthma

morbidity after controlling gender and exercise. Using this Taiwanese birth discordant twins cohort, and following adjustment for potential confounding factors, big twin with higher weight has higher risk of developing asthma interacted with ambient ozone exposure than small twin. Furthermore, big twin may have higher sensitivity to air pollution to developing asthma after controlling gender, exercise frequency, genetics, parents' socio-demographic characteristics and household-related risk factors. It indicates that birth weight may partly reflect underlying sensitivity difference to ambient air pollution as important as genetic consideration. The twin-pair comparisons indicate that the interaction effect of birth weight and air pollution may be meaningfully attributable on asthma morbidity in addition to genetic factors.

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#### **BODY MASS INDEX MAY MODIFY THE SHORT-TERM EFFECT OF OZONE ON THE PULMONARY FUNCTION IN YOUNG CHILDREN**

Evidence showed that ozone might have adverse effects on pulmonary function. The objective of this study was to evaluate whether body mass index modified the short-term effect of ambient air pollution on the pulmonary function in young children. The study population was a random sampling of junior high school students in Yunlin County, a relative low traffic and industrial polluted agricultural county in Taiwan. Asthma in this study was confirmed by physicians through parental report (New England core questionnaire) and video questionnaires administered to children (ISAAC video questionnaire). Interviewers also collected information on age, gender, body height, body weight, exercise, drinking, smoking, environmental tobacco smoke (ETS) exposure, burning incense, asthma status, eczema, rhinitis, and parent's education level. The pulmonary function tests followed the 1977 criteria of the American Thoracic Society (ATS) Snowbird Conference, and the ATS update statement of 1987. After controlling variables (including: age, gender, body height, body weight, exercise, drinking, smoking, ETS exposure, burning incense, asthma status, eczema, rhinitis, parent's education level, rain, temperature, and NO<sub>2</sub>), maximum ozone concentration&#65288;dominantly with 1-day and 2-day lags&#65289;related to pulmonary function. Furthermore, there was a significant modification effect of body mass index on ozone exposure related to pulmonary function.

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#### **ESTIMATING PARENTAL WILLINGNESS TO PAY TO REDUCE RISK OF NEUROLOGICAL DAMAGE TO CHILDREN FROM LEAD PAINT: A TEST OF THE ROLE OF INTRA-HOUSEHOLD BARGAINING**

Children's environmental health is a growing policy concern. Empirical estimates of household willingness-to-pay (WTP) to reduce children's environmental health risks have almost exclusively assumed that the household is a black box and it does not matter whether one observes the behavior of or surveys mothers or fathers. Revealed preference studies of health and education programs in developing countries, the U.K. and Canada all provide evidence that bargaining within the household can affect children's health outcomes. Generally, these studies have shown that transfers to mothers are more likely to be invested in children's health and education than transfers to fathers. This paper reports the results of one of the first stated-preference studies to test the importance of these results for valuation of children's benefits from environmental health policy.



The survey is structured to test for differences in mothers' and fathers' attitudes towards environmental health hazards and WTP to reduce children's environmental health risks from lead paint exposure in the home. A sample of 250 two-parent household living in housing built before 1978 with children under age 8 were surveyed in Minneapolis. A split sample conjoint design was used. Half of the parents first responded individually to the survey. The parents then worked through conjoint choice questions together. The other half of the households only answered the choice questions as a couple. The study tests a variety of hypotheses that shed light on the relative influence of different parents' preferences on family decisions. In particular, the study tests for systematic differences in men's and women's influence on household decisions about protecting children's health. This study helps inform future stated preference research, and provides a new means for researchers to investigate how family structure influences the translation of individuals' risk attitudes into household risk mitigation actions.

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#### **HIV RISK COMMUNICATION IN A CULTURALLY DIVERSE ENVIRONMENT IN MEXICO**

The State of Oaxaca is a predominantly rural, culturally diverse and multilingual and is located in Southern Mexico. This state is primarily agrarian and is known for its hand-made pottery and apparel industry. Oaxaca has a low literacy rate reflective of the low education level as compared to other states within Mexico. Over the past few years there appears to be an increasing incidence of HIV infection, which is predominantly transmitted heterosexually. We have been able to trace the influx of this epidemic to migrant workers. In a series of interviews, we have found that HIV was contracted by workers who migrated to the US, contracted the disease in the US and brought it back to Mexico. The disease was transmitted to their wives and ultimately to their babies. We describe here a 4-component plan to communicate risk to Oaxacans, and thus stem the influx and dissemination of disease. The first phase of this plan, to identify the source of the infection, is now complete. The second phase, to elicit cooperation and support of local and state health agencies is now underway with positive feedback to date. The third phase is to develop a communication strategy, coupled with appropriate training tools. We report a general strategy to accomplish this task. This phase is complicated by the multilingual nature of the cohort and the lack of local financial resources to support the effort. It is our strategy to make this communication effort community clinic-based to reach as many migrant workers and families as possible before they enter the US or when they return. Components of this strategy will be distribution of graphic (in contrast to textual) literature on HIV cause and protection. Finally, we will conduct post audits to evaluate our success and to improve the effort.

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#### **INHALATION CANCER RISK FROM AIRBORNE POLYCYCLIC AROMATIC HYDROCARBONS MEASURED IN THE ERIE, PA REGION**

The purpose of this study was to estimate the excess cancer risk from inhalation exposure to polycyclic aromatic hydrocarbons (PAHs). The concentration of 18 separate PAH particulate and vapor-phase species were collected and measured at three separate sites within the Erie, Pennsylvania area during a one-year period. The toxic equivalency (TEQ) approach was then used to normalize the cancer potency of 15 of the 18 measured PAH species relative to benzo(a)pyrene. Toxicity equivalency factors (TEFs) available in the literature were multiplied by the correspon-

ding 95% upper confidence level (UCL) of the mean concentration for each PAH species. The appropriate population assumptions were then utilized to determine the lifetime average daily intake for both adult and child populations. Intake values for each population were then multiplied by the cancer slope factor for benzo(a)pyrene. The point values for cancer risk from inhalation exposure to PAHs using a deterministic approach were  $1.5 \times 10^{-6}$  and  $4.2 \times 10^{-6}$  for adults and children populations, respectively. The next step in this effort is to run a probabilistic model using Monte Carlo analysis.

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#### **SURFACE SAMPLING AREAS REQUIRED TO INFORM RISK-BASED RESPONSES TO B. ANTHRACIS CONTAMINATION**

In many cases human health risk from biological agents is associated with aerosol exposures. Concentrations found on surfaces may be used to infer future or past aerosol exposures. When concentrations exceed decision threshold values, they would trigger response actions, such as remediation (to avoid future risks) or prophylactic antibiotics (to mitigate risks of past exposure). In this project, analytical equations are developed to relate the risk from aerosol exposure to the concentrations of spores on surfaces. This allows for the determination of decision threshold concentrations for surface samples, if the overall level of acceptable risk is specified. However, biological agents present risks at extremely low concentrations, which means that a non-detect result may not guarantee that the agent is present at a concentration below the decision threshold value. To address this concern, estimates of sampling areas required to demonstrate compliance with surface concentration standards are developed. It is assumed that microbial occurrence follows a Poisson distribution. This allows the principles of classical statistical inference to be used to estimate surface sampling areas that would allow for classification of a site as below the decision threshold at specified levels of confidence given non-detectable results. This method is then extended to consider non-zero method detection limits. The calculated sampling areas are large but may not be totally infeasible.

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#### **RISK ASSESSMENT AND THE TERRORIST: CURRENT AND FUTURE DIRECTIONS FOR RESEARCH**

Given the scale of challenges posed by the threat of terrorism and the perpetually limited resources available to counter terrorism, there is at least widespread agreement on the urgent need to find ways to prioritize and synchronize the use of those resources. With this in mind, the creation of empirically valid risk assessment models for aspects of terrorist behavior is likely to be a useful enterprise. To date, however, there has been little systematic study of the specific relationship between risk and the terrorist. This has been evident in a variety of settings, ranging from prison to operational contexts. Consequently, there is both a lack of knowledge about the basic underlying issues and a lack of clear guidelines to help guide practice in the management of terrorist behavior as well as the mitigation of accompanying threats. This paper explores and discusses a series of issues related to the current and future research on the development of risk assessment procedures. In particular, a case is made for the greater consideration for the role of psychology in the development of risk assessment tools that may prove useful tool in enabling prioritization in a number of critical operational areas.

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**LEARNING ABOUT, AND MAKING SENSE OF, NUCLEAR FUSION AS AN ENERGY TECHNOLOGY: THE ROLES OF MATERIALITY, SOCIALITY, DIFFERENT KINDS OF KNOWLEDGE, AND PRACTICAL REASONING**

This paper sets the scene for the symposium, by addressing a number of themes that will be addressed in the following presentations. It does so by drawing upon comparative UK/Spanish work on lay understanding of nuclear fusion. Levels of awareness and knowledge about fusion among the lay public are very low. In order to investigate how people make sense of fusion, and their views on fusion as a potential energy source, a hybrid social research/problem structuring/citizen engagement methodology has been adopted, allowing a range of lay respondents to participate in a sensitisation, learning and deliberative process. Importantly, the method has concentrated on the use of ordinary language, and the elicitation of patterns of demotic practical reasoning using multiple forms of knowledge, rather than pre-framing the issues exclusively in terms of technical categories. In this way, groups of citizens have engaged in discussion and deliberation about issues concerning fusion in quasi-naturalistic ways. The paper will present research findings to date concerning lay interrogation of knowledge about fusion; the relationship between levels of knowledge and modes of reasoning; and the ways in which the entwining of the social and material characters of the technology shapes the ways in which sense-making is practically accomplished.

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**CLIMATE CHANGE AND INSURANCE: (IN)COHERENCE IN FINANCING ADAPTATION UNDER CONDITIONS OF AMBIGUITY**

Climate change presents unique insurance challenges due to ambiguity in the underlying catastrophe-risk models compounded by the global reach and variety of insured risks climate change can directly and indirectly affect. Where, only twenty years ago, insurers and reinsurers wondered about the insurability of multiple catastrophes imposing \$4 billion in losses, today the industry openly wonders about the insurability of a \$1 trillion series of events. There has been a wide range of insurance-industry responses. In high-risk areas such as Florida, many insurers have increased their underwriting discipline, effectively withdrawing from climate-related risks either by refusing to write/renew policies or by using deductibles and other risk-sharing features to increase insureds' retention of climate-related losses. On the other hand, the reinsurance and equity markets recently created the first-ever regional catastrophe insurance pool in the Caribbean — one of the highest climate-risk regions — using financial innovations such as international “catastrophe swaps.” There is also a range of governmental responses. Florida is now one of 17 states operating its own insurance/reinsurance weather-related risk pool, often at such subsidized rates that the state's chief financial officer openly says she has her fingers crossed against a monster storm. Congress recently rejected a proposal for a National Catastrophe Fund. Throughout all of this, one wonders about the underlying moral hazard of both private/public insurance actually in increasing future losses. This paper explores the possibility of policy coherence among the various insurance-related approaches, both market- and government-based.

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**ASSESSMENT OF HEALTH RISK TO TAIWANESE CONSUMERS FROM CANADIAN BEEF**

Objectives: Canada is a bovine spongiform encephalopathy (BSE) infected country. In consideration of lifting the ban of their beef to be imported to Taiwan, the risk of new variant Creutzfeldt-Jakob disease (vCJD) due to consumption of Canadian beef was assessed for food safety purposes. The beef in question was specified as boneless meat from animals under 30 months of age. The results of the assessment were aimed at helping regulatory agencies in their decision making and at clarifying the doubts of common consumers. Methods: A combined toxicological and microbiological risk assessment method was developed to calculate the rate of accumulation of BSE infectivity in the number of human oral 50% infective dose (hoID50) units toward the 2 hoID50 units that is required for the clinical signs of vCJD to appear. This rate was determined for the 15-year old, high beef consuming group, who would be the most sensitive group of Taiwan consumers. Results: The vCJD infectivity accumulated through continuous daily consumption of Canadian beef in this high risk group in 70 years, under worst case assumptions, was 0.000987 hoID50 units, which is over 2000 times lower than the 2 hoID50 units required for the disease to appear. The disease would appear at the age of over 180 years. Conclusions: Our assessment results indicate that the risk of vCJD due to consumption of Canadian beef as specified, even under some worst case assumptions, would be negligibly small. It should be noted that this extremely low level of risk can only be enjoyed when risk management was properly done through strict enforcement of beef importation specifications.

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**BENEFIT-COST ANALYSIS TO DEVELOP TARGETS FOR AMBIENT AIR SAMPLING**

There are current efforts to monitor ambient air for biological agents of concern. This study proposed a framework to address the questions of 1) at what level of risk would response be justified based on benefit-cost considerations, 2) what environmental concentrations would have to be detected to identify the target risk level. In the first part of the framework, a decision model is developed to assess the costs and benefits of prophylactic antibiotic treatment for *Y. pestis* as a function of the risk of illness. A sensitivity analysis is then conducted to identify a threshold level of risk at which medical treatment of exposed individuals is justified. Risk levels of  $5 \times 10^{-5}$  are estimated to be sufficient to justify treatment of exposed individuals. A dose-response function for rodents, based on intra-peritoneal exposure is developed to map these risk levels to delivered doses to individuals. Estimates are that an average dose of 4 organisms is sufficient to trigger medical treatment for an exposed population. A range of human breathing rates are used to estimate the air phase concentrations corresponding to this dose over an 8-hour exposure period. Adjustments to this value to reflect removal in the upper respiratory track may be appropriate. Corresponding air phase concentrations for smallpox are two orders of magnitude lower than for *Y. pestis*, while those for *B. anthracis* are an order of magnitude higher, possibly because the dose-response model is fit to primates exposed by the inhalation route. These air phase concentrations represent idealized goals for the sensitivity of detector systems. By linking environmental concentrations to goals for detection, this paper provides a framework for assessing the sensitivity of novel sensing systems and which can also inform the interpretation of negative results from such systems.

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#### **OPTIMAL DESIGN OF QUALITATIVE RISK MATRICES TO CLASSIFY QUANTITATIVE RISKS**

A risk matrix presents the risk associated with paired categories of risk components, such as frequencies and severities of outcomes. As such it discretely approximates a quantitative risk calculation. Relative to a given decision threshold (often interpreted as “acceptable risk” or “risk appetite”), how well can a risk matrix classify risks? It is known that risk matrices are inherently ambiguous, have limited ability to rank quantitative risks correctly, and can result in worse-than-random decisions. Despite these limitations, risk matrices are frequently used for convenience and simplicity. Optimizing their performance can help to limit the harm from using them. This paper shows how to construct optimized risk matrices with respect to either of two criteria: the expected number of misclassification errors or the maximum possible size of misclassification errors. The method has a simple and practical geometric interpretation. The solutions reveal a close connection between minimizing expected number of errors (when risky prospects have a joint uniform distribution of the risk components) and minimizing the maximum possible size of errors for misclassified prospects. It turns out that the same risk matrices can solve both types of optimization problem (for different thresholds, though). In the common case of 5 x 5 risk matrices often used in practice, the optimal designs differ from typical naive designs and can have less than 1/7 their error rate.

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#### **DOD’S EMERGING CONTAMINANTS RESPONSE TO PERCHLORATE, HEXA-VALENT CHROMIUM AND NAPHTHALENE**

Emerging contaminants (ECs) are of interest to the Department of Defense (DOD) in the context of their potential to impact public health, occupational health, the environment, and/or national security. The potential impacts to DOD functions due to changing regulatory status of each, perchlorate, hexavalent chromium (CrVI) and naphthalene, were assessed by the Emerging Contaminants Directorate. The results indicated the potential for significant mission impacts and the Directorate is organizing integrated risk management responses. With regard to naphthalene; two Army Small Business Innovative Research Projects are underway that will apply new sensor technologies to the development of a naphthalene dosimeter. The goal is to generate data that will inform new occupational health protections and fill data gaps in the naphthalene human health risk assessment. Additionally, the Air Force is conducting formulation research aimed at understanding the amount of naphthalene in fuels and identifying opportunities for reducing naphthalene exposures from fuel-related emissions. With regard to perchlorate; environmental sampling continues and response actions are underway or completed. In California for example, 924 sites have been reviewed and prioritized. Also, perchlorate has been replaced by black powder in simulators that account for approximately 70% of perchlorate annually used in Army training contexts and DOD continues to invest in perchlorate treatment and substitution R&D. With regard to CrVI; current risk management investments include implementation of new environmental management systems to track regulatory compliance and investments in testing and evaluating alternatives to CrVI. Future risk management investments are being formulated.

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#### **THE IDENTIFICATION OF RISK FACTOR IN INTAKE OF THE CHILDREN FAVORITE FOODS**

To investigate correlation between intake of favorite foods classified as the guideline given by KFDA and obesity of children, we searched with questionnaire for intake frequency on the children and analyzed the Korea National Health and Nutrition Examination Survey (KNHNES) DB for favorite foods intake. And then, correlation was evaluated between obtained data and BMI of school children, respectively. After convenience sampling from school children in elementary, middle and high schools residing in Seoul and GyeongGi-Do, the subjects of this investigation were 1,634 students. All data with questionnaire were analyzed using the General Linear Model SAS 9.0 program. Favorite foods intake of the subjects through results from DB was converted to calorie and relation was confirmed with factor analysis and curve estimation. Linear regression analysis was used to verify relation between BMI and intake. Intake frequency of dried marine products (dried filefish, etc.) and fast foods (pizza, hamburgers, etc.) for elementary school students, ice cream for middle school students and confectionery (cookies, bread, chocolate, etc.), fast foods and other foods (cereals, etc.) for high school students affected BMI ( $p < 0.05$ ). Results of the KNHNES showed that intake of confectionery, fast foods and instant foods for elementary school students, drinks for middle school students and fast foods for high school students affected BMI ( $p < 0.05$ ). In conclusion, this study showed that intake and frequency of fast foods contributed to BMI increase on all school children ( $p < 0.05$ ), BMI increased as drinks intake on middle school students ( $p < 0.05$ ) and confectionery intake affected BMI on elementary school students ( $p < 0.05$ ).

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#### **LISTERIA SAMPLING PLANS - CONSIDERATIONS AND SELECTION**

Listeria monocytogenes has been implicated in foodborne listeriosis associated with the consumption of ready-to-eat meat and poultry products, seafood, vegetables, and dairy products. Food products may be contaminated with L. monocytogenes due to inadequate processing and improper handling of the product during manufacturing, distribution, and storage. Product sampling for the presence of L. monocytogenes is one measure that may ensure that no product contains an infectious dose of L. monocytogenes before being consumed. The effectiveness of product sampling in reducing L. monocytogenes contamination in a food product depends greatly on the sampling plan. The International Commission on Microbiological Specifications for Foods (ICMSF) has recommended Listeria sampling plans for various food products. A recommended sampling plan for a food product is based on two factors. One factor is the degree of hazard of listeriosis of the product for its intended consumers, and the other is the possible changes of degree of the hazard under conditions that the product is expected to be handled and consumed. Once the degree of the listeriosis hazard is determined, a Listeria sampling plan, number of samples, sample size, and criteria for determining acceptance or rejection of a food production lot, can be chosen. This presentation will summarize the considerations and guidelines for selecting Listeria sampling plans recommended by the ICMSF and regulatory agencies.

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#### **USING AUTOMATED TOOLS TO ANALYZE EXTERNALIZED MENTAL MODELS OF RISK AND DECISION-MAKING**

One essential question concerning the assessment and analysis of decision-making is which methodology and tools can be used. Many authors consider concept maps to be an adequate format of externalization for analyzing complex knowledge structures. Concept maps seem to be preferable to classical knowledge tests such as multiple choice tests for the purpose of representing linked knowledge by means of network-like visualization. On the other hand, there are strong arguments that natural language representations are a good basis for assessing knowledge, decision-making, and mental models. When we think about assessment, we often think of externalization. Sometimes we ignore the fact, that externalization itself influences the learning outcome and decision-making, while there is a high demand for assessment that contributes to the learning at the same time. Several new assessment methodologies have been developed with the aim to gain knowledge about what the learner does now rather than finding out, what he or she doesn't know - which is often the case in classical testing. We will discuss three different mental model elicitation and analysis techniques including MITOCAR and SMD. Whereas classical methodologies are used to let the learner conceptualize their knowledge graphically, natural language oriented methodologies like MITOCAR use multiple phases from statements over multiple instruments to represent the graph. The newly developed T-MITOCAR toolset aims at converting prose text to a graph directly. SMD automatically generates numerical indicators and standardized graphical representations of externalized mental models to more precisely describe decision-making processes. In our presentation we will focus on mental models and knowledge structures and discuss the dilemma of knowledge representations and decision-making processes. We then present a brief overview of the characteristics of MITOCAR and SMD and conclude with findings from various research studies.

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#### **DISASTER RISK GOVERNANCE: LIGHTS AND SHADOWS OF DISASTER RISK COMMUNICATION**

Rapid progress of urban agglomeration with collapse of traditional communities and aging population, has made the Japanese communities extremely vulnerable to the emerging risks of "low probability but high consequences". We need to renovate approaches of disaster risk management where residents, communities, administrative agencies, and other related organizations used to act independently without adequate interaction toward the integrity of disaster prevention policies. Here appears a concept of "disaster risk governance" which is defined as a participatory and interactive management approach to disaster risks. It calls for enhancement of collaborative efforts among stakeholders in terms of self-support and mutual-assistance, primarily through informal or social networking efforts, rather than depending on the formal or institutional governmental-assistance. Clearly the concept of disaster governance differs from paternalistic reliance on regulatory bodies in terms of preventive or recovery measures for coping with disasters. Hence, such collaborative interactions imply that "disaster risk communication" has to put more emphasis on informal and/or horizontal networking ways, rather than the formal and/or vertical ways of stakeholders-participation. Three requirements for implementing "risk governance" will be discussed based on the lessons learned from our implementation experiments in Japan. Those are: i) sharing risk information such as expert-knowledge, local or folk wisdom and experiential knowl-

edge in multi-disciplinary perspective, ii) customizing "risk communication" with provision of tools or platforms for stakeholders not only to improve analytic deliberation of the risk information but also to facilitate informed choice of acceptable levels of disaster risks, iii) creating an informal setup of collaboration by enhancing social networking primarily based on the non-regulatory and/or non-market incentives.

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#### **EFFECTS OF THE DISPLAY OF EVACUATION CONDITION IN A LOCAL AREA ON DECISIONS TO EVACUATE**

We focused on the information system that facilitates the evacuations of residents in a flood. In particular, this study examined empirically if the presentation of probabilities of evacuees in the surrounding helps the residents decide to evacuate. For this purpose, we used a virtual disaster information interface that made by resembling the current system in Japan. In the experiment, participants were asked to be residents in the hypothetical area near a river. They judged the refuge from their house on the basis of the disaster information on the monitor. Three types of information were presented on a monitor. Two of them, that are currently served, were evacuation instructions and data of the natural conditions including the radar rainfall data and a river level. The other was the probability of evacuated residents in a local area that we added in this study. After each trial started, the river level and the evacuation probability were gradually elevated. Appearance of the evacuation instructions depended on the river level. Participants were required to press "Evacuate" or "Stay" button. The elevation of measurements such as the river level continued until the "Evacuate" button was pressed. We compared the number of pushes of that "Evacuate" button. The number of the presses of the "Evacuate" button was greater when the evacuation probability reached the highest or the moderately high level than under the condition that evacuation probability was not provided or low. This finding allows us to speculate the facilitating effect of the display of the evacuation condition on decisions to evacuate. However, many participants who decided to escape did not acknowledge the use of the neighborhood evacuation probability. We will discuss about such problem and also report the results in an additional experiment.

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#### **ON THE EVALUATION OF CHEMICAL FATE AND TRANSPORT MODELS**

The utility of a calibrated chemical fate and transport model is generally judged by the ability of model predictions to replicate observed trends in one or more validation datasets. Ideally, this "validation" should serve strictly as a post audit of the calibration, i.e., there should be no feedback or recalibration necessary to make model predictions consistent with validation data. Proper model evaluation must not, however, be limited to such validation, even in the case of favorable model-data agreement. Validation datasets usually lack the spatial and/or temporal resolution to verify model accuracy over the entire model domain and over the full range of possible environmental conditions. As such, the model may appear to be correct for the wrong reasons, e.g., if validation conditions and metrics are not sufficiently challenging to expose model shortcomings, or if the validation period is too short to expose temporal drift in model accuracy. Rather, model evaluation requires a holistic approach which also considers the appropriateness and constrainedness of each component of the model. The evaluation process needs to go beyond "Does the model do a good job?" to consider "Can the model do a good job?". In this talk, we explore examples of chemical fate and transport model applications that highlight the value of each mode of evaluation.



**T2-C.2** Isukapalli SS, Sasso AF, Georgopoulos PG, Krishnan K; sastry@risk.rutgers.edu  
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### **A NOVEL INTERACTION-BASED ALGORITHM FOR PREDICTING BIOLOGICAL DOSES DURING CHRONIC EXPOSURES TO CHEMICAL MIXTURES**

A physiologically-based algorithm was developed for predicting the steady-state internal doses of inhaled volatile organic chemicals (VOCs) resulting from chronic exposures to mixtures of VOCs. This algorithm takes into account metabolic interactions of chemicals in mixtures, and was developed as a simplification of the full Physiologically Based Toxicokinetic (PBTk) model by utilizing a set of equations constituting pulmonary uptake and metabolic clearance, including the consideration of dose-dependent change in the free concentration of chemicals at the metabolizing site (liver), and competitive inhibition. The resulting algorithm, based on critical determinants of the internal dose during chronic exposure to VOCs (i.e., alveolar ventilation rate, blood flow rate to liver, blood:air partition coefficient, maximal velocity of metabolism, Michaelis affinity constant, inhibition constants, and free concentration of chemical at the metabolizing site) provides predictions of dose metrics (e.g., arterial blood concentration and rate of amount metabolized) identical to those of the corresponding whole-body PBTk models. This algorithm is dose-independent, and facilitates the rapid, direct computation of steady-state internal doses for a variety of exposure concentrations and mixture constitution by accounting for the non-linear processes. In data-poor situations, when the statistical distributions for all input parameters in mixture models are not known or available, the application of the steady-state algorithm allows rapid assessment of the impact of interactions. Demonstration case studies are presented for mixtures of different complexities involving benzene, toluene, xylene, etc., covering binary, tertiary, quaternary, and a complex 12 chemical mixture.

**P.104** Jardine CG, Given LM, Driedger SM, Routledge M, Ritcey C, McMillan A; cindy.jardine@ualberta.ca  
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### **SYSTEMATIC REVIEW OF THE LITERATURE ON COMMUNICATING UNCERTAINTY ASSOCIATED WITH ENVIRONMENTAL HEALTH RISKS**

The assessment of hazards and the associated risks posed to human health are based on varying levels of direct evidence and therefore reflect varying levels of certainty. These different levels of scientific certainty present distinct challenges in communicating about these risks. There is obviously both a pressing need - and agency responsibility - for comprehensive and transparent communication about well-known and immediate risks. However, appropriate policies for the communication of uncertain risks are not as clear. While a few systematic reviews have been done on very specific aspects of risk communication, there has been no attempt to date to systematically review and integrate the findings of the numerous studies and reports pertaining to the communication of uncertainty related to environmental health risks. The specific objectives of this research project in progress are to provide evidence-informed recommendations (and identify any gaps in knowledge) on: (a) how uncertainty in environmental health risks can be best understood from the perspectives of multiple stakeholders, with a specific focus on the general public; (b) how to best engage the public in a dialogue about risks with associated uncertainty in exposure, effects and/or magnitude of health consequences; (c) the best methods and channels for communicating uncertainty in environmental health risks; and (4) the optimum timing of communicating uncertainty in environmental health risks. In addition, this research seeks to develop and test a protocol for assessing qualitative evidence in systematic reviews based on this specific topic area. Both

peer-reviewed and grey literature are being reviewed. This poster presents the results to date and some of the challenges encountered in doing a systematic review on a broadly defined and complex subject area that is based on different types of evidence.

**M3-E.3** Jaykus L, Anderson M, Beaulieu S, Dennis S; amokhtari@rti.org  
RTI International

### **FOOD SAFETY RISKS ALONG THE FARM-TO-FORK CONTINUUM: DATA DEVELOPMENT AND PRIORITIZATION OF PATHOGEN-COMMODITY PAIRS OF CONCERN**

The epidemiological significance of fresh produce as a vehicle for human foodborne illness is undisputed. However, the application of quantitative risk assessment models to each of these potential pathogen-commodity pairs is impractical given the sheer number of combinations and current data limitations. Thus, FDA needs a simple, reliable, and transparent model to compare the relative risks of pathogen-commodity pairs. To address this need, we developed a comprehensive relational database that consolidates an enormous amount of data on pathogens and produce commodities. The information collected for database population includes epidemiological associations with foodborne disease, produce and pathogen characteristics impacting exposure, severity of disease, consumption and production patterns for various commodities, and other characteristics of the farm-to-fork supply chain that are relevant to contamination, exposure, and subsequent disease. Data sources included the scientific literature, grey literature, CDC reports, expert opinion, and other sources. The database was specifically designed to retain information on plant taxa (e.g., spinach, lettuce, cabbage), allowing for aggregation under general produce categories (e.g., leafy vegetables). The database includes a "built-in" risk ranking tool that supports the identification and ranking of priority pathogen-commodity pairs. The risk-ranking tool accepts user preferences on a wide range of risk factors, including the burden of disease, likelihood of pathogen contamination and growth, severity of effect, production and/or consumption volume, and other factors. The flexible database design supports the prioritization and ranking of pathogen-commodity pairs, as well as a quantitative risk assessment model developed specifically to characterize the risks of foodborne illness due to the consumption of fresh produce.

**T4-I.1** John RS, Rosoff H; richardj@usc.edu  
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### **ESTIMATING THE EFFECTS OF COUNTER-TERRORISM ON TERRORIST THREAT**

This presentation describes a general methodology for estimating the relative likelihood of various terrorist events and results obtained from an application of this methodology. The central focus of this methodology is a model of terrorist objectives and values using a proxy multi-attribute utility model. We describe an application that includes an extensive literature review as well as interviews with four separate surrogate terrorist intelligence analysts. Results suggest that terrorist preferences for attack mode are sensitive to certain counter-terrorism strategies and insensitive to others. Extensive interviews were conducted with four separate surrogate terrorist intelligence analysts to elicit information about terrorist beliefs, uncertainties, value trade-offs, and attitude towards risk. The results of these interviews are four separate multi-attribute models of alternative attack modes for an identified terrorist organization. Monte Carlo simulation methods are used to obtain a risk profile for each attack mode, spanning a broad range of plausible attack modes. These risk profiles reflect uncertainties for both the surrogate analyst and the terrorist leader, but ultimately capture the total uncertainty regarding the desirability of alternative terror

attack modes. A method is described for computing relative terrorist choice probabilities from the utility distributions for each terrorist attack mode, based on logic analogous to that used in constructing a random utility model (RUM). Further insight is gained by partitioning the total uncertainty about the attractiveness of each attack mode into uncertainties about impacts, trade-offs, risk attitudes, and likelihood of attack success.

**M3-H.2** Johns DO, Brown JS; johns.doug@epa.gov  
US Environmental Protection Agency, National Center for Environmental Assessment  
**AN ANALYSIS OF SULFUR DIOXIDE-INDUCED RESPIRATORY HEALTH EFFECTS OBSERVED IN CONTROLLED HUMAN EXPOSURE STUDIES**

Sulfur dioxide (SO<sub>2</sub>) has been established as the indicator for the national ambient air quality standards for gaseous sulfur oxides, which is one of six criteria air pollutants regulated under the Clean Air Act. In assessing the health effects associated with exposure to a given criteria pollutant, the U.S. EPA conducts an extensive evaluation of all published scientific literature from both human and animal studies. Results of controlled human exposures are critical in establishing a causal link between exposure to an air pollutant and human health effects. There is an impressive body of literature on controlled exposures to SO<sub>2</sub>, with the majority of effects observed among asthmatics following brief exposures during exercise. Based on recent recommendations from the American Thoracic Society on the differentiation between adverse and nonadverse health effects of air pollution, an analysis of SO<sub>2</sub>-induced respiratory health effects from both new and old controlled human exposure studies has been undertaken. The results of this analysis have demonstrated consistent moderate to large decrements in lung function following 5-10 minute exposures to concentrations of 0.4-0.6 ppm, with some sensitive asthmatics experiencing similar decrements at SO<sub>2</sub> concentrations as low as 0.2-0.3 ppm. These decrements in lung function are frequently accompanied by mild to severe respiratory symptoms. At concentrations between 0.2 and 1.0 ppm, a concentration-response relationship has been observed, both in terms of severity of effect and percentage of asthmatics affected. These findings provide conclusive evidence of SO<sub>2</sub>-induced respiratory effects among asthmatics following brief exposure, and support the significant association observed between ambient SO<sub>2</sub> exposure and respiratory effects in epidemiological studies. Disclaimer: The views expressed are those of the authors and do not necessarily reflect the views of the U.S. EPA.

**P.51** Johnson BB; brandenjohnson@msn.com  
Rutgers University  
**TRUST AND TERRORISM: CITIZEN RESPONSES TO ANTI-TERRORISM HISTORY**

Trust of citizens in anti-terrorism agencies is vital to their success. An experiment revealed that police action against a potential terrorist was more trustworthy if it was deemed risk-tolerant (i.e., police shot even if innocents might be harmed), particularly by citizens who rated high in right-wing authoritarianism. Correct actions (Hits—true threat identified; All Clears—lack of threat identified) were more trustworthy than incorrect ones (Misses and False Alarms). The current study examined response to two sequential hypothetical incidents, in which the Department of Homeland Security was either risk-tolerant or risk-averse, and the outcome was either correct or incorrect (for one or both incidents, varying order). This paper reports effects on trust of this manipulation, factors in the Intuitive Detection Theorist and Salient Value Similarity models of trust, likelihood and personal risk of terrorism, benefits of terrorism policy, prior trust in DHS, and political ideology and partisanship.

**W4-A.1** Johnson BB, Vercellotti T, Bunzl M; brandenjohnson@msn.com  
Rutgers University, Western New England College  
**HOUSEHOLD ENERGY BEHAVIOR CHANGE AND CONSUMERS' CONSIDERATIONS**

Several behavior change theories (e.g., Precaution Adoption Process Model, Theory of Planned Behavior, Value-Beliefs-Norms Model) suggest perceived good and bad consequences of proposed behaviors influence people's intentions to change. We examine the role of these considerations and tradeoffs in household-level energy conservation and renewable energy behaviors.

**T2-F.4** Johnson MS, Quinn MJ, Wickwire WT; Mark.Johnson@AMEDD.ARMY.MIL  
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**IMPROVING RISK PREDICTIONS THROUGH THE INTEGRATION OF SPATIAL HETEROGENEITY AND HABITAT SUITABILITY: AN APPLICATION OF THE SPATIALLY-EXPLICIT EXPOSURE MODEL (SEEM)**

Interactions of biological entities within the environment occur on spatial and temporal scales. Likewise, the spatial and temporal distributions of contamination within the environment affect the degree to which plants, animals, and humans are exposed and how they respond. These interactions can be complex, however, through the recent advances in geographical information systems (GIS) and other models that integrate spatial considerations, estimates of risk can be more accurately described. Moreover, presentation of contaminated sites on spatial scales allow for a clearer understanding of the problem. The present study describes how a simple three-part delineation of soil lead (Pb) concentrations and three part habitat delineation can provide more accurate risk predictions. Risk predictions were verified through a comparison with blood Pb data from songbirds collected from two test sites and compared with a blood Pb toxicity reference value. Both spatial risk predictions and those derived using simple deterministic approaches were compared and evaluated. Positive and negative aspects of each will be described.

**M3-B.8** Jovanovic AS, Salvi O; jovanovic@eu-vri.eu  
EU-VRI, European Institute for Integrated Risk Management  
**ASSESSING TECHNICAL AND OTHER HAZARDS IN NEW TECHNOLOGIES: DEVELOPING COMMON METRICS IN THE EU**

Recent efforts of organizations and bodies like OECD, API, IAEA, HSE and/or other organizations have recently brought new ideas in the area of establishing metrics for technical hazards and risks. The metrics is largely based on the concept of key and/or safety performance indicators (KPIs/SPIs). A review of these efforts and the directions in which new projects and activities should go is provided in the paper. In particular, the paper will concentrate and report of what is done in the following projects and activities: a. The newly approved (20 million € budgeted) FP7 project iNTeg-Risk "Early Recognition, Monitoring, and Integrated Management of Emerging, New Technology related Risks" has KPIs as one of the cornerstones of the work of establishing the consolidated EU response to the risks related to the development, introduction and use of new technologies; based on the 17 well-defined practical applications a common concept (framework) will be developed and tested by a consortium of over 80 leading European partners; KPIs will play a pivoting role in this process; b. Development of a fast growing data and information base (in Sept. 2008, containing over 500 KPIs, out of over 20 sources, and over 100 different documents devoted specifically to KPIs/SPIs), including the options to compare and hierarchically organize KPIs/; c. Current results and future plans of the activities related to the European (CEN) and national (DIN) standardization aspects of KPIs/SPIs – e.g. inclusion of KPIs/SPIs into the new

standardization documents (e.g. already included into CEN 15740); CEN/ETPIS survey on the use of KPIs in the European industry (results of Sept. 2008); d. Inclusion of the KPIs/SPIs related issues into the respective, risk/safety related academic (University of Stuttgart) and professional education (Steinbeis). The above activities are expected to significantly improve the situation in terms internationally recognized and accepted references and de facto standards.

**M4-C.3** Judson R, Dix D, Houck K, Martin M, Kavlock R, Shah I, Knudsen T; judson.richard@epa.gov

US Environmental Protection Agency/ORD/NCCT

#### **PREDICTIVE MODELING OF APICAL TOXICITY ENDPOINTS USING DATA FROM THE EPA TOXCAST PROGRAM**

The US EPA and other regulatory agencies face a daunting challenge of evaluating potential toxicity for tens of thousands of environmental chemicals about which little is currently known. The EPA's ToxCast program is testing a novel approach to this problem by screening compounds using a variety of in vitro assays and using the results to prioritize chemicals for further, more detailed testing. Phase I of ToxCast is testing 320 chemicals (mainly pesticide active ingredients) against ~400 cell-based and biochemical assays. In order to anchor these studies, we are using in vivo guideline study data for subchronic, chronic, cancer, reproductive and developmental endpoints. This data is compiled in the EPA toxicity reference database, ToxRefDB. The main goal of ToxCast is the discovery and validation of "signatures" linking in vitro assay data to in vivo toxicity endpoints. These signatures will be collections of assays that are correlated with particular endpoints. These assay collections should also help define molecular-and cellular-level mechanisms of toxicity. This talk will discuss our strategy to use a combination of statistical and machine learning methods, coupled with biochemical network or systems biology approaches. Our initial examples will focus signatures for endpoints from 2 year rodent cancer bioassays. Most of the data we have analyzed is in dose or concentration response series, so to effectively use this data we have developed novel approaches to combine many kinds of dose-response data together with standard machine learning methods. A key issue to be discussed is the validation of ToxCast predictive signatures, an issue involving statistics, as well as data coverage in both biological and chemical space. This work has been reviewed by EPA and approved for presentation but does not necessarily reflect official Agency policy

**T2-D.1** Kahan DM; dan.kahan@yale.edu  
Yale Law School

#### **THE CULTURAL COGNITION OF RISK: MECHANISMS**

The cultural cognition of risk refers to the tendency of individuals to conform their factual beliefs about putatively dangerous activities to their cultural evaluations of those activities. Recent research has focused on identifying the discrete psychological mechanisms that connect cultural values to risk perception and on exploring their relationship to one another. This presentation will describe this research and present original empirical findings.

**P.21** Kajihara H, Takai A, Yoshikado H; kajihara.hideo@aist.go.jp  
National Institute of Advanced Industrial Science and Technology (AIST), Saitama University  
**INVERSE ANALYSIS OF EMISSION SOURCE AROUND HIGH-CONCENTRATION MONITORING POINTS BY USING METI-LIS MODEL**

In order to take prompt and appropriate countermeasures toward an environmental risk, the inverse analysis method that clarify the cause (ex. emission source) by using result (ex. concentration data) is needed. In Japan, a large amount of measured concentration data is available for

hazardous air pollutants; this data is mostly used for environmental surveillance, and rarely for emission source analysis. In this report, an inverse analysis method that provides the most probable location of an emission source and the emission amount corresponding to a time-series of measured concentration data is proposed. The METI-LIS (Ministry of Economy, Trade and Industry - Low rise Industrial Source dispersion) model, which has been developed by our group and METI, was used for performing dispersion calculations at hypothetical source locations. Correlation coefficients between the measured and calculated concentration data were plotted at the corresponding hypothetical source locations, and a contour map of the correlation coefficients was obtained. Sakai area in Kinki district, where high concentrations of ambient acrylonitrile have often been observed, was selected for the verification of the proposed method. By using the method with acrylonitrile concentrations measured at a fixed station in the area during 2000 - 2004, a zone where the probability of finding the source is high was determined. Additionally, short-term monitoring of the concentration was performed at two points in 2006. By employing the abovementioned inverse analysis method and by considering this additional data, the location of the emission source was limited to a small area that overlapped with an acrylonitrile-discharging plant reported in the PRTR (Pollutant Release and Transfer Register) system. However, the reported emission amount was only approximately one-fourth or less of that estimated by the inverse analysis method. It is thus shown that the inverse analysis method can possibly be used for checking the validity of the reported emission amount.

**P.112** Kallischnigg G, Weitkunat R, Browne H, Smith M, Sanders E, Dempsey R, Urban HJ; Gerd.Kallischnigg@pmintl.com  
Philip Morris International

#### **QUANTIFYING THE LEVEL OF KNOWLEDGE OF HEALTH RISKS FOR NEW TOBACCO PRODUCTS: DEVELOPMENT OF A MEASUREMENT CERTAINTY INDEX**

Epidemiological risk assessment of new, potentially reduced-risk tobacco products (PRRTP) relates use of these products to morbidity and mortality risks. It quantifies the probability of developing a disease under specific exposure conditions. Although an epidemiological approach is the benchmark for health-risk assessment of tobacco products, it is often not applicable for risk assessment of new and innovative products where it is necessary to provide reliable predictive estimates of comparative risk prior to launch on a market. This is especially true when there is a long latency period between exposure and health outcome. The aim of this paper is to introduce the Measurement Certainty Index (MCI) as a method based on objective rules to determine the level of certainty provided by a given dataset in a risk assessment context. The level of certainty depends on methodological aspects as well as on the underlying data, and the two core dimensions of the MCI are reliability and validity. While reliability of measurement is primarily a technical issue, validity is more complex. The MCI is a quantitative measure of empirical evidence weighting different criteria of reliability and validity with respect to the level of certainty of a risk assessment. Application of such an index can help with both the retrospective assessment of existing data sets and the prospective design of assessment strategies to determine the probability of reduced risk prior to launch (and subsequent collection of epidemiological data).

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#### **INSTITUTIONAL CAPABILITIES FOR COPING WITH UNCERTAINTY**

The more difficult risk management decisions typically involve serious health or environmental risks, value differences, and significant scientific uncertainties. This presentation inquires



into the last of these—scientific uncertainties—and the distinct challenges they pose to management institutions. Uncertainties, it may be argued, generate significant reluctance to confront risks by management practitioners and publics alike. They also call for institutional capabilities and resources that may be in short supply. Such capabilities include permeable institutional boundaries, incremental decisionmaking, well-developed monitoring systems, ambitious public engagement, and varying and diverse centers of expertise, as discussed herein.

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#### **REGULATION AND THE NEW ADMINISTRATION**

Some modest suggestions for the new Administration with the objective of depoliticizing the regulatory process, using analytical tools (including risk assessments and cost benefit analyses) productively, and finding common ground on regulatory review.

**M2-E.4** Kazemi R, Mosleh A; rezakazemi@gmail.com

University of Maryland, College Park

#### **A BAYESIAN METHODOLOGY FOR UNCERTAINTY ANALYSIS OF DEFAULT**

Financial risk involves any risk associated with financing. It includes investment related risks (i.e. capital risk), insurance related risks, business related risks and debt related risks (i.e. credit risk). Credit risk is endured by creditor in case of obligor's failure or refusal to repay the debt in principal or interest. Credit risk is a natural consequence of a dynamic economy and since it can not be avoided it is best to be assessed as accurately as possible. Many models have been developed to estimate credit risk. In fact rating agencies date back to the 19th century. In the past two decades, the Basel committee on banking supervision has imposed regulatory capital requirements for credit risk that has led many large banks and financial institutions to develop sophisticated models in an attempt to measure credit risk with precision. A major component of credit risk assessment is estimating probability of default. Rating agencies express their beliefs about probability of default and transition probabilities of various firms in their annual reports. As the objective of this paper, through uncertainty analysis, we attempt to bind the true value of default within the smallest range of possible values with some confidence. For uncertainty analysis the proposed Bayesian framework, uses the estimates from one or more rating agencies and incorporates their historical accuracy in estimating default risk and transition probabilities and ultimately provides better, more accurate estimates. The default probability estimations of rating agencies and their difference with the true values of default which have actually occurred over several years (performance data) are used as evidence to form the likelihood function in our methodology. The methodology is further designed to utilize multiple estimations from multiple models (from different rating agencies). Several examples are presented to demonstrate how the proposed methodology assesses the probability of default such that it exceeds the estimations of all the models individually, in accuracy.

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#### **APPLICATION OF NONLINEAR DOSE-RESPONSE METHODS BASED ON MODE OF ACTION FOR PCBs**

A mode-of-action (MOA) for PCB-promoted rat liver tumors that fulfills the Hill Criteria and the comprehensive requirements of strength, consistency, specificity, temporality, dose-response and biological plausibility, was used as the basis for deriving a set of preliminary

Tolerable Daily Intakes (TDIs) for four different PCB mixtures using a nonlinear dose-response model. Nonlinear approaches are suitable for this investigation because none of the MOA elements show linearity at low doses. The derived TDIs were then compared to allowable intake levels calculated using the linear default extrapolation approach as currently used by EPA. The statistical dose-response analysis was conducted using EPA Benchmark Dose Software, which was initialized to employ a dichotomous multi-stage procedure to model dose response in the observable region of the data in order to extrapolate to a point-of-departure (POD) at or near the fringe of the observable region. In this preliminary evaluation of a nonlinear dose response model for PCBs, the application of conservative toxicological uncertainty factors (UFs) was used as the simplest method for extrapolating below the POD to the threshold dose anticipated by the MOA. This resulted in the determination of a preliminary set of TDIs, one for each PCB mixture, that were approximately 400 to 600 times greater than the corresponding values for the risk-specific dose (10-6). This nonlinear dose-response assessment indicates that much higher levels of PCBs can be tolerated without subjecting individuals to unreasonable excess cancer risks. Further refinements to the nonlinear approach may include the application of probabilistic methods to estimate the changing shape of the dose-response curve as it flattens from the POD to the unobservable region where it approaches a threshold consistent with the PCB MOA.

**T2-B.3** Keller C; ckeller@ethz.ch

ETH Zurich, Institute for Environmental Decisions (IED)

#### **INFLUENCE OF THE USE OF RISK LADDERS ON RISK PERCEPTION DEPENDING ON NUMERACY**

The use of graphical displays has often been recommended, especially for risk communication with low-numerate individuals. Risk ladders are graphical displays that are used to communicate environmental risks. There is little empirical evidence, however, about the effect of risk ladders on risk perception. Furthermore, it is not known how low-numerate individuals interpret risk ladders compared to high-numerate individuals. Past research indicates that the comprehension of low-numerate individuals is not necessarily improved by communication formats that provide comparative information in graphical displays. Utilizing a random sample from the general population, we examined the effect of the radon risk ladder on risk perception. The radon risk ladder provides comparative risk information about the radon equivalent of smoking risk. We compared a risk ladder providing smoking risk information with a risk ladder not providing this information. A 2(numeracy; high, low) x 3(risk level; high, middle, low) x 2(smoking risk comparison: with/without) experimental design was used. Results showed that participants with low numeracy skills as well as participants with high numeracy skills generally distinguished between low, middle and high risk levels when the risk ladder with comparative smoking risk information was presented. When the risk ladder without the comparative information about the smoking risk was presented, low-numerate individuals differentiated between risk levels to a much lower extent than high-numerate individuals did. These results provide empirical evidence that the risk ladder can be a useful tool in enabling people to interpret various risk levels. Additionally, these results allow us to conclude that providing comparative information within a risk ladder is particularly helpful to the understanding of different risk levels by people with low numeracy skills.



**M2-B.1** Kellon DS, Arvai JL; kellonde@msu.edu  
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### **FIVE PROPOSITIONS FOR IMPROVING DECISION MAKING ABOUT THE ENVIRONMENT IN DEVELOPING COUNTRIES: LESSONS FROM COSTA RICA**

Decisions focused on managing the natural environment while also addressing the needs of natural resource-dependent communities present some of the most imposing challenges to stakeholders, scientists, and policy makers. Complicating matters is that these decisions must often be made under extreme time pressure, either because of impending environmental damage or because of political constraints faced by decision makers. These challenges are especially salient in developing countries, where most decisions about the environment directly impact the livelihood of one or more stakeholder groups. A common response to these challenges typically involves two parallel parts. First, experts and analysts work to improve the technical information base upon which decisions can be made. And second, facilitators work to foster a more transparent, participatory backdrop for decision making. However, as researchers who study individual and group decision-making processes, we are concerned that without adequate attention to, and understanding of, how people in developing countries evaluate information and make decisions, these two strategies alone will miss their mark. To address this concern, we draw from lessons learned in Costa Rica and present five propositions for improving decision making about the environment in developing countries. These propositions deal with: 1) implementing participatory approaches; 2) the scientific basis for decisions; 3) the inclusion of local and traditional knowledge; 4) structuring decision-making process; and 5) the threat of decision paralysis.

**M3-C.4** Keshava C, Keshava N, Davis A, Gift J; keshava.channa@epa.gov  
US Environmental Protection Agency

### **INTEGRATION OF TOXICOGENOMICS DATA IN MODE OF ACTION ANALYSES AND CANCER RISK ASSESSMENT**

Development of new experimental approaches capable of differentiating among a wide range of mechanisms of action is expected to significantly improve risk assessment (RA) methodologies. US EPA's 2005 Guidelines for Carcinogen Risk Assessment encourages incorporation of data from new technologies to better inform RA. Toxicogenomic (TG) data are beginning to be used in RA to inform qualitative mode of action (MOA) analyses and support weight-of-evidence evaluations for the characterization of carcinogenicity of environmental chemicals. One of the hallmarks of TG is identification of molecular signatures of specific classes of toxic compounds that discriminates direct-acting genotoxicants from indirect-acting genotoxicants based on their gene expression patterns. TG approaches have demonstrated that changes in pathway-associated gene expression profiles could be used to differentiate genotoxic from non-genotoxic hepatocarcinogens in rodents. Additional quantitative methods for analysis of TG data include benchmark dose modeling of dose-responses from results of microarray studies. This methodology allows for the analysis of changes in transcriptional profiles due to chemical exposure in individual genes as well as families of genes associated with specific cellular processes, and calculates benchmark doses which identify the most susceptible single gene and cellular process. These quantitative methodologies can in turn be informative in the overall determination of carcinogenic MOAs. The goal of this presentation is to summarize current scientific progress in TG methodologies and to integrate such data for evaluating and characterizing genotoxic from non-genotoxic carcinogens. The information obtained from such analyses can be utilized to improve understanding of the

MOA for environmental carcinogens and to facilitate better cancer risk characterization. (The views expressed are those of the authors and do not necessarily reflect the views or policies of the US EPA)

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The Ohio State University

### **LIFE CYCLE ENERGETIC EVALUATION OF CARBON NANOFIBER POLYMER COMPOSITES**

Nanotechnology is often touted as the biggest scientific breakthrough of the 21st century. The potential impacts of nanotechnology arise from the altered physicochemical properties of the materials at the nanoscale that enable a broad spectrum of novel applications. It is beyond doubt that the inherent properties of nanoscale materials do pose several new challenges. Research into the holistic evaluation of emerging nanotechnologies using systems analysis is pivotal for guiding their safe and sustainable development. This work presents the first most comprehensive energetic life cycle assessment of carbon nanofiber (CNF) reinforced polymer nanocomposites (PNCs) that evaluates both thermoplastic and thermoset resins. Both simple carbon nanofiber (CNF) and carbon nanofiber-glass fiber (CNF-GF) hybrid nanocomposites are evaluated and compared with steel. The issue of life cycle inventory is tackled based on published literature and best available engineering information. A cradle-to-gate comparison reveals that CNF reinforced PNCs are 1.3-10 times more energy intensive than steel and thus the product use phase is likely to govern whether any net savings in life cycle energy consumption can be realized for PNC based products. A case study involving the use of CNF and CNF-GF reinforced PNCs in the body panels of automobiles is further presented and highlights that the use of PNCs with lower CNF loading ratios may result in net life cycle fossil energy savings relative to steel. Other factors such as cost, toxicity impact of CNF, and end-of-life issues specific to CNFs need to be considered to evaluate the final economic and environmental performance of CNF reinforced PNC materials. The results of this study can easily be used for evaluating other CNF based PNC applications.

**T4-G4** Kher SV, De Jonge J, Wentholt MTA, Frewer LJ; swaroop.kher@wur.nl  
Wageningen University

### **UNDERSTANDING CONSUMER PERCEPTIONS OF FOOD CONTAMINANTS AND VULNERABILITIES ASSOCIATED WITH FOOD CHAINS: RESULTS FROM A CROSS-NATIONAL STUDY**

The development and implementation of effective systems to identify vulnerabilities of food chains to chemical and microbiological contaminants must take account of consumer priorities and preferences for risk identification and mitigation. This research aimed to understand consumer perceptions of microbiological and chemical contaminants across different food chains. Ten consumer focus groups were conducted in Poland, Ireland, France, the Netherlands and Brazil. The study focused on four highly vulnerable food chains (drinking water, farmed salmon, chicken and milk powder). No major cross cultural differences were observed across the countries. The results indicated that focus group participants perceived none of the food chains to be free from risk of potential contamination. Consumers ranked their perceived risks for different stages of food chains. Ratings were mainly linked to consumer knowledge of production processes and the severity of consequences. Greater concerns were expressed about chemical contamination because of its persistent nature, potential long term effects and lack of personal control over the potential risks when compared to microbiological contamination. Consumers were generally aware of microbial and chemical food contaminants. However, they were unable to identify specific contaminants

associated with particular food chains. Consumers tended to prefer shorter food chains, and factors such as hygiene, storage conditions and product origin were thought to be important in determining product safety. Producers and retailers were considered to be responsible for safety throughout the food chain as well as for information provision. Consumers were moderately familiar with the concept of traceability. Most consumers were positive about product recalls should a contamination incident occur. Such recalls were considered an indication of effective implementation of safety monitoring systems, and producer acknowledgement of consumer concerns.

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### **MULTI-CRITERIA DECISION ANALYSIS TO ASSESS OPTIONS FOR MANAGING CONTAMINATED SEDIMENTS: APPLICATION TO SOUTHERN BUSAN HARBOR, S. KOREA**

Many years of untreated effluent discharge from residential areas and industries including a shipyard, marina and a large fish market resulted in serious contamination of bottom sediment in Southern Busan Harbor, South Korea. The contaminants include toxic heavy metals and organic pollutants. Furthermore, the newly introduced regulations for ocean disposal of dredged material in S. Korea pose significant challenges to the government because the previous practice of offshore disposal will no longer be possible after 2008 for contaminated dredged material. Therefore, the Korea Government analyzes the best dredged material management alternatives in term of multiple objectives such as environmental, social, and cost. Using multi-criteria decision analysis in combination with comparative risk assessment, a systematic and transparent framework was applied for prioritizing the dredged sediment management alternatives. We illustrate how multi-criteria decision analysis can recognize the multiple goals of management. Values used in weighting decision criteria were surveyed from three interaction sessions with sediment management professionals, business owners, and government decision makers. As a result of workshops involving stakeholders, the analysis shows that the reclamation is the best alternative because it performs well over all criteria. However, the alternative assumes that they will use the existing near shore confined disposal facility within reasonable distance from dredging area. In the absent existing CDF, the reclamation alternative may not be preferred.

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### **THE ROLE OF GENETIC POLYMORPHISM ON SUSCEPTIBILITY TO 2-AMINO-1-METHYL-6-PHENYLIMIDAZO[4,5-B]PYRIDINE**

2-Amino-1-methyl-6-phenylimidazo[4,5-b] pyridine (PhIP) is one of heterocyclic amines (HCAs) that are naturally produced during common cooking process for meats and fish and found in tobacco smoke. PhIP is classified as a 'possibly carcinogen to humans' to develop breast cancer, colon cancer, and prostate cancer. PhIP is metabolized by various enzymes, including cytochromes P450 (CYPs), N-acetyltransferase, and UDP-glucuronosyl transferase and its metabolites bind to DNA or protein to elicit a carcinogenic effect. The purpose of this study was to evaluate exposure levels of PhIP in Korean and to understand the role of genetic polymorphisms on PhIP metabolism. Urine samples were collected from subjects (n=100) when recruited and for 12 hr before and after received grilled chickens (62.06±9.96 ng of PhIP/g). To examine genetic polymorphisms, blood samples were collected prior to administration of grilled chickens. PhIP

level in urines collected at the recruitment was 2.27±0.17 pg/g of creatinine. PhIP in urines after administered with chickens was amounted for 19.93±1.01 ng, while it was accounted for 0.39±0.20 ng in the urines before the administration, with the diet excluding any meats or chickens. In investigation of the role of genetic polymorphisms on PhIP metabolism, PhIP excretion showed significant difference among genotypes of CYP1A1/T6235C(MSP I). PhIP amounts significantly increased in urine of variants (C/C) compared with wild types (T/T) and variants (T/C) (p<0.05), suggesting that subjects with genotype C/C might metabolize PhIP less than others. In CYP1A2/-2467delT, variants (-/-) highly excreted PhIP compared with both wild types (T/T) and variants (-/T) (p<0.05). Consequently, polymorphisms of CYP1A1 and CYP1A2 play a role on PhIP metabolism, which might be related to health effect due to PhIP exposure.

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### **RHETORICS OF RISK AND A PROPOSED NUCLEAR RENAISSANCE**

In the U.S. and elsewhere, there is talk of a coming nuclear renaissance. This choice of terminology is rhetorically powerful, suggesting material, social, and technological progress and cultivating a sense of inevitability. The context for this discourse includes concerns about global climate change and energy independence, and in the U.S., new opportunities afforded to the nuclear industry by the 2005 Energy Policy Act. In such a context the theme of nuclear renaissance appears especially timely. For the proposed nuclear renaissance to be effective, however, it must overcome a legacy of public skepticism, technological and economic challenges, and political opposition. This paper examines some rhetorical dimensions of the U.S. nuclear industry's efforts to jumpstart a self-described nuclear renaissance, and of the responses of critics and skeptics. Data include textual materials authored by the nuclear industry, the U.S. Department of Energy, the U.S. Nuclear Regulatory Commission, public interest and environmental advocacy groups, and independent energy and environmental research institutes; as well as ethnographic field data associated with a reactor licensing proposal in the Southeastern U.S. Analytical themes include the positioning of nuclear fission as a "wedge strategy" for reducing the risks of global climate change; competing framings of health, safety, waste disposal, and terrorism risks; and representations of economic, financing, and insurability risks.

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### **CHANGE IN PUBLIC ACCEPTANCE AND COMMERCIALIZATION OF NANOTECHNOLOGY PRODUCTS IN JAPAN**

This study reports the results and analyses of internet surveys on public perception of nanotechnology, which has been conducted for four consecutive years. Since 2006, more than 95% of Japanese residents have heard about nanotechnology and about 60% of them answers s/he claims to know something about nanotechnology. Almost all people continue to have positive images about nanotechnology, although many people do not have direct experiences of enjoying nanotechnology-enabled benefits. However, it should be noted that the percentage of the respondents having bought "nanotechnology products" were growing from 20% in spring 2007 to 30% in spring 2008. Half of them reported that they felt specific benefits to nanotechnology, were satisfied with the products, and expressed their willingness to buy the same products again in the future. These results also show that half of them could not realize the substantial benefits of nanotechnology, which means that public strong support and large benefit perception of nanotechnology is partly made from inflated expectation toward "next industrial revolution". Emerging mass media reports of hazard information may easily degrade public confidence toward nanotechnology.

gy and scientific and business communities. We also launched the world's second online inventory called "nanotechnology-claimed consumer products inventory in Japan" in May 2006. It contains more than 400 products and 1000 articles as of spring 2008. They are classified according to product category and compared the distribution of the products between the inventory and the ones that the survey respondents have bought.

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**FURTHER EXAMINATION OF THE PERSISTENT LOW-LEVEL CONTACT EXPOSURE (PLACE) HYPOTHESIS USING PENTACHLOROPHENOL AND 2,4-DICHLOROPHENOXYACETIC ACID DATA FROM CTEPP**

It has been demonstrated that urinary excretion of the primary metabolite of chlorpyrifos, TCPY, by the CTEPP children cannot be explained by the sum of contributions of dietary ingestion, inhalation, and soil and dust ingestion using environmental and duplicate diet data from CTEPP and reasonable estimates of relevant exposure factors. This has led to hypothesis that a phenomenon dubbed PLACE (persistent low-level ambient contact exposure) is the best explanation for the observed shortfall between prediction and observation. Further testing of this hypothesis is warranted. Unfortunately only rarely do study designs include collection of enough data to permit mass balance analysis of human exposure to environmental contaminants. An important lesson of the chlorpyrifos/TCPY case is that direct exposure to the metabolite in the environment may account for a substantial fraction of urinary metabolite production. For most of the other compounds studied in CTEPP, environmental metabolite data were not collected, rendering those compounds unsuitable for the analysis envisioned here. Two exceptions are pentachlorophenol (PCP) and 2,4-dichlorophenoxyacetic acid (2,4-D) for which the urinary biomarker is the parent compound. Examination of CTEPP data for these compounds confirms that dietary and soil ingestion and inhalation exposures cannot account for observed excretion rates. Apportionment of unexplained exposure among dust ingestion, hand and object-to-mouth contact and PLACE for 2,4-D and PCP is the object of current research. Acknowledgments: This work was supported in part by US EPA via STAR Grant RD-83184401-0. EPA has not reviewed material presented here and no Agency endorsement should be inferred. JAS also received support via CDC/NIOSH Training Grant T42/CCT010418-11.

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**SUSTAINING DISASTER POLICY: A COMMITMENT BASED MITIGATION MODEL**

Disasters, when defined as unique modes of interaction between nature and society, need effective and sustainable models of policy formulation and implementation. 1999 Marmara and Düzce Earthquakes, as significant events uncovering the weaknesses of disaster mitigation system in Turkey, triggered creative modes of thinking and self-critique amongst key institutions like planning, policy making, architecture, management and engineering sciences, NGO's and central and local level administrations. After 1999 EQs, applications covering a wide range of spectrum came into Turkey's mitigation agenda. NGO's served as a backup system when central state could not catch up with rapid emergency relief action, as central state achieved significant successes in post-disaster housing policies.

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**RISK RANKING PROCEDURES FOR FRAUD SIGNALS DETECTED IN TRADE DATA**

JRC action Statistics and Information Technology for Anti-fraud and Security has developed statistical methods to be applied on trade data and produce sets of trade flows, i.e., combinations of Product, Origin and Destination suspected for possible fraud activities against the budget of the European Community. Two of the main and most mature statistical techniques, implemented in proprietary software, are detecting sudden, unexpected, abrupt increases in trade (called spikes) and price outliers. A large number of signals are usually detected in a single dataset; typically several hundreds. Therefore, a prioritization procedure of the signals detected is needed for anti-fraud investigation activities. This paper presents the development of quantitative risk indicators to detect fraud in trade, against the budget of the European Community. Such indicators are developed for use by analysts. Indicators are based on classical risk definition. The paper presents a number of such indicators and discusses their strengths and weaknesses.

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**PARAMETERS OF A DOSE-RESPONSE MODEL ARE ON THE BOUNDARY. WHAT HAPPENS WITH BMDL?**

It is well known that, under appropriate regularity conditions, the asymptotic distribution for the likelihood ratio statistic is chi-square. This result is used in EPA's benchmark dose software (BMDS) to obtain a lower confidence bound (BMDL) for the benchmark dose (BMD) by the profile likelihood method. The problems arising when true values of parameters of a dose-response model may be on the boundary (i.e. regularity conditions are violated) were acknowledged long ago, but have not been resolved clearly for the practitioners of dose-response modeling. In this presentation, we study by simulation the coverage of one- and two-sided confidence intervals for BMD (obtained by BMDS which uses the profile likelihood method) when some of the model parameters have true values on the boundary of a parameter space. BMDL coverage was systematically different from nominal both for a group size of 50 animals and asymptotically (group size 100,000). How to improve BMDL coverage and approaches other than profile likelihood are discussed. Another important observation is that when the true parameter is below an imposed boundary constraint, as with the shape parameter of a log-logistic model, the coverage of BMDL in a constrained model may be very small and even approach 0 asymptotically.

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Toxicology Excellence for Risk Assessment (TERA)

**PROGRAMS TO FACILITATE EXCHANGE OF RISK ASSESSMENT INFORMATION AMONG STATES: THE STATE HAZARD EVALUATION LENDING PROGRAM (STATEHELP)**

State and local risk assessors are often faced with pressing public health issues, with limited access to the funding, special expertise, or time resources necessary to conduct a complex risk assessment or evaluate submitted risk assessments. Toxicology Excellence for Risk Assessment (TERA)'s StateHELP Program (State Hazard Evaluation Lending Program) offers U.S. state and local government agencies a limited amount of free technical support to assist with human health risk assessments. To demonstrate the need for such technical assistance programs, a sampling of the variety of challenging risk issues received and addressed by the StateHELP program is pre-



sented. Projects described include 1) providing risk assessment input for the California Green Chemistry Initiative, 2) identifying potential risks posed by the application of biocides applied to a golf course located atop a local water supply in Ohio, and 3) compiling literature regarding dietary exposure to arsenic in soil for public health agencies in Hawai'i and Texas. The need for State and local assistance is compounded by limited venues for formal communication among agencies, often resulting in overlapping assessments and unnecessary costs. StateHELP provides for enhanced transfer of risk assessment methods technology through links with multi-state risk groups. In addition, a recent tool - the Risk Information Exchange (RiskIE) available for free at [www.allianceforrisk.org/RiskIE.htm](http://www.allianceforrisk.org/RiskIE.htm), has been developed to further enhance such interstate information transfer. RiskIE is a resource of the Alliance for Risk Assessment (ARA) and provides another tool to discover opportunities for collaboration by identifying parallel assessment efforts by different agencies or groups.

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#### **THE MEDIA COVERAGE OF A DISASTER OVER TIME: FRAMING AND TONE-OF-VOICE**

In 2000, an explosion took place at the S.E. Fireworks factory and warehouse in Enschede, the Netherlands. In this explosion 22 people were killed and a residential area was destroyed. The paper presents a quantitative analysis of the media coverage in the local and three national newspapers over a three-year period of time. Research questions related to 1) the characterisation of the amount of coverage over time by means of a statistical function, 2) the characterisation of the coverage content from the perspective of news selection and news framing and 3) the differences in framing and tone-of-voice between periods with high coverage and normal coverage. All articles on the Fireworks disaster that were published in the major newspaper in the affected area (TcTubantia), and three national newspapers (Algemeen Dagblad, Volkskrant, Telegraaf) in the three years following the disaster were included in the analyses (n=4.928). In all periods, the local newspaper published more articles on the disaster. The newspapers used a responsibility frame most often (64%), followed by a conflict-frame (52%), human-interestframe (36%) and economic-consequences frame (31%). The total number of articles per 4-week-period declined over the years, as did the number of articles in which specific frames were used. The decline over time was statistically best described by the inverse function. In certain periods, the media coverage suddenly peaked compared to the hypothesized inverse-function. These peaks seemed to be related to specific events that took place in the three-year period following the disaster, such as the publication of the outcomes of an investigation by an independent committee (Commissie Oosting). The frame-use and tone-of-voice in these periods with excessive coverage will be compared to those in the periods with normal coverage.

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#### **ETHICAL AND POLICY ANALYSIS OF LINKAGES BETWEEN PUBLIC PERCEPTION AND OVERSIGHT OF EMERGING TECHNOLOGIES**

This paper addresses the current disconnect between public perception studies on emerging technologies and the design of risk and oversight policy for them. Although there is body of information on public perceptions of bio- and nanotechnology, there is little work to guide the use of that information in decision- and policy-making. Our presentation addresses three questions in this context: what features of oversight systems, including processes for risk analysis, affect public perception of and confidence in emerging technologies”, what are ethical arguments associated with

using public perception information and public input in the design and execution of oversight systems”, and what are appropriate mechanisms, from ethical and policy standpoints, for their use” The historical case study of genetically engineered organisms (GEOs) in food and agriculture is presented to address these questions, and then they are considered in the context of developing oversight models for nanotechnology. Relationships among features and outcomes of GEOs oversight are examined through a multi-criteria policy analysis framework using expert and stakeholder elicitation (termed previously as “integrated oversight assessment”, Kuzma et al. in press). From quantitative and qualitative data, an influence diagram is presented to illustrate hypotheses about how features of oversight such as opportunities for public input and stringency of data requirements are important for outcomes such as public confidence and environmental health and safety. Ethical analysis is used to consider whether and how information from public perception studies and integrated oversight assessment should be incorporated into risk and oversight policy-making. Mechanisms for direct public input into oversight design and execution, such as public engagement or analytical-deliberative approaches, are also examined from ethical and policy perspectives.

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#### **COMMENTS ON REVESZ/LIVERMORE AND ADLER/POSNER**

This presentation offers comments on two significant contributions to the literature on the philosophical justification and practical impact of cost-benefit analysis of environmental, health, and safety regulations: “Retaking Rationality: How Cost Benefit Analysis Can Better Protect the Environment and Our Health,” by Richard Revesz and Michael Livermore, and “New Foundations of Cost-Benefit Analysis,” by Matthew Adler and Eric Posner. It will argue that both books should be widely read and, indeed, applauded, as they offer valuable correctives to prevalent misunderstandings and excesses concerning the use of cost-benefit analysis as a method of social planning. The presentation will then raise a series of moral and political questions that, although vital to the achievement of a just and sustainable global polity, cannot be subsumed within cost-benefit analysis, and thus should become the central focus of environmental, health, and safety policy discussion, now that cost-benefit analysis has been put in its proper place.

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#### **EXPERIENCE WITH THE LISTERIA MONOCYTOGENES RISK RANKING ALGORITHM FOR SAMPLING ALLOCATION OF LISTERIA RULE ESTABLISHMENTS AND SIGNIFICANT CORRELATION OF ESTABLISHMENT RANK WITH SAMPLING RESULTS**

The Food Safety and Inspection Service began using the Listeria monocytogenes risk ranking algorithm in 2005 based on the 2003 FDA/FSIS deli meat risk assessment to determine and to assign the highest risk plants to be sampled on a monthly basis for the purpose of regulatory risk-based verification. Establishments producing ready-to-eat products falling under the Listeria Rule for post lethality exposure (9 CFR 430) are required to report the risk alternative and annual production volume they produce product under in up to seven product categories. Beginning in 2006 two additional product categories were added and additional sampling result data from food contact and environmental surfaces became available for incorporation into the risk ranking algorithm. An establishment's baseline risk ranking is calculated from the ranking of its summed prod-



uct alternative risks using risk weighted annual product volumes for all RTE products produced and does not change until a new form is submitted annually or submitted for a change in process. The establishment baseline risk can be changed according to monthly positive sampling results that increase calculated risk or negative sampling results that decrease calculated risk. Culture results are obtained from all FSIS programs sampling *Listeria* rule plants for *Lm*. Review of the correlation between *Lm* risk ranking and culture result history over the risk-based sampling verification program's span so far reveals a significant correlation between establishment risk ranking and culture results. The binary phi correlation coefficient and the Cochran-Armitage test for proportional trend of ordered risk rank categories are both significant ( $p < 0.001$ ). These are indications that risk-based sampling verification using the *Lm* risk ranking algorithm is predictive of risk and targets plants more likely to produce contaminated product or that are more likely to have contaminated production environments.

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#### **BEYOND CONTAMINATED SITES, ECOLOGICAL RISK ASSESSMENT AS THE DEFAULT ENVIRONMENTAL EVALUATION AND MANAGEMENT TOOL**

Ecological risk assessment (EcoRA) was originally developed with a focus on contaminated sites (CERCLA), pesticide use (FIFRA) and in making decisions about the manufacture of new chemicals (TSCA). The original methodology was derived from human health risk assessment. Modifications were made to the methodology to incorporate the broader range of species and the alteration of the chemicals due to degradation, transport and other processes. Contaminated sites and toxics are one of many factors altering ecological structures. Fragmentation of landscapes, non-indigenous species, emergent diseases, and climate change affect ecological structures at regional scales and with a variety of effects. In order to accommodate the use of risk assessment in these situations and broader framework of EcoRA is being formulated that includes spatial and temporal axes, a variety of environmental factors, multiple endpoints, and ecological services. From this perspective, toxic chemicals, although dominating the field for two decades, appear to be a special and perhaps limited case. The historical artifact of the development of EcoRA appears to have lead to a misunderstanding of the supposed limitations of regional based risk assessment that will be discussed. Ultimately there will be recognition that EcoRA is a general tool for many types of environmental management that will broaden range of applications.

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**AN ECOLOGICAL RISK ASSESSMENT OF THE IMPACT OF WHIRLING DISEASE ON POPULATIONS OF RIO GRANDE CUTTHROAT TROUT IN THE SOUTHWESTERN UNITED STATES.**

Although non-indigenous species are a recognized issue, the pathogens that they can carry have received little attention. Whirling disease is caused by the pathogen *Myxobolus cerebralis* and was native to Eurasia. The disease moved to North America as European salmonids were introduced to the region. Once introduced to a region the disease can be transported by a number of vectors, including the introduction of infected hatchery fish to local habitats. Part of the life cycle is of the *M. cerebralis* uses *Tubifex tubifex* as the intermediate host. In this initial risk assessment the exposure of the native Rio Grande cutthroat trout (*Oncorhynchus clarki virginalis*) is the initial endpoint. We have now constructed a conceptual model that incorporates the pathogen, the intermediate host, the spores of the pathogen and the seven vectors that transmit the organism to

uninfected habitat in Northern New Mexico and southern Colorado. Distances between infected and uninfected sites, likelihood of fishing and the isolation of the Rio Grande cutthroat population are among the factors being considered. A modification of the relative risk model is being applied to this regional risk assessment. The eventual goal is to expand the model to include other species of native trout and to eventually generate a framework for calculating risks due to introduced pathogens.

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#### **VARIATION IN CULTURAL ORIENTATIONS AND THEIR IMPACT ON ENVIRONMENTAL RISK PERCEPTION, ATTITUDES, AND INFORMATION ACQUISITION: LESSONS FROM CHINA**

Central to the process of decision making is understanding the social and psychological predictors of risk-related attitudes and behaviors of stakeholders. Evidence is accumulating that there are, what appear to be, culturally-based differences in the ways in which people perceive environmental risks, process information associated with those risks, and subsequently make decisions about behaviors related to a risk. Studies of these processes at the level of national culture indicate that this level of analysis may or may not be useful because of both between and within country variability in value orientations. Predicting and explaining these differences, however, requires theoretical advancement in this area. Research describing the role of value orientation in risk perceptions and behaviors can explain at least some of this variability. This paper draws on data from samples in Mainland China, Taiwan, and the United States to provide lessons for the management of environmental risks.

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#### **RISK AND UNCERTAINTY IN LONG TERM PLANNING FOR THE AIDS EPIDEMIC**

aids2031 is a global initiative dedicated to taking a critical look at what we need to do now in order to change the face of AIDS by 2031, 50 years since AIDS was first reported. Thus the effort is an attempt to inject a long term view in planning responses to the epidemic. aids2031 has nine working groups in the following areas: leadership, financing, social drivers, modeling the epidemic, programmatic response, science and technology, communication, the special needs of hyper-endemic countries, and of countries in rapid economic transition. The web-site [www.aids2031.org](http://www.aids2031.org) provides more detailed information. The initiative uses a risk, vulnerability, uncertainty perspective to better synthesize findings from the nine working groups and to aid in the identification of practical management activities to improve the response to the epidemic. It focuses on communities rather than individuals as the unit of analysis. Of particular concern are institutional capabilities for making sustained commitments, for coping with surprises, and for building and maintaining trust.

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#### **EChemPortal - THE GLOBAL PORTAL TO INFORMATION ON CHEMICAL SUBSTANCES**

Phase 1 (<http://www.oecd.org/ehs/eChemPortal>) was released to the public in June 2007 by the Organization for Economic Co-operation and Development in collaboration with the European Commission, the United States, Japan, Canada, the World Health Organization (WHO)

International Programme on Chemical Safety (IPCS), the United Nation Environment Programme Chemicals (UNEP), the Business and Industry Advisory Committee (BIAC), the International Council of Chemical Associations (ICCA) and environmental non-governmental organizations. eChemPortal is an Internet gateway that provides public access to information on the properties, hazards and risks of chemicals free of charge. It is an integrated system that allows users to simultaneously search multiple databases prepared for government chemical review programs around the world. The High Production Volume Information System (HPVIS) is a participating database in eChemPortal as well as the repository for information sent into the Agency for the HPV Challenge Program. This presentation will provide an overview of the goals and objectives of eChemPortal including the international events leading to its development, and will describe the search capabilities on chemical names and CAS numbers and those databases participating in Phase 1, and will discuss enhancements to direct searching on chemical properties to follow in Phase 2, now under development.

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#### **UNCERTAINTY AND VARIABILITY IN ENVIRONMENTAL EXTERNALITIES FROM COAL-FIRED POWER PLANTS IN THE UNITED STATES**

Multiple factors contribute to heterogeneity in environmental externalities across power plants, but studies have not adequately characterized key predictors. We evaluated 407 coal-fired power plants in the United States, focusing on fine particulate matter (PM<sub>2.5</sub>), sulfur dioxide (SO<sub>2</sub>), and nitrogen oxide (NO<sub>x</sub>) emissions. We linked an atmospheric dispersion model with a concentration-response function for premature mortality that incorporated non-linearities and model uncertainty, and valued mortality with a value of statistical life approach, characterizing and propagating uncertainties in all model elements. At the median, damages across plants ranged from \$30,000-\$500,000 per ton of primary PM<sub>2.5</sub>, \$6,000-\$50,000 per ton of SO<sub>2</sub>, \$500-\$15,000 per ton of NO<sub>x</sub>, and \$0.018-\$1.57 per kWh electricity generated. Variability in externalities per kWh was best explained by age of the facility, downwind population density, and the extent of SO<sub>2</sub> controls. Our findings emphasize that control strategies that consider variability in externalities across facilities would yield more efficient outcomes.

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#### **EVALUATING EFFICIENCY-EQUALITY TRADEOFFS FOR MOBILE SOURCE CONTROL STRATEGIES IN AN URBAN AREA**

In environmental risk management, there are often interests in maximizing public health benefits (efficiency) and addressing inequality in the distribution of health outcomes. However, both dimensions are not generally considered within a single analytical framework. In this study, we estimate both total population health benefits and changes in quantitative indicators of health inequality for a number of alternative spatial distributions of diesel particulate filter retrofits across half of an urban bus fleet in Boston, Massachusetts. We focus on the impact of emissions controls on primary fine particulate matter (PM<sub>2.5</sub>) emissions, modeling the effect on PM<sub>2.5</sub> concentrations and premature mortality. Given spatial heterogeneity in baseline mortality rates, we apply the Atkinson index and other inequality indicators to quantify changes in the distribution of mortality risk. Across the different spatial distributions of control strategies, the public health benefits varied by more than a factor of two, related to factors such as mileage driven per day, population density near roadways, and baseline mortality rates in exposed populations. Changes in health

inequality indicators varied across control strategies, with the subset of optimal strategies considering both efficiency and equality generally robust across different parametric assumptions and inequality indicators. Our analysis demonstrates the viability of formal analytical approaches to jointly address both efficiency and equality in risk assessment, providing a tool for decision-makers who wish to consider both issues.

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#### **INCORPORATING EQUITY ISSUES INTO BENEFIT-COST ANALYSIS**

When developing regulations to address environmental or safety risks, decision makers often attempt to take into account both cost-benefit considerations and environmental justice or equity issues. While methods to quantify population health benefits and other measures of efficiency have been well defined and extensively applied, there have been many fewer attempts to develop meaningful and interpretable methods to address the distribution of benefits. The two books presented within this session emphasize some of the ways in which cost-benefit analysis could be refocused or modified in order to embrace a broader set of issues and explicitly consider issues of equity. I present some empirical case examples to reinforce some of the key arguments within these books and to raise analytical and data collection challenges that these frameworks raise. Specifically, I describe the application of quantitative measures of inequality, originally constructed to describe economic inequality, to the domain of health benefits analysis. I consider the ways in which these indicators should be applied and interpreted to adhere to cost-benefit analysis principles, and I discuss findings for a case example across the United States addressing power plant emissions and a local-scale case example within Boston addressing diesel bus emissions. These analyses suggest that, in settings with a sufficiently expansive set of risk management alternatives, more efficient risk management strategies may often correspond with more equitable strategies, reinforcing the argument that cost-benefit analyses can both incorporate equity considerations and help to determine strategies that are optimal across both efficiency and equity measures.

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#### **EFFECT OF FULVIC ACID FRACTIONS ON THE REMOVAL EFFICIENCY OF PERMANENT ORGANIC POLLUTANTS BY ALGAE**

Lacustrine microalgae play an important role in removing permanent organic pollutants (pops) in aquatic environment. The removal efficiency is dependant on the chemical conditions such as pH, ion strength, dissolved organic matters. Fulvic acid as a dissolved organic matter, not only can associate with pops, but can be sorbed or uptaken by algae, changing the surface properties of algae. In the study, we first fractionated original fulvic acid into four fractions by a novel method, a solid-adsorption chromatography technique. Fulvic acid sorbed on the XAD-8resin was eluted sequentially by a series of solution with different polarity to obtain four fractions with different polarity. Then, the complicated effects of fulvic acid fractions with different polarity on the removal efficiency were evaluated. A three-stage variation model was developed that encompasses increasing and decreasing trends in the removal efficiency associated the mechanisms behind these trends, including the variation of polarity, structure configuration, and the concentration. This model gave the importance of fulvic acid with different polarity on the removal efficiency.

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#### **MODELING NOROVIRUS TRANSMISSION IN THE FOODSERVICE SYSTEMS**

Noroviruses have been regarded as the most common cause of gastroenteritis in the United States. Outbreaks of norovirus-related gastroenteritis are most often caused by eating contaminated foods or the poor hygiene practices of food handlers. Survival and transfer rates of noroviruses on or between different surfaces under certain environments have been investigated using feline calicivirus as a surrogate. Limited work has been done however, to estimate norovirus transmission in an integrated food service system which allows for the possibility of cross contamination. The purpose of our study was to build a simulation model using Arena software (Rockwell Automation, Warrendale, PA) that can mimic the complex interactions involved in norovirus transmission that may take place in a food service system. Arena is a commercial off-the-shelf high-end discrete-event simulation package which can be used to conduct the simulation of food-service worker movement, as well as virus transfer and survival. Data from the peer reviewed literature was collected and used to build the model. Due to the limited availability of published data, our model focused primarily on quantifying the effects of specific steps on norovirus transmission including (1) transmission between food, hands and other possible sources of contamination, (2) virus survival on different surfaces and (3) the effect of different cleaning agents on the handwashing process. The model shows key points in the virus transmission process that lead either to further spread or to reduction in the spread of the virus. The model has the potential to reduce the morbidity and economic loss currently associated with norovirus outbreaks, and to identify key foodservice worker behaviors that increase or decrease virus transmission risk.

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#### **QUANTITATIVE RISK ASSESSMENT FOR LISTERIA MONOCYTOGENES REDUCTION ON POULTRY PRODUCTS DURING POST-PACKAGE THERMAL PROCESSING**

Listeria monocytogenes is a foodborne pathogen frequently associated with ready-to-eat (RTE) poultry products. Poultry products may be re-contaminated with *L. monocytogenes* during the post-package procedure. Post-package pasteurization is an effective method to eliminate *L. monocytogenes* in RTE products. The objective of this research was to develop a risk assessment model to estimate the changes of Listeria prevalence and concentration on fully cooked chicken drumsticks during post-package hot water pasteurization. The model mainly addressed two issues: bacterial contamination after packaging and post-package pasteurization. Relevant data were obtained from scientific literature and experiments. The initial prevalence and level of Listeria were collected from scientific literature and were described by Discrete ( $\{1, 0\}$ ,  $\{61, 39\}$ ) and Pert (0, 2, 2.85) ( $\log_{10}$  CFU/g) distributions, respectively. The thermal treatment time and temperature was described by Pert (60, 70, 80) ( $^{\circ}$ C) and Pert (0, 10, 30) (min) distributions, respectively. Predictive models for thermal inactivation of Listeria were established and validated based on experimental data from thermal processing tests conducted in lab and pilot plant. The kinetic parameters derived from predictive models were used as input variables to the risk assessment model. The prevalence and concentration of Listeria after post-package pasteurization were calculated by Monte Carlo simulation with 1, 000 iterations using the @risk software. The results indicated that, when the cooked chicken drumsticks were initially contaminated with an average of 1.85  $\log_{10}$  CFU/g of Listeria, the post-package thermal treatment can reduce the contamination level to less than 1  $\log_{10}$  CFU/g at an average temperature of 70 $^{\circ}$ C after an average time of

11. 67 min. The model can be used to determine the risk of *L. monocytogenes* at plant level and provide a quantitative approach for process development and optimization.

**P.96** Lin Yi Hsin; yhlin1218@asia.edu.tw  
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#### **SELECTION AND APPLICATION OF IMPORTANT DETERMINANTS OF AVIATION INSURANCE**

The purpose of this thesis is to investigate expert opinions to identify determinants of aviation insurance and their priority. Results from Fuzzy analytic hierarchy process (FAHP) showed that the loss experience, fleet profile, operations, flight crew performance and technical practices of individual airlines were the top five elements associated with aviation insurance premiums paid by each airline. Knowledge of these factors combined with effective risk management strategies could potentially result in lower premiums and a reduction in expenditures for airline companies.

**P.35** Lin MH, Ho WC, Ho CC, Lin YS, Chen PC, Wu TN, Lin RS; linmh911@yahoo.com  
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#### **EFFECT OF EXERCISE IN DUSTY AIR ON RESPIRATORY HEALTH: A TWIN STUDY**

The nature of twin study provides the possibility of assessing the interaction effect of environmental and physical activity related to asthma after controlling genetics and related factors. To examine the effect of exercise frequency interacted with air pollution on asthma, in this twin study, we analyzed 2,564 twin pairs from the birth to the adolescence in Taiwan. The measures included birth weight, gender, exercise frequency, and air pollution concentrations. Conditional logistic regression analysis was used to establish whether exercise in dusty air was associated with children respiratory health. After controlling birth weight and gender, the interaction effect of exercise frequency and PM10 concentrations significantly related to asthma. Children who exercised sometime seemed to have higher risk to developing asthma after high PM10 exposure than no exercise and exercise often. Exercise in the dusty air may have adverse effects on children respiratory health, especially who exercise sometime. The possible explanation is children who exercise sometime were higher sensitivity and/or lower tolerance to air pollution after controlling birth weight, gender and genetics.

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#### **FISH CONSUMPTION AND MERCURY EXPOSURE IN A US RECREATIONAL FISHING POPULATION**

The goal of this study was to characterize fish consumption and mercury (Hg) exposure in a group of recreational anglers in coastal Louisiana. During summer-fall of 2006, 534 recreational anglers living in Louisiana were recruited either at dockside or through a web-based survey. Anglers completed a questionnaire detailing how frequently they consumed 88 different types of fish and shellfish caught recreationally or bought in a store or restaurant. Hair samples were collected from 402 anglers and analyzed for total Hg as a marker of exposure. Anglers' median hair-Hg concentration was 0.81  $\mu$ g/g (range: 0.02-10.7  $\mu$ g/g). In addition, total Hg intake was estimated for each participant by combining self-reported frequency of consumption of each fish type with fish Hg concentration data from regionally specific databases. Multivariate linear regression models indicated that consumption of finfish from all sources ( $p < 0.0001$ ) and estimated total Hg intake ( $p < 0.0001$ ) were both significantly associated with hair-Hg after controlling for age, gen-



der, BMI, race, education, and type of survey (web or in-person). Participants had higher hair-Hg concentrations and higher reported levels of fish consumption as compared to the general US population. Of the total Hg intake calculated across the group 74% came from consumption of 10 fish types (speckled trout, fresh tuna, crab, white trout, red drum, canned tuna, shrimp, largemouth bass, tuna sushi, and crappie). All of these fish types, excluding canned tuna and perhaps tuna sushi, are likely to be caught recreationally. Hair-Hg concentrations suggest that anglers in coastal Louisiana are more highly exposed to Hg than the general US population, and their consumption of a wide variety of fish species, including recreationally caught species, contributes to this exposure. Assessments of exposure and risk in this and similar groups should account for local consumption patterns and region-specific fish types and fish Hg levels.

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#### **PUBLIC HEALTH RISKS ASSOCIATED WITH CADMIUM ACCUMULATION IN PUGET SOUND SHELLFISH**

Puget Sound is home to many shellfish food industries, but also to many industries that contribute contaminants to its waterways. The heavy metal cadmium (Cd) is of particular concern due to the cumulative health risks involving kidney damage and bone disease. Shellfish are particularly adept at accumulating Cd in their tissues, posing a health risk to consumers. We used data of Cd levels in shellfish from nine locations in Puget Sound from the NOAA's Mussel Watch Program combined with national data on average shellfish consumption to determine health risk. We found that there is no immediate public health risk for those who consume shellfish from Puget Sound at low rates (<5g/day), if the Cd concentration does not exceed 4ug/g of tissue. At this exposure level and assuming negligible elimination, it would take an individual 60 years to accumulate toxic levels of cadmium. However, men and Asian populations are at higher risk due to higher average intake per kg of body weight. The number of years it would take to accumulate toxic levels of Cd was estimated from only 4 years, for consumption of 21g/day (Asian average combined seafood consumption) of shellfish containing 12.8ug/g Cd (Straits of Juan de Fuca, 2002), to almost 200 years, for consumption of 3.2g/day (Pacific region average shellfish consumption) of shellfish containing 2ug/g of Cd (Commencement Bay, 2002). Defining the risk in terms of amount of the specific food consumed and the source location may be a more accessible way of communicating risk to the public.

**T3-D.1** Linkov I, Schultz M, Bridges T, Moser D, Yoe C, Loney D; Igor.Linkov@usace.army.mil  
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#### **TOLERABLE RISK: STATE OF THE PRACTICE REVIEW**

Even though risk assessment as the field encompasses a wide range of approaches and tools, many applications often boils down to comparison of exposures associated with specific hazards to tolerable risk corresponding to safe exposure levels expressed in units specific to the problem in hand. Recent workshop on Tolerable Risk sponsored by the US Army Corps of Engineers, US Bureau of Reclamation, and the Federal Energy Regulatory Commission brought together representatives from several US and international agencies, academia, and industry to discuss approaches for developing regulatory benchmarks as well as for their use in risk management. This presentation will: (i) summarize definitions of tolerable risk used by multiple agencies and stakeholders, (ii) list major regulatory documents used in the field, (iii) discuss implementation of tolerable risk by the agencies, and (iv) highlight implementation challenges. Approaches used by several regulatory agencies in the US, UK, Australia as well as chemical and oil industry will be discussed in detail.

**T4-C.2** Lipscomb JC, Rice G, Lambert JC; lipscomb.john@epa.gov  
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#### **APPLICATION OF PHARMACOKINETIC DATA IN CUMULATIVE RISK ASSESSMENTS**

Physiological and biochemical processes impact the absorption, distribution, metabolism and elimination of chemicals, and can significantly impact dose-response. Because the ultimate description of dose is in the form of the toxicologically active chemical species in the target tissue, the application of pharmacokinetic (PK) data and models has refined both exposure assessment and dose-response evaluation. For example, PK models provide a scientifically defensible approach for estimating doses that result from multi-route exposures. Although chemical interactions in either PK or pharmacodynamic processes can alter response, chemical interactions typically have been characterized on the basis of 1) external, applied dose, 2) studies of defined mixtures, and 3) predicted commonalities in key components of the mode of action (MOA) using data collected under single-chemical exposure designs. Methods that express dose as target tissue dose over time allow the characterization of PK influences on response, and can identify doses and exposure conditions under which the potential for interactions may be evaluated. PK models allow the extrapolation of dosimetry across dose, species, route, and time, and represent a valuable tool in cumulative or mixtures risk assessment. The application of PK models to multiple chemical exposures provides an opportunity to characterize response based on target tissue doses over time. This presentation will describe the data requirements for and benefits of the inclusion of PK approaches in cumulative risk assessment.

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National Taiwan University

#### **QUANTITATIVE RISK ASSESSMENT FOR CATTLE CONTAGIOUS BOVINE SPONGIFORM ENCEPHALOPATHY IN TAIWAN**

The aim of the study was to assess the cattle contagious risk of bovine spongiform encephalopathy in Taiwan by the hypothesis that BSE pathogen could invade Taiwan through importing live cattle, meat and bone meal (MBM), porcine blood meal, chicken meal, tallow, animal vaccines and serum. The scenario tree included routes of cattle feeding, slaughtering, rendering and environmental residues in Taiwan. All the risk events evaluated were from the importation data period of 1979-2007. Based on the epidemic trend in UK, an estimated growth rate of  $r=0.53$  per year was applied in calculating year prevalence of all importing countries, and age susceptibility of the cattle was retrieved by the equation  $B(a) = 0.1 + 1.8 \cdot e^{-2a}$ . Data after Latin Hypercube sampling showed that the maximum BSE risk was the importation of infected cattle and production of MBM after rendering to feed domestic cattle causing at least one BSE case by oral exposure in 1995. The major contributing countries were Japan and Canada. The major BSE risk regarding maternal transmission was from Canada, 2002; the highest BSE risk in importing MBM was 1.23  $\cdot 10^{-3}$  in 1990 from UK. The TSE risk of other animal products was between 10<sup>-9</sup>~10<sup>-12</sup>. The total risk of the year of 2007 was less than 10<sup>-8</sup>. According to the sensitivity analysis, feeding cattle with contaminated MBM was the most important risk factor in this risk assessment. Thus, close monitoring the BSE epidemic in the world and insisting ruminant feed ban is the most important risk control point. We also suggest that a specific rendering plant for ruminant byproducts processing only is necessary and a secured system for tracing and monitoring sources of condemned carcasses to the rendering plant in order to reduce cross-contamination is also critical.



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### **RETAKING RATIONALITY**

Since in 1981, the federal Office of Management and Budget and the federal courts have used cost-benefit analysis extensively to determine which environmental, health, and safety regulations are approved and which are sent back to the drawing board. However, cost-benefit analysis is ill-understood both by the public affected by these regulatory decisions and many of the interests groups - such as environmentalists, consumer groups, and labor organizations - that tend to advocate for stronger regulations. Industry and other antiregulatory interests, however, have embraced cost-benefit analysis as a tool to justify deregulation and weak regulation. The result is that cost-benefit analysis has come to have an antiregulatory bias, tending to over-count costs and under-count benefits. *Retaking Rationality: How Cost-Benefit Analysis Can Better Protect the Environment and Our Health* argues that cost-benefit analysis can be a neutral tool of policy analysis, but only if proregulatory interests - and the broader public - join the debate over how cost-benefit is conducted and how it is used. The book sets out the historical origins of antipathy toward cost-benefit analysis, discusses eight “fallacies” that tend to bias cost-benefit analysis against strong regulation and shows how the institutional arrangements of regulatory review lead to antiregulatory bias. For each of the problems that are identified, concrete solutions are offered, giving those interested in joining the debate over cost-benefit analysis a clear agenda for reform. Authors Richard L. Revesz and Michael A. Livermore offer an optimistic vision for a more balanced approach to cost-benefit analysis, as well as a clear roadmap for how to get there.

**W3-B.4** Lofstedt RE; ragnar.lofstedt@kcl.ac.uk  
King’s College London

### **POST TRUST RISK COMMUNICATION AND THE RISE OF THE WHISTLE BLOWER**

Following a number of regulatory scandals ranging from mad cow (BSE), to tainted blood in France and dioxins in Belgian chicken feed, the public no longer trust regulators and industry. In this “post trust” society the regulators no longer control the communication environment. The regulator are now treated by the media as just another stakeholder, and as a result in many cases their press releases and other announcements are more or less ignored. Today the most credible communicator is a neutral third party actor, be it an academic institution, charity or an NGO. In this talk through two cases (Avandia and food colorings), I analyse the power of the whistle blower and the consequences that this entails for communicating risks to the public.

**W3-H.3** Loney D, Kim J, Kim SH, Suedel B, Bridges T, Hong G, Linkov I, Loney Drew, Loney Drew, Loney Drew; dloney@mit.edu  
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### **USE OF MULTI-CRITERIA DECISION ANALYSIS TOOLS TO FACILITATE WEIGHT-OF-EVIDENCE EVALUATION IN ENVIRONMENTAL MANAGEMENT**

Evaluation of risks associated with management of contaminated and disturbed ecosystems requires multiple sets of information due to both the variability in exposure and multiple socio-political factors influencing management decisions. This complexity requires multiple sets of information to elucidate the many factors influencing management decision at a given site. After the multiple analyses of potential effects at the site are assembled, assessors weigh the various lines of evidence and apply professional judgment and/or calculations to decide where the weight of evidence lies—that is, whether the various lines of evidence point to potential risk in the case of

each receptor, or not. Even though the weight-of-evidence (WOE) considerations may use some quantification, this approach often results in arbitrary selection of weights (e.g., conservative bias) and thus in risk estimates that include an unquantified degree of uncertainty and potential bias. The use of Multi-Criteria Decision Analysis (MCDA) offers a more rigorous and consistent approach. This presentation will review recent applications of weight of evidence approaches to environmental management and illustrate potential of MCDA to facilitate evaluation of multiple line of evidence used in sediment management. We will illustrate application of combined WOE and MCDA methodology to a contaminated coastal site in Korea.

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Gradient Corporation

### **HOW CLOSE ARE WE TO RELIABLY PREDICTING THE TOXIC POTENTIAL OF ENGINEERED NANOMATERIALS BASED ON PHYSICAL-CHEMICAL PROPERTIES?**

Definitions of nanotechnology commonly refer to materials with diameters covering the range of 1 to 100 nm, without mention of the numerous other physical-chemical properties aside from size that may also influence the toxic potential of nanomaterials. While size is certainly a toxicologically relevant property for nanomaterials, it is becoming clear that size alone is not a sufficient predictor of nanomaterial risk. Researchers have identified a number of quantifiable nanomaterial properties in addition to size that may be important risk predictors, including surface area, surface chemistry, charge, shape, agglomeration state, chemical composition, crystal structure, and solubility. Importantly, the lack of consistent study-to-study characterization of these properties, as well as considerable heterogeneity in toxicity assay systems, contribute to the difficulty of using a comparison of results across studies to assess the toxicological relevance of the various properties. We thus conducted comprehensive literature searches to identify the nanotoxicology studies that intentionally varied one or more nanomaterial properties and characterized the effect on toxicity. We identified over 150 such studies, and these provide support for the potential toxicological significance of a suite of properties. However, we found considerable heterogeneity as to the degree of study that some properties and classes of nanoparticles have received compared to others, e.g., only a small number of studies have investigated the effects of size on carbon nanotube toxicity, despite the established importance of size in the mineral fiber paradigm. Although uncertainty remains as to the relative importance of various properties, it is clear that a suite of properties in addition to size needs to be considered for risk management of nanomaterials, and there is evidence that the predictive importance of various properties differs depending on nanomaterial type.

**T2-J.3** Longstaff H, McDaniels T, Hawkins D, Chew G, Chang S; longstaf@interchange.ubc.ca  
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**FOSTERING REGIONAL RESILIENCE IN DISASTERS: SETTING PRIORITIES FOR MITIGATION EFFORTS**

The objective of this paper is to describe the procedures and findings of setting regional priorities for mitigation efforts. We use an earthquake scenario in the Vancouver region of the Lower Mainland, British Columbia, Canada to establish means and opportunities for making regions and their infrastructures more resilient in extreme events. In this paper, fuel supply, water supply, and road mobility are identified as three cross-sector areas most requiring collaborative attention. The mitigation principles of redundancy and hardening are then used to generate and structure mitigation alternatives for addressing specific critical elements, or sub-objectives, within the three sec-

tors. These mitigation alternatives are converted to a matrix enabling their comparative assessment in terms of the time, number of agencies, difficulty, and cost required for their eventual implementation, as well as in terms of their comparative contribution to fostering a more resilient region. This matrix then forms the basis of an identification, discussion, and ranking of mitigation priorities by diverse experts assembled for a workshop in the study region. The paper concludes with a presentation of the findings of the ranking exercise and the degree of regional consensus to emerge, and a final reflection on the merits and limitations of the adopted method.

**RT1.5** Louis G, Hassenzahl DM, Clauberg M, Oeberg T, Watt J, Corr L, Thran B; clauberg@utk.edu

University of Virginia, University of Nevada, Las Vegas, University of Tennessee, Knoxville, University of Kalmar, Middlesex University, University of Nevada, Reno

#### **GROUP / PANEL DISCUSSION OF THE SRA EDUCATION COMMITTEE**

This group / panel discussion will allow the audience to pose questions as well as provide the panel an opportunity to interact with each other and the audience. A set of challenge questions will be prepared in advance to stimulate and structure the discussion as needed, but preference will be given to audience questions.

**P.90** Louis GE; louis@virginia.edu

University of Virginia

#### **RISK AND SUSTAINABLE DEVELOPMENT: AN OVERVIEW OF THE ISSUES**

By 2050, 87% of the world's population will live in developing countries where significant portions of the population lack access to basic services (food, shelter, safe water, sanitation, household energy, and security), as well as healthcare and education. Developing countries must manage a host of competing objectives as they invest their finite resources for development. Their challenge is to develop in a manner that meets the needs of the present generation without compromising the ability of future generations to meet their own needs. Risk analysis could be an invaluable aid to countries in this situation. The discipline is well suited to assess the different categories of risk, evaluate the options for addressing those risks, communicating the risks and options to stakeholders for collaborative decision making, and managing the implementation of policies and programs to mitigate the risks. A risk analysis approach to sustainable development shifts the focus of development planning from open-ended economic and social development to objective-driven programs for risk management. The goal of this symposium is to craft the framework of a risk analysis approach to sustainable development. This will be achieved by four objectives; i) characterize the major classes of risk associated with underdevelopment (human health, the natural environment, the built environment, socio-economic systems), ii) Propose the most important options for addressing those risks (local, national, international, short and long term), iii) Devise effective strategies for communicating the risks and options to stakeholders, iv) Recommend the major research, policy, and program requirements for incorporating risk analysis into all levels of planning for sustainable development. This symposium will draw practitioners from the fields of risk assessment, risk communication, risk management, environmental sciences, public health, infrastructure, economics and the social sciences.

**T3-A.5** Luchansky JB; john.luchansky@ars.usda.gov

US Department of Agriculture/ARS/ERRC

#### **TACKLING THE TRUE PREVALENCE OF LISTERIA MONOCYTOGENES IN 16 TONS OF FRANKFURTERS**

Given its ubiquity, persistence, and pathogenicity in our food supply, *Listeria monocytogenes* remains a serious threat to public health. To minimize the load and occurrence of the pathogen and concomitantly continue efforts to develop and implement effective interventions to ensure that an infectious dose of LM will not reach the consumer's table, it is imperative to quantify the prevalence, levels, and types of this pathogen in target foods. To this end, we conducted a multi-collaborator study to quantify the prevalence of *L. monocytogenes* in frankfurters, a higher-risk, high-volume and mass produced food, consumed by a significant segment of the population, including those at elevated risk. The pathogen was recovered from 532 of 32,800 pounds/packages (1.6%) of frankfurters using the ARS package rinse method. The frankfurters were obtained by a third-party contractor from 12 volunteer producers. Enumeration, when possible, showed pathogen levels of about 70 to 190 MPN per package; about 90% of the 1100 retained isolates were serotype 1/2a and displayed the same pulsotype. These baseline data shed light on the prevalence of the pathogen in RTE frankfurters that have proven useful to risk assessors and regulators worldwide because of the design and scope of the study wherein these data were generated.

**T4-A.7** Luke N; luken@cdm.com

Camp Dresser & McKee Inc.

#### **NANOTECHNOLOGY AND NANOTOXICOLOGY: CHALLENGES**

Nanotechnology is becoming a growing presence in our daily life and a major player in our global economy. It is defined as "ability to measure, see, manipulate, and manufacture products usually between 1 and 100 nanometers". The field of nanotechnology has great potential applications, in consumer products, health care, transportation, energy, and agriculture, for social, economic and environmental benefits. However, in addition to chemical properties, the physical properties of nanomaterials, such as particle size, solubility, surface area and characteristics, shape, state of dispersion and agglomeration, have contributed to adverse effects on human health and the environment. Furthermore, little is known of the long term toxicity effects to health and of the fate of nanomaterials in the environment. Thus, nanomaterials have been cited as a major concern to public and regulatory communities. Consequently, a new science of nanotoxicology has emerged with the need to study, investigate, evaluate, and determine whether and to what extent these materials may pose a threat to human health and the environment. Although nanotoxicology is still in its infancy, it has created an exciting field for toxicologists. The immediate challenges facing nanotoxicologists include: How to develop the scientific basis for evaluating and characterizing exposure, toxicity, and risks associated with nanomaterials and how to establish toxicity guidelines. How to communicate public understanding of the benefits of nanotechnology and the risk assessment of nanomaterials, how to establish regulatory guidance and regulations to protect human health and the environment, and how to direct research and resources to investigate the impacts of nanomaterials and minimize the health and the environmental risks, while supporting sustainable development. Answering these questions constitute major challenges for global researchers and regulators in the field of nanotechnology.

**W4-J.3** Lundy SJ, Watt J; s.lundy@mdx.ac.uk  
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### **DEVELOPMENT OF POST GRADUATE EDUCATION AND CONTINUING PROFESSIONAL DEVELOPMENT IN OCCUPATIONAL SAFETY AND HEALTH RISK MANAGEMENT**

This paper examines the ethical decision making dilemmas faced by occupational safety and health practitioners and the educational and continuing professional development (CPD) requirements needed to meet the emerging challenges of this pertinent role in risk management. The function of the safety and health practitioner is a diverse and complex one covering an eclectic range of disciplines. Additionally the professional practitioner will need to be a persuasive communicator both written and verbally at every level of the organisation from employees to management and at the most senior level in the board room. Following a review of the available CPD training and the recent validation of accredited programmes at BSc and MSc level there appears to be a knowledge gap in the important area of professional ethics as it pertains to safety and health practitioners; although ethical dilemmas may be discussed during seminars there are no explicit requirements to provide the underpinning knowledge on professional ethics in the current syllabus. The recent discussions between the UK government and the Institution of Occupational Safety and Health regarding the intended move towards a regulated profession have raised questions regarding education, codes of conduct and the continuing professional development of practitioners in relation to ethical dilemmas and sound risk based decision making.

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University College Dublin, Ireland, Rochester University

### **OUTCOME OF THE HUMAN HEALTH WORKING GROUP AT THE NATO ADVANCED RESEARCH WORKSHOP (ARW) ON EMERGING METHODS AND TOOLS FOR ENVIRONMENTAL RISK ASSESSMENT, DECISION-MAKING, AND POLICY FOR NANOMATERIALS.**

The Human Health WG considered approaches to enable rapid reduction in the uncertainties of the risk assessment process. The lack of clarity as to the specific challenges associated with nanomaterials, coupled with the fact that this class covers a diverse range of material types, solubilities, reactivities, sizes, presents difficulties in designing suitable studies and interpreting the resultant data. There is also concern that existing endpoints are not sufficient for predicting nanoparticles impacts, and recent reports have highlighted interferences in cytotoxicity assays related to specific nanomaterial properties. There is also considerable debate about relevant exposure metrics, such as mass, surface area, and particle number. Focusing on physicochemical properties alone is insufficient, as these may change (agglomeration, oxidation, and interaction with biomolecules) upon contact with liquid or gaseous media and with biological fluids. Screening tests that focus on toxicological mechanisms without any connection to plausibility or real-world exposure concentrations are of little use. Thus, the Working Group felt that these two approaches should be combined with dosimetric information. The lack of standard nanoparticles with full physical, chemical and "biological" characterization (including in aqueous and gaseous media used in test systems), and the fact that current characterization techniques are at their limit of applicability with nanomaterials were highlighted as concerns. The round-table discussions resulted in the conclusion that short-term research should focus on the following key areas: 1. External exposure assessment (i.e., concentrations and characteristics of nanomaterials suspended in air or liquid); 2. Target organ dose (internal concentration, characteristics); 3. Potential screening strategies (mechanistically relevant). Longer-term issues include the need for mechanistic studies once the susceptible organs are identified and addressing methodological gaps.

**M2-C.2** Lynch MK, Heiger-Bernays WJ, Hattis D, Ozonoff A; megkeaney@yahoo.com  
Abt Associates Inc.

### **QUANTIFICATION AND CORRECTION OF THE BIAS IN THE ESTIMATED GEOMETRIC STANDARD DEVIATION: IMPACT ON REGULATORY STANDARDS**

We will present a quantification of the bias in the Geometric Standard Deviation (GSD) resulting when it is estimated from the arithmetic summary statistics. A correction to this bias will also be presented. Many data sets across the sciences, including pharmacokinetic parameters, are best described by a lognormal distribution and the geometric mean (GM) and GSD. Increasingly, there is interest in incorporating available PK data into the estimation of regulatory standards such as the Reference Dose (RfD), specifically in the use of pharmacokinetic (PK) data to estimate the human variability uncertainty factor (UFH), either directly or through PBPK modeling. Often, PK data are published as arithmetic summary statistics, such as the arithmetic mean and standard deviation or the Coefficient of Variance (CV). Use of the GSD calculated directly from summary statistics without correction will lead to underestimation in the variability, and subsequently, an underestimation of the resulting regulatory standard. The Aitchison and Brown Estimator has been used for over fifty years to estimate the Geometric Standard Deviation (GSD) from the CV. We will present calculations with simulated and real data demonstrating that the Aitchison and Brown Estimator systematically underestimates the GSD, particularly at smaller sample sizes. This bias increases with the size of the standard deviation. The median relative underestimation with simulated data at a sample size of  $n=5$ , and a known  $\ln$  GSD of 0.7, is approximately 20%. This underestimation decreases with increasing sample size to approximately 5% at  $n=50$ . In addition, we will report an unexpected bias in the GSD calculated directly from individual data at smaller sample sizes. This bias did not vary with the magnitude of the standard deviation. At sample sizes of  $n=5$ , the median relative underestimation was approximately 8%. This underestimation decreased to less than 2% at sample sizes of  $n=20$ .

**T3-C.3** MacDonell MM, Rice GE, Picel KC, Hildebrand RD, Butler JP, Chang YS, Hertzberg RC, Haroun LA, Wright JM; macdonell@anl.gov  
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### **EXPOSURE-BASED GROUPINGS TO GUIDE CUMULATIVE RISK ANALYSES**

Cumulative assessments are often exposure-centric, reflecting the community focus of environmental health protection programs. Stressor levels are a common initiator, typically for chemicals but also for other agents. Joint exposure considers coexistence in time and space, so stressors can be grouped by: source and release type; properties that affect fate, including interactions; and receptor location and timing. Many contaminants were released decades ago, and assessments often extend over a lifetime to assess chronic exposures and effects. Thus, the period of interest can be 100 years or more, and the spatial scale can extend a similar number of miles. Various models assess fate and transport, but few incorporate transformation rates and products. Cumulative assessments consider the impact of natural processes on concentrations and compositions of mixed stressors, as illustrated by pesticide weathering. Stressors can be grouped by inherent physical-chemical properties then regrouped to account for setting-specific characteristics to produce joint fate-partitioning sets over time. These estimates are linked with groupings of activity patterns and other receptor characteristics to identify key space-time combinations. When the assessment objective involves identifying main contributors to environmental levels so those sources can be targeted for control measures, environmental forensics may be used. These source attributions can

involve groups linking air pollutants to a chemical mass balance dispersion model, or comparing measured soil or groundwater levels with indicators (e.g., cesium-137 profile or uranium isotopic ratio). The presentation will illustrate exposure-based grouping approaches for assessing cumulative risks of various stressors. Examples will consider use of data from emission and release inventories, land use maps and remote sensing; generating process and seasonal impacts; occupational context; surrogates; and hindcasting to inform forecasting.

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### **REGULATION BY RULES OF THUMB**

People's perceptions of risk appear rooted more in cognitive heuristics than reason, leading naturally to the inference that the direct translation of public preferences into regulatory policies is undesirable. Hence the broadly pejorative view of heuristics, and wide support of risk and cost-benefit assessments as the normative basis for risk regulation (hereafter, optimisation). Yet our study of brominated flame retardants reveals many chemical regulatory regimes, e.g. the Stockholm Convention, to be based on heuristics, for example qualifying a substance as a significant risk when it is persistent, bioaccumulative and toxic. The implications of heuristic regulation include: their transparency and simplicity allow broader stakeholder participation; they clarify when science is "sufficiently sound" to support precautionary action; however, by their very nature they leave the potential for systematic regulatory error. The final point leads us to consider the normative status of heuristic regulation. The conventional view would be that heuristic approaches are broadly inferior to optimisation, yet reduce decision costs and time. The "Panglossians" may hold that heuristics can at times outperform optimisation, by focussing on critical variables and filtering out the noise which pervades risk and cost-benefit analyses. In considering the origins of this noise we reach a third position. This noise arises from the theoretical and practical constraints to optimisation, which necessitate various simplifications and assumptions on the part of the regulator. In other words, optimisation is an analytical superstructure underpinned by a series of heuristics, at times made explicit and directly applied in decision making, at times hidden deep in risk assessment models and so not clearly known to policy makers. Their pervasive nature means that the challenge is to uncover, critically evaluate and, where necessary, modify the heuristics underlying all regulatory regimes.

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### **USING RISK ANALYSIS AND CONSTRUCTIVE SIMULATION TO EVALUATE BORDER SECURITY TECHNOLOGIES**

Evaluating new technologies for border security is difficult because of the scope and complexity of the task. Using border surveillance as an example, this study presents the results from a probabilistic risk analysis model and constructive simulation of the 28-mile demonstration project conducted as part of SBI Net. The work provides an example of how these methods can be used to help evaluate proposed technologies for border security and develop concepts of operation for their use.

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### **CONSTRUCTING RISK INDICES**

Several different types of risk indices span a wide variety of disciplines. These risk indices are used to communicate risks to the public, measure how risk is changing over time, compare

among different risks, and support decision making. These indices range from categorical scales to more complex numerical scales based on complicated mathematical equations. Given this wide variety, we propose some principles for constructing a risk index. The goal of the index should determine how it is constructed. The index should also take into account the uncertainty inherent in risk.

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### **RISK FACTOR ANALYSIS - BODY LESIONS OF CART-PULLING EQUINES IN SHERBIN, EGYPT**

The Brooke is a working equine welfare charity aiming to develop evidence-based interventions on priority equine welfare issues. A welfare assessment in the Sherbin region of Nile Delta, Egypt, in addition to results of a participatory community prioritisation process, identified body lesions as a priority welfare issue for cart-pulling animals in this area. A risk assessment (RA) was initiated to identify possible causes of these body lesions. RA development included familiarisation with the area, animals, work type and local practices. Participatory approaches (PA's) were used in meetings with saddlers, owners, saddle merchants and Brooke staff to incorporate local knowledge and further identify potential Risk Factors (RF's). Templates and measurement techniques were developed to record them. A total of 266 animals were sampled (195 donkeys and 71 horses) using a stratified sampling plan. Processes were in place to ensure inter-observer reliability. Initial screening of data used linear or logistic regression to identify relationships between outcome and explanatory (RF) variables. Further analysis examined interactions between variables and tested hypotheses developed through field experience. Results found that; 1) Owners did not recognise hairless lesions as a welfare problem. 2) Dirty padding and neck collar were associated with hairless lesions and skin broken lesions. 3) Broken or badly maintained neck collars were associated with breast and shoulder lesions. 4) Asymmetric wooden bars of the neck collar were related to hairless lesions in the withers area. Results suggest both owner attitude and resource-based RF's for body lesions. A plan was designed to integrate results with Brooke current activities (schools programs, animal health worker training etc.). Using measurement systems developed during RA, we will monitor the impact of plan implementation, gaining further knowledge on the use of RA findings in community-based animal welfare interventions.

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**RISK PATH FINDER FOR FOODRISK.ORG**

Risk Path Finder, an information system dealing with document databases about food safety risk, is being developed. When a keyword is input, the system visualizes the interrelation of characteristic terms in the documents including the keyword, as well as displays a list of the retrieved documents. Users can comprehend interrelations between documents and terms written in the documents through the system. Moreover, it is expected that the system support users to find hidden relationships in documents and terms, in particular, hidden causal relationship from causes to hazardous consequences of risk events from the pile of documents. The RPF is developed by using two open source program codes, GETA, the Generic Engine for Transposable Association, and TouchGraph, a Java applet for rendering graphs consisting of nodes and edges. Previously, the RPF was developed to examine food safety risks in the Japanese context. This time a version of RPF for risk analysis of food safety in the US is being developed. This system deals with FoodRisk.org document database of Joint Institute of Food Safety and Applied Nutrition (JIF-SAN).



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### **RISK COMMUNICATION SUPPORT PLATFORM: RECENT ISSUES AND LESSONS**

In this presentation, development and current situation of risk communication support systems in Japan will be introduced. About fifteen years ago, development of risk communication support systems started on the viewpoint how these systems should inform the people scientific information about risk, particularly information of risk assessment. However, it has been realized that laypeople do not necessarily need such a detailed scientific information. Then some systems, which guide users how to and whom to communicate if they feel risks, have developed on the people's viewpoint. In some domains, information platforms on which stakeholders can exchange information and opinions have been developed. However, systems utilized in actual risk management contexts are rare. One of them is a communication platform designed to be worked to support community activities in ordinary condition, but in risk events to be a communication tool between the community and stakeholders. This presentation will discuss the brief history of development of these systems and remaining problems.

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### **DERIVATION OF IMMEDIATELY DANGEROUS TO LIFE OR HEALTH (IDLH) VALUES FOR HIGH PRIORITY CHEMICALS TO EMERGENCY RESPONSE PERSONNEL USING REFINED METHODOLOGY**

The National Institute for Occupational Safety and Health (NIOSH) has been investigating methods to improve the derivation of Immediately Dangerous to Life or Health (IDLH) values. IDLH values are 30-minute atmospheric concentrations of any toxic, corrosive, or asphyxiant substance that, via inhalation exposure, poses an immediate threat to life or would cause immediate or delayed irreversible adverse health effects or would interfere with an individual's ability to escape from a dangerous atmosphere in the event of a respirator failure. The goals of this study were 1) to create a process to prioritize high priority chemicals of interest to emergency response personnel (i.e., chemical terrorism agents, industrial chemicals or agrochemicals subject to emergency releases) and 2) to apply current research findings to derive potential IDLH values for high priority chemicals using a refined weight of evidence approach. We developed a prioritization process that accounts for metrics of exposure potential as well as toxicity. Since many current IDLH values are based on acute lethality data in animals, we investigated methods for extrapolating from acute lethality data in animal studies (LC50, LC10, etc.) to human effect thresholds and the impact of toxic mode of action on such extrapolations. Based on the results of this research a refined IDLH methodology was developed that uses a weight of evidence approach. We evaluated the impact of the refined methodology by developing new IDLH values for high priority chemicals of interest identified from our prioritization strategy. The resulting IDLH values were contrasted to the IDLH values that would have been developed using a default IDLH calculation approach. The lessons learned from this research will help inform additional methodology issues of relevance for setting IDLH values for chemicals of interest to homeland security applications and emergency preparedness.

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**AGGREGATE HUMAN HEALTH RISK FROM EXPOSURE TO TOLUENE AND XYLENES USING "QUALITY ADJUSTED LIFE-YEARS (QALYS)"**

Efficient management of human health risk from simultaneous exposure to various chemical substances of which human health endpoints are different requires the risk of each substance to be quantified in common unit. In this study, we (i) quantify the risks from exposure to toluene and xylenes (they are among the well known indoor air pollutants) in Japan as "loss of quality adjusted life-years (QALYs) per year" and (ii) estimate the cost per QALY saved (CP-QALYS) of installation and operation of ventilation equipment which reduce the indoor air concentrations of toluene and xylenes simultaneously. Inhalation from the atmosphere and the indoor air are assumed as exposure routes. The concentrations of the substances in the atmosphere are estimated by the atmospheric dispersion models. Those in the indoor air are estimated using the survey data on the concentrations of some indoor air pollutants in 1999 conducted by the Ministry of Health, Labour and Welfare. Based on the results of epidemiologic studies on Chinese workers exposed to toluene and xylenes chronically, we estimate the dose-response functions of each substance that relate the exposure concentrations to the incidence of some neurological endpoints. Then, we quantify the neurological health risks from exposure to toluene and xylenes to be 133 QALYs/year, using the dose-response functions and the "quality of life (QOL)" of the neurological endpoints. The annual cost of installation and operation of the ventilation equipment in all households in Japan is estimated to be 3.2 trillion yen/year. The CP-QALYS of installing and operating ventilation equipment in all households in Japan is estimated to be 24 billion yen/QALY (= 3.2 [trillion yen/year]/133[QALYs/year]). This value is much higher than the cost per life year saved (CPLYS) of some risk reduction measures for other chemical substances, i.e., the cost-effectiveness of the ventilation equipment is worse.

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### **MICROBIAL RISK ASSESSMENT: OVERVIEW**

Microbial risk assessment (MRA) evaluates the adverse human health effects following exposure to pathogenic microorganisms. In 1998 USEPA developed a conceptual framework for assessing risks of waterborne pathogens with the information needed to quantitatively assess health risks from exposure to microbial agents in water. USEPA's 1998 MRA requires risk assessments to consider the microbial and potentially hazardous chemical concentrations in finished water, tap water intake rates, and dose-response assessments for the microbial and chemical agents. This MRA's approach follows the four steps used in chemical risk assessments: hazard identification, dose-response assessment, exposure assessment, and risk characterization. However, this MRA framework has not received the attention as a chemical risk assessment until recently. Following the Public Health Security and Bioterrorism Act of 2002 and Homeland Security Presidential Directives 7, 9, and 10, USEPA is charged to protect our nation's critical water infrastructure and to monitor chemical, biological, and radiological terrorism threats to public health and the environment. Consequently, USEPA is working closely with other agencies, e.g., DoD, USDA, and FDA, to develop a MRA guideline to estimate plausible levels of risk that might result from exposure to environmental pollutants, including microbes and pathogens. The effects are to be translated or expressed in terms of measurable human health conditions, such as cases of cancer and infection and illness from infectious diseases. Quantitative MRA enables direct measurement of pathogens in developing acceptance and rejection guidelines for water sources of

microbial exposure to human populations. The guidelines intend to be applicable to all types of microbial pathogens and aqueous media. Thus, pathogen-specific MRA could be developed to characterize the risk associated with each medium

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#### **DISCLOSING UNCERTAINTY IN GOVERNMENT RISK COMMUNICATION: CITIZENS' PERSPECTIVE**

Health risk information that is transmitted to the public typically does not account for scientific uncertainty (e.g. about prevalence, or generalizability) involved in risk assessment. What is the effect of disclosing this uncertainty to the public? Scant literature provides ambivalent findings concerning the public's acceptance of uncertainty disclosure in risk communication (Johnson, 2003; Miles & Frewer, 2003). A qualitative design that involved 9 focus groups and included 43 individuals from the adult population of 2 major Canadian cities was employed to clarify how and why the public express the acceptability of uncertainty disclosure in government risk communication in the context of four health risks (cancer, food safety, global warming, terrorism). After inter-rater agreement, analysis supported the view that lay public audiences are capable of perceiving and criticizing risk uncertainty. The acceptability of uncertainty disclosure was related to assumptions about outcomes. For instance, the communication of information disclosing uncertainty was favored in cases where it seemed to inform consumer choices concerning risks and when it promoted individual autonomy, in contrast to instances where it seemed to justify government inaction or serve political strategizing. These findings suggest that risk regulators should study how public audiences construe the purpose of uncertainty disclosure within a given framework of risk communication in order to determine how to communicate risk uncertainties more effectively.

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#### **FROM SMOKE TO DISEASE RISK MODELLING. AN INTEGRATED APPROACH FOR RISK ASSESSMENT OF POTENTIAL REDUCED-RISK TOBACCO PRODUCTS**

Philip Morris International is committed to the development of Reduced-Risk Tobacco Products (RRTP). This requires a state-of-the-art scientific approach to disease risk assessment, integrating toxicological and clinical assessment together with disease risk modelling. Evaluation of the relative toxicity of smoke constituents from a potential RRTP is the first stage of this process. Further investigations are then performed to evaluate the toxicological profile and to assess the potential for reduced risk. Short-term confinement studies to evaluate changes in biomarkers of exposure in subjects switching to potential RRTPs are performed. If clear reductions in exposure are demonstrated, longer-term clinical studies are performed to evaluate biomarkers of effect in real-life situations. Another important component is human smoking topography, which involves evaluating changes in the smoking behavior of subjects switching to potential RRTPs. Effectively quantifying risk is a complex task. Predictive mathematical and computational models are being developed and refined for three major smoking-related diseases (cardiovascular disease, chronic obstructive pulmonary disease, and lung cancer). This case history illustrates a model of cardiovascular disease which comprises the pathophysiology of cholesterol metabolism, atherosclerosis, thrombosis, and plaque rupture. Using longitudinal data from clinical stud-

ies, changes in biomarkers of effect are translated into an index of plaque instability. When extrapolated over time, this can predict cardiovascular risk for both an individual and a virtual population. The certainty of the risk is evaluated using a Measurement Certainty Index based on the validity and reliability of the integrated data. This abstract describes a unique integrated risk assessment process which enables objective categorization of potential RRTPs according to their predicted risk.

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#### **CLASSIFICATION AND DOSE-RESPONSE CHARACTERIZATION OF ENVIRONMENTAL CHEMICALS BASED ON STRUCTURED TOXICITY INFORMATION FROM TOXREFDB**

Thirty years and over a billion of today's dollars worth of pesticide registration toxicity studies, historically stored as hardcopy and scanned documents, have been digitized into highly standardized and structured toxicity data, within the U.S. Environmental Protection Agency's (EPA) Toxicity Reference Database (ToxRefDB). The source toxicity data in ToxRefDB covers multiple study types, including subchronic, developmental, reproductive, chronic, and cancer studies, resulting in a diverse set of endpoints and toxicities. Novel approaches to chemical classification are performed as a model application of ToxRefDB and as an essential need for highly detailed chemical classifications within the EPA's ToxCast research program. In order to develop predictive models and biological signatures utilizing high-throughput screening (HTS) and in vitro genomic data, endpoints and toxicities must first be identified and globally characterized for ToxCast Phase I chemicals. Secondly, dose-response characterization within and across toxicity endpoints provide insight into key precursor toxicity events and overall endpoint relevance. Toxicity-based chemical classification and dose-response characterization utilizing ToxRefDB prioritized toxicity endpoints and differentiated toxicity outcomes across a large chemical set. This work was reviewed by EPA and approved for publication but does not necessarily reflect official Agency policy.

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#### **NANO: AMPLIFICATION AND THE NEW MEDIA**

Assessing risk in nanoscience is especially troublesome given the extremely high levels of uncertainty associated with hazard, dose, and exposure. A project at NCSU involves the design of a White Paper for the NNCO (National Nanotechnology Coordinating Office) of the National Nanotechnology Initiative. Social amplification can produce "ripples" of secondary and tertiary effects that may be just as influential as the initial impact of an event. Previous literature on media and amplification states that media influence public perceptions of risk through multiple effects including pure volume, filtering, mixing, equalizing, "stereo" and by deleting and adding information. Research has focused on trends of reassurance in newspaper reporting and televisions' focus on extremes and unknown risk. With the rise of digital media and the citizen journalism, the trends in risk reporting across genres are changing as well as the extent and pervasiveness of the multiple effects. This paper examines new media's influence on public perception and involvement and how that in turn influences amplification.

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#### **GLOBAL RISKS: A QUANTITATIVE ANALYSIS**

The scope and possible impact of global, long-term risks presents a unique challenge to humankind. The analysis and mitigation of such risks is extremely important, as such risks have the potential to affect billions of people worldwide; however, little systematic analysis has been done to determine the best strategies for overall mitigation. Direct, case-by-case analysis can be combined with standard probability theory, particularly Laplace's rule of succession, to calculate the probability of any given risk, the scope of the risk, and the effectiveness of potential mitigation efforts. This methodology can be applied both to well-known risks, such as global warming, nuclear war, and bio-terrorism, and lesser-known or unknown risks. Although well-known risks are shown to be a significant threat, analysis strongly suggests that avoiding the risks of technologies which have not yet been developed may pose an even greater challenge. Eventually, some type of further quantitative analysis will be necessary for effective apportionment of government resources, as traditional indicators of risk level- such as press coverage and human intuition- can be shown to be inaccurate, often by many orders of magnitude.

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#### **COMMUNICATING AVALANCHE RISK TO OUT-OF-BOUNDS SKIERS AND SNOWBOARDERS**

Within ski area boundaries, avalanche risk is well-mitigated and the chances of being injured or killed by an avalanche are very low. But outside ski area boundaries, uncontrolled avalanche slopes can pose a serious risk. The transition between these two domains is often marked only by a single rope line or warning signs, with the change in actual danger being largely invisible. Most ski resorts do not restrict exit from their boundaries, and many recreationists venture into high-stakes terrain without a full appreciation of the dangers. The result that many avalanche fatalities occur just outside of ski resort boundaries. To date, there has been little research on what strategies and formats of risk communication are effective as people leave these boundaries. This project used a mixed-methods, multi-level ecological methodology to characterize avalanche hazard recognition among out-of-bounds recreationists and to identify effective strategies for communicating avalanche risk. Formative investigation included focus groups, intercept surveys, interviews, site visits, and retrospective accident analysis. Content and thematic analysis revealed a typology of avalanche risk awareness approximating a precaution-adoption process model. Each of six categories of risk awareness exhibited a unique cognitive and psychosocial profile, where behavioral moderators such as trust, efficacy, social influence and hedonic motivators played key roles. The model suggests specific modalities of risk communication that are likely to be effective at the personal, interpersonal, institutional, community and policy levels, including choice architecture approaches that are consistent with libertarian paternalism. The study concludes with a series of recommendations for communicating avalanche hazard to recreationists exiting ski resort boundaries that may have value in other domains characterized by high hedonic engagement, social pressures, and catastrophic outcomes.

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#### **WHEN VOICE MATTERS: EXPLORING THE RELATIVE INFLUENCE OF PROCEDURAL FAIRNESS AND SALIENT VALUES SIMILARITY ON TRUST JUDGMENTS IN THE CONTEXT OF RISK**

Research suggests that individuals weigh procedural fairness and perceived shared values when choosing whether to trust people holding positions of power or authority in a decision making process. Results are mixed, however, about which of these variables matters more to trust judgments. Some research has found that procedural fairness may be more important when individuals are unsure of whether authorities share their values. In these cases, whether authorities allow citizens to have a voice in the process may become a more salient factor in trust judgments. On the other hand, having a voice may become less salient than shared values when individuals consider themselves more familiar with authorities. To examine this further, we conducted a mail survey in the spring of 2008 with residents (N=203; 48% adjusted response rate) in three Colorado communities adjacent to a proposed uranium mining facility. The survey evaluated the perceived trustworthiness of the two primary power brokers in the mining operation debate: the industry, Powertech Uranium, and the citizen's group, Coloradoans Against Resource Destruction (CARD). Using measures drawn from previous research on procedural justice and salient values similarity, the analysis compared the relative influence of these two variables on trust judgments of CARD and Powertech Uranium. The results of the regression analysis found that both variables significantly related to trust in CARD, with salient value similarity showing a much stronger relationship. In comparison, only salient values similarity was significantly related to respondents' trust in Powertech Uranium. The results also found that 77% of respondents reported that they had heard at least something about the mine from both sources. Taken together, the findings lend support to the hypothesis that familiarity may influence the relative importance of procedural fairness and perceived shared values on individuals' trust judgments of authorities.

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#### **BUILDING REGIONAL RESILIENCE: CHARACTERIZING VULNERABILITY OF INFRASTRUCTURE SYSTEMS TO AN EARTHQUAKE SCENARIO**

Resilience of complex systems is of great interest to researchers, system operators and those who rely on system outputs. The focus here is on resilience of infrastructure systems in disasters such as earthquakes, storms or terrorism, from a regional perspective as opposed to a site or individual system perspective. The objective is to develop and apply an approach for characterizing regional infrastructure resilience in extreme events. The approach is practice-oriented, while building on important concepts from system resilience, making use of extensive interviews and a structured workshop involving infrastructure system owners and operators. We focus specifically on the potential for and implications of infrastructure system interactions (IFIs), which may prolong and greatly exacerbate the effects of an extreme event on the regional population and economy. Our approach rests on two basic assumptions: (i) previous experience with infrastructure systems in disasters is important in attempting to predict potential IFIs and their consequences., and (ii) the informed, and structured judgments of technical specialists familiar with the specific systems and their interrelationships, are crucial for understanding potential IFIs, the consequences, and the merits of mitigation efforts to reduce IFI risk. We begin with a detailed earthquake scenario for the Lower Mainland of British Columbia, reflecting recent information from provincial disaster man-

agement officials. We present the results of extensive interviews with infrastructure owners regarding (i) how their system would be expected to perform after the earthquake scenario, (ii) what that system needs and expects as inputs from other infrastructure systems in order to maintain function, and (iii) what other systems need and expect from that system.

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#### **ENVIRONMENTAL AND SECURITY RISK PERCEPTION**

The study of risk has included significant attention to perceptions of risk. In addition to characteristics of the hazard, prior research indicates that citizen perceptions of risk are driven by sociopolitical factors including status, alienation, and trust. These dimensions are, in turn, shaped by gender, race, age, and education. This paper attempts to contribute to our understanding of risk perception by analyzing several of the most important and publicly discussed risks in contemporary society: climate change, terrorism, and border security. The paper tests the extent to which common dimensions shape the perception of risk across these domains and the extent to which sociopolitical worldviews distinguish the perceptions of these risks. The data come from a survey of residents of the state of Michigan conducted in the fall of 2007.

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#### **JUST HOW CONFIDENT ARE YOU IN YOUR ANALYSIS?: THE ROLE OF ANALYTIC CONFIDENCE IN EVIDENCE-BASED TERRORISM RISK ASSESSMENTS**

When presenting their findings to decision makers, risk and intelligence analysts are often challenged by the question “just how confident are you in your results?” In fact, the expression of analytic confidence in intelligence assessments is considered to be so important that congress made it a requirement per the Intelligence Reform and Prevention of Terrorism Act of 2004. Most intelligence assessments are evidence based, where sparse information of oftentimes imperfect reliability is combined with reasoning and assumptions to form judgments of what has happened, what is happening, and what will happen in the future. Much of the terrorism risk assessment problem is of this same character, where the risk analyst is leverage the current state of knowledge of terrorism, systems vulnerabilities and response in light of available information to make reasoned arguments about a decision maker’s exposure to risk. What is lacking, however, is effective guidance on how to make statements about analytic confidence. This presentation will talk about the role of analytic confidence in evidence-based risk and intelligence analysis, to include its definition, how it differs from statistical confidence and subjective confidence, and proposes strategies for its assessment. A few new ideas will also be offered, such as conservative discounting of judgments, to demonstrate how the quantification of confidence can be included as part of an evidence-based risk assessment.

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#### **USE OF A RISK-RANKING MODEL OF SALMONELLA CONTAMINATION IN FRESH AND FRESH-CUT TOMATOES AND TO EVALUATE COST EFFECTIVENESS OF INTERVENTIONS**

Fresh and fresh-cut tomatoes have been associated with recurring Salmonella outbreaks over the last 20 years, including 10 large, multi-state outbreaks of foodborne illnesses between 2002 and 2006. These outbreaks have motivated FDA to better understand the pre-harvest and

post-harvest factors that influence the risk of contaminated tomatoes. FDA contracted with Eastern Research Group, Inc. to develop a quantitative benefits assessment and cost-effectiveness model to help identify those control interventions that substantially reduce the incidence of Salmonella in fresh and fresh-cut tomatoes and assess their relative cost effectiveness. Each stage of tomato production involves activities (such as manure application), characteristics (such as animal intrusion), and interventions (such as washing with sanitizer before packing) that increase or decrease the risk of Salmonella contamination. The model is based on a comprehensive assessment of the activities, characteristics, and interventions associated with tomato production. To determine overall contamination risk, key activity, characteristic, and intervention combinations are scored according to their contribution to the likelihood that a tomato will arrive at retail sufficiently contaminated with Salmonella to cause foodborne illness *ceteris paribus*. The relative importance of these activity-characteristic-intervention combinations are then ranked to scale their relative contribution to contamination risk. The operational model uses these risk scores and rankings obtained through an expert elicitation and data from secondary sources, such as peer-reviewed studies, government reports, and USDA farm statistics to evaluate the cost effectiveness of various interventions, such as fencing, buffer zones, or employee training programs in reducing Salmonella contamination risk. The baseline scenario of the model is calibrated using an estimate of annual current incidence of foodborne illness caused by Salmonella in tomatoes.

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#### **MEASURING THE HUMAN HEALTH RISK REDUCTION FROM MEDICAL COUNTERMEASURE STRATEGIES**

Recent Homeland Security Presidential Directives (HSPDs) 10 (Biodefense for the 21st Century) and 18 (Medical Countermeasures against Weapons of Mass Destruction) have provided specific requirements from the President for executing risk assessments specific to Weapons of Mass Destruction (WMD) for the purpose of guiding strategic planning in such areas as biodefense and medical countermeasure acquisition to defend against chemical, biological, radiological, and nuclear (CBRN) terrorism. In support of this activity, the Department of Homeland Security’s Science and Technology Directorate has developed an end-to-end quantitative CBRN terrorism risk assessment. This risk assessment models both the threat and consequences associated with particular terrorism events and calculates risk as the product of these quantities in order to support evaluation of how particular medical countermeasure strategies would reduce overall risk. Improved medical countermeasure strategies reduce risk through reduction of human health consequences of terrorism events, should they occur. To support the evaluation of various strategies detailed modeling of how the public health system would be able to mitigate fatality and illness consequences of such an attack was performed. In this talk, a simple discrete event simulation model describing the progression of events following a covert terrorist attack with a biological agent is briefly described, followed by discussion of the methodological approach to using the outcomes of this model to measure human health risk reduction within the CBRN terrorism risk assessment. Three human health risk reduction metrics are explored. Each metric provides different, yet valuable information to the risk manager to support more informed decision making.



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**CRS CRITERIA FOR TESTING THE APPLICABILITY OF ADAPTIVE MANAGEMENT CONCEPTS TO EMERGENCY PLANNING AND RESPONSE: A STUDY CASE FOR FIRE**

Concepts of adaptive management have begun to be considered for disaster mitigation and emergency response. A fundamental basis for the view that adaptive management concepts can be effective for disaster mitigation and emergency response is the assertion that one cannot develop disaster mitigation and emergency response plans or policies which can a priori anticipate all possible events, and therefore, the plans and policies should be structured in such a way so as to learn from actual events as they occur, or within a reasonable time after the event, and adapt appropriately. Adaptive approaches make sense for disaster mitigation and emergency response because the situations are complex and adaptive, changing with time, agent, and agent influences, are highly uncertain and challenging to predict (at least for some critical details), and the ultimate effectiveness is driven by actions taken by agents during events. In considering various perspectives on complex adaptive systems and adaptive management, the Center for Risk and Security (CRS) suggest that adaptive management concepts may be well suited to some, but not all, types of disaster mitigation and emergency response planning and implementation, and propose a set of key assumptions, goals and features for use in determining suitability for adaptive approaches. The CRS criteria for testing the applicability of adaptive management or emergency planning and response are presented, along with outcomes of a study case for fire as an extreme event. The study case illustrates that adaptive management concepts can be helpful in identifying better fire regulatory approaches, mitigation design concepts, evacuation strategies and emergency response requirements, including technologies and strategies to increase situational awareness for building occupants and first responders, which will result in more efficient and effective evacuation and emergency response, and decreased life loss, damage and financial impact.

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**ECOLOGICAL RISK ASSESSMENT FOR NANOMATERIALS: NATO WORKING GROUP DISCUSSION SUMMARY**

This presentation summarizes discussions during the NATO Workshop in Portugal. The ecological risk assessment WG discussed a number of past case studies where the traditional approach to risk assessment failed to reveal unforeseen risks, including recent developments with perfluorinated surfactants (PFOA/PFOS) where unexpected fate and biological effects became evident only after approval and inclusion of these compounds in a variety of consumer products (e.g., Teflon). In the opinion of the working group, the pace of development of nanomaterials will exceed the capacity to conduct adequate risk assessments using current methods and approaches. The WG recognized that traditional risk assessment procedures are inadequate for predicting the ecological risks associated with the release of nanomaterials. The problem lies in an inadequate application of solid phase chemical principles (e.g., particle size, shape, and functionality) in the risk assessment of nanomaterials. The WG proposed that traditional risk assessment processes could be augmented by having the risk assessors play a more proactive role in evaluating all aspects of the nanomaterial life cycle, allowing the assessor to better formulate the problem. Risk assessors should be integrally involved in both the manufacturing and material development, providing information relevant to risk assessments to the product developers, and involved in decisions to utilize appropriate lower-risk materials, without compromising the desired characteristics

of the materials. In addition, risk assessors should obtain specific information regarding material properties for the development of new risk models.

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**MEASUREMENT ERROR IN DISINFECTION BY-PRODUCT EXPOSURE ASSESSMENT DUE TO SPATIAL AND TEMPORAL VARIABILITY**

Most epidemiological studies of disinfection by-products (DBPs) rely on town-average (i.e., group-level) total trihalomethane (TTHM) concentrations as a surrogate measure for individual-level exposure. In addition to ignoring inter-individual variability, these data may not adequately capture spatial and temporal variability in DBP concentrations. We assessed temporal and spatial variability in routinely-collected DBP monitoring data for 16 large water distribution systems in Massachusetts. Preliminary data for ten years (1995-2004) suggest that TTHM concentrations have begun to decrease over time. Mean TTHM value decreased from 50 to 38 µg/L in 1995 versus 2004, most likely due to treatment process changes in anticipation of the DBP Stage 1 rule (effective in 2004). We also detected seasonal variability with average TTHM concentrations 30-40% higher in the summer compared to the winter. We also examined towns with high spatial variability to determine the validity of using town average concentrations to estimate individual level DBP exposures. Five of the towns showed high spatial variability amongst the quarterly sampling locations. One-half of the sampling locations in these towns had TTHM concentrations differing by more than 60%. This spatial variability was fairly consistent (30-50%) across the quarterly sampling periods, although most towns demonstrated less spatial variability in the winter quarter. These preliminary data on 16 of 180 towns demonstrate the need to examine the impact of measurement error due to temporal and spatial variability in assigning individual-level DBP values. In systems with considerable spatial variability, average town-level data may not adequately characterize exposures for individuals in these water systems. Temporal variability also has important implications for exposure assessment in epidemiological studies especially for health outcomes with narrow critical periods of exposures.

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**RECOMMENDATIONS FOR IMPROVING RISK ASSESSMENT TO BE USEFUL IN RISK MANAGEMENT**

This presentation will focus on conclusions of the ITRC Risk Assessment Resources team overview document titled Use of Risk Assessment in Management of Contaminated Sites. Key findings of the document will be presented and factors of variance that impact risk assessment findings will be discussed. Recommendations for improving the practice and implementation of risk assessment in managing hazardous waste sites will be presented.

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**IMPORTANCE OF EVENT IDENTIFICATION AND COUNTERMEASURE DELIVERY IN MEDICAL MITIGATION STRATEGIES FOR BIOTERRORISM**

Homeland Security Presidential Directive 21 (HSPD-21), Public Health and Medical Preparedness, establishes a broad national public health and medical preparedness strategy for protecting the health of the American people against all disasters. The Department of Homeland Security uses quantitative risk analysis in support of strategic preparedness planning for Chemical,

Biological, Radiological, and Nuclear (CBRN) terrorism events. A critical component of these analyses is the public health response model used to estimate the time required for event identification, the ability of the public health system to provide the necessary countermeasures for mitigating an attack, and countermeasure quantity and efficacy. In particular, this public health response model can be used to assess the benefit that is expected to result from the preparedness and response strategies outlined in HSPD-21. In this talk, the impact of the timeline under which the public health system identifies and responds to a bioterrorism event will be discussed. Mitigation of a terrorism attack requires that the attack be recognized, the causative agent identified, and the appropriate prophylaxis and/or treatment be administered to those people affected. Presented here are studies examining the impact of speed of clinical diagnosis after a mass exposure event for various biological agents and countermeasure deployment options using the public health response model developed for use with the DHS Bioterrorism Risk Assessment.

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#### **RISK ASSESSMENT OF NANOPARTICLES IMPACT ON ORGANISM BASED ON BIOLOGICAL MARKERS SYSTEM**

The adverse effects of nanoscale particles are mostly related to the surface area and surface characteristics that are considered to be key factors in the generation of free radicals and reactive oxygen species. The aim of this study was to evaluate the effect of carbon nanoparticles (CNP) on organismal and cellular levels and to estimate their involvement into free radical processes, energy metabolism, membrane structural changes and genotoxic effect. Biological markers system includes DNA damage detection, estimation of xanthine oxidase (XO) activity, bioenergetic status, phospholipids profile and apoptose related mobile lipid domains (MLD) formation in Ehrlich ascite carcinoma cells (EAC) in vivo and in vitro exposed to fullerene C60 and multiwalled carbon nanotubes (MWCNT). Cells exposures to CNP induced dose-dependent DNA damage both in in vivo and in vitro systems. Treatment with MWCNT led to escalation of hypoxia and activation of membrane component synthesis as determined by 31P NMR. Effects of fullerene or high doses of MWCNT revealed activation of energy metabolism and reduction of membrane permeability, low doses of MWCNT caused opposite changes. Phospholipid metabolism decreased after treatment with fullerene or low concentration of MWCNT, exposure to high doses of MWCNT caused elevation of phospholipids content. Treatment with CNP increased XO activity but level of the lipid peroxidation was decreased. 1H NMR analysis confirmed apoptosis associated MLD formation in fullerene C60-treated cultured cells in contrast with MWCNT. Use of biomarkers demonstrated that CNP may pose genotoxic effect, change energy metabolism and alter membrane structure, modify free radical level via XO activation and cause MLD formation as determined on EAC model and in cell culture. Obtained correlation between exposure cells to CNP and corresponding changes of the studied biomarkers suggest their use for risk assessment related to toxic and carcinogenic CNP impact on living cells.

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#### **AN EVALUATION OF THE RISK THRESHOLD FOR PROPHYLAXIS AND TREATMENT AFTER AN ANTHRAX RELEASE**

In the wake of the 2001 terrorist attacks, the use of *Bacillus anthracis* (anthrax) in bioterrorism is of concern. Thus, it is necessary to prepare a contingency plan in case of such an attack. While antibiotic prophylaxis alone or in combination with vaccination is clearly justified for indi-

viduals exposed to substantial quantities of spores, there are likely to be very large numbers of individuals exposed to very small quantities of spores. The risk of infection is variable based on the size of the release and/or the amount of exposure to which a person is subjected. At lower risk, the "no action" alternative is therefore important to investigate. This study addresses the establishment of a risk threshold at which individuals should receive antibiotics, be vaccinated or both. A decision model was developed to evaluate the costs and benefits associated with each alternative. The risk of infection necessary to justify treatment was estimated to 0.0052 percent or 1 in 20,000 individuals. This conclusion is sensitive to a variety of factors, including the monetary value of a quality adjusted life year.

**M3-E.4** Mokhtari A, Beaulieu S, Jaykus L, Dennis S; amokhtari@rti.org  
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#### **FOOD SAFETY RISKS ALONG THE FARM-TO-FORK CONTINUUM: QUANTITATIVE MODELING OF HIGH PRIORITY PATHOGEN-COMMODITY PAIRS**

Fresh produce may become contaminated with pathogens at any point during cultivation, harvesting, processing, distribution, or preparation. Although only a small number of these pathogen-commodity combinations have been epidemiologically linked to human disease, the impacts on public health and economic welfare associated with these outbreaks can be severe. Given the wide range of pathogen-commodity combinations of potential concern, the FDA needs practical tools to characterize the risks and explore different mitigation strategies. In response to this need, we developed a quantitative predictive risk assessment model (QPRAM) that simulates the probability of pathogen contamination during each stage of the continuum. The QPRAM is a stochastic model designed to characterize baseline risks and estimate potential reductions in risk that may be achieved through proposed interventions to prevent, reduce, or eliminate pathogen contamination at critical points along the farm-to-fork continuum. The model is supported by a comprehensive relational database which provides scientifically-based information on the specific pathogens and produce items; its flexible design allows for an unlimited number of refinements by incorporating subroutines and/or additional data. This work provides: (1) a mathematical approach for predicting the contamination of fresh produce along the farm-to-fork continuum; (2) a practical tool with which to compare/contrast proposed mitigations aimed at reducing the risk of disease incidence; and (3) a transparent methodology to establish risk-based standards for mitigation strategies.

**W3-D.2** Mora-Applegate L, Siddhanti, S\*; ligia.mora-applegate@dep.state.fl.us  
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#### **INSIGHTS ON USE AND IMPLEMENTATION OF RISK-BASED CRITERIA AT SITES BY VARIOUS STATE REGULATORS**

A hypothetical case study was constructed to present as simple a site as possible that would still allow some insight and comparison into how risk-based corrective actions are implemented at various states and how they deal with similar complications, such as soil data and its inherent variability, use and implementation of soil criteria, land use scenarios, interpretation of sampling results, comparison to risk screening criteria or cleanup values, exposure unit size, risk management options. Participating State representatives completed a review of a hypothetical case study - a former skeet range sampled at 76 locations for lead. Soil samples were taken at 0 to 6 inches and 6 to 12 inches at each sampling location and analyzed by US EPA method 6010/6020. The hypothetical project is proposed to be developed into six residential lots. The sampling locations were provided in a plot map along with the layout of the proposed development and a conceptu-

al site model. Because of this, the participants answered several questions in the prospective mode - describing what options might be acceptable, and what the requirements (sampling, removal, engineering controls, institutional controls etc.) might be for those options. Lessons learned and results from this exercise provide a useful insight for risk management.

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#### **IMPROVING COMMUNICATION OF WEATHER FORECAST UNCERTAINTY INFORMATION BY UNDERSTANDING ITS USE IN DECISION MAKING**

Future weather is inherently uncertain, and weather forecasts are received and used every day by millions of people in both everyday and hazardous weather situations. This makes weather forecasting a form of risk communication that is familiar to much of the public. Meteorologists have substantial information about uncertainty in future weather, yet most weather forecasts communicated today are single-valued, in other words, do not reflect the forecasts' uncertainty. Two important components of providing useful weather forecast uncertainty information are understanding how people perceive and interpret uncertainty information and how different types of uncertainty information affect people's weather-related decisions. To begin building this knowledge empirically, we incorporated several questions about people's perceptions, interpretations, and uses of weather forecast uncertainty information into a nationwide, controlled-access Internet survey with over 1500 respondents. The survey included a set of hypothetical scenarios in which the respondents were asked to use precipitation or temperature forecasts to make decisions to protect or not protect (involving monetary costs) from a potential flood or frost (involving monetary losses). For each scenario, respondents were given deterministic forecasts and forecasts that explicitly conveyed uncertainty in different ways, and they were asked what decision they would make with the different information. These scenario questions are similar to experimental economics approaches that empirically assess how individuals use information. Using an expected value framework, we examine whether individuals were able to make better decisions using the forecasts with uncertainty information than without that information, and we explore their inferences of forecast uncertainty. This paper will discuss findings from the uncertainty communication component of the survey, including initial analysis of data from these scenario questions.

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#### **COMMUNITY READY! ASSESSING AND MEETING THE NEEDS OF PARENTS IN ARLINGTON COUNTY, VIRGINIA**

A multi-level public health preparedness study was conducted on parents in Arlington County, VA, with an emphasis on the Latino community in order to address their preparedness needs. Methods: A survey was administered to parents attending parent/teacher conferences in March of 2006. The survey was administered in English or Spanish and was used to evaluate English and Spanish speakers regarding their levels of personal preparedness, access to preparedness materials, and personal needs. Statistical analyses were performed to characterize the sample population and predict personal preparedness. The analysis was performed in April of 2006. Results: English-speaking respondents reported more formal education than Spanish-speaking respondents, with 75% vs. 18%, respectively, receiving a high school degree or beyond. English-speaking respondents most prefer the Internet (68%) and Spanish-speaking respondents prefer television (87%) for receiving information. Both groups were most concerned about fires (E=63%

and S=86%) and acts of terrorism (E=69% and S=84%). Speaking English was associated with being prepared for hurricanes (OR=2.41, 95% CI=1.29-4.51) and terrorist attacks (OR=3.01, 95% CI=1.59-5.72). Conversely, speaking Spanish was associated with not being prepared for hurricanes (OR=0.42, 95% CI=0.22-0.78) and terrorist attacks (OR=0.33, 95% CI=0.18-0.63). Conclusions: Spanish speakers surveyed were less prepared for emergencies than English speakers. Differences between groups, such as language and cultural barriers, lower literacy levels, and different preferences for acquiring information need to be considered in designing preparedness outreach programs for the Latino population. Based on this study a model is being developed, called Community Ready!, which could be reproduced in other municipalities and school districts.

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#### **PANDEMIC FLU PLANNING FOR THE CITY OF ALEXANDRIA, VIRGINIA.**

The City of Alexandria, Virginia has developed a comprehensive report to address the needs of their community in the event of a pandemic flu. The report was developed based on the following key three assumptions: - The challenge of pandemic flu, or any other potential public health hazard, is ongoing and constantly evolving. - Potential public health emergencies like a pandemic are a challenge and encompass all elements of the City. - "All hazards" planning will strengthen the City's capacity to address pandemic flu as well as other emergencies. Communication with the public is a key element of the pandemic flu plan. The primary goal for the City of Alexandria is to inform ALL PEOPLE about public health preparedness. In order to assure all members of the community are reached, outreach efforts will target all vulnerable populations for whom traditional communication channels may be less viable. A comprehensive matrix of audiences and methodologies was developed. A special brochure, a number of posters to be placed around the City and a pre-designed presentation applicable to many audiences have been created. Sessions are being conducted to "train trainers" so that information can be widely disseminated. By taking an all emergencies preparedness approach and involving members of the entire community in a city-wide response, the City of Alexandria will ensure all people receive information, materials, and services vital to protecting everybody's health and safety.

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#### **AGROTERRORISM AND FARM MANAGEMENT**

Agroterrorism is the potential of terrorist attacks against agricultural targets such as livestock and crops. Biological weapons (e.g., foot-and-mouth disease) against livestock pose the greatest risk because they are easy to produce and have widespread effects. Preparing for an agroterrorism event involves consideration of the following key elements: (1) Building surveillance systems that are integrated into a community that can respond to a number of events (2) Planning for an event (3) Educating all members of the community. Surveillance is a key element in preparing for this type of event. Partnerships need to be created between: public health, veterinary health, farm workers, farm management, poison control centers, emergency communication centers, animal shelters, game wardens and others. First responders are faced with a number of challenges including: difficulty in detecting and identifying affected animals, shortage or lack of on hand antidote and a lack of animal vaccination. Communication is a key element of an agroterrorism plan. A primary goal for developing a community preparedness for agroterrorism is to educate all members of the community including farm owners, farm workers, veterinarians, local,



state and federal officials BEFORE an agroterrorism event occurs. In order to assure all members of the community are reached, outreach efforts should target the "hard to reach" members of the community for whom traditional communication channels may be less viable. A comprehensive matrix of audiences and methodologies will be developed for the farm industry. The development of a pre-designed presentation targeted to and for the farm workers will be created by the GWU SPHHS. Sessions will be conducted to "train trainers" so that information can be widely disseminated. By taking an all emergencies preparedness approach and involving members of the entire community in a community-wide response, the farming industry will ensure people receive information, materials, and services vital to protecting health and safety.

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### **CHARACTERIZING THE QUANTITATIVE FEATURES OF HORMETIC DOSE-RESPONSES IN A SINGLE HIGH-THROUGHPUT ASSAY EVALUATING ANTICANCER AGENTS**

Presented here is a unique analysis of the quantitative features of select dose-responses generated from a single study that evaluated the response of 13 yeast (*Saccharomyces cerevisiae*) strains to 2,189 putative anticancer agents, resulting in 28,457 replicated dose-responses. We have used a previously described entry and evaluative methodology to determine the quantitative features of the hormetic dose-responses in this database. The quantitative features of the hormetic curves that are described are: (1) the width of the concentration range showing stimulation above 10% of the control (mean of 5.3-fold), (2) the maximum stimulation of the concentration-responses (mean of 127.4%, compared to a control of 100%), and (3) the width from the maximum stimulation to the toxic threshold (mean of 6.7-fold). These data are compared across the 13 yeast genotypes, as well as with previously reported quantitative features of other chemicals displaying hormetic dose-responses. In addition we will describe the relationship between the toxic threshold (the zero equivalence point) and the magnitude (height) of the stimulatory response. These results show that 51% of the 2,189 anticancer agents evaluated display hormetic dose-responses in at least one of the 13 yeast strains used as models for human cancers. While there have been prior meta-analysis type studies that quantitatively describe the dose-response relationships of previously published dose-responses, this paper represents the first work that focuses entirely on the results of a single defined study (e.g., the NCI Yeast Anticancer Drug Screen). Thus, this analysis has the advantage of evaluating hormesis in 28,457 dose-responses that were derived from identical experiments conducted in the same laboratory.

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### **STATISTICAL EXAMINATION OF THE POSSIBLE LINK BETWEEN CLIMATE CHANGE AND HURRICANE HAZARD IN THE UNITED STATES**

A great deal of attention has been directed towards the possibility of climate change leading to increases in hurricane hazards in the U.S. The objective of this research is to analyze the potential relationship between climate variability, climate change and hurricane hazards in the Atlantic Coast and Gulf Coastal Regions of the United States. Counts and intensities of hurricanes that made landfall in the United States since 1948 were used, dividing the U.S. coast into three distinct sections: the Atlantic Coast excluding Florida, Florida State, and the Gulf Coast excluding Florida. The impact of 173 climate-related variables on yearly cumulative destructive potential of land-falling hurricanes was subsequently studied. This study talk presents the result of using distinctly

different statistical modeling approaches than used in the previous works in the literature to examine the possible link between climate variables and the frequency and intensity of hurricane land-falls in the United States. The results will yield a clear insight into whether warmer climates (induced by anthropogenic green house gas emissions) will indeed lead to higher hurricane frequency and intensity in the future.

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### **DERIVATION OF AN ORAL CANCER SLOPE FACTOR FOR 4-(METHYLNITROSAMINO)-1-(3-PYRIDYL)-1-BUTANONE USING THREE APPROACHES**

The tobacco-specific nitrosamine (TSNA) 4-(methylnitrosamino)-1-(3-pyridyl)-1-butanone (NNK) is detected in tobacco products at varying concentrations. Risk assessment involving TSNAs largely relies on potency values estimated from animal models. In the case of NNK, available oral cancer slope factor (CSFo) values are highly conflicting. This report presents three approaches to deriving a CSFo for NNK based on US EPA guidelines. The key study utilized in the present analysis provided the largest number of dose groups, the largest number of animals per group, and the lowest dose range to evaluate tumor incidence in response to NNK exposure. In the selected study, male F344 rats were exposed to NNK via drinking water for 27 months. Statistically significant increases in lung, pancreatic, liver and nasal cavity tumors were observed, with lung tumors identified as the most sensitive endpoint. The first approach in deriving a CSFo for NNK used US EPA recommended default values for dosimetric adjustments. The second approach primarily relied on values abstracted from the experimental data presented in the key study. In both approaches, the multistage-cancer model was fitted to the tumor incidence data to determine a point of departure for low-dose linear extrapolation, assuming a genotoxic mode of action and using a benchmark response of 10%. While both CSFo values derived here were lower than the expedited estimate available from California EPA, the CSFo obtained based on experimental data was approximately 3-fold higher than the value derived by sole use of default assumptions. As a third approach, the dose response model was fit using Bayesian methods, and the CSFo was recalculated. Monte Carlo simulations were used for generating a distribution of the CSFo. In conclusion, the approach using Bayesian methods better accounts for the uncertainty inherent in the values generated using input assumptions and provides for a more robust dose-response assessment.

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### **A PROBABILISTIC CANCER RISK ASSESSMENT MODEL OF 4-(METHYLNITROSAMINO)-1-(3-PYRIDYL)-1-BUTANONE IN SMOKELESS TOBACCO**

The compound 4-(methylnitrosamino)-1-(3-pyridyl)-1-butanone (NNK) is found in tobacco products at varying levels. This report describes a probabilistic lung and pancreatic cancer risk assessment model of NNK in two categories of commercially available smokeless tobacco (ST) products, moist snuff and snus. The concentration of NNK as well as moisture content varied considerably between products tested. Distributions incorporated in the model included: NNK moisture-adjusted concentration (built from quantitative chemical analysis data collected in triplicate for each product), daily ST consumption (based on market surveys and the peer-reviewed literature), frequency of use and body weight (based on data from the 1999-2006 National Health and



Nutrition Examination Surveys) and duration of use (based on U.S. Census Bureau life expectancy data). A distribution of NNK oral cancer slope factors was also used in the risk model. Risk characterization by Monte Carlo simulations revealed that the median lifetime lung cancer risk estimate was  $3.84 \times 10^{-4}$  for snus products and  $1.43 \times 10^{-3}$  for moist snuff. The median lifetime pancreatic cancer risk was lower for both product categories and was estimated to be  $2.49 \times 10^{-4}$  for snus and  $8.91 \times 10^{-4}$  for moist snuff. In both cases, the estimated risk presented by NNK was significantly lower for users of snus products compared with users of moist snuff. Sensitivity analyses indicated that overall, the concentration of NNK in the product and the daily ST consumption had the greatest impact on the risk outcome. By allowing the analyses of multiple observations of each parameter in the model, the probabilistic analysis described here provides a better informed conclusion on the cancer risk presented to ST users by NNK than deterministic methods. The resulting distribution of the risk outcome translates into greater confidence in health-based risk management decisions needed to guide the necessary actions for harm reduction.

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#### **THE RURAL COMMUNITIES OF NEVADA AND NATIONAL DEFENSE EXTERNALITIES: AN EXAMINATION OF PUBLIC ATTITUDES TOWARD ENVIRONMENTAL ACTIVITIES AT THE NEVADA TEST SITE**

The long term relationship between rural communities and nearby industrial sites is complex given the potential conflicts among economic, social and environmental factors. There are few papers that examine the relationship between rural communities of Nevada and the Nevada Test Site where the U.S. government conducted over 900 nuclear tests above and below ground between the early 1950s and 1992. Some papers such as Schwer and Waddoups (1996) examined the impact of the US nuclear moratorium on workers but did not distinguish impacts on workers living near the Nevada Test Site. To address this gap in the literature, the purpose of this paper is to measure the awareness and attitudes of citizens from rural communities surrounding the Nevada Test Site. We distributed a mail questionnaire and received 837 responses, a 14% response rate. Our results showed that the majority of respondents supported present cleanup efforts and risk reductions for future generations. To examine attitudes and awareness levels further, we presented results from multiple binary choice models to identify which characteristics were significant predictors.

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#### **A RISK ASSESSMENT OF ACRYLAMIDE INTAKE FROM DRINKING COFFEE**

Coffee drinking is a common habit in the American society. Looking at American's diet habit with lots of de-fried starchy based food, such as French fries, potato chips, and pizza, the populations tend to have higher risk of exposure to acrylamide from dietary intake. The health risk caused by acrylamide ingestion from diet is a big concern for the American society. This research is mainly focus on the additional health risk of exposure to acrylamide from coffee drinking in the American society. Research showed with the increasing roasting time of coffee, the concentration of acrylamide drops. Medium roasted coffee beans tend to contain higher concentrations of acrylamide than dark roasted coffee. Since the formations of acrylamide vary because of processing temperature and roasting time, the amounts of acrylamide are diverse in different manufactures of coffee. A risk assessment of acrylamide intake from coffee was conducted for both cancer risk and non-cancer risk. Risk was calculated for dark roasted coffee, medium roasted coffee, and instant coffee. Cancer risk was estimated according to two exposure scenarios, average exposure scenario

and reasonable maximum exposure scenario. The carcinogenic risk for average exposure scenario was in the range of  $1E-05$  and  $1E-06$ . For reasonable maximum exposure scenario, the carcinogenic risk was at the  $1E-04$  level. Non-carcinogen risk assessment was also conducted in two scenarios, average exposure scenario and reasonable maximum exposure scenario. For both scenarios, hazard indexes were both well below 1.

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#### **RE-INVESTIGATING THE FACTORS AFFECTING CONSUMERS' FOOD-RELATED RISK PERCEPTION; A CROSS-NATIONAL CASE STUDY APPLYING LADDERING METHOD**

The gap in risk perception between experts and general public has been well established in many risks. To carry consensus-based food-related risk management, thorough understanding of consumers' perception of risks, knowledge, attitude, and behavior as well as factors affecting them is essential. According to previous studies, not only the characteristics of hazard and/or risks but also individual and social factors such as socio-demographic and personality characteristics, confidence on institutions, experience and socio-cultural background etc. influence the risk perception of consumers. Although the uniqueness of psychological concerns in food related risks have been indicated, quantitative research on public risk perception on food have often been conducted based on the fact indicated by Slovic which covered wide range of risks. In this study, we tried to investigate the factors and reasons why does consumer perceive specified food-related risk as high or low by applying laddering method. In-depth face-to-face interview were conducted on 46 female who are mother of school-aged-child; 11 in Japan, 11 in Korea, 11 in USA and 13 in Vietnam. Along with rating food-related risk of 14 hazards including chemical and biological substances and dietary pattern, the respondents were asked the reasons why they think the specific hazard as high or low risk. Then, continuous question why the mentioned factor makes her feel the risk as high/low until no new factors are indicated. The results indicated that the perception of risk severity of food-related hazards varied between countries. Moreover, the factors affecting their perception also were characterized among countries. Japanese respondents tend to judge the risk by recalling visual scenery or image. On the other hand, logical thinking (apart from accuracy of knowledge) was observed in US and confidence on government and experts were mentioned in Korea.

**M4-F.5** Nowak E, Caldwell D, Mastrocco F, Johnston J, Anderson P, Hoyt M, Pfeffier D; paul.anderson@amec.com

Johnson & Johnson Pharmaceutical Research and Development, L.L.C., Pfizer Inc, Wyeth, AMEC Earth & Environmental

#### **AN ASSESSMENT OF EXPOSURE TO PRESCRIBED ESTROGENS IN DRINKING WATER**

Detections of estrogens in the environment have raised concerns in recent years because of their potential to affect both wildlife and human development. Often little context is provided as to whether potential exposure to estrogens in drinking water (present from excretion after human therapeutic use) in the United States is large or small compared to other sources of exposure (e.g., dietary intake) and whether they are similar to, above, or below acceptable daily intakes. This study uses the PhATEA model to estimate exposure to prescribed estrogens in drinking water and compares those to the exposure to naturally occurring background levels of estrogens in the diet

and also to several independently derived allowable daily intakes (ADIs). Estrogens predicted to be present in drinking water (from excretion after human-use) comprise less than 0.0001% of total estrogen exposure on a mass-basis. Translating these estimates of potential exposure into estimates of potential risk from estrogens in drinking water can be complex. Estrogens affect many endpoints and their relative biological activity varies among endpoints. In addition, the traditional method of using receptor binding to account for differences in potency fails to take into consideration more recent understanding of other factors that regulate the biological activity of estrogens. Appreciating these uncertainties, this analysis uses a range of estimates of relative potency (derived primarily from alpha and beta receptor binding studies) and finds that exposure to total prescribed estrogens in drinking water is between 700 to 18,000 times lower than exposures to background levels of naturally occurring estrogens in the diet. Exposure to total prescribed estrogens in drinking water is also far below several available ADIs. The consistently large Margins of Safety for all comparisons clearly indicate that prescribed estrogens in drinking water in the United States are not causing adverse effects in US residents.

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#### **EXPERIENCE IN TEACHING THE CONCEPTS OF VARIABILITY AND UNCERTAINTY IN ENVIRONMENTAL RISK ANALYSIS**

Variability and uncertainty are key concepts in all quantitative risk assessments. Here, we will describe and discuss how these concepts can be introduced with practical examples and problem solving, in university teaching of environmental risk analysis. Our discussion will particularly focus on the methods found in two popular calculation and simulation software - Crystal Ball® and Risk Calc™ - that are used in our master's program at the University of Kalmar, Sweden. Multimedia models for exposure assessment are easy to implement with both software, although the separation of variability and uncertainty can be realized with fundamentally different approaches. Likewise, dependency assumptions and incomplete information is often treated differently. We have found it very useful for students in the advanced classes to experiment with these different approaches to model the same or similar problems. These exercises bring further insight into statistics, probabilities, modeling, and the many assumptions involved in probabilistic exposure models. Additionally, the different approaches to treat uncertainty - intervals, probability distributions, and "p-boxes" - raise interesting questions regarding the boundaries of knowledge.

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#### **THE INFLUENCE OF A NUCLEAR POWER PLANT'S LOCATION ON THE IMAGE OF THE REGION, AND THE EFFECT OF INFORMATION EMPHASIZING THE BENEFITS OF THE NUCLEAR POWER PLANT**

This research studied the influence that a nuclear power plant's location has on the image of the region, from a psychological viewpoint. It also examined the effect of information emphasizing the benefits of the nuclear power plant on people's image of the region. This survey was conducted in Japan with 2,000 randomly selected adult participants. The participants were divided into four groups: group 1 was given information about the nuclear power plant's location and benefits; group 2 was given information about the benefits only; group 3 was given information about the location only; and group 4 was given no information. Three factors, 1) comfort of living there, 2) possibility of growth, and 3) volume of energy, were extracted by factor analysis of twenty items concerning image of the region. It was found that when the participants were

informed that nuclear power plants were located in the region, the image depicted by nine of the items constituting the "comfort of living there" factor changed negatively. However, the image of four items of the "possibility of growth" factor changed positively, and the image depicted by seven of the items of the "volume of energy" factor did not change. On the other hand, providing information concerning the benefits of a nuclear power plant did not lead to a negative change in image in the case of three of the nine items constituting the "comfort of living there" factor, namely, 1) cheerful, 2) prosperous, and 3) being clean. This indicates that giving information about the location of a nuclear power plant may not affect the image of the region, if information about the benefits of the nuclear power plant is given.

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#### **PROBABILISTIC AND MONTE CARLO RISK MODELS FOR CARBON NANOMATERIAL PRODUCTION PROCESSES**

Given considerable uncertainty surrounding the occupational, consumer, and environmental, health and safety (EHS) risks of various nanomaterial manufacturing processes, modeling their relative risks and benefits is especially important. This paper discusses possible risk assessment methods that might be useful in such applications and explores three probabilistic approaches in greater detail: Monte Carlo (MC) simulation models, Bayesian belief networks, and multi-criteria decision trees. These approaches are illustrated for single wall carbon nanotubes (SWNT) produced via high pressure carbon monoxide (HiPco) processes to study the impact of inherent uncertainties and early EHS standards decisions on predicting long-term manufacturing costs, occupational health (OH) exposure risks, and associated tradeoffs. Until research progresses on the EHS risks of nanomaterials, these types of analyses can provide useful information for private and regulatory decision-makers and for guiding research priorities.

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#### **RISK COMMUNICATION IN GLOBAL CLIMATE CHANGE: POLICY ISSUES AND CHALLENGES FOR NIGERIA**

Nigeria and its people are expected to be most affected by climate change through sea level rise along its coastline, intensified desertification, erosion, flood disasters, and general land degradation. Although Nigeria has signed up to the United Nations Framework Convention for Climate Change, much still needs to be done to develop local awareness, knowledge and expertise. To make informed decisions about climate change, policy-makers will need timely and useful information about the possible consequences of climate change, people's perceptions of those consequences, available adaptation options, and the benefits of slowing the rate of climate change. Perhaps the biggest obstacle to reducing the impact of climate change in Nigeria is lack of awareness and knowledge. Lack of information and knowledge about climate change also means that many Nigerians are reluctant to accept the reality. As well, there is a lack of public policy, government preparedness and commitment to promoting climate change adaptation strategies in the country. Given the existing low level of awareness about climate change in Nigeria, the way the risk of climate change is presented to the public will determine the way the public will take it and react to it. Fortunately, there is the prospect that the connection between climate change and its impacts, once established by the public, will invigorate the debate on the scale and nature of action to be taken. There is, therefore, need for studies that will develop frameworks for methodology to assess the status of public awareness among the populations in Nigeria on climate change, coping

mechanisms and adaptation strategies. Using empirical methods and analysis, this study addressed these issues and justified the need to integrate people's knowledge and understanding of climate change and potential response measures into existing development frameworks, particularly those which promote participation of stakeholders in Nigeria.

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#### **CLIMATIC CONSEQUENCES OF NUCLEAR CONFLICTS**

We use a modern climate model and new estimates of smoke generated by fires in contemporary cities to calculate the response of the climate system to a range of nuclear wars, producing 5, 50, and 150 Tg of smoke. The response to both regional and large scale nuclear war scenarios produce climate changes that are large and long-lasting because the fuel loadings in modern cities are quite high and solar insolation heats the resulting smoke cloud and lofts it into the high stratosphere, where removal mechanisms are slow. We find that even a much smaller regional nuclear conflict can have global effects. The significant cooling and reductions of precipitation would last years, which would impact the global food supply and have devastating consequences for the planet.

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#### **PANDEMIC ANALYSIS: INCORPORATING TIME VARYING PERTURBATIONS INTO THE DYNAMIC INOPERABILITY INPUT-OUTPUT MODEL**

Economists have long understood and conceptualized the inherent interdependent relationships among different sectors of the economy. This concept paved the way for input-output modeling, a methodology which accounts for sector interdependencies governing the magnitude and extent of ripple effects due to changes in the economic structure of a region or nation. Recent extensions of input-output modeling have enhanced the model's capabilities to account for the impact of an economic perturbation; two such examples are the Inoperability Input-Output Model and the Dynamic Inoperability Input-Output Model (DIIM). These models introduced sector inoperability, or the inability to meet as-is production plans, into input-output modeling. While both model extensions provide a foundation for understanding the impacts of inoperability, there are several aspects of the current formulation that do not account for idiosyncrasies associated with certain disasters, such as a pandemic. This research extends the formulation of the DIIM to account for economic perturbations resulting from an event such as a pandemic which creates a time varying and probabilistic inoperability to the workforce. A pandemic is a unique disaster, because the majority of its direct impacts are workforce-related. Therefore, the paper first develops a method of translating unavailable workforce into a measure of sector inoperability. Additionally, while previous formulations of the DIIM only allowed for the specification of an initial perturbation, this research incorporates the fact that a pandemic can cause direct effects to the workforce over the entire period of time that it affects a region. Lastly, given the uncertainty associated with the impact of a pandemic, the paper develops a simulation model to account for the possible variations in consequences. The enhancements to the DIIM formulation are incorporated into a MATLAB program and applied to a case study to simulate a pandemic scenario in Virginia.

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#### **USE OF MULTI CRITERIA DECISION ANALYSES TO PRIORITIZE RISKS AND ALLOCATE RESOURCES**

Decision analysis methods, including multi criteria and risk-based prioritization systems are objective and transparent tools for comparing risks and aiding in the allocation of resources. FDA is investigating the use of these tools to assist in the implementation of goals outlined in the 2007 Food Protection Plan (FPP). The FPP aims to identify and prevent food-borne contamination, intervene at critical points in the food supply chain, and respond rapidly to minimize harm. Key principles in a comprehensive food protection approach include (1) the focus on risks over a product's life cycle from production to consumption and (2) the need to target resources to achieve maximum risk reduction. A risk ranking/evaluation process includes categorizing/classifying commodities and identifying hazards of public health concern. A prioritization process reveals data gaps and illuminates aspects of the food protection system where applying resources into inspection, regulation, new mitigation technologies, research, education or outreach, would serve to improve food safety. This presentation will highlight current agency thinking and progress to develop a systematic framework for risk ranking and prioritization of hazards in food commodities

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#### **CONCEPTUAL FRAMEWORK FOR ANALYSIS OF UNCERTAINTY IN COUPLED MODELS FOR THE SOURCE-TO-DOSE CONTINUUM**

Quantitative assessment of the continuum of human exposure to air pollutants and the associated health effects requires consideration of air quality, exposure assessment, and dose assessment. Traditionally, each of these three major components of the source-to-dose continuum are addressed by different expert communities and using different data and modeling tools. A key challenge is to integrate these three components on a consistent spatial and temporal basis taking into account linkages and feedbacks. The current state-of-practice for scenario-based assessments is to exercise air quality, exposure, and dose models separately, and to link them together by using the output of one model as input to the subsequent downstream model. Quantification of variability and uncertainty has been a strong technical theme in the exposure assessment community for a number of years. There is increasing interest and research regarding methods for quantifying uncertainty in the structure and inputs of air quality models and in dose models. An emerging challenge is regarding how to quantify variability and uncertainty in source-to-dose continuum integrated assessments taking into account each individual component as well as the interaction among the components. For a case study based on fine particulate matter (PM<sub>2.5</sub>), we identify and characterize variability and uncertainty associated with each individual component model, and use a conceptual framework to explore the interaction of variability and uncertainty when the three components are coupled into an integrated framework. Although variability and uncertainty in each component can be substantial, the variability and uncertainty in the coupled modeling framework increases at a sublinear rate for cases of independent variations in each component. Implications for decision making and for future work are described. Disclaimer: Although this work was reviewed by EPA and approved for publication, it may not necessarily reflect official Agency policy.

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#### **ADAPTIVE OPTIMAL DESIGNS FOR DOSE-FINDING BASED ON THE SIGMOID EMAX MODEL**

When a new drug is under development, a conventional dose-finding study involves learning about the dose-response curve. An alternative way of learning about a drug's true dose-response will be to learn from the study as it is ongoing and make changes to the design in a pre-planned manner- using an adaptive clinical trial design. The advantages in learning about the drug early can be substantial in terms of both resources and time required to develop the drug. This can translate to a benefit to the patients in terms of having a drug available to treat a disease much earlier than would have been possible otherwise. Here, we propose an adaptive procedure for optimal dose-finding in clinical trials when the primary efficacy endpoint is continuous. We model the mean of the efficacy endpoint, given the dose, according to an Emax model. The efficacy endpoint at each dose is distributed according to either a normal or a gamma distribution. We consider the cases of fixed variance and fixed coefficient of variation, both known and unknown. The analytic formulae for the Fisher information matrix are obtained. We build adaptive D-optimal and c-optimal designs (for different goals of the experiment). We show that this procedure of learning about the dose-response leads to greater efficiencies (translating to smaller sample sizes required) and higher precision of estimation of the dose-response relationship. We show results of simulation studies conducted to investigate these designs. We further extend the methodology by solving the bivariate case of this problem (competing efficacy and toxicity outcomes). PS - Part of this research was published in Journal of Biopharmaceutical Statistics, Volume 17, Issue 6, 2007.

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#### **CHARACTERIZING NANOMATERIALS FOR RISK ASSESSMENT: COPING WITH UNCERTAINTY TO SUPPORT DECISION-MAKING**

Many nanomaterials have a unique molecular identity that is not easily defined by traditional chemical measurements such as concentration or mass. Unique material characteristics result from variations in surface chemistry, crystalline structure, particle size and distribution, and a host of other factors. These characteristics may dramatically affect the toxicology, dosimetrics, environmental fate and transport characteristics and many other aspects of exposure. As a result, accurate characterization is necessary for risk assessments of nanomaterials. In most cases, the ability to measure and develop predictive models for key components of a risk assessment challenges risk analysts with substantial and novel uncertainties at virtually every stage. This presentation will describe and compare various strategies for describing the extent of knowledge and ignorance through uncertainty analysis, and considers how these strategies might be tailored to address the characterization challenges posed by nanomaterials. The presentation will include a summary of the findings of the SRA Workshop.

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#### **RISK AND CULTURE: THE VARIATIONS OF PERCEPTIONS OF DIOXIN RISK AMONG SEVEN SOCIAL GROUPS IN JEONJU CITY, KOREA**

This research was designed to examine the variations among seven social groups from different occupational, educational, and geographical backgrounds in the perceptions of dioxin risk in the City of Jeonju, Korea. In the questionnaire developed for this research, I included the fol-

lowing questions: awareness, knowledge, willingness-to-act for risk-related behaviors (WTA), opinions of responsibility, opinions of risk management methods, risk communication channels, worldview (Connectedness-to-Nature Scale, CNS), and demographics. The items were developed based on the content analysis of mass media and existing literature. I selected survey individuals from seven different social groups: people who live near (vs. farther from) incineration facilities, governmental experts, NGO members, business-related office workers, college students in environmental classes, and college students in business classes. I visited available groups in order to administer the survey (N = 334). One-way ANOVA and descriptive analysis (mean distributions and percentage distributions) were used for the inter-group comparison. I found that the group of people living near incineration facilities were significantly higher aware of the risk than the group of people living far from incineration facilities, nevertheless, both groups showed equal levels of WTA. The groups with a higher CNS values (e.g. governmental experts and NGO members) showed higher WTA behaviors than other groups (e.g. business-related office workers, two lay people groups, and two student groups). Furthermore, the respondents shared similar opinions of collective responsibility ( $p > .05$ ). All groups are similarly exposed to the risk information through mass media ( $p > .05$ ); whereas, the groups of high environmental education level have significantly more access to academic channels for obtaining information ( $p < .001$ ). The implications on the patterns of the variations among the groups according to the effect of different values should be discussed at length.

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#### **STATISTICAL TOOLS FOR STUDYING COMPONENT EFFECT AND INTERACTIONS IN CHEMICAL MIXTURES TOXICITY**

The main limitation in risk assessment of chemical mixtures is the various types of interactions that can occur among the mixture components and hampered toxicity interpretation study. The aim of the present study was to apply statistical tools such as  $2^n$  full factorial design, normal order score (NOS), multifactor ANOVA and scaled t-distribution for identifying the component effect and interactions among components in chemical mixtures. Mixtures can be designed using  $2^n$  full factorial design where, "n" refers to the number of components in a mixture, each component being present at two fixed dose levels, low (-) and high (+). The main effects (components) and interactions can be calculated by applying the standard equations for full factorial design. It is often difficult to determine the significant main and interaction effects simply by estimating the values of these effects, hence the significant main and interaction effects can be estimated using the normal order score (NOS) approach, multifactor ANOVA and scaled t-approach. In the normal order score method, the effects that are insignificant and random will fall on a straight line in a standard normal plot, whereas those that are statistically significant and non-random fall off the line. The normal plots can be obtained by plotting the mean effects against the standard normal order score. However, for interaction effects this method is not very sensitive since it assumes that the higher order effects are random effects and ignores the information contained in the replicate runs, therefore the multifactor ANOVA and scaled t-approach can be applied to determine the significance of main and interaction effects using the full information contained in the replicates.



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### **EVOLVING EUROPEAN LAW REGARDING SCIENTIFIC EVIDENCE**

Two European Union laws—the Water Framework and Environmental Liability Directives—help centralize and harmonize approaches to water quality protection. Harmonizing these laws might be impeded by implementation in the various member states. Effective, transnational implementation of Union law must be based ultimately on a shared understanding of legal causation; however, individual states treat legal causation in significantly dissimilar ways. When models are used to describe environmental phenomena, they are not merely an empty collection of symbols. Rather, they convey, in the language of mathematics, our understanding of what drives environmental events. New modelling methods can serve as a harmonizing, science-based approach for drawing causal inferences that cuts across different legal regimes, thereby integrating water protection across the Union in a manner envisioned by European’s legislation.

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### **PSYCHOLOGICAL EFFECTS OF WEAPONS OF MASS DISRUPTION (WMD)**

Terrorism involving weapons of mass destruction (WMD) may have powerful psychosocial consequences which have the potential to severely impede recovery after the event. The events of September 11, 2001, caused profound stress in the United States, with one study finding almost 50% of people surveyed showing stress symptoms. Traumatic incident stress may produce overwhelming numbers of casualties that could rapidly overwhelm medical capacity. In many cases, symptoms from traumatic stress (flu-like symptoms, such as fatigue, malaise, headache, arthralgia, myalgia, dizziness, dyspnea, and weakness) may be similar to prodromal symptoms seen following exposure to chemical, radiological or biological weapons. The recovery of a community must take into consideration the psychosocial consequences of the WMD event, including stigma and economic impacts. Much of the psychosocial impact will be based on risk perception. Risk perception is strongly influenced by risk communication by leaders and information and reporting by the news media. The terminology used will also impact risk perception. Terms such as worried well and mass hysteria are not only misleading, but also pejorative. Other terms such as mass panic, are often used incorrectly. Long term health effects can be expected, such as multiple, unexplained physical symptoms (MUPS), which may or may not have a psychological origin.

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Toxicology Excellence for Risk Assessment (TERA)

### **“GREENER” PEER REVIEW MEETINGS - AS CLOSE AS YOUR PC**

In-person meetings are generally the most effective way to insure clear communication and understanding among a group evaluating and discussing complex risk assessments and scientific evaluations. However, they are costly in terms of time, resources, travel expenses, and carbon release when participants are in multiple and far-flung locations. With rising energy costs and global warming concerns, many are looking for ways to reduce travel and waste. Telephone conference calls have long been an alternative, but are often less effective and frustrating for participants. Video conferencing has also been used to provide the advantage of seeing the other participants - this technology has its own advantages and disadvantages. In recent years, the advent of the Internet has provided additional techniques to expanding traditional meeting options. When meetings are addressing complex scientific questions and issues, such as the situation for expert peer reviews of risk assessment documents and projects, the need for effective and efficient communication and understanding among participants is critical. This poster will describe several

Internet-based technologies and how they have been used for peer review and consultation of risk assessments. We will present several case studies of our experience using these technologies for risk assessment peer review and consultation meetings. We will present views of different types of participants, including observers, panel members, chairpersons, and presenters, and discuss the benefits and limitations of these technologies for use in the field of risk assessment and peer review.

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### **NUMERACY AND THE PERCEPTION AND COMMUNICATION OF RISK**

Numerical information is ubiquitous in risky decisions, both big and small, and high quality risk data are increasingly available to experts and the public. To a degree never before possible, individuals are in a position to understand risks, and, in the process, increase control over their lives. However, individuals may lack the skills, knowledge, or motivation to access credible sources, process information, and make informed choices. As a result, the same data may not be understood or used in the same way by all users. In particular, individuals low and high in numeracy (number ability, measured through a math test) appear to understand and use numeric and non numeric sources of information in decisions differently. Highly numerate individuals appear to pay more attention to numbers, to better comprehend them, and to retrieve and use appropriate numerical principles (Peters et al., 2006). They also appear to draw more precise affective meaning from numbers and numerical comparisons and to use this affect in decisions. Decisions of the less numerate are informed less by numbers and more by other non-numeric sources of information such as their emotional reactions and mood states. Careful attention to information presentation, however, allows the less numerate to understand and use numbers more effectively in decisions. As a result, the challenge is not merely to communicate accurate information to the public, but to understand how to present that information so that it is used in risky decisions.

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### **BUSINESS AND VENTURE CAPITAL PERCEPTIONS OF THE BENEFITS, RISKS, AND POTENTIAL REGULATIONS OF NANOTECHNOLOGIES**

In the current climate of regulatory and scientific uncertainty, businesses and venture capital firms play a key role in determining which nanotechnologies may enter the market in the near future. In order to understand the factors influencing these decisions, a series of semi-structured interviews with key individuals in such organizations is underway. Specifically, the research explores attitudes towards the benefits, risks, and potential regulations of nanotechnologies, and the interactions among these perceptions. The presentation will include a preliminary evaluation of the results, and a discussion of the ramifications for policy and strategy options in the medium term. In particular, the analysis will focus on the viability and usefulness of employing an explicit risk-benefit framing as a decision tool, and on the possibilities and challenges of establishing cooperative risk assessment arrangements.

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### **LIVING WITH NUCLEAR RISK: A NARRATIVE APPROACH**

The question of new nuclear power is again reappearing in many countries. Concerns about meeting climate change targets, and over energy security, have forced a reappraisal of its potential future. Future nuclear siting proposals will have to involve members of affected publics - and com-

munities near existing nuclear sites are likely to be some of the first involved. We report findings from a major empirical investigation of community understandings of nuclear energy close to two existing Magnox stations in England: Bradwell in Essex, and Oldbury in Gloucestershire. Findings from two empirical phases are reported: (1) following the approach adopted by Satterfield (2001), a series of in-depth narrative interviews (n=61) with local community samples at both sites; and (2) a Q-method study (n=84). The narrative interviews revealed a range of positions on the plants and their presence which reflected the ways in which people's complex life-histories impacted their perceptions of risks and benefits: salient themes in the analysis included normalisation of threat and processes of "distancing" both the facility and any latent anxieties about health risks. The Q-study (n=84) revealed 4 distinctive points of view amongst the samples, and interestingly an "asymmetry of trust" in that reasons for distrusting the management of the risk (amongst those who strongly opposed the facility) were different for the reasons advanced for trusting management (amongst its supporters). We conclude with methodological reflections on the novel narrative approach, and the implications of the findings for risk communication and policy.

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#### **UNDERSTANDING PUBLIC RISK PERCEPTION OF PERSONALIZED NUTRITION: A COMPARISON OF AUSTRALIA AND THE NETHERLANDS**

Nutrigenomics, the study of how foods interact with our genes, promises solutions in medicine and health, but will also have an impact on society. Various studies show that citizens have second thoughts concerning applications of gene technology, especially related to food (Bauer, 2005; Gaskell, 2004). If genomics technology is able to predict diseases and prescribe preventive diets based on a person's genes, it is important to understand the public's risk perception and intention to take a genetic test and adopt such personalised diets. Based on the existing literature, several factors which might influence this process have been identified. The aim of the present study is to bring together in one model the intention to adopt personalized nutrition, general affective evaluation and the determinants, trust, risks/benefit perception, perceived consequences, the value of science and experience. We conducted survey research among representative samples in The Netherlands (n=2170) and Australia (n=1000) to explore cross-cultural differences and test the fit of the model for both populations using structural equation modelling.

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ODU

#### **DELAYED BANG APPROACH: RISK TRADEOFF BETWEEN PREVENTION & PREPAREDNESS**

Benjamin Franklin (1706 - 1790) wrote "An ounce of Prevention is worth a pound of cure." Can we confidently declare the same for Prevention and Preparedness, including detection, response, & recovery from security disruptions? In practice, Prevention is viewed to have higher dollar-per-dollar benefit than Preparedness. But the fact is there currently is no agreement on how one would meaningfully know if or when this holds true. The question nowadays is not the need for more security, but how much to spend for this added security. This research tries to use Delayed Bang approach to bring Security Preparedness & Recovery closer to being a cost-justified and sustainable management of security-related risks. This approach has three propositions: (1) Security risk management resources can be classified as either prevention or preparedness, the latter includes detection, response, and recovery, (2) Pure prevention pushes into the future the occurrence of security events while (3) Malicious agents always try to pull closer to the present the

occurrence of security events. The concept of Delayed Bang is a step towards cost-justifiable resource allocation decisions grounded on the mission to prevent and deter security events by providing an intuitive representation of chance of occurrence of a security event consistent with generally acceptable risk management framework. It allows visualization & comprehension of trade-off between prevention & preparedness, allows the use of temporal information such as intelligence & counter intelligence, new or emerging technology from R&D, and can accommodate advances in data fusion and data mining. It also serves as foundation for descriptive & prescriptive resource allocation in security risk management, benefit-cost evaluation of security related resources, and refinement of the concept of chance of a security event.

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#### **EVALUATING EMERGING CONAMINANT ISSUES WITHIN DOD**

Emerging Contaminants (ECs) can affect human health and safety, readiness and mission accomplishment, acquisition, operation and maintenance of Department of Defense (DoD) assets, and the DoD cleanup program. The Office of the Secretary of Defense (OSD) has established an EC Directorate to address emerging contaminant issues. The EC Directorate has developed, in conjunction with the Military Services, EC "watch" and "action" lists. This presentation will provide examples of how ECs have been assessed using a phased process and the results of two years of assessments. How risk drivers affect the DoD functional areas will be discussed, and the speaker will summarize EC issues and ongoing activities of DoD's Emerging Contaminants Directorate.

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#### **PRIMATE DOSE-RESPONSE DATASETS: UNDERSTANDING RESISTANCE AND SUSCEPTIBILITY TO INHALATION ANTHRAX SET THE STAGE FOR DISCUSSING "ACCEPTABLE RISK" LEVELS**

Humans appear to be relatively resistant to B. anthracis infection. The most appropriate animal model for extrapolation to humans is uncertain due to the limited information on inhalation anthrax in humans making a comparison with animal data difficult and animal species differ in their natural resistance to the disease. Nonhuman primates are considered the most appropriate for investigations of experimental anthrax. Macaque models, especially the rhesus macaque, have been used extensively since the 1950s to study the pathogenesis of the disease and vaccine efficacy. More recently, the African Green monkey (AGM) model has been established to address disease progression and therapeutic efficacy. Dose-response data is crucial to animal model development. Knowledge of these data sets, generated using well defined methodology, merits scrutiny for risk analysis. Two recent datasets generated in Rhesus and AGM incorporate low doses in the experimental design that influence confidence in empirical dose-response models fit to the data. Empirical techniques were applied for dose-response analysis, including traditional probit modeling, logistic regression, and application of Weibull and other functions encoded in Benchmark Dose software. These analyses include estimation of confidence, including upper and lower limits for mortality. In addition, supplemental studies on the natural history of the disease, expand our understanding beyond variable LD50 estimates. Mechanistic understanding of deposition and clearance of spores in diverse primate species, including humans, is essential to application of new research findings to risk analysis and decision making for inhalation anthrax, as well as other bio-threat agents. Future research will address influential gaps in knowledge that will enhance the scientific basis for microbial risk assessment models and expand opportunities for analytic-deliberative process regarding protection of human health and biothreat preparedness.

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Environmental Profiles, Inc.

### **EVALUATION OF A MATHEMATICAL MODEL USED FOR ESTIMATING SOLVENT EXPOSURES IN THE WORKPLACE**

When prospectively assessing the need for exposure controls, mathematical modeling may be more useful than traditional air monitoring in instances where operations associated with certain exposures have been discontinued, or historical air monitoring data either are not sufficient or are lacking entirely. In the context of industrial hygiene and retrospective epidemiology as well as legal matters, the need often arises to estimate occupational exposures to airborne chemicals. If sufficient information on chemical use, plus the physical and environmental factors is available, mathematical models can be used as a means of estimating exposures. Evaluation of a model's performance is an important step to reduce the uncertainty associated with a particular model's outcome and to refine the exposure assessment process. A model is evaluated by comparing measured air concentrations generated under well-controlled laboratory conditions, with modeled concentrations that use parameters that are the same as the laboratory conditions. The objective of this research was to compare the airborne solvent concentrations measured during three simulated parts disassembly processes with concentrations estimated by a mathematical model. The study involved three test simulations where cyclohexane, used as a penetrating solvent was squirted onto a gate valve during disassembly of the valve. For statistical considerations, six replicate solvent application trials were conducted for each simulation. The near field-far field (NF-FF) model was selected to estimate the solvent vapor concentrations. Monte Carlo analysis was used to quantify uncertainty in the input parameters of the model, and ASTM Method D5157 was used to evaluate the correlation between the predicted and measured results. Application of the NF-FF model under the conditions described suggests there is a reasonable degree of reliability in forecasting airborne contaminant levels in the workplace environment.

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### **CASE STUDY: LETTER MATH VS NUMBER GAMES**

The following case study will present two methodologies used in the scoping and managing the risk in the technical development of a cutting edge nuclear fuel. Of particular interest will be the effort in executing each methodology by the identical panel of subject matter experts, the divergent results, and finally, their acceptance and influence in managing the project.

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### **OPEN ASSESSMENT ON IMPACTS OF EMISSION TRADING ON CITY-LEVEL**

Emission trading is a cost-effective mechanism for transforming greenhouse gas emission (GHG) reduction targets into practical decisions on climate change mitigation. However, decisions appearing similarly effective in GHG emission reduction may not be equivalent in terms of other impacts, for example health impacts. The way an emission trading system (ETS) is set up may significantly affect the overall impacts of these decisions. Understanding this effect is crucial for minimizing the adverse impacts of climate change mitigation, and calls for broad integration of knowledge. We have initiated an open assessment on impacts of emission trading on city-level, where an ETS is considered as a constraint to city-level decision making, and impacts of different decision options and combinations are assessed. The assessment covers health and climate impacts as well as costs. The chosen location is Helsinki metropolitan area, and assessed decisions relate to

personal transport, heating and power consumption. Decisions are considered in light of the EU ETS as planned for 2013 onwards with some potential alterations. The open assessment is carried out on a virtual collaborative assessment workspace on the internet (<http://opasnet.org>) and is open to anyone interested. Also several experts on the topic are invited to participate. Opasnet runs on Mediawiki platform and is complemented with connections to simulation and calculation software as well as a database for storing results. In order to guarantee the scientific integrity of the assessment, the contributions of participants are organized by means of formal pragma-dialectical argumentation. The goal of the open assessment is to contribute to the general awareness about the role of city-level decision making and health impacts in climate change mitigation. It also aims to have a remarkable influence on the COP-15 meeting in Copenhagen December 2009 and the related World Wide Views citizen meetings during autumn 2009.

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**“MC2D”, AN R PACKAGE FOR TWO-DIMENSIONAL MONTE-CARLO SIMULATIONS**

The need for use of quantitative methods for characterizing variability and uncertainty in risk assessment has received increasing attention in recent years, while few software packages are able to deal with it. Moreover, models and sensitivity analysis methods are getting more and more sophisticated, and consequently the available software packages might not be flexible enough to deal with new methods. We developed, initially for our own use, “mc2d”, a specific R package to build and study two-dimensional Monte-Carlo simulations. R is an open-source integrated suite of software facilities for data manipulation, calculation and graphical display extended by a large collection of packages where up-to-date statistical methods are implemented. “mc2d” is an additional set of integrated functions specifically written to: i) build distributions: with additional specific distributions and tools to choose and fit distributions on available data, to estimate and model uncertainty on the parameters by bootstrap, to build correlation structure between parameters, etc.; ii) build models: the package transfers easily variability and uncertainty along a mathematical model; iii) study the model: through ad-hoc summaries and graphics, sensitivity analyses (rank correlation on the variability or the uncertainty dimension, ANOVA), etc. The R environment allows a flexible use of any methods implemented in the basic distribution or any additional package. Less “user friendly” than some of the commercially available programs, “mc2d” is suitable for users with intermediate experience with R. A training session performed in France demonstrated that students with no prior experience with R are able to develop their own models in few days. The presentation will provide an overview of “mc2d,” illustrated by an example in the food safety domain. “mc2d” is available on request to the authors.

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### **QUANTITATIVE RISK ASSESSMENT FOR LISTERIA MONOCYTOGENES IN SELECTED CATEGORIES OF DELI MEATS: IMPACT OF LACTATE-DIACETATE ON LISTERIOSIS CASES**

Foodborne disease associated with consumption of *Listeria monocytogenes* contaminated ready-to-eat (RTE) foods represents a considerable public health concern. A risk assessment by the U.S. Food and Drug Administration (FDA) and the U.S. Food Safety and Inspection Service



(FSIS), conducted in 2003, estimated that about 90% of human listeriosis cases in the U.S. are caused by consumption of contaminated deli meats. This risk assessment grouped all deli meats into one of 23 categories of RTE foods and considered only the post-retail growth of *L. monocytogenes*. In order to provide an improved risk assessment for *L. monocytogenes* in deli meats, we developed a revised risk assessment that (i) models risk for three subcategories of deli meats (i.e., ham, turkey, and roast beef) and (ii) models *L. monocytogenes* contamination and growth from production to consumption while considering subcategory specific growth kinetics parameters. This model was also used to assess how reformulation with *L. monocytogenes* growth inhibitors (i.e., lactate-diacetate) impacts the number of human listeriosis cases. Use of product specific growth parameters demonstrated how certain deli categories differ in the relative risk of causing listeriosis, with products that support more rapid growth and have reduced lag phases (e.g., turkey) having a higher risk. While reformulation of deli meats with growth inhibitors was estimated to reduce human listeriosis cases linked to a given deli meat subcategory by about 2.5 to 7.8 fold and thus would reduce risk of human listeriosis, even with reformulation, deli meats would still cause a considerable number of human cases. A combination of strategies is thus needed to provide continued reduction of human listeriosis cases. Risk assessment models, like the one described here, will be critical for evaluation of different control approaches, to help define the combinations of control strategies that will have the greatest public health impact.

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#### **EVALUATING RISKS ASSOCIATED WITH RECREATIONAL USE OF STREAMS IN AN URBAN SETTING**

This study reports initial findings from an ongoing project whose goal is determination of risk associated with recreational use of streams in an urban area. Potential risks to recreational users of urban streams in urban areas arise from the biological quality of the water, the chemical quality of the water and the nature of the locales used for recreation (e.g., the depth of pools into which swimmers dive or stream discharge during flooding). Although the current study focuses on risks associated with biological water quality, risk managers must balance all risks to recreational users when developing strategies for protecting public health. This paper describes the methodology by which researchers determined areas of known and expected recreational use on three streams in an urban area. Patterns of recreational use at seven sites of suspected use were determined via in-person surveys conducted during the recreational use season of 2007. Additional in-person and photographic monitoring is being conducted during the 2008 recreational use season. Recreational use observations on the nature of the activity were used to estimate water volumes ingested at each of the study sites. These estimates, along with water quality data and dose-response models relating the incidence of gastrointestinal illness with bacterial indicator organisms, were used to produce site-specific estimates for the incidence of illness. Estimates were made for wet and dry weather conditions modeled separately and for all data modeled together. Results indicate risk is not strongly influenced by wet-weather use and water quality. Risk managers may use this information in development of strategies for optimal use of public funds in protection of public health.

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#### **CUMULATIVE RISK ASSESSMENT: INTEGRATING ESTABLISHED APPROACHES WITH NEW CONCEPTS TO IMPROVE POPULATION HEALTH PROTECTION**

Cumulative risk assessment (CRA) is an increasingly valuable discipline for informing community and environmental health programs. CRAs combine many factors, including population characteristics and the nature of exposures and responses to multiple chemicals and other stressors. CRA initiating factors include: multiple pollution sources, from factories to farmlands; environmental quality metrics such as air pollution levels; exposure metrics, including biomonitoring data; and effect metrics such as low birth weights, high cancer rates; and effects on ecosystem function and services (e.g., declining fish populations). U.S. EPA's CRA framework and recent issue papers emphasize population-based analyses of effects from combined exposures to multiple chemical, biological or physical stressors and consider population vulnerabilities (i.e., susceptibility/sensitivity and differential exposure, preparedness and ability to recover). Existing tools are being adapted and new tools developed to integrate data on multiple chemicals and stressors across populations over spatial and temporal scales. A new joint Agency resource document outlines concepts, methods, and data sources for cumulative health risk assessments, to support applications within the larger "unregulated" context of lifestyle, behavioral, nutritional, social and economic factors. It is suggested that epidemiological methods, public health data and surveillance systems be examined to evaluate effects of key concern for a given community. No one U.S. Agency is responsible for population health across all settings and stressors, e.g., industrial pollution, food contamination, pharmaceuticals, invasive species and noise. Thus, cross-Agency/cross-community and private industry collaborations are needed to integrate risk information for effective health protection programs within the U.S. The presentation highlights recent cumulative risk initiatives, including at the state, national, and international levels.

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#### **IMPACT OF INFORMATION ABOUT RISK AND REGULATION ON PUBLIC PERCEPTION OF NANOTECHNOLOGY**

Theoretical linkages between media content and public perception have been well established and extensively studied, but in practice these relationships are neither powerful nor direct. This presentation will report on experimental research that seeks to clarify this link in the specific case of risk and regulation information with regard to risk perception for various forms of nanotechnology. The study is using, as independent variables, both type of risk (whether a physical risk to health or environment, or a "social risk" such as maldistribution of benefits or erosion of privacy) and whether the nanotechnology in question is or is not described as regulated by appropriate US agencies. These elements are embedded (or not) in news type stories about various forms of nanotechnology, and these stories are then used as experimental stimuli. The research is exploratory because while some evidence suggests "social risks" may be important triggers of heightened risk perception, the generality or strength of this relationship, in comparison to the influence of physical risks, is unknown. Common sense might suggest regulated risks would be seen as less threatening; however, this too is questionable given speculation about the erosion of trust in regulatory agencies in the US and elsewhere. This research is the first of a series of related experiments being conducted under Nanotechnology Exploratory Research grant number 758195 from the National Science Foundation.



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### **THE PORT OF POTI: A CASE STUDY IN RISK ASSESSMENT OF A COMMERCIAL PORT FOR MILITARY USAGE**

One of the challenges facing the Military Services involves conducting risk assessments of large commercial ports used for the shipping of ammunition and explosives then providing the risk assessment information to leaders facilitating informed decisions. Often these risk assessments must be conducted quickly and the risk information presented in a matter of weeks. The authors conducted such a risk assessment of the Port of Poti, Republic of Georgia in April of 2008 using a model developed within DOD. This paper reports on the model, the methods used, and how the information gathered can be presented to leaders to facilitate the decision process. The paper begins with the physical inventory of the risks at the port location, evaluation of the potential explosion site, and identification and documentation of the exposed sites. Next the paper explains how the authors entered the data and how the model calculates and sums the resulting risks. Finally, the paper describes how the model displays the data can to facilitate leaders in making informed decisions about accepting the risks.

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### **LOCAL DISCLOSURE ORDINANCE AS REGULATORY CATALYST: INSIGHTS FROM THE BERKELEY, CA MANUFACTURED NANOSCALE MATERIALS HEALTH AND SAFETY DISCLOSURE ORDINANCE**

In December 2006, the Berkeley City Council became the first government entity in the United States (U.S.) to approve a specific law requiring the reporting of nanomaterials used in local facilities. In this research, we analyze the Berkeley Manufactured Nanoscale Materials Health and Safety Disclosure Ordinance (BNO) as an example of targeted transparency, an increasingly prominent regulatory approach in U.S. consumer protection and environmental policy. We test several hypotheses about the context (causes) and consequences (effects and effectiveness) of the ordinance using qualitative data, including content analysis of public records and applicable media accounts as well as stakeholder interviews with actors embedded in relevant policy networks, including city council staff, local businesspersons and entrepreneurs, environmental health services personnel, organizational spokespersons, and scientists. Our aims are to: (1) document and understand the role of this event in the emerging domain of nanotechnology governance even as the science, commerce and public perceptions of nanotechnology continue to evolve, and (2) to use the BNO case to shed light on the feasible and appropriate roles that local disclosure laws can play in shaping risk policies more generally.

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### **ADDRESSING RISKS TO EARTH FROM POTENTIALLY HAZARDOUS NEAR EARTH OBJECTS (NEOS)**

Near Earth Objects (NEOs) are asteroids and comets that pose varying levels of threats to Earth from impact. Researchers have linked NEO impacts in the geologic past to mass extinctions and recently to significant documented damage (e.g., 1908 Tunguska meteorite in Siberia). Like hurricanes, tornadoes, and earthquakes, the more powerful incidents are separated greatly in time, making the likelihood of catastrophe vanishingly small for a given generation. Still, the historical

record and current concerns regarding probable damage from modest size NEOs have prompted attempts to assess the risks more systematically. This paper summarizes multidisciplinary thinking on NEOs by focusing on implications for risk assessment, management, mitigation, perception, and communication. Risk assessment is largely the province of astronomers who find NEOs and track their orbits. NEO's may be detected from decades to hours in advance, making it difficult to precisely estimate an impactor's magnitude and location, both necessary for risk management decisions. Risk mitigation rests on engineering solutions and technologies intended to diminish the NEO's size or divert it from Earth. Risk perception involves awareness of commonalities and differences between asteroid impacts and other disasters, as well as on psychological and cultural factors which may converge to impede effective planning. Finally, risk communication for policymakers and the public requires generating interest in very low probability but potentially devastating events-as well as designing reliable warning systems that accommodate uncertainty, and developing methods to prepare the worldwide public for pre-impact, impact, and post-impact events. Such communication will be complicated by scientific vs. supernatural interpretations of NEOs and willingness to take steps proactively to protect lives and minimize collective loss. As extreme examples of low probability, high consequence events, NEOs are interesting models for studying preparedness for rare, potentially devastating events.

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### **THE FEDERAL AND STATE RESPONSE TO IDENTIFICATION, MANAGEMENT, AND RESPONSE TO EMERGING CONTAMINANTS**

Emerging contaminants pose a significant public health and environmental issue of growing concern to the public. This presentation provides an overview of the growing interest in emerging contaminants across the federal and state government. The federal/state response ranges from regulatory to science/research and other agencies that perform vital tasks in the public interest. Chemicals that are not regulated are being identified in human bio-monitoring programs and in environmental media; however, the significance of the results is often unknown. The current response is geared largely towards identification of emerging contaminants with only a limited focus on management and response. The long-lead time necessary for meaningful research to improve decision-making means that early detection is important. However, the federal government's response to emerging contaminants should be better coordinated across federal agencies to allow for not only early detection but also a health protective response. The federal/state response must provide for a credible gathering and vetting of information to develop appropriate societal responses. Federal and state management of emerging contaminants must be based on a science-based process that uses all available information while making plans to integrate new data as they become available. Identification of data gaps in the current process will be helpful in forming more integrated responses.

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### **APPLICATION OF SET COVER LOCATION MODELING AND HAZARD ZONE SETS TO SITE EMERGENCY AND BACKUP FACILITIES**

The use of emergency backup and storage facilities to supplement existing facilities in response to the potential effects of various natural and anthropogenic hazards (e.g. floods, fires, outages, and acts of malice) can be an effective way of reducing vulnerability and enhancing the resilience of existing supply chain and other logistics functions. Although there can be additional costs associated with utilizing emergency backup and storage facilities, they can be a particularly

attractive and cost-effective alternative in those cases where long-term disruptions can, or should be, expected. We use set cover location modeling as a decision aid to determine the number of backup facilities to locate under varying cover, anti-cover and complementary anti-cover distances. We then add the flexibility of allowing existing facilities to serve as backup facilities and explore the interrelationships among hazards, vulnerability and location models. To address the issue of vulnerability to different types of hazards in the location models, we define and use the concept of Hazard Zone Set, which is comprised of the potential locations for backup facilities that would be vulnerable to the same hazards (e.g. floods, fires, acts of malice) as the primary facility. The development of the hazard zone sets, and the input data for the location models, are facilitated by the use of Geographical Information Systems. By accounting for the distance between facilities, the potential exposure of facilities to the same geographically-related hazard event, and the costs associated with opening new or utilizing existing facilities, this approach can provide a powerful and flexible tool to assist with back-up and emergency facility location decisions. We demonstrate this through application of the model to emergency facility siting problem in the Northeast United States.

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#### **SEISMIC AND VOLCANIC RISK IN THE AZORES: REASONS TO STAY IN ENDANGERED PLACES**

Earthquakes and volcanic eruptions have been regular phenomena throughout the Azores' six centuries of history. In spite of the knowledge already gathered by local historians and Earth sciences researchers, there are no scientific data on the socio-cultural dimensions of volcanic and seismic risks. A study - TOPOI METUS. Social cosmographies of danger. Risk perception of natural hazards - is being carried out in order to construct and validate an instrument capable of (1) characterizing volcanic and seismic risk perception in the archipelago; and (2) producing knowledge to clarify communication aspects such as: Who do people trust? What forms, strategies, and means of communication do people value most? and What functions should risk messages serve? To guarantee that the questionnaire is sensitive to the Azorean context, to the historical mysticism embedded in natural disasters, and to people's identification and emotional relationship with the place, thirty extensive interviews were conducted. The present communication focuses on the instrument features and construction process, and discusses data collected in interviews. Consistent with findings from other studies, "Being in the hands of God" and a strong identification with the living place emerge as common reasons appointed to by people who live in and insist in staying in a vulnerable area such as the Azores.

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#### **ANALYSIS OF THE CHOLINESTERASE VARIABILITY IN ANIMALS AND IMPLICATIONS FOR DOSE-RESPONSE ASSESSMENT**

In 2002, the U.S. Environmental Protection Agency (EPA) began conducting a cumulative risk assessment for organophosphate (OPs) pesticides. OPs have a common mechanism of toxicity, inhibition of cholinesterase. As part of its assessment, EPA compiled a large database of chemical registrant toxicity data on cholinesterase inhibition. This large dataset provides a unique opportunity for analysis. EPA and others are increasingly using benchmark dose (BMD) analysis for risk assessment, in place of the previous policy of using No Observed Effect Levels (NOELs). For continuous endpoints, the benchmark response (BMR) is often based on an estimate of the sta-

tistically detectable difference of the assay. In other words, if the assay can reliably detect a 10% change in response, then a BMD10 representing the dosage that results in a 10% response is used for risk assessment. For cholinesterase, there are different forms, including plasma, red blood cell (RBC), and brain cholinesterase that have different levels of variability. This talk presents an analysis of the variability in animals for different cholinesterase compartments and its implications for BMD analysis and standard statistical analyses of data to determine NOELs. Additionally, other interesting aspects of the data are discussed, including decreased variability at higher dosages, which also has implications for statistical analysis.

**W4-A.3** Renn O  
University of Stuttgart, Germany

#### **DESIGNING SUSTAINABLE ENERGY POLICIES IN THE LIGHT OF CLIMATE CHANGE: THE TRI-ENERGY PUBLIC CONSULTATION PROGRAM IN SWITZERLAND**

The paper describes an approach to use analytic-deliberative methods for designing energy policies in Switzerland. The deliberation process is structured around a multi-criteria decision aid that was developed by a research consortium consisting of several universities, consulting companies and the second largest Swiss electricity utility (Axpo). Our part was to develop the social indicators and to facilitate the deliberation process. A total of four deliberative workshops with representatives from national stakeholder groups was conducted in the fall of 2008 as a means to get policy recommendations for sustainable energy policies. The paper will describe the process, the satisfaction and subjective impressions of the participants concerning the process and its results as well as the policy-related outcomes of the deliberation.

**W2-F.4** Revesz R.; richard.revesz@nyu.edu  
New York University

#### **ELIMINATING ANTI-REGULATORY BIASES**

The new Administration will face a number of challenges as it implements its policies with respect to the use of cost-benefit analysis in the administrative state: 1. how to engage progressive groups in methodological discussions about how benefits and costs should be evaluated. 2. how to eliminate anti-regulatory biases that have emerged over the past decades as a result of the disproportionate impact in methodological debates of anti-regulatory academics and interest groups representing polluters. 3. how to use cost-benefit analysis as an affirmative prompt for regulations that would have favorable cost-benefit ratios. 4. how to meaningfully assess the distributional consequences of individual policies and how to correct aggregate distributional imbalances.

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WSL Swiss Federal Institute for Snow and Avalanche Research

#### **DISCRETE CHOICE EXPERIMENTS: FALSE FRIENDS FOR VALUING MORTALITY RISK?**

Discrete Choice Experiments (DCE) have been increasingly used to elicit preferences for risk reductions in public health and safety programs. These stated-preference methods aim at valuing reductions in mortality risk by estimating the marginal rate at which individuals would trade off their money against small changes in their likelihood to die within a specified time period. This trade-off rate, commonly termed the value of statistical life (VSL), is widely used as policy guideline in cost-benefit analyses. To estimate the VSL, DCE-respondents are asked to choose among hypothetical risk reduction programs. The attributes of these programs describe their most important features, including their reduction in risk and their individual costs. However, concerns have

been raised about the validity of stated-preference studies, as difficulties in explaining small risk changes to survey respondents may affect their choices. While we share some of these concerns, we raise another issue that might impact the valuation of risk reductions in DCE: the framing of risk. This paper analyzes, whether risk framing impacts DCE-based VSL-estimates. We conducted a survey-based experiment that asked about 450 people from Switzerland about their willingness-to-pay for safety against avalanches, rock falls and ordinary car accidents on Alpine roads. Half of the respondents was asked how much they would be willing to pay for the reduction of up to 16 fatalities per year in reference to the Swiss residential population; the other half was presented with identical decisions except that the avoided fatalities were framed in reference to the annual number of fatal car accidents. The results suggest that the framing of risk reductions impacts the willingness-to-pay. Since VSL-estimates may significantly vary with different risk framings, this has further implications for the use of DCE in cost-benefit analysis.

**T4-C.1** Rice GE, Teuschler LK, Hertzberg R, Lipscomb JC, Lambert JC, Wright JM, MacDonell M; rice.glenn@epa.gov  
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#### **GROUPING CHEMICALS BY TOXICITY FOR CUMULATIVE RISK ASSESSMENT**

The U.S. Environmental Protection Agency defines cumulative risk as, “the combined risks from aggregate exposures to multiple agents?” Although such risks might include biological or physical agents, this presentation focuses on the development of an approach for characterizing the combined risks from exposures to multiple chemicals. Our practical approach builds on methods that identify the timing and intensity of co-exposures to multiple chemicals; co-exposure might be evaluated as potential (external) or internal doses. For chemicals comprising a co-exposure group, our approach identifies common toxicity groups. In our approach whole mixture toxicity data are preferred to component chemical or metabolite data. Our approach initially examines the data describing the toxicity of the whole mixture itself or a similar mixture. If whole mixture toxicity data are not available, toxicity data describing the component chemicals in the mixture or their toxic metabolites are evaluated. If only component or component metabolite data exist, our approach next evaluates potential primary and secondary toxic effects and toxic mode of action (MOA). Chemicals sharing a common toxic effect (e.g., same primary or secondary target tissue or effect) or a common MOA are grouped and the risk posed by the toxicity group can be assessed using component approaches. The approach also evaluates the potential for chemical interactions. The Agency for Toxic Substances and Disease Registry’s Interaction Profiles provide a source of data to assist such evaluations. Chemicals with probable toxicologic interactions are grouped and evaluated separately through methods such as EPA’s interaction-based hazard index. The possible use of computational toxicology approaches for grouping when “traditional” toxicity data are not available also is discussed. This grouping approach increases the feasibility of conducting assessments that examine the cumulative health risks of multiple chemicals.

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#### **MODEL EVALUATION FOR REGULATORY AIR QUALITY HUMAN EXPOSURE MODELS: REAL WORLD CHALLENGES AND PERSPECTIVE**

There is an increasing demand from stakeholders, scientific advisory committees, and others for more extensive model evaluation of environmental models that are used to support regulatory decisions. The EPA’s Office of Air Quality Planning and Standards uses several population

human exposure models to support decision making on the national ambient air quality standards for the criteria air pollutants and residual risk standards for hazardous air pollutants (i.e., air toxics). This presentation will provide specific examples of the many challenges that exist in carrying out comprehensive model evaluation for regulatory air pollution human exposure models and provide a real world perspective. Some of these challenges include the lack of representative personal exposure monitoring studies, the absence of lightweight portable personal exposure monitors that can accurately measure short-term exposures, the paucity of longitudinal human activity data, and the large uncertainties associated with emission inventory data and that the most recent inventories are typically 5 to 6 years old. Suggestions will be provided for future research that would aid future model evaluation in this area. Since comprehensive model evaluation is rarely possible for regulatory exposure models, alternative approaches to building confidence in exposure models will be discussed including evaluation of individual model components. Finally, progress in evaluating individual exposure model components will be briefly summarized.

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#### **SERVICE WITH A SMILE: ACCIDENTAL RISK COMMUNICATORS (ARCS) AND THE ROLE OF EMOTIONAL LABOR**

Risk communicators are often envisioned as government officials, PR gurus, or public health workers. Yet much of the public’s risk information comes from alternative sources: unintentional or impromptu messages from “unofficial” carriers. Referred to in this paper as “accidental risk communicators” (ARCs), these individuals routinely relay health and environmental risk information to public audiences, though often informally and outside of the formal job description. Often service workers, ARCs may be judged not only on their ability to execute technical aspects of their jobs but also on how they interact with clients. In terms of client interaction, research has examined the need for service workers to showcase normatively “appropriate” emotions in face-to-face communication, a concept known in the management literature as “emotional labor.” What has not yet been investigated is how emotional labor is affected when the services provided involve risk. Might the “work” of risk communication, like service jobs, require both technical and emotional proficiency? To explore this question, this paper examines the communicative practices of one sect of ARCs: commercial pesticide applicators. I offer data from in-depth interviews with 29 respondents affiliated with the Green Industry (e.g., lawncare, landscaping, etc.) in New York State, and short written questionnaires from 24 participants at the 2007 Empire State Green Industry Show. From acknowledging clients’ concerns, to listening without judgment, applicators perform many of the role requirements described in case studies of other ARCs, including flight attendants, sales clerks, and even rafting guides. As this paper argues, applicators merge their own technical and cultural orientations towards pesticides while displaying empathy in order to construct a unique variety of risk communication. The emotional labor that applicators perform is both highly regarded and seen as vital; less clear, however, is the degree to which this work is recognized, legitimized, and/or supported by employers.

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#### **EXPLORING OCCUPATIONAL RISK COMMUNICATION AND WORKPLACE CULTURE AMONG GREEN INDUSTRY PESTICIDE APPLICATORS IN NEW YORK STATE**

Efforts to address concerns over health risks posed by exposure to turf and lawn care pesticides are emerging across New York State (NYS). Reducing the risks of pesticide exposure

requires, in part, that commercial pesticide applicators receive, understand, and communicate relevant health risk information to their co-workers, clients, and others who may be affected by pesticide applications. However, little is known about the extent to which health risk communication occurs among these workers, or how one's workplace culture might influence this behavior. Aspects of workplace culture in this context may include personal responsibility; trust between and among co-workers and management; the extent to which pesticide use is minimized and pesticide safety is emphasized; and other factors. Drawing upon data from concurrent qualitative and quantitative studies of commercial turf and ornamental pesticide applicators in NYS, this project describes how and to what extent occupational health risk communication occurs and how workplace culture may influence this communication. In one study, a mail survey was administered to 1,200 NYS-certified applicators (n=412). In another study, 26 in-depth interviews were completed with commercial turf and lawn care applicators and other pesticide professionals in various sectors of the Green Industry, such as golf and landscape services. Examined together, study results illustrate workplace communication among these workers, including who applicators talk to about pesticide exposure and safety issues and how frequently, how qualified and confident they feel in discussing this information, and the degree to which they perceive this communication as part of their job responsibility. The extent to which differences in communication can be attributed to differences in workplace culture is discussed.

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Consultant

#### **VALUING MORTALITY RISK REDUCTIONS FOR HOMELAND SECURITY RULES**

Similar to other Federal regulatory agencies, the Department of Homeland Security requires estimates of the value of mortality risk reductions for use in assessing the benefits of its rules. The value per statistical life (VSL) estimates applied by other agencies may not be entirely appropriate in this context, however. Other Federal agencies address risks that often affect different sub-populations. In addition, the risks associated with terrorist attacks are likely to be viewed with substantially more dread, as more ambiguous, and as less voluntary and controllable than most risks considered by other regulatory agencies. Recent expert panel advice and new research also has not yet been fully incorporated into these approaches. This presentation will summarize the results of a project conducted for U.S. Customs and Border Protection in the Department of Homeland Security. The project uses the benefit transfer framework to develop an approach for valuing homeland security mortality risk reductions, involving a panel of experts. The presentation will first discuss the conceptual framework, and then summarize the VSL estimates applied by different U.S. agencies. It will review and evaluate different sources of VSL estimates, including available meta-analyses and individual revealed and stated preference studies. In addition, it will discuss the recent theoretical and empirical evidence on the effects of differences between the populations and risks studied and those addressed by homeland security rules. It will conclude by describing the implications of this project for the values used in related regulatory analyses.

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#### **BIOMONITORING - INTRODUCTION**

A critical challenge for scientists and decision-makers is interpreting biomonitoring data in a risk-based context. The National Academy of Sciences, the ILSI Health and Environmental Sciences Institute (HESI) and the European Center for Ecotoxicology and Toxicology of

Chemicals (ECETOC) have all recently published reports that highlight many of the key issues associated with interpreting biomonitoring data. In addition, a framework for developing biomonitoring equivalents, which offers another approach for risk-based interpretation of biomonitoring data, has recently been published. Key principles needed for evaluating biomonitoring data include an understanding of analytical methods, validation of biomarkers of exposure, assessing exposure scenarios, application of toxicology and interpretation epidemiologic data. The speakers at this workshop will use benzene as a case study example to illustrate some of the considerations needed for integrating biomonitoring data into a risk-context.

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**LIVING WITH ROCKSLIDE RISK**

Living with Rockslide Risk - people's communication needs and perceptions of risk On the west coast of Norway, about 3000 people are currently living in a danger zone with the threat of a major rockslide of 40-70 million cubic meters, which may splash into the fjord below and cause a tsunami. Waves estimated up to 40 meters will then hit the communities along the fjord. A research project has been initiated to provide answers to two fundamental questions: What factors may make the public comply with the evacuation plans in the case of an emergency? What risk messages seem more effective in meeting the public's information and communication needs? In this geographical area, a similar natural disaster happened in 1934, which caused the deaths of 40 people. In the analyses to be presented, subgroups within the population will be contrasted: those living in the areas likely to be hit when a major rockslide occurs, and those who live above those sea levels; those who had relatives involved in the former rockslide in 1934, and the rest, etc. Moreover, psychosocial data, personality issues and locus of control will be studied to explore what affect the perception of risk in the inhabitants, and also, what are the possible implications for mass communication and PR campaigns to people in such situations? An anonymous questionnaire survey was distributed to all 875 people above 18 years living in four communities under threat. A total of 400 questionnaires were returned. Preliminary data will be presented and discussed.

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#### **DO AS I SAY, NOT AS THEY DO: ADDRESSING VARIATIONS IN RISK ASSESSMENT, OPERATING PROCEDURES AND PPE BETWEEN EMERGENCY RESPONSE ORGANISATIONS**

Multi-agency response to chemical, biological, radiological and nuclear CBRN terrorism requires a number of organisations to work together in complex, hazardous environments. The situation is made even more difficult as the primary emergency response organisations (Police, Fire, and Ambulance) are historically dissimilar. As a result, these organisations operate under different command and control structures, apply different forms of risk assessment to their decision-making, and deploy to the same situation in vastly different levels of personal protective equipment (PPE). In spite of these differences, these organisations are expected to comply with Government strategies and frameworks targeted at streamlining prevention, preparedness and emergency response strategies. This presentation will describe the variations in command and control structures between organisations, explore the variations in risk assessment applied to decision making within and between organisations, and investigate the front-line experience of PPE in areas contaminated by CBR terrorism. This information will then be applied to the larger Government



framework driving multi-agency response in order to make recommendations for bridging the gaps between theory, targets and the reality of multi-agency response in hot zones.

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#### **BENEFITS TRANSFER OF VSL IN AN AIR POLLUTION CONTEXT: CAN EXPERT ELICITATION HELP?**

Analyses of the health benefits of air pollution rules are typically dominated by the monetized value of avoided premature mortality; therefore characterization of the uncertainty surrounding these estimates is critical to good policymaking. Formal expert judgment elicitation methods have been successfully applied to characterize uncertainty in one key input to these estimates — the concentration-response relationship linking particulate air pollution with mortality (see Roman et al., 2008 and Cooke et al., 2007). However, the usefulness of expert elicitation methods to characterize the valuation part of the mortality benefits equation has yet to be explored. Health Canada has sponsored a pilot expert judgment study to elicit quantitative probabilistic judgments of uncertainties in Value-of-Statistical-Life (VSL) estimates when applied in an air pollution context. The study focuses on uncertainties related to benefits transfer of published VSL estimates to populations affected by changes in air pollution. This includes uncertainties related to the effects of demographic characteristics such as age, income, and health status on VSL as well as the impact of factors such as risk perception. The ultimate goal of this project is to develop quantitative probabilistic representations of uncertainty in VSL that can be incorporated into Health Canada's Air Quality Benefits Assessment Tool (AQBAT).

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#### **ADVANTAGES OF THE COMPREHENSIVE ENVIRONMENTAL ASSESSMENT APPROACH TO EVALUATING TRADE-OFFS ASSOCIATED WITH ETHANOL AND BIOFUELS**

The environmental and health issues associated with ethanol and other biofuels among fuel options are accompanied by inherent trade-offs. Comprehensive environmental assessment (CEA) is a holistic assessment approach that can be applied to the evaluation of environmental risks and benefits of fuels and fuel additives in a systematic, scientifically rigorous manner. CEA combines the risk assessment paradigm with a product life cycle framework and uses collective expert judgment methods to deal with limitations in empirical data. As such, the CEA approach is more qualitative in nature than typical life cycle assessments. Through the CEA framework, this presentation will integrate the information on transport and transformation of ethanol fuel-blends in the environment, routes of exposure of humans and other organisms for primary and secondary contaminants, as well as human health effects of ethanol and associated byproducts as covered by previous speakers. Both point source (e.g., spills) and nonpoint source water and air quality issues associated with the production of ethanol through corn as a feedstock will also be considered in terms of pesticides, fertilizers, and other production-related topics. The CEA approach also considers exposure potential to VOCs associated with ethanol processing as well as the potential for higher combustion levels of aldehydes and other toxicants. The primary objective of a CEA for ethanol or the biofuels would be to identify in as much detail as possible all of the issues associated from production through use and to provide risk managers with input regarding potential environmental impacts of different fuel options. Given the time constraints of a single session, a complete CEA of ethanol or biofuels generally is not feasible, but the issues highlighted here illus-

trate some of the advantages of the CEA approach. Disclaimer: The views expressed in this abstract are those of the authors and do not represent the policy of the USEPA.

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#### **DEVELOPMENT OF PUBLIC POLITICS FOR THE MAJOR INDUSTRIAL RISK ADMINISTRATION BASED IN THE ANALYSIS OF CRITICAL EVENTS IN A STORAGE ZONE OF HYDROCARBONS: BOGOTA/COLOMBIA**

According to Mines and Energy Ministry statistics, the demand of the main energetic source in Colombia increased at an annual average rate of 3.5% during the 1990-2005 periods. During this period, the population in urban areas such as Bogotá had an augment of 25%, reaching 6'776.000 inhabitants in 2005. The significant increment of the population implies a greater demand of energy use originating from the derivatives of petroleum (DP). The DP are the main source of energy for the transport sector. In order to guarantee the supplying in Bogotá and to respond the exigency of its inhabitants and the economic and industrial growth which the capital is facing, the city has a zone destined for the storage of hydrocarbons. This sector is located within the urban perimeter. As it was mentioned previously, an enterprise and urban significant increment has been predicted, near this storage zone. In the last ten years, Bogota has had a significant increment in the demand of houses, due to the augment of the population, of shopping malls and sensible infrastructure, near to the storage complex. Faced this problem, Colombia, as a development country, is becoming increasingly aware of the risks that can affect the population as well as the need to create an Industrial Accident Prevention policy. Due to this reason in Bogotá, the Direction of Prevention and attention of Emergencies has united efforts with the Universidad de los Andes, to generate a reflection space on the administration of the major industrial risks at local level. A product of this inter-institutional effort is the developing of different cases for the evaluation of critical non-wished events, like the Unconfined Vapor Cloud Explosions and Boiling Liquid Expanding Vapor Explosion. This communication shows the work done by different local institutions, heading for the construction of different instruments for the major industrial risk analysis, in a development country without any studies of this type.

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#### **ANALYZING BENEFITS & COSTS OF SECURITY WHEN FACING ADAPTIVE ADVERSARIES**

The Office of Management and Budget requires that proposed federal regulations provide a positive benefit before they can be approved. Benefit-Cost analysis also supports other kinds of government decisions, such as proposed changes in federal programs, agency operational capabilities, etc. Accordingly, a number of different analytical approaches have been developed for conducting such analyses. Unfortunately, the existing approaches were largely developed for relatively static threats and are not terribly useful when facing an adaptive adversary intent on frustrating security force actions. This presentation takes observations from recent DHS-sponsored RAND studies into terrorist adaptive behavior and presents them ways which begin to operationalize these insights for incorporation into strategic planning and other decision-making processes. Potential future cost-benefit histories will be presented together with their implications. Potentially useful strategies for preserving the benefits of security technology and operational measures will be offered.

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#### **HOMELAND SECURITY RISK MANAGEMENT - A STATUS REPORT**

There is little dispute that “risk” is a factor that must be considered as DHS decision-makers decide what, if anything, should be done about a given identified risk. This does not mean, however, that homeland security risk analysts and managers have been standing still waiting for an answer to be delivered from on high. To the contrary, much energy has gone into improving our understanding of the homeland security problem space and a number of fundamental principles are increasingly being accepted across the community. Among these are that there is no single homeland security risk manager, that there is no single risk assessment methodology that will answer all the questions, and that there is little likelihood of getting definitive answers when risk is driven by an adaptive and strategically-driven adversary whose purpose is to confound security. This presentation will provide a status report on efforts since SRA 2007 to improve risk assessment and risk management practices, both inside DHS and across the larger national homeland security enterprise. There is a strong possibility that there will be a Presidential Directive issued with respect to security risk management across the whole of government. If so, highlights of that document will be presented. In presenting the current status, the discussion will touch on organizational issues, such as the allocation of responsibilities, as well as on advances in both our understanding of the homeland security risk space and in analytic approaches appropriate to homeland security.

**M3-J.4** Ross RG; bob.ross@dhs.gov  
Department of Homeland Security

#### **OBSERVATIONS ON THE IMPORTANCE OF RISK COMMUNICATION IN MANAGING HOMELAND SECURITY RISK**

Effective Risk Communications, in the fullest possible sense, are essential for managing risks that are as complicated, diverse, unfamiliar and potentially serious as those found within the realm of homeland security. Unfortunately, homeland security risk managers, perhaps due to a too narrow understanding of what “risk communications” means, have not been effective in communicating about homeland security risks. Among the consequences of that communications failure, government authorities have been unable to achieve the level of public understanding and trust required for the most beneficial public response to adverse events. More significantly, due to the lack of an effective risk dialogue, emergency response planners have been hamstrung in their planning efforts - they may understand the initiating events for which they are planning but they do not know how subsequent public reactions will enable or frustrate the planned response. This presentation will provide a larger perspective on what Risk Communications should mean in the homeland security context and will show, with specific examples, how intimately risk communications and effective emergency response are linked.

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#### **ROLE OF PARTICIPATORY APPROACHES IN DEVELOPING RISK ASSESSMENTS IN EQUINE WELFARE**

The Brooke is a working equine welfare charity aiming to develop evidence-based interventions tackling priority equine welfare issues. Risk Assessment (RA) methods are used to identify the causes of prioritized welfare issues and provide evidence for use by community and veterinary teams working in the field. Methodology uses participatory tools (PT’s) which enable incorpora-

tion of a community’s unique perspective of risk; facilitate data collection in the community and improve acceptance of interventions. PT’s allow members of the animal-owning community to express their knowledge, needs, practices and expectations. Brooke uses PT’s for community inclusion in three areas: 1) Prioritizing welfare issues for RA to investigate. A selection of key stakeholders performs brainstorming exercises and matrix scoring to identify human needs and relate them to animal needs. The resulting recognition of an animal welfare framework has previously been difficult to achieve. Animal welfare then forms the basis of a participatory process in which owners prioritize welfare issues considered most important from both the animal and owner perspective. 2) Sourcing potential risk factors for future measurement. Root cause analysis and focus group discussion are carried out with the community. Knowledge of the community often identifies details of human practices and daily work which may not have otherwise been considered for inclusion in a RA. 3) Social mapping offers a detailed knowledge of local service providers, animal work types and the equine population. Such knowledge ensures a good design of RA and provides a sound basis for implementation. RA tools and methods enable Brooke community and veterinary teams to run intervention and monitoring activities based on community acceptance and well documented knowledge of community dynamics. We believe this level of community participation is vital in the successful running of “in field” RA and the use of RA findings in interventions.

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#### **COMPARATIVE BENCHMARK DOSE ESTIMATES FOR GENOMIC DATA FROM TCDD-, TCDF-, OR PECDF-TREATED HUMAN AND RAT NORMAL HEPATOCYTES**

Assessing health risks associated with mixtures of dioxins and dioxin-like compounds (DLCs) utilizes the toxic equivalency factor (TEF) approach that calculates a potency estimate for a DLC relative to that of 2,3,7,8-tetrachlorodibenzo-p-dioxin (TCDD). The TEF concept assumes exposure additivity for the DLCs in a mixture and the single TEF value for a DLC is assumed to be the same in all species. Thus, TEFs are central to the risk assessment of DLCs. The application of genomic technologies has the potential for improving the accuracy of the TEF approach by allowing comparisons of potency across a wide-range of signaling pathways and in multiple species and cell types. This study used such an approach by measuring microarray-based gene expression changes in primary human and rat hepatocytes treated with seven log-order concentrations of TCDD, 2,3,7,8-tetrachlorodibenzofuran (TCDF), or 2,3,4,7,8-pentachlorodibenzofuran (PeCDF). The data were analyzed using the BMDEExpress software application that combines traditional benchmark dose (BMD) methods with gene ontology classification in the analysis of dose-response data from microarray experiments. In this presentation, the BMD estimates for affected pathways in human and rat hepatocytes will be discussed and compared with the standard TEF approach.

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#### **A RISK MANAGEMENT APPROACH TO UNUSED PHARMACEUTICALS**

The fate of unused pharmaceuticals is poorly understood, although the issue has received increasing attention over the past several years. Households are a critical point at which substantial quantities of a variety of pharmaceuticals accumulate (Ruhoy and Daughton 2007). These

accumulated pharmaceuticals are susceptible to undesirable exposures, including accidental misuse, intentional misuse/abuse, unauthorized transfer to a third party (e.g. dropping controlled substances off at a pharmacy), and environmental exposure through illegal dumping, disposal to municipal sewers or landfills. Reducing the transfer of pharmaceuticals from households to inappropriate locations requires an understanding of the factors that promote or minimize acquisition, accumulation, appropriate use or disposal, and inappropriate use or disposal. Potential undesirable outcomes of efforts to reduce accumulation and inappropriate transfer include inadequate medication, a transfer of unused pharmaceuticals from one inappropriate disposal to another, and illegal disposal behavior. In this paper, we outline the key drivers of household accumulation of unwanted pharmaceuticals, strategies for reducing such accumulation, and potential unintended consequences of changes to those drivers. We find that reducing undesirable exposures can best be accomplished through a strategy that integrates improved prescription practices, information for consumers about prescription compliance and appropriate disposal, clarification of legal disposal options, and changes to chain of custody that allows and regulates return of unused pharmaceuticals to points of purchase. Implementing this strategy will require cooperation among a range of agencies, including the Department of Justice, the Food and Drug Administration, the Environmental Protection Agency, and the Centers for Disease Control.

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#### **THE KEY EVENTS ANALYTICAL FRAMEWORK: A CASE STUDY WITH RETINOL (VITAMIN A)**

Methodology used to establish tolerable upper intake levels (UL) for nutrients borrows heavily from risk assessment methods used by toxicologists. Empirical data are used to identify the intake levels associated with adverse effects, and uncertainty factor (UFs) are applied to establish ULs. An underlying assumption in setting ULs has been that of a threshold dose - an intake level that must be exceeded before any adverse effect occurs. With nutrients there is also a second type of threshold - an intake level required to prevent adverse effects associated with deficient or inadequate intakes. In each case, however, the assumption of a threshold intake has been fundamental to establishing reference intake levels for public health purposes. Typically, the threshold intake values calculated for a given nutrient are estimates, due to inadequate understanding of the relationship between the biologically relevant intake(s) and the causative biological effect(s) that ultimately lead to the observed adverse effect. The ILSI Key Events Analytical Framework can be used to systematically examine the main biological events that occur between initial intake and the ultimate effect of interest with regard to the influence of each event on the overall intake-response relationship. This presentation will discuss application of the Key Events Analytical Framework to a case study of retinol (Vitamin A) where the effect of concern is caused by excess intake. The connection between homeostatic controls and threshold intakes at various pharmacokinetic and pharmacodynamic steps will be discussed, along with intake levels and processes that may disrupt such controls. Also, the role of modifying factors (e.g., life stage, exposure patterns) on the efficacy of homeostatic controls will be considered. Information useful for focusing future research and for public health applications will be discussed.

**P.85** Ruzante JM, Fazil A, Davidson VJ, Cranfield JAL, Henson SJ, Caswell JA, Anders SM, Schmidt C, Farber J; jruzante@uoguelph.ca  
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#### **A MULTI-FACTORIAL RISK PRIORITIZATION FRAMEWORK FOR FOOD-BORNE PATHOGENS**

To lower the incidence of human food-borne disease, experts and stakeholders have urged the development of a science- and risk-based management system in which food-borne hazards are analyzed and prioritized. Most approaches to risk prioritization developed to date are based on public health measures and do not account for other factors that are important to decision making. The Multi-Factorial Risk Prioritization Framework developed here considers four factors that are important to risk managers: public health; consumer risk perceptions and acceptance; market-impacts; and social sensitivity. In order to demonstrate the framework, six pathogen product combinations (Campylobacter in chicken; Salmonella in chicken and spinach; E. coli O157 in beef and spinach; and L. monocytogenes in ready-to-eat meats) were analyzed and prioritized using these criteria. The basic building block of the information structure is a three-dimensional cube based on pathogen-food-factor relationships. Each cell of the cube has an information card associated with it and data from the cube can be aggregated along different dimensions. The framework is operationalized in three stages. The first stage is the information cards that provide information on each factor; the second, aggregates the data on the various information cards into cobweb diagrams and creates a graphical summary of the food-pathogen combination. The third stage is the formal multi-criteria decision analysis in which the four factors are aggregated to produce a ranking of priorities. Three different scenarios representing hypothetical stakeholders' interest were used to further illustrate the final step of the framework. The Multi-Factorial Risk Prioritization Framework provides a flexible instrument to support policy makers in complex risk prioritization decision making when multiple pathogen-food combination enter the decision process.

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#### **GENERAL RESOURCE ALLOCATION FOR SECURITY AND PROTECTION (GRASP): A FRAMEWORK FOR PUBLIC ADMINISTRATORS AND PRIVATE MANAGERS**

Organizations select projects to mitigate risk and improve security of entities under their purview. Tools to support this process need to go beyond traditional capital rationing models. These models have limits and rarely incorporate explicit consideration of costs, risks, and benefits beyond traditional tangible valuations. We have found municipalities with mandates to fund programs with limited resources. Thus, municipalities have to determine various characteristics of the programs including vulnerability, risk, impact scope, event uncertainty, locational visibility, and other factors. The priorities, depending on event currency, will change, investment structures will also change. For example, the perceived vulnerabilities and impacts of terrorist events will be of importance after the event occurs, while natural disaster events may garner greater interest by managers if a recent natural event has occurred. Some allocations may simultaneously address many risk situations or events depending on program. These and other characteristics and nuances need to be integrated into management decision models. In this presentation we introduce the "Generalized Resource Allocation for Security and Protection Model". A variety of factors ranging from program characteristics to managerial perceptions of vulnerability (including expansion of the risk and hazard taxonomy for extreme risk and security events) are introduced. The possibilities of synergistic investments, those that may address more than one type of event and inte-

gration of typical business priority factors such as cost, quality, flexibility, and speed will be included. The conceptual model will be based on multiattribute utility theory incorporating interdependencies of factors and their dynamic nature. The model integrates tangible, intangible, short-run (operational) and long-run (strategic) dimensions. Extensions to the model such as integration of optimization resource allocation models using goal programming will also be advanced in this presentation.

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#### **INFLUENCE OF THE PERCEIVED SEVERITY OF DISEASE ON PROBABILITY PERCEPTION**

Background: Within the “affect” theoretical approach, people’s differential sensitivity to diverse formats of risk communication is explained assuming the existence of two modes of thinking: the experiential system and the analytical system. The former relies on images, metaphors and narratives, while the latter relies on probabilities and logical reasoning. Objectives: On the basis of the literature, we assume that the same objective risk can give rise to higher perceived risk when its affective meaning is enhanced. In this study the affective meaning is enhanced by varying the perceived severity of the outcome (Down syndrome, deafness and insomnia). We expect to find that the same risk is perceived higher when attached to a more severe outcome (Down syndrome) than when it is attached to a less severe outcome (Insomnia). Methods: A total of 549 subscribers to a Pediatric Newsletter agreed to answer an on-line questionnaire. The study employed a 3 (risk level) x 3 (severity) design. Participants were randomly assigned to one of 3 conditions and were presented with the following scenario, “Imagine to be a pregnant woman. Your gynecologist informs you that there is a risk of [1 in 28, 1 in 300, 1 in 3000] that your child is affected by [Down syndrome, deafness, insomnia].” Two dependent variables were tested: i) perceived probability; ii) worry. Results: Concerning the perceived probability, results showed the expected significant main effect of severity,  $F(2,1092)=45.73$ ,  $p<.001$ , an expected main effect of risk level,  $F(2, 546)=31.10$ ,  $p<.001$ , and an unexpected significant interaction between the two factors,  $F(4,1092)=3.25$ ,  $p=.012$ . As hypothesized, given the same objective risk, Down Syndrome ( $M=3.98$ ) and Deafness ( $M=3.81$ ) were both perceived more likely to affect the child than insomnia ( $M=3.48$ ) at  $p<.05$ . Similar results were replicated for worry confirming the influence of severity’s outcome on affective measures. More research is needed to explain the interaction effect. Conclusions: People tend to perceived more likely a disease to affect a child when the disease is more severe, even if the probability is the same. This has implications for doctor-patient communication because it means that the same risk (e.g., 1 in 200 of having a Down syndrome child) can be evaluated as more likely by those parents that rate Down syndrome as more severe than by those that rate it as less severe.

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#### **THE ECONOMIC BURDEN OF FOODBORNE ILLNESS IN THE UNITED STATES**

Few studies have been published that evaluate the economic burden from foodborne illnesses. In the past, where such studies were conducted, the economic cost of foodborne illness was typically evaluated for either one or a small number of important pathogens. The seminal USDA Economic Research Service study of the burden of foodborne illness estimated annual total costs of \$6.7 billion in 2000. However, this study was admittedly under-inclusive because it only measured costs for 5% of all pathogens and did not account for lost quality of life. Alternatively, a more

recent study using stated preferences methods estimated annual costs of foodborne illness to be over \$1.4 trillion, not including external costs. While this estimate is inclusive of all pathogens and internal costs to ill individuals, it probably overestimates actual burden given evidence of measurement error (such as embedding effects) in the primary study. In this study we utilize an enhanced cost-of-illness methodology that includes values for all pathogens examined by Mead et. al. (1999) and values for lost quality of life. Building on the methodology developed by Scharff et. al. (2007) our preliminary results suggest a mean annual economic burden from foodborne illness of up to \$148 billion. We characterize uncertainty in our analysis using @Risk software to perform Monte Carlo analyses. We also present sensitivity analyses for alternative assumptions. Our results are likely to be of particular interest to food safety risk managers and public health officials generally.

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#### **EFFECTIVENESS OF FOOD SAFETY EDUCATION FOR LOW-INCOME PREGNANT WOMEN**

Low-income pregnant women are particularly vulnerable to foodborne illnesses. Notably, CDC estimates that pregnant women are approximately 20 times more likely to be afflicted with listeriosis. Additionally, lower income women typically have less education than other women and, as a result, are not as aware of foodborne illness risks and risk protection measures. In this study, we examine the effects of risk communication on risky behavior, as measured by survey instruments, visual inspection of subjects’ kitchen cleanliness, and presence of Listeria and Salmonella in their kitchens and foods. Our sample consists of 600 low-income pregnant women, equally divided between Spanish and English speakers, in Columbus, OH and Pueblo, CO. We use preliminary kitchen cleanliness data, microbiological data, and a pre-intervention survey instrument to assess subjects’ baseline knowledge and practices. Half of the sample is then exposed to enhanced food safety education. Following this educational intervention, subjects are again visited to assess changes in knowledge, behavior, and objective measures of cleanliness. Multivariate analyses are used to isolate those factors that are predictors of intervention success. In particular, we estimate the effectiveness of the intervention for those with different risk preferences and demographic characteristics. Multiple measures of intervention success are used to test the robustness of our conclusions. Our results have both specific and general importance. Specifically, we are able to determine whether a food safety intervention aimed at low income pregnant women is effective. More generally, however, we advance the risk communication literature by examining the factors that lead to educational intervention success. This study is funded by the USDA National Integrated Food Safety Initiative.

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#### **EPA’S MICROBIOLOGICAL RISK ASSESSMENT EFFORTS TO SUPPORT REGULATORY PROGRAMS**

The EPA Office of Water (OW) has conducted microbiological risk assessment (MRA) activities to support its regulatory programs for well over a decade. The Agency is required to use risk assessments for establishment of drinking water regulations under the Safe Drinking Water Act and also applies MRA to support its Clear Water Act Guidelines efforts for ambient water criteria and biosolids. Since the mid-1990’s OW has recognized that the NAS Red Book for conducting chemical risk assessment is difficult to use in conducting MRAs without modifications. Since



then, OW has sponsored the development of a MRA framework and has applied a number of available risk assessment tools, methods, and approaches to it for conducting microbial assessments. Currently, revisions are being made to OW's draft MRA protocol for application to water-based media. Improvements include an enhanced approach for dynamic population susceptibility modeling, developing an approach to community based risk assessment, and producing an expanded chapter on risk characterization. Separately, OW is developing tailored quantitative MRA procedures for specific ambient water and drinking water uses. Additionally, OW has prepared a comprehensive thesaurus of terms and definitions used in association with MRA. OW is directly participating with other Offices, other federal agencies, and international agencies to enhance MRA capabilities and to harmonize them. Currently, the OW is working jointly with other health-based agencies to establish an interagency MRA guidance document and has initiated collaborative efforts with the World Health Organization to provide international harmonization of MRA for water-based media.

**P.80** Scherer AC, Younglove LR, Griffith WC, Krogstad FTO, Tsuchiya A, Faustman EM; scherera@u.washington.edu  
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#### **NOVEL DOMOIC ACID RISK ASSESSMENT FRAMEWORK: NEW CONSIDERATIONS FOR TWO SUSCEPTIBLE POPULATIONS**

Numerous geographic regions, including the US Pacific Northwest have struggled to confront the problems of domoic acid (DA), a marine biotoxin that causes amnesiac shellfish poisoning (ASP) in humans. The primary route of exposure to DA is via the consumption of contaminated seafood and thus the public health challenges are to balance access to shellfish resources against protection from contaminated shellfish. Currently, the Washington State Department of Health closes a beach to shellfish harvest when the DA level in shellfish tissue reaches or exceeds 20 µg/g. In this poster we focus on a re-evaluation of two potential susceptible populations to determine if these populations are protected in light of new scientific information. In order to do this re-assessment we have developed a new framework that incorporates kinetic and dynamic considerations into our current DA risk assessments. Framework considerations are presented here for two susceptible populations. Research in the rat model has shown DA can transfer from an exposed mother to the fetus via the placenta as well as the blood-brain barrier. This suggests in utero exposures of humans to DA be reconsidered. Individuals with compromised kidney function have also been identified as being especially vulnerable to the effects of DA exposure, since the kidneys play an important role in DA clearance. Recent considerations of incorporating inter-individual differences in renal excretion kinetics into a risk assessment framework have provided the new basis for our revised DA risk assessment framework for these populations. We incorporate susceptibility among two populations, fetuses and individuals with compromised kidney function, into a new framework for assessing DA risks and demonstrate the utility of including kinetics in our DA risk assessment models. Supported by: NIEHS 12762 and NSF 434087.

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Cornell University, Smithsonian Environmental Research Center, NOAA National Ocean Service  
**INCREASING STAKEHOLDER UNCERTAINTY WHILE INCREASING TRUST IN SCIENCE: AN EXPLORATORY STUDY**

Involvement of stakeholders in complex decisions related to science continues to grow in popularity. However, it remains unclear how successful these efforts are at explaining complex science to the public, or its role in increasing their trust of the sponsoring scientific groups. Uncertainty Reduction Theory suggests that increasing information to the public will result in

decreasing their uncertainty. The underlying assumption has been that messages providing specific, reliable, and accurate messages purposefully designed to reduce uncertainty has a high likelihood of success. However, accurate science messages about many topics must or should recognize the scientific uncertainty ubiquitous to science. Consider the uncertainty of scientific information related to genetically modified foods, or climate change. To be scientifically accurate, messages must recognize that there are many areas in which science is uncertain, resulting in increasing stakeholders' uncertainty: Are GMO's safe? How do we balance economic interests with climate change prevention? This line of argument would suggest that non-expert stakeholders tend to have a seemingly simplistic view of possible solutions to complex problems. What if more information increases uncertainty, not decrease it? This study examines Florida Coast stakeholders' understanding and reaction to a presentation of science information about red tide. The science-based presentation included discussion of costs, benefits, known and unknown effects about the proposed approaches to red tide control, monitoring, mitigation and prevention. Stakeholders responded to a pre and post-test questionnaire as a part of a series of group meetings across the state of Florida. Results discuss the relationship between uncertainty reduction and trust in science and the sponsoring science-based organizations.

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#### **ECONOMIC IMPACTS OF THE AMERITHRAX ATTACKS**

The potential economic impacts of bioterrorism are widely predicted to be significant, however, little research exists to evaluate the impact of bioterrorism events. Moreover, no economic impact assessment exists for the most serious bioterrorism event in the United States to date, the letter attacks of 2001 involving anthrax contamination, widely referred to as the amerithrax attacks. This study attempts to quantify the economic impact of the amerithrax events. These impacts are evaluated by determining the costs directly associated with the event as well as the specific industries impacted. These direct costs include the costs of decontamination and medical services associated with the letter attacks, as well as an evaluation of the broader costs of detection devices and market impacts of the events on the postal service and US government. In particular, understanding impacts of the amerithrax attacks on consumption behavior is key to estimating economic impacts. An input-output analysis is conducted to evaluate the inter-industry effects associated with the amerithrax events. An important methodological consideration in this analysis is the careful accounting of payment sources for remediation and detection. In this way, transfer payments among taxpayers, the government and affected industries are explicitly stated so that economic winners and losers associated with the events can be clearly identified. This avoids a common pitfall in economic evaluations of disasters, in which injections to the economy are disregarded or counted as economic damage.

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#### **CAN QMRA BE USED TO DISCOUNT PATHOGEN RISK TO SWIMMERS FROM ANIMAL FECAL CONTAMINATION? DOHENY BEACH, CA CASE STUDY**

Estimated health risks to swimmers from seagull and bather sources of fecal contamination at Doheny Beach, California were compared using quantitative microbial risk assessment (QMRA) with a view to aiding beach closure decisions. Surfzone pathogens from seagulls were thought to be less of a human health threat than human fecal contamination. To evaluate if the seagull fecal contribution can be discounted, possibly reversing a beach closure, a discounting process is proposed here that estimated the risk to swimmers of gastro-intestinal illness and com-

pared the predicted risk to the 19 illnesses per 1000 benchmark. The discounting process was exemplified for *Campylobacter jejuni* using 1) the counts of seagulls and swimmer/shedders and assumed pathogen load distributions, or 2) a hypothetical source tracking tool that measures the proportion of total fecal contamination attributed to the two sources. A beta-Poisson dose-response model was utilized to calculate the probability of infection using Monte Carlo analysis of the uncertain input variables. The conditions under which the seagull fecal contribution could be discounted were specified for the observed range of surfzone enterococci (ENT) concentration over the 2007 recreational season. However, even using a perfect source tracking tool, seagull fecal contributions could not be discounted for ENT concentrations above the 108 CFU/100ml single sample limit, at the 95% confidence level, given the 19/1000 benchmark. The same conclusion was drawn using fecal load estimates from the number of gulls, and various ratios to swimmers. The proposed discounting process negates the belief that gull fecal-derived enterococci counts contribute less of a health threat to swimmers than human sources, given the current large uncertainty in human infectious campylobacters in gull feces, let alone their unknown environmental persistence. The discounting process suggested could be applied to additional locations and sources, using appropriate reference pathogens for locations with different sources of fecal contamination.

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#### **CALIBRATION OF SUBJECTIVE JUDGMENTS FOR LONG-TERM ENERGY DEMAND THROUGH BOUNDING ANALYSIS**

Now that the scientific community has concluded that human activities are inducing climate change, long-term scenario analysis to inform mitigation and adaptation strategies in response to climate risks has taken on new relevance. Morgan & Keith noted in a recent issue of *Climatic Change* that “judgments about the subjective probability of future states of the world lies [sic] at the heart of scenario construction.” (p. 196) However these judgments are seldom communicated to decision makers explicitly. Pinpointing such subjective probability judgments so that they can be explicitly expressed requires systematically thinking about all the possible ways in which different outcomes might occur. Numerous studies have demonstrated that this is cognitively difficult due to heuristics such as availability and overconfidence. This work-in-progress poster details the first step of a larger research effort to identify subjective probabilities for long-term emissions scenarios – calibration of judgment for the upper and lower bounds of a distribution. As suggested by Morgan & Keith, calibration could be achieved by beginning a scenario analysis with an account of the many different ways in which a quantity might have a high, medium, or low value over time spans of interest. In this study, the upper and lower bounds of U.S. electricity demand several decades into the future are considered.

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#### **A CRITIQUE OF LCA WITH RESPECT TO NANOMATERIAL APPLICATIONS**

Production alternatives for single-walled carbon nanotubes (SWCNT) such as chemical vapor deposition, laser, arc and flame, vary widely in material and energy yields, catalyst requirements and product characteristics. The overall environmental profile must be assessed relative to performance in a specific end-use application, such as lithium ion batteries for electric or plug-in hybrid vehicles. Although in general SWCNT have several properties that make them attractive for transportation applications, production is a material- and energy-intensive process. High-yield

synthesis pathways may be environmentally inefficient if extensive purification is required. Life cycle assessment (LCA) is an approach to quantifying the environmental tradeoffs engendered by technology substitution. However, it is essential to recognize that the results of LCA for one type of SWCNT may not be applicable to SWCNT of different purity, length, diameter, chirality or conductivity. This paper discusses sources of variability and uncertainty in production of SWCNT and makes several recommendations with regard to LCA of nanomaterials.

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#### **ENGAGING PUBLIC INTO NANOTECHNOLOGY R&D: CHALLENGES AND PROGRESS**

This paper discusses the findings from the past projects and current activities with focuses on newly started research project “Research on development of comprehensive database index for a basis of facilitation of nanotechnology R&D”. In Japan, the government investment into nanotechnology R&D has been steadily growing as it is doubled since 2000. The Japanese government estimates the size of the nanotechnology related market will be as large as 260 billion dollar in 2030. A considerable number of nano-products, which proclaim either using nanomaterials or nanotechnologies, are already in market as commodities like cosmetics or building materials like antifouling coating. At this point, expected innovative use of nanotechnologies is still being in laboratory stage and waiting for debut in market. The fact that nanotechnologies and nanomaterials are new to many people and bear many uncertainties raises concern about its development. Media already starts to cover effects of nanotechnology on society negatively. Currently, many researches are underway to shed light on uncertainty and understand various societal effects of nanotechnologies and nanomaterials throughout the world with strong focus on environmental and health effects. How to share information collected through these researches with public is a key issue for future society to overcome specter and enjoy benefit from use of nanotechnologies. As one of the ways to address this issue, the government has conducted inter-ministerial collaborations since fiscal 2007 and a new three-year project “Research on development of comprehensive database index for a basis of facilitation of nanotechnology R&D” has started in September 2007. The project is conducted as collaborative work of a university and two research institutes and its goal is to develop indexes available in nanomaterials R&D database. This project attempts to incorporate communication factor into nanomaterials R&D database.

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#### **SCIENTIFIC KNOWLEDGE AND MYTHOLOGY**

Acquisition of the human knowledge is a complex process tightly connected with the society and culture. The paper presents a new approach proposed to be used in the evaluation of the paradoxes appearing in the methodologies of various studies and theories (with examples and references from risk analyses) and in the search of solutions and the path forward. The approach is based on the defined isomorphism between scientific knowledge and mythological knowledge and is composed of three steps: Firstly the limits and strengths of the analogy are defined and then a set of proposed rules which are considered to be acting in various phases and for various types of scientific knowledge are formulated in an axiomatic type. Examples are also indicated. Even if they are mainly from the risk and complexity theories (and based on real cases and results in which the author was involved so far), it is considered that the approach is actually applicable (with its nuances of course) to any scientific field. Secondly a set of possible interpretations (based on the isomorphism as defined initially between mythological and scientific knowledge) of the types of

paradoxes is defined for every specific phase defined previously for a scientific knowledge process. A group of principles considered to be applicable is formulated and it is defined how they work at each phase and what is their interconnection with paradox solving goal of the endeavor. In final step a set of guiding rules of how to search for solutions when paradoxes appear, which was identified as being typical paradigms for typical type of scientific paradoxes, is presented.

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#### **AN INTRODUCTION TO TOXCAST(TM)**

ToxCast™ is a chemical prioritization research program to develop the ability to forecast toxicity using bioactivity profiling. The point is to use results in a variety of in vitro and rapid non-mammalian in vivo assays to explore effects at different toxicity targets. The design of the study (from receptor-specific assays through cellular assays to evaluations of toxicity in zebrafish) allows data analysis to proceed in both unsupervised and supervised modes. In unsupervised modes, assay results are used to explore and define common toxicity pathways. Supervised analyses are used to develop predictors of animal toxicity as determined from a database of the results of toxicity testing using guideline registration studies. In Phase I of ToxCast™, just over 300 chemicals, largely registered pesticide active ingredients, have been tested in over 400 assays. Phase II will evaluate predictors derived in Phase I by testing toxicity predictions in an additional set of chemicals. While the initial phases of ToxCast™ have focused on hazard identification and prioritization, many assays have been run at multiple concentration levels, so concentration-response analysis is feasible. Combined with work developing PBPK models described in Dr. Clewell's talk in this session, such analysis could foster the development of purely in vitro-based dose-response analysis, as envisioned in the National Academy's recent document "Toxicity Testing in the 21st Century." All data collected in Phase I are being made available to the public, and investigators are encouraged to explore this rich dataset with their own methodologies. This work was reviewed by EPA and approved for publication but does not necessarily reflect official Agency policy.

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#### **THE FUTURE OF THE BUSH ADMINISTRATION REGULATORY REFORMS**

The past eight years have been busy ones for aficionados of the regulatory process. Not since the late 1970s/early 1980s have as many requirements been imposed upon agencies writing a regulation. These include the implementation of the Information Quality Act, regulatory peer review, Executive Order 13422, and electronic rulemaking requirements among others. Since many of these requirements were imposed by executive order or other presidential action, the new administration will have important choices to make about whether to weaken, maintain, or strengthen these requirements. These decisions will affect nearly every area of regulatory policy but particularly risk regulation since many deal with the underlying science supporting regulations. This paper examines the questions of what the new administration should consider in evaluating these regulatory procedures and makes recommendations about the future of the Bush regulatory reforms.

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#### **DEVELOPMENT OF A SCREENING-LEVEL FATE AND TRANSPORT AND FISH BIOACCUMULATION MODEL FOR MINNESOTA ECOSYSTEMS**

ICF has developed a computer model that estimates the uptake of selected persistent, bioaccumulative, and toxic chemicals (PBTs) in freshwater fish consumed by people to support the Minnesota Pollution Control Agency (MPCA) air emissions risk assessment process. This model, the Fish Pollutant Accumulation Spreadsheet System (F-PASS), leverages components of existing fate and transport algorithms and an aquatic food web model (AQUAWEB) within a free-standing, user-friendly framework tailored toward conducting screening-level assessments of point sources of air toxics in Minnesota. Required inputs that must be provided by the user include chemical source terms and selected water body and watershed parameters (such as physical dimensions of the modeled environment). The majority of the model parameters (including the overall structure and specifications of aquatic food webs assumed to be present at the site) are set to county- or region-specific values that were developed for ecosystems specific to Minnesota. The flexibility of the model allows the user to optionally enter specific local data to conduct a more refined site-specific analysis. As a part of the development process, ICF also constructed an integrated sensitivity tool that was used to estimate the influence of model parameters on important model outputs (i.e., concentrations in fish tissue) and evaluate the default values specified for the model. This presentation provides a general overview of the technical background of F-PASS, discusses the relative importance of model parameters in the context of using region-specific biotic and abiotic default values, and describes the results of a range of sensitivity analyses and other analyses. Based on our model evaluations, we conclude that the F-PASS model is a useful tool that can be applied with a minimum of site-specific data for estimating the possible impacts on human health via the fish ingestion pathway of air emissions of PBTs from point sources in Minnesota.

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#### **TO LABEL OR NOT TO LABEL OF PAPAYA FRUITS**

The evolution of technology and the ever increasing demands on food supplies worldwide, has recently led to the development of Genetically Modified Organisms (GMOs). Currently, the USDA and FDA does not mandate labeling of GMOs. The review of literature reveals there are pros and cons for and against labeling GMO products. A study recently showed that mandatory labeling in Europe had eliminated the ability to choose GMO foods because there were fewer than ten GMO products available. At least 22 countries have indicated they are beginning legislation to make labeling mandatory. The argument exists that for religious and ethical reasons, people would want to be informed to avoid eating animal products, including animal DNA. In Hawaii USA, the state is debating mandatory labeling of all GMO fruits and vegetable produced in Hawaii. This includes taro, papaya, and coffee. The objective of this research is to provide policy makers in Japan and US with information about the consumer's attitudes towards labeling GMO fruits. Japan is the main export market for Hawaiian papayas, and large percentages of Hawaiian Papayas are GMOs, which can't be shipped to Japan. In this study, 493 respondents were selected at random from shopping malls in Japan. Cross tabulation between respondents who know about GMO and their attitudes toward labeling indicated that there is a significant relationship between these two variables. In general, respondents in Japan are not well informed about the GMO food products. Many are wary of consuming GMO because they feel they may be unsafe. This lack of knowledge about how GMO products are produced may cause misconceptions for



consumers in Japan. The results showed that both consumers strongly support labeling of GMO fruits and that it should be mandatory. The cost of labeling Hawaii GMO papayas needs to be examined to assess the cost and benefit of such a policy.

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#### **THE PSYCHOLOGY OF STRATEGIC TERRORISM: GOVERNMENT AND PUBLIC RESPONSES**

Three themes are essential to understand public behaviours and attitudes when developing prevention, preparedness and emergency response strategies. Combined with effective risk communication, incorporating these characteristics in counter terrorism plans can reduce the utility of terrorism as a tool of political coercion through reducing the disorientation of society that terrorist groups seek to achieve their political objectives. 1) Case study evidence dispels the myth of a panic prone public that is unable to engage with authorities following a terrorist attack. Research suggests a more rational public with individuals changing elements of their everyday lives to reduce the perceived risk to them of being exposed to a terrorist attack. 2) The public undertakes changes in behaviours and attitudes that can be detrimental to the safety of themselves and those around them. The terror generated by an attack is limited. Beyond those in close vicinity to the attack, the repercussions for the wider society are mainly disruption to the public's normal behaviours (e.g., avoiding venues with large crowds or transportation systems or locations previously attacked). However, these responses can adversely affect individual's risk perceptions to such a degree that they calmly embark on activities that can be detrimental to the safety of themselves and those around them, or place pressure on limited resources like public health assets. 3) Effective risk communication can reduce the terror of terrorism and adverse responses. The behavioural reactions of the public partly depends on how their perceived risks are amplified or reduced by media reporting, authorities' risk communication strategies (threat advisories and advice provided during and after an attack), and responses by public health and the emergency services (e.g., speed of response and availability of resources). These can amplify or attenuate the disorientation of society sought by terrorists for political ends.

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#### **EPA'S NEW CHEMICAL ASSESSMENT AND MANAGEMENT PROGRAM (CHAMP) AND EPA'S EFFORTS UNDER CHAMP**

EPA's Office of Pollution Prevention and Toxics (OPPT) will profile efforts under its new Chemical Assessment and Management Program (ChAMP). ChAMP facilitates EPA in fulfilling the U.S. commitments made under the Security and Prosperity Partnership of North America (SPP). The SPP of North America Leaders' Summit, held in Montebello, Canada, in August 2007, called for cooperation on chemicals and outlined commitments on behalf of the United States, Canada, and Mexico to work together to ensure the safe manufacture and use of industrial chemicals. Each country is sharing scientific information and approaches to chemical testing and risk management. To fulfill its part of the SPP commitment, the United States will, by 2012, complete screening-level risk characterizations and take action, as appropriate, on more than 6,750 chemicals produced above 25,000 pounds per year. The U.S. commitment to complete assessments and take action on these chemicals will apply the results of EPA's work on High Production Volume (HPV)-those chemicals produced or imported in the United States in quantities of 1 million pounds or more per year-and extend its efforts to moderate production volume chemicals-those

produced or imported in quantities above 25,000 and less than 1 million pounds per year. As part of the efforts under ChAMP, EPA is developing screening-level documents that summarize basic hazard and exposure information on HPV chemicals, identify potential risks, note scientific issues and uncertainties, and indicate the initial priority being assigned by the Agency for potential future appropriate action. The EPA began posting the first set of Hazard Characterization documents in September 2007 and subsequently posted the first risk-based prioritization documents in March 2008. EPA is expecting to continue to make its efforts public via its website ([www.epa.gov/champ](http://www.epa.gov/champ)).

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#### **MEDIA PRESENTATION OF RISKS AND BENEFITS ASSOCIATED WITH NANOTECHNOLOGY AND ITS CULTURAL IMPLICATION**

Research has suggested that public attitudes toward nanotechnology depend largely on people's evaluation of its associated risks and benefits. The general public, however, does not experience nano-related risks or benefits by themselves; instead, they acquire such information from mass media. Examining media portrayal of technological risks and benefits, therefore, is important in understanding the bases on which people make sense of nanotechnology. However, most research involving risks and benefits of nanotechnology focused on the "perceptual" aspect; that is, how public perception of risks and benefits affects attitudes. Rarely did scholars link such perception with media content. Even when they did, researchers were mainly concerned about media "framing" of the issue. This study will address the gap by focusing on how the media present information on various types of risks and benefits. In addition, it will place such presentation under different cultural contexts because risks and benefits may possess different meanings in different cultures. Specifically, this study will content-analyze two elite press, the New York Times (NYT) in the U.S. and the United Daily News (UDN) in Taiwan. We will also incorporate the idea of issue attention cycle in light of the evolving nature of sciences and media interests. In other words, we will compare the presentation of risks and benefits across different phases of media attention. Therefore, we propose three research questions. First, which risks or benefits are most prevalent in news coverage of nanotechnology? Second, how does media coverage of risks and benefits evolve over time? Third, do media cover risks and benefits differently in the two culturally distinct newspapers? We searched in Lexis-Nexis with a revised string of keywords developed by Porter and colleagues (2007). The total number of news articles obtained is 431. The Scott's pi intercoder reliability coefficients for NYT and UDN are .9 and .8, respectively.

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**EVALUATION OF HEALTH BENEFIT OF ACUTE MORTALITY DUE TO PM10 AND PM2.5**

Quantitative health risk assessment achieved to presume benefit from improving PM10 and PM2.5 quality in this research, and willingness to pay amount of local residents estimated to calculate a value of statistical life. To evaluate the relationship between PM exposure and daily mortality, we studied time-series analysis of them. The association of PM10/PM2.5 with daily mortality was examined in Seoul, during the period of 2004-2005. Generalized additive Poisson models controlling for confounders were used to evaluate the acute effects of particle exposures on total, respiratory, and cardiovascular mortality. An IQR increase of PM10 (39.7  $\mu\text{g}/\text{m}^3$ ) was associated with 1.005 (95% CI: 1.001-1.016) increase in total mortality and PM2.5 (22.7  $\mu\text{g}/\text{m}^3$ )



was associated with 1.045 (95% CI: 1.021-1.065) increase in total mortality. We used the linear concentration-response function to evaluate the attributable number of death from PM10 and PM2.5. PM10 caused more than 306 of all-cause mortality per year and 92 / 282 of respiratory mortality and cardiovascular mortality, respectively. And PM2.5 caused more than 1,488 of all-cause mortality per year and 146 / 486 of respiratory mortality and cardiovascular mortality, respectively. For the benefit comparison between managing PM10 and PM2.5, we estimated a value of statistical life to presume the theoretical mortality rate's benefit that is result or health risk assessment, and used contingent valuation method to investigate a willingness-to-pay to produce a value of statistical life. The monthly average WTP for 5/1,000 mortality reduction over ten years was \$25.3(2007\$) per month and the implied value-of-statistical-life (VSL) was 6.1 million dollar per year. We combined the annual attributable number of death and the value of statistical life to calculate the damage cost. The total damage cost of PM10 in ambient air was 1.87 billion dollar and total damage cost of PM2.5 was \$9.08 billion dollar

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#### **RISK ANALYSIS FOR THE NANOMATERIAL FULLERENE C60**

Although fullerene C60, which has unique physical and chemical properties, has hitherto been used only in the manufacture of sporting goods and oil additives, it can potentially be used in several fields such as in industry for energy conversion and in medicine for drug delivery. In order to manufacture new industrial nanomaterials that would not have adverse effects on the environment, the potential risks of industrial nano-C60 were analyzed. In the hazard assessment, information from previous literature and the results of the project "Evaluating Risks Associated with Manufactured Nanomaterials" funded by New Energy and Industrial Technology Development Organization (NEDO), in which the authors were also involved, were used. The endpoint of C60 in the hazard assessment was set as the pulmonary toxicity because the clearance of carbon nanomaterials was reported to be slow. C60 was reported to induce few adverse effects in inhalation exposure tests and intratracheal injection tests, while it was reported to have adverse effects in intracavernous administration tests and intraperitoneal administration tests. The no observed adverse effect level (NOAEL) of C60 for humans was estimated on the basis of the results of previous studies on rats and the respiratory volume and alveolar surface area of humans and rats. Since current usage of C60 is very little and there are few current quantitative monitoring data, emission and exposure of C60 in future were estimated for sporting goods and oil additive, solar battery and so on during every life cycle. The emission and exposure of C60 in future was calculated by revising the corresponding data pertaining to the other nanomaterials on the basis of the physical characteristics and future applications/usage of C60.

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#### **CLARIFICATION OF INTERDEPENDENCY ASSOCIATED WITH A SYSTEM FAILURE OF CRITICAL INFRASTRUCTURE NETWORKS IN VIEWS OF A SEISMIC RISK**

In the paper the interdependency associated with a system failure of critical infrastructure networks is clarified quantitatively in views of a seismic risk. First, focusing on electric power supply systems, gas supply systems, and water treatments distributed in Tokyo metropolitan area, those systems were modeled as network nodes and links taking into account the mechanical interdependency. Second, adopting the BDD method, system reliability on subject networks was

revealed when the number of affected nodes and links varied and the related sensitivity analysis was carried out. Finally, the parameters associated with average degree  $\langle k \rangle$ , average path length  $L$  and, maximum and average cluster size  $S$ ,  $s$ , of subject networks were evaluated when the nodes exposed to the high seismic hazard were failed.

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#### **DIFFICULTIES IN RISK COMMUNICATION: FREQUENCY FORMATS DO NOT AUTOMATICALLY ELICIT BAYESIAN REASONING**

Research in the tradition of the heuristics and biases paradigm suggests that most people don't follow the laws of probability when making decisions under uncertainty. This pessimistic view has been challenged by a number of studies. Several researchers concluded that evolution shaped the human mind to make accurate judgments based on natural frequencies. In all these studies, however, students or academics were tested. The goal of our first study was to examine how often both probability-based and frequency-based versions of a medical diagnostic problem elicit Bayesian responses in a random sample of the general female population. In line with previous studies, we found that subjects are more likely to correctly solve a Bayesian problem when the information is presented in a frequency format compared with a probability format. The percentage of respondents who correctly solved the frequency problem was much lower than the percentage reported in earlier studies. The present results call into question the proposition that humans are automatically good intuitive statisticians when information is presented in a frequency format. Humans may not be suitably adapted to solve medical decision problems, but humans could be well adapted to solve Bayesian problems in the domains of food and social cognition. Results of two additional studies with participants from the general population suggest that people's abilities are domain specific. People are better able to solve a Bayesian problem stated in natural frequencies within the context of a social problem as compared within the context of medical decision making. The present study demonstrates that the results of information format studies employing student samples should not be generalized to the general population.

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#### **COMPARISON OF PSA RESULTS OBTAINED WITH BDD AND CONVENTIONAL APPROACH**

Significant usage of Probabilistic Safety Assessment (PSA) models for various practical applications in the nuclear and some other industries makes model solving and quantification very important. Conventional approach to the PSA model quantification is by means of finding partial solution. This is done because resources related difficulties to find complete minimal cutset solution and to properly perform various quantifications (i.e., top event probability and important measures) in acceptable time. This is especially so for some advanced PSA applications like estimation of the effects from the configuration variations for on-line risk monitoring. Event trees and fault trees linked together create each PSA model. They can be presented with equivalent fault tree model for each sequence for the analysis purposes. Any fault tree can be very economically encoded by means of Binary Decision Diagrams (BDDs). The only limitation to this is in the fact that for very complicated models there is no analytical way to determine respected BDD representation. This is proven to be NP-hard problem, and various heuristic are being developed to improve this potential. Main subject of work described here is comparison for the various results quantification for the number of PSA model sequences. Based on the fact that current conventional trun-

cation type of quantification has no satisfactory way of error estimation it seems important to have this kind of comparisons. Different sequences are having different levels of differences with complete and truncated result. Overall, total results are not showing significant differences in the comparison. But this is not so for all sequences and work is still in progress. Because of BDD construction limitations it is not possible to do this comparison for the very huge PSA models. Therefore, it is not possible for now to have complete comparison.

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#### **THE AFFECT HEURISTIC & THE CULTURAL THEORY OF RISK**

This presentation will explore the connection between two theories of risk perception. The first is the “affect heuristic,” which refers to the central role that affect and related states play in the cognition of risk. The other is the cultural theory of risk (Douglas & Wildvasky, 1982), which examines the role that cultural worldviews play in shaping risk perceptions. Featuring empirical findings, the presentation will examine the potential relationships between these two accounts.

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#### **PUBLIC ENGAGEMENT WITH GLOBAL WARMING: A SOCIAL REPRESENTATIONS APPROACH**

The present investigation explores public engagement with global warming risk. Using an open ended and exploratory interview schedule, the associations of 56 British respondents to the term “global warming” were explored. Virtually all respondents believe that human activities are to blame for recent temperature increases although the location of this cause is geographically distant with “other countries” blamed for polluting the atmosphere. The tangible impact this is having in the UK, however, brings the issue closer to home with “unsettled weather” and “changing seasons” widely discussed. Although concrete examples are readily identified, respondents do not feel personally at risk from any immediate danger. Interpreted within a social representations framework, the global warming threat is assimilated into popular understanding of environmental issues more generally, with recycling widely symbolised as an action the public can take to “make a difference” at an individual level. The findings challenge existing public perception research that finds global warming to be a future-orientated threat but also illustrate the utility of using qualitative methodologies to identify nuanced understandings of public engagement with risk issues.

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#### **COMPARISON OF HOMELAND SECURITY RISK ASSESSMENT METHODOLOGIES**

Are we using the best risk analysis methods to allocate resources towards protecting our nation against an intelligent adversary who will adapt to our actions? There are several risk analysis techniques that have been used for risk assessment and risk management. We summarize the usefulness of these techniques to assess threats, vulnerabilities and consequences for homeland security decision making. Due to the significant potential consequences, we use bioterrorism as an illustrative example. We use commercially available off the shelf software (COTS) to compare several techniques including event trees and decision trees. We specifically focus on the feasibility of using COTS software to perform risk assessment and risk management for large scale applications. We explore different scale models to assess the benefits of additional fidelity. In addition, we consider the ability to perform sensitivity analysis and cost benefit analysis.

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#### **EVIDENCE MAPS - A TOOL FOR SUMMARIZING AND COMMUNICATING EVIDENCE IN ASSESSMENT OF UNCERTAIN NOXES AND ITS PRACTICAL APPLIANCE: TWO CASE STUDIES**

The initial idea to develop this tool was to deliver a possibility to handle uncertain risks, i.e. risks about which there is little or inconsistent scientific data. Evidence assessment based on such data can be difficult. There are several approaches to evidence assessment which have different purposes and focus on different aspects accordingly. The method we apply is that of “Evidence Maps”. Our purpose in its development is to create a tool for communication about inconsistent results from studies and of dissimilar scientific expertise with different stakeholders. In order to reach this goal, the method provides for applying scientific argumentation backing up the evidence assessment as well as its transparent and unambiguous graphical presentation. This is achieved by the following elements of an evidence weighting process: database, arguments for or against the existence of a causal relationship between exposure to a (potential) hazard and the biological effect that is considered, as well as the conclusions based on such argumentation and the remaining uncertainties. This line of argument is graphically presented in the so-called “evidence map” (inspired by the “Mental Models” approach). A key part of generating evidence map input is scientific dialogue. Based on two case studies (evidence assessment of the health-relevant impact of mobile EMF and engineered nanoparticles) we show the practical implementation of the method. Because of the differences in the evidence base and the specifics of the two noxes considered, this processes demonstrate some differences as well. In addition, we tested evidence maps as a means of communication between scientific experts. Together with the unalloyed positive experience we gathered in this communication, we present some weak points of the model, which we are anxious to eliminate in our ongoing work on this approach.

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#### **CORPORATE SUSTAINABILITY INITIATIVES AND THEIR FOOD SAFETY RISKS: THE ROLE OF CERTIFICATION, TRACEABILITY, AND AUTHENTICATION**

Economic food fraud, or food profiteering, is not new though the huge opportunity of the growing consumer preference for sustainable products creates tremendous new momentum for this risk. As with other food safety and food defense initiatives, a root solution is in supplier certification, product traceability, and product authentication. While the risk of conventionally grown food products co-mingled with organic food products may seem merely a technicality, diethylene glycol in cough syrup is deadly. This presentation builds off previous SRA journal articles that define the sustainability issues for risk managers, to now examine specific public health, economic, and brand equity risks associated with the consumer drive towards sustainable products. The major retailers and brand manufacturers are moving from initiating corporate sustainability programs, to implementing sustainability initiatives across their entire organizations, to the next stage of incorporating focused standard operating procedures across all their business. These procedures expand from seeking and buying a sustainable product to assuring that the product is safe and authentic. The presentation leverages experience with corporate sustainability initiatives and the work of the Michigan State University’s Packaging for Food and Product Protection (P-FAPP) Initiative.

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### **THE AHP BASED ASSESSMENT OF HUMAN-RELATED WORK RISK FACTORS BY FORKLIFT DRIVERS**

Occupational diseases and disorders are often among forklift drivers, mostly as a result of the lack of systematic assessment and prevention of highest risks. Risks can be divided as human-related, machine-related, task-related, and management-related factors. Ability of any worker to respond to risk factors is unique, and profound understanding of the drivers perception of the human-related risks can enable application of appropriate counter measures for different workers and lowering such risks. This paper proposes systematic and comprehensive participative framework for forklift driver's assessment of the following significant classes of risk related factors: psychological (preoccupation during the task, unconscious misjudgment, intentional task omission, monotonous task and boredom), physiological (fatigue and worker's health level), and organizational (physical defect, labor relations, and absence of suitable communication). Even ranking of the risk factors by importance for forklift drivers is complicated because it assumes both multicriteria and multi-individual (group) context. This in turn requires application of specific tool, such as the Analytic hierarchy process (AHP), well known methodology that support participative multicriteria analysis. We propose the use of AHP because it is convenient to set psychological, physiological and organizational factors as global risk-related factors which can be compared in pairs to find out which one is of major concern for the drivers. If this is followed by pair wise comparisons of the aforementioned specific factors within global groups it is possible to create full list of risk factors ranked by their real importance for drivers' health. The three experienced forklift drivers participated in a proof-of-concept experiment. Individual AHP assessments are aggregated to obtain the final (group) ranking and main results are summarized and discussed in the paper.

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### **DO FAIR PROCEDURES MATTER? AN EMPIRICAL INVESTIGATION OF A FORMER DISPOSAL PROJECT FOR NUCLEAR WASTE IN SWITZERLAND**

It is often claimed that an improved communication can alleviate perceived risks. That is, involvement of the public in decision-making processes would increase acceptance e.g. of new technologies. Procedural fairness might be essential when an equal sharing of burdens per se is not possible, e.g. in nuclear waste management due to the geological-technical constraints. Yet in the field of risk perception, aspects of procedural fairness are rarely addressed. Empirical work suggests that risk perception is positively influenced by trust and negatively by perception of benefits. Moreover, the affect heuristic concept proposes that positive affect increases perception of benefits but decreases the perception of risks. Justice literature, on the other hand, expects that unfair (perceived) processes lead to negative emotions. Integrating these considerations in a new model, we expect that past experience of a process influences acceptance, not directly, but moderated by emotions, trust and risk perception. As we believe that actual experience differs from a situation based on artificial scenarios used in experiments, we choose a concrete case example: a former disposal project for nuclear waste in Switzerland. Here a process over close to 20 years led to a double rejection by the electorate of a site for a deep geological repository. We carried out a representative postal survey (N = 532, random sample, response rate 30.7%). Using structural equation modeling, we show that perceived unfairness of the siting process induces negative emotions which affect trust negatively and risk perception positively, leading to sharp increase in refusal of the disposal project. Further results confirm that procedural aspects are all judged as of

major importance. We conclude that perceived procedural fairness actually matters. Participation of the public seems an appropriate and important strategy in site selection process for nuclear waste repositories.

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### **A FLEXIBLE COMPUTATIONAL APPROACH FOR ESTIMATING CANCER RISKS FROM EXPOSURE TO MUTAGENIC CARCINOGENS DURING EARLY LIFE STAGES**

Current EPA Guidelines for Carcinogen Risk Assessment require that age dependent adjustment factors (ADAFs) be applied to cancer potency and unit risk factors when estimating the excess cancer risk from exposure to mutagenic carcinogens during early life stages, from birth to age 16, to account for the increased carcinogenic response to exposure during this life stage. As noted in EPA's supplemental guidance on early life-stage exposures, physiological and behavioral factors - age specific exposure factors (ASEFs), also vary with age during early life stages, affecting exposure, and hence risk. Unfortunately the age ranges applicable to EPA's ADAFs - 0 - less than 2 and 2 - less than 16 years do not correlate well with those typically used to estimate child exposures - 0 - less than 7 years. This report describes a simple, flexible computational approach for accurately matching ASEFs for any receptor age range with the relevant ADAFs. Exposure factor values for soil and water ingestion rates, inhalation rates, skin surface areas and soil loading rates for various activities, body weights, etc. were obtained directly, or interpolated from EPA's Exposure Factors Handbook (EFH) or Child-Specific EFH for each age year from birth through 21, plus average values for ages 21- 65 and less than 65 years. A composite intake factor (IF) is then calculated for each age year. The IFs are multiplied by the number of years the receptor spends in an age year or period and divided by 70 years for cancer risks. IFs are summed for the receptor age years falling in each of the ADAF age ranges. These aggregate IFs are then combined with cancer slope factors (SFs) and ADAFs to estimate cancer risks during each ADAF age range. This allows IFs to be accurately and flexibly matched with ADAFs for any receptor age range. The total cancer risk for a receptor is obtained by summing risk estimates across all ADAF age ranges and chemicals of potential concern. A spreadsheet application illustrating the process will be presented.

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### **A RISK-INFORMED DECISION FRAMEWORK FOR CONTAMINATED DREDGED MATERIAL MANAGEMENT IN S. KOREA**

To meet pending London Protocol requirements, South Korea is preparing to reduce the need for disposal of dredged material at sea. The new requirements controlling ocean disposal of dredged material pose significant challenges to the S. Korean government because the previous practice of offshore disposal of contaminated dredged material will no longer be possible after August 2008. Hence, other alternatives for treating and disposing of contaminated dredged material are being evaluated and selected for implementation. A new management and decision framework is therefore needed for regulators and implementers to show what information and what processes were used to make the decision and to increase administrative transparency for such projects in the public domain. To address this need, a framework was developed that offers an iterative approach to dredged material management that includes the essential elements of process,



people, and tools needed for successful environmental decision making. The framework has six steps, incorporating problem definition, developing objectives and criteria, identifying alternatives, performing the evaluation, comparing alternatives and selecting the preferred alternative. The primary objective of the framework is to provide a systematic means of exploring dredged material alternatives in S. Korea using criteria that integrate risk, and economic and stakeholder value information. The framework incorporates the desired decision making attributes of transparency, comparative analysis, and inclusion of public input. While developed for S. Korea, the framework can be applied in any situation where dredged material management alternatives are being considered to manage contaminated sediment risks.

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### **THEORETICAL APPROACHES AND LIMITATIONS FOR MULTI-CRITERIA DECISION ANALYSIS TECHNIQUES APPLIED TO ENVIRONMENTAL PROBLEMS**

Environmental remediation and land-use problems are characterized by complexity, multiple technical disciplines, and multiple stakeholders with different values. Arriving at a decision that balances risk management, cost and benefit of various options, and values (e.g. value of biodiversity, protection of endangered species, etc) is a difficult and often contentious process. Without a structured framework, the decision can be driven by a single issue and sub-optimal decisions can be reached. Multi-Criteria Decision Analysis (MCDA) and other techniques have been developed to address decisions that have components with different measures. Each MCDA technique has certain advantages and disadvantages and there is some confusion, in the environmental field, as to which technique is best for a given problem. A computer software tool (Decision Evaluation in Complex Risk Network Systems-DECERNS) has been developed and allows the application of several decision analysis techniques on the same problem. This presentation will focus on the decision analysis techniques implemented into DECERNS, which include: ♦ Cost Benefit Analysis (CBA) or Cost Effectiveness Analysis (CEA) methods. ♦ Value function methods which define value functions that describe a person's preference regarding different levels of an attribute. Outranking methods that use pair wise comparisons between criteria for each alternative. PROMETHEE and Alternative Hierarchy Process techniques will be discussed. ♦ Advanced methods including TOPSIS (Technique for Order Preference by Similarity to Ideal Solution), and fuzzy sets will be addressed. Each of these techniques will be reviewed in terms of their theoretical basis, ease of use including the ability to explain the results, ability to address uncertainty, and limitations in their application.

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### **VALUES, EMOTION, AND BOUNDED RATIONALITY**

Both values and emotions shape risk perception. This presentation will explore the relationship of these two influences, and also their normative and prescriptive implications for risk regulation.

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### **THE ECONOMICS OF DOOM: MEDIA RESPONSIBILITY IN COVERING PREDICTED CATASTROPHES**

Scientific models tracking polar ice changes and oil production have prompted predictions of slow-onset global catastrophes. Sea-level rise caused by melting polar ice and a peak oil ener-

gy crisis that could cripple industrialized nations could radically alter human civilization within this century. News organizations often face intense financial pressure to avoid complex or upsetting stories, marginalize them as conspiracy theories, or to politicize risk assessments. This study identifies media economics factors associated with news coverage of sea-level rise and peak oil. The Lexis-Nexis database was used to identify 133 U.S. newspapers that covered these issues from 2005-2007, representing 56% of the papers in the database. The sample contained 534 news stories about sea-level rise and 499 about peak oil. Media economics data was obtained from annual newspaper directories for papers in the sample: ad rate, circulation, parent company, number of newspapers owned, combined newspaper circulation, and price per share. Six hypotheses guided a systematic analysis: H1: Higher circulation papers cover sea-level rise and peak oil less frequently than papers with lower circulation. H2: Papers with higher ad rates cover sea-level rise and peak oil less frequently. H3: Corporate papers cover sea-level rise and peak oil less often than independent papers. H4: Papers whose parent companies have a higher combined circulation cover sea-level rise and peak oil less frequently. H5: Papers whose parent companies are listed on the stock exchange cover sea-level rise and peak oil less often. H6: Papers whose parent companies have a higher price per share cover sea-level rise and peak oil less frequently. A discussion of key findings includes implications for news coverage of risk assessments and other uncertainties about predicted disasters and for weighing the economic considerations of media organizations and journalistic responsibility.

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### **Research institute: Centre for Interdisciplinary Studies in Environment and Development (CISED) ARE WE DRINKING POISON? UNDERSTANDING THE NOTION OF RISK PERCEPTION WITH REFERENCE TO GROUNDWATER ARSENIC CONTAMINATION IN WEST BENGAL STATE OF INDIA**

It is estimated by school of environmental studies, Jadavpur University that almost fifty per cent districts of West Bengal are severely affected by groundwater arsenic contamination. Despite various strategies taken by the policy makers, it is still a challenge to synchronize people's need and scientific mitigation techniques for successful risk governance. By employing both qualitative and quantitative methods this study elicits risk perception of the people who are situated in and around contaminated area. In my research I have examined how the "subjective" perceptions of laypersons differ from the "objective" views of scientists. Moreover, I have studied how different media and other social agencies help to build up risk perception of the public. The present research suggests that even highly successful technology may not succeed in the affected areas unless it fits the social circumstances and is well accepted by the affected people. I conclude that people's action regarding acceptance or rejection of mitigation techniques is more guided by their perception of the problem rather than the "actual" or "real" problem.

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### **DOSE METRIC ISSUES PERTAINING TO MICROBIAL RISK ASSESSMENT**

The dose metric for evaluating clinical or experimental pathogen-challenge studies is a key factor, particularly for viruses. Ideally, the dose should be expressed in terms of the lowest irreducible infective unit: virions for viruses or individual organisms for bacteria or protozoa. Bacterial and protozoan doses are typically reported in irreducible units. Viral doses are usually expressed as focus-forming units (FFU), plaque-forming units (PFU), tissue-culture infective dose (TCD50) or culture-based most-probable number (MPN). All of these units relate to viral infec-



tivity in a specific cell culture, with dozens to thousands of virions corresponding to one infection. Viral particle count can be estimated from a particle-to-plaque ratio (PPR). PPRs are not well characterized, particularly for TCD50 and MPN measures, and can be a source of considerable uncertainty. The nature of the dose metric is important for obtaining unbiased dose-response parameters and for relating environmental monitoring data to dose-response data for conducting risk assessments. As a result of species- and tissue-specificity, cell culture-based units generally are not comparable across viruses and cell cultures. For example, on the basis of FFUs or PFUs, the infectivities of rotavirus and echovirus-12 in adults differ by 8 to 235-fold depending on cell cultures used. In contrast, their infectivities are virtually identical when based on viral particles. Viral occurrence measures, such as concentrations in water, for culturable viruses are typically given as liquid culture-based MPNs. Thus, units of occurrence are not equivalent to the units used to estimate infectivity in terms of virion count. To produce unbiased health risk estimates, all culture-based units need to be converted into comparable virion count units. Quantitative uncertainty analysis of these conversions remains as an open issue.

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#### **RISK FACTORS AND THEORY BUILDING AS AN ALTERNATIVE TO THE CAUSAL CHAIN FRAMEWORK: A STUDY TO IMPROVE MARITIME SAFETY**

Given the inherent complexity of the maritime transportation system, developing effective policy can be challenging. Using risk factors identified by expert judgment elicitation and aggregation, a measure-of-mediation design was developed in the theory building tradition of the social sciences. The model was empirically evaluated using 18 months of data about the US small passenger vessel sector. The model identified that the top 15% of highest risk vessels accounted for 50% of all marine casualties during the period of examination. A policy for deploying the model nationally is proposed.

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#### **RISK ASSESSMENT AND FINE PARTICLES: METHODS AND UNCERTAINTIES**

Fine particles (PM<sub>2.5</sub>) pose serious harm to human health worldwide. The mitigation strategies, such as new European Union Air Quality Directive (3696/1/07), are formed to minimize their health effects. Models are increasingly used to guide the decision making. Both data used and the choices of model structure and methods include uncertainty which might have influence on decision making. In this study we summarize our findings from several risk assessment projects where we have evaluated the health effects of primary fine particles and respective uncertainties. The health effects of fine particles were estimated in both city-scale and regional-scale models. For each separate model, we have evaluated uncertainties for emissions, exposure and health effects. Both parameter and model uncertainties were considered. The effect of uncertainty to model results was tested using sensitivity analyses and value of information analyses. Special attention was paid on comparison of uncertainties between emissions sources. The most important uncertainties were (i) plausibility of health effects, and (ii) concentration-response functions. Especially differences in toxicity between different fine particle emissions sources had significant effect on health impact estimates and on relative differences between emission sources. The effect of other uncertainties was small. However, uncertainties related to dispersion models are difficult to evaluate and therefore these uncertainties, and their importance, might be underestimated. The uncertainty on dose-response of fine particles dominates the health impact assessments of fine particles.

The emissions, exposures and health effects are very different between different emission sources. Especially fine particles from traffic have both higher intake fraction and higher toxicity than particles from other sources.

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#### **PROSPECT THEORY UNDER UNCERTAINTY WITH APPLICATION TO ASSESSING GLOBAL ENVIRONMENTAL-ECONOMIC POLICIES**

In this presentation a descriptive model of individual decision making under uncertainty is described. This is an extended version of Prospect Theory (PT) developed by Kahneman and Tversky in 1979 and we call this "Prospect Theory under Uncertainty (PTU)." In PT it is postulated that probability of occurring each event is given, but in PTU it is postulated that for some events probability of occurring each event is not known but the basic probability for occurring the set of events is given. It is shown that the Ellsberg paradox is consistently resolved by using the model described by PTU. Ellsberg paradox is a well-known phenomenon arising in decision theory and experimental economics in which people's choices violate the expected utility hypothesis because of their tendency for ambiguity aversion. We formulate a model for assessing quantitatively how the policy of carbon tax and emissions trading would be effective to achieve the targeted reduction of the Kyoto Protocol. We evaluate the cost of reducing CO<sub>2</sub> emissions for three scenarios as follows using a model of prospect theory under uncertainty: <Scenario 1>: Each sector reduces its emissions by taking into account the carbon tax, without the emissions trading. <Scenario 2>: Besides Scenario 1 two sectors engage in the emissions trading. <Scenario 3>: Besides Scenario 1 six sectors engage in the emissions trading between a pair of sectors. In this presentation it is found that for each sector the undesirable influence on the profit would be reduced by joining the emissions trading, and it would become more profitable for all the sectors by increasing the number of trading sectors. Furthermore, it is shown that by using the prospect theory under uncertainty we could model various attitudes (pessimistic, neutral or optimistic) of a decision maker in each sector.

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#### **PROBABILISTIC REVERSE DOSIMETRY: USING PHARMACOKINETIC MODELING TO ESTIMATE POPULATION-SCALE DISTRIBUTIONS OF EXPOSURE FROM BIOMONITORING DATA**

Biomonitoring data on chemicals in human blood or other specimens identify the presence of small amount of chemicals in human populations. Biomonitoring data by themselves are not direct measures of exposure or risk. The degree of risk posed by these chemicals depends on levels of exposure and the relationship of these exposure levels to those that cause toxicity in test animals or in more highly exposed human populations. In the case where toxicity values are available on a chemical, several approaches may be used to interpret biomonitoring data in a health risk context. One of these approaches is to use pharmacokinetic modeling in a probabilistic manner to provide a distribution of exposures that are consistent with the measured biomarker levels. This approach is referred to as probabilistic reverse dosimetry. Reverse dosimetry integrates pharmacokinetic modeling with exposure pattern characterization/modeling, variability analysis and Bayesian approaches to incorporate probabilistic information regarding chemical pharmacokinetics and the nature of potential exposures to infer external exposures from internal exposures (i.e., biomarker levels). The estimated distribution of exposures can then be compared with various reg-

ulatory guidelines based on exposure levels. Here, examples such as chloroform and perchlorate are presented to demonstrate the process and application of probabilistic reverse dosimetry. This reverse dosimetry methodology allows objective interpretation of biomonitoring data in relation to risk, helping regulators and an informed public to place the observations in a health risk context.

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#### **DEVELOPMENT, IMPLEMENTATION, AND MONITORING OF RISK AND SAFETY PROGRAMS FOR ENGINEERING AND TECHNOLOGY-BASED SYSTEMS**

This paper applies systems analysis and requirements analyses to the development and operations of a risk program of a technology agency or enterprise. We address a risk program as an entity charged with administering interrelated risk assessment, risk management, and risk communication activities on a large scale, such as the risk, safety, or environmental division of an international agency, federal agency, large corporation, or military organization. We identify the canonical missions and requirements of a risk program, develops a business process model of the program, and compares management methodologies and tools. We posit the three canonical questions of a risk program as: (i) What sources of risk are able to be managed by the risk program? (ii) What are the allocations of program resources to various risks, across geographic, temporal, and other divisions? (iii) How is the efficacy of the risk program to be monitored and evaluated? We apply a business process model to diagram about thirty activities of the risk program. We demonstrate a scenario-based analysis of policies of the risk program subject to emerging conditions. We describe a prototype of a maturity model for assessing and guiding the capabilities of the risk program office. We describe feedback from stakeholders and agency program managers. The results should be of interest to various sectors of government and industry and military engaged in engineering and technology-based activities.

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University of Twente

#### **TO KNOW OR NOT TO KNOW? A FRAMEWORK OF RISK INFORMATION SEEKING IN THE SPHERE OF INDUSTRIAL RISKS.**

Communication regarding industrial hazards and the risks involved for humans and their assets is subject to major changes in contemporary society. The rapid growth of modern communication media such as the Internet create opportunities for both risk communication practitioners and the public. Governments and other purveyors of risk information could make risk information permanently available and accessible to the public, for example on the Internet. Similarly, the public could obtain and seek personally relevant risk information whenever perceived necessary or desired. A mass-media campaign aimed at stimulating people to go out of their way to seek and use the information provided on the Internet could be an effective effort to promote self-protective behavior in regard to external safety risks. As risk information seeking has not been seen as important self-protective behavior until recently, little is known about how the public could be stimulated to actually use various information channels to gain personally relevant risk information. This study looks at predictors of the information seeking or avoidance strategies people employ regarding external safety risks. Specifically, a framework of risk information seeking (FRIS) is proposed and tested based on survey data (N=466). FRIS is a model that identifies factors leading people to seek risk information through various channels or, alternatively, avoid additional information. As such, it accounts for the various social-psychological risk-related factors that drive such decisions.

Results indicate that, next to cognitive information needs, affective and social factors are just as important predictors of the risk information seeking strategy that people employ. Of equal importance, a certain level of interest or involvement in the topic is found to play a key role in public responses to risk information.

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#### **CATEGORICAL REGRESSION MODELING OF MULTIPLE EFFECTS FROM CHEMICAL MIXTURE EXPOSURES IN CUMULATIVE RISK ASSESSMENT**

An important difference between cumulative risk assessment and traditional single-chemical assessments is the number of health effects evaluated. For chemical mixture exposures, secondary health effects that are different in toxicological nature or severity from effects caused by single chemicals may be observed at higher or lower exposure levels than the critical (primary) effect levels. In addition, the single chemical threshold dose(s) for the same or additional effects may be lowered by co-exposure to other chemicals in the mixture (i.e., potentiation). Thus, both primary and secondary effects should be evaluated for mixture exposures. Further, joint toxic action may be of concern for multiple chemicals; dose- or response-additivity may be observed or toxicological interactions (e.g., synergism, antagonism) may occur. In this presentation, categorical regression is used to model multiple health effects for each component of a mixture. Using expert judgment, each observed effect is assigned to a category on a scale of increasing severity. Using a logistic link function, these severity categories, representing levels of effect severity across different toxic endpoints or effects within the same tissue, are regressed on dose to produce a multiple effect dose-response curve for integration with mixture risk assessment methods. Benchmark doses are estimated from the model and used in the hazard index to screen for health risks; for each component, risks are estimated for the actual exposure level and these are summed under response addition. Uncertainties in the approach and the potential for toxicological interactions to play a role in qualitatively adjusting the assessment are discussed. The method will be demonstrated using a binary mixture. (Abstract does not reflect EPA policy.)

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#### **RISK ANALYSIS IN OIL & GAS FIELD DEVELOPMENT PLANS- AN OILFIELD APPROACH TO THE ENERGY RELATED RISKS**

This paper is intended to present the applications of risk analysis in today's oil and gas industry. In particular the optimization of oil and gas recovery and production (recovery= % of reserve). Risk Analysis should be essential to the decision process in quantifying and minimizing the risk associated with each decision step in the production cycle of oil and gas fields. From the seismic interpretation to the wells' abandonment procedure, each phase has its own internal risks and the phases also exhibit interrelated risks. Furthermore, the current market value of the commodity (oil or gas) allows for the proper approach to the fields' development. Our argument evolves around the notion that every step of the field development involves risks associated with the quality of the treatment of the reservoir. As the scarcity of the commodity is increasing while our dependence on it is not substantially decreasing, there is pressure to make the most of the reservoirs not just as economic sources but also as a natural resource. The pressure is the consequence of a race to cover the energy needs created by the accelerated growth of newly developed countries, against the timeframes of making other sources of energy widely available. Upon providing a brief background on the current Oil Crisis, its causes and effects, we present the ways in which

Risk Analysis is used in the upstream oil and gas industry. The production stages whose risk analysis we address are: geophysics, geology, reservoir engineering, production engineering and planning, facilities engineering. This paper makes use of Monte Carlo simulation.

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#### **THE POTENTIAL OF GENOMIC DOSE-RESPONSE DATA TO DEFINE MODE-OF-ACTION AND LOW-DOSE BEHAVIOR OF CHEMICAL TOXICANTS**

There is increasing acceptance within the toxicology community that high dose animal studies are not predictive of low dose risks in humans or even in the test animals themselves. New genomic technologies now provide a unique opportunity to evaluate the relevance of current low dose default assumptions used in chemical risk assessment and identify dose-dependent transitions in modes of action. In this presentation, we describe the application of benchmark dose analysis to gene expression microarray data collected following ninety day exposures to five different lung and liver carcinogens. The benchmark dose methods were used to estimate doses at which different cellular processes are altered and showed that benchmark dose values for certain processes mirrored the tumor response in a two-year rodent bioassay. The results show that dose-response changes in gene expression, when related to higher-order biological processes and pathways, reflect the dose dependent changes in key events in the carcinogenic process and can support non-linear modeling of the events in the low dose region within the framework of a mode of action risk assessment.

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#### **MULTI-CRITERIA FRAMEWORKS FOR CONSIDERING DIVERSE RISKS IN INFRASTRUCTURE DESIGN**

Major items of infrastructure have lifetimes of decades. The design of new infrastructure must now account for uncertain trends and diverse risks over coming decades. Relevant global issues include: resource constraints (peak oil, etc.); environmental limits (climate change, etc.); geopolitics (competing power centers, roles of multilateral bodies, etc.); natural and industrial hazards (infectious disease, etc.); economic interconnections (propagating financial crises, etc.); weapon developments (nuclear proliferation, etc); and asymmetric conflict (terrorism, etc.) Design concepts for addressing those issues include: sustainability; resilience; flexibility; and precaution. Those broad concepts yield specific design principles such as: diversity; redundancy; independence or loose coupling of system elements; passive safety; fault tolerance; de-materialization; industrial ecology; and renewable supply of energy and materials. Social approaches to design include: environmental and social impact assessment; integrated resource planning; and various modes of stakeholder engagement. Design of a particular item of infrastructure must apply these concepts and approaches in the context of specific constraints and opportunities. The design process operates within a framework of rules, practices, concepts, institutional interests, and expectations. Optimization of design requires the weighing of multiple objectives by a range of stakeholders. These considerations create major new challenges in infrastructure design. The risk-analysis community can contribute by developing multi-criteria frameworks to address diverse risks. This presentation discusses needs and opportunities in developing those frameworks, and potential approaches to that task.

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Branded Professional Services

#### **PROGRAM DEVELOPMENT FOR THE FIRST SRA RISK ANALYSIS EDUCATION CONFERENCE TO BE HELD JULY 14-15 2009 AT THE UNIVERSITY OF NEVADA, RENO**

The SRA Education Committee has identified a general need and unique opportunity for SRA to support the development of “train-the-trainer”-type educational initiatives. Various outreach strategies have been proposed and explored by the Education Committee, such as providing a status update of risk education, identifying resources, and fostering the sharing of experiences in delivering risk education by educators for different grade levels. The latter opportunity for sharing is the focus of this presentation. Program development is well underway for the first SRA Risk Analysis Education Conference. The 2-day conference will be held on the University of Nevada, Reno campus on 14 - 15 July, 2009. The expected audience for the conference is K-12 and university educators who use or are interested in learning how to incorporate risk analysis into their curriculum. Plenary sessions will cover topics related to the real world application of risk analysis and how those experiences can be used to enhance classroom learning. Breakout sessions will include presentations and discussions by the Society’s Specialty Groups aimed at university professors as well as special breakout sessions for K-12 educators. This presentation will highlight the planned speakers, topics, opportunities to participate, and provide insight as to why risk analysis in the classroom has the potential to improve student achievement across science, math, social studies, and language arts.

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#### **APPLICATION OF REACH WITH RESPECT TO US COMPANIES: AN OPPORTUNITY TO IMPROVE CHEMICALS MANAGEMENT ACTIVITIES IN THE UNITED STATES**

The passage of REACH highlights the growing divide between the United States and Europe with regards to assessment and management of toxic substances. While US companies will have to comply with REACH, there has been little movement at the federal level in the US to support compliance with REACH or raise the standard of U.S. federal chemicals management policy. While new federal programs such as CHAMP are a step in the right direction, there has been little attention to reform of the 30 year old Toxic Substances Control Act. In absence of this reform, the states have begun to fill the gap of federal leadership by developing and passing far reaching new legislation. Many leading companies are also taking steps towards application of safer chemicals and products. This presentation will provide an overview of the implications of REACH for US policy and an analysis of the drivers and directions of chemicals policy in the US into the future.

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#### **MULTICRITERIA DECISION ANALYSIS WITHIN DECERNS WEBSDSS**

The DECERNS is a Web-based Spatial Decision Support System (DECERNS WebSDSS) for assistance in decision-making process when solving multicriteria problems with spatially distributed information. DECERNS includes several interrelated modules including Decision Support (DS) module. This module allows decision makers to use various methods of

Multicriteria Decision Analysis (MCDA) to solve various decision problems for the land use planning and management. The DS module has been integrated with the GIS module of the DECERNS system to successfully solve spatial decision problems. The DS module implements various MCDA methods including MAVT, MAUT, AHP, TOPSIS, PROMETHEE, SMAA and other methods. This variety of methods allows user to choose an appropriate MCDA model (or several ones) for the particular multicriteria decision problem analysis. In addition to Performance Table, Value Tree can be used for decision problem structuring using both top-down and bottom-up approaches. Special tools can be used for extensive sensitivity analysis both for weight factors and partial value functions, and uncertainty analysis with the use of probabilistic methods in MAUT and fuzzy numbers in Fuzzy-MAVT and Fuzzy-PROMETHEE. Acceptability analysis (SMAA) realization within DS module is based on original approach to implementation of probabilistic methods without Monte Carlo computations. The architecture of the DS module provides easy way for the feature implementation of new MCDA methods and tools. The DS module can be used as a stand-alone system for multicriteria problem analysis (MCDA-DECERNS), and as a component within DECERNS WebSDSS for spatial multicriteria problem elaboration. This work is carried out within the DECERNS project (IPP/ISTC #3549, [www.decerns.com](http://www.decerns.com)).

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#### **INTEGRATION OF MULTI-CRITERIA DECISION ANALYSIS WITH NEURAL NETWORKS AND BAYESIAN METHODS: METHODOLOGY AND APPLICATION CASE STUDIES**

Multicriteria Decision Analysis (MCDA), Neural Networks (NN) and Bayesian Methods (BM) have been successfully used in decision support systems, including application in risk assessments. This presentation illustrates integrated applications of these methods in two hypothetical, but realistic case studies. The first case study illustrates application of NN and MCDA for screening of landuse planning alternatives. Even though MCDA alone can be used to select a small set of preferred alternatives, the typical MCDA software could handle a limited number of possible planning options. Realistic landuse planning requires consideration of hundreds spatially-explicit scenarios. Development of NN and its training can be used to reduce the number of alternatives by preliminary ranking and screening. Our second example illustrates the joint use MCDA and BM for maximizing efficiency of sensor network (e.g., fire detectors, security cameras, etc.). The proposed methodology allows to take into account network design and performance (e.g., reliability, accuracy, etc.), and environmental and socio/political factors (cost, safety, risks, etc.) in selecting optimal network configuration for specific applications.

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#### **NATIONAL RECONNAISSANCE OF THE CHEMICAL QUALITY OF WATER FROM PUBLIC-SUPPLY WELLS**

The U.S. Geological Survey's (USGS) National Water-Quality Assessment Program is assessing the occurrence of organic and inorganic compounds-many without U.S. Environmental Protection Agency (USEPA) drinking-water standards or guidelines-in public-supply wells across the United States. This study assesses a greater number of compounds, spanning more chemical classes, than any previous public-well study. Between 1993 and 2007, one ground-water sample was collected prior to treatment or blending (which may reduce compound concentrations) from

each of about 900 public wells and analyzed for as many as 216 compounds. The majority of pesticides and volatile organic compounds (VOCs) were infrequently detected, whereas nutrients and major ions were frequently detected in public-well samples. When detected, most compounds from these four chemical classes occurred at concentrations less than USEPA Maximum Contaminant Levels or USGS Health-Based Screening Levels (to the extent these benchmarks were available) in most wells. These results suggest a low potential for adverse effects on human health due to exposure to these individual compounds. In contrast, about 15 and 60 percent of samples, respectively, contained naturally occurring trace element or radionuclide concentrations greater than human-health benchmarks. Additionally, mixtures of organic compounds in public-well samples were a common occurrence. At least two pesticides or VOCs were detected in about 50 percent of samples, and both pesticides and VOCs were detected in about 35 percent of samples. The human-health significance of the occurrence of many individual compounds (those without benchmarks) and chemical mixtures in public wells remains uncertain because of inadequate toxicity data and uncertainties about the human-health effects of commonly occurring mixtures, indicating the need for further research in these areas.

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#### **ESTIMATING RISK AND SYSTEM PERFORMANCE OF INTERDEPENDENT INFRASTRUCTURES DURING DISASTERS**

Interdependent infrastructures such as power distribution systems, water distribution systems, and cellular networks serve critical roles for emergency responders during and immediately after disruptive events, e.g. acts of vandalism, urban fires, and hurricanes. However, the performances of these infrastructures are not highly reliable during such events. The need for new and improved multi-disciplinary approaches for assessing and understanding infrastructure interconnectedness is necessary for estimating infrastructure risk and performance during catastrophic events. Based on information gathered from fire spread, wind field, structural reliability, and cellular network models we show how risk and interconnected system performance can be estimated for a power distribution system, water distribution system, and a cellular network during and immediately after two simulated events: (1) an urban fire spread and (2) a hurricane.

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#### **BETTER REGULATION IN ITALY: MAKING A VIRTUE OUT OF NECESSITY**

The Italian regulatory system has traditionally been known for lacking transparency and for the need to be simplified (OECD, 2001). The 4.5 million Italian Small and Medium Enterprises suffer particularly from the excessive amount of administrative burdens. The attempts by the Government to overcome these obstacles render the Italian case particularly interesting to present at the SRA symposium on regulatory reform for at least two reasons. First, Italy has a fairly complex regulatory system which has also been defined as "heavily legalistic". It has been demonstrated that highly legalistic systems imply that regulatory reform is hindered by existing legal constraints. For instance, in Italy the emphasis of the regulator is on technical legislative analysis prevails rather than on Regulatory Impact Assessments. Hence, at least in theory, the focus is on the legal dimension of regulatory change rather than the economic dimension, i.e. costs, benefits and risks. Second, because of a relatively low political emphasis on administrative burdens and red tape, Italy has the potential to achieve more in terms of reduction of administrative burdens. By



carrying out measurement activities with fewer resources, but also less precipitation, more time and more attention on reducing only where it is really needed, Italy might diminish “red tape” in a more effective way than other countries. This study presents specific recent initiatives in Italian regulatory reform: -Regulatory proposal for simplified Impact Assessment system; -OECD 2008 report on regulatory reform; -Results of first year in the measurement of administrative burdens on business; -State of the art of Impact Assessment by regulatory authorities. The latter point is developed based on the experience of the Italian regulatory authority for energy, which is considered both in the literature and by practitioners as a case of best practice.

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### **INTEGRATING ANALYSIS AND DELIBERATION TO EVALUATE BIODIESEL OCCUPATIONAL AND ENVIRONMENTAL EXPOSURES**

Many U.S. organizations interested in a renewable, green and domestic source of energy are considering switching from petroleum diesel to biodiesel blends for transportation and heavy-duty equipment use. While there is a considerable body of evidence on the negative health effects of petroleum diesel exhaust, there has been little research examining the impact of biodiesel fuel on occupational and environmental exposures. This research combined a collaborative exposure assessment of B20 (20% soy-based biodiesel/80% diesel) at a rural recycling center with a policy intervention to deliberate the results of the analysis and potential policy outcomes. I applied the National Research Council’s (1996) analytic-deliberative model to connect the collaborative exposure assessment with a Biodiesel Working Group, which catalyzed local policy decisions about the manufacture and use of biodiesel in Keene, NH. Researchers and undergraduate students from Keene State College and employees from the City of Keene quantitatively estimated diesel and biodiesel exposure profiles for particulate matter (< 2.5 microns diameter), elemental carbon, organic carbon, and nitrogen dioxide using standard occupational and environmental air monitoring methods. I collected qualitative data to examine the genesis, evolution and outcomes of the Biodiesel Working Group. Integrating analysis and deliberation led to a number of positive outcomes related to local use of B20 in nonroad engines. Particulate matter and elemental carbon concentrations were significantly reduced (60% and 22% respectively) during B20 use at the field site, yet organic carbon levels were significantly higher (370%). Although NO<sub>2</sub> levels were 19% higher, this increase was not statistically significant. Connecting the analysis with deliberation improved the quality of the exposure assessment, increased dissemination of the research results in the local community, and catalyzed novel policy outcomes, including the development of a unique public/private partnership to manufacture biodiesel locally from waste grease.

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### **MONITORING THE LONG-TERM PERFORMANCE OF ENGINEERED CONTAINMENT SYSTEMS: MITIGATING ECOLOGICAL RISKS**

A key component for isolating the effects of contaminants in the environment and mitigating associated human and ecological risks is to apply engineered covers over landfills used for disposal of radioactive, hazardous chemical and municipal solid waste. Long-term cover systems, which are composed of various layers of engineered barriers, are needed at U.S. Department of Energy (DOE) sites to assist in isolating contaminants from the biosphere at near-surface landfills, waste-disposal sites, and high-level radioactive waste tanks. It is necessary to develop a rigorous method to evaluate long-term performance of covers with quantification of risk and uncertainty.

The hazards and potential risks associated with the waste frequently persist beyond 100 years hence. Yet, cover design and performance evaluation guidelines have historically been narrow and frequently fail to consider consequences of inevitable changes in ecological settings. This research examines lessons learned over years of experience gained through monitoring existing covers, designing alternative covers that accommodate ecological change, and using natural analog studies in combination with monitoring and modeling to project the long-term performance of covers. This investigation into the role of ecological monitoring of isolation containment systems will include ways to identify parameters and processes for performance verification and monitoring. It is becoming apparent that in order for long term monitoring of engineered barriers to be successful, it must combine monitoring, modeling, and natural analog studies to evaluate long-term performance of covers. Furthermore, it is essential to develop a risk-based performance-assessment approach for selection, design, modeling, and monitoring ecological components of covers.

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### **INSTITUTIONAL TRUST MODERATES THE EFFECT OF SOURCE CREDIBILITY AND VALUE SIMILARITY ON PERCEPTION OF RISK FOR IN-SITU URANIUM MINING**

Institutional trust is an important concern in studies of risk perception and communication. We propose that two threads of work might be profitably combined within this concern. In this pilot study we consider an important approach to trust developed in the risk literature - salient value similarity - and examine it in concert with an established approach to source credibility from the communication literature that has also been applied in the context of risk. We develop a model in which source credibility and salient value similarity function together as antecedents to institutional trust, with institutional trust then moderating any direct effects on risk perception. To begin exploring this model, we conducted a mail survey in the spring of 2008 with residents in three Colorado communities adjacent to a proposed in-situ, or leach uranium mining facility (N=203; 48% adjusted response rate). Establishment of in-situ uranium recovery operations has recently become a salient issue as uranium prices have climbed. The survey focused on the two primary information sources in the mining debate: the industry, Powertech Uranium, and the citizen’s group, Coloradans Against Resource Destruction. Using measures drawn from previous research on risk perception, institutional trust, source credibility, and salient value similarity, the analysis shows that credibility’s effect on trust is somewhat stronger than value similarity’s (betas = .57 and .44, both  $p < .01$ ). The effect of institutional trust on risk perception is also strong (beta = .43  $p < .01$ ). The overall fit is good in the structural model (chi-square/df ratio 1.1  $p = .27$ ) and is not significantly improved by opening direct paths from credibility and values to risk. Our initial interpretation of the results suggests that trust remains a very central influence over risk perception and that credibility may play as important a role as values in the formation of trust. We feel this model merits further development.

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### **RISK PERCEPTION OF THE JAPANESE: WHICH HAS MORE EFFECTS ON RISK PERCEPTION, AFFECT OR REASON?**

Results of social surveys conducted in Japan for decades showed that the risk perception of the Japanese seemed to have changed when they experienced Kobe earthquake and bursting the bubble economy, although they had some stable tendencies (e.g. middle-age female effect). On

this presentation, I focus on the effects of affect and reason on the risk perception of the Japanese. In general, people are often assumed to behave irrationally and emotionally when they manage risks. Slovic (1987, 1999) pointed out the “emotion heuristics” which stress the emotional process of risk judgments. However, some researchers (e.g. Behavioral Economy: c.f. Kahneman & Tversky, 1979) argues that people’s behaviors are basically very rational even though they have some irrational biases. Two experimental surveys were carried out in 2007 in Japan on which we focused on the judgment processes of risk communication, and examined which would have stronger effects on risk acceptance and trust formation, rational-oriented-communication or emotional-oriented-communication. The results of them suggested that sufficient rational explanations would be necessary for the Japanese people at risk communications even when their judgment processes were influenced by their affects because of their trust formation.

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### **DESIGNING ENVIRONMENTAL RISK INDICATORS TO MOTIVATE SUSTAINABLE BEHAVIOR**

Meaningful indicators of environmental risk may serve the purpose of motivating stakeholders toward sustainable action. Scientifically-derived indicators, however, often lack salience to the public and decision makers. In this paper, we draw on theories of pro-environmental behavior from environmental psychology to develop hypotheses about the type of indicators that are likely to motivate sustainable action. Based on norm activation theory and the value-belief-norms theory, we hypothesize that indicators designed specifically to activate personal moral norms are more likely to motivate behavior that benefits the environment than indicators derived strictly according to scientific criteria. More specifically, we suggest that the most effective indicators are those which: (1) expose adverse consequences to objects closely associated with people’s personal values and (2) highlight individual responsibility for alleviating those adverse consequences. We test our hypotheses using a questionnaire survey of a random sample of respondents in New England.

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### **RISK ASSESSMENT METHOD BASED ON STRICT SCIENTIFIC CRITICISM**

The current risk assessment methods are based on extensive scientific expertise and practical experience. They are typically created by lengthy processes involving the best experts that seek a consensus about the best practices. When applied, these methods generally produce fairly solid assessments. Here, solid means an assessment product that holds well against scientific criticism (SC) after it is published. SC is a process where falsifiable predictions (hypotheses) are tested empirically, and hypotheses that are inconsistent with observations are rejected. However, the assessment method itself or the process of making an assessment is rarely subject to SC. The objective of the study was to explore the properties of a risk assessment method that is constantly subject to SC and that is still able to produce solid assessments. Both the product and the method producing it should be subject to SC at all times. Ideally, SC may be presented by anyone, and thus we took open participation as the starting point for the study. We found out that the hypothesis-testing approach requires us to describe an assessment as series of research questions. This leads to modular structure, where each distinct object describe a particular phenomenon of the world. An object consists of a research question about the phenomenon (scope), information relevant for answering the question (definition), and potential answers to the question (result). The

potential answers are treated as hypotheses that are critically evaluated against existing information in the definition. Formal argumentation can be used to organize SC and resolve disputes. A risk assessment method is treated in the same manner, as a modular compilation of sub-modules with scope, definition and result. However, methods cannot be directly evaluated against observations. Instead, explicit performance criteria must be developed, and the research question is whether a (sub-)method fulfills its performance criteria.

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### **MOTIVATING DISASTER PREPAREDNESS: EFFECTS OF ANGER, GUILT, AND FEAR ON RISK PERCEPTION AND BEHAVIORAL INTENTIONS**

Despite highlighted awareness of natural disasters and terrorist attacks, the majority of Americans have not taken action to prepare themselves and their families for possible disaster or attacks in their community. Previous campaigns have used informative and largely neutral persuasive appeals for emergency preparedness. Persuasion and emotion scholars recognize the potential of strategically crafted messages to not only induce emotions, but to also use emotions to increase risk perceptions and motivation to engage in subsequent behavior. Despite advances in understanding of emotions “relation to information processing and persuasion, however, the role of message-relevant emotion in cognition and decision making is still largely unclear. Whereas previous risk scholarship has examined the effect of anger, fear, and sadness, these studied incidental emotions (those that are non-related to the judgment). Thus, this paper seeks to extend understanding of the interplay of message-relevant emotion and decision making in a disaster preparedness context. This study investigates the use of negative discrete emotional appeals within the context of disaster preparedness to enhance risk perceptions and increase behavioral intentions to prepare. Although fear and sadness have received the most attention from risk scholars, this study will also examine how feelings of guilt influence risk perceptions. The study employed a 4(emotion: anger, guilt, fear, or control) X 2(intensity: low or high) between subjects experimental design. The field experiment drew a random sample from Knowledge Networks” nationally representative panel. Respondents listened to an example radio public service announcement (PSA) and gave feedback. All participants listened to one PSA and completed posttest measures that assessed emotional reaction, risk perception, and behavioral intention. It was hypothesized that feelings of anger, guilt, and fear would uniquely affect perceptions of risk and behavioral outcomes.

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### **THE EXTERNAL FETAL MONITOR: AN OBSTETRIC RISK COMMUNICATION SYSTEM**

Purpose: The purpose of this paper is to determine if the external fetal monitor (EFM) can be established as a risk communication system. This paper suggests that the EFM acts as a primary obstetric risk communication system between the health care provider and the laboring woman, and maintains an important role in the perpetuation of risk throughout the labor and delivery process. Risk is an inherent aspect of childbirth, particularly in the United States where birth has become a highly medicalized event. The EFM is the most widely used technology in the intrapartum period in spite of the fact that research does not support its use as an effective tool for establishing obstetric risk factors or for the prevention of adverse maternal and fetal outcomes. Within the health care system, complex risk analysis systems including, risk assessment, risk manage-

ment, and risk communication influence decision making and standards of care for the laboring woman. The primary goals of the EFM as a risk communication system are to improve maternal and fetal outcomes as well as minimize the risk of litigation in the event of adverse outcomes. Therefore, established standards of risk communication systems must be applied to the EFM in order to appropriately and effectively use this technology as a primary obstetric risk communication system. Key words: external fetal monitor, risk communication

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### **INDUSTRIALIZED FOOD RISKS AND GREEN CONSUMERISM: TOWARDS A MULTIDIMENSIONAL APPROACH**

This study compares and tests risk approaches that relate risk acceptance to a limited set of dimensions (cf. the grid-group model: Douglas & Wildavsky, 1982) with more recent calls for a multidimensional approach to green consumerism (cf. Lockie et al., 2004). Using quantitative data from a recent web survey that were collected among young adults between April and June 2008 in Belgium (N=3179), attention is paid to the role of gender and the extent to which individual and social characteristics influence organic food consumption after it is controlled for financial aspects and several risk issues (e.g.: the perception of organic and industrialized food risks). Statistical analyses show that, on average, young women perceive the risks of industrialized food (e.g.: genetically modified organisms) relatively higher than young men and expect slightly higher benefits of organic food (e.g.: lower chemical residues). Further, young woman have significantly higher scores on motivations that affect food choice in general (e.g.: health concerns, food safety, etc.). However, the latter effect sizes are weak and gender has no direct effect on people's commitment to the consumption of natural foods. In addition, multivariate regression analyses reveal the prominent role of environmental values, health concerns, and perceived food risks and benefits. Although the importance of the latter variables point to the role of group characteristics as well as suggest that there might be some truth in the stereotypes of "greenies" and "health nuts" among young adults, the limited importance of actual budget and the negative effects of convenience and availability supports the need for a mobile version of cultural risk theory and a multidimensional approach to green consumerism.

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### **MODELLING THE COST-EFFECTIVENESS OF RISK REDUCING MEASURES**

The transport of hazardous materials is an activity that has the attention of the Dutch authorities due to the serious consequences this could have for the health of citizens in the vicinity of the transport. Rail transport of hazardous materials is a complex problem for the Netherlands, as the transport runs through dense urban areas. In cases where risks are too high according to the norms, large attempts are made to lower them. One of the possibilities and wishes is to lower risks according to the As Low As Reasonably Practical (ALARP) criterion. However, what is reasonable has not been determined yet. This paper is meant to explore whether there is a quantitative way of expressing reasonability. To express this, a cost-effectiveness model is created and presented in this paper. With this cost-effectiveness model a first answer can be given to the question of what is reasonable.

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### **DEVELOPMENT OF A COMPREHENSIVE VESSEL TRAFFIC RISK MANAGEMENT TOOL**

BP contracted with a research team from The George Washington University, Rensselaer Polytechnic Institute, and Virginia Commonwealth University to conduct a Vessel Traffic Risk Assessment in the context of the expansion of their BP Cherry Point terminal. The US Coast Guard and the US Army Corps of Engineers provided guidance and support for the project. The Puget Sound Harbor Safety Committee served as advisory committee for the project. The scope of the study included evaluation of the change in risk due to increased vessel traffic that could result in an accident involving a tank vessel and the discharge of crude oil or petroleum products. The model developed may also serve as a comprehensive traffic risk management tool. Our model represents the chain of events that could potentially lead to an oil spill. Earlier versions and its approach have previously been used in the Prince William Sound Risk Assessment, the Washington State Ferries Risk Assessment, and the Exposure Assessment of the San Francisco Bay ferries. Our maritime simulation model attempts to re-create the operation of vessels and the environment within the geographic scope of the study. The simulation counts the situations in which accidents could occur, while recording situational variables that could affect the chance that an accident will occur. We know how often accidents do occur from an analysis of incident and accident data, but there is not enough data to say how each of these variables affects the chances of an accident; accidents are rare! To determine this, we turn to maritime experts. We ask experts to assess the differences in risk of two similar situations that they have extensive experience of. The experts involved include tanker masters, tug masters, pilots, Coast Guard VTS operators, and ferry masters. Consequences of accidents are evaluated by means of collision and grounding oil outflow models based on kinetic energy principles. Our analysis results are geographic profiles of accident frequencies and average oil outflows overlaid on nautical charts.

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### **SAMPLE TO SAMPLE ANALYSIS: IMPROVEMENT IN DETECTION AND RECOVERY**

In 2007, and again in 2008 a series of exercises were conducted to investigate the efficacy and operational utility of a variety of sample collection methods, strategies, and analytical techniques for assessing the microbial risk during building decontamination events. Conventional analytical techniques coupled to specific sampling methods (swabs, wipes, vacuum socks) were tested in a small scale (single room, 400 ft<sup>2</sup>) and large scale (Location: Idaho National Laboratory, Abandoned Office Building, 2 levels, 15 rooms per floor, 4025 ft<sup>2</sup> per floor) setting. Techniques and methods were assessed for overall recovery (of *Bacillus atrophaeus*, provided from Dugway Proving Grounds, Dugway, Utah), throughput, consumables use, and their potential for introducing contamination to the analytical process. Based on test results, modifications to CDC-recommended protocols resulted in a reduction of 3 minutes per sample extraction time per sample for wipes and vacuum socks, with a reduction in consumables for all of the sampling methods without a loss in recovery. Similarly, a rapid viability protocol utilizing a combination of culturing and time-point PCR was tested/improved. This yielded improved agreement between RV-PCR and plating-based culture from 50% to > 99% in small-scale testing, and 98% in large-scale testing. Testing also showed a need for separate culture-based plating methods were necessary to quantify recovery in characterization (pre-fumigation) and clearance (post-fumigation) stages of the



decontamination process. One of the major products of this work is a set of modified protocols and techniques for rapid laboratory analysis, founded on one of the first large-scale decontamination exercises ever conducted to test the risk mitigation efforts associated with a biological contamination event.

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#### **INTEGRATING HOUSEHOLD PERCEPTIONS INTO REVEALED PREFERENCE MODELS**

Valuation of morbidity associated with childhood asthma is significant both to policy and to non-market valuation methodologies. Asthma is a complex chronic disease marked by changes over time in both factors that trigger symptoms and the severity of those symptoms. Households vary substantially in how they conceptualize risk-reducing behaviors, and the public health literature documents the deviations in household perceptions from treatment guidelines. We begin with the standard health production function that describes the relationship between health inputs and asthma morbidity. We then explicitly model the heterogeneity in preferences as a function of health beliefs and perceptions. In this paper we use data from a health beliefs survey to improve willingness to pay estimates using revealed preference. We allow for two complexities to enter into the model of averting behavior. First, we model the production function as an endogenous process by introducing a technology parameter that modifies the effectiveness of inputs based on how (which) medical inputs are used. Second, we explicitly incorporate beliefs about asthma by modeling the perception of symptoms and behaviors. Factors in common in all the beliefs equations are race/ethnicity and education of mother, which are standard in the literature, belief that asthma is a risky disease (asthma risk) and the weight at birth/gestational age at delivery. We use childhood asthma to illustrate this approach; however, this approach is suitable to many other chronic diseases with episodic symptoms.

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#### **FOOD TERRORISM MENTAL MODELS: FACTORS THAT IMPACT CONSUMER DECISION-MAKING AND EXPERTS' KNOWLEDGE OF THOSE FACTORS**

Little is known about how consumers would react to a food terrorism event. In order to better understand possible consumer responses, we must first determine whether consumers' risk perceptions, priorities, and information needs during a food terrorism event differ from those associated with food-related disease outbreaks and food recalls. A qualitative Mental Models approach was used to research and model factors involved in consumer decision-making in the event of a hypothetical increase in the Homeland Security threat level associated with the food sector. The model is constructed from the results of one-on-one, telephone interviews with forty-five (45) U.S. adult, consumers with children under 18. Comparison of the model with a previously constructed expert model of consumer decision-making factors reveals consequential knowledge gaps and alignments. Information gleaned from this exercise provides the basis for developing a food-terrorism related risk communication strategy.

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#### **INTEGRATIVE TOOLS FOR IMPROVING OUR EVALUATION OF ACCOUNTABILITY: LESSONS FOR PESTICIDE BIOMARKER STUDIES**

We have designed a tool for evaluating within- and across-model uncertainty for pesticide risk assessment and regulatory decision making. For this project we developed and characterized

a Markov chain Monte Carlo (MCMC) based integrative modeling tool, in order to evaluate interventions on pesticide exposure and overall risk reduction. This research directly reflects the FIFRA call for methods that integrate approaches for risk management. Integrative models, such as those available for lead and methylmercury, have not been as available for complex issues such as aggregate and cumulative pesticide management. Tools that are available within the EPA have focused on integrative exposure assessments of dietary intake and predictions of overall population exposures using estimated intake from exposure factors and pesticide tolerance levels for US diets. In our model, we examined the contribution of the occupational take-home pathway to pesticide exposure, which we hypothesize is the largest unaccounted exposure pathway for farm-worker family exposures. Exposure pathways are also a target for regulatory actions but ones for which there have been minimal assessment of decision impacts. By improving our understanding of within- and across-model barriers in integrative models for environmental assessment, we have both addressed key issues in uncertainty analysis and provided insight and methods for evaluating complex, mixed exposures to organophosphate pesticides (OP). Detailed biomonitoring and environmental modeling data was available from our EPA-NIEHS funded Children's Health Center and thus we had a unique opportunity to evaluate the impact of specific regulatory actions with chlorpyrifos and azinphos-methyl and understand the impacts of intervention actions on integrated OP exposures and predicted health impacts. Supported by NIEHS 5-P01-ES009601, NIEHS P30-ES007033, NIEHS P50-ES012762, NIEHS U10-ES011387, NSF OCE-0434087, EPA RD-83170901, and EPA RD-83273301.

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#### **DIFFERENCES BY GENDER USING CONFIRMATORY FACTOR ANALYSIS.**

In little more than a decade, societies within developing countries such as Chile have experimented important changes that have led them to analyze their people's attitudes towards the risks they face. In general, we know that there are major differences between men and women regarding risk perception. Our study explores these differences using a multivariate technique. Bronfman and Cifuentes 2003, uses the technique of principal component analysis and obtains, to explain the perceived risks in a developing country, three factors that were tagged as Catastrophic Potential, Unknown Risk, Personal Effect. Our work uses the same data base used by Bronfman and Cifuentes. We present the results of a confirmatory factor analysis to test the adequacy of the factorial structure proposed by Bronfman. Improvements to the original factor structure are presented. Differences by gender are explored using between-group model analysis. Discussions on public policies of these findings are discussed.

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#### **HOW WELL ARE WE PREDICTING FISH TISSUE CONCENTRATIONS?**

Typically, when an environmental decision is made (e.g., a Record of Decision issued), there is very little, if any, opportunity to revisit the results of the models used to support the decision. The decision relied upon the results of one or more models that were used to predict the impact of specific management alternatives. This paper addresses the issue of post-decision model predictions to monitoring data comparisons specifically with respect to bioaccumulation models. We present the results of several case studies that compare bioaccumulation model predictions with data collected following a decision, or even implementation of a remedial alternative.



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### **DEVELOPMENT OF A SCREENING LEVEL TOOL TO EVALUATE HEALTH IMPACTS OF ELECTRICITY TECHNOLOGY OPTIONS**

Decision makers often wish to know the human health and public welfare implications of alternative strategies related to energy sector development, but formally modeling these implications is challenging and computationally demanding given the array of effects across different geographic areas and electricity generation technologies. There is therefore a need for a relatively simple but risk-relevant tool that can be used by decision makers to rapidly evaluate the implications of various energy futures. We present the data and approach used to evaluate future potential health risks and social costs associated with electricity generation under specific assumptions concerning technology development, process, and fuel stock. We first develop estimates of predicted cradle-to-grave emissions of criteria pollutants and greenhouse gases associated with electricity generation. We model the emissions-to-exposure relationship using spatially-varying intake fraction values, which summarize the effects of primary fine particulate matter (PM<sub>2.5</sub>), nitrogen oxides (NO<sub>x</sub>), and sulfur dioxide (SO<sub>2</sub>) emissions on ambient PM<sub>2.5</sub> concentrations, considering both stack and upstream emissions. We link these values with concentration-response functions for premature mortality associated with exposure to PM<sub>2.5</sub>. We utilize a value of statistical life approach, applying a value of \$6 million US, and assign carbon emissions a value of \$20/ton per the Intergovernmental Panel on Climate Change (IPCC). We demonstrate how synthesis of this information into a comparative risk model can be used to evaluate the potential for human health effects associated with technology development and fuel use forecasts through the year 2030 through a simple, screening-level spreadsheet tool. The tool can be expanded to include other constituents and health effects.

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### **CHARACTERIZATION OF THE ECONOMIC AND PUBLIC HEALTH IMPACTS OF TRAFFIC CONGESTION**

Traffic volumes are anticipated to increase in upcoming decades, which could contribute to increased economic and public health impacts. Increased congestion is associated with greater tailpipe emissions for multiple air pollutants, increased time in a high-exposure microenvironment, increased fuel utilization and vehicle costs, and lost time and productivity. Previous studies have quantified subsets of these impacts but have not considered them jointly in a single analytical framework, and have rarely considered the influence of time-varying factors. In this study, we project population and traffic density out to 2030 for various metropolitan areas in the United States. Assuming that the current transportation infrastructure is unchanged and the numbers of vehicles continue to increase, we estimate increases in time spent in traffic, reductions in vehicle speeds, and increasing periods of gridlock. We also determine the extent to which overloaded urban freeways and toll roads result in traffic flow shifts to secondary roads, potentially increasing residential exposures. We use MOBILE6.2 to estimate emissions over time given changes in vehicle technologies and speeds, and we link emissions estimates for particulate matter and particle precursors with models linking emissions with population exposure in different areas of the country. We estimate particle-related premature mortality impacts in monetary terms, accounting for changes over time in the age distribution of the population and the value of statistical life. We similarly estimate time trajectories of carbon dioxide emissions and the economic value of lost productivity and vehicle expenses. Comparisons among these impact categories allow us to deter-

mine the dominant contributors to monetized impacts at different points in time and the degree to which this varies across different metropolitan areas. In the long term, our analysis provides a basis for optimal design of congestion mitigation measures.

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### **DEFENDER-ATTACKER DECISION TREES FOR TERRORISM RISK ANALYSIS**

Terrorism risk analysis is complicated by the fact that terrorists can observe our defensive actions and adapt to them by changing tactics or targets. In this presentation I will propose an adaptive and dynamic decision tree framework which begins with defensive actions, followed by the attackers' actions which are represented as events, followed by additional defensive actions and subsequent attackers' adaptations. This framework was applied to the problem of protecting airplanes against missile attacks. The framework will also be compared with traditional extended forms of games.

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### **A STOCK AND FLOW MODEL OF THE U.S. BLOOD SUPPLY AND POTENTIAL IMPACT OF PANDEMIC INFLUENZA**

Blood donation inputs and outputs for the aggregate U.S. blood supply have been reported; however, the total amount of blood available at any given moment is not well known. Determining the amount of blood in the aggregate U.S. blood supply is essential for understanding how long the blood supply can last during a specific period of reduced blood donation as might occur during an outbreak of pandemic influenza. A discrete-event stock and flow simulation was designed that uses probabilistic inflow and outflow values, a first in-first out policy for blood units, and a rule that "expires" any blood units older than 42 days. Simulations revealed that the steady-state levels of total number of units depended only on the average number of incoming units of blood, provided there was a net positive inflow. The steady-state value of the total number of units in the aggregate supply appears to be the average inflow times 42 (the shelf life of blood). To better characterize the behavior of the blood supply, daily blood units donated were probabilistically simulated based on yearly records of blood donations. Blood demand was probabilistically simulated based on data from multiple years of MedPAR records from the U.S. Centers for Medicare & Medicaid Services. Using these data sets in the simulation replicated known behaviors of the blood supply, such as the decline in the aggregate supply that occurs during the summer followed by recovery of surplus levels of blood in the winter. A scenario was developed that reduced the incoming blood units to a minimum at midpoint of a 12 week pandemic followed by a symmetric increase back to normal levels over the second half of the pandemic. The model allows different mitigation strategies to be explored and provides risk-managers with the opportunity to evaluate the strategy's likelihood of success.

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### **F344/N RATS SHOW BIPHASIC NONMONOTONIC RESPONSES TO SUB-CHRONIC LEVELS OF ANTIMONY POTASSIUM TARTRATE**

In this study, we analyzed mean total body weight growth data from the National Toxicology Program (NTP) to evaluate developmental effects in male and female F344/N rats exposed sub-chronically to antimony potassium tartrate (APT). These animals were exposed to intraperitoneal injections of 0, 1.5, 3, 6, 12 and 24 mg/kg of APT for 90 days. We fitted a dipha-

sic logistic growth model to the NTP data using a computerized nonlinear least-squares technique. Our objectives were two fold: 1) to determine whether the model could accurately describe their weight, velocity and specific growth rate curves and 2) to determine whether the model's five parameters varied with APT dose. We fitted the dose response data using a LOESS smoothing technique. Based on standard goodness of fit criteria, we found that, for all dose groups, the model fit the growth curves extremely well. Furthermore, both male and female growth parameters, such as the growth rates, ages at maximum velocity and asymptotic weights for the two phases of growth, showed biphasic nonmonotonic responses to APT, as the dose increased. These findings are similar to what we observed earlier when studying developmental effects in Sprague-Dawley rats exposed to APT from drinking water. This study provides additional support for the use of the diphasic growth model for assessing developmental effects in rodents exposed during the growth period from 6 to 14 weeks of age.

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#### **WATERBORNE ZONOOSES AND CHANGES IN HYDROLOGIC RESPONSE DUE TO WATERSHED DEVELOPMENT INFORMS RISK ASSESSMENT**

Hawaii's mountain to sea ecosystems provide unique opportunities to evaluate watershed scale processes. In this presentation the watershed on Oahu, Hawaii (Manoa Stream) is used to explore the link between watershed development, hydrologic response and increased risk of waterborne disease as a result of flooding and the presence of commensal rodents chronically infected with leptospirosis. Flooding from the watershed in 2004 led to an outbreak of leptospirosis among people exposed to flood waters during clean-up efforts. We present hydrologic analysis of a flood-producing storm and animal sampling results to illustrate the hypothesis that watershed development may increase likelihood of flooding and the magnitude of sources of pathogenic microbes that could be mobilized during flood-producing rainfall. The analysis considers land use changes in the Manoa stream watershed that took place between 1939 and 2005 and their impact on potential risk. In addition, this research project provides an example of where an academic research project can provide valuable data for risk assessors.

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#### **CONTRIBUTORS TO VARIABILITY IN ORGANOPHOSPHATE AND PYRETHROID PESTICIDE DOSES IN A LOW-INCOME URBAN ENVIRONMENT**

In urban low-income multi-unit dwellings, pesticide exposures may be elevated due to frequent applications to address pest infestation. However, even within a single housing development, doses may vary substantially as a function of pesticide concentrations, time-activity patterns, diet, age, and genetic polymorphisms or other factors that influence exposure-dose relationships. Understanding the drivers of dose variability and the factors that put a child at risk for elevated pesticide doses could inform future interventions. To quantify and compare sources of variability in pesticide doses, we linked physiologically based pharmacokinetic (PBPK) models for organophosphates and pyrethroids with exposure models for these compounds. Pesticide residue and dust concentrations were collected from 42 low-income dwellings as part of the Boston Healthy Public Housing Initiative. We simulated exposures by fitting distributions to the measurements, incorporating correlations between pesticides, and linking this information with simulated activity patterns. We built PBPK models for the organophosphates diazinon and chlorpyrifos and

for the pyrethroids permethrin, cypermethrin and cyfluthrin. PBPK model parameters were modified to assess variability due to polymorphic enzymes, using enzyme parameter data from the literature. We assessed variability in delivered doses, comparing the contribution to variability due to genetic polymorphisms, PBPK model parameters, and exposure and concentration factors. We consider the degree to which simultaneous exposure to multiple pesticides alter delivered doses and variability factors, and we consider the factors contributing to upper percentile doses across pesticides, to determine if subpopulations would tend to be exposed to multiple compounds with similar modes of action. Our analyses suggest substantial variability in delivered doses within a defined subpopulation and allow for refined characterization of heterogeneity in risk.

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#### **USING SITUATIONAL SIMULATIONS/GAMING ENVIRONMENTS TO DEVELOP MENTAL MODELS OF RISK AND DECISION-MAKING**

Mental models of effective decision-making, specifically decisions made in high-risk situations, reflect the underlying temporal and resource relationships that shape a domain. This is founded in results from expert-novice research that shows, compared to novices, experts have more structured knowledge organization. Formal development of such mental-models requires analysis of human decision-making data gathered from scenarios that present high risk and uncertainty. Collecting such data through direct observation is difficult and case studies provide limited narratives of scenario specific responses, without the ability to experiment with outcomes from alternative decisions. In this presentation, we discuss ways of using interactive situational simulations to capture decision-making data and develop methods that describe the mental-models of managers in construction project management crisis scenarios. Situational simulations are similar to first-person role-playing gaming environments, where the subject takes the role of a construction manager aiming to complete a complex project on schedule, and under budget. We will discuss how such environments can be used to collect decision-making data, while a human subject is 'playing' the simulation. The specific research questions addressed are: What is the appropriate level of detail at which human decision-making data needs to be collected? What is the level of abstraction at which such data needs to be analyzed? What mathematical methods can be applied to develop statistically significant relationships structuring the mental model of an effective decision-maker? We present a formal method to capture decision data from a simulated construction environment and analyze it using multivariate graphical modeling techniques.

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#### **THE ROLE OF PUBLIC SAFETY IN THE SUSTAINABLE RISK MANAGEMENT OF URBAN TREES.**

There has been increasing concern and uncertainty within the arboricultural sector and amongst landowners in Europe, and especially in the UK, about the management of trees from a human safety perspective. This has been stimulated by a handful of court cases and other responses to incidents involving tree failure and the public. The concepts of reasonableness and "So Far As Is Reasonably Practicable (SFAIRP), are important in underpinning the allocation of resources to the management of risk in society but are by no means universally understood. This has contributed to behaviours ranging from acting in a way which reduces risk at any cost, to doing nothing at all. At the same time, risk assessment and risk management have sometimes acquired a dubi-

ous reputation in the public mind, through the banning and demolition of many things that people have traditionally valued. This paper describes a stakeholder engagement process that seeks to provide a means by which this matter can be tackled, confidence restored, and an acceptable tree management regime, consistent with wider societal aspirations, be implemented. Data have been gathered to provide the most authoritative reference in the UK to quantify the risk of harm from accidents involving tree failure, which will be used to place the risk posed by trees in perspective. This will be presented as a) a comparison with other risks which people face, and b) by comparison against the criteria described by the UK Health and Safety Executive in its “Tolerability of Risk” framework. The paper will also discuss preliminary findings of research on ways that public outrage and, especially, practitioner perceptions of being under pressure from the legal and insurance sectors may act to cause a potential distortion of the usual balance between the cost and difficulty of control of a hazard, and the benefits of control (risk reduction) in tree risk management.

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#### **INSIGHTS INTO THE FUTURE OF RISK EDUCATION FROM A SURVEY OF SRA MEMBERS**

Risk analysis is a complex and changing profession and the SRA is determined to be at the forefront of efforts to ensure that the best fit is achieved between the needs of the profession and the educational programmes available. In the Spring of 2008 the Education Committee of the SRA invited the members of the Society to take part in a survey which aimed to identify current practice and future opportunities for risk related education. The resulting sample (n=189), representing almost 10% of the membership of the Society, provides a reflection of the many facets of the profession and a worldwide coverage with respondents from 29 different countries. This paper presents the results of the research and, along with an earlier study that provided a synopsis of risk analysis academic syllabi and curricula currently available in the USA (reported elsewhere), provides a platform for the ongoing discussion over future provision. There is a large body of academic research to draw upon and one key challenge is to identify common components that need to be present for a programme to include risk analysis or risk management in its title.

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#### **DEVELOPMENT OF A POST GRADUATE CURRICULUM IN RISK MANAGEMENT**

This paper examines the development of a postgraduate programme that looks at risk from an integrated standpoint. The paper draws on practical experience in the ongoing development to illustrate some of the ways that emerging research can be integrated into curriculum development and identifies some challenges to advancing risk education. It is argued that the increasing requirement for high level responsibility and accountability for undertaking strategic level risk management is driving a demand for professionals equipped to identify and prioritise risks emanating from a number of different sources. Discipline specific research within the different specialisations in an organisation need to be combined into a coherent strategy to protect the mission and objectives of organisations of all sizes from nation state to small business. The emergence of the IRGC Risk Governance Framework has provided an excellent functional framework for many of the myriad tasks associated with risk management at the global level and it has proved ideal for adaptation to many different scales.

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#### **MEDIA RISK COMMUNICATION METHODS AND THE WEST NILE VIRUS**

The public receives much of its information about science, policy and environmental risks through various media presentations. Hence, the media plays a substantial role in the formation of risk perceptions among the lay public. Journalists use emotive language to keep their reader captivated with a story. Thus an important dimension to risk issues lies in the way they are communicated to their audience. At times, the media can be one of the primary sources of information to the public for a health risk event or can play an important role in how they shape the risk communication messages of sources. The goal of this Manitoba based case study is to gain a better understanding of the risk communication methods and messages used to communicate the risk of West Nile Virus (WNV) and the risk of malathion application to the general public. The data for this study will include government materials (both provincial and municipal), the Winnipeg Free Press newspaper, and grey materials from community groups. The media will be examined to determine how risk is presented and defined in the context of WNV and malathion application. There will also be a focus on risk message placement within the story, particularly how positive and negative messages are presented.

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#### **BUILDING TRUST IN COUNTERWEIGHT TO RISKS IN INTER-ORGANISATIONAL RELATIONS OF BUSINESS NETWORKS IN RUSSIA**

Rapidly growing business of Finnish companies in Russia during this decade has increased the need for a more comprehensive understanding of key success factors in inter-organisational relationships with Russian partners. Working with Russian partners often under conditions of uncertainty of Russian market environment, foreign companies are involuntarily exposed to certain risks there. Being aware of these risks is a precondition for successful business decisions. Risks can never be entirely eliminated, but to a large extent as literature suggests trust plays an important role in counterbalancing risks. It affects perceptions of risks and benefits as well as decisions to cooperate. Therefore, ability to establish, maintain, and increase trust between partner organizations is one of the most important factors to success in inter-organisational relationships. This research aims at deeper understanding of the trust development process as a counterweight to the potential risks involved in different stages of inter-organisational relationships in Russia. The research specific objectives are to identify these risks, to explore the relationship between risks and trust in inter-organisational settings, and to outline preconditions and management efforts necessary for trust development. The initial results achieved at the first stage of this research provide an overview of most significant risks and those trust preconditions that are associated with positive changes in marginal trust.

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#### **USING HUMAN THERAPEUTIC DATA TO ASSESS POTENTIAL RISKS FROM PENTAERYTHRITOL TETRANITRATE AT CONTAMINATED SITES**

Pentaerythritol tetranitrate (PETN) is a percussive explosive once used therapeutically as a coronary vasodilator to treat angina pectoris. Its use as a pharmaceutical agent in the USA was discontinued in the mid-1990s, but it still is found as a contaminant at Superfund sites. In response to a request from the US EPA Office of Superfund Remediation and Technology Innovation, we

analyzed available data to develop a toxicity assessment for PETN. Reviews of available literature revealed several sources of human and animal data considered appropriate for evaluating toxicity following subchronic and chronic oral exposure. However, available animal studies reported effects only at doses more than two orders of magnitude higher than therapeutic doses at which angina patients reported side effects. Adverse patient responses to PETN were similar to those from other organic nitrates used as vasodilators, and generally were secondary to its therapeutic actions on the cardiovascular system. In a preliminary analysis, transient symptoms reported by treated patients suggested that the highest generally recommended clinical dose of 160 mg/day (~2.3 mg/kg-day) might be a NOAEL. However, vasodilation in people with normal blood pressure leads to dizziness, headache, and other consequences resulting from reduced arterial blood flow to the brain. Furthermore, more serious consequences could result in already hypotensive people exposed to PETN. We considered these potential consequences of vasodilatory effects in non-hypertensive humans to be adverse effects and, thus, concluded that the lowest therapeutic dose of 40 mg/day (~0.6 mg/kg-day) should be considered as a LOAEL, appropriate for use as the point of departure for deriving oral toxicity reference values.

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#### **MICROBIAL DOSE RESPONSE MODELING IN THE 21ST CENTURY: THE DEVELOPMENT OF MECHANISTIC DOSE RESPONSE MODELS**

Currently dose response models treat the internal host responses as a black box. As the field stands currently, the dose response relationship is evaluated using exposed dose, which does not directly account for in vivo biological response. This response can be as far ranging as the death of the animal or development of characteristic symptoms. It is known that different factors within a population, such as age, may affect the severity and progression of a disease in that host population. If these mechanisms or factors can be placed into a dose response model, the output will be a more descriptive and useful model of that pathogen's actions in the host. Work will be presented which will include: bulk fluid transport, deposition from bulk fluid and intracellular transport of pathogens in the respiratory tract. It is envisioned that the development of this physiologically based pathogen transport and kinetics (PBPTK) model, will be the first step in a series of models analogous to physiologically based pharmacokinetics (PBPK) models used in chemical toxicology for two decades now. It is known that different pathogens have different target sites in the body at which they initiate an infection focus, allowing for disease progression to occur. This knowledge will be included into dose response models, using the principles of bulk fluid transport, deposition and intracellular transport for *Bacillus anthracis* and *Neisseria meningitidis*, two very different bacterial pathogens with potentially high lethality. Again it is envisioned that these mechanistic additions to dose response models will affect the power, precision and descriptive quality of the dose response assessment.

**W3-H.4** Wenning RJ, Magar VS, Conder JM; rjwenning@environcorp.com  
ENVIRON

#### **FRAMEWORK FOR EVALUATING BENEFICIAL USE IMPAIRMENTS POSED BY CONTAMINATED SEDIMENTS**

Considerable efforts are underway in the U.S. and other countries to develop guidance addressing investigation and remediation of sediments containing hazardous substances. With few exceptions, there are no established, regulatory mandated sediment cleanup criteria for substances in freshwater or marine environments; hence, the focus on guidance on methods for evaluation,

assessment, and remediation. The few available guidance typically recommend use of screening levels to identify contamination and determine if response actions are warranted, even though what constitutes contamination has not been established on either a generic or site-specific basis. Departing from strict focus on the presence/absence of substances above ecotoxicological or health effect limits, more attention is turning to the linkage between sediment conditions and different beneficial use impairments. In the absence of a clear, transparent, and scientifically-sound evaluation process, decision-making with regard to mitigation and elimination of sediment conditions alleged to contribute to one or more use impairments could result in inaccurate and inappropriate conclusions as to sediment conditions that pose actual risks and merit response actions. This paper presents a framework for evaluating different use impairments, including particular details for evaluating impairments that have the potential to be affected by substances in sediment. The approach is proposed as a means to independently reach sound conclusions as to whether sediment conditions pose or imply resource impairments such that response actions (including detailed assessment and mitigation measures) may be required. The framework is intended to assist in decision-making for circumstances where the nature and distribution of substances in sediments are well characterized, as well as circumstances where data is limited. In the later case, the framework may be useful as a screening tool for preliminary evaluation and to identify data gaps that can be filled by focused site-specific investigation.

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#### **METHODS AND APPROACHES FOR EVALUATING CHEMICALS IN COMMERCE: USING SCIENCE TO MEET POLICY CHALLENGES**

Risk-based prioritization of commodity chemicals is an efficient means of evaluating large numbers of chemicals for potential impacts to health and the environment. Risk-based prioritization identifies critical information needs and helps regulators and the regulated community focus testing and risk management resources effectively and efficiently. To be of value, screening batteries must be able to differentiate chemicals based on their intrinsic properties. Discussing prioritization approaches is particularly timely. Under U.S. EPA's Chemical Assessment and Management Program (ChAMP), the agency will develop screening-level risk prioritizations and determine the potential need for additional risk management actions for the approximately 6,750 chemicals produced in or imported into the U.S. in quantities greater than 25,000 pounds annually, the vast majority of chemicals in commerce by volume. One input to ChAMP will be the information that industry is providing on more than 2,200 high production volume (HPV) chemicals through the HPV Challenge Program and its international companion program. The HPV Challenge employs the Screening Information Data Set (SIDS) developed by the member countries of the Organization for Economic Cooperation and Development (OECD) to develop a consistent baseline of screening-level information. This talk will present an industry perspective on different screening methods developed to prioritize commodity chemicals both in the U.S. and internationally, as well as a summary of recent literature on prioritization approaches. Several tools that can facilitate prioritization, including qualitative structure-activity relationships, chemical categories, and screening-level use and exposure information, will be considered. The talk will conclude with a discussion of opportunities and challenges with prioritization processes, including the need for clear communication when prioritization results are made publicly available.



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National Library of Medicine

### **RISK RELATED DATABASES AND OTHER RESOURCES FROM THE US NATIONAL LIBRARY OF MEDICINE (NLM)**

This presentation will begin with an overview of NLM databases and tools of relevance to toxicology and risk. NLM is among the world's largest purveyors of free scientific and technical information. The Toxicology and Environmental Health Information Program (TEHIP), established in 1967, provides an array of Web-based databases within and outside its TOXNET system, to help support the risk assessment process. Among these are TOXLINE, a bibliographic files of over 3 million references, and the 5000 chemical record, peer-reviewed, Hazardous Substances Data Bank (HSDB), as well as specialized databases in carcinogenesis, genetic toxicology, toxic releases to the environment, occupational safety and health, household products, dietary supplements, radiation event management, etc. Within the realm of risk assessment per se, TEHIP offers the U.S. EPA's Integrated Risk Information System (IRIS) and TERA's Integrated Toxicity for Risk Assessment (ITER) databases, is a partner in the Alliance for Risk Assessment, and will also be adding its Risk Information Exchange (RiskIE) to the TOXNET system in the near future. Other activities, including a new initiative to offer a portal to worldwide sources of information related to toxicology, risk assessment, and related areas, will be discussed. This World Library of Toxicology, Chemical Safety, and Environmental Health (WLT) will provide multi-lingual links to sources of information (governmental, non-governmental, academic, poison control centers, professional societies, databases, legislation, etc.) in toxicology and related disciplines. Produced by Country Correspondents from dozens of countries, the WLT also, provides links to multi-lateral organizations.

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### **DATA AND OBSERVATIONS FROM GERMANY**

The survey experimental study from Germany described here provides crucial scientific data related to understanding trust and risk perception of mobile communication technology by the general public in regards to the issue of precautionary measures towards both mobile phones and base stations. Contrary to the prevailing assumption that implementation of precautionary measures, or more precisely communicating or informing about taking such precautionary measures, will increase trust, alleviate fears, and reduce risk perceptions in the general public, previous studies indicated that the opposite effect may be observed. Various theoretical hypotheses can be posited to explain this countervailing effect which perhaps stems from an incongruity in the social amplification of the perceived risk as a result of trust issues towards those implementing the precautionary measure and the perceived need for them to implement it. To verify whether this effect holds true across larger sample sizes and across different cultures and countries, an international comparative study was performed in nine countries using a standardized survey instrument that, however, was culturally adapted. Stimulus texts in 20 different survey variants were randomly addressed by 400 respondents in Germany. Survey variables included the information about the level of precautionary measure, the basic intention behind implementing it, and the order of addressing base stations and mobile phones. Respondents rated their perceived risks and organizational trust. The implications of the German results and combined international results are not only important for improving the understanding of risk perception and risk communication, but may have significant ramifications for risk management.

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### **CHALLENGES FOR INSTITUTIONAL EDUCATION OF RISK COMMUNICATION FOR ORGANIZATIONS IN GERMANY**

In order for organizations to effectively manage their risk communication challenges, they must also identify and address their educational needs for this knowledge area. Companies or organizations that ignore or are not vigilant in their institutional education as part of an integral risk communication strategy do so at their own peril. Not only are there legal requirements in Germany for specific companies to have the capability to engage in risk communication with various stakeholders, but there are also compelling economic reasons for businesses to avoid risk communication failures that can lead to real crises for the company. Consequently, many organizations in Germany, from insurance companies to regulatory agencies, have recognized the need to engage in institutional education efforts of risk communication. We present a multi-step risk communication concept that has been developed and employed to assist organizations to self-evaluate their overall and issue-specific risk communication and education needs. A special challenge is that many organizations do not have dedicated risk communication departments or specialists on staff, but rather typically assign professionals with other, perhaps closely-related, specialty backgrounds or even managerial professionals to perform the organization's risk communication.

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### **TEN IDEAS TO IMPROVE REGULATORY OVERSIGHT**

Oversight of risk regulation through impact assessment and OMB/OIRA review has become the consensus among all US Presidents of both political parties over the last four decades. Yet it remains contested and can be improved. I offer 10 ways for the next President and Congress to improve the analytic and institutional features of regulatory oversight: (1) Create a regular (not ad hoc) mechanism for OIRA to prompt agencies to act when they are not acting, accompanying the existing OIRA review when agencies do act. (2) Adopt a principle of "warm analysis" emphasizing the full portfolio of important impacts. (3) Strengthen the system for interagency consultation on impact assessments (as in the European Union). (4) Replace current dollar thresholds for levels of analytic scrutiny with the principle of "proportionate level of analysis" (as in the EU). (5) Expand the scope of OIRA oversight to cover a broader set of actions, including not only health & environmental regulation but also trade measures, forest and resource management, international agreements, counterterrorism policies, et al. (6) Apply impact assessment to legislation (as in the EU), not just to agencies' implementing regulations. (7) Increase use of ex post impact assessment to revise policies and to improve ex ante impact assessment methods. (8) Create a Council of Risk Analysts to improve government evaluation of risks, ancillary effects, and extreme low-probability high-consequence catastrophic risks. (9) Give agencies a "superauthorization" (not supermandate) to consider the full portfolio of consequences, and economic incentive instruments, notwithstanding prior statutory restrictions. (10) Strengthen international cooperation and learning through US-EU cooperation, cross-country studies, and a new international Committee of Regulatory Oversight Chairs.

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### **VARIABILITY IN MODEL EVALUATION - A REVIEW OF EPA EXPOSURE MODELS**

The U.S. Environmental Protection Agency (EPA) relies on a number of models to estimate pollutant concentrations and human or ecological exposures for use in regulatory or research applications. In this presentation, we will provide an overview of historical or ongoing evaluation efforts for more than a dozen exposure models that have been developed or are currently supported by the EPA. Specifically, we will summarize the degree to which different types of EPA exposure models have been evaluated and peer reviewed, and discuss some of the limitations and challenges to evaluating these types of models. We will also present specific examples of approaches that have been used for model evaluation such as (1) comparing modeling results to those of other models, (2) comparing model predictions to measured (ambient monitoring) data, and (3) comparing estimated exposures (doses) to biomonitoring sampling data. A variety of exposure models will be covered including environmental exposure models, screening-level exposure models, and personal time-integrated exposure models. This presentation should serve as a useful resource to modelers and practitioners both within and outside the EPA who are interested in a better understanding about the extent to which commonly used exposure models have been evaluated. Disclaimer: The views expressed are those of the authors and do not reflect the policies of the U.S. EPA.

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### **SYMMETRICAL CHARACTERIZATION OF RISK - THE CASE OF NANOTECHNOLOGY**

In the NRC's report "Understanding Risk: Informing Decisions in a Democratic Society," the goal of risk characterization was redefined as an analytical/deliberative effort that increased the probability that stakeholders would accept the results of a risk assessment by ensuring that they were involved in its creation. Historically, risk characterization is viewed as the final phase of a risk assessment that integrates hazard identification, dose-response assessment and exposure assessment to arrive at a "safe" or "acceptable" level of exposure. However, nanotechnology and other technologies that offer the possibility of risk-reducing benefits, present a new challenge for characterization of risk. Because there may be a risk of consumers' failure to accept the new technology, particularly where the risk-reducing benefits exceed the risks that might be introduced, part of the challenge of getting consumers to accept the risk assessment will be to assess both risks and risk-reducing benefits on the same scale and in a way that is made understandable to consumers and risk managers. Because of the possibility of risk-reducing benefits offered by these technologies, the acceptability of risks is altered from the traditional approach of asymmetrically characterizing risks in isolation. This results was somewhat anticipated by the NAS report which listed as a principle that, where appropriate, risk characterization should address social and economic concerns. This paper will present a way to think about a risk/benefit model which will characterize the uncertainties associated with both introduction of nanotechnologies and the possibilities of the risk-reducing potential of those technologies. Finally, some attention will be paid as to how stakeholders can be effectively integrated into this process.

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### **SIMPLIFIED FRAMEWORK FOR MICROBIAL RISK ASSESSMENTS: A MULTIPLIER APPROACH**

Farm-to-table risk assessment models have traditionally tracked changes in pathogen prevalence and levels up to consumption, at which point a dose-response model is applied to the pathogen distribution to predict the number of human illnesses. The effect of uncertainty regarding the true parameterization of the model is incorporated using Monte Carlo simulation wherein random draws from the uncertainty distribution are used as input to the model. However, when uncertainty about multiple parameters is added to the model, combinations of multiple parameters can produce predictions of the number of illnesses that are either unlikely or impossible to observe. FSIS is investigating a new modeling framework where the number of human illnesses observed through public health surveillance is treated as data that inform the model, rather than being a model output. Estimation of model parameters is carried out using Markov-Chain Monte-Carlo techniques. This framework has a number of advantages over a traditional Farm-to-table approach. For example: • Information from outbreak investigations regarding the probability of illness given a person was exposed can be incorporated in the model as prior information. • New information is readily incorporated into the model using Bayes' theorem. • Variability and uncertainty of parameters are easily incorporated. • Constraining the model with the observed number of human illnesses prevents unrealistic combinations of input parameters. An overview of the modeling framework is provided and an example of its application with *Escherichia coli* O157:H7 in ground beef is presented.

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### **COMMUNICATING THE BENEFITS OF AN INTEGRATED RISK MANAGEMENT APPROACH: A MENTAL MODEL STUDY OF FARMER DECISION MAKING**

Integrated management approaches are believed to be necessary for preventing and managing agricultural risks that result from an over-reliance on one management approach (e.g., chemical use). However, anecdotal and case history evidence suggests that farmers' hold widely varying beliefs regarding the need for integrated approaches. Here we report an initial empirical investigation of how farmers make decisions about the management of risks related to weeds (i.e., risks to environmental health, human health, agricultural productivity, etc.). The long-term goal of this on-going study is to inform risk communication efforts designed to encourage greater adoption of integrated weed management approaches. In the research reported here, farmer decision-making processes were probed using a mental models research approach. The results indicate that, compared to the expert model, farmers were less likely to believe human activities contribute significantly to weed-related risks. Farmers also placed less importance on risks posed to the agroecosystem while focusing almost exclusively on economic risk. They were largely unable to identify any benefits associated with weeds. Finally, the preferred management strategies of farmers reflected some integration of techniques but a disinterest in prevention (a major tenet of an integrated approach). The initial analyses indicate that farmer decision-making for weed-related risk management is guided by several cognitive and motivational heuristics. These heuristics include loss aversion, an assumed inverse relationship between risk and benefit, and over-attributing negative outcomes to external factors (i.e., the fundamental attribution error). The actual use of these

heuristics is currently being assessed through a confirmatory survey with a representative sample of farmers from the upper Midwestern United States. Initial results from the survey will also be discussed.

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#### **COGNITIVE BARRIERS IN FLOOD RISK PERCEPTION AND MANAGEMENT: MENTAL MODELING**

The US Army Corps of Engineers is responsible for The Louisiana Coastal Protection and Restoration (LACPR) project and the Mississippi Coastal Improvement Program (MsCIP) initiated as a result of the devastation caused by hurricanes Katrina and Rita in 2005. These projects clearly reveal decision problems that challenge the analytical and deliberative processes that can be deployed to resolve them. This presentation will illustrate the needs to reveal and characterize people's intuitive theories about natural disaster risks, specifically in this case flood risks, using a mental modeling approach. The ultimate goal of the study is to characterize flood risk perception by experts across different organizational elements and disciplines within USACE and assess how it translates into formulating risk mitigation and response plans. This presentation will review of approaches available for visualizing mental models. It will introduce major schools of mental modeling (e.g., concept mapping, influence diagrams, etc.) and compare and contrast the strength and limitation of these methodologies. Practical applicability for the operational USACE programs and scientific rigor are used as the main assessment criteria. In-depth understanding of expert and stakeholder MM will enable USACE to bridge cross-cultural and cross-disciplinary differences, and develop approaches for dealing with floods as well as other emerging challenges.

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#### **DEVELOPING SHARED RISK ASSESSMENT RESOURCES: A REPOSITORY OF TOXICOLOGICAL DOSE-RESPONSE DATA AND ARRAYS OF AVAILABLE HEALTH EFFECT REFERENCE VALUES**

There has been an on-going dialogue established to coordinate efforts across multiple agencies within the US federal government (EPA, ATSDR, FDA, OSHA, and others) which use data from dose-response studies to develop human health risk assessments and associated reference values (RfCs, RfDs, MRLs, PELs). Other interested stakeholders that have been involved in these discussions include agencies from other nations, the National Libraries of Medicine, the Department of Homeland Security, the Department of Defense, as well as a number of organizations that develop risk assessments and/or support information management for risk assessments. This talk will highlight some of the efforts directed toward establishing a universally available repository of dose-response toxicological data, thereby providing a cost-effective method to fully use these critical data in risk assessments. Discussion will also cover how the health effect reference values developed by various organizations from these dose-response data - often for disparate applications - relate to one another, and what resources are being developed to help guide the selection of an appropriate reference value. Examples will be provided on how these types of collections of dose-response data and graphical arrays of information are being used in developing the Integrated Science Assessment documents for the National Ambient Air Quality Standards, Toxicological Reviews for the Integrated Risk Information System (IRIS), and on other recent activities to support various programs within and outside the EPA. [The views expressed in this abstract are those of the authors and do not necessarily reflect the views or policies of the U.S.

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#### **CUMULATIVE RISK ASSESSMENT: CONSIDERATIONS FOR QUANTIFYING THE RISK OF EXPOSURE TO MULTIPLE CHEMICALS AND STRESSORS.**

Given ubiquitous exposures to multi-source environmental contaminants, cumulative risk assessment (CRA) is an increasingly important tool to quantify risk. CRA includes an evaluation of health risks for multiple health endpoints from multi-route exposures to multiple chemicals and other stressors with a population focus and emphasis on stakeholder involvement. Important considerations for conducting CRAs include the following: environmental transformations of mixture component chemicals, assessment of joint toxic action, the potential integration of epidemiological data including biomonitoring data into CRAs, the use of strategies for grouping chemicals by exposure or toxicity, as well as development of methodological approaches for conducting risk characterizations. Other key components include the identification of initiating factors for a CRA and quantification of the potential impact of various vulnerability factors. Identifying populations susceptible to various exposures and health conditions, including exposure modifying behaviors (e.g., time activity patterns), diet and other lifestyle behaviors, are critical as they can directly impact exposure levels. The importance of different vulnerability factors, such as genetic variability, health and nutritional status, and access to health care, should be considered as they can impact an individual's susceptibility to disease and their ability to recover. Since socio-demographic factors, such as socio-economic status and group-level characteristics (e.g., community/neighborhood factors such as poverty or social deprivation), can modify the effects of cumulative exposures (i.e., statistical interaction/effect measure modification), these critical stressors need to be examined when quantifying risk to multiple environmental pollutants. These considerations should allow for better quantification of risk due to multi-route exposures to multiple chemicals and non-chemical stressors in CRAs.

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#### **INCORPORATION OF THE MECHANISM OF ABNORMAL PRION ACCUMULATION IN THE ASSESSMENT OF VARIANT CREUTZFELDT-JAKOB DISEASE RISK FROM DAILY BEEF CONSUMPTION**

Variant Creutzfeldt-Jakob disease (vCJD) is a fatal neurological disease in human and was first identified in Great Britain 1996. The development of vCJD is most likely due to exposure to infective agents of Bovine Spongiform Encephalopathy (BSE) cattle. BSE and vCJD are considered as caused by the accumulation of abnormal prion protein (PrP<sup>Res</sup>), which serve as a template to convert the norm prion (PrP<sup>n</sup>) to PrP<sup>Res</sup>. In order to protect the public from exposures to PrP<sup>Res</sup>, health risk assessment on vCJD from daily consumption of beef has been used a tool to set international trade policy of beef among the WTO member countries. The objective of this study was to incorporate the mechanism of PrP<sup>Res</sup> accumulation in human brain into the development of a mathematical model to assess vCJD risk from daily consumption of beef. The model was solved by assuming that the intake of beef containing PrP<sup>Res</sup> is a rare event and can be approximate to a Poisson process. In order to validate this model, the number of vCJD cases (172 cases) up to the end of 2007 of UK was used for modeling. Our results show that the mean number of vCJD cases is 209 cases and the upper bound of 95% CI is 394 cases, which comparable

to the mean number was 205 cases and the upper bound of 95% CI was 403 published by Valleron et al., 2001. These results demonstrate that the incorporation of the mechanism of PrPRes accumulation into mathematical model would definitely improve risk assessment and decision-making process to set international trade policy of beef.

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#### **COLLABORATION AND COMMUNICATION OF GLOBAL RISK ASSESSMENT INFORMATION**

With limited resources to keep up with a high demand for risk assessment products, it is critical that existing information is readily available and that risk assessors collaborate during the risk assessment process. Several global risk assessment tools are available to address these issues. First, the Alliance for Risk Assessment (ARA) is a collaboration of organizations dedicated to supporting public health protection by working together on projects to improve the process, efficiency, and quality of risk assessment. Second, the International Toxicity Estimates for Risk (ITER) is a free Internet database of chronic human health risk assessment data from organizations around the world for 620+ chemicals. ITER is available at [www.tera.org/iter](http://www.tera.org/iter) and on National Library of Medicine's TOXNET system (<http://toxnet.nlm.nih.gov/>). Finally, the Risk Information Exchange (RiskIE) is a free Internet database that contains notifications about a variety of human health risk assessment projects that are underway or recently completed. RiskIE is available at [http://www.allianceforrisk.org/ARA\\_tools.htm](http://www.allianceforrisk.org/ARA_tools.htm) and will join ITER on TOXNET. ITER and RiskIE provide risk assessors essential tools for easily identifying and comparing available human health risk data, for sharing in progress risk assessments, and for enhancing interaction among risk assessment groups to decrease duplication of effort. ITER and RiskIE were developed by Toxicology Excellence for Risk Assessment (TERA) and are also resources that support the mission of the ARA by tracking up-to-date information on risk assessment activities.

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#### **TRADE-OFFS BETWEEN BLOOD AVAILABILITY AND SAFETY ASSOCIATED WITH MALARIA ANTIBODY SCREENING AND DONOR DEFERRAL POLICIES**

Five cases of transfusion-transmitted malaria (TTM) have been reported in the United States in the past decade. The dominant risk of TTM is attributed to blood donors who may have been exposed to malaria during a visit or residence in malarious regions of the world. Current policy defers blood donations by travelers who have recently visited malaria endemic regions for 1 year and defers immigrants from those regions for 3 years. Donor deferral effectively reduces the risk of TTM, however, it also causes a loss of >100,000 donors each year. Antibody testing can be used to detect malaria infection in donors and has been implemented in the United Kingdom, France and Australia for donor screening in lieu of a year long deferral. We present a probabilistic model to evaluate the risks (TTM) and benefits (donor recovery) of using the malaria antibody test to screen all blood donors (scenario 1), currently deferrable donors (scenario 2), or donors currently deferrable because of travel to Mexico (scenario 3). The model consists of four modules, "at-risk populations", "blood donation", "donor deferral", and "antibody testing". The model considers donation rate, disease prevalence, probability of being asymptomatic when donating, efficiency of deferral, and sensitivity and specificity of malaria antibody testing. The model estimates that with

99% sensitivity and 99.98% specificity of antibody testing, scenarios 1 and 2 would reduce risk of TTM by ~50%, and recover ~110,000 donors each year. Scenario 3 would recover ~10,000 donors, while maintaining the blood supply at a level of safety comparable to the current deferral policy. This model has a user friendly interface. It provides a tool to inform risk management of TTM associated with the US blood supply, and also allows risk managers to modify inputs and assumptions for different risk management questions.

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#### **THE ROLE OF POSITIVE AFFECT IN MOTIVATING RISK INFORMATION SEEKING AND PROCESSING - A STUDY ON COMMUNICATION ABOUT CLINICAL TRIAL ENROLLMENT**

Low patient accrual in clinical trials poses serious concerns for the advancement of medical science in the United States. Past research has identified health communication as a crucial step in overcoming barriers to enrollment. However, few communication scholars have studied this problem from a socio-psychological perspective in order to understand what motivates people to look for or pay attention to information about clinical trial enrollment. This study applies the Risk Information Seeking and Processing (RISP) Model to this context of health decision making. By recognizing that clinical trial participation poses certain risks even though individual may benefit from the treatment, we view clinical trial participation as a proxy for risk. With data from a random digit dial telephone survey of 500 adults in the US, we used structural equation modeling technique to test the central part of the RISP model. Informed by the original proposition and recent development of the RISP model, we specifically examined the role of optimism, as a type of affective responses, in motivating information seeking and processing. Our results indicated that besides exerting an indirect influence on information seeking through motivating a need for more information, termed as information sufficiency threshold in the RISP model, optimism also directly influences information seeking and processing. Similarly, informational subjective norms, as another key component of the RISP model, also seem to have a more direct influence on information seeking and processing. These results suggest that communication researchers could apply the RISP model to study health decision making related to clinical trial enrollment. Our findings also render practical implications on how to improve communications about clinical trial enrollment.

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#### **MULTICRITERIA DECISION ANALYSIS, SPATIAL ANALYSIS AND LAND MANAGEMENT: DECERNS APPROACH**

Land use management problems, including allocation of land to new or different uses, land suitability analysis, habitat site selection, health care resource allocation, water resource management, contaminated site remediation and many others require implementation of both spatial data analysis and multicriteria analysis. Such problems involve consideration not only various risk and cost criteria and constraints, but also different ecological, technological, socioeconomic and other objectives and stakeholders interests along with alternatives appropriate for land use management and revitalization of contaminated or abandoned sites. Multicriteria decision analysis (MCDA) is at the core of approaches and site-specific decision support systems (DSS) for investigation of



indicated problems. Up-to-date approaches to spatial data collection, processing, analysis and presentation within investigation of environmental problems are based on implementation of GIS-technologies along with math models for examination of different scenarios and assessment of corresponding risk values and criteria under consideration. Approaches on implementation of all the main MCDA methods along with the basic and advanced GIS functions and math models within an original Web-based Spatial DSS DECERNS will be presented. Development of the DECERNS WebSDSS as well as corresponding case studies elaboration is carried out within the DECERNS project (IPP/ISTC #3549, www.decerns.com ).

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#### **MULTICRITERIA SPATIAL DECISION SUPPORT SYSTEM DECERNS WEBSDSS FOR RISK BASED LAND MANAGEMENT**

Decision-making support for selecting remediation options and various alternatives for land use management should take into account not only risk and cost criteria, but also different technological, ecological, geological and social objectives along with the stakeholders' interests. Spatial data processing, analysis and presentation within investigation of environmental problems are based on implementation of GIS-technologies along with the use of math models for examination of different scenarios and assessment of corresponding risk values and criteria under consideration. Original Web-based Spatial Decision Support System (software) DECERNS (DECERNS WebSDSS) has been developed for assistance in decision-making process when solving multicriteria problems with spatially distributed information/alternatives. This system is an MCDA-oriented SDSS with implementation of MAVT, MAUT, AHP, TOPSIS, PROMETHEE and some other multicriteria models, and with realization of the basic and advanced GIS-functions. Special tools allow extensive sensitivity analysis both for weight factors and partial value functions, and uncertainty analysis with the use of probabilistic methods in MAUT and fuzzy numbers in Fuzzy-MAVT and Fuzzy-PROMETHEE. The structure of DECERNS WebSDSS, features of integrating different MCDA methods, GIS-technologies and math models, and implementation within the case studies will be presented. This work is carried out within the DECERNS project (IPP/ISTC #3549, www.decerns.com ).

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#### **POLYCYCLIC AROMATIC HYDROCARBONS (PAHS) IN ROAD DUST IN BEIJING, CHINA: THE POTENTIAL RISK FOR ENVIRONMENT**

Researches have shown that polycyclic aromatic hydrocarbons (PAHs) cause cancers and non-cancer health effects to human. PAHs generated from vehicle emissions related to fast urbanization and motorization have been a major concern for human health in developing countries. The purpose of this research is to conduct an evaluation of the risk associated with PAHs in road dust in major roads in Beijing, and build a framework of properties of trace organic contaminations in road dust. Road dust was sampled monthly from April 2006 to July 2007. The samples were collected at the vehicle lane and sidewalk of a branch road (with low traffic volume), and the sidewalk, vehicle lane and bicycle lane of a trunk road (with a high traffic volume). The concentration of  $\Sigma 16$ PAHs in road dust of vehicle lane of Haidian Road (a branch road) was higher than that of vehicle lane of Chengfu Road (a trunk road). And the concentration of road dust PAHs of bicycle lane was higher than that of vehicle lane at Chengfu Road. The geometric means of road dust

PAHs of vehicle lane of Haidian Road, bicycle lane of Chengfu Road and vehicle lane of Chengfu Road were 6010.28, 6602.20 and 2294.66 ng/g respectively. At each sampling site, PAHs concentration in road dust was higher in spring/winter than in summer/autumn. Furthermore, PAHs were analyzed in different particle size fractions. The PAHs concentrations were in the same level in the fractions of 0-75 $\mu$ m (4305.29 ng/g) and 75-214 $\mu$ m (4048.47ng/g), which were two times of the PAHs concentration in the fraction of 214-750 $\mu$ m (2018.32ng/g). Finally, the risk of PAHs in road dust from various types of roads, as well as the temporal variation at one sampling site were analyzed.

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#### **RISK ASSESSMENT FOR OPERATOR PERFORMANCE IN COMPLEX SYSTEMS**

A method of modeling human operator performance in complex systems, which uses two-dimensional concept of a risk, when a hazardous event depends on both the likelihood of occurrence of the event, and the severity of its consequences, is presented. Along with other characteristics, it allows to conduct a detailed analysis of an operator's performance to observe the nature of his errors in the different stages of his control action: perception of a problem, motivation for solving it, the evaluation of variants of a solution; then, making a decision, and its implementation. It takes into account personal and social factors of the operator performance, his conscious and unconscious motives, as well as organizational and technical components. The method, which was implemented in the aviation domain for pilots and air traffic controllers, provides a deeper analysis of underlying factors, using the proposed frame descriptions for errors with logical, decision-making, and risk assessment algorithms.

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#### **TOWARD IMPROVED RISK COMMUNICATION ABOUT BSE: PERCEIVED RISKS OF DOMESTIC BEEF IN JAPAN BASED ON THE FINDINGS FROM A LARGE-SCALE FACE-TO-FACE INTERVIEW SURVEY**

On September 2001, the first case of BSE infected cow was found in Japan. Due to fear of the links between BSE and vCJD and the uncertainty still left about the mechanism, its impact to Japanese public was large and significant at that time. Since then, various measures have been taken to minimize the BSE risk of domestic beef. Recently, based on the risk assessment by the Food Safety Commission, the Japanese governmental risk assessment agency, the government decided to cease its funding for BSE testing for cows under 21-month-old. Using stratified random sampling method, 3,000 adults across the country were selected, and 2,008 of them answered the questionnaire. The questionnaire asked their perception toward the safety of domestic beef, the degree of their knowledge about the current Japanese BSE policy, and their opinions about the change in the government funding for BSE test. Then, after explaining about the risk of BSE and the results of risk assessment which the change in government funding for BSE testing was based on were presented to the interviewees, they were asked about their opinions toward the change in the government funding again. Their answers before and after the explanation were compared. It is found that people who understood certain points of explanation, such as "the risk of getting vCJD by eating domestic beef is very low," were more likely to change their opinion toward the government's decision to change the government funding for BSE testing than others such as "the use of meat-and-bone feed are prohibited in order to prevent cows from infecting with BSE." The

findings give us some insights about how we could better communicate with the public about the BSE risks. The web-based survey was also conducted using the same questionnaire and the results were compared to determine the usefulness of and issues with the web-based survey method for future use.

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#### **DATA AND DECISION ANALYSIS IN THE CONTEXT OF VAPOR INTRUSION**

Vapor intrusion challenges investigators in determining whether volatile contaminants in subsurface soil and groundwater can migrate to indoor air at levels of concern. Approaching the problem from either direction can yield inconclusive results. For example, starting with a measured pattern of contamination in groundwater, models such as the Johnson and Ettinger algorithms can be applied to predict chemical concentrations in indoor air in buildings above the contaminated area. In this case, health protective biases demand assumption of a high level of vapor transport to account for preferred migration pathways that have been observed empirically in some situations, and concentrations in indoor air predicted to exceed target risk levels. At the alternative extreme, indoor air quality can be monitored directly. This approach typically detects any number of indoor contaminants, but there is no way to know for certain if those contaminants are due to vapor intrusion. Many contaminants are ubiquitous in air, and there are many potential sources within buildings. Thus, distinguishing vapor intrusion from background can be difficult. Due to the shortcomings of each extreme, an integrated approach typically involves developing a conceptual site model of the cause-and-effect mechanisms whereby vapor intrusion could occur, thus heuristically establishing the transport pathways that relate contaminants in subsurface soil and groundwater to their presence in indoor air. Multi-media sampling is undertaken to confirm and determine the completeness and strength of the transport pathways. The combined, integrated sampling of groundwater, soil, soil-gas (both sub-slab and near contaminant sources), and indoor air, as well as observed variables such as the integrity of floors and the presence of sumps or other preferred flow conduits, leads investigators to consider multiple lines of evidence necessary to evaluate vapor intrusion. The key to successfully tackling vapor intrusion involves careful, balanced decision-making to capture sufficient and compelling data.

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#### **USE OF QALY FOR RISK- BENEFIT ANALYSIS FOR FISH CONSUMPTION IN JAPAN**

There are increasing debates about fish consumption for its health benefit and risk. Recommendations on fish consumption are issued in many countries for women of childbearing age to modify fish consumption, however, nutritional benefits encourage people to increase their fish consumption. Therefore, how to integrate the impacts of fish consumption becomes research issue, especially for risk and benefit related with different endpoints. A common metric based on the quality-adjusted life-year (QALY) method has been used to aggregate the impacts of hypothetical shifts in fish consumption for Japanese population. The hypothetical shifts in fish consumption are designed to reflect various actions following the government recommendation on fish consumption. Then n-3 polyunsaturated fatty acid (PUFA) intake and hair mercury (Hg) are estimated for each change pattern. Risk and benefit are analyzed in terms of PUFA-related benefits on cardiovascular system (CHD mortality, stroke mortality and morbidity) and MeHg-related risk on fetal neuronal development (IQ loss or gain). Results illustrate that women decrease their fish

consumption can gain positive net health benefit. However, if all other adults also reduce (mistakenly and inappropriately) their fish consumption, the total public health benefit will go to negative. The best net health benefit yields when substitution of fish containing high MeHg with fish containing less MeHg among women of childbearing age and increment of fish consumption among other adults. This study is to provide a quantitative risk-benefit analysis for changes in fish consumption among Japanese population, which will help risk managers to improve their efforts to aid public health.

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#### **PROBABILISTIC RISK ASSESSMENT FOR POLYCYCLIC AROMATIC HYDRO-CARBONS (PAHS) IN ROAD RUNOFF IN BEIJING, CHINA**

Pollutant loading from storm runoff has been considered to be an important component of non-point source pollution in urban areas. Researches have shown that the levels of toxicity in storm runoff may be unacceptable for aquatic life. In China, due to the accelerated urbanization and motorization over the past decades, storm runoff pollution has become a health threat to aquatic organisms. The primary objective of this study is to conduct a probabilistic risk assessment for the toxic effects of polycyclic aromatic hydrocarbons (PAHs) contamination in road runoff in Beijing, China. In 2006 and 2007, the concentrations of sixteen parent PAHs were measured in road runoff in a composite commercial and residential catchment of Beijing. A probabilistic risk assessment of the toxic effects of road runoff on aquatic organisms was conducted. The factors affecting the occurrence and magnitude of toxicity were analyzed. It was found that storm characteristics such as the antecedent period have significant effects on toxicity. Furthermore, an analysis of the variation of runoff toxicity among various types of roads, as well as the temporal variation in a runoff event, was performed. Finally, suggestions were provided on how to develop a risk-based decision framework to help the authority to set regulatory standards to protect aquatic ecological systems.

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#### **PREDICTORS OF HETEROGENEITY IN AIRCRAFT EMISSIONS OF AIR TOXICS ASSOCIATED WITH INDIVIDUAL AND POPULATION CANCER RISKS**

Airports represent a complex source type of increasing importance that may contribute appreciably to air toxics risks. Given the increasing interest among community groups and other stakeholders in including air toxics risks when considering the marginal contribution of airports or proposed airport expansions to health risks, it would be valuable to be able to predict the exposure and health risk of emissions or emissions changes at an airport, both from an individual and a population perspective. In this study, we apply a high-resolution atmospheric dispersion model (AERMOD) to a sample of 33 airports, including small and large airports in urban and rural settings across the U.S.. We estimate the emission rates required at these airports to exceed a specified individual risk threshold (i.e., 10<sup>-6</sup> for the lifetime cancer risk for the maximally exposed individual), and we additionally calculate the total population risk to determine whether prioritization based on maximum individual exposure and risk would correspond with that based on total population exposure and risk. Furthermore, we develop models to explain the heterogeneity in these emission rates across airports, based on meteorological and population data. We focus on air toxics with different chemical characteristics-benzene, 1,3-butadiene, and particle-bound PAHs. We apply AERMOD and estimate incremental concentrations from airports at the centroids of census tracts or

block groups within 50 km. Our findings indicate that the minimum emissions threshold varies significantly across airports and that optimization based on individual exposure and risk thresholds will differ from optimization based on total population exposure and risk. These results provides a method to quickly but reasonably determine the likelihood of public health impacts of concern for airport modifications or expansions, and can be expanded to include non-cancer or criteria pollutant effects in future assessments.

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#### **MODELING SECRECY AND DECEPTION IN A MULTIPLE-PERIOD ATTACKER-DEFENDER SIGNALING GAME**

In this paper, we apply game theory to model strategies of secrecy and deception in a multiple-period attacker-defender resource-allocation and signaling game with incomplete information. At each period, we allow one of the three possible types of defender signals—truthful disclosure, secrecy, and deception. We also allow two types of information updating—the attacker updates his knowledge about the defender type after observing the defender’s signals, and after observing the result of a contest if one occurs in any given time period. Although our model is not generally analytically tractable due to its complexity, some special cases of our model are readily solvable using numerical methods. Our model provides insights into the balance between capital and expense for defensive investments, and shows how defenders can achieve more cost-effective security through secrecy and deception in a multiple-period game.

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#### **MEASURES OF CRITICAL INFRASTRUCTURE DENSITY AROUND VULNERABLE FACILITIES**

Public and private decision-makers continue to seek risk-based approaches to allocate funds to secure facilities that are potentially vulnerable to terrorist attacks. A potentially important input into decisions about allocating funds for security is the density of critical infrastructure systems around facilities that are potential targets of attack. A terrorist attack on a vulnerable facility located in the vicinity of a critical infrastructure system could disable that system, producing cascading impacts on other infrastructure systems and the economy, which has important implications for emergency management and response. To illustrate this approach, approximately 180 potentially vulnerable targets have been analyzed relative to the infrastructure that is around them in the state of California. Geographic Information Systems (GIS) were first used to visualize spatial clustering of facilities and to estimate distances between the vulnerable facilities and the infrastructure systems of interest. The infrastructure systems included in the analyses are dams, rail and light-rail stations, airports, ports, highways and others. Infrastructure density measures around these facilities were developed using smoothing methods based on a log-linear local likelihood density estimator. This density estimator approximates the log-density locally with a straight line, and can be used to estimate the probability of infrastructure occurring within any specified distance of the vulnerable facility. The results show that this methodology can be used as an input to resource allocation policies.

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